Planning Policy Guidance 22: Annex on photovoltaics

Contents

Introduction

1. The Government has a target to produce 10% of electricity from renewable sources by 2010. A positive, strategic approach to planning for renewable energy is essential to help deliver the Government's targets and goals for renewable energy and climate change, which are central to achieving sustainable development. Photovoltaic (or PV) technology can play a small but significant part in delivering these targets.

2. The Government's national planning policy with regard to renewable energy is set out in Planning Policy Guidance note (PPG) 22: Renewable Energy which gives local planning authorities guidance on a range of issues that affect the siting of all renewable energy projects. This paper updates the PPG 22 annex with specific reference to PV systems and offers guidance on the basic technology, including the key characteristics, and the main applications of PV. It has the same status as a PPG annex. PV systems may be installed or integrated onto commercial and domestic buildings for converting solar energy directly into electrical energy.

3. PV systems are now being connected to local electrical networks and the solar tiles and modules are being integrated into the roofs and facades of buildings. Electricity companies, architects, developers and construction companies are being introduced to the technology as clients are specifying PV systems in their buildings. The capacity of PV installed in the UK has more than doubled, from 1MWp (MegaWatts peak) by 1999 to 2MWp at the end of 2000.

The Technology

4. PV systems convert solar radiation to electricity by the effect of photons (tiny packets of light) on the electrons in a solar cell. The most common PV cells are made of crystalline silicon, but thin films of silicon or other materials that are typically cheaper but less efficient, are gaining market share and hold good prospects for further improvement. In bright sunlight, and connected to a suitably matched load, a typical single, 100mm square crystalline silicon PV cell will produce 2.5 to 3.0 amps of direct current (DC) at about 0.4 volts (1-1.2W). The operating voltage is more or less independent of the solar intensity. However, the current, and therefore the power output, is almost directly proportional to the level of solar radiation received, i.e. the brighter it is the more output you get. PV cells produce power even if there is no direct sunlight - on a cloudy day up to 30% of the 'bright sun' power output can be produced.

From Cell to System

5. The cells are generally deposited onto or encapsulated under a glass cover with a backing sheet of glass or other material to protect them from the environment and handling. A set of cells is encapsulated into a versatile product called a module. Modules come in many 4 Planning Policy Guidance Note 22 shapes and sizes, from small roof tiles up to panels 2 metres square. Maximum output will depend on the cell technology and cell density in the module, it can range from 50 to 150 Wm-2 (Watts per square metre). PV modules have proved to be very reliable and can have a design life of 25 years or more.

6. Depending upon the required output, a number of modules are mounted on a support structure and wired together. This 'array' is preferably orientated due South to maximise the capture of incoming solar radiation. A PV system will include other components such as an inverter if alternating current (AC) is required as used in most buildings, or batteries and an electronic controller if it is to operate as a stand alone power supply.

PV Applications

7. PV technology has a wide range of applications such as watches, calculators and garden lights etc, but those relevant to planning considerations can be summarised as:

- stand-alone systems for remote power generation;
- central PV generating stations connected to distribution networks;
- building-integrated and building-attached (retrofit) systems connected to local networks.

Stand-alone systems: PV is widely used to provide power for communications and monitoring systems in remote areas. The use of PV for street lighting, parking meters, and road 'furniture' lighting is increasing as it reduces costs of mains connections and cabling. Stand-alone systems need a battery to store energy during low sun conditions and an electronic controller to manage the energy from the array to the battery as well as the load.

Central PV power stations: In the UK, the cost of land and the variability of solar radiation reduces the options for central PV generation. Incorporating PV panels into appropriately orientated sound barriers, erected along motorways or railways in densely populated areas is one application that has been demonstrated in several European countries and could be developed here.

Building-integrated systems and building-attached (retrofit): These use PV technologies such as modules, laminates, solar tiles and a range of other PV building products in place of, or in addition to, traditional roof or facade materials, and the electricity generated is used mainly by the building concerned. Any surplus can be exported to the local distribution network with the agreement of the network operator and an electricity supplier. Power conditioning electronics, known as an inverter, is required to change the DC power into AC and to meet power quality requirements of the electrical network.

Building Integrated PV

8. PV modules have no moving parts, generate no noise or emissions and can be integrated into all types of buildings - houses, offices and industrial units, etc.

9. Interest is already being translated into action in several areas of the UK. For example the new Jubilee Campus at Nottingham University which has crystalline PV modules in the atria of several of the academic buildings, The Ford Motor Company's Bridgend engine plant which uses large area

PV laminates in south facing roof lights, and numerous newbuild and refurbishment housing projects under the Department of Trade and Industry's domestic PV systems field trial which use both crystalline and thin film modules.

Jubilee Campus, Nottingham University
Courtesy of the School of the Built Environment, Nottingham

10. In different parts of the country some domestic consumers are generating their own power from PV. Average costs at 2001 prices are £6,000-£12,000 for a 1-2kWp system on their roof. Prices have reduced by an average of 5% per year over the past decade, and are expected to continue to fall as the technology improves and economies of scale are introduced. Some electricity suppliers are offering to buy 'exported' electricity, some at domestic tariffs (also known as 'net-metering').

11. There are special building integrated PV products available that replace conventional cladding systems, roof-tiles and slates. These may be installed as a retrofit system, although costs will be lower if included in new-build schemes. There are international type approval standards for both crystalline and thin-film PV modules[1] covering resistance to environmental exposure including impact damage and weathering, but they may not cover all aspects of use in buildings. More international standards for PV installations are under development.

Electrical Connection

12. Whilst there are no general licensing requirements relating to PV systems, as with any embedded generator, those that are connected to the electricity network must have the prior consent of the local Distribution Network Operator (DNO). Small PV systems may come within the scope of Engineering Recommendation G77 - Recommendations for the connection of inverter-connected single-phase PV generators, up to 5kVA, to public distribution networks. Issue 1: 2000, a revised version, ERG77/1 was published in March 2002. Larger systems may be required to meet ER G59 - Recommendations for the connection of embedded generating plant to the regional electricity companies' distribution systems.

Location and Design

13. Most PV arrays will be fixed in a position to provide maximum capture of solar radiation. PV designers or installers will calculate the best orientation but generally, in the UK, the array (see paragraph 4) should face roughly south, towards the sun, and at a tilt of around 30 degrees from the horizontal. Shadows from buildings, trees or other structures can significantly reduce performance of the PV system. However, building design and site conditions may help to optimise performance.

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[1] IEC 61215 - Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval.
IEC 61646 - Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval.

Planners and designers should take reasonable steps to minimise overshading of the PV, although some thin film solar technology can be used effectively in low light conditions.

14. PV arrays make no sound and have no moving parts but visual appearance may need to be considered at the planning stage not least to ensure that the modules are not detrimental to the attractiveness of an area. PV modules range in colour from almost black through blue to shades of dark brown, depending on the type of cell technology and construction, though other colours are possible. Integrated PV systems can be built flush with the surrounding roof materials in new build projects, whereas it is often cheaper to fit retrofit systems on top of an existing tiled or slate roof.

15. PV modules can convey a modern impression similar to glazing or glass cladding that will compliment the appearance of contemporary buildings. PV tiles are now available that simulate traditional tile and slate roofs and so blend well with conventional pitched roofs. PV installed on flat or low-pitched roofs are largely invisible from below and therefore have little visual impact. The use of PV systems is not limited to roofs, but can be applied to walls and in the case of semi-transparent modules, windows and skylights.

A grid-connected, solar electric generating system in the South West of England at Kelbechan House, Capton, Dartmouth
Courtesy of the DTI New and Renewable Energy Slide Library

Planning Implications

16. *New Buildings*: If a local planning authority (lpa) receives a planning application for a new building incorporating PV, it has to assess what visual impact, if any, the PV system would have on local amenity. If minded to grant planning permission, the authority could impose conditions on the permission to prevent or limit any adverse impact.

17. *Existing Buildings*: If it is proposed to install PV cells on an existing building, the lpa will have to decide if the PV array would be a material alteration of the external appearance of the building. If the lpa considers it would ***not*** be a material alteration, planning permission will ***not*** be required (but see paragraph 17 on Listed Buildings). On the other hand, if the lpa considers it would be a material alteration, planning permission will be required. However, it may not always be necessary to submit a planning application. That is because there is a general planning permission or "permitted development right" available in certain strictly limited circumstances, which may authorise a householder to install PV cells.

18. *Listed Buildings*: Installation of a PV array on a building listed for its special architectural merit or historic interest - or on another building or structure in its curtilage - is likely to require an application for listed building consent to the lpa. This will be so, even if specific planning permission is unnecessary. Listed buildings form only a small proportion of the nation's stock, but on many of them a PV array could be seen as an unacceptable alteration of the building's character. Lpas have to assess each case on its merits.

19. *Conservation areas, National Parks, the Broads, Sites of Special Scientific Interest (SSSI) and Areas of Outstanding Natural Beauty (AONB)*: If PV cells are fitted in the roof of a dwelling house so that in the lpa's view they do not project significantly above the existing roof plane, a planning

application may not be necessary. However, permitted development rights to clad the walls or enlarge the roofs of dwelling houses do not apply in AONBs, conservation areas, the Broads, SSSIs and National Parks. When considering applications in conservation areas, lpas have a duty to consider the potential impact on the character or appearance of the area. In National Parks and AONBs, particular importance is attached to conserving the special character and natural beauty of the area.

20. If an application for a PV array is submitted on a building close to a conservation area, or close to a listed building, its proximity to such area or buildings may be a material consideration for the local planning authority in deciding the application. If the proposal is to install PV on a building or structure close to a National Park, the planning authority would have a legal duty to have regard to the purposes of the National Park, and to consider the impact the development might have on the setting of the area.

21. If a planning application is refused permission, or if the lpa has not determined the application after eight weeks, there is a right of appeal to the Secretary of State.

Further information can be found in the following reports, commissioned under the DTI Sustainable Energy Programme, and can be obtained from the Environmental and Energy helpline, telephone **0800 585794**.

1. Photovoltaics in Buildings: Town Planning Considerations Terence O'Rourke - ETSU S/P2/00304/REP 1999
2. Photovoltaics in Buildings: A Design Guide Max Fordham & Partners - ETSU S/P2/00282/REP 1999
3. Photovoltaics in Buildings: Safety and the CDM Regulations BSRIA - ETSU S/P2/00313/REP 2000
4. Photovoltaics in Buildings: BIPV Projects Studio E Architects - ETSU S/P2/00328/REP 2000 The following planning guidance may also be of interest:
5. Planning - A Guide for Householders DTLR Free Literature, PO Box 236, Wetherby, West Yorkshire, LS23 7NB (telephone: 0870 1226 236). This booklet may also be viewed on the ODPM website
6. Planning Policy Guidance Note 15, Planning and the Historic Environment The Stationery Office, PO Box 276, London SW8 5DT (telephone: 0870 600 5522 or the text of PPG15 is available on the ODPM website.

A further source of information on PV technology and application can be obtained from The British Photovoltaic Association at www.pv-uk.org.uk