

Solar PV Analysis for Social Landlords

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Introduction

This case study describes a service to provide building-level assessments of solar energy potential to social housing landlords, allowing them to determine feasibility for solar photovoltaic (PV) installations across their housing stock. The assessment not only supports the business case, which is largely funded by the UK's Feed-in Tariff (FIT) provisions, but also provides a candidate installation schedule to drive implementation.

The methodology of the service uses high-resolution aerial photography (typically between 10cm and 25cm) and stereo photogrammetry to create 3D polygons of roof surfaces for a given list of properties. From these polygons, the key determinants of solar PV feasibility can be derived; namely roof surface area, aspect and slope. The resulting data is made available to landlords, most of whom do not have GIS resources available, as datasets and also through a web-based mapping portal, built on an open source application stack.

Background

Sustain works with a large number of UK Registered Social Landlords (RSLs), including both Housing Associations and Local Authorities, to improve the energy efficiency of their housing stock, both for the benefit of tenants and to reduce carbon emissions. The introduction of the Feed-in Tariff in April 2010 provided a strong incentive for RSLs in the UK to install solar PV panels, with guaranteed payments in return for electricity generated (whether or not used) for 25 years on an index-linked basis. Under the current rates (about 43p per kwh) and installation costs, payback times on investments are in some cases under 10 years, providing a strong business case to owners even before the reduction in electricity bills for occupiers, and the additional export tariff income from unused electricity generated (currently 3p per kwh), are taken into account.

For social landlords, however, although the full lifecycle case for solar PV is a strong one, financing an installation programme which could cost a minimum of £7,000 per property is a major challenge, and needs to be supported by a robust business case based on verifiable data and analysis. Sustain and Bluesky began working together in 2010 to develop a package which could be provided to social landlords to meet these data requirements, and started to deliver this early in 2011.

In order to meet the needs of landlords for a strong business case, it was important that the service:

- Provided accurate information for individual buildings and roof surfaces, taking into account not just physical roof characteristics but also the potential for shading from obstructions
- Was economical, and therefore affordable from constrained RSL budgets
- Could be delivered quickly, particularly in view of the likelihood of a reduction in FiT rates in 2012
- Provided data in a form which could easily be accessed, analysed and disseminated by RSLs.

These factors were important drivers in the design and costing of the service.

Methodology

The methodology used to deliver a feasibility analysis to RSLs has four phases:

- Data creation
- Solar potential calculation
- Solar PV programme business case development and planning
- PV map publication

These phases are described in more detail below.

Data Creation

Creation of the raw roof polygon data which is analysed in later phases is undertaken by Bluesky, working from an address-level schedule of buildings, and using a manual digitisation process based on stereo aerial photography to create individual polygons for each roof surface on a building which is deemed suitable for solar PV. Although initial research focussed on the use of LiDAR-derived data, stereo photography was found to have three key advantages:

- **Cost/availability:** current 'off the shelf' availability of LiDAR data is around 70% in England and Wales, much of it at 2m resolution, and coverage is patchy outside urban areas. Stereo photography coverage is close to 100%, and is significantly cheaper.
- **Boundary identification:** with aerial photography, boundaries between buildings, whose identification is essential where a scattered property portfolio is being assessed, can usually be identified using visual features such as party walls, roofing materials, garden fences or even fascia decoration. These features will not always be apparent in LiDAR imagery, and although OS MasterMap data can be used for building identification, this adds a major overhead to the exercise for the majority of Housing Associations who don't have a MasterMap licence.
- **Accuracy:** LiDAR often gives vertical walls a slight slope which can affect aspect calculations. Moreover, without very accurate building footprints and high resolution LiDAR, any offset between the two will tend to skew results.

It is also technically feasible to use Google Earth data, but leaving aside the licensing implications, the resolution of the data precludes anything other than a very high level assessment of feasibility, with no accurate estimation of area or pitch possible.

Using the aerial photography, for each roof polygon, the following attributes were able to be derived:

- **Usable area:** the area of the roof surface, taking into account features such as chimney stacks and roof lights.
- **Pitch:** the angle of slope of the roof surface
- **Aspect:** the number of degrees from north in which the roof (if not flat) faces
- **Obstruction:** the extent to which the solar irradiation reaching the roof surface was likely to be affected by obstructions such as trees, chimney stacks or adjacent buildings



Figure 1: 3D Images With Roof Polygons

Finally, a further stage in the generation process was to use a custom script to create a second polygon layer for the dataset, representing the maximum number of solar PV panels that could be fitted to each roof surface, based on a set of user-defined parameters including panel size, and border between panels and edge of roof.

Solar Potential Calculation

The next stage is to calculate, using the pitch and aspect attributes of each roof surface and its geographic location, the annual solar irradiance which is likely to accrue to each panel. There are a number of open source tools which can be used for this task, including the r.sun module which is implemented in GRASS and used by the JRC's PVGIS website (<http://re.jrc.ec.europa.eu/pvgis/index.htm>), and is generally considered to be the standard, and also SAGA GIS. In either case, this irradiance value, combined with the technical characteristics of a specific panel type, will give rise to an annual figure for each roof surface for expected electricity generation in kwh. There are two stages to this calculation: first the irradiance is calculated as energy per m² received by the panel, and this is then converted into an anticipated yield using data on panel efficiency and losses.

With appropriate assumptions on the amount of generated electricity likely to be used by the occupants of buildings, figures can be estimated for each building for the likely savings to tenants; the income to the landlord from a combination of FiT generation and export tariffs; and the impact on carbon emissions.

Solar PV Business Case

The dataset which has been derived from the aerial photography can now be fed directly into the business case which will support decision-making on the solar PV installation programme. By combining the roof data with estimated current installation costs, landlords can estimate:

- Total programme costs: how much would it cost to carry out a full solar PV programme for all suitable roofs?
- Payback times: using income and cost data, which roofs will give the fastest payback time?
- Lifetime ROI: which roofs are likely to provide the best return on investment over the 25 life of the FiT?

In addition, additional datasets can be added or created to address questions which are specific to the area, or provide information about goals which may be of particular interest, for example:

- Fuel poverty: what is the intersection between areas of high fuel poverty and short payback times on solar PV installations? Landlords may want to target these areas for early phases of an installation programme to reduce fuel costs for tenants.
- Roofing programmes: which roofs in an RSLs existing roofing programme are suitable for solar PV? Panels or tiles could be installed as part of this programme to reduce installation costs.
- Clustering: are there clusters of buildings, for example terraces or estates, which can be identified for installation programmes, taking advantage of the potential to reduce costs because of the proximity of installations?

As well as supporting decision making on individual installations, the data generated can also be used to support financing options. If landlords do not have the capital reserves to fund a solar PV installation programme themselves, the detailed data provided by the feasibility study can be used to provide evidence of viability to a funding provider.

Mapping Solar PV Potential

The outputs from the study are delivered as a simple dataset, with a set of attributes for each building. However for RSLs there are strong advantages in providing a map-based interface to the data. First, it provides an intuitive and powerful visualisation tool – individual roof surfaces and panels can be represented and styled in a way which immediately shows generation potential in a geographic context, and providing visual reassurance to back up the raw data. This has been found to be particularly useful in building confidence and support amongst decision makers and

fundes. Second, the web-based approach that has been used allows easy access for all relevant staff, including asset managers, building programme supervisors, building surveyors and so on. Finally, by combining the solar data with the additional datasets mentioned above, spatial analysis can be carried out to support specific questions or objectives.

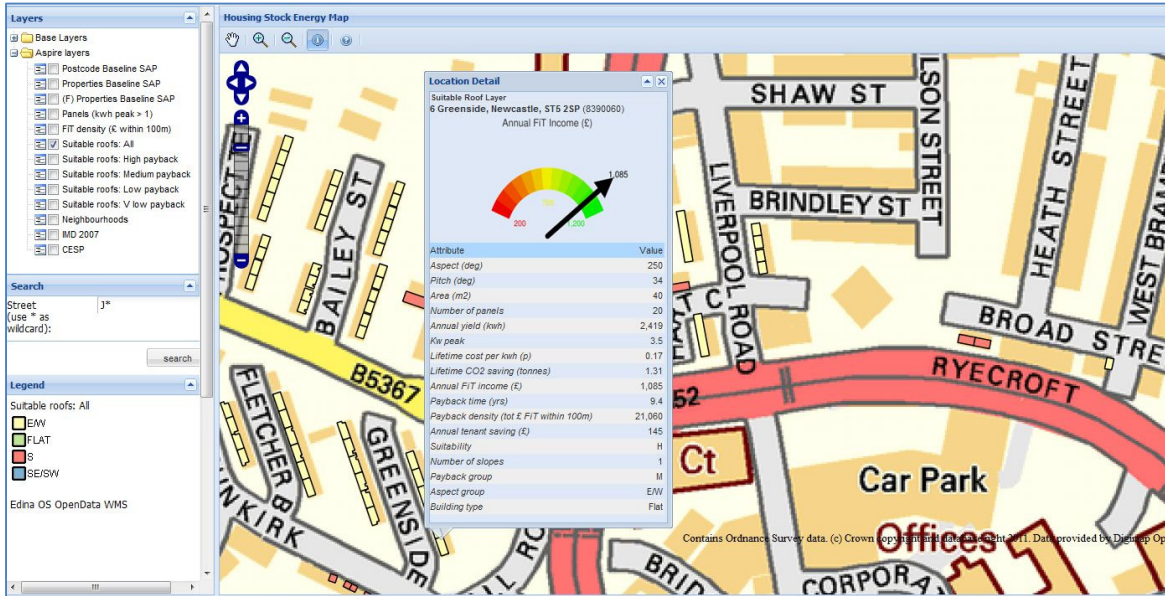


Figure 2: Application Interface

An open source web mapping framework has been used to provide a lightweight interface to all relevant roofing data, with styling, graphics and filters which are designed to support the end user in navigating and understanding the underlying data. Open source mapping was selected partly because of the obvious benefits of minimising the financial barriers to deployment, but also because of the flexibility, interoperability and scalability which is inherent in much open source software, supporting integration with Sustain's existing open source energy mapping products and customers' own GIS infrastructure where required. Ordnance Survey OpenData layers are used for background mapping.

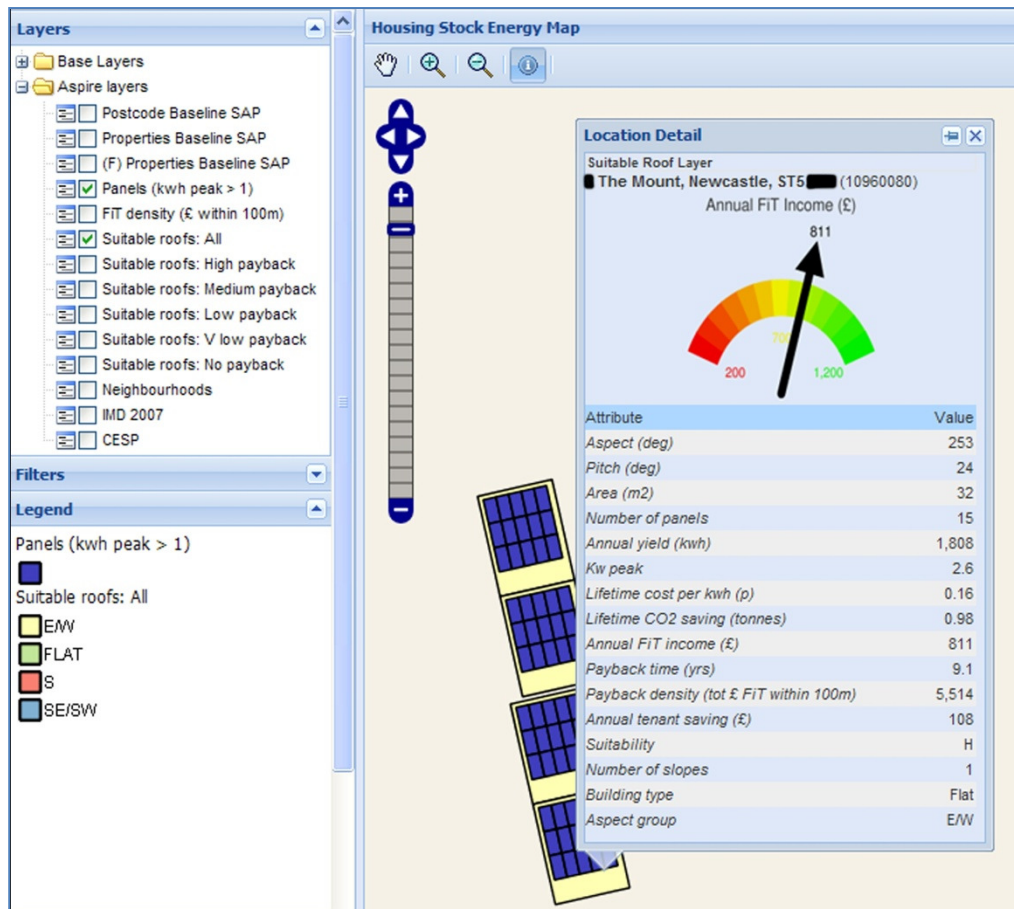


Figure 3: Popup Detail and Panels Layer

Conclusion

The key characteristics of the service are its relatively low cost (typically well under £1 per property where datasets of more than 5,000 buildings are assessed), its technical robustness, and its provision of a set of deliverables which are able to support all stages in the solar PV lifecycle, from feasibility through business case development to installation and in the longer term, performance monitoring. As the service has evolved, the focus has been very much on maintaining appropriate levels of accuracy, cost, and usability for the specific client group – RSLs – at which it is being targeted, and on analysing and presenting the data generated in the initial digitisation stages in ways which recognise the specific requirements of RSLs and the context in which they operate.

To date around 50,000 roofs have been analysed and mapped using this service, and there is strong interest amongst social landlords for further studies. There is scope for adapting and extending the service to cover other renewables, in particular solar thermal heating, and for customers outside the social housing sector.