Community Energy London

Solar PV guidance

Lorraine Haskell

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Should groups have any comments on this guidance they should email directors@communityenergy.london

Contents

1. Introduction

This guidance is for community energy groups looking to deliver a solar PV project in London. It should be read in conjunction with the Step by Step Project Guide found on the CEL website, which sets out the various stages to delivering a project from start to finish.

This guidance on solar PV is full of information, tips, and tools groups can use to help them progress their projects. This guidance is not exhaustive but should give groups a good basis for their projects.

A list of contractors that groups have worked with before can also be found on the CEL website, to help groups when procuring various services.

The government's introduction of the Feed in Tariffs (FITs) policy in 2010 helped kickstart much of the initial activities by groups, with solar PV being the primary choice of technology. The closure of the FITs programme in 2019 has meant that groups have had to become more innovative, to make solar PV projects viable. Groups are encouraged to read this guidance in full to understand the complexities of delivering a viable solar PV project.

The advantages of a solar PV project:

- Solar PV is an established technology
- It can help reduce the energy bills of site owners and allow them to become more self sufficient
- There should be some financial return for the group
- It will reduce the building's carbon emissions by using the generated energy over energy from the grid
- Solar PV is low maintenance
- Solar PV has a long life - typically around 25 years
- There is the potential to store surplus electricity in a battery.

The disadvantages:

- The efficiency of solar PV can be low compared to other renewable sources of energy. Energy from the sun can only be generated during daylight hours
- Finding available and suitable roofs in London can be a challenge
- A lot of buildings in London have shading. Even where there is no shading, new developments built after the installation can cause over-shading which can impact the generation of the solar PV system
- Some people consider solar PV panels to be unsightly.

2. Suitable sites

Optimum conditions for solar PV are:

- A south facing site – this will provide the greatest amount of sunlight on your solar panels over the day maximising generation output, although east west facing can work too.
- No shading - structures such as chimney stacks can reduce the output of solar panels significantly as they will tend to throw shade on the panels for most of the day. Further away objects such as trees or a neighbouring building may not block the sun during summer but create shade when the sun is lower in the sky in winter.
- Pitched at 30 - 40 degrees - if installed on a flat roof, panels can be installed on a frame.

(Installers can advise on devices that will help the efficiency of panels when they are not installed in optimum conditions).

Solar panels are normally around 1m x 1.65m in size. As a general rule of thumb, around 6,000-8,000m^2 of sloping roof space is required per megawatt of capacity installed (MWp). A flat rooftop will accommodate less capacity, as spacing must be left in between each row of panels to avoid self-shading. For more on this see BRE's guidance.

On average, panels weigh about 18kg each. You will need a structurally sound roof and likely a structural survey (this may also be required for insurance purposes). If a building is getting a new roof then consider installing solar panels (possibly integrated) or solar tiles at the same time to reduce costs. Solar panels on a flat roof should be secured by ballasting as drilling into a flat roof may risk causing leaks. To make sure there is enough ballasting the solar installer will need to carry out a wind load calculation. For more on wind loads, see BRE's guidance above.

Consider the electrics and cable runs. You need to be able to connect the solar panels to the electricity supply of the building. Long and complicated cable runs will be more costly and there will be more energy loss.

Consider: leisure centres/gyms, schools and universities, care homes, warehouses, offices, hotels, supermarkets and retailers, churches and mosques, GP practices.

Once you have found suitable roofs, arrange to meet site owners/ managers. Find out:

- How long is any lease in place for?
- What is the site currently paying for electricity?

- Can you get a copy of the energy bills and/or half hourly metered electricity data to calculate future savings? Aim for buildings on electricity tariffs of >11p/kWh and high onsite usage of >80%.
- Has a PV project been tried before and is there support for the project?
- Are there any existing feasibility studies to build on?
- Can you get physical and legal access to the site to deliver, erect and maintain the solar PV system, like scaffolding for example? Barriers to roof access will increase installation and ongoing maintenance costs.
- Are there any other obvious crucial barriers e.g. land/building lease restrictions, building conservation issues etc.
- Who owns the building? Can they make a decision on the project?

Buildings which have high onsite electricity usage, and pay a high amount for electricity are best for solar PV projects.

Once you have found a site you will need to secure it. A key challenge includes the complexity and costs associated with putting in place such a legal agreement, which involves risk for the site owner over a period of many years. Pure Leapfrog explains the various legal documents that might be required.

Site owners/ managers will need to set aside time for site meetings and visits, they should be made aware of this in advance and be happy to do so.

Additional support:

- Find suitable roofs by looking at satellite aerial photos/ Google maps, and the GLA's London Solar Map. Check out Forum for the Future's tool 'Power Paired' to identify potential interested sites, or contact your local council for an idea of what buildings might be attainable and likely to get planning permission.
- Schools Energy Coop have created a template roof license, and CREW Energy a template MOU, they would both be happy to talk to other groups about. Find details of groups on the CEL website.

3. Feasibility

When finding a suitable site for solar PV, groups will also need to complete an initial feasibility study to work out:

- the size of the array that could be installed,
- the capital involved with delivering the project,
- and the energy and income that will be generated.

An installer or project developer can help you with this. Alternatively, groups can use the London Solar Map and the Energy Saving Trust's solar calculator to give them an approximate idea of how much energy might be produced and exported.

Once the site has been found and secured, a full feasibility study will usually need to be undertaken before applying for planning, grid connection and securing capital funding.

At this point groups should consider and create a balance sheet of all costs and all potential income to work out if the project is actually viable.

Costs: Consider all costs, make sure these are as accurate as possible and include: feasibility studies, community consultation, project development, architect's drawings, structural surveys, planning, the equipment and installation, roof work, grid connection and commissioning, ongoing maintenance and replacing parts, operational costs such as ground rent and insurance, community fund payments (if applicable), and any other expenditures involved.

Include for repaying loans, return to investors etc if applicable.

Groups can find out more about the different types of insurance for community energy projects here.

Income: Consider how much of the electricity generated by the PV will be used on-site, and how much is likely to be exported back to the grid to work out project revenue.

There are two main forms of income for solar PV systems:

1. Income from the electricity generated and sold to the site owner.
2. Income from exporting the energy generated but not used back to the grid, paid for by an energy supplier.

For the site owner, there will be savings to be made through buying the onsite PV generated electricity at a cheaper unit price.

It is best to use as much of the power generated on site, to get as much revenue as possible from selling the generated electricity to the site owner. This is because the price you get for exporting the electricity generated is less than the cost of selling the power produced.

If at this stage the project looks unviable it must be stopped or re-designed to reduce cost or boost income. One way in which this can be done is to look at the impact of changing the size of the scheme.

Additional support:

- A number of CEL members have extensive experience on solar roof feasibility – do discuss your projects with them.
- CEL has a detailed post-FiT financial model, created by Andre Pinho of Brixton Energy in 2019. This is available to all groups and is an excellent starting point.

3.1 Calculating performance and consumption

It is helpful to work out the annual, monthly, daily and half hourly generation of the solar PV system in working out the viability of a project.

Solar generation:

1. By using the MCS installer standards and irradiance sets for solar PV, the amount of electricity generated per year in kWh can be determined. To do this the size of the solar PV system in kWp, panel orientation and pitch, and the shading factor need to be known.
2. The Met Office's historical record for Heathrow can be used to calculate monthly generation. Take the sun hours for months 1 – 12, add these up, and calculate the percentage of sun hours each month. Then take the annual kWh and multiply this by each %, to work out the kWh figure for each month. Alternatively, monthly generation can be estimated by using such tools as Sheffield pvprofiler and the Solcast API toolkit.
3. To work out daily generation, take the monthly estimates and divide these by the number of days in the month.
4. Half hourly expected generation is finally worked out by taking the daily generation and dividing this by each half hour of daylight for that day. Find daylight hours for each month here.

Usage profile: If possible, get the site's electricity consumption data, preferably kWh used every half hour, which by comparing this to solar generation will provide an indication of how much of the energy generated by the PV will be consumed onsite for every half hour.

Energy loggers can be used to record the electricity consumed by the site before and after solar. These cost £60 upwards.

Carbon savings: Groups can convert generation (measured in kWh) to carbon savings by using the Rensmart calculator. CEL has more on calculating carbon savings in its Monitoring and Evaluation toolbox found on its website.

3.2 Maximising the value of electricity generated

Once the group has worked out the amount of electricity generated per half hour, and the onsite consumption, it can then look at revenue, and from this project viability.

Power Purchase Agreements (PPA): Groups should aim to sell the PV power generated to the site owner at a fixed rate which is below the tariff the owner would otherwise buy electricity from the grid. This is known as an onsite PPA. The term of an onsite solar PPA is typically 25 years but can be any length which best suits the group. The group will also be responsible for the ongoing operation and maintenance of the system for the duration of the agreement.

Onsite PPAs provide for a secure long-term guaranteed income stream for the project, as well as a fixed price for the site-owner lower than that offered in the market. The PPA could rise in line with inflation (RPI), or if this is too onerous, groups can factor in review periods every 5 years to negotiate the new cost of the PPA.

At the end of the contract term, the PPA might be extended, the system removed, or the system given or sold to the site owner.

Should a site owner move premises, the PPA should be transferred to the new owners of the building.

There are other PPA models out there however, these are often more complex models bearing more costs and risk.

Additional support:

- SE24 and Schools Energy Coop are both happy to talk about their PPA agreements and share advice with groups.

The Smart Export Guarantee (SEG): The SEG is a government incentive, paid by certain energy suppliers, to those with a solar PV system up to 5MW for power exported back to the grid. Groups may sell any electricity generated surplus to the site's needs back to the grid, as long as they have an export meter. How much groups can make from the SEG depends on:

- how much electricity is exported to the grid,
- the export tariff rate agreed with the energy supplier.

SEG income is typically not enough to make a project feasible currently, but can boost income.

Before signing up for the SEG, groups should shop around and compare tariffs that suppliers are offering.

Longer SEG contracts will provide groups with stability and help them forecast long term income more easily, however, a longer contract will not necessarily guarantee more income for the group.
Groups do not have to receive the SEG from the same energy supplier who provides the building with electricity, and they can switch suppliers at any point if they find a better deal.
It may not be quick and straightforward to sign up for the SEG if the site has a Meter Operator (MOP) contract in place. A MOP contract is a legal requirement for all half hourly electricity supplied meters.

Solar Energy UK holds a table of current tariffs offered by different suppliers.

As a general rule of thumb:

- With FITs no longer available, projects need to aim for a site that will use more than 80% of the electricity generated by the solar PV system (unless you are getting grant funding) to be financially viable.
- Aim to sell electricity generated to the site owner for about 10% less than their existing energy supplier tariff.
- The bigger the PV installations the better the return on investment.
- When working with an installer, ensure any quote includes a written estimate of predicted generation from the PV system. Get quotes from several installers.
- It can be difficult to carry out modelling when data is incomplete. In these cases groups will need to make good assumptions.
- Should the distribution network operator (DNO) want to charge to upgrade the grid (see below), then this cost is likely to make the project unfeasible.

Additional support:

- Andre PInho's post-FiT financial model might prove a useful tool for groups when working out feasibility, though is not intended to be relied upon by users in making any investment decisions.
- Easy PV and OpenSolar are some other online tools groups can use.
- Repowering London, CREW Energy and most of the more established groups already have financial and feasibility models that they would be happy to talk about, or possibly share.

4. Planning

Solar PV installations of up to 1 MW usually fall under permitted development rights which allow the installation of solar PV without the need for planning permission. Permitted developments will still need to observe a number of conditions and limits, as set out on the Planning Portal website. Where an installation falls outside of this criteria, planning permission will need to be obtained.

Listed buildings, historic buildings or buildings in designated areas such as Sites of Special Scientific Interest (SSSI), Areas of Outstanding Natural Beauty (AONB) and National Parks are likely to have planning restrictions associated with them. Development in these areas will require additional consultation and will likely require more detailed background information to be supplied as part of the planning process.

Some London planning authorities have published Planning Policy Guidance on renewable energy systems, which may cover solar PV. Such guidance, if it is in place, should be checked ahead of any feasibility study and planning application. In addition, many planning departments welcome early informal discussions with solar energy developers about their plans.
Groups should check if any plans of the roof or drawings of the building already exist. You may need: site plan, roof plan, elevations, cabling detail and possibly pictures of the local area. For historic buildings you may need to write about the history of the building, its significance and the impact of solar and how you have improved the efficiency of the building in other ways. Your local building control may have some of these.

If other solar PV projects have already been proposed, or built in the area, the local authority website will contain details of these planning applications, the objections and any restrictions. These can be a valuable source of local information and can help to identify where there may be serious planning barriers.

If planning is rejected, consider if it is worth appealing.

5. Grid connection

Check if the building is on a single phase network, or a three phase network (usually larger and commercially used buildings). You can connect up to 16A (3.68kW) on each phase, notifying the local DNO at the point of commissioning, in accordance with the G98 connection guide.

However, if you need to connect more power to each phase then the installer will need to obtain permission from the local DNO to connect to the grid before installation, in accordance with the G99 connection guide. There may be a need for the local grid to be upgraded, and if so it is up to the DNO to determine how much this will cost. Alternatively, applications to the DNO may be capped or rejected. Further information on connecting to the local electricity distribution grid can be found on UK Power Networks (UKPN) community energy website. PV installers are familiar with these connection issues, and will guide group’s through the connection process.

Where a project is installed on multiple dwellings at the same time, a G98 Application Form must be submitted to the DNO in advance of installation.

At present, the electricity generated by a solar PV project on a block of flats will typically go to the communal areas and not the individual flats, with the exception of some innovation projects.

In some cases, if it can be shown through the calculations completed at feasibility stage that all the electricity will be used on site, then the DNO's 'connection cost' will be £0.

6. Operations and maintenance

Usually the group will be responsible for the operation and maintenance of the array for the length of time agreed in legal documents.

Additional support:

- Wrike, and even Google and Trello, can be used for project management.
- Xero and Quickbooks can be used for accounting.

Monitoring: All solar PV systems come with an electricity generation meter. Groups will also want to install an export meter to help determine the electricity exported and consumed on site, which they can then use to charge the site owner.

Monitoring generation using software like Orsis, is also essential. This way groups and site owners can record 'historical' data, learn to use electricity in the building more efficiently, and monitor how the solar PV system is working. Low output might indicate a technical problem and this in turn will reduce income, leading to reduced financial returns.

In addition, groups can install an energy display to show visitors the amount of energy generated and CO_2 saved. This can help encourage behaviour change in building users.

System degradation will be difficult to factor in before the project but will have an impact on performance over time.

Some sort of monitoring and regular feedback may be required by your funder, to make sure the project is achieving its outcome and having the desired impact. See CEL's Monitoring and Evaluation toolbox for further information on this aspect.

Reviewing data can help assess the success of the project and decide what changes should be made to it, if any. Groups may revisit this from time to time as communities change and evolve.

Finances: The group should make sure they apply for any applicable support mechanisms by any associated deadlines, like the SEG for example.

Proper management will need to be in place for the lifetime of the project to oversee spending and the process of collecting and distributing income, and managing liabilities. Groups need to pay back fixed costs such as interest and loan repayments, O&M contract costs and land rent before distributing the remaining income to shareholders, if applicable.

Alternatively, groups may choose to work with an organisation who can manage the operation side of the project for them, like Energy4All.
Maintenance: For domestic sized solar PV installations you need virtually no maintenance and systems are estimated to last 25 years. However, for all systems, you may need to replace the inverter within the lifetime of the system. A flat roof may also need to be re-covered at least once within the lifetime of the system.

Other than this, groups or site owners can maintain solar panels themselves by removing leaves and debris from panels, and rinsing panels down with a hose to remove dust and dirt (air pollution in urban areas is a particular problem) which reduces the generation and efficiency of panels. Avoid sponging down or touching panels.

Have panels serviced every year or so by the installer or by another certified service provider. However, do check the terms of any warranties before you do so, to make sure you will not make it void. Groups may decide to put a maintenance agreement in place with an installer.

BRE has some information on solar PV and fires, which groups should ensure they are familiar with.

7. Decommissioning

PV Cycle is a take back and recycling scheme for PV panels, providing full compliance services under the Waste Electrical and Electronic Equipment (WEEE) Directive for the UK. Much of a silicon-based PV panel can be recycled.

8. Equipment

When reviewing different PV panels, you should consider: efficiency, power tolerance (how much your system can deviate from its stated power), size, weight, length of product warranty and performance warranty, and wind load.

Monocrystalline panels are currently the most efficient amongst the commercially used panels, but also the most expensive. The efficiency of these panels is normally 15-20%. The other type of crystalline panel is polycrystalline. Other types of panels, like thin film based, are becoming more commercialised.
Panels can come in blue or black and can be integrated into roofs. These are well suited for buildings where aesthetics are important such as listed buildings.

8.1 Related products

Through the installation of certain products you may be able to increase performance and revenue. In other cases, some installers may offer additional products. Some of these are covered below to help groups navigate this area.

Batteries: Batteries store any surplus electricity that is generated during the day but not used at the time, so it can be used later on. Maximising the amount of electricity used and sold on site will increase the project's financial viability. Stored energy in a battery may also be used to charge an electric vehicle (EV). Battery costs remain high, so study this option carefully in relation to your project finances, however, prices are falling and this may be a technology that groups can fit alongside solar PV or retrofit into projects over the coming years.

Using the solar generated electricity to charge the batteries of EVs is a great way to reduce export and to have an additional income stream. EVs can also play an important role in smoothing out the peaks of sunny days and can discharge their power back to site when electricity prices are higher.

Solar switching devices: These divert excess solar electricity to an immersion or water tank to heat water. Savings will vary, depending on how much 'surplus' energy is diverted, what fuel is being displaced that would otherwise be used to heat the water (i.e. predominantly gas in London) and how the hot water is used. These devices might not be suitable if there is no water tank, immersion or store of water to heat.

Voltage optimisers: These are designed to reduce the electricity voltage coming into the building to around 220V. It is claimed that this voltage reduction leads to a reduced energy consumption and in turn lower electricity bills, and a longer life for appliances. However, a 10% reduction in voltage does not automatically mean a 10% reduction in electricity usage (or a 10% reduction on the energy bill). Furthermore, not all appliances will use less electricity when voltage is lower. Appliances with a heating element (such as kettles and electric ovens) might even consume less power with a Voltage Optimiser, but also produce less heat or take longer to boil, so you will end up using the same amount of kWhs anyway.

Power optimisers: These allow each panel to operate independently maximising the performance of each individual panel and increasing overall system yield. They help mitigate the effects of shading, they give a small increase in performance by dealing with module mismatch where panel power ratings differ, and also minimise the effects of debris and dirt on panels. However, these need to be paired with particular inverters, can be expensive and are not always necessary.

Microinverters: Solar PV systems typically use string inverters. However, micro inverters can be used instead and are connected under each solar panel. These can help address issues with shading or where panels face multiple angles. However, as you need one for each panel costs will be more, and when one goes wrong working out which one it is can be complicated.

9. Case studies and advice for different types of buildings

9.1 Schools case study

Morpeth School, Bethnal Green: Power Up North London (PUNL) installed a 126kWp solar PV system on Morpeth School. Funds were raised through grants from the local council, Tower Hamlets, and Salix Finance. PUNL analysed historical electricity consumption data which indicated a Monday to Friday daytime hourly base load of 150-200kWh during term times, 100kWh during holidays and 60-100kWh at weekends, plenty of scope for PV. The project saves 25 tonnes of CO_2 a year.

Ealing schools: Ealing Transition, Ealing Council and the Schools' Energy Co-operative have been working together to put solar PV on local schools. Ealing Transition members provided the funds for the panels, and have been reported to be getting a 4.5% return on their investment. By December 2019, there were a total of 12 schools and 2 children's centres in Ealing that had benefited from the programme. These sites support a total solar PV generating capacity of 389 kWp, reduce the schools' electricity bills and carbon footprints, and demonstrate that a decentralised, fossil-fuel free energy system is possible.

Advice for projects on schools:

- Solar PV on a school can be an effective way to reduce electricity bills and to reduce CO_2 emissions. It can also be a great way to engage school children and parents in learning about energy and climate change, support environmental behaviour change and can be tied into the curriculum.
- School PV projects are however challenging and do not always proceed to completion. Key to success is finding a 'way in' to the decision makers at the outset of the project i.e. head teacher, school governors, bursar, business manager etc, The way in may be through the Parents Teachers Friends Association (PTFA), a local councilor, a parent, or by approaching the head or the trustees etc. If you are already working with a school then ask them to introduce you to others.
- Different types of schools often need a different approach of engagement and decision-making. It can sometimes be easier to get an agreement from Academies rather than council-maintained schools, due to the levels of 'sign off' required. Councils should have a strong motivation to decarbonise school buildings, as schools typically contribute a significant element of their overall estate carbon-impact.
- Working with faith schools has proved very challenging in terms of sign off from the diocese, which can take months and even years.

- Consider when you can get access for the installation. You may only be able to carry out work on site after 4pm or in school holidays. It can be a long process in organising work-on-site with health and safety a particularly critical issue.
- Schools will not use as much energy out of school hours, you will have to make assumptions on energy consumption for these times when working out project feasibility.

9.2 Churches case study

Walworth Methodist Church, Southwark: SE24 installed a 50kWp solar PV system on Walworth Methodist Church. This project was grant-funded with an LCEF grant covering the research and feasibility costs; and the British Airways Carbon Fund covering the capital and installation costs. Walworth Methodist Church has a large, active congregation and the associated buildings are used extensively by a wide variety of organisations. The community benefit fund created from the revenue of this project is used to tackle fuel poverty and increase awareness of climate change in the local area.

Advice for projects on places of worship

- Projects on places of worship can help bring about behavioural changes amongst congregations, and contribute towards the church's environmental objectives.
- Unless used for other community purposes, places of worship tend to use very little electricity. Look for one with community groups going there for classes.
- Consumption data can be difficult to understand due to the sometimes infrequent use of the premises. Electrical testing tools, like clamp meters, can be used to understand the consumption profile of a building, to help groups work out feasibility.
- Charitable foundations, particularly places of worship, can have complex trustee arrangements that can complicate and slow down agreement of legal contracts. Churches will require sign off from the diocese for example, which can take months and even years.

9.3 Community buildings case study

Westway Sports Centre: North Kensington Community Energy, part of Repowering, installed a 138kWp solar PV system on Westway Sports Centre. Funds were raised through a community share offer, attracting more than 100 investors, and match-funding from the Community Shares Booster programme, funded by Power to Change. The project saves 28 tonnes of CO_2 a year, creates a Community Fund over £35,000 and generates an estimated 3% annual return on investment. The community fund supports projects addressing local issues in the Kensington and Chelsea borough. The Westway Sports Centre share offer was awarded the Community Shares Standard Mark.

Advice for community buildings and civic centres

- Ownership and decision making can be tied up with the local Council. Site managers can be very cautious.
- Understand early on when work can be carried out. These buildings are very busy with multiple users, so planning is key.
- Community sites sometimes require multiple layers of consent and those involved may need education on the benefits of solar PV.
- Try to find someone on the client side who is keen and committed to the decarbonisation agenda and who will help to drive the project forward and get approvals internally (an internal champion).

The CEL map shows all community energy groups' projects in London.

10. Further resources

- CARES Toolkit although a little out of date is still a good resource for groups
- Resources from the Centre of Sustainable Energy
- How to section from Community Energy England
- Good practice guide for designers, manufacturers and installers from BRE and CPRE
- More on CPOs and MSPs can be found in Virta Global's guide

11. Version control

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