Planning aspects of solar parks

A number of 'solar parks' are being planned at different locations around the UK. The emerging interest in these systems is sponsored by the government's Renewable Energy Strategy[i] to meet the requirements of the 2009 EU Renewable Energy Directive.

Although new to the UK, solar generation installations of this type have been widely adopted in other countries, starting in the USA in the 1980's and deployed in substantial volumes in Germany[1] in recent years.

This document provides a description of how solar parks are typically designed and gives an overview of the main planning considerations, in the following sections:

[1] where most of the pictures in this document are taken from

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This document covers particularly ground-mounted installations. Similar advice may be available separately for building-integrated and roof-top systems.

1 Site location

The energy source for a 'solar park' or 'solar farm' is daylight, so the range of potential sites is almost endless.

Because radiation levels in the South West, South Wales, and the South and South East of England are somewhat higher than the rest of the UK, most of the activity has been focussed there, but well designed systems can be viable almost anywhere in the country.

1.1 Local energy usage

Many solar farms are merchant generating systems feeding power straight into the national electricity grid.

Under the present Feed-In Tariffs regime, further described in 3.2.1 below, the viability of projects can be enhanced by supplying electricity to on-site users. This also benefits the local economy, and so site near to industrial estates and power-consuming agricultural installations, such as dairies, can prove particularly suitable.

1.2 Current land use

The best locations for solar parks are often previously developed land or brownfield sites, as these often have substantial energy use nearby. However agricultural land is often also suitable, subject to the planning considerations mentioned in 3.1.2 below.

Solar parks are not typically proposed in landscapes designated for natural beauty, or sites of acknowledged archaeological or ecological importance.

1.3 Grid connection

Another significant consideration in the location of solar parks is the availability of a suitable grid connection. Even where much of the energy produced is to be supplied to local users, there are likely to be times when the system will export most of its energy to the grid, so a connection is needed, normally at 11 or 33kV.

The distribution network in the UK is fairly ubiquitous, and nearby connections can normally be found by the DNO's who manage the local electricity distribution network[2].

An early part of the site selection and design process is to identify where there is adequate grid capacity to connect the system.

2 Solar park development proposals

Ownergy has advised on over one hundred prospective solar park developments. This document synthesises the typical objectives of land-owners and developers and offers best-practice approaches to enhance the planning aspects of projects.

[2] The Distribution Network Operators manage these networks in designated regions. The high voltage transmission network above 120kV is managed by National Grid, but solar parks are not large enough to connect at that level.

2.1 Typical arrangements

The primary constituent of the installation is the array of solar photovoltaic (or 'PV') modules, which convert incident sunlight directly to electricity. These are configured in rows across the majority of the site, interspaced to minimise shading.

As a rule of thumb in the UK the space between rows is about three times the width of the row. Typically an installation of one megawatt (1MW – one thousand kilowatts under full sunlight) would require 2 to 2½ hectares.

2.2 Rationale for development

Solar park developments are generating stations producing clean renewable energy for local consumers and/or electricity users in general. This contributes to the national policy objectives described below and also to local and national energy security.

2.3 Contribution to sustainable energy supply

In a good sunshine area a 1MW installation would generate about 1,000 MWh (one million kilowatt hours) per annum. This is equivalent to the total annual electrical consumption of some 240 typical households[3].

2.4 Contribution to the environment

Solar generation reduces the need for traditional sources of power generation. Therefore 1,000 MWh displaces electricity, which if it had been produced at the UK's average grid mix[4] would have produced over 544 tons of carbon emissions.

2.5 Contribution to the social economy

Solar installations also reduce the dependence of local economies on energy imports. The installation and maintenance, though modest, can generally be provided by local workers.

3 Relevant local and national policies

3.1 Planning Policy

Because solar systems are physically inert and environmentally benign, as described below, they present few planning concerns. Indeed for many applications they fall within the scope of permitted development[ii].

The government's planning policy statement on renewables PPS22[iii] encourages planners to promote suitable renewable energy projects, saying:

> Local planning authorities and developers should consider the opportunity for incorporating renewable energy projects in all new developments. Small scale

[3] Based on energy regulator OFGEM's figure of 4,100 kWh p.a. for an average household

[4] 0.544 tonnes per MWhr according to The Carbon Trust

renewable energy schemes utilising technologies such as solar panels, Biomass heating, small scale wind turbines, photovoltaic cells and combined heat and power schemes can be incorporated both into new developments and some existing buildings. Local planning authorities should specifically encourage such schemes through positively expressed policies in local development documents.

These objectives are reflected in the regional and district strategies as further described below.

3.1.1 Planning fees

There is no national guidance on the fee category specifically for solar PV installations.

Some authorities classify them as 'other operations' within category 9(b) of the Planning regulations[iv]. This category imposes a fee of £170 for each 0.1ha.

Other authorities consider that such applications fall within Category 5 for plant or machinery, which carries a fee of £335 for each 0.1ha up to 5ha. Above 5ha the fee is £16,565; plus an additional £100 for each additional 0.1ha.

In both cases, though not typically applicable to solar parks, the fee is subject to a maximum total of £250,000.

3.1.2 Agricultural land

Because of the spacing of solar arrays within a solar farm, as described above, it is possible to retain agricultural usage of the land on which they are sited.

Although arable application would generally prove difficult, grazing remains possible within array fields and indeed is particularly synergistic as it prevents plant growth which may in due course shadow the solar arrays.

For similar reasons array fields can also play a part in nature conservation plans, as further described in 6.1 below.

The government's planning policy statement on sustainable development PPS7[v] requires the presence of land in grades 1, 2 and 3a of the Agricultural Land Classification to be taken into account alongside other sustainability considerations. This suggests that classifications 3b, 4 and 5 will generally be more suitable for solar parks, though the statement also recognises the need to support diversification of agricultural land that helps to sustain an agricultural enterprise.

3.2 National energy Policy

In addition to the planning issues described above, the government is encouraging a positive approach to renewables as detailed in its draft National Policy Statement[vi].

This policy is supported by a range of incentive mechanisms. One of these in particular has stimulated the demand for solar park installations.

3.2.1 Feed-In Tariffs

This project will be supported by the Feed-In Tariffs a newly introduced incentive for renewable energy generation pursuant to the Energy Act 2008[vii].

Feed-In Tariffs are payments to anyone producing renewable electricity (a 'generator') for every kilowatt-hour (kWh) of power that they produce. They have two elements:

- The generation tariff for every kWh of electricity generated (whether consumed on site or exported); and
- An export tariff for kWhs not used, but fed back into the grid.

In addition, generators get a third benefit in that every kWh of electricity that they generate and use themselves saves having to buy that electricity from their supplier.

3.3 Local development policy

Most regional and local development frameworks include policies on the development of renewable generation. Many have set targets for the level of renewable energy generation they intend to achieve in future years.

The benign nature of solar photovoltaic generation, in particular makes it compatible with virtually all such plans.

As Cornwall boasts the highest solar radiation figures in the UK, it has been the first to experience high demand for PV installations. The council has drafted a document[viii] on planning issues, which others may find helpful.

4 Solar energy technology

4.1 Solar generating stations – how they work

Solar power stations convert daylight into electricity. The output is then conditioned to match the utility supply and connected to the electricity grid.

The electricity is created in arrays of solar panels. The active devices are solar cells as further described in section 4.2 below. They convert light to DC electricity silently with no moving parts and no emissions. In fact they are just larger versions of the cells used in solar calculators. In large solar parks the solar panels are configured in banks of sub-arrays as illustrated for this solar farm in Germany. These blocks are spaced both to allow access and to ensure that one sub-array does not cast a shadow over the one behind.

The electricity is cabled to inverters, which convert DC power to AC, synchronised to the electricity grid. The output is connected through various switchgear, protection devices and meters to local users and the grid.

On-site power users benefit from the solar power, whenever it is available. At times when the solar system produces more power than is being used locally, the surplus is fed back to the grid. When there is a shortfall, the extra power required is drawn from the grid in the usual way. This all happens automatically without any disruption to local power users.

4.2 Description of the solar arrays

The largest and most visible elements of the system are the arrays of solar modules. Solar modules are solid state semiconductor devices with no moving parts. They convert light directly into DC electricity silently and with no emissions.

The solar cells themselves are made from silicon, which is the most abundant element in the surface of the earth (the primary constituent of rock and sand). It is treated to become a semiconductor – essentially a large light-sensitive diode.

The front surface of the solar modules is toughened glass with an anti-reflective coating to maximise the light captured by the solar cells. From the front, the modules look predominantly black in appearance, though from close-up a grid of silver contacts is visible.

Modules are framed with anodised aluminium, and will be mounted as sub-arrays on frames of anodised aluminium and hot-dipped galvanised steel.

4.3 Other equipment

The inverters, switchgear and other electrical equipment are standard items as used for a wide range of industrial applications.

The other major operating component of the system is the inverter, which converts the DC power produced by the solar modules into AC power which can be used by local users and fed into the grid. Depending on the size and configuration of the overall system, this may either be a single unit or a number of separate inverters, each handling a part of the overall solar array.

Sensitive equipment will typically be housed in equipment shelters within the solar array field, similar to telecommunications and power equipment visible in many locations around the countryside.

5 Potential impacts on the local environment

5.1 Landscape and Visual Change

Because there are no adverse environmental impacts, planning considerations tend to focus on the physical and visual impacts of solar systems – principally the solar array.

Designs proposed by Ownergy minimise such visual impacts by limiting the height of the solar arrays, even at their steepest angle, to typically less than 4m – so they are often no higher than surrounding hedgerows.

Rows of arrays can be arranged to follow local topography. The arrangement of discrete array blocks at staggered intervals and with spacing in between breaks up any potential visual monotony and avoids undue wind concentration or turbulence.

5.2 Light reflection

Solar panels are designed to absorb, not reflect, irradiation. They are therefore responsible for only limited levels of either ‘glint’ or ‘glare’, as the photographs in this document show, and are substantially less reflective than glass-houses for example.

Glint may be produced as a direct reflection of the sun in the surface of the PV solar panel, but will be substantially reduced by the anti-reflective coating that most modules incorporate to maximise the light capture of the solar cells as the photograph in section 3.1.2 above illustrates. Glare is a continuous source of brightness, relative to diffused lighting. This is not a direct reflection of the sun, but rather a reflection of the bright sky around the sun. Glare is significantly less intense than glint.

This aspect has also been considered by aviation authorities, and is addressed further in 7.2 below.

5.3 Ground Conditions and Contamination

Solar arrays are typically installed using screw piled, piled or ballast supported systems. They therefore cause no adverse impact on the ground and no contamination.

The effect on wildlife is also minimised as further discussed in 6.1 below.

Only where necessary will concrete plinths or other more intrusive foundations be used.

5.4 Noise and Vibration

Solar cells are inert solid state devices which convert light into electricity. The systems therefore produce virtually no noise and no emissions.

The inverters require some cooling, so there is a slight fan noise perceptible only if standing immediately adjacent to the housing.

Otherwise there are no moving parts, except in the minority of systems, which may be designed to be manually adjusted twice per annum.

5.5 Air Quality

The panels do not give rise to any emissions which will impact on air quality.

The level of traffic generation is minimal as discussed in 7.1 below.

5.6 Surface Water Drainage and Flooding

Solar panels drain to the existing ground, and (except in unusual circumstances where substantial concrete plinths are used) runoff should be no greater for the developed site than it was for the pre-developed site.

If suitably designed, solar farms can be located in flood plains and offer a good applications for such areas.

5.7 Safety

5.7.1 Electrical safety

The electrical aspects of the system are covered by Engineering Standard G59[ix], which sets down requirements for electrical safety and grid-connection of generating systems.

Cross-site cabling is typically led underground between equipment housings.

5.7.2 Security Fencing

Generally there is a need to ensure solar facilities are adequately secured to reduce theft and vandalism risk and protect passers-by.

The requirements will vary from site to site and designs produced to avoid unacceptable landscape or visual impact. This includes utilising existing hedges, minimising the height of security fencing, using natural features and appropriate measures for continued access by larger mammals, such as badgers and foxes.

6 Ecology, Nature Conservation and Cultural Heritage

6.1 Nature conservation

Solar farms have the potential to increase the biodiversity value of a site if the land was previously intensively managed. Sheep grazing or an autumn cut with removal of grass cuttings could increase the botanical diversity of the site.

The solar park at Kobern-Gondorf in Germany, for example, is used as a nature reserve for endangered species of flora and fauna.

Solar parks typically present no negative environmental impact to the surrounding area and wildlife. They, of course, make a substantial positive contribution towards the country's efforts to achieve a reduction in CO_2 emissions as described in 2.4 above, and this has a positive impact on ecology generally.

6.2 Environmental Impact Assessments

Solar arrays are not expressly listed in Schedule 2 to the EIA Regulations 1999.

Some authorities consider that solar developments appear similar to greenhouses and therefore follow Annex A to the EIA Circular 02/99:

> 'Development (such as greenhouses, farm buildings etc.) on previously uncultivated land is unlikely to require EIA unless it covers more than five hectares'

6.3 Cultural Heritage

The impact of solar park developments on local heritage assets will be very site dependent.

A recent approval on a previous airfield site, for example, was adjudged "a very effective re-use of the heritage assets, in character with the innovative technological history of the site".

6.4 Archaeology

The support structures for the solar arrays typically protrude up to 1.5 metres into the ground. In a minority of cases of known archaeological interest, therefore it might be necessary to commission a geophysical evaluation of the site or an appropriate programme to ensure that any archaeological interests are safeguarded and if necessary mitigated.

It is possible to employ ballasted support systems, which do not penetrate the ground.

7 Traffic and Transport

7.1 Traffic movements

During the construction stage, each MW of capacity may generate a few dozen movements for the delivery of the equipment.

Thereafter there will be visits by service personnel typically twice per annum.

The systems need no refuelling or other routine provisions so will generate no additional traffic movements in the area.

7.2 Aviation

Systems are designed to avoid adverse effects from reflected light and thus to conform to the Air Navigation Order 2009, particularly articles 137, 221 and 222

The Civil Aviation Authority (CAA) is seeking to develop its policy on the installation of solar photovoltaic systems and their impact on aviation[x].

8 Community engagement

Solar parks are still virtually unknown in the UK and developers are advised to inform local communities about the characteristics and benefits of this technology as part of the engagement process.

Because solar systems are silent, clean and unobtrusive, they have proven to be one of the most acceptable of the renewable energy technologies, and substantially less contentious than, for example, wind power. The lack of traffic movements also avoids the objections sometimes raised against thermal technologies, like anaerobic digestion and biomass.

Attention normally centres on the potential visual impact. Because as detailed in 5.2 above there are no substantial reflection issues, and well-designed schemes maintain the height of the systems below that of surrounding hedges and landscaping, Ownergy has found that its proposed developments have met with widespread support from local communities.

This document has been prepared in part to contribute to such community education initiatives.

9 Legacy issues

Solar farms are regarded as a temporary use of land.

Solar facilities developed on agricultural ground are 'reversible', allowing the site to be easily restored to a more intensive agricultural use. Intrusive development, such as trenching and foundations, are minimised.

Some planning consents apply the condition that the land be permanently reinstated to its original condition at the end of the project life, and Ownergy's projects can meet such a condition.

The equipment can be recycled at the end of its useful life.

10 Referenced documents:

i See www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx
ii See www. communities.gov.uk/documents/planningandbuilding/pdf/microgenelectriccars.pdf
iii See www. communities.gov.uk/planningandbuilding/planning/planningpolicyguidance/planningpolicystatements/planningpolicystatements/pps22/
iv The Town and Country Planning (Fees for Applications and Deemed Applications) (Amendment) (England) Regulations 2008; see http://www.legislation.gov.uk/ukdsi/2008/9780110809892/contents
v Planning Policy Statement 7: Sustainable Development in Rural Areas; see http://www.communities.gov.uk/publications/planningandbuilding/pps7
vi See http://data.energynpsconsultation.decc.gov.uk/documents/npss/EN-3.pdf
vii See www.FITariffs.co.uk
viii See http://www.cornwall.gov.uk/Default.aspx?page=25182
ix See www. energynetworks.org/engineering/pdfs/DG/FES_00318_v040211.pdf
x See http://www.caa.co.uk/docs/375/srg_asd_solarphotovoltaicsystguidance.pdf