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 2002

Prepared by
Rebecca Gunning, IT Power Ltd.
The Manor House, Lutyens Close
Chineham, Hampshire
RG24 8AG, UK

May 2003
Sponsored by the
UK Department for Trade and Industry

Table of Contents

Document control	
File path & name	I:\0WorkITP\0Projects\Solar\0677_PVPSTask1\Work\NSR\UK\2002\0677 IEA-PVPS_NSR2002UK V2.doc
Author	RG
Project Manager	RG
Approved	RO
Date	25/06/02
Distribution level	Public Domain

i Foreword

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

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

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

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

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

ii Introduction

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

This National Survey Report of PV Power Applications in the UK has been produced following discussions with, and input from, organisations and individuals involved in the development and implementation of PV Technology in the UK. It represents an overview of the key developments and achievements in the UK PV sector during the year 2002.

UK National Survey Reports covering the past four years (1999, 2000, 2001 and 2002), together with other information about the UK's participation in IEA-PVPS, is available from the UK-PVPS website: www.iea-pvpsuk.org.uk.

iii Definitions, symbols and abbreviations

For the purposes of this report, the following definitions apply:

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

DNO: Distribution Network Operator.

DFT: Domestic Field Trial - Demonstration programme of PV for use in residential applications, supported by the DTI.

DTI: (UK Government) Department for Trade and Industry.

EPSRC: The Engineering and Physical Sciences Research Council. EPSRC funds research and postgraduate training in universities and other organisations throughout the UK.

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

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

Grid-connected centralised PV power system: Power production system performing the function of a centralised power station.

Grid-connected distributed PV power system: A PV system installed on consumers' premises usually on the demand side of the electricity meter. This includes grid-connected domestic PV systems and other grid-connected PV systems on commercial buildings, motorway sound barriers, etc. These may be used for support of the utility distribution grid.

Installed PV power: Power delivered by a PV module or a PV array under STC – (also see 'Peak power').

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.

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

NC: National Currency (GBP - Pound Sterling)

Off-grid domestic PV power system: System installed in households and villages that are not connected to the utility grid. Usually a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'.

Off-grid non-domestic PV power system: System used for a variety of 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'.

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

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.

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

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.

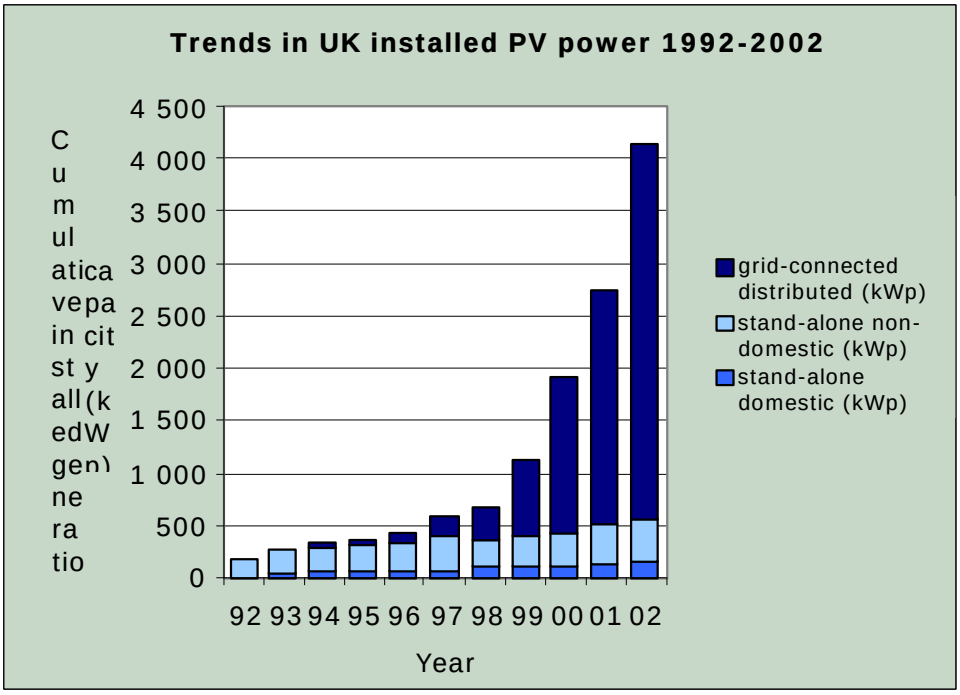
STC: Standard Test Conditions – irradiance of 1 000 W/m^2, cell junction temperature of 25°C, AM 1,5 solar spectrum

Turn-key price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid system, the prices associated with battery maintenance/replacement are excluded.

1 Executive summary

1.1 Installed PV power

There was a significant increase in the annual installed PV generation capacity in 2002 of 70 % compared to 2001. A total of 1 390 kW was installed in the UK in 2002. The cumulative installed PV generation capacity increased by over 50 % during 2002 reaching a total of 4,14 MW. Much of this increase is due to the rapid expansion of the grid-connected market, accounting for 96 % of the 2002 installations. Government support in the form of Field Trials, together with the Major Demonstration Programme launched in 2002 accounted for approximately 51 % of the total new capacity.



1.2 Costs & prices

Average module prices remain approximately the same as for 2001, typically in the range 3 to 3,7 GBP/W for reasonable volume orders. For small orders (few modules) retail prices range from approximately 3,8 up to 5,4 GBP/W. Lower minimum prices however have been achieved. The lowest price achieved during 2002 was for multicrystalline modules and was 2,69 GBP/W.

Overall system prices range considerably because they take into account the significant differences in the projects, the level of integration and technology used. On-grid prices ranged from 4,3 GBP/W to 14,8 GBP/W. The average turnkey price for a standard 1-3 kW system was 6,7 GBP/W, this is similar to prices in 2001.

1.3 PV production

The UK's only major indigenous cell manufacturer, ICP Global Technologies (previously Intersolar), increased its production from 1,6 MW to 2,3 MW in 2002. Production capacity (3,0 MW) remained the same as that reported in 2001.

Crystalox, producers of multi-crystalline silicon blocks, increased production by 250 % in 2002 (compared to 2001). Total production in 2002 was sufficient for 75 MW of cells. The company, the UK's largest employer in the PV sector, increased production capacity from 58 MW in 2001 to 90 MW in 2002.

1.4 Budgets for PV.

Budgets for pre-competitive R&D and Demonstration / Field Trials (supported by the Department for Trade & Industry) amounted to 8,01 million GBP in 2002. This total is more than double the figure reported for the previous year. A large proportion of this funding has been for the three separate demonstration and field trial programmes, provided by the DTI.
The Engineering and Physical Science Research Council figure of 2,6 million GBP for PV related research represents a 40 % increase compared to 2001.

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.

2.1 Applications for photovoltaics

UK installed photovoltaic generation plant contributed an estimated 2.5 GWh to the UK's total energy supply in 2002. This remains very small < 0,0005 %, compared to total electricity consumption of just over 340 TWh[1]. Nevertheless, PV provides an invaluable cost-effective service in an increasing variety of niche applications, particularly where power requirement is relatively small and/or accessibility is poor. There is also sustained expansion in the distributed grid-connected sector.

2.1.1 Stand-alone applications

Until the mid-1990s, the use of renewable energy for professional applications in the UK was limited to mountain-top telecoms equipment and light-house or harbour beacons. Since then, the number of applications using solar generators has advanced significantly. A total of 47,5 kW was installed off-grid in 2002. Of this 56 % was installed on domestic properties with the remaining installations for a range of applications.

Table 1 presents an overview of stand-alone applications for photovoltaics in the UK, categorised by end-users. Many of the applications have an installed capacity of less than 40 W.

[1] Digest of UK Energy Statistics 2002. Data not available for 2002 yet.

Table 1: 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 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
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

END-USERS	TYPICAL APPLICATIONS
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)

In November 2002 London's Bus Services (LBS) announced a field test of bus shelters with roof-integrated panels to provide electricity for lighting. Solar Century, Sepco Holdings Plc and Canadian Carmanah Technologies Inc. will deliver the products. If the three pilot shelters are successful it is likely that the project will to be expanded to 200 further bus shelters which are too expensive to connect to the grid. The company is also considering PV for lighting of bus timetables. Similarly Plymouth City Council is expected to install 300 solar bus shelters in the next year as well as Leicester City Council.

2.1.2 Grid-connected applications

The grid-connected PV market with 2002 installed capacity of 1 343 kW now accounts for over 96 % of the annual total. This was an increase of 87 % over that installed in 2001. This is largely due to the completion of a number of projects under the DTI's grant supported programmes. In 2002, PV was installed at 16 separate clusters of houses under the DTI's Domestic Field Trial (DFT) totalling 472 kW and two large scale projects were installed under the DTI's Large Scale BIPV programme, with a combined capacity of 165 kW. The first 33 projects under Stream 1 of the DTI's Major Demonstration Programme (< 5 kW systems) were also completed (see section 2.3). These DTI grant funded projects account for approximately 51% of the total installed capacity in 2002.

Therefore about 687 kW was fully paid for by the customer or received funding from sources other than the DTI (eg. the European Commission). These projects included 142 kW installed by Woking Borough Council on four different buildings and B&Q installed PV on one of their stores.

Prior to 2001, the UK grid-connected PV market had been dominated by BP and its own programmes of installations. Although BP Solar continues to install a significant proportion of the annual installed capacity, most UK installers have benefited from an upturn in the market. Two companies, BP Solar and Solar Century installed 728 kW in 2002, the remaining 662 kW was installed by over 20 PV installation companies.

2.2 Total photovoltaic power installed

The year-on-year total cumulative installed PV power for the UK sub-markets (stand-alone domestic, stand-alone non-domestic, and grid-connected distributed) from 1992 onwards are presented in Table 2.

Note, there are no centralised grid-connected PV power generation systems in the UK.

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

Sub-market/application	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
stand-alone domestic (kWp)	7	47	52	57	69	83	108	119	121	135	162
stand-alone non-domestic (kWp)	166	213	232	252	279	316	254	276	302	385	406
grid-connected distributed (kWp)	0	6	54	59	75	190	328	736	1 506	2 226	3 568
grid-connected centralised (kWp)	0	0	0	0	0	0	0	0	0	0	0
TOTAL (kWp)	173	266	338	368	423	589	690	1 131	1 929	2 746	4 136

This was a significant increase in the annual installed PV generation capacity in 2002 of 70 % compared to 2001. A total of 1 390 kW was installed in the UK in 2002. The cumulative installed PV generation capacity increased by over 50 % during 2002 reaching a total of 4,14 MW. The growth rate over the last three years has been high and has averaged 55 %.

2.3 Major projects, demonstration and field test programmes

Approximately 51 % of the total installations (in W) during the year were carried out under the three UK funding programmes. These are described in the following sections.

2.3.1 Major Demonstration Programme

The PV Major Demonstration Programme (MDP) was officially launched on 26th March 2002. 20 million GBP was made available for the three-year programme from the Department of Trade and Industry. It is expected that the first phase of the MDP will result in at least 3 000 homes and 140 larger non-domestic buildings receiving solar PV systems. Its long-term aim is to assist in making PV technology an attractive investment for both domestic and corporate customers. The UK government hopes that long-term sustained investment will result in a ten-fold increase in PV installations by 2005.

The scheme, administered by the Energy Savings Trust, comprises two application streams:

- Stream One – individual or small-scale applications (systems from 500 W to 5 kW) are dealt with on a rolling basis.
- Stream Two – medium or large-scale company or group applications of 5 kW to 100 kW are dealt with in three-monthly tranches.

The maximum eligible subsidies were initially as follows:

- Public Sector buildings – 65 % of the nominal cost.
- Large profit making organisations – 40 %.
- All others, including SMEs and homes (Stream 1), - 50 %.

The subsidy level will diminish over time. From June 2003 maximum grant levels for Stream One will be capped as follows:

- Bolt-on systems will be eligible for a capped grant of the lesser of 3 000 GBP/kW or 50 %.
- Integrated systems will be eligible for a capped grant of the lesser of 4 250 GBP/kW or 50%.

For Stream Two applications Public Sector grant applications were capped to a maximum of 60% funding.

Grants are available for both on and off-grid applications and are eligible for modules, inverters and installation but not batteries or complex charge controllers. Only building related off-grid applications are eligible for funding. All grant applications require the use of approved products and accredited installers and designers.

In Stream One, 144 applications were approved in 2002 and 1 046 061 GBP was allocated for the total installation of 288 kW. 33 of these systems were installed during the year (approximately 66 kW). The vast majority of the approvals (76%) are for 'bolt-on' systems and 70 % of the systems use crystalline technology. Projects have been approved all over the country but approximately 50 % of the approvals are situated in the south of England (South-West, South-East and London regions).

In Stream Two, 27 applications totalling 890 kW were approved during 2002 and 3 535 985 GBP allocated. The approved systems, none of which have been installed yet, will be installed on social housing, schools and universities, museums, and tourist attractions such as The National Marine Aquarium in Plymouth and the Eden Project in Cornwall. As with Stream 1 approvals, approximately 50 % are in the south of England. One of the several high profile installations approved is the Vauxhall Interchange in London. As part of the re-development of central London, a new 24 hour bus terminal will be constructed in the Vauxhall Cross area. The 29,4 kW photovoltaic system will be integrated into the "ribbon canopy" to create a landmark feature. The PV system will use HIT (Heterojunction with Intrinsic Thin layer) technology. The hybrid PV cells composed of thin amorphous silicon and single crystalline silicon are considered to be the most efficient in the UK climate.

2.3.2 Domestic PV Field Trials

The Department of Trade and Industry's Domestic Field Trial (DFT) aims to use the design, construction and monitoring of a wide range of domestic types of installation as a learning opportunity for key players in the process of PV installation. In total, 30 sites, constituting over 519 dwellings and over 750 kW generation capacity will benefit from the 5,4 million GBP funding provided under DFT. The funding was allocated in two rounds. 16 of the 30 projects were installed during 2002 equalling 472 kW installed. This brings the total installed capacity under this programme, at the end of 2002, to 520 kW. Two thirds of the projects are in social housing or mixed developments and the systems are fitted in conjunction with exemplar energy efficiency technology. The projects will investigate some novel integration approaches for the UK, including various solar roof tile systems.

The installed systems will be monitored for a period of two years after installation. Issues which will be and are being investigated by the managing contractors at each site include system efficiency, annual yield and system reliability. The performance data will allow comparison between system types and also comparison between several systems of the same design and location. This will provide information on the uniformity of output of the systems and the reliability of components such as inverters. Identification and quantification of system losses will also be possible. Data is already being collected on at least four installations.

As well as the collection of data on the performance of the systems during the monitoring stages, also of importance are the key lessons learned during design and construction of the systems. The issues arising include[2]:

- Regional variations in building regulations (for example, Scottish regulations require that tiles are nailed to roof battens).
- Ensuring that PV products comply with British Standards. One PV tile product failed British Standards on fire testing and had to be modified.
- Having efficient and effective contractual arrangements, including involvement of all parties to the planned use of PV at the earliest stage of any development.
- Consideration of responsibilities at the early stage of the contract to avoid problems or delays related to items such as insurance and damage due to vandalism.
- Well planned logistics to minimise additional costs and ensure good working relationships are maintained.
- Good co-ordination between PV system installers and other building tradesmen, particularly roofers and electricians, to ensure adherence to quality and to the building schedule.
- Continuity of contract workers and ensuring training on handover when there are changes.
- Consulting with tenants to secure positive support for the installations.
- Having flexibility in the mounting systems, particularly for refurbishment projects, to allow for alignment with irregular or non-square roof members on site.
- Positioning of the array on the roof to take account of loading, particularly for older, refurbished properties.
- Some pre-payment electricity meters do not allow export of electricity and can be damaged by attempted export, or assume tampering and cut off supply.
- Labelling is a key issue for DNOs and attention to detail is required when finalising to ensure that the installation is acceptable to them.
- Ensuring that good practice is maintained with respect to wiring, i.e. clipping of cables to rafters or similar without long lengths of spare cable.
- Health and safety issues must be continually re-iterated because access to roofs is sometimes required in addition to standard roof installation, i.e. checking connections if problems are found on commissioning.

2.3.3 Large-Scale BIPV Field Trial

In November 2001 3 million GBP was allocated for 12-15 large building integrated PV projects (i.e. >20 kW), with the objectives of raising awareness and of creating confidence in the application of PV, increasing UK capabilities in the application of the technology, providing opportunities for UK industry and assessing the potential for BIPV in the near term and its role in future energy policies and strategies.
In March 2002 UK Energy Minister, Brian Wilson, announced 4 million GBP funding for 18 projects totalling almost 1,15 MW on public buildings across the UK. The extra funding was made available due to the large number of quality schemes proposed.

[2] Taken from Photovoltaics in Buildings Domestic Field Trial Newsletter No.4 May 2003

All the designs are for true building integrated systems, and modules and inverters are required to conform to appropriate certification standards.
The supported projects include: a 32,8 kW installation of double-glazed laminates containing multicrystalline and monocrystalline PV cells/modules on the atria and façade of the Zuckerman Institute for Connective Environmental Research (ZICER) building at the University of East Anglia's School of Environmental Sciences; and a 20 kW system using Sunslates for the Columba Centre, a Gaelic language and culture centre on the island of Islay, Scotland. Two of the 18 projects were completed during 2002 and are described below.

2.3.4 Gaia Energy Centre

The new visitor centre at Delabole, Cornwall is situated next to the UK's first commercial wind farm. It provides a specialist building for the education and demonstration of renewable energy. The building is also used for community social events. 530 m2 of integrated PV modules has been installed on the south-facing roof and the system forms a primary exhibit within the centre. The 63 kW array uses BP Solar laminates and is constructed to form a sealed skin incorporating fans. A system of ductwork draws the solar heated air from behind the array and feeds it into the building.
The system is being utilised in an EC Thermie funded programme project with Loughborough University, which will assess how much heat is generated by the system and how this can best be used.

2.3.5 Birmingham City Council - Indoor Sports Training Centre

The largest single installation during 2002 was the integration of 1760 IBC Solar Kaneka thin film laminates into the roof of the new Birmingham High Performance Centre at the Birmingham Alexander Stadium (the main training venue during the global indoor athletics championships held in March 2003.) for the English Institute of Sport. This is the largest solar roof in the UK (102 kW over 1500 m^2).
The system will supply all of the anticipated power demands of the building and provide additional solar shading thus avoiding the need for mechanical cooling

2.3.6 BP 'Harmony' programme

BP’s ongoing international programmes to equip its petrol stations with PV generators accounted for 56 kW of thin-film (double-junction amorphous silicon) PV modules on petrol stations under the company’s ‘Harmony’ initiative. The projects ranged from 5 kW to 16 kW PV systems on five petrol station canopies. This is a reduction from previous years and accounts for 4 % of the total installed in 2002, compared to over 40 % in 2001.

2.3.7 Woking Borough Council

Woking Borough Council provides services for over 93 000 residents and businesses in Woking. Through its Environmental Charter and Energy Efficiency Policy, the Council is leading the way and has introduced a number of measures to protect the environment and reduce pollution to make Woking a cleaner, greener borough. In 2002 Woking Borough Council installed PV on four separate sites in the borough. These included a glass-glass atrium roof of 9,1 kW at the Pool in the Park, and three residential PV installations for sheltered housing, totalling 133 kW.

Table 3: Summary of major projects, demonstration and field test programmes

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2002/problems and lessons learned	Funding	Project management	Remarks
Domestic Field Trial 2000-2002	1,4m GBP was originally assigned for 9 cluster projects – total >220 kW for >160 residences. (One of the nine projects was since cancelled)	To use the design, construction and monitoring of the installations as a learning opportunity for utilities, building developers and other key players. Geographical spread and technologically varied systems will maximise lessons learned. Monitoring of the systems will be carried out to assess performance over the two years following commissioning.	Seven developments totalling 170 kW commissioned as at end 2002. Four installations were carried out in 2002 with a capacity of 122 kW.	Up to 100% DTI (some projects have secured complementary EC funding)	BRE (leader), EMC Ltd., IT Power, NPAC	The installation process in each case has run smoothly. Any delays experienced have been due to the main building programme or to the complexities of monitoring. The first results from the monitoring are now being analysed.
Domestic Field Trial – Phase II 2001-2003	4m GBP was originally assigned for 23 developments – total >600 kW for 379 dwellings. (One of the 23 projects is subject to acceptance of a new contract).	As above, with increased regional distribution allowing introduction of new players, including new DNOs	12 developments totalling almost 350kW were installed during 2002. Information on emerging problems and issues associated with the installations has been recorded as part of the programme.		BRE (leader), NPAC, EMC, EA Technology	
Major Demonstration Programme 2002-2005	20 million GBP has been made available for the three-year programme from the DTI. It is expected that the first phase of the MDP will result in at least 3 000 homes and 140 larger non-domestic buildings receiving solar PV systems.	Its long-term aim is to assist in making PV technology an attractive investment for both domestic and corporate customers.	144 small scale (< 5 kW) applications approved and 1 046 061 GBP allocated for 288 kW. 33 systems installed in 2002. 27 large scale (> 5 kW) applications totalling 890 kW approved in 2002 and 3 535 985 GBP allocated.	20 million GBP is available for the three-year programme.	EST	
Large Scale Building Integrated PV Trial (LSBIPV)	18 projects totalling almost 1,15 MW on public buildings across the UK	The objectives of LSBIPV are to: raise awareness and create confidence in the application of PV; increase UK capabilities in the application of the technology; provide opportunities for UK industry;	Two projects (165 kW) completed in 2002 – details below.	4 million GBP funding has been allocated for projects totalling almost 1,15 MW.	Halcrow Group Ltd.	

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2002/problems and lessons learned	Funding	Project management	Remarks
		and assess the potential for BIPV in the near term and its role in future energy policies and strategies				
Gaia Energy Centre	Total 63 kW BP Solar laminates installed as a fully integrated system over 530m^2 in area.	System forms a primary exhibit within the renewable energy demonstration and education centre and will be used in a research project with Loughborough University to investigate heat recovery from PV.	System was completed during 2002 and the research project started.	DTI (Under Large-Scale BIPV Field Trial) 199 000 GBP for the PV modules. Thermie (EU) Euro 327 000 for installation costs and heat recovery research project.	PV Facades	
National Indoor Athletics Training Centre, Birmingham	1 500m^2 102 kW fully integrated roof system comprising 760 thin film Kaneka LSU 202 amorphous silicon modules. Total project cost was just under 400 000 GBP.	To use new and innovative solar technology to provide for 100% of the world class venue's electricity demand.	Modules were installed by end 2002 and the system was commissioned in time for the 9th IAAF World Indoor Athletics Championships held in March 2003.	DTI (Under Large-Scale BIPV Field Trial)	Solar Century	The lightweight mounting system and module configuration was developed specifically for the project. It could be easily adapted to other new-build or existing buildings.
BP Harmony	BP Programme to install thin-film PV on its own filling stations.	International programme – to project a 'green' image and raise public awareness of PV power systems	Total of 56 kW installed on 5 stations in 2002.	BP / BP Solar	BP Solar	Successor to 'Sunflower' programme which resulted in 734 kW on 43 filling stations around the UK
Woking Borough Council	9,1 kW installed at Pool in the Park – glass/glass atrium (St Gobain). 47 kW installed at Brockhill sheltered housing scheme. Total at site is now 81,48 kW (BP solar laminates) 41 kW installed on The Vyne sheltered housing and 45 kW installed on The	In line with Council's Environmental Charter and Energy Efficiency Policy.	Total of 142 kW installed in 2002.	Woking Borough Council	Woking Borough Council	At two sites PV is installed with CHP units – one 30 kW gas fired unit and a 200 kW fuel cell CHP unit.

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2002/problems and lessons learned	Funding	Project management	Remarks
	Broadway sheltered housing dwellings. (BP Solar laminates)					

2.4 Highlights of R&D

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

EPSRC's PV research priorities are ostensibly defined under the Supergen programme, although some funding is provided for unsolicited research proposals. Supergen is a consortium of future network technologies and is focussed an electrical power network that will support and encourage renewable energy sources. The areas it covers include distribution networks and micro-generation and scenario planning.

Current projects within the engineering sector range from the development of components for building integrated systems to development of more stable amorphous silicon cells. At a more fundamental level, several institutions are currently investigating organic dye solar cells including the applicability of nanocrystalline films, while novel cell materials and process techniques are also popular academic research topics.

The Department for Trade and Industry (DTI) R&D programme is concentrating mainly on cost reduction. The programme's main emphasis is on new, leading edge cell technology and manufacturing and also on improving the cost-effectiveness of balance of systems components.

In March 2002 the DTI awarded a research and development grant of 680 000 GBP to Plasma Quest to partly fund a 1,1 million GBP project. The project aims to produce thin film polycrystalline silicon PV cells by a fundamentally new thin film deposition technique, using a development of Plasma Quest's advanced high density plasma process - HiTUS. This allows substantially reduced process temperatures to be used, allowing the use of cheap substrate materials such as glass and providing the basis for a low cost production process. It is hoped that thin film PV cells with efficiencies exceeding 10 % and costs lower than 1 USD/W will be achieved.

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

Table 4a: Public budgets (in GBP million) for R&D, demonstration/field test programmes and market incentives.

		R&D	Demo / Field Test	Market
National	DTI	1,45	3,96	
	EPSRC	2,6	-	-
Regional		Not Available		
Total	GBP	8,01		

Budgets for Pre-competitive R&D and Demonstration / Field Trials (supported by the Department for Trade & Industry) amounted to 8,01 million GBP in 2002. This is over double the total for the previous year, with increased funding from both the DTI and EPSRC. The

majority of the increase however came from the DTI directly in the form of support for the field trials and demonstration programmes. The three separate programmes are described in section 2.3 and the approximate amount of funding issued is shown in table 5 below. (The amounts have been rounded to the nearest 10 000 GBP.)

Table 5: DTI funding (in GBP million) for field trials and demonstration programmes.

Programme	**2002 funding in GBP million**
Major Demonstration Programme (MDP)	0,3
Large scale BIPV	0,46
Domestic field trial	3,2
TOTAL	**3,96**

The EPSRC figure represents a 40 % increase compared to 2001. The figure is calculated pro-rata from total project budgets and may not necessarily reflect actual spend committed during 2002. Additionally, EPSRC is providing 3,9 million GBP over 3 years for a national consortium investigating carbon-based electronics. This could generate important results for the PV sector amongst others, but has not been included in the above figures.

Some EPSRC funding is used by INREB (Integration of New and Renewable Energy into Buildings) Faraday Partnership. Its activities include research and development into the impacts and limits to the widespread use of distributed generation including by PV. INREB also use DTI funding for projects such as the development of PV training for installers and demonstration projects.

The Low Carbon Innovation Programme, from the Carbon Trust, funds research and development, demonstration and market diffusion projects in low carbon technologies, with the aim of reducing carbon dioxide emissions. Whilst it is a potential source of funding for PV in practice other technologies which produce the same carbon reductions more cheaply are usually favoured. Information on Carbon Trust spending for 2002 is not yet available.

Information on Local Authority spending on incentives for PV has not been accessible.

3 Industry and growth

3.1 Production of photovoltaic cells and modules

Table 5: Production and production capacity information for the year for each module manufacturer

Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production		Maximum production capacity	
		Cell (MWp)	Module (MWp)	Cell (MWp)	Module (MWp)
Thin-film technology					
Intersolar	a-Si	2.3	2.3	3	3

The UK has only one major manufacturer of PV modules: ICP Global Technologies (Intersolar) manufactures thin-film amorphous silicon cells and modules at its factory in Bridgend, South Wales. Intersolar was taken over by ICP Global Technologies of Canada in January 2003. ICP develops, manufactures and markets solar-powered consumer products. ICP will continue the company's development and consumer product business but is separating them. The consumer products will be integrated into ICP's business and a new entity ICP Solar Technologies UK Ltd controls R&D and production of a-Si modules. The company operates to ISO 9001 Quality Assurance management system.

Intersolar has developed a unique High Rate Deposition (HARD) Process. This produces solar cells on a standard sheet of float glass, which acts as the cover glass. The cell is laid down starting from the front in the following process steps:

Deposition of a transparent front contact surface
Laser Isolation of the front contact into separate solar cell strips
Deposition of the thin film silicon solar cell junction
Laser isolation of the junction into separate solar cell strips
Deposition of the reflective rear contact and isolation into cell strips.

This produces solar plate which is then tested for performance. Depending on whether it is then used for solar modules or cut plate, it will then proceed to either:

Cut plate coating and cutting
Edge isolation, lamination and module framing.

Intersolar increased its production from 1,6 MW in 2001 to 2,3 MW in 2002, an increase of over 40 %. A large proportion of the company's production is exported: in 2002 Intersolar sold 30% of its 2,3 MW to the UK market with the remaining 70% being exported. The production figure also includes cells produced for a variety of consumer products manufactured in-house. Production capacity has remained static from the level reported in 2000 at 3,0 MW. However the company aims to increase production capacity to 3,5 MW in 2004

Intersolar has recently developed a PV product for slate roofs. The 'Electra-Slate' incorporates a 1,4 W thin film solar cell (at 46 V). Each Electra-Slate fits to the next by means of an integrated plug in connector, allowing easy installation. The product is undergoing a variety of relevant tests for roofing products, and for solar panels. The

company is continuing its development of the Electra-slate roof tile to increase its output to 3,5 W, 24 V by the end of 2003, and to be certified to IEC 61646 by September 2004.

The company is also developing dual junction a-SI in their purpose built development plant and is developing large area a-Si deposition and new connection systems.

Crystalox, based in Wantage near Oxford, pioneered development of multi-crystalline silicon directional solidification as a production process for the PV industry and delivers automated equipment to many of the world's leading PV companies.
The company also produces multi-crystalline silicon ingots, and following its production increase in 2001 by 200 %, it further increased production in 2002 by 250 % (compared to 2001). Its total production in 2002 was sufficient for 75 MW of cells. These are exported mainly to Japan and also to Germany, where they are wafered by PV Silicon. The company employs 90 staff and is the UK's largest employer in the PV sector. The firm increased its production capacity from 58 MW in 2001 to 90 MW in 2002. It has ISO 9001 accreditation.

Module prices in the UK

Average prices remain approximately the same as for 2001, typically in the range 3 to 3,7 GBP/W for reasonable volume orders. For small orders (few modules) retail prices range from approximately 3,8 GBP/W up to 5,4 GBP/W. Lower minimum prices however have been achieved. The lowest price achieved during 2002 was for multicrystalline modules and was 2,69 GBP/W.

3.2 Manufacturers and suppliers of other components

Approximate price ranges for a range of inverter sizes are presented in Table 6.

Table 6: Price (in GBP) of inverters for grid-connected PV applications

Size of inverter	<1kVA	1-10 kVA	10-100 kVA	>100kVA
Average price of inverter per kVA (GBP)	280-900	370-700	~ 300	~ 3 000

Manufacturers and suppliers of components in the UK include:

BecoSolar of Dartmouth manufacture a range of controllers, batteries and building customised systems for industrial, commercial, leisure and domestic uses, particularly for the off-grid sector, often for harsh environments.

Dabbrook Power Systems, based in Yarmouth are BP Solar product distributors and design and supply packages for off-grid applications.

Dulas Engineering of Machynlleth is a worker-owned company specialising in renewable energy system design and supply. The company designs and manufactures a range of robust electronic control equipment in-house. Dulas is also UK agent for Fronius inverters and during 2002 launched their new grid-connected range featuring improved visual display and flexible monitoring options.

Invertec Ltd, traditionally a low-voltage lighting manufacturer, supplies a range of inverters for stand-alone PV applications.

Futronics Power Designs Ltd, based in Hertfordshire, designs and manufactures the 'Sustain' range of inverters for stand-alone applications.

I-Power of Gateshead produces a range of Stand-Alone and Grid Linked Inverters for (PV) Applications.

Labcraft of Romford is a specialist manufacturer of low voltage fluorescent lighting and inverters for PV and other alternative energy applications.

Mastervolt UK is the UK sales and distribution arm of Mastervolt, headquartered in Amsterdam. The company designs and manufactures inverters, battery chargers and related components, and distributes batteries and modules. A new range of sine wave inverter/ charger products has been designed for BP Solar for use in stand alone PV systems (Combi range). The Combi inverters can be supplied with an advanced Generator Start/ Stop Control system and an intelligent digital remote panel, offering battery status diagnostics and system failure indication.

Solar Century of London is the main UK agent for a number of innovative roofing products including UniSolar's flexible shingles and structural standing seams, Pfleiderer's roof-tile integrated 'Terra Piatta' system, SES-Atlantis's Sunslates and Powerlight's insulated 'Powerguard' system for flat roofs.

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

Sollatek of Slough manufactures low-voltage DC lights and battery charge controllers for stand-alone applications, predominately for the export market. Their latest product is the solar powered Glowstar lantern.

SunDog Energy of Penrith is sole UK stockist of the Redland Integrated PV Roofing System. The 35 W panels come with a unique mounting system that integrates directly into a tiled roof, using standard battening and requiring no visible brackets or supporting structure. A basic system consists of 20 panels.

Wind & Sun of Leominster is the main agent and authorised service centre for Xantrex-Trace inverters in the UK. The company also supplies SMA and Studer inverters for grid-connect applications.

DIY systems are available for stand-alone marine and leisure applications and also for educational purposes, as listed in section 2.1.1, but no DIY systems are available for grid-connected applications.

3.3 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 kWp	Modules for leisure market (holiday homes, boats, caravans)	5,4 - 10,0
OFF-GRID >1 kWp	Remote homes with battery storage or backup generator; Pumping Systems	5,2 - 9,0
ON-GRID Specific case	1-3 kWp domestic roof mounted	4,3 - 12,8
	1-3 kWp domestic roof integrated (e.g. slates or tiles)	5,0 - 14,8
ON-GRID up to 10 kWp	Roof or ground-mounted systems (e.g for commercial building retrofits)	4,4 - 6,6
ON-GRID >10 kWp	e.g. 20 kWp roof mounted system (on filling stations, commercial / industrial buildings)	~ 4,3
	One-off true building-integrated designs will be more expensive	7,0 - 12,7

Table 8: National trends in system prices (current and constant GBP) for 1-3 kW domestic roof mounted system

YEAR	2000	2001	2002
Price /WW: Current	5,0 - 7,0	5,5 - 8,5	4,3 – 12,8
Constant	5,13 - 7,18	5,62 - 8,69	4,3 – 12,8

The range of prices takes into account the significant differences in the projects: the type of technology, the level of standardisation, level of integration etc. This is clearly illustrated by the approved prices for the Major Demonstration Programme (MDP) in 2002. Under Stream 1 (< 5kW) the average turnkey price for bolt on systems was 6,7 GBP/W. However the prices ranged from 4,8 GBP/W up to 12,8 GBP/W. Similarly for integrated PV systems under 5 kW the prices ranged from 5 GBP/W up to 14,8 GBP/W. The average price for approved integrated systems was GBP 8,9 GBP/W. The prices for the projects approved in Stream 2 of the MDP (> 5kW) in 2002 were a similar price to the small-scale projects. The costs ranged from GBP 4,4 GBP/W up to 12,7 GBP/W with an average of 7,1 GBP/W.

3.4 Labour places

An estimate of (full-time equivalent) labour places related to the photovoltaics sector in the UK is presented as Table 9.

Table 9: Estimated PV-related labour places in the UK

Research and development (not including companies)	67
Manufacturing of PV system components, including company R&D	173

All other, including within electricity companies, installation companies etc.	155

Of the 'All other' category, approximately 115 labour places are in the system supply and installation and/or distribution sectors.
The total number of labour places in 2002 is estimated at 395, which represents an increase of just under 10%. Most of this increase occurred in the installation companies.

3.5 Business Value

The value of PV business in the UK for 2002 is estimated at 18,2 million GBP. This figure is based on the sum of total end financial value of the PV Systems installed during the year and the components -PV modules and multi-crystalline silicon ingots, exported during the year.

4 Framework for deployment (Non-technical factors)

4.1 New initiatives

4.1.1 Promotional initiatives

Marketing of the Major Demonstration Programme is being carried out by The Energy Saving Trust (EST), as part of their contract with the DTI to manage the overall scheme, in partnership with Halcrow (technical and monitoring partner). EST is responsible for strategically developing the programme and dealing with installer accreditation, reporting, marketing, analysis and managing the application process. Marketing of the scheme is done via a website and by presentations at suitable energy efficiency, renewable energy and housing fora.

PV-DOMSYS is a European Commission ALTENER funded project designed to stimulate the take-up of photovoltaic (PV) systems on homes. The UK partners, Guildford Borough Council and The National Energy Foundation (NEF), are working with seven other partners in Germany, France, Spain, and Belgium. This two-year project started in January 2002 and in the UK has the support of many local authorities, the Government Office for the South East, South East England Development Agency, the British Photovoltaic Association, Thames Valley Energy Agency and a housing developer, Laing Homes. The overall aim of the project is to learn from the experience of the more advanced countries to develop tools for stimulating the take up of domestic PV in the participating regions including:

- Marketing campaigns for installers and the public;
- Training programmes for installers;
- Educational materials for system users; and
- Financial tools.

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

- TXU-Europe (Eastern Energy) under an agreement with Greenpeace is continuing to offer net-metering of residential PV systems under the '*Solarnet*' scheme.
- London Electricity (LE) / Seeboard offer to pay 0,075 GBP/kWh for exported electricity for installations up to 3 kW. Payment for export will be made once a year. However the customer must install an export meter and must sign up to LE's green tariff.
- npower / Innogy are paying customers in the South West, South East, London and the South 120 GBP/year and 0,01 GBP/kWh to take part in a trial. Extra meters will be fitted free, and customers must take meter readings every month. In addition npower, has agreed to provide net-metering for the 102 kW PV roof installation on the new English Institute of Sport in Birmingham.
- Powergen (who now own TXU Energi), Scottish & Southern and Southern Electric all also offer some form of net-metering.

Laing Homes, a housing developer has marketed the added value of PV on homes. 15,6 kW was installed on nine homes, funded by the DTI's Domestic Field Trial, which were then sold for a premium price.
Sunpower/UDALLGreen offer green mortgages for solar power.
VAT on professional installations of PV systems has been set at 5 % since April 2000.
The regional governments are setting targets for energy generation from each renewable technology including PV.
In addition promotional initiatives continue to be undertaken by private companies. Solar Century has been particularly active in raising the profile of solar electricity through adverts in the quality national press and appearances on national radio and television.

4.1.2 Utility perception of PV

Most of the 13 regional Distribution Network Operators now have direct experience of grid-connected PV systems.
Naturally, given the current low-level of PV penetration in the UK, the DNOs do not see solar electricity as a business priority at this time. Nevertheless, there is a general interest in PV issues and all DNOs are keeping a watching brief to see how the sector develops. Several DNOs have reported a recent increase in public enquiries since the solar grants (MDP) scheme was announced.

4.1.3 Public perceptions

Since the announcement and associated press releases for the MDP, nearly all installers have noted a step increase in enquiries from the general public.
A number of important policy announcements, including speeches by the Prime Minister and the Energy and Environment Ministers, have helped to raise the public profile of PV and other renewable energy technologies. Likewise the continuing promotional efforts of the government supported programmes and the installation companies appear to be having a positive impact on public opinion.
The British Photovoltaic Association (PV-UK) noted another substantial increase in traffic to its website over the year.

4.1.4 Major new projects / initiatives

As detailed in section 2.3 the Major Demonstration programme (MDP) and Large-Scale BIPV Field Trial were launched in 2002 and a substantial number of projects allocated funding for projects. Some of these have already been completed but many are scheduled for 2003 and beyond. Of the approvals from both schemes made up to 31 December 2002, a total of 2,22 MW is still to be installed.
A Distributed Generation Co-ordinating Group (DGCG) has been set up as an expert group and is chaired jointly by the DTI and Ofgem (Office of the Gas and Electricity Markets). It advises Ofgem, the DTI and other governmental departments on the removal of unjustifiable barriers to the development of distributed generation.

4.1.5 Other new issues

Training and Accreditation

Under the MDP grants, installers are required to be accredited. This means they must sign a Code of Conduct, ensuring the best possible service for customers. The first installations of each newly accredited installer are site-inspected to ensure workmanship to an agreed standard.

In order to kick-start the accreditation scheme, installers with proven experience in the field have been invited to join the scheme. In the longer term, the accreditation scheme will be opened up to other installers to grow the market and to widen the skills base in the UK.

A new Guide for the Installation of PV Systems and a blueprint for an Installer Accreditation Scheme is being prepared for publishing to help develop the UK PV industry and to meet the demand resulting from the Major Demonstration Programme.

In addition a City & Guilds Training course for installers of domestic photovoltaic systems is being developed by IT Power. The course has been developed as part of a European Altener project which set up a Europe wide Accreditation Scheme for courses in the installation of photovoltaic systems. The aim of the project is to ensure common elements are taught, so maintaining the quality and standards of courses throughout Europe. The Altener project also developed a syllabus from which 4 pilot courses are to be developed in the UK and run in 2003. Feedback from these pilots will be used to develop the course further for eventual release.

Carbon Trust funding will take this course forward and develop training material for trainers and students. The project will also provide for the training of more trainers providing greater coverage throughout the UK. These courses have the opportunity to play an important role in the process of becoming an accredited.

4.2 Indirect policy issues

The Renewables Obligation was introduced in the UK on 1st April 2002. This aims to see 5 % of UK electricity generated from renewable energy sources by 2003 and 10 % by 2010. All suppliers of electricity in the UK need to supply the set percentage of electricity from renewables, or pay a penalty. For each unit of 1 MWh (rounded to the nearest whole MWh) of electricity produced per month from accredited renewable energy schemes, the generator will be awarded a 'Renewables Obligation Certificate' (ROC) which can then be sold to an electricity supplier as evidence of a renewables purchase. Suppliers that fail to purchase sufficient ROCs must buy-out of their obligation. The penalty/buy-out price for 2002/3 was 0,03 GBP/kWh and has increased to 0,0305 GBP/kWh for 2003/4. The obligation should encourage development of near cost-effective renewable energy schemes, but is unlikely to promote photovoltaic generation capacity in the near to medium term.

The UK's New Electricity Trading Arrangements (NETA), which were introduced at the end of March 2001, have led to a reduction in wholesale electricity prices for the consumer. However NETA penalises generators that fail to deliver to their contracted supply agreement and has therefore not been helpful for renewable electricity generators. The intermittent nature of most renewables makes forecasting very difficult and leaves generators open to under-supply penalties or diminished value for over-supply. Modifications of the trading arrangements to protect renewables and small generators are currently under discussion. The British Electricity Transmission and Trading Arrangements (BETTA), due to be implemented by April 2004 at the very latest, will bring into existence a single electricity market for Great Britain by introducing a single set of trading rules across Great Britain and will reduce barriers faced by independent generators. As the arrangements only apply to wholesale generation, PV is largely unaffected, except in as much as the reduction in retail electricity price implies a divergence from economic viability for PV power.

The 'Climate Change Levy' (CCL) on business use of energy was introduced on 1st April 2001. The levy on electricity is initially set at 0,0043 GBP/kWh, plus VAT and is set to rise year-on-year. Renewable energy, however, is exempt from the levy and businesses that sign up to a renewable energy tariff can avoid paying the CCL. To avoid being charged the levy, businesses need to sign a contract with a supplier containing a 'renewable source declaration'. This ensures that for every kWh that is used, a kWh of electricity is generated from renewable energy sources. However, the CCL itself is unlikely to stimulate significant growth in PV, as for the foreseeable future, PV generated electricity will remain significantly more expensive than conventional electricity (even with the levy imposed) and other renewable energy technologies such as wind and landfill gas that are closer to the bulk electricity price.

The UK Energy White Paper was published in March 2003. The White Paper restates the UK's goal of a 60 % reduction in CO_2 emissions by 2050 and calls for 10 % renewables generated electricity by 2010 with an ambition to extend the policy to 2020. Specifically for PV, the White Paper includes a chart showing the extension of the Major Demonstration Programme up until 2012, with funding allocated until 2005.

The Sustainable Energy Bill was introduced in December 2002. It calls for a sustainable energy policy to include specification of measures to move towards the achievement of the amount of electricity generated from renewable sources being increased to 25 % by the end of 2020.

4.3 Standards and codes

The first revision of G 83 '*Recommendations for the connection of small-scale embedded generators (up to 16A per phase) in parallel with public low voltage distribution networks'* is due to be issued in summer 2003. It is expected to have 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. A technical annex on PV is proposed, which would mean that G83 would supersede G77.

The second issue of the Engineering Recommendation G77 '*Recommendations for the connection of inverter-connected single-phase PV generators up to 5 kVA to public distribution networks'* was published in 2002, with the acceptance of all DNOs and representatives of the PV industry.

Grid-interconnection of PV systems rated above 5 kW 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'.*

In July 2002 the DTI issued a new publication ' Photovoltaics in Buildings - a guide to the installation of PV systems' to supply system installers with information to ensure that a mains-connected PV system meets current UK standards and best practice recommendations.

The Government's national planning policy with regard to renewable energy is set out in Planning Policy Guidance note (PPG) 22: Renewable Energy which gives local planning authorities guidance on a range of issues that affect the siting of all renewable energy projects. A new annex of PPG22 presenting specific information pertaining to photovoltaic installations was published in April 2002 by the Department of Transport,

Local Government and the Regions. Its aim is to provide planning control officers who consider planning applications for PV installations with clear guidelines on assessing such applications.

5 Future trends

Further installations in the Domestic Field Trial, Large-scale BIPV Field Trial and the Major Demonstration Programme will facilitate a continued healthy rate of grid-connected PV installation until 2005. In particular a significant increase in the annual installed capacity is expected in 2003. The DTI will review the first phase of the MDP against its objectives of bringing down the costs of PV and establishing a more sustainable PV market and will make further funding recommendations in the light of the review's findings.

The future development of the sector is heavily dependent upon the performance of existing manufacturers, installers and suppliers. The current programmes are addressing the need for well-qualified technicians and the participation of players from the building and planning sectors so it is important that the UK PV industry delivers quality products and services when required.

6 Annex A Method and accuracy of data

The information for this survey report has been drawn from many sources. The assistance of Sarah Davidson, and co-operation of all parties who provided information for the 2002 survey is gratefully acknowledged.

Data was gathered directly from most of the UK industry players via e-mail questionnaire and personal discussions. The British Photovoltaic Association (PV-UK), Energy Savings Trust and Building Research Establishment provided access to their information for comparisons. The various data was collated in a spreadsheet, sorted into the required categories and totalled.

The estimated accuracy of the year 2002 data is ± 10 %, except for data relating to the new installed generation capacity in the grid-connected distributed sector and UK production where the accuracy is estimated to be ± 5 % or better.