

Portugal: Sun & Innovation Drive Change

Portugal has one of the highest solar energy resources in Europe (see Figure 1), but the solar thermal market in Portugal is not in line with this fact as can be seen in the most recent publication of the IEA SHC's *Solar Heat Worldwide* (see Figure 2). Portugal's cumulated installed capacity is lower than in other European countries with much lower solar resources.

Solar Resource versus Market Penetration

Portugal's abundant solar resource has served as the basis for incentives to increase the application of solar thermal technologies starting in the 1970s. Along the years, the public policies gave mainly fiscal incentives for the installation of solar thermal systems for domestic hot water preparation. Despite these incentives, the installed collector area in 2000 was only 219,500 m².

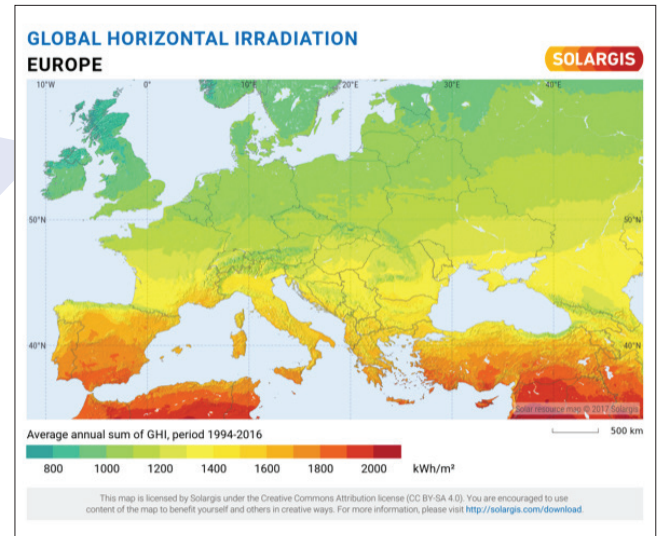
In the 2000s, public policies were implemented to profit from this resource but added the "quality" paradigm. In 2001 a program called "Solar Hot Water for Portugal" was implemented, and it introduced certification schemes for:

1. Solar thermal collectors and systems, which was very similar to Solar Keymark also implemented at the same time at the European level, and
2. Installers of solar collectors and systems.

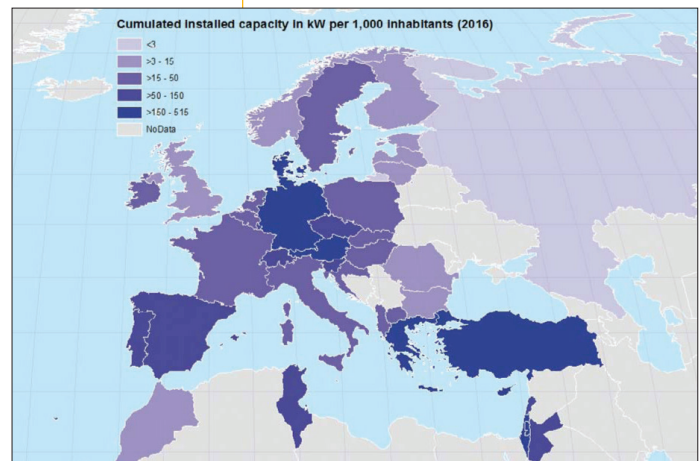
In 2002, the Directive 2002/91/EC of the European Parliament and the Council on the energy performance of buildings was published, and the work of transposition to the Portuguese law initiated. Benefiting from the work performed in the framework of the "Solar Hot Water for Portugal" program, the transposition of the Directive introduced the obligation to use solar thermal collectors for hot water preparation in new buildings and large renovations. This obligation included the following criteria: only solar thermal systems with certified collectors, installed by certified installers and having six years guarantee could be accepted for verification of this obligation.¹

These policies were important for growing the solar thermal market and supported by some fiscal incentives. Fiscal incentives were directed towards families as individual income tax deductions as well as towards corporate income taxes (for a few years a very beneficial condition was possible – the amortization of investment in renewable energies could be done in four years).

In 2009 an effective solar thermal incentive program busted the growth of the market especially in the domestic sector (a solar thermal system for a single-family home could be purchased for a reduced price of 30% to 60% depending on the type and size of the system). Deductions in individual income taxes could also be applied. In 2010 the



▲ **Figure 1. Global Horizontal Irradiation**
(Solar resource map © 2018 Solargis)



▲ **Figure 2. Solar Thermal market penetration per capita in Europe in kWh per 1000 inhabitants**

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incentive scheme was directed to the social service sector, but the financial crises lead to the end of this incentive in a few years along with the fiscal incentives.

Presently, although statistics are not available past 2016, the total installed collector area is around 1.2 million m², primarily in the residential sector. Figures 3a and 3b show the latest market statistics dated from 2015.

The National Action Plan for Renewable Energies (PNAER) forecasts an 11.5% annual average installation rate for solar thermal collectors with a total capacity of 2.2 million m² by the year 2020. However, contrary to the objectives of the PNAER, an annual average decrease of 30% between 2010 and 2012 was recorded followed by a 37% decrease in 2013. Between 2013 to 2015, the average decline was around 10%. There is no information available for 2016 and 2017, but we can expect an increase since the construction market is now growing with the construction of new buildings and the retrofiting of old buildings and the fact that building regulations continue to require the installation of solar thermal collectors for water heating. However, to recover from the low installation rates observed between 2010 and 2015, there is still a need for an extra effort to meet the 2020 objectives of the PNAER.

Work on a new National Plan for the period 2021-2030 (Integrated National Plan for Energy and Climate) is already underway, and the first proposal is expected at the end of 2018. In this plan, new and increased objectives for renewable energies and heating and cooling are expected.

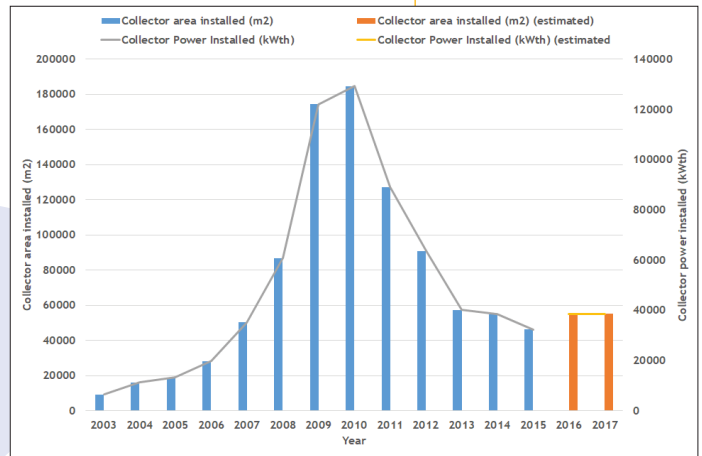
Solar Thermal in Portugal

Most of the collector capacity installed in Portugal is in the domestic sector for hot water preparation. A small fraction is for large installations in hotels, swimming pools, elderly homes, and schools (the average area of these installations is 40 m²). The share of large installations was around 10% in 2015. This may be explained by the fact that Portuguese legislation only mandates the installation of solar thermal collectors for the preparation of hot water in individual homes and does not extend this obligation to the service sector.

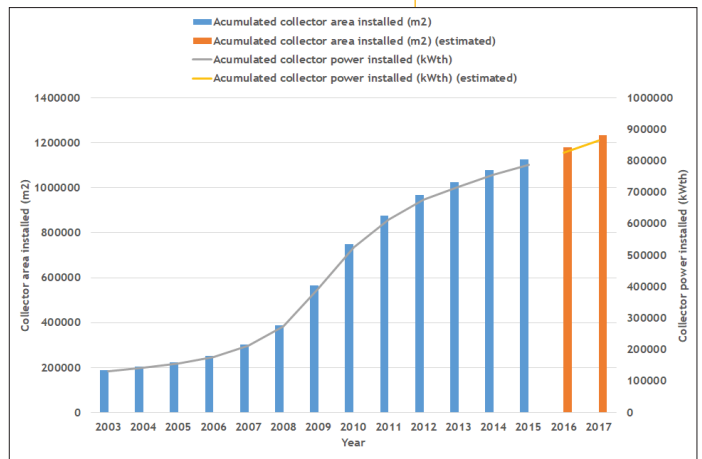
That said, there are examples of service sector installations worth noting.

One emblematic installation is the heating and cooling installation at the Headquarters of CGD Bank (see Figure 4). This installation is the largest installed on a service building with 1,600 m² of collectors mounted on the rooftop, which save up to 70% of the energy required for the building's water heating and have a cooling capacity of 545 kW using an absorption chiller. The system was commissioned in 2008.

Another installation of note is at the Calouste Gulbenkian Foundation Headquarters. This building is considered a national monument and so special care was taken to ensure that the installation would have no visual impact on the building. In this case, vacuum tubes were installed almost at a horizontal position (see Figure 5). The solar thermal system was installed to produce hot water and thereby reduce the consumption of fossil energy in the Headquarter's Building and Modern Art Center. The system has a rated power of approximately 67kWth, which corresponds to a gross collector area of slightly less than 140m² and is expected to provide 77MWh of power per year. The average daily consumption of hot water is 7m³ at 60°C and so covers approximately 60% of the FCG's hot water needs.



▲ Figure 3a. Collector area/power installed per year²



▲ Figure 3b. Cumulated collector area/power installed per year²

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In Portugal, there are only a few solar process heat installations despite their tremendous potential. One example is an installation with parabolic trough collectors (ICARUS HEAT) at Silampos, a manufacturer of mostly stainless steel kitchenware. The industrial process requires washing and drying finished products at a temperature range of 50°C and 160°C. Another industrial application that can be reported is the use of solar thermal systems for the production of hot water used for natural gas preheating at Gas Regulation and Measuring Stations. Two such installations were built in 2012 by REN – the national energy network operator.

Portuguese Manufacturers

Although much higher numbers were reported during the peak of the solar thermal industry in 2009-2010, it is estimated now that there are around five manufacturers of collectors and storage tanks. The majority of the commercial systems (produced and imported) are based on flat plate collectors (98.2% according to Solar Heat Europe's report, "Solar Thermal Markets in Europe - Trends and Market Statistics 2015). Figure 6 shows a large solar thermal installation with flat plate collectors produced by the Portuguese company OpenPlus.

Storage tanks are also produced in Portugal by the Portuguese company, VIDEIRA, LDA and by the international company, Worthington Industries. These companies are also exporters.

Portuguese Innovation

Examples of the innovative products being developed in Portugal include SUNAITEC's tracking collector. This one axis tracking collector can be installed horizontally and be used as a shading device, or can be mounted vertically on a facade (see Figures 7 and 8).

Another innovative concept was developed by the T&T, a Portuguese company working in home automation, energy efficiency and sustainability. The company's air and water heating collector for façade integration is unique. Installed on a façade of their Headquarters these collectors circulate the hot water in tubes connected to the absorber while the air circulates in the space between the glass and absorber and the warm air can then be injected into the building when space heating is needed (see Figure 9).

Another Portuguese company, MCG, within the framework of the European project REELCoop, developed a stationary evacuated CPC solar collector to provide a high operating temperature (outlet temperature of 177°C) with high efficiency (51%) at a maximum solar radiation level (1000 W/m²). The



▲ Figure 4. Solar thermal installation at the CGD's Headquarters in Lisbon, Portugal



▲ Figure 5. Collectors at Calouste Gulbenkian Foundation in Lisbon, Portugal (photo credit: FCG)



▲ Figure 6. A solar thermal installation with flat plate collectors produced by the Portuguese company OpenPlus for domestic hot water preparation (580 m²) in Matosinhos, Portugal (photo credit: Openplus)



◀ Figure 7. Collectors used for hot water preparation and swimming pool heating at the Bela Vista Hotel and Spa in Paria da Rocha

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evacuated CPC solar collectors combined with a biomass boiler burning olive oil waste is used to drive an ORC power cycle with a micro-expander and with the possibility of using useful heat from the ORC cycle condenser and boiler recovery. This prototype is installed in Ben Guerir, Morocco (see Figure 10).

As part of the national SHIP (Solar Heat for Industrial Processes) project, MCG in cooperation with two other companies, KEMET and ONControl, and with University of Évora and INEGI (research partners) is further developing the collector for installation at Kemet Electronics Portugal, S.A. in Évora, Portugal.

Research Activities

Currently, there is no specific national R&D program for solar thermal or solar buildings in Portugal. However, universities, research institutes, and businesses can apply for national programs, where it has been possible to accommodate part of the research and demonstration needs of solar technologies. These programs are managed by:

- FCT (Science and Technology Foundation) that supports graduate education and training, carrier development, research and development grants, research units, etc., in all areas of science and technology.
- Portugal 2020 that sponsors R&D in industry and services, promoted by businesses that can apply alone, in a consortium or as subcontract R&D national entities.
- In the framework of the Portuguese Roadmap on research infrastructures (2014-2020), the area of “Energy” has four research infrastructures, of which two have a strong connection to research in the field of solar energy:
- NZEBlab Research Infrastructure on Integration of Solar Energy Systems in Buildings that is coordinated by LNEG.
- INIESC (National Research Infrastructure Solar Energy Concentration) that is coordinated by the University of Évora with the participation of LNEG.

This article was contributed by Maria João Carvalho and João Farinha Mendes of LNEG and the Portuguese SHC Executive Committee members.



▲ Figure 8. Collector used for swimming pool heating in Estoril



▲ Figure 9. Collectors used for hot water preparation and air heating at the T&T Headquarters (Project Senergy Force) in Vouzela, Viseu, Portugal



▲ Figure 10. MCG's CPC collectors with evacuated tube receiver.

¹ Directive 2002/91/EC of the European Parliament and the Council, 16 December 2002 on the energy performance of buildings, withdrawn and replaced by Directive 2010/31/EU of the European Parliament and the Council, 19 May 2010 on the energy performance of buildings

² ref. 4: ADENE/DGE/INETI (2001) “Água Quente Solar para Portugal” ISBN 972-8646-02-X https://www.aguaquentesolar.com/publicacoes/15/Brochura_AQS.pdf