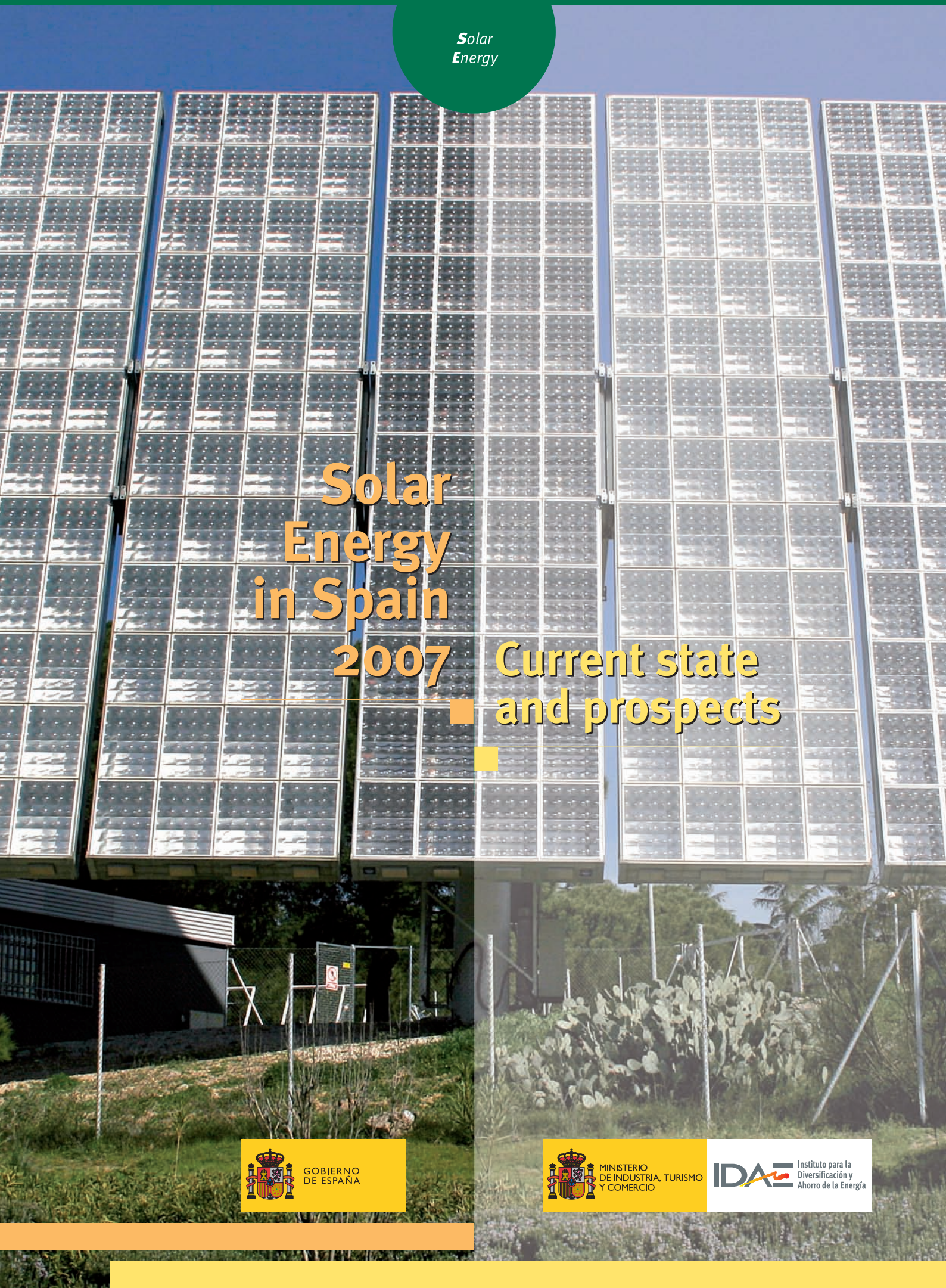
Solar
Energy



Solar Energy in Spain 2007

Current state and prospects

GOBIERNO DE ESPAÑA
MINISTERIO DE INDUSTRIA, TURISMO Y COMERCIO
IDAE Instituto para la Diversificación y Ahorro de la Energía

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Madrid, June of 2007

State of technology

Growth sector with a growth rate of 26% in 2006, 11% in 2005 and 8% in 2004

Economic data 2006 (Provisional)	• Over 135,000 m² have been supplied and installed between national manufacturers & distributors and international importers. • National manufacturers have supplied the 50% of the surface. • The sector's invoicing is put at over 140 million euros. • Over 1,500 direct and 3,000 indirect jobs.

Increase of the features and product quality

Main applications	• With flat-plate collector: – Sanitary hot water and swimming-pool heating.
Other applications	• High performance flat-plate and vacuum collector: – Heating by radiant elements, industrial processes, cooling with solar energy.

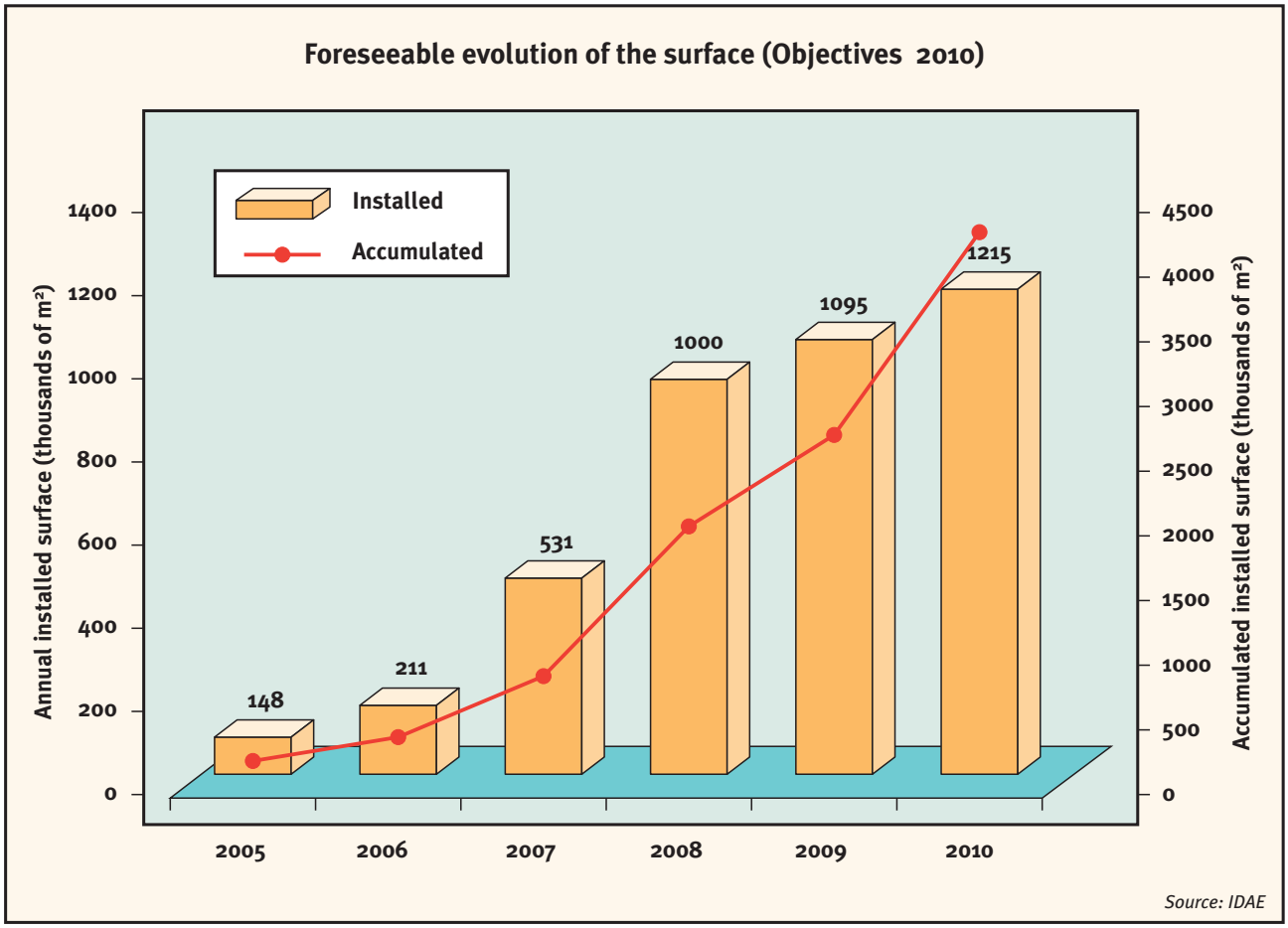
Manufacturing and supplying firms

Introduction of highly prestigious firms in the sector

Manufacturers	• There are over 12 manufacturers in Spain. • Manufacturing capacity over 200,000 m² and continuously expanding because of the market expectancies.
Entrepreneurial structure	• Equipment-manufacturing firms: Over 150. • Firms that sell equipment: Over 200. • Firms to install, maintain and repair equipment: Over 350. • Design and assembly firms: Over 250.

Renewable Energies Plan (PER) 2005-2010:
12% of the primary energy with renewable energies in 2010

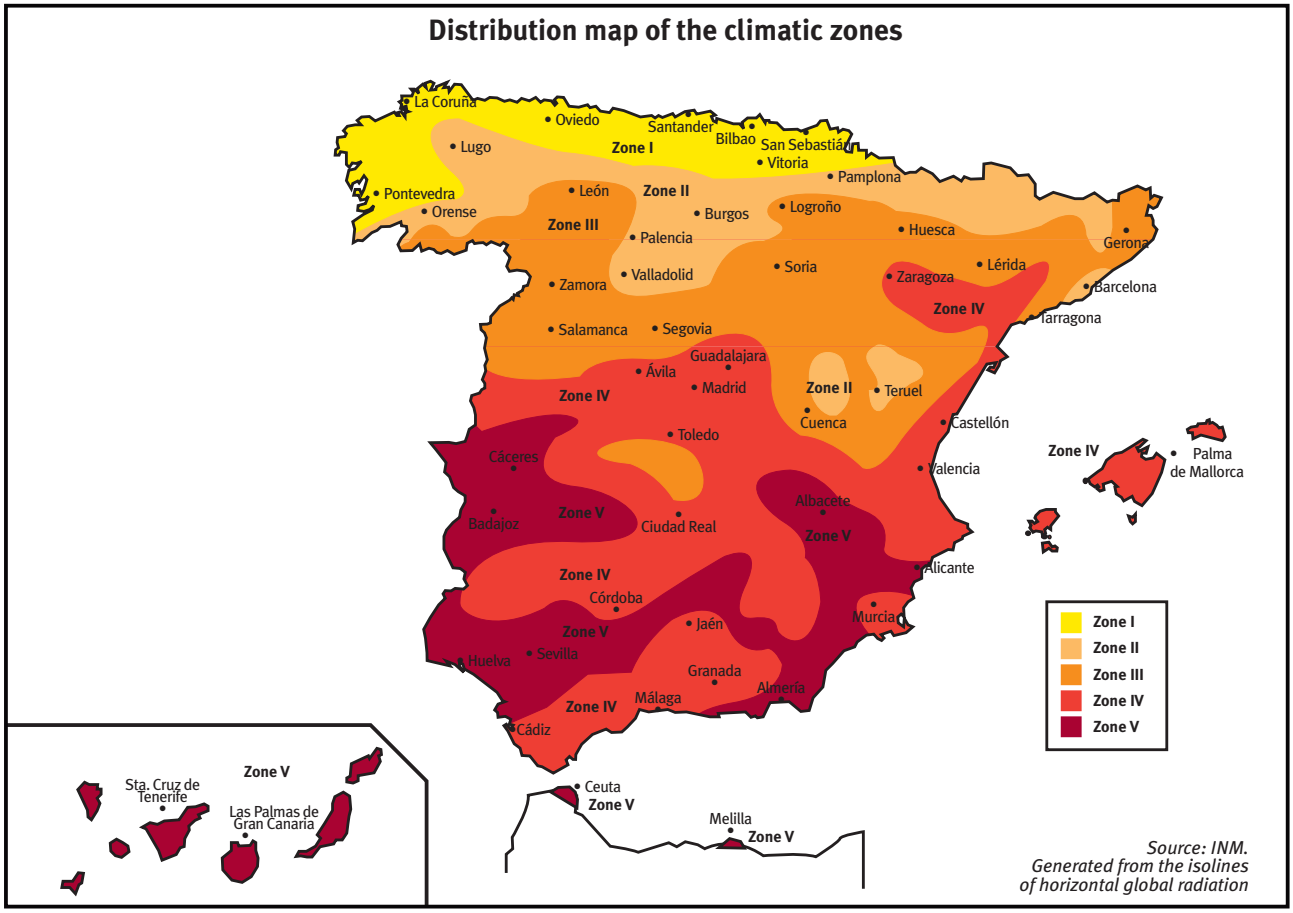
Background	• Solar thermal energy contributes with the installation of 4,200,000 m² as an increase objective with respect to 2005. (4,900,000 m² accumulated to 2010). • Main measures: – Approval of the Technical Building Code. – Support and enhance the enforcement of the Municipal Solar Bylaws by spreading them among the Local Councils. – Application of public funds to investment. – Specific training of municipal technicians to design projects related to the Technical Building Code and Municipal Solar Bylaws.
Energy data	• It is estimated that the 4,200,000 m² are distributed in the following way: – 840,000 m² for prefabricated installations. – 3,360,000 m² for installations by elements. • The accumulated energy during the period will amount to 809,000 tons of oil equivalent (toe).
Economic and environmental data	• The investment envisaged for the period amounts to 2,685 million euros. • Investment aids established at 348 million euros. • Generation of almost 4,500 jobs on the 2010 horizon. • 1,000,000 tCO_2 will stop being sent into the atmosphere from 2010 each year (Diesel oil as source of comparison).



The Technical Building Code:
Obligation to install solar thermal energy for Sanitary Hot Water in buildings

Background	• Approved by Royal Decree 314/2006. Spanish Official Gazette 28/03/06. • The Document on Energy Saving (HE) in Section HE 4 of the Technical Code shows the obligation to install a solar thermal energy system in new buildings or in those to be refurbished with a demand of DHW and/or swimming pool heating. This installation must cover between 30% - 70% of the demand, according to: – Demand of the building (litres/day). – Climatic zone (Zones I, II, III, IV, V). – Substituted fuel: General case (fossil fuels) & Joule effect electricity.

Distribution map of the climatic zones



Source: INM. Generated from the isolines of horizontal global radiation

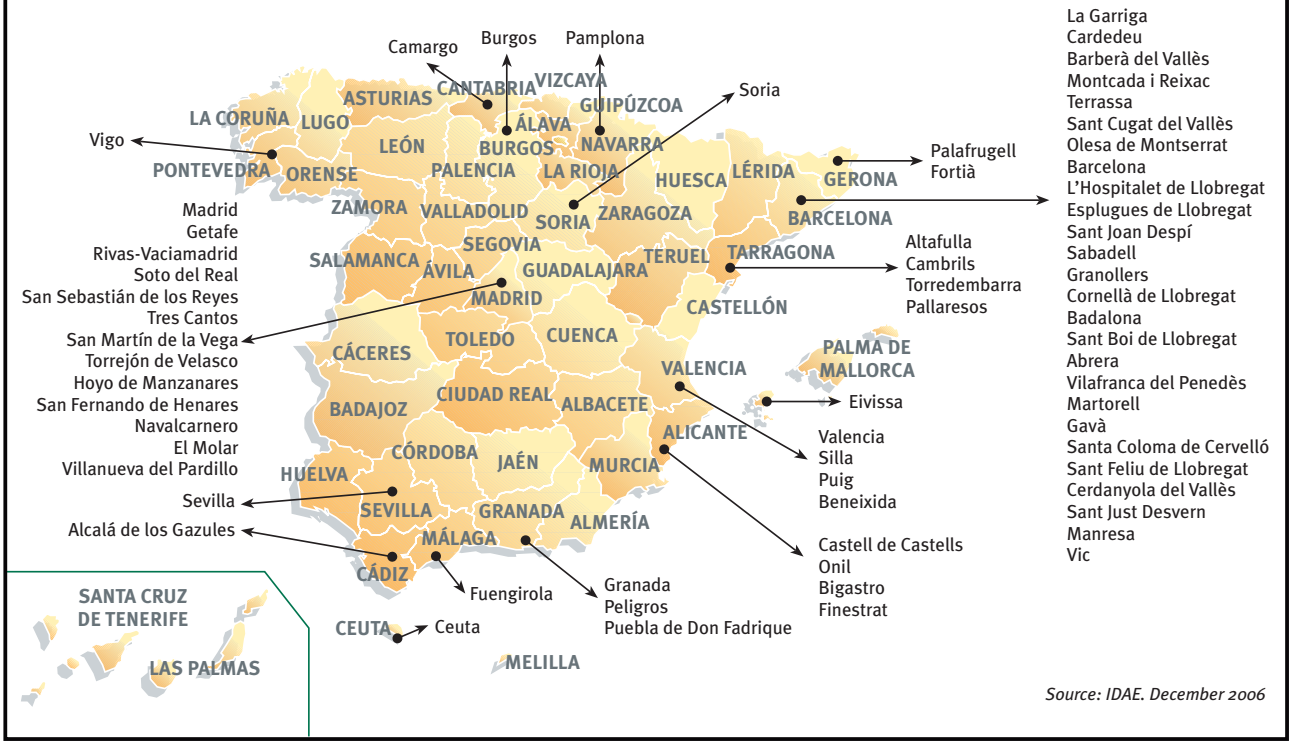
Percentages of solar contribution for DHW. General Case

Total demand of DHW (l/d)	Climatic zone				
	I	II	III	IV	V
50-5,000	30	30	50	60	70
5,000-6,000	30	30	55	65	70
6,000-7,000	30	35	61	70	70
7,000-8,000	30	45	63	70	70
8,000-9,000	30	52	65	70	70
9,000-10,000	30	55	70	70	70
10,000-12,500	30	65	70	70	70
12,500-15,000	30	70	70	70	70
15,000-17,500	35	70	70	70	70
17,500-20,000	45	70	70	70	70
> 20,000	52	70	70	70	70

Foreseeable results	• The compulsory enforcement took place on 29th September 2006. • During the 2006-2010 period 2,000,000 m² may have been implemented as a result of this demand, with an associated investment of 1,300 million euros. • A production of an amount of energy of 132,000 tons of petrol equivalent and emission avoidance of 490,000 tons of CO_2.

Solar bylaws	• Municipalities are entitled to regulate the obligation to install solar collectors - an obligation that must be higher than the demands in the Technical Code since this decree is just the basis in the Spanish legislation. • Aesthetic and technical conditions of the installations are included in some bylaws. • There are over 50 solar bylaws approved in Spain that affect over 20% of the population.

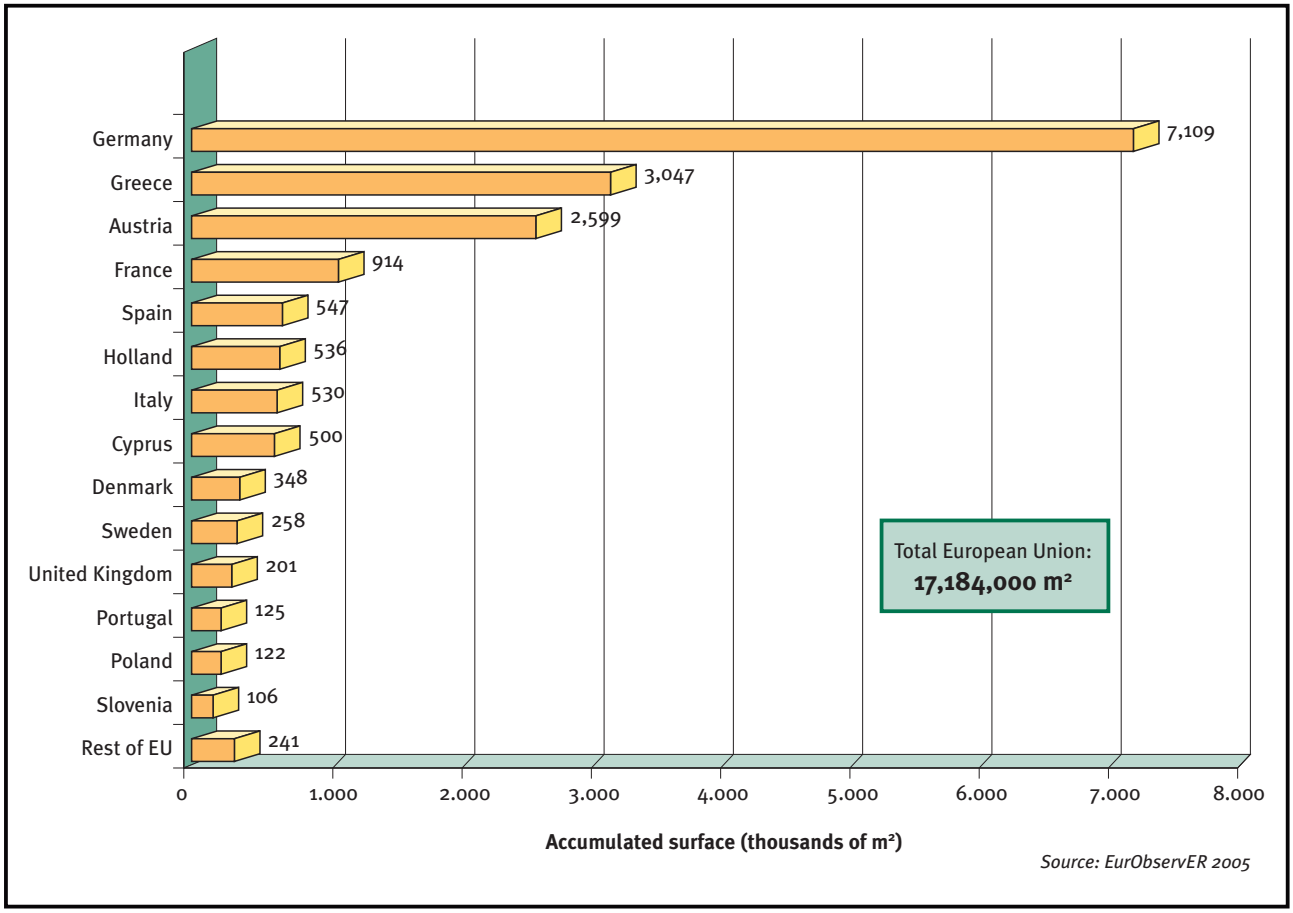
Distribution of the municipal solar bylaws



Source: IDAE. December 2006

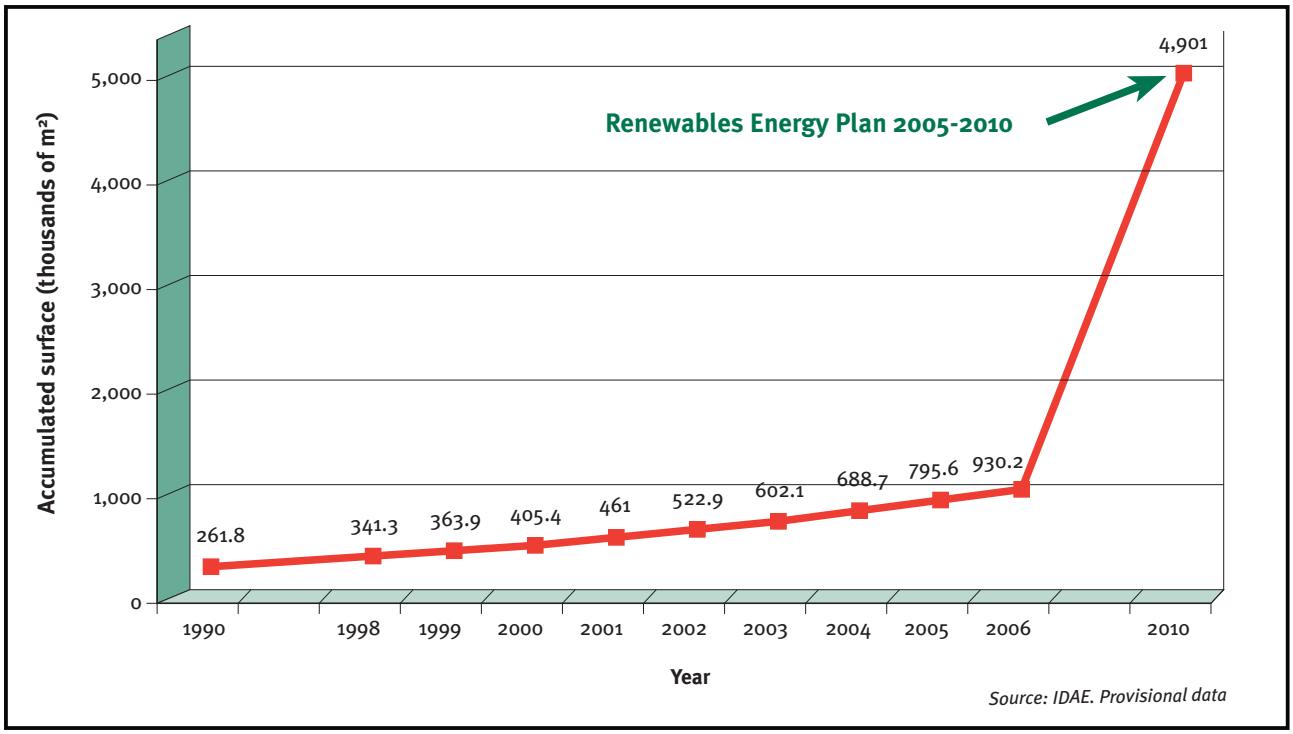
Solar Thermal Energy

Accumulated installed surface in the European Union (Year 2005)



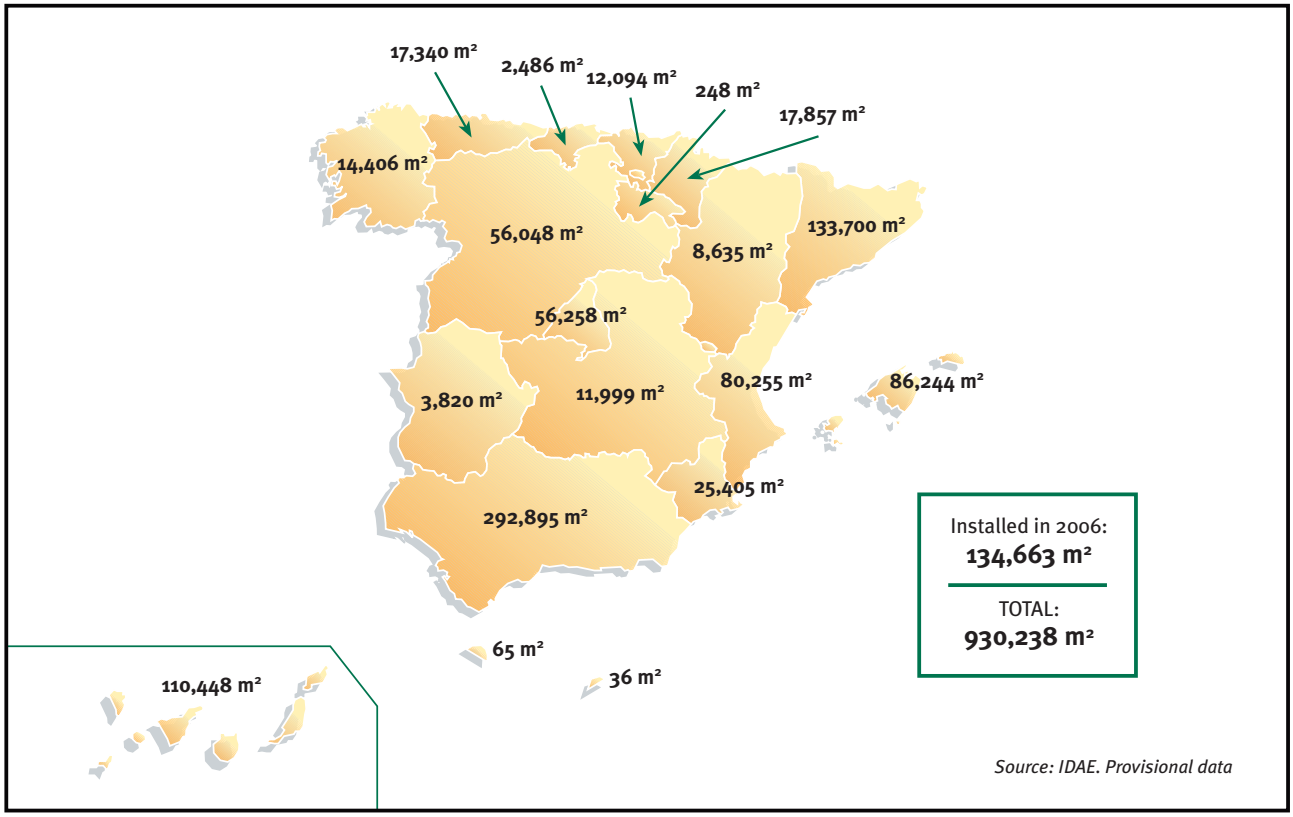
Source: EurObserER 2005

Evolution of the installed surface in Spain



Source: IDAE. Provisional data

Accumulated installed surface in Spain (Year 2006)



Keys for the development of solar thermal energy

Resources	• Supply of many resources coming from the Sun.
Technology	• Technological maturity in flat-plate collectors and mass production. • Development of new applications (solar cold, industrial processes...).
Legislation	• Application of the Technical Building Code.
Public aids	• To achieve a return on the investment.
Information and training	• Information to users in relation to the use of solar thermal energy. • Training for the installers sector to design and execute installations.

IDAE's investments in the solar thermal sector

Activities	• The sector's monitoring and analysis. • Promotion and spreading of activities. • Financing and development of innovative and replicable projects. • Technical consultations. • International cooperation.

Projects shared by IDAE

- **ERDF programme projects for SMEs:** 16 installations implemented under this programme. The IDAE acted as a mediator between the installer and the user providing technical support, financing the project and supervising the execution works of the installations.

  The user pays back the investment to IDAE by instalments, with a prime rate.

- **Solar cooling programme.** Collaboration agreements with:
  – Several Autonomous Communities.
  – The firm ROTARTICA: a firm that has developed a 4.5 kW absorption machine adapted to the characteristic running of solar thermal energy installations and facilities.

  Up to 10 installations of solar energy are implemented in each Autonomous Community with the application of solar-energy cooling.

  The IDAE finances the installation and the user pays back the investment according to the energy produced by the installation at conventional substituted fuel price.

IDAE's investments in the solar thermal sector

- **El Cabril.** Solar facility for producing of sanitary hot water and cooling, with a 35 kW absorption machine in ENRESA Waste Storage Centre of Low and Mid Intensity. Collection surface: 155 m². The investment is worth €117,000.

  The IDAE is carrying out a turnkey project hired by ENRESA (National Waste Enterprise), and it also relies on the technical counselling by INTA (National Institute of Aerospace Technique).

- **Sports Centres in Alcalá de Henares (Madrid).** Under the collaboration agreement with the Alcalá de Henares Local Council, IDAE is financing three municipal sports centres, associated with primary education schools.

  The surface of the installations amounts to 139 m² and the investment to €146.000.

Solar Thermoelectric Energy

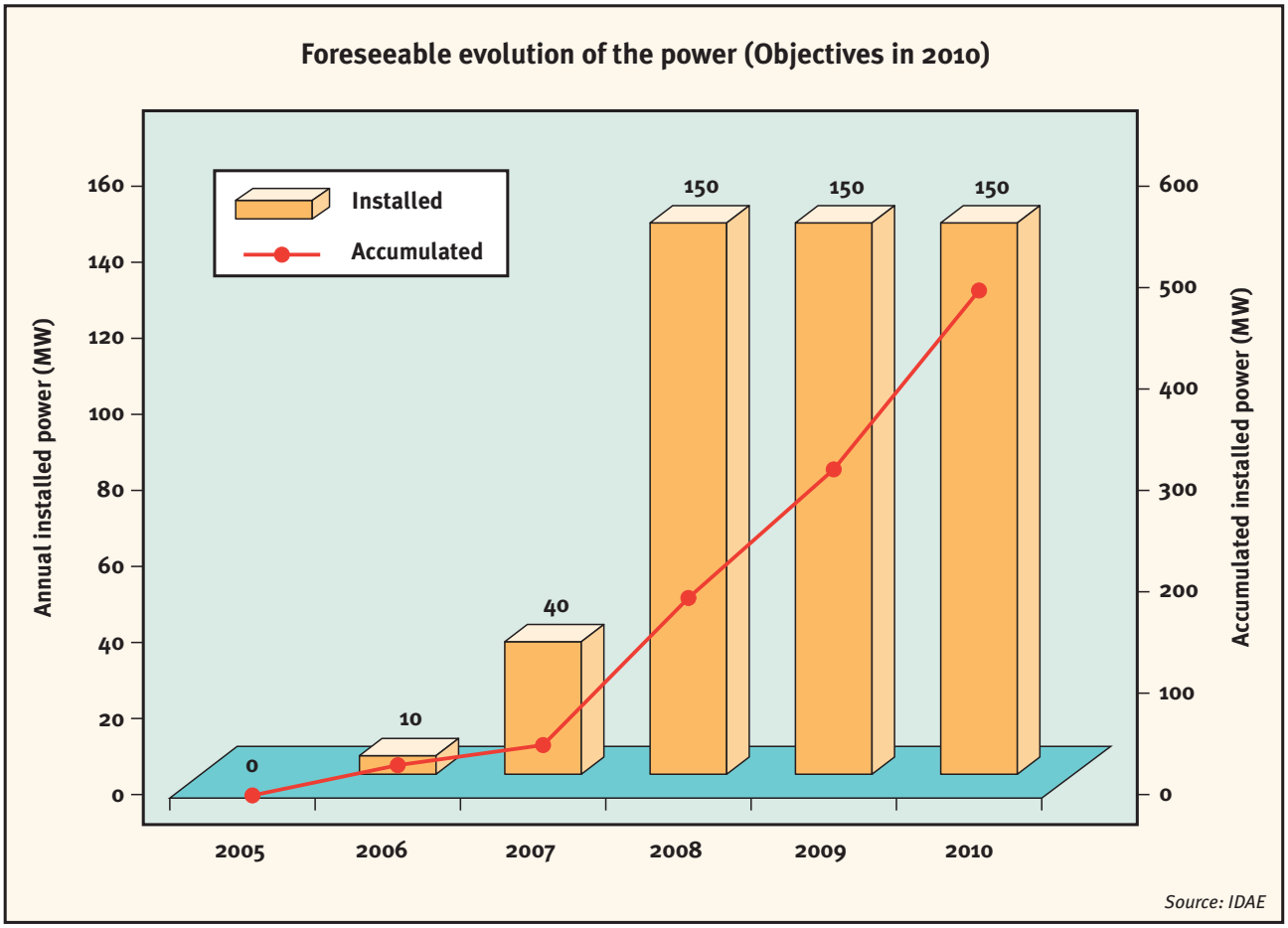
State of technology

General points	• The promotion and execution of these kind of projects is a long process. • The developers are large entrepreneurial groups linked to the energy and infrastructure sectors which have a high financial and debt-servicing capacity to undergo projects of this kind. • Few specific firms and with low capacity to supply the materials.
Manufacturers and suppliers	• There are not manufacturers and suppliers of materials in Spain. • Manufacturers of other products are interested in the manufacturing of some main components of these plants.

National regulatory framework

Renewable Energies Plan (PER) 2005-2010:
12% of the primary energy with renewable energies in 2010

Background	• Solar thermoelectric energy contributes with the installation of 500 MW as an increase contribution in with respect to 2005. • Main measures: – Support to carry out demonstration and innovation projects. – Promotion of the creation of a components industry for the sector.
Energy data	• Installed power 500 MW. • Accumulated energy produced during the period 2,882 GWh.
Economic and environmental data	• Investment envisaged for the period of 2,163 million euros. • Generation of 11,600 jobs in the 2010 horizon. • 483,000 tCO_2 each year will stop being sent into the atmosphere from 2010 on (Comparison source: Natural Gas Combined Cycle).



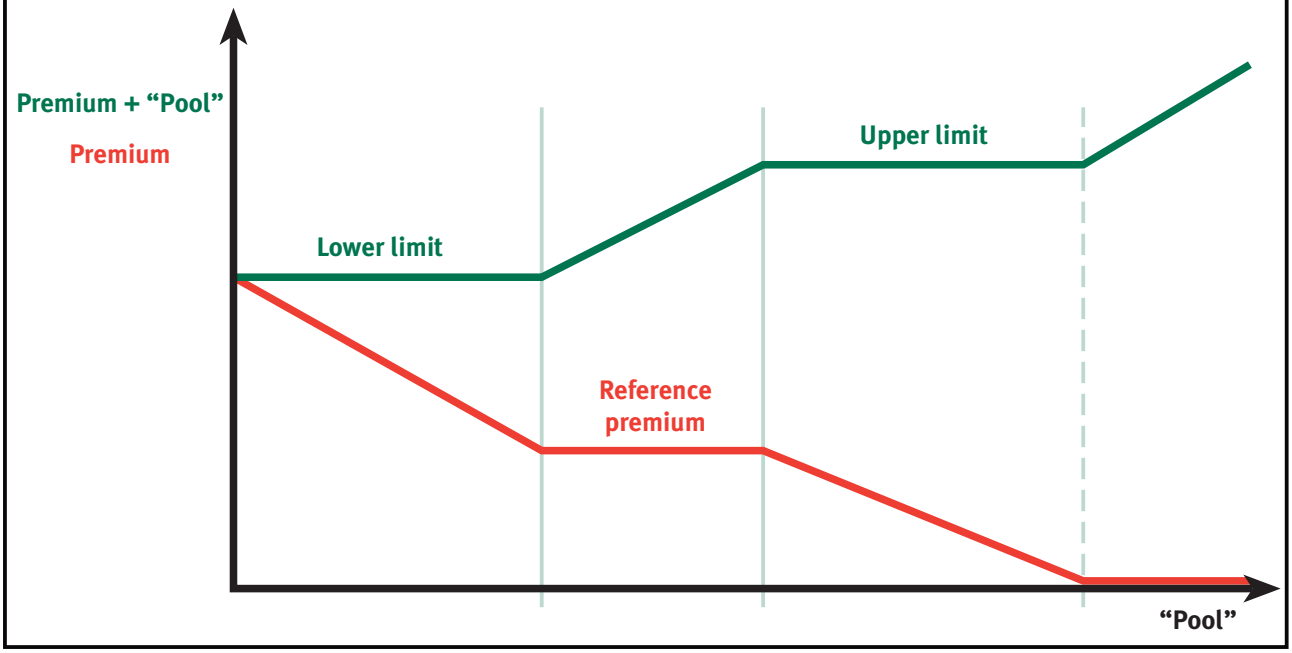
Royal Decree of the Special Scheme 661/2007 of 25th May

Object	• Establishment of the legal & economic scheme of the electricity production activity under the special scheme.
Methodology	• These installations belong to the b.1 group b1.2 subgroup. • The energy fed into the grid by these installations can be done: – Transferring electricity to the system by means of a transport or distribution grid, and being paid a feed-in tariff for it, a single one for all the programming periods. – Sell the electricity on the electricity production market. The final sale price will be the price resulting in the organised market plus a reference premium.

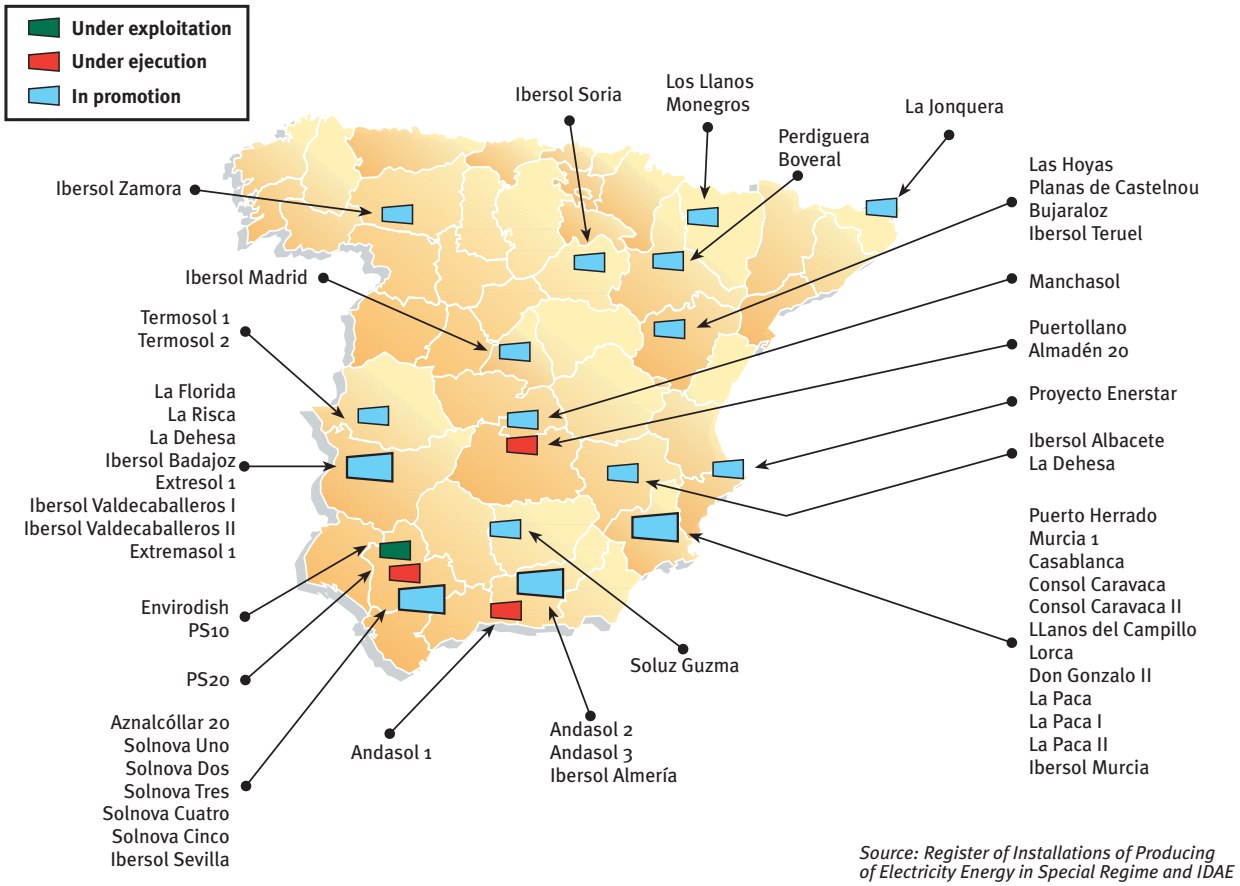
Royal Decree of the Special Scheme 661/2007 of 25th May *(Continuation)*

Economic scheme	• Feed-in tariff: – First 25 years: 26.9375 c€/kWh. – From then on: 21.5498 c€/kWh. • Reference premium: – First 25 years: 25.4000 c€/kWh. – From then on: 20.3200 c€/kWh. – Variable market price. • Establishment of lower and higher limits to protect the investor.
Strong points	• Support of fossil fuels between 12-15% of the whole electrical production of the plant. • Hybridization with other renewable fuel groups: – Biomass from energy crops, agriculture and gardening residues and forestry residues. – Biomass from manure, biofuels or biogas from anaerobic digestions and municipal solid waste. – The energy produced with these renewable fuel groups have to be lower than 50% of the whole electrical production.

Variation of the premium according to the pool with the higher and lower limits



Situation of the projects as of May 2007



Source: Register of Installations of Producing of Electricity Energy in Special Regime and IDAE

Future development of solar thermoelectric energy

Keys

- High direct radiation.
- Economic scheme that enables the feasibility of projects by means of feed-in tariffs and premiums to energy production.
- Support of the PSA (Almería Solar Platform). A cutting-edge innovation centre in this solar technology.
- Experience in the execution of projects.
- The specific sector's industry is being implemented.
- Specific plans for the development of innovative projects.
- Over 2,000 MW registered in a provisional way into the Register of Installations of Producing of Electricity Energy in Special Regime.

IDAE's investments in the solar thermoelectric sector

Name and location	Iberdrola Energía Solar de Puertollano. Puertollano (Ciudad Real).
IDAE's partners in the project	IBERDROLA Group.
Description	Execution and exploitation of a parabolic trough plant without storage. IDAE takes part with 10%.
Power (MW)	50
Budget (M€)	184
Surface (ha)	135
Commissioning	2008

Name and location	Direct Steam Generation (DSG). Almería Solar Platform. Tabernas (Almería).
IDAE's partners in the project	ABENGOA Group, IBERDROLA Group, CIEMAT & SENER.
Description	Viability study and execution of a parabolic trough pre commercial plant where the fluid of the collectors is the same than the power block. IDAE takes part with 10%.
Power (MW)	3
Budget (M€)	19
Surface (ha)	12
Commissioning	2009

Name and location	Almadén Solar. Almadén (Ciudad Real).
IDAE's partners in the project	ABENGOA Group & SEPIDES.
Description	Execution and exploitation of a central receiver technology plant without storage. IDAE takes part with 20%.
Power (MW)	20
Budget (M€)	97
Surface (ha)	80
Commissioning	2009

State of technology

Growth sector with a growth rate of 105 % in 2006, 54 % in 2005 and 39 % in 2004

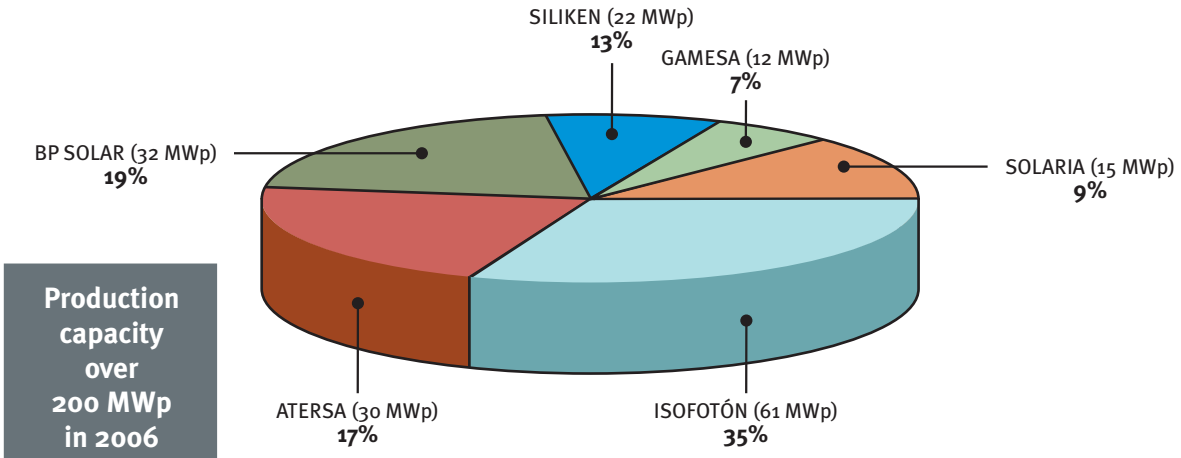
Data 2006	• Over 60 MWp have been supplied and installed between national manufactures & distributors and international importers. • Sector is divided into two main types of installations: – Installations in buildings. – Installations on floor, generally these plants have a great size.
State of technology	• Commercial explosion of concentration technology. • Beginning the introduction onto the market of other technologies different from the silicon. • In 2009 is expected to finish the production line of silicon, from mineral to photovoltaic module, because of the starting of plants to produce polysilicon.

Manufacturing and supplying firms

Industrial fabric	• The sector is made up of over 400 firms. • An experience of over 25 years in manufacturing and project developments. • An important international presence. • Continuous increase of the number of manufacturers and of their production capacity. • Reputable research and development centres. • Leader in innovative projects.

Manufacturing and supplying firms

Manufacturers of solar photovoltaic module in 2006.
Firms with a production capacity of over 15 MWp

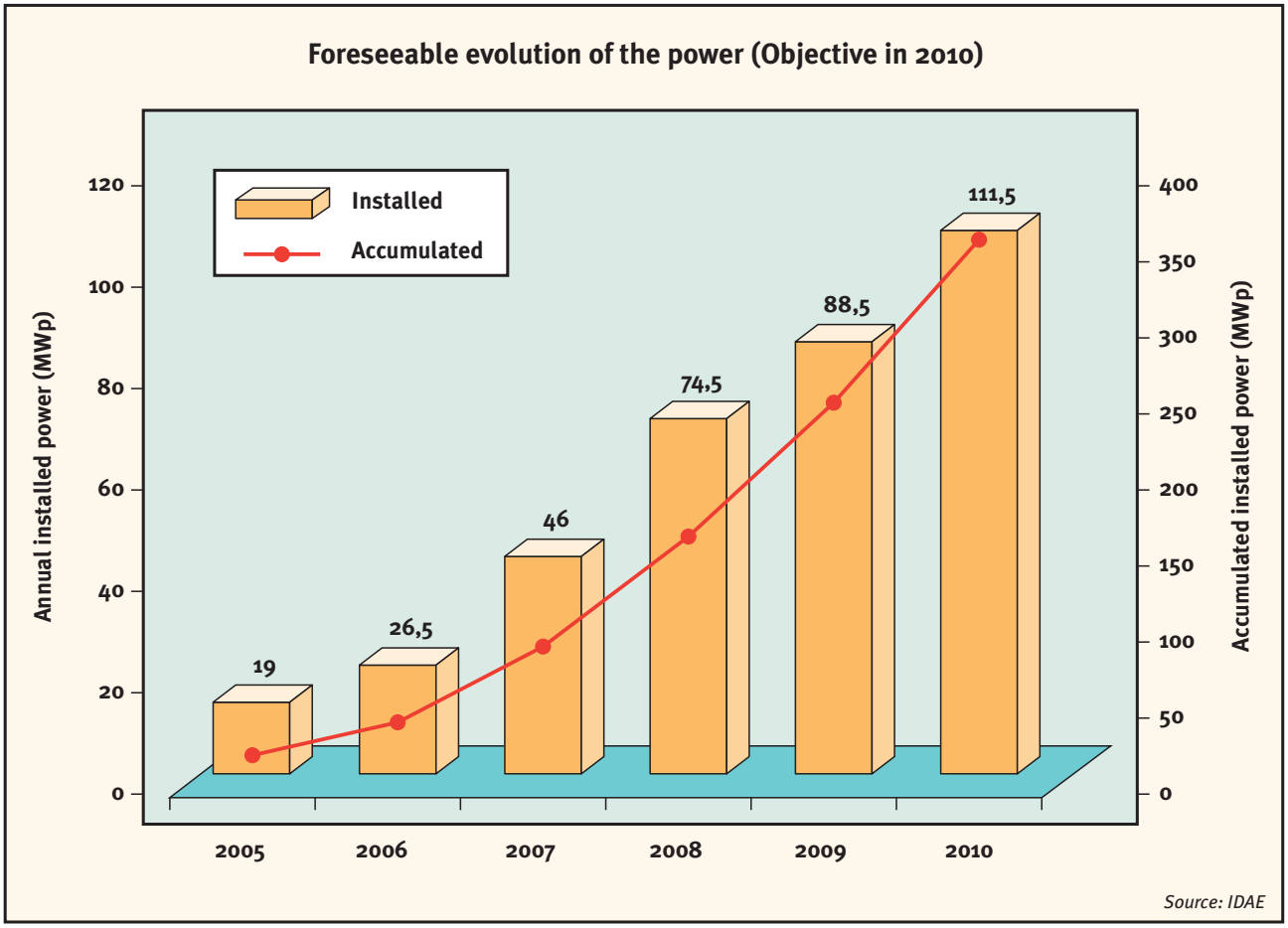


Source: Photon International and IDAE. March 2006

National regulatory framework

Renewable Energies Plan (PER) 2005-2010:
12% of the primary energy with renewable energies in 2010

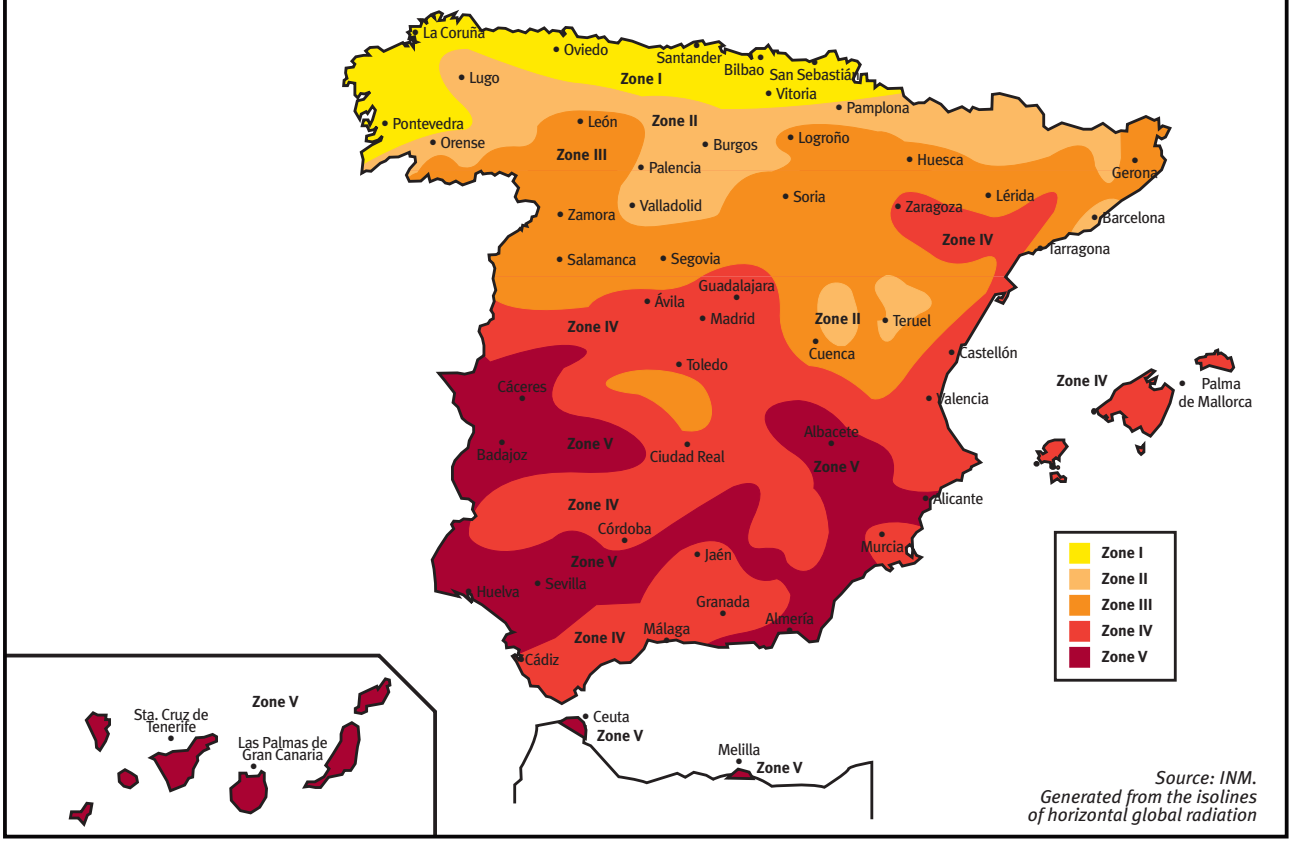
Background	• Solar photovoltaic energy contributes with an increase objective with respect to 2005 of 363 MWp. (400 MWp accumulated to 2010). • Main measures: – Approval of the Technical Building Code. – Support to innovation. – Application of public funds to investment in isolated installations.
Energy data	• It is estimated that the 363 MWp are distributed between installations: – Off-grid: 15 MWp. – Grid-connected: 348 MWp. • The accumulated energy produced during the period will amount to 1,360 GWh.
Economic and environmental data	• Envisaged investment during the period of 2,039 million euros. • Investment aids established at 43 million euros. • Generation of almost 9,200 jobs on the 2010 horizon. • 206,000 tCO_2 will stop being sent into the atmosphere from 2010 each year (Comparison source: Natural Gas Combined Cycle).



The Technical Building Code:
Obligation to install solar photovoltaic energy in specific buildings

Background	• Approved by Royal Decree 314/2006. Spanish Official Gazette 28/03/06. • The Document on Energy Saving (HE) in Section HE 5 of the Technical Code shows the obligation to install a solar photovoltaic energy system in new buildings or in those to be refurbished, mainly those linked to the services sector (hypermarkets, hospitals, hotels...) according to the: – Kind of building. – Climatic zone (Zones I, II, III, IV, V). – Floor space area (m^2). • There are charts with coefficients regulating the parameters of the formula to obtain the peak power to be installed.

Distribution map of the climatic zones



Source: INM. Generated from the isolines of horizontal global radiation

Formula to obtain the peak power to be installed in the building:

$$P = C * (A*S+B)$$

Where:

P the peak power to be installed (kWp)

A and ***B*** coefficients defined according to the kind of building

C coefficient defined according to the climatic zone where the building is

S floor space area of the building

Foreseeable results	• The compulsory enforcement took place on 29th September 2006. • During the 2006-2010 period, a power of 80 MWp may have been implemented as a result of this demand, with an associated investment of 562 million euros. • A production of 89 GWh and emission avoidance of 53,000 tons of CO_2.

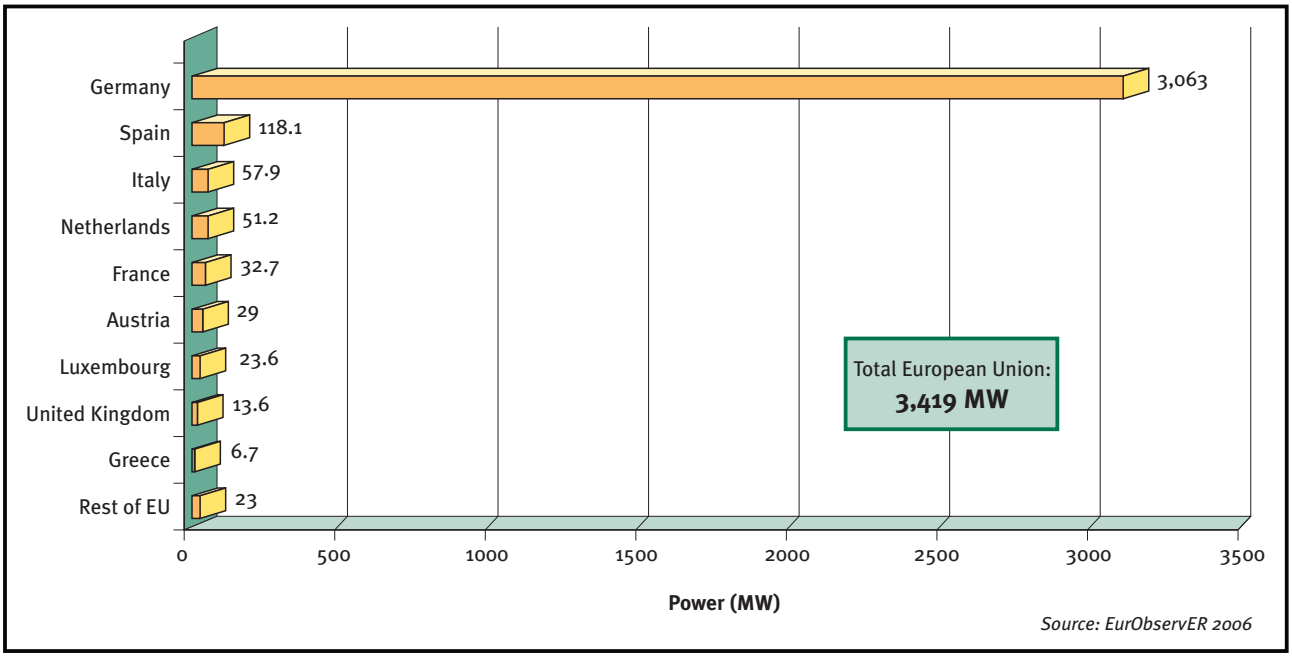
National regulatory framework

Royal Decree on the Special Scheme 661/2007 dated 25th May

Object	• Establishment of the legal & economic scheme of the electricity production activity under the special scheme.
Methodology	• These installations belong to the b.1 group b1.1 subgroup. • The energy fed into the grid by these installations can be transferred to the system by means of a transport or distribution grid and being paid a feed-in tariff for it, a single one for all the programming periods.

Economic scheme	• Feed-in tariff:
	  • P ≤ 100 kW
	  – First 25 years: 44.0381 c€/kWh.
	  – From then on: 35.2305 c€/kWh
	  • 100 kW < P ≤ 10 MW
	  – First 25 years: 41.7500 c€/kWh.
	  – From then on: 33.400 c€/kWh.
	  • 10 < P ≤ 50 MW
	  – First 25 years: 22.9764 c€/kWh.
	  – From then on: 18.3811 c€/kWh.

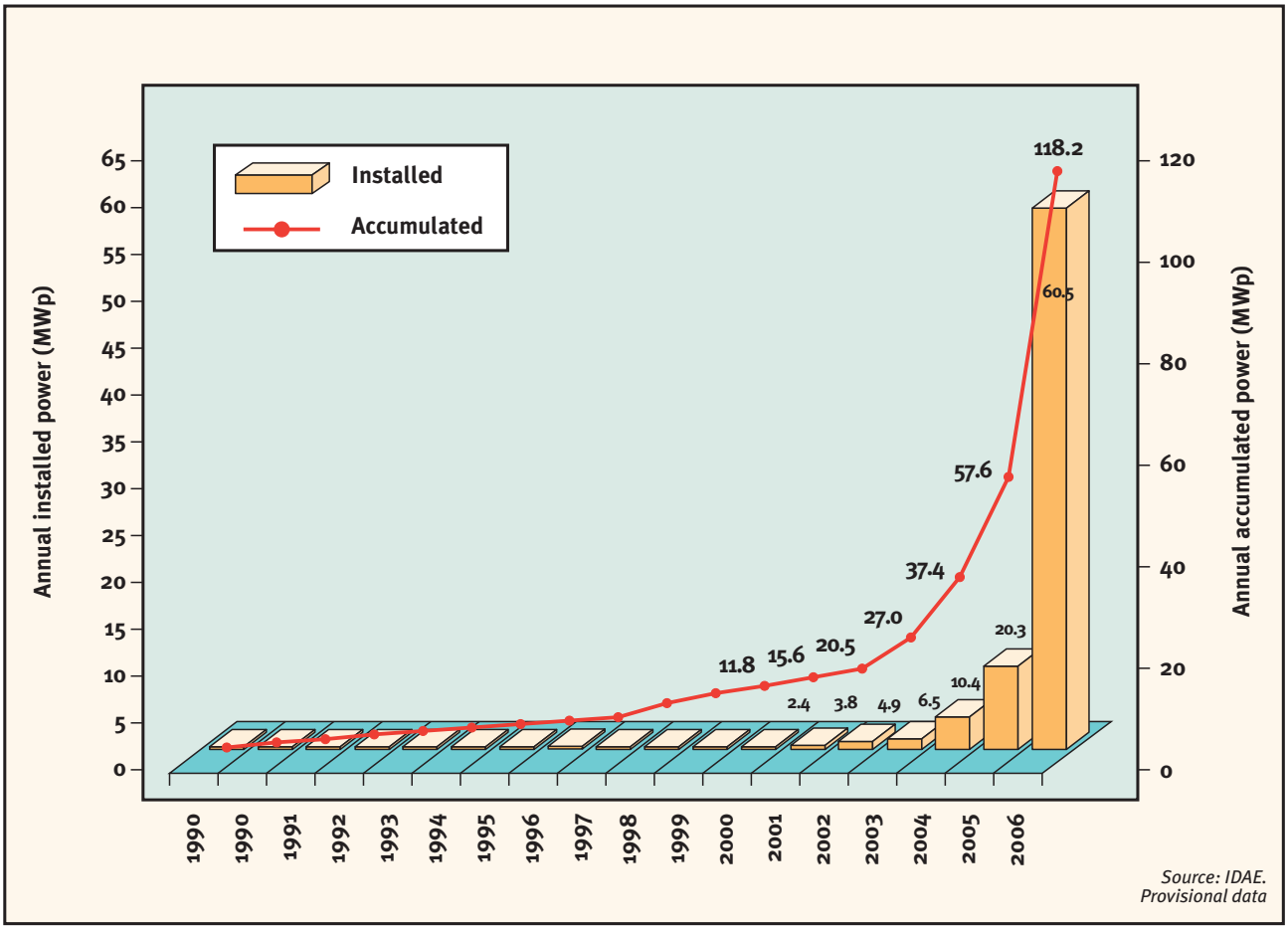
Accumulated installed power in the European Union (Year 2006)



Source: EurObservER 2006

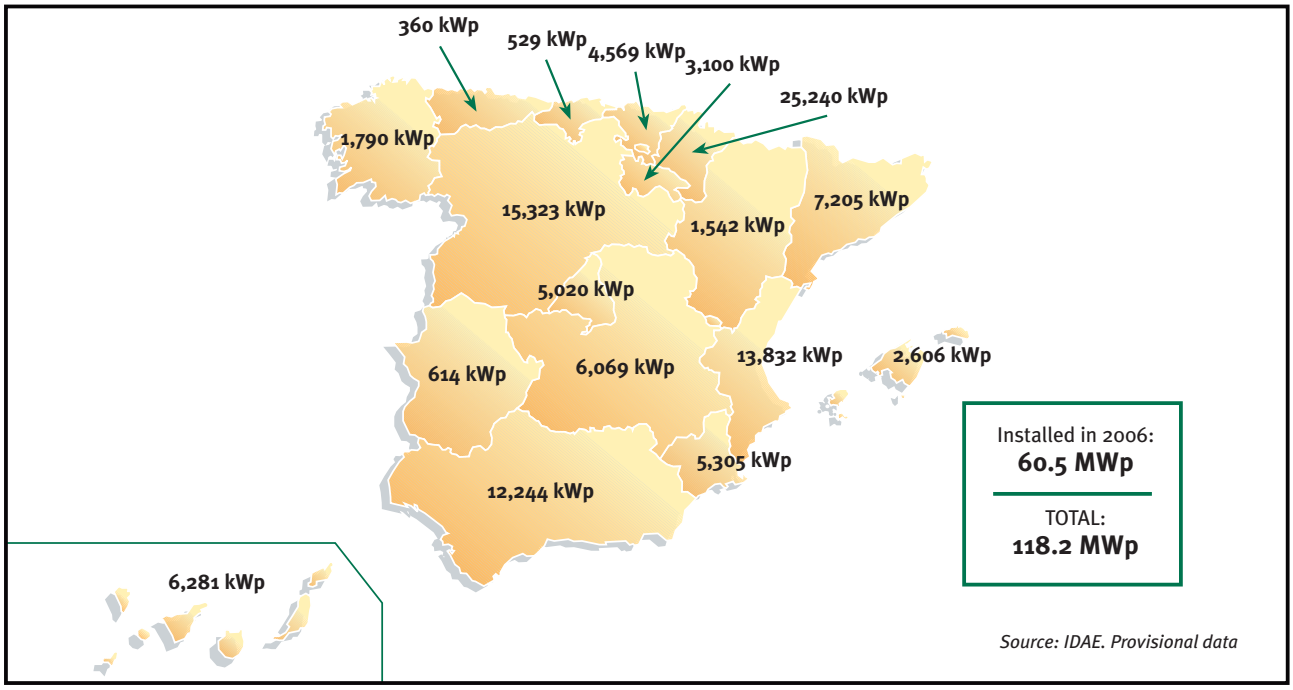
Solar Photovoltaic Energy

Evolution of the installed power in Spain



Source: IDAE. Provisional data

Installed power in Spain (Year 2006)



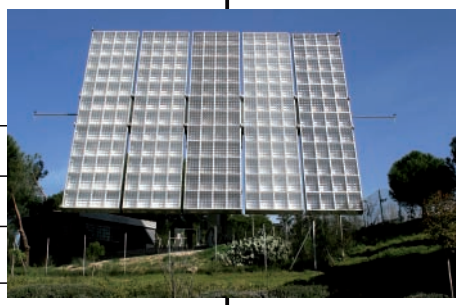
Source: IDAE. Provisional data

Keys for the development of solar photovoltaic energy

- Developed industrial fabric.
- Solar resource.
- Suitable legal framework.
- Appropriate planning.

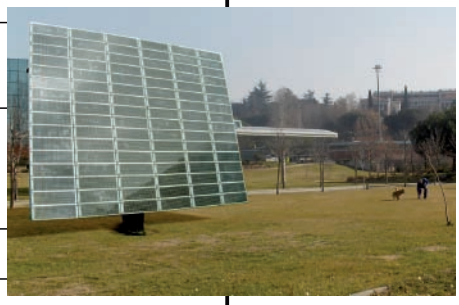
IDAE's investments in the solar photovoltaic sector

Name and location	Photovoltaic concentration innovation system. Institute of Solar Energy. Ciudad Universitaria (Madrid).
IDAE's partners in the project	GUASCOR FOTÓN & IES.
Power (kW)	25 (concentration 250x).
Budget (€)	200,000
Commissioning	2006



Name and location	Forum 2004. Phase II. Roof of the Besós sewage treatment plant (Barcelona).
IDAE's partners in the project	100% IDAE.
Power (kW)	600
Budget (€)	3,500,000
Commissioning	2007

Name and location	Innovación solar en el Complejo de La Moncloa (Madrid).
IDAE's partners in the project	Ministry of the Presidency & ISOFOTÓN.
Power (kW)	4.8 (concentration 1000x). Solar thermal for cooling (35 kW).
Budget (€)	300,000
Commissioning	2007



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