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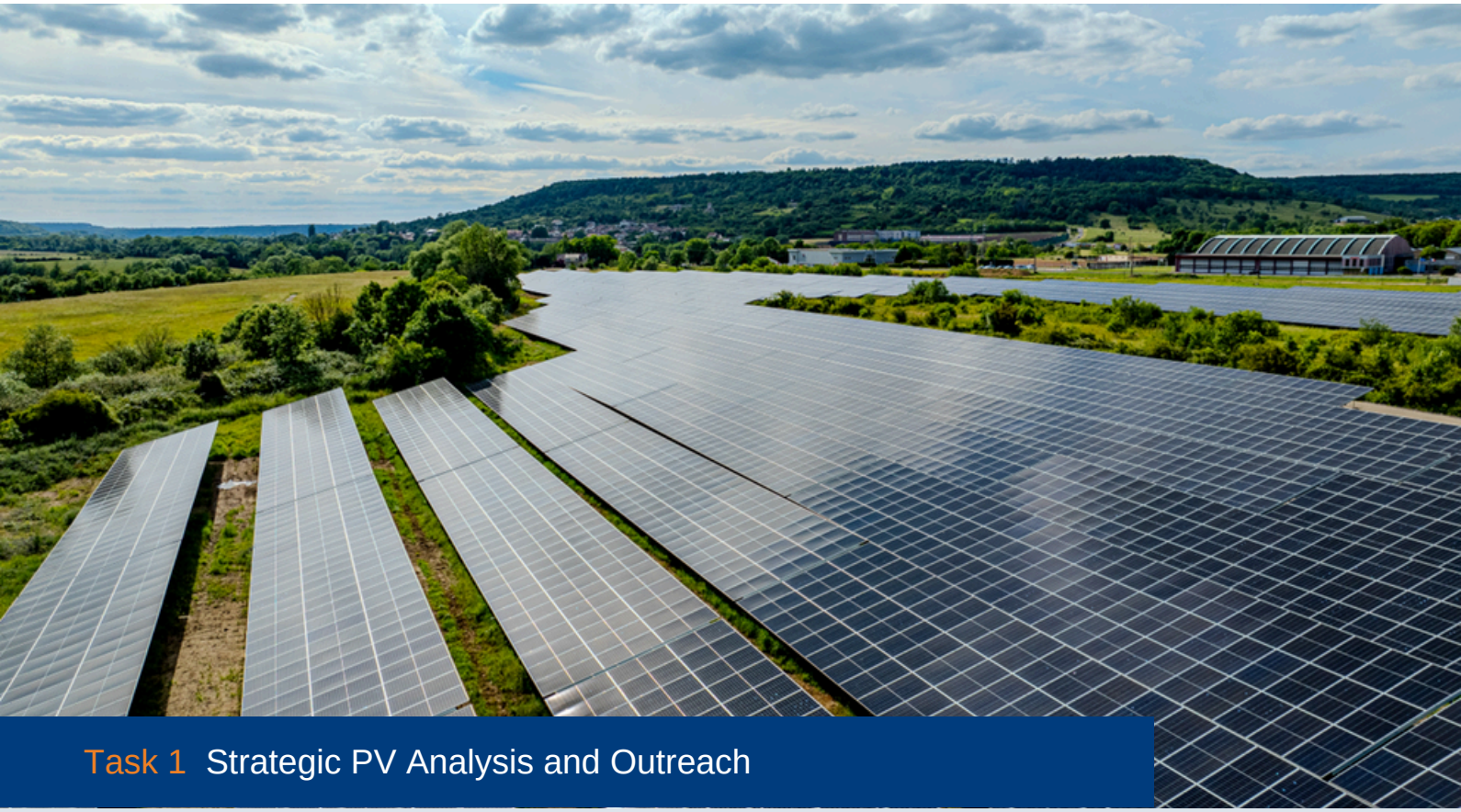
by IEA

International Energy Agency
Photovoltaic Power Systems Programme



Task 1 Strategic PV Analysis and Outreach

PVPS

National Survey Report of PV Power Applications in FRANCE

2024

ADEME
AGENCE DE LA TRANSITION ÉCOLOGIQUE

What is IEA PVPS TCP?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The Technology Collaboration Programme (TCP) was created with a belief that the future of energy security and sustainability starts with global collaboration. The programme is made up of 6.000 experts across government, academia, and industry dedicated to advancing common research and the application of specific energy technologies.

The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the TCP's within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems." In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, China, Denmark, Finland, France, Germany, India, Israel, Italy, Japan, Korea, Malaysia, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom and the United States of America. The European Commission, Solar Power Europe and the Solar Energy Research Institute of Singapore are also members.

Visit us at: www.iea-pvps.org

What is IEA PVPS Task 1?

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual "Trends in photovoltaic applications" report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2024. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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COVER PICTURE

11.8 MW system on 12 hectares of military wasteland in Ecrouves (France), public-private investment with citizen and public governance
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INTERNATIONAL ENERGY AGENCY

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

National Survey Report of PV Power Applications in France 2024

IEA PVPS
Task 1
Strategic PV Analysis & Outreach

July - 2025

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ACKNOWLEDGEMENTS

This paper received valuable contributions from different sources mentioned in the references.

MAIN 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° 735, May 2025 (SDES — Service de la donnée et des études statistiques, Commissariat au Développement Durable, Ministery for Ecological Transition and Territorial Cohesion of France;
- Registre national des installations de production et de stockage d'électricité (National Register of Generators and electricity storage systems);
- "Bilans des Raccordements", Enedis Open Data (distribution grid manager for 95% of the nation);
- "Bilan électrique 2024" (RTE Electricity Report 2024), RTE, February 2025 (Transport grid manager);
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- "" EU Solar Jobs Report 2024 » SolarPowerEurope;
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- "Baromètre des achats d'énergie verte en France" T1 to T4 2024 Capgemini invent;
- Public reports on national Call for Tenders dedicated to solar energy, 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, 2024, 2025);
- « Observatoire de la CRE relatif aux contrats d'achat d'électricité portant sur des actifs de production d'électricité renouvelable (« PPA ») situés en France métropolitaine continentale et recommandations en faveur de leur développement » CRE, March 2025
- https://forum-photovoltaique.fr

FRENCH PARTICIPATION IN IEA PVPS TASKS

Organisation	**Name, Role,**	**Specific contributions 2024** Note: where not stated, contributions cover background participation in Task meetings, working documents and research.
Task 1 Strategic PV Analysis & Outreach		
Becquerel Institute France	DE L'EPINE Melodie	(subcontractor: Data collection and authoring Annual Report, NSR, contribution to Snapshot, Trends)
Task 12 PV Sustainability		
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Task 13 Performance, Operation and Reliability of Photovoltaic Systems		
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CEA (French Alternative Energies and Atomic Energy Commission)	TSANAKAS Ioannis	
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Task 15 Enabling Framework for the Development of BIPV		
EnerBIM	ALAMY Philippe	
CSTB (Scientific and Technical Centre for Building)	BODDAERT Simon • Co-author: Building-Integrated Photovoltaics: A Technical Guidebook - doi: https://doi.org/10.1201/9781003432241 • Co-author : Advancing BIPV Standardization: Addressing Regulatory Gaps and	Events : • April 2024 - T15 phase 3 kickoff • September 2024 EUPVSEC (Vienna) - IEA PVPS Parallel Workshops Fact-sheets • Multi-Dimensional-Evaluation of BIPV Installations -. doi:

	Performance Challenges - isbn: 978-3-907281-67-3 • Co-author : Fire Safety of BIPV: International Mapping of Accredited and R&D Facilities in the Context of Codes and Standards 2023 CALDERON Laurent GUIOT Thierry OLIVE François	https://doi.org/10.69766/WADZ1776 Scientific publications: • Solar Heat Gain Coefficient of BIPV modules for electricity-generating facades - doi: https://doi.org/10.1016/j.enbuild.2024.114843 | https://doi.org/10.1016/j.enbuild.2024.114592 • Cross-Sectional Analysis of BIPV Installations: Performance Evaluation as Building Component and Energy Generator EUPVSEC 2023 (Lisbon) - isbn: 3-936338-88-4
Task 16 Solar Resource for High Penetration and Large Scale Applications		
Ecole Polytechnique à Palaiseau	BADOSA Jordi CROS Sylvain	Events • April 2025 – 16th meeting of Task 16 Scientific Contributions • Solar energy forecasting using deep learning methods on satellite images (Polytechnique–TotalEnergies collaboration) • Influence of North Atlantic weather patterns on the performance of solar forecasting methods in France • Performance comparison of short-term solar energy forecasts using satellite images (Polytechnique–Mines Paris collaboration)
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Laboratoire PIMENT, University of Reunion	LAURET Philippe MATHIEU David	

Mines ParisTech	AMARO E SILVA Rodrigo EISSA Yehia MENARD Lionel SAINT-DRENAN Yves-Marie	Scientific Contributions • Performance comparison of short-term solar energy forecasts using satellite images (Polytechnique–Mines Paris collaboration)
RTE (Réseau de Transport d'Électricité)	DUBUS Laurent	
TotalEnergies	TUOMIRANTA Arttu	Scientific Contributions • Solar energy forecasting using deep learning methods on satellite images (Polytechnique–TotalEnergies collaboration)
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1 HIGHLIGHTS

Much awaited new feed in tariffs were published for overseas territories in 2024, whilst discussion continued regarding an anticipated feed in tariff for small ground mounted systems on already urbanised land, although it was not published. Consultations to revise the national Energy Decree continued, with government support for ambitious targets variable over time.

Module prices continued to decline across all segments, however, increases in costs of (amongst others) mounting supports meant that utility scale costs were relatively stable. The residential segment did experience a drop in prices (0.2 EUR/Wp), although they remain well above EU market averages with a widespread. The drop in market electricity prices reduced the attractiveness of corporate PV power purchase agreements (CPPA), and whilst contracts negotiated in 2023 were announced in Q1 2024, lower volumes were initiated.

Over 2024 cumulative installed capacity grew to approximately 30 GW DC (25 GW AC), with a record breaking 6 GW installed (of which 3.3 GW are accessing Feed in tariffs). More than 2/3 of this was installed on rooftops, across the residential, commercial and industrial segments. By far the largest segments (35% of new capacity, +10% compared to 2023), more than 2 GW of commercial systems between 100 kW and 250 kW were installed, above the government's planned (and budgeted) volume for this segment. The residential segment dropped 5% in share, whilst industrial and utility dropped slightly to 35%, a long way from the 66% share in 2021. About half of new residential and commercial capacity was self-consumption, once again in progression (+10%).

In France projects progress from gaining urban planning approval (permitting) to entering the grid connection queue to commissioning. The grid connection queue has more than 6 GW of projects with signed preliminary DSO contracts, and a further 19 GW of authorised projects. With around 11 GW of new entries (up from 7 GW in 2023) to the queue outstripped projects exiting through commissioning or abandon by approximately 4 GW.

2 INSTALLATION DATA

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

For the purposes of this report, PV installations are included in the 2024 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2024, although commissioning may have taken place at a later date.

Data collection includes information on storage capacity, and the injection type is now collected by Enedis (total or partial self-consumption, full generation sales).

Official statistics report the AC power of photovoltaic fields, despite eligibility for Feed-in Tariffs and Tender support mechanisms being indicated in peak DC power thresholds. It may be useful for the reader to know that the average generation across France is 1 100 kWh/kWp, but that systems installed in the southern half of mainland France will generate more, up to 1 550 kWh/kWp, and in overseas territories up to and over 1 700 kWh/kWp. For the purposes of this report, all AC data has been converted to DC power, with a standard ratio of 1,2 (AC to DC) unless otherwise specified. In the particular segment of utility scale systems, some data is available on both DC and AC power and the reported DC power has been used.

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

2.1 Applications for Photovoltaics

The principal applications for photovoltaics in France in 2024 are grid connected:

- **Residential** (house and multi-apartment) systems. These systems tend to range from one or two modules with self-consumption through to standard 3 kW, 6 kW or 9 kW systems. Much of the current total capacity was installed during the 2009/2011" boom" and is building integrated – however, since 2017, new capacity is only building applied PV;
- **Commercial, agricultural or industrial** systems on buildings (36 kW to 250 kW AC or around 300 kW DC). A small proportion (3% of total new capacity) are systems between 9 kW and 36 kW, generally on public buildings such as town halls, primary schools or technical services buildings;
- **Industrial** building mounted or **parking canopy** systems (250 kW to 1 MW);
- **Utility scale ground mounted** systems (over 1 MW).

Small but growing segments include micro (balcony) kits, agrivoltaics and floating PV.

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

2.2 Total photovoltaic power installed

- **Centralised**: any PV installation which only injects electricity and is not associated with a consumer (no self-consumption) over 1 MW;
- **Decentralised**: any PV installation which is embedded into a customer's premises (either with or without self-consumption) under 1 MW.

Cumulative PV installed capacity as of the end of 2024 reached 25 307 MW (AC or inverter power) or roughly 30.5 GW DC (module power).

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, < 500 kW and above 500 kW). Data is estimated to be accurate to within about 5% of published values.

Capacity data published by the SDES and in the national register is given as the AC power of systems. Enedis does not specify if the data is DC or AC, but it does tend to correspond to AC power, with an unknown of the capacity of total self-consumption systems. If the difference between the DC and AC reported powers in the past was not consequent, the divergence is now increasing, particularly considering the current world-wide trend to increase the DC/AC (module power to inverter power) ratio. See introductory notes on the conversion actors.

For the purposes of this report, we have considered the following hypotheses for data collected in 2024:

Grid connected distributed (decentralised) systems:

- **Residential**: up to 9 kW - no data was available concerning the split BIPV/BAPV for new systems from 2017 to 2022, the BIPV volumes with the bonus Feed-in tariffs are presumed to be the maximum allowed volumes in the feed in tariffs for 2022 and 2023 but do not include bespoke BIPV;
- **Commercial:** all systems 9 kW to 250 kW are Commercial BAPV (Building Applied Photovoltaics).

Grid connected centralised ground mounted systems:

- **Industrial**: all systems from 250 kW to 1 MW are Industrial or Ground-mounted. The split between Building-mounted and Ground-mounted is extrapolated from grid connection data published by Enedis;
- **Utility scale** systems: all systems over 1 MW and/or floating systems under 1 MW if known.

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

Table 1: Annual PV power installed during calendar year 2024

		Installed PV capacity in 2024 [MW DC]
	Decentralised	4 139
	Centralised	1 871
	Off-grid	
	Total	6 010

SOURCES: SDES, Observ'ER, Enedis, *split is estimated Becquerel Institute France

Table 2: PV power installed during calendar year 2024

			Installed PV capacity [MW]	Installed PV capacity [MW DC]
Grid-connected	BAPV	Residential	4 139	1 176
		Commercial		2 761
		Industrial		202
	BIPV	Residential	Not tracked	
		Commercial		
		Industrial		
	Utility-scale	Ground-mounted	1 870	1 834
		Floating		>31
		Agricultural		>5
Off-grid		Residential	NA	
		Other		
		Hybrid systems		
Total			6 010	

SOURCES: SDES Observ'ER, Enedis, some splits estimated Becquerel Institute France

Table 3: Data collection process

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	All power data is given in AC power. The conversion coefficient is 1.2. For systems > 1 MW, the conversion coefficient is 1.20 based on survey of systems commissioned in 2024, 1.25 in 2023.
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. Enedis (national DSO) publishes segmented data. author has further segmented data as required.
Link to official statistics (if this exists)	https://www.statistiques.developpement-durable.gouv.fr/les-energies-renouvelables?rubrique=21
Data quality	Data is of good quality, however provisional, and may be revised as grid operators provide additional information. Some divergence in capacity volumes may exist depending on the segments represented; the error source may be related to reporting dates, provisional data and/or collection methods. Historical data may be in DC.

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

Year	Off-grid [MW] (including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralised [MW] (Ground, floating, agricultural...)	Total [MW]
2009	29.2	360	50	440
2010	29.3	1 126	290	1 445
2011	29.4	2 690	842	3 562
2012	29.6	3 662	1 214	4 906
2013	29.7	4 145	1 517	5 691
2014	29.75	4 756	2 051	6 836
2015	30.15	5 108	2 782	7 920
2016	30.15*	5 488	3 118	8 635
2017	30.15*	5 982	3 701	9 713
2018	30.15*	6 410	4 315	10 756
2019	30.15*	6 955	4 945	11 931
2020	30.15*	7 571	5 497	13 513*
2021	30.15*	8 873	7 865	16 960*
2022	/	11 211	8 388	20 610*
2023	/	12 188	12 387	24 576

2024	/	16 638	13 835	30 478

*revised in 1st quarter 2024

Table 5: Other PV market information

	2024			
Number of PV systems in operation in your country	Peak Power range	Installations (number)	Power [MW AC]	Power [MW DC]
	0 – 3 kW	656 336	1 629	1 995
	3 kW – 9 kW	405 004	2 311	2 773
	9 kW – 36 kW	45 198	1 041	1 249
	36 kW – 100 kW	42 117	3 615	4 338
	100 kW – 250 kW	22 615	4 396	5 275
	250 kW – 500 kW	981	392	470
	> 500 kW	2 938	11 923	14 413
	Total	**1 175 189**	**25 307**	**30 368**
Decommissioned PV systems during the year [MW]	0 (estimated)			
Repowered PV systems during the year [MW]	10 - 100 MW. Currently no official reporting of repowered volumes is published			
Unregistered capacity	Analysis of the data from the 3 major sources (SDES, Enedis and the Register). Unregistered capacity possible with micro (balcony) systems.			

Sources: SDES, Registre national des installations de production et de stockage d'électricité, Open data réseaux énergies (ODRÉ) *Becquerel Instititute France extrapolations.

Table 6: PV power and the broader national energy market

	2023	2024
Total power generation capacities [GW]	Total: 149.4 GW of which • Nuclear: 61.4 GW • Fossil fuel: 17.4 GW • RES: 70.6 GW (see below)	Total: 155.5 GW of which • Nuclear: 61.4 GW • Fossil fuel: 17.4 GW • RES: 76.7 GW (see below)
Total renewable power generation capacities (including hydropower) [GW]	• PV*: 20 GW • Hydro: 25.7 GW • Wind: 22.7 GW • Other RES: 2.2 GW	• PV*: 24.3 GW • Hydro: 25.7 GW • Wind: 24.3 GW • Other RES: 2.3 GW
Total electricity demand [TWh]	445.7	449.2 (gross value)
New power generation capacities installed [GW]	Total: 4.8 GW of which • Gas: 0 GW • Coal: 0 GW • Diesel: 0 GW • Nuclear: 0 GW PV and other RES: 4.8 GW (see below)	Total: 4.8 GW of which • Gas: 0 GW • Coal: 0 GW • Diesel: 0 GW • Nuclear: 0 GW PV and other RES: + 6.7 GW (see below)
New renewable power generation capacities (including hydropower) [GW]	• PV*: + 3.3 GW • Wind: + 1.6 GW • Hydro: + 0.00 GW • Other RES: 0 GW	• PV*: + 5 GW • Wind: + 1.7 GW • Hydro: + 0.00 GW • Other RES: < 0.1 GW
Estimated total PV electricity production (including self-consumed PV electricity) in [GWh]	21 600	24 800
Total PV electricity production as a % of total electricity consumption	4.8%	5.52 %
Average yield of PV installations (in kWh/kWp)	1 100 kWh/kWp	1 100 kWh/kWp

2023 RTE France Electricity Report 2023. 2024 RTE France Electricity Report 2024.
*Data in this table is provided by RTE and provisional PV **are AC power only**.

2.3 Key enablers of PV development

Table 7: Information on key enablers.

	Description	Annual Volume	Total Volume	Source
Decentralised storage systems	Systems with conformity declaration	8 391 (Mainland) 2 618 in (Overseas Territories)	Approx. 28 000 systems	Consuel Annual Report 2024
Residential Heat Pumps (number)	air/air + water/water + air/water	841 111 + 2 679 + 182 648 = 1 026 438		Uniclim Bilan 2024
100% Electric cars (number)		317 501	1 336 106	AVERE Bilan 2024
Hybrid rechargeables (number)		147 213	723 449	AVERE Bilan 2024

3 COMPETITIVENESS OF PV ELECTRICITY

In 2023 and 2024, the price of photovoltaic modules dropped significantly (and although mainstream module costs declined only 25% over 2024 (as compared to nearly double that over 2023), high performance modules declined by up to 45%. The main drivers of this drop remain unchanged: high production capacity, in China, well above the markets ability to absorb. Confronted with market barriers in North America and India, Chinese modules continued to be oriented towards the European market, with supply largely exceeding demand.

3.1 Module prices

Table 8: Typical module prices

Year	Typical price of a standard module crystalline silicon EUR/Wp			
	2021	2022	2023	2024
Average module price (all technologies)	0.25 – 0.4	0.25 – 0.4	0.15 – 0.3	0.09 - 0.22

SOURCES: CRE “Coûts et rentabilités du grand photovoltaïque en métropole continentale”, pvXchange and Hespul estimate. 2024 data from Becquerel Institute France limited market survey.

Note: these module prices are for direct buys or professional sales. Residential clients’ prices range from 0,2 EUR/Wp up to over 1 EUR/Wp.

3.2 System prices

There is a wide range in turnkey prices, especially in the small to medium size segment. This range of prices is determined by the ease of installation (or the state of repair and complexity of the existing roof), the type of supporting structures needed, the complexity of the grid connection and the development time associated with these complexities. While the cost of panels on the international market has fallen sharply in 2023, the total price of installations dropped slightly for Residential and C&I sectors, and even less for utility scale systems as other components increased, including supports, studies and financing.

The highest prices concern the residential segments, with a significant gap between the lowest and highest prices in the segment. Regarding the small commercial BAPV segment, there is a very large difference between the prices for 10 kWp and 100 kWp systems. The same comment can be made regarding the small, centralised PV segment for 1 MWp and 20 MWp systems.

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

Category/Size	Typical applications and brief details	Current prices [EUR/W]
Residential BAPV < 3 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes. Equipment and labour.	2.5 (2.2 – 2.7)
Residential BAPV 3-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes. Equipment and labour.	2.1 (1.1 – 2.4)
Residential BIPV 3-10 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected households. Typically, on villas and single-family homes.	2.0 - 3.5
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	0.8 (0.65 - 1.6)
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	0.65 - 0.9
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	0.9 (0.6 - 1.1)
Small centralised PV 1-20 MW	Grid-connected, ground-mounted, centralised PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	0.59 (0.40 - 0.85)
Other	Parking canopy distributed >250 kW	0.95 – 1.2

SOURCE: estimation Becquerel Institute France based on limited market surveys.

Table 10: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW **[EUR/W]**	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW **[EUR/W]**	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-500 kW **[EUR/W]**	Centralised PV Grid-connected, ground-mounted, centralised PV systems 10-50 MW **[EUR/W]**
2007	8.4	7.8		6.3
2008	8.2	7.6		6.2
2009	6.9	6.4		5.2
2010	5.9	5.5		4.5
2011	3.9	2.6		2
2012	3.7	2		1.6
2013	2.7	2		1.3
2014	2.6	2		1.3
2015	2.5	1.9		1.2
2016	2.41	1.58		1.1
2017	2.2	1.2		0.9 - 1.1
2018	2.2	1.2		0.7 - 0.9
2019	2	1.2	1.2	0.65 – 0.85
2020	1.9	1.1	0.9	0.65 – 0.85
2021	1.7 – 2.5	0.6 – 1.7	0.7 – 1.1	0.5 – 0.9
2022	2.2 (1.2 – 3)	1.1 (0.8 – 1.3)	0.7 – 0.9	0.65 – 0.95
2023	2.5 (1.3 – 2.9)	1.2 (0.9 – 1.5)	0.7 – 0.9	0.65 – 0.95
2024	2.3 (1.1 – 2.4)	0.8 (0.65 - 1.6)	0.6 – 1.1	0.6 (0.4 – 0.85)

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 9 kW since 2017. The range of peak power for large commercial systems has been increased from 100 – 250 to 100 – 500 to reflect changing market conditions.

SOURCES: Previous IEA NSR-FR reports, Observ'ER, limited market surveys by Hespul, Becquerel Institute France. VAT not included *IAB: completely building integrated; **ISB: simplified building integration; BAPV building applied/roof top systems.

3.3 Cost breakdown of PV installations

Limited market surveys have been used to evaluate the cost redistributions in the context of rising upstream costs as professionals responded to these events. The survey indicates that as the cost of modules and inverters dropped, the cost of mounting structures and installation increased. A much larger proportion of surveyed data was on the lower side of median prices, pushing the average down. A wider variety in system peak power was also observed; the previous limitations linked to reduced VAT and untaxed revenue seem to no longer dictate system size with as much consistency as in 2023 and before.

Table 11: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of 5-10 kW

Cost category	Average [EUR/W]	Low [EUR/W]	High [EUR/W]
Hardware			
Module	0.48	0.27	
Inverter	0.40	0.22	
Mounting material	0.25	0.14	
Other electronics (cables, etc.)	0.18	0.10	
Subtotal Hardware	1.3		
Soft costs			
Planning	0.56	0,09	
Installation work		0,26	
Shipping and travel expenses to customer			
Permits and commissioning (i.e. cost for electrician, etc.)			
Project margin			
Subtotal Soft costs	0.56		
Total (excluding VAT)	1.9		
Average VAT	20%		
Total (including VAT)	2.3		

SOURCE: market surveys (Hespul, Becquerel Institute France).

For this segment, module and inverter prices are well above that of other segments; in France both distributors and installers add a margin to module costs.

Table 12: Cost breakdown for a grid-connected, ground-mounted, centralised PV systems of >10 MW

Cost category	Average [EUR/W]
Module	0.13
Inverter	0.04
Mounting material	0.17
Other electronics (cables, etc.)	0.16
Subtotal Hardware	**0.50**
Planning	0.10
Installation work	
Shipping and travel expenses to customer	
Permits and commissioning (i.e., cost for electrician, etc.)	
Project margin	
Subtotal Soft costs	**0.10**
Grid connection	0.12
Total (excluding VAT)	**0.71**
Average VAT	20%
Total (including VAT)	**0.86**

SOURCE: "Évaluation et analyse de la contribution des énergies renouvelables à l'économie de la France et de ses territoires" SER/EY June 2021, Limited survey and estimations by Hespul, Becquerel Institute France 2024.

3.4 Financial Parameters and specific financing programs

Table 13: PV financing information in 2024

Different market segments	Loan rate [%]
Average rate of loans – residential installations	7% - 9% over 12 years (incl. insurance) for consumer credit or 4.1% to 5% for PV loans (assigned credit) over 12 - 15 years
Average rate of loans – commercial installations	3.5% to 4.0% over 12 to 20 years (not including insurance), slight decrease compared to 2023
Average cost of capital – industrial and utility installations	3 to 4% over 20 years, slight increase compared to 2023

SOURCES: Statinfo Le crédit aux particuliers Déc 2023 and 2024 Banque de France, Taux des crédits aux entreprises by Banque de France, S&P Dow Jones Indices SIN: DE000A0ME5S6; estimation Becquerel Institute France.

Interest rates for all residential and smaller commercial sectors continued to slightly increase month on month through 2023 after more significant increases in 2023. For larger projects, interest rates increased over 2023 until they dropped approximately 1% from October through to January 2024.

3.5 Specific investments programs

Table 14: Summary of existing investment schemes

Investment Schemes	Introduced in France
Third party ownership (no investment)	Used for commercial and industrial systems (roof and land rental), but also to a lesser extent on new agricultural buildings.
Renting	Small-scale operations. A company specializing in photovoltaic installations will install solar panels on your roof, retaining ownership of the panels. They will also look after the maintenance of the installation for the duration of the lease. The renters pay a monthly instalment.
Leasing	Leasing is a common financing instrument in France for commercial systems. “Sofergie” (Energy Financing Company) provide credit or leasing options for projects developed by municipalities, social housing organisations, commercial companies and agricultural companies.
Financing through utilities	Some electric utilities (more often their subsidiaries) develop and invest in PV systems, but they do not offer finance for third parties. Utilities can access all support mechanisms, including FiT and Tenders for systems that they develop or own.
Investment in PV plants against free electricity	(See self-consumption).
Crowd funding (investment in PV plants)	Crowdfunding generally finances debt through crowd-funding platforms, however some platforms allow for equity financing. Examples of platforms: MiiMOSA, Enerfip, Lendosphere (in particular with AkuoCoop), Lumo, Lendopolis, Blue Bees, LITA.co, Flolend, Spear, etc...
Community solar	Yes
International organization financing	No

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

Cleantech investments in France in 2024 decreased significantly, however renewables were by far the biggest sector with 16 operations for 375 million euros. The largest operation in the RES sector was Valorem with 200 million euros raised across several investors.

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.

The EIB supports a number of renewable energy source (RES) investment funds available for photovoltaic projects. In Europe, France was the largest beneficiary of EIB Group financing in 2024 (12.6 billion EUR). The EIB authorized 500 million EUR for loans for small to medium renewable project financing through public entity bpifinance.

Other major actors include La Banque des Territoires (Caisse des Dépôts) and its subsidiary bpifrance. Bpi officialized a future portfolio financing deal with Solarhona Invest as one of several financers for open credit lines to reach the company's goal of over 1 000 MW of commercial solar roofs and car parks by 2030.

Project financing

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

Project financing is also available through Sofergies (Société de Financement des Économies d'Énergie) - financial companies that provide debt financing or leasing options for energy efficiency and renewable energy projects by municipalities, social housing organisation, commercial companies and agricultural companies. These companies have a specific status that allows them to propose optimal financing solutions to projects.

Bpifrance participated in a number of operations in 2024, including a hybrid solar and storage system with ZA Energy (52 million EUR of loans raised). The bpi Climate Plan financing scheme, intended to run 5 years, met its goals in only 4 years (20 billion EUR), with a 6.5 billion EUR going to renewable project financing.

Community solar (citizen investment)

Citizen investment is mobilised through specific citizen RES funds and crowdfunding platforms - financing both equity and debt. The principal organisations active in channelling citizen investment are crowdfunding platforms (debt and equity investments) and Energie Partagée.

In 2024, 29 new solar community projects for 21.55 MW were commissioned by Energie Partagée.

Residential project financing

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

3.6 Merchant PV/PPA/CPPA

The corporate power purchase agreement (CPPA) market in France continued growth in the first half of 2024 despite relatively stable market electricity prices. The individual volume in new CPPA's progressed, and the average duration dropped slightly. Multi-technology (wind and solar) was the most common, with one of France's first baseload CPPA's announced in Q4 and a first solar plus storage contract. An increasing number of CPPA are for brownfield sites coming out of support mechanisms. Buyers continued to look to hedge against future volatility although other motivations such as corporate responsibility were important drivers in the second half.

Price cannibalisation, a consequence of the increase in negative prices on the electricity market, is expected to lead to a change in remuneration with a migration away from straight pay-per-kWh, as has been the case elsewhere. The PPA Guarantee Fund operated by bpifrance (public investment bank) was opened to multi-buyer contracts, increasing access to a wider diversity of consumers.

3.7 Additional Country information

Retail electricity prices for a household	Time of use contracts available. Eurostat Band DC (2 500 kWh < consumption < 5 000 kWh) • 292.6 EUR/MWh all taxes and levies included.
Retail electricity prices for a commercial company	Time of use contracts available. Eurostat Band IB (20 MWh < consumption < 500 MWh): • 214.2 EUR/MWh excluding VAT and other recoverable taxes and levies
Retail electricity prices for an industrial company	Time of use, demand response, peak shaving contracts available. Eurostat Band ID (2 000 MWh < consumption < 20 000 MWh): • 144.6 EUR/MWh excluding VAT and other recoverable taxes and levies
Liberalization of the electricity sector	France's electricity industry is highly concentrated but not vertically integrated in theory. However, the French State now holds the entire share capital and voting rights of EDF, who have a roughly 70% market share (number of clients) and own the distribution system operator that manages around 95% of the distribution grid.

SOURCE: INSEE, CRE, Eurostat [nrg_pc_204] and (nrg_pc_205) 2024S2.

4 POLICY FRAMEWORK

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

Table 15: Summary of PV support measures

Category	Residential		Commercial + Industrial		Centralised	
Measures in 2024	**On-going**	**New**	**On-going**	**New**	**On-going**	**New**
Feed-in tariffs	yes	Yes (changes to Feed in Tariff conditions)	yes	- Yes (changes to Feed in Tariff conditions)	-	-
Feed-in premium (above market price)		-	Yes, (CfD in competitive Tenders)	Minor changes to Tender conditions	Yes, (CfD in competitive Tenders))	Minor changes to Tender conditions
Capital subsidies		-		-	-	-
Green certificates		-		-		
Renewable portfolio standards with/without PV requirements		-		-	-	-
Income tax credits		-		-	-	-
Self-consumption	yes	-	yes	-	-	-
Net-metering		-		-	-	-
Net-billing	yes	Yes (changes to Feed in Tariff conditions)	Yes (Feed in Tariffs up to 500 kW)	Yes (changes to Feed in Tariff conditions)	-	-
Collective self-consumption and delocalized net-metering	yes	-	yes	-	-	-
Sustainable building requirements		-		Yes – mandatory solar/livings roofs on some buildings and car parks	-	-
BIPV incentives				-	-	-
Merchant PV facilitating measures				Yes, guarantee fund for CPPA		Yes, guarantee fund for CPPA

4.1 National targets for PV

The framework for developing photovoltaics policies in France falls within the long term National Low Carbon Strategy (SNBC, 2050 horizon) and the 10-year Energy Programme Decree (PPE). The Pluriannual Energy Programme (PPE) still sets the target for French photovoltaic capacity at 20.1 GW AC[1] in 2023 and a cumulative capacity range of 35.1 GW AC to 44 GW AC to be achieved by 2028. In order to achieve these targets, a schedule of calls for tenders has been adopted, with around ten calls for tenders launched each year.

By the end of 2024, France had deployed 5 069 MW AC of new solar PV capacity. As a result, the cumulative installed capacity reached 26 066 GW AC.

France submitted a revised National Energy and Climate Plan (NECP), raising its ambitions with a suggested target of up to 60 GW of installed solar capacity by 2030. This updated target marked a significant increase from previous plans and was accompanied by proposals to install 5.5 to 7 GW per year moving forward. The projected breakdown of new capacity emphasizes utility-scale projects (65%), followed by commercial and industrial (25%), and residential systems (10%).

Early drafts and discussion for the PPE3 suggested a cumulative national target in the range of 75 to 100 GW by 2035, distributed approximately 2/3 of installations on roofs and 1/3 on the ground, 2/3 small installations and 1/3 large installations. (It must be noted that a 2025 revised project significantly reduced this target). In addition, a plan for PV gigafactories with up to 10 GW of components in various strategic links in the value chain by 2030 (3 to 5 GW in the silicon value chain, 5 to 10 GW of ingots & wafers, 5 to 10 GW of battery cells, 3 to 5 GW of solar glass, 3 GW of inverters, etc.) was presented.

4.2 Direct support policies for PV installations

4.2.1 Open volume feed-in tariffs for BAPV

Feed-in tariffs and net-billing tariffs are segmented according to system size and vary each trimester, with the variation pegged to grid connection requests for previous trimesters. For overseas regions, the tariffs are adapted to regional irradiation levels. Tables 17 and 18 detail 4th quarter 2024 tariff levels.

The October 2021 framework, (modified several times) for feed in tariffs for systems up to 500 kW on buildings, greenhouses and parking canopies includes differentiated tariffs depending on system size and lump sums for smaller self-consumption systems (with net-billing) as well as specific building integrated products.

To be eligible, the system must meet several criteria. The system sale is with injection of all or the surplus (individual or collective self-consumption), its power must be ≤ 500 kWp. The installation must be on a building, shed or canopy (includes agricultural greenhouses, covered areas, use to house animals). The installer must be professionally qualified or certified.

The system's carbon footprint must be of less than 550 kg eqCO_2/kWp for installations of more than 100 kWp (Simplified Carbon Evaluation carried out by an accredited certification body: Certisolis in France).

In 2024, 3 312.8 MW of systems accessing the FiT were commissioned, nearly 80% more than in 2023.

[1] National targets are published in AC, hence in this section volumes are indicated in AC.

Table 16 — Systems commissioned accessing the FiT in 2024 – Mainland France

Peak Power range	Power accessing FiT [MWp]
0 – 3 kW	213.7
3 kW–9 kW	707.4
9 kW–36 kW	129.2
36 kW–100 kW	237.4
100 kW–500 kW	2 025.1
Total	**3 312.8**

SOURCE *:* « Bilan du développement de projets » CRE, April 2025

Table 17 — Feed-in Tariff remuneration levels – Mainland France

Tariff category	Power of PV installation	Tariff Q4 2024* (EUR/MWh)
Continental France — building applied PV		
Ta (no self-consumption)	≤3 kW	103.1
Ta (no self-consumption)	3 kW to 9 kW	87.6
Tb (no self-consumption)	9 kW to 36 kW	130.2
Tb (no self-consumption)	36 kW to 100 kW	112.6
Tc (with or without self - consumption)	100 kW to 500 kW	105.2 x inflation coefficient

* Installations for which a complete request for connection was made between 01/11/24 and 31/01/25.

Table 18: Example Feed-in Tariff remuneration levels – Overseas France

Tariff category	Power of PV installation	Tariff end of 2024 (EUR/MWh)
Overseas France — building applied PV		
Sample system in Guadeloupe	2 kW	295.6
Sample system in Corsica	8 kW	216.3
Sample system in Réunion	50 kW	150.2

Note: New Feed in Tariff structure and conditions published for 2024

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

Volume capped periodic competitive tenders for systems from 500 kW to 30 MW (no size limit for ground-based systems on waste land) are segmented according to size, application and separated between mainland/non-interconnected zones (i.e. islands). Contracts are Contract for Difference, allowing candidates to set a premium level (that, depending on market costs, could go below the market costs). Specific conditions for AgriPV system were introduced (height, exclusion of co-siting with sheep or cow pastures).

4.2.3 BIPV development measures

There are currently no specific support measures for BIPV systems in France, and BIPV product manufacturers had a noticeable drop in installed volumes between 2023 (last support mechanism) and 2024.

Public institutes are still supporting research projects and continue to be involved in new BIPV developments to meet building requirements, in addition to module standards. For example, the CSTB[2] (Simon BODDAERT Head of BIPV innovation), involved in IEA PVPS T15, is leading research on "Long term behaviour of BIPV" to define how the quality of BIPV changes over time and to determine if BIPV is as fit for purpose, durable and reliable as traditional building components. CSTB is also involved in national and European research project to develop products that address current and future regulations and requirements, working towards compliance with these future measures

4.2.4 Merchant and corporate PV development measures

In 2024, the French photovoltaic market experienced a significant consolidation in merchant and corporate solar development, driven by evolving regulatory frameworks, shifting economic pressures, and growing corporate responsibility regarding sustainability and energy independence. While the national deployment strategy remains centered on CRE tenders, a parallel and increasingly robust ecosystem for unsubsidized and corporate-backed PV installations continued to develop throughout the year.

Merchant PV projects—those not reliant on fixed feed-in tariffs or state-backed contracts—gained visibility in 2024 as developers continued to explore the open electricity market. While merchant models can be exposed to market risks, lessons learnt across Europe are likely to be integrated into future contract and remuneration structures to reach viable options.

On the corporate side, solar PV has evolved from a tool for stakeholder engagement and compliance with ESG standards, promoting corporate responsibility to an active contributor to operational efficiency.

Power Purchase Agreements (PPAs) remained the principal mechanism throughout 2024, enabling businesses to secure long-term access to clean energy at predictable costs (the average new PPA contract is 17 years). The improved bankability of PPAs in France facilitated the emergence of standardized contract templates and greater third-party investor participation.

The PPA guarantee fund set up in 2022 can guarantee approximately 500 MW of capacity. It facilitates obtaining financing for greenfield systems selling in CPPA, operating as insurance in case of an off-taker defaulting. Eligible buyers are industrial companies based in France, with no strict size or turnover criteria, and with a flexible financial rating. In 2024 the minimum volume

[2] The CSTB is an industrial public organisation providing research and innovation, consultancy, testing, training and certification services in the construction industry.

was reduced to 5 GWh/year from 10 GWh/year and multi-buyer contracts became eligible. Meanwhile, the European Union intensified pressure on member states to accelerate permitting processes and enhance grid integration, two persistent bottlenecks for corporate developers.

4.3 Self-consumption measures

Table 20: Summary of self-consumption regulations for small private PV systems in 2024

PV self-consumption	Right to self-consume	Individual self-consumption: the PV generator can be the consumer or a third-party owner. Participation in a collective self-consumption operation is limited to 3 use cases (see below). Virtual net-metering (virtual battery storage): the consumer must be the PV generator.
	Revenues from self-consumed PV	Lump-sum for partial self-consumption systems in association with net-billing FiT. Self-consumed electricity is not subject to tax for individual self-consumption. However, collective self-consumption is subject to tax. For individual self-consumption and in case of partial self-consumption, installed capacity is subject to capacity taxes, such as grid taxes.
	Charges to finance Transmission, Distribution grids & Renewable Levies	Systems with total self-consumption pay no connection or annual grid access costs. Systems in collective self-consumption systems pay grid connection costs and annual access fees.
Excess PV electricity	Revenues from excess PV electricity injected into the grid	Net-billing set by FiT (see below) or by Tender specifications (FiT or wholesale market + premium) or by PPA (Power Purchase Agreement). Systems may sell into collective self-consumption before selling excess within FIT framework.
	Maximum timeframe for compensation of fluxes	For single consumers: 5 minutes; in virtual collective self-consumption metering timesteps are 15 minutes (down from 30 minutes in October 2024.
	Geographical compensation (virtual self-consumption or metering, use of the public or private grid)	Called “collective self-consumption” in France. Participation in a collective self-consumption operation is limited to 3 use cases: 1. Default case: PV installations and consumers located in the same building. This opens the possibility for the participation of medium voltage connected PV installations. 2. Extended case: PV installations and consumers connected to the low voltage grid within a distance of 2 km. The Minister responsible for energy may grant a derogation at the reasoned request of the legal entity of an extended collective self-consumption project, where all the participants "are located exclusively in

		one or more rural or peri-urban municipalities in mainland France". The distance separating the two furthest participants can then be extended to 10 km (instead of 2 km) from September 2023. 3. Exceptional case: PV installations and consumers within a distance of 20 km, where the low population and building density require an exceptionally large perimeter. In all cases, generators(s) and consumers(s) must be linked through a common legal entity. Compensation on a 30-minute time-step.
	Number of participants (individual or collective self-consumption)	Individual self-consumption limited to 1 participant. No limit in participant numbers for collective self-consumption, but there are generator capacity limits, the combined capacity of the generating facilities involved in the operation must not exceed 3 MW.
Other characteristics	Regulatory scheme duration	20 years for surplus (net-billing) sold in FiT, 10 years in Self-Consumption Tender. Collective self-consumption determined by private contract.
	Third party ownership accepted	Third party ownership is allowed but can be complex to manage.
	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	Grid connection fees for systems over 36 kVA. No grid access fees for total self-consumption systems. Reduced grid access fees for partial self-consumption systems (with net-billing). Energy taxes will apply in the case of collective self-consumption but not for individual self-consumption, even if the PV system is owned by a third-party.
	Regulations on enablers of self-consumption (storage, DSM…)	Electricity 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 500 kW on buildings for access to net-billing and lump-sum within FiT framework. Systems must be between 500 kW to 10 MW to access Tenders (it is possible in this context to have a generator sell directly to a consumer without the generator being a registered electricity supplier). In the case of “extended” collective self-consumption projects, the total PV volume is limited to 3 MW mainland and to 0.5 MW (power is expressed in peak DC power) in non-interconnected territories.

	Electricity system limitations	Mainland, no limits. In overseas territories (ZNI), self-consumption systems must respect the same capacity and disconnect limits as feed-in systems (i.e. active capacity must not go over 30% (or as specified in the regional energy planning decree) of consumption (with the objective of raising this threshold to 45% by 2023), 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/Balancing Responsible Party. Collective self-consumption systems can access FiT for excess production sales.

4.3.1 Net-billing feed-in tariff and lump sum for BAPV systems under 500 kW

Table 21: Net billing Feed-in Tariffs for BAPV systems

Tariff category	Power of PV installation	Net-billing tariff (+ lump sum) Q4 2024 (EUR/MWh)
Continental France — building applied PV		
Pa (net-billing)	≤3 kW	126.9 (+0.22 EUR/W installed)
Pa (net-billing)	3 kW to 9 kW	126.9 (+ 0.16 EUR/W installed)
Pb (net-billing)	9 kW to 36 kW	76.1 (+ 0.19 EUR/W installed)
Pb (net-billing)	36 kW to 100 kW	76.1 (+ 0.10 EUR/W installed)
Tc (net-billing)	100 kW to 500 kW	105.2 x inflation coefficient (no lump sum)

4.3.2 Net-billing with feed-in premium

Winning candidates in Self-Consumption Tender (systems from 500 kW to 10 MW) receive a bonus on self-consumption at the tendered rate plus net-billing set by tender specifications (wholesale market + premium).

4.4 Collective self-consumption, community solar and similar measures

Consumption within a building, a 2 km, or exceptionally, a 10 or 20 km geographical perimeter. Where generators and consumers are in the same building, the PV installation can be connected to the medium voltage grid. In other cases, installations are connected to the low voltage grid and are limited to a total of 3 MW. Virtual metering is implemented by the grid manager and requires smart meters on all generation and consumption sites. Each operation must have a legal entity, whose primary role is to supply the grid manager with algorithms or rules defining the distribution of the PV power, and an updated list of registered members of the operation.

The number of virtual metering collective self-consumption projects once again doubled in 2024, with a total of 73.6 MW AC (+ 50.9 MW in 2024) across 698 projects, 7 232 consumers and 1 100 generators were involved. The average size of a generator has increased to 66 kW AC.

Economic models for self-consumption systems remain uncertain in the long term, as the competitivity of the self-consumed electricity is very dependent on consumer electricity costs and electricity and grid taxes. In other words, grid parity is reached in certain sectors, and not in others, even when consumption costs were high over 2022. With the suppression of Feed in tariffs for small systems outside of self-consumption, collective self-consumption could prove to be a facilitated mechanism for remuneration.

4.4.1 Solar Community (Renewable energy or citizen energy communities)

In December, the much-awaited decree completing dispositions for renewable energy community (REC) or citizen energy community (CEC), specifies in particular the concepts of autonomy and geographical proximity, so France now has a framework for accelerating participative renewable energy projects led by local players. It distinguishes, as European law does, between renewable energy communities (RECs) and citizen energy communities (CECs), and sets out their operating and control procedures: conditions of autonomy, geographical proximity criteria (for RECs), procedures for leaving a community, compensation for network operators, etc.

A renewable energy community can produce, consume, store and sell renewable energy, and share the energy produced within it. A CEC has a broader scope: energy production, supply, consumption, aggregation, storage and sale of electricity. It can also provide its members with energy services (energy efficiency, recharging points, etc.).

This text complements the citizen investment movement that operates in standard generation and electricity sales frameworks (see chapter 3.5 Community solar (citizen investment)).

4.5 Tenders, auctions & similar schemes.

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.

Since 2016, the winners of the calls for tenders are no longer supported by a feed-in - tariff but by a contract for difference mechanism (CfD). With the CfD, the generators of photovoltaic electricity sell their production on the market, and when the reference market costs are under the tendered costs, they receive additional remuneration from the state which compensates for the difference between the market price and the tendered cost. Conversely, when the reference market costs are above the tendered costs, operators are required to pay the difference back to the state.

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

The current framework (called PPE2) has selection criteria on a lowest price basis for commercial and self-consumption systems, but price weighted with additional environmental or land use criteria (low module carbon footprints and degraded anthropized sites are benefited), or even innovation levels, for larger 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. CfD remuneration is paid to operators by EDF (or, in certain areas, local public distribution grid managers, or other authorised organisations).

In 2024, France maintained its structured and competitive approach to scaling photovoltaic (PV) deployment through national tenders under the PPE2 framework (Programmation Pluriannuelle de l'Énergie). These tenders remain the primary mechanism for allocating support to large-scale PV projects, both for ground-mounted systems and for rooftop installations in the commercial and industrial (C&I) sector.

Two major tender rounds were held for ground-mounted systems, with the fifth round conducted in March and the sixth in November. These rounds confirmed both the appetite for PV on the French PV market. The March round resulted in the allocation of 911.5 MWp across 92 projects, with an average awarded tariff of €81.90/MWh. The November round saw a decrease in allocated capacity, reaching 948.3 MWp across 120 projects, while the average tariff declined slightly to €79.28/MWh, but still well above early 2022 bids.

The rooftop PV sector saw four calls aimed at installations above 500 kWp awarded. Two were sufficiently subscribed, two were undersubscribed – and all were under-awarded as competitivity safeguards were actioned. Tender prices decreased slightly, but, as for the ground mounted calls, still remained above mid-2022 values at 98,2€/MWh – nearly 20€/MW above the most competitive winning bids in 2018!

In addition to traditional tendering mechanisms, 2024 also saw the launch of an innovative scheme targeting PV deployment along the national highway network. In April, the government initiated a program to allocate approximately 240 MW of capacity on public land under the management of the Direction Interdépartementale des Routes (DIR). The tender covered 140 parking areas and around 100 highway interchanges, representing a combined surface area of over 200 hectares. Projects were grouped into geographic clusters and will be awarded based on technical and financial criteria, with developers securing public domain occupation agreements for 33 years. Concession fees were structured with both fixed components and revenue-based contributions linked to electricity sales. This initiative reflects France's growing interest in integrating solar PV into multi-functional land uses, particularly in infrastructure zones that offer large surfaces without conflicting with agricultural or residential needs.

4.5.1 Competitive tenders

Table 22: PPE2 (2021-2026) competitive tender volumes and results

System type and size	Building mounted systems, greenhouses and parking canopies	Ground-based systems and parking canopies	Systems located in non interconnected areas (ZNI)	Technology neutral
Individual system size limits	From 05 MW No upper limit	0.5 MW to 30 MW No upper limit on degraded sites	From 0.5 MW (Group 1) and from 0.5 MW to 12 MW	
Volume	14 calls of 300 MW to 800 MW	10 calls of 700 MW to 925 MW	11 calls of 40.5 MW and 58.8 MW	5 calls of 500 MW

Number of Bids	**4 th call:** 180 MW selected for 400 MW called **5 th call:** 253 MW selected for 300 MW called **6 th call*:** 220MW selected for 400 MW called	**3th call:** 925 MW selected for 949 MW called	**1 st call:** 49.77 MW selected for 99 MW called	**3rd call:** 435.2 MW (PV only) selected for 500 MW called
Average tendered price (or bonus for self-consumption)	**4 th call:** 100.74 EUR/MWh **5 th call:** 99.95 EUR/MWh **6 th call*:** 98.20 EUR/MWh	**3 th call:** 79.28 EUR/MWh	**1 st call:** 89.52 EUR/MWh	**3rd call:** 80.31 EUR/MWh (PV only)

All systems are remunerated through CfD = Contract for difference = Market sales + Additional Remuneration Contract to reach tendered rate.

4.6 Other utility-scale measures including, floating and agricultural PV

These systems are financed through competitive tenders, generally in a specific call for innovative systems. Agrivoltaic systems were defined in law as dual-purpose systems, using the same land for both solar energy production and agricultural activities. This approach integrates solar panels with farming practices, including growing crops, raising livestock, managing greenhouses, and supporting pollinators, to maximize land efficiency and productivity.

In 2024, agrivoltaics was regulated by Decree no. 2024-318 the Order of 5 July, providing a precise legal framework for this practice combining agriculture and solar energy production. From now on, AgriPV installation must contribute directly to agricultural activity (agronomic improvement, climatic adaptation, protection against hazards, animal welfare) while guaranteeing a sustainable agricultural income. The decree also imposes a limit on the amount of land that can be used (a maximum of 10% of the surface area), the reversibility of the installations, and compulsory inspection reports.

Given the constraints, AgriPV systems are unlikely to be developed on the same scale as ground mounted systems on farmland. The eligibility conditions for the PV on Buildings competitive tender were modified to explicitly exclude canopies over livestock (reserved for over plants). Parking canopies are mandatory for certain car parks over 500 m^2 (new) 1 500 m^2 (existing) and this is likely to become an important market segment in France for large scale systems, with systems eligible for the PV on Buildings Competitive Tenders.

In 2024, floating photovoltaic systems experienced a remarkable boom in interest in France, marked by a number of large-scale projects. Among them, the Îlots Blandin power plant in Haute-Marne, supported by Q Energy, will become the largest in Europe at 74.3 MWp, while the Leutenheim power plant (20 MWp) in Alsace and the Lazer dam power plant (20 MWp) in the Hautes-Alpes region illustrate the successful integration of floating solar power into former industrial or hydroelectric sites. Invitations to tender have also been issued, notably by EDF at Le Cheylas (Isère), supporting the expansion of the sector, encouraged by the France 2030 plan.

Innovation is also on the agenda, with Ciel & Terre's Hydrelio aiR Optim technology and the development of floating solar power at sea, such as the SolarinBlue project in Sète.

4.7 Indirect policy issues

4.7.1 Support for electricity storage and demand response measures

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

Large scale storage: In mainland France, by the end of 2024 about 455 storage facilities were connected to the medium-voltage grid with a capacity of 607 MW.

Individual/small scale storage: Conditions are not economically favourable for the development of small-scale storage in France (no subsidies, previously relatively low electricity consumption costs and winter peak consumption profiles on mainland France). There are about 20 000 (15 800 mainland, + 5 000 overseas territories) storage facilities in France on residential or small-scale installations. After a peak of 2 500 new installations per year in 2018 and 2019, the rate of decrease through 2020 and 2021, but began to rise in 2022. In 2024, the Consuel (independent body that manages electrical conformity, mandatory for grid connection) indicated more than 8 400 new conformity certificates for residential PV systems with storage in mainland France. However, Enedis, the DSO that manages 95% of mainland France's distribution grid, only indicated about half of this number – hence questions remain surrounding data quality.

Demand Response Measures: Time-of-use electricity rates are offered to consumers in France, with a particular historical 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, changes in early 2025 resulting from the increasing hours where production exceeded demand during solar peak hours in 2024 will see the introduction of more midday off-peak pricing to displace consumption.

Demand response mechanisms (flexibility) include both reduction and increases in consumption to respond to specific conditions – either through equipment shutdown or storage; given the habitual consumption profile and nuclear generation capacity in France, most is for reducing demand. Projects offering less than 1 MW of flexibility must be aggregated with other projects, but projects offering over 1 MW can be certified individually. Projects must also certify that their CO_2 content for combustible fuels is below 550 gCO_2/Wh.

Enedis, the operator of the public electricity distribution network, has mapped ongoing calls for and potential future calls for local flexibility capacities. These calls are separated by locality and whether they are calling for increased consumption to absorb generation capacity or voluntary curtailment in specific zones to allow greater renewables capacity to be connected to the grid. The call for capacity in 11 zones in 2023 allocated 6 winners and contracted 4 local services; in semester 1 2024, 44 zones were covered with 51 winners identified, a very significant jump; contracts perimeter will be worked un until early 2025.

4.7.2 CPPA/PPA market

The market for corporate PPA's continues to expand in France, albeit at a lower rate in 2024 than in 2023, a reflection of the reduced cost of electricity. PPA's are far more generalised as they are an integral part of the Contract for Difference support mechanism used in the national

competitive tenders. A 2024 report[3] by the energy regulator into the PPA market in France up to the end of 2023 indicated roughly 141 PV systems in corporate or utility PPA's (from 112 survey participants). The report indicates that many PPA's were signed at prices up to 30% above initial CfD levels, whilst contracts remained in the order of 20 years - significantly above the estimated average length across Europe of approximately 13 years. The average power is 13.4 MW, very close to the average power of systems contracted in CfD support mechanisms. Although nearly 50 are under 5 MW, and nearly all are pay-as-produced contract, contrary to international trends in (for example) the USA.

The corporate PPA market is mostly lead by major companies such as SNCF (national railways), airports, and international corporations (Amazon etc). In 2024, at least 17 new CPPA contracts were signed for PV, all but two for greenfield sites, for a cumulative 650 GWh/year (compared to 513 GWh/year in 2023). Of particular note, SNCF signed a 25-year contract with Neoen for 172 GWh/year. Contracts for greenfield systems run from 15 to 25 years, although Clearvise AG offered an 11-year contract in 2024. For systems moving away from feed in contracts, contracts tend to a 3-to-5-year limit. The national guarantee fund was operating in 2024 and expanded to allow multi-buyer contracts.

4.7.3 Support for encouraging social acceptance of PV systems.

On a general level, solar enjoys a good level of social acceptance and approval level. However, an increasing number of groups express continued disapproval for PV on agricultural lands, including a number of agricultural unions and local chambers – one consequence of this is the increasingly strict definition of AgriPV, now legislated. The multi-partner national observatory for "Renewable Energies, Biodiversity, Soil, Water and Landscapes", was included in the 2023 Law for the Acceleration of Renewable Energies and has been collecting information and planning industry wide meetings and conference in 2024, with a larger roll out in 2025.

The government also has supported the development of citizen investment as a tool to increase social acceptance, and industry groups such as Enerplan regularly commission opinion surveys.

4.8 Financing and cost of support measures

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

Over-costs are calculated based on a typical production curve weighting of monthly average day time spot prices on the national electricity market. The estimated total cost of compensation for 2024 for photovoltaic contracts (Feed-in tariffs and CfD) for continental France is 2 187 million EUR, a return to a cost burden to the government after 156 million EUR were credited to the government in 2023, a result of the very high electricity market prices. The 2024 value is nearly twice the 2022 value, a consequence both of the change in market electricity prices and large

[3] Observatoire de la CRE relatif aux contrats d'achat d'électricité portant sur des actifs de production d'électricité renouvelable (« PPA ») situés en France métropolitaine continentale et recommandations en faveur de leur développement. March 2025, CRE

volumes installed since 2022. Photovoltaics is the single biggest cost in the governments "electricity public service" costs.

4.9 Grid integration policies

4.9.1 Grid connection policies

In France grid connection costs are paid by generators, with total costs shared between an initial upfront payment by the generator directly proportional to costs and an annual access fees (TURPE). In France, initial grid connection costs are shared between a payment by the producer directly proportional to costs, and a portion paid by all grid users (TURPE) and managed by the DSO. In addition, the producer pays annual fees, which are added to the TURPE.

The cost to the generator depends on:

- the works needed to connect the system to the grid, determined by the DSO and based on the existing grid capacity and infrastructure and the projects and works already in the grid connection queue.
- the cost of these works - part of these costs are based on a pre-established framework and part depends on the specific system and site and they cover modifications needed upstream on the grid.
- the distribution of costs between the generator and the DSO; this distribution depends on the nominal voltage of the grid connection.

Costs can be mutualised if several systems are grouped together and connected in the same time frame.

Connections to the medium voltage grid and impacts on the medium and high voltage grid include contributions to regional funds (Schéma Régional de Raccordement au Réseau des Energies Renouvelables (S3REnR)) that finance future grid upgrades that are planned according to projected renewables growth, allowing for mutualised contributions to infrastructure costs such as high voltage grid upgrades, new substations etc. The regional contribution is payable for systems connected at 250 kVA and up, and ranges from 0 to roughly 90 000 EUR/MW depending on the regions current grid capacity and infrastructure and projected growth of decentralised generation.

The upfront costs can be significant, affecting project feasibility at all power levels, from residential systems to utility scale ground-based systems. These costs and the cost sharing framework between generators and DSO is a recurring source of conflict with calls for more transparency on methods but also more agility in adjusting the S3REnR considering growth in renewables.

In the past, single phase grid connection costs for small residential systems were a real barrier to the development of the sector, however the shift to self-consumption, with its mostly zero-fee grid connection, has both lowered the overall cost of residential systems and accelerated the grid connection times. It is unlikely that grid connection capacity will be a barrier for increased development of small residential systems.

Currently, the cost of grid connection for small commercial systems up to about 1 MW is extremely variable and difficult for installers and building owners to predict, which means that grid connection studies and quotes must be made before generators or investors can validate business plans – mechanically adding months to project planning. High costs are generally the direct consequence of older grid infrastructure or saturated substations, requiring the generator to assume the costs of infrastructure upgrades often benefitting both the generator but also

consumers. Changes to the DSO (Enedis) standard method of determining transformer capacity in late 2023 are likely to free capacity for more solar to be connected without triggering upgrades, whilst since early 2023 small scale inverters must meet new parameter requirements, a move that Enedis estimates will allow to connect 30% more capacity without upgrades. At the end of 2024, Enedis (GRD) made changes to the network voltage balancing rules (known as the “voltage plan”), to make them more favourable to generators: for some low-voltage generators, their voltage margin, which was 1%, can now rise to 8%, depending on the case. The unpredictability of grid connection costs is a factor in the longer lead times for commissioning in France, and the abandon rate for projects across this segment. DSO efforts to improve visibility on grid connection costs in planning phases include establish grid capacity maps and automated web services to indicate the complexity of grid connection. Whilst these services do not supply all information, they are providing a first level of service that facilitates project planning.

Delays for grid connection are variable – from none for residential self-consumption systems up to a dozen years if TSO infrastructure is inadequate for a utility scale project. As a general rule, most commercial systems on the low voltage grid have delays from 3 months to about 18 months, whilst delays for connection to the medium voltage grid are dependent on local grid capacity and project works. Once a connection request has been validated, the connection proposal (PDR) specifies the indicative connection deadline from the date of your approval and, where applicable, the list of work to be carried out.

To manage connection requests for generation facilities in the same zone, RTE and the public distribution system operators use a capacity reservation system known as the "Queue" (File d’Attente). RTE classifies connection requests with a view to prioritising them on a "first come, first served" basis. This can result in small projects wanting to connect to the low voltage grid being frozen out as larger projects immobilise all remaining capacity despite not being able to use the available capacity until upgrades on the medium or high voltage grid can be planned, often requiring several years to be completed.

With its strongly interlinked network, grid capacity in itself should not be a substantial barrier to the developments of photovoltaics per se, however aging rural infrastructure and the cost sharing model – with its impact on project viability - are not negligeable barriers, and the long lead time for increasing transport network capacity means that France’s ambitious development goals may not be that easy to reach. Réseau de transport d'électricité (RTE) has published, in September 2023, a study on the French electricity system up to 2035. The operator of the French electricity system is fairly reassuring about France's ability to meet its sharply rising electricity needs, provided a faster deployment of renewable energies. In parallel, Enedis, the major DSO on mainland France, published a preliminary document to its "Network Development Plan" in March 2023. This work continued in 2024, with publication scheduled for early 2025. This preparatory report is intended to shed light on Enedis' growing investment trajectory up to 2027 and 2032, and to contribute to the debates surrounding the future Multiannual Energy Programme (PPE).

4.9.2 Grid access policies

Recurring grid access fees (Tarif d’Utilisation des Réseaux Publics d’Electricité – TURPE) are paid by all users with contributions calibrated to cover all of a DSO’s operating and investments costs, including the cost of capital. Access costs are determined according to:

- voltage level of the user grid connection.
- the type of user (consumer/generator).
- and for certain users, the time of use.

Unlike many other European countries, there is no geographical differentiation of tariffs.

The total cost of the TURPE is defined by the energy regulator (CRE), directly defining DSO's revenue for public service type missions. The energy regulator also defines the cost sharing between types of users, based on a study of the users' impact on the network and the costs they generate.

The fee structure is based on cost components and adapted to voltage level and type of user and the principal components for generators are:

- Annual management component (CG).
- Annual metering component (CC).
- Annual injection component (CI) – high voltage grid connections only.
- Connection point grouping component (CR).
- Annual component of reactive energy (CER).

Costs have a significant capacity base but include an energy cost. Whilst grid access costs are generally not a significant part of OPEX costs, this does vary depending on the type of injection and the different legal entities attached to a system and consumption points - access fees for self-consumption systems are significantly lower than full sales systems as several cost categories are mutualised with the consumer fees.

The fixed part of annual access fees ranges from approximately 10 EUR/year for self-consumption systems under 36 kVA to approximate 500 EUR/year excluding VAT for systems between 36 and 250 kVA in full injection. For systems connected to the high voltage grid (above 250 kVA) in full injection this as in the range of 850 EUR/year.

5 INDUSTRY

5.1 Production of ingots and wafers (crystalline silicon industry)

Table 23: Silicon feedstock, ingot and wafer producer's production information for 2024.

Manufacturers	Process & technology	Estimated Total Production
Photowatt EDF ENR PWT	mc-Si wafers [MW]	100 MW (capacity)

Photowatt (EDF ENR PWT) is a French wafer manufacturer and module supplier specialized in low carbon content solutions. It produces cast-mono silicon ingots, bricks and wafers (Crystal advanced process). In 2022, Photowatt was the first company in Europe to upgrade its production to the large format G12/210 mm. In 2023, Photowatt ordered some new slicing equipment to be implemented in mid-2024 to increase capacity to more than 200 MW. In 2024, activity was reduced by the closure of a workshop and EDF Renouvelables is looking to sell the business (closed in 2025). Negotiations for a takeover were held with Carbon in 2024, but these were abandoned. In particular, employees were opposed to this option, preferring the business to be closed with a redeployment plan within EDF or support from outside the group.

ECM Technologies group, based in Grenoble and near Montpellier, focuses on supplying photovoltaic equipment manufacturing for the end-to-end value chain, from ingots to cells.

5.2 Production of photovoltaic cells and modules

Table 17: PV cell and module production and production capacity information for 2024

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe, CIGS, OPV)	Production and/or capacity (MW/year)	
		Cell	Module
Wafer-based PV manufactures			
Voltec Solar	Sc-Si		500 (capacity)
Reden Solar	Sc-Si		200 (capacity)
Heliup	Sc-Si		100 (capacity)
S'tile	Sc-Si		35 (capacity)
Recom Technologies	Sc-Si		closed down
Systovi	Sc-Si		closed down
CréaWatt	Sc-Si		/
Thin film manufacturers			
ARMOR	OPV	/	/
Dracula Technologies	OPV	/	/
Solems SA	a-Si		/

SolarCloth	CIGS		7 (capacity)
Soy PV	CIGS		/
Other products			
Edilians	Sc-Si (PV tiles)	/	/
Dualsun	PVT	/	/
Total			**Approximately 800 MW**

Sources: Le photovoltaïque: choix technologiques, enjeux matières et opportunités industrielles, French Ministry of Energy and Environment; interviews with manufacturers and Hespul estimates.

The national industry is relatively small, with several manufacturers targeting specific niche markets, often related to building integrated products (PV tiles, façade elements...), PV/thermal hybrid modules (Dualsun...) or small-scale production runs and pre-industrial research (Photowatt...). This industry operates with strong public R&D/industry links. Manufacturers struggled in 2024 as module prices dropped significantly at the end of 2023 and Chinese imports grew, and several went into liquidation towards the end of 2023 or in 2024.

5.2.1 Small-scale producers of modules dedicated to the national or European market:

- **Voltec Solar** assembles modules on their Alsace site, its production capacity is 500 MW/year thanks to a new production line installed in early 2024. In 2024, Voltec invested €1 million to launch production of a new generation of TOPCon technology panels, as well as launching a new tile-coloured module suitable for use in heritage protected areas, and is expanding in the residential segment, which accounts for 50% of its sales. Voltec, in partnership with IPVF, also announced its intention to launch the industrialisation of a 4T perovskite-silicon tandem technology developed in-house by IPVF, to reach a 200 MW industrial demonstrator in 2025.
- **Reden Solar** is not only manufactures modules but also develops and operates photovoltaic and agrivoltaic power plants. Its module production is entirely dedicated to its own installations. Its former 65 MW/year production line has been replaced by a new 200 MW/year half-cell module production line, which was inaugurated at the end of 2024. To consolidate Reden Solar's business development, Macquarie Asset Management, BCI and MEAG acquired Reden Solar for €2.5 billion in 2022.
- **Heliup**, start-up founded in 2022, assembles lightweight, durable modules with thin glass protection and no frame. Their main product was launched in 2024 (5 kg/m2 module) and A 100 MW/year production line was launched in Le Cheylas (Isère) at the end of 2024 and there are plans to increase production to 1 GW/year in the following years.
- **Recom Technologies**'s Lannion site production had a capacity of around 100 MW/year. In April 2024, the company was closed down.
- **Systovi** assembled monocrystalline modules in Carquefou, close to Nantes. It closed down its module assembly activity in April 2024, which represented a capacity of 80 MW/year and 87 employees.
- **VMH Energies** production site is located in Châtellerault near Poitiers. Its production capacity was 60 MW per year. After ceasing production of conventional modules in France in 2022, VMH has also ceased production of special modules in 2023. Its activities

have been refocused on the development of mobile and modular ground-mounted installations.

- **Creawatt**, based in Ambilly, is focusing on the production of lightweight modules that can be attached to the roof using a grip, in partnership with the Chinese group Sunman. These products are intended for logistics and supermarket roofs. For the time being, only the grip is being added in France. Creawatt has announced that it intends to bring a module production line back to France and is considering the development of a gigafactory based on this technology. Creawatt is a France 2030 laureate and has been awarded €3.5 million by the French government in late 2024.

5.2.2 Other markets: Photovoltaic tiled roofs, photovoltaic thin films and aero-voltaic modules:

- **S'Tile** uses the technology known as i-cells, bi-glass and bifacial modules. Their modules are either integrated into buildings or integrated into off-grid systems. Over 2022 they have been active in repowering, replacing modules on damaged systems. This last activity accounted for half of their business in 2024. They develop made-to-measure photovoltaic modules, with annual production varying between 25 and 50 MW. Around 70% of their production is sent to Europe, with only 30% of modules destined for French installations.
- **ARMOR** developed and manufactured proprietary organic "ASCA" films under the ASCA brand with part of the manufacturing process in France before products are finished in Germany. The products target the market for connected devices, wearable photovoltaics as well as building integration applications (semi-transparent glazing...). The German construction group HERING bought ASCA in 2023. Since 2023, Armor has been manufacturing reels of organic photovoltaic film, which it sells to its customers, including Hering.
- **Dracula Technologies** is a start-up developing printed organic photovoltaic cells (trademarked LAYER technology) whose aim to replace traditional batteries in connected device market. Their cells capture ambient light, whether natural or artificial. Their modules have a standard surface area of 16 cm^2 and power up to 144 µW under 200 lux. Its pilot line was inaugurated in September 2019 and its "Green Micropower" Factory became operational in January 2024 and has increased its capacity to 150 million cm^2 of printed surface per year. The company is studying the possibility of quadrupling its production capacity by 2026.
- **Solems SA** manufactures thin-film elements and modules up to 30 cm x 900 cm for connected devices and self-powered automates and building elements.
- **SolarCloth** develops flexible solar on different supports for integration onto canvas (tourism and agricultural uses) and vehicle roofs with Renault Trucks (VIPV). They supplied products used in the Paris Olympic precinct. With **Soy PV**, SolarCloth launched an R&D project in 2023 with a pilot demonstrator for an industrial sector, with the aim of going to commercial scale and producing 30 MW/year by 2030. In 2024, SolarCoth raised funds via a participative financing platform and announced the arrival of a Rothschild & Co bank foundation in its capital. By 2025, the company has announced a doubling of its sales and a major fund-raising operation.
- **Edilians**, manufacture PV tiles (previously eligible for the BIPV bonus in the feed in tariff, that stopped in October 2023). They also put a red tile on market).
- **DualSun** develops and markets photovoltaic-thermal hybrid modules (PV-T). The photovoltaic part is manufactured in China, then the thermal part is added in French factories.

5.3 Manufacturing Projects

In 2024 there were three major manufacturing projects in France: Holosolis, Carbon and DAS Solar.

Holosolis, a consortium including EIT InnoEnergy, IDEC (a French property developer) and TSE (a utility scale and agrivoltaic developer), has planned factory on the site previously abandoned by a REC project. Production is due to start in 2025, rising to 5 GW/year from 2027.

Carbon, a start-up backed by local industry, aims to build an integrated plant producing 5 GW/year of cells and modules. In 2024, this plant project in Fos-sur-Mer (near Marseille) was qualified as a project of major national interest. Construction could begin in the 2nd half of 2025, with production starting in 2027. The overall project represents a budget of 1.7 billion euros. In 2024, Carbon announced the launch of its CARBON one project, a 1st production unit of 500 MWp/year which would be operational in autumn 2025.

DAS Solar is planning to set up in France, in particular to anticipate European objectives for the relocation of production. By the end of 2024, the company had announced the purchase of an industrial site in Mandeure (Doubs), an initial investment of 109 million euros and the launch of a 3 GW/year assembly activity by mid-2025, representing 600 jobs. The aim is to achieve module and cell production of 5 GW/year by the end of 2027.

5.4 Manufacturers and suppliers of other components

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

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

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

Storage batteries

Market penetration remains very low for residential systems, although offers are present, and whilst national industry has international players (SAFT, EDF), deployment of large-scale storage is limited – mostly to overseas territories, although some projects on the mainland are supplying flexibility measures. Several battery manufacturing projects are currently under development in France, primarily aimed at serving the electric vehicle industry.

Supporting structures

A number of local manufactures of supporting structures exist: products range from PV tiles (Edilians, SunStyle), roof integration supports (IRFTS, bought by Edilians in early 2022) and GSE), pergolas (Mitjavila, Adiwatt) and residential car ports (many manufacturers anticipating new mandatory solar on car parks but also the uptake of electric vehicles…).

Solar parking supports are designed and manufactured by a number of companies present, with a range of materials used (wood, steel, aluminium).

Manufacturers of on-roof systems for industrial metallic roofs and bituminous or polymer roofs are also present. A number of manufacturers of solar support buildings (agricultural hangars, greenhouses) are also present (Mecosun…).

With a unique lead on the international market, Ciel & Terre is a leading designer and manufacturer of floating photovoltaic supports and systems.

5.5 Recycling

PV is collected for recycling by SOREN in France under the WEEE national legislation. There were 549 sellers subscribing to SOREN in 2024 (up from 461 in 2023), responsible for putting 8.1 MW (up from 5.9 MW) of modules on the market (17 million modules/382 000 tonnes). 9 477 tonnes was collected, of which 87% was sent for recycling. Over the past years, there has been a notable drop in the volume of locally made modules, dropping from approximately 18 000 tonnes in 2021 and 2022 (over 8%) down to under 8 000 tonnes (2%) in 2024. The recycling rate of treated modules fluctuates between 82% and 92% with yearly variations, and the monetary remuneration for treated materials is in the range of 150 € per recycled tonne.

6 PV IN THE ECONOMY

6.1 Labour places

Table 25: Estimated PV-related full-time labour places

	Number of full-time (FTE) labour places	Number of full-time (FTE) labour places
Market category	**2022**	**2024 (est)**
Research and development (not including companies)		
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	2 300	2 110
Distributors of PV products and installations	27 000	37 000
Other including operations and maintenance	2 900	6 500
Total	**≈ 32 200**	**≈ 46 000**

Sources: Évaluation et analyse de la contribution des EnR à l'économie de la France et des territoires 2020, SER, and Becquerel Institute France estimates. Etude ADEME "Marchés et emplois concourant à la transition énergétique" (2024), Solar Power Europe.

Jobs related to the manufacture of photovoltaic equipment dropped again over 2024/early 2025 with the closure of EDF Photowatt (162 jobs), insufficiently compensated by the arrival of Heliup in the manufacturing space.

Labour distribution remains heavily concentrated in installation services, which accounted for the majority of new employment opportunities. This is closely linked to the high number of new connections—nearly 250 000 systems were connected to the grid in 2024, with over 225 000 of these stemming from small-scale residential and C&I installations. An additional 20 000 systems went through conformity checks (Consuel), to be connected early 2025. Before grid connection, each small to medium scale PV systems must have a Consuel certificate generated, either by a electricity professional (company or tradesman) or a non-electricity professional (roofer, individual…). The number of professional installers increased more than 20% in 2024, up to 6 800, and non-professionals up nearly 45%, as an increasing number of individuals self-installed small systems – it must be noted that only 4% of all conformity requests were submitted by non-professionals, whilst professionals submitted an average 38 conformity requests in 2024, indicating a healthy average workload.

The rapid growth of the sector, and the lack of qualified manpower, has led to continued tensions in recruitment since 2021. The Brawo/Dualsun 2024 solar jobs barometer indicated 57 000 job offers published in the first half of 2024 in France, up 18% on H1 2023. Installation jobs were the most prevalent (over 4 000 offers), but Sales jobs were also present in large numbers (over 3 000).

Project sales and development, studies and operations jobs continue to grow, although some individual companies have let people go (France Solar / 150 jobs). The increased complexity of energy systems and smart grid integration necessitates more digitally literate professionals who can work with modeling, remote monitoring, and data-driven decision-making tools.

Nevertheless, the PV labour market faces key challenges. Regulatory instability and shifting support schemes create uncertainty for companies planning long-term investments. Market up and down swings test job stability and company viability. More critically, the rapid growth of the sector has outpaced the availability of trained professionals, creating skill shortages in several occupations considered “in tension”, such as grid electricians, solar installers and project engineers, although the employment market tensions are not as pronounced as in recent years. There remains a need for updated training frameworks, accelerated certification pathways, and stronger collaboration between public institutions and industry actors.

6.2 Business value

Investments and turnover are studied by ADEME every two years in the study “Marchés et emplois liés à l’efficacité énergétique et aux énergies renouvelables”.

The market value for 2024 (below) has been estimated based on 2024 trending prices and rectified 2024 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 systems with power above 250 kW and ground-mounted systems. The following table represents the value of investments in commissioned PV systems, and not the value of the market itself that includes future systems, services, research and other sectors.

Table 26: Estimation of the value of the PV business in 2024 (VAT is excluded)

Sub-market	Capacity installed in 2024 [MW DC]	Average price with VAT [EUR/W]	Average price without VAT [EUR/W]	Estimated value M EUR
Off-grid				
Residential < 3 kW	334	0.5 to 2.7	/	876*
Residential < 9 kW	842	1.8 to 2.5	1.5 to 2.05	1 571*
Commercial < 100 kW	702	0.8	0.67	468
Commercial < 250 kW	2 059	0.8	0.67	1 373
Industrial 250 kW - 1 MW	202	0.9	0.75	152
Grid-connected distributed	**4 139**			**4 431**
Grid-connected centralized	**1 871**	0.71	0.59	**1 107**
Estimated Value of PV investments in 2024				**5 000 to 6 000****

SOURCE: SDES, Enedis, Becquerel Institute France.
*cumulative value of sub-segments
** A range is published due to the approximate nature of data.

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

With a highly concentrated electricity the 100% state owned EDF and its different wholly or partially owned subsidiary companies are the principal generator, transport grid manager, distribution grid manager and retailer. In response to the open market European Directives, the different entities are legally separate, with grid management missions run as “delegated public services”. The EDF group has an extensive portfolio of nuclear and renewable energy sites.

Secondary operators include the generator Engie (the state holds over 23.6% of the share capital) and public distribution networks, which are owned by the municipalities (they cover about 5% of the population). Although the 1996 European Directive on common rules for the internal market in electricity mandated open markets in EU member states, there are still more than 55% of consumers on regulated electricity tariffs, and EDF, either through regulated tariffs or open market contracts has a roughly 70% market share (by number, not by volume). Engie has an approximately 15% market share, Total energies (11%) and the rest is alternative suppliers.

The National Energy Regulator, Commission de régulation de l’énergie (CRE) is an independent administrative authority and supervises market regulations, grid access conditions and manages competitive tender processes based on rules established by the government. They also judge grid access conflicts and are a mandatory consultative body for changes to the legislative and regulatory energy framework.

7.2 Interest from electricity utility businesses

In France the only private electricity utility is EDF (fully owned by the State as of June 2023 after a buyback of remaining stock in 2022), that covers 95% of the population - all other utilities are (generally very small) public entities – a legacy of the post-war nationalisation of private electricity companies.

EDF and its subsidiary companies are major players in photovoltaics, with branches dedicated to different market segments present in France and across the world. EDF Renouvelables (EDF Renewable for the international branch – centralised photovoltaics), EDF Solutions Solaires (EDF Solar Solutions), Sunzil (operating in the Caribbean and other isolated/off grid areas) and Agregio Solutions (electricity aggregation for the market and keep the electricity grid balanced even with variable renewable energies) are all active in France. EDF EN Photowatt is a photovoltaics manufacturer that closed early 2025.

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 a worldwide installed capacity of 118.8 GW, and a net installed renewable capacity of 39.5 GW worldwide at end-2024.

ENGIE is a gas utility also present in the development and generation of electricity capacity and has a solar portfolio of 9.3 GW installed and 2.4 GW under construction worldwide.

7.3 Interest from municipalities and local governments

Almost all local authorities have climate energy plans that are generally ambitious in terms of photovoltaic development. This is one of the reasons why municipalities and local governments continue to be active participants in the growth of photovoltaics in France, both investing in

projects, experimenting innovative projects (particularly collective self-consumption), and facilitating citizen investment and grid integration. Many have created public-private development and investment companies to both facilitate project development without the constraints of public procurement but also serve as a vehicle for their projects. Some notable examples are: GEG (Gaz et Électricité de Grenoble) is based in the Alps region, where it acts as a producer, supplier, and distributor of electricity and gas. With 51% of its shares held by public stakeholders, GEG operates 59 renewable energy facilities, including 39 photovoltaic installations. Its total installed renewable capacity of 15 MW supplies electricity to around 178 000 people. It has 43 MW / 39 PV systems supplying local clients in the Grenoble area.

Sorégies, is 85% owned by the public utility department of the Vienne department. Following its 2024 merger with its renewable energy subsidiary Sergies, Sorégies has solidified its role as the historic electricity provider in the region. Sorégies owns 201 photovoltaic power plants with a combined installed capacity exceeding 144 MW.

Sipenr is the renewables arm of the Sipperec, the public utility serving the local government areas in the periphery of Paris. To date, Sipenr has invested a total of €96 million in regional projects PV projects, with 50.2 MW of ground-mounted systems and 21 MW on rooftops. They generate 108 GWh of renewable energy annually. They also operate the largest community solar farm in France, located in Ecrouves (12 MW), and one of the largest parks equipped with French-made modules (Photowatt). Sipenr has five ground-mounted solar projects currently under construction for 2025 and 2026, targeting a combined capacity of 43 MW, and four (23 MW) under consideration, and seven in the preliminary study phase, aiming for a combined capacity of 80 MW.

8 PROSPECTS

After strong growth in 2024, support mechanisms were overhauled in early 2025, with a drop or cancelling of some feed in tariffs and a planned shift to simplified tenders for C&I systems to allow the government more control over the volume of projects. The impact will mean reduced volumes in residential sectors in 2025, however C&I system have longer lead times, so 2025 should see relatively consistent volumes there. Amendments to mandatory solar laws may see a loosening of requirements, with lower-than-expected volume there. In parallel, there is a strong pipeline of authorised utility scale projects, and whilst regulatory changes are likely to slow growth there, it shouldn't be felt until 2026 at earliest.