

TOPIC: PV as Part of the Energy System. (6.1)

ANALYSIS OF THE PRESENT SITUATION OF SOLAR PHOTOVOLTAIC SYSTEMS INTEGRATION IN THE SPANISH PORTS

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SUMMARY: The Spanish port authorities as promoters of sustainable energy patterns, are participating in several projects at European and national level on the integration of renewable energy into their ports. 46% of the Spanish port authorities have within their environments, facilities for renewable energies. Solar photovoltaic installations, with 53%, are those that have greater presence. In this paper we will discuss the experiences made by the Spanish port authorities who have opted for the integration of photovoltaic solar energy facilities in their ports, revealing the potential offered by photovoltaics within ports as an energy tool.

PURPOSE OF THE WORK:

The aim of this paper is to present the experiences of integrating solar photovoltaic installations made by the Spanish port authorities in their ports to publicize the potential offered by photovoltaics in these environments and that these experiences serve as a reference to other Spanish and European ports that wish to integrate photovoltaic solar energy.

APPROACH:

One of the main challenges currently faced by the Spanish ports within its development policy, is promoting actions that facilitate port management models based on the principle of sustainability.

Correct sustainable management of the port environment makes necessary to provide tools that allow to foster strategic lines of action in key areas, such as the energy.

The so called, port authorities, are the management bodies for the Spanish seaports. Those entities, within their energy planning, are carrying out the study and the subsequent integration of renewable energies in their environments, and within this energy development strategy, solar PV is playing a leading role. Its multiple applications within the port environments are becoming a safe bet that contributes to improving the development of port activities and progress in the search for a new energy model within them.

SCIENTIFIC INNOVATION AND RELEVANCE:

This paper is one of the first studies, regarding the integration of photovoltaics in Spanish port environments. The importance of the sustainable use of these infrastructures is beyond doubt, so the analysis of the solar photovoltaics integration is a priority.

RESULTS AND CONCLUSIONS:

Considering the information and data collected, we could conclude that solar photovoltaic facilities, are an active part of sustainable energy management in Spanish ports. In fact, PV generation is, with the 53%, the renewable energy which has the largest number of facilities within national ports because of the multiple possibilities for integration: on roofs, lighthouses and beacons, integrated into buildings, etc. We can also conclude that, although the Spanish port authorities are committed to the shift to energy models where renewables are present, the negative effect of the current Spanish energy legislation is hampering the development of new facilities. However this paper shows the interesting possibilities offered through the integration of new facilities.

The Spanish port system, state owned, is composed of 46 ports of general interest, managed by 28 Port Authorities, coordinated in by the government agency State Ports. The Port Law in Spain attaches to the Port Authority, the management and administration of ports and their activities [1]. One of the basic and main functions of the Port Authorities is the energy management. For ports as major consumers of energy, is essential to optimize its energy resources seeking alternatives to their current models [3].



Figure 1. Spanish port authorities. Source: Puertos del Estado.

In search of a sustainable energy model, and in addition to European and national policy framework, within the port area there are voluntary initiatives such as the *European Sea Ports Organisation (ESPO)* or the *World Port Climate Initiative (WPCI)* [1] due to the importance of energy as a fundamental pillar in terms of economic competitiveness and environmental sustainability.

Given the existing initiatives we can say that port authorities play a decisive active role in implementing sustainable energy models within port environments [5]. In the case of Spain, the Port Authority of Algeciras, Barcelona, Valencia and Vigo, are active part of the above mentioned projects [1].

Within the Port Authorities in Spain, 46% have conducted in the past five years, or are running, power generation performances by renewable source. Renewable energy present in Spanish ports are: solar thermal and solar photovoltaic, tidal, wave and wind power generation [4]. In this paper we will focus on analyzing the current situation of the integration of photovoltaics in the Spanish port environments.

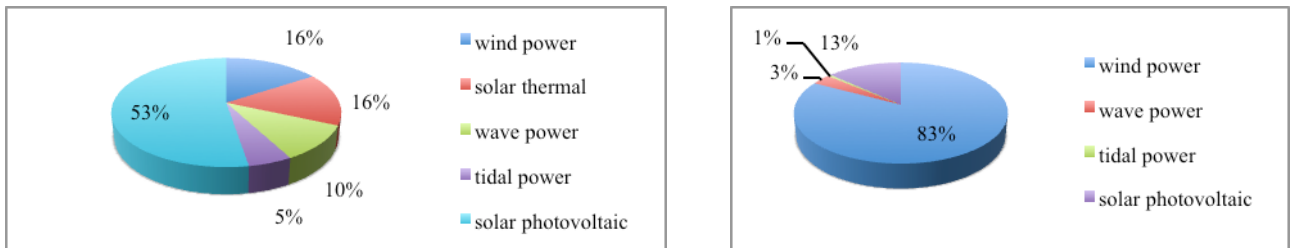


Figure 2. Percentage of the number of renewable energy installations in Spanish ports. Source: The authors

Figure 3. Installed capacity of renewable energy in Spanish ports. Source: The authors.

There are several technical alternatives for the implementation of solar PV installations in ports. So, we can have different kind of facilities:

- Rooftop. Feeding into the grid.
- Isolated systems.
- Building integrated. Self consumption and net metering.

There are two important issues to take into account when referring to ports [1].

Firstly, Ports are urbanized and industrialized areas electrically connected to the grid, and that have great power consumption. This is the reason why the facilities installed under the so called “self consumption” regulation usually have a support system and does not remain completely isolated.

Secondly, we have the problem of the land value. On ground installations have a tremendous handicap because of the opportunity cost due to the high price of land, what leads port authorities to use it in productive port activities. This is the reason why most of the facilities are on rooftops on buildings, industrial warehouses or parkings.

Figure 4 shows information about the installed photovoltaic power in different Spanish port authorities, and about the type of installation we can find.

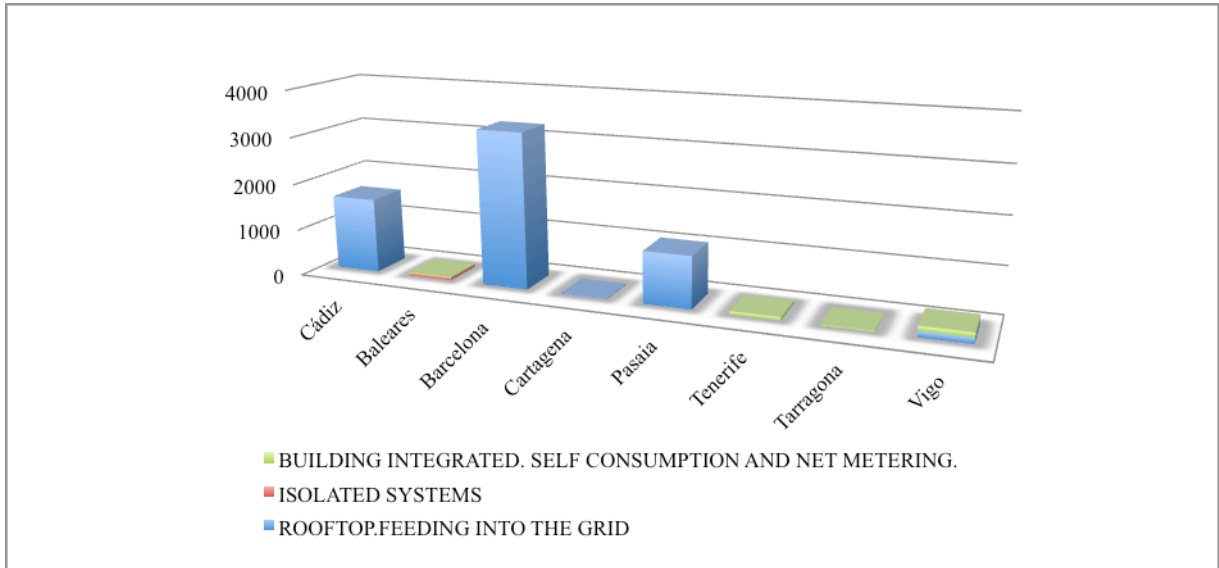


Figure 4. Port authorities having photovoltaic solar installations by type and installed power. Source: The authors.

The installed photovoltaic power is 6140 kW for rooftop facilities. For installed isolated systems, photovoltaics power is 52 kW and 204 kW is the building integrated PV power. Total photovoltaic installed power is 6397 kW.

Solar photovoltaic power started to be used inside Spanish ports around 1990. It was a good solution to the electrification problems in isolated systems. However, it was not until 2009, as we can see in Figure 5, when they began to have a greater presence. This increase in photovoltaic participation was due to stimulus policies implemented in those years by the Spanish government.

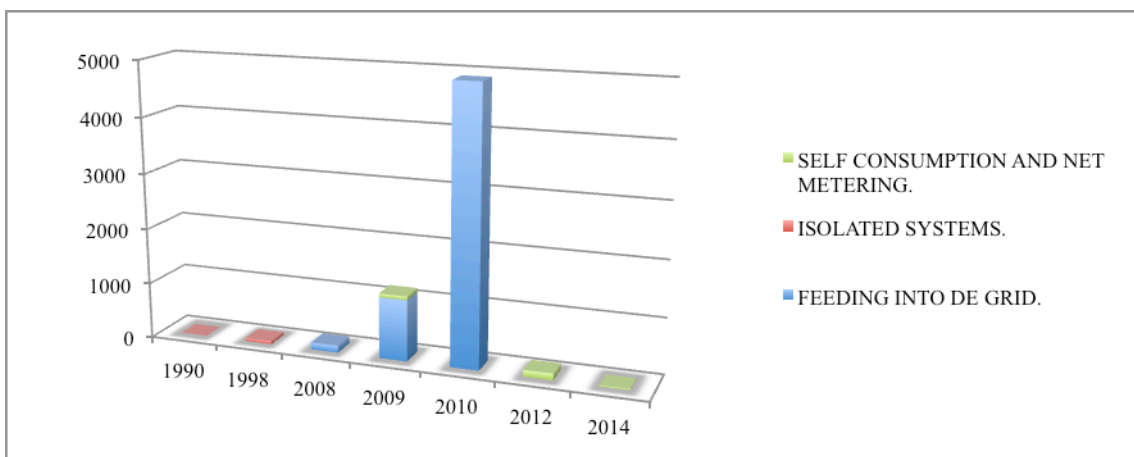


Figure 5. Temporal evolution of the integration of photovoltaic solar installations. Source: The authors.

Among the most significant experiences in the Spanish port environments, include the port authorities of Vigo and Barcelona, which are leaders in sustainability in the Spanish port area. In the port of Barcelona, Spain first green port, we found several facilities of interest. The most important one is the photovoltaic park to be located in the ZAL (area of logistics activities) and the facility in the Marina Forum of Cultures.

The ZAL project, to be developed in phases, will occupy a total of 316,535 m² on the roofs of logistics warehouses. The installed power will be 8 MW. Currently the first phase is already implemented, it occupies a total of 65,600 m², and has an installed capacity of 3.3 MW. This installation, due to its surface and installed power, is one of the largest existing photovoltaic plants in Spain, and the largest located in port environments [6].

In the meeting “*I Green Energy Ports Conference*“, the port authorities of Vigo, Valencia and Castellón, received the specific environmental certification of ports (Pers) for their initiatives in renewable energies [7]. The Vigo port includes two photovoltaic facilities, one in the parking of the Bouzas terminal, and another one in the workshops of the Port Authority itself [1].

On the other hand, the Port Authority of Balears has opted significantly by integrating photovoltaics in isolated systems, to be used in beacons and lighthouses. This option was chosen because of the impossibility of having power from the grid. Also within the actions implemented by the Port Authority of Balears, we found 250 m² of photovoltaic glazing, with a total of 200 panels in the own building of the Port Authority of Puerto de Mallorca, integrated on its cover, in particular in its skylight. The installed power is 17 kWp and produces 18,000 kWh annually, covering more than the electrical energy consumption of the building itself [8].



Figure 6. Forum of Cultures
Source: A.P Barcelona

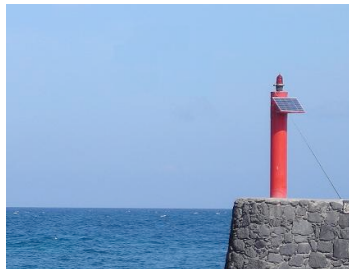


Figure 7. Solar lighthouse
Source: A.P Balears

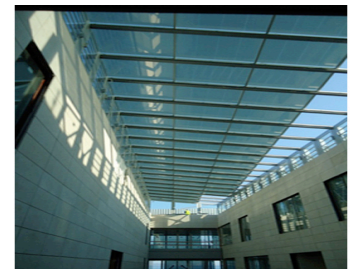


Figure 8. Skylight
Source: : A.P Balears

Considering the information and data collected, we could conclude that solar photovoltaic facilities, are an active part of sustainable energy management in Spanish ports. Though photovoltaics represent only 13% of the total renewable energies installed in ports, it is the one that has the most of the installed facilities, the 53%. This is due to the wide range of options presented for integration within ports as we have shown. We can also conclude that, although the Spanish port authorities opt for the shift to energy models where renewables are present, the negative effect of the current Spanish energy legislation is hampering the development of new facilities. However, it is clear that new facilities will be welcome because there is plenty of room for them into the Spanish ports.

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