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 United Kingdom 2007

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June 2008

Department for Business Enterprise and Regulatory Reform

Department for Business Enterprise and Regulatory Reform

Client contract No.: S/P2/00492/00/00

IT Power reference: 1039

UK National Status Report 2007

May 2008

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Document control	
File path & name	I:\0WorkITP\0Projects\1039 IEA PVPS Task 1\2 Work\1_NSR\2007\Report\UK NSR 2007 v1.0.doc
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Approved	Not approved
Distribution level	Draft

Template: ITP REPORT Form 005
Issue: 02; Date: 27/08/04

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Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

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^oC, 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/TVA/sales taxes, 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.

Currency: The currency unit used throughout this report is Great Britain Pound (GBP)

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

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems. An important deliverable of Task 1 is the annual Trends in photovoltaic applications report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the UK's National Survey Report for the year 2007. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 EXECUTIVE SUMMARY

1.1 Installed PV power

The annual installed PV capacity in 2007 was 4020 kW. This compares to 2700 kW in 2005 and 3400 kW in 2006. The cumulative installed PV generation capacity increased by 22 % during 2007 reaching a total of 18.3 MW. Government support through the Low Carbon Buildings Programme and other grants supported approximately 85% of the total new capacity. Figure 1 shows the cumulative installed PV capacity up to the end of 2007.

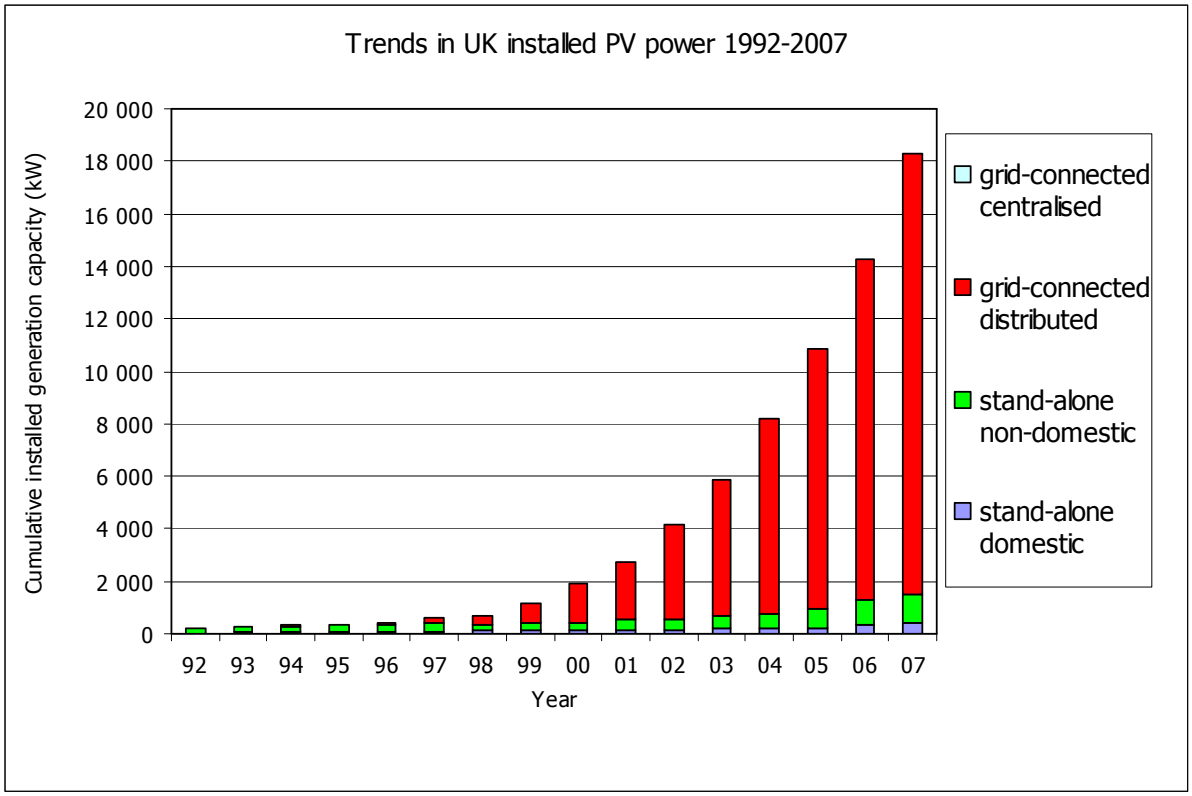

Figure 1: Cumulative installed PV capacity up to the end of 2007

1.2 Costs & prices

Average retail module prices are similar to those in 2006, typically around GBP 3.6 per W for reasonable volume orders. For small orders (few modules) retail prices are around GBP 3.8 per W. Minimum prices are slightly higher than in 2006, around GBP 3.0 per W for polycrystalline modules imported from mainland Europe.

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 installed prices ranged from GBP 3.4 per W to GBP 9.4 per W. However the average turnkey price for a standard 1-3 kW system was GBP 7.4 per W, compared to GBP 6.3 per W in 2006.

1.3 PV production

Crystalox Limited, an operating subsidiary of PV Crystalox Solar plc is one of the world's largest producers of multicrystalline silicon ingots, exporting to PV companies in Europe and Japan. In 2007 the company produced multicrystalline silicon ingots sufficient for 190 MW.

Sharp's module assembly plant in Wrexham uses EVA lamination encapsulation and produced 124 MW of crystalline PV modules during 2007. The company doubled its production capacity during 2007 to 220 MW

Romag's Building Integrated Photovoltaic (BIPV) lamination facility in Consett produced 4 MW in 2006. The facility doubled its capacity to 12 MW in 2007 with a further 16 MW under construction.

GB Sol based in Taffs Well, South Wales produced 0.5 MW of crystalline modules.

Epod Solar Wales in Bridgend produced 1.52 MW of amorphous silicon PV cells and modules in 2007. The Bridgend facility formally owned by ICP Solar Technologies was sold to EPOD in May 2007 and the company is now known as Epod Solar Wales.

1.4 Budgets for PV

Budgets for Pre-competitive R&D and Demonstration / Field Trials (supported by the Department for Business Enterprise and Regulatory Reform (BERR), The Northern Ireland Department for Enterprise, Trade and Investment (DETI) and The Engineering and Physical Science Research Council) totalled GBP 17.1 million in 2007. This compares to a total of £15.03 million in 2006. A large proportion of this funding (GBP 9.5 million) has been for the demonstration and field trial programmes, provided by BERR and DETI.

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 2007 statistics if the PV modules were installed between 1 January and 31 December 2007, although commissioning may have taken place at a later date.

2.1 Applications for photovoltaics

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 increasingly common. A total of 160 kW was installed off-grid in 2007.

The table below presents an overview of stand-alone applications for photovoltaics in the UK, categorised by end-users. Some 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
National Trust, Youth Hostel Association, etc.	• Remote visitor centres / hostels • Wardens' huts and workshops
Universities, Research Laboratories	• Remote monitoring of equipment

END-USERS	TYPICAL APPLICATIONS
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)

2.2 Grid-connected applications

The total capacity of grid connected installations during 2007 was 3 860 kW, which represents 96% of the annual total.

The majority of grid connected PV installations are building integrated.

2.3 Total photovoltaic power installed

The total PV capacity installed during 2007 was 4020 kW.

Table 1: Total PV power installed during 2007 in 4 sub-markets.

Sub-market/ application	off-grid domestic	off-grid non-domestic	grid-connected distributed	grid-connected centralized	total
PV power installed in 2007 (kW)	90	70	3 860	0	4020

A summary of the cumulative installed PV Power, from 1992-2007, broken down into four sub-markets is shown in Table 2.

Table 2: The cumulative installed PV power in 4 sub-markets.

	Cumulative installed capacity as at 31 December															
Sub-market	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Stand-alone domestic	7	47	52	57	69	83	108	119	121	135	162	172	193	227	320	420
Stand-alone non-domestic	166	213	232	252	279	316	254	276	302	385	406	542	585	697	980	1 050
Grid-connected distributed	0	6	54	59	75	190	328	736	1 506	2 226	3 568	5 189	7 386	9 953	12 960	16 830
Grid-connected centralised	0	0	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	14 260	18300

The cumulative installed power includes power installed before 1992.

The stand alone installed capacity in 2006 differs from that published in the International Trends Report 2006 due to one installer submitting information after the Trends report had gone to press.

2006 and 2007 figures are reported to the nearest 10 kW.

2.4 Key PV policy initiatives, promotional activities and other market drivers of significance in 2007

2007 saw the continued implementation of the Government's Microgeneration Strategy for Great Britain (launched in 2006). The term microgeneration effectively refers to low and zero carbon technologies (<50kW electricity and <45kW heat). It includes solar photovoltaics, small wind turbines, micro hydro, solar thermal, ground/water/air source heat pumps, bio-energy, renewable CHP, micro-CHP (combined heat and power) and fuel cells. The objective of the new strategy is to create conditions under which microgeneration becomes a realistic alternative or supplementary energy generation source for the householder, communities and small businesses.

Progress during 2007 included the development of a certification scheme for products and installers and a code of practice **www.microgenerationcertification.eu**. A trial of smart meters for households was launched in August 2007.

The Low Carbon Buildings Programme forms part of the microgeneration strategy and provides grants to support installations of microgeneration technologies including PV for householders, community organisations, schools, the public sector and businesses. 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. A total of GBP 80 million was announced for the 3 year programme. GBP 50 million of which is to be used for public sector and not for profit organisations with the aim of reducing costs of microgeneration installations. The programme has been extremely popular with householders; an additional GBP 6 million for the householder stream was announced in March 2007 (see **www.lcbp.org.uk**) and the grant available to householders was reduced to GBP 2500. By the end of 2007 there was GBP 11 million in grants available under Phase 1 for householders and GBP 44 million remaining for the public sector.

In Northern Ireland, where energy is the responsibility of the Northern Ireland Assembly, the Energy and Environment Fund was launched in February 2006 and later renamed as Reconnect. This package of funding included GBP 8 million over two years for householders installing renewable energy systems including PV. Additional funding was made available for promotion of renewable energy.

Northern Ireland Electricity, the Department of Agriculture and Rural Development and the Education and Library Boards in Northern Ireland have been working in partnership as part of the Switched on Schools programme which aims to install solar photovoltaic panels at 21 rural schools throughout Northern Ireland as well as 25 renewable streetlights at 9 of the schools.

Other highlights include the Code for Sustainable Homes, a voluntary initiative in England, by Government and Industry, to actively promote the transformation of the building industry towards more sustainable practices. The code was launched by the Department for Communities and Local Government in December 2006. It is a standard for key elements of design and construction which affect the sustainability of a new home. There are minimum standards for energy and water efficiency at every level of the Code, with the lowest levels raised above the level of mandatory building regulations. The higher levels of the code require the installation of Microgeneration technologies such as PV.

The Government announced its intention for all new homes to be zero carbon by 2016 with a major progressive tightening of the energy efficiency building regulations - by 25% in 2010 and by 44% in 2013 - up to the zero carbon target in 2016.

Local planning policies, requiring new developments or refurbishments to include on-site renewables have also become increasingly important in encouraging PV as well as other small scale renewables.

While many of the large utilities have announced their support of microgeneration technologies including PV, seeing potential particularly within the domestic market, export tariffs for microgenerators vary widely between different electricity suppliers. Arrangements are structured in different ways making comparison difficult for consumers. Domestic customers may be offered around 0.06 to 0.08 GBP/kWh for export, which is similar or less than the average retail price of electricity. Alternatively between 0.035 and 0.045 GBP/kWh for total generation may be offered. Many such preferential rates are available only to domestic customers. Further information is provided in section 0.

Northern Ireland Electricity continued to offer top up grants for PV installations in Northern Ireland during 2007, providing an extra 15% of the total capital cost in addition to the government grants.

2.5 PV implementation highlights, major projects, demonstration and field test programmes

During 2007 85% of all PV installations in the UK received grant support from one of the government grants programmes. The programmes, together with the installed capacity supported were as follows (projects can only receive support from one of these schemes):

- Major Demonstration Programme 1433 kW
- Low Carbon Buildings Programme (Householders) 1295 kW
- Low Carbon Buildings Programme (Larger projects) 526 kW
- Reconnect fund (Northern Ireland only) 124 kW
- Switched on Schools (Northern Ireland only) 105 kW

The Major Demonstration Programme closed for applications in March 2006 but installations under the programme continued until April 2007. The programme provided up to 50% capital grants for PV installations during 2007 with maximum levels per kW set for small scale installations (<5kW).

The Low Carbon Buildings Programme has proved to be very popular with householders. The grants available to householders were reduced due to high demand. From May 2007 Photovoltaic installations were eligible for a maximum of GBP 2 000 per kW of installed capacity, subject to an overall maximum of GBP 2 500 or 50% of the relevant eligible costs, whichever is the lower.

For larger projects including community organisations and small and medium enterprises, successful applicants receive up to 50% of their total eligible installation cost with a maximum grant of 1 000 000 GBP. These projects aim to deliver standard low carbon buildings across different sectors. Projects aim to demonstrate the business case for these low carbon developments and are used to encourage replication working with the construction industry. Phase 2 of the programme has a clear focus on schools, reducing carbon emissions in schools and educating students and communities about renewable energy.

The Re-connect scheme provided householders in Northern Ireland with up to 50% of the total installed cost. 38 systems were supported during 2007, totalling 124 kW. The total Reconnect grant support for PV during 2007 totalled GBP 335 808. The scheme closed to new applications in March 2008.

Northern Ireland Electricity (NIE) provided a grants for 57 projects (273 kW) during 2007, providing an additional 326 000 GBP. 35 of the grants were 15% top up grants for projects receiving funding under the LCBP or the Northern Ireland Reconnect scheme. The grants also included contributions to the Switched on Schools programme

UK PV installation highlights during 2007 include the completion of a large solar shading array using thin film PV for Manchester University. The highly visible 42 kW installation uses semi-transparent thin film photovoltaic laminate modules mounted to provide shading to the building atrium below.

2.6 Highlights of R&D

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 Government funded Technology Strategy Board. Within a new call launched in Autumn 2007, the Board sought proposals for research into whole systems approaches to integrating microgeneration in buildings and also for PV technology Research and Development that significantly reduces costs and improves efficiencies.

The EPSRC Sustainable Power Generation and Supply (Supergen) Programme supported two multi-disciplinary consortia focused on advanced PV materials during 2007:

- The 'Photovoltaic Materials for the 21st Century' consortium was launched during 2004 and aims to develop low-cost thin-film solar cell devices fabricated from inorganic semiconductors. This thin film process has the potential for considerable cost reductions. The project has been approved for funding for a further four years from 2008.

- The Supergen Excitonic Solar Cells consortium, led by the University of Bath, is researching dye and nanoparticle- sensitized and organic cells which may offer the possibility of low toxicity, flexible and easy to manufacture PV materials. Consortium members are concentrating on understanding the factors which limit efficiencies as well as on combining their expertise to devise entirely new types of solar cells.

NaREC's Photovoltaic Technology Centre was officially opened in October 2006. It is the only commercial crystalline cell research and development laboratory in the UK. Using a pilot production line, NaREC is creating new manufacturing techniques, working to provide the rapidly expanding photovoltaics industry with the bespoke manufacturing operations it needs.

The **Carbon Trust** is an independent company set up by the government in 2001 to work with organisations to develop commercial low carbon technologies. In 2007 it announced its selection of Cambridge University and the Technology Partnership as preferred bidders to develop the Advanced PV Research Accelerator. The initiative will focus on in line, roll to roll manufacturing processes to fabricate organic solar cells. It aims to produce organic PV modules of 5% efficiency with a lifetime of 5 years.

2.7 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 2007, the EPSRC provided GBP 6.5 million in funding for photovoltaic and photovoltaic-related research. This funding is for 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 Business and Regulatory Reform -BERR[1]) totalled GBP 17.2 million, this compares to GBP 15.03 million in 2006 and GBP 9.8 million in 2005.

Table 3: Public budgets for R&D, demonstration/field test programmes and market incentives.

		R & D (GBP)	Demo/Field test (GBP)	Market incentives (GBP)
National	EPSRC	6 472 284	-	-
	BERR	1 100 000	9 192 200	-
Northern Ireland Re Connect Programme		-	335 808	-
Northern Ireland Education & Library Boards (Switched on Schools Programme*)		-	120 000	-
Total		17 220 292		

* The total funding for the Switched on Schools programme totaled GBP 750 000, of which GBP 562 800 was funded under the EU Building Sustainable Prosperity Programme (BSP), GBP 120 000 from the Education & Library Boards and the balance of approximately £70,000 from Northern Ireland Electricity.

Table 3a: BERR funding (in GBP million) for field trials and demonstration programmes

Programme	GBP
Major Demonstration Programme (MDP)	4 444 500
Large scale BIPV and PV Residential field trials	125 000
Low Carbon Building Programme (PV only)	4 622 700
TOTAL	**9 192 200**

[1] Formally the Department for Trade and Industry

3 INDUSTRY AND GROWTH

3.1 Production of feedstocks, ingots and wafers

Crystalox Limited, an operating subsidiary of PV Crystalox Solar plc, 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 one of the world's largest producers of multicrystalline silicon ingots, exporting to PV companies in Europe and Japan where the material is processed to produce cells for PV modules. The company has a planned expansion of production capacity from 290MW to 350MW, to be completed in the first quarter of 2009.

Table 4: Production and production capacity information for the year for silicon feedstock, ingot and wafer producers

Producer	Process & technology	Total Production	Maximum production capacity	Product destination	Price
Crystalox	mc-Si ingots	190MW	290MW	Europe and Japan	n/a

3.2 Production of photovoltaic cells and modules

Total PV cell and module manufacture together with production capacity information is summarised in Table 4 below.

Table 5: Production and production capacity information for 2007 for each manufacturer

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)			Maximum production capacity (MW/yr)		
		Cell	Module	Concentrators	Cell	Module	Concentrators
Crystalline silicon PV manufactures							
Sharp	sc-Si, mc-Si	*Zero*	124	*zero*	*zero*	220	*zero*
Romag	sc-Si, mc-Si	*zero*	4	*zero*	*zero*	12	*zero*
GB Sol	sc-Si, mc-Si	*zero*	0.5	*zero*	*zero*	3	*zero*
Total		*zero*	129	*zero*	*zero*	235	*zero*
Thin film manufacturers							
EPOD Solar Wales	a-Si	1.52	1.52	*zero*	2	2	*zero*
TOTALS		**1.52**	**130**	***zero***	**2**	**237**	***zero***

Sharp's module assembly plant in Wrexham uses EVA lamination encapsulation and produced 124 MW of crystalline PV modules during 2007. The PV manufacturing plant employs 447 full time equivalent staff. PV cells used in the modules are imported from

Japan. The plant produces a range of modules from 162 W to 210 W modules certified to IEC 61730. The typical warranty length for modules produced is 25 years. The majority of modules produced during 2007 were exported to Germany with a small percentage being used for projects in the UK. Total production capacity was increased from 110 MW in 2006 to 220 MW in 2007. The company operates to ISO 9000 and ISO 14000.

Romag's photovoltaic lamination facility in Consett uses crystalline silicon PV cells and produces glass/glass and glass/tedlar laminates. The facility produces a full range of both standard and building integrated PV up to 2.2m x 3.6m for facades, roof top, louvres, solar shading, tracker systems etc. The facility doubled its capacity to 12 MW in 2007 with a further 16 MW under construction. The company is certified to ISO 9001 and its standard products SMT 155 and SMT 180 are certified to IEC 61215, three further products were submitted for certification during 2007 and are expected to be approved during 2008.

GB Sol based in Taffs Well, South Wales started producing PV modules for power production during 2005. The plant uses EVA encapsulation in a vacuum laminator. The company produces a range of modules from 2 to 200 W. 20 % of the modules produced during 2007 were exported. The facility in Taffs Well employs 8 staff.

Epod Solar Wales manufactures thin-film amorphous silicon cells and modules at its factory in Bridgend. The company operates to ISO 9001-2000. The Bridgend facility was sold by the ICP Group of Companies to EPOD in May 2007. The facility produced a total production of 1.52 MW in 2007 (compared to 1.9 MW in 2006). 100% of the company's production in 2007 was exported to Africa. During 2007 20 staff were employed at the Bridgend factory. The new owners plan to increase capacity to 5 MW by the end of 2008, with a further 5 MW expansion planned for the next two years.

G24 Innovations Ltd started production of dye sensitized solar cells (DSSC) on a commercial scale at a facility in Cardiff, Wales in early 2007. The facility produces a variety of solar lighting and consumer products.

3.3 Module prices

Average retail module prices are similar to those in 2006, typically around 3.6 GBP/W for reasonable volume orders. For small orders (few modules) retail prices range from approximately 3.8 GBP/W. Minimum prices are slightly higher than in 2006, around 3 GBP/W for polycrystalline modules imported from mainland Europe.

Table 6: Typical module prices for a number of years

Year	2001	2002	2003	2004	2005	2006	2007
Average retail module prices for large orders, GBP (2007)/W	4.6	4.6	4.4	4.1	4.0	3.6	3.6
Average retail module prices for small orders, GBP (2007)/W	4.7	4.7	4.5	3.9	4.7	4.1	3.8
Best price, GBP (2007)/W						2.5	3.0

3.4 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.

3.4.1 PV inverters

The most popular inverters being used for grid connected applications are SMA and Fronius, both of which are imported from Germany and Austria respectively.

3.4.2 Storage batteries

SEC Industrial Battery Company introduced two new Monobloc batteries in 2007:

- The CELLYTE 2ETGB tubular plate deep cycle gel range of batteries come in capacities of 100-300 Ah and have a 15 year design life.
- The CELLYTE 6-12TSG flat plate deep cycle gel batteries Range use tin alloy and are fitted with a VRLA Catalyst for normal battery life even when operated at 30°C. The range has a 10 year design life and is made in capacities of 20 Ah to 250 Ah.

3.4.3 Supporting structures

Solar century launched its complete solar roof which uses its C21e solar electric tiles and C21t solar thermal tiles generating electricity and hot water respectively.

3.5 System prices

Table 7: Turnkey Prices of Typical Applications

Category/Size	Typical applications and brief details	Price per Wp in GBP
OFF-GRID Up to 1 kW	Modules for leisure market (holiday homes, traffic monitoring, bus stops)	5-7.5
OFF-GRID >1 kW	Remote homes with battery storage or backup generator	5-11
ON-GRID Specific case	1-3 kW domestic roof mounted	3.4-9.3
ON-GRID up to 10 kW	Roof or ground-mounted systems (e.g for commercial building retrofits)	4.5-9.0
ON-GRID >10 kW	e.g. 20 kW roof mounted system (on commercial / industrial buildings)	4.6-8.9

Table 7a: National trends in system prices (current) for 1-3 kW domestic roof mounted

YEAR	2000	2001	2002	2003	2004	2005	2006	2007
Price /W:	5.9-8.3	6.5-10.0	5.1-15.1	5.4-16.3	5.0-11.5	5.2-16.5	4.6-10.3	3.4-9.4

3.6 Labour places

An estimate of (full-time equivalent) labour places related to the photovoltaics sector in the UK is presented as Table 8. The total number of labour places is estimated at 1066. This represents an increase of 19% over the figure for 2006. The majority of this increase has been within manufacturing.

Table 8: Estimated PV-related labour places in the UK

Research and development (not including companies)	51
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	634
Distributors of PV products	85
System and installation companies	263
Utilities and government	10
Other	24
Total	1066

3.7 Business value

As shown in Table 10, the total value of the PV business in the UK is estimated at 205 million GBP. This estimate is calculated from the value of the installations completed during 2007, the value of export sales from PV manufacturers (figures provided by Crystalox and estimated at 1.9 GBP/W for EPOD Solar Wales, 2.5 GBP/W for Sharp and GB Sol and 3 GBP/W for Romag), minus the value of imports of PV products. The value of imports is calculated assuming a wholesale price of 2.5 GBP/W and assuming that 100% of all PV inverters installed are imported at a wholesale price of around 0.4 GBP/VA.

Table 9: Value of PV business

Sub-market	**Capacity installed in 2007 (kW)**	**Price per kW (GBP)**	**Value (GBP)**	**Totals (GBP)**
Off-grid domestic	90	6000	540000	
Off-grid non-domestic	70	6000	420000	
Grid-connected distributed	3100	6310	19561000	
Grid-connected centralised	0	-	0	
Total value of PV installations				*25 316 600*
Export of PV products				*415 043 000*
Change in stocks held				*unknown*
Import of PV products				*234 929 000*
Value of PV business				***205 430 600***

4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

Table 10 lists the main support measures for PV in the UK during 2007. Further details on these are provided on the following pages.

Table 10: PV support measures

	On going measures	Measures that commenced during 2007
Enhanced feed-in tariffs	No	-
Capital subsidies for equipment or total cost	Yes, national grants programmes provide up to 50% grants. Household scale installations are automatically awarded a grant provided they meet minimum energy efficiency criteria and use approved installer. Larger projects must compete for funding via quarterly competitions.	-
Green electricity schemes	Yes, offered by most electricity suppliers	-
PV-specific green electricity schemes	Yes, offered by many electricity suppliers. Generally schemes reward export	-
Renewable portfolio standards (RPS)	Yes, the Renewables Obligation places an obligation on electricity suppliers to source 6.7% of their electricity from renewable sources. The mechanism encourages 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.	-
PV requirement in RPS	No	-
Investment funds for PV	No	-
Income tax credits	No income tax credits but VAT on professional installations of PV systems for domestic customers has been set at the reduced rate of 5% since April 2000.	-
Net metering	Yes, depending on the electricity supplier – see above	-
Net billing	Yes, depending on the electricity supplier – see above	-
Commercial bank activities	Yes – supporting LCBP Phase 2 projects	-
Electricity utility activities	Yes, Northern Ireland Electricity has provided top up grants for installations in Northern Ireland which are awarded a government grant.	-
Sustainable building requirements	No	-

4.1 Tariffs and metering

A number of electricity utilities offer to pay either for exported electricity from a PV system or electricity generated, where the price paid is based on the value of the *Renewables Obligation Certificates* (ROCs –see section 4.3) associated with all of the electricity generated by the PV system. Most require a separate export meter or generation meter to be installed. Most export tariffs pay similar to or less than the average price domestic customers pay for imported electricity.

The microgeneration strategy (see 2.4) is supporting the introduction of smart metering. A trial of smart meters for households was launched in August 2007.

4.2 Capital grants and tax incentives

The Microgeneration strategy and the Low Carbon Buildings Programme, which provides up to 50% grant funding for PV installations are described in section 2.4.

Northern Ireland Electricity continued to offer top up grants for PV installations in Northern Ireland during 2006, providing an extra 15% of the total capital cost in addition to the government grants.

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

4.3 Indirect policy issues

The Energy White Paper, published in May 2007, sets out the Government's energy strategy to tackle climate change and ensure a secure, clean and affordable energy supply. One of the key elements to the strategy is to support the development of low carbon technologies.

The 2007 White Paper confirmed and strengthened the government's commitment to The Renewables Obligation (RO), the UK's key mechanism for encouraging new renewable generating capacity. The RO was introduced in 2002 and requires licensed electricity suppliers to source a specific and annually increasing percentage of their sales from eligible renewable sources. For 2007/08 the level of the RO is 7.9% rising to 15.4% in 2015/16. Suppliers can meet their obligation by either presenting Renewable Obligation Certificates (ROCs); paying a buyout price (GBP 34.30 per MWh in 2007/08 rising each year with inflation); or a combination of the two. Renewable Obligation Certificates (ROCs) are issued to generators for every 1MWh of eligible renewable electricity that they generate. These ROCs can then be sold to suppliers. At the end of an obligation period the money in the buyout fund is recycled to those suppliers who presented ROCs on a pro rata basis.

Minor changes to the RO introduced in April 2007 included measures to make it easier for small generators such as photovoltaic systems to access the benefits of the RO.

More significant changes to the RO are planned for 2009 and consultation on the proposed changes was conducted during 2007. The changes include providing differentiated levels of support to different technologies in order to encourage a larger contribution from emerging renewable technologies. Microgenerators (i.e. generators under 50kW) including PV will receive two ROCs per MWh generated from April 2009.

A consultation on how the UK is to meet its contribution towards the European Union's 20% renewables by 2020 target was announced in November 2007. A full renewable energy strategy is to be published in 2009.

The Government's report on the Energy Review: "The Energy Challenge" was released on 11 July 2006. The review focused on the two major long-term challenges in UK energy policy: the need to tackle climate change by reducing carbon dioxide emissions; and the need to deliver secure, clean energy at affordable prices. As part of the 2006 Energy Review the Government announced a number of proposals for changes to the Renewables Obligation as well as proposals for aggressive implementation of the Microgeneration Strategy to remove barriers to household renewables. The proposed changes to the RO include providing differentiated levels of support to different technologies and extending the level of the RO to 20%. A preliminary consultation on these changes was published in late 2006 and will be followed by further consultation. The earliest these proposals could be implemented would be 1 April 2009. Alongside this consultation a consultation on some more limited changes to the RO was also published including changes to make it easier for small generators to access the benefits of the RO.

Table 11 shows the number of PV systems that were registered for the RO, NIROCS and ROS as at the end of 2006 as well as the total capacity.

Table 11: Number of PV systems that were registered for the RO, NIROCS and ROS as at the end of 2007

	RO (England and Wales Renewable Obligation)	**NIROCS (Northern Ireland RO)**	**ROS (Renewable Obligation Scotland)**	**Total**
Number of PV systems registered by the end of 2007	TBC	TBC		
Total Capacity of registered PV systems (kW)				

Note: Stations accredited for the RO and for the RO & CCL, BERR

Planning Policy Statement on Renewable Energy (PPS 22) and its Companion Guide are intended to encourage the appropriate development of new 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 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 government committed to a review of PPS 22 (which was originally published in 2004) in March 2006 to analyse whether emerging plans contained a policy that reflected paragraph 8 of PPS 2. Paragraph 8 of PPS 2 states that local planning authorities may include policies in local development documents that require a percentage of energy to be generated from on-site renewable energy developments. The review showed that of the vast majority of new-style emerging developing plans did include a policy requiring renewable energy to be included in certain new developments.

A new Planning Policy on Climate Change for England was published in December 2007. The new PPS makes it clear that the location and design of new developments should also promote the reduction of carbon dioxide. This will encourage the use of microgeneration technologies such as PV.

During 2007 the Scottish Executive published a draft Energy Efficiency and Microgeneration Strategy for Scotland. The strategy aims to ensure that energy efficiency and microgeneration make an increased contribution to sustainable development, climate change and energy objectives.

In March 2007 The Scottish Executive published a new Scottish Planning Policy: Renewable Energy (SPP6).

The International Energy and Climate Change Strategy aims to ensure security of energy supply and accelerate the transition to a low-carbon global economy. Within this strategy the UK government has been active in promoting the integration of climate change and energy policies in the international stage, particularly in Europe. In the Summit led in the UK in 2005, the EU leader gave the European Commission a mandate to develop for the first time a common energy policy. Thus in March 2007, the European commission approved an ambitious climate change and energy package to build a low carbon economy in Europe.

As mentioned in section 2.4, there are now a number of local governments which require significant new developments in their area to use onsite renewable energy to reduce annual carbon dioxide emissions. North Devon has chosen to demand 15% CO_2 reduction from renewables and Oldham requires 10%. Kirklees Council have proposed that by 2011, 30% of energy consumption in its new buildings will come from renewable sources.

4.4 Standards and codes

The Code for Sustainable Homes is a new national standard for key elements of design and construction which affect the sustainability of a new home. Launched in December 2006, it is intended as a means of driving continuous improvement, greater innovation and excellent achievement in sustainable home building. Environmental performance is expressed on a scale of Level 1 to Level 6, where Level 1 is the entry level, already above the Building Regulations, and Level 6 is the highest level, corresponding to exemplar development in sustainability terms. The Code for Sustainable Homes is currently voluntary, but may become mandatory in 2008, with increasingly tougher standards being phased in. Higher levels of the code require the installation of Microgeneration technologies such as PV. Currently the code applies only in England. In Scotland and Wales the Ecohomes standard, from which the new Code was developed still applies. The Ecohomes continues to apply for refurbishments of existing homes in all parts of the UK.

The European Energy Performance of Building Directive (EPBD) came into force on 4th January 2006. This is being implemented in the UK partly by changes to the building regulations: in England the Approved Documents L of the Building Regulations, which came into effect in April 2006. The amendments 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 provide a stronger incentive to designers to consider Low and Zero Carbon systems including PV.

A revised version of the Department of Trade and Industry's Photovoltaics in Buildings: Guide to the installation of PV Systems was published in 2006. The document was first published in 2002 and aims to provide best practice guidance on the installation of small scale PV systems. The new version updates the reference and settings required in the grid interface document ER G83/1 which now covers all micro-generation, to supersede those in

ER G77/1 which it replaces. The scope has also been extended in this 2nd edition to provide some guidance on larger systems and off-grid battery installations, and also modify some of the wording to include much of the valuable practical experience gained by installers in the PV demonstration programmes.

The grid connection of PV systems is governed by two Electricity Association Engineering Recommendations:

- 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'*.

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 of the Technical Committee . An Action Plan for UK participation in standardisation was prepared by a PV-UK team in 1999 and is still under discussion. UK representatives contributed to the 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.

5 HIGHLIGHTS AND PROSPECTS

2007 saw continued growth of the UK PV industry, both in terms of installed capacity, manufacturing output and number of staff employed in PV activities.

Continued growth in installations can be expected in 2008, supported by the Microgeneration Strategy and the Low Carbon Buildings Programme and also through the increase in demand for low carbon buildings as a result of planning policy, the Code for Sustainable Homes and local government targets.

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	Industrial
Retail electricity prices (year and reference)	9.64p per kWh (10.12p per kWh including VAT) 2006*, BERR Energy Prices Chart 5.5.1)	6.12p per kWh (6.34 including taxes) 2006*, DTI Energy prices Chart 5.3.1)

* at the time of writing this is the latest year for which figures were available

2) Typical household electricity consumption (kWh)

The typical annual household electricity consumption is 3 300 kWh, including VAT. (2007, DTI Average annual domestic electricity bills for UK countries, Table 2.2.2)

3) Typical metering arrangements and tariff structures for electricity customers

There is a choice of credit, credit debit, direct debit and pre-payment meters for domestic costumers, of which pre-payment meters have a slightly higher tariff then direct debit, which is slightly cheaper, where a fixed amount is automatically debited from the costumer's account each month. The majority of consumers pay a small standing charge and are then charged for each kWh of consumed energy. Some consumers, particularly those with electric heating and hot water, use an Economy 7 tariff which has a tiered electricity tariff with 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 settled for a fixed amount of time. A contract could be for a set amount of years, normally between 1 to 5 years for small to medium business.

4) Typical household income

According to the Office of National Statistics: Family Spending Survey 2006 (latest year for which figures are available), the average household gross income in the UK was £32 800.

5) Typical mortgage interest rate

Typical mortgage interest rates in 2007 were around 5.5%