

**ADEME**



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

# **Photovoltaic Power Applications in France National Survey Report 2012**

Prepared for

The INTERNATIONAL ENERGY AGENCY  
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Task 1 - Exchange and dissemination of information

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## FOREWORD

The department SRER of French Agency for Environment and Energy management (ADEME) prepared this document. It constitutes the annual French Photovoltaic National Survey Report as requested by the International Energy Agency PVPS cooperation programme. Information from this document will be used as input to the annual IEA PVPS “Trends in photovoltaic applications – Survey report of selected IEA countries between 1992 and 2012”.

The French Agency for Environment and Energy management (ADEME) is a public agency under the authority of the Ministry for Ecology, Sustainable development and Energy (MEDDE) and the Ministry of Higher Education and Research (MESR).

The agency’s mission is to encourage, supervise, coordinate, facilitate and undertake operations with the aim of protecting the environment and managing energy. The focus areas are energy (including renewables), air, noise, transport, waste, polluted soil and sites, and environmental management.

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Cooperation and Development (OECD) which carries out a comprehensive programme of energy cooperation among its 28 member countries. The European Commission also participates in the work of the Agency.

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

The 23 participating countries are Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), China (CHN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission, the European Photovoltaic Industry Association, the US Solar Electric Power Association, the US Solar Energy Industries Association and the International Copper Association are also members.

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

## INTRODUCTION

This report provides an update on photovoltaic activity in France in 2012. It describes the underlying political and financial framework, the current state of the markets and the industry as well as support measures and R&D programmes. It also provides some outlooks for the future. The information contained in the report concerns the year 2012, and some key data from the first quarter of 2013.

The report has been prepared as part of an international study commissioned by the IEA Photovoltaic Power System Programme (IEA PVPS). Each participating country produces its own status report.

An annual summary is published in a document entitled *Trends in photovoltaic applications – Survey report of selected IEA countries*. These studies are available on the following website: [www.iea-pvps.org](http://www.iea-pvps.org).

The main sources of information that were used are the following:

ADEME reports and studies, indicators produced by the French observation and statistics office (SOeS), reports and studies produced by the Syndicat des énergies renouvelables (SER) and ENERPLAN, "Systèmes solaires, Observ'er" publications (Le Journal du Photovoltaïque, Le Journal des énergies renouvelables), articles from Plein Soleil magazine, data from websites ([photovoltaïque.info](http://photovoltaïque.info), [lechodusolaire.fr](http://lechodusolaire.fr), etc.), data from equipment suppliers, company publications and press releases and contacts with professionals in the sector.

The studies, documents and press articles below, proved to be most useful when preparing the report:

- *Tableau de bord éolien-photovoltaïque*, French observation and statistics office (SOeS) of the *Commissariat Général au Développement Durable* (the French General Commission for Sustainable Development) (No. 396, February 2013);
- *Marchés, emplois et enjeu énergétique des activités liées aux énergies renouvelables*, ADEME (produced by In Numeri), July 2012;
- *Contribution de l'ADEME à l'élaboration de visions énergétiques 2030-2050*, ADEME, November 2012;
- *Annuaire de la recherche et de l'industrie photovoltaïque française* (SER-SOLER) 2013-2014, May 2013;
- *Observ'er, Le Journal du photovoltaïque*, No. 7, April 2012 (*338 acteurs face à leur avenir*) and No. 8, November 2012 (*Atlas des grandes centrales PV > 750 kW*);
- *Observ'er, Le Journal des énergies renouvelables*, Nos. 207 to 212, 2012;
- *Bilan électrique RTE 2012*.

## **1 EXECUTIVE SUMMARY**

### **1.1 Installed photovoltaic power**

The PV power of all grid-connected photovoltaic systems installed in 2012 stood at 1 079 MW. This represented a 38 % fall compared with 2011. New grid-connected distributed systems, the majority of which were building-integrated, represented a total power of 756 MW, while grid-connected centralised ground-based power plants accounted for 323 MW. New PV installations in mainland France accounted for 35 % of total new electricity production capacity commissioned in 2012. The off-grid stand-alone photovoltaic system sector remains marginal with around 0,2 MW installed.

The cumulative power capacity of all photovoltaic systems in operation at the end of 2012 stood at 4 003 MW (281 724 systems) representing an increase of 37 % compared with 2011. Residential systems less than or equal to 3 kW accounted for 86 % of all installations and 16 % of total power capacity, while systems exceeding 250 kW accounted for 0,3 % of all installations and 44 % of total capacity. In 2012, photovoltaic electricity production accounted for 0,7 % of France's total electricity production.

### **1.2 Price of photovoltaic modules and systems**

In France, the estimated average price of European-manufactured photovoltaic modules stood at 0,72 EUR/W in 2012. The fall in prices observed over the last two years has led to substantial growth in the medium-power and high-power systems sector.

The turnkey price stood at around 3,7 EUR/W in 2012 for building-integrated residential systems (IAB) using European modules. The price of simplified building-integrated systems (ISB) on commercial and industrial buildings stood at 2,0 EUR/W, and at 1,6 EUR/W for high-power grid-connected ground-mounted systems (all prices mentioned are exclusive of VAT).

### **1.3 Photovoltaic industry**

The French photovoltaic component industry faced stiff international competition in 2012. The industrial value chain has, on the whole, remained relatively unscathed, but small installation companies have been the worst affected.

Upstream of the PV sector, photovoltaic-grade silicon manufacturing is currently at the industrial project stage. Manufacturers are producing multicrystalline silicon ingots (annual capacity: 130 MW equivalent), slicing these into thin wafers (capacity 70 MW). Crystalline silicon cell manufacturers offer total annual production capacity of around 115 MW and 2012 production is estimated at 50 MW. There are around a dozen module manufacturers, serving a wide range of markets. Their annual production capacity stands at around 750 MW and annual 2012 production is estimated to be 300 MW. New initiatives have emerged in the concentrator photovoltaic (CPV) sector (cells and modules) and in the solar tracker sector for grid-connected ground-mounted systems.

### **1.4 Support measures**

The government has introduced two major support measures to encourage the development of the photovoltaic sector in France. These measures involve guaranteed feed-in tariffs and tender processes for the construction and operation of systems exceeding 100 kW. The feed-in tariffs favour building-integrated photovoltaic systems (IAB) or simplified building-integrated photovoltaic systems (ISB). They are revised each quarter. For building-integrated IAB systems ( $\leq 9$  kW), the tariff was set at 0,3415 EUR/kWh in Q4 2012. The tariff for ISB systems (36 kW – 100 kW) was set at 0,1837 EUR/kWh. For all other types of system up to 12 MW, the tariff was cut by 24 % over the year, ending at 0,0840 EUR/kWh. At the end of 2012 the government announced a new support measure namely a feed-in tariff rise of up to

10 % for systems using photovoltaic modules manufactured in the European Economic Area. At the same time the tariff schedule was simplified (three tariff categories instead of five).

The 2012 tender process for systems between 100 kW and 250 kW led to the selection of 369 projects totalling 145 MW. The *Commission de régulation de l'énergie* (CRE - French energy regulation commission), which is responsible for these matters, launched a new tender process in early 2013 with a target of 120 MW. The 2012 tender process for systems exceeding 250 kW resulted in a high number of bids, with a total of 520 MW of projects. A new tender process has been launched in this power category in October 2013, with a target of 400 MW.

### **1.5 R&D and budgets**

Major R&D projects and industrial developments are funded by three national public bodies: ADEME, ANR and OSEO. ADEME, as part of the national *Investissements d'avenir* (Future investment) programme, selected nine new projects for the AMI PV programme in 2012. ANR, meanwhile, selected five new research projects as part of its PROGELEC (renewable electricity production and management) programme in 2012. OSEO, an agency that supports innovation in SMEs and SMIs, supported two new industrial initiatives in 2012. Public/private partnership projects of a 3 to 5 year duration received support from these three agencies amounting to 100 MEUR (refundable advances and subsidies) over the 2011-2012 period.

□



## 2 IMPLEMENTATION OF PHOTOVOLTAIC SYSTEMS

### 2.1 Photovoltaic system applications in France

Photovoltaic (PV) systems have been in use in France since the 1980s. Initially, these systems were used to supply power to off-grid sites (homes, farms, telecommunications repeater stations, etc.). More recently, PV systems have been used as decentralized power plants that supply electricity to the public electricity grid. Photovoltaic systems comprise both electrical and electrotechnical components. The electricity is generated via photovoltaic modules exposed to sunlight (the modules are arranged into panels, strings and arrays). The direct current produced by these modules is then converted, via an inverter, into alternating current (at the required ampere rating). Electrochemical batteries can be used to store this energy for applications such as isolated sites. The PV system also features other equipment together with control and safety devices.

The nominal power of a photovoltaic system is calculated as the sum of all its constituent photovoltaic modules power.

NOTE: The power of a PV module is measured in the manufacturing plant under standard test conditions (STCs). The power data published in the report are expressed in watt (W) and its multiples kW and MW, and not in the non-standardised unit "watt-peak" (Wp) sometimes used by some professionals.

In line with the IEA's statistics requirements, the report distinguishes between four types of photovoltaic system:

1) **grid-connected distributed PV power system:** electricity-producing system applied to dwellings, tertiary, commercial, industrial and agricultural buildings, or simply installed in the built environment (power between 1 kW and 1 MW).

NOTE - The sale of energy generally provides a secondary income source for the owner of the system.

2) **grid-connected centralised PV power system:** ground-mounted production system supplying bulk power electricity (power greater than 1 MW).

NOTE - The sale of energy generally provides the primary income source for the owner of the system.

3) **off-grid domestic PV power system:** system installed to provide power mainly to a household or village not connected to the utility grid. Power category: 1 kW to 100 kW.

NOTE - This stand-alone PV power system includes a storage battery and, in some cases, an additional source of electricity (diesel generator, wind power, etc.).

4) **off-grid non-domestic PV power system:** system used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Power category: 1 kW to 100 kW.

NOTE - This stand-alone PV power system includes a storage battery and, in some cases, an additional source of electricity (diesel generator, wind power, etc.).

Initially, the IEA used to take into account off-grid domestic and off-grid non-domestic systems separately. This distinction has not been used in the report.

Whereas at the end of 2006 off-grid photovoltaic systems accounted for 50 % of total power output, they now amount to 0,7 %. Nowadays, most of France's photovoltaic (PV) systems are connected to the grid.

The government's decision to promote the development of photovoltaic energy in France led to the publication of a decree in 2006 ruling on the compulsory purchase of photovoltaic electrical energy at an attractive price for the producer. The government's strategy is to encourage the use of building-integrated photovoltaic systems. At the end of 2012, building-

integrated systems represented 76 % of total power output, with ground-mounted power plants accounting for 24 %. The latter have achieved considerable growth in recent years.

### **2.1.1 Data collection**

#### **2.1.1.1 Grid-connected systems**

Data concerning grid-connected photovoltaic systems come from a publication by the French observation and statistics office (SOeS) of the *Commissariat Général au Développement Durable* (the French General Commission for Sustainable Development) (No. 396, February 2013). The SOeS relies on the files of the various transport and distribution network operators: ERDF, RTE, SEI and the main local distribution companies (ELDs).

The SOeS's statistics cover systems physically connected to the grid in 2012. Systems that had been installed but not connected as at the end of 2012 are not included. In this respect, this report for the IEA does not fully comply with the specifications, which stipulate that the report should cover all systems installed during the year. In other words, the purpose of the report is to reflect industrial activity in the sector. In order to avoid confusion between the various information sources available, a decision was taken to use the SOeS's overall figures.

It is also important to note that the SOeS statistics do not break down the data by application category, as defined by the IEA PVPS for this report (grid-connected distributed and centralised systems). The *Atlas des grandes centrales photovoltaïques > 750 kW* published by *Observ'er/Journal du photovoltaïque* (No. 8 November 2012) is an important source of information in determining the total power of ground-mounted photovoltaic power plants. Nevertheless, some data are missing and it was therefore necessary to determine which were ground-mounted centralised systems (> 1 MW) or distributed systems (industrial, agricultural or commercial roof-mounted systems, parking shades, etc.). The results of this assessment are presented in Tables 1a, 1c, 1d, 2a and 2c, and are illustrated in Figure 1.

#### **2.1.1.2 Off-grid systems**

According to FACE (rural electrification subsidy fund) off-grid domestic photovoltaic power installed in 2012 stood beneath 70 kW (mostly in mainland France). So-called off-grid non-domestic systems, such as those supplying power to telecommunications and other industrial applications, are more difficult to identify due the lack of accurate statistics. A figure of around 130 kW is considered for this type of application mostly installed in French overseas departments.

## **2.2 Total photovoltaic power installed**

All photovoltaic systems referred to in the report were installed in France during the 2012 calendar year. The term "France" refers to mainland France, the island of Corsica and France's overseas departments (DOM): Guadeloupe, French Guiana, Martinique, Mayotte and Réunion.

### **2.2.1 PV power commissioned in 2012**

Total photovoltaic power connected to the grid in France in 2012 stood at 1 079 MW, compared with 1 759 MW in 2011.

The power of grid-connected distributed systems – most of which were building-integrated – reached 756 MW, while the power of grid-connected centralised ground-mounted power systems (> 1 MW) stood at an estimated 323 MW for 2012 (Sources: SOeS, Atlas Observ'er, ADEME). Off-grid applications were estimated at 0,2 MW (Sources: Face, ADEME). Table 1a shows total photovoltaic power commissioned in 2012, across all grid-connected and off-grid categories.

**Table 1a – Photovoltaic power installed during calendar year 2012 (MW)**

Grid-connected			Off-grid
Distributed	Centralised	Sub-total grid	Domestic and Non-domestic
756	323	1 079	0,2

Sources: SOeS, Atlas Observ'er, FACE, ADEME.

Table 1b shows new systems connected to the grid in 2012 by power category (source: SOeS). The 38 % fall in grid-connected power was even more significant in terms of the number of installations, which was down 58 %, with 34 538 systems in 2012, compared with 82 330 in 2011. In terms of systems up to 9 kW, 2012 saw a slow-down of 57 % compared with 2011. This figure stood at 33 % for systems above 250 kW. Across the year as a whole, PV systems above 250 kW accounted for around 59 % of total connected power output, due to the connection of a number of large photovoltaic power plants.

**Table 1b – Grid-connected installed capacity during calendar year 2012**

Power category	Installation number	Power (MW)
0 – 3 kW	23 827 (69 %)	66 (6,1 %)
3 kW – 9 kW	5 907 (17,1 %)	36 (3,3 %)
9 kW – 36 kW	2 209 (6,4 %)	50 (4,6 %)
36 kW – 100 kW	1 246 (3,6 %)	97 (9,0 %)
100 kW – 250 kW	1 100 (3,2 %)	197 (18,3%)
> 250 kW	249 (0,7 %)	632 (58,7 %)
Total	34 538 (100 %)	1 079 (100 %)

Source: SOeS.

Over the period 2008-2012, a total of 105 ground-mounted power plants (> 1 MW) were installed, representing total power output of 898 MW (Table 1c, mainland France including Corsica but excluding overseas territories) (source: *Observ'er Atlas*, Nov. 2012).

**Table 1c – Power and Number of ground-mounted centralized by power range**

Power range	1 to 5 MW		5 to 10 MW		10 to 50 MW		50 to 65 MW		Total	
	MW	nb	MW	nb	MW	nb	MW	nb	MW	nb
Mainland France, Corsica, not DOM										
2012	25	10	0	0	174	9	115	2	314	21
2011	85	27	160	22	165	12	0	0	409	61
2010	19	10	36	5	101	4	0	0	155	19
2009	8	2	5	1	0	0	0	0	14	3
2008	0	0	7	1	0	0	0	0	7	1
Total	137	49	208	29	440	25	115	2	898	105

Source: Atlas Observ'er, 2012.

Table 1d shows the total power of systems annually installed between 2005 and 2012.

**Table 1d – PV power capacity annually installed by application (MW)**

Application	2005	2006	2007	2008	2009	2010	2011	2012
Off-grid	1,1	1,5	1,0	0,4	6,3	0,1	0,1	0,2
Grid-connected distributed	5,9	9,4	36,6	97	150	653	1 317	756
Grid-connected centralised	0	0	0	7	35	164	442	323
Grid-connected sub-total	5,9	9,4	36,6	104	185	817	1 759	1 079
Total (MW)	7,0	10,9	37,6	104,4	191,3	817,1	1 759,1	1 079,2

Sources: SOeS, preceding IEA PVPS NSRs France. Grid-connected centralised figures from preceding IEA NSR were reviewed to take into account latest adjustments from SOeS, Atlas Observ'er and ADEME.

## 2.2.2 Cumulative PV power at the end of 2012

Table 2a shows total photovoltaic power at the end of 2012, broken down into grid-connected and off-grid categories.

The total power of all grid-connected photovoltaic systems at the end of 2012 exceeded the 4 GW level. With total power output of 4 003 MW (281 724 systems), France's national capacity had increased by 37 % compared with the situation at the end of 2011 (2 924 MW and 247 186 systems).

**Table 2a – Cumulative installed PV power at the end of 2012 (MW)**

Grid-connected			Off-grid
Distributed	Centralised ground-mounted	Sub-total grid	Domestic and non-domestic
3 032	971	4 003	29,6

Sources: SOeS, Atlas Observ'er and ADEME.

Table 2b shows total power at the end of 2012 by power category, using the categories proposed in the SOeS statistics. Residential systems up to 3 kW accounted for 86 % of all installations and 16 % of total power, while systems above 250 kW accounted for 0,3 % of all installations and 44 % of total power.

**Table 2b – Grid-connected cumulative installed capacity at the end of 2012**

Power category	Installation number	Power (MW)
0 – 3 kW	242 793 (86 %)	645 (16 %)
3 kW – 9 kW	15 333 (5,4 %)	85 (2,1 %)
9 kW – 36 kW	12 938 (4,6 %)	318 (7,9 %)
36 kW – 100 kW	4 905 (1,7 %)	350 (8,7 %)
100 kW – 250 kW	4 888 (1,7 %)	847 (21,2 %)
> 250 kW	867 (0,3 %)	1 759 (44 %)
Total	281 724 (100 %)	4 003 (100 %)

Source: SOeS.

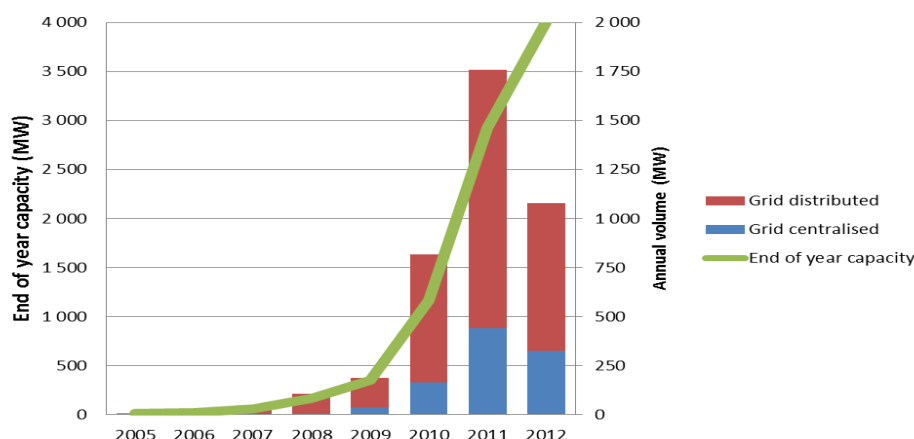
Table 2c lists cumulative power on 31 December of each year since 2005, broken down by system category, i.e. off-grid and grid-connected (distributed and centralised). The data published in the previous French reports produced for the IEA PVPS have been adjusted in line with the latest SOeS information (e.g. 2 924 MW connected at the end of 2011, instead of 2 831 MW as previously stated) and data published by the *Observ'er Atlas des systèmes photovoltaïques > 750 kW*.

**Table 2c – Cumulative installed PV power by application as at 31 December (MW)**

Application	2005	2006	2007	2008	2009	2010	2011	2012
Off-grid	20	21,5	22,5	22,9	29,2	29,3	29,4	29,6
Grid-connected distributed	13,0	22,4	59	156	306	959	2 276	3 032
Grid-connected centralised	0	0	0	7	42	206	648	971
Grid-connected sub-total	13	22,4	59	163	348	1 165	2 924	4 003
Total (MW)	33,0	43,9	81,5	192,6	377,2	1 194,3	2 944,4	4 032,6

Sources: SOeS, preceding IEA PVPS NSRs France. Grid-connected centralised figures from preceding IEA NSR were reviewed to take into account latest adjustments from SOeS, Atlas Observ'er and ADEME.

Figure 1 shows changes in total power of grid-connected photovoltaic systems in France between 2005 and 2012 (annual grid-connections and cumulative output at end of year).



**Figure 1 - Annual and cumulated power of grid-connected installations in France**

The *Observer Atlas* provides details of the photovoltaic module technologies used in systems above 750 kW (324 systems, representing total power output of 1 320 MW). Crystalline silicon modules account for 58 % of installed power (covering distributed and centralised ground-mounted) while thin-film modules amount to 42 % (Table 2d). The situation with regard to ground-mounted power plants is reversed, with thin-film modules standing at 54 % and crystalline silicon at 46 %. A more detailed analysis of all systems installed in France (4 GW) is currently unavailable but estimates suggest that crystalline silicon is the dominant technology at around 85 %.

**Table 2d – Modules technologies for PV systems > 750 kW**

Module technology	Cell material	Power percentage
Crystalline silicon	Multicrystalline silicon (mc-Si)	35 %
	Single crystalline silicon (sc-Si)	23 %
Thin film	CdTe/CdS	40 %
	a-Si:H and CIGS	2 %

Source : Atlas Observ'er.

At the end of 2012, there were 29 ground-mounted PV power plants above 10 MW, accounting for total power of 576 MW, the most powerful one amounting to 115 MW.

Excluding ground-mounted PV power plants, most photovoltaic systems are installed on building rooftops, either as Building-Integrated Photovoltaic Systems (BIPVs) or Simplified Building-Integrated Photovoltaic Systems (Simplified BIPVs). Added-on rooftop systems are found mainly on the island of Réunion. Carports and greenhouses equipped with PV know some development.

The majority of photovoltaic installations in mainland France are located in regions where there is the most sunshine. The most active regions include Provence – Alpes – Côte d'Azur (14,4 % of total power), Midi-Pyrénées (11,3 %), Aquitaine (11,2 %), Languedoc-Roussillon (8,9 %), Rhône-Alpes (7,0 %) and Pays de la Loire (7,0 %). The Burgundy and Centre regions doubled their PV power in 2012.

France's overseas departments (DOM) account for 7,8 % of total national power output and 2 % of systems by number. The island of Réunion alone accounts for almost 50 % of total power installed in overseas departments. There has been a significant fall in the number of photovoltaic system connection requests in the overseas departments and in Corsica due to the 30 % threshold of intermittent energies allowed by EDF SEI.

A few examples of new systems in 2012: automotive manufacturer Renault opened 59 MW of rooftop-mounted photovoltaic systems at six production sites in France. Fonroche Énergie and Solairedirect made substantial progress in 2012 in agricultural greenhouse cover technologies. La Compagnie du Vent (GDF SUEZ group) opened a 3,8 MW power plant with

a single-axis Exosun solar tracking system. EDF EN commissioned the largest power plant in Europe, in the Lorraine region of France, with total power of 115 MW (65+50).

Table 3 shows photovoltaic energy production in relation to the electricity market in mainland France (excluding Corsica and DOM) in 2012. The data, taken from the "*Bilan électrique RTE 2012*", are slightly different from the SOeS statistics. According to RTE, total operational PV power output stands at 3 515 MW, with production of 4 GWh and PV power output installed in 2012 is evaluated at 1 012 MW. Based on these figures, photovoltaic technology accounts for 2,7 % of total national power output and 0,7 % of national electricity production. It is worth noting that PV installations in 2012 accounted for 35 % of total new electricity production capacity in mainland France (gas power plants: 34 %, wind: 26 %).

**Table 3 – Photovoltaic power and the broader national electricity market**

Ratio of total PV power output to total electricity generation capacity	Ratio of new PV power output (2012) to <u>new</u> electricity generation capacity (2012)	Ratio of total PV electricity production to total electricity production
2,7 %	35,4 %	0,7 %

Source: Bilan électrique RTE 2012.

There is growing interest in the concept of self-consumption of electricity produced by photovoltaic systems installed on the roofs of manufacturing and commercial premises. Often these buildings have a large roof surface area capable of producing sufficient electricity to allow companies to run off their own electricity production during daylight hours. These systems are designed to allow businesses to use more than 95 % of their production for their own purposes.

## 2.3 PV implementation highlights, main projects

### 2.3.1 General framework

The French action plan in favour of renewable energy intends to increase the share of renewable energies in energy consumption to at least 23 % by 2020. The government objective (PPI 2009) is to have 5 400 MW connected to the grid by 2020. To reach this objective – with spectacular progress already well underway in the sector – the government decided to control the financial impact of its support measures from the end of 2010. In March 2011, a new order set up a system of feed-in tariffs adjustable each quarter for projects up to 100 kW and a tender process for installations above 100 kW. The annual target was set at 500 MW for installations wanting to benefit from the support schemes: 100 MW for building-integrated residential installations (BIPVs) up to 36 kW, 100 MW for simplified building-integrated installations between 36 kW and 100 kW (Simplified BIPVs), 120 MW for installations between 100 kW and 250 kW, and 180 MW for installations above 250 kW. There were plans to revise the annual target at the end of 2012 and to set a new target of 1 000 MW for 2013.

### 2.3.2 Feed-in tariffs

In an order of 4 March 2011, the government set out quarterly reductions in feed-in tariffs, depending on the number of full connection requests submitted in the previous quarters. For building-integrated installations up to 3 kW, the tariff dropped from 0,580 EUR per kWh at the start of 2010 to 0,3415 EUR per kWh at the end of 2012. For ground-mounted power plants, the tariff dropped from about 0,276 EUR per kWh at the end of 2010 (three-month moratorium on these systems) to 0,084 EUR per kWh at the end of 2012 (Table 4a).

The order of 7 January 2013 simplified and amended the feed-in tariff schedule, with the new schedule coming into force on 1 February 2013. The T1 building-integrated tariff now applies to all buildings, irrespective of the building's use, and for all systems up to 9 kW (Table 4b). The feed-in tariffs apply to total energy sales or surplus energy sales. As before, depression coefficients will be applied to these tariffs each quarter.

A new measure was introduced in late 2012. This new measure came partially into force in Q4 2012, and fully into force on 1 February 2013 for all applications. It involved an increase of the electricity feed-in tariff for systems using photovoltaic modules manufactured at a site located within the European Economic Area (EEA). The increase amounted to 10 % for modules fully manufactured in the EEA (crystalline silicon ingot/wafer/cell; crystalline silicon cell and module; thin-film module) or 5 % for partial manufacture in the EEA (crystalline silicon cell or module).

**Table 4a – Applicable PV feed-in tariffs as at Q1 2012 and Q4 2012 (EUR/kWh)**

PV system type	Building usage	PV power (W)	Tariff (EUR/kWh) Q1 2012	Tariff (EUR/kWh) Q4 2012
Building-integrated photovoltaic system (IAB)	T1 – Residential use	$P \leq 9$ kW	0,3880	0,3415
		$9$ kW < $P \leq 36$ kW	0,3395	0,2988
	T2 – Building for education or health activities	$P \leq 36$ kW	0,3009	0,2279
	T3 – Other type of building	$P \leq 9$ kW	0,2609	0,1976
Simplified building-integrated (ISB)	T4 – Any type of building	$P \leq 36$ kW $36$ kW < $P \leq 100$ kW	0,2249 0,2137	0,1934 0,1837
Other installations	T5 – Any type of installation (Ground mounted, etc.)	$0$ kW < $P < 12$ MW	0,1108	0,0840*

\*T5 tariff increased by 5 % or 10 % for modules manufactured in the European Economic Area.

In the last quarter of 2012, the T5 tariff fell by 20 %.

**Table 4b – New applicable PV feed-in tariffs as at Q1 2013 (EUR/kWh)**

PV system type and tariff category	PV power (W)	Tariff (EUR/kWh) Q1 2013*
T1 Building-integrated photovoltaic systems (IAB)	$P \leq 9$ kW	0,3159*
T4 Simplified building-integrated systems (ISB)	$P \leq 36$ kW $36$ kW < $P \leq 100$ kW	0,1817* 0,1727*
T5 Other installations	$0$ kW < $P < 12$ MW	0,0818*

\*T1, T4 and T5 tariffs increased by 5 % or 10 % for modules manufactured in the European Economic Area.

In France, PV energy purchase contracts are managed financially by the EDF Compulsory Purchase Agency (EDF OA) and other local distribution companies (ELDs). ERDF is responsible for the national grid and provides connection and access contracts for the public distribution and operation network (photovoltaic systems < 36 kVA). Note that the tariff granted when signing the contract is guaranteed for a period of 20 years. Once fixed, the feed-in tariff for a project is no longer affected by the quarterly degression. It is, however, adjusted on an annual basis using a specific coefficient.

This promotional policy is funded by electricity customers via the *Contribution au service public de l'électricité* (CSPE - public electricity service contribution).

### 2.3.3 Tender processes

Two types of tender process covering photovoltaic systems above 100 kW were launched in 2011, and the first results were published in 2012. The tender process is managed by the *Commission de régulation de l'énergie* (CRE - French Energy Regulation Commission), France's electricity and gas market regulator.

Projects are selected according the price that the bidder wishes to charge for electricity supplied to the grid over a period of 20 years.

- The first type of tender process covered the construction and operation of photovoltaic installations of between 100 kW and 250 kW. These installations had to comply with the rules governing simplified building-integrated photovoltaic (Simplified BIPV) systems. The tender process was divided into seven bidding phases, with a total new production output target of 300 MW, divided into 120 MW for the first phase and 30 MW for the next six phases. A total of 218 projects (45 MW) were selected in the first phase, short of the target of 120 MW. In the second phase, 109 projects were selected (21 MW). The third, fourth and fifth phases led to the selection of 369 projects (79 MW). A total of 145 MW of projects were selected, well under the target of 240 MW. The selected projects are located in those areas of France that receive the most sunshine, in order to maximise productivity. The average electricity sale price proposed by the bidders in the first phase of the tender process was 229 EUR per MWh. This fell to 194 EUR per MWh in the fourth phase.

The Ministry for Ecology (MEDDE) did not find the tender results satisfactory, particularly in terms of its outcomes for French industry. As a result the last bidding phases, originally scheduled for launch in early 2013, were suspended and replaced with a new tender process, launched in March 2013. This new process focuses on the construction of rooftop PV systems of between 700 m<sup>2</sup> and 2 000 m<sup>2</sup>, with total power output of 120 MW installed by 2015, divided into three phases of 40 MW each. The amended specifications will focus not only on the proposed electricity purchase price, but also on the carbon footprint of the PV module manufacturing process. The bid submission deadline for the first 40 MW phase has been set for 31 October 2013.

- The second type of tender, launched in September 2011, covers the construction and operation of photovoltaic installations above 250 kW (simplified building-integrated PV systems, ground-mounted power plants and parking shade systems, concentrator photovoltaic modules and thermodynamic solar installations). A total of 105 projects have been selected (520 MW), some 70 MW above the original target of 450 MW. The specifications for this type of project feature stricter environmental and industrial quality requirements, including mandatory end-of-life dismantling and recycling and an obligation to produce a life-cycle analysis report.

A new tender process in the greater than 250 kW category was launched in March 2013, targeting maximum total power output of 400 MW. This new process concerns simplified building-integrated (Simplified BIPV) systems, parking shades, concentrator ground-mounted power plants and ground-mounted power plants featuring traditional modules with a solar tracking system. The specifications differ from the first tender process as they include criteria that focus on the technical innovation and carbon footprint of the PV modules concerned (a 30 % weighting in the final score). The aim is to favour projects that boost industrial growth and job creation in France.

At the end of year professionals were awaiting the new emergency measures promised by the government to ensure the survival of the sector. These were well received when published, but the schedule proposed was not considered totally satisfactory since the tender results would not be published before 2014, which meant more than a year of slower business. Professionals also felt that the chosen selection criteria and scoring method would fail to provide sufficient transparency to secure industrial investment for manufacturers based in France.

## 2.4 Highlights of R&D

The government photovoltaic policy is implemented through a number of subsidiary agencies such as ADEME (French Environment and Energy Management Agency), ANR (French National Research Agency) and OSEO (organisation providing support to French SMEs and SMIs for innovation projects).

Public research activities range from studies upstream of the value chain (ANR's PROGELEC programme) to finalised projects and industrial prototypes (ADEME's AMI PV, and OSEO's reindustrialisation support programme). These R&D projects are run on a



public/private partnership basis. SER-SOLER Directory of PV Research and Industry lists about 40 public research teams.

ADEME launched two calls for expressions of interest, known as "AMI PV" and "AMI Solaire", at the end of 2009. These formed part of the major national future investment programme known as "*Investissements d'avenir*" (IA). Under the AMI PV programme, nine projects were selected. Initial progress reports on these projects were presented at ADEME's photovoltaic research and innovation event (*Journée ADEME, recherche et innovation photovoltaïque*), held in Sophia Antipolis on 15 November 2012. The event covered the following topics: the production of photovoltaic solar silicon by metallurgical route; the manufacture of crystalline silicon ribbon; the manufacture of thin-film CIGS modules by electrodeposition; the manufacture of thin-film amorphous silicon modules and variants; the manufacture of cells using III-V materials for high-concentration photovoltaic applications; the development of concentrator photovoltaic (CPV) modules; and the development of encapsulation processes using advanced polymers.

ANR is continuing its efforts in the PV sector with the PROGELEC 2011-2013 (Renewable electricity production and management) programme. Five photovoltaic projects were selected in 2012, in addition to the five chosen in 2011.

OSEO through its industrial strategic innovation (ISI) business support programme, provides assistance for industrial manufacturing pilot projects. In 2012 it supported two pilot production lines: one for n-type crystalline silicon cells, and the other for organic cells using inkjet printing technology.

The *Institut national de l'énergie solaire* (INES - French national solar energy institute) is currently undergoing rapid growth. With a staff of over 300 people, INES is involved in numerous projects in public/private partnership. Public bodies CEA and CNRS, university laboratories and engineering schools are involved in research and innovation programmes. The *Institut photovoltaïque d'Île-de-France* (IPVF - Ile-de-France Photovoltaic Institute) includes several teams around IRDEP (EDF, CNRS) focusing their efforts on developing thin-film materials and new concepts.

In terms of PV applications in architecture, the Canopea® urban solar-powered housing project, designed by Team Rhône-Alpes, won the 2012 Solar Decathlon Europe competition. This positive-energy apartment block project includes a communal area under a glass roof fitted with PV/T hybrid collectors. The next international competition will be held at the Palace of Versailles in 2014.

## **2.5 Budgets for market stimulation and R&D programmes**

### **2.5.1 Support measures**

The government has introduced a range of incentives to encourage the development of the photovoltaic sector in France.

#### *2.5.1.1 Electricity feed-in tariffs*

The cost of the feed-in tariff PV promotion policy (see section 2.3.2) is not covered by a public budget. Instead, it is electricity company customers who help fund these promotional tariffs through the CSPE tax (4.1.2). The CRE has estimated the cost of the PV feed-in tariff promotion scheme at 1 500 MEUR for 2012.

#### *2.5.1.2 Tender processes*

The decree of 4 March 2011 introduced the government's new strategy by launching tender processes for photovoltaic systems above 100 kW. These measures are detailed in paragraph 2.3.3.

### 2.5.1.3 Tax credit, tax exemption on sale and VAT

Individuals who own a PV system up to 3 kW are eligible for a sustainable development tax credit (CIDD). The credit covers 11 % of the cost of the equipment shown on the estimate. It is deducted directly from the individual's income tax liability. The credit was capped at 1 056 EUR for 2012. Private individuals are not taxed on the sale of photovoltaic electricity. The rate of VAT on the cost of equipment and installation is 7 % (instead of 19,6 %). The cost of these measures was evaluated at 670 MEUR in 2010.

### 2.5.1.4 Grants from local authorities

Local authorities play an important role in the development of the PV market. Regional councils, departmental councils and communes award grants in various forms. The financial level varies. The list of grants available is provided by the ENERPLAN professional union. Some regions provide general industrial development support in addition to the OSEO grants (see 4.3).

### 2.5.2 Public R&D budget

In 2011/2012, public agencies ADEME, ANR and OSEO launched new photovoltaic R&D initiatives (see section 2.4). Projects are funded through subsidies and/or repayable advances (in case of failure, the advances do not have to be entirely reimbursed, unlike bank loans). A total of 100 MEUR of central government funding was allocated by ADEME, ANR and OSEO in 2011 and 2012 to support projects (ranging from 3 to 5 years).

## 3 INDUSTRIAL ACTIVITY

All professions in the photovoltaic value chain are represented. The SER-SOLER PV Directory (May 2013), provides a description of the activity of 220 actors active in the field.

In the most upstream part there are companies that manufacture ingots, wafers, cells and modules and companies that build and develop production machinery and equipment. Companies belonging to large groups offer a range of industrial materials. BOS components such as inverters, cables, instruments of control, structural components, trackers, etc. are taken into account. The downstream part of the value chain for implementation activities includes design, integration of components, construction, operation, maintenance, material recycling, etc.

This chapter focuses on photovoltaic component and equipment companies with manufacturing facilities in France. The statistics relating to annual production capacities of ingots, cells and modules are taken from manufacturers' statements and declarations. Precise data on 2012 production levels are more difficult to obtain and an overall estimate has therefore been made.

In 2011/2012, global overproduction, a significant drop in module prices and contraction of the French market had a serious impact on company results, and some production capacity expansion projects were put on hold. It was a difficult period, with some companies forced to lay off part of their workforce. Some companies went bankrupt, and others changed hands.

### 3.1 Main changes of ownership in 2012

Two pioneering companies in the French photovoltaic sector underwent restructuring in 2012.

#### 3.1.1 Photowatt taken over by EDF ENR

Created in 1979, Photowatt is France's long-standing vertically integrated manufacturer (multicrystalline silicon ingots, wafers, photovoltaic cells and modules). In March 2012, the company was bought out by EDF ENR. EDF ENR also acquired a 100 % stake in the PV

Alliance consortium, which is working on new silicon cell manufacturing processes under a pilot programme. Photowatt is now known as EDF ENR PWT.

### **3.1.2 *Tenesol taken over by SunPower***

Tenesol is the second largest long-standing player in the French photovoltaic sector. It has long been involved in the design and installation of PV systems, and in the manufacture of crystalline silicon photovoltaic modules. Under the ownership of Total, Tenesol was bought in 2012 by SunPower Corp., a California-based manufacturer of high-efficiency single-crystal silicon cells and modules. Total Group took control of SunPower in May 2011. The overseas branch of Tenesol is now operating under the name of Sunzil a jointly owned subsidiary of Total and EDF groups.

## **3.2 Silicon materials, ingots and wafers**

In France, the multicrystalline silicon (large grain crystalline material) sector has historically been the technology favoured by the public authorities. Photowatt/EDF ENR PWT produces multicrystalline silicon ingots using directional solidification (annual capacity equivalent to 70 MW). Emix Company uses an electromagnetic semi-continuous casting technique (annual capacity equivalent to 60 MW). Manufacturers use wire saws to cut the silicon ingots into 200 µm-thick wafers. Photowatt, in cooperation with a Swiss mechanic, pioneered the development of this technique. The technique is now used across the industry. Annual wafer slicing capacity is equivalent to 70 MW.

There are two industrial projects that offer an alternative to silicon ingot slicing: the manufacture of a silicon ribbon by SolarForce (RST process) and the manufacture of silicon wafers by sintering silicon powder, proposed by S'Tile.

Studies on the preparation of feedstock silicon concern the metallurgical method rather than the traditional chemical method. FerropemAtlantica, Apollon Solar and INES are working on the development of a production pilot programme.

## **3.3 Photovoltaic cells and modules**

In the crystalline silicon sector, photovoltaic cells are manufactured on silicon wafers (around 200 µm thick, single-crystal, quasi-mono or multicrystalline variants). Photovoltaic modules consist of cells connected together and protected from the environment between a transparent front, usually glass, and a backing material, usually plastic or glass.

In the thin-film sector, thin film photovoltaic cells (around one micrometre thick) are formed into a single flexible or rigid substrate and are encapsulated with transparent plastic or glass as front material.

### **3.3.1 *Crystalline silicon photovoltaic cells***

Photowatt (EDF ENR PWT since March 2012) is France's long-standing vertically integrated manufacturer of multicrystalline silicon ingots, wafers and cells. Its annual photovoltaic cell production capacity (dimension: 156 mm x 156 mm) is 70 MW. The manufacturer produces cells, while improving its industrial processes through its PV Alliance LabFab and with the support of CEA-INES.

MPO Energy is working on a project to manufacture crystalline silicon photovoltaic cells. The capacity of the metallisation line is 35 MW and the future production line using the ion implantation technique to form the junction will have an annual capacity of 70 MW. The process used was developed as part of the PV20 project, with the support of OSEO, the Pays de la Loire regional council and ADEME. In April 2012, the company published a cell conversion efficiency of 19,1 %, in conjunction with CEA-INES.

Irysolar Company, a subsidiary of equipment supplier Semco Engineering, is running a silicon cell pilot production (capacity: 10 MW). The aim of the Monoxen project is to install an

n-type cell production demonstrator. The project was launched in October 2012, with the support of OSEO.

In summary, annual crystalline silicon photovoltaic cell production capacity in France stood at 115 MW for 2012 and PV cell production is estimated at around 50 MW.

### 3.3.2 Concentrator photovoltaic cells

See paragraph 3.3.3.3.

### 3.3.3 Photovoltaic modules

There are two types of photovoltaic module, depending on the semiconductor materials of the cells used. Crystalline silicon photovoltaic modules use cells made from (single or multi) crystalline silicon wafers. These modules comply with standard IEC 61215. Thin film modules, the second type, use thin-film semiconductor materials such as hydrogenated amorphous silicon and its variants, or CIGS (Cu, In, Ga, Se,...) compounds or CdTe/CdS based compounds. These thin-film modules, are formed by depositing thin layers of semiconductor onto a backing material (such as glass or steel) using various techniques. This backing material is the basis of the thin-film commercial module. These modules comply with standard IEC 61646.

#### 3.3.3.1 Crystalline silicon PV modules

France has two long-standing crystalline silicon module manufacturers: Photowatt (now EDF ENR PWT) and Tenesol (now SunPower).

Photowatt/EDF ENR PWT used to manufacture its modules in France using its own cells. This activity has been outsourced to foreign subcontractors since 2011. The company plans to bring production back to France in autumn 2013. The modules retain their original name.

Tenesol/SunPower has a module production facility in France and one in South Africa. In 2012, the Total/SunPower Company introduced SunPower single-crystal high efficiency silicon cells in its new module production facility in Lorraine region.

In recent years, several companies have started to manufacture modules using imported crystalline silicon cells. As of the end of 2012, there were around a dozen such companies operating in France. Only one company (Auversun) ceased production. The sector has remained resilient in the face of difficulty by finding new markets and diversifying its activity.

Production line automation levels remain highly variable. Typical modules have a nominal power of between 200 W and 340 W. France's annual module production capacity stands at around 750 MW, with actual estimated production in 2012 of 300 MW.

Table 5 contains a list of module manufacturers with a production facility in France. Photowatt/EDF ENR PWT has not been included in Table 5 as its modules are not manufactured in France in 2012 (conforming with the guidelines of the IEA PVPS national survey report).

#### **Table 5 – Crystalline silicon PV module manufacturers operating in France**

Bosch Solar Energy, Elifrance, Fonroche Énergie, Francewatts, KDG Energy, Luxol, Sillia Énergie, SNAsolar, Solarezo, Systovi, Tenesol/SunPower, Total/SunPower, Tournaire SA, Voltec Solar.
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Source: SER, ADEME.

Among these companies some produce photovoltaic laminates which can be mounted in special framing systems for building-integrated applications. Some others develop and/or manufacture photovoltaic tiles (PV tiles differ from traditional modules by their smaller surface area) and other ones produce photovoltaic/thermal (PV/T) modules for building applications.

In 2012, Bosch Solar Energy, located in Vénissieux, opened a second production line, giving the company an annual module production capacity of around 150 MW. Total/SunPower (Total group) opened a new 44 MW module production line in Porcellette (Lorraine region).

Some French companies own production capacity abroad: Solairedirect and Tenesol/SunPower operate c-Si PV module factories in South Africa, and Total group, through its controlled SunPower Company manufactures c-Si cells in Malaysia and the Philippines, together with PV modules in the USA.

### 3.3.3.2 *Thin-film modules*

The technique of thin-film is attractive, as it requires a low quantity of semiconductor material. In France, manufacturers of this type of module use hydrogenated amorphous silicon (a-Si:H), using the plasma-enhanced chemical vapour deposition technique (PECVD), and CIGS compounds (electrodeposition process). Organic photovoltaic (OPV) materials are at the early stages of industrial production, with initial aims to use these for micropower applications.

In France, two manufacturers of amorphous silicon on glass substrate, Free Energy Europe (5 W to 19 W modules) and Solems SA (modules < 0,1 m<sup>2</sup>) operate with an annual production capacity of 1 MW. Their products mainly deal with off-grid applications. There is no industrial production of large-area thin-film modules for centralised power applications.

Two companies are at the industrial pilot production stage:

- Solsia, a partner of Solems, is developing a PECVD production pilot for large modules made from amorphous silicon and its variants.
- Nexcis is preparing to launch full-scale production of CIGS modules through electrodeposition of copper, indium and gallium, coupled with annealing in a sulphur and selenium atmosphere. This process was initially studied by the IRDEP mixed institute (EDF and CNRS). The modules are either dual-glass or metal/polymer.

The French Saint-Gobain group through its subsidiary Avancis manufactures CIGS modules in Germany.

In terms of organic photovoltaic (OPV) materials, there are two companies working with inkjet printing techniques: Armor and DisaSolar. More development work is required before OPV materials make genuine inroads into the energy market.

### 3.3.3.3 *Concentrator photovoltaic cells/modules and solar trackers*

Concentrator photovoltaic (CPV) technology is designed for regions with high levels of direct sunshine. This technique is based on high-efficiency photovoltaic cells and light concentrators mounted on solar trackers.

Soitec Company who took over Concentrix Solar is now developing multijunction GaInP/GaInAs/Ge photovoltaic cells using proprietary technologies. In December 2012, Soitec Solar opened a CPV module production line (approx. 500 suns with Fresnel lens) in San Diego (USA). It also commissioned five CPV power plants in Africa.

Heliotrop develops and sells a concentrator system (approx. 1 000 suns with Fresnel lens). The company works in partnership with Exosun.

Exosun designs, develops and produces traditional and concentrator photovoltaic power plants fitted with patented solar tracking systems. The ground-mounted power plant opened in Corsica in May 2012 is the largest photovoltaic power plant in France fitted with traditional modules on Exosun solar trackers.

Axiosun, a subsidiary of Sunpartner, develops and sells a ground-mounted, low-concentration photovoltaic system concept (12 suns) with a series of parabolic mirrors. Two projects were launched in Morocco in 2012.

### 3.3.3.4 *PV product recycling*

Photovoltaic modules are now included in the scope of European Directive 2012/19/EU on Waste electrical and electronic equipment (WEEE). Transposition into French law is scheduled for February 2014. In France, CERES (an association with around 100 members) has developed in partnership with Photocycle industries an innovative economic model covering the collection and recycling of photovoltaic products. Arena Technologies, which specialises in the processing and recycling of electronic grade silicon, has diversified into photovoltaic materials, while Recupyl is investigating possible module recycling solutions using its expertise in batteries and accumulators.

## 3.4 **Manufacturers and suppliers of other components**

### 3.4.1 *Photovoltaic industry equipment and machinery*

Around twenty companies manufacture silicon ingot, cell and module production machinery and equipment. Industrial materials (gas, glass, polymers, etc.) are supplied by a further twenty or so companies, some of which are leaders in their fields.

### 3.4.2 *Electrical and electronic equipment*

There are several large French companies that produce the full range of photovoltaic system connection, testing, measurement and monitoring hardware and equipment. There are also several French companies that develop and/or manufacture inverter ranges. These operate on both domestic and export markets.

### 3.4.3 *Structural components and BIPV products*

The SER directory lists around 50 companies that specialise in the production of structural components (building roof and facade components, ground structures, etc.).

The financial support offered to systems which include building-integrated photovoltaic components encourages companies to develop this type of component. Numerous companies manufacture building-integrated or simplified building-integrated products, on roof or roof-terrace. *Le Journal du photovoltaïque* (no. 6, Oct. 2011) described more than 70 building-integrated photovoltaic products.

Building-integrated photovoltaic products and processes are eligible to receive Technical assessment certificates (*ATec PV*) or *Pass'Innovation Vert* certificates from the CSTB (see 4.4.4).

## 3.5 **Other stakeholders**

### 3.5.1 *Installers*

There are numerous companies that install PV systems. The sector is extremely heterogeneous and it is estimated that about 80 % of the installers install only a couple of systems a year, whereas around a thousand install about 10 or 20 systems. There are no more than a few dozen large companies, and these are said to account for around one third of all installations (source: ADEME).

Installers can take advantage of quality labels like QUALIBAT, QUALIFELEC, QUALIPV, etc. issued by professional organizations (see 4.5.2.1).

### 3.5.2 *Developers and operators*

As well as generalists such as EDF and GDF SUEZ and their subsidiaries, there is a broad network of highly active, independent developers and operators of large roof installations and ground-mounted power plants. An indicative list of main developers with projects greater than 1 MW installed in 2012 is given in Table 6 (source: *Atlas Observ'er*).

**Table 6 – Main developers of large grid-connected systems in 2012**

Distributed applications (2012 projects > 1 MW)	Centralised ground-mounted (2012 projects > 1 MW)
AE3000, Altus Energy, Arkolia Énergies, Armorgreen, Briand Énergies, Coruscant, Fonroche Énergie, Hanau Énergies, JMB Énergie, JP Énergie, Neoen, Solairedirect, Solar Invest, Solvéo Énergie, Ténergie, Urbasolar, Valéco Ingénierie...	Delta Solar, EDF EN, Eneyo, La Compagnie du Vent, Langa solar, Luxel, Sidec, Solairedirect...

Source: Atlas Observ'er.

The activity of main developers and operators is described in *Le Journal du Photovoltaïque* No. 7 (April 2012, 338 actors in the French PV field).

### 3.6 Module prices

The average sale price of European-origin crystalline silicon photovoltaic modules is shown in Table 7. Excessive global production capacity, caused by substantial investment by Asian manufacturers, has led to falling prices. On the spot market, the *pvXchange* index showed a 27 % fall for German modules in 2012, and a 54 % drop over two years. The price of Asian-origin modules has fallen by 60 % over two years. This price drop has led to strong growth in the medium-power and high-power systems sector in France.

**Table 7 – Typical crystalline silicon module prices (EUR/W)**

2006	2007	2008	2009	2010	2011	2012
5,10	4,80	3,17	2,00	1,66	0,91	0,72

Sources: IEA PVPS NSR France up to 2010 and SER 2011, 2012, Autan Solaire.

### 3.7 System prices

The prices of photovoltaic systems (Tables 8a and 8b) have dropped significantly over the last few years. The installed price for building-integrated (BIPV) residential systems using European modules stood at around 8,4 EUR/W in 2007 and around 3,7 EUR/W in 2012.

The price stood at 2,82 EUR/W for a 9 kW system installed on a new building, and at 2,10 EUR/W for a system exceeding 36 kW.

The cost of simplified building-integrated systems (Simplified BIPVs) installed on commercial and industrial premises fell from 7,8 EUR/W in 2007 to 2,0 EUR/W in 2012, while the turnkey price for ground-mounted power plants fell by 75 % over the same period to 1,6 EUR/W (all prices indicated are exclusive of VAT).

**Table 8a – Turnkey prices of typical applications in 2012 (EUR/W)**

Category/Size	Typical applications	Current prices
Grid-connected less than 3 kW	Residential building-integrated system	3,7 EUR/W
Grid-connected 100 kW to 250 kW	Industrial, commercial agricultural large roof	2,0 EUR/W
Grid-connected ground-mounted > 2 MW	Centralised production, utility scale plant	1,6 EUR/W
Off-grid domestic 2 kW (with storage battery)	Principal residence	15 EUR/W

Sources: SER, Autan Solaire, FACE.

**Table 8b – Trends in system prices for three types of grid-connected systems (EUR/W)**

Application	2007	2008	2009	2010	2011	2012
Residential building-integrated	8,4	8,2	6,9	5,9	3,9	3,7
Large commercial roof	7,8	7,6	6,4	5,5	2,6	2,0
Centralised production	6,3	6,2	5,2	4,5	2,0	1,6

Sources: IEA PVPS NSR France up to 2010 and SER 2011, 2012, Autan Solaire.

**Case study:** 3 kW residential system: The typical maximum turnkey price for a 3 kW integrated photovoltaic roof system on a private home is 12 000 EUR (inc. VAT at 7 %). It costs round 1 000 EUR to connect the system to the grid, and this cost is normally included in the quoted price. The maximum tax credit entitlement is 1 056 EUR. Annual electricity purchase management fees are 162 EUR. A provision of 100 EUR per year is usually required to fund a new inverter after 10 years. Not all insurers apply an additional multi-risk home insurance premium for properties with such systems.

The annual income generated by a grid-connected system with Q1 2013 (prices including the 10 % increase for modules manufactured in the European Economic Area) would be 1 254 EUR in southern France (average annual production of 3 600 kWh) and 836 EUR in northern France (production of 2 400 kWh). The owner will cash his first revenues about 17 months after the official prior agreement of PV installation.

### 3.8 Employment and training

#### 3.8.1 Employment

In 2012, jobs created through investment stood at an estimated 16 400 (component manufacturing, research and installation). Down from 27 400 for 2011 (source: ADEME). The decrease in the number of jobs has mainly affected the installation sector. It is due to a fall in the number of low-power systems being installed (down 57 %). The number of jobs in energy production and maintenance is estimated at 1 600 in 2012.

#### 3.8.2 Training

Training is a key factor in the development of renewable energies and eco-construction. *Le Journal des énergies renouvelables* (March 2013) lists around 600 training courses in this field. Building companies are taking action to ensure compliance with the new thermal regulations (RT). Several new courses aimed specifically at architects or repair and maintenance technicians. INES-Éducation also contributes to training provision by offering 14 internships. Design offices Transénergie and Metrol also play a major role with specialist technical forums. Meanwhile, Tecsol, Autan Solaire, Evasol, etc. offer their own in-field experiences. Companies also organise training cycles specific to their products.

### 3.9 Photovoltaic production value

The annual production value of the French photovoltaic sector was an estimated 1,8 GEUR in 2012, down 29 % compared with 2011. Table 9 shows the changes in production values between 2007 and 2012 (source: ADEME).

**Table 9 – Value of annual photovoltaic production in France (MEUR)**

Value	2007	2008	2009	2010	2011	2012*
Sales value	301	794	1 785	5 851	3 839	2 385
Export of PV products	117	91	33	62	43	43
Import of PV products	169	216	566	2 311	1 414	666
Value of production	248	669	1 252	3 602	2 469	1 762



Source: ADEME, \*provisional.

## 4 FRAMEWORK FOR DEPLOYMENT

### 4.1 Support measures

A few aspects of the national policy which were not detailed in the previous paragraphs are described below.

#### 4.1.1 Feed-in tariffs

(also refer to 2.3.2)

Under the terms of the renewable energy support scheme set up by law, EDF OA (EDF Agence obligation d'achat) and local distribution companies (ELDs) must purchase the electricity produced from renewable energies at a feed-in tariff higher than the market price so that the renewable energy sector is able to continue its learning curve while offering investors normal profitability. The feed-in tariff is set by an official order, or is the outcome of a tender process.

The feed-in tariff policy is funded through the CSPE (see 4.1.2) paid by electricity consumers via their energy bills.

Key dates of the feed-in tariff support policy:

- 10 July 2006: order introducing attractive feed-in tariffs for photovoltaic electricity (following the creation of a 50 % tax credit for households on the price of equipment in 2004);
- 10 December 2010: three-month suspension of the compulsory purchase scheme for installations exceeding 3 kW (the measure did not affect residential installations below 3 kW);
- 4 March 2011: publication of an order indicating the new applicable feed-in tariffs. Introduction of a quarterly adjustment for installations on buildings up to 100 kW and creation of a tender process for PV installations over 100 kW. Volume capped at 500 MW per year (value of 2012 tariffs, Table 4a).
- 7 January 2013: as announced by the new government in October 2012, the pricing structure is simplified (Table 4b) and feed-in tariffs are increased by 5 % or 10 % for projects using photovoltaic modules manufactured in Europe. The annual volume is raised to 1 000 MW per year and new tender processes are introduced for systems above 100 kW.

#### 4.1.2 CSPE tax

Introduced by a French law in 2003, the *Contribution au service public de l'électricité* (CSPE, public electricity service contribution) is a tax set by the government. The rate of 10,50 EUR per MWh (July 2012) applies to the quantity of electricity consumed by domestic and industrial consumers. It is designed to compensate electricity operators for the higher costs incurred through their public utility obligations. These obligations include a requirement to provide all French citizens with electricity at the same cost (including in overseas departments), and reduced rates for low-income households. These additional costs are also incurred through support policies for cogeneration and renewable energies.

#### 4.1.3 Sustainable development tax credit

(see 2.5.1.3).

#### 4.1.4 Support from local authorities

(see 2.5.1.4 and 4.3).

#### **4.1.5 Other support**

##### *4.1.5.1 Competitiveness clusters*

There are three competitiveness clusters that operate in the photovoltaic sector: Tenerrdis in the Rhône-Alpes region, Derbi in the Languedoc-Roussillon region and Capenergie in the Provence – Alpes – Côte d'Azur region. The partners of each cluster receive funding from OSEO, ANR, ADEME and local authorities, according to the technical, economic and social features of the projects submitted.

##### *4.1.5.2 Professional organisations and associations*

Professional unions ENERPLAN, SER-SOLER, and associations such as ASDER, CLER and HESPUL as well as the PV user and producer's associations GPPEP and APESI are highly active in promoting the development of the photovoltaic sector. They deeply committed themselves to their cause during France's 2012 presidential campaign, and during preparations for the national debate on energy transition (see 4.1.6.3). Some of these organisations are involved in transnational projects, as part of the European Intelligent Energy Europe (IEE) programme: PV LEGAL (completed in February 2012) and the subsequent PV GRID project (to promote the integration of photovoltaic electricity into grid systems).

##### *4.1.5.3 Events*

Several events were held in 2012 to promote photovoltaic technology and applications. The 14<sup>th</sup> SER conference – held on 7 February 2012 and entitled "*Énergies renouvelables, énergies du siècle*" (Renewable energies, 21st century energies) – attracted government representatives, major energy company leaders, and managers from administrative bodies and the European Commission.

The *Salon des énergies renouvelables* trade show in Paris (3 to 5 April 2012) and the sixth edition of the ENERGAIA trade show in Montpellier (5 to 7 December 2012) included conference cycles and networking opportunities. The fifth edition of the *Journées européennes du solaire* (JES), organised by ENERPLAN and its partners (9 to 15 May 2012), was an opportunity for a wide audience to attend some 560 educational sessions across France.

#### **4.1.6 Indirect policy issues**

##### *4.1.6.1 Export and Mediterranean rim initiatives*

Operators such as the *Agence Française de Développement* (AFD - French development agency), Ubifrance and the Ministry of the Economy and Finance through its aid tools such as the FASEP (Private Sector Study and Support Fund) and the RPE (Emerging Country Fund) provide assistance to help French companies in the solar energy sector develop abroad.

The France Solar Industry mark, managed by SER, covers all manufacturers in the PV, CPV and thermodynamic solar sectors. The aim is to provide French companies and SMEs in particular, with sufficient exposure to penetrate international markets. This initiative led to the successful construction of a vertically integrated photovoltaic factory in Kazakhstan. The factory, which opened in 2012, was built with expertise from French equipment manufacturers.

There are several initiatives in place to promote a new cooperation and development policy across the Mediterranean region. One of the Union for the Mediterranean's (UfM) current projects is the Mediterranean Solar Plan (MSP), which aims to achieve total installed power output of 20 GW by 2020. The IMEDER institute is an umbrella organisation covering professional organisations on both sides of the Mediterranean. A range of events, such as conferences and trade shows, have been organised in France, Morocco and Tunisia under its authority.

#### 4.1.6.2 Thermal regulations

The RT 2012 thermal regulation sets the maximum permitted primary energy consumption level for new buildings at 50 kWh/m<sup>2</sup> per year. This regulation offers new growth opportunities for France's solar power sector (Figure 2 shows an example of a low-energy building constructed in accordance with RT 2012). Furthermore, this regulation is an intermediate step towards a future regulation (RT 2020, the so-called BEPOS positive-energy buildings), under which new buildings will be required to become net producers of energy.



**Figure 2 – Low-energy building in Paris' 17<sup>th</sup> arrondissement. 96 kW BIPV designed and installed by Sunvie.**

#### 4.1.6.3 Energy transition

The government has revealed plans for a major national debate on energy transition, starting in 2013. Energy transition involves the switch from a society based on abundant fossil fuel consumption, to one that is more restrained and environmentally minded. The topics on the agenda include energy sobriety, the optimisation of production systems, and the increased use of renewable energies. Photovoltaic solar energy will play a role in this debate. Following consultation with stakeholders and the general public, a draft bill will be submitted to Parliament in October/November 2013.

#### 4.1.6.4 French and German cooperation

The purpose of the *Office franco-allemand pour les énergies renouvelables* (Franco-German renewable energies office) is to share experiences and knowledge between the two countries and remove barriers to growth of the renewable energies sector. A communication platform has been put in place for stakeholder networking purposes. One of the latest topics under consideration was the role of solar photovoltaic systems in the construction industry.

## 4.2 Interest from electricity utility companies

In France, the main electricity utility companies EDF and GDF SUEZ along with their subsidiaries are involved in the development of photovoltaics. More recently smaller highly motivated companies have also been created to develop and operate renewable energy power plants (see 3.5.2 and Table 6).

### 4.2.1 EDF group

EDF EN (EDF Énergies Nouvelles) is an EDF subsidiary created in 1990. EDF EN develops, builds and operates renewable energy power plants in Europe and North America. At the end of 2012, the company owned photovoltaic power plants in France totalling 447 MW. Major facilities commissioned in 2012 include Europe's largest ground-mounted PV power plant in Toul-Rosières, Lorraine region (115 MW), the Crucey power plant in the Centre region (60 MW) and the Massangis power plant in Burgundy (56 MW). These three local projects use cadmium telluride thin-film modules.

EDF ENR (EDF Énergies nouvelles réparties) is an EDF subsidiary created in 2007. Along with its two subsidiaries EDF ENR Solaire and EDF ENR PWT (Photowatt), EDF ENR is the only French company present along the entire solar photovoltaic value chain: EDF ENR participates in several public/private R&D consortia.

- EDF ENR Solaire offers PV systems for all types of domestic roofs (11 600 installations at end 2012), as well as for agricultural, industrial and local authority buildings. It also provides supervision and maintenance services;
- EDF ENR PWT (Photowatt) manufactures crystalline silicon ingots, wafers, cells and modules. In March 2012, EDF ENR finalized the takeover of Photowatt (also refer to 3.1.1 and 3.3.1).

#### **4.2.2 GDF SUEZ group**

The company operates as a systems integrator, turnkey project developer for private individuals and institutional investors, or PV power plant developer/operator. It has several subsidiaries, La Compagnie du Vent, La Compagnie Nationale du Rhône-CN'Air, Ineo, which, together, have installed 41 MW in France (five power plants, including one of 26 MW). The Porette power plant in Corsica (3,8 MW), commissioned in 2012, is the only power plant mounted on single-axis solar trackers.

### **4.3 Interest from local authorities**

The regional climate and energy plans (SRCAE) prepared by the Regions in 2012 defined the paths of development with more than 13 GW of PV installations in 2020.

The Languedoc-Roussillon region has launched an investment fund with three partner banks to grant loans at preferential rates. The Poitou-Charentes region has introduced a regional "green energy" microcredit system with 0 % loans. These loans are granted to individuals for a term of 6 to 60 months, with the region paying the interest. The region has also joined forces with Solairedirect Company to found Ester (*Électricité solaire des territoires*), an innovative semi-public company. The Midi-Pyrénées region provides subsidies of up to 20 % for energy-efficient new-build projects or existing buildings. The Aquitaine region has launched a tender process for self-consumption photovoltaic projects on both new and existing public and private buildings. This process forms part of a wide-ranging energy efficiency strategy and makes no distinction in terms of building integration method.

Photovoltaic generators are regularly installed on the roofs of communal public buildings. Such systems are often funded through loans, avoiding the need for subsidies. The installation of ground-mounted photovoltaic power plants on brownfield sites such as waste burial areas is a commendable application, highly valued by some local stakeholders.

The *Fédération nationale des collectivités concédantes et régies* (FNCCR - national federation of licensor and direct control local authorities) includes around 70 energy associations, all of which are highly active in the renewable energies field. A total of 13 MW of photovoltaic projects have emerged from this organisation. The federation has remarked that the national tender process encourages a tendency towards high-power, centralised projects, which are beyond the investment capabilities of local authorities, and which can only be conducted by major companies. As such, this arrangement penalises local SMEs and SMLs. Local authorities and photovoltaic sector professional associations have brought this issue to the attention of the public authorities.

### **4.4 Standards and codes**

#### **4.4.1 Photovoltaic standards**

France does not develop its own photovoltaic standards but adopts those prepared either by the international organisation IEC or by the European organisation CENELEC.

French AFNOR-UTE is responsible for the mandatory translation of these Standards into French. For example, a well-known Standard such as IEC 61215 for photovoltaic modules has been transposed to Standard NF EN 61215. Tender documents may refer to either IEC or NF EN Standards.

AFNOR-UTE's UF 82 French photovoltaic commission is the equivalent of the IEC/TC 82 and CENELEC/TC 82 commissions. This commission, with its 27 experts, is involved in drafting comments and voting on draft Standards.

The following international Standards were translated into French and published in 2012: NF EN 60904-8 Ed. 3 « *Dispositifs photovoltaïques – Partie 8 : Mesure de la réponse spectrale d'un dispositif photovoltaïque (PV)* » ; NF EN 62548 Ed. 1 « *Exigences de conception pour les groupes photovoltaïques (PV)* » ; NF EN 61701 Ed. 1 « *Essai de corrosion au brouillard salin des modules photovoltaïques (PV)* » ; NF EN 62109-2 « *Sécurité des convertisseurs de puissance utilisés dans les systèmes photovoltaïques – Partie 2 : Exigences particulières pour les onduleurs* » ; NF EN 50521/A1 « *Connecteurs pour systèmes photovoltaïques – Exigences de sécurité et essais* ».

In 2012, four French translations were delivered to international organisations: EN 50530 : 2010/prA1 « *Efficacité globale des onduleurs photovoltaïques raccordés au réseau* » ; EN 50548 : 2011/prA1 « *Boîtes de jonction pour modules photovoltaïques* » ; CEI 62716 Ed.1 « *Essai de corrosion à l'ammoniac de modules photovoltaïques (PV)* » ; CEI 61730-1 am2 Ed.1 « *Qualification pour la sûreté de fonctionnement des modules photovoltaïques (PV) – Partie 1 : Exigences pour la construction* ».

Note that Technical Specifications (TS) do not have to be translated into French. Nevertheless, considering the importance of the IEC TS 62257 series, Part 1 Ed. 2 "General introduction to rural electrification" has now been translated into French. We emphasize the important involvement of EDF and ADEME for the development and promotion of this Technical Specification.

#### **4.4.2 Installation certificate of conformity**

All electricity production installations up to 250 kVA and external electrical installations connected to the public grid require a certificate signed by the Consuel (French committee for the safety of electricity users), testifying that they comply with safety recommendations.

Low-voltage photovoltaic systems must comply with the recommendations of the UTE C 15-712-1 practical guide entitled "*Installations photovoltaïques raccordées au réseau public de distribution*" (photovoltaic installations connected to the public power grid). This document complements general standard NF C 15-100 concerning low-voltage electrical systems.

#### **4.4.3 Ten-year guarantee**

The ten-year guarantee is mandatory for all building trades. The guarantee provided by the photovoltaic installer covers the repair of the roof in the event of a leak.

#### **4.4.4 Technical approvals**

In 2008, the *Centre scientifique et technique du bâtiment* (CSTB - French scientific and technical centre for building) set up an evaluation procedure to ensure that the photovoltaic products and processes used on a building pose minimal accident risk and are covered by basic insurance contracts.

Photovoltaic technical approvals (*ATec PV*) are renewable, modifiable and public. They are valid for a maximum of 3 years.

The CSTB's *Pass'Innovation Vert* is an optional step before starting the technical approval procedure. It consists of a simplified evaluation obtained within a short period of time. It is valid for a maximum of 2 years, allowing time to collect the necessary documents and acquire sufficient feedback to issue a technical approval. As of the end of 2012, 25 photovoltaic products and processes had been awarded an *ATec PV* and around 80 a *Pass'Innovation Vert*.

## 4.5 Qualification and quality label

### 4.5.1 Tests and certification

CERTISOLIS TC, a subsidiary of LNE and CSTB, is the photovoltaic module performance testing and certification laboratory. In 2012, two years after its creation, the laboratory received COFRAC accreditation, demonstrating that it meets international standards in the field. Certisolis accreditation confirms that the PV modules comply with standard NF EN 61215 (crystalline silicon) or NF EN 61646 (thin film), and with Class II of standard NF EN 61140 or NF EN 61730 for electrical safety.

The tested modules bear the CERTISOLIS MPV mark, which not only guarantees their conformity with applicable standards, but also indicates that they undergo an annual quality audit for design and manufacture.

Since the release of the order of 7 January 2013, which raised the electricity feed-in tariffs by 5 % or 10 %, CERTISOLIS and other organisations have conducted audits to confirm that crystalline silicon ingots/wafers/cells or crystalline silicon cells or photovoltaic modules (both c-Si and thin-film) are manufactured within the European Economic Area.

### 4.5.2 Quality marks and labels

#### 4.5.2.1 Quality marks

The companies in the construction and energy sectors can take advantage of certifications such as QUALIBAT (EE/ENR), QUALIFELEC (SPV), QUALIPV (Elec., Bât.), etc. These qualifications issued by professional organisations recognize the ability of firms to make photovoltaic services entrusted (see also 4.5.2.3).

#### 4.5.2.2 AQPV

The *Alliance Qualité Photovoltaïque* (AQPV – photovoltaic quality alliance) is a mark managed by the *Syndicat des énergies renouvelables* (SER – Renewable energies union). The *AQPV-modules* mark is designed to promote the development of photovoltaic modules manufactured in France, with quality requirements that are stricter than applicable standards. Modules from other sources containing PV cells manufactured in France are also eligible. The Mark indicates whether the PV modules have the feed-in tariff increase "Made in EEA" of 5 % or 10 %. The Mark "*AQPV-Contractant général*" (General Contractor) is dedicated to companies in the field of design, installation, and operation/maintenance of PV systems on buildings.

#### 4.5.2.3 "Reconnu Grenelle Environnement" label

ADEME decided that it wanted to provide guidance to private consumers to help them identify the various quality labels applicable to companies and products. Working with the Ministry for Ecology and its partners (FFB, CAPEB, Qualibat, Qualit'ENR, and Qualifelec), a charter was drawn up. This charter sets out the requirements to be met. Therefore all qualifications and quality marks concerned will bear the label "Reconnu Grenelle Environnement" (*Recognised by Grenelle Environment*). Consumers will therefore find it easier to identify companies with the necessary professional skills to conduct energy efficiency and renewable energies work.

## 5 HIGHLIGHTS AND PROSPECTS

The French public authorities have decided to develop a photovoltaic sector focusing on building-integrated applications, by setting six years ago a more attractive feed-in tariff for such applications. The tariff depends on the degree of integration of the photovoltaic modules, as well as on the power of the installation. The support scheme for systems above 100 kW involves a tender process.

These incentives have created favourable conditions for sustained development of grid-connected applications. At the end of 2012, the cumulative total power output of all grid-connected photovoltaic systems in France stood at 4 GW with more than 281 000 PV systems installed. This represents a total power increase of 37% compared with 2011.

The French photovoltaic component industry faced stiff international competition in 2012. Some projects to increase production capacity or develop new cell and module production lines were put on hold. France's photovoltaic manufacturing pioneers underwent restructuring schemes and small installation companies were the worst affected. Nevertheless, the industrial value chain has, on the whole, remained relatively unscathed, allowing a broad network of active, independent developers and operators of large roof installations and ground-mounted power plants to gain strength.

The new government has acknowledged that recurring pricing and regulatory changes caused some difficulties in the wind power and photovoltaic sectors. As such, it launched a range of new measures to boost the photovoltaic sector in late 2012 and early January 2013, including doubling the target volume to 1 000 MW per year, simplifying the feed-in tariff schedule, launching new tender processes and increasing feed-in tariffs by up to 10 % for systems using photovoltaic modules manufactured in the European Economic Area. According to the Ministry for Ecology, these measures should generate more than 2 billion EUR of investment, secure existing positions and create new jobs (approximately 10 000 in total).

France's national debate on energy transition, launched in Q4 2012, should lead to the publication of a draft bill in October 2013. The industry is keen to see a bill that supports the French photovoltaic sector.

Regions will play an important role in the development of photovoltaics. Their regional climate and energy plans (SRCAE) defined in 2012 suggested more than 13 GW of PV installations by 2020. The industry set the target of 20 GW of installed capacity by that time. ADEME has conducted an outlook study to assess the growth potential of the photovoltaic sector, with estimated capacity of 33 GW by 2030 under reasonable technical and economic conditions.

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## Annex A Country information 2012

This informative annex gives the reader some background about the French national environment in which photovoltaics is deployed. The readers should do their own research if they require data that are more detailed.

### 1) Retail electricity prices

In 2012 average price for consumer is 0,141 EUR/kWh (VAT included), for industry 0,097 EUR/kWh.

### 2) Typical household electricity consumption

Typical household electricity consumption: 3 000 kWh per year (not including heating and domestic hot water).

NOTE - In France, the building sector represents an energy consumption of 43 % of final consumption and nearly 20 % of CO<sub>2</sub> emission. The average annual consumption of primary energy in the building sector is around 400 kWh/m<sup>2</sup> per year. To meet its commitments "Factor 4" and as part of the "Grenelle Environment", Parliament has set two objectives for this sector:

- 2012 (Réglementation thermique RT 2012, BBC) new buildings should not consume more than 50 kWh/m<sup>2</sup> of primary energy per year.

- From 2020 (RT 2020, said BEPOS) new buildings should produce more energy than they consume.

These two objectives can be achieved with the use of renewable energy especially building integrated PV systems which will play a major role.

### 3) Typical metering arrangements and tariff structures for electricity customers

The electricity bill paid by the consumer is the sum of: a) cost of producing electricity (40 %), b) costs of delivering electricity through transmission and distribution (calculated by CRE, 33 %), c) local taxes (TLE, 7 %), and routing (CTA, 2 %), d) public electricity service contribution (CSPE, 4 %), and e) VAT (14 %).

The regulated tariffs (TRV) are proposed to CRE by Ministry of Energy. The TRV offer different categories, tariff options or versions. Category Blue, Yellow or Green depends on the power subscribed. Residential customers choose a contract power (from 3 to 36 kVA) and an option. The tariff option allows consumers to optimize their electricity bills based on their ability to shift some of their consumption away from peak hours. In consideration for this virtuous behaviour, the consumer benefits from lower bills adapted to this behaviour. Option 'base', option 'off-peak-peak hours' and options 'EJP' and 'Tempo'.

### 4) Typical household income

Income for household paying income tax: 32 000 EUR per year; not paying income tax: 9 000 EUR per year; all households: 21 500 EUR per year (source: france-inflation.com)

### 5) Typical mortgage interest rate

Fixed mortgage rate by end 2012: loan for 10 years: 3,4 % to 4,3 %, loan for 20 years: 3,9 % to 4,8%.

### 6) Voltage (household, typical electricity distribution network)

230 V, 50 Hz

### 7) Electricity industry structure and ownership

The electricity market in France is organised around four major areas: a) production: three main players, EDF, Endesa France and CNR. They provide more than 95 % of electricity production in France, 90 % being provided by EDF mainly nuclear (85 % of EDF's output is nuclear). This segment of the electric sector is fully open to competition; b) transportation: RTE is the public organisation in charge of transport infrastructure (management, construction, maintenance); c) distribution: actors are EDF and local distribution companies (ELDs). The Energy Regulation Commission (CRE) regulates both the transportation and distribution; d) marketing: financial activities such brokerage and trading on the OTC market or on the power exchange (Pownext).

### 8) Price of diesel fuel

1,40 EUR per litre (motor vehicles).

### 9) Typical values of kWh/kW for PV systems in parts of France

A PV system delivers an average annual electrical energy of 800 to 1 000 kWh/kW in Alsace Region, 1 200 to 1 400 kWh/kW in Provence – Alpes – Côte d'Azur Region and an average of 1 450 kWh/kW per year in Overseas departments (DOM).

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