IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of Photovoltaic Applications in SPAIN 2017

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Prepared by

UNEF

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Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its member countries

The IEA Photovoltaic Power Systems Technology Collaboration Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The participating countries and organisations can be found on the www.iea-pvps.org website.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "*Trends in photovoltaic applications*" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2017. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 INSTALLATION DATA

The PV power systems market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report.

For the purposes of this report, **PV installations are included in the 2017 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2017, although commissioning may have taken place at a later date**.

1.1 Applications for Photovoltaics

Since 2011, when the lack of regulatory support in Spain began, the national market has been affected and a good example of this is that none ground-mounted installation ''on-grid'' has been installed in 2015.

At the beginning of 2015, the country went through a new start in the connection of on self-consumption installations, both in residential and industrial sector.

However, with the publication of the Royal Decree 900/2015 on the 5th of October 2015, which regulates the installation of on self-consumption systems, the development and promotion of new projects went down significantly. Still during 2017, some progress towards the implementation of self-consumption systems has been proceed, as for example, the removal of the prohibition of the collective self-consumption systems.

As a consequence of the current legislation, in the last five years not big projects in Spain have been developed. Most of the PV Spanish companies have decided to internationalize them, with some installations in Africa, America and Middle East.

In contrast, thanks to the high costs of fuel, very few off-grid installations, mainly pumping facilities, have been done in the agricultural sector. There are other sectors, as the food sector or hostelry which slowly are introducing self-consumption systems, as well as improvements to enhance the efficiency.

The decrease of the prices in the PV sector, as well as the increase in the willing for investment, has increased the attraction of the Spanish PV sector for Power Purchase Agreements.

1.2 Total photovoltaic power installed

The Transmission System Operator "Red Eléctrica de España" (REE) has informed that the PV capacity connected to the grid has increased 6 MW, with a total installed PV generation capacity in the Spanish national system of 4675 MW in 2017. Nevertheless, this data does not include the cumulative capacity not connected to the grid and self-consumption installations not registered yet.

UNEF, thanks to the collaboration of national providers and installer companies, has been able to estimate a total PV capacity installed in 2017 of 135 MW, as described below:

Table 1: PV power installed during calendar year 2017

AC			**MW installed in 2017 AC**	**MW installed in 2017 DC**
Grid-connected	BAPV	Residential	84 MW	92.4 MW
		Commercial		
		Industrial		
	BIPV (if a specific	Residential		

	legislation exists)	Commercial		
		Industrial		
	Utility-scale	Ground-mounted	6 MW	6.6 MW
		Floatting		
		Agricultural		
Off-grid		Residential (SHS)		
		Other		
		Hybrid systems	45MW	49.5 MW
		Total	135 MW AC/ 148.5 MW DC	

The value of the capacity of PV installed in 2017 Grid-connected and Off-grid has been determined considering that around 2/3 of 135 MW of PV capacity installed in 2017 is on-grid. From this value, REE has given 6MW as the PV installed capacity in 2017 connected to the transport network, and therefore, this represents the data of the utility scale capacity installed in 2017. The difference between 90 MW of capacity connected to the grid and 6 MW from the capacity installed with utility scale, 84 MW, it is the capacity of self-consumption installations. However, there is no information about capacity installed in BAPV and BIPV. For the calculation of this table, we have used the updated numbers provided by REE in 2017.

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Figures are in AC, the conversion rate from AC to DC – 10%, i.e, AC/DC ratio 1.1
Is the collection process done by an official body or a private company/Association?	Collection process has been done by official institutions (CNMC, REE, OMIE) and a private association (UNEF)
Link to official statistics (if this exists)	www.unef.es www.ree.es www.cnmc.es www.omie.es
Graphics	The figures from UNEF have been collected by the information supplied by their members.

Table 3: PV power and the broader national energy market.

MW-GW for capacities and GWh-TWh for energy	**2017 numbers**	**2016 numbers**
Total power generation capacities (all technologies)	104,122 MW [1]	105,279 MW [1]

Total power generation capacities (renewables including hydropower)	48,208.486 MW (46,3% of 104,122)	42,953.832 MW (40,8% de 105,279)
Total electricity demand (= consumption)	268,140 GWh	265,009 GWh
Total energy demand (= final consumption)	Only 2016 is indicated	85.874 Ktep [2]
New power generation capacities installed during the year (all technologies)	324 MW	104 MW
New power generation capacities installed during the year (renewables including hydropower)	324 MW[3]	104 MW
Total PV electricity production in GWh-TWh	8,385 GWh	7,965 GWh
Total PV electricity production as a % of total electricity consumption	3.13%	3%

[1] Source: REE

[2] Source: Ministerio de Industria, Energía y Turismo

[3] Done by UNEF with data from REE

Table 4: Other information

	2017 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	61456 installations [1]
Capacity of decommissioned PV systems during the year in MW	13 MW[1]
Total capacity connected to the low voltage distribution grid in MW (PV)	1,354.34 MW
Total capacity connected to the medium voltage distribution grid in MW (PV)	3,335.88 MW
Total capacity connected to the high voltage transmission grid in MW (PV)	109 MW [2]

[1] Done by UNEF with the number of systems register in PRETOR

**Fuente: REE http://www.ree.es/es/actividades/gestor-de-la-red-y-transportista/acceso-a-la-red/gestion-de-solicitudes

Table 5: The cumulative installed PV power in 4 sub-markets (MWp).

Sub-market	Stand-alone domestic		Stand-alone non-domestic		Grid-connected distributed		Grid-connected centralized	
	AC	**DC**	**AC**	**DC**	**AC**	**DC**	**AC**	**DC**
2014	35	38.5	53	58.3	2,619	2,880.9	1,953	2,148.3
2015	41	45.1	55.9	61.49	2,645.1	2,909.6	1,953	2,148.3
2016	42.2	46.2	58.9	64.79	2,645.1	2,909.6	1,954	2,149.4
2017	50.73	55.8	69.88	76.86	2,723.39	2,995.7	1,960	2,156

REE gives the value of the PV cumulative capacity connected to the transport network, and therefore, the PV cumulative capacity of Grid-connected centralized installations. The AC/DC ratio used is 1.1. UNEF has determined the value of the PV cumulative installed capacity considering also self-consumption and off-grid installations. The total PV cumulative installed capacity given is, therefore, the value made by UNEF. The trend of the evolution of the PV cumulative installed capacity (in AC) done by UNEF is shown in Figure 1.

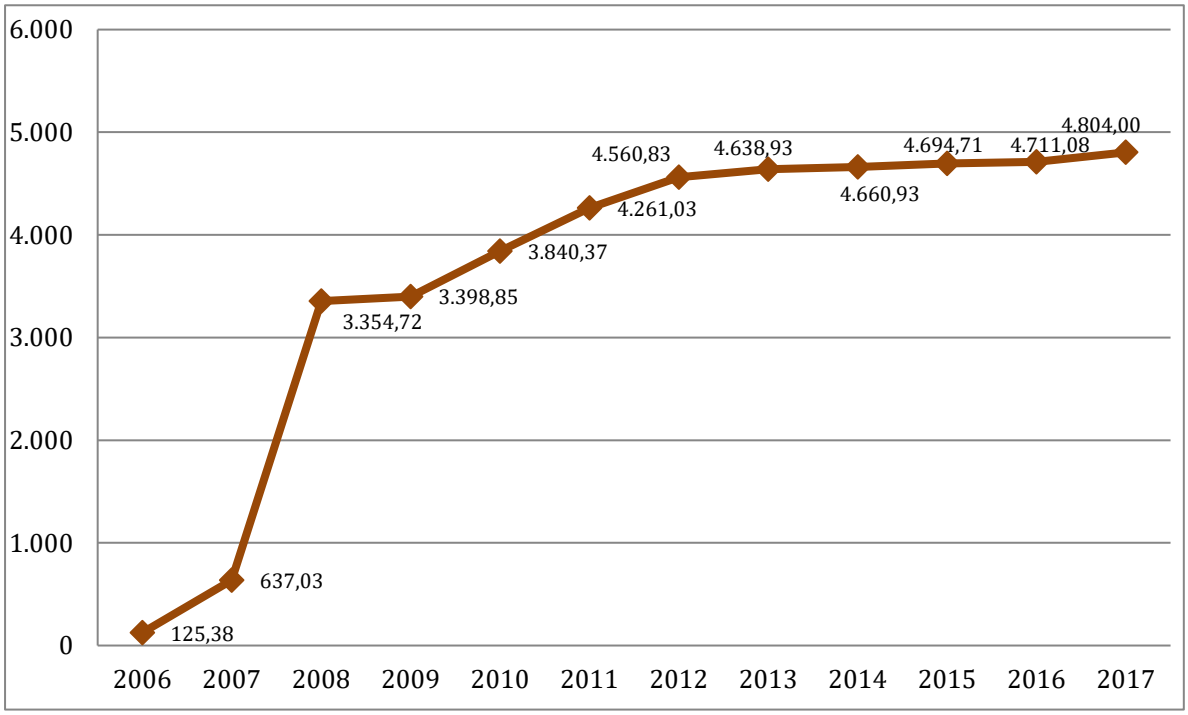

***Figure 1**: PV cumulative installed capacity. This data has been calculated by UNEF, taking into account the PV cumulative installed capacity given by REE, but also not connected to the grid and self-consumption installations not registered yet.*

1.3 Key enablers of PV development

Table 6: information on key enablers

	Description	Annual Volume 2017 (Units)	Source
Decentralized	Storage systems	There are 58	Data done by

storage systems	which help to save the energy generated by PV modules but not use in the moment	decentralized installations with storage systems*	UNEF with the collected data from PRETOR
Electric cars (and light weight)	The use of electric vehicules is essential to reduce the CO_2 especially in big cities as Madrid and Barcelona. However, it is important that the electricity the electric vehicles use is based on renewable energy.	8627 units have been registered in 2017	Annual report 2017 anfac: http://www.anfac.com/documents/tmp/MemoriaANFAC2017.pdf
Electric buses/trucks	The same as electric cars, electric buses are very important to reduce the level of pollution in big cities, but also electric trucks, to decrease the emissions of CO_2 in long ways	18 units have been registered in 2017	Annual report 2017 anfac: http://www.anfac.com/documents/tmp/MemoriaANFAC2017.pdf

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

The prices are in Euro per Watt peak (€/Wp) in Table 7 and they have been provided by suppliers companies (excluding transport to the site, VAT/TVA and sales commission).

Table 7: Typical module prices for a number of years

Year	2014	2015	2016	2017
Standard module crystalline silicon price(s): Typical	0.60	0.60	0.55	0.55
Lowest prices	0.50	0.50	0.45	0.45
Highest prices		1.05	0.64	0.64

2.2 System prices

There are many kinds of self-consumption installations in Spain, depending on the characteristics of the surface available (ground or rooftop), location and meteorological conditions of the project, and this has a large impact on the associated costs.

To understand the estimation provided regarding costs, it is necessary to describe the regulatory situation in Spain nowadays, which has a strong influence on them.

Before the publication of Royal Decree 900/2015 which regulates the installation of on self-consumption systems, all installations in development during 2015 in Spain, were approved to be connected directly to the main switch board of the electrical installation in low voltage.

When the new regulation entered into force, all installations had to be modified to fulfil all the mandatory requirements established. Among others, each installation has to submit a new application to the Distributor System Operator (DSO) to be connected to the grid and to be granted with a point of connection. Plus, it is mandatory to install a new energy meter, to measure the power production, in a location accessible from a public way to warranty 24/7 access to the DSO.

Currently, the technical conditions to be connected to the grid have not been approved yet by the National Authorities and each DSO has developed different and particular rules to be connected to their networks. This situation means that there are different costs depending on the regional area in the country.

By analysing the range of PV companies in Spain, it is posible to determine the direct contribution of this sector to the Spanish GDP, estimated around 2,154 millions of euros in 2016 (0.19% of the total GDP) and 2,250 millions of euros in 2017 (0.20% of the total GDP)

Table 8: **Turnkey Prices of Typical Applications – local currency?**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW (SHS)	Streetlight, telecommunication system, taximeter, camping, shelter…	2.5-3 €/W (can be higher with batteries)
Grid-connected Rooftop up to 5-10 kW (residential BAPV)	Service sector, PYMES, Domestic Sector	1.4-1.5 €/W

Grid-connected Rooftop from 10 to 250 kW (commercial BAPV)	Hotels, Big industries, Cinemas	0.8-1.2 €/W
Grid-connected Ground-mounted above 10 MW		0.88 €/W

Table 9: National trends in system prices (current) for different applications – local currency?

Price/Wp	2011	2012	2013	2014	2015	2016	2017
Residential PV systems < 5-10 KW	2.7	2.6	2.4	2.2	1.9	-	1.874
Commercial and industrial BAPV	2	1.8	1.6	1.5	1.2	-	1.05
Ground-mounted > 10 MW	1.6	1.4	1.2	1.2	0.9	-	0.88

The Commercial and Industrial system has been considered as a PV system of 1.5 MW

2.3 Cost breakdown of PV installations

The data of the cost for each type of PV installation has been collected by supplier companies.

2.3.1 Residential PV System < 5-10 kW

The values included in the next table represent the average and range of the budget for a standard residential PV system and it has been obtained from different supplier companies. In order to get the average, as well as the range of the prices, examples of PV residential systems between 1.5 kW and 3.5 kW has been used.

Table 10: Cost breakdown for a residential PV system – local currency

Cost category	Average (€ /W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	0.57 € /Wp	0.55€ /Wp	0.59 € /Wp
Inverter	0.25 € /Wp	0.23 € /Wp	0.31 € /Wp
Other (racking, wiring…)	0.32 € /Wp	0.28 € /Wp	0.38 € /Wp
Soft costs			
Installation (Including the installation of all the electrical components)	0.53 € /Wp	0.44 € /Wp	0.62 € /Wp
Customer Acquisition (Transportation of the	0.074€ /Wp	0.053€ /Wp	0.11€ /Wp

materal)			
Profit	-		
Other (permitting, contracting, financing…)	0.13€ /Wp	0.12€ /Wp	0.188€ /Wp
Subtotal Hardware	1.14 € /Wp	1.06 € /Wp	1.28 € /Wp
Subtotal Soft costs	0.734 € /Wp	0.613 € /Wp	0.918 € /Wp
Total	1.874 € /Wp	1.673 € /Wp	2.19 € /Wp

2.3.2 Utility-scale PV systems > 10 MW

The data represented in Table 11 is the budget of a Utility-scale installation of 50 MW.

Table 11: Cost breakdown for an utility-scale PV system – local currency

Cost Category	Average (local currency/W)	Low (local currency/W)	High (local currency/W)
Hardware			
Module	0.47 €/Wp	0.35 €/Wp	0.59 €/Wp
Inverter	0.13 €/Wp		
Other (racking, wiring, etc.)	0.17 €/Wp		
Soft cost			
Installation Labor	0.10 €/Wp		
Customer acquisition	-		
Profit	-		
Other (contracting, permitting, financing etc.)	0.1 €/Wp		
Subtotal Hardware	0.77 €/Wp		
Subtotal - Soft cost	0.11 €/Wp		
Total Installed Cost	0.88 €/Wp		

2.4 Financial Parameters and specific financing programs

In order to increase the amount of renewable energy included in the energy mix, the use of some tools as auctions is essential. However, and depending on the parameters used, auctions can be more or less efficient depending on the circumstances. In the case of Spain, a model of auction that it is very marginal and gives a very high asymmetry between the different technologies that can compete in the auction has been applied. The level of uncertainty of the pay-back of the investment is very high, which slows down the development of the PV sector. Therefore, it is necessary to look for new types of financing to stabilize the sector and to increase the investment. New producers need guarantee to finance the PV projects and auctions don´t give the stability necessary. Therefore, it is starting to increase in Spain the interest for Power Purchase Agreements (PPAs), which can be

propelled due to the decrease of the prices in the PV sector, as well as the increase in the willing for investment. However, there is still a lack of regulation for PPAs that has to be addressed.

Table 12: PV financing scheme

Not information available.

Average rate of loans – residential installations	
Average rate of loans – commercial installations	
Average cost of capital – industrial and ground-mounted installations	

2.5 Specific investments programs

Table 13: Specific investment programs

Third Party Ownership (no investment)	Self-consumption regulation
Renting	Not information available.
Leasing	Not information available.
Financing through utilities	Not information available.
Investment in PV plants against free electricity	Not information available.
Crowdfunding (investment in PV plants)	Some companies are working with Crowdfunding, but there are private companies
Community solar	Not information available.

2.6 Additional Country information

Table 14: Country information

Retail Electricity Prices for an household (range)	9.09 c€/kWh -11.28 c€/kWh
Retail Electricity Prices for a commercial company (range)	6,10 c€/kWh-12.36 c€/kWh
Retail Electricity Prices for an industrial company (range)	0.87 c€/kWh- 5,42 c€/kWh
Population at the end of 2017 (or latest known)	The population on 25/06/2018 is 46,659,302 (data given by the National Institute of Statistics)
Country size (km^2)	505,990 Km^2
Average PV yield (according to the current PV development in the country) in kWh/kWp	1745 kWh/kWp (considering the Energy generated in 2017 and the cumulative capacity given by UNEF)
Name and market share of major electric	ENDESA, IBERDROLA, GAS NATURAL FENOSA, EDP

utilities.	

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

3.1 Direct support policies for PV installations

3.1.1 New, existing or phased out measures in 2017

3.1.1.1 Climate change Commitments

The Spanish Government endorsed the Paris Agreement. Nevertheless, no specific measures have been taken to move towards the objectives agreed.

3.1.1.2 Description of support measures (excluding BIPV, VIPV and rural electrification)

In Spain, the main support scheme (the "Régimen Especial") operated until the end of 2011 and was suspended at the beginning of 2012. In October 2015, a new support scheme (the "Régimen Retributivo Específico") was established.

The premium tariff or "specific remuneration regime" is not technically defined as a support scheme, but as a complementary retribution to allow renewable technologies to compete with traditional technologies in the energy market.

The specific amounts are based on a number of parameters, each calculated for a set of "standard plants". The rationale behind the scheme is to provide developers an amount based on the "reasonable profitability" that a well-managed renewable plant would have. In order to determine such costs and values, a set of theoretical standard installations has been developed and their values calculated. Furthermore, these values are linked to the "reasonable profitability", defined as the average yield of the State obligations to ten years in the secondary market for the 24 months prior to the month of May of the year preceding the start of the regulatory period increased by a spread (art. 19 RD 413/2014). On the basis of these results, an actual plant would receive the amount that its correspondent well-managed theoretical standard installation would receive. For PV plants the "reasonable profitability" is 7.4% approximately.

The main statutory provisions are:

Royal Decree 413/2014 of 6 June, regulating the activity of electricity production from renewable energy, CHP and waste);

Order IET/1344/2015 of 2 July, approving the "standard plants" and their corresponding specific compensation regime, applicable to specific new plants of electricity production from renewable energy, CHP and waste);

Order IET/2735/2015 of 17 December, establishing grid access charges for 2016 and approving certain "standard plants" and compensation regimes for plants of electricity production from renewable energy, CHP and waste);

Royal Decree 900/2015 of 9 October, regulating the administrative, technical and economic conditions for the supply and production of electricity under self-consumption);

3.1.1.3 BIPV development measures

The technical building code from 2006 establishes the requirement of building PV panels to contribute to the global electricity demand of certain buildings, such as hotels with more than 100 beds, sport centres, etc.

As of 2017 Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012, on energy efficiency, energy audits, accreditation of service providers and energy auditors and promotion of efficiency of the power supply, promoting the use of renewable energy systems integration in buildings to achieve “zero energy buildings” has been only partially implemented. The required update of the technical building code hasn´t been published yet.

3.1.1.4 Utility-scale measures including floating and agricultural PV

Several regional governments have opened financing lines for agricultural PV self-consumption to increase their competitiveness.

3.1.1.5 Rural electrification measures

3.1.1.6 Support for electricity storage and demand response measures

The Catalan Government opened a line of financial support for the purchase of batteries for solar photovoltaic self-consumption installations. Domestic and communities installations will be eligible for these grants. The Government assigned to this concept a budget amounting to 360,000 euros.

3.1.1.7 Support for electric vehicles (and VIPV)

The Plan to Promote Mobility with Alternative Energy Vehicles (MOVEA) is a measure that is part of the Strategy for the Promotion of Vehicles with Alternative Energies (VEA) in Spain 2014-2020. A support scheme promoted by the Ministry of Economy, Industry and Competitiveness that aims to provide financial aid for the purchase of alternative energy vehicles (LPG, CNG, LNG and electric vehicles, motorbikes and bicycles) and the implementation of electric vehicle charging points.

The budget for this plan is has been 16.6 MEUR. This plan is related to the decrease of transport emissions, rather than PV oriented.

Table 15: PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2017 - residential	On-going measures Commercial + industrial	Measures that commenced during 2017 – commercial + industrial	On-going measures Ground-mounted, including floating	Measures that commenced during 2017 – ground mounted, including floating
Feed-in tariffs	No	No	No	No	No	No
Feed-in premium (above market price)	No	No	No	No	No	No
Capital subsidies	No	No	No	No	No	No
Green certificates	No	No	No	No	No	No
Renewable portfolio standards (RPS) with/without PV requirements	No	No	No	No	No	No
Income tax credits	No	No	No	No	No	No
Self-consumption	No	No	No	No	-	-
Net-metering	No	No	No	No	No	No
Net-billing	No	No	No	No	No	No
Collective self-consumption and virtual net-metering	Yes	-	Yes	-	Yes	-
Commercial bank activities e.g. green mortgages promoting PV	No	No	No	No	No	No
Activities of electricity utility businesses	Yes (minimum energy in certain buildings)	No	No	No	No	No
Sustainable building requirements	No	No	No	No	No	No
BIPV incentives	Yes	-	Yes	-	Yes	-
Other						

3.2 Self-consumption measures

- Self-consumption is allowed in Spain under Royal Decree 900/2015.

- Maximum capacity of the self-consumption installation must be equal or below the contracted capacity.
- There are two types of self-consumers:
    - Type 1: maximum capacity installed of 100 kW – there is no compensation for the electricity surplus fed in the grid.
    - Type 2: not limit to the allowed capacity – the surplus can be sold in the wholesale market directly or through an intermediary. A specific grid tax of 0.5 EUR/MWh has to be paid together with a 7% tax on the electricity produced.
- Self-generated power above 10 kW is charged with a fee per kWh consumed as a "grid backup toll", also known as the "sun tax".
- Adding battery storage implies also an additional tax.
- Collective self-consumption is not prohibited but not regulated as of 2017.

Table 16: Self-Consumption Schemes

			Type 1	**Type 2**
PV self-consumption	1	Right to self-consume	Yes	Yes
	2	Revenues from self-consumed PV	Savings on the electricity bill	Savings on the electricity bill
	3	Charges to finance Transmission & Distribution grids	Yes ("sun tax")	Yes ("sun tax")
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	No	Yes (sold in the wholesale market)
	5	Maximum timeframe for compensation of fluxes	Real time	Real time
	6	Geographical compensation	No	No
Other characteristics	7	Regulatory scheme duration	Unlimited	Unlimited
	8	Third party ownership accepted	No	Yes
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Yes (> 10 kW)	Yes
	10	Regulations on enablers of self-consumption (storage, DSM…)	No	No
	11	PV system size limitations	< 100 kW but ≤ capacity contracted	Not limited but ≤ capacity contracted
	12	Electricity system limitations	Distributors license	Distributors license
	13	Additional features	Charge on batteries	Charge on batteries

3.3 Collective self-consumption, community solar and similar measures

On the subject of self-consumption, following the judgment of the Constitutional Court 68/2017, of May 25, some articles of Royal Decree 900/2015, of October 9.

The aspects of the Royal Decree that are cancelled as of July 1, 2017 are:

- Article 4. Classification of self-consumption modalities.
- Point 3. In no case can a generator be connected to the internal network of several consumers.
- Article 19. Administrative record of self-consumption of electric power.
- Article 20. Registration in the administrative record of self-consumption of electric power.
- Article 21. Registration procedure in the administrative record of self-consumption of electric power.
- Article 22. Modification and cancellation of the inscriptions.

With this, the procedure of the administrative record of self-consumption at national level is cancelled, so the distributors do not have to ask for proof of having registered in the national self-consumption administrative record to approve a project. Now it is the regional governments that must regulate the self-consumption register for each region.

With regard to collective self-consumption, its prohibition has been lifted as seen in Article 4 Point 3, but its legal development continues to depend on the regional governments and the Ministry of Ecological Transition.

3.4 Tenders, auctions & similar schemes

Two different tenders were organized in Spain in 2017. The first one, in May, was technologically neutral. However, the requirements to be awarded penalized PV. The government introduced a floor investment cost so that developers will not be able to bid below this amount, which would raise the chances of there being a tie in the lowest bids. Simultaneously, there is measure dictating that if there is a tie in bids then projects with greater hours of operation will be awarded ahead of those with lower operating hours. The hours awarded to wind were higher than those awarded to solar. Because of this, out of 3000 MW awarded, only 29 went to solar PV.

The second tender, in July, awarded mora than 5 GW of renewable energy capacity, divided in solar PV and wind. It also put forward a bidding parameter change, wind 81.91% and solar 65.80%, which gave the solar sector a stronger possibility of succeeding. This was what happened, awarding almost 3 GW to solar PV projects.

Participante	Potencia adjudicada (kW)
ALTEN EL CASAR, S.L.	13.020,00
ALTER ENERSUN S.A.	50.000,00
BIERTEC 2000, S.L.	100,00
CLIMASTER SOLAR FV, S.L.	3.911,00
COBRA CONCESIONES, S.L.	1.550.000,00
DALAR SOLAR SLU	1.620,00
DESARROLLOS FOTOVOLTAICOS MERIDIONALES	316.000,00
ENEL GREEN POWER ESPAÑA SL	338.670,00
ENGIE ESPAÑA, S.L.U.	50.000,00
FRES WIND MOON SYSTEMS, S.L.	23.750,00
GAS NATURAL FENOSA RENOVABLES	250.000,00
GESTAMP EOLICA, S.L.	24.000,00
GRUPO TEC SERVICIOS AVANZADOS S.A.	91.666,00
ISABEL SEVILLANO MARTÍN	500,00
JAÑEZ Y CARRERA, S.L.	1.000,00
JORGE ENERGY S.L.	9.400,00
LIPMES, S.A.	1.500,00

LOTAPERA, S.L.	182.500,00
METEO FOR ENERGY S.L.	300,00
MONEGROS SOLAR, S.A.	50.000,00
OPERATING BUSINESS 2, S.L.	20.000,00
OTRAS PRODUCCIONES DE ENERGÍA FOTOVOLTAICA, S.L.	200.000,00
PLANTA FV3, S.L.	250.000,00
RAIOLA FUTURE S.L.	1.500,00
RIOS RENOVABLES S.L.U.	21.000,00
SINLIMITSOL, S.L.	2.000,00
SOLAR FOTOVOLTAICA NAVARRA, S.L	1.146,00
SOLARPACK CORPORACION TECNOLOGICA, S.L.	100,00
SOLMAYOR ENERGIAS RENOVABLES S.L.	420,00
X-ELIO ENERGY, S.L.	455.000,00
TOTAL	**3.909.103,00**

The outcome of the tenders has a major consequence, which is an easier way to getting financing for the projects awarded in the tender. Because of the requirements of the tender, the projects will get mostly the market price for the electricity they fed into the grid, unless market price decreases greatly. In that case, projects will receive incentives from the government.

3.5 Financing and cost of support measures

In Spain, the remuneration of the plants is a regulated charge that all electricity consumers pay in the tariff. In 2016 the remuneration for renewable energy sources, CHP and waste was 2.3% of the total electricity bill for industrial consumers and 6.5% for household consumers according to Eurostat. In 2016 the total amount awarded for PV support was 2,432.610 million € according to the Spanish regulator, the CNMC.

3.6 Indirect policy issues

In Spain the EU Clean Energy Package will influence a great deal the implementation of PV power systems, particularly the Renewable Energy Directive and the Electricity Market Directive. These Directives will increase the share of renewable energy consumption, establish a regulatory framework for self-consumption and set rules for the operation of the electricity market.

4 INDUSTRY

The Spanish industrial sector distinguishes for the high capability of the companies to internationalize, becoming in the last six years leaders in engineering, construction and provision of photovoltaic installation in the main markets.

4.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Silicio FerroSolar is a company dedicated to the production of silicon metal with quality solar electrometallurgical procedures.

4.2 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where the process of the production of PV modules (the encapsulation) is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

In Spain, there is only one manufacturer of pollycristalline silicon, ATERSA, and 1 manufacturer of amorphous silicon, ONYX Solar, which produces PV glasses.

a) PV modules manufacturers in Spain were the following:

- Atersa
- Exiom Solution
- Helios Energy Europe
- Sitecno
- Tamesol

b) Thin film and crystalline cells

- Onyx Solar

Total PV cell and module manufacture together with production capacity information is summarised in Table 18 below.

4.3 Manufacturers and suppliers of other components

1. PV inverters:

- Circutor
- Fronius
- Ingeteam
- Power Electronics
- GPTech
- Gamesa
- SMA
- Ampere Power Energy S.L
- KACO NEW ENERGY
- Kostal

2. Supporting structures:

- Clavijo

- Hiasa
- Praxia
- Soltec
- SUNFER Energy
- ALUSIN SOLAR
- Nclave RENEWABLES S.L.
- MAC Green Power

3. Storage batteries

- Exide
- Ampere power energy S.L
- CEGASA Portable Energy

5 PV IN THE ECONOMY

The number of labour places in Spain is devoted primarily to production and distribution and business development in third countries.

In Spain, direct labour places were 6,035, while direct, indirect and induced labour places in 2017 were 18,990 according to UNEF.

5.1 Labour places

Total number of labour places in 2017, divided into sectors, was:

Table 19: Estimated PV-related labour places in 2017

		Producers and Distributors	Engineering and installer companies	Equipment manufacturers	Mixed	Total
Direct Footprint	Spain	2.415	1.590	938	1.150	6.102
Indirect Footprint	Spain	6.115	1.902	706	755	9.485
	Rest of the world	7.714	4.570	3965	1.688	17.978
Induced Footprint	Spain	1.164	683	563	1.039	3.469
	Rest of the world	639	375	309	570	1.905
Total domestic footprint		9239	9.694	4.175	2752	2.944
Total external footprint		7956	8.353	4.945	2157	2.259
% domestic footprint		50%	51%	51%	15%	12%
% external footprint		41%	42%	42%	11%	22%

5.2 Business value

Direct contribution of this sector as a whole to the GDP of Spain would be 2,154.2 million euros in 2016, which is 0.19% of the national total , increasing to 2,250.3 (0.20%) in 2017.

After years in which the sector has had difficulties to grow, especially at domestic level, we begin to observe a change in trend in 2017, which should continue with the most promising forecasts for the coming years. As can be seen in Table 20, it is expected that the growth rate has been around 4%, both for sales figures and for the direct GDP of the sector.

Table 20: Value of PV business

	2017
Sales figure	4183.5
a) Income in Spain	3245.2
b) Exports	938.3
Sales figure	4183.5
1. Materials	1933.2
1.1. Payments to Spanish suppliers	1399.4
2. Imports	533.8
2. Direct GDP	2250.3
2.1. Personal expenses	352.0
2.2. Gross surplus	1898.3

In relation to the value structure for the total sector, as a result of the sum of the four previous categories, we can point out that this structure starts with a total sales figure of 4,020.6 million euros, of which 919.1 correspond to exports (22.9%) while 3,101.5 million euros are sales in the national market. From this sales figure, we discounted € 1,866.4 million corresponding to the purchases of materials, obtaining the total number of direct GDP of the sector mentioned above: € 2,154.2 million. By type of activity, the production and distribution of electrical energy accounts for 72% of the total, while the rest of the sector is divided into 12% for mixed activities, 11% of Engineers and installers and 5% of equipment manufacturers and components.

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

The structure of the electricity system is separate in different players from generation to consumers. It is an open market, partially regulated by the Government, to guarantee the security of supply, environmental protection and climate change, and competitiveness of the market.

The main players of the electricity system are:

- Generators: they are the agents that produce electricity, regardless of the type of technology used for it. The generation is a liberalized activity.
- Transport System Operator (TSO): It is the company that transports electricity from power plants where it is produced to the consumption centers where it is delivered to distributors. In Spain, by law, there is one single TSO, Red Eléctrica de España (REE).
- System Operator: It is the company, in this case REE, who is responsible for the whole process of the operation of the system.
- Distributor System Operator: companies who transport electricity to the final consumers in medium and low voltage. There are different companies in Spain who operates as DSO in a specific regional area of the country.
- Retailers: they are the agents who sell energy. They buy electricity in the wholesale market and sell it to consumers. It is also a liberalized activity.
- Consumers: any person or company who consumes electricity at any time.

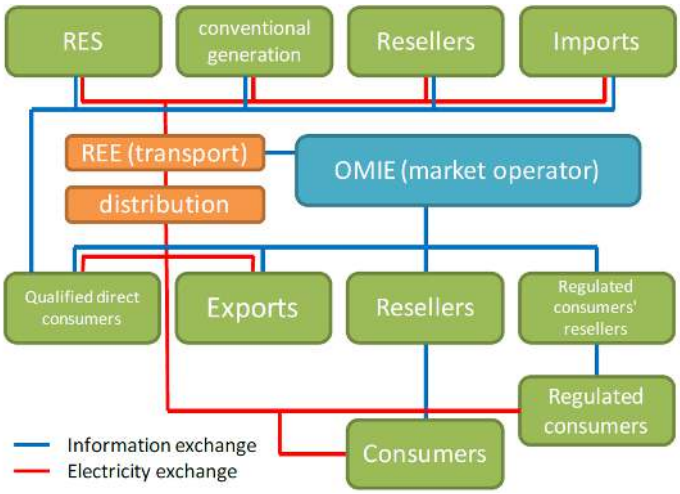

Figure 1: Structure of the electricity system in Spain

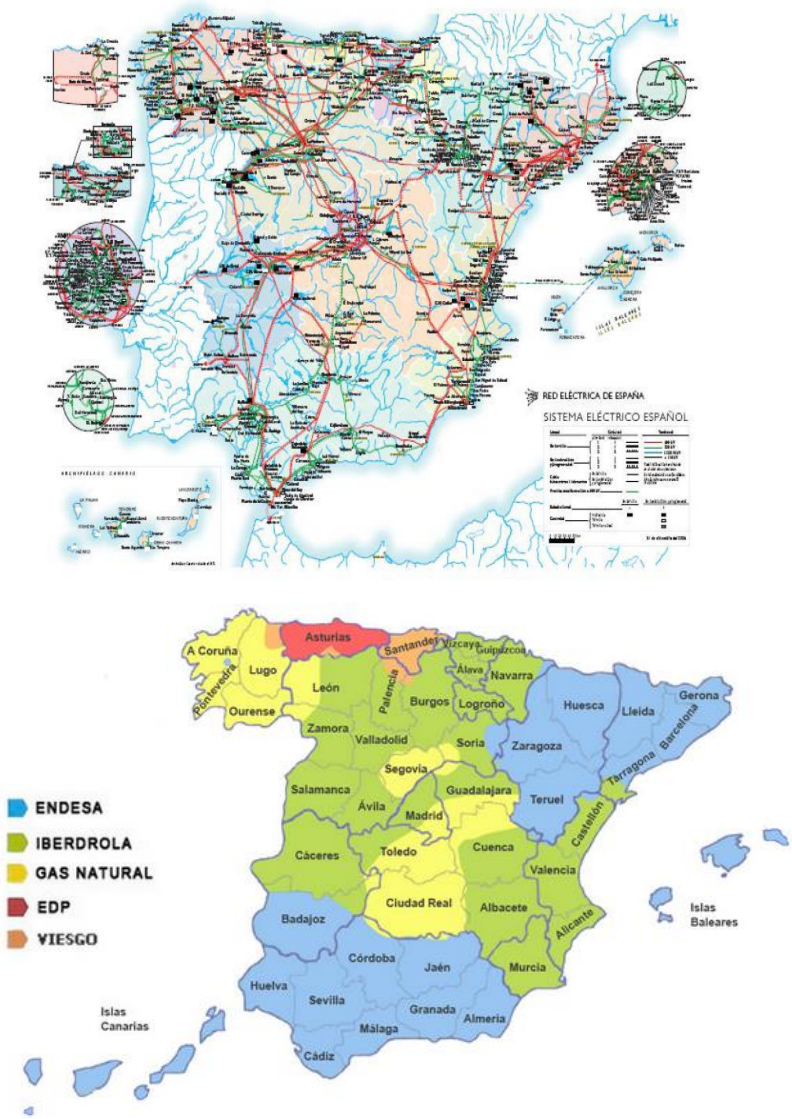

Figure 2: Transport and Distribution System Operators of the electricity system in Spain

6.2 Interest from electricity utility businesses

The new interest shown by the key electricity utility companies in the PV business is remarkable. They have already implemented customer solutions with PV support initiatives. A few examples:

- Iberdrola has several self-consumption products. Although its position has always been contrary to change the existing self-consumption legislation, it seems that the company is now willing to look into ways to support better legislation for self-consumption.
- Endesa offers several integral solutions for self-consumption. They are heavily involved in changing self-consumption regulation in Spain and regulating collective self-consumption.
- Gas Natural Fenosa changes its name to Naturgy. The company is heavily investing in renewable energies, mainly PV in Spain and won more than 500 MW in the second tender which took place in July 2017.
- Viesgo also offers self-consumption solutions for consumers.

6.3 Interest from municipalities and local governments

ANDALUSIA

In 2017 the Andalusian Energy Agency made available to citizens and Andalusian SMEs the incentive program for sustainable energy development of Andalusia 2020 "Andalusia is more". This program is placed in the Operational Program FEDER in Andalusia 2014-2020, a program of European Funds approved by the European Commission in June 2015. The purpose of this program is to contribute to increase economic competitiveness, strengthen cohesion and equality and the sustainability of the productive model of the Andalusian region.

The incentive program for Sustainable Energy Development of Andalusia 2020 "Andalusia is more" has three lines of incentives:

- Sustainable construction incentives line

- Sustainable SME incentive line

- Smart networks incentive line.

ARAGON

The reference document of 2017 for energy subsidies is the EIE / 840/2017 order of June 7 (Official Gazette of Aragon No. 121), which calls for aid in energy saving and diversification, rational use of the energy and use of indigenous and renewable resources, financed with own funds of the region of Aragon. This document - after defining the regulatory bases of the region of Aragon in energy matters - regulates the measures to obtain subsidies in terms of savings and energy diversification, rational use of energy, use of indigenous and renewable resources, and energy infrastructures.

PRINCIPALITY OF ASTURIAS

The Principality of Asturias decided to allocate 925,000 euros of subsidies for private companies that promote the use of renewable energy and energy saving and efficiency actions. The regulatory bases of these subsidies are contained in the Resolution of December 12, 2016 of the Ministry of Employment, Industry and Tourism, which approves the regulatory bases for the granting of subsidies, under competitive concurrency, for the use of renewable energies and for saving and energy efficiency actions for private companies.

BALEARIC ISLANDS

The Government of the Balearic Islands decided to allocate a subsidy of € 400,048 for individuals, legal persons of private law and communities of property and business associations that operate in the territorial area of the region of the Balearic Islands and that carry out the installations established in section 4 of the Resolution of the Minister of Territory, Energy and Mobility of May 19, 2017, approving the public call to submit applications for subsidies for the promotion of photovoltaic solar energy facilities aimed at individuals, entities without profit, companies and business associations. The purpose of this Resolution is to approve and regulate the public call for aid for the promotion of photovoltaic solar energy facilities, up to 3 kWp peak power, promoted by individuals, communities of owners and non-profit entities and up to 30 kWp peak power, promoted by companies and business associations.

CANARY ISLANDS

The Government of the Canary Islands made available subsidies for renewable energy installations, framed in the Operational Plan FEDER of the Canary Islands 2014-2020, with a total budget of 500,000 euros. Only the following renewable energy facilities will be eligible:

- Thermal biomass until reaching the figure of 50,000 euros

- Low temperature thermal solar to reach the figure of 100,000 euros

- Solar photovoltaic isolated to reach the figure of 90,000 euros

- Isolated wind energy to reach the figure of 20,000 euros

- Small facilities for obtaining and using biogas to reach the figure of 30,000 euros

- Geothermal energy to reach the figure of 80,000 euros

- Aerothermal to reach the figure of 80,000 euros

- Other facilities up to the figure of 50,000 euros.

CANTABRIA

In 2017, the Government of Cantabria created subsidies for renewable energies and energy saving and efficiency actions for 2017. These subsidies are aimed at individuals as well as legal entities registered or residing in Cantabria. In addition, energy services companies (ESCO) may also benefit from the subsidy service, as indicated in Royal Decree-Law 6/2010 of April 9.

Investments in renewable energy and savings and energy efficiency will be eligible through the application of the following technologies:

Renewable energy:

• Low temperature thermal solar

• Solar photovoltaic

• Mini-wind

• Thermal biomass

• Geothermal

• Energy savings and efficiency:

  - Renovation of lighting installations by led technology
  - Electric vehicle charging points
  - Microcogeneration.

The total amount of the eligible investment must be between 5,000 and 50,000 euros.

The amount of the investment will be equal to 40% of the eligible cost of the investments executed, except for solar thermal renovation of lighting installations by LED technology, which will be 30%. The deadline for submitting applications ended on September 14.

CATALONIA

With the Agreement of the Govern 11/2017 of February 7, the creation of a Table to Promote Self-consumption was approved. The objective of this agreement is to facilitate joint action and coordination of the different actors involved in self-consumption, in order to achieve a better and faster penetration of photovoltaic solar energy in Catalonia.

With this agreement, the Catalan Government intends to frame the transition towards a new energy model that is committed to clean and renewable energy, and to the efficiency of all public policies.

In addition, in 2017 in Catalonia the Catalan Institute of Energy opened a new line of aid for the acquisition of batteries to take advantage of solar electricity that capture the roofs and roofs of homes. About 360,000 euros were made available to families and communities of owners for the installation of lithium-ion batteries that store the electrical energy generated by the photovoltaic panels that are associated.

The deadline for requesting aid for the purchase of batteries was closed on October 13.

CASTILLA LA MANCHA

The Government of Castilla-La Mancha made available a total of € 650,000 for the use of renewable energy in 2017. The aid is aimed at two types of area: photovoltaic or mixed wind-photovoltaic, and geothermal. The conditions to be able to benefit from these subsidies are contained in the

Resolution of 04/20/2017 of the General Directorate of Industry, Energy and Mining, whereby aid is summoned, co-financed by the European Regional Development Fund for the use of the renewable energies in Castilla-La Mancha for 2017.

CASTILLA Y LEÓN

The government of Castilla y León approved in 2017 a package of grants - co-financed by the FEDER - aimed at the use of renewable energy in the building sector. The beneficiaries of these grants are communities of owners and associations or non-profit entities, duly registered.

VALENCIAN COMMUNITY

The IVACE (Valencian Institute of Business Competitiveness) presented new grants aimed at industrial self-consumption projects in the Valencian Community for companies and both public and private entities, and individual entrepreneurs. The objective of this aid is to promote energy and industrial programs to encourage the economy of the Valencian Community.

Although the deadline for requesting the aid proposed by the IVACE is finished, the municipalities or groups of municipalities with a population of less than 20,000 inhabitants can apply for the subsidies that the IDAE (Institute for Diversification and Energy Saving) offered to the self-consumption facilities of the small town halls. The granting of direct subsidies like this is regulated in Royal Decree 616/2017. The amount allocated by the IDAE to these projects is 336 million euros, of which 27,000,000 are destined for the Valencian Community. To benefit from these grants, projects must be carried out focused on reducing CO_2 emissions for energy savings and efficiency, sustainable urban mobility, use of renewable energy, photovoltaic self-consumption. In this case, the facilities must have an installed power of more than 5kW and entail investments between 50,000 and 1,000,000 €. In 2017, the Valencian Community also created other types of aid to finance electricity self-consumption projects for companies and entities. The aid consists of the granting of a subsidized loan on the eligible costs of the associated projects. This subsidized loan has the following characteristics: maximum amount of 300,000 euros, maximum percentage of 100% in the investment, interest rate 0%, absence of study fees and opening of the operation, ten years as the maximum loan repayment period, guarantee of 50% of the amount of the loan granted, 50% guarantee adjustment by the IVACE after the half of the term.

EXTREMADURA

In 2017, through Decree 133/2017, the government de Extremadura created a subsidy for the solar self-consumption facilities of irrigators. The beneficiaries of these grants are the Communities of Irrigators in the region of Extremadura that have their corresponding water right.

The government of Extremadura established that the amount of the eligible cost will be a maximum of € 750,000, and at least € 50,000 per beneficiary and call for assistance.

GALICIA

In 2017, the region of Galicia announced the call for subsidies for photovoltaic installations projects in the communities of owners.

LA RIOJA

With a resolution of March 13, 2017 of the Economic Development Agency of La Rioja, the Government of La Rioja approved a call for grants for the promotion of renewable energy, savings, energy efficiency and environmental protection. The aid contained in this call is intended to create incentives aimed at achieving a sustainable and integrated climate and energy business policy to achieve higher levels of environmental protection while encouraging companies to innovate, advance and evolve strategically to position itself in competitive positions. The beneficiaries of the aid of this call are companies and public, semi-public or private entities or organizations, which have an establishment in the region of La Rioja.

REGION OF MURCIA

In 2017, the Region of Murcia convened subsidies for the promotion of energy efficiency and the use of renewable energies by companies within the framework of the 2014-2020 FEDER operational programs for the Region. The beneficiaries of the grants are companies in the industrial or tertiary sector.

The purpose of the grant is:

• Energy audits.

• Renewal of energy consuming equipment and installations.

• Improvement of energy efficiency in production processes.

• Power generation facilities at the point of consumption.

NAVARRA

The Government of Navarra decided to open a call for aid to local entities for the promotion of energy efficiency, the implementation of renewable energies and the promotion of electric mobility; is developed within the framework of the new Energy Plan of Navarra Horizonte 2030. This plan has among its objectives to promote an efficient consumption of energy, increase the contribution of renewable energy in the final consumption of energy, as well as reduce the consumption of fossil fuels and the percentage increase of renewable energy in transport. Therefore, the purpose of this call is to contribute to achieving the objectives of the Energy Plan of Navarra Horizonte 2030 that we have just listed.

BASQUE COUNTRY

In 2017, the Basque Government opened numerous aid programs for the energy sector. In particular these programs are:

- Aid program for investments in energy efficiency and the use of renewable energies in the industrial sector;

- Aid program for investments in energy efficiency and the use of renewable energies in the tertiary sector;

- Aid program to promote energy efficiency and the use of renewable energies in public facilities and buildings in the Basque Country through contracts with energy service companies (ESES);

- Aid program for investments in the promotion of renewable energy installations for electricity production.


AYUDAS PARA
EL FOMENTO
DEL AUTOCONSUMO
EN ESPAÑA
AHORRO O EFICIENCIA ENERGÉTICA
AUTOCONSUMO (INCLUIDO FV)
VEHÍCULOS ELÉCTRICOS
BOMBEO SOLAR PARA REGANTES
BATERÍAS
EDIFICACIÓN SOSTENIBLE CON EE.RR.
REDES INTELIGENTES
APOYO A LAS EE.RR.
alimentasolar
GRUPO OPERATIVO DE AUTOCONSUMO
FOTOVOLTÁICO EN LA INDUSTRIA
AGROALIMENTARIA
PNDR

7 HIGHLIGHTS AND PROSPECTS

The solar PV sector in Spain is about to enter in its second golden age. Some scenarios of the future and necessary decarbonisation of the national electricity sector, estimate, by 2030, of the necessary installation of 7 GW of wind energy and 34-43 GW of photovoltaic solar energy to achieve these objectives in a model where coal disappears as a primary energy source, nuclear power plants are maintained until 2025-2030 and requires the installation of 13 GW of backup in the system. In this context, the future of photovoltaic solar energy can not only be described as promising, but also as a key to achieving the established objectives.

In the coming years the investment in photovoltaic technologies will be a constant because a huge amount of capacity must be built to meet the energy and climate targets. As part of the agreement reached in the European Union, and aware of the legal security that this scenario will require, the recent transition agreement towards clean energy in the European Union identified as key objectives the need to design stable legal and regulatory frameworks, which reduce administrative obstacles and support the development of self-consumption in the coming years.

Only until 31st December 2019, the 4 GW of solar PV tendered will have to be built and then it is expected that 2-3 GW of solar PV will be built annually. The most needed reform of the electricity market in Spain and whether this happens at all will impact on the path of installation of this capacity and their remuneration.

Regarding to self-consumption, an increase in the capacity installation is expected in 2018. A change in the regulation is also expected because of the entrance of the new government, which was always in favour of a more favourable self-consumption regulation. Changes in the self-consumption are likely to happen at the end of 2018 or beginning 2019.