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 2008

Prepared by Samantha Cook, IT Power

May 2009

Department of Energy and Climate Change

Department of Energy and Climate Change

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

IT Power reference: 1069

UK National Status Report 2008

May 2009

Contractor:

IT Power
Grove House,
Lutyens Close, Chineham,
RG24 8AG, United Kingdom.
Tel. +44 1256 392700
Fax. +44 1256 392701
E-mail: itpower@itpower.co.uk
http://www.itpower.co.uk

Document control	
File path & name	W:\DriveI@DATA\0WorkITP\0Projects\1069 IEA PVPS Task 1 (2009)\2 Work\1. NSR and trends report\NSR UK 2008 v1.5.doc
Author	Samantha Cook
Project Manager	Samantha Cook
Approved	Rebecca Gunning
Date approved	19th May 2009
Distribution level	Final Report for Distribution

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

TABLE OF CONTENTS

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^{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/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 (£).

PV support measures:

Enhanced feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility) at a rate per kWh somewhat higher than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility (often the electricity retailer) source a portion of their electricity supplies from renewable energies (usually characterized by a broad, least-cost approach favouring hydro, wind and biomass)

PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams
Net metering	in effect the system owner receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and netted over the billing period
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity fed into the grid is valued at a given price
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Electricity utility activities	includes 'green power' schemes allowing customers to purchase green electricity, large-scale utility PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development

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 National Survey Report for the year 2008. 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 2008 was 4420 kWp. This compares to 3810 KWp in 2007 and 3400 kWp in 2006. The cumulative installed PV generation capacity increased by 24% during 2008 reaching a total of 22.5 MWp. Government support through the Low Carbon Buildings Programme and other grants supported approximately 72% of total new capacity. Figure 1 shows the cumulative installed PV capacity up to the end of 2008.

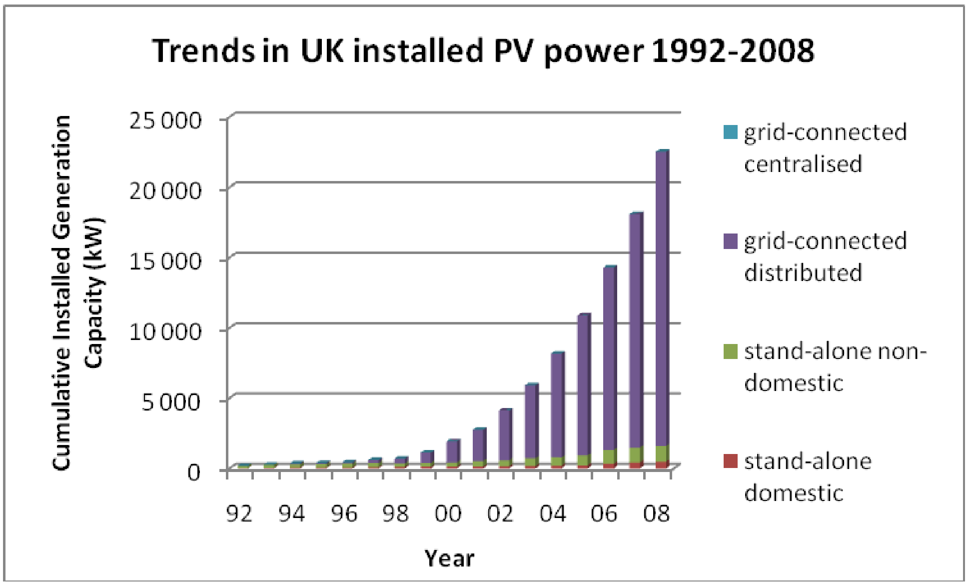

Figure 1: Cumulative installed PV capacity 1992 - 2008

1.2 Costs & prices

Prices for both systems and modules have dropped from 2007 levels and are more similar to those seen in 2005 and 2006. Average retail module prices are slightly lower than in 2007 with an average price of £3.2 per Wp for reasonable size order. Minimum prices are lower than 2007, around £2.6 per Wp, showing similar prices to 2005 and 2006.

Overall system prices range considerably as they take into account the significant differences in the projects, the level of integration and technology used. On-grid installed prices range from £3.4 to £10.2 per Wp. However the average turnkey price for a standard 1-3 KWp system was £6.2 per Wp, compared to £7.4 per Wp in 2007 and £6.3 per Wp in 2006.

1.3 PV production

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. In 2008 the company produced multicrystalline silicon ingots sufficient for 230 MW. The company has a planned expansion of production capacity from 290 MW to 350 MW, to be completed in the first quarter of 2009

Sharp's module assembly plant in Wrexham uses EVA lamination encapsulation and produced 206 MW of crystalline PV modules during 2008. Total production capacity remained consistent at 220 MW for 2008.

Romag's Building Integrated Photovoltaic (BIPV) laminating facility in Consett produced 19 MW in 2008, a 15 MW increase from 2006. The facility, again, increased capacity from 12MW in 2007 to 34MW in 2008

GB Sol based in South Wales produced 0.5 MW of crystalline modules and has a maximum capacity of 4 MW per year.

Epod Solar Wales manufactures thin-film amorphous silicon cells and modules at its factory in Bridgend. Capacity was expanded to 5 MW in 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.

1.4 Budgets for PV

In 2008 nearly £12 million in funding was provided for research from the EPSRC, Technology Strategy Board, the Carbon Trust and the DTI. Budgets for Demonstrations and Field Tests came through the grants programmes and amounted to over £12.7 million. Total funding amounted to £24.7 million, a substantial increase from 2007's total funding of £17.6 million.

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 2008 statistics if the PV modules were installed between 1 January and 31 December 2008, although commissioning may have taken place at a later date.

2.1 Applications for photovoltaics

In the UK the majority of PV installations are grid connected distributed systems; installed on the roofs of domestic and non-domestic buildings. Ground mounted arrays are rare. Building integrated PV (BIPV) is becoming increasing popular with the use of solar tiles which take the place of traditional roof tiles and also the use of photovoltaics in facades, louvres and canopies. Systems are typically small; 1-3 kWp for domestic installations or 5-30 kWp for non-domestic installations on average. The largest system in the UK to date is the 391 kWp PV façade on the CIS tower in Manchester.

The off-grid market is small; just over 100 kWp was installed off-grid in 2008. Typical applications include PV systems at remote non-grid connected locations to meet both domestic and non-domestic electricity demand. PV is also used for stand alone applications such as remote lighting, speed cameras, lighthouses and remote battery charging although these applications are often smaller than 40 W.

2.2 Total photovoltaic power installed

To determine the installed capacity information was obtained from the grants scheme administrators for PV installed within the government grants programmes, and PV installers for PV installed outside of the grants programme. This method is utilised to prevent companies having to reveal commercially sensitive information about their total capacity installed. The data received is analysed and verified using previous year's data as well as knowledge of the UK PV sector to prevent any irregularities. It is believed that this gives a good representation of the installed capacity however it should be noted that it is not 100% accurate due to difficulties arising in obtaining information from some PV installers and difficulties regarding whether installation dates or commissioning dates were recorded. Within the grants programmes the installation date is not typically recorded therefore any installations where the grant was paid in 2008 are included in 2008's data. Although it is acknowledged that grants claimed in 2008 may have been for installations completed in 2007 this will not be true for the majority of cases as grants will typically be claimed soon after installation

Table 1: PV power installed during calendar year 2008 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 2008 (kW)	61	60	4303	0	4423

A summary of the cumulative installed PV Power, from 1992-2008, broken down into four sub-markets is shown in Table 2.

The total PV capacity installed during 2008 was 4423 kWp, with the vast majority (96%) in the grid-connected distributed market as shown in Table 1. This is slightly larger than the PV capacity installed during 2007 of 3810 kWp. The majority of these installations received grant funding through the government support programmes, with total government funding amounting to £12.7 million. Top-up funding also proved to be important with some proposed projects not going ahead due to a lack of additional funding. The grant programmes and top-up funding are discussed further in Section 2.3.

Other factors which have had a positive impact on the UK installed capacity are discussed in Section 4 and include permitted development rights for PV and a doubling of the value of Renewable Obligation Certificates for PV. Sustainable building requirements such as the code for sustainable homes and renewable energy generation and greenhouse gas emission reduction targets will also contribute to installed PV capacity.

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	2008
Stand-alone domestic	7	47	52	57	69	83	108	119	121	135	162	172	193	227	320	420	48
Stand-alone non-domestic	166	213	232	252	279	316	254	276	302	385	406	542	585	697	980	1 050	1110
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	16 620	20 920
Grid-connected centralised	0	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	18 090	22 510

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.

From 2005 onwards figures are reported to the nearest 10 kWp.

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

As in previous years a high proportion of the PV installations received grant support from one of the grant programmes; in 2008, 72% of projects received government grant support. The Low Carbon Buildings Programme (LCBP) has been the most significant grant programme, 2008 saw a larger than ten-fold increase in PV capacity installed under Phase 2 from around 150 kWp in 2007 to over 1700 kWp in 2008. However Phase 1 saw a slight drop in installed capacity from 1295 kWp to 967 kWp.

The programmes together with the installed capacity supported were as follows (projects can only receive support from one of these schemes);

- Low Carbon Buildings Programme Phase 1
  - Stream 1 Householders 967 kWp
  - Stream 1 Communities 46 kWp
  - Stream 2A Businesses 84 kWp
- Low Carbon Buildings Programme Phase 2 (non-domestic) 1744 kWp
- Northern Ireland Reconnect 251 kWp
- Northern Ireland Switched on Schools 93 kWp

The **Low Carbon Buildings Programme (LCBP)** funded by the Department of Energy and Climate Change (DECC), 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 and aims to demonstrate how energy efficiency and microgeneration will work hand in hand to create low carbon buildings. A total of £80 million was announced initially for the 3 year programme running from 2006. PV has proved to be the most popular technology accounting for over 50% of the grant funding awarded under Phase 2. In December 2008 an additional £7 million was made available for PV installations (transferred from money allocated for micro-wind) under Phase 2 of the programme which supports installations for community organisations. Despite this the funding under Phase 2 unexpectedly ran out in February 2009, 4 months before the anticipated end of the grant programme in June 2009. An additional further £45 million for the LCBP Phase 2 was announced in budget 2009 however it has not yet been determined how this will be allocated across the various technologies. Phase 2 of the programme has a clear focus on schools, reducing carbon emissions in schools and educating students and communities about renewable energy. This has been successful with over 40% of the 1032 PV grants offered providing funding for installations on schools.

For householders PV installations are eligible (under Phase 1) for a maximum of £2000 per kWp of installed capacity, subject to an overall maximum of £2500 or 50% of the relevant eligible costs, whichever is the lower. Grant applications to the householder stream dropped dramatically after the maximum grant was capped at £2000 in May 2007. 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.

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 £8 million over two years for householders installing renewable energy systems including PV. 108 PV installations have been supported by the fund, representing 3% of the total number of installations awarded grants by the programme.

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 will invest over £1.3 million in the installation of solar PV and small wind devices in 35 rural schools. PV installations were completed at 22 schools in 2008 with a total peak capacity of nearly 100 kW.

In addition to the government grant programmes 'top up' funding is available from a number of sources. This is often used as match funding to the government grant funding resulting in a virtually free PV system for some customers. The amount of funding varies and sometimes certain criteria apply, for example a minimum level of energy efficiency has to be met, before funding is granted.

Additional funding in 2008 included the following;

- The **Community Sustainable Energy Programme** was launched in April 2008 and provides money from the Big Lottery Fund towards the cost of microgeneration technologies and energy efficiency measures. For PV up to 50% of the project cost or £50,000 (whichever is the lower) is available.
- In 2008 **Northern Ireland Electricity** (NIE) provided £222,815 for 76 PV projects, which were mostly used to top up funding from the Reconnect Programme. 15% of the total installed cost or £900 per kWp was available up to a cap of £4,500.
- The **EDF Green Fund** provides funding for renewable energy projects and has provided £3.7 million since it was established in 2001 along with EDF's Green Tariff. Organisations can apply for up to £30,000 in funding to provide 50% of the total project cost. In 2008 £284,000 was awarded to 17 projects; 12 of which consisted solely of PV and 5 which also included Solar Thermal, Heat Pump or Wind Turbine technologies as well as PV. This supported nearly 120 kWp of PV capacity installated.
- The **E.ON Sustainable Energy Fund** is available to community groups, charities and not for profit organisations across the UK. Grants of up to £20,000 are awarded for projects which cover microgeneration or energy efficiency including new or innovative technologies.
- The **Green Energy Trust**, operated by Scottish Power, awards grant funding to community based renewable energy projects in the UK. The trust provides up to 50% of the project cost up to a maximum of £25,000, although a typical project receives £10,000. In 2008 9 projects with a solar component were awarded grants totalling £101,892, although only 2 of these projects have claimed their grants to date.
- From 2007 to 2008 **The Co-operative Group** provided £1 million for the installation of PV systems at 100 schools nationwide. Each school received £10,000 from The Co-operative Group which was used in conjunction with funding from the Low Carbon Buildings Programme Phase 2. The Co-operative has announced a further £1 million will be spent on providing PV, CHP and wind turbines to additional schools across the UK.
- The **Gloucester Renewable Energy Grant Scheme** has made available £110,000 to fund 110 domestic renewable energy installations at £1000 each. **South Gloucester Future Energy** awards up to £500 towards the cost of renewable energy technology and installation. In 2008 funding was provided for 10 PV installations under the Gloucestershire Grant Scheme and 2 PV installations under the South Gloucestershire Grant Scheme.

2.4 Highlights of R&D

Research in the UK is largely funded by the Engineering and Physical Sciences Research Council (EPSRC). The UK Energy Research Centre (UKERC) Research Atlas provides details of publicly funded past and ongoing research activities in the solar sector, available at: http://ukerc.rl.ac.uk. Research is primarily carried out by academic institutions although some private company R&D is supported by funding, particularly where companies are conducting research in association with academia. PV research typically focuses on increasing efficiency or developing new materials with the ultimate aim of cost reduction.

In 2008 the EPSRC funded **Photovoltaic Materials for the 21st Century (PV-21)** project was launched, building on an initial four year project. This £6.3 million project, led by the University of Durham with support from 7 other universities and 9 industrial partners has the ultimate goal of making solar energy more competitive and affordable.

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.

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 2008 the EPSRC provided £8.6m in funding for 82 photovoltaic and photovoltaic-related research projects. A limited selection of them includes;

- A feasibility study for a new approach to designing non-tracking solar concentrators
- Low-cost extremely thin layer absorber solar cell: a novel approach to make the conformal ETA layers
- Fast Energy Rating for Photovoltaic Devices and Modules (FENRA)
- High-efficiency Block Copolymer Solar Cells: A Scalable Prototype for Low Cost Energy Generation

The **Carbon Trust** is an independent company set up by the government in 2001 to work with organisations to develop commercial low carbon technologies. The Carbon Trust is funding the **Advanced PV Research Accelerator** for which Cambridge University, in collaboration with The Technology Partnership, has been announced as the preferred bidder.

The **Technology Strategy Board (TSB)** runs networking activities through Knowledge Transfer Networks, funds R&D projects through companies and their university partners and supports product and process development in businesses through Knowledge Transfer Partnerships. In May 2007 the TSB launched the **Low Impact Buildings Innovation Platform**. The platform has an initial budget of £30 million over three years and aims to help the UK construction industry deliver buildings with a much lower environmental impact both for new build to meet zero carbon targets and for the retrofit of existing building stock. Initial activity will support businesses to innovate in 5 areas one of which is 'low carbon energy sources – integrating them into low-impact buildings and the supply grid'. In April 2008 the £10m competition **Retrofit for the Futur**e was opened creating the opportunity for companies to integrate PV into low energy solutions for new and existing houses of the future and to assess it's effectiveness.

In 2008 the following PV related projects were funded by the TSB;

- Solar Concentrate: Affordable building integrated photovoltaic solar concentrator systems

- Polymer Photovoltaic Architectural Glass
- Low Bandgap Thermophotovoltaic cells for clean energy generation and efficient waste heat energy conversion
- CONVERT - Enhancing Photovoltaics
- Development of low-cost, high-efficiency and long-life photovoltaic cells
- Lower-cost Concentrating Photovoltaic Systems using III-V cells ("III-V CPV")
- Low cost integrated PV in double glazed windows using CdTe bifacial solar cells
- Lower-cost Concentrating Photovoltaic Systems using III-V cells ("III-V CPV")

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

In 2008 nearly £12 million in funding was provided for research from the EPSRC, Technology Strategy Board, the Carbon Trust and BERR (formerly the DTI). Budgets for Demonstrations and Field Tests came through grant programmes including the LCBP and Reconnect, as discussed in Section 2.3 and amounted to over £12.7 million. In 2008 there weren't any market incentives targeted to the PV sector. Total funding in 2008 amounted to £24.7 million, a substantial increase from 2007's total funding of £17.6 million.

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

		R&D	Demo/Field test	Market incentives
National/Federal	DECC (LCBP)		£11,674,315	
	DETI (Reconnect)		£639,770	
	ELBS & DARD (Switched on Schools)		£296,866	
	EPSRC	£8,556,980		
	TSB	£2,666,667		
	DTI/BERR	£756,405		
State/Regional	Gloucestershire Grants		£111,000	
Total		**£11,980,052**	**£12,721,951**	
Grand Total	**£24,702,003**			

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 290 MW to 350 MW, 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

Manufacturers	Process & technology	Total Production	Maximum production capacity	Product destination	Price
PV Crystalox	mc-Si wafers	230 MW equivalent	290 MW/year	Japan and Europe	-

3.2 Production of photovoltaic cells and modules

Total PV cell and module manufacture together with production capacity information is summarised in Table 5.

Table 5: Production and production capacity information for 2008 for each manufacturer

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)		Maximum production capacity (MW/yr)	
		Cell	Module	Cell	Module
Wafer-based PV manufacturers					
Romag	Sc-Si	0	19	0	34
GB Sol	Sc-Si, mc-Si	0	0.5	0	4
Sharp	Sc-Si, mc-Si	0	206	0	220
Total		0	225.5	0	258
Thin film manufacturers					
EPOD Solar	a-Si	2.5	2.5	5	5
TOTALS		**2.5**	**228**	**5**	**263**

Sharp's module assembly plant in Wrexham uses EVA lamination encapsulation and produced 206 MW of crystalline PV modules during 2008. PV cells used in the modules are imported from Japan. The plant produces a range of modules from 162 W to 220 W modules certified to IEC 61730. Sharp is considering manufacturing larger modules. The typical warranty length for modules produced is 25 years. The majority of modules produced during 2008 were exported to Germany with a very small percentage being used for projects in the UK. Total production capacity remained constant at 220MW for 2008. 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 4.0m for facades, roof top, louvres, solar shading and tracker systems. The facility, again, increased capacity from 12 MW in 2007 to 34 MW in 2008. The company is certified to ISO 9001 and its standard products SMT 155 and SMT 180 are certified to IEC 61215.

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. 50% of the modules produced during 2008 were exported.

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 facilities production in 2008 was 2.5 MW (compared to 1.5 MW in 2007). 100% of the company's production in 2008 was exported to Europe. Capacity was expanded to 5 MW in 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.

All cells, apart from those made by EPOD Solar Wales, are bought on the international market by UK manufacturers of solar modules.

All manufacturers reported that efficiency improvements were a major factor of their research.

3.3 Module prices

Retail module prices are slightly lower than 2007, ranging from £2.6/W to £3.9/W with an average price of £3.2/W for reasonable size orders from the major UK module wholesalers. The 'best price' of £2.6/W is UK construction but sold on the European Market. For small orders (few modules) and lower output modules e.g. less than 100 kWp, retail prices will be higher. A limited number of thin film modules are also available at a cost of around £2.2/W.

Table 6: Typical module prices for a number of years

Year	2001	2002	2003	2004	2005	2006	2007	2008
Standard module price(s): Typical [£/w]	4.7	4.7	4.5	3.9	4.7	4.1	3.8	3.2
Best price [£/w]					2.6	2.6	3.0	2.6
PV module price for concentration	N/A							

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. Some installers have also started to use Mastervolt inverters from The Netherlands for small domestic systems.

3.4.2 Building integrated products and supporting structures

Solstice Energy have developed a Lead Roll Clamp which offers a means of mounting on lead rolled roofs without requiring ballast or the need to fix through, constrict or cause damage to the lead. This system was successfully used on a grade 2 listed church in Hickney. Solion has developed a flat roof mounting system which only requires light ballast without the need for roof penetration which it is looking to sell on the European and US markets next year in addition to the UK market where it currently retails. Romag who manufacture photovoltaic glass products are developing a new product 'PowerPark' a solar canopy which will produce electricity that can be connected into the grid as well as charging electric vehicles. Two prototypes will be trialled in 2009.

3.4.3 Monitoring Products

Monitoring systems are increasingly being included as a component in PV system installations. Naturalwatt's microgrid controllor monitors and displays combined renewable energy and energy usage via the internet. Web logging equipment from Fronius, SMA and other manufacturers allows users to directly monitor what their system is generating.

3.5 System prices

A summary of typical system prices (excluding VAT) is provided in the following tables. This information is based on grant applications approved by the Low Carbon Buildings Programme during 2008.

As a general rule of thumb the turn key price for a small scale system is £5000 per kW plus £2000. E.g. 1kW is £7000, 2kW is £12,000 3kW is £17,000[1]. For larger systems the price tends to drop by around £1/Wp. In comparison to 2007 prices have dropped slightly. Roof-mounted systems cost £5.6/W on average, roof and building integrated systems are more expensive with an average of £6.7/W.

Table 7: **Turnkey Prices of Typical Applications**

Category/Size	**Typical applications and brief details**	**Range of prices per W (£)**	**Average prices per W (£)**
OFF-GRID Up to 1 kW	Modules for leisure market (holiday homes, traffic monitoring, bus stops)	5.0 – 7.5	6.3
OFF-GRID >1 kW	Remote homes with battery storage or backup generator (From LCBP Phase 1 – application made in 2008)	4.0 – 7.6	6.0
ON-GRID Specific case	1-3 kW domestic roof-mounted system, if available (From LCBP Phase 1 – application made in 2008)	3.4 – 10.2	6.2
ON-GRID up to 10 kW	Roof or ground-mounted non-domestic systems e.g. for commercial, industrial and not for profits	4.4 - 8.8	5.8 (5.6 for 3-10 kW systems)
ON-GRID >10 kW	Large non-domestic systems	4.0 - 8.0	5.4

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

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008
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	3.4-9.3	3.4–10.2

3.6 Labour places

An estimate of (full-time equivalent) labour places related to the photovoltaics sector in the UK is presented in Table 8. The total number of labour places is estimated at 1333, this represents an increase of 20% over 2007. However it should be noted that a more comprehensive survey of those involved in academia was conducted for the 2008 survey in comparison to previous years. A total of 88 installation companies are registered as PV suppliers on the Microgeneration Certificate Scheme, although many of these offer other technologies as well and may only have a small amount of work in the PV sector, if any. A few of the smaller companies were found to have stopped working in the PV sector due to insufficient work and the high price and effort involved in registering with the Microgeneration Certificate Scheme.

[1] Environmental Change Institute Analysis of LCBP Phase 1 up to May 2008

Table 8: Estimated PV-related labour places in 2008

Research and development (not including companies)	196
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	744
Distributors of PV products	31
System and installation companies	335
Utilities and government	7
Other	20
Total	**1333**

3.7 Business value

As shown in Table 9, the total value of the PV business in the UK is estimated at £243 million. This estimate is calculated from the value of the installations completed during 2008, the estimated value of export sales from PV manufacturers (figures provided by Crystalox and estimated at £1.9/W for EPOD Solar Wales, £2.5/W for Sharp and GB Sol and £3/W for Romag), minus the value of imports of PV products. The value of imports is calculated assuming a wholesale module price of £2.6/W and assuming that all PV inverters are imported at a wholesale price of around £0.48/VA.

Table 9: Value of PV business

Sub-market	**Capacity installed *in 2008* (kW)**	**Price per W**	**Value**	**Totals**
Off-grid domestic	61	6.0	£364,980	
Off-grid non-domestic	60	6.25	£374,250	
Grid-connected distributed	4308	5.80	£24,955,428	
Grid-connected centralized	0	-	-	
				£25,694,658
Export of PV products				£628,100,000
Change in stocks held				Unknown
Import of PV products				£410,343,980
Value of PV business				**£243,450,700**

4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

4.1 PV Support Measures

Table 10 lists the main support measures (definitions at start of guidelines) for PV during 2008. Further details on some of these measures are provided on the following pages.

Table 10: PV support measures

	On-going measures	Measures that commenced during 2008/due to commence 2009
Enhanced feed-in tariffs (see Section 4.1.1)		No, anticipated from April 2010
Capital subsidies for equipment or total cost (see Section 2.3)	Yes, national programmes provide up to 50% grants	
Green electricity schemes (see Section 4.1.2)	Yes, offered by most electricity suppliers	
PV-specific green electricity schemes		
Renewable portfolio standards (RPS) (see Section 4.1.3)	Yes, the Renewables Obligation places an obligation on electricity suppliers to source an increasing percentage of their electricity from renewable sources.	
PV requirement in RPS		
Investment funds for PV (see Section 4.1.4)		Yes, the Environmental Transformation Fund
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 (see Section 4.1.5)	Yes – varies dependant on electricity supplier	
Net billing (see Section 4.1.5)	Yes – varies dependant on electricity supplier	
Commercial bank activities e.g. green mortgages promoting PV (see Section 2.3)	Yes – the Co-operative has provided funding to support LCBP Phase 2 projects	
Electricity utility activities (see Section 2.3 for top-up funding, Section 4.1.6 For CERT)	Yes, utilities have provided top-up funding for PV installations	Utilities obligated to provide grants and offers for energy efficiency and RE generation through CERT
Sustainable building requirements (see Section 4.1.7)	Yes – Merton rule, Code for sustainable homes	

4.1.1 Enhanced Feed-in tariffs

In October 2008 the UK parliament published amendments to the Energy Bill to enable two renewable tariffs; one for electricity and one for heat and biogas, with an upper threshold of 5 MW. It is anticipated these tariffs will be introduced in April 2010 (for electricity) and April 2011 (for heat and biogas). Details of the tariffs are yet to be established.

The Renewable Energy Association (REA) has provided a blueprint for the tariffs to the government following extensive consultation with key stakeholders in the PV sector and other microgeneration technologies.

4.1.2 Green Electricity Schemes

Most electricity suppliers now offer a 'green' tariff in addition to their standard tariff. The green tariff allows customers to purchase green electricity based on renewable energy, usually at a premium price. The amount of renewable electricity used in the electricity mix varies by supplier and tariff but will be in addition to that which suppliers are already required to meet through the Renewables Obligation. There are no PV-specific green electricity schemes in the UK. Some of the suppliers invest in new renewable energy schemes as part of their green tariffs.

4.1.3 The Renewables Obligation

The Renewables Obligation (RO) was introduced in 2002 and required licensed electricity suppliers to source a specific and annually increasing percentage of their sales from eligible renewable resources. For 2008/09 the level of the RO is 9.1%, rising to 15.4% by 2015/2016. Suppliers can meet their obligation by either presenting Renewable Obligation Certificates (ROCs); paying a buyout price (£35.76 per MWh in 2008/09 rising each year with inflation); or a combination of the two. ROCs are issued to generators for every MWh 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 distributed amongst the suppliers who presented ROCs on a pro rata basis.

Minor changes to the RO introduced in April 2007 include measures to make it easier for small generators such as photovoltaic systems to access the benefits of the RO. From April 2009 banding will be introduced; providing differentiated levels of support to different technologies in order to encourage a larger contribution from emerging renewable technologies. PV will receive two ROCs per MWh generated from this time. During 2008 the Renewables Obligation was extended by 10 years to 2037.

4.1.4 The Environmental Transformation Fund

The Environmental Transformation Fund (ETF) began operation in April 2008 and is administered by Defra and DECC. The fund has UK and international elements, funds within the UK element will total £400 million during the period 2008/09 to 2010/11. The aim of the initiative is to accelerate the commercialisation of low carbon energy and energy efficiency technologies with a specific focus on the demonstration and deployment phases of bringing low carbon technologies to market. The ETF brings together existing funding programmes including;

- Low Carbon Buildings Programmes
- Carbon Trust's innovation programme, including research accelerators, technology accelerators and incubators
- Carbon Trust funding for new low carbon technology enterprises, including Partnership for Renewables
- Carbon Trust investments in low carbon technology businesses

4.1.5 Net Metering and Billing

A number of electricity utilities offer to pay either for exported electricity or total electricity generated from a PV system. Most require a separate export meter or generation meter to be installed. In 2008 prices varied from around 10 – 30p per kWh generated, dependent on the utility, with some paying for total generation whilst others only paid for electricity exported to the grid.

4.1.6 Carbon Emissions Reduction Target

CERT 2008-2011 is the third phase of a scheme (originally known as the Energy Efficiency Commitment) which obligates energy suppliers to achieve reductions in carbon emissions in the household sector.

CERT obligates electricity and gas suppliers to promote energy efficiency improvements and renewable energy generation with homeowners through grants and offers. There is a ring fence of no more than 6% of the suppliers' obligation for demonstration and market transformation. This rises to 8% if microgeneration measures account for at least 2% of the market transformation action. Through this 6-8% of the target CERT aims to demonstrate the potential of microgeneration technologies and to stimulate the market by driving up demand, leading to price reductions and greater accessibility. With CERT expected to deliver £3,700 million of investment over three years, 2% of this would result in £74 million for the microgeneration technologies. However it is likely that suppliers will opt for lower cost energy efficiency measures rather then renewable energy generation.

4.1.7 Sustainable Building Requirements

In May 2008 **The Code for Sustainable Homes** became mandatory in England (originally launched as a voluntary measure in 2006). The code uses a 1 to 6 star rating system to mark the sustainability performance of a new home against nine categories of sustainable design including energy. All new homes must attain at least a level 3 rating and the higher levels of the code require the installation of microgeneration technologies such as PV. **BREEAM** is a similar assessment for non-domestic buildings, however it is not yet mandatory for non-domestic buildings to have a BREEAM assessment.

The government has committed to **zero carbon targets** for other building categories; all new schools to be carbon zero by 2016, new public sector buildings by 2018 and new non-domestic buildings by 2019. PV is ideally suited to building integrated applications and therefore provides an option for meeting zero carbon and other targets.

Local planning policies requiring new developments or refurbishments to include on-site renewables have become increasingly important in encouraging PV as well as other small scale renewables. The '**Merton Rule**' pioneered by the London Borough of Merton in 2005 requires all new major developments to use onsite renewable energy to reduce annual CO_2 emissions by a set percentage, typically 10-30%. This policy has been adopted by numerous other local authorities and boroughs, in total at least 70 local authorities have either included or are looking to include similar policies in their plans.

The **Nottingham Declaration** requires 10% of the energy supply in all new developments over 1,000 square metres to be produced using renewable technologies on and/or from a decentralised, renewable or low carbon energy supply. This policy was adopted by Nottingham Council in 2007. So far over 340 councils have signed up to the framework voluntarily.

From October 2008 all buildings, whenever sold, built or rented, need an **Energy Performance Certificate (EPC)**. The certificate provides energy efficiency A-G ratings and recommendations for improvement. The ratings are standard so the energy efficiency of one building can easily be compared with another building of a similar type. Large public buildings are now required (from October 2008) to have on public view a **Display Energy Certificate (DEC)** showing the building's energy efficiency rating, based on the energy consumption of the building as recorded by gas, electricity and other metres. At present there are no minimum rating/requirements that a building has to reach however it is thought a low energy rating may lower the value of a building. The inclusion of renewable technologies such a PV will improve the energy performance of a building.

4.2 Indirect Policy Issues

The European Photovoltaic Industry Association (EPIA) has agreed a target to provide 12% of the Europe's electricity from PV by 2020. Although there are no specific targets for PV in the UK there are policy initiatives regarding energy efficiency and renewable energy which influence the PV sector. The renewable energy and greenhouse gas emission reduction targets which have some influence on the PV sector are listed in Table 11. The various policies are summarised below.

The **Energy White Paper**, published in May 2007, sets out the Government's strategy to tackle climate change and ensure a secure, clean and affordable energy supply. The legislative aspects of the white paper will be implemented through the Energy Act which was given Royal Assent in November 2008 (prior to this it was known as the Energy Bill). Important aspects of the Energy Act for the PV sector are plans to introduce banding of the renewables obligation and a renewable electricity tariff.

A new **Renewable Energy Strategy** for the UK will be published in spring 2009 following a 3 month consultation period which ended in September 2008. The strategy aims to identify how the UK will meet its target under the Renewable Energy Directive; ensuring that 15 % of its energy comes from renewables by 2020.

In 2006 the Government launched its **Microgeneration Strategy** with the objective of creating conditions under which microgeneration becomes a realistic alternative or supplementary energy generation source for the householder, communities and small businesses. A number of these actions supported the PV sector including; a certification scheme for microgeneration system installers and products, permitted development rights for homeowners, extension of the Low Carbon Buildings Programme (LCBP) grant and clearer information for consumers, for example a scheme run by the Energy Saving Trust 'Act on CO_2'.

From April 2008 microgeneration installations which have little or no impact beyond the host property were classified as **permitted development**. This removes the need for specific planning consent, reducing the cost and speeding up the process of a PV system installation.

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.

Planning and Climate Change - Supplement to Planning Policy Statement 1 for England was published in December 2007. The new supplement makes it clear that the location and design of new developments should also promote a reduction in carbon dioxide emissions. This will encourage the use of microgeneration technologies such as PV.

Carbon Reduction Commitments (CRC), is a cap and trade system which will affect around 20,000 large public and private sector organisations with half-hourly metered electricity use exceeding 6000 MWh. Organisations will be required to purchase carbon allowances at around £12/tonne to cover their carbon emissions over a yearly period; either from the government at the start of the year or through trading on a secondary market. All the revenue raised from selling allowances will be recycled back to participants. Organisations with the best performance in terms of reducing emissions will receive the largest proportion of the revenue through a performance league table. CRCs are due to commence in April 2010 with an initial 3 year introductory phase. From April 2013 the Capped Phase will commence when the total number of allowances made available to participants will be capped and the annual sale of allowances will be by auction. If an organisation generates electricity 'electricity credit's' can be claimed for the amount of electricity generated and exported, which can be subtracted from CRC emissions meaning fewer allowances have to be bought (if ROCs have not been claimed).

We Support Solar, a campaign to promote solar power in the UK, was initiated in September 2008 by the UK Solar PV Manufacturers Association. Supported by companies, NGOs, individuals and MPs We Support Solar is campaigning to ensure that the feed-in tariff is set at an appropriate rate to ensure growth in the PV sector.

Table 11: Carbon reduction and energy generation targets affecting PV

Sector	Region	Target*	Policy
All Energy	EU	12% from renewables by 2010	EU Renewables Directive
		20% from renewables by 2020	
Electricity	EU	22% from renewables by 2010	
		12% of electricity from PV by 2020	EPIA target September 2008
	UK	10% from renewables by 2010	EU Renewables Directive
		15% from renewables by 2020	
Green House Gas (GHG) emissions	UK	34% cut in GHG by 2020	UK Budget 2009
		80% cut in GHG by 2050	Climate Change Act 2008
CO_2 Emissions	UK	20% reduction by 2010	White Paper 2007/Energy Act 2009
		26% reduction by 2020	
		60% reduction by 2050	
CO_2 Emissions from new domestic properties	UK	25% reduction by 2010 (Code Level 3)	Code for Sustainable Homes
		44% reduction by 2013 (Code Level 4)	
		100% reduction by 2016 (Code Level 5/6)	

CO_2 Emissions from new schools	UK	100% reduction by 2016	The Children's Plan 2007
CO_2 Emissions from new public sector buildings	UK	100% reduction by 2018	UK Budget 2008
CO_2 Emissions from new non-domestic properties	UK	100% reduction by 2019	

* All reduction targets are measured from a 1990 baseline.

4.3 Standards and codes

The Microgeneration Certification Scheme (MSC) assesses microgeneration products and installers against robust standards with the aim of creating a rapidly growing and sustainable microgeneration industry, based on quality and reliability. The scheme was developed by BRE Global and launched in 2007. From November 2008 the scheme entered a new phase and is now funded and regulated by the microgeneration industry with technical working groups developing new standards for the scheme. 85 companies are registered as PV installers with MSC accreditation in the Green Book Live. From March 2009 the grant programmes will only be accessible to installers registered with the scheme.

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. UK representatives contributed to the IEC/TC-82 meeting in Brussels in Spring 2008.

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

2008 saw continued growth of the UK PV industry in terms of manufacturing output, number of staff employed in PV activities and PV related research. Module and system prices have decreased from 2007 although the new installed capacity remained similar to the amount installed in 2007. It was originally anticipated there would be a funding gap between the end of the LCBP and the introduction of the feed-in-tariff; however in the 2009 Budget an additional £45 million was allocated for the Low Carbon Buildings Programme. In addition there are 675 grants offered under the LCBP Phase 2 which have not yet been claimed, suggesting almost 6 MW of capacity is still to be installed or the funding claimed. If all of these projects go-ahead it should lead to an increased installed capacity in 2009/2010.

Looking forward the major highlight will be the introduction of the Feed-in tariff, due for electricity in April 2010. It is anticipated this will provide a much needed boost to the UK PV industry as the economics of installing PV will be greatly improved.

ANNEX A: 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 and Commercial
Retail electricity prices (year and reference)	11.39 pence per kWh (13.10p per kWh including taxes) 2008, BERR Quarterly Energy Prices Table 2.2.3 Direct Debit Price[2]	7.86 pence per kWh (8.12p per kWh including taxes) 2008, BERR Quarterly Energy Prices Table 3.4.1[3]

2) Typical household electricity consumption (kWh)

The typical annual household electricity consumption is 3 300 kWh.

(2008, BERR 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. Pre-payment meters have a slightly higher tariff than direct debit, (12.85p to 11.39p respectively[4]). The majority of domestic consumers pay a small standing charge and are then charged for each kWh of consumed energy. Some consumers, particularly those with electric heating and electric hot water, use an Economy 7 tariff which has a tiered electricity tariff with a lower rate for electricity consumed during off-peak times (After 7pm).

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

Taking an average household size of 2.36 the average household gross income in 2008 was £35,214.[5]

---

[2] http://stats.berr.gov.uk/energystats/qep223.xls Sheet 2 accessed: 23/04/09

[3] http://stats.berr.gov.uk/energystats/qep341.xls Sheet 3 accessed: 23/04/09

[4] http://stats.berr.gov.uk/energystats/qep223.xls accessed: 23/04/09

[5] Office of National Statistics: Economic & Labour Market Review - April 2009 Edition, Table 1.06 http://www.statistics.gov.uk/elmr/04_09/downloads/Table1_06.xls , average household size http://www.statistics.gov.uk/census2001/profiles/commentaries/housing.asp accessed 23/04/09

5) Typical mortgage interest rate

Mortgage rates varied considerably in 2008 due to the current financial climate, ranging from 3% to 6.4% throughout the year.

6) Voltage

On 1st of January 1995[6] the voltage of domestic supply was reduced from 240V to allow harmonisation across Europe, the specifications were changed to 230 Volts RMS +10%/-6%, also running at a frequency of 50Hz, other transmission lines in the UK vary from 230 Volts to typically 400,000 and even 765,000 Volts.

7) Electricity industry structure and ownership

In the UK, Electricity Generation is shared between several privately owned companies. The National Grid Company (Private company with shareholders) owns and operates the high voltage (400kV and 275kV) transmission system, through which bulk electricity is transported from the electricity generators to the Regional Electricity Suppliers.

Regional Electricity Suppliers provide an electricity supply and service to consumers. From 1999 the supply of electricity was fully liberalised so all consumers are free to choose their supplier.[7] Distribution Network Operators (DNOs) connect and maintain the equipment at a local level. The electricity industry regulator in the UK is OFGEM[8]

8) Price of diesel fuel

The typical prices of petroleum products in January 2009 in pence per litre were 98.74 for diesel, 36.01 for standard grade burning oil and 43.83 pence for Gas Oil[9].

9) Typical kWh output per kWp

850 kWh/kWp is often taken as the average output from PV modules installed in the UK. Across the UK PV output varies from less than 750 kWh/kWp in the North of Scotland to greater than 950 kWh/kWp in Cornwall as is shown in Figure 2.[10]

---

[6] Department of Trade and Industry Statutory Instrument 1994 No. 3021 The Electricity Supply (Amendment) (No. 2) Regulations 1994 http://www.opsi.gov.uk/si/si1994/Uksi_19943021_en_1.htm accessed: 23/04/09

[7] http://www.parliament.uk/post/e5.pdf page 18 accessed: 17/04/09

[8] www.ofgem.gov.uk accessed: 17/04/09

[9] Table 4.1.3 Typical retail prices of petroleum products(1)(5) 1976 to 2009 http://stats.berr.gov.uk/energystats/qep413.xls accessed: 17/04/09

[10] http://re.jrc.ec.europa.eu/pvgis accessed: 17/04/09

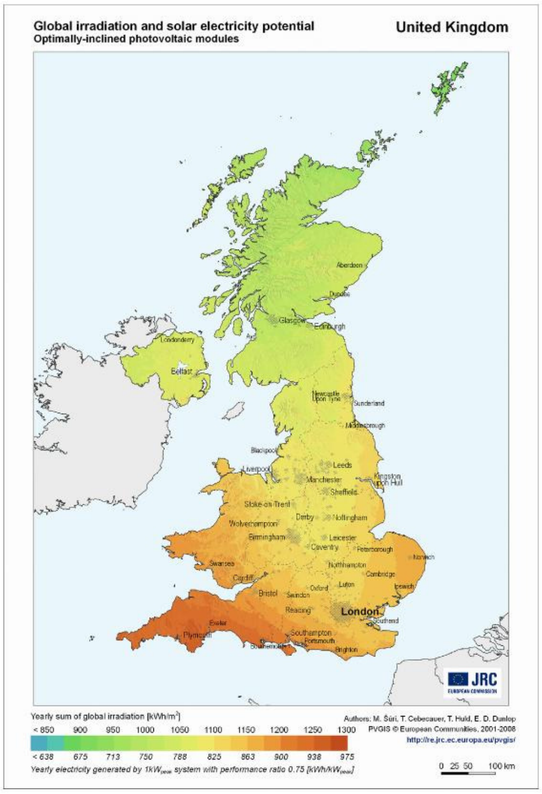

Figure 2: Solar Electricity Potential

ANNEX B: CONTRIBUTORS

AAG Swepco, Abacus Renewable Energy Ltd, Absolute Solar and Wind, Action South Facing, Aissac Electrical and Solar, Alternative Energy Technology Ltd, Apollo Renewables Ltd, Beco Limited, Blue Flag Ltd, Bowller Solar, BRE, Bright Green Energy, Brunel University, CE Electric, CE Solar, Central Networks, Chiltern, Chiltern Future Energy, Cleaner Air Solutions UK Limited, Cranfield University, Dabbrook, DECC, Defoe, DETI, Dulas Ltd, Durham University, Eco Environments Ltd, Ecoheat Plumbing Heating and Solar Engineers, Ecolution, Ecovolt Ltd, EDF Energy, EDF Green Energy Fund, energi holdings plc, Energy Savings Trust, Engenius Limited, EPOD Solar Wales, EPSRC, Equinox Renewable Energy Limited, EST, EvoEnergy, forest:engineering, Frontier Solar, G24i innovations, GB Sol, Gensol, Greenearth Energy Ltd, H Percival Electrical Services, Heriot-Watt University, Imagination Solar, Imperial College London, J A Graham renewable Energy Services, Loughborough University/ CREST, Mark Group Limited, MITIE Energy Limited, MMU, Naps UK, Naturalwatt, New World Solar Installations Ltd, NIE, Northumbria University, Photon Energy Limited, Plug into the Sun, PV Systems, Rayotec Ltd, Reliable Plumbing Services, Romag, Scoraig wind electric, Scottish & Southern, Scottish Power, Scottish Power Green Energy Trust, SEI, Select Energy Engineering, Select Solar, Sharp, Solar Energy Alliance, Solar Logic, Solarcentury, SolarSense UK Ltd, Solion Ltd, Solstice Energy Ltd, Southampton University, Southern Electric Contracting, Southern Solar Ltd, SPE Engineers Ltd, Strathclyde university, Sun Renewables Ltd, Sundog Energy Ltd, Sustainable Energy Installations, Sustainable Energy Systems, Sustainenergy, Technology Strategy Board, TSB, UK Energy Research Centre, United Utilities, University of Bath, University of Cambridge, University of Edinburgh, University of Leicester, University of Oxford, University of Sheffield, University of Warwick, Western Power Distribution, Wind & Sun Ltd, Winsund International Ltd.