IEA INTERNATIONAL ENERGY AGENCY

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in Spain 2018

Prepared by:

UNEF

PHOTOVOLTAIC POWER SYSTEMS
TECHNOLOGY COLLABORATION PROGRAMME

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WHAT IS IEA PVPS TCP

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The IEA carries out a comprehensive programme of energy cooperation among its 30 member countries and with the participation of the European Commission. The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the collaborative research and development agreements (technology collaboration programmes) within the IEA and was established in 1993. The mission of the programme is to "*enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems*."

In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas. This report has been prepared under Task 1, which deals with market and industry analysis, strategic research and facilitates the exchange and dissemination of information arising from the overall IEA PVPS Programme.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Copper Alliance are also members.

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WHAT IS IEA PVPS task 1

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 2018. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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DISCLAIMER:

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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 2018 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2018, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

PV applications in Spain are mostly based on ground-mounted applications, but the figures show the difficult path this segment has walked through the years. In a first stage, comprised between the years 2007 and 2012, the installed capacity of the PV sector grew ostensibly, almost 4 GW in 6 years.

However, from 2014 to 2017, this capacity hardly increased with a total of 48 MW installed in 3 years reaching the figure of 4,686 MW. However, these figures will rise in the near future as in 2017 new renewable auctions were held awarding 3,903 GW to photovoltaics. The winners of 2017 auctions have to be commissioned during 2019.

Since 2014 self-consumption applications started to be installed in Spain but with very limited capacity installed (few MWs in total) due in part to the regulatory framework that presented certain barriers. During 2017 the ban on collective self-consumption was raised and self-consumption figures were above 100 MW in a year for the first time.

Self-consumption development entered in a new phase with Royal Decree-Law 15/2018 which eliminated the most restrictive items of previous framework leading to figures above 200 MW of installed capacity. Self-consumption is mostly installed in the food sector or hostelry. There are also off-grid applications, mainly pumping facilities for agriculture.

1.2 Total photovoltaic power installed

The Transmission System Operator Red Eléctrica de España (REE) informs that the PV capacity connected to the grid as utility-scale generation facilities reached 4,714 MW in 2018 thanks to 26 MW of new PV capacity.

Nevertheless, this data of new capacity does not include other PV applications than utility-scale as off-grid or self-consumption installations, not yet registered. UNEF, thanks to the collaboration of national providers and installer companies, has been able to estimate a total PV capacity installed in 2017 of 262 MW, as described below.

Table 1: Annual PV power installed during calendar year 2018.

		Installed PV capacity in 2018 [MW]	AC or DC
PV capacity	Off-grid	79	AC
	Decentralized	157	AC
	Centralized	26	AC
	Total	**262**	AC

REE published 26 MW as the PV installed capacity in 2018 connected to the transmission network, therefore, this represents the data of the utility scale capacity installed in 2018. From UNEF associates the total off-grid installed capacity can be estimated as 79 MW and the difference between 262 MW of total capacity connected, 79 MW from off-grid and 26 MW from centralized, results in 157 MW, the capacity of on-grid self-consumption installations.

Table 2:Data collection process.

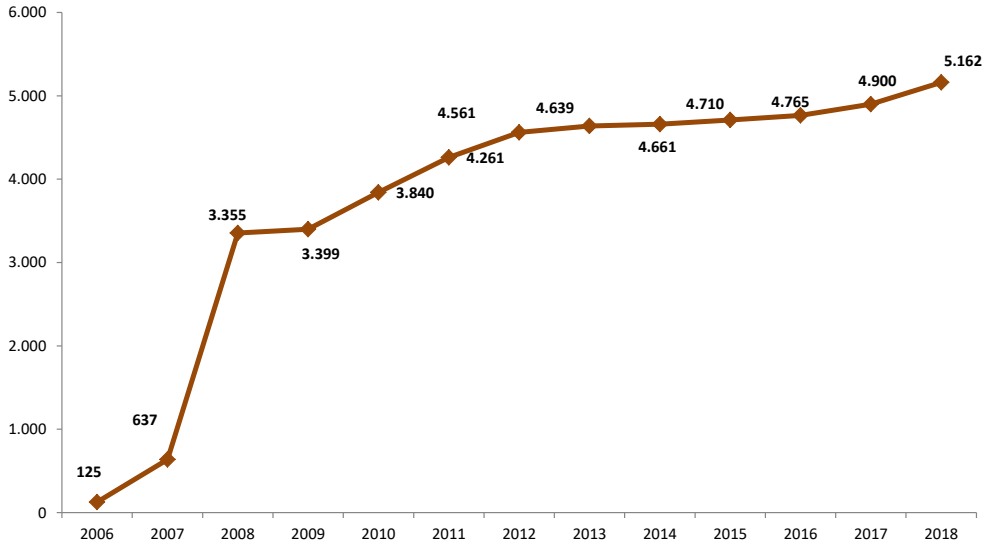
If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	Figures are in AC, the conversion rate from AC to DC – 10%
Is the collection process done by an official body or a private company/Association?	Collection process has been done by official institutions (CNMC, 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
Other	The figures from UNEF have been collected by the information supplied by their members.

Table 3:The cumulative installed PV power in 4 sub-markets.

Year	Off-grid [MW]	Grid-connected distributed [MW]	Grid-connected centralized [MW]	Total [MW]
2014	5	10	4.646	**4.661**
2015	10	19	4.681	**4.710**
2016	26	53	4.686	**4.765**
2017	71	141	4.688	**4.900**
2018	149	298	4.714	**5.162**

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. 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 calculated by UNEF is shown in Figure 1.

Figure 1: PV cumulative installed capacity (MW).



Note: 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.

Table 4:Other PV market information.

	2018 Numbers
Number of PV systems in operation in your country	Centralized: 61,594 [1] Self-consumption: Unknown (No public data available) [2]
Capacity of decommissioned PV systems during the year [MW]	0,045 [1]
Total capacity connected to the distribution grid [MW]	4.605 [3]
Total capacity connected to the high voltage transmission grid [MW]	109 [4]

[1] Register of production facilities
[2] In the last update of self-consumption register of RD 900/2015 (Nov-18), there were around 1,600 registered facilities but this number does not represent the real deployment at the date.
[3] Total given by REE in 2018 minus connected to transmission grid
[4] Source: REE Requests of connection permits

Table 5: PV power and the broader national energy market.

	2017	2018
Total power generation capacities [GW]	104 [1]	104 [2]
Total renewable power generation capacities (including hydropower) [GW]	51.5 [1]	51.9 [2]
Total electricity demand [TWh]	268 [3]	269 [3]
Total energy demand [TWh]	980 [4]	N.A.
New power generation capacities installed in 2018 [GW]	0.22 [5]	0.69 [5]
New renewable power generation capacities installed in 2018 (including hydropower) [GW]	0.22 [5]	0.66 [5]
Estimated total PV electricity production (including self-consumed PV electricity) in [GWh]	Grid: 8,385 [6] SC: 298 [7]	Grid: 7,759 GWh [6] SC: 580 [7]
Total PV electricity production as a % of total electricity consumption	3.13% [6]	[6]

[1] REE, Power system annual report 2017
[2] REE, Annual statistics series, 2019
[3] REE, Power system annual report 2017/ 2018. Data at generator terminals.
[4] IDAE, Energy balance
[5] Calculated as the difference of installed capacity in the different years published by REE. For PV we use the data provided by UNEF associates.
[6] REE, Renewable energies report 2017 and 2018
[7] Estimated using SC accumulated capacity given by UNEF and 1,200 equivalent hours.

1.3 Key enablers of PV development

Table 6: Information on key enablers.

	Description	Annual Volume	Source
Electric vehicles [#]	The use of electric vehicles is essential to reduce the CO_2 especially in big cities as Madrid and Barcelona and can increase electricity demand through electrification.	Registrations in 2018: - Cars: 11,852 - Motorbikes: 3,372 - Trucks and vans: 2,502 - Buses: 30	Dirección General de Tráfico

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 €/Wp

Year	Lowest price of a standard module crystalline silicon	Highest price of a standard module crystalline silicon	Typical price of a standard module crystalline silicon
2014	0.50		0.60
2015	0.50	1.05	0.60
2016	0.45	0.64	0.55
2017	0.45	0.64	0.55
2018	0.23	0.34	0.31

2.2 System prices

Table 8: Turnkey PV system prices of different typical PV systems.

Category/Size	Typical applications and brief details	Current prices [€/W]
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	1.5-2
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	0.8-1
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	0.75-1
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	0.75-1
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	0.7-0.75
Large centralized PV >20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	0.65-0.7

Table 9: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW **[€/W]**	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW **[€/W]**	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW **[€/W]**	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW **[€/W]**
2011	2.7	2	2	1.6
2012	2.6	1.8	1.8	1.4
2013	2.4	1.6	1.6	1.2
2014	2.2	1.5	1.5	1.2
2015	1.9	1.2	1.2	0.9
2016	-	-	-	-
2017	1.87	1.05	1.05	0.88
2018	1.75	0.90	0.88	0.72

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 BAPV 5-10 kW

Table 10 Cost breakdown for a residential BAPV 5-10 kW – €/W

Cost category	Average (€ /W)	Low (€/W)	High (€/W)
Hardware			
Module	0.50	0.43	0.57
Inverter	0.23	0.20	0.25
Other (racking, wiring…)	0.30	0.28	0.32
Soft costs			
Installation (Including the installation of all the electrical components)	0.53	0.44	0.62
Customer Acquisition (including transportation of the material)	0.074	0.05	0.11
Profit	-		
Other (permitting, contracting, financing…)	0.12	0.10	0.15
Subtotal Hardware	1.14	1.06	1.28
Subtotal Soft costs	0.73	0.613	0.918
Total	**1.75**	**1.50**	**2.02**

2.3.2 Small commercial BAPV 10 kW-100 kW

Table 11 Cost breakdown for a small commercial BAPV 10 kW-100 kW – €/W

Cost Category	Average (€/Wp)	Low (€/Wp)	High (€/Wp)
Hardware			
Module	0.38	0.31	0.45
Inverter	0.12		
Other (racking, wiring, etc.)	0.22		
Soft cost			
Installation Labor	0.15		
Customer acquisition	-		
Profit	-		
Other (contracting, permitting, financing etc.)	0.03		
Subtotal Hardware	0.90		
Subtotal - Soft cost	-		
Total Installed Cost	**0.90**		

2.3.3 Utility-scale PV systems > 20 MW

Table 12 Cost breakdown for a Utility-scale PV system > 20 MW – €/W

Cost Category	Average (€/W)	Low (€/W)	High (€/W)
Hardware			
Module	0.27	0.23	0.30
Inverter	0.10		
Other (racking, wiring, etc.)	0.15		
Soft cost			
Installation Labor	0.10		
Customer acquisition	-		
Profit	-		
Other (contracting, permitting, financing etc.)	0.10		
Subtotal Hardware	0.52		
Subtotal - Soft cost	0.20		
Total Installed Cost	**0.72**		

2.4 Financial Parameters and specific financing programs

In the PV sector nowadays, with the generalized cost reduction of components, the competition is played on the financing arena. The agents able to obtain better financing conditions have a competitive advantage over those who are not.

The access to finance can be a barrier for the development of PV by medium-small companies that can be mitigated implementing auctions. However, auctions can be more or less efficient depending on the design.

Another element that can ease financing are Power Purchase Agreements (PPAs) that continue their upward trend of last years as a result of the increase in consumers interest in having renewable energy supply.

Regarding residential installations, financial entities are treating PV self-consumption investments as a consumer credit a without collateral, so they see high loan rates. In fact, loans are being managed by consumer finance units not by investment units.

For the commercial sector, the range is bigger as the offered rate by financial entities depends a lot on the provision of guarantees. With very basic guarantees (smaller facilities), loans will be around 5%, but if a strong guarantee can be provided (larger customers), this could decrease to 2%-3%.

Regarding utility-scale, average cost of capital was estimated by CNMC during 2018 for all the renewables technologies as 7.09% using WACC methodology. In the same report, the CNMC estimated debt cost as 4.05% before taxes.

Table 13: PV financing information in 2018.

Different market segments	Loan rate [%]
Average rate of loans – residential installations	6%-7%
Average rate of loans – commercial installations	2%-5%
Average cost of capital – industrial and ground-mounted installations	7.09%

2.5 Specific investments programs

Both utilities are new agents in the self-consumption sector offer different financing schemes for new PV plants.

Table 14: Summary of existing investment schemes.

Investment Schemes	Introduced in country
Third party ownership (no investment)	Yes
Financing through utilities	Yes
Crowd funding (investment in PV plants)	Yes
Community solar	Yes

2.6 Additional Country information

Spanish electricity system is arranged under an ownership unbundling model. There is a single transmission system operator, Red Eléctrica de España, managing transmission network and operating the power system. Generation and retailing are liberalized and distribution is regulated. These three activities are concentrated in five big utilities.

Table 15: Country information.

Retail electricity prices for a household [c€/kWh]	17,81 - 18,01 [1]			
Retail electricity prices for a commercial company [c€/kWh]	12,25 - 13,65 [1]			
Retail electricity prices for an industrial company [c€/kWh]	7,18 - 10,04 [1]			
Population at the end of 2018	46.934.632 [2]			
Country size [km^2]	505,990 [2]			
Average PV yield in [kWh/kW]	1,745 [3]			
Name and market share of major electric utilities (optional)		Electricity production [%][5]	Share of grid Subscribers [%][6]	Number of retail customers [%][7]
	Iberdrola	18%	37,5%	36.6%
	Endesa	23%	41,0%	29.6%
	Naturgy	6%	12,7%	12.6%
	EdP	16%	2,3%	5.1%
	Viesgo	3%	2,4%	2.6%

[1] Electric indicators bulletin CNMC, April 2019. Range for domestic between the 2.0x and the 2.1x tariff. Range for commercial between 3.0 and 3.1. Range for industrial 6.x tariffs. Period Jan 2018 – Dec 2018. Without taxes.
[2] National Institute of Statistics (INE)
[3] UNEF
[5] CNMC, Wholesale electricity market monitoring report, includes Portugal.
[6] CNMC, Retail electricity market monitoring report, data of Q4 2017.
[7] CNMC, Retail changes monitoring report Q4 2018. Viesgo Retail is part of Repsol since November 2, 2018

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.

Table 16: Summary of PV support measures.

	On-going measures in 2018 – Residential	Measures introduced in 2018 – Residential	On-going measures in 2018 – Commercial + Industrial	Measures introduced in 2018 – Commercial + Industrial	On-going measures in 2018 – Centralized	Measures introduced in 2018 – Centralized
Feed-in tariffs	-	-	-	-	-	-
Feed-in premium (above market price)	-	-	-	-	-	-
Capital subsidies	-	-	-	-	-	-
Green certificates	-	-	-	-	-	-
Renewable portfolio standards (RPS) with/without PV requirements	-	-	-	-	-	-
Income tax credits	-	-	-	-	-	-
Self-consumption	Yes	Yes	Yes	Yes	-	-
Net-metering	-	-	-	-	-	-
Net-billing	-	-	-	-	-	-
Collective self-consumption and virtual net-metering	Yes	-	Yes	-	-	-
Commercial bank activities e.g. green mortgages promoting PV	-	-	-	-	-	-
Activities of electricity utility businesses	Yes	-	-	-	-	-
Sustainable building requirements	-	-	-	-	-	-
BIPV incentives	Yes	-	Yes	-	-	-
Exemption on local taxes	Yes		Yes			

3.1 National targets for PV

During the year 2018 the member states of European Union agreed a revision of their common energy policy. These new policies are a result of the negotiations that started in 2016 with the publication of a legislative proposal by the European Commission comprising eight directives and regulations, the so called Clean Energy Package.

During these negotiations the EU's main objectives for 2030 increased to 32% for renewable energy (in final energy consumption) and 32.5% for energy efficiency (with respect to baseline projections), including a clause for a potential upward revision in 2023.

Part of the Clean Energy Package proposals approved in 2018 was the Governance Regulation that introduced a long-term planning instrument called National Energy and Climate Plans (NCEPs). All member states have submitted a draft of their NCEPs including the main elements of their energy policy for the decade 2021-2030.

The draft NCEP published by Spain included a 'target scenario' for 2030 in which the following indicators were met:

- Reduction of emissions: -21% with respect to 1990.
- Participation of renewables:
  - 42% of the final energy use
  - 74% of the electricity generation mix
- Energy efficiency: -39.6% with respect to baseline.

Regarding photovoltaics, 37 GW of installed power was established in 2030 compared to 8.4 GW of installed power in 2020, which would mean at least 2,800 MW installed per year during 2020-2030 decade. The draft NCEP also included as one of its measures, the development of a self-consumption strategy, but without specific targets of installed power.

3.2 Direct support policies for PV installations

3.2.1 Specific remuneration regime

Current support scheme for renewables is called "specific remuneration regime" and was approved by Royal Decree 413/2014. In this scheme, this specific remuneration is defined as a complementary retribution to the market in order to allow renewable technologies to achieve a "reasonable profitability".

This "reasonable profitability" is defined as the retribution on the electricity generation activity that a well-managed renewable plant would have. In order to determine the regulated incomes to be given, a set of theoretical standard installations with standard costs was developed.

For the first regulatory period the "reasonable profitability" was calculated 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 200 pbs spread (art. 19 RD 413/2014), resulting in a value of 7.4%.

Royal Decree 413/2014 included the possibility of CNMC to develop a new methodology for the calculation of the "reasonable profitability" for the second regulatory period 2020-2025. After request by the Government, on November 2018 the CNMC published a report proposing a WACC methodology and a 7.09% rate.

On December 2018 the Council of Ministers approved a draft law including the 7.09% as the retribution for new renewable facilities under the "specific regime" installed during 2020-2025. However, for existing facilities, the draft law established that the renewable facilities installed prior to 2013 would maintain the previous profitability: 7.4%.

The draft law will have to be approved during 2019 in order to finally set these values as the remuneration of the 2020-2025 regulatory period.

3.2.2 BIPV development measures

In June 2018 a Royal Decree proposal was published modifying the Technical Building Code (CTE), which was intended to update the definition of "Almost Null Energy Buildings" according to the with the European directive 2010/31/EU. This proposal modified the Basic Document of Energy (DB-HE)

that is part of the CTE, which includes the energy indicators to determine the energy efficiency of a building, as well as the minimum generation of electrical energy with renewable energy sources. However, this proposal was not finally approved.

In July 2018 it was approved the Energy Performance Building Directive (EPBD) 2018/844/UE that reviews the Directive 2012/27/EU raising the ambition on renewable energy systems integration in buildings but it has not yet been transposed to Spanish legislation.

To sum up, current legislation does not include specific measures for BIPV promotion.

3.3 Self-consumption measures

Self-consumption in Spain was regulated under Royal Decree 900/2015 that presented certain regulatory barriers that have prevented the activity from reaching its full potential:

- Maximum capacity of the self-consumption installation had to be equal or below the contracted capacity.
- There were two types of self-consumers:
    - Type 1: maximum capacity installed of 100 kW – there was no compensation for the electricity surplus fed in the grid.
    - Type 2: not limit to the allowed capacity – the surplus could be sold in the wholesale market directly or through an intermediary. A specific grid tax of 0.5 EUR/MWh had to be paid together with a 7% tax on the electricity produced.
- Self-generated power above 10 kW was charged with a fee per kWh consumed as a “grid backup toll”, also known as the “sun tax”.
- Adding battery storage implied also an additional tax.
- Collective self-consumption was initially prohibited. Then the article including the prohibition was annulled by Constitutional Court in 2017 but was left as an empty space without specific regulation.

During 2018 Royal Decree-Law 15/2018 was passed, which, among other things, modified the regulatory framework for self-consumption established in the Power Sector Act and the Royal Decree 900/2015. The new royal decree law highlighted the renewable electric self-consumption as "*an essential element to achieve that the consumer can obtain a cleaner and cheaper energy*" and based its provisions on the following three fundamental principles:

i. The right to self-consume electricity without charges,
ii. The right to collective self-consumption,
iii. An administrative and technical simplification.

In the first place, RD-Law 15/2018 modified the definition of self-consumption included in Law 24/2013 reviewing the applicable modalities and reducing them only to with or without excess electricity. In addition, RD-Law 15/2018 introduced the following measures:

- Removal of charges: Self-consumed energy of renewable origin is exempted of all types of charges and tolls.
- Compensation of electricity excess: RD-Law announces the future development of a mechanism for simplified excess energy compensation for production facilities not exceeding 100 kW.
- Extending self-consumption out of the inner consumer network: The RD-Law introduced the concept of ‘self-consumption through the network’ eliminating the obligation of locating the production facility inside the consumer's network.
- Relaxation of registration obligations: Self-consumption production facilities not exceeding 100 kW are exempt from the obligation to register in the electricity production facilities registry (RAIPEE).

- Access and connection: The self-consumption facilities without surplus of up to 100 kW are exempt of the access and connection permits, subjecting themselves exclusively to the technical regulations.
- Simplification of measurement configuration: New text suppresses the obligation of installing a specific generation meter.
- Collective self-consumption: The new RD-Law eliminates the requirement that there be only one consumer, although the prohibition had already been annulled by the Constitutional Court in June 2017 (Judgment 68/2017).

Table 17: Summary of self-consumption regulations for small private PV systems in 2018.

PV self-consumption	1	Right to self-consume	Yes
	2	Revenues from self-consumed PV	Savings on the electricity bill
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	No
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Not in 2018 but will be developed in 2019
	5	Maximum timeframe for compensation of fluxes	NA
	6	Geographical compensation (virtual self-consumption or metering)	No
Other characteristics	7	Regulatory scheme duration	Not limited by regulation
	8	Third party ownership accepted	Yes
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	No
	10	Regulations on enablers of self-consumption (storage, DSM…)	Yes
	11	PV system size limitations	No
	12	Electricity system limitations	Distributors license
	13	Additional features	

3.4 Collective self-consumption, community solar and similar measures

As mentioned, since 2015 self-consumption in Spain was regulated by RD 900/2015 that explicitly banned collective applications. This prohibition was suppressed by the 68/2017 judgment of the Constitutional Court. Despite the prohibition was lifted, the necessary legal developments were pending.

Royal Decree-Law 15/2018 formally permitted collective self-consumption but yet did not introduce detailed dispositions on the topic. Despite that, the first residential collective self-consumption facility was 'legalized' in Spain in 2018.

3.5 Tenders, auctions & similar schemes

During 2018 no renewables tenders or auctions were held in Spain.

3.5.1 Previous tenders

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 resulting in only 29 MW were awarded to solar PV of 3,000 MW.

The second tender of 2017, held in July, awarded more than 5 GW of renewable energy capacity, between solar PV and wind. Due to changes in the bidding parameters solar PV had stronger chances of being awarded and almost 3 GW were given to solar PV projects.

Despite tender were celebrated and the winners were awarded with the "specific retribution regime", the projects will get in general the market price for the electricity they fed into the grid. Only if wholesale market price decreases greatly from current levels, projects will receive incentives from the government.

The awarded projects must comply before December 31 2019 with certain requirements or lose the financial guarantees and rights associated with the specific remuneration regime. These requirements include that the installation is fully operational (including accreditation of the beginning of the delivery of electrical energy) and definitively registered in the Administrative Register of Electric Power Production Facilities (RAIPEE).

3.6 Other utility-scale measures including floating and agricultural PV

On December 2018 the Ministry for the Ecologic Transition established the regulatory bases for granting investment aids to electricity production facilities of wind and photovoltaic technologies located in the non-mainland territories co-financed with European Union funds (FEDER). This Order was the first step for a call for investment aid for renewables in the Canary Islands and the Balearic Islands.

Some regional governments, as Andalucia have lines of support for agricultural PV. During 2018 it was approved a line of grants to promote investments aimed at improving the performance and sustainability of agricultural operations for intensive crops in greenhouses, with a budget of 10 million euros. Grants were a minimum of 50% of the investment.

This kind of investment grants apply in other regions such as Valencia. In April 2018 the Valencian Institute of Business Competitiveness (IVACE) presented its Renewable Energy and Biofuels Program with non-recoverable grants aimed among others at isolated photovoltaics for companies.

3.7 Retrospective measures applied to PV

In Spain, the support scheme of centralized PV consists in ensuring regulated payments up to a certain remuneration rate. Current PV installed capacity has a 7.398% rate but this value applies during the regulatory period 2015-2019. During 2018 the process for calculating the rate that will apply during 2020-2025 started with the publication of the proposal of CNMC of 7.09%.

On December 2018 the Council of Ministers approved a draft-law including the rate proposed by the CNMC but maintaining current profitability (7.398%) for renewable facilities installed prior to 2013, to avoid retrospective changes in the rate. This law will have to be approved during 2019.

3.8 Indirect policy issues

The revision of European directives as a result of the EU Clean Energy Package will influence a Spanish regulation in the following years. For example, the Revised Renewable Energy Directive approved in December as 2001/2018, included in its article 21 the following dispositions on self-consumption:

- Recognizes the basic right to become a self-consumer of renewable energy without being subject to excessively burdensome or discriminatory conditions,
- Gives the right to sell surplus electricity at least at market value,
- Requires that there be no charges for self-consumed energy for installations of less than 30 kW,
- Allows third-party ownership of the facilities,
- Allows shared self-consumption,

- Prohibits retroactive changes.

3.8.1 Support for electric vehicles (and VIPV)

During 2018 the MOVALT Program (Alternative Vehicle Program) was carried out granting € 16 million to support the purchase of electric motorcycles and 'alternative technology' vehicles including electric vehicles, liquefied petroleum gas, compressed and liquefied natural gas vehicles.

3.9 Financing and cost of support measures

In Spain, the renewable support is financed through the electricity tariff as a regulated charge that all electricity consumers pay. In 2018 the total amount awarded for PV support was € 2,446 million according to the Spanish regulator, the CNMC.

4 INDUSTRY

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

During several years FerroAtlantica (now Ferroglobe) has been developing a new method for obtaining solar-grade silicon. In 2018 a pre-commercial solution was tested obtaining promising results in both efficiency and costs compared with conventional production techniques. After the tests, the company announced that it will start production at a new factory in Spain by the end of 2018.

However, at the end of 2018 the Company decided to temporarily suspend investment in the project (by the company's Spanish subsidiary FerroSolar) due to deterioration in the market environment for solar-grade silicon worldwide, aiming to finalize the construction of the factory as soon as market circumstances change.

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

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

4.3 Manufacturers and suppliers of other components

Numerous companies are present in the PV system value chain, specifically:

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

This chapter aims to provide information on the benefits of PV for the economy.

5.1 Labour places

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 7,549, while direct, indirect and induced labour places in 2018 were 20,942 according to UNEF.

Table 18: Estimated PV-related full-time labour places in 2018

		Producers and Distributors	Engineering and installer companies	Equipment manufacturers	Mixed	Total
Direct Footprint	Spain	2,983	2,260	1,454	852	7,549
Indirect Footprint	Spain	5,875	2,312	1,303	3,903	13,393
	Rest of the world	6,263	5,323	6,670	7,841	26,097
Induced Footprint	Spain	2,611	2,385	1,476	1,892	8,365
	Rest of the world	1,474	1,347	834	1,068	4,723
Total domestic footprint		11,468	6,958	4,233	6,647	29,306
Total external footprint		7,737	6,670	7,504	8,910	30,820
% domestic footprint		39%	24%	14%	23%	100%
% external footprint		25%	22%	24%	29%	100%

5.2 Business value

Table 19: Rough estimation of the value of the PV business in 2018 (VAT is excluded).

Sub-market	Capacity installed in 2018 [MW]	Average price [€/W]	Value [M€]	Sub-market [M€]
Off-grid	79	0.9	71	**71**
Grid-connected distributed	157	0.9	141	**141**
Grid-connected centralized	26	0.72	19	**19**
Value of PV business in 2018				**231**

According to UNEF estimates, direct contribution of PV sector to the GDP of Spain was 2,711 million euros in 2018, which is 0.22% of the national total.

Table 22: Value of PV business

	2018
Sales figure	**5,873**
a) Income in Spain	4,482
b) Exports	1,391
1. Materials	**3,162**
1.1. Payments to Spanish suppliers	2,450
2. Imports	712
2. Direct GDP	**2,711**
2.1. Personal expenses	408
2.2. Gross surplus	2,303

According to UNEF estimates, from total sales figure of 5,873 million euros, 1,391 correspond to exports (23.7%) while 4,482 million euros are sales in the national market. From this sales figure, if € 3,162 million corresponding to the purchases of materials are discounted, the total number of direct GDP of the sector mentioned € 2,711 million is obtained.

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

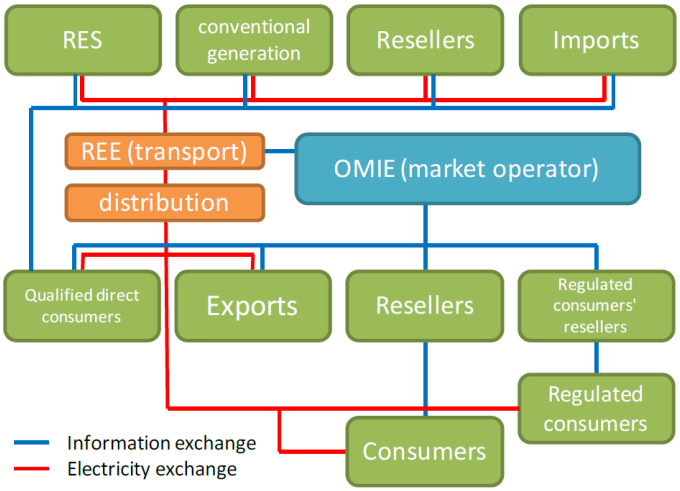
6.1 Structure of the electricity system

The Spanish electricity sector has undergone a profound transformation since 1998. Until then, the activity of the sector was concentrated in vertically integrated companies exercising a monopoly in the different Spanish regions.

This situation changed with the approval of Law 54/1997 of the Electricity Sector that started the liberalization of the sector establishing transmission and distribution as regulated monopolies and ensuring third party access to the networks. Law 54/1997 liberalized generation activity establishing an organized wholesale market for the negotiation of energy, managed by OMIE. In 2009 retailing was also liberalized, despite regulated retailers were maintained, who still offer a regulated tariff, currently called PVPC.

Currently the basic norm that regulates the structure and operation of the sector is Law 24/2013 of the Electricity Sector.

Figure 2: Structure of the electricity system in Spain



The main roles of the electricity system are:

- Generators: agents that produce electricity, regardless of the type of technology used for it.
- Transmission System Operator (TSO): It is the company that transports electricity from centralized power plants to the consumption centers where it is delivered to distributors.
- Distributor System Operators: companies who manage production and consumption connected to the distribution networks distributing electricity to the final consumers in medium and low voltage.
- Retailers: they are the agents who sell energy. They buy electricity at the wholesale market and sell it to consumers.
- Consumers: any person or company who consumes electricity at any time.

Five private-owned vertically integrated utilities are present in Spanish market: Ibedrola, Endesa, Naturgy, EdP and Viesgo. These companies are the main DSOs and represent the main share of generation and retailing activities. In 2018 Repsol became also a relevant actor of the power system by buying retailing and part of electricity generation activities from Viesgo.

Figure 4: Area covered by main Distribution System Operators

Transmission System Operation is performed solely by Red Eléctrica de España (REE) under an Ownership Unbundling (OU) model in which it is the owner of transmission network and power system operator without performing any liberalized activity. REE is partially publicly owned (20%) but the state keeps a golden share.

Electricity industry policy is elaborated by the Ministry for the Ecologic Transition (MITECO). However, in accordance with European Directives, there is also an independent energy regulator aside from the Government, the National Commission of Markets and Competition (CNMC).

6.2 Interest from electricity utility businesses

As it has been mentioned, during 2017 two renewable auctions were held awarding 3,903 GW to photovoltaics that will have to be installed during 2019. Two of the electric utilities were awarded PV projects in the auctions:

- Endesa, through its renewable branch Enel Green Power, was awarded 339 MW,
- Naturgy, was awarded 250 MW

In addition, main utilities have announced plans to significantly increase their renewable energies portfolio during the 20-30 decade, what will mean the construction of new utility scale PV projects.

- Endesa: According to its CEO, the utility aims to develop between 7-8 GW during 2021-2030 (700-800 MW/year) covering a share of 10%-15% of the 65 GW of new developments included in the NECP compensation the closure of thermal and nuclear plants.
- Iberdrola: the company plans to develop at least 10 GW of new solar and wind energy plants in Spain by 2030, which is almost three times its current capacity in the country with these two technologies. By 2022 Iberdrola will have already built 3 GW.
- Naturgy: it has not announced its plans to 2030 but the utility aims to reach 2.1 GW of renewable power in 2022, a growth of more than 80 percent from today's values.

These new developments of utilities are sometimes supported by Power Purchase Agreements (PPAs) signed using the retail branch of the companies with the end consumers. For example, Iberdrola has signed PPAs with BBVA or Euskaltel with the energy that will be generated by a solar PV plant to be built in Extremadura.

Apart from PV plant developments, utilities are also offering self-consumption applications mainly to the household consumer:

- Iberdrola includes the previous feasibility study, the design, assembly and maintenance of the facility and financing.
- Endesa also performs the initial analysis, the installation and maintenance of the plant including a special 'solar' tariff from its retailer.
- Naturgy gives a similar service including the pre-analysis, the installation and maintenance (free the first year) and complemented with a specific tariff.

6.3 Interest from municipalities and local governments

6.3.1 City of Madrid

Madrid city council with the collaboration of Renewable Foundation presented in July 2018 a 2030 roadmap for energy sustainability based on increasing energy efficiency and PV self-consumption.

In order to develop PV self-consumption 900 municipal buildings were evaluated identifying 735,000 m2 as usable to install photovoltaic self-consumption systems, reaching an installed power of 75 MWp and coverage of 61% of the electricity demand expected in 2030. This process started this year, building 89 self-consumption facilities.

In addition, Madrid has a 50% property tax reduction during three years for residential buildings installing PV self-consumption.

6.3.2 City of Barcelona

Barcelona has a Program for the promotion of solar energy generation including a series of tax credits to facilitate the installation of renewable energy systems in private buildings.

Currently there is already a 50% property tax reduction for three years for solar installations - thermal and photovoltaic- and other reductions in construction taxes or economic activities taxes.

On the other hand, the city hall is also working on various facilitating measures, such as creating a single window for the processing of energy generation facilities, simplifying the management and legalization procedures and creating energy advice points.

Barcelona also created a publicly owned retailing and energy services company Barcelona Energía as a vehicle to promote self-consumption and install these facilities for vulnerable consumers.

6.3.3 Autonomous community of Balearic Islands

In August 2018 the Balearic Government agreed the text of its climate change project of law with ambitious objectives and scope. The project of law establishes a renewable participation target of 35% by 2030 (2% in 2018) and 100% in 2050 and the closure of thermal power plants between 2020 and 2025.

Regarding photovoltaic energy, the project of law introduces the obligation to install photovoltaic panels in all new car parks of more than 1,000 m2 and existing ones of more than 1,500 m2 is established. All new buildings must also have photovoltaic energy installations.

6.3.4 Autonomous community of Madrid

In December the Community of Madrid approved the Plan of Photovoltaic Self-consumption in the Residential Sector. The experience of this first program was a success since many companies participated, and it was announced that it will be reconvened soon.

6.3.5 Autonomous community of Valencia

In April 2018, the Valencian Institute of Business Competitiveness (IVACE), presented its Renewable Energy and Biofuels Program with two million euros of non-recoverable grants up to 45% aimed at companies and entities for stand-alone PV, stand-alone PV+wind, and other sources of renewable energy. In May, Community of Valencia published a new call for grants for electric self-consumption facilities in companies through IVACE.

6.3.6 Autonomous community of Navarre

In January, the Government of Navarre approved the Climate Change Roadmap and the Energy Plan for Navarra 2030. These documents commit the Autonomous Community to reduce its total greenhouse gas emissions by 45% by 2030, with respect to 2005.

In May an aid of almost one million euros was approved to promote energy efficiency of local entities. Of that amount, almost 300,000 euros were allocated to investments in renewable energy facilities. The electricity generation facilities could be stand-alone or connected to the grid, individual or collective self-consumption.

7 HIGHLIGHTS AND PROSPECTS

After some years of struggle, the prospects of PV sector in Spain are promising. The favourable regulatory framework, the costs reductions technology in latest years and the recent increase of renewable targets for the European Union set the scene for a second golden age of PV in Spain.

In the first place during 2019 we will see the development of around 3.9 GW awarded in renewable auctions of 2017. For the decade 2020-2030 PV will represent the main investment force in the electricity generation in Spain. According to the draft National Energy and Climate Plan of Spain sent to the European Commission, a total PV capacity of 34 GW is expected in 2030, which from 4.7 GW in 2018, means installing around 3 GW per year.

PV development is not only a target of energy policy from government plans: companies are showing interest in investing in PV in Spain. According to REE with date June 2019, up to 29.5 GW of PV projects have authorizations to connect to networks and 80 GW more have requested authorization.

Regarding self-consumption, the suppression of main barriers of former regulatory framework will surely have a positive impact in upcoming years. Under a liberalized regulation as was introduced by RD-Law 15/2018, the sector will grow towards figures of annual installed capacity around 300 MW - 400 MW, in line with other European countries.