International Energy Agency

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

Task 1

Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in the UK

2005

REPORT

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i Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD), which carries out a comprehensive programme of energy co-operation among its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The nineteen participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), The United Kingdom (GBR) and The United States of America (USA). The European Commission is also a member.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (tasks) is the responsibility of Operating Agents. Ten tasks have been established, and currently five are active. Information about these tasks can be found on the public website www.iea-pvps.org. A new task concerning PV hybrid systems is now being developed.

The objective of Task 1 is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

ii Introduction

This report has been prepared under the auspices of IEA-PVPS Task 1. An important deliverable of Task 1 is the annual International Survey Report (ISR) *'Trends in Photovoltaic Applications'*. The Trends Report presents summary information on trends in PV power applications in the nineteen member countries, based on the information provided in the National Survey Reports (NSR) of each participating country.

This National Survey Report of PV Power Applications in the UK has been produced following discussions with, and input from, organisations and individuals involved in the development and implementation of PV Technology in the UK. It represents an overview of the key developments and achievements in the UK PV sector during the year 2005.

UK National Survey Reports covering the past four years (2001 2002 2003 and 2004), together with other information about the UK's participation in IEA-PVPS, are available from the UK-PVPS website: www.iea-pvpsuk.org.uk.

iii Definitions, symbols and abbreviations

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power capacity of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^{o}C, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (E.g. If extra

costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication systems in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, utilities etc.

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

1 EXECUTIVE SUMMARY

1.1 Installed PV power

The rate of annual installed PV capacity in 2005 was similar to that in 2004. A total of 2713 kW was installed in the UK in 2005 (compared to 2261 kW in 2004). The cumulative installed PV generation capacity increased by 33 % during 2005 reaching a total of just under 10.9 MW. Government support through the Major Demonstration Programme supported approximately 80 % of the total new capacity. Figure 1 shows the cumulative installed PV capacity up to the end of 2005.

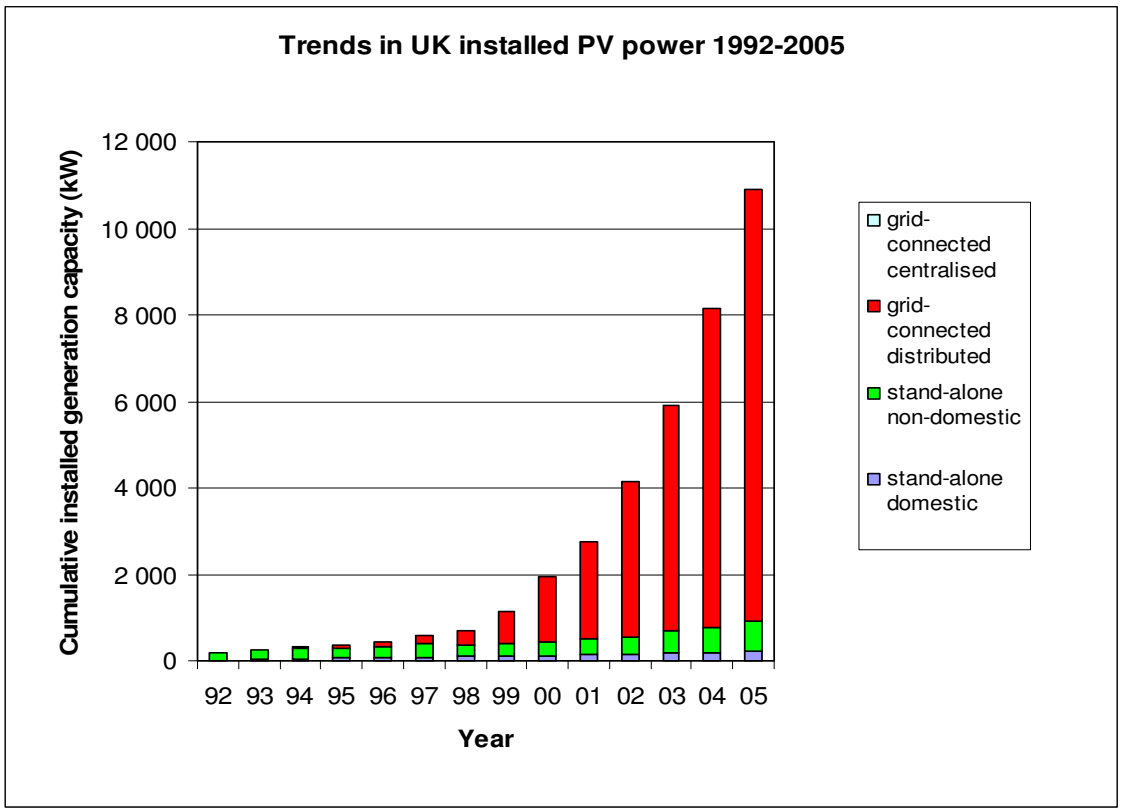

Figure 1: Cumulative installed PV capacity in the UK

1.2 Costs & prices

Average retail module prices are similar to those in 2004, typically around £3.7/W for reasonable volume orders. For small orders (few modules) retail prices range from approximately £3.4/W up to £5/W. Minimum prices remain the same as in 2004, around £2.4/W for polycrystalline modules imported from mainland Europe. The higher prices reported (up to £8.22/W) were paid for bespoke glass-glass laminates for one off building integrated projects.

Overall system prices range considerably because they take into account the significant differences in the projects, the level of integration and technology used. On-grid prices ranged from £3.4/W to £15.2/W. However the average turnkey price for a standard 1-3 kW system was £6.1/W, compared to £6.4/W in 2004 (at 2005 prices).

1.3 PV production

Crystalox, producers of multi-crystalline silicon blocks, increased production by 32 % in 2005 (compared to 2004). Total production in 2005 was sufficient for 225 MW of cells. The company increased production capacity from 185 MW equivalent in 2004 to 250 MW equivalent in 2005.

The UK's only major indigenous cell manufacturer, ICP Global Technologies, produces amorphous silicon cells and modules at its factory in Bridgend, South Wales. ICP UK increased production from 1.5 MW in 2004 to 1.8 MW in 2005. Most of the company's production in 2005 was exported.

Sharp's module assembly plant in Wrexham produced 39.98 MW of crystalline silicon modules during 2005. The majority of modules produced were exported to mainland Europe with a small percentage being used for projects in the UK. The company is the UK's largest single employer in PV and employed 260 people at the Wrexham plant.

Romag, a specialist glass manufacturer, produced 0.5 MW of semi transparent crystalline PV laminates during 2005 at its 6 MW lamination facility in Consett, County Durham.

1.4 Budgets for PV

Budgets for Pre-competitive R&D and Demonstration / Field Trials (supported by the Department for Trade & Industry and The Engineering and Physical Science Research Council) totalled £12.06 million in 2005. This compares to a total of £8.74 million in 2004. A large proportion of this funding (£9.15 million) has been for the demonstration and field trial programmes, provided by the DTI.

2 THE IMPLEMENTATION OF PV SYSTEMS

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

For the purposes of this report, PV installations are included in the 2005 statistics if the PV modules ere installed between 1 January and 31 December 2005, although commissioning may have taken place at a later date.

2.1 Applications for photovoltaics

2.1.1 Stand-alone applications

Until the mid-1990s, the use of renewable energy for professional applications in the UK was limited to mountain-top telecoms equipment and light-house or harbour beacons. Since then, the number of applications using solar generators has advanced significantly and solar street lighting, solar lit road signs and bus stops are becoming increasing common. A total of 146 kW was installed off-grid in 2005.

The table below presents an overview of stand-alone applications for photovoltaics in the UK, categorised by end-users. Many of the applications have an installed capacity of less than 40 W.

Overview of stand-alone applications for photovoltaics in the UK

END-USERS	**TYPICAL APPLICATIONS**
INSTITUTIONAL	
Environment Agency, British Waterways	• Lock and sluice operation • Water pumping • Water quality monitoring
Local Councils	• Parking meters and "pay & display" machines • Car park security lighting • Street/path lighting • Bus stop and shelter lighting
Highways Authorities	• Emergency phones • Road-side information and hazard warning signs • Mobile units for temporary warning signs • Speed cameras • Remote junction/crossroads lighting • Powered 'cats-eyes' • Vehicle weigh-in-motion measurement • Traffic and pollution monitoring
Rail network	• Remote rail stations – lighting • Point greasers • Signalling and warning signs
Harbour Authorities / Trinity House	• Lighthouses • Offshore (buoy-mounted) navigation beacons • Harbour navigation beacons and warning signs
Met Office	• Weather stations - wind speed, temperature, etc. • Air quality monitoring

END-USERS	TYPICAL APPLICATIONS
National Trust, Youth Hostel Association, etc.	• Remote visitor centres / hostels • Wardens' huts and workshops
Universities, Research Laboratories	• Remote monitoring of equipment
UTILITY	
Gas suppliers	• Unmanned oil/gas platforms • Remote meter reading • Gas pressure and flow measurement • Valve operation
Electricity suppliers	• Remote meter reading • Monitoring of HV cable insulation
Water companies	• Remote meter reading • Valve operation • Anti-freeze heating ("trace" heating) • Water level measurement • Water pumping, treatment and purification • Energy recovery in water supply lines
Telecoms companies	• Mobile phone local transmitters • Telecoms repeater stations
COMPANY	
Farming and agriculture	• Electric fencing • Pest control - flashing lights, bird-scarers • Waterpumping for livestock drinking water • Lighting for stables and out-houses • Fish farm pond aeration • Fish farm feeding systems • Greenhouse lighting & heating
General	• Alarms for remote buildings • Area lighting • CCTV • Advertising
INDIVIDUAL	
Leisure boats	• Electric boat battery-charging
Camping & remote homes	• Battery charging (lighting/TV)

2.1.2 Grid-connected applications

The total capacity of grid connected installations during 2005 was 2567 kW, which represents 95 % of the annual total. This is slightly greater than the capacity installed during 2004. The majority of projects were supported by grant funding under the DTI's Major Demonstration Programme.

2.2 Total photovoltaic power installed

The total PV capacity installed during 2005 was 2713 kW. A summary of the cumulative installed PV Power, from 1992-2005, broken down into four sub-markets is shown in Table 1.

Table 1: The cumulative installed PV power in 4 sub-markets.

Sub-market/ application	31 Dec. 1992 kW	31 Dec. 1993 kW	31 Dec. 1994 kW	31 Dec. 1995 kW	31 Dec. 1996 kW	31 Dec. 1997 kW	31 Dec. 1998 kW	31 Dec. 1999 kW	31 Dec. 2000 kW	31 Dec. 2001 kW	31 Dec. 2002 kW	31 Dec. 2003 kW	31 Dec. 2004 kW	31 Dec. 2005 kW
Stand-alone domestic	7	47	52	57	69	83	108	119	121	135	162	172	193	227
Stand-alone non-domestic	166	213	232	252	279	316	254	276	302	385	406	542	585	697
Grid-connected distributed	0	6	54	59	75	190	328	736	1 506	2 226	3 568	5 189	7 386	9953
Grid-connected centralised	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL (kW)	173	266	338	368	423	589	690	1 131	1 929	2 746	4 136	5 903	8 164	10 877

2.3 Major projects, demonstration and field test programmes

2.3.1 The PV Major Demonstration Programme

The PV Major Demonstration Programme (MDP) was officially launched on 26th March 2002. £20 million was originally made available for the three-year programme from the Department of Trade and Industry. A further £11 million additional funding was announced in 2004 and another £750 000 in 2005. Its long-term aim is to assist in making PV technology an attractive investment for residential, public organisations and corporate customers. The programme ceased offering new grants at the end of March 2006 and has now been replaced by the new Low Carbon Buildings Programme (see page 20).

The MDP, was managed by the Energy Savings Trust, and comprised two application streams:

- Stream One – individual or small-scale applications (systems from 500 W to 5 k) dealt with on a rolling basis.
- Stream Two – medium or large-scale company or group applications of between 5 kW and 100 kW dealt with quarterly by a competitive call process.

The subsidy level was reduced over time. The maximum eligible subsidies during 2005 were as follows:

- Public Sector buildings: 50 % of the nominal cost (originally 65% at the start of the programme).
- Large profit making organizations: 40% (originally 40 % at the start of the programme).
- All others, including SMEs and homes (Stream 1): 50 %.

From June 2003, maximum grant levels for Stream One were introduced. These maximum grant levels were reduced further during 2004 and 2005. The 2005 levels were as follows:

- Bolt-on systems: £2500/kW or 50% of total costs, whichever is lower.
- Integrated systems: £3500/kW or 50% of total costs, whichever is lower.
- Semi-integrated systems: £3000/kW or 50% of total costs, whichever is lower.
- Glass/glass systems: £5000/kW or 50% of total costs, whichever is lower.

Grants were available for both on and off-grid applications (since June 2003) and were eligible for modules, inverters and installation but not batteries or complex charge controllers. All grant applications required the use of approved products and accredited installers and designers.

By the end of 2005, a total of 1018 systems (4905 kW)[1] had been installed under the programme as a whole. The installations completed during 2005 are broken down as follows:

- In Stream One, 458 systems were installed during the year (approximately 1109 kW). The vast majority of installations (94%) are for grid connected systems.
- In Stream Two, 44 systems (1072 kW) were installed in 2005 and grant applications for 44 further systems (1188 kW) were approved for funding.

Northern Ireland Electricity (NIE) runs the Smart Programme which aims to encourage the local market for small scale renewable energy options including PV and the take up of the nationally available grants. The scheme was started in 2003 when following a zero uptake of the MDP solar grants in Northern Ireland, NIE started to offer an additional 25% grant of the total installed cost of a PV system in addition to the 50% grant available through the MDP. During 2004 this was reduced to 15%, granted automatically once a grant from the MDP has been approved. During 2005 NIE provided £180 524 in additional grant support for PV systems installed under the MDP in Northern Ireland.

2.3.2 Domestic Field Trial

The Department of Trade and Industry's Domestic Field Trial (DFT) aims to use the design, construction and monitoring of a wide range of residential types of installation as a learning opportunity for key players in the process of PV installation. In total, 28 sites, constituting over 474 dwellings have benefited from the £4.7 million funding provided under the DFT. The total installed capacity under this programme was 741 kW with the final installations completed during 2004.

Two thirds of the projects are in social housing or mixed developments. The projects investigate a variety of integration approaches for the UK, including various solar roof tile systems. The performance of the installed systems is being monitored for a period of two years after installation. As well as the collection of data on the performance of the systems during the monitoring stages, also of importance are the key lessons learned during design and construction of the systems. The first of a two part Good Practice Guide, based on

[1] The MDP funds projects up to 100 kW so where projects are larger than 100 kW the capacity above 100 kW is not eligible for funding. The figure above represents only the capacity installed which was eligible for funding under the scheme.

experiences of the field trials was developed during 2005 and published in early 2006. Part One entitled 'Project Management and Installation Issues' focuses on domestic building integration issues, covering project development through to operating and maintenance. More specific details on system component design, performance and operating costs will be covered in Part Two, which together with the final technical report will be produced later in 2006.

2.3.3 Large-Scale BIPV Field Trial

The UK Large Scale Field Trial for building integrated photovoltaics commenced in 2002, with the objectives of raising awareness and of creating confidence in the application of PV, increasing UK capabilities in the application of the technology, providing opportunities for UK industry and assessing the potential for BIPV in the near term and its role in future energy policies and strategies. Eighteen projects were selected to receive a share of £4.2 million towards the installation and monitoring of large photovoltaic systems (>20kW) on their buildings. Out of these eighteen projects that were awarded funding, twelve have been built and are undergoing detailed monitoring. The twelfth and final project under the programme was completed during 2005 at the Civic Centre in Barnstaple. The 89 kW system consists of roof and wall mounted PV arrays. This brings the total installed capacity under the programme to over 639 kW. The remaining 6 projects are not proceeding for a variety of reasons including lack of matching funding and some of the new buildings being abandoned at the design stage.

All the designs are for true building integrated systems, on a variety of construction types. The completed projects use a variety of PV technologies and include new build and retro-fit applications. All completed installations are being performance monitored for a period of two years and the results of this are to be used to make best practice recommendations. Data collected to date shows that most systems are performing close to modelled predictions. There have been some discrepancies which have been mainly due to problems with inverter outages. These have demonstrated the necessity of automatic fault detection of the inverters to maximise system performance. In addition, two projects have recorded problems with the G59 relay tripping due to high grid voltage conditions. The systems installed within the programme are all high profile installations on public buildings and as such are playing an important role in raising public awareness of PV.

3 HIGHLIGHTS OF R&D

Academic research in the UK is largely funded by the Engineering and Physical Sciences Research Council (EPSRC). In addition to companies' internal research activities, some pre-competitive industrial Research and Development projects are supported by the Department of Trade and Industry (DTI) mainly under the Technology Programme.

The DTI's Technology Programme funds industrially focused collaborative research. Funded research projects relating to PV are currently focused on identifying, developing and evaluating novel materials and/or cell structures that offer significant improvements in performance, reliability and generation costs. One such project funded under the programme is led by Merck Chemicals. The project aims to synthesise new organic polythiophene based polymers and copolymers specially designed for PV. This will be followed by the subsequent development and evaluation of photovoltaic devices based upon these polymers. Such materials offer the possibility of substantial cost reductions for PV.

The EPSRC Sustainable Power Generation and Supply (Supergen) Project 'Photovoltaic Materials for the 21st Century' (PV21) was launched during 2004. The project consortium is

made up of six universities (University of Wales Bangor, University of Durham, University of Bath, University of Northumbria, University of Loughborough and University of Southampton) and seven companies. The project aims to reduce the cost of at least one class of solar cell by 50%, to use ultra thin structures to reduce costs and to reduce costs in silicon processing. It also aims to make efficiency improvements. The integrated PV21 team will work on silicon, cadmium telluride and copper indium di-selenide PV. Main accomplishments to date include the installation of major new materials preparation and characterisation plant. Technical achievements so far include:

- Progress towards novel light trapping and anti-reflection nano-structure silicon. These novel structures will enable much thinner silicon wafers to be used and will achieve greater light capture from solar radiation throughout the day.
- Development of an innovative electrochemical deposition method for copper indium diselenide (CIS) PV. This thin film process has the potential for considerable cost reductions.
- Fabrication of all-MOCVD (metal organic chemical vapour deposition) CdTe/CdS cells with 12% efficiency. MOCVD enables all the materials deposition and annealing steps to be carried out in one process, reducing manufacturing cost and reducing process variations.

PV-ERA-NET "networking and integration of national and regional programmes in the field of photovoltaic (PV) solar energy research and technological development (RTD) in the European Research Area (ERA)" was launched during 2004. The European project brings together national and regional photovoltaic research programmes from ministries, energy agencies and research councils from 11 countries. Its overall objective is to strengthen Europe's position in photovoltaic technology through increasing cooperation and coordination of fragmented research efforts. So far the network has focussed on exchanging information on the RTD programmes of the member countries. Survey Report 1, published in October 2005, gives an overview of each country and the different RTD programmes, examining the set up and strategy of the programme and its objectives and priorities.

The UK Energy Research Centre was opened during 2004. It is a central part of the £28 million cross-Research Councils programme Towards a Sustainable Energy Economy (TSEC) and is funded by three research councils: the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC) and the Economic and Social Research Council (ESRC). The Centre will provide a focus for energy research including PV in the UK, and for co-operation between the UK and researchers from other countries. PV focussed research falls under the 'Solar PV Research and Networking Programme', lead by Prof. David Infield of Loughborough University and also the 'Materials Processing for 3rd Generation Polymer Photovoltaics', led by Dr. Jenny Nelson of Imperial College London. The latter will assess various methods of material deposition from solution over large areas, using techniques such as contact printing. This work is supported by a DTI grant (total budget £1.2 million, over 3 years) and began in November 2005.

3.1 Public budgets for market stimulation, demonstration / field test programmes and R&D

Research funded by the EPSRC may be dedicated specifically to photovoltaic research, or may support more general research which may result in advances in photovoltaics as well as in other adjacent areas. In 2005, EPSRC provided £2.26 million in funding for photovoltaic

and photovoltaic-related research. This funding is part of both short term and long term projects including the Supergen PV materials for the 21st Century, as mentioned above.

Budgets for Pre-competitive R&D and Demonstration / Field Trials (supported by the Department for Trade & Industry) totalled £9.8 million* in 2005, this compares to £8.05 million in 2004 and £8.74 million in 2003.

Table 2: Public budgets for R&D, demonstration/field test programmes and market incentives.

		R & D (£)	Demo/Field test (£)	Market (£)
National	EPSRC	2 261 321	-	-
	DTI	650 000*	9 150 000*	-
Regional		n/a		
Total		12 061 321		

Table 2a: DTI funding (in £ million) for field trials and demonstration programmes.

Programme	**£ million**
Major Demonstration Programme (MDP)	8.05
Large scale BIPV and Residential field trials	1.1*
TOTAL	**9.15**

* These figures relate to the financial year 2005 to 2006 rather than the calendar year 2005 however the difference is between the figures for the two time periods is expected to be small.

Information on Regional funding programmes has not been accessible.

4 INDUSTRY AND GROWTH

4.1 Production of feedstocks, ingots and wafers

Crystalox, based in Wantage near Oxford, pioneered the development of directional solidification of multi-crystalline silicon as an industrial production process for the PV industry. The company has grown to become the world's largest producer of multicrystalline silicon, exporting to PV companies in Europe and Japan where the material is processed to produce cells for PV modules. Crystalox employs 90 staff at the facility in Wantage and reported a business value of £70 million. The company reported very strong demand for its multicrystalline silicon during 2005. No change in technology or facilities is expected for 2006. The company's production and production capacity during 2005 is summarised below in Table 3.

Table 3: Production and production capacity information for 2005 for silicon feedstock, ingot and wafer producers

Producer	Process & technology	Total Production during 2005 (MW equivalent)*	Maximum production capacity (MW equivalent)*	Product destination	Price
Crystalox	Multi crystalline-Si ingots	225	250	Europe and Japan	n/a

* Conversion factor used: 9.5-12. g/W

4.2 Production of photovoltaic cells and modules

PV cell and module production in the UK is summarised below in Table 4.

Table 4: **Production and production capacity information for 2005 for each manufacturer**

Module manufacturer	Technology	Total Cell Production (MW)	Maximum Cell production capacity (MW/yr)	Total Module Production (MW)	Maximum Module production capacity (MW/yr)
Sharp	sc-Si, mc-Si	Zero	Zero	39.98 MW	50 MW
Romag	sc-Si, mc-Si	Zero	Zero	0.5 MW	6-7 MW
GB Sol	sc-Si, mc-Si	Zero	Zero	0.3 MW	4 MW
Thin film manufacturers					
ICP Solar Technologies	a-Si	1.8 MW	3.5 MW	1.8 MW	3.5 MW
TOTALS		1.8 MW	3.5 MW	42.58 MW	63.5-64.5 MW

Sharp's first European module assembly plant in Wrexham opened in July 2004. The plant uses EVA lamination encapsulation and produced 39.98 MW of modules during 2005. The PV manufacturing plant employs 260 full time equivalent staff. PV cells used in the modules are imported from Japan. The plant produces 175 W and 165 W modules certified to IEC 61215. The typical warranty length for modules produced is 25 years. The majority of modules produced during 2005 were exported to mainland Europe with a small percentage being used for projects in the UK. About half of all modules exported are sold to Germany and the rest to Spain, Italy and France. Sharp introduced additional production lines during February 2006 increasing the facility's capacity from 50 MW to 110 MW.

Romag, a specialist glass processor, opened its new production facility in Consett in September 2004 for the manufacture of laminated glass Building Integrated Photovoltaic panels (BIPV). The lamination facility uses BP Solar crystalline silicon PV cells and produces glass/glass and glass/tedlar laminates. The BIPV panels can be produced up to 3.3m x 2.2m in size and can also be supplied in Insulating Units. The 6 MW production facility is now fully operational and has supplied BIPV into a number of projects, including the London Science Museum. Romag's panels are designed to form part of the structure of the building such as facades, roof tiles, doors and windows and can offer variable spacing of cells so as to allow maximum transparency or maximum power density, depending on the design concept. The company is certified to ISO 9001 and IEC 61215 certification is pending for some products. Typical product warranties are for 10 years. The company has no current plans for expansion of the facility.

GB Sol based in Taffs Well, South Wales started producing PV modules for power production during 2005. Prior to 2005 the company, which is part of the Energy Equipment Testing Service group of companies, manufactured very small modules for use in consumer applications. The company now has a range of five different modules from 60 to 120 W, which received IEC 61215 certification from TUV in 2005. The modules use single and multicrystalline cells which are imported from Q Cells in Germany. The plant uses EVA encapsulation in a vacuum laminator. Most of the modules produced are exported for use in remote power applications but some modules are used by the parent company for installation in the UK. The facility in Taffs Well employs 15 people.

ICP Solar Technologies UK Ltd (ICP UK) manufactures thin-film amorphous silicon cells and modules at its factory in Bridgend, South Wales. The company operates to ISO 9001-2000. ICP UK is part of the ICP Group of Companies, which has its head Office in Canada. It employs 33 staff at the Bridgend factory. ICP UK develops and manufactures advanced Thin Film Solar Cells (ATF) based on a-Si thin film technology. Recent investment in back-end process equipment has resulted in cell efficiency gains of up to 2%.

ICP UK increased production at the Bridgend factory from 1.5 MW in 2004 to 1.8 MW in 2005. Most of the company's production in 2005 was exported, 30 % of which to North America, 8 % to Europe, 29% to Asia and 32 % to Africa. The production figure also includes cells produced for a variety of consumer products manufactured in-house.

The average size of modules produced by ICP Solar at Bridgend is around 18 W however the company is currently developing modules up to 42 W modules.

Typical module prices are given in Table 5a below:

Table 5a: ICP Solar Technologies wholesale module prices

Size of order	Modules prices, £ per W
Orders <1kW	2.4
Orders 1-10kW	2.05
Orders>10kW	1.9

4.3 Photovoltaic modules prices

Average module prices are similar to those in 2004, typically around £3.7/W for reasonable volume orders. For small orders (few modules) retail prices range from approximately £3.4 /W up to £5 /W. Minimum prices remain the same as in 2004, around £2.4 /W for polycrystalline modules imported from mainland Europe. The higher prices reported (up to £8.22 /W) were paid for bespoke glass-glass laminates for one off building integrated projects.

Table 5: Average module prices for a number of years

Year	2001	2002	2003	2004	2005
Average retail module prices for small orders, £ (current)/W	4.24	4.24	4.02	3.8	4.3
Average retail module prices for large orders, £ (current)/W	-	-	-	3.6	3.7
Best price, £ (current)/W	-	-	2.3	2.4	2.4

4.4 New PV products

A new larger module in the Sanyo HIT (Heterojunction with Intrinsic Thin layer) range became available in the UK during 2005. The new module is rated at 210 W.

Lafarge Roofing offer two integrated PV roofing systems rated at 40 W and 80 W. Since 2005 the PV panels are now manufactured by Romag in Consett.

4.5 Manufacturers and suppliers of other components

A large proportion of balance of system components installed in the UK are imported from mainland Europe and sold through distributors in the UK.

PV inverters and their typical prices

Fronius and SMA are the most common manufacturers of PV inverters for grid connection available in the UK. A new larger sized SMA inverter became available in the UK during 2005. The 6000 has a rated output of 5.5 kW AC.

An approximate price range for a series of inverter sizes are presented in Table 5b.

Table 5b: Price (in current £) of inverters for grid-connected PV applications

Size of inverter	**<1kVA**	**1-10 kVA**	**10-100 kVA**	**>100kVA**
Average price of inverter per kVA (£)	500-1200	400-1000	~450	~450

For off-grid applications popular manufacturers include Xantrec /Trace, Victron and Studer.

Storage batteries

Batteries for PV applications available in the UK include Trojan, Elecsol Carbon Fibre, Rolls and Exide Solar. SEC battery, based in Corby, Northants manufacturers the Cellyte TSG Solar range of valve regulated rechargeable batteries designed for use in daily cyclic renewable PV Solar energy applications. The 6 and 12 volt batteries come in a range of capacities between 60 Amp Hours and 300 Amp Hours. The batteries have a design life up to 10 years.

Battery charge controllers

Charge controllers from a variety of manufacturers are available in the UK including Steca, Solarix, Morningstar, Trace, and BP Solar. One of the largest available is the Canadian OutBack MX60 which is rated up to 60 Amps DC and incorporates Maximum Power Point Tracking (MPPT). Several UK manufacturers exist including Sollatek of Slough which also has a range of other off-grid PV system components.

Supporting structures

The Solion's Sunmount system was launched during 2004 and offers a new solution to mounting PV modules on flat roofs without the need to penetrate the roof. The system uses a series of interlocking pieces made from recycled plastic and is designed to withstand wind speeds of more than 100 mph. The company now offers the product in a range of colours and at two different tilt angles.

Off grid PV powered street furniture

SolarGB of Leeds produces a wide variety of products using LED technology powered by small PV modules including amber flasher units, bollards, traffic lights, street lights and road studs (powered cats-eyes). They also offer a PV powered twin LED amber flasher unit for use on school safety zones and crossings or other warning zone applications such as cattle crossings.

Solagen Solutions produce a range of solar powered lighting products for public lighting and information and warning signs.

Advanced LEDs are a company specialising in LED products and solar lighting. The company provides solar lighting solutions for security/amenity lighting and the illumination of car park/ticket machines.

4.6 System prices

Table 6 below shows turn key prices for a range of typical PV applications in the UK.

Table 6: Turnkey Prices of Typical Applications

Category/Size	Typical applications in the UK	2005 prices, £ per W
OFF-GRID Up to 1 kW	Modules for leisure market (holiday homes, boats, caravans)	5.5-9.5
OFF-GRID >1 kW	Remote homes with battery storage or backup generator; Pumping Systems	5.5-9.5
GRID-CONNECTED Specific case	1-3 kW roof-mounted system, average price	6.1
GRID-CONNECTED Up to 10 kW	Roof or ground-mounted systems (e.g. for commercial building retrofits)	4.7-6.5
	One-off true building-integrated designs will be more expensive	6.0-15.2
GRID-CONNECTED >10 kW	Roof or ground-mounted systems (e.g. for commercial building retrofits)	3.4-6.0
	One-off true building-integrated designs will be more expensive	6.0-10.5

Table 6a: National trends in system prices (2005 £) for 1-3 kW roof-mounted system

YEAR	2000	2001	2002	2003	2004	2005
Price range per W:	5.4-7.6	6.0-9.3	4.7-13.9	4.7-14.2	4.3-10	3.4-15.2
Average price per W (£)	-	-	-	7.1	6.4	6.1

The range of prices takes into account the significant differences in the projects: the type of technology, the level of standardisation, level of integration etc. This is clearly illustrated by the approved prices for the Major Demonstration Programme (MDP) in 2005. Under Stream One (< 5kW) the average turnkey price for all systems was £6.3 /W. However the prices ranged from £4.5 /W up to £15.2 /W. The highest prices were paid for systems using fully integrated systems using PV roof tiles. The average turnkey price for a standard 1-3 kW system was £6.1 /W, compared to £6.4 /W in 2004 (at 2005 prices).

The prices for the projects approved in Stream Two of the MDP (> 5kW) in 2005 were similar to the small-scale projects. The costs ranged from £3.4 /W up to £10.5 /W with an average of £6.3 /W. The lowest reported turnkey system price in 2005 was £3.4 /W for a 42 kW retrofit system using thin film PV on a University building.

4.7 Labour places

An estimate of (full-time equivalent) labour places related to the photovoltaics sector in the UK is presented as Table 7. The total number of labour places is estimated at 716. This represents an increase of over 20% over the figure for 2004. The majority of this increase has been in system installation companies and at Sharp's module manufacturing facility.

Both the number of installation companies and the number of labour places in system installation increased during 2005. There were 55 PV installation companies in 2005 compared to 40 in 2004 and the number of labour places increased by 24% compared to 2004.

Table 7: Estimated PV-related labour places in the UK

Research and development (not including companies)	52
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	399
Distributors of PV products	37
System and installation companies	196
Utilities and government.	9
Other	23
Total	**716**

These figures were produced as a result of email questionnaires and personal discussions with most of the UK PV industry players.

4.8 Business value

As shown in Table 8, the total value of the PV business in the UK is estimated at £109 million. This estimate is calculated from the value of the installations completed during 2005, the value of export sales from PV manufacturers (figures provided by ICP Solar Technologies, Crystalox, Romag and estimated at £2.3 /W for Sharp and GB Sol), minus the value of imports of PV products. The value of imports is calculated assuming a wholesale price of £2.3 /W and assuming that 100% of all PV inverters installed are imported at a wholesale price of around £0.4 /VA.

Table 8: Estimated value of PV business

Sub-market	**Capacity installed *in 2005* (kW)**	**Price per kW (£)**	**Value (£)**	**Totals (£)**
Off-grid domestic	34	6 400	217 600	
Off-grid non-domestic	112	6 400	716 800	
Grid-connected distributed	2 567	6 100	15 658 700	
Grid-connected centralised	0	-	0	
Total value of PV installations				16 593 100
Export of PV products				162 343 000
Change in stocks held				unknown
Import of PV products				70 343 000
Value of PV business				**108 593 100**

5 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

5.1 New initiatives

Utility perception of PV

All UK Distribution Network Operators (DNOs) have experience of PV systems. Due to the low-level of PV penetration in the UK, the DNOs do not see solar electricity as a business priority at this time. Nevertheless, there is a general interest in PV issues, particularly by the DNOs in the south of the country where PV systems are more common, and all DNOs are keeping a watching brief to see how the sector develops.

Changes in public perceptions of PV

In general there is still limited awareness of PV among the general public. This is largely because PV is still too expensive for a homeowner to consider for their own home. Various initiatives and projects have been launched to encourage the use of PV and awareness is growing. Some local authorities are promoting PV by installing PV systems on their own buildings. The Suncities Project aims to install a total PV capacity of 400 kW in Kirklees, West Yorkshire and has similar targets for cities in the Netherlands and Germany. The UK part of the consortium is led by Kirklees Metropolitan Council. As part of the project the UK's largest grouped domestic PV installation was completed during 2005 and resulted in PV systems being installed on 100 council owned homes.

Other issues

Regional targets are being set for energy generation from renewable energy technologies including PV. For example, South West England has a renewable electricity target of 563-665 MW by 2010 as a result of the REvision 2010 project. Targets have been adopted by counties in the region and are being incorporated into county renewable energy strategies. Different UK regions are at different stages of adopting targets. In the East Midlands the Regional Planning Guidance (RPG8) proposes a target of 15.9 MW of photovoltaic capacity by 2010. The Scottish Executive has set a target of 40% of its electricity to be met by renewable energy by 2020.

Marketing of the Major Demonstration Programme was carried out by the Energy Saving Trust (EST), as part of their contract with the DTI to manage the overall scheme, in partnership with Halcrow (technical and monitoring partner). The EST was responsible for strategically developing the programme and dealing with installer accreditation, reporting, marketing, analysis and managing the application process. Marketing of the scheme was done via a website and by presentations at suitable energy efficiency, renewable energy and housing fora. The scheme is no longer accepting grant applications and since April 2006 has been replaced by the new Low Carbon Buildings Programme.

The Low Carbon Buildings Programme forms part of the new Government strategy for the promotion of microgeneration technologies. The term microgeneration includes the following small scale technologies: solar photovoltaics, small wind turbines, micro hydro, solar thermal, ground/water/air source heat pumps, bio-energy, renewable CHP, microCHP (combined heat and power) and fuel cells. The new Microgeneration Strategy aims to tackle the wider barriers to the development of sustainable markets for small scale renewables and micro-CHP. It sets out a list of wide-ranging actions, including an accreditation scheme for products and installers, a review of planning procedures, a pilot to

assess the benefits of smart metering, as well as the Low Carbon Buildings Programme, all of which should be of benefit to development of the PV industry.

The Low Carbon Buildings Programme will provide grants for microgeneration technologies including PV for householders, community organisations, schools, the public sector and businesses. In November 2005, the Energy Minister, Malcolm Wicks announced a new £30 million budget over 3 years for the programme. In the March 2006 budget statement, it was announced that there would be a further £50 million for the programme. This additional £50 million will be used for installations on large scale public buildings with the aim of reducing costs of microgeneration installations. The programme is UK wide (apart from the Channel Islands and the Isle of Man) and aims to demonstrate how energy efficiency and microgeneration will work hand in hand to create low carbon buildings. Minimum energy efficiency standards must be met before applying for a grant. As with the PV Major Demonstration Programme there are two streams, depending on the size of installation planned and the type of applicant. Under Stream One grants for PV are available up to a maximum of £3 000 per kW subject to an overall maximum of £30 000 or 50% of the relevant eligible costs, whichever is the lower. Under Stream Two, grants will be awarded on a competitive basis and up to a maximum of 50% of the capital and installation costs of the technologies installed.

A number of electricity utilities offer to pay for exported electricity from a PV system. These include:

- EDF Energy: If no export meter is fitted, EDF will pay £10 per year per kW installed. If an export meter is fitted, EDF will pay £0.0764 per kWh for exported electricity
- Powergen: will either estimate the exported electricity, or supply and install an export meter (paid for by the customer) under the *solarnet* scheme. £0.0688 to £0.0854 per kWh paid for export depending on the region.
- npower: will pay £0.05 per kWh for generation (not export), as read from the kWh meter for the PV system. No export meter required. Customers must sign up to npower's green electricity tariff, Juice.
- The Royal Society for the Protection of Birds' (RSPB) 'Going Solar' scheme, encourages people to use PV (and also solar water heating). The scheme offers 'solar loans' from the Co-operative bank together with a fixed price installation. The scheme also makes available a net metering arrangement through Scottish and Southern. An export meter is required.

VAT on professional installations of PV systems has been set at the reduced rate of 5 % since April 2000.

5.2 Indirect policy issues

The Renewables Obligation (RO) was introduced in the UK on 1st April 2002. The Renewables Obligation provides an incentive for the development of new renewable generating capacity that will be needed to meet the UK's target of 10% of electricity generation by 2010. The Renewables Obligation requires licensed electricity suppliers to source specified percentages of the electricity they supply from renewable sources, or make a 'buy-out' payment to Ofgem[2] for all or any part of the percentage which is not covered by

[2] The Office of Gas and Electricity Markets

the presentation of certificates. The percentage obligation level is set to increase each year from its current level of 5.5 per cent in 2005/06 to reach 15.4 per cent by 2015/16. The buyout payments made by suppliers under each order are combined into a fund, the proceeds of which are recycled to all suppliers in proportion to the extent to which they have correctly presented certificates. The penalty or buy-out price increases each year in line with inflation and is set at £0.03233/kW for 2005/2006.

The obligation is a technology-neutral support mechanism which provides the same level of subsidy for all eligible renewable technologies. This has meant that thus far it has encouraged the development of the least cost, nearest market renewable energy technologies, but has not thus far incentivised the longer-term renewable technologies that are presently more expensive such as photovoltaics. A total of 21 PV systems were registered for the renewables obligation as at the end of 2005. The 21 systems had a total capacity of 286 kW.

A review of the Renewables Obligation took place during 2005, with the aim of improving the effectiveness of the Obligation and strengthening the development of electricity generation capacity using renewable energy sources. Changes affecting PV and other small generators which are to be implemented in the Renewables Obligation Order 2006 include the removal of the sale and buy back requirement (previously, as ROCs were only issued for exported power, a small generator had to sell and buy back the electricity if it was to take advantage of the RO), and the allowing of agents to act on behalf of the owner of the small generator and amalgamate output from a number of different generating stations.

A previous consultation on the Renewables Obligation took place in 2004 and the following measures in the Renewables Obligation Order 2005 came into force on 1 April 2005:

- Extension of the level of the Renewables Obligation beyond 2010/11 to 2015/16;
- Allowing tradeability between Northern Ireland Renewables Obligation Certificates (NIROCs) and Great Britain ROCs;
- Introduction of measures that will further secure the buy-out fund in the event of a shortfall occurring;
- Introduction of more flexibility for small generators.

Renewable Energy Guarantees of Origin (REGOs) were introduced in 2003 to enable producers of renewables electricity to demonstrate that the electricity they sell is produced from renewable sources. This will in turn enable electricity suppliers to use REGOs to demonstrate that the electricity to which the REGO applies is generated from renewable sources for the purpose of green electricity tariffs. REGOs are issued in units of 1kWh, making the scheme attractive to smaller generators including PV. The scheme works alongside the existing RO.

The British Electricity Transmission and Trading Arrangements (BETTA), came into effect on 1 April 2005, and have brought into existence a single electricity market for Great Britain by introducing a single set of trading rules across Great Britain, thereby reducing barriers faced by independent generators. As the arrangements only apply to wholesale generation, PV is largely unaffected, except in as much as the reduction in retail electricity price implies a divergence from economic viability for PV power.

The 'Climate Change Levy' (CCL) on non-domestic use of energy was introduced on 1st April 2001. The levy on electricity is set at £0.0043/kWh, plus VAT. Renewable energy, however, is exempt from the levy and businesses that sign up to a renewable energy tariff can avoid

paying the CCL. To avoid being charged the levy, businesses need to sign a contract with a supplier containing a 'renewable source declaration'. This ensures that for every kWh that is used, a kWh of electricity is generated from renewable energy sources. However, the CCL itself is unlikely to stimulate significant growth in PV, as for the foreseeable future, PV generated electricity will remain significantly more expensive than conventional electricity (even with the levy imposed) and other renewable energy technologies such as wind and landfill gas that are closer to the bulk electricity price.

The UK Energy White Paper was published in March 2003. The White Paper restates the UK's goal of a 60 % reduction in CO_2 emissions by 2050 and calls for 10 % renewables generated electricity by 2010 with an ambition to extend the policy to 2020. Since then, the Renewables Innovation Review was published in February 2004 and stated that PV was not expected to be fully economic in terms of the cost of the electricity produced until after 2020 although a next generation solution could bring forward economic entry. The review identified the key renewable technologies for the delivery of the UK targets and aspirations for renewables; the barriers to the development and deployment of the key renewable technologies; and, the most cost effective Government measures to facilitate delivery of the UK targets.

In January 2006 an Energy Review was announced and a consultation entitled "Our Energy Challenge: securing clean, affordable energy for the long term" launched. The consultation has a broad scope and considers all aspects of the energy system including both energy supply and demand.

Planning Policy Statement 22 (PPS 22) and its Companion Guide are intended to encourage the appropriate development of further renewable energy schemes throughout England. The guide advises planners how to implement PPS22 in their local communities. It explains what makes a 'good' renewable energy application, how to assess the impact of plans on the landscape and how to give the community greater involvement. The guide provides advice on the broad range of renewable energy technologies, including biomass, hydro, solar and wind. It aims to provide planners with the guidance they need to make informed decisions, enabling the renewable energy sector to expand while safe-guarding the interests of local communities and the environment. The UK government committed to a review of PPS 22 (which was originally published in 2004) in February 2006.

Regional policies favouring and encouraging renewables include the London energy strategy which requires new developments over 1000m^2 to obtain 10% of its energy requirement from renewables as well as aiming for 7000 domestic PV systems to be installed by 2010.

5.3 Standards and codes

The Code for Sustainable Homes was issued by the Office of the Deputy Prime Minister (ODPM) for consultation in December 05. The code is intended as single national standard for the sustainability performance of new dwellings. The proposed code covers energy, water, waste and materials as well as other elements such as sound insulation and security. In the light of the consultation, some revisions to the Code will be made to strengthen it including the provision that new homes using micro-generation technologies such as wind turbines and solar PV panels will gain extra points under the Code.

International Standards for PV Systems and components are developed and published under the auspices of the International Electrotechnical Commission (IEC), through its Technical Committee No.82 (TC/82). European Standards are also made in a similar way

by the European Committee for Electrotechnical Standardisation (CENELEC), through committee CLC/TC/82. International and European Standards, once released, automatically become British Standards, and are published by the British Standards Institution (BSi).

The UK participates in the work of IEC/TC-82 and CLC/TC-82 through the British National Committee established by BSi, BSi/GEL-82. The UK has appointed experts to most of the Working Groups (WGs), as shown in Table 14.

Table 9: IEC committees and UK Representation

Committee		**UK Representation**
IEC/TC-82	International Standards	Yes
WG1	Glossary	No
WG2	Modules	Yes
WG3	Systems	Yes
WG5	Quality and Certification	Yes
WG7	Concentrators	Yes
JCG TC82/88/21	Rural Electrification	Yes
CLC/TC/82	European Standards	Yes

An Action Plan for UK participation in standardisation was prepared by a PV-UK team in 1999 and is still under discussion. UK representatives will contribute to the next IEC/TC-82 meeting in Japan in October 2006.

The UK also has a member on the Board of the Global Approval Programme for Photovoltaics (PV-GAP). PV-GAP publishes Recommended Specifications as an interim measure while IEC/TC-82 develops full standards.

The European Energy Performance of Building Directive (EPBD) is being implemented in the UK by the revised Approved Documents L of the Building Regulations which will come into effect in April 2006. The amendments made will raise performance standards and set maximum carbon dioxide emissions for whole buildings. This performance-based approach enables designers to choose solutions that best meet their needs, and that are cost-effective and practical. The raised performance standards will provide a strong incentive to designers to consider Low and Zero Carbon systems including PV.

A review of the Department of Trade and Industry's Photovoltaics in Buildings: Guide to the installation of PV Systems took place during 2004 and 2005. The document was first published in 2002 and aims to provide best practice guidance on the installation of small scale (less than 5 kW) PV systems. The revised guide will be published in 2006.

The grid connection of PV systems is governed by two engineering recommendations made by the Electricity Association:

- G 83/1 'Recommendations for the connection of small-scale embedded generators (up to 16A per phase) in parallel with public low voltage distribution networks' contains a generic first section addressing the network requirements of all distributed micro-generators (including PV and micro-CHP), complemented by a series of annexes

focusing on technology-specific issues, including annex C on photovoltaics. Under G83/1 the generator is required to inform the DNO on the day of connection and then provide full details within 30 days.

- Grid-interconnection of PV systems over 16 Amps per phase is governed by Engineering Recommendation G.59/1, Amendment 1 (1992) and Amendment 2 (1995), *'Recommendations for the Connection of Embedded Generating Plant to the Public Electricity Suppliers' Distribution Systems'*.

6 HIGHLIGHTS AND PROSPECTS

2005 saw continued growth of the UK PV industry, both in terms of installed capacity, manufacturing output and number of staff employed in PV activities.

The vast majority of new installed capacity in 2005 was part funded under the UK Government funded Major Demonstration Programme. This programme ended in March 2006 and the final installations funded by the scheme will be completed by March 2007. Continued grant support will be provided by the Low Carbon Buildings Programme which forms part of the new Government strategy for the promotion of microgeneration technologies (small scale renewables and micro-combined heat and power including PV, small wind, solar water heating etc.).

The new Microgeneration Strategy aims to tackle the wider barriers to the development of sustainable markets for small scale renewables and combined heat and power. It sets out a list of wide-ranging actions, including an accreditation scheme for products and installations, a review of planning procedures, a pilot to assess the benefits of smart metering, as well as the Low Carbon Buildings Programme, all of which should be of benefit to development of the PV industry.

Public funding for PV research and development is focused on supporting projects to develop novel materials offering significant improvements in performance, reliability and generation costs. There are several long term projects under way involving industry and universities. Encouraging results are beginning to emerge.

Annex A: Method and accuracy of data

The Energy Savings Trust provided access to their information on installations funded under the Major Demonstration Programme. Other data was gathered directly from most of the UK industry players via e-mail questionnaires and personal discussions. The various data was collated in a spreadsheet, sorted into the required categories and totalled.

The estimated accuracy of the year 2005 data is ± 10 %, except for data relating to the new installed generation capacity in the grid-connected distributed sector and UK production where the accuracy is estimated to be ± 5 % or better.

Annex B: Country information

This information is simply to give the reader some background about the national environment in which PV is being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they require more detailed data.

1) Retail electricity prices

	Household	Commercial (Manufacturing)	Public institution
Retail electricity prices (Year and reference)	£0.0864/kWh (2005, DTI press release P/2006/082)	£0.04141/kWh, (2005, DTI Energy prices Table 3.1.3)	Unavailable

The costs above do not include taxation. Electricity is taxed at 5% for domestic and small users (up to 33 kWh per day) and 17.5% for commercial users. In addition there is a Climate Change Levy of £0.043/kWh on commercial use for non-renewable electricity.

2) Typical household electricity consumption (kWh)

3 300 kWh/year (DTI)

3) Typical metering arrangements and tariff structures for electricity customers.

Domestic customers have a choice of credit, direct debit and pre-payment meters, of which pre-payment meters have a slightly higher tariff and direct debit, where a fixed amount is automatically debited from the customer's account each month, is slightly cheaper. The majority of customers pay a small standing charge and are then charged per kWh of electricity used. Some customers, particularly those with electric heating and hot water use an economy 7 tariff which has a lower rate for electricity used during off-peak times.

Domestic contracts are usually rolling contracts with the option of cancelling at any time and moving to a different supplier within 28 days. Industrial and commercial contracts are usually for a fixed amount of time. A contract could be for a set amount of years, normally between 1 and 5 years for a small to medium business.

4) Typical household income

According to the Office of National Statistics Family spending survey 2004-2005 the average annual household gross income in the UK was £31 252.

5) Typical mortgage interest rate

The average interest rate in the UK in 2005 was 6.4 % (Council of mortgage lenders)

6) Voltage

Household	230V 50 Hz AC
Distribution	11 kV and 33kV 50 Hz AC

7) Electricity industry structure and ownership

The liberalisation process of the UK electricity industry started in 1990 and has created a highly competitive market underpinned by open access to transmission and distribution networks. Privatisation of the industry has created different structures for England & Wales, Scotland and Northern Ireland. However, all are based on the same principles. In England and Wales, the monopoly transmission and distribution businesses are clearly separated from those based on competition, so that no supplier is put at a disadvantage in the competitive process. Where the generation market was once totally dominated by a single supplier, it now includes about 40 companies regarded as major power producers.

Electricity is traded in bulk on a wholesale market heavily revised in 2001 to bring it more in line with other commodity markets and reduce opportunities for price manipulation by major players. National Grid has a focal role as the owner and operator of the principal high voltage highways of power. The distribution networks operate at lower voltages within each designated region. They are monopoly businesses, legally separated from the competitive retail activity.

Further information on the UK electricity industry can be obtained from the following organisations:

- Ofgem (The Office of Gas and Electricity Markets) is the regulator for Britain's gas and electricity industries. Its role is to promote choice and value for all customers.
- The Association of Electricity Producers
- The Energy Networks Association (ENA) represents the licensed gas and electricity transmission and distribution companies in the UK.
- The Energy Retail Association, formed in 2003, represents suppliers in the competitive UK energy market.

8) Price of diesel fuel

£0.9086/litre (December 2005, DTI Energy Prices Table 4.1.1

9) Typical values of kWh / kW for PV systems

The industry agreed figure for annual average electricity production of a PV system is 750 kWh / kW/ annum.