IEA INTERNATIONAL ENERGY AGENCY

Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in France 2018

Prepared by:

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PHOTOVOLTAIC POWER SYSTEMS
TECHNOLOGY COLLABORATION PROGRAMME

ADEME

Agence de l'Environnement et de la Maîtrise de l'Energie

Cover picture: 11,4 MW system on the abandoned Faux rally cross circuit

Credits: Urbasolar/Commune de Faux

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.

Visit us at: **www.iea-pvps.org**

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.

Authors:

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Data: Service de la donnée et des études statistiques, Commissariat au Développement Durable, the Ministry for the Ecological and Inclusive Transition, Commission de Régulation de l'Energie, Enedis Open Data, other.
Analysis : Melodie de l'Epine – HESPUL

DISCLAIMER:

Data for non-IEA PVPS countries are provided by official contacts or experts in the relevant countries.
Data are valid at the date of publication and should be considered as estimates in several countries due to the publication date.

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REFERENCES

The principal references are cited below; however, a number of additional sources, including web sites, private communications and diverse publications were also used.

- Tableau de bord photovoltaïque, St@tinfo, n° 171, February 2019 (Service de la donnée et des études statistiques, Commissariat au Développement Durable, the Ministry for the Ecological and Inclusive Transition).
- "Coûts et rentabilités du grand photovoltaïque en métropole continentale", Commission de Régulation de l'Energie, March 2019
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- Bilans de Raccordement, Enedis Open Data (distribution grid manager for 95% of the nation)
- Bilan électrique 2018 (RTE Electricity Report 2018), RTE, February 2019 (Transport grid manager))
- Baromètre annuel 2018, AVERE
- Rapport d'activité 2018 – Installations de production, Consuel, June 2019
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- Mise à jour des charges de service public de l'énergie prévisionnelles au titre de l'année 2018, CRE, July 2018
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- France Territoire Solaire Bilan 2018, March 2019
- Baromètre 2018 du crowdfunding EnR, Green Univers, April 2019
- Le baromètre 2018 des énergies renouvelables électriques en France, Observ'ER
- Étude qualitative du marché du solaire photovoltaïque résidentiel en France, Observ'ER, Novembre 2018
- Public reports on Call for Tenders, CRE (Rapport de synthèse (version publique), Appel d'offres portant sur la réalisation et l'exploitation d'installations de production d'électricité à partir de techniques de conversion du rayonnement solaire, Commission de Régulation de l'Energie) (several publications, 2018 and 2019)

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.

Data collection does not yet include information on storage capacity, however injection type is now collected by Enedis (total or partial self-consumption, full generation sales).

Official statistics report the DC power of photovoltaic fields, as eligibility for Feed-in Tariffs and Tender support mechanisms is conditioned on peak DC power thresholds. It may be useful for the reader to know that the average generation across France is 1 160 kWh/kW, but that systems installed in the southern half of mainland France and in overseas territories will generate more, up to 1 400 kWh/kW.

Little data is available on off-grid applications as there are few support mechanisms that allow observers to track installation volumes.

1.1 Applications for Photovoltaics

The principal market segments in France in 2018 were all grid connected:

- Residential building integrated systems (0 kW to 9 kW)
- Commercial, agricultural or industrial building integrated systems (36 kW to 250 kW)
- Industrial building mounted or parking canopy systems (250 kW to 3 MW)
- Centralised ground mounted systems (over 1 MW)

This market segmentation is a result of the different support mechanism structures.

A small amount of off grid systems has been and are installed in overseas territories (Guiana, etc.) or in mainland mountainous areas.

The progressive change from total sales to partial self-consumption for residential systems under 3 kW seen in 2017 was confirmed with more than 60 % of new grid connection requests in 2018 as opposed to under 30 % in 2017, although the rate of connection remains to be seen. Systems under 36 kW represented approximately 12 % of installed volumes in 2018.

Small commercial systems from 36 KW to 100 kW were slightly down from the previous year at 16% of total capacity

Commercial systems are predominantly over 100 kW and below 250 kW, and installed within the framework of national Tenders, building mounted or on parking canopies- mostly by France's major development companies, and in 2018, with regular tenders this market segment saw growth and accounted for nearly 100 MW, or over 15 % of the years installed capacity.

Multi-megawatt systems (building or ground-based systems) are exclusively within the framework of national tenders and represent nearly 60% of new capacity.

1.2 Total photovoltaic power installed

Cumulative PV installed capacity as of the end of 2018 reached 8 947 MW (DC). Cumulative PV installed capacity by application is 30 MW for off-grid and 8 917 MW for grid-connected.

Data collection process

Data supplied by all transmission and distribution grid managers is aggregated and published by the SDES: Service de la Donnée et des Etudes Statistiques, Ministry for the Ecological and Inclusive Transition. Data is segmented by systems size (< 3 kW, < 9 kW, < 36 kW, < 100 kW, < 250 kW, above 250 kW). Data accuracy is an estimated 5%. Data publication segments published by the major distribution grid manager, Enedis, were modified and now include segments for total self-consumption, partial self-consumption and total sales systems.

For the purposes of this report, we have considered the following hypotheses for 2018 data:

Grid connected distributed (decentralized) systems:

- Residential: the split BIPV/BAPV has been extrapolated from CRE grid connection request data and SDES grid connection data.
- Commercial: all systems 9 kW to 250 kW are Commercial BAPV (Building Apposed Photovoltaics);
- Industrial: all systems from 250 kW to 10 MW are Industrial or Ground-mounted. The split between building-mounted and ground-mounted is extrapolated from the Observ'ER Atlas of megawatt systems and grid connection data published by Enedis. Parking canopies are considered Industrial.
- Grid connected centralised ground mounted systems:
- Industrial: all systems from 250 kW to 10 MW are Industrial or Ground-mounted. The split between Building-mounted and Ground-mounted is extrapolated from the Observ'ER Atlas of megawatt systems and grid connection data published by Enedis.
- Utility scale systems: all systems over 10MW

Off-grid PV power systems: There is no official data collection process for off-grid systems in France; any data presented are best-of-knowledge estimates.

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

		Installed PV capacity in 2018 [MW]	**AC or DC**
PV capacity	Off-grid	/	DC
	Decentralized	357	DC
	Centralized	505	DC
	Total	862	DC

SOURCE : SDES, Observ'ER, Enedis, *estimate HESPUL

Table 2: PV power installed during calendar year 2018.

			Installed PV capacity in 2018 [MW]	Installed PV capacity in 2018 [MW]	AC or DC
Grid-connected	BAPV	Residential	335	61*	DC
		Commercial		255	DC
		Industrial		19*	DC
	BIPV	Residential	22	22*	DC
		Commercial		0	DC
		Industrial		0	DC
	Utility-scale	Ground-mounted	505	505*	DC
		Floating		0	DC
		Agricultural		0*	DC
Off-grid		Residential	No data available		DC
		Other			DC
		Hybrid systems			DC
Total			862		DC

SOURCE : SDES, Observ'ER, Enedis *estimate HESPUL

Table 3: Data collection process.

Reported in AC or DC?	All power data is given in DC power
Body collecting data	Data supplied by all transmission and distribution grid managers is aggregated and published by the Service de la donnée et des études statistiques, Commissariat au Développement Durable, the Ministry for the Ecological and Inclusive Transition. Segmented data is published by the major distribution grid manager (Enedis), covering approximately 95% of the continental territory.
Link to official statistics	https://www.statistiques.developpement-durable.gouv.fr/les-energies-renouvelables?rubrique=21
Data quality	Data is of good quality but provisional and may be revised as additional information is provided by grid managers. Some divergence in capacity volumes may be present depending on the segments represented; the error source could be related to reporting dates, provisional data and/or collection methods.

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

Year	Off-grid [MW] (including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralized [MW] (Ground, floating, agricultural…)	Total [MW]
1992				1,8
1993				2,1
1994				2,4
1995				2,9
1996				4,4
1997				6,1
1998				7,6
1999				9,1
2000				11,3
2001				13,9
2002				17,2
2003				21,1
2004				24,2
2005				25,9
2006				37,5
2007	22,5	53	0	75,5
2008	22,9	150	7	179,9
2009	29,2	300	42	371,2
2010	29,3	938	242	1209,3
2011	29,4	2242	702	2973,4
2012	29,6	3052	1012	4093,6
2013	29,7	3454	1264	4747,7
2014	29,75	3963	1709	5701,75
2015	30,15	4257	2318	6605,15
2016	30,15*	4573	2598	7201,15
2017	30,15*	4985	3084(revised)	5015,15
2018	30,15*	5342	3589	8961,15

SOURCE: SDES and previous IEA NSR-FR reports (revised), PV Atlas Observ'ER and ADEME

* No data available

Table 5: Other PV market information.

<table>
<tr><th></th><th>2018</th></tr>
<tr><td>Number of PV systems in operation in your country</td><td>
<table>
<tr><th>Peak Power range</th><th>Installations (number)</th><th>Power (MW)</th></tr>
<tr><td>0 – 3 kW</td><td>301037</td><td>811</td></tr>
<tr><td>3 kW–9 kW</td><td>82 631</td><td>526</td></tr>
<tr><td>9 kW–36 kW</td><td>18 212</td><td>456</td></tr>
<tr><td>36 kW–100 kW</td><td>14 811</td><td>1 212</td></tr>
<tr><td>100 kW–250 kW</td><td>6 563</td><td>1 172</td></tr>
<tr><td>> 250 kW</td><td>1 551</td><td>4 740</td></tr>
<tr><td>Total</td><td>424 805</td><td>8 917</td></tr>
<tr><td>Total Off-grid</td><td></td><td>30</td></tr>
</table>
</td></tr>
<tr><td>Capacity of decommissioned PV systems during the year [MW]</td><td>0 (estimated)</td></tr>
<tr><td>Capacity of repowered PV systems during the year [MW]</td><td>0 to 10 (estimated)</td></tr>
<tr><td>Total capacity connected to the low voltage distribution grid [MW]</td><td>423 254 systems for 4 177,28 MW</td></tr>
<tr><td>Total capacity connected to the medium voltage distribution grid [MW]</td><td>1 478 systems for 4 098,91 MW</td></tr>
<tr><td>Total capacity connected to the high voltage transmission grid [MW]</td><td>73 systems for 640,9 MW</td></tr>
</table>

Table 6: PV power and the broader national energy market.

	2017	2018
Total power generation capacities [GW]	Total: 130,761 GW of which - Nuclear: 63,130 GW; - Fossil fuel: 18,947 GW; - RES: 48,685 GW (see below)	Total: 132,889 GW of which - Nuclear: 63,130 GW; - Fossil fuel: 18,588 GW; RES: 51,171 GW (see below)
Total renewable power generation capacities (including hydropower) [GW]	- PV*: 7,660 GW (5,9%); - Hydro: 25,517 GW; - Wind: 13,559 GW; - Other RES: 1,949 GW	- PV*: 8,527 GW (6,4%); - Hydro: 25,510 GW; - Wind: 15,108 GW; - Other RES: 2,026 GW
Total electricity demand [TWh]	482 TWh	478 TWh
Total energy demand [TWh]	153,6 Mtoe	154,3 Mtoe**
New power generation capacities installed in 2018 [GW]	Total: - 0,093 GW of which - Gas: +0,183 GW; - Coal: 0 GW; - Diesel: -3,039 GW; - Nuclear: 0 GW; PV and other RES: 2,763 GW (see below)	Total: 2,054 GW of which - Gas: +0,218 GW; - Coal: 0 GW; - Diesel: -0,657 GW; - Nuclear: 0 GW; PV and other RES: 2,493 GW (see below)
New renewable power generation capacities installed in 2018 (including hydropower) [GW]	- PV*: +0,887 GW; - Wind: + 1,797 GW; - Hydro: + 0,048 GW; Other RES: + 0,031 GW	- PV*: + 0,873 GW; - Wind: + 1,558 GW; - Hydro: - 0,011 GW; Other RES: + 0,073 GW
Estimated total PV electricity production (including self-consumed PV electricity) [TWh]	PV: 9,2 TWh	PV: 10,2 TWh
Total PV electricity production as a % of total electricity consumption	1,9%	2,1%

2017 : RTE France Electricity Report 2017.

2018 : RTE France Electricity Report 2018. *RTE provisionnelle PV figures differ from those of SDES, Bilan énergétique de la France métropolitaine en 2017. Bilan énergétique de la France en 2018, SDES ** Non energy uses included.

NOTE: The annual RTE France Electricity Report publishes provisional capacity values; the new power generation capacity is calculated using 2017 definitive data (not published here) and 2018 provisional data.

1.3 Key enablers of PV development

Table 7: Information on key enablers.

	Description	Annual Volume	Total Volume	Source
Decentralized storage systems	On residential sites	Mainland France: 3 818 Overseas: 212		www.consuel.com Consuel Rapport d'activité 2017
	Other sites	Mainland France: 31 Overseas: 9		
Residential Heat Pumps	Mono and multi-split reversible heat pumps	571 140	3 673 735	www.uniclima.fr Uniclima : Bilan 2018 et perspectives 2019 du genie climatique
	Thermodynamic domestic water heater	103 879	503 572	
	Total since 2012	675 019	4 177 307	
Electric cars	Electric cars	32 203	123 948	www.avere-france.org AVERE: Bilan 2018
	Lightweight utility vehicles	8 103	40 379	
	hybrid rechargeable cars	13 439	38 734	
	Total since 2010	53 745	203 061	

Note 1: the Uniclimat Bilan comments that "there has been observed to be a market for replacing heat pumps that were initially installed after the 2003 heatwave", and also that "Thermodynamic domestic water heaters in particular fulfill requirements for RES in new buildings".

Note 2: decommissioned units are not accounted for, the total volume may not represent the total volume in service.

2 COMPETITIVENESS OF PV ELECTRICITY

The Energy Regulator, CRE, has published statistical data based on the business plans submitted by candidates in the competitive Tenders from 2011 to 2018.

For more information, the CRE statistical analysis of the competitive tender candidate projects can be obtained on the CRE website: https://www.cre.fr/content/download/20543/261330.

2.1 Module prices

The business plans in the CRE study include the module prices that the candidates expect to pay. The lead time between project development and module acquisition is generally between 16 and 18 months. The module costs reported below are average costs according to the expected commissioning year, and are separated according to the system size.

Table 8: Typical module prices for a number of years.

Year	2011	2012	2013	2014	2015	2016	2017	2018
Average module price (all technologies) for systems in Tenders	2	1,5	/	0,7	0,6	0,7	/	/
Average module price (all technologies) for systems in Building Applied PV Tenders Over 90% of modules in the survey were monocrystalline silicium							0,6	0,6
Average module price (all technologies) for systems in ground based PV Tenders 60% of modules in the survey were monocrystalline silicium, 13% polycrystalline silicium and 27% thin film technologies							0,55	0,4

SOURCE : CRE “Coûts et rentabilités du grand photovoltaïque en métropole continentale”

Note: These costs are indicated for the year of commissioning, and are based on the costs that developers anticipate paying for modules in their business plans. The business plans have been submitted by developers in the competitive tender process, generally 12 to 18 months before module acquisition.

2.2 System prices

Table 9: Turnkey PV system prices of different typical PV systems.

Category/Size	Typical applications and brief details	Current prices [€/W]
Residential BAPV < 3 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.	2 – 3,5
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.	1,7 – 2,1
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.	1,0-1,2
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.	1,1-1,4
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	0,9-1,2
Small centralized PV 1-10 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.	0,8-1,0
Medium centralized PV 10-20 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.	0,6-0,8
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.	No data
Parking canopies up to 5 MW	Grid-connected, distributed PV systems installed over impermeable car parks to produce electricity to grid-connected industrial buildings, warehouses, etc.	1,3
Parking canopies 5 to 10 MW	Grid-connected, distributed PV systems installed over impermeable car parks to produce electricity to grid-connected industrial buildings, warehouses, etc.	1,1

for 2017 Trends: estimation HESPUL, sources Hespul/In Sun We Trust/Observ'ER

for 2018: FiT systems: estimation HESPUL. Tenders source CRE "Coûts et rentabilités du grand photovoltaïque en métropole continentale"

Table 10: 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]
2007	8,4	7,8		6,3
2008	8,2	7,6		6,2
2009	6,9	6,4		5,2
2010	5,9	5,5		4,5
2011	3,9	2,6		2
2012	3,7	2		1,6
2013	2,7	2		1,3
2014	2,6	2		1,3
2015	2,5	1,9		1,2
2016	2,41	1,58		1,1
2017	2,2	1,2		0,9 - 1,1
2018	2,2	1,2		0,7 - 0,9

NOTE - The table includes BIPV-IAB systems up to 3 kW until 2012, BIPV-IAB systems up to 9 kW from 2013 to 2016 and BAPV systems up to 9kW since 2017.

SOURCE: Previous IEA NSR-FR reports, VAT not included. *IAB: completely building integrated; **ISB: simplified building integration; BAPV building applied / roof top systems.

2.3 Cost breakdown of PV installations

The CRE study (see above) included turnkey for systems over 100 kW, by segment.

Table 11: Cost breakdown for a grid-connected, ground-mounted, centralized PV systems of >10 MW.

Cost category	Average [€/W]
Hardware	
Module	0,368
Inverter	0,062
Mounting material	
Other electronics (cables, etc.), including installation	0,2
Subtotal Hardware	**0,63**
Soft costs	
Planning	
Installation work	(included in Other Hardware costs)
Shipping and travel expenses to customer	
Customer acquisition	0,041
Permits and commissioning (i.e. cost for electrician, etc.)	0,074
Project margin	-
Subtotal Soft costs	**0,115**
Grid connection	0,071
Total (excluding VAT)	**0,816**
Average VAT	20%

SOURCE : CRE “Coûts et rentabilités du grand photovoltaïque en métropole continentale”

2.4 Financial Parameters and specific financing programs

Table 12: PV financing information in 2018.

Different market segments	Loan rate [%]
Average rate of loans–residential installations	5 % - 6 %* over 12 years
Average rate of loans–commercial installations	2,09% over 18 years
Average cost of capital–industrial and ground-mounted installations	2,63 % over 19 years

SOURCE : CRE “Coûts et rentabilités du grand photovoltaïque en métropole continentale”, *estimation Hespul

2.5 Specific investments programs

Table 13: Summary of existing investment schemes.

Investment Schemes	Introduced in France
Third party ownership (no investment)	Used for commercial and industrial systems (roof and land rental), but also to a lesser extent on new agricultural buildings.
Renting	A few small-scale operations in self-consumption models where building occupiers rent PV systems. Not common.
Leasing	Leasing is a common financing instrument in France for commercial systems. “Sofergie” (Energy Financing Company) provide credit or leasing options for projects developed by municipalities, social housing organisations, commercial companies and agricultural companies.
Financing through utilities	Some electric utilities (more often their subsidiaries) develop and invest in PV systems, but they do not offer finance for third parties. Utilities can access all support mechanisms, including FiT and Tenders for systems that they develop or own.
Investment in PV plants against free electricity	(See self-consumption)
Crowd funding (investment in PV plants)	Crowd-funding generally finances debt through crowd-funding platforms, however some platforms allow for equity financing. More than 60% of all projects in the competitive tenders were eligible for the crowdfunding bonus.
Community solar	Yes
International organization financing	No

The principal financing organizations are commercial banks (both French and foreign), debt funds (French and foreign insurers) and institutional lenders (European and national)

There is a wide range of financial instruments available in France for photovoltaics projects, including 7 funds (on 31/12/2018) that have obtained the Transition Énergétique et Écologique pour le Climat (TEEC) label, guaranteeing the environmental criteria of the investments (specifically relate to energy transition) and the respect of a certain number of additional financial criteria including transparency.

In 2018, about half of the 114 operations to raise capital for French cleantech companies were for renewable energy companies (769 M EUR)–for example, Neoen (450 MEUR, 1,6 GW of photovoltaics in construction or operation around the world) and GreenYellow (150MEUR, 190 MW of photovoltaics in construction or operation), both active in photovoltaics. These operations include capital investment, business angels, crowdfuding and floating on the stock exchange.

Portfolio financing

Portfolio financing/refinancing and large or utility-scale projects can make use of the European Investment Bank (European long-term investment fund—EIB) offers, generally for up to 80% of capital costs—the programme "France Energie Renouvelables II", signed in December 2017 has a total EIB contribution of 1125 MEUR. The programme runs through national banking partners and is available to both private and public-sector entities.

The EIB supports a number of renewable energy source (RES) investments funds available for photovoltaics projects. A risk-sharing project with financial institutions implemented in 2017 was replicated in 2018, and will operate until 2022, with a project investment cost of 1 800 MEUR for renewable energy plants including photovoltaics. According to the BEI, new financial institutions not involved in the 2017 project are expressing strong interest in developing similar partnerships.

Project financing

Project financing, classically used for infrastructure projects is based on project cash flows repaying project debt and equity. Project financing for privately owned projects is available through both commercial banks and bpifrance, a public investment bank. Public authorities can access financing from public long-term investors such as the Caisse des Dépôts (Deposits and Consignments Fund).

Project financing is also available through Sofergies - financial institutions that provide debt financing or leasing options for energy efficiency and renewable energy projects by municipalities, social housing organisation, commercial companies and agricultural companies.

Community solar (citizen investment)

Citizen investment is mobilised through specific citizen RES funds and crowd-funding platforms—financing both equity and debt. Launched in January 2018, EnRciT finances the development phase of large-scale citizen investment projects (community solar) with a 10 M EUR envelope available for 150 projects over the next 10 years.

Crowdfunding

Crowdfunding of RES projects was in significant progression (+89%)[1], of which 2/3, or approximately 24 MEUR was for 102 photovoltaic projects, stimulated by the feed-in tariff/premium bonus' within the competitive tenders. Whilst for most projects crowdfunding represents less than 5% of project finance, for building mounted photovoltaics it is a high 25%.

Residential project financing

Residential systems are financed through different schemes: 100% owner capital, home renovation loans or consumer credit loans.

[1] Baromètre 2018 du crowdfunding EnR en France, GreenUnivers.

2.6 Additional Country information

Table 14: Country information.

<table>
<tr><td>Retail electricity prices for a household</td><td colspan="4">Time of use contracts available.
Eurostat Band DC (2 500 kWh < consumption < 5 000 kWh)
• 175,0 €/MWh all taxes and levies included</td></tr>
<tr><td>Retail electricity prices for a commercial company</td><td colspan="4">Time of use contracts available.
Eurostat Band IB (20 MWh < consumption < 500 MWh):
• 128,4 €/MWh excluding VAT and other recoverable taxes and levies
• 153,4 €/MWh all taxes and levies included
Eurostat Band IC (500 MWh < consumption < 2 000 MWh):
• 98,2 €/MWh excluding VAT and other recoverable taxes and levies
• 117,4 €/MWh all taxes and levies included</td></tr>
<tr><td>Retail electricity prices for an industrial company</td><td colspan="4">Time of use, demand response, peak shaving contracts available
Eurostat Band ID (2 000 MWh < consumption < 20 000 MWh):
• 77,3 €/MWh excluding VAT and other recoverable taxes and levies
• 92,1 €/MWh all taxes and levies included</td></tr>
<tr><td>Population at the end of 2018</td><td colspan="4">67 992 699</td></tr>
<tr><td>Country size [km^2]</td><td colspan="4">543,965 km^2 EU, Corsica included</td></tr>
<tr><td>Average PV yield in [kWh/kW]</td><td colspan="4">1 160 kWh/kW (30° with system losses (PV GIS) – France mainland)
ranges from 900 kWh/kW to 1550 kWh/kW
(30° with system losses (PV GIS) – continental France)</td></tr>
<tr><td rowspan="5">Name and market share of major electric utilities</td><td></td><td>Electricity production
[%]</td><td>Share of grid Subscribers
[%]</td><td>Number of retail customers
[%]</td></tr>
<tr><td>EDF</td><td>Approx. 80%</td><td>76,7</td><td>78%</td></tr>
<tr><td>Engie / CNR</td><td></td><td>10%</td><td></td></tr>
<tr><td>Total Direct Energie</td><td></td><td>4%</td><td></td></tr>
<tr><td>E.On</td><td></td><td></td><td></td></tr>
</table>

SOURCE: INSEE, CRE, Eurostat [nrg_pc_204] and (nrg_pc_205) 2018S2 on 21 March 2019

3 POLICY FRAMEWORK

Table 15: 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	Yes	-	Yes, (competitive Tenders)	-	-	-
Feed-in premium (above market price)			Yes, (competitive Tenders)		Yes, (competitive Tenders)	
Capital subsidies	-	-	Yes, some regions	-	-	-
Green certificates	-	-	-	-	-	-
Renewable portfolio standards (RPS)	-	-	-	-	-	-
Income tax credits	-	-	-	-	-	-
Self-consumption	Yes	-	Yes	Yes	-	-
Net-metering	-	-	-		-	-
Net-billing	Yes	-	Yes	-	-	-
Collective self-consumption and virtual net-metering	Yes	-	Yes	-	-	-
Commercial bank activities e.g. green loans	-	-	-	-	Yes	Yes
Activities of electricity utility businesses	-	-	-	-	-	-
Sustainable building requirements	Yes	-	Yes	-	-	-
BIPV incentives	-	-	-	-	-	-

3.1 National targets for PV

France presented its revised National Low Carbon Strategy (SNBC) project in December 2018 after a lengthy consultation process, with a planned adoption in the second half of 2019. The strategy provides guidelines to an "ecological and inclusive transition towards carbon neutrality" by 2050, as it sets carbon budgets that are in principal legally binding for the public sector. Within the SNBC, photovoltaics is seen as a tool to be used in bringing the building sector to rely exclusively on carbon-free energy sources (including photovoltaics, and particularly in overseas territories). Environmental regulation, such as the E+C- building label trialled through 2018 should encourage the use of carbon free energy sources. The agricultural sector is also identified as capable of providing buildings for deploying photovoltaics on a large scale. For the energy sector, the strategy includes guidelines to "pursue and bolster measures favouring the development of renewable energies."

The SNBC project was partially built on a modelling process used to establish the revised Multi-annual Energy Programming (PPE), announced in November 2018 but published in January 2019.

The revised PPE established targets for the development of photovoltaics in France, setting a goal of 20,6 GW for 2023 (up from the previous PPE's 18,2 GW to 20,2 GW) and 35,6 GW to 44,5 GW for 2028.

3.2 Direct support policies for PV installations

The measures summarized in table 15, and their effectiveness, are described below.

Support measures include, for self-consumed electricity from systems under 1 MW, exemption from the CSPE surcharge, local electricity taxes and VAT (these taxes and levies normally represent approximately 30% of a consumer's electricity bill). Property tax exemptions for agricultural and public sector buildings equipped with photovoltaic systems are also in place, and thermal and environmental building regulations that should encourage the use of photovoltaics on new buildings.

3.2.1 Open volume feed-in tariffs for BAPV

Feed-in tariffs and net-billing with uncapped volumes for building applied systems under 100 kW levels are segmented according to system size and decrease each trimester, with the decrease pegged to grid connection requests for previous trimesters. The tariffs are adapted to regional irradiation levels, with specific tariffs for overseas regions. Tables 16a and 16b detail 4th quarter 2018 tariff levels.

Table 16a - Feed-in Tariff and Tender remuneration levels–Mainland France

Tariff category	Power of PV installation	Tariff Q4 2018 (EUR/MWh)
Continental France - building applied PV		
Ta (no self-consumption)	≤3 kW	185,9
Ta (no self-consumption)	3 kW to 9 kW	158,0
Tb (no self-consumption)	9 kW to 36 kW	120,7
Tb (no self-consumption)	36 kW to 100 kW	111,9
Call for Tenders	100 kW - 500 kW Building applied systems	Last 2018 average selling price (average EUR/MWh) 82,7

Table 16b: Feed-in Tariff and Tender remuneration levels–Overseas France

Tariff category	Power of PV installation	Tariff Q4 2018 (EUR/MWh)
Tariff base		9,73
Sample system in Guadeloupe	2 kW	223,4
Sample system in Corsica	8 kW	175,2
Sample system in Réunion	50 kW	157,7
Power factor		
≤3 kW 3 kW to 9 kW 9 kW to 36 kW 36 kW to 100 kW	1,35 1,2 1,1 1 0	= 9,73 x 1,35 x location factor = 9,73 x 1,2 x location factor = 9,73 x 1,1 x location factor = 9,73 x 1x location factor = 0
Location factor		
Guadeloupe & Martinique Corsica Réunion French Guiana Mayotte	17 15 16 18 19	= 9,73 x 17 x power factor = 9,73 x 15 x power factor = 9,73 x 16 x power factor = 9,73 x 18 x power factor = 9,73 x 19 x power factor

Note: To calculate overseas tariffs, multiply the trimestral tariff base by the power factor and a location factor—for exact tariffs, refer to CRE publications.

Note: there is also a time-based compensation for grid manager commanded disconnections.

3.2.2 Feed-in tariffs and Feed-in premiums in competitive tenders

Volume capped periodic competitive tenders for systems from 100 kW to 30 MW are segmented according to size and application (building applied, ground based etc), leading to either feed in tariffs (under 500kW) or feed-in premiums.

Ten competitive Tenders were called in 2018, for a total volume of 2,66 GW: for building applied, for ground-based systems, for self-consumption systems in continental France, for innovative systems and a wind/solar technology neutral competitive tender (see section 3.4).

3.2.3 BIPV development measures

The feed-in tariff bonus for small building integrated systems was finally phased out in October 2018, marking the end of more than a decade of targeted support mechanisms for building integration PV (BIPV).

The last bonus, only available for systems up to 9 kW, was 0,0075 EUR/kWh for grid connection requests received 3rd quarter 2018. Eligibility for the bonus was based on criteria from the previous (2011) Feed-in Tariff Order, with modules having to provide waterproofness.

Table 16c: Feed-in Tariffs for BIPV systems

Tariff category and PV system type	Power of PV installation	Tariff Q3 2018 (EUR/MWh)
Full building- integration (IAB)	P ≤ 3 kW	185,5 + 7,5 = 193,0
Full building- integration (IAB)	P ≤ 9 kW	157,7 + 7,5 = 165,2

Actual thermal regulations, and voluntary high-performance building labels–especially the "Bâtiments à Energie Positive et Réduction Carbone (E+/C-)" label that prefigure the future building thermal regulations - encourage photovoltaics and self-consumption as electricity consumed and exported from the building can be integrated into the performance calculations.

A tax credit for the elements producing thermal energy is available for residential hybrid PV-T systems as well as for some energy management systems.

3.3 Self-consumption measures

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

PV self-consumption	1	Right to self-consume	Individual self-consumption: consumer must also be PV producer. Virtual net-metering: producer(s) and consumers(s) must be linked by a common legal entity.
	2	Revenues from self-consumed PV	Lump-sum for partial self-consumption systems in association with net-billing FiT. Winning candidates in the Self-Consumption Tender (systems from 100 kW to 1 MW) will receive a bonus on self-consumption at the tendered rate. Self-consumed electricity is not subject to tax; however installed capacity may lead to capacity taxes, such as grid taxes.
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	Systems with total self-consumption pay no connection or recurrent grid access costs. Systems in collective self-consumption systems pay grid connection and recurring access fees.
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Net-billing set by FiT, or by Tender specifications (FiT or wholesale market + premium) or by PPA.
	5	Maximum timeframe for compensation of fluxes	Within FiT and Tenders no compensation, consumptions and grid injections managed separately. Timeframe varies with virtual battery storage offers (month, semester, year)
	6	Geographical compensation (virtual self-consumption or metering)	Called "collective self-consumption" in France. Limited to parties connected to the same low voltage substation, compensation on a ½ hour time-step.
Other characteristics	7	Regulatory scheme duration	20 years for surplus (net-billing) sold in FiT, 10 years in Self-consumption Tender.
	8	Third party ownership accepted	Only within framework of Self-consumption Tenders. The possibility of 3rd party ownership was one of the major discussion points during 2018 industry

			discussions, although no legislative changes were concluded or announced by the end of the year.
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Grid connection fees for systems over 36kVA. No grid access fees for total self-consumption systems. Reduced grid access fees for partial self-consumption systems (with net-billing). If the consumer is not the producer, energy taxes will apply.
	10	Regulations on enablers of self-consumption (storage, DSM…)	Electrical storage is considered as both a consumer and a generator when integrated into collective self-consumption.
	11	PV system size limitations	Automatic grid connection limited to systems < 36 kVA with no surplus injections and no grid fees– other systems require approval. Systems limited to 100 kW on buildings for access to net-billing and lump-sum within FiT framework. Systems must be between 100 kW to 1 MW for access to Tenders (it is possible in this context to have a producer sell directly to a consumer without the producer being a registered electricity supplier) Individual systems limited to 100 kW in collective self-consumption projects (although multiple systems may be involved in the operation) No structural limits.
	12	Electricity system limitations	Mainland, no limits. In overseas territories (ZNI), self-consumption systems must respect the same capacity and disconnect limits as full sale systems (ie active capacity must not go over 30% of consumption, grid manager disconnects on a first installed-last disconnected priority order.).
	13	Additional features	Markets sales of surplus in the framework of Tenders require access to an Aggregator. Collective self-consumption systems may not access FiT for excess production sales. Several virtual battery storage offers were offered on the market in 2018,

3.3.1 Net-billing feed-in tariff and lump sum for BAPV systems under 100kWp

Table 18: Net billing Feed-in Tariffs for BAPV systems

Tariff category	Power of PV installation	Net-billing tariff (+ lump sum) Q4 2018 (EUR/MWh)
Continental France - building applied PV		
Pa (net-billing)	≤3 kW	100 (+0,39 EUR/W installed)
Pa (net-billing)	3 kW to 9 kW	100 (+ 0,29 EUR/W installed)
Pb (net-billing)	9 kW to 36 kW	60 (+ 0,19 EUR/W installed)

3.3.2 Net-billing with feed-in premium

Winning candidates in the Self-Consumption Tender (systems from 100 kW to 1 MW) will receive a bonus on self-consumption at the tendered rate plus net-billing set by Tender specifications (wholesale market + premium).

3.4 Collective self-consumption, community solar and similar measures

3.4.1 Virtual net-metering

The legal framework surrounding collective self-consumption in France is that of virtual self-consumption within a geographical perimeter. The principal elements to the legal framework are that one or several generators supply one or several consumers, connected to the same substation. This last condition was a focal point of discussion through 2018, and should be modified to a 1 km perimeter in 2019. Virtual metering is implemented by the grid manager and requires communicating meters on all generation and consumption sites. Each operation must have a legal entity, whose primary role is to supply the grid manager with the virtual meter algorithms selected for the operation.

By the end of 2018, less than a dozen projects were operational (less than 50 consumers), although approximately 100 were expected to be in operation by late 2019.

Economic models for self-consumption systems are uncertain, as the competitivity of the self-consumed electricity (up to 0,16 EUR/kWh) is very dependent on consumer electricity costs.

3.4.2 Community Solar

3.5 Community solar is developed through citizen investment, generally built on access to feed-in tariffs. However, community groups have clearly stated their interest for self-consumption schemes, although the economic viability has not yet led to installations. The main non-profit organisation promoting community and citizen Tenders, auctions & similar schemes

3.5.1 Competitive tenders

Competitive tenders are the chosen tool for the French government to encourage the development of photovoltaic systems over 100 KW. Tender selection criteria are on a lowest price basis for commercial and self-consumption systems, but price weighted with additional environmental or land use criteria (low module carbon footprints and degraded urbanised sites are benefited), or even

innovation levels, for larger systems. Calls have continued from previous years, with some changes to Tender specifications, for example the maximum size of systems for the self-consumption Tender was increased to 1 MW from 500kW, and to 30 MW from 17 Mw for ground-based systems.

The Energy Minister establishes the Tender specifications, the CRE (Energy Regulator) manages the Tenders and transmits a list and analysis of the highest-ranking candidates to the Minister, who then determines and publishes the winning candidates. Remuneration (through Feed-in PPA, Feed-in premiums, bonuses etc.) is paid to operators by EDF (or, in certain areas, local public distribution grid managers, or other authorised organisations).

The CRE publishes a summary analysis after Tenders are awarded, making available aggregated and comparative information on the provenance of materials, average bids, etc.

There were 10 national call for tenders over 2018, with results published for nine, including the innovation and the technology competitive wind energy/ground-based solar energy tenders, for which all winning tenders were for solar power.

However, the national Energy Regulator, CRE, has emitted strong reserves on the building mounted systems for self-consumption tenders, as the average tendered rate was four times higher in the 2nd Call than the 1st. Significantly under-subscribed and with high tendered prices, the CRE recommended declaring the 3rd Call unsuccessful and suspending further Calls, citing high capital remuneration and lack of competition. The CRE reiterated these recommendations for the 4th Call, insisting on the economic feasibility of self-consumption systems competing in the tenders without any subsidies.

A number of Tenders had calls open in 2018, as detailed in Table 19 below.

Table 19: National tender volumes and results 2018

System type and size	Building mounted systems and parking canopies	Building mounted systems	Ground-based systems and parking canopies	Building mounted systems for self-consumption	Innovative solar systems	Wind and/or ground-based photovoltaic systems
Individual system size limits	100 kW to 500 kW	500 kW to 8 MW	Ground: 500 kW to 30 MW Canopies: 500 kW to 10 MW	100 kW to 1 MW	100 kW to 3 MW	5 MW to 18 MW
Support Mechanism	Call for Tenders 2017–2019	Call for Tenders 2017–2019	Call for Tenders 2017–2019	Call for Tenders** 2017–2020	Call for Tenders 2017–2019	Call for Tenders 2018
Volume	825 MW in 9 calls of 75 MW to 150 MW)	1050 MW in 9 calls of 75 MW to 150 MW	3,92 GW in 6 calls of 500 MW to 850 MW	450 MW in 9 calls of 50 MW	210 MW in 3 calls of 70 MW	200 MW in 1 call
Remuneration type	PPA***	FIP****	FIP	Self-consumption + bonus on self-consumption + FIP	PPA (5 MW) FIP (65 MW)	FIP
Number of Bids	6th call: 223 for 61 MW of bids (undersubscribed)	6th call: 26 for 53 MW of bids (undersubscribed)	4th call: 145 for 994 MW of bids	4th call: 39 for 16,3 MW (undersubscribed)	1st call: 164 for 259 MW of bids	
Average tendered price (or bonus for self-consumption)	6th call: 91,16 EUR/MWh	6th call: 77,21 EUR/MWh	4th call: 58,2 EUR/MWh	4th call: 29,8 EUR/MWh	1st call: 80,7 EUR/MWh	54,94 EUR/MWh

** Call for Tender is not limited to photovoltaics systems; other RES technologies are eligible

*** PPA = Power Purchase Agreement at tendered rate

**** FIP = Market sales + Additional Remuneration (Feed in premium) Contract at tendered rat

3.6 Other utility-scale measures including floating and agricultural PV

3.6.1 Place au Soleil Initiative

As a conclusion to the Place au Soleil initiative in June, the government announced that major land and infrastructure owners including the Army, the national railway (SNCF), France's five major supermarket owners would pledge to develop or make their land available for the development of large-scale photovoltaic systems.

3.6.2 Rural electrification measures

Rural electrification in France is primarily concentrated in overseas territories and isolated alpine activities. Overseas territories include remote or difficult to access zones with small villages with either no mini-grid or fossil fuel powered mini-grids, particularly in French Guiana and the Reunion Isle.

The national budget includes a line dedicated to off grid production in rural areas, with a 1,9 M EUR budget. However, it is unlikely that the whole budget was used, as the 2017 budget of 2 M EUR was itself underspent, with only 0,6 M EUR of costs engaged, and the government has indicated in the 2019 Budget that underspending is likely to continue to occur. A 2017 report for the government indicated difficult access and difficulties coordinating projects as reason for long delays.

3.6.3 Support for electricity storage and demand response measures

There are no universal support mechanisms for electricity storage in France. However, public demand has seen a slow development in the residential sector, despite the low economic returns.

Large scale storage

In the past there have been competitive call for tenders with mandatory storage for overseas territories, however none were called or awarded in 2018.

Individual / small scale storage

Whilst conditions are not favourable for the development of small-scale storage in France (relatively low electricity consumption costs and winter peak consumption profiles), there has been a slow uptake. There are no specific support programs in place.

Demand Response Measures

Time-of-use electricity rates are offered to consumers in France, with a significant emphasis on displacing winter peak consumption to late night/early morning. France has very high winter evening peak demand, reflecting the high penetration of resistive electric heating.

2018 saw competitive tenders run by the national Transport Grid Manager RTE for consumption reduction as a demand response measure to both contribute to grid stability and provide primary reserve production capacity. These Tenders are an explicit support measure for the development of demand response capacity.

In 2018, 48,9GWh of demand reduction was registered, through 2 different programs–and demand response supplied 10% of the primary reserve production capacity.

3.6.4 Support for electric vehicles (and VIPV)

A national subsidy of 6000 EUR was available for the purchase of electric cars. However, plug-in hybrid cars are no longer eligible. Electric trucks and buses were eligible for a 4000 EUR subsidy. An additional subsidy of 2 500 EUR was available if the purchase of an electric car was accompanied by the destruction of an older model petrol- or diesel-powered car. These subsidies were accompanied

by tax breaks such as accelerated depreciation and an exoneration of the company vehicle tax for companies purchasing electric cars or trucks.

A number of local authorities (including Paris) have subsidies for the purchase of electric vehicles including bicycles, scooters and private or commercial use cars. Many local authorities that normally collect a one-off tax on a vehicles first registration have waived the tax for electric vehicles.

A 30% tax credit on the costs of installing a charge station in a single or multiple-occupancy dwelling, plus direct subsidies from a number of local authorities was continued through 2018.

3.6.5 Curtailment policies

In France's ZNI (Non inter-connected zones, ie the French Antillies, French Guiana, Corsica and other small islands), the production from intermittent sources is limited to a maximum of 30% of consumption at any time. This maximum is maintained by disconnecting intermittent production sources (solar, wind…) on a last connected / first disconnected basis. EDF, who manages the grid in these zones, evaluates the number of hours they expect new projects to be disconnected from the grid to give new projects enough visibility to go ahead (or abandon).

3.6.6 Other support measures

France is a founding member, with India, of the Alliance Solaire Internationale (ASI). The ASI's primary goal is to massively reduce the costs of solar energy to accelerate the deployment of solar energy in countries between the tropics, through the creation of a "common market" for solar. The first international summit was held in 2018, when the government announced having already engaged 800 M€ of a promised 1 billion euros by 2022.

3.7 Financing and cost of support measures

Operator remuneration (through Feed-in PPA, Additional remuneration (market premium), bonuses etc.) is paid to operators by a designated Co-contractor (EDF, other authorised organisations or, in certain areas, local public distribution grid managers). The Co-contractor is compensated for over-costs from a dedicated account in the national budget (Energy Transition). This account is financed by a tax on petrol and its derivatives when used as an energy source for transport or heating.

Over-costs are calculated based on a typical production curve weighting of monthly average day time spot prices on the national electricity market. The estimated total cost of compensation for 2018 for photovoltaic contracts (Feed-in tariffs and premiums) is 2 738,4 M EUR (source CRE).

4 INDUSTRY

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

Table 20: Silicon feedstock, ingot and wafer producer's production information for 2018.

Manufacturers	Process & technology	Estimated Total Production
Photowatt EDF ENR PWT	mc-Si wafers [MW]	50 MW

Photowatt EDF ENR PWT was a vertically integrated manufacturer, manufacturing its own cells, wafers and modules. Its processes produced multicrystalline and quasi-monocrystalline ingots (Crystal Advanced Process). In June it created a subsidiary, Photowatt Crystal Advanced (in partnership with CSI and ECM Greentech), specialised in low carbon production of advanced technology silicon ingots and wafers, with a goal of increasing the current 50 MW capacity of the Bourgoin Jallieu (France) site to 500 MW

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.

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

Table 21: PV cell and module production and production capacity information for 2018.

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe, CIGS)	Production and/or capacity (MW/year)	
		Cell	Module
Wafer-based PV manufactures			
Irysolar (SEMCO technologies)		5	
S'Tile			15
EDF ENR PWT (Photowatt)	sc-Si, mc-Si, qc-Si		10 - 15
Reden Solar			65
Francewatts			2
Recom Sillia			300
SCNAsolar			60
Systovi			80
Sunpower (Total)			128
VMH Energies			60

Voltec Solar			70
Thin film manufacturers			
ARMOR	/		
Dracula Technologies	OPV		
Totals			**Approximately 1 GW**

The national industry is relatively small, with several manufacturers targeting specific niche markets, often related to building integration products (PV tiles, façade elements…) or small-scale production runs and pre-industrial research (Photowatt, Irysolar…), but often with strong public R&D / industry links. Several manufacturers have increased or plan to increase production capacity based on the market visibility given by the national competitive tenders:

- **ARMOR** develops proprietary organic "ASCA" films, targeting the market for connected devices, wearable photovoltaics as well as building integration applications (semi-transparent glazing…), with a manufacturing capacity of 1 million m^2 / year. A partnership agreement was signed with the UNESCO for the deployment of Armor products to school children in unelectrified areas of Togo.
- **Dracula Technologies** is a start-up developing printed organic photovoltaic cells (trademarked LAYER technology) aimed at the connected device market. Its pilot line was inaugurated in September.
- **Irysolar**, part of the ECM Greentech group, focus on supplying photovoltaic equipment manufacturing for the end to end value chain, from ingots to cells.
- **S'Tile** develops a 15 MW pilot line where their proprietary "i-Cells®" are assembled into modules since early 2017. The company develops a line of modules from 25 W to 200 W with customised formats for BIPV or off grid applications, such as integration into streetlights. They have a small range of standardised modules targeting high end building integration clients.
- **Photowatt/EDF ENR PWT** is a vertically integrated manufacturer of crystalline silicon materials. In January 2018 it announced significant changes to its industrial strategy, and in June it created a subsidiary, Photowatt Crystal Advanced (in partnership with CSI and ECM Greentech), specialised in low carbon production of advanced technology silicon ingots and wafers, with a goal of increasing the current 50 MW capacity of the Bourgoin Jallieu (France) site to 500 MW. In parallel, the Bourgoin Jallieu site, rebranded the Photowatt Lab is reducing it's module assembly lines to manufacturing 10 MW to 15 MW per year and will concentrate on research and development to "foster the emergence of new technological solutions" and test them in pre-industrial conditions.
- **Reden Solar** manufactures modules, but also develops and operates photovoltaic power plants. It's semi-automated and automated production lines manufacture modules but also PV powered streetlamps, street furniture and solar thermal equipment.
- **Recom Sillia** has increased the Lannion site production capacity from 50 MW to 300 MW in November, and has advanced plans for a new large scale heterojunction manufacturing facility in the region of Lyon.
- **Solems SA** manufactures thin-film elements and modules up to 30cm x 30 cm for connected devices and self-powered automates and building elements.
- **Sunpower (Total Group subsidiary)** has two factories in France: Tenesol Technologies in Toulouse and SunPower Manufacturing de Vernejoul, Moselle, and manufactures modules from PV laminates. The modules use single-crystal silicon back-contact cells manufactured by

overseas Sunpower factories, with industry high performances of up to 24%. In June Sunpowere announced a reduction of the Toulouse facility capacity, from 70 to 44 MW, citing the high, uncompetitive, manufacturing costs.

- **Systovi** assembles polycrystalline and monocrystalline. It also manufactures PV/thermal hybrid modules (hot air). Its manufacturing facilities were transferred to a new site at Carquefou, close de Nantes, in August after a 7 M€ investment from it's new owners, the Cetih group.
- **Voltec Solar** assembles modules on their Alsace site, and in 2018 announced its desire to more than double its manufacturing capacity.
- Other operator's such as Captelia (Imerys Toiture), manufacture PV tiles (size 45 cm × 31 cm and 136 cm × 50 cm respectively), while DualSun develops and markets photovoltaic-thermal hybrid modules (PV-T).

- **Sunpartner**, who adapted market available thin film laminates to create transparent building and transport integration products was declared insolvent in January 2019.
- **Francewatt**, who manufactured laminates that were assembled into building integration products, closed in September before being liquidated in November.

4.3 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain. There are a number of French companies with an international presence providing a full range of electrical solutions for connection, conversion and management of photovoltaic systems. The France solar Industry initiative is designed to showcase French know how across all solar technologies, and members are present from upstream (research and machine tools) all the way through the value chain from industry to support, installation and O&M.

PV inverters (for grid-connection and stand-alone systems)

Only a small handful of inverter manufacturers are French–a large multinational with a complete offer (string and centralised inverters), and other manufacturers with a small range of products targeting specific markets with (off grid, on grid, storage…).

Storage batteries

Market penetration remains very low for residential systems, although offers are present, and whilst national industry has international players (SAFT, EDF), deployment of large-scale storage is limited to overseas territories.

Supporting structures

France has, for the past 10 years, strongly encouraged fully building integrated PV, with preferential feed-in tariffs and access to Tenders, only being phased out over 2017/2018.

Photovoltaics, and their building integration or on-roof installation accessories, are not considered "traditional building techniques" in France, and as such require individual material and installation procedure certification (Avis Technique) before being accepted as viable solutions by most insurers. Obtaining an Avis Technique is a lengthy process, and cost returns are not evident when there is only a small market. The insurer representative body Agence Qualité Construction (AQC), placed most BIPV systems *under observation*[2] on the 1st January, increasing the difficulty of finding decennial building liability insurance for professionals installing building integrated photovoltaics systems. Whilst a number of manufacturers demonstrated the quality of their products to the satisfaction of the AQC and had their systems exempted (place on a Green List), others struggled through the year.

Some manufacturers that had previously invested in building-integration systems have now developed a wider range of supporting structures, and the domestic market is seeing, in particular, carport solutions for residential and commercial sites.

[2] See the 2017 report: "under observation" indicates that the AQC considers that these types of systems may lead to serial liability claims

5 PV IN THE ECONOMY

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

5.1 Labour places

The 2018 study Marchés et Emploie des ENR en France (Markets and Jobs in RES) by ADEME[3] indicates a provisional estimation of 7260 jobs, including2010 in operations and maintenance. This is an increase since 2016, reflecting market development.

Table 22: Estimated PV-related full-time labour places in 2018

Market category	Number of full-time labour places
Research and development (not including companies)	/
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	700
Distributors of PV products	/
System and installation companies	4360
Electricity utility businesses and government	/
Other - Operations and Maintenance	2010
Other - Design and consulting	150
Other - Export	40
Total	**7260**

5.2 Business value

Investments and turnover are studied for ADEME in the semi-yearly “Marches et emplois liés à l’efficacité énergétique et aux énergies renouvelables“.

An idea of the 2018 market size can be seen in manufacturers’ and distributors’ Market Declaration to PV Cycle. PV CYCLE is the national collective compliance and waste management scheme for WEEE and Battery products, with a special focus on photovoltaics. For the year 2018, 3,9 million modules were declared as marketed in France (down from 5,1 million in 2017, however up from 2016).

The market value for 2018 (below) has been estimated based on 2018 Trending prices and extrapolated official 2018 grid connection volumes. Data accuracy may be compromised by the use of Trends costs (these costs are from a reduced sample across France and may not accurately reflect real costs) and the volume estimate spread across segments for Industrial > 250 kW and ground-mounted systems. The following table represents the value of investments in PV systems.

[3] Unpublished, providing provisional estimates for 2017

Table 23: Rough estimation of the value of the PV business in 2018 (VAT is excluded).

Sub-market	Capacity installed in 2017 [MW]	Average price [€/W]	Value M EUR	M EUR (provisional)
Off-grid				/
Residential < 3 kW	32	2,5	80	
Residential < 9 kW	51	1,9	112	
Commercial < 100 kW	155	1,1	171	
Commercial < 250 kW	100	1,2	120	
Industrial > 250 kW	19	0,9	17	
Grid-connected distributed	**357**	**1,4**		**500**
Grid-connected centralized	**505***	**0,8**		**404**
Estimated Value of PV investments in 2018				**900 to 1200****

SOURCE : SDES, Observ'ER Baromètre Electrique 2018, France Terre Solaire Bilan 2018 *estimate HESPUL, Marches et emplois liés à l'efficacité énergétique et aux énergies renouvelables 2019, ADEME, unpublished. ** A range is published due to the approximate nature of data

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

France's electricity industry is highly concentrated but nominally not vertically integrated. To conform to European Directives, generation, transmission and distribution are managed by different legal entities: the national transmission grid (HVB) is managed by RTE, an EDF subsidiary, and much of the national distribution grid (95%) is managed by Enedis (ex-ERDF), another EDF subsidiary. These missions are run as "delegated public services". EDF is the principal generator in France with an extensive portfolio of nuclear power stations.

Retail sales and grid access are separate businesses, although the distribution grid manager has commercial agreements to delegate residential and small commercial client relations to retailers (electricity suppliers provide one-stop "integrated contracts").

The major actors in the French electricity market are private actors with partial state ownership - EDF and its subsidiary companies (the French government owns 83,7% of EDF's share capital), ENGIE (the French government owns 23,64% of ENGIE's share capital).

The national energy regulator, Commission de regulation de l'énergie (CRE) is an independent administrative authority and supervises market regulations, grid access conditions and manages competitive Tender processes. The CRE also judges conflict relating to grid access and must be consulted before the application of a range of grid access and management procedures, and before modifications are applied to the national Energy Code.

6.2 Interest from electricity utility businesses

France's major energy companies, EDF and ENGIE, are both major international players, with a wide international portfolio covering both fossil (and nuclear) and renewable energies. There are no legal or regulatory barriers to their active involvement in photovoltaics generation in France, although EDF must demonstrate a complete separation of its public service delegations (network management, electricity contracts on government regulated prices) and commercial activities.

EDF Renouvelables (EDF Renewable for the international branch), a subsidiary of EDF, EDF Renouvelables Services (O&M services in Europe), and EDF Energie Nouvelles Réparties (EDF ENR), its own subsidiary, are both active in France. EDF ENR is active in the residential market. A second subsidiary company, EDF EN Photowatt, is a photovoltaics manufacturer. EDF is also active in R&D activities through both EDF internal research departments, research partnerships with public research organisations and Photowatt. Through its different subsidiaries, EDF has installed more than 2 GW worldwide, and owns roughly half this capacity.

ENGIE is the biggest solar generator in France, with over 900 MW in operation, and a comprehensive offer on all market segments, from residential to public and private development of utility scale ground-based systems.

6.3 Interest from municipalities and local governments

Municipalities and local governments continue to be active participants in the growth of photovoltaics in France, both investing in projects, experimenting innovative projects (particularly collective self-consumption and the projects to facilitate grid integration), and facilitating citizen investment and grid integration.

Specific barriers continue to hamper local ambitions; the Feed-in tariff conditions are particularly difficult for local authorities to access as they tend to have infrastructure in close proximity, incompatible with Feed-in Tariffs (Feed-in Tariffs are limited to under 100 kW within a radius of

100m) and direct access to competitive tenders is also difficult, combining risk and binding calendar requirements generally incompatible with local authority direct investment.

However, as mandatory and voluntary climate action plans are deployed by local authorities, the need to develop photovoltaics increases, and investment on infrastructure belonging to local authorities continues to accelerate, either through direct investment or by third party investment (commercial, private-public investment vehicules or citizen-led).

7 HIGHLIGHTS AND PROSPECTS

7.1 Highlights

The new Energy Programme Decree (PPE) for photovoltaics has a 2023 target of 20,6 GW and a 2028 target of 35,6 GW to 44,5 GW. These targets may be ambitious, considering the current combined commissioned and project (grid connection queue) volume of approximately 13 GW. The PPE maintains and strengthens the priority given to the development of less costly ground based and parking canopy systems. A number of different measures were announced within this framework including:

- increasing the maximum size limit for systems in the self-consumption call for tenders to 1 MW, up from 500 kW;
- encouraging investments in innovative agrivoltaic or floating photovoltaics systems, as well as more citizen orientated measures such as affirming support for both local government and citizen investment in photovoltaics;
- enlarging the geographical perimeter for virtual collective self-consumption projects to better include urban development zones and eco-villages, and a dedicated call for tenders for these systems.

National photovoltaic capacity grew by 862 MW, less than the 884 MW in 2017 (591 MW in 2016), for a cumulative capacity of 8 917 MW for grid connected installations. Citizens have predominantly turned to partial self-consumption for residential systems, by T4 2018 approximately 2/3 of projects under 36 kW were for partial self-consumption. T4 2018 saw low volumes of large systems commissioned.

7.2 Prospects

The pipeline of competitive tender winning projects is significant, and 2019 should see over 1 GW of new systems installed

Individual and collective self-consumption will continue to develop, and the most significant market impact is likely to be the commissioning of self-consumption systems on supermarkets and commercial sites over 100kW with no form of public subsidy and an increase in very large utility scale projects as major public and private landholders (the army, supermarkets operators) make available their infrastructure to third parties.

Legal framework changes, including more flexible perimeters for collective (virtual) self-consumption and fiscal changes to facilitate third party investment in individual self-consumption systems are expected to be published in 2019.