Revista de Estudios Andaluces (REA) | Núm. 39, febrero (2020) | e-ISSN: 2340-2776.
https://dx.doi.org/10.12795/rea.2020.i39 | © Editorial Universidad de Sevilla 2020
https://editorial.us.es/es/revistas/revista-de-estudios-andaluces
https://revistascientificas.us.es/index.php/REA

SUMMARY OF ARTICLE: doi: https://dx.doi.org/10.12795/rea.2020.i39.04

The Production of Electricity with Photovoltaic Solar Energy in Spain in the 21st Century

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KEYWORDS

Electrical Production
Photovoltaic Solar Energy
Energy Policy
Spain

1. INTRODUCTION AND OBJETIVE

Since the end of the 20th century, Spain has been one of the countries on the planet that has most implemented renewable energy technologies for the production of electricity. Wind and solar energies (photovoltaic and solar thermal energies, as well) have joined the hydroelectric plants. Three factors have contributed to this: the Policies for the Promotion of Renewable Energies of the European Union, the availability of natural resources for their development (wind and heat stroke), as well as the promotion of the Governments of Spain.

The general objective of this work is the study of the process of implantation of photovoltaic solar energy in Spain, its development and its current situation.

As specific objectives, this work aims at:

a. Analyzing the production of electricity in Spain.
b. Collecting the legal and economic framework for the production of electricity from photovoltaic solar sources.
c. Studying the production of photovoltaic solar energy in Spain.
d. Exposing recent measures to support this energy technology.
e. Describing the main causes of the expansion of photovoltaic solar energy worldwide.

2. METHOLOLOGY

In order to achieve theseobjectives, it has been made a review of the basic bibliographical references, as well as a series of key documents, among which the following stand out: Renewable Energy Plans, laws and decrees that emanate from them, reports from the Commission National Markets and Competition, and other statistical documents.The method used has focused on the analysis of the consequences of the decisions of

DOI: https://dx.doi.org/10.12795/rea.2020.i39.04
Formato de cita / Citation: Espejo-Marín, C. y Aparicio-Guerrero, A. E. (2020). The Production of Electricity with Photovoltaic Solar Energy in Spain in the 21st Century. *Revista de Estudios Andaluces,* 39, 66-93 https://dx.doi.org/10.12795/rea.2020.i39.04
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the Governments of Spain in relation to this energy sector, in reference to the evolution of installed power and its territorial distribution.

The work has been structured in the following parts:

a. a presentation of the structure of the electricity generating park in Spain and the role of renewable energies.
b. a compilation of the entire legal-economic framework that has affected energy photovoltaic solar since the end of the last century.
c. an analysis of the evolution of the installed power and its relevance in the European Union and on the Planet, as well as of the production of electricity throughout this century.
d. an exhibition of the territorial distribution by Autonomous Communities of power and electricity production.
e. a list of recent measures to support photovoltaic solar energy.
f. the evolution of the prices of the components of a photovoltaic system.

3. MAIN RESULTS

At the end of 2018, Spain already had a power for the production of electricity that exceeds 104,000 MW, of which 95% are installed in its peninsular territory. Among the renewable energies, for their contribution to the total of the aforementioned power, stand out: wind energy (22.6%), hydraulic energy (19.6%), photovoltaic solar energy (4.5%) and thermoelectric solar one (2.21%). The four provide half of the total capacity.

The implementation since the end of the last century of wind and solar energies has resulted in an increase in their contribution to total electricity production, going from 21.3% in 2007 to 40.1% in 2018, and, what is not less relevant, is a reduction in energy dependence in Spain, which went from 81.3% in 2007 to 76.1% in 2018.Since the end of the last century two Laws of the Electricity Sector and several Royal Decrees have regulated in Spain the production of electricity with renewable energies and therefore the photovoltaic solar one.

The origin of the renewable energy support takes place with the approval of Law 54/1997 of the Electricity Sector, which establishes a special regime for renewable energy production. Law 24/2013 of the Electricity Sector, changes the model and states that the remuneration regime of renewable energies must be based on the necessary participation in the market of these facilities, complementing market revenues with a specific regulated remuneration that allows them to compete on an equal level with the rest of the technologies in the market.

The Renewable Energy Development Plan in Spain 2000-2010, the Renewable Energy Plan 2005-2010, and the Renewable Energy Plan 2011-2020 have also played an important role in its development.Spain goes from having a capacity of 17 MW in 2005, 146 MW in 2006, 690 MW in 2007, 3,398 MW in 2008, 4,232 MW in 2011, 4,645 MW in 2013 and 4,700 MW in 2018. This initial boost is due to the Increase in incentives of Royal Decree 661/2007, especially regarding the attractive rates for developers of photovoltaic installations (€ 0.440381 / kWh, that is, 575% of the average reference rate that year). According to the Spanish Photovoltaic Union (UNEF, by its acronym in Spanish), in the figures of recent years the power in isolated installations and part of the power in plants for self-consumption are not considered. The installed capacity in self-consumption plants was 55 MW in 2016, 122 MW in 2017 and 236 MW in 2018.

At the end of 2018, five Autonomous Communities accumulate most of the power and production of photovoltaic solar electricity in Spain. In Castilla-La Mancha a fifth of the power and production is located. It is followed by Andalusia, which contributes to the national total with 19% and 18.7% respectively; Extremadura provides 13.1% and 12.1%; Castilla y León 10.5% and 10.4%; and the Region of Murcia 9.5% and 9.4%. These five regions accumulate 70.2% of installed capacity and 72.5% of production.

Several measures are contributing to the recent boost of photovoltaic solar energy in Spain.

Firstly, in order to fulfill the European objective that by 2020 renewable energy contributes 20% to final energy consumption, the Government of Spain decided to establish renewable power auctions in which the different technologies participate in competitive concurrencewith the aim of introducing the most efficient

 e-ISSN: 2340-2776 | doi: https://dx.doi.org/10.12795/rea.2020.i39.04

projects in costs. In the third auction, of July 27, 2017, of the 5,037 MW awarded, 3,909 MW were for photovoltaic installations.

Secondly, the Royal Decree 244/2019 classifies and defines the different types of electric self-consumption, consecrating the type of collective self-consumption, so that several consumers can associate with the same generation plant. It also implements a simplified surplus compensation mechanism, that is, the energy generated by self-consumption facilities and the costumer does not consume instantly.

Thirdly, the lines of support and bonuses promoted by the Governments of the Autonomous Communities are being relevant. The majority are grants that are supported by funding from the European Regional Development Fund (ERDF, by its acronysm in Spanish).Photovoltaic solar technology is constantly evolving and improving technically, so it is currently one of the most relevant research áreas globally. The price (euros / watt) of the photovoltaic panel has gone from 3.30 euros in 2007 to 0.25 euros in 2018, and that of investors from 0.125 euros to 0.055 euros, representing a decrease of 90% and 57, 7% respectively.

It must also be taken into account that, in order to reduce costs and environmental impact on the ground where the photovoltaic installations are based, the implementation of the driving technique and the technique of screwing the metal structure on the ground has been developed.

4. CONCLUSIONS

The evolution of photovoltaic solar power for the production of electricity has been conditioned by the Energy Policy of the Governments of Spain.The implementation of photovoltaic farms has preferably occurred in peninsular Spain, and within it in, its southern area, which is explained by the presence of greater solar radiation, as well as by the structure of land ownership, that has made it possible to have leasable farms for three decades.At the end of 2018, the installed capacity, together with the power allocated for this technology in the auction of July 2017, as well as the one that is being implemented outside the auction, and that both will be in operation at the end of 2020, will allow the objective established in the Renewable Energy Plan 2011-2020.

The new electrical production of photovoltaic solar origin will contribute to increase the contribution of renewable energies to primary energy consumption in Spain, and to reduce the energy dependence of our country. It also represents a guarantee for our electricity supply at the moment when the thermal power plants gradually end their productive life cycle.Spain, which became a world leader in the production of electricity with photovoltaic solar energy in the mid-first decade of this century, once again opts for this technology. Its new impulse comes from two areas: The traditional one, with the construction of large plants, both those under the auction system and those that go by their own means, and that allocate their production entirely for commercialization; and on the other hand, the great development of self-consumption facilities at different scales, once the Government of Spain has created a legal framework that really favors its implementation.The fundamental factor that justifies the recent and outstanding growth of photovoltaic solar energy, both in Spain and on the Planet, has been the reduction in the prices of the basic components of an installation (panels and inverters). With this, it has been achieved that this technology has become very competitive compared to traditional electricity production systems.

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