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 Spain 2008

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July 2009

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Definitions, Symbols and Abbreviations

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

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

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25°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 Euro (€).

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 Spain 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

To differentiate the National Survey Report from the Annual Report the Executive summary should focus clearly on national numbers and trends. For consistency, each Executive summary should contain the following sub-headings:

1.1 Installed PV power

During 2008 the number of PV installations in Spain went up to 29 983 installations. Then, the total PV installations in Spain until the end of 2008 went up to 49 971. This means that in 2008 there was 2 661 MW PV of power installed. This represents an increase of 385 per cent on the same figures for 2007. Next, the PV total installed capacity in Spain went up to 3 354 MW. Energy sold coming from PV systems reached more than 2 492 GWh, five times that of 2008.

1.2 Costs & prices

The PV module prices varied in a wide range depending on the type of application: between 2.3 and 3.5 euros. The cheaper prices were obtained for PV modules come from China.

On the other hand, the cost for typical applications ranged between 5.5 and 14.4, depending of category of PV installation.

1.3 PV production

In total, the PV Spanish industry manufactured 195 MW dedicated to PV cells and 498 MW dedicated to PV modules. The maximum capacity for PV cells went up to 260 MW and 891 MW for PV modules.

1.4 Budgets for PV

It is estimated that 12 millions of Euros were dedicated to R+D+I. During 2008 one hundred and sixty-seven programs of I+D were registered, that are shared irregularly.

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

PV technology has many applications in Spain: stand-alone, grid connected and hybrid systems.

2.1.1 Off-grid applications

The off-grid sector includes domestic PV applications for leisure such as electrical power for weekend houses. Non domestic applications are implemented in the 'mobile' sector, such as cars and caravans (sunroofs combined with ventilation), camping, boats, water pumping and electricity supply for many traffic applications and tool sheds, which are increasing and difficult to distinguish in the total number of PV systems installed in the off-grid sector.

Domestic off-grid PV systems are offered by specialized manufacturers, distributors and system-houses.

2.1.2 Grid-connected applications

The Spanish national programmes favour the installation of grid-connected PV power systems and this has led to fewer installations of off-grid applications. Installation and system companies as well as the fact that the great majority of manufacturers focus on the installation of grid-connected systems. Within the grid-connected PV power applications the distributed systems dominate.

2.1.3 PV Hybrid applications

PV-hybrid systems combine a photovoltaic generator with other power sources, typically a diesel generator, but occasionally another renewable supply such as a wing turbine.

2.2 Total photovoltaic power installed[1]

During 2008 the number of PV installations in Spain went up to 29 983 installations (Figure 1).

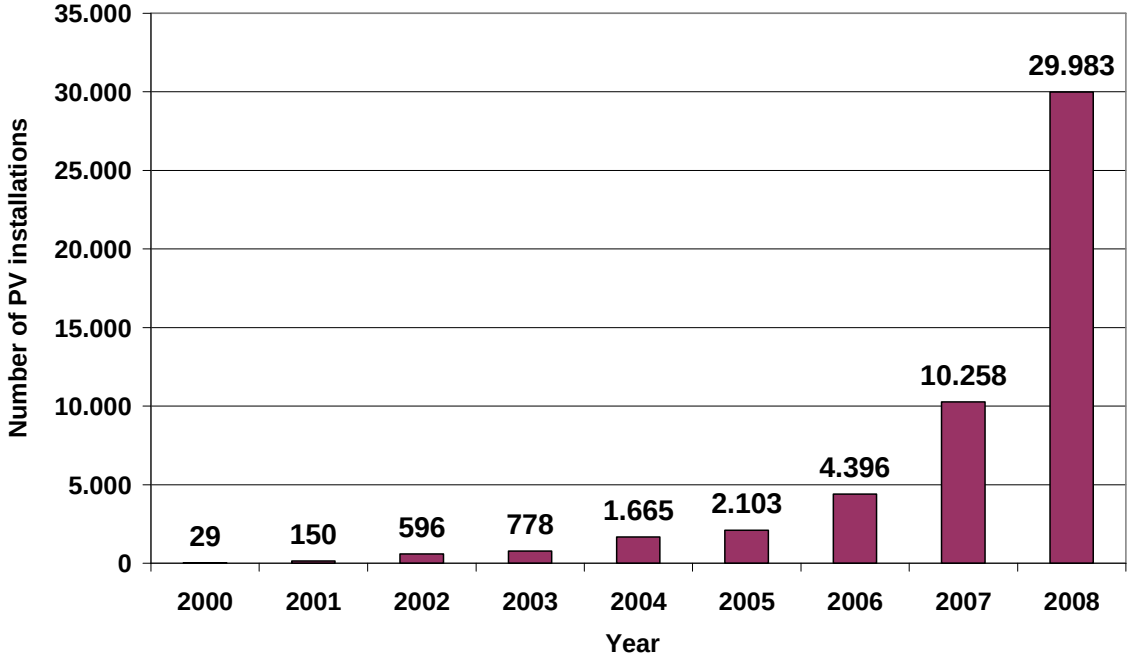

Figure 1 Number of PV installations in Spain, yearly, from 2000 to 2008

Then, the total PV installations in Spain until the end of 2008 went up to 49 971 (Figure 2).

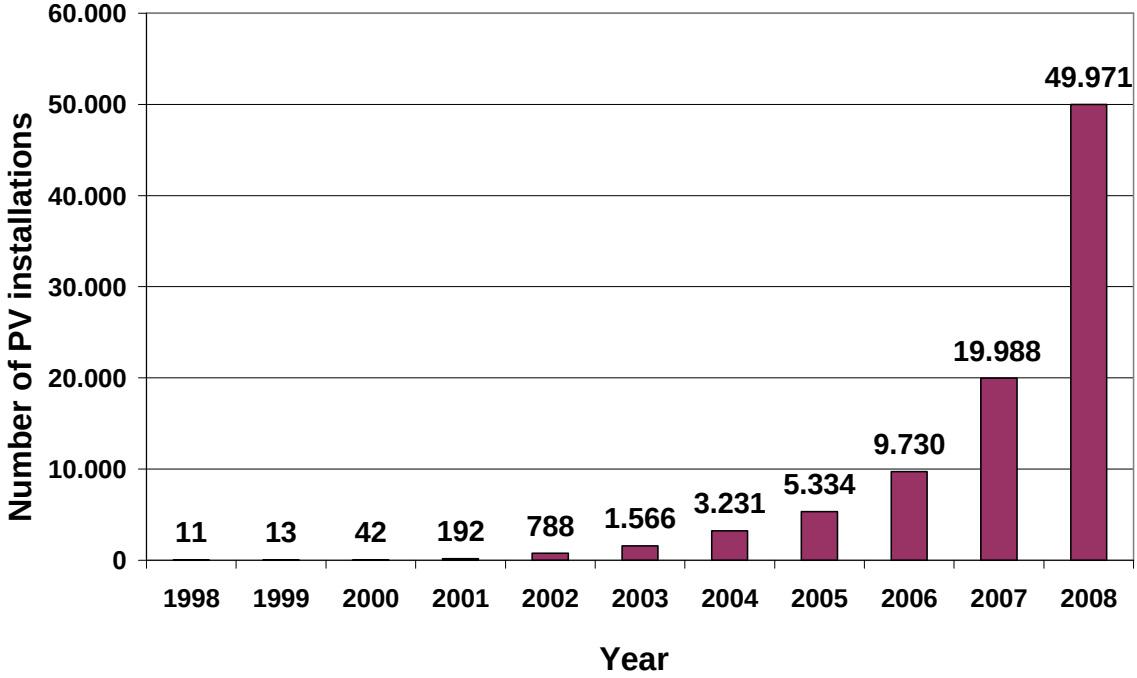

Figure 2 Number of PV installations (cumulative) in Spain from 1998 to 2008

[1] All data were obtained from The Spanish National Energy Commission (CNE)

This means that in 2008 there was 2 661 MW PV of power installed (Figure 3). This represents an increase of 385 per cent on the same figures for 2007.

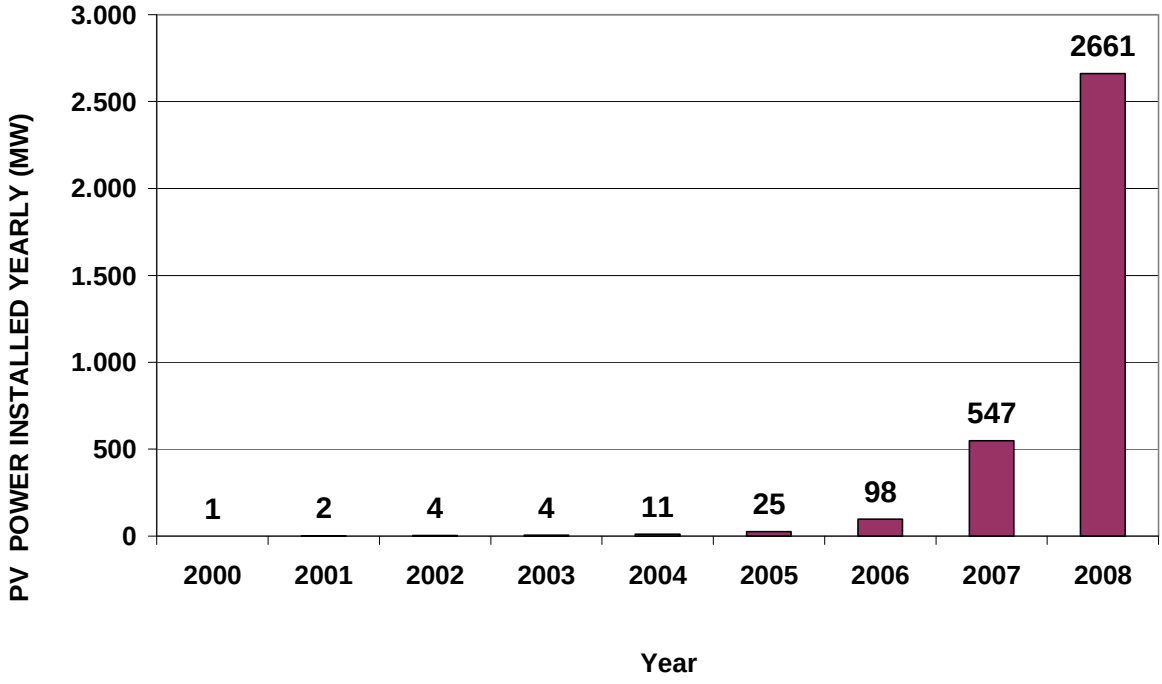

Figure 3 PV power yearly installed in Spain (MW)

Currently, the distribution (%) of the PV installations in Spain is 99.06 % grid connected systems whereas only 0.04 % are off grid systems.

Out of all PV Spanish installations there is a preeminence of big PV plants. These installations can be grouped in different ways (Figure 4). So, according to the size of the plant, 20 % of PV installations have between 2 and 5 MW installed. 36 % have less than 2 MW and the 44 % of them have more than 5 MW installed.

With respect to the method of installation, 98 % of them were installed on the ground and only 2.2 % in the roof.

Regarding technology used, 97 % of them PV plants used sc-Si, mc-Si, a-Si or CdTe technology, 2.1 % thin film and only 0.6 % PV concentrating.

With respect to the tracking method, 63 % of PV plants used a fixed system while 37 % use one type of tracking; so 24 % use a two-axis tracking system and 13 % a one-axis tracking system.

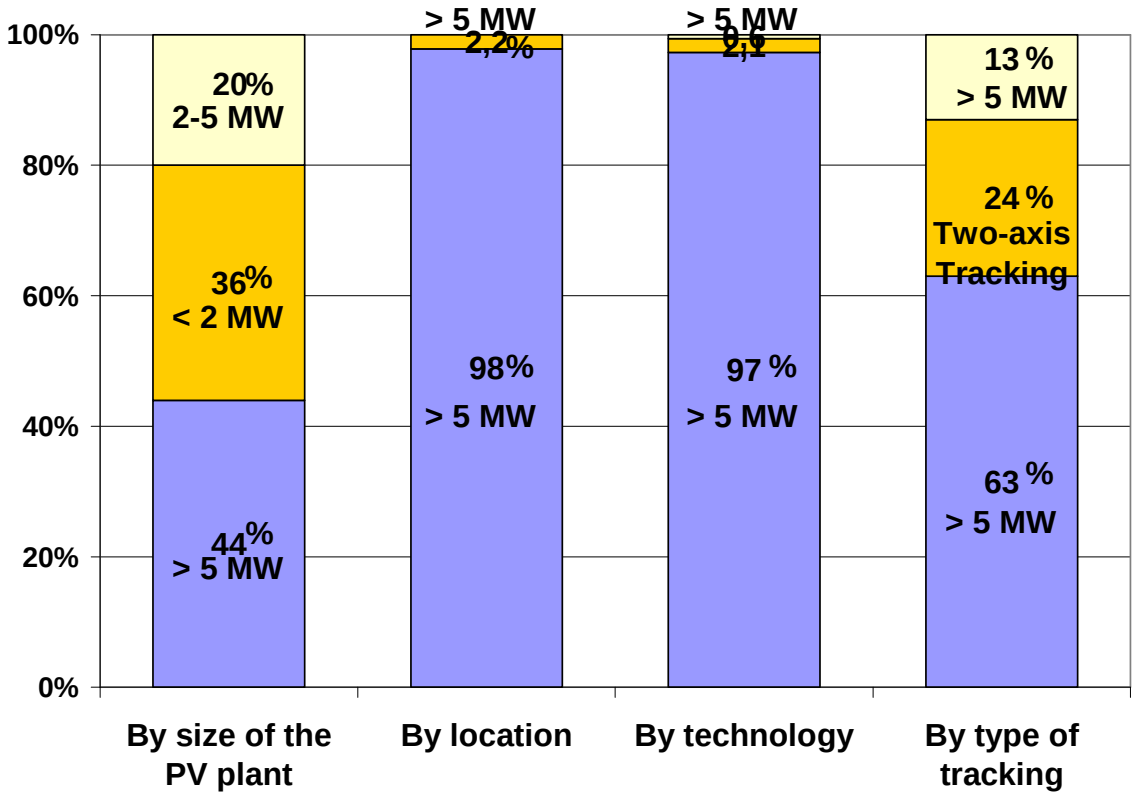

Figure 4 Distribution of PV Spanish installations (%), Source: ASIF

With respect to PV grid-connected installations, in the Figures 5 and 6 are shown the distribution of those installations, between 2006 and 2008, in function of sizing of installation. Therefore, in 2008 there were 2 668 installations with a power between 5 and 100 kW; 629 with a power > 100 kW and only 57 installations with a power < 5 kW.

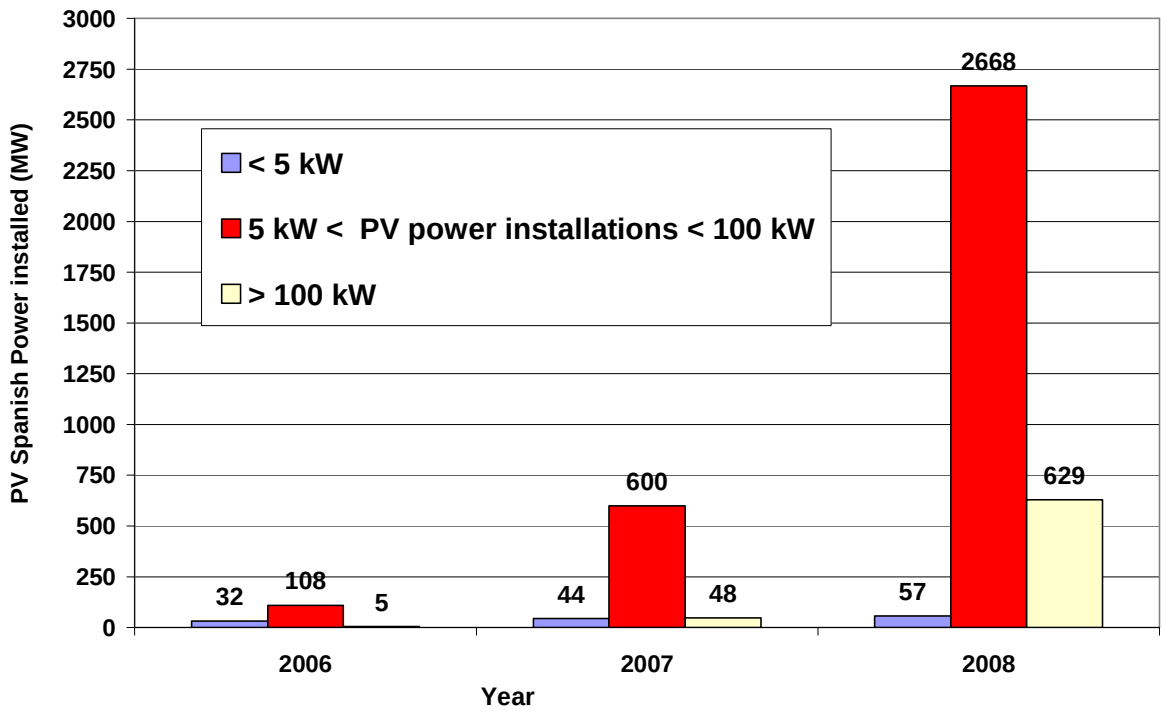

Figure 5 PV Spanish power installed (MW) by sizing of installation, Source: ASIF

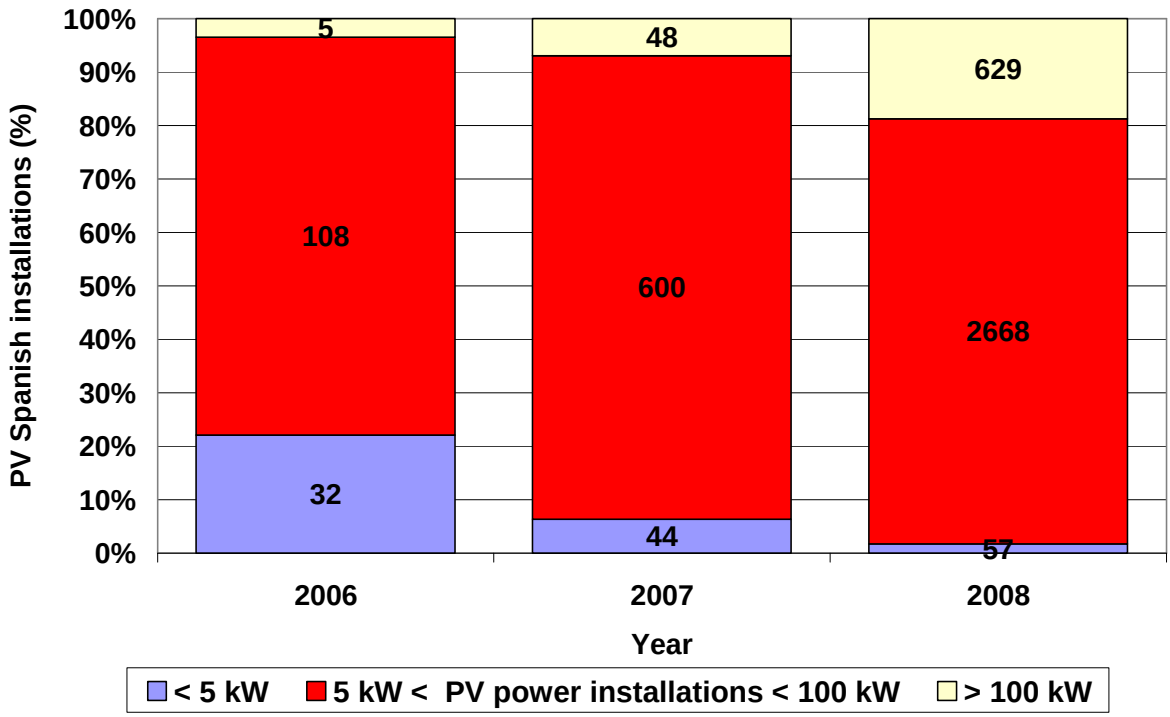

Figure 6 PV Spanish installation by sizing of installation (%), Source: ASIF

Distribution of PV power installed in 2008, for every Autonomous Community, is shown in the Figure 7. As can be viewed in Castilla La Mancha almost 700 MW were installed in 2008.

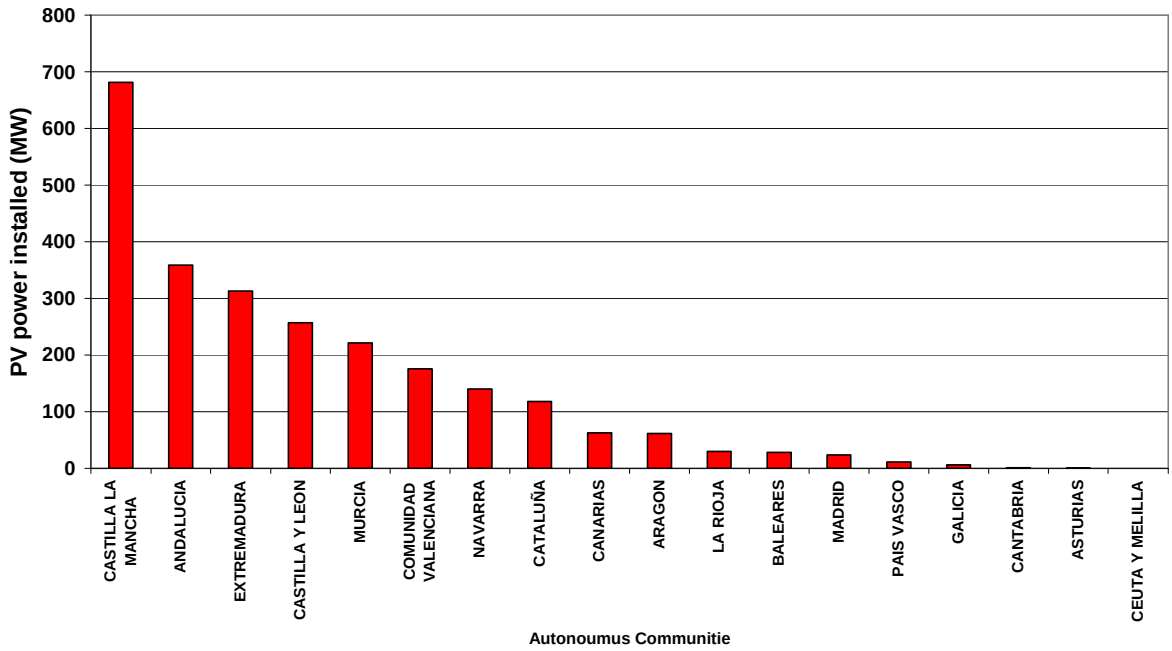

Figure 7 Distribution of PV power installed (MW) for every Autonomous Community

Next, the PV total installed capacity in Spain went up to 3 354 MW (Figure 8).

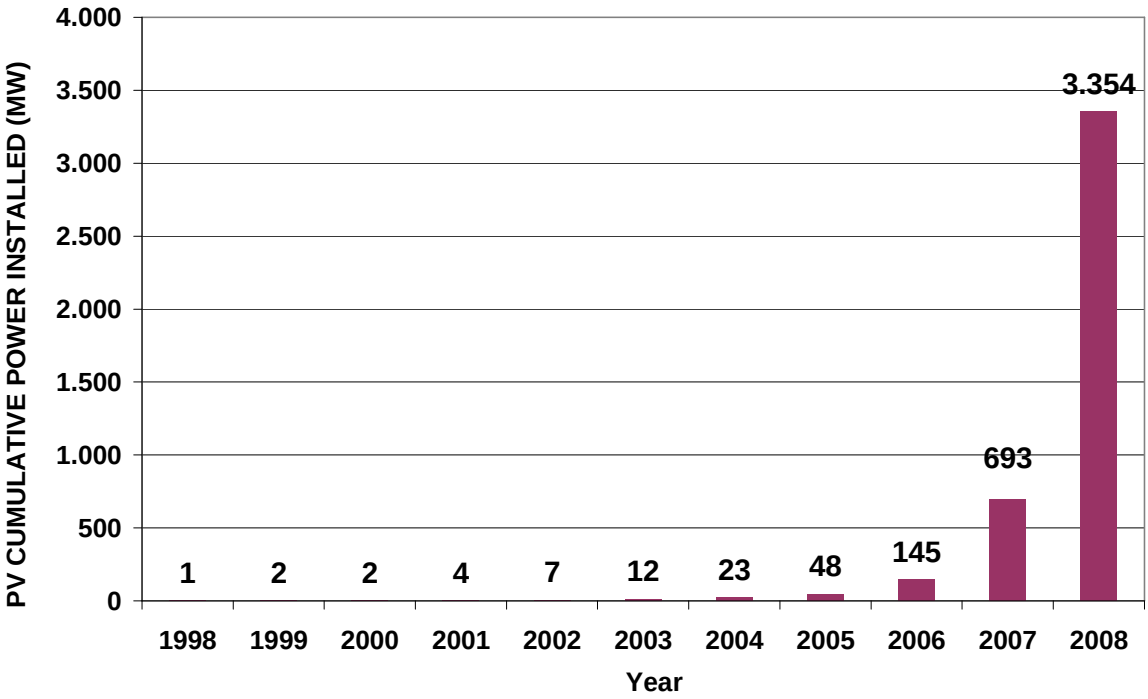

Figure 8 PV power cumulative installed in Spain (MW)

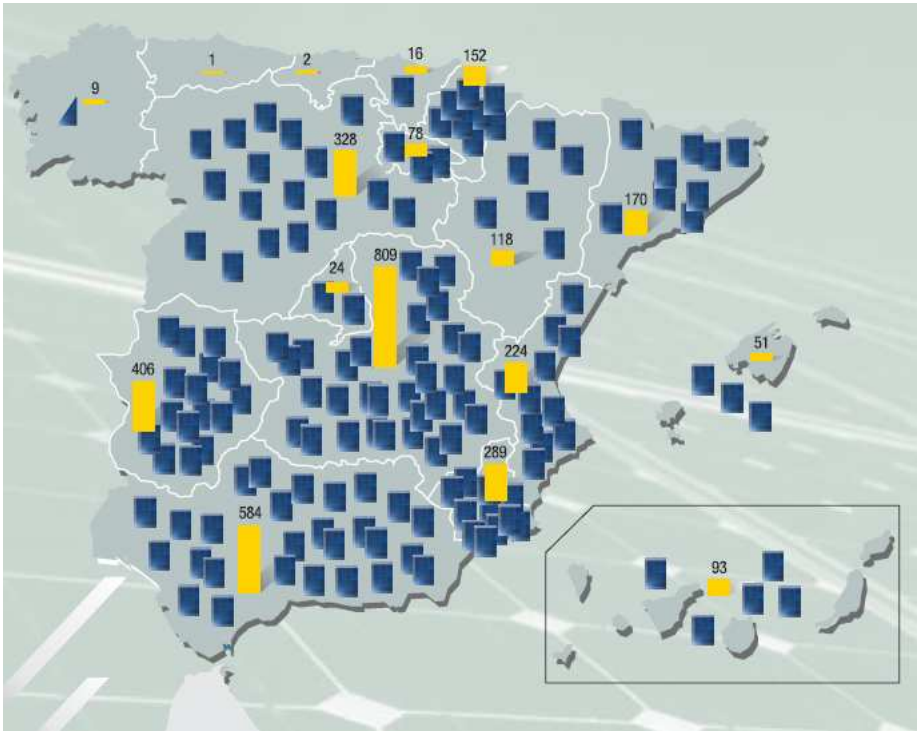

Figure 9 Distribution of PV cumulative power installed (MW) for every Autonomous Community, Source: ASIF

On the other hand, in Figures 8 is illustrated the PV power cumulative in Spain until now. An in Figure 9 is shown the distribution of PV cumulative power installed, for every Autonomous Community. In addition, in Table 1 is shown the evolution of the cumulative installed PV power from 1998 until now.

Table 1: The cumulative installed PV power.

	Cumulative installed capacity as at 31 December 2008																
Sub-market	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
TOTAL (kW)	~	~	1	1	1	1	1	2	2	4	7	12	23	48	145	693	3 354

And on the other hand, energy sold coming from PV systems reached more than 2 492 GWh, five times that of 2008. The evolution of the energy sold from 2006 until 2009, according to the size of the plant is shown in Figure 10.

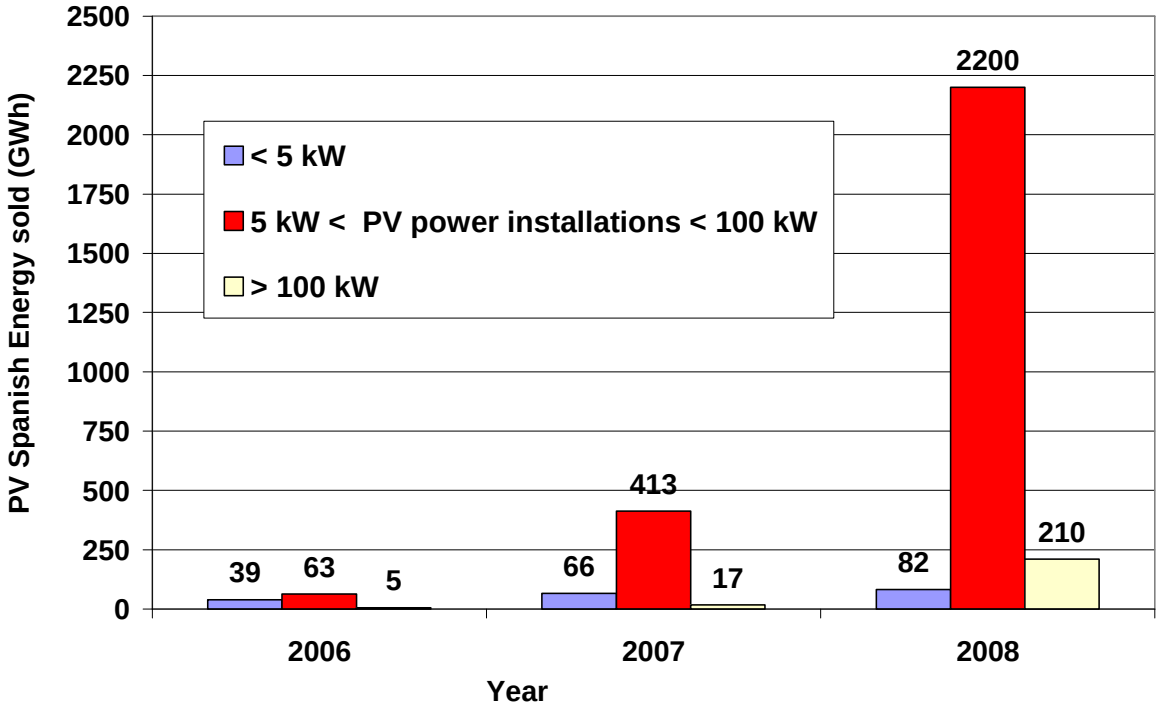

Figure 10 PV Spanish energy sold (GWh) between 2006 and 2008, Source: ASIF

An in Figure 11 is shown the distribution of the PV Spanish production taking into account the different electricity utility suppliers.

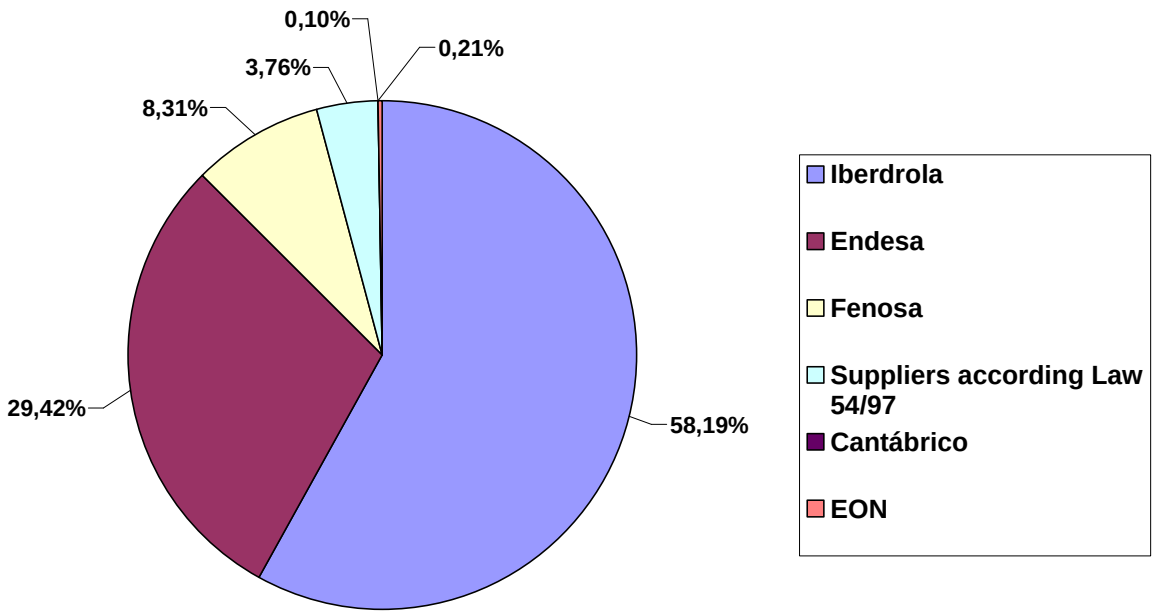

Figure 11 Distribution of the PV Spanish production for different electricity utility suppliers, Source: ASIF

In the other hand, in 2008, Spanish PV industrial investment reached 16 000 mill.€. This is 500 % more than in 2007.

In addition, the PV Spanish industry has registered very low levels of exportation because of the great pressure from the internal demand in 2008. Only 16 % of the PV modules manufactured in Spain were exported; 2 % of the inverters and only 4 % of the trackers.

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

Accordingly major projects relating to PV in Spain they can be divided into two groups: Huertas Solares, big PV plants, with conventional and concentration PV panels, and demonstration projects.

With respect to demonstration projects we might mention the following:

1) Firstly, five projects including an innovative element for building integrated photovoltaics (BIPV) were deployment by VidurSolar, Figures 12, 13, 14, 15 and 16. They used glass-glass photovoltaic (PV) modules. They designed high-tech construction elements substituting other traditional construction elements and taking over the same functions as for security, solar protection, thermal and acoustic insulation, while generating at the same time electrical power.

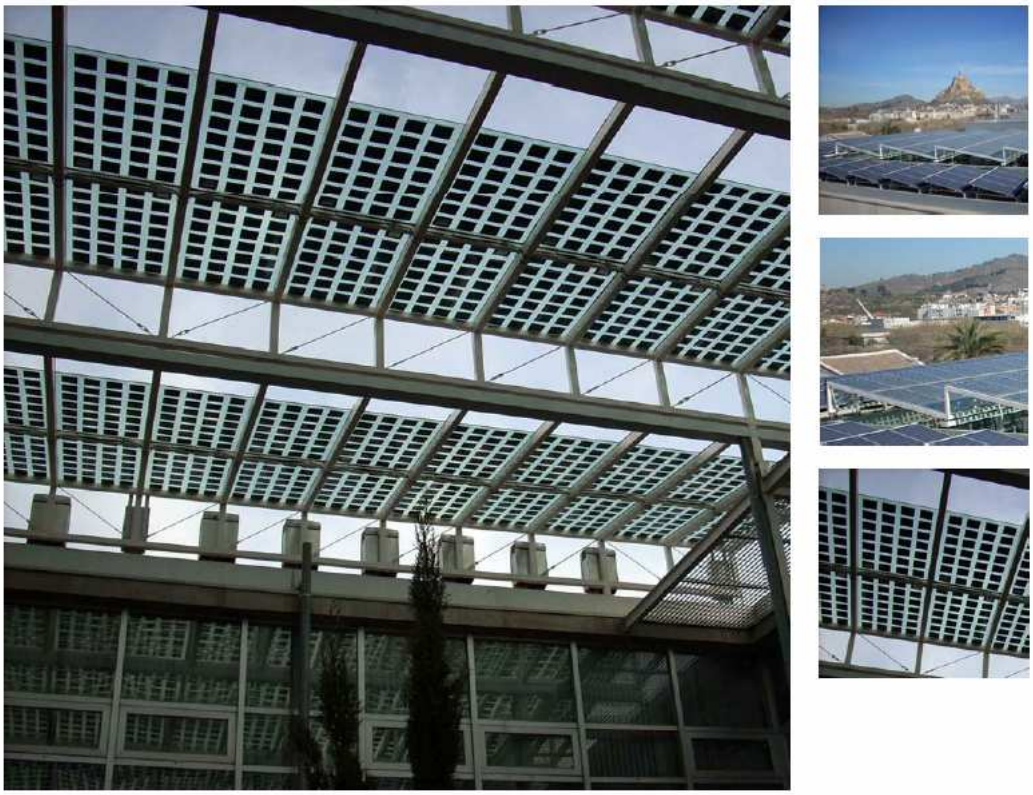

Figure 12 Skylight of the regional library in Murcia, 2008 (11.26 kW)

Figure 13 Skylight in the Síndic of Greuges, Passeig Lluís Companys, Barcelona (5,4 KWp)

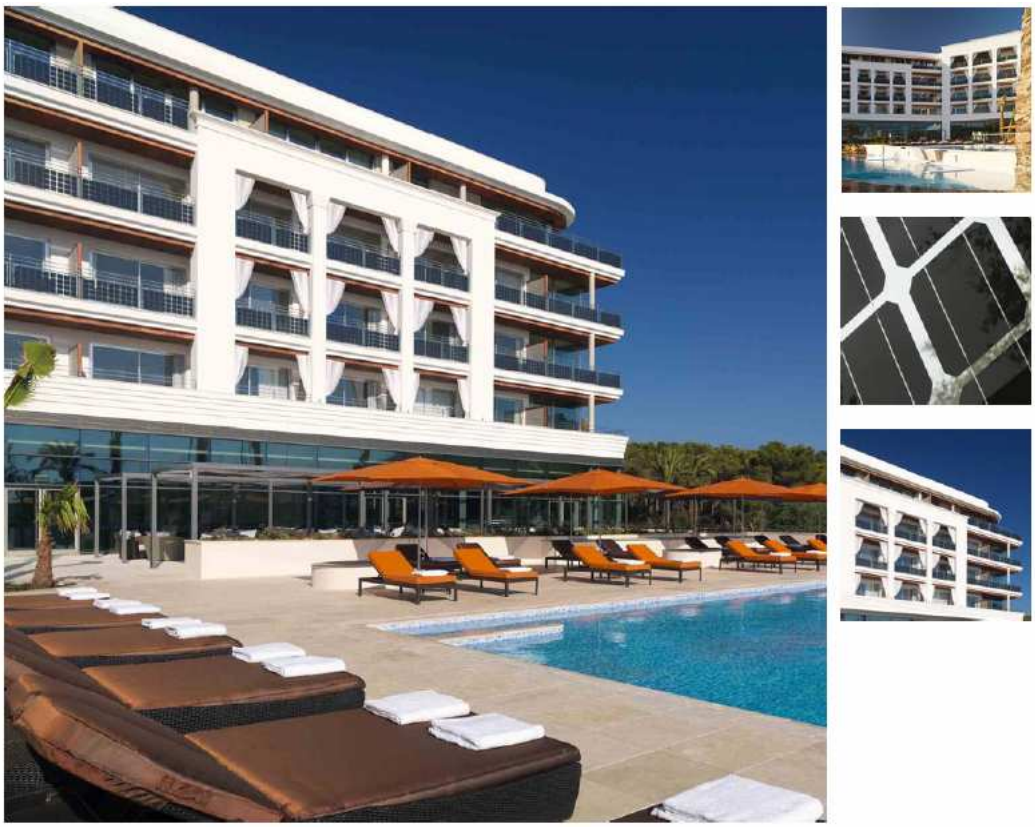

Figure 14 Balcony of terrace – Hotel Aguas de Ibiza, 2008

Santa Eulalia del Rio (Ibiza), 19,5 kW

Figure 15 Façade of the a kindergarten, installed in 2008, Sant Celoni (Barcelona) 7,5 KWp

Figure 16 Façade of the a creche 2008, Barri Serra de Sanferm Vic (Barcelona) 4,26 KWp

2) Regarding large projects using **conventional technology**, Spain has in their territory several of the PV plants biggest in the world. We might mention the following:

60 MW, Olmedilla de Alarcón (Castilla La Mancha)

Number of PV modules: 270.000

Number of grid-connected inverters: 500 of 100 kW

Investment: 384 millions of euros

Lead time: 16 months

Annual production: 87.500 Mwh

50 MW, Puertollano (Castilla La Mancha)

34 MW, Arnedo (La Rioja)

30 MW, Trujillo (Cáceres)

3) Regarding **High Concentration PV** projects we could mention the following:

Guascor-Foton has installed two High Concentration PV plants during 2008: in Ecija (1.5 MW), Figure 17, and Villafranca (7.8 MW), Figure 18.

Figure 17 High Concentration PV plant (1.5 MW) installed in Écija (Sevilla), with 60 trackers

Figure 18 High Concentration PV plant (7.8 MW) installed in Villafranca (Navarra)

In addition, the company **SOL3G** installed in 2008 nine PV high concentration solar plants**:** Flix (Tarragona), Santa Pola (Alicante), Valladolid, Vallverd (Lleida), Olocau del Rei (Castellón), Orense, Manresa, Huesca, Israel and Valencia.

The more important project was the plant installed in Flix (Tarragona), 800 kW, Figure 19. It was concluded in September 2008, within the solar photovoltaic plant promoted by the company Flix Solar S.L. Until now, it is the world's biggest installation using triple junction cell based modules.

Figure 19 High concentration photovoltaic plant (800 kW) in Flix (Tarragona)

The installation has 916 kWp (DC) peak power, result of the sum of the concentration modules wattage in terms of standard radiation (1.000 W/m2 of DNI and 25 º C of cell temperature). This value corresponds to a nominal power of 800 kW using a SMA SB3300 inverter per tracker.

Each module has a geometric concentration ratio of 476 suns. The triple junction cell ensures significantly higher efficiency than the conventional silicon cells, thanks to its ability to convert to electrical energy a bigger part of the incident solar spectrum.

The use of this cell, in addition to the amplification of the radiation intensity caused by the optical concentration system, increases saving semiconductor material and allows efficiency to reach about 35%, being the module efficacy 24%.

The tracker installed is the HCPV S4000 system, which is specially designed for solar farms and equipped by 112 Sol3g HCPV M40 modules, which are mounted on dual axis FEINA SC16 trackers specifically developed for concentration technology.

To reach the nominal power of 800 kW, 240 trackers have been installed, for a total of 26,880 HCPV modules.

The Sol3g installation in Flix is situated in the Ramon Escriche Photovoltaic Solar Farm, the largest in Catalonia and one of the biggest in Europe.

The solar farm, which extends over a total of 40 hectares into the Devesa's estate, is promoted by the company Flix SL and has the capacity to generate a 15 MWh per year.

Figure 20 High Concentration PV plant (200 kW) installed in Puertollano for the Institute of Concentration Photovoltaic Systems (ISFOC)

In addition, Solfocus installed for the Institute of Concentration Photovoltaic Systems (ISFOC) two High Concentration PV plants: Puertollano, Castilla La Mancha, Spain (200 kW), Figure 20, and Almoguera, Castilla La Mancha, Spain (300 kW), Figure 21.

Figure 21 High Concentration PV plant (300 kW) installed in Almoguera for the Institute of Concentration Photovoltaic Systems (ISFOC)

The PV plant in Puertollano is of 200 kW, comprised of 33 arrays meanwhile the PV plant in Almoguera is of 300 kW and 54 arrays. At Puertollano, each 6.2 kW system has an inverter, while at Almoguera, multiple systems are attached to a small number of inverters. AC electrical output at both sites is via a central transformer and metering station. Of the two sites, Almoguera proved to be the more challenging site to install as it is located on a hilltop withshading complications that were readily addressed by using SolFocus single-pole CPV tracking systems.

Moreover at the end of September, Concentrix Solar and Abengoa Solar successfully connected in **S**OLÚCAR LA MAYOR, SEVILLE (SPAIN), the 2 MW PV plant to Spanish grid, Figure 22. The power station is installed near Seville consists of both silicon flat modules and concentrator PV modules which are mounted on tracking systems. It is the first combination power plant of this kind. Flatcon® modules are high concentration photovoltaic systems that employ fresnel lens and extremely high-efficiency cells and achieve 500 times sun's concentration.

Figure 22 PV plant of 2 MW that consist of both silicon flat modules and concentrator PV modules mounted on tracking systems (Solúcar la Mayor, Seville)

2.4 Highlights of R&D

R&D activities in Spain are carried out by both the research centres and universities and PV industry. They develop R+D activities through open contests. What is more, they can access public funds intended for R+D+I, to finance their activities, and which are responsible for their execution.

The main lines of activity can be summarized as follows:

- New thin-film PV materials.
- Production technologies thinner cells and improvements in efficiency
- Deposited silicon PV devices.
- New materials
- PV solar cells, modules and fields.
- Concentration technologies
- New prototypes of PV components.
- PV modules and inverters connected to the grids for integration in buildings.
- Stand-alone PV Systems for professional use and developing countries.
- Engineering and evaluation of PV power plants.

Executive agents existing in Spain are varied. Among these are Public R+D Centres:

- Universities (www.mec.es), regulated by the University Reform Act of 25 August 1983.
- Public Research Organisms (OPIs) acknowledged as such by the Science Act and, in general, any R+D centre dependent on public administrations.

Up to 48 centres have been found. Among them, seven centers can be mentioned (by alphabetic order): CENER (Navarra), CIEMAT (Madrid), FUNDACIÓN CIRCE (Zaragoza), IES (Madrid), INSTITUTO DE MICROELECTRÓNICA (Bilbao), ISFOC (Ciudad Real) and TECNALIA (Vizcaya).

Inncentives

There are numerous **financial** (non-refundable subsidies, soft loans or a combination of both) and **tax incentives** for activities pursued in certain industries deemed to be a priority due to their potential for growth and their impact on the Spanish economy as a whole. The Autonomous Communities grant similar incentives in most of these industries.

These incentives include most notably those aimed at fostering innovation, technological improvement and research and development projects, which have been one of the main priorities of the Spanish authorities in recent years.

In this connection, the Government approved the VI National R&D&I Plan for the 2008-2011 period (in line with the VII European Union R&D&I Framework Program for the 2007-2013 period), which is expected to double the financing with respect to the preceding period and improve incentive management (www.plannacionalidi.es). Subsidies granted under this Plan may be co-financed with EU Structural Funds.

The basic **objectives** of the National R&D&I Plan (2008-2011), which were set up in line with the provisions of he National Strategy for Science and Technology (Estrategia Nacional de Ciencia y Tecnología or ENCYT), are, inter alia, (i) placing Spain at the cutting edge of

knowledge; (ii) promoting a highly competitive corporate fabric; and (iii) creating a favorable environment for investment in R&D&I.

In summary, the National Plan for R&D&I for the 2008-2011 period may be said to have a structure based on four areas directly related to the Plan's general objectives and linked to instrumental programs which pursue specific objectives: (i) **generating knowledge** and capacities; (ii) **fostering cooperation** in R&D; (iii) industry-wide **technological development and innovation**; (iv) **strategic actions** .

In addition, in order to meet the objectives of the 2008-2011 National R&D&I Plan, and based on the four areas identified, a series of instruments are envisaged, grouped along six Instrumental Action Lines (LIA): (i) Human Resources (HR); (ii) R&D&I projects; (iii) strengthening of institutions; (iv) infrastructure; (v) use of knowledge; and (vi) structuring and internationalization of the system.

These Action Lines are implemented through 13 National Programs (e.g. the National Program for Fundamental Investigation Projects, the National Program for Applied Research Projects, etc.) which, in a departure from the thematic model of previous plans, represent the main action instruments of the National R&D&I Plan.

In particular, the R&D&I Plan includes five Strategic Actions which relate to horizontal sectors or technologies: (i) strategic action in health; (ii) strategic action in biotechnology; (iii) strategic action in energy and climatic change; (iv) strategic action in telecommunications and the information society; (v) Strategic action in nanoscience and nanotechnology, new materials and new industrial processes. These Strategic Actions are aimed at supporting the Government's firmest R&D&I commitments, with an integral concept valuing the research carried out, as well as its transformation into processes, products and services for society.

In connection with the specific characteristics of each Instrumental Action Line, the majority of the Orders regulating the Instrumental Action Lines have been published in the first few months of 2008, with only the Order relating to the strengthening of institutions still to be published(www.micinn.es/planidi/lias.html).

Thus, for example, Order PRE/621/2008, of March 7, 2008, regulating the bases, aid regime and management of the Instrumental Action Line for R&D&I projects, within the framework of the 2008-2011 National Plan for Scientific Research, Development and Technological Innovation, was published in the Official State Gazette of March 8, 2008.

The Instrumental Action Line for R&D&I projects includes the following National Programs: (i) Fundamental Investigation Projects; (ii) Applied Research Projects; (iii) Experimental Development Projects; and (iv) Innovation Projects, and the respective calls must be adjusted to the content of the above-mentioned Order.

On the other hand, the Renewable Energies Plan (2005-2010) provides for the granting of incentives for investments by enterprises in technological innovation in the field of renewable energies, as well as the creation of lines of public aid, with a planned investment of approximately €23,598,641 million.

The Plan has a twofold purpose, first to bolster the priority aims of the Government's energy policy, focused on guaranteeing the supply of electricity, on its security and on respect for the environment, and secondly, to fulfill Spain's commitments at international level (Kyoto Protocol, National Allotment Plan) and those arising from Spain's membership in the EU.

In line with this line of support for business investments in renewable energies, the Council of Ministers approved a new Action Plan 2008-2012 for the Energy Saving and Efficiency Strategy in Spain (PAE 4+) which is to strengthen Spain's position at the cutting edge of energy saving and efficiency.

In this context, the Institute for Energy Diversification and Saving (Instituto para la Diversificación y Ahorro de la Energía or IDAE) has been developing a number of specific aid programs in the renewable energy industry.

In particular, the IDAE currently provides potential investors, inter alia, with the following lines:

- Loan line to finance investments in solar thermal, stand-alone photovoltaic and domestic biomass energy and in cogeneration installation projects, initially allocated a total budget of approximately 30 million euros. The beneficiaries of these loans can be individuals, SMEs, condominiums of owners, municipal councils and other public bodies, their dependent agencies and other legal forms, excluding large enterprises.

- Project Finance and Lease of Services Line fundamentally aimed at investment projects in energy savings, energy efficiency and renewable energies, which have a preliminary analysis of technical/economic viability.

- Strategic Projects Aid Program, designed to provide incentives to companies for carrying out multi-year investment projects in energy saving and efficiency technologies.

Meeting the objectives of the Plan for the Development of Renewable Energies also requires R&D&I initiatives, which has led to the involvement of the energy industry in the various R&D&I programs currently being implemented at EU and national level. In particular, the National Plan for R&D&I (2008-2011) includes an initiative focused on Energy and Climatic Change in the area known as "Strategic Action".

In turn, most Autonomous Communities also offer subsidies and public aid under their own plans and programs to support renewable energies.

On the other hand, the following weakness and obstacles can be found in: the SPANISH &D-PV SECTOR the

- Lack of funds directly targeted to R&D-PV.
- Fragmentation of research efforts.
- Poor technology transfer from R&D to the industry.
- Need for a network of excellence/reference centres on R&D-PV
- Lack of available trained R&D-PV labour force

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

Public budgets come from three different sources:

1) **European Commission**: Photovoltaic R&D activities receiving support from the European Commission can be divided into short to medium-term and medium to long-term, and are managed by DG TREN and DG RTD respectively. The following PV projects are currently ongoing in the Sixth Framework Programme (FP6): The project information below has been reproduced from the EUROPA website of the European Communities with permission.

CRYSTAL CLEAR
Full Title: Crystalline silicon PV: Low-cost, highly efficient and reliable modules
Website: http://www.ipcrystalclear.info/
Coordinator: W. Sinke
Energy Research Centre of the Netherlands (ECN)
The Netherlands
Instrument: Integrated Project
EC contribution: 16 M€
Starting date: 01/01/2004
Duration : 60 months

The main objective of the CRYSTAL CLEAR project is to research, develop and integrate crystalline silicon technologies that allow PV modules to be produced at module costs of €1/Wp in next generation plants while improving their environmental profile by 20%. Although crystalline silicon is currently dominating the market, there is still considerable potential for improvement, and one of the main objectives of CRYSTALCLEAR is to reduce module manufacturing costs by 60%. The project also aims to drive down energy payback time – the period of operation of a module required to produce the same amount of energy consumed during its manufacturing.

FULL SPECTRUM

Full Title: A new wave making more efficient use of the solar spectrum
Website: http://www.fullspectrum-eu.org/
Coordinator: A. Luque, Universidad Polit?cnica de Madrid, Spain
Instrument: Integrated Project
EC contribution: 8.3 M€
Starting date: 01/11/2003
Duration : 60 months

The FULL SPECTRUM Project aims to further develop concepts that are already scientifically proven but not yet developed, and by trying to prove new ones in search of a breakthrough for PV technology, notably the development of:

- III-V multi-junction cells towards 40% efficiency
- Solar thermo-photovoltaic converters

- Intermediate band materials and cells
- Molecular-based concepts for full utilization of the solar spectrum
- Manufacturing technologies for novel concepts

HICONPV

Full Title: High concentration PV power system
Website: http://www.solucar.es/hiconpv/
Coordinator: V. Fern?ndez Quero, Solucar, Spain
Instrument: STREP
EC contribution: 2.7 M€
Starting date: 01/01/2004
Duration : 36 months

HICONPV aims to develop, set up and test a new cost-effective high concentration PV system with a concentration factor of 1,000. The cost goal for the proposed type of system is €1/Wp until 2015. The most challenging task will be the development of a high-efficiency 2kWp III-V receiver with a module area of about 100cm2.

BIPV-CIS

Full Title: Improved building integration of PV using thin-film modules in CIS technology
Website: http://www.zsw-bw.de/
Coordinator: D. Geyer, Zentrum für Sonnenenergie und Wasserstoff-Forschung, Germany
Instrument: STREP
EC contribution: 2.3 M€
Starting date: 01/01/2004
Duration : 48 months

Project Data: The aim of this project is to improve the potential for fitting copper-indium-diselenide (CIS) photovoltaic technology to new and existing buildings. Photovoltaic roof tiles, overhead glazing and façade elements based on CIS materials will be developed, including innovative connection and mounting techniques. The building elements produced in the project will undergo characterisation and performance tests, including thermal behaviour, reliability and outdoor exposure. The project will also address the architectural and aesthetic aspects of building integrated photovoltaics, including a European market survey on PV roof tiles.

MOLYCELL

Full Title: Molecular Orientation, low bandgap and New Hybrid Device Concepts for the Improvement of Flexible Organic Solar Cells
Website: http://www-molycell.cea.fr/
Coordinator: C. Sentein, Commissariat à l'Energie Atomique, France
Instrument: STREP
EC contribution: 2.5 M€
Starting date: 01/01/2004
Duration : 30 months

The goal of the MOLYCELL is to improve the lifetime and efficiency of organic solar cells. The MOLYCELL project will focus on the development of two types of photovoltaic devices: all-organic solar cells and nanocrystal / organic hybrid solar cells. The consortium will bring together experts from the polymer and dye-sensitized solar cell communities, with expertise in the design and synthesis of organic polymers, low temperature fabrication, and roll-to-roll manufacturing of materials. The cost-target is to reduce future production costs to below €1/WP.

PV-CATAPULT

Full Title: European collaboration for identification of photovoltaic research and market opportunities, socio-economic studies, performance assessment and dissemination of PV-thermal technology.

Website: http://www.pvcatapult.org/
Coordinator: H. de Moor, Energy Research Centre of the Netherlands (ECN), The Netherlands
Instrument: Coordination Action
EC contribution: 1.7 M€
Starting date: 01/12/2003
Duration : 26 months

PV-CATAPULT is a Coordinated Action consisting of 10 diverse work packages, centred on a common goal of accelerating the development of the photovoltaic technology (including hybrid solar) towards market deployment. The work in PV-CATAPULT includes studying the potential of PV in the emerging electricity markets of developing countries, engaging the construction industry on applications of PV in buildings (BIPV), producing a roadmap for the penetration of hybrid solar (PV and thermal), and comparing the measurement performance of different solar testing laboratories. Round-robin testing will lead to the publication of best-practise guidelines on measurement procedures and a better understanding of solar simulator performance. The project will organise meetings to discuss market development and will produce status reports on socio-economic issues.

PV-MIPS

Full Title: Photovoltaic module with integrated power conversion and interconnection system
Website: http://www.iset.uni-kassel.de/pls/w3isetdad/www_iset_page.show_menu?p_name=7231007&p_lang=eng
Coordinator: Institut für Solare Energieversorgungstechnik - ISET e. V., Germany
Instrument: Integrated Project (IP)
EC contribution: 4.4 M€
Starting date: 01/10/2004
Duration : 60 months

The aim of this project is to significantly reduce the cost of grid connected PV systems through the development and demonstration of PV modules with integrated inverters. The research has a strong focus on building-integrated PV, because the potential for this application is especially high in the densely populated areas of Europe. The cost targets for production are 0.3 €/Wp for the inverter and 3.0 €/Wp for the complete system.

SOLAR PLOTS

Full Title: Multiple Ownership Grid Connected PV Solar-Plots With Optimised Tracking And Low Concentration Reflectors
Coordinator: Alternativas Energ?ticas Solares, S.A. - AESOL, Spain
Instrument: STREP
EC contribution: 1.8 M€
Starting date: 09/07/2004
Duration : 24 months

The main objective of the project is to foster the market penetration of grid-connected PV systems in the south of Europe by engaging around 250 European investors, removing barriers, developing new PV products and financial mechanisms. The project focuses on the connection of PV elements in plots and in commercial and domestic buildings. The objective is to reduce the PV systems costs through an optimal innovative design (trackers and reflectors), and a better economic efficiency, from 7.07 €/Wp to as little as 3.12 €/Wp.

BITHINK

Full Title: Bifacial Thin Industrial multi-Crystalline Silicon Solar Cells
Coordinator: CENER - The National Centre of Renewable Energies of Spain
Instrument: STREP
EC contribution: 1.9 M€
Starting date: 06/09/2004
Duration : 36 months

The aim of the project is to significantly reduce the cost of PV energy through the development and demonstration of new thin-film bifacial modules. Bifacial solar cells will be developed using thin silicon solar cells manufactured by an integral screen-printing technique and using a BSF structure. The project aims to obtain low cost crystalline technology (under 1.6 €/Wp) in a multi-megawatt facility - to be implemented at the end of the project.

PV-ERA-NET

Full Title: Networking and Integration of National and Regional Programmes in the Field of Photovoltaic (PV) Solar Energy Research and Technological Development (RTD) in the European Research Area (ERA)
Coordinator: I. Arzberger, Forschungszentrum Jülich GmbH, Germany
Instrument: Coordination Action
Starting date: 01/10/04
Duration : 48 months

The mission of PV-ERA-NET is to carry out activities towards networking and integration of national and regional programmes in the field of PV RTD in the European Research Area (ERA). The consortium comprises 17 participants from 11 countries with more than 20 national RTD programmes (or parts of programmes) and two regional RTD programmes.

2) **National**: Research in Spain is mainly funded by the Ministry of Education and Science (MEC) and by the Ministry of Science and Technology (MCyT). The MEC activities are aimed at developing all disciplines of science, stimulating and funding research at universities and research institutes. MEC manages funding through the National Plans of Research, Development and Technological Innovation (PN I+D+I) which, with a duration of four years, set priorities for annual, peer-reviewed competitive calls. The design of priorities and programmes is carried out by the Ministry in the framework of National interests, taking into consideration the EU RTD Programmes.

3) **Regional**: Spain has 17 Autonomous Communities. In many of them there is a public budget for R&D.

It is estimated that 12 millions of Euros were dedicated to R+D+I. During 2008 one hundred and sixty-seven programs of I+D were registered, that are shared irregularly.

The projects done can be classified, by type of activity, Figure 23:

Materials, test, concentrating, special PV applications, improving the productive process, solar resource studies and others.

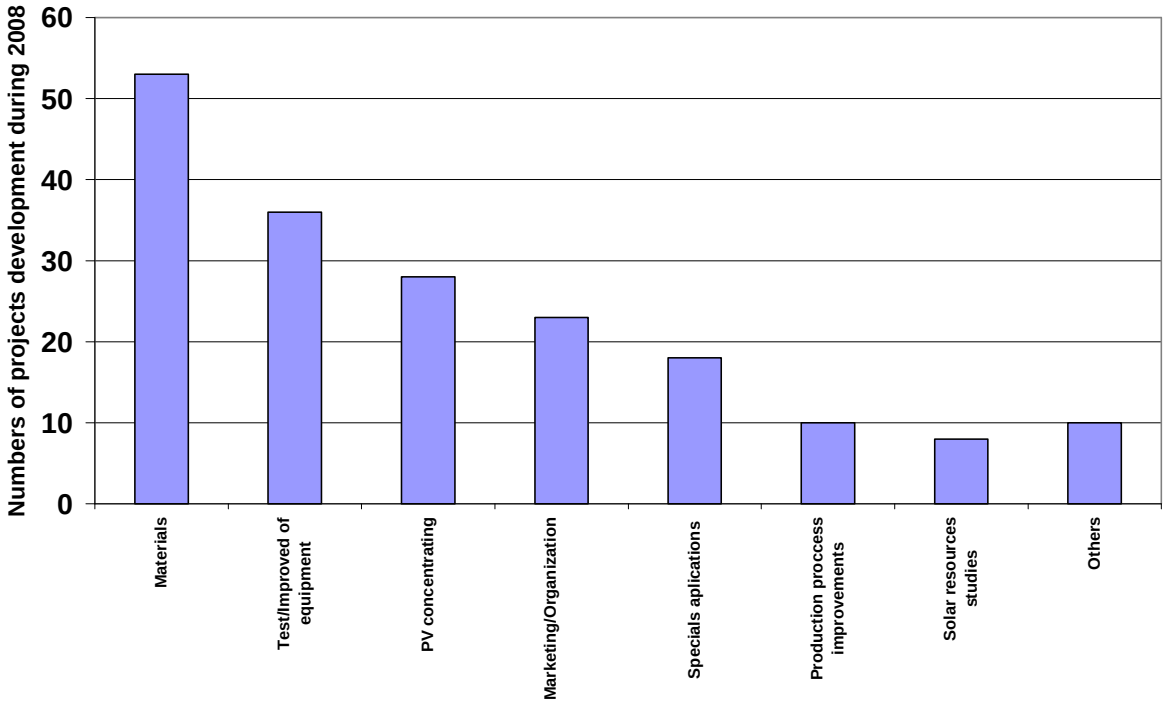

Figure 23 Numbers of PV projects done during 2008, by type of activity

3 INDUSTRY AND GROWTH

Eighty-three companies have been identified. They potentially manufactured PV cells, modules, inverters and tracking

3.1 Production of feedstocks, ingots and wafers

About solar-grade silicon there is only one Spanish silicon metal producer: Ferroatlántica. However, their production will begin in 2009. More specifically, FerroAtlántica has signed an agreement with a local government in China's Sichuan Province to invest EUR 820bn (USD 1.09bn) in a 50,000-ton solar-grade silicon plant.

Construction on the plant will begin in September 2009 and will be completed by 2013. The plant will have an annual production capacity of 50,000-tons of solar-grade silicon and 100,000 tons of chemical grade silicon.

Regarding to ingots and wafers, there is only one company producer of such products: Silicio Solar (Ciudad Real). It takes part of the Dutch Enterprice Corporation Pillar Group B.V. The production in 2008 was the following:

INGOTS

Period	**per month/year:**
Monosilicon ingots	**46.000/552.000 kilos**
Multisilicon ingots	**46.000/552.000 kilos**

WAFERS

Period	**per month/year:**
Monosilicon wafers	**1.350.000/16.200.000 kilos**
Multisilicon wafers	**900.000/10.800.000 kilos**

WAFERS GRADE

Type: monosilicon

diameter=150 mm, square side=125x125 mm, thickness 240 - 300 microns diameter=165 mm, square side=125x125 mm, thickness 240 - 300 microns diameter=195 mm, square side=125x125 mm, thickness 240 - 300 microns

Type: multisilicon

square side=125x125 mm, thickness 240 - 300 microns square side=156x125 mm, thickness 240 - 300 microns

3.2 Production of photovoltaic cells and modules

In total, the PV Spanish industry manufactured 195 MW dedicated to PV cells and 498 MW dedicated to PV modules. The maximum capacity for PV cells went up to 260 MW and 891 MW for PV modules.

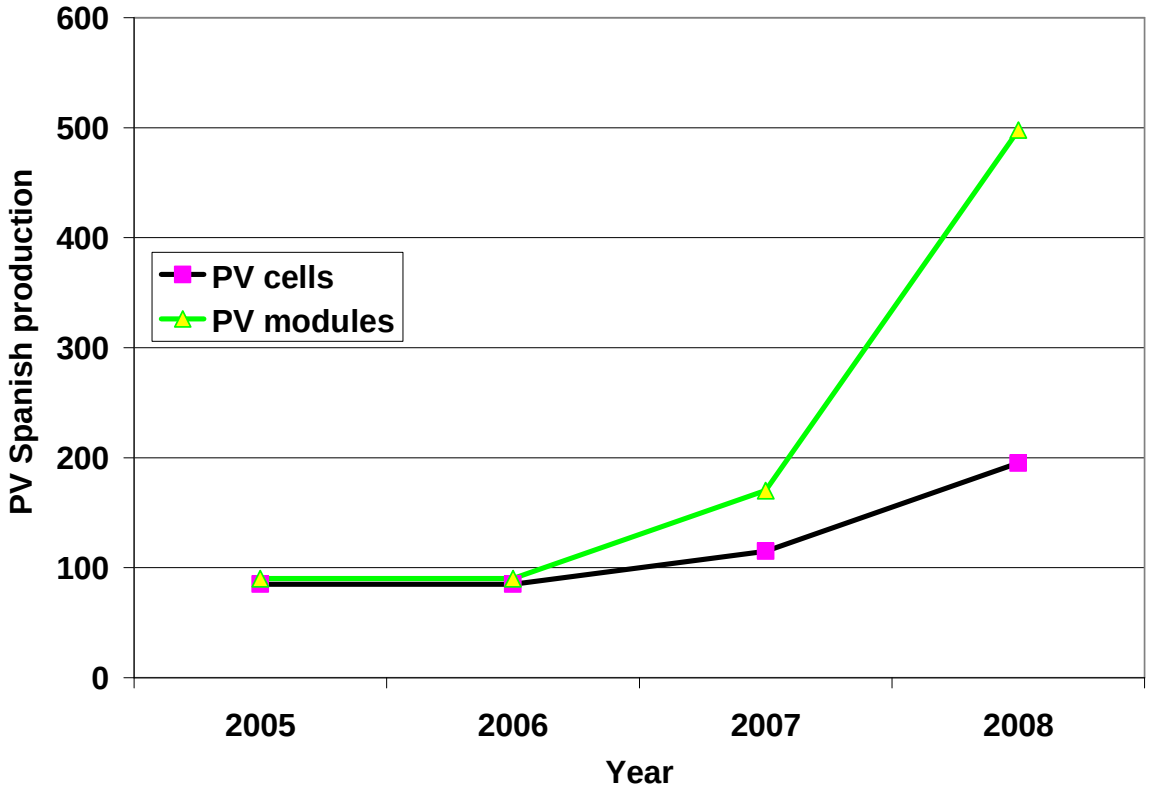

Figure 24 PV Spanish production for PV cells and modules between 2005 and 2008

According to this data in the year 2008 deployment increased by 70 % with respect to 2007 in PV cell manufacturing and 215 % for PV modules, Figure 24. The average increase in the three last years has been 41 % for PV cells and 81 % for PV modules. 75 % of the PV cell capacity was used and 56 % of PV modules was used.

Solar cells

In 2008, in Spain there were four companies dedicated to PV cells: BP Solar Spain, and Isofoton dedicated to conventional cells whereas Guascor Foton and Sol3G manufactured high concentration silicon photovoltaic cells, although all this production was for use by the same companies.

It is expected that there will be new manufacturers for 2009: Gadir Solar, Instalaciones Pevafersa, MX Group (Solarcell) and T-Solar Global.

PV modules

In 2008, in Spain there were twenty-one companies dedicated to photovoltaic modules that can be grouped into three types:

1) **Those that manufacture conventional PV modules**. There were fifteen manufacturers (in alphabet order):

- ALEO SOLAR (Barcelona), ATERSA (Valencia), BP Solar España (Madrid), CUANTUM SOLAR (Burgos), EURENER (Alicante), GAMESA CORPORACIÓN TECNOLÓGICA (Sevilla), GUHELIENE (Barcelona), IFV-ENSOL (Madrid), INNOVACIÓN EN ALTA TECNOLOGÍA SOLAR (Alicante), INSTALACIONES PEVAFERSA (Zamora y Valladolid), ISOFOTON (Málaga), SILIKEN (Valencia, Tenerife and Albacete), SOLARIA ENERGÍA Y MEDIO AMBIENTE (Ciudad Real), TECNOLOGÍA SOLAR KANARIAS (Gran Canaria), and YOHKON ENERGIA (Valladolid).

2) Those that manufacture thin film modules:

T-solar is going to be the only Spanish company that produces thin-film amorphous Silicon (a-Si) photovoltaic modules. It is a Spanish company whose main investors are the Isolux Group and the regional savings bank Caixanova, opened yesterday a state-of-the-art plant in Orense (Galicia, Northwestern Spain).

T-Solar has invested so far more than 80 million euros ($99.5 million) in this modern plant, that will employ 190 workers and will have an expected turnover in 2009 exceeding 100 million euros.

The factory, with an initial production capacity of 40 MW. The production plant is based on the SunFab Thin Film line from Applied Materials (California). It will churn out 20 modules an hour in sizes from 1.1m x 1.3m to 2.2m x 2.6m (5.72 square meters or 61.6 square feet).

The nanomanufacturing technology used in the plant reduces the cost of utility-scale PV installations by more than 25%, through automation and improvements in cabling and installation. The panels need less silicon than standard ones. Plus, they are better suited to building integration because their sizes are adapted to current architectural standards.

3) **Those that manufacture concentrating modules.** We migth find four of them: Campos Solares (Ciudad Real), Guascor Foton (Vizcaya), Sol3g (Barcelona) and Zytech.

Regarding **Sol3G**, the last 15th July Sol3g carried out its number 1.000 M40 Modules grid. Every grid is made up for 14 HCPV technology modules, designed to yield best performance and durability at a very competitive cost. Each module has 10 triple-junction high efficiency cells, each attached to a secondary optical element, offering +/- 1.15 degrees angular acceptance. An efficiency up to 24% and 35 W of power can be achieved under standard conditions: 1000 W/m2 direct normal irradiance and 25ºC cell temperature. Thanks to this efficiency and a concentration ratio of 476 suns our module uses approximately 900 times less semiconductor than a crystalline flat panel.

Since the factory opening in Terrassa the last January, Sol3g has notability increased its production capacity. Specifically, with the number 1000 grid has reached the production of about 500KWp.

The future plans of the company are to increase the production capacity up to 10 Mw/year for the end of 2008 and to maintain an intense work of investigation and development to continue leading the world-wide market of HCPV systems.

Sol3g uses tandem triple junction cells, consisting of a stack of cells of different composition with a progressively decreasing bandwidth, so that the cells in the top of the stack absorb higher energy photons than those of the bottom part.

These cells are made by MOCVD (Metal Organic Chemical Vapor Deposition) with groups III-V compounds (InGaP and AsGa) deposited on a germanium substrate. They resist the concentration of the radiation very well and have an efficiency of around 35%, much higher than traditional silicon cells.

Concerning **Guascor Foton**, they base their production exclusively on 400X high concentration based on silicon. Guascor Foton, member of the Guascor Solar Corporation, designs, manufactures, develops and implements the high concentration photovoltaic turnkey integrated systems (HCPVIS). Guscor Foton was set up in 2005, establishing close ties with Amonix, a North American technology company which boasts more than ten years experience of high concentration photovoltaic energy production. Guascor Foton manufactures its HCPVIS in its centre in Ortuella, (Basque Country) where the photovoltaic cells are produced and the high concentration photovoltaic modules are assembled.

Guascor Foton's High Concentration system (HCPVS) produces electrical energy from sunlight as does flat panel technology. However, there are several characteristics which differentiate high concentration technology: (i) the incorporation of the Fresnel lens to focus and concentrate the sunlight; (ii) the cell area required is much smaller (thus lessening the dependency on silicon – 400 times less than a flat panel system); (iii) greater system efficiency (high concentration cells have an efficiency of 27% compared with flat panel systems which have 14-17% efficiency), and, (iv) integration of a two-axis high precision tracking system.

The HCPVS system principally uses direct sunlight and therefore offers greater results in central or southern areas, in other words, areas of high irradiation. Furthermore, due to its large dimensions (25kW – 215 m2) the HCPVS is suitable for ground level power plants.

4) **Those where the characteristics of this product allow it to be used in a myriad of applications where functionality and beauty are needed**. There were only one manufacturer: Vidursolar (Barcelona). So, Vidursolar is dedicated to wall-mounted sunshades, façade coverings, curtain walls, flat glass coverings and pergolas. Their production was of 80 kW in 2008.

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

Table 2: 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 manufactures					
ATERSA			111		
EURENER			30		45
ISOFOTON		130	110		
PEVAFERSA			*35*		
QANTUM			*5*		
SILIKEN			*92*		
SOLARIA			*50*		
Cells for concentration					
GUASCOR FOTON			*9*		
SOL3G			*1.5*		
OTHERS		65	56	260	
TOTALS		**195**	**498**	**260**	**891**

3.3 Module prices

The PV module prices vary in a wide range depending on the type of application, see Table 4.

Table 3: Typical module prices for a number of years

Year	2008
Module price (€): off grid	3-3.5
Module price(€): grid-connected	2.5-3
Best price	2.3-2.4

3.4 Manufacturers and suppliers of other components

In Spain the PV components more important are the PV inverters and trackers. With respect to tracker manufacturers up to 17 manufacturers can be distinguished: ADEM, ADES, AVANSOLAR, BRAUX, CONTROL y ACCESOS, DENERSA, ECOTECNIA, ESAUNE SOLAR, FEINA SCP, INSTALACIONES PEVAFERSA, MECAPIS-ENERGÍAS RENOVABLES, MECASOLAR, PRIUS ENERGY, SOLTEC ENERGÍAS RENOVABLES, SOLUCIONES ENERGÉTICAS (SOLENER), TALLERES CLAVIJO and TITAN TRACKER.

With respect to inverters manufacturers up to 9 manufacturers can be distinguished (including grid-connected and off-grid inverters): ATERSA, ENERTRON, FAGOR AUTOMATION, GREENPOWER TECHNOLOGIES, INGETEAM, JEMA, SILIKEN, SOLUCIONES ENERGÉTICAS (SOLENER) AND ZIGOR.

The more important manufacturers of grid-connected inverters are INGETEAM and GREENPOWER TECHNOLOGIES.

3.5 System prices

Please give in Table 7 turnkey prices (excluding VAT/TVA/sales tax) per W for the various categories of installation. Prices should not include recurring charges after installation such as battery replacement or operation and maintenance. Additional costs incurred due to the remoteness of the site or special installation requirements should not be included. Please indicate whether you are reporting an average price, a range of all known prices, a typical example, or so on.

Additional information should also be provided, where possible, regarding national trends in the turnkey prices of selected applications (in Table 7a)

Additional information should also be provided, if applicable, on the price of home PV system kits (marketed in some countries through retail outlets). Please also specify what components are sold as part of the kit.

A summary of typical system prices is provided in the Table 5.

Table 4: **Turnkey Prices of Typical Applications**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW		14.4-11.4
OFF-GRID >1 kW		11.4-9-7
ON-GRID Specific case	For example: 1-3 kW roof-mounted system, if available	
ON-GRID up to 10 kW		7.5-7
ON-GRID >10 kW		5.7-6
GRID – CONNECTED (centralized, if relevant)		11.4-9-7

3.6 Labour places

Estimated labor places are as follows;
a) Research and development (not including companies): about 500
b) Manufacturing of PV systems components, including company R&D: about 6 500
c) All other, including within electricity companies, sales and installation companies etc.: about 11 000

Table 5: Estimated PV-related labour places in 2008

Research and development (not including companies)	500
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	6 500
Utilities and government	50
Other	11 000
Total	12 200

3.7 Business value

During peak production in spring-summer of 2008, the Spanish PV sector employed 41 700 people. However, a great percentage of those jobs not were stable. Many of them were temporary: hired for specific work of services; hired as independent contractors or subcontracted to businesses, Figure 25.

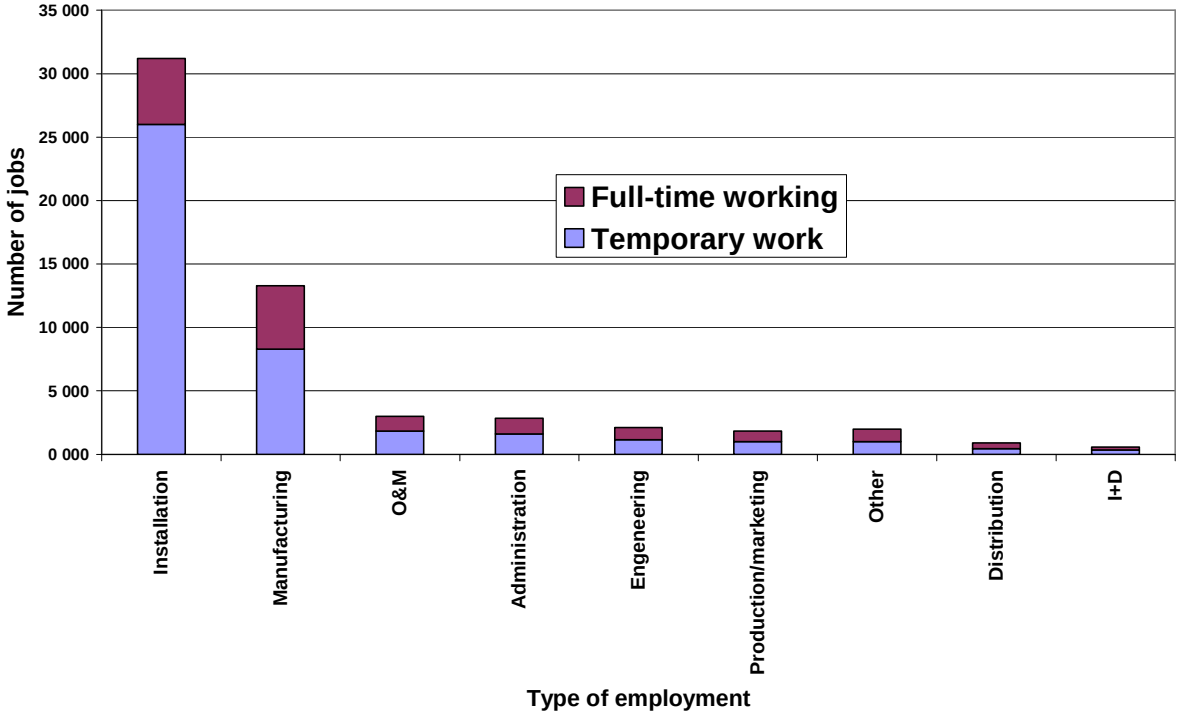

Figure 25 Number of jobs applied to PV business

It is estimated that the number of direct employees was 31 300. But as a result of the last Royal Decree 1578/2008 (approved at the end of 2008) the number of employees that have stopped is around 27 800.

That is to say, during 2008 the PV Spanish sector created employment within a short time, adapting their cost to the volume of activity.

In the other hand, the PV Spanish industry has registered very low levels of exportation because of the great pressure from the internal demand in 2008. Only 16 % of the PV modules manufactured in Spain were exported; 2 % of the inverters and only 4 % of the trackers.

4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

The main Spanish PV support measure is the Feed-in-tariff system.

Table 6: PV support measures

	On-going measures	Measures that commenced during 2008
Enhanced feed-in tariffs	Royal Decree 661/2006	New Royal Decree 1578/2008
Capital subsidies for equipment or total cost	No	
Green electricity schemes	Regulated by the Orden ITC/1522/2007	
PV-specific green electricity schemes	No	
Renewable portfolio standards (RPS)	No	
PV requirement in RPS	No	
Investment funds for PV	Yes	
Income tax credits	No	
Net metering	No	
Net billing	No	
Commercial bank activities e.g. green mortgages promoting PV	No	
Electricity utility activities	Yes	
Sustainable building requirements	Building Technical Code, approved in March 2006 through Royal Decree 314/2006, requires all new or renovated buildings to cover 30-70% of Domestic Hot Water demand with solar thermal energy. As of October 2007 Spain complies with EU Energy Performance in Buildings Directive.	

Current Feed-in-tariff system

The feed-in tariff for electricity generated from solar sources may be amended in 2012. However, this depends on technological and market developments and on the smoothness of the distribution process (art. 15, RD 1578/2008).

Royal Decree 1578/2008 (published on September 27 2008) has introduced significant changes to the financial regime relating to power generation through solar photovoltaic technology which was previously governed by Royal Decree 661/2007.

Although the new decree applies only to those plants that did not obtain final registration in the Special Administrative Registry on or before September 29 2008, there is an additional provision that requires electricity to be sold at an earlier stage in order to retain the existing feed-in tariff. Some concern has been raised by the potential retroactive application of this provision.

Royal Decree 1578/2008

Types of plant

The new decree establishes a new classification system for photovoltaic plants.

Type	Subtype	Description
I		Photovoltaic roof plants or plants developed for similar surfaces
I	I.1	Power plants with a capacity equal to or less than 20 kW
I	I.2	Power plants with a capacity greater than 20 kW
II		Any other type of plant (essentially, ground photovoltaic plants)

Type I photovoltaic plants shall not exceed a capacity of 2 MW. Type II plants shall not exceed 10 MW.

Registration for pre-assignment of tariff

To be entitled to the feed-in tariff established by the new decree, a plant must be recorded in the Register for Pre-assignment of Tariff, which is a new subsection of the existing Administrative Special Register and is managed solely by the General Directorate for Energy and Mines of the Ministry of Industry, Tourism and Commerce, without any involvement of the autonomous communities. Registration in the Register of Pre-assignment of Tariff does not affect the mandatory registration of the relevant solar photovoltaic plant in the Administrative Special Register.

Registration in the Register for Pre-assignment of Tariff will be publicized by temporary announcements. Each announcement will fix the time and capacity limits for remuneration with the feed-in tariff.

Capacity quotas

The government has limited the feed-in tariff for the first year to a maximum power capacity of 400 MW. Two-thirds of the quota (ie, 267 MW) will be reserved for photovoltaic roof plants (in particular, 10% for plants corresponding to Subtype I.1 and 90% for plants

included in Subtype I.2), and the remaining third (133 MW) for ground photovoltaic plants. These quotas shall be divided among tenders from the Ministry of Industry.

For 2009 and 2010 the government has allowed for additional extraordinary quotas of power capacity amounting to 100 MW and 60 MW respectively, which shall not modify the existing feed-in tariff.

Administrative procedure for registration

The new decree establishes the procedure for the registration of new photovoltaic plants in the Register of Pre-assignment of Tariff. Registration priority is based on the date of application for registration and, if multiple applications were applied for on the same date, the date of the remaining documents filed for registration. Likewise, the new decree establishes the amount of the guarantees required under Article 66(*bis*) of Royal Decree 1955/2000, as well as the procedure for the release or cancellation and enforcement of such guarantees upon voluntary dismissal by the developer of the plant, or where the developer has not met the information requirements or any other request from the public administration within three months.

Economic regime

The new economic regime significantly reduces the amount of the previous regulated tariffs, though not in the proportion that was initially announced (the draft of the new decree that circulated last July proposed €0.29 per kilowatt-hour (kWh). This caused considerable controversy and opposition from trade associations.

The tariff for photovoltaic plants from the first announcement is set out in the following table.

Type	Subtype	Feed-in tariff rate (€ per kWh)
I	I.1	0.34
I	I.2	0.32
II		0.32

For subsequent announcements the relevant tariffs will be calculated on the basis of the results of the preceding announcement. If the approved power capacity for the new announcement does not exceed 75% of the approved capacity of the preceding announcement, the feed-in tariff will be maintained. If the capacity exceeds 75%, the feed-in tariff will be reduced.

If two consecutive announcements do not reach 50% of the agreed power quota for a particular type or subtype of plant, the government may increase the tariff. This may be done through a grounded resolution from the General Secretariat for Energy in the same proportions by which the tariff would have been reduced if the relevant power quota had been reached.

Tariffs will be updated in accordance with similar provisions to those contained in Article 44.1 of the previous decree, as from January 1 of the second year after the relevant announcement.

Inspections

The new decree (as advanced by the Ninth Additional Provision of Order ITC/1857/2008 in connection with the plants registered with Administrative Special Registry by September 29 2008) mandates the commission to carry out regular and random inspections of those plants

it governs, which represent in aggregate at least 5% of the plants and 5% of installed capacity. The purpose of these inspections is to verify compliance with the accuracy requirements for information provided about plants according to the administrative procedure.

Release of guarantees

The approval of the new decree is considered sufficient to require the release of the guarantees referred to in Articles 59 (*bis*) and 66 (*bis*) of Royal Decree 1955/2000. These Articles relate to those solar photovoltaic plants for which registration in the Register for Pre-assignment of Tariff will not be requested or which have not been registered within 12 months of registration being requested by an announcement.

This provision is intended to facilitate the withdrawal of developers (primarily due to lack of expected profitability) from projects initiated before the new degree enters into force.

Second Additional Provision

The second additional provision initially generated some concern within the industry. It originally stated that:

"*In general, for the purposes of the provisions of Article 17(c) and 22.1 of Royal Decree 661/2007 of May 25, it is deemed mandatory in order to benefit from the regulated tariff or, if applicable, the premium, to initiate the sale of the net output of electric power before the deadline, as evidenced by the appropriate record of measure on the measurement devices before that date.*"

It could be construed that the provision establishes a new requirement not included in the previous decree. If so, certain doubts may arise as to whether a new requirement for receiving the tariff established in the previous decree (ie, the sale of power output before September 29 2008) may be required of the solar photovoltaic plants registered before September 29 2008. According to that interpretation of the regulation, access to the tariff established in the previous decree would depend not on final registration in the Administrative Special Register, but on the sale of electricity on or before September 29 2008.

However, another interpretation is that the new requirement does not apply to photovoltaic plants that comply with the requirements set out in the previous decree and Ministerial Order ITC 3860/2007 of December 28 2007 implementing the economic regime of the previous decree. This is because the introduction of a new requirement for plants registered on or before September 29 2008 would imply a breach of the legal certainty principle (as contained in Article 9 of the Constitution), as the regulation would apply a new and unforeseen requirement for access to the feed-in tariff regulated in Article 36 of the previous decree. Moreover, only one day elapsed between the date of publication of the new decree and the September 29, 2008 deadline, so it was not possible to comply with the new requirement on or before the deadline.

As a result of the concerns expressed by the solar industry regarding interpretation of the provision, the government published a statement of amendment in the *Official Gazette* whereby the sale of power output is required only as from October 1 2008 and consequently does not apply to photovoltaic plants registered on or before September 29 2008.

Notwithstanding the foregoing, for the remaining technologies (ie, thermo-solar plants) the second additional provision will apply. Therefore, plants which come into operation after its entry into force will benefit from the feed-in tariff of the previous decree only if, in addition to final registration before the relevant deadline, they started the sale of power output on or before such relevant date.

In this regard it is significant that the reference to the "the relevant deadline" contained in the provision will be construed as referred to the deadline established in Article 22 of the previous decree.

According to Article 22 of the previous decree, the deadline for the application of the economic incentives provided in the previous decree shall be determined for each technology by resolution of the General Secretariat for Energy, taking into account the average term for the completion of projects and the implementation of the new technologies.

So it seems that the second additional provision is significant for renewable electricity production technologies that - unlike photovoltaics - have not yet reached the targets under the previous decree, but does not apply to solar photovoltaic installations which meet the requirements for receipt of the tariff provided in Article 36 of the previous decree.

Rates guaranteed 25 years

• 500 MW cap for 2009 (267 MW rooftop and 233 MW open-space)

• The annual digression rate is capped at 10%. Annual caps adjust in inverse proportion to digression. If rates decrease by 8%, caps will increase by 8%.

Regulation by the Autonomous Communities

During 2008 some autonomous communities approved rules relevant to the administration of solar energy in their territory, particularly with respect to administrative procedures for projects as well as for access and connection of the installations to the electric grid.

Thus Andalusia published the Decree 50/2008 and the Council of Innovation, Science and Business issued the Circular E-1/2008; the Council of Industry, Commerce and Tourism of the Government of Aragon published the Order of the 5th of February; the Board of Energy and Mines of the Council of Economy and Employment of Castilla y Leon released a Resolution the 21st of April; the Council of Industry and Technological Development of the Cantabrian Government issued the Order IND 16/2008;Extremadura, in turn, published two regulations, the Order of the 10th of March of the Council of Industry, Energy and Environment- which includes a simplified procedure for small installations- and the Decree 256/2008; finally, the Council of Infrastructure and Transport of the Community of Valencia published the Order of the 6th of June.

Some contain heterogeneous requisites that determine the particular typology of the installations in their territories.

It is worth indicating that some of these rules contain specific regulations for managing the great volume of photovoltaic power that is connected to the electric grids during summer.

4.1 Indirect policy issues

The Government supports a lot of public relation e.g. internet portals, conferences, events, Journals…in order to increase the awareness of photovoltaic energy. Further on there are a lot of associations of industry, handcraft and of a private basis which promote PV in Spain.

4.2 Standards and codes

The elaboration of standards and codes for PV is performed on the European level (CENELEC) and international level (IEC). The actual list of international standards and codes can be found on the web site: www.iec.ch.

5 HIGHLIGHTS AND PROSPECTS

Photovoltaic energy in Spain went through an extraordinary period in 2008, with a growth of 385% more than in 2007. Between January and September of last year, 2.661 MW were produced, pushing Spain up to first place in world ranking (ahead of Germany and South Korea). As a result of this astonishing and unexpected development, photovoltaic energy last year covered 1% of demand for electricity and this year will cover around 1.5%. It should be noted, however, that this jump- result of numerous external and internal factors- did not take place in a sustainable way.

The approval in September of the Royal Decree 157/2008 caused a paralysis in the national market during six months. This was then followed by the great drop in world photovoltaic demand, of which Spain formed 45%. In the case of Spain, this sudden halt has destroyed 27% of fixed employment and 90% of temporary employment within the solar energy sector, a total of more than 25.000 jobs.

This adjustment is extremely strong : not even the maximum 500 MW established by law (RD 1578/08) will be installed in 2009 and ,at a global level , there has been a rapid decrease in the price of solar equipment, with a possible fall in the short to medium term of more than 50%. Moreover , there are other factors that have a bearing upon this decrease, such as the effect of successful R+D, the great increase in supply of solar energy (the global market of which increased by 130% in 2008) and the end of the shortage in polysilicon (whose prices had multiplied by 10 since 2004).

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) **Electricity prices:**

	In terms of Power	**In terms of Energy**
	€/kW month	**€/kWh**
Low voltage:		
Power > 1 kW	0.291980	0.0065630
1 kW < Power ≤ 2.5 kW	1.621373	0.092111
2.5 kW < Power ≤ 5 kW	1.634089	0.093303
5 kW < Power ≤ 10 kW	1.642355	0.00562
10 kW < Power ≤ 15 kW	1.752513	0.095576
> 15 kW	1.988549	0.097596
High voltage:		
Power < 36 kV	2.391482	0.0824034

2) **Typical electricity consumption (kWh)**

Low voltaje domestic household.
Maximum power permitted per household: 3,3 kW
Bi-monthly consumption: 400 kWh

CONCEPT	Bi-monthly CALCULATION	TOTAL TO BE PAID Bi-monthly INVOICE
Amount charged for power (fixed)	Price: 1,461129 € / kW month 3,3 kW x 1,461129 € x 2 months	9,64 €
Change for consumption (variable)	Price:0,083007 €/kWh 0,083007 € x 400 kWh	33,20 €
Electricity tax	Electricity tax: 4,864% x 1,05113 Taxable base = 42,84	2,19 €
Energy Meter hire (up to 15 kW)	0,54 € / month 0,54 € X 2 months	1,08 €
VAT	16% (46,11)	7,38 €
Total		**53,49 €**
Price by kWh (without VAT)	**45,34€ / 400 kWh**	**11,52 cent €/kWh**

3) **Typical tariff structures for electricity customers**

Organisational Model of the Spanish Electricity System

The model for the electricity sector in Spain comprises two systems: The Regulated (or Tariff) System and the Liberalised System.

In the Regulated System, consumers purchase electricity from the distributors under a regulated tariffs regime. The distribution companies purchase electricity on the wholesale market, it is then immediately delivered on the distribution network by means of a transport network. The transport and distribution businesses are regulated activities.

In the Liberalised System, qualifying consumers (those entitled to purchase electricity on the deregulated market) and the suppliers, establish the transaction conditions bilaterally.

The two main characteristics of the Spanish Electricity market are the following:
- The existence of a wholesale market (Spanish pool);
- The fact that since January 1, 2003, all consumers have been able to choose their electricity supplier.

Special Regime Generation

Special Regime Generators are those using renewable resources with an installed capacity of up to 50 MW and cogeneration. Special Regime Generators may sell their net electricity production to the system at:

- The tariff fixed by royal decree, which is indexed to the average or reference tariff of the Spanish system or;

- The Spanish pool price, plus certain premiums and incentives.

4) **Typical household income**

INCOME	Household	People	Average size household
Total	16 103 177	44 120 939	2,74
Up to 499 euros	0 757 562	1 089 097	1,44
From 500 to 999 euros	2 746 913	5 302 944	1,93
From 1.000 to 1.499 euros	3 153 369	8 020 627	2,54
From 1.500 to 1.999 euros	2 851 181	8 141 792	2,86
From 2.000 to 2.499 euros	2 537 846	7 732 526	3,05
From 2.500 to 2.999 euros	1 611 190	5 256 969	3,26
From 3.000 to 4.999 euros	1 994 345	6 908 060	3,46
From 5.000 euros	0 450 771	1 668 925	3,7

5) Typical mortgage interest rate

During 2008, the evolution of the Euro Interbank Offered Rate (**Euribor**) has been the following:

2008	
Diciembre	**3.452**
Noviembre	**4.350**
Octubre	**5.248**
Septiembre	**5.384**
Agosto	**5.323**
Julio	**5.393**
Junio	**5.361**
Mayo	**4.994**
Abril	**4.820**
Marzo	**4.590**
Febrero	**4.349**
Enero	**4.498**

6) Voltage (household, typical electricity distribution network)

230 V / 380 V

8) Price of diesel fuel

Average prices	**Euros/litre**		
Petrol	112.3		
Diesel fuel	114.1		
Dispersion of the prices	**Maximum absolute price**	**Minimum absolute price**	**Difference**
Petrol	125.3	100.8	24.5
Diesel fuel	126.2	98.6	27.5