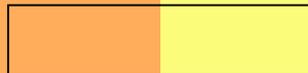


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# ***SITUATION OF THERMOELECTRIC SOLAR ENERGY IN SPAIN***

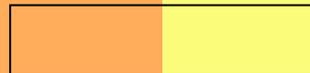
***Cayetano Hernández González***  
***Operations Manager***



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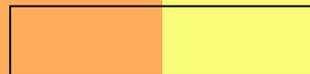


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# ***1. INTRODUCTION***



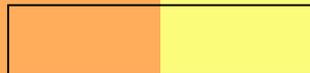
## **INTRODUCTION:**

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The Council of Ministers finally approved the Plan for Promotion of Renewable Energies for the period 2000-2010, at its meeting on 30 December 1999.

The promotion activities have been drawn up within the legal framework in which electricity and thermoelectric generation plants using renewable energy sources operate, on the basis that those sources must be supported, owing to their contribution to the essential goals of the national energy policy:

- ✓ Diversification of the primary sources to guarantee security of supply.
- ✓ Efficient utilisation and respect of the environment, with a favourable effect on industry.



## **INTRODUCTION:**

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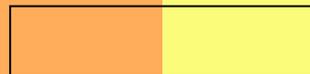
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There is, therefore, a legal framework that establishes the possibility of setting a higher premium for energy produced using thermoelectric plants than that granted for other renewable energies, such as photovoltaic energy.

Legal framework:

- ✓ The Electricity Act 54/1997 of 27 November.
- ✓ Royal Decree 2818/1998 of 23 December.
- ✓ Act 14/2000 of 29 December on Fiscal, Administrative and Social Measures.

Definition of the premium for thermoelectric plants, which is expected to be published shortly, will be the final stepping-stone for development of the first investment projects, which are currently being drawn up.



# Situation of Thermoelectric Solar Energy in Spain

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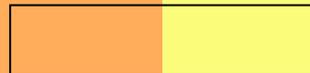
## SPECIAL REGIME. - PREMIUM AND FIXED PRICES FOR THE YEAR 2002

		Premium (€/kWh)	Fixed Prices (€/kWh)
Primary biomass		0.0279	0.0617
Secondary biomass		0.0258	0.0596
Wind Power		0.029	0.0628
Small hydroelectric plants	≤10 MW	0.0301	0.0638
	> 10 MW y ≤ 50 MW	0.0301/0	
Photovoltaic Solar	≤ 5 MW	0.361	0.3967
	> 5 kW	0.1803	0.2164
Thermoelectric Solar Energy			

Source: R.D. 1483/2001 de 27 de diciembre (BOE 28 de diciembre de 2001)

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## ***2. THERMOELECTRIC SOLAR ENERGY IN THE PLAN FOR PROMOTION***



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## **TECHNOLOGIES:**

### ✓ **Parabolic Trough Technology:**

Formed by collectors consisting of a mirror that reflects the radiation onto a tube positioned on the focal line, which contains the absorbent area and the heat-carrying fluid.      **Stage: forthcoming commercial development.**

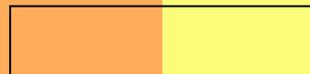
### ✓ **Central Receiver Technology:**

Formed by a field of heliostats that reflect the radiation onto a heat exchanger situated at the top of a central tower.      **Stage: proven technical feasibility.**

### ✓ **Parabolic Disk Technology:**

Formed by a set of mirrors forming this figure, with a solar receiver at the point source, in which a fluid is heated or a Stirling motor or Brayton turbine is activated.

**Stage: forthcoming technical feasibility.**

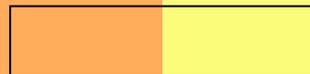


## **TECHNOLOGIES:**

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**In Spain, the Solar Platform in Almería is the only high-temperature thermoelectric project in which a tower system has been installed with a peak capacity of 7 thermal MW, together with a cylinder parabolic collector plant with a capacity of 1.2 thermal MW.**

**There are also disk parabolic systems, DISTAL I and II, based on Stirling motors, of 40 and 50 thermal kW. Since 1996 it has been used as an applied research centre, seeking to achieve the technological improvement of components and systems and diversification of solar energy applications.**



***ENVIRONMENTAL ASPECTS:***

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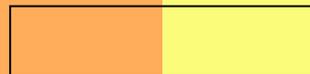
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**Thermoelectric solar energy belongs to the set of renewable energy technologies that are used mainly to produce electricity without combustion processes and, consequently, without emissions.**

**The CO<sub>2</sub> potential reduction is estimated at 2,000 t/year per MWe installed capacity, in other words, each GWh produced with solar energy avoids 700-1,000 t of CO<sub>2</sub>.**

**There is, therefore, no impact on the physical environment, or on the quality of the air, or on the ground, nor does it cause noise or affect the existing hydrology.**



## **ENVIRONMENTAL ASPECTS:**

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The main repercussions on the environment are the visual impact and occupation of land, which can be significant for very large installations. This occupation of land may affect the flora and fauna on and around the site.

<b>TECHNOLOGY</b>	<b>EFFECTS ON THE ENVIRONMENT</b>
<b>Parabolic Disk Technology</b>	<b>Occupation of land</b>
<b>Parabolic Trough Technology</b>	<b>Visual impact and occupation of land</b>
<b>Central Receiver Technology</b>	<b>Visual impact and occupation of land</b>

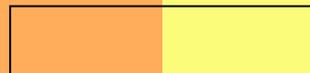
## ***COST OF INSTALLATION :***

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### **CURRENT SITUATION OF SOLAR CONCENTRATION TECHNOLOGIES AND ESTIMATE OF COSTS**

	<i>Technological state</i>	<i>Unit Capacity</i>	<i>Cost of capital</i> ( $\square$ / kW)
<b>Cylinder parabolic</b>	Forthcoming Commercial Development	30 MW to 80 MW	2,680
<b>Tower system</b>	Proven Technical Feasibility	30 MW to 200 MW	2,221 to 2,684
<b>Disk / motor</b>	Forthcoming Technical Feasibility	5 kW to 50 kW	2,684

Source: "Markets for Concentrating Solar Power". Department of Energy's Concentrating Solar Power Program. U.S. Department of Energy (DOE).



## **BARRIERS:**

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Concentration technologies have not yet reached the phase of commercial demonstration.

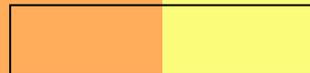
- ✓ First, the development of the initial demonstration projects to prove their technological and economic feasibility.
- ✓ Secondly, the investments to be made per kW installed capacity are still very high, although the prospects of lowering costs seem to be encouraging in the medium term.
- ✓ Finally:
  - The possible problems regarding connection of solar plants to the grid should not be overlooked, especially for solar plants at remote sites.

## **MEASURES AND INCENTIVES:**

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The Promotion Plan proposes a number of measures and incentives to foster introduction of these technologies on the market, such as:

- ✓ Public support for the investments to encourage the building of the first plants.
- ✓ Tax allowance on the investment made to build the plants, consisting of a 10% reduction in corporation tax.
- ✓ Public support would also provide grants and financing for research and development activities, with a view to improving the technology and adapting it to the different potential applications.



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## **MARKET FORECASTS:**

The commercial development of thermoelectric solar energy as future energy is based on the advantages over other energy sources, among others:

- ✓ Positive from an environmental point of view, because produce no emissions.
- ✓ Safe and inexhaustible energy source.
- ✓ Generation of qualified employment; it could be an element of regional economic development.

- ✓ Solar energy is one of the most widely-accepted energy sources among consumers.
- ✓ It is possible to build hybrid, or mixed, plants with conventional technologies based on the combustion of fossil fuels, combining the advantages of both sources of energy.

### ***MARKET FORECASTS:***

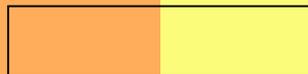
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The first thermoelectric solar plants could be developed on the basis of these advantages and the target for increasing the share of renewable energies on the overall energy market, initially for demonstration and subsequently moving on to a pre-commercial phase at the horizon of the Plan. In view of the high level of solar radiation in Spain, our country could pioneer the commercial development of these technologies.

It could, therefore, be feasible to establish a target of 200 MW installed capacity, equivalent to eight 25 MW plants.



## **MARKET FORECASTS:**

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### **Targets for thermoelectric Solar Energy by Autonomous Community (Installed capacity in MW)**

<b>Autonomous Community</b>	<b>Targets under Promotion Plan</b>
Andalusia	50
Canary Islands	25
Castille-La Mancha	50
Extremadura	25
Madrid	25
Murcia	25
<b>TOTAL</b>	<b>200</b>

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**TARGETS AND PRIORITIES  
FOR TECHNOLOGICAL  
INNOVATION:**

**TECHNOLOGICAL INNOVATION TARGETS:**

✓ Investments in short / medium term for generation of electricity using concentration systems:

400,000 Pta/kW (2,404 €/kW)

✓ Cost of production of kWh in short / medium term in hybrid solar systems more than 50%:

13.5 Pta/kWh (0.08 €/kWh)

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## **TARGETS AND PRIORITIES FOR TECHNOLOGICAL INNOVATION:**

### **PRIORITY LINES OF ACTION:**

#### **Priority I**

- ✓ Development of two commercial demonstration plants in the range of 10/20 MW installed capacity with central tower system.
- ✓ Development of a commercial demonstration plant in the range of unit MW, with cylinder parabolic concentration system<sup>1</sup>.

<sup>1</sup>Plant with 100% solar contribution or hybrid solar/conventional fuel plants with solar contribution over 50%.

#### **Priority II**

- ✓ Development of more efficient, cheaper and more compact advanced receivers with working capacity at higher radiation flows and in the range of installed capacity of several MW.
- ✓ Enhancement of technology for the design and manufacturing of heliostats.
- ✓ Development and fine-tuning of technologies for direct generation from steam through absorbing tubes.

#### **Priority III**

- ✓ Development of cylinder parabolic collectors.

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### ***3. IDAE SUPPORT TO THE THERMOELECTRIC SOLAR ENERGY SECTOR***

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**IDAE is involved in the following activities in the thermoelectric area:**

- ✓ **Participation in development of the legislative framework .**
- ✓ **Promotion and publicity activities.**
- ✓ **Collaboration with Public Administrations.**
- ✓ **Promotion of demonstration projects.**
- ✓ **The ICO-IDAE finance line.**

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## **PROJECT WITH IDAE**

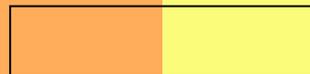
### **INVESTMENT:**

<i>Title</i>	<i>Power (MW)</i>	<i>Investment (€)</i>	<i>State</i>
Sanlucar Solar Project	10	27 M€	Approved

The project consists of the building and start-up of a 10 MW thermoelectric solar energy plant using Central Receiver technology. This plant is to be built on the Casaquemada estate, in San Lucar La Mayor, Seville.

IDAE has the intention of participating in the SANLUCAR SOLAR project, holding 10% in the promotor, Sanlucar Solar, S.A., currently majority owned by Sieme (Abengoa Group).

The project requires an investment of the order of 27 million euro and has been awarded a grant of 5 million euro by the European Union, within the V Framework Programme for R+D+D.



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## **4. CONCLUSIONS**

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## **CONCLUSIONS**

- ✓ Owing to the high level of radiation available in Spain, it is possible to adopt concentration technologies with greater prospects of profitability than in most other Member States of the European.
- ✓ The Solar Platform in Almería can offer technical assistance for development of the sector.
- ✓ Both the tower systems and the systems using cylinder parabolic collectors have proved their technical feasibility and are ready to move on to the stage of pre-commercial demonstration.
- ✓ The forecasts set a target of 200 MW, equivalent to the development of 8 plants with approximately 25 MWe each.