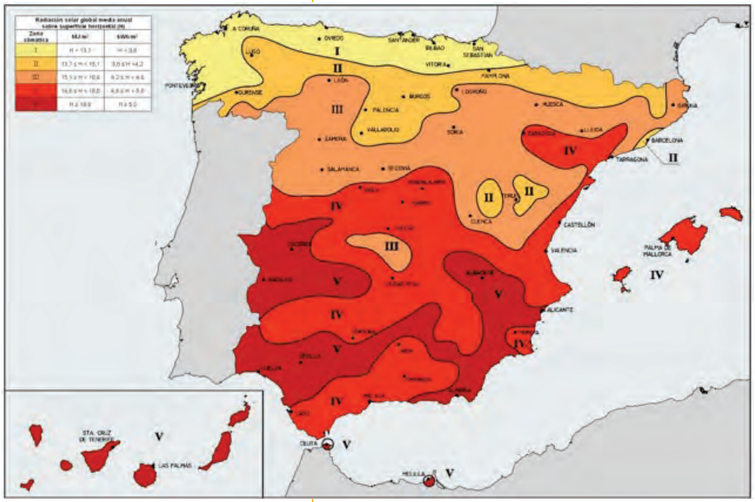
Spain

A Sunny Paradise Truncated by a Financial Crisis: The Building Code Experience

In the recent past decades, Spain has pioneered two solar revolutions: mandatory inclusion of solar thermal in new and refurbished buildings and solar thermal electricity. The 2008 financial crisis deeply impact the industry and the future recovery and development will depend strongly on these and other adopted policies.



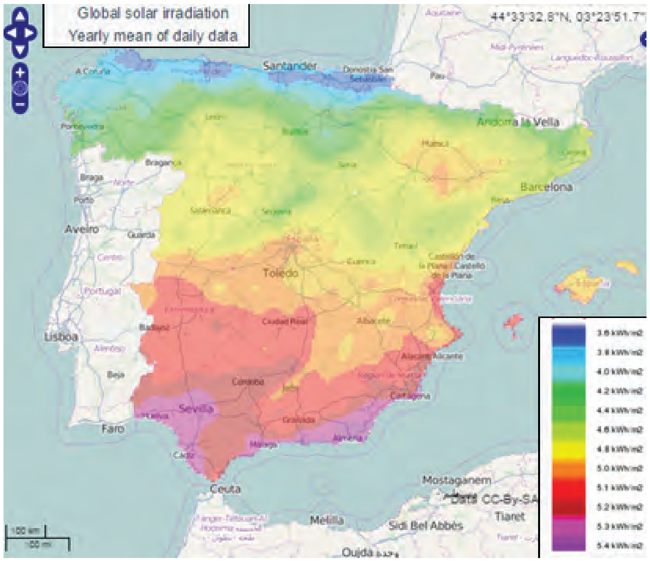
▲ **Figure 1. Climatic Zones as defined in the Spanish Building Technical Code.**

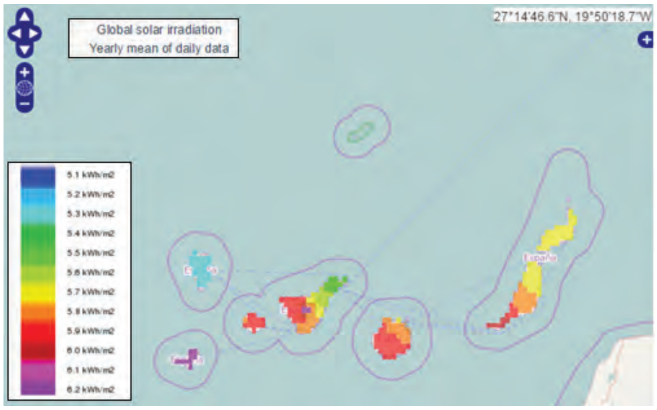
A Tale of Two Successes: Solar Thermal Building Codes and Concentrating Solar

Spanish people are proud of their sun, as is confirmed by a long sunny tourism-oriented tradition. The sun is also a strategic policy-making focus. After a series of local solar regulations, in 2006 the Spanish Building Technical Code was approved, which included explicitly mandatory energy-saving measures in terms of energy demand limitation, HVAC and lighting performance and a minimal solar contribution. The minimal solar thermal contribution is for domestic hot water (DHW), and when applicable swimming pools, according to different climatic zones (see Figure1).

The Spanish government allows for both technologies (thermal and photovoltaic) the application of official climatic zones map from the building technical code. In 2012, CIEMAT (Spanish Energy, Environment and Technology Research Centre) published the Spanish Solar Global Irradiation map (http://www.adrase.es/en/) to contribute to the solar resource knowledge for the development of both technologies in the country.

The spatial distribution of solar radiation was estimated using satellite imagery and the processing of measured data in more than 50 AEMET (Spanish Meteorological Agency) stations over 10 years.





▲ **Figure 2. Spanish Solar Global Irradiation map for solar energy applications.** (Source: CIEMAT)

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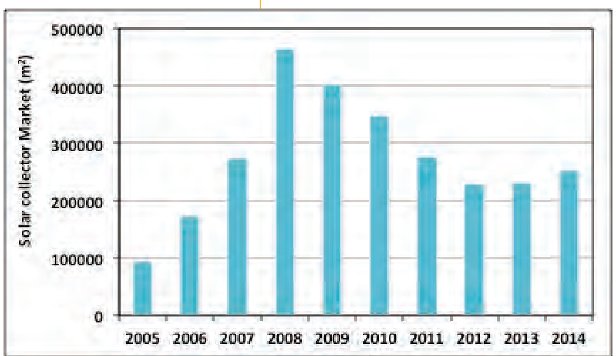
▲ **Figure 3. CHEQ4, a software package to promote solar thermal systems compliance with the Spanish Building Technical Code** (Source: http://www.codigotecnico.org/index.php/cheq4).

The energy saving measures were actualized in 2013, according to national implementation of the European Energy Performance of Buildings Directive 2010/31/UE. A new limit for the non-renewable contribution to DHW and HVAC was established, which created an opportunity for solar thermal applications beyond DHW. To promote solar thermal among the different stakeholders, IDAE (Institute for Energy Saving and Diversification, Spanish Ministry of Industry) and ASIT (Spanish Solar Thermal Industry Association) developed CHEQ4, a software package to evaluate a broad variety of solar thermal systems, assess their performance and generate all the official documentation for the project (see Figure 3). This tool allows in-situ system checking, which helps commissioning the appropriate system size.

The Key Issue: Solar Thermal Policies

Solar thermal systems in Spain consist mainly of water-based flat plate collectors. In 2012, the total capacity was 2,074 MWth (2,962,824 m^2) with a breakdown of flat plate collectors (1,862.9 MWth, 2,661,260 m^2), unglazed (93.9 MWth, 134,191 m^2) and evacuated tube (117.2 MWth, 167,373 m^2) collectors. In 2014, 178.5 MWth (255,000 m^2) was added to the overall system, representing a 9.7% increase with respect to 2013 figures. The share for the newly added capacity corresponds to flat plate collectors and prefabricated systems (92%), unglazed (2%) and evacuated tube collectors (6%).



▲ **Figure 4. Evolution of the solar collector market in Spain.**

As can be seen in Figure 4, the building code produced a relevant increment of the market size during the first years of application. But when the construction industry crashed, there was an exponential decay observed in 2008-2013. After this period, in 2014, a 9% increase of the Spanish market was reported. More than a half of this increment was due to a regional promotion program in Andalucía (PROSOL program), showing that policymaking is a key issue for solar thermal development. This regional program to promote renewable energy has produced a record 56 MWth installed in Andalucía.

National Strategy Addresses Building Energy Refurbishment

The Spanish policy at the national level is to promote the ESCO business model and to improve energy efficiency and the use of renewables in existing buildings. To achieve this goal there are specific financing programs (SOLCASA, 5 M€approximately) and cross sectorial ones, such as the renewable energy promotion in deep refurbishment of the building stock (see PAREER CRECE, 200 M€ approximately) in addition to a State plan for building refurbishment and urban renovation (RD233/2013, in total 2,300 M€approximately; with 100 M€approximately for energy efficiency measures). A hotel industry energy refurbishment program (PIMA SOL, 400 M€ approximately) is also expected to promote solar thermal in this sector.

The support of combined measures of Energy Efficiency and Renewables gives a common and homogenous framework where applicants can find the means to finance their actuations.

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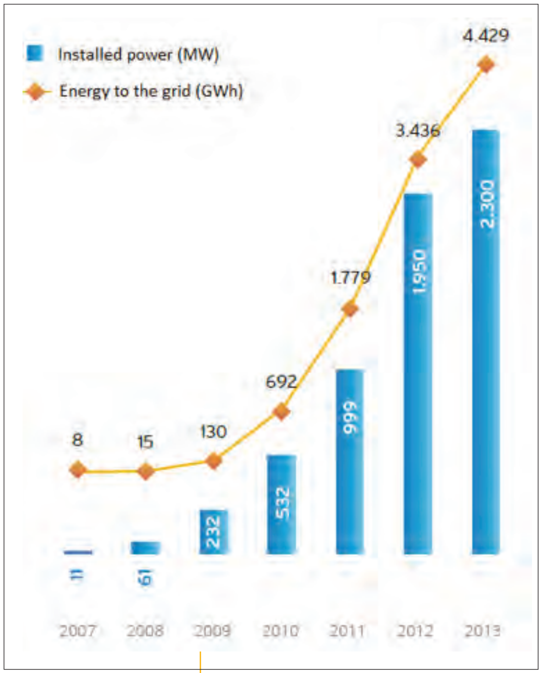
Solar Thermal Electricity: The Golden Age

Since 2007 when the first commercial plant using concentrating solar thermal technology was connected to the Spanish grid, the figures for both installed capacity and generated energy saw enormous growth up to 2013 at which time the government drastically cut its support for electricity production using this renewable energy source (see Figure 5(a)).

The installed capacity is implemented in 50 solar thermal electricity (STE) plants, 40% of them with thermal storage systems. Normally, the STE plants are provided with thermal storage designed to cover 4 to 7 hours of operation after sunset or during cloudy periods, but the reference plant, Gemasolar, can produce electricity 24 hours during the summer (Figure 5 (b)). Commercial storage systems with such big capacities makes STE technology pivotal for creating an energy mix with a high percentage of renewables, including wind and PV although not being dispatchable electricity sources at this moment.

The experience gained in the design, construction, operation and maintenance of these 50 plants has placed the STE Spanish industry as 'number 1 worldwide' in the words of the European Solar Thermal Electricity Association. The experience and optimization of operation of the plants can be seen clearly by comparing the energy production in 2014 (4,958 GWh) to 2013 (4,429 GWh), resulting in an increase of around 12% in the energy production with the same power installed in both years.



▲ **Figure 5(a) Evolution of the solar thermal electricity installation and energy generated in Spain** (Source: Estudio del impacto macroeconómico de las renovables en España, 2013)

Despite the Spanish Government's current negative position to renewable power generation in general, and to STE in particular, new markets are emerging at across the globe in regions and countries with the objective of increasing its share of renewable energy and that are blessed with high levels of solar radiation and clear skies, such as the U.S., Australia, Turkey, Middle East, North Africa and South Africa, plus others. It is clear that in these new markets, the Spanish STE industry is playing an important role.

A New Look At Concentrating Solar: Solar Heat For Industrial Processes

Spain has been the leader in concentrating solar for power production, and in recent years there has been growing activity to promote applications for industrial processes. In 2010, Solar Concentra (Spanish Concentrating Solar Thermal Technological Platform) was created from a joint initiative of Fundación CTAER (Advanced Technology Centre for Renewable Energies), Andalucía regional government, and the National Economy and Competitiveness Ministry. At present there are 180 members, representing the different stakeholders involved.

▲ **Figure 5(b) Gemasolar power plant** (Source: www.torresolenergy.com/TORRESOL/gemasolar-plant/en)

IEA SHC Task 49: Solar Process Heat for Production and Advanced Applications (http://task49.iea-shc.org/) was launched in 2012 and Spanish participants, including CIEMAT, are contributing important work on process heat collectors and design guidelines for the integration of solar thermal systems in industrial processes. Main contributions include the design and definition of general requirements and relevant parameters for process heat collectors and tender information for the integration of process heat collector for industrial applications. Spain has identified the potential for solar process heat demand to be 14 million m^2.

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In addition, as a result of SHC Task 49, Spanish participants from CIEMAT, Tecnalia, and CENER are also involved in the European project STAGE-STE "Scientific and Technological Alliance for Guaranteeing the European Excellence in Concentrating Solar Thermal Energy" (http://stage-ste.eu/), which is strongly connected to issues addressed in SHC Task 49, for example, process heat concentrating solar collectors development, process integration guidelines, and modelling and simulation of specific case studies in the industry. Spanish participants have also led the preparation of a database on concentrating solar collectors that will be available the end of 2015, and which is linked to both projects SHC Task 49 and STAGE-STE.

▲ **Figure 6. View of a parabolic trough solar field for process heat (water desalination) at the Plataforma Solar de Almería.**

In addition, in 2014, promoted by Fundación CTAER, a medium temperature concentrating solar working group was created on Solar Concentra. There are 21 members representing the different stakeholders involved in promoting national market development through innovative public procurement. This working group is represented in the RHC Technology Platform Solar Panel Steering Committee. The group is currently developing studies that look to ascertain the potential market for concentration collectors. The group has become a meeting point for public administrations, solar collector manufacturers, research centers, universities, etc. to share their views on the current and future use of this technology.

Up & Coming Solar Technologies

One of the most promising solar thermal technologies for the future are those coupled to district heating and cooling networks. In Spain, DHC networks are not the rule, but the exception. According to ADHAC (Spanish Association of District Heating and Cooling Companies) census, there are close to 240 networks in Spain (including micro-networks), with a documented installed power of 1,109.3 MW (data from 2014). Heating networks share 37%, heating and cooling networks share 62% and less than 1% cooling networks. Two thirds of the networks include a high percentage of renewables, almost exclusively biomass. Solar thermal is not present at the moment, but that has not stopped Spain from actively in the recently completed IEA SHC Task 45: Large Solar Systems and plans for contributing to the upcoming related activities.

Solar thermal it is not present in a single facility at the moment. IDAE recently published a study that analyzes the technical and economic feasibility of including a solar thermal installation in a DHC plant3and will publish a second study that analyzes the feasibility of including a concentration solar facility in a DHC located in southern Spain. The aim of these studies is to encourage the use of solar thermal energy in existing and future DHC facilities, the numbers for which are expected to grow in the short term.

Spain is also participating in IEA SHC Task 53: New Generation Solar Cooling and Heating Systems (PV or Solar Thermally Driven Systems) and IEA SHC Task 46: Solar Resource Assessment and Forecasting. In SHC Task 46, two Spanish institutions are leading activities in new advanced modeling and improved satellite-derived data for long term analysis.

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