



ADEME



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

National Survey Report of PV Power Applications in FRANCE 2016



PVPS

**PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME**

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Foreword

This report prepared by the French Environment and Energy Management Agency (ADEME), is part of a collaborative research project within the International Energy Agency PhotoVoltaic Power Systems programme (IEA-PVPS).

The French Environment and Energy Management Agency (ADEME) is a public organisation under the authority of the Ministry for the Ecological and Inclusive Transition and the Ministry of Higher Education Research and Innovation.

ADEME participates actively in the implementation of public policies in the areas of the environment, energy and sustainable development. The agency provides expertise and advisory services to businesses, local authorities and communities, government bodies and the public at large, to enable them to establish and consolidate their environmental action. The agency also helps finance projects, from research to implementation, in the areas of waste management, soil conservation, energy efficiency, renewable energies, air quality and the fight against noise.

ADEME, designated by the French Government, has signed the IEA-PVPS cooperation agreement and thereby participates in the Executive Committee of the IEA-PVPS programme; it also contributes to the work of Task 1 through its Energy Networks and Renewable Energy department (SRER). www.ademe.fr

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

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

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

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

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual “*Trends in photovoltaic applications*” report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2016. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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

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, SOeS, n° 89, February 2017 (2017 (Service de l’Observation et des Statistiques, the Ministry for the Ecological and Inclusive Transition)

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Atlas 2016 des grandes centrales PV > 1 MW, Observ’ER, Journal du photovoltaïque n° 19, Novembre 2016

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Bilan électrique 2016 (RTE Electricity Report 2016), RTE, February 2017 (Transport grid manager))

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Enerplan / ADEME – Etude de la compétitivité et des retombées de la filière solaire française – April 2017

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Couts énergies renouvelables en France ed. 2017, ADEME

NOTE : the "Service de l’observation et des statistiques" (SOeS) was renamed SDES : "Service de la Donnée et des Etudes Statistiques" in April 2017. For the purpose of this report, the name SOeS has been maintained, as it appears on the 2016 publications.

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 these elements. Other applications such as small mobile devices are not considered in this report.

This report on the state of the photovoltaics market in France for the year 2016 takes into consideration the deployment of systems installed, registered and connected to the national distribution or transmission grid from 1st January to 31st December 2016, unless otherwise stated. Systems may or may not have been commissioned in this period. Data collection does not yet include information on storage capacity or injection models (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 1 000 kWh/kWp, but that systems installed in the southern half of mainland France and in overseas territories will generate more, up to 1 400 kWh/kWp.

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 2016 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 have been and are installed in overseas territories (Guiana, etc.) or in mainland Alpine areas.

The Residential market, once an homogeneous market of 3 kW building integrated systems, has evolved through 2016, with the addition of building integrated 9 kW systems on the one hand, and micro self-consumption systems (500 W to 1,5 kW) on the other hand. Few systems between 9 kW and 36 kW are installed due to Feed-in Tariff ceilings and grid connection costs. These Residential systems represent approximately 14% of new capacity in 2016.

A small but significant intermediate segment is composed of systems close to the feed-in tariff limit of 100 kW, often on agricultural buildings (12% new 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 one of the dozen or so of France's major development companies (9% of new capacity).

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

A small but growing number of large-scale systems with storage are being installed in the overseas territories (French Antilles and Reunion).

1.2 Total photovoltaic power installed

Cumulative PV installed capacity as of the end of 2016 reached 7 164 MW (DC). Cumulative PV installed capacity by application is 30 MW for off-grid and 7 134 MW for grid-connected.

1.2.1 Data collection process

Data supplied by all transmission and distribution grid managers is aggregated and published by the SOeS, 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%.

For the purposes of this report, we have considered the following hypotheses for 2016 data:

Grid connected distributed systems:

- Residential: all systems under 9 kW are Residential BIPV (Completely Building Integrated Photovoltaics)¹
- Commercial: all systems 9 kW to 250 kW are Commercial BAPV (Building Apposed Photovoltaics);
- Industrial: all systems over 250 kW 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 over 250 kW 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.

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.

¹ The 2016 feed in tariffs in France for BAPV are half the feed in tariffs for BIPV: the difference is significant enough that it is reasonable to assume no BAPV systems where BIPV tariffs are available.

Table 1: PV power installed during calendar year 2016

			MW installed in 2016	AC / DC	
Grid-connected	BAPV	Residential	0	DC	
		Commercial (9 kW – 250 kW)	131	DC	
		Industrial (> 250 kW)	109	DC	
		Total of BAPV	240	DC	
	BIPV	Residential (< 9 kW)	76	DC	
		Commercial	0	DC	
		Industrial	0	DC	
		Total of BIPV	76	DC	
	Ground-mounted	cSi and TF	243	DC	
		CPV	0	DC	
		Total of ground-mounted	243	DC	
Off-grid		Total of off-grid	unknown		
			Total	559	DC

SOURCE: SOeS, Observ'ER, Enedis

Table 1b: PV power installed during calendar year 2016 (Unit: MW)

Sub-market	Application	MW
Grid-connected	Distributed (Mainly building-integrated applications)	316 (estimated)
	Centralized ground-mounted	243 (estimated)
	Total grid-connected	559
Off-grid	Off-grid rural electrification (mainly hybrid systems)	unknown

SOURCE: SOeS, Observ'ER, Enedis

Table 1c: Segmented Grid-connected PV power installed during calendar year 2016 (Unit: MW)

Power range	Application	Installation number	Power (MW)
0 – 3 kW	Completely building integrated (IAB)	5 462	15
3 kW – 9 kW	Completely building integrated (IAB)	8 916	61
9 kW – 36 kW	Simplified building integration (ISB)	423	11
36 kW – 100 kW	Simplified building integration (ISB)	798	69
100 kW – 250 kW	Simplified building integration (ISB)	268	51
> 250 kW	Large rooftops, ground-mounted plants	103	351
Total		15 970	559

SOURCE: SOeS

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	All power data is given in DC power
Is the collection process done by an official body or a private company/Association?	Data supplied by all transmission and distribution grid managers is aggregated and published by the SOeS, Service de l'Observation et des Statistiques, Ministry of Environment
Link to official statistics (if this exists)	http://www.statistiques.developpement-durable.gouv.fr/energie-climat/r/differentes-energies-energies-renouvelables.html?tx_ttnews%5Btt_news%5D=20647&cHash=470a0ab6e6d4aad97459c455743b12bf
Additional comments on market and data collection, especially the estimated accuracy of data.	Data is of good quality but provisional and may be revised as additional information is provided by grid managers

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

MW-GW for capacities and GWh-TWh for energy	2016 numbers	2015 numbers
Total power generation capacities (all technologies)	Total: 130 818 MW of which <ul style="list-style-type: none"> - Nuclear: 63 130 MW; - Fossil fuel: 21 847 MW; - RES: 45 842 MW (see below) 	Total: 129 310 MW of which <ul style="list-style-type: none"> - Nuclear: 63 130 MW; - Fossil fuel: 22 553 MW; - RES: 43 627 MW (see below)
Total power generation capacities (renewables including hydropower)	<ul style="list-style-type: none"> - PV*: 6 772 MW (5,2%); - Hydro: 25 482 MW; - Wind: 11 670 MW; - Other RES: 1 918 MW. 	<ul style="list-style-type: none"> - PV*: 6 191 MW (4,8%); - Hydro: 25 421 MW; - Wind: 10 312 MW; - Other RES: 1 703 MW.
Total electricity demand (= consumption)	483 TWh	476 TWh
New power generation capacities installed during the year (all technologies)	Total: 1699 MW of which <ul style="list-style-type: none"> - Gas: +881 MW; - Coal: -10 MW; - Diesel: -1359 MW; - Nuclear: 0 MW; - PV and other RES: 2 187 (see below). 	Total: 2085 MW of which <ul style="list-style-type: none"> - Gas: +63 MW; - Coal: -1 500 MW; - Fossil fuel: + 23 MW; - Nuclear: 0 MW; - PV and other RES: 1 999 (see below).
New power generation capacities installed during the year (renewables including hydropower)	<ul style="list-style-type: none"> - PV*: + 576 MW; - Wind: + 1345 MW; - Hydro: - 51 MW; - Other RES: + 215 MW. 	<ul style="list-style-type: none"> - PV*: + 895 MW (43%); - Wind: + 999 MW (48%); - Hydro: - 1 MW; - Other RES: + 105 MW.
Total PV electricity production in GWh-TWh	PV: 8,3 TWh	PV: 7,4 TWh
Total PV electricity production as a % of total electricity consumption	1,7%	1,5%

2015: SOURCE: RTE France Electricity Reports for 2015 and 2016.*RTE provisional PV figures differ from those of SOeS.

2016: RTE France Electricity Report 2016. *RTE provisional PV figures differ from those of SOeS (total PV 6772 MW for RTE, 7134 MW for SOeS)

Table 4: Other information

	2016		
	Power range	Installations (number)	Power (MW)
Number of PV systems in operation in your country (a split per market segment is interesting)	0 – 3 kW	284 368	764
	3 kW – 9 kW	62678	399
	9 kW – 36 kW	16945	422
	36 kW – 100 kW	11317	903
	100 kW – 250 kW	5786	1020
	> 250 kW	1288	3627
	Total Grid connected	382382	7134
	Total Off-grid		30
Capacity of decommissioned PV systems during the year in MW	N.A.		
Total capacity connected to the low voltage distribution grid in MW	381 094 systems for 3 507,46 MW		
Total capacity connected to the medium voltage distribution grid in MW	1 223 systems for 3 054,82 MW		
Total capacity connected to the high voltage transmission grid in MW	65 systems for 571,9 MW		

SOURCE: SOeS, ADEME

Table 5a: The cumulative installed PV power in 4 sub-markets.

Sub market	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Off-grid	21,5	22,5	22,9	29,2	29,3	29,4	29,6	29,7	29,75	30,15	30,15
Grid-connected centralized ground-mounted	0,0	0,0	7	42	242	702	1012	1264	1709	2318 (revised)	2561
Grid-connected distributed	16	53	150	300	938	2242	3052	3454	3963	4257	4573
Grid-connected total	16	53	157	342	1180	2944	4064	4718	5672	6575 (revised)	7134

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

Table 5b: Cumulative installed PV power, 1992-2005 (MW)

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1,8	2,1	2,4	2,9	4,4	6,1	7,6	9,1	11,3	13,9	17,2	21,1	24,2	25,9

SOURCE: ADEME

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 System prices

System price and price breakdown data is collected from the “Etude des retombées de la filière solaire française” study (I Care & Consult, for Enerplan / ADEME). Prices are average estimated prices based on models developed for previous studies, Enerplan (an industry association) member feedback and industry surveys. Consolidated data provided is for the year 2015, to ensure quality, coherent data in line with previous publications. Data may not be representative for small Residential systems as unaffiliated tradespeople may not be represented in survey groups. “Trends” data is based on limited surveys of industry stakeholders regarding system prices in 2016; the data is more recent but the survey sample is smaller and may be less reliable.

Table 7: Turnkey Prices of Typical Applications – local currency

Category/Size	Typical applications and brief details	Current prices (2015) per W (EUR/W)	Trends 2016 (EUR/W)
Grid-connected Rooftop up to 10 kW (residential)	Fully building integrated (IAB) < 3 kW Fully building integrated (IAB) 3 kW - 9 kW	< 3 kW: 3,39 3 kW - 9 kW: 2,41	< 3 kW: ↘2,9 3 kW - 9 kW: ↘2,2
Grid-connected Rooftop from 10 to 250 kW (commercial)	Building integrated (ISB) 36 kW - 100 kW (FiT) Roof top 100 kW - 250 kW (Tender)	36 kW-100 kW: 1,58 100 kW - 250 kW: 1,33	36 kW-100 kW: ↘1,2 100 kW - 250 kW: ↘1,2
Grid-connected Rooftop above 250 kW (industrial)	Roof top systems in framework of Tenders	1,25	↘ 1,2
Grid-connected Ground-mounted above 1 MW	Ground mounted systems in framework of Tenders	1,10	↘ 0,9 - 1,1
Other categories (hybrid diesel-PV, hybrid with battery...)		demonstration systems only	

SOURCE: for 2015: “Etude de la compétitivité et des retombées de la filière solaire française” study (I Care & Consult, for Enerplan / ADEME, for 2016 Trends: HESPUL

Table 8: National trends in system prices (current) for different applications – local currency

Price/Wp	NSR 2007	NSR 2008	NSR 2009	NSR 2010	NSR 2011	NSR 2012	NSR 2013 *	NSR 2014 *	NSR 2015 *	NSR 2016 *
Residential < 10 KW (BIPV - IAB < 9 kW)	8,4	8,2	6,9	5,9	3,9	3,7	2,7	2,6	2,5	2,41
Commercial and industrial (BIPV - ISB rooftop 36 kW - 100 kW)	7,8	7,6	6,4	5,5	2,6	2,0	2,0	2,0	1,9	1,58
Ground-mounted (Centralized ground-mounted > 1 MW)	6,3	6,2	5,2	4,5	2,0	1,6	1,3	1,3	1,2	1,10

*NOTE - The Table includes BIPV-IAB systems up to 3 kW until 2012, and BIPV-IAB systems up to 9 kW since 2013.

SOURCE: Previous IEA NSR-FR reports, VAT not included. *IAB: completely building integrated; **ISB: simplified building integration.

2.2 Cost breakdown of PV installations

1.1.1 Residential PV System < 10 kW

Table 9: Cost breakdown for a residential PV system – local currency

Cost category	9 kW BIPV (IAB) (EUR/W)	9 kW roof-top lowest residential prices (EUR/W)	3 kW BIPV (IAB) highest residential prices (EUR/W)
Hardware			
Module	0,59	0,59	0,62
Inverter	0,16	0,16	0,18
Other (racking, wiring...)	0,54: 0,25(electricity) + 0,29(structure)	0,37: 0,25(electricity) + 0,12(structure)	0,68: 0,35(electricity) + 0,33(structure)
Soft costs			
Installation	0,65: 0,17(electricity) + 0,45(structure) + 0,03(un-tiling)	0,39: 0,17(electricity) + 0,21(structure) + 0,01(un-tiling)	0,94: 0,2(electricity) + 0,71(structure) + 0,03(un-tiling)
Customer Acquisition	0,15	0,15	0,4
Profit	(not surveyed)	(not surveyed)	(not surveyed)
Other (permitting, contracting, financing...)	0,18(grid connection) 0,14(other roof works)	0,18(grid connection) 0,00(other roof works)	0,41(grid connection) 0,16(other roof works)
Subtotal Hardware	1,29	1,12	1,48
Subtotal Soft costs	0,8(without other costs)	0,54	1,34(without other costs)
Total Installed Cost	2,09(without other costs) 2,39(with other costs)	1,66(without other costs) 1,84(with other costs)	2,82(without other costs) 3,39(with other costs)

SOURCE: I Care & Consult – Etude compétitivité et retombées de la filière solaire française – April 2017

1.1.2 Utility-scale PV systems > 1 MW

Table 10: Cost breakdown for a utility-scale PV system – local currency

Cost Category	Average (EUR/W)
Hardware	
Module	0,53
Inverter	0,1
Other (racking, wiring, etc.)	0,15: 0,05 (electricity + monitoring) + 0,1 (structure + fencing)
Soft cost	
Installation Labor	0,07
Customer acquisition	0,09
Profit	(not surveyed)
Other (contracting, permitting, financing etc.)	0,16: 0,05 (studies) 0,06 (grid connection) 0,05 (grid upgrade)
Subtotal Hardware	0,78
Subtotal - Soft cost	0,16 (without other costs)
Total Installed Cost	0,94 (without other costs) 1,09 (with other costs)

SOURCE: I Care & Consult – Etude compétitivité et retombées de la filière solaire française – April 2017

2.3 Financial Parameters and specific financing programs

There is a wide range of financial instruments available in France for photovoltaics projects.

Portfolio financing/re-financing 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 – programme “France Energie Renouvelables”: 50 M EUR CAPEX and 25 M EUR of loans.

The EIB also ran two regional programmes that were available for photovoltaics in 2016, in the Centre and Aquitaine regions. Both public and private corporations were eligible.

The support mechanisms in France in 2016 – Feed-in Tariff and PPA in Tenders both encourage the creation of project companies, requiring project financing. Project financing, classically used for infrastructure projects is based on project cash flows repaying project debt and equity. Project financing is available through commercial banks and bpifrance (public investment bank).

Public authorities can make use of specific “green loans” from public long term investors such as the Caisse des Dépôts (Deposits and Consignments Fund). The Caisse des Dépôts also invests in project equity.

Commercial project financing is also available through a Sofergie (Energy Financing Company) - a type of financial institution existing specifically for financing investments in energy efficiency and renewable energies. Sofergies provide debt financing or leasing options for projects developed for, or by municipalities, social housing organisation, commercial companies and agricultural companies.

Citizen investment is mobilised through specific citizen RES funds and crowd-funding platforms – financing both equity and debt.

Consolidating on growing interest by local authorities for developing local energy productions, and encouraging citizen investment, 2016 saw a number of related publications, including Financing the Development of Local RES Projects (Financement du développement de projets d'énergie renouvelable d'intérêt territorial) by the CLER / Caisse des dépôts, Legal and Regulatory Framework for citizen investment in RES (Étude du cadre législatif et réglementaire applicable au financement participatif des énergies renouvelables) by ADEME / RAEE.

September saw the publication of a decree modifying citizen and crowd-funding regulations for RES projects, as part of the Energy Transition Act for Green Growth. This decree opened new possibilities for citizen groups and crowd-funding platforms, raising the ceiling for public offers to 100 000 EUR, or up to 5 MEUR (on the condition that the public offer be for less than 50% of existing equity). Crowd-funding platforms may now publish offers for up to 2.5 M EUR for RES projects. Previous regulations restricted public offers to very small amounts or forbade all publicity.

Several local authorities have also created RES Investment funds, such as the Nouvelle Aquitaine Region, that launched an 8.2 M EUR fund called Terra Energies in April 2016; or the OSER RES capital risk fund created in 2014 by the Region Rhône-Alpes.

Residential systems are financed through different schemes: 100% owner capital, home renovation loans or consumer credit loans. Consumer credit loans, close to double the cost of home renovation loans, offered with so-called “self-financing” photovoltaic systems by targeted marketing are a recognised problem, with many unwary private citizens having bought systems at double (or more) market prices on credit, with pay back times of up to 30 or 40 years.

Table 11: PV financing scheme (debt financing)

Average rate of loans – residential installations	5,65%
Average rate of loans – commercial installations	3,45%
Average cost of capital – industrial and ground-mounted installations	3,45%

SOURCE: I Care & Consult – Etude compétitivité et retombées de la filière solaire française – April 2017

2.4 Specific investments programs

Third Party Ownership (no investment)	Used for commercial and industrial systems (roof and land rental). Generally only viable for projects with a high rate of return.
Renting	A few small scale operations in self-consumption models where building occupiers rent PV systems. Not common yet.
Leasing	Leasing is a common financing instrument in France, with a type of financial institution existing specifically for financing investments in energy efficiency and renewable energies. Called “Sofergies” (Energy Financing Company), they 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)	<p>Crowd-funding can provide equity through citizen investments funds (Energie Partagée) or more rarely crowd-funding platforms, but also finance debt through crowd-funding platforms.</p> <p>Crowd-funding and citizen investment rules were modified by the Energy Transition Act for Green Growth application decrees published in September 2016, giving more flexibility to citizen projects.</p>
Other (please specify)	Reduced taxes (on self-consumed electricity) and accelerated depreciation on self-consumption systems have been used in 2016.

2.5 Additional Country information

Table 12: Country information

Retail Electricity Prices for an household (range)	<p>Time of use contracts available.</p> <p>Eurostat Band DC (2 500 kWh < consumption < 5 000 kWh)</p> <ul style="list-style-type: none"> • 17,11 c€/kWh all taxes and levies included
Retail Electricity Prices for a commercial company (range)	<p>Time of use contracts available.</p> <p>Eurostat Band IB (20 MWh < consumption < 500 MWh):</p> <ul style="list-style-type: none"> • 11,0 c€/kWh excluding VAT and other recoverable taxes and levies • 12,94 c€/kWh all taxes and levies included <p>Eurostat Band IC (500 MWh < consumption < 2 000 MWh):</p> <ul style="list-style-type: none"> • 8,93 c€/kWh excluding VAT and other recoverable taxes and levies • 10,56 c€/kWh all taxes and levies included
Retail Electricity Prices for an industrial company (range)	<p>Time of use, demand response, peak shaving contracts available</p> <p>Eurostat Band ID (2 000 MWh < consumption < 20 000 MWh):</p> <ul style="list-style-type: none"> • 7,43 c€/kWh excluding VAT and other recoverable taxes and levies • 8,84 c€/kWh all taxes and levies included
Population at the end of 2014 (or latest known)	31/12/2016: 66 991 000
Country size (km ²)	543 965 km ² EU, Corsica included

Average PV yield (according to the current PV development in the country) in kWh/kW	1 160 kWh/kW (30° with system losses (PV GIS) – France mainland) ranges from 900 kWh/kW to 1 550 kWh/kW (30° with system losses (PV GIS) – continental France)
Name and market share of major electric utilities.	EDF approx. 76% by electricity or 85% by number of sites Engie/CNR approx. 11% non-residential sites/energy Engie/CNR approx. 4% residential sites/energy A dozen or so minor suppliers.

SOURCE: Mediateur de l'Energie, Eurostat, CRE, Eurostat [nrg_pc_204] and (nrg_pc_205) 2016S2

3 POLICY FRAMEWORK

3.1 Direct support policies for PV installations

3.1.1 New, existing or phased out measures in 2016

3.1.1.1 Description of support measures excluding BIPV, and rural electrification

2016 saw the publication of the Energy Transition Act for Green Growth Act application decrees defining RES Support Mechanisms (May) and the Energy Programme Decree (PPE) in November. The new RES support mechanisms include Feed-in Tariffs for systems under 100 kW and Tenders for systems over 100 kW with Feed-in tariffs (systems under 500 kW) and market premiums for systems over 500 kW.

National target volumes for photovoltaics in the PPE decree are set to increase from 6.6 GW cumulative capacity mid-2016 to 10.2 GW by the end of 2018. The decree provided a provisional calendar for future Calls for Tender for RES capacity, with 1 GW per year planned in ground based photovoltaic plants and 0.45 GW per year planned on building mounted photovoltaic systems over 100 kW.

The existing Feed-in Tariff was continued through 2016, but limited to building mounted systems under 100 kW by the May decree (although the tariff levels determined by the Feed-In tariff Order remain unchanged under this threshold).

The nation-wide mandatory deployment of the Linky communicating meter kicked off in 2016 (to be completed by 2021), and has provided an indirect support measure for small partial self-consumption systems by removing grid connection costs (more than 12% of the price of 3 kW systems, making partial self-consumption schemes more financially attractive than before).

Tenders called from 2016 will provide market premiums for systems over 500 kW (or over 100 kW in self-consumption Tenders), a significant change to previous practice. Operators will be required to better understand market mechanisms, and new services (aggregators) have appeared.

Tariff bonuses (3 EUR/MWh) for participative and municipal investments are offered in Call for Tenders since early 2016, and have proven popular (28 of the 72 winning bids in the Self-consumption Call).

The Feed-tariff for ground based and non-building-integrated systems until 2nd quarter 2016 was 58 EUR/MWh, and for building mounted non-integrated systems under 100 kW in the 4th quarter 2016 was 55 EUR/MWh.

3.1.1.2 BIPV development measures

France's Feed-in Tariffs in 2016 are predominantly aimed at encouraging BIPV, with tariffs for completely building integrated systems (IAB- the photovoltaic modules replace roof elements, are the main waterproofing element and do not exceed the roof plan by more than 2 cm) and simplified building integration (ISB- the photovoltaic modules replace roof elements and are mounted parallel to the roof plan).

Modifications to the Feed-in tariffs were introduced in May, eliminating FiT support for non-building mounted photovoltaic systems. See table 13a for details.

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 is available for residential hybrid PV-T systems, with air-based systems being building integrated.

Table 13a: Feed-in Tariff and remuneration levels

Tariff category and PV system type	Power of PV installation (w)	Tariff Q4 2016 (EUR/kWh)
T1 - Full building- integration (IAB)	$P \leq 9 \text{ kW}$	0,239
T4 - Simplified building- integration (ISB)	$P \leq 36 \text{ kW}$	0,124
T4 - Simplified building- integration (ISB)	$36 \text{ kW} < P \leq 100 \text{ kW}$	0,118
Call for Tenders	100 kW - 250 kW	Average selling price (EUR/Average MWh) 131,25

3.1.1.3 Rural electrification measures

Off-grid electrification is concentrated in overseas territories and for 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. For overseas territories, tropical climates and difficult local economic conditions or regulations (see below) have meant that rural electrification has not been completed as rapidly as in mainland France. For 2016, 24 publicly co-funded systems were budgeted for a total of 2 M EUR. (1.2 M EUR spent in 2015). However, a 2017 report by the Senate mentions that whilst there is an identified need for a number of projects, site access, project management and procurement problems mean projects end up over budget and are delivered late. (2017 budget, Senat report, “Compte d'affectation spéciale "Financement de l'aide aux collectivités pour l'électrification rurale" » by M. Jacques GENEST, rapporteur spécial)

3.1.1.4 Support for electricity storage and demand response measures

Security of supply, grid stability and high fossil fuel generation costs are important issues in France's overseas territories. Regulations limit RES capacity to a 30% penetration to theoretically reduce load imbalance risks. Storage and electric vehicles are regarded as key elements to allowing higher penetration rates for RES.

Large scale storage

Winning candidates for May 2015 Call for Tenders for systems with storage in ZNI territories were announced in June 2016; of the 356 MW of submitted projects, 52 MW were selected with an average contract tariff of 204 EUR/MWh. Half of the volume will be built in the French Antilles (including Guiana). Half of the volume will be ground mounted or parking canopy systems, the rest building-mounted. An expected 70 GWh will be produced annually from these systems, for 140 M EUR of investments.

A second Tender for 50 MW of systems over 100 kW with storage in the ZNI was launched in December 2016, with a closing date in June 2017. The Tender has 3 categories:

1. 10 MW of building mounted or parking canopy systems 100 kW to 250 kW,
2. 15 MW of building mounted or parking canopy systems 250 kW to 1,5 MW and
3. 25 MW for ground based systems from 250 kW to 5 MW.

Bids must be from 100 EUR/MWh to 300 EUR/MWh for Categories 1 and 2, and between 50 EUR/MWh and 250 EUR/MWh for Category 3. Environmental performance is included in the weighted notation scheme, with a low carbon footprint required for modules and the exclusion of previously un-urbanised land for ground mounted systems (specifically agricultural zones). Storage capacity must be at least 0.5 kWh per kW installed.

Individual / small scale storage

There is growing interest for individual storage systems, with approximately 300 systems declared in mainland France (Private communication, Enedis December 2016). The project Millener, which ran from 2011 to 2015, installed 200 home systems with 4 kWh nominal storage capacity across overseas territories (the primary goal was experimental grid frequency management). Other experimental smart-grids programmes have deployed dispersed and semi-centralised storage in experimental zones, for example the NICEGrid experiment that terminated in December 2015 (1.5 MWh disseminated storage on 15 sites). No consolidated data is available as of yet.

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. However, many of the mobile peak time-of-use offers for commercial consumers were on government regulated contracts that were phased out on 1st January 2016 – approximately 1 GW of demand response on mobile peak days was terminated at this date. An adjustment mechanism (since 2003) and demand response exchange (remuneration on electricity market- since 2013) have financed approximately 2 100 MW of demand response capacity, predominantly from industrial consumers. An additional mechanism became operative on 1st January 2017.

With the deployment of the Linky communicating meter, expected to be complete by 2021, more mobile peak time-of-use offers are expected to be developed by suppliers.

Experimental storage – Power to Gas

The Jupiter 1000 is a large scale experimental Power-to-Gas project that will combine 1MW of RES with a Power to Gas installation. This project is financed through European Regional Development Funds, the Investissements d'Avenir state programme, regional government and private participation. Announced late 2015, it should be operational in 2018.

Table 13: PV support measures (summary table)

	On-going measures residential	Measures that commenced during 2016 - residential	On-going measures Commercial + industrial	Measures that commenced during 2016 – commercial + industrial	On-going measures Ground-mounted	Measures that commenced during 2016 – ground mounted
Feed-in tariffs	Yes, see table 13a	Limited to building mounted systems	Yes, within Tenders for systems 100 kW to 500 kW	Limited to building mounted systems under 100 kW	Yes, within Tenders for systems from 500 kW	Yes, within Tenders for systems with storage in ZNI
Feed-in premium (above market price)	No	No	No	Yes, within Tenders, for systems over 500 kW or self-consumption	No	Yes, within Tenders, for systems over 500 kW
Capital subsidies	No	No	For TEPCV territories for non-FIT systems	For new TEPCV territories for non-FIT systems	No	No
Green certificates	No	No	No	No	No	No
Renewable portfolio standards (RPS) with/without PV requirements	No	No	No	No	No	No
Income tax credits	No	Tax credits for PV-T hybrid systems, only the thermal elements are eligible	Tax reductions to encourage investment in plant and equipment to improve productivity : special depreciation of 40%	No	No	No

			(valid April 2015 to April 2017)			
Self-consumption	No	No support mechanism but a regulatory framework was established	No	Yes, within Tenders for self-consumption	No	No
Net-metering	No	No	No	No	No	No
Net-billing	No	No	No	No	No	No
Collective self-consumption and virtual net-metering	No	Framework initiated, not completed	No	Yes, within Tenders for self-consumption	No	No
Commercial bank activities e.g. green mortgages promoting PV	There are various financing options as an extension of home improvement loan.		EIB financing programmes through regional banks		EIB financing programmes	
Activities of electricity utility businesses	No	Alternative supplier Enercoop will buy at a fixed rate (lower than FiT but no integration conditions)	No	Alternative supplier Enercoop will buy at a fixed rate (lower than FiT but no integration conditions)	No	No
Sustainable building requirements	Yes – self-consumption and electricity exports can be counted in energy balance to meet thermal regulations	No	Thermal regulations and voluntary building performance labels may include PV generation in energy	No	N/A	N/A

	for new buildings		balance calculations			
BIPV incentives	FiT for BIPV and BAPV systems – see tariff structure table 13a		FiT has specific tariffs for BAPV systems	Building integration is no longer obligatory for candidate systems in Tenders		
Other (specify)	<p>Reduced value added tax for systems under 3 kW (10% instead of 20%)</p> <p>FiT revenue not taxed for systems under 3 kW</p> <p>Systems under 9 kW exonerated from land taxes (CFE)</p>		Systems on agricultural buildings exonerated from certain land taxes (TFPB)			

3.2 Self-consumption measures

Self-consumption measures are described below, and follow the methodology defined in the IEA Self-consumption Report Methodology.

PV self-consumption	1	Right to self-consume	<p>Legal framework initiated in 2016, application decrees published in 2017.</p> <p>Individual self-consumption: consumer must also be PV producer. Collective self-consumption: producer(s) and consumers(s) must be linked by a common legal entity.</p>
	2	Revenues from self-consumed PV	<p>Winning candidates in the Self-Consumption Tender (systems from 100 kW to 500 kW will receive a bonus on self-consumption at the tendered rate.</p> <p>Self-consumed electricity is not subject to tax; however installed capacity may lead to capacity taxes, such as grid taxes.</p>
	3	Charges to finance Transmission & Distribution grids	<p>Systems with total self-consumption pay no connection or recurrent grid access costs.</p> <p>Systems in collective self-consumption systems will pay grid connection and recurring access fees (fees not yet determined).</p>
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	Set by FiT, or by Tender specifications (FiT or wholesale market + premium).
	5	Maximum timeframe for compensation of fluxes	No compensation, consumption and production sales managed separately.
	6	Geographical compensation	Called “collective self-consumption” in France. Legal framework sketched in 2016, but application decrees and administrative procedures published in 2017. Limited to generators and consumers connected to the same low voltage substation, compensation on a ½ hour time-step.
Other characteristics	7	Regulatory scheme duration	20 years for surplus sold in FiT, 10 years in Self-consumption Tender.
	8	Third party ownership accepted	In 2016 some experimental commercial trials were conducted but the legal foundation is uncertain.
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	<p>Not yet clear: large systems will pay grid code fees.</p> <p>If the consumer is not the producer, energy taxes will apply.</p>

	10	Regulations on enablers of self-consumption (storage, DSM...)	Not in 2016.
	11	PV system size limitations	Systems limited to < 36 kVA for automatic grid connection with no surplus injections and no grid fees. Systems must be between 100 kW to 500 kW 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) 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.
	13	Additional features	Markets sales of surplus in the framework of Tenders require access to an Aggregator. Several regional authorities provided investment subsidies or preliminary feasibility study subsidies through Project Calls. Self-consumption investment bonus planned for systems under 100 kW from mid-2017.

3.3 Collective self-consumption, community solar and similar measures

Collective self-consumption was defined in an August 2016 Order – however, all details for implementation require ratification by Law and application Decrees (published in 2017). The Order defines collective self-consumption as “the supply of electricity produced by one or more generators to one or more consumers, linked by a common legal entity”. It also specified that generators and consumers must be on the same low voltage feeder (extended to all feeders on the same substation upon ratification, in February 2017). Implementation will use virtual metering managed by grid managers, with the algorithm for the allocation of kWhs supplied by the common legal entity. Economic models are uncertain, as the competition between feed-in tariffs (up to 0.23 EUR/kWh) and self-consumed electricity (up to 0.16 EUR/kWh) is very dependent on the very competitive consumer electricity costs.

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.

3.4 Tenders, auctions & similar schemes

The French government has chosen to control the development of PV systems over 100 kW through Tenders awarded on a lowest price basis (with additional criteria on environmental performance for ground-mounted 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. Selection criteria are either exclusively on the requested remuneration level (self-consumption, commercial systems) or on a combination of

requested remuneration level and environmental performance. Environmental performance is based on photovoltaics module carbon footprint for all Calls, and previous land use for ground mounted systems, with highest marks for degraded urbanised sites.

Remuneration (through Feed-in PPA, Additional remuneration, bonuses etc.) is paid to operators by EDF (or, in certain areas, local public distribution grid managers, or other authorised organisations). EDF is compensated for over-costs through the Electricity as a Public Service Charge (CSPE). The CSPE fund is financed by all electricity consumers through the CSPE surcharge on electricity bills.

Five different Tenders were launched, each for specific market segments.

Operators are free to negotiate private PPA at market conditions. Currently, wholesale market conditions for PPA are not as attractive as the national Tenders, however self-consumption is garnering interest.

System type and size	Building mounted systems and parking canopies 100 kW to 500 kW	Building mounted systems 500 kW to 8 MW	Ground based systems 500 kW to 17 MW and parking canopies 500 kW to 10 MW	Systems 100 kW to 5 MW in non-interconnected zones (ZNI*)	Building mounted systems for self-consumption
Support Mechanism	Call for Tenders 2017-2019, launched 09/09/2016	Call for Tenders 2017-2019 launched 09/09/2016	Call for Tenders 2017-2019 launched 24/08/2016	Call for Tenders 2017 launched 16/12/2016	Call for Tenders** 2016-2017 launched 01/08/2016 (continental) launched 16/12/2016 (ZNI)
Volume	675 MW in 9 calls of 75 MW	675 MW in 9 calls of 75 MW	3 GW in 6 calls of 500 MW	50 MW with storage in 1 call	40 MW in 2 calls of 20 MW (continental) 20 MW in 1 call (ZNI)
Remuneration type	Power Purchase Agreement at tendered rate	Market sales + Additional Remuneration Contract at tendered rate	Market sales + Additional Remuneration Contract at tendered rate	Power Purchase Agreement at tendered rate	Self-consumption + market sales + bonus on self-consumption + bonus on grid injections at tendered rate

*Non interconnected zones (overseas territories)

**Technology neutral

3.5 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 through the Electricity as a Public Service Charge (CSPE). The CSPE fund is financed by all electricity consumers through the CSPE surcharge.

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 2016 for photovoltaic contracts is 2 200 M EUR (source CRE), although little of this is due to systems commissioned in 2016.

The unitary contribution to the compensation fund was fixed by the energy regulator (CRE) at 22.5 EUR/MWh for 2016, with partial or whole exonerations possible for certain sectors (energy intensive industries, transport...). For residential consumers in France, support for photovoltaics represents approximately 4% to 5% of the cost of kWh consumption in 2016. The cost of support measures for systems installed pre-2015 is an estimated average 335 EUR/MWh, but is estimated to be approximately 76 EUR/MWh in 2017 for new capacity. (Etude des retombées socio-économiques du développement de la filière solaire française Etat des lieux et prospective 2023 : Synthèse de l'étude, Février 2017 - I Care & Consult – Etude des retombées de la filière solaire française – février 2017).

3.6 Indirect policy issues

The national 1.5 billion EUR Energy Transition Finance Fund (FFTE - Fonds de financement de la transition énergétique) is managed by the Caisse des Dépôts. The territories (joint-local authorities) that successfully candidate for TEPCV status “Territoire à énergie positive pour la croissance verte” (Territories with Positive Energy for Green Growth) receive financial support from the national TEPCV fund, to be spent on a list of priority actions, including the development of RES systems. There were nearly 500 TEPCV by the end of 2016, up from 260 in early 2015. Eligible Territories may use their 500 000 EUR allocation to invest in photovoltaics systems, on the condition that these systems may not benefit from Feed-in Tariffs or Tender PPA's. Budgets spent on photovoltaics have been spread across developing action plans, feasibility studies and capital investment (self-consumption systems linked to buildings or electric vehicles – such as the project for 241 parking canopies in Martinique). The TEPCV movement has been important in the emergence of local solar policies (solar cadastres, local action plans, etc.)

The Energy/Climate contribution (Contribution Climat-Energie - Carbon Tax) on fossil fuels, set at 22 EUR/tCO₂ in 2016, does not directly finance support mechanisms for photovoltaics in 2016, although it may in 2017.

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

Research and Development in France ranges from fundamental materials science, to pre-market development and process optimisation. The principal state agencies financing research are:

- the National Research Agency (ANR), that finances projects through topic-specific and generic calls and also through tax credits for in-company research.

Programmes accepted in the ANR Calls with a photovoltaic component operating in 2016 were spread across over 70 laboratories. Many of these laboratories are joint university/research institute facilities linked to the national research institutes CNRS, CEA, INES or IPVF. Topics are predominantly materials science-based, with growing interest in III-V semiconductor/silicon and Perovskites/silicon tandem cells. Process improvements for mainstream technologies were well represented. Photovoltaics as an energy source for embedded applications was also present in several projects (road surfaces, drones...).

- the French Environment and Energy Management Agency (ADEME), that manages most of the State “Investing in the future” programme (Investissement d’Avenir) financing innovative pre-industrial technologies. ADEME also runs its own Calls for R&D on RES and has an active policy supporting PhD students with topics related to photovoltaics, as well as being the French relay for the IEA PVPS and SOLAR-ERA.net pan-European network.

Mid-2016, the second Investissement d’Avenir programme was launched with two dedicated Renewable Energy Calls. The first provides support for the development of advanced or innovative manufacturing equipment and processes, photovoltaic cells and modules as well as for experimental trials of innovative photovoltaic systems and building integration equipment.

The second Call, “SME Initiatives” (Initiatives PME), targets SME innovation with funding for the development-to-market stage of innovations. Beneficiaries have been primarily in software, design and supervision sectors of the photovoltaics market. Grid and energy production management tools were also supported through a specific section, demonstrating a clear increase in support for smart energy management systems, energy storage interfaces and mobile solutions.

French participation in European SOLAR-ERA.net projects has focused on applied research targeting technological improvements for manufacturing processes and cost reductions.

- Bpifrance (a French public investment bank) that provides, amongst others, low-cost financing and subsidies for research-to-enterprise technology transfers and technology innovation-to-market deployment, feasibility studies and accompaniments.

Industrial applied innovations were also encouraged through the Innovation component of 2015’s Call for Tenders for photovoltaic systems over 250 kW. Eligible contributions to innovation were opened in three domains: component performance, photovoltaics system design and operations and maintenance (including ancillary grid services). The winning bids were announced in December 2015. However, with no official publications for commercial confidentiality reasons, it may be difficult to evaluate the success and added value of this Call for Tenders.

Industrial development projects were financed through various different measures, including tax credits and research Calls, include the integration of photovoltaics into specific applications (glazing, cloths, roads, floating elements ... but also mobile electronics).

The major show-cases for photovoltaics research in France are:

- the PVTC (PhotoVoltaic Technical Conference) in April with a focus on materials and advanced processes to innovative applications,
- the National Solar Energy Days (JNES) in June (FédEsol (CNR) and DERBI competitiveness cluster), focused on energy storage
- and the National PV Days (JNPV) in late December at the initiative of the Fed-PV, (CNRS PV research federation) and IPVF.

4.2 Public budgets for market stimulation, demonstration / field test programmes and R&D

There are no public data collections undertaken regarding research budgets by narrow domains such as photovoltaics; the finest grain is generally energy specific. For example, the ADEME “Programme Recherche” had a 2016 budget of 30 M€, of which 38% was allotted to Sustainable Energy and/or Renewable Energies.

5 INDUSTRY

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

Silicon Feedstock

EMIX, working on an experimental metallurgical process for silicon, was closed and liquidated in 2016, EMIX’s mother company indicated that costs were too high compared to international competition.

Ingot and Wafer production

Photowatt / EDF ENR PWT is a vertically integrated manufacturer, manufacturing its own cells, wafers and modules. Its processes produce multicrystalline and quasi-monocrystalline ingots (Crystal Advanced Process).

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

Total PV cell and module manufacture together with production capacity information is summarised in Table 16 below.

Table 16: Production and production capacity information for 2016

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)		Production capacity (MW/yr)	
		Cell	Module	Cell	Module
<i>Wafer-based PV manufactures</i>					
Irysolar				5	
S'Tile					15
EDF ENR PWT (Photowatt)	mc-Si, mc-Si, qc-Si			100	100
Fonroche					90
Francewatts					25
Sillia VL			150 (approx.)		260
SNAsolar					25
Systovi					40
Sunpower (Total)					154
VMH Energies					20
Voltec Solar					60
TOTALS				105	789*

SOURCE : SER-SOLER, novembre 2015 - Capacités déclarées par les fabricants, L'Echo du Solaire

*Note : the 2017 Edition of the ADEME « Marchés et emplois liés à l'efficacité énergétique et aux énergies renouvelables » study estimates a total production capacity of 820 MW, with no detail.

Irysolar, with a capacity of 10 MW cell production, was placed in liquidation in mid-2016, and was acquired by SEMCO Group, in turn acquired by ECM Greentech, with a 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 for silicon cells based on their proprietary sintered silicon substrates. The 'i-Cells[®]', are made by connecting thin monocrystalline silicon layers on the low-cost silicon substrates. 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. PV cells are prepared from thin wafers (< 200 µm) sliced from silicon ingots. The cell production capacity of the company is 100 MW per year. Photowatt produces two types of silicon cells: multicrystalline and quasi-monocrystalline. The conversion efficiency of quasi-monocrystalline cells is half way between multicrystalline and monocrystalline. The company participates in several collaborative R&D projects on crystalline silicon in order to increase cell efficiency and reduce production costs. A pilot line is operated for testing new cell processes.

Fonroche not only manufactures modules, but also develops and operates photovoltaic power plants. Their semi-automated and automated production lines manufacture modules but also PV powered streetlamps and solar thermal equipment. Fonroche Solaire was bought in February 2017 and is now called REDEN SOLAR.

Sillia VL was placed in liquidation in March 2017 after a year at partial capacity, despite 2,5 years of orders in the books, and are is currently looking for an investor.

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%. The company announced plans for restructuring in 2016, including the closure of a 700 MW700MW capacity Philippines factory (and transfer of production lines to Mexico, closer to the American markets) and a reduction of its workforce by 30%.

Nexcis, a thin film R&D subsidy of EDF was dissolved late 2015, with a partial transfer of activities to Sunpartner Technologies, (whose Wysips Glass was planned to be manufactured from mid- 2017), and a partial transfer to CrossLux, who are industrialising transparent photovoltaic glazing.

The Concentrix CPV technology, held by Soitec who disengaged from solar activities mid 2015 was ceded to the Canadian company STACE mid 2016.

Other companies, Luxol and Captelia (Imerys Toiture), manufacture PV tiles (size 45 cm × 31 cm and 136 cm × 50 cm respectively), while DualSun and Systovi develop and market photovoltaic-thermal hybrid modules (PV-T).

5.3 Manufacturers and suppliers of other components

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.

- 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 (off grid, on grid, storage...). Major international manufacturers are well represented on the local market, with little differentiation to other European markets. Inverters must be adapted to the local electricity grid, and although no local standard exists, the distribution grid manager has built requirements on a modified version of the German DIN VDE 0126-1-1/A1.

As elsewhere, 2016 saw growing interest for micro-inverters and a continued growth for new-comer Asian brands. With increasing interest in self-consumption, production and demand piloting should see a more diversified offer arrive in France.

- Storage batteries

With Tenders for large scale storage systems in overseas territories, France has been an attractive country for industrials (both national and international) providing large scale storage systems -and France has, with SAFT, a leading international manufacturer of storage solutions. Research has been particularly active, with demonstration programmes for disseminated storage and solar + car storage. Many solar suppliers have added storage solutions to their offers in 2016, however, with competitive electricity costs, storage for residential clients has had minimal market penetration.

- Supporting structures

With over 10 years of targeted support for building integrated photovoltaics, France has a number of companies (national, independent or subsidiaries of major national or international companies) with a strong focus on building integration structures for photovoltaics. Most products have been developed to satisfy the building integration criteria of France's very specific Feed-in Tariff eligibility

requirements, with products adapted to either the residential sector (IAB), commercial or important agricultural sector (ISB). There is also a growing offer for parking canopy structures.

There is a very specific building insurance environment in France- insurers require building products to have a proven 10 year durability, taking into account specified building implementation. Where there are no standards or state-of-the-art practices for a technology or product, insurers require a Technical Assessment of the products and its implementation (Avis Technique) from a public national laboratory (CSTB) before insuring professionals that install the product, or buildings incorporating the product. This prerequisite has led to significant investments by product developers in certification, testing and assessment in order to have access to the local market.

Several events led to an uncertain environment for industrials in 2016: the 2015 announcement by France's Minister of Ecology, Sustainable Development and Energy stating that the requirements for building integration for Feed-in Tariffs would be abandoned, pressure by insurers to minimise risks, and changes to the Tenders for systems over 250 kW, with the abandon of building integration requirements.

Despite this, local industry has continued to innovate, offer innovative PV-T supports, integration structures for flat roofs, steel pan roofs and 'universal' tile roof integration systems. However, with the confirmation of the phase-out of building integration requirements in 2017, and continued pressure by insurers to abandon building integration to reduce fire risk the future is far from clear for these industrial actors, who may have to look to export markets to ensure market stability or growth, as France's solar tracker industry actors have done in the past.

6 PV IN THE ECONOMY

6.1 Labour places

Employment numbers have reduced in 2016, reflecting the lack of growth in the local market. Manufacturing jobs are relatively few, with the majority of jobs in design, installation, and increasingly in operations and maintenance.

Table 17: Estimated PV-related labour places in 2016

Research and development (not including companies)	Not quantified
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	750
Distributors of PV products	4290
System and installation companies	
Electricity utility businesses and government	Not quantified
Other – operations and maintenance	1640
Total	5720

SOURCE: 2017 Edition “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables », ADEME

6.2 Business value

The value of investments in photovoltaics in France in 2016 was lower than for previous years, a reflection of the lesser capacity installed and the drop in prices. Investments and turnover are studied for ADEME in the yearly “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables”.

An extrapolation of 2016 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 2016, 2.9 million modules were declared as marketed in France in 2016, (2.8 million in 2015).

The market value for 2016 (below) has been estimated based on 2016 Trending prices and extrapolated official 2016 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.

Table 18: Value of investments in PV: TRENDS 2016 prices

Sub-market	Capacity installed in 2016 (MW)	Price per W <i>(from table 7)</i>	Value	Totals M EUR <i>(provisional)</i>
Grid-connected distributed				466
Residential < 3 kW	15	2,9	44	
Residential < 9 kW	61	2,2	134	
Commercial < 100 kW	80	1,2	96	
Commercial < 250 kW	51	1,2	61	
Industrial > 250 kW	109	1,2	131	
Grid-connected centralized	243	1	243	243
Export of PV products				40
Change in stocks held				-
Import of PV products				302
<i>Value of PV business</i>				447

SOURCE: SOeS, Observ’ER Barometre Electrique 2016, HESPUL, 2017 Edition “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables », ADEME

The ADEME “Marchés et emplois liée à l’efficacité énergétique et aux énergies renouvelables » study looks in detail at the market value of the PV business :

Table 19: Value of national PV market

	M EUR (provisional)
Investments	749
Operations, maintenance and energy sales	3 072
Total domestic market	3 821
Export of PV equipment	40
Total market	3 862
Imports	302
Production	3 560

SOURCE : 2017 Edition “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables », ADEME

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

<ul style="list-style-type: none"> - Short description of the electricity industry landscape structure – vertically integrated or separate generation, transmission, distribution; - retailers and network businesses – integrated or separate; - ownership – private – public (state owned or municipal) 	<p>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 acquired a majority share in AREVA, and is now owner/operator of the national portfolio of nuclear power stations, providing over 70% of electricity generation.</p> <p>Retail sales and grid access are separate businesses, although the distribution grid manager habitually delegates residential and small commercial client relations to retailers (called “integrated contracts”).</p> <p>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%</p>
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<p>- Electricity industry regulator?</p>	<p>of EDF's share capital), ENGIE (the French government owns 28% of ENGIE's share capital).</p> <p>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 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.</p>
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7.2 Interest from electricity utility businesses

France's national major energy companies, EDF and ENGIE, are both major international players, with a wide international portfolio covering both fossil 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

EDF Energie Nouvelles (EDF EN), a subsidiary of EDF, 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 vertically integrated photovoltaics manufacturer. EDF is also active in R&D activities through both EDF internal research departments, research partnerships with public research organisations and Photowatt.

EDF EN is an active developer in France, developing small to utility scale systems for clients (local authorities, third party investors), and as owner-operator. They also provide operations and maintenance services for third parties.

Grid integration is a key subject in France, with unique challenges due to local context; grid connection costs are borne by plant owners, significantly increasing the cost of installation. Grid stability and the management of intermittent energy sources in the non-interconnected overseas zones (ZNI) also impacts project development costs.

EDF R&D branches are involved in different research projects, or have created spin-off companies including energy generation forecasts, storage and intermittency management services, such as EDF Store & Forecast, contracting for the management of a 20 MWh storage facility in the United States of America in 2016.

7.3 Interest from municipalities and local governments

Local authorities and public utilities have demonstrated growing interest in the development of photovoltaics on their territories. However, the combination of binding public tendering constraints and their inherent incompatibility with national Tender specifications (the difficulties lie in the calendar requirements), combined with a lack of capital for investment, has meant that most local authorities look to market actors to develop on their territories.

Despite this, several local public utilities have active development policies, operating through subsidiary companies, to avoid complex public tendering constraints. Sergies, wholly owned by a local utility, has 25 MW in operation and 30 MW in construction in 2016, either directly or through participation in local public energy companies.

Joint local authorities subscribing to the national Territoire à Énergie Positive pour la Croissance Verte program (TEPCV) may develop Solar Plans, defining market segment development plans, and leading to the creation of public companies for investing in RES production, encouraging the development of citizen investment groups and facilitating solar opportunity studies on members' buildings. In support of this local approach to energy production, ADEME published an analysis called "Integration of local RES projects with citizen participation – state of the art and best practice (Quelle intégration territoriale des énergies renouvelables participatives? Etat des lieux et analyse des projets français).

Some regional governments have encouraged the development of solar through 2016 with Project Calls, predominantly for self-consumption systems, proposing either investment subsidies or preliminary study subsidies. Regional RES project investment funds have also been used as a support mechanism.

8 HIGHLIGHTS AND PROSPECTS

The year 2016 saw the publication of application decrees for 2015's Energy Transition Act for Green Growth, defining power thresholds, separation distances, and technology-specific conditions for RES systems, determining eligibility for Power Purchase Obligations or Additional Remuneration Contracts, and limiting Feed-In Tariffs (FIT) to small building mounted systems. Access to the Electricity as a Public Service Contribution Fund (CSPE) was officially opened, allowing private energy suppliers to acquire Power Purchase Obligation contracts. An ordinance defining individual and collective self-consumption operations was published, however the application decrees were not yet published in early 2017.

The November Energy Programme Decree (PPE) target an increase from 6.6 GW cumulative capacity mid-2016 to 10.2 GW by the end of 2018, and between 18.2 GW and 20.2 GW by the end of 2023. The decree provided a provisional calendar for future Calls for Tender for RES capacity, with 1 GW per year planned in ground based photovoltaic plants and 0.45 GW per year planned on building mounted photovoltaic systems over 100 kW.

Grid connections over most of 2016 were lower than 2015 for multi-megawatt systems, a result of the previous Call for Tenders for large systems calendars. However, approximately 1.5 GW was awarded through Tenders from December 2015 to the end of 2016, most of which will be connected to the grid in the first semester 2017.

The provision for Additional Remuneration (market premium) contracts instead of fixed Power Purchase Agreements in Calls for Tender has stimulated market actors to a better understanding of the complexities of the electricity market. With a limited initial volume of electricity and the creation of a new role for actors (aggregators), it is not yet clear whether a sufficient number of purchase offers from market aggregators (buyers) will be available to guarantee a competitive market when the first contracts become operational in late 2017 or early 2018.

Overall, grid-connected volumes grew an estimated 559 MW (compared to 894 MW in 2015 and 955 MW in 2014) for a cumulative capacity of 7 134 MW. 72% of the capacity installed in 2016 was for systems over 100 kW commissioned within the framework of Call for Tenders.

Domestic manufacturing capacity will be diminished, as SILLA VL goes into receivership.

The publication of legal texts enabling self-consumption, and changes to the Feed-in Tariff eligibility criteria should lead to an increase in the number of total or partial self-consumption systems and a move away from building integration. The market is expected to grow in 2017.

