



**ADEME**



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

# National Survey Report of Photovoltaic Applications in FRANCE 2017



**PVPS**

PHOTOVOLTAIC  
POWER SYSTEMS  
PROGRAMME

This report was undertaken for the  
French Environment and Energy Management Agency (ADEME)  
under the supervision of Paul KAAIJK  
with the assistance of Céline MEHL, Tristan CARRERE and Paul KAAIJK (ADEME)

Author: Melodie DE L'EPINE - HESPUL

Contract n° 17MAR001118

May 2018

*Cover photo: Self-consumption with battery storage on the Local Energy and Climate Agency  
(ALEC) offices in Grenoble, France - credit: HESPUL / IRFTS*

## TABLE OF CONTENTS

Introduction .....	4
1     INSTALLATION DATA .....	5
1.1 Applications for Photovoltaics .....	5
1.2 Total photovoltaic power installed .....	6
2     COMPETITIVENESS OF PV ELECTRICITY .....	13
2.1 System prices .....	13
2.2 Cost breakdown of PV installations .....	15
2.3 Residential PV System < 10 kW .....	15
2.4 Utility-scale PV systems (multi-megawatt) .....	16
2.5 Financial Parameters and specific financing programs .....	16
2.6 Specific investments programs .....	18
2.7 Additional Country information .....	19
3     POLICY FRAMEWORK .....	20
3.1 Direct support policies for PV installations .....	20
3.2 Self-consumption measures .....	29
3.3 Collective self-consumption, community solar and similar measures .....	30
3.4 Tenders, auctions & similar schemes .....	31
3.5 Financing and cost of support measures .....	33
4     INDUSTRY .....	34
4.1 Production of feedstocks, ingots and wafers (crystalline silicon industry) .....	34
4.2 Production of photovoltaic cells and modules (including TF and CPV) .....	34
4.3 Manufacturers and suppliers of other components .....	36
5     PV IN THE ECONOMY .....	37
5.1 Labour places .....	37
5.2 Business value .....	37
6     INTEREST FROM ELECTRICITY STAKEHOLDERS .....	39
6.1 Structure of the electricity system .....	39
6.2 Interest from electricity utility businesses .....	39
6.3 Interest from municipalities and local governments .....	40
7     HIGHLIGHTS AND PROSPECTS .....	40

## 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](http://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](http://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](http://www.iea-pvps.org).

## Introduction

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

The PVPS website [www.iea-pvps.org](http://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, St@tinfo, n° 103, May 2018 (Service de la donnée et des études statistiques, Commissariat au Développement Durable, the Ministry for the Ecological and Inclusive Transition);
- Tableau de bord photovoltaïque, St@tinfo n° 79, February 2018 (Service de la donnée et des études statistiques, Commissariat au Développement Durable, the Ministry for the Ecological and Inclusive Transition);
- Atlas 2017 des grandes centrales PV > 1 MW, Observ’ER, Journal du photovoltaïque n° 24, Novembre 2017;
- Bilans de Raccordement, Enedis Open Data (distribution grid manager for 95% of the nation);
- Bilan électrique 2017 (RTE Electricity Report 2017), RTE, February 2018 (Transport grid manager);
- Panorama des cleantech en France en 2017, GreenUnivers & EY March 2018;
- Baromètre annuel 2017, AVERE;
- Rapport annuel du registre des déchets d’équipements électriques et électroniques 2017, ADEME (unpublished);
- 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, 2017 and 2018).

## 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 mobile devices are not considered in this report.

This report on the state of the photovoltaics market in France for the year 2017 takes into consideration the deployment of systems installed, registered and connected to the national distribution or transmission grid from 1<sup>st</sup> January to 31<sup>st</sup> December 2017, 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 1 160 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 2017 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 Residential market has seen a progressive change from total sales to partial self-consumption for systems under 3 kW. Systems under 36 kW represented only 10% of installed volumes in 2017.

Changes to the Feed-in Tariffs has encouraged more installations in the 36 kW to 100 kW segment, with 18% of 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 France's major development companies, but with relatively high grid access costs and the need to compete on a cost per kWh basis with systems up to 500 kW in Tenders, new capacity is a low 5% of total volumes.

Multi-megawatt systems (building or ground-based systems) are exclusively within the framework of national tenders and represent more than 70% of new capacity.

## 1.2 Total photovoltaic power installed

Cumulative PV installed capacity as of the end of 2017 reached 8 014 MW (DC). Cumulative PV installed capacity by application is 30 MW for off-grid and 8 044 MW for grid-connected.

### 1.1.1. 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 were modified in May 2017, in line with the requirements of the new Feed in Tariff Order.

For the purposes of this report, we have considered the following hypotheses for 2017 data:

Grid connected distributed 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 10 MW.

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: PV power installed during calendar year 2017**

			MW (DC) installed in 2017
<b>Grid-connected</b>	<b>BAPV</b>	Residential	16,5*
		Commercial (9 kW – 250 kW)	223
		Industrial (> 250 kW)	114*
		<b>Total of BAPV</b>	<b>353,5</b>
	<b>BIPV</b>	Residential (< 9 kW)	59,5*
		Commercial	0
		Industrial	0
		<b>Total of BIPV</b>	<b>59,5</b>
	<b>Ground-mounted</b>	<b>cSi and TF</b>	<b>384*</b>
		CPV	0
	<b>Utility-scale</b>	Ground-mounted / Floating/ Agricultural	<b>78*</b>
<b>Off-grid</b>		Total of off-grid	unknown
		<b>Total</b>	<b>875</b>

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

**Table 1b: PV power installed during calendar year 2017 (Unit: MW)**

Sub-market	Application	MW (DC)
<b>Grid-connected</b>	Distributed (Mainly building-integrated applications)	412*
	Centralized ground-mounted (including utility scale)	462*
	Total grid-connected	<b>875</b>
<b>Off-grid</b>	Off-grid rural electrification (mainly hybrid systems)	unknown

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



**Table 1c: Segmented grid-connected PV power installed in 2017**

Peak Power range	Application	Installation number	Power MW (DC)
0 – 3 kW	Building Applied PV (BIPV and BAPV)	6269	18
3 kW – 9 kW	Building Applied PV (BIPV and BAPV)	9044	58
9 kW – 36 kW	Building Applied PV (BIPV and BAPV)	574	17
36 kW – 100 kW	Building Applied PV (BIPV and BAPV)	1817	162
100 kW – 250 kW	Building Applied PV (BAPV)	236	44
> 250 kW	Large rooftops, ground-mounted plants	131	577
Total		18071	875

SOURCE: SDES

**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 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	<a href="http://www.statistiques.developpement-durable.gouv.fr/energie-climat/r/differentes-energies-energies-renouvelables.html?tx_ttnews%5Btt_news%5D=20647&amp;cHash=470a0ab6e6d4aad97459c455743b12bf">http://www.statistiques.developpement-durable.gouv.fr/energie-climat/r/differentes-energies-energies-renouvelables.html?tx_ttnews%5Btt_news%5D=20647&amp;cHash=470a0ab6e6d4aad97459c455743b12bf</a>
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.  A small volume of systems in total self-consumption may not be included in data.  Some divergence (less than 1%) 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 3: PV power and the broader national energy market**

	2017	2016
Total power generation capacities (all technologies)	Total: 130 761 MW of which - Nuclear: 63 130 MW; - Fossil fuel: 18 947 MW; - RES <sup>1</sup> : 48 685 MW (see below)	Total: 130 818 MW of which - Nuclear: 63 130 MW; - Fossil fuel: 21 847 MW; - RES: 45 842 MW (see below)
Total power generation capacities (renewables including hydropower)	- PV*: 7 660 MW (5,9%); - Hydro: 25 517 MW; - Wind: 13 559 MW; - Other RES: 1 949 MW.	- PV*: 6 772 MW (5,2%); - Hydro: 25 482 MW; - Wind: 11 670 MW; - Other RES: 1 918 MW.
Total electricity demand (= consumption)	482 TWh	483 TWh
Total energy demand. (= final consumption)	153,6 Mtoe	
New power generation capacities installed during the year (all technologies)	Total: - 93 MW of which - Gas: +183 MW; - Coal: 0 MW; - Diesel: -3039 MW; - Nuclear: 0 MW; - PV and other RES: 2 763 MW (see below).	Total: 1699 MW of which - Gas: +881 MW; - Coal: -10 MW; - Diesel: -1359 MW; - Nuclear: 0 MW; - PV and other RES: 2 187 (see below).
New power generation capacities installed during the year (renewables including hydropower)	- PV*: + 887 MW; - Wind: + 1797 MW; - Hydro: + 48 MW; - Other RES: + 31 MW.	- PV*: + 576 MW; - Wind: + 1345 MW; - Hydro: - 51 MW; - Other RES: + 215 MW.
Total PV electricity production	PV: 9,2 TWh	PV: 8,3 TWh
Total PV electricity production as a % of total electricity consumption	1,9%	1,7%

2016: RTE France Electricity Report 2016.

2017: RTE France Electricity Report 2017. \*RTE provisional PV figures differ from those of SDES (total PV 7 660 MW for RTE, 8 044 MW for SDES), Bilan énergétique de la France métropolitaine en 2017 – Données provisoires.

NOTE: The annual RTE France Electricity Report publishes provisional capacity values; the new power generation capacity is calculated using definitive 2016 data (not published here) and provisional 2017 data.

---

<sup>1</sup>RES: renewable energy sources

**Table 4: Other information**

	<b>2017</b>		
	<b>Peak Power range</b>	<b>Installations (number)</b>	<b>Power (MW)</b>
Number of PV systems in operation in your country	0 – 3 kW	289 494	779
	3 kW – 9 kW	73 224	467
	9 kW – 36 kW	17 522	438
	36 kW – 100 kW	13 213	1 070
	100 kW – 250 kW	6 071	1 072
	> 250 kW	1 415	4 219
	<b>Total</b>	<b>400 939</b>	<b>8 044</b>
	<b>Total Off-grid</b>		<b>30</b>
	Capacity of decommissioned PV systems		
Total capacity connected to the low voltage distribution grid	400 522 systems for 3 834,82 MW		
Total capacity connected to the medium voltage distribution grid	1 344 systems for 3 576,63 MW		
Total capacity connected to the high voltage transmission grid	72 systems for 642,6 MW		

SOURCE: SDES, ADEME

**Table 5a: The cumulative installed PV power in 3 sub-markets.**

	Off-grid	Grid-connected centralized ground-mounted	Grid-connected distributed	Grid-connected total
2007	22,5	0	53	53
2008	22,9	7	150	157
2009	29,2	42	300	342
2010	29,3	242	938	1180
2011	29,4	702	2242	2944
2012	29,6	1012	3052	4064
2013	29,7	1264	3454	4718
2014	29,75	1709	3963	5672
2015	30,15	2318	4257	6575
2016	30,15	2598 (revised)	4573	7171 (revised)
2017	30,15	3059	4985	8 044

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

**Table 5b: Cumulative installed PV power, 1992-2006**

Year	Power (MW DC)
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

SOURCE: ADEME and previous IEA NSR-FR reports

**Table 6: information on key enablers**

	Description	Annual Volume (Units)	Total Volume (Units)	Source
Residential Heat Pumps <i>(does not include air/water or water/water heat pumps for heating)</i>	Mono and multi-split reversible heat pumps	483 912	3 102 595	www.uniclimate.fr Uniclimate : Bilan 2017 et perspectives 2018 du genie climatique
	Thermodynamic domestic water heater	88 891	399 693	
	<b>Total since 2012</b>	<b>572 803</b>	<b>3 502 288</b>	
Electric cars	Electric cars	25 983	91 745	www.aver-france.org AVERE: Bilan 2017
	Lightweight utility vehicles	6 011	32 276	
	hybrid rechargeable cars	10 803	25 295	
	<b>Total since 2010</b>	<b>41 724</b>	<b>149 316</b>	

## 2 COMPETITIVENESS OF PV ELECTRICITY

### 2.1 System prices

“Trends” data is based on limited surveys of industry stakeholders regarding system prices in 2017; the data is recent but the survey sample is small and may be less reliable.

**Table 7: Turnkey prices of typical applications – local currency**

Category/Size	Typical applications and brief details	Trends 2016 (EUR/W)	Trends 2017 (EUR/W)
Grid-connected Rooftop up to 10 kW (residential)	BAPV* < 3 kW BAPV 3 kW - 9 kW	< 3 kW: ↘2,9 3 kW - 9 kW: ↘2,2	3 kW: ↘2,6 3 kW - 9 kW: ↘1,9
Grid-connected Rooftop from 10 kW to 250 kW (commercial)	BAPV 36 kW - 100 kW (FiT) Roof top 100 kW - 250 kW (Tender)	36 kW-100 kW: ↘1,2 100 kW - 250 kW: ↘1,2	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	↘ 1,2	↘0,9
Grid-connected Ground-mounted above 1 MW	Ground mounted systems in framework of Tenders	↘ 0,9 - 1,1	↘0,8-1,0
Other categories (hybrid diesel-PV, hybrid with battery...) (industrial, floating, agricultural PV) (offgrid < 1kW, offgrid > 1MW)			demonstration systems only or no data available

\* BAPV, Building Applied PV

for 2016 trends : estimation HESPUL, sources HESPUL/ Observ'ER

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

**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	NSR 2017
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	2,2
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	1,2
Ground-mounted > 1 MW	6,3	6,2	5,2	4,5	2,0	1,6	1,3	1,3	1,2	1,10	1,10
Ground-mounted > 10 MW											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.

## 2.2 Cost breakdown of PV installations

No comprehensive cost surveys were published for 2017 – the indicative cost breakdowns presented are based on data for the year 2015 from the I Care & Consult report “Etude compétitivité et retombées de la filière solaire française” published in April 2017, combined with limited survey (HESPUL/ISWT/Observ’ER) “Trends” costs for 2017.

## 2.3 Residential PV System < 10 kW

Table 9: Cost breakdown for a residential PV system (no VAT)

Cost category	3 kW roof-top Average (EUR/W)	9 kW roof-top Low (EUR/W)	3 kW BIPV High (EUR/W)
<b>Hardware</b>			
Module	0,62	0,61	0,62
Inverter	0,21	0,17	0,18
Other (racking, wiring...)	0,56	0,38	0,68
<b>Soft costs</b>			
Installation	0,67	0,40	0,94
Customer Acquisition	0,46	0,15	0,40
Profit	0,09	(not surveyed)	(not surveyed)
Other (permitting, contracting, financing...)	0,00	0,19	0,57
Subtotal Hardware	1,38	1,16	1,48
Subtotal Soft costs	1,22	0,74	1,91
Total	2,60	1,90	3,39

SOURCE: HESPUL based on I Care & Consult / HESPUL/ISWT/Observ’ER



## 2.4 Utility-scale PV systems (multi-megawatt)

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

Cost Category	Average (EUR/W)
<b>Hardware</b>	
Module	0,39
Inverter	0,07
Other (racking, wiring, etc.)	0,11
<b>Soft cost</b>	
Installation Labor	0,05
Customer acquisition	0,07
Profit	
Other (contracting, permitting, financing etc.)	0,12
<b>Subtotal Hardware</b>	0,57
<b>Subtotal - Soft cost</b>	0,23
<b>Total Installed Cost</b>	0,80

SOURCE: HESPUL based on I Care & Consult / HESPUL

## 2.5 Financial Parameters and specific financing programs

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, with a number of specialized funds being created in 2017 addressing financing needs for project development and construction phases, as well as company consolidation and expansion.

### **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”: 50 M EUR CAPEX and 25 M EUR of loans, running through 3 national banking partners, 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. In 2017 the EIB established new partnerships with commercial banking consortiums and private firms for investing in solar and other RES. Five of these risk-sharing agreements were signed in 2017 for a total of 900 M EUR, including 220 M EUR for the Valeco Group wind and solar farm projects.

### ***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).

Short-term debt financing for projects is available through specific Funds, such as the Eiffel Energy Transition fund, which has 200 M EUR in funds available; this particular fund is of interest because it has made short term financing available to relatively modest projects requiring less than 1 M EUR—projects that may not have easy access to traditional financing from bank and infrastructure funds. In its first year of operation 272 projects, including solar projects, accessed financing through the fund. The French environment and energy agency, ADEME, has joined the fund with PAI (Investing in the Future) funds.

Public authorities can make use of specific “green loans” from public long-term investors such as the Caisse des Dépôts (Deposits and Consignments Fund), which 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.

### ***Business development financing***

Capital expansion financing is available through the 100 M EUR bpi (public investment bank) France Investissement Energie Environnement (FIEE) fund, launched in July 2017. The fund is geared to accompanying Res sector SME’s as they consolidate and expand.

### ***Citizen and participative financing***

Citizen investment is mobilised through specific citizen RES funds and crowd-funding platforms—financing both equity and debt. Launched in January 2018, the EnRciT fund, specifically for financing the development phase of large scale citizen investment projects, has an envelope of 10 M EUR available for 150 projects over the next 10 years.

Crowdfunding of RES projects was in significant progression, with 10 platforms operating in 2017. More than 20 M EUR were collected for 92 projects (40 solar / approx. 100 MW total); mostly in the form of debt-financing.

Several Regional authorities have created investment funds for RES systems, often to fill in the gaps for project profiles that are difficult to finance through traditional sectors (such as citizen investment projects).

### ***Residential project financing***

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.

Crédit rates were at historically low levels, having decreased since 2016 before a slight increase at the end of 2017.

**Table 11: PV financing scheme (debt financing)**

	2016	2017 (Trends)
Average rate of loans – residential installations	5,65%	↘
Average rate of loans – commercial installations	3,45%	↘
Average rate of loans – industrial and ground-mounted installations		2,5%
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, Trends : Banque de France

## 2.6 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 crowd-funding platforms, but also, more commonly, finance debt through crowd-funding platforms.</p> <p>The Tenders have a tariff bonus for citizen financing, with approximately 1/3 of projects meeting the requirements.</p>

	11 crowdfunding platforms were active in the RES sector in France in 2017.
Other (please specify)	Reduced taxes (on self-consumed electricity) has been used in 2017..

## 2.7 Additional Country information

**Table 12: Country information**

Retail Electricity Prices for a household (range)	Time of use contracts available. Eurostat Band DC (2 500 kWh < consumption < 5 000 kWh) <ul style="list-style-type: none"> <li>• 169,0 €/MWh all taxes and levies included</li> </ul>
Retail Electricity Prices for a commercial company (range)	Time of use contracts available. Eurostat Band IB (20 MWh < consumption < 500 MWh): <ul style="list-style-type: none"> <li>• 123,0 €/MWh excluding VAT and other recoverable taxes and levies</li> <li>• 147,5 €/MWh all taxes and levies included</li> </ul> Eurostat Band IC (500 MWh < consumption < 2 000 MWh): <ul style="list-style-type: none"> <li>• 99,2 €/MWh excluding VAT and other recoverable taxes and levies</li> <li>• 119,8 €/MWh all taxes and levies included</li> </ul>
Retail Electricity Prices for an industrial company (range)	Time of use, demand response, peak shaving contracts available Eurostat Band ID (2 000 MWh < consumption < 20 000 MWh): <ul style="list-style-type: none"> <li>• 79,3 €/MWh excluding VAT and other recoverable taxes and levies</li> <li>• 95,0 €/MWh all taxes and levies included</li> </ul>
Population on 01/01/2018	67 187 000
Country size (km <sup>2</sup> )	543,965 km <sup>2</sup> 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 1550 kWh/kW (30° with system losses (PV GIS) – continental France)
Name and market share of major electric utilities.	EDF: approx. 69% by electricity or 80% by number of sites Engie/CNR: approx. 10% Direct Energie: approx. 4% A dozen or so minor suppliers, including 100% RES suppliers

SOURCE: INSEE, CRE, Eurostat [nrg\_pc\_204] and (nrg\_pc\_205) 2017S1

## 3 POLICY FRAMEWORK

### 3.1 Direct support policies for PV installations

#### 1.1.2. New, existing or phased out measures in 2017

##### 3.1.0.1 Climate change Commitments

France presented a Climate Action Plan in July 2017, targeting “carbon neutrality” for 2050 – i.e. annual greenhouse gas emissions must be equal or lower to captured or absorbed greenhouse gases (through natural or engineered means). The first four measures for citizens adopted within this framework are subventions for replacing older vehicles, for people in energy poverty, for the insulation of residential buildings and the modernisation of older heating boilers. Although none of the initial measures specifically included photovoltaics, the planned reduction in nuclear capacity leans on both increased solar and wind production and demand side reductions.

##### 3.1.0.2 Description of support measures excluding BIPV, and rural electrification

Direct support measures are separated into basically two categories: open volume feed-in tariffs for building applied systems under 100 kW, and volume capped periodic competitive tenders for systems from 100 kW to 30 MW, segmented according to size and application (building applied, ground based etc.), leading to either feed in tariffs or feed-in premiums. A direct support measure in the form of reduced grid connection costs for RES systems under 5 MW was re-introduced, and self-consumed energy produced by PV systems was exempted from taxes and levies.

In 2017 new feed-in tariff conditions were published in May, heralding a real move away from the all-BIPV recent past in France. Specificities of the new Feed-in tariff include regional tariffs for overseas territories adapted to local irradiance (for example the French Antilles), different tariffs for partial self-consumption systems and zero self-consumption systems, a system power-based lump-sum for partial self-consumption systems and new mandatory installer certification requirements. As previously, feed-in tariff levels are segmented according to system size and decrease each trimester, with the decrease pegged to grid connection requests for previous trimesters. Table 13a details 4<sup>th</sup> quarter 2017 tariff levels.

Until 2010, all grid connections were paid for by both the user (producer or consumer) and the grid manager (a percentage, set by the government at 40 %, was “refacted” to the grid manager). In 2010, producers were excluded from this measure and required to pay the full cost. This Refaction was re-introduced in 2017 and became operational for grid connections contracts signed after the 4<sup>th</sup> December 2017, at a set rate of 40% for systems under 500 kVA, and a linearly diminishing rate for systems up to 5 MW.

Through 2017, self-consumed electricity from systems under 1 MW was exempted from the CSPE surcharge, local electricity taxes and VAT. As these taxes and levies normally represent approximately 30% of a consumer’s electricity bill, the exemption could be a significant incentive for the installation of PV in self-consumption. Late December 2017 changes to financial law removed some of these benefits, although a lack of mandatory metering for self-consumed electricity may make its application complex.

Eleven competitive Tenders were called in 2017, for a total volume of 2,16 GW: for building applied, for ground-based systems, for self-consumption systems in continental France, for non-interconnected zones (ZNI - overseas territories) and for innovative systems. Up to 80%

of winning projects in Calls will receive tariff bonuses (3 or 1 EUR/MWh) for associating participative and municipal investments or crowdfunding.

In December an additional 1 GW was added to the Call for Tenders for the period 2017-2019, to be effective in the 2018 and 2019 volumes called. Additional volumes are mostly for very large ground-based systems, with a raise in the upper ceiling for individual systems from 17 MW to 30 MW. At the same time, the Tender specifications were made more stringent with regards to citizen and public authority investment tariff bonuses, reflecting the high value placed on mobilising citizen and public capital investment by the government.

**Table 13a: Feed-in Tariff and Tender remuneration levels – Mainland France**

Tariff category	Power of PV installation	Tariff Q4 2017 (EUR/MWh)
Continental France - building applied PV		
Ta (no self-consumption)	≤3 kW	184,8
Ta (no self-consumption)	3 kW to 9 kW	157,1
Tb (no self-consumption)	9 kW to 36 kW	120,7
Tb (no self-consumption)	36 kW to 100 kW	113,6
Pa (partial self-consumption)	≤3 kW	100 (+0,39 EUR/W installed)
Pa (partial self-consumption)	3 kW to 9 kW	100 (+ 0,29 EUR/W installed)
Pb (partial self-consumption)	9 kW to 36 kW	60 (+ 0,19 EUR/W installed)
Call for Tenders	100 kW - 500 kW Building applied systems	Last 2017 average selling price (average EUR/MWh) 89,0

**Table 13b: Feed-in Tariff and Tender remuneration levels – Overseas France**

Tariff category	Power of PV installation	Tariff Q4 2017 (EUR/MWh)
Tariff base		9,788
Sample system in Guadeloupe	2 kW	224,6
Sample system in Corsica	8 kW	176,2
Sample system in Réunion	50 kW	156,6
<b>Power factor</b>		
≤3 kW	1,35	= 9,788 x 1,35 x location factor
3 kW to 9 kW	1,2	= 9,788 x 1,2 x location factor
9 kW to 36 kW	1,1	= 9,788 x 1,1 x location factor
36 kW to 100 kW	1	= 9,788 x 1x location factor
	0	= 0
<b>Location factor</b>		
Guadeloupe & Martinique	17	= 9,788 x 17 x power factor
Corsica	15	= 9,788 x 15 x power factor
Réunion	16	= 9,788 x 16 x power factor
French Guiana	18	= 9,788 x 18 x power factor
Mayotte	19	= 9,788 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.

### 3.1.0.3 BIPV development measures

The new Feed-in Tariff Order removed the “all integration” obligation but retained a BIPV bonus for systems up to 9 kW, to be progressively phased out by September 2018. The bonus was 0,045 EUR/kWh for grid connection requests received 2<sup>nd</sup> quarter 2017 and its progressive decrease had reduced it to 0,03 EUR/kWh for grid connection requests received 4<sup>th</sup> quarter 2017. Eligibility for the bonus is based on criteria from the previous (2011) Feed-in Tariff Order, with modules having to provide waterproofness.

**Table 13c: Feed-in Tariffs for BIPV systems**

Tariff category and PV system type	Power of PV installation	Tariff Q4 2017 (EUR/MWh)
Full building- integration (IAB)	$P \leq 3$ kW	184,8 + 30 = 214,8
Full building- integration (IAB)	$P \leq 9$ kW	157,1 + 30 = 187,1

The October Innovation Tender offered 5MW for systems between 100 kW and 500 kW. The winning candidates were announced in early 2018. There were 14 winning projects of an average of 349 kW for a combined power of 4,9 MW, requesting an average 0,1178 EUR / kWh Feed-in Tariff. However, only 5 of these projects are building integrated.

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.

#### *3.1.0.4 Utility-scale measures including floating and agricultural PV*

See section 3.4 Tenders, auctions & similar schemes

#### *3.1.0.5 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.

For overseas territories, tropical climates and difficult local economic conditions or regulations have meant that rural electrification has not been completed as rapidly as in mainland France – and new areas are becoming inhabited, notably in French Guiana and Mayotte where rapidly developing demographics are fuelling demand for rural electrification.

The national budget includes a line dedicated to off grid production, with a 2 M EUR budget (maintained at the same level as 2016). This is roughly 2% of the total rural electrification budget, much of which is dedicated to replacing fragile overhead lines both in continental and overseas France. In the February 2018 report by the national Court of Audit, a need to more closely associate overseas territories in the management of this and related budget lines was raised.

Regional Energy Programme (PPE) targets set in 2017 will include in some cases rural electrification, for example in French Guiana, where the local PPE includes the creation of an Electrification Authority to coordinate actions and subsidies for rural electrification, as well as experimental Call for tenders for complementary RES productions. The possibility of calling



on the local grid manager to co-invest in new rural electrification production capacities is also being examined.

#### *3.1.0.6 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. Intermittent production sources (i.e. RES sources) may not go above 30% of supply in non-interconnected zones; this means that as demand goes down, RES systems may be disconnected (on a last arrived first disconnected basis) from the grid by the grid manager so that the 30% limit is maintained. In these territories, storage and electric vehicles are regarded as key elements to allowing higher penetration rates for RES.

The 2015 energy law created a National Registry of Electricity Production and Storage Installations, with application texts published in 2016. Early 2018 saw the first publication of the National Register, with a partial dataset up to October 2017. No chemical storage systems are included in this first edition of the Register, however, the Transport Grid Manager, RTE, who manages the register, notes that more complete data will be progressively added. For confidentiality reasons, installations under 36KW are aggregated.

#### ***Large scale storage***

A 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 winging bids were announced in August 2017, with an average Feed-in Tariff of 113,6 EUR/MWh (37 % to 67 % lower than comparable sized systems in Tenders from 2015). The 63 MW for 67 projects include 50 projects that elected to inject in peak consumption times (i.e. on command) and receive a Feed-in Premium of 200 EUR/MWh during these peak hours, adding an estimated 30% to project revenue.

#### ***Individual / small scale storage***

Discussion and interest in residential storage continues although the economic factors are not yet set for high take up rates – neither the relatively low electricity consumption costs nor peak consumption profiles in continental France are favourable. Past experimental programmes have deployed residential storage with grid services (frequency management, islanding...) as primary goals, both in overseas territories and continental France.

However, the increasing interest has led the major distribution grid operator Enedis to publish a technical note on grid connection conditions for stationary storage systems in October 2017.

#### ***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.

The national Transport Grid Manager RTE had a minimum of 340MW of demand response available through 2017, with peaks at 1 898 MW. The average demand response capacity offered by consumers (generally industrial clients) was 726 MW, up 26% from 2016. This capacity led to the reduction of 27 GWh of consumption in 2017, up from 16 GWh in 2016. In 2017, demand response was authorised to contribute up to 10% of primary reserve production capacity.

### *3.1.0.7 Support for electric vehicles (and VIPV)*

Charging stations: 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.

Purchase of electric or rechargeable hybrid cars: a national subsidy was available, and a number of local authorities (including Paris) have subsidies for the purchase of electric vehicles including bicycles, scooters and private or commercial use cars.

There are as yet no documented links between the acquisition of photovoltaics and electric vehicles, although anecdotal evidence does suggest that one may stimulate an individual's interest in the other.

**Table 13d: PV support measures**

	Residential		Commercial and industrial		Ground mounted and floating	
	On-going measures	Measures commenced in 2017	On-going measures	Measures commenced in 2017	On-going measures	Measures commenced in 2017
<b>Feed-in tariffs</b>	Terminated May 2017	Limited to building mounted systems under 100 kW	Yes, within Tenders for systems 100 kW to 500 kW	Limited to building mounted systems under 100 kW	No	Yes, within Tenders for systems with storage in ZNI
<b>Feed-in premium (above market price)</b>	No	No	Yes, within Tenders, for systems over 500 kW or self-consumption	Yes, within Tenders, for “innovative” systems over 500 kW	Yes, within Tenders, for systems over 500 kW	Yes, within Tenders, for “innovative” systems over 500 kW
<b>Capital subsidies</b>	No	No	Some local schemes exist, not compatible with FiT	No	No	No
<b>Green certificates</b>	No	No	No	No	No	No
<b>Renewable portfolio standards with/without PV requirements</b>	No	No	No	No	No	No
<b>Income tax credits</b>	Tax credits for PV-T hybrid systems, only	No	Special depreciation rate of 40% to promote investments	No	No	No

	the thermal elements are eligible		in productivity improving equipment (valid 04/2015 to 04/2017)			
<b>Self-consumption</b>	No	Lump sum and net-billing for partial self-consumption systems on buildings under 100 kW	Yes, within Tenders for self-consumption	Lump sum and net-billing for partial self-consumption systems on buildings under 100 kW	No	No
<b>Net-metering</b>	No	No	No	No	No	No
<b>Net-billing</b>	No	Lump sum and net-billing for partial self-consumption systems on buildings under 100 kW	No	Lump sum and net-billing for partial self-consumption systems on buildings under 100 kW	No	No
<b>Collective self-consumption and virtual net-metering</b>	No	Yes – half-hour time step for virtual metering	Yes, within Tenders for self-consumption	No	No	No
<b>Commercial bank activities</b> 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	

<b>Activities of electricity utility businesses</b>	Alternative supplier Enercoop will buy at a fixed rate (lower than FiT but no installer certification requirements)	No	Alternative supplier Enercoop will buy at a fixed rate (lower than FiT but no installer certification requirements)	No	No	Alternative supplier Enercoop may buy at a fixed rate
<b>Sustainable building requirements</b>	Self-consumption and electricity exports can be counted in energy balance to meet thermal regulations for new buildings	No	Thermal regulations and voluntary building performance labels may include PV generation in energy balance calculations	No	N/A	N/A
<b>BIPV incentives</b>	FiT for BIPV and BAPV systems. Terminated in May	New FiT bonus for BIPV systems under 9 kW – see Table 13a	FiT for BAPV systems. Terminated in May.	Building integration is no longer obligatory in Tenders		
<b>Other</b>	Reduced VAT for systems under 3 kW (10% instead of 20%) FiT revenue not taxed for systems under 3 kW Systems under 9 kW exonerated from land taxes (CFE)		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.

**Table 14: Self-consumption support measures**

PV self-consumption	Right to self-consume	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.
	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 500 kW) 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.
	Charges to finance Transmission & Distribution grids	Systems with total self-consumption pay no connection or recurrent grid access costs.  Systems in collective self-consumption systems will pay grid connection and recurring access fees (fees not yet determined).
Excess PV electricity	Revenues from excess PV electricity injected into the grid	Net-billing set by FiT, or by Tender specifications (FiT or wholesale market + premium).
	Maximum timeframe for compensation of fluxes	No compensation, consumption and production sales managed separately.
	Geographical compensation	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	Regulatory scheme duration	20 years for surplus (net-billing) sold in FiT, 10 years in Self-consumption Tender.
	Third party ownership accepted	Only within framework of Self-consumption Tenders
	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.
	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.
	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 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)  Individual systems limited to 100 kW in collective self-consumption projects (although multiple systems may be involved in the operation)  No structural limits.
	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 (i.e. active capacity must not go over 30% of consumption, grid manager disconnects on a first installed-last disconnected priority order.).
	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 regional authorities provided investment subsidies or preliminary feasibility study subsidies through Project Calls.

### 3.3 Collective self-consumption, community solar and similar measures

Collective self-consumption was first defined in 2016, however the necessary application decrees were published in 2017. Each generator must be under 100 kW, although several generators can be part of the operation, and all generators and consumers must be on the same substation. 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.

Much discussion by industry actors and institutions through 2017 was held concerning the requirements and appropriate levels of grid access fees as well as other taxes and sur-charges that may be applied to the self-consumed electricity. The discussion concerning the existence and level of these different fees, taxes and sur-charges has not been finalised, although in the intervening period they have been applied to the few experimental projects completed (the first project was commissioned in December 2017).

Economic models for self-consumption systems are uncertain, as the competitiveness of the self-consumed electricity (up to 0,16 EUR/kWh) is very dependent on 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, although the economic viability has not yet led to installations.

### **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 and/or innovation level in some Calls). Calls have continued from 2016, with minimal changes to Tender specifications, but in December 2017 volumes for future call were increased by 1 GW, principally for large ground-based systems.

The modifications include an increase in the financial guarantees required (up to 50 000 EUR), and tariff / premium penalties for delayed commissioning.

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.

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

A number of Tenders had calls open in 2017, as detailed in Table 15 below.



**Table 15: National tender volumes and results**

<b>System type and size</b>	Building mounted systems and parking canopies	Building mounted systems	Ground-based systems and parking canopies	Systems with storage in non-interconnected zones (ZNI**)	Building mounted systems for self-consumption		Innovative solar systems	Wind and/or ground-based photovoltaic systems
<b>Individual system size limits</b>	100 kW to 500 kW	500 kW to 8 MW	Ground: 500 kW to 30 MW <i>(raised from 17 MW in 2017)</i> Canopies: 500 kW to 10 MW	100 kW to 5 MW	100 kW to 500 kW	100 kW to 500 kW	100 kW to 3 MW	5 MW to 18 MW
<b>Support Mechanism</b>	Call for Tenders 2017–2019	Call for Tenders 2017–2019	Call for Tenders 2017–2019	Call for Tenders 2017	Call for Tenders** 2016–2017	Call for Tenders** 2017–2020	Call for Tenders 2017–2019	Call for Tenders 2018
<b>Volume</b>	825 MW in 9 calls of 75 MW to 100 MW (up from 675 MW)	1050 MW in 9 calls of 75 MW to 150 MW (up from 675 MW)	3,92 GW in 6 calls of 500 MW to 850 MW (up from 3 GW)	50 MW in 1 call	40 MW in 2 calls of 20 MW (continental) 20 MW in 1 call (ZNI*)	450 MW in 9 calls of 50 MW	210 MW in 3 calls of 70 MW	200 MW in 1 call
<b>Remuneration type</b>	PPA***	FIP****	FIP	PPA	Self—consumption + bonus on self-consumption + FIP	Self—consumption + bonus on self-consumption + FIP	PPA (5 MW) FIP (65 MW)	FIP
<b>Average tendered price (or bonus for self-consumption)</b>	2 <sup>nd</sup> call: 98,5 EUR/MWh	2 <sup>nd</sup> call: 88,4 EUR/MWh	2 <sup>nd</sup> call: 63,9 EUR/MWh	113,6 EUR/MWh	Mainland 2 <sup>nd</sup> call: 19,35 EUR/MWh ZNI 2 <sup>nd</sup> call: 34,19 EUR/MWh	1 <sup>st</sup> call: 7,9 EUR/MWh <i>(note: 36 candidates tendered at 0 EUR/MWh)</i>		

\* ZNI: non-interconnected territories (Corsica and French overseas departments)

\*\* 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 rate

### **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 2017 for photovoltaic contracts is 2 857 M EUR (source CRE), although little of this is due to systems commissioned in 2017.

The unitary contribution to the compensation fund was maintained by the energy regulator (CRE) at 22,5 EUR/MWh for 2017, with partial or whole exonerations possible for certain sectors (energy intensive industries, transport...).

The CRE estimates at approximately 76 M EUR the cost to the CSPE in their first year of operation for the Call winners announced in 2017 - new capacity from the 2<sup>nd</sup> Call for ground-based systems, with winners announced in June 2017, will cost as little as 15 M EUR for 500 MW in the first year of operation – depending on the capacity factors, this may be as low as an average 25€/MWh.

For residential consumers in France, support for photovoltaics represents approximately 5% the cost of kWh consumption in 2017.

#### **1.1.3. Indirect policy issues**

Indirect support measures were the subject of discussion during the self-consumption consultation organized by the energy regulator CRE in late 2017, with most actors agreeing that indirect support policies were less desirable as they could not be managed as pro-actively as direct support measures.

However, indirect policy decisions, such as the reduction in the direct cost of grid connection for RES systems under 5 MW, announced in February and implemented in December, will have an impact - with part of the upfront connection costs (40% for residential systems) being integrated into annual access charges, the economic accessibility of grid connection is greatly improved.

## 4 INDUSTRY

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

#### Ingots 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).

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

Cell and module manufactures together with production and/or capacity information is summarised in Table 16 below.

**Table 16: Production and production capacity information for 2017**

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc- Si, OPV)	Production and/or capacity (MW/yr)	
		Cell	Module
<i>Thin-film technologies</i>			
ARMOR		/	
Dracula Technologies		OPV	
<i>Wafer-based PV manufactures</i>			
Irysolar (SEMCO technologies)		5	
S'Tile		15	15
EDF ENR PWT (Photowatt)	sc-Si, mc-Si, qc-Si	50	70
Reden Solar (ex Fonroche)			65
Francewatts			2
Sillia VL (now Recom Sillia)			50
SCNAsolar (ex SNASolar)			25
Systovi			80
Sunpower (Total)			154
VMH Energies			20

Voltec Solar			60
<b>TOTAL</b>			Approximatel y 500

SOURCE: private communication, manufacturers' websites

Continuing on the movements and difficulties experienced by some manufacturers in 2016, 2017 saw liquidations and acquisitions. 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:

- **ARMOR** develops their proprietary organic 'ASCA' films up to 60cm wide and 30m long, 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<sup>2</sup> / year.
- **Dracula Technologies** is a start-up developing printed organic photovoltaic cells (trademarked LAYER technology) aimed at the connected device market. The company is currently raising finance for a small industrial line.
- **Francewatt** manufactures laminates that are assembled into their building integration products, in particular their PV tile.
- **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. However, in January 2018 EDF announced a new industrial strategy for Photowatt, centred around their innovative ingot and wafer fabrication, with cell and module assembly being outsourced overseas. A joint venture baptised Photowatt Crystal Advance,d incorporating Canadian Solar Inc. and ECM Greentech (see Irysolar above) will increase today's 50 MW of wafer production to 500 MW. The company will continue its R&D branch for EDF – the Photowatt Lab, capable of manufacturing 10 MW to 15 MW per year for testing new products in pre-industrial conditions.
- **Reden Soalr (ex Fonroch Solaire)** 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.
- **Sillia VL** was placed in liquidation in March 2017 after a year at partial capacity, despite 2,5 years of orders in the books. The Lannion site was acquired by Recom Italia, who plan to extend annual capacity from the current 50 MW to 150 MW by the end of 2018. The Venissieux site was liquidated.
- **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%.
- **Systovi** assembles polycrystalline and monocrystalline modules and doubled their manufacturing capacity in late 2017. It also manufactures PV/thermal hybrid modules (hot air).
- **Sunpartner** has developed techniques to adapt market available thin film laminates to create building and transport integration solutions with varying degrees of transparency.
- 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).

### 4.3 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 with (off grid, on grid, storage...). The distribution grid manager has built requirements on a modified version of the German DIN VDE 0126-1-1/A1.

Micro-inverters were of strong interest to residential consumer, and international manufacturers were well presented, with aggressive marketing campaigns through distributors.

#### ***Storage batteries***

Large scale storage systems continue development in the framework of previous national Calls – although no new Calls specifically targeting storage were announced in 2017. Market penetration remains very low for residential systems, although offers are present.

#### ***Supporting structures***

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

The specific building insurance environment in France requires 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, generally carried by manufacturers of support structures.

Fire damages (especially the SCHEUTEN case) and leakages in agricultural roofs over the past years has led insurers to take a close look at the photovoltaics industry. After reflection, the insurer representative body Agence Qualité Construction (AQC) took the unprecedented

move of announcing, in March 2017, that as of January 1st, 2018, most BIPV systems would be placed under observation – making building liability insurance harder to find, more expensive and more restrictive, as insurers add surcharges to cover probable losses or move out of the photovoltaics sector to avoid potential risks. Manufacturers of building integration support structures were hit hardest by this announcement, and long delays in presenting products to the AQC Product Prevention Commission (C2P) to be added to the Green List of products, considered by insurers to be “normal risk level” building products has further weakened local industrials.

This decision, added to the May revision and announced phase-out of full BIPV bonuses for feed-in tariffs was responsible for increasing insurance and commercial difficulties for local manufacturers.

## **5 PV IN THE ECONOMY**

### **5.1 Labour places**

No new survey of employment in the photovoltaics sector was conducted for 2017. The 2017 edition of the Observ'ER qualitative survey of actors in the photovoltaics market in France tests the general confidence of market actors. Installers were confident through 2017, despite relatively low demand in early 2017, and the liquidation of some industrial actors in difficulty.

The last reliably estimated PV related labour places for 2016 indicated approximately **5 700 labour places, 13% in manufacturing, 28% in operations and maintenance and the remaining 41% in system and installation companies**. It may be noted that in 2015, with an installed volume close to 2018 volumes, an estimated 6800 labour places were present in France. However, with a strong concentration in the largest systems that are the least labour-intensive, it is unclear whether labour places have improved. The next edition of the ADEME report on the national RES market and labour places in France will be published in 2019.

SOURCE: 2017 Edition “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables », ADEME, Étude qualitative du marché du solaire photovoltaïque résidentiel en France, Observ'ER, December 2017.

### **5.2 Business value**

Investments and turnover are studied for ADEME in the semi-yearly “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables” - the next edition of the ADEME report with data concerning 2017/2018 will be published in 2019.

An idea of the 2017 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 2017, 5,1 million modules were declared as marketed in France. This is a significant progression with regards to the 2,9 million declared in 2016, consistent with the expected volume of construction work on Tender winning ground-based systems. Whilst the volume of modules has progressed, it must be remembered that unit price is still decreasing, so market value has progressed more slowly.

The market value for 2017 (below) has been estimated based on 2017 Trending prices and extrapolated official 2017 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.

<b>Sub-market</b>	<b>Capacity installed in 2017 (MW)</b>	<b>Price per W</b> <i>(from table 7)</i>	<b>Value</b>	<b>Totals</b> <b>M EUR</b> <b>(provisional)</b>
<b>Grid-connected distributed</b>				528
Residential < 3 kW	18	2,6	47	
Residential < 9 kW	58	1,9	110	
Commercial < 100 kW	179	1,2	215	
Commercial < 250 kW	44	1,2	53	
Industrial > 250 kW	115	0,9	103	
<b>Grid-connected centralized</b>	462	0,9		415
<b>Export of PV products</b>				Expected range 0 to 50*
<b>Change in stocks held</b>				-
<b>Import of PV products</b>				Expected range 300 to 500*
<i>Value of PV business</i>				<i>Expected range 450 to 700*</i>

SOURCE: SDES, Observ'ER Baromètre Electrique 2017, \*estimate HESPUL

## 6 INTEREST FROM ELECTRICITY STAKEHOLDERS

### 6.1 Structure of the electricity system

<ul style="list-style-type: none"> <li>- structure – vertically integrated or separate generation, transmission, distribution;</li> </ul>	<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>
<ul style="list-style-type: none"> <li>- retailers and network businesses – integrated or separate;</li> </ul>	<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>
<ul style="list-style-type: none"> <li>- ownership – private – public (state owned or municipal)</li> </ul>	<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 83,5% of EDF's share capital), ENGIE (the French government owns 24% of ENGIE's share capital).</p>
<ul style="list-style-type: none"> <li>- Electricity industry regulator?</li> </ul>	<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>

### 6.2 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 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 Energie Nouvelles (EDF EN), a subsidiary of EDF, EDF EN 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 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. Through its different subsidiaries, EDF has 311 MW of PV in operation in France and just under 1 GW worldwide.

In December EDF announced its intention of installing 30 GW in France between 2020 and 2035.

ENGIE has aggressively invested in both RES production and major RES market players in France, such as the CNR and Solair Direct. It is the biggest solar generator in France, with 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 are active participants in the growth of photovoltaics, both through facilitating actions, direct and indirect investment. Participation and development is nonetheless hampered by the Feed-in Tariff access conditions, as municipalities 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). Direct access to national Tenders is also difficult, combining risk and binding calendar requirements generally incompatible with local authority direct investment. A growing number of local authorities, municipalities and public utilities have created public-private subsidiary companies for the development of photovoltaics and other RES systems, generally within their local territories. Several of these ventures are more ambitious, developing a significant volume of building and ground-based systems, as well as accelerating investment by accompanying other local authorities in their own territories.

A number of municipalities and joint local authorities have climate action plans, tending towards 100% RES communities, with RES, or solar development plans, support mechanisms for citizen investment, RES investment companies and, in some cases specific RES investment funds.

## **7 HIGHLIGHTS AND PROSPECTS**

Industry actors were actively engaged in market evolutions in 2018, with the publication of a new Feed-in tariff Order for systems under 100 kW in continental France, and another for overseas territories. The new conditions removed the previous all-BIPV obligation, and include a specific investment bonus for partial self-consumption systems. Grid access and regulatory consideration for individual and collective self-consumption systems were clarified, whilst mandatory commissioning certification requirements and minimal installer qualifications for all RES systems were also published. A reduction in the direct cost of grid connection for RES systems under 5 MW was announced in February and implemented in December, with part of the upfront connection costs being integrated into annual access charges, improving the economic accessibility of grid connection.

Call for Tenders capacity was increased to 2,5 GW (up from 1,5 GW) in December, coming into force in 2018, with proportionally more volume for the largest systems. Citizen investment continues to garner support, with an adjustment to tariff bonuses for both direct citizen investment in equity and crowdfunding of debt.

National photovoltaic capacity grew by 875 MW, compared to less than 600 MW in 2016 (894 in 2015), for a cumulative capacity of 8 044 MW. Citizens have predominantly turned to partial self-consumption for residential systems, with stable volumes, however the changes in Feed-in tariff conditions saw the re-emergence of systems in the 36 kW to 100 kW segment after a lean 18 months. The second half of 2017 saw nearly 500 MW of multi-MW systems connected to the grid, as 2015 Tender winners reached their mandatory completion dates. As for 2016, approximately 70% of the capacity installed in 2017 was for systems over 100 kW commissioned within the framework of Call for Tenders.

The year 2018 should see volumes consistent with 2017 as Tender winners from 2016 and early 2017 commission their systems. Self-consumption is likely to be the norm for residential systems, and more experimental collective self-consumption systems should be finalised. The May 2018 “Lecornu” solar workshops aimed at simplifying solar to accelerate market deployment may lead to regulatory or even legislative changes, as industry actors campaign for fixed treatment delays for planning authorisations and the facilitation of third-party investing and leasing conditions, amongst others subjects.

