

**International Energy Agency**

**COOPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS**

**Task 1**

**Exchange and dissemination of information on photovoltaic power systems**

**Solar Photovoltaic Electricity Applications  
in France  
National Survey Report 2008**

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## Foreword

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 23 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 nineteen participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), The United Kingdom (GBR) and The United States of America (USA). The European Commission is also a member. The European Industry Association (EPIA) is an associated partner.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (tasks) is the responsibility of Operating Agents. Eleven tasks have been established, and currently six are active including a new task concerning environmental impact. Information about these tasks can be found on the public website [www.iea-pvps.org](http://www.iea-pvps.org).

## Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme (PVPS) is to facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

An important deliverable of Task 1 is the annual ***Trends in photovoltaic applications*** report. This report presents information on trends in photovoltaic power applications in the PVPS participating countries and other countries and is largely based on the information provided in the **National Survey Reports** which are produced annually by each Task 1 participant. The public photovoltaic website also plays an important role in disseminating information arising from the programme, including national information.

The 2008 national survey report for France presented here is prepared by Mr Yvonnick Durand, from ADEME (Agence de l'environnement et de la maîtrise de l'énergie) ([www.ademe.fr](http://www.ademe.fr)), IEA/PVPS/Task 1 participant and includes contributions from Mr Philippe Jacquin, consultant ([www.phkconsultants.com](http://www.phkconsultants.com)).

## Definitions, symbols and abbreviations

For the purposes of the report, the following definitions and symbols apply:

PV: abbreviation of photovoltaic (adj.) or photovoltaics (noun).

BIPV: building integrated photovoltaic(s)

STC: standard test conditions (irradiance of 1 000 W/m<sup>2</sup>, cell junction temperature of 25 °C, AM 1,5 solar spectrum).

EUR: euro currency unit (ISO code). MEUR means million euro (10<sup>6</sup> EUR).

Photovoltaic (PV) system market: the market for all nationally installed (terrestrial) photovoltaic applications with a photovoltaic power capacity of 40 W or more.

Installed photovoltaic (PV) power: power delivered by a photovoltaic array under standard test conditions (STC). Also see 'Rated power'.

Rated power: available power delivered by a photovoltaic module, a photovoltaic panel or a photovoltaic array under standard test conditions (STC). Unit written as W (multiple: kW, kilowatt, MW, megawatt).

Photovoltaic (PV) system: set of interconnected elements such as photovoltaic modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a rated photovoltaic power of 40 W or more.

Module manufacturer: a company which produces PV modules via PV cells encapsulation.

Off-grid domestic photovoltaic system: system installed to provide power mainly to a household or village not connected to the (main) utility electricity grid(s). Is often connected to an electricity storage device (most commonly lead-acid batteries). Also referred to as 'stand-alone photovoltaic power system'. Can also provide power to domestic and community users (and for other applications) via a 'mini-grid', often in association with another source of power (hybrid system).

Off-grid non-domestic photovoltaic 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. Is often connected to an electricity storage device. Also referred to as 'stand-alone photovoltaic system'.

Grid-connected distributed photovoltaic system: system installed to provide electricity to a grid-connected customer or directly to the electricity network (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be either integrated or on the roof of the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed to support the utility distribution grid. Size is not a determining feature – while a 1 MW photovoltaic system on a rooftop may be large by photovoltaic standards, this is not the case for other forms of distributed generation.

Grid-connected centralized photovoltaic power system: power production system performing the function of a centralized power plant. The power supplied by such a system is not associated with a particular electricity consumer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. They are normally installed at ground level and function independently of any nearby development.

Turnkey price: price of an installed photovoltaic system excluding VAT sales taxes, operation and maintenance costs but including installation costs. For an off-grid photovoltaic system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for reasons not directly related to the photovoltaic system, these should be excluded. (e.g. if extra costs are incurred fitting photovoltaic modules on a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. The additional transport costs of installing a telecommunication system in a remote area are also excluded).

Field test programme: a programme to test the performance of photovoltaic systems/components in real conditions.

Demonstration programme: a programme to demonstrate photovoltaic systems and their application for potential users/owners.

Market deployment initiative: set of measures to encourage the market deployment of photovoltaics using market instruments such as green pricing, rate based incentives, feed-in tariffs, tax credits, etc. These may be implemented by government, the finance industry, utilities, etc.

Final annual yield: total photovoltaic energy delivered (kWh) during the year per unit (kW) of rated (STC) power.

Performance ratio: ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per unit (kW) of rated (STC) power.

NOTE – The currency unit used throughout the report is the euro (EUR). Other units are euro per watt (EUR/W), euro per kWh (EUR/kWh), kilowatt-hour per unit (kWh/kW) of installed photovoltaic power (kW).

# 1 Executive summary

## • Overview

According to a report by the French Renewable Energy Syndicate (SER), France had an installed photovoltaic fleet of 180 MW in late 2008, a substantial increase from 2007 (75 MW). This growth is largely due to the government's market-supporting policy that implemented a tax and tariff policy which encourages individuals to invest in so-called "building integrated" systems; the goal of this policy is to bring together innovation in the building industry and the development of renewable energy among the French energy mix.

The key event for the future of renewable energy and the photovoltaic sector in France was the "Grenelle of the Environment". This government initiative, launched in late 2007, became the subject of public debate and afterwards led to a bill which set the conditions under which France wishes to grow solar power's share of its energy mix. Working committees that bring together representatives from government authorities and industrial and public renewable energy stakeholders have proposed benchmarks. A few proposals with particular significance for photovoltaic power have been adopted by the government:

- objectives for PV cumulative installed capacity in France of 1 100 MW in 2012 and 5 400 MW in 2020;
- confirmation until 2012 of the current feed-in tariffs and the creation of an additional one targeting installations on large buildings such as commercial and industrial sheds. This tariff shall be set approximately at 0,45 EUR per kWh;
- a call for tenders for the construction by 2011 of at least one solar photovoltaic power plant in each French region, for a total installed capacity of 300 MW.

The nationally initiated actions for growing the market are heavily relayed by public assistance to regional councils, general councils, communities of communes and communes themselves, in accordance with their own particular specifications.

The incentive to purchase electricity produced by built-in installations has caused a growth in the so-called "eligible" products on the market. The availability of an increasing number of technical solutions on the market enables builders, architects and promoters to offer their clients new options for incorporating photovoltaics into their structures.

The development of the market has attracted new stakeholders at all stages of the photovoltaic supply line, and many companies have been created to study, engineer, install, provide and operate such systems. Investors are taking part in large-scale projects, such as the construction of major multi-megawatt ground power plants. New activities and actors are appearing, such as in the field of funding specifically for photovoltaic projects, leasing rooftops for installing systems and surveying ground for building power plants on.

The industrial sector has been strengthened with the ambition to be able to vertically integrate the photovoltaic supply chain, from the production of silicon to the operation of electrical power production systems.

This development creates jobs. According to the SER's member companies (which represent 80% of the market), photovoltaic activity has generated about 1,500 direct jobs in 2008, and the total estimated jobs for supply chain is about 4,000, or three times what it was in 2004, representing 70% growth over 2007.

A new consortium that has brought together private companies and public bodies, known as the "PV Alliance Lab Fab" was established, and a major R&D project known as "Solar Nano Crystal" began in late 2008. Research programs concentrate efforts to improve the conversion efficiency of cells and modules, as well as their life span. A major effort has been undertaken to reduce production costs, engineer new photovoltaic materials, prevent environmental impacts, and manage systems.

ADEME (the French Environment and Energy Management Agency) as well as ANR (the National Research Agency [www.agence-nationale-recherche.fr](http://www.agence-nationale-recherche.fr)), OSEO (Organization for Funding Companies for Creation, Innovation, and Development Projects - [www.oseo.fr](http://www.oseo.fr)) and the regional councils are continuing their support for research activities in the field of PV.

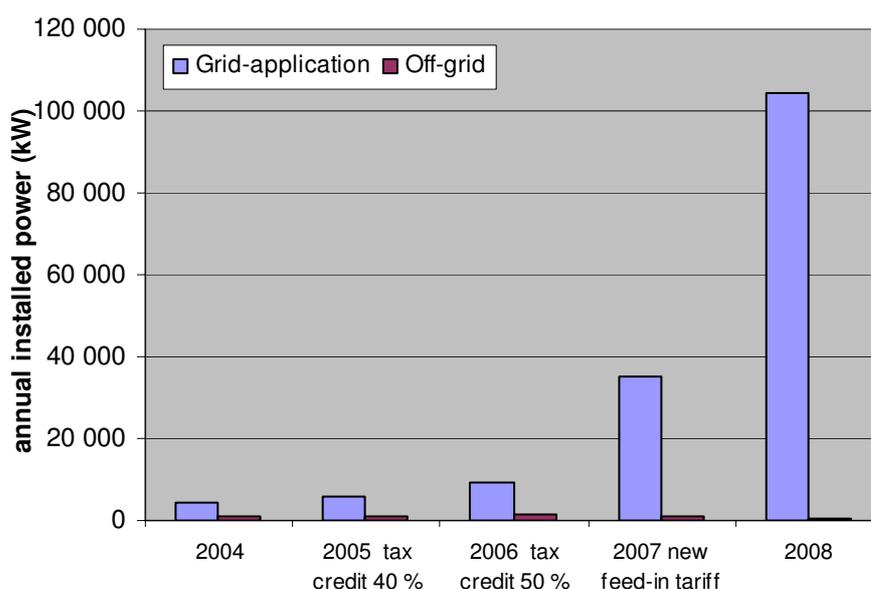
• **Installed photovoltaic power**

Over the course of the year, ~75 MW were installed in Metropolitan France and ~30 MW in overseas departments and territories, for a total of ~105 MW, which represents three times the volume of the installations realized in 2007 (35MW).

80% of the systems installed in 2008 (i.e. ~80 MW) are installations for individuals who benefit from the mandatory feed-in tariff and the tax credit.

Given the time delay between installation periods and connection dates, ERDF and EDF SEI estimated the power of the entire French photovoltaic fleet connected to the grid at the end of 2008 as being 68,8 MW. Thus a power of 36,2 MW is waiting to be connected to the grid at the end of 2008.

For the year in total, the connected French photovoltaic fleet represented about 70 GWh of electrical power. The impact of tariff- and tax-based incentives is shown clearly in Figure 1.



**Figure 1 - Photovoltaic power installed annually in France<sup>1</sup> (2004-2008)**

<sup>1</sup> Includes Metropolitan France, Corsica and the four overseas departments: Guadeloupe, French Guiana, Martinique and Réunion.

## • Costs and prices

According to a survey of about 100 professional installers ([www.outilssolaires.com](http://www.outilssolaires.com)) the average turnkey prices 2008 for small systems installed on rooftops dropped by about 3 to 4% from the prices charged in 2006.

It should be noted that for building integrated systems, the total cost must be calculated for all of the integrated functions, not only the photovoltaic portion, which makes it more delicate to compare one system to another.

Grid-connected systems whose power is greater than 10 kW are realized for a turnkey price that varies from 5,20 to 7 EUR per watt, not including taxes, 80% of which are from a "building integrated" system.

With respect to the multicrystalline silicon modules, the sales price for bulk quantities may be negotiated at the industrial level at prices of about 3,20 EUR per watt, not including taxes.

## • Cell and Module Production

In 2008, companies with a production unit located in France totaled 61,2 MW of cell production capacity, and 160 MW of crystalline module production capacity (source: SER).

Photowatt International produces ingots, wafers, cells, and modules. 2008 module production is 55 MW (SER survey). Its annual capacity is of 60 MW of cells and 60 MW of modules.

Tenesol produces 55 MW of modules and has an installed capacity of 70 MW.

EMIX produces multicrystalline silicon ingots from the cold crucible electromagnetic casting technology (with an annual installed capacity of 360 tons). Its 2008 production is 80 tons.

Other companies (Sunland 21, Unit-E, Sillia Energie, Fonroche Energie) have joined the group of historic French producers, and the SER estimates total 2008 production of crystalline modules at 109,5 MW.

Free Energy produces amorphous silicon modules on glass substrates (0,7 MW in 2008, for an annual installed capacity of 1,2 MW).

## • Public R&D Financing

For the year 2008, the R&D project which drew the attention of government agencies was Solar Nano Crystal (2008-2012). Financed by OSEO and ADEME, this project consists of implementing a production prototype (Lab-Fab) for crystalline silicon photovoltaic cells. This prototype will test the technical innovations derived from public research laboratories. The general goal is to decrease production costs, increase photovoltaic conversion efficiency, and reduce the environmental impacts of production processes. The work strategies are:

- Direct production of solar photovoltaic-quality silicon;
- Significant increase of cells and modules efficiency;
- Direct experimentation of research results in a pilot cell production unit.

The project coordinator is the PV-ALLIANCE consortium (Photowatt, EDF EN and CEA-Innovation) in association with silicon-specializing companies such as EMIX, SILPRO, PHOTOSIL and APOLLON SOLAR, and the National Solar Energy Institute (INES).

Furthermore, as part of the 2008 "HABISOL" call for projects (ANR's "Intelligent Homes and Photovoltaic/Solar Energy" program), new R&D projects have been adopted for the following themes:

- Methods for managing energy in the home;
- Energy efficiency and increasing the use of renewable energy in buildings;
- Developing photovoltaics in order to make its usage in buildings widespread.

These projects complement the 30-odd R&D projects currently underway which have been supported by ANR and ADEME since 2005.

The National Solar Energy Institute (INES), created in 2006 at the initiative of government agencies with teams from the CEA, CNRS, the University of Savoie and CSTB, is now France's cornerstone of excellence in solar power research on both the national and international levels. It contributes to the development of industrial innovation in France for the usage of solar power, particularly for the purpose of energy efficiency in buildings.

Three national competitive clusters instituted in 2005 (Derbi, Capénergies, Tenerrdis) now include more than 40 research centers, 30 training centers, and 150 companies based around solar power issues, in connection with energy efficiency and buildings.

Also noteworthy are other public R&D reorganization initiatives in the field, within institutes such as IRDEP (Chatou), INESS (Strasbourg), INL (Lyon) and TECSEN (Marseille).

### • Incentives

Since the implementation of the decree of July 10, 2006, the feed-in tariff for electrical power produced by a photovoltaic generator is as mentioned in Table 1 (2008 and updated 2009 forecast).

**Table 1 – Electrical power feed-in tariff in 2008 (EUR/kWh)**

<b>Tariff</b>	<b>Metropolitan France</b>	<b>Departments Overseas and Corsica</b>
Base tariff (PV installed)	<b>0,31193</b>	<b>0,41591</b>
Building incorporation bonus	<b>0,25594</b>	<b>0,15596</b>
Tariff with bonus included (PV integrated)	<b>0,57187</b>	<b>0,57187</b>

Source: EDF-Obligation d'achat

As a result of the "Grenelle of the Environment" in November 2008, the 0.57 EUR/kWh feed-in tariff shall be reserved for individuals. A new tariff of around 0.45 EUR/kWh will be created: it shall be reserved for integrated projects, with no size limitations. The definition of integration shall be discussed with trade professionals.

Purchasing contracts are set for a period of 20 years and are updated annually, partially indexed to inflation. They express the volunteer policy adopted by the government and ADEME to promote photovoltaics as an active component of building.

The financial act passed in December 2008 specifies that the proceeds from the sale of PV generated electricity will now be exempt from taxation through income tax when the associated system does not exceed 3 kW.

Other measures completed this incentive program:

- An income tax credit equal to 50% of the amount invested in supplies for photovoltaic systems, capped at 8 000 EUR per taxpayer (16 000 EUR for a couple);
- For off-grid systems, the ADEME-FACE contracts have been maintained.

The Regional Councils also offer additional aid for funding systems (see section 2.5).

ADEME also offers financial aid for demonstration operations implementing innovative technologies.

• **Outlook**

The growth of the French market is very strong. The feed-in tariff instituted in 2006, the bonus for building integrated systems, and the creation of the "sustainable development" tax credit were decisive elements. These incentives had many positive effects on the dynamic growth of the market, in particular:

- an increased number of applications for individuals;
- more diverse types of applications (first ground solar power plants);
- the structuring of industrial and commercial offerings;
- the development of technological R&D innovations for new products;
- the creation of qualified jobs.

The French industrial sector is undergoing a total change, with the involvement of major French energy stakeholders (EDF, Total, GDF-SUEZ, CEA, etc.).

With the initiative of the "Grenelle of the Environment". the French government has provided support to the development of the industry, relayed by specific regional initiatives.

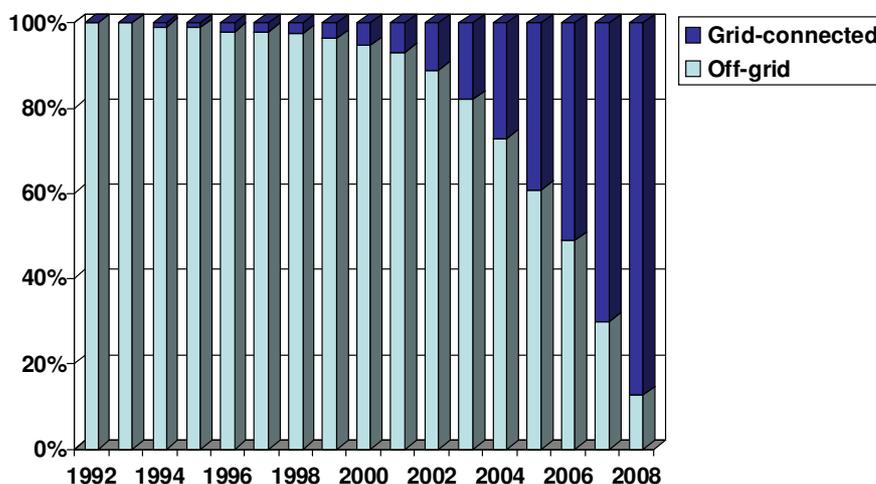
Industry players reacted favorably to strategies undertaken, and believe that the goal of attaining 5 400 MW of installed capacity by 2020 is achievable.

## 2 Implementation of Photovoltaic Systems

### 2.1 Applications for photovoltaics

About a decade ago, the development of photovoltaic systems was closely linked to electrification projects for rural areas and off-grid sites. These facilities now represent less than 10% of the installed fleet as shown in

Figure 2:



## Figure 2: Shares of grid-connected and off-grid PV power installed in France

Grid connection applications form a substantial majority, both in Metropolitan France and in Corsica and overseas departments (DOM). The major applications are rooftop systems for individual homes (~3 kW) as well as systems that produce a few tens of kilowatts for office or commercial buildings. Applications on the roofs of farm buildings are also developing, spurred by individuals or professional organizations. The share of building integrated systems installed in 2008 is a majority, about 80%, taking into account the preferential rate granted to this sort of system.

Within a year, the average power of installations connected to the grid has changed little in France's western regions and in Rhône Alpes/Bourgogne (going from ~3 to ~4 kW), whereas in regions close to the Mediterranean, the average connected power went from ~3kW to ~8 kW, indicating the appearance of the first power plants in the southern part of the country. Indeed, one of the key events of the year was the implementation of major photovoltaic investments made for the purpose of creating an "industrial" electricity production activity. By the end of 2008, 8 PV plants with power greater than 500 kW were operational across Metropolitan France and the overseas departments.

## 2.2 Total photovoltaic power installed

The power installed during the year 2008 was 105 MW, 75 MW was in Metropolitan France and 30 MW in overseas departments and territories, three times that of the previous year. The total capacity installed at the end of 2008 is estimated at 180 MW.

The average power of these facilities is 4,5 kW in Metropolitan France, and 17 kW overseas and in Corsica. During the last quarter of 2008, four plants with power greater than 500 kW were connected to Metropolitan France's grid, bringing their total number to eight.

Given the delay observed between the power being installed and being connected to the grid, the operational installed power (i.e., connected by the end of 2008) is 68,8 MW according to information relayed by the Solar Industry Association ENERPLAN.

In a single year, the production of the connected French photovoltaic fleet represents about 70 GWh of electricity. According to the SER, this is the equivalent yearly energy consumption of about 31 000 people, all consumption uses included.

Table 2 and

Table 3 depict the change in installed annual capacity over the past six years.

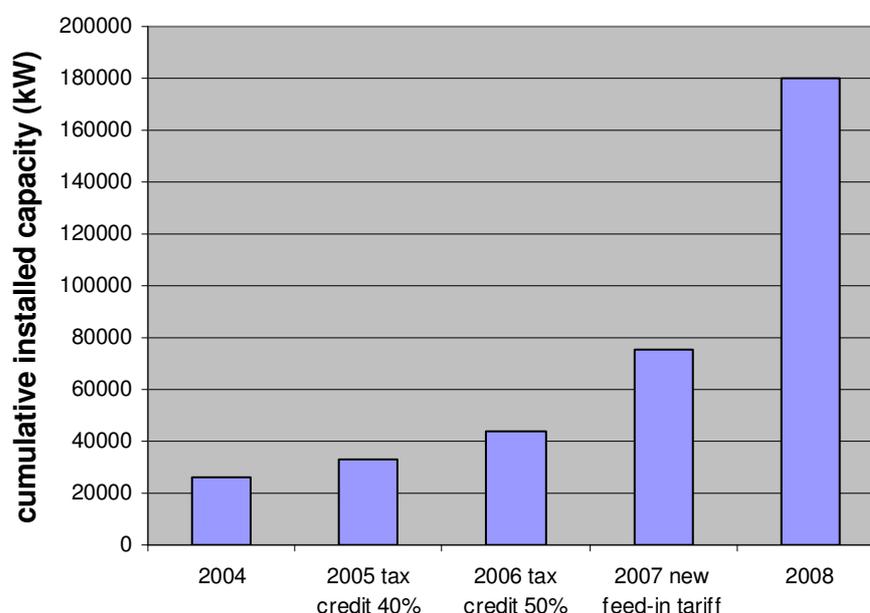
**Table 2 – Annual installed photovoltaic power in 4 sub-markets**

Sub-market application	2003 kW	2004 kW	2005 kW	2006 kW	2007 kW	<b>2008 kW</b>
off-grid domestic	1 487	1 100	820	1 171	866	<b>300</b>
off-grid domestic non domestic	470	600	300	307	127	<b>~100</b>
grid-connected distributed	1 875	3 250	5 900	9 412	30 306	<b>88 100</b>
grid-connected centralized	0	0	0	0	0	<b>16 000</b>
<b>TOTAL</b>	<b>3 832</b>	<b>4 950</b>	<b>7 020</b>	<b>10 890</b>	<b>31 299</b>	<b>104 500</b>

The impact of the tariff policy since 2006 has boosted "grid-connected" applications. (nearly 90% of total capacity installed).

**Table 3 – Cumulative photovoltaic power installed en France in 4 submarkets**

	31 Dec. 2002 kW	31 Dec. 2003 kW	31 Dec. 2004 kW	31 Dec. 2005 kW	31 Dec 2006 kW	31 Dec 2007 kW	<b>31 Dec 2008 kW</b>
off-grid domestic	10 437	11 924	13 024	13 844	15 015	15 881	<b>16 181</b>
off-grid domestic non domestic	4 862	5 332	5 932	6 232	6 539	6 666	<b>6 766</b>
grid-connected distributed	1 942	3 817	7 067	12 967	22 379	52 685	<b>140 785</b>
grid-connected centralized	0	0	0	0	0	0	<b>16 000</b>
<b>TOTAL</b>	<b>17 241</b>	<b>21 072</b>	<b>26 023</b>	<b>33 043</b>	<b>43 933</b>	<b>75 232</b>	<b>179 732</b>

**Figure 3 – Change in total photovoltaic power installed in France 2004-2008**

## 2.3 National photovoltaic implementation highlights, major projects

### 2.3.1 General Aspects

Besides individuals' enthusiasm for installing systems on their rooftops, the year 2008 was marked by the appearance and initial operation of high-capacity PV power plants.

French producers of photovoltaic modules increased their share of the national market. New investments are being prepared with the arrival of new industrial stakeholders.

One other noteworthy aspect of the year 2008 was the substantial support provided by regional and departmental councils for funding projects, in addition to the national tax- and tariff-based policy;

depending on the region, different strategies were adopted, as depicted in Table 6 (see section 2.5.1).

Partnerships between financial organizations and companies in the energy sector were instituted, devoted to developing PV.

Finally, at the initiative of trade associations and groups, numerous demonstrations targeted at the general public were organized in order to promote PV technology and show how to benefit from it.

At the moment, the heavy demand from individuals and investors is running up against the capacity of the national operator (ERDF) to handle all requests to connect systems to the national power grid.

### **2.3.2 Funding Partnerships**

Caisse d'Épargne and EDF Energies Nouvelles Réparties (EDF ENR) announce the signing of a partnership agreement to encourage the use of photovoltaic equipment in individual homes.

In 2008, CAPENERGIE, Crédit Agricole's investment fund, purchased capital in URBASOLAR, a company that specializes in developing, constructing, and operating solar power plants.

The Caisse des Dépôts et Consignations invested in VALECO, a photovoltaic power operating company. In December, it also announced that it was taking part ownership in VOLTALIA GUYANE. VOLTALIA is an electrical producer from renewable energies.

### **2.3.3 New Stakeholders**

Bolstered by favorable feed-in tariffs, photovoltaics continues to attract investors.

SOLAIRE DIRECT, which initially targeted only individuals, is diversifying into the role of operator to become the third-largest French photovoltaic operator, after EDF EN (EDF Energies Nouvelles) and GDF-SUEZ.

Newcomers continue to arrive: the young company "8minutes33" targets building owners and industrial firms that wish to have solar panels installed on surface areas between 5 000 and 15 000 m<sup>2</sup>.

EDF EN intends to develop the wind and solar sectors in parallel. The group set a goal of 500 MW of photovoltaic capacity by 2012.

In December 2008, AEHLIOS, which specializes in selling, designing and installing photovoltaic solar roofs, signed a multi-year supply contract to provide Scheuten Solar with Multisol modules (10 MW over 2 years).

La Compagnie du Vent, GDF-SUEZ group and a French pioneer in wind power, is continuing its diversification into the production of solar energy. Likewise, AEROWATT, a wind operator that intends to install solar farms and building integrated photovoltaic systems, invested in HELIOWATT, a research office.

Better known as HYDROWATT, the group UNITE (which operates 20 hydroelectric power plants and three wind farms) opened a facility in Ariège to produce and install solar roofs in partnership with UNISOLAR (modules) and RIGIDAL (aluminum frame) with the financial backing of CAPENERGIE.

IMERYS TOITURE, a French leader in clay tiles, and EDF ENR have created a joint company (whose name has not yet been selected) to develop photovoltaic roofing products.

In January 2008, FONROCHE joined with the Spanish company PEVAFERSA (which makes "tracker" systems) to create FONROCHE ENERGIE and built a production facility to manufacture solar panels for the national individual home and professional building market (office, industrial and agricultural building rooftops) as well as for solar farms.

In October, AIR LIQUIDE, an international group that specializes in liquefied and compressed industrial and medical gases, announced the signing of multiple contracts with solar cell manufacturers, which has enabled it to strengthen its world-leading position in supplying gas for the solar power industry.

SFR Business Team, an IT operator, entered a partnership with SOLAIRE DIRECT enabling the latter to offer its clients a service to remotely track the working order of the photovoltaic installation and its electricity production levels.

The company 3I PLUS established itself as a technical and commercial interface for the Australian company BBE (Beyond Building Energy), particularly for fulfilling large industrial and commercial projects by implementing 380 W photovoltaic modules.

The group VERGNET and BP SOLAR France decided to pool their efforts and skills in terms of expertise and experience in developing countries via VERGNET's solar subsidiary PHOTALIA.

In November, AEROWATT and APEX BP SOLAR signed an agreement for a new solar power plant program overlapping rooftops, connected to the EDF grid, with a capacity of 3,7 MW in overseas departments and territories.

#### **2.3.4 New Opportunities**

Leasing rooftops: the number of companies becoming photovoltaic operators can no longer be counted. They range from single-person small businesses to the largest companies, such as EDF EN.

RATP (the Parisian Transportation Authority), will offer its premises (more than 30 large industrial sites, bus depots and maintenance workshops for tram, subway and local rail cars) in order to install photovoltaic systems there.

In October 2008, VALMERE CAPITAL, a consulting company which holds shares in renewable energy and sustainable development began surveying major industrial and farming rooftops in southern France. The firm identified rooftops larger than 1,000 m<sup>2</sup> for the purpose of constructing building integrated photovoltaic solar installations.

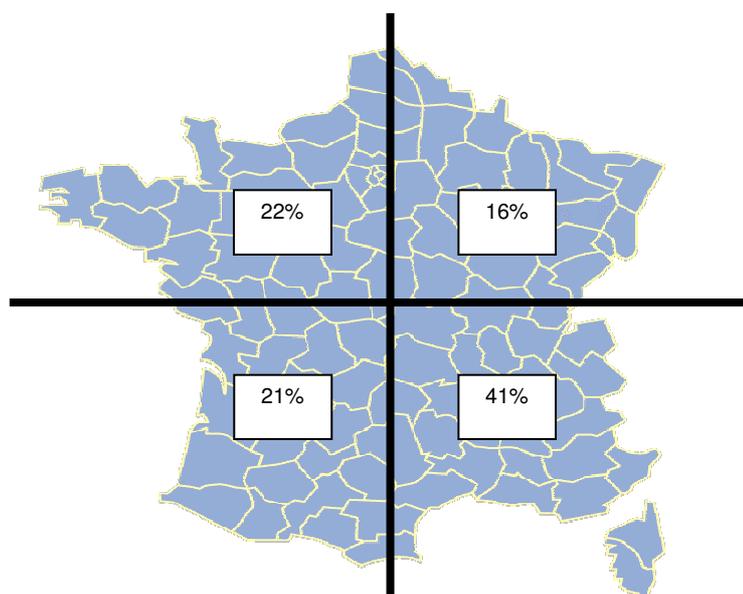
Likewise, communes are looking to make use of their capacity to accommodate photovoltaic equipment in order to raise revenue.

CORUSCANT, a renewable energy producer is offering 100% turnkey solar-covered parking lots to its partner companies and institutions.

#### **2.3.5 Installation Capacities**

According to surveys of trade members, 8 000 installations were constructed in 2008 (all power levels and applications included). The heavy growth in volume installed was only made possible by the entry of new installers into the market. 2 500 installation companies that received the "Quali PV" label (see section 3.8) had been catalogued by the end of 2008 (source: Qualit'EnR).

Figure 4 depicts the geographical distribution of these installers across Metropolitan France.



**Figure 4 - geographic distribution of installation companies in 2008**

50% of these companies are concentrated in four regions: Rhône Alpes, Provence Alpes Côte d’Azur, Languedoc Roussillon, and Pays de la Loire.

According to ERDF, EVASOL, an exclusive partner of TENESOL, with 270 people in 2008, was the leading PV installer in France for the individual market (4,5 MW in 2008). EVASOL received ERDF certification nationwide to connect its installations to the public power grid by itself.

All regions are affected by the boom in the profession, to varying degrees (Table 4).

**Table 4 - Change in the number of installers in each region (2008 / 2007)**

growth rate in number of installers		regions affected
min rate observed	16%	Ile de France
<b>average rate</b>	<b>65%</b>	<b>all regions combined</b>
max rate observed	138%	Provence Alpes Côte d’Azur

## 2.4 Research and Development

### 2.4.1 Paths Forward

The French Environment and Energy Management Agency (ADEME) ([www.ademe.fr](http://www.ademe.fr)) is the establishment which has historically funded photovoltaic power promotion and development activities in France. Since 2005, new national and regional initiatives have emerged to complement ADEME's activity. The creation of the National Research Agency (ANR) ([www.agence-nationale-recherche.fr](http://www.agence-nationale-recherche.fr)) and the agency OSEO have made it possible to streamline R&D work.

Task-sharing between ADEME and ANR has led ANR to treat research and development of a pre-industrial nature beforehand, and to delegate to ADEME the task of backing industrial technological developments intended to market new commercial products.

ADEME's strategy to support development of the French market has been organized around the following five aspects:

- Encouraging the design of photovoltaic construction materials as part of PREBAT (the research and study program instituted by the 2004 Climate Plan aimed at synergizing the efforts undertaken in various programs such as Bâtiment 2010, the Fondation pour la recherche Bâtiment énergie, the European Construction Technology Platform, the 6<sup>th</sup> and 7<sup>th</sup> Framework Programmes), etc.;
- Participating in the funding of highly-visible exemplary operations, such as operations combined into one, which have a high added architectural and educational value;
- Developing a method for taking photovoltaics into account in building economy;
- Strengthening the installations' quality control and performance;
- Closely tracking the incorporation of photovoltaics in changes to thermal regulation;
- Researching the formation of financial tools capable of accelerating the growth of the market (subsidized loans, bridge loans, etc.).

The agency acts on several levels:

- Cooperation between financial partners;
- The publication and distribution of information;
- International action.

In 2008, ANR launched a new three-year research program. It chose to combine work in the construction and photovoltaic sectors into the program known as HABISOL, in order to signify the importance of incorporating photovoltaic technology into buildings.

In parallel of ANR's actions, a major industrial project drew the attention of government bodies in 2008. This was the Solar Nano Crystal R&D project (2008-2012). OSEO and ADEME pooled their funding in order to launch this ambitious project. (see section 2.4.2)

ADEME is currently less involved in providing financial backing for opening markets, because favorable tax and funding measures have been instituted, namely the 50% tax credit for photovoltaic equipment and preferential feed-in tariffs (see below).

ADEME is still active in training project assemblers (PHOTON and PHOTON RÉSEAU instruction programs), but in order to meet demand, other initiatives have arisen in professional training centers or at the National Solar Energy Institute (INES). Hence, in October, TRANSENERGIE opened its 220 m<sup>2</sup> educational and demonstrational photovoltaic solar platform known as QUALIPHOTON®, equipped with the main photovoltaic components available on the market and illustrating various technologies: mono-Si, multi-Si, a-Si, CIS, CdTe. The tool must serve to train builders, trendsetters, architects, electricians, and roofers.

The regional councils are also very active in providing backing for photovoltaic installation projects by way of targeted calls for tenders, in which energy efficiency and solar power must be linked. Also noteworthy is the involvement of the competitive clusters, which bring together regional initiatives by public and industrial stakeholders in research activities.

## 2.4.2 Technological Research and Development

The R&D Solar Nano Crystal project, funded by OSEO and ADEME, consists of constructing a prototype (Lab-Fab) for manufacturing crystalline silicon solar cells. This prototype will test the technical innovations derived from public research laboratories. The general goal is to decrease production costs, increase photovoltaic conversion efficiency, and reduce the environmental impacts of production processes. The work strategies are:

- Direct production of solar photovoltaic-quality silicon;
- Significantly increasing the efficiency of cells and modules;
- Directly experimenting with research findings in a prototype cell production unit.

The project coordinator is the PV-ALLIANCE consortium (Photowatt, EDF EN and CEA-Innovation) in association with silicon-specializing companies such as EMIX, SILPRO, PHOTOSIL and APOLLON SOLAR, and the National Solar Energy Institute (INES).

With respect to the 2008 call for projects of ANR's new "Intelligent Homes and Photovoltaic/Solar Energy" program (HABISOL), three major research fields are being encouraged:

- Methods for managing energy in the home;
- Energy efficiency and increasing the use of renewable energy in buildings;
- Developing photovoltaic power in order to make its usage in buildings widespread.

10 new R&D projects were accepted for these topics. These projects complement the 30-odd R&D projects currently underway which have been supported by ANR and ADEME since 2005. The teams presented the progress of their findings at the contractors' seminar on December 16 and 17th, 2008 in Marseille. For ADEME, two major industrial technological R&D projects have been completed: the RÉDUCOP project under the guidance of Photowatt (multicrystalline silicon solar modules, cells, and materials) and the PHOTOSIL project coordinated by Apollon Solar (solar photovoltaic-quality silicon prepared by a metallurgical process). The expert committee that ADEME has been relying upon noted the satisfactory results achieved, and issued recommendations for the follow-up.

In addition to the development of INES, public R&D reorganization initiatives will occur in the field, within institutes such as IRDEP (Chatou), INESS (Strasbourg), INL (Lyon) and IM2NP (Marseille).

### **2.4.3 Development of the National Solar Energy Institute (INES)**

INES, which gathers researchers from the CEA, CNRS, CSTB and the University of Savoie (~150 people), is an important research centre supported by national and regional agencies. INES is established at Bourget-du-Lac in Savoie.

INES is located at the heart of a territory which is home to a large number of solar power stakeholders: industrial stakeholders (CLIPSOL, PHOTOWATT, TENESOL, etc.) major research and training center laboratories (CEA, CNRS, University of Savoie), and associations (ASDER, HESPUL). INES is the solar platform of the competitive cluster known as TENERDIS, and its purpose is to work with other clusters that specialize in renewable energy, particularly DERBI (Languedoc Roussillon), Cap Energie (Provence-Alpes-Côte d'Azur) and S2E2 (Centre).

In the field of photovoltaic technology research, the activities are focused on the following issues:

- Organic cells: creating flexible solar cells out of plastic, achieve lifespans several thousands of hours long, use "printing" technologies;
- Silicon: optimizing an original metallurgical silicon purification process (the PHOTOSIL process);
- Silicon cells: developing high-efficiency cells by improving manufacturing processes, introducing new concepts by making use of nanotechnology ("RESTAURE" R&D platform);
- Photovoltaic modules: measuring modules' performance, studying the influence of factors such as climate, the downstream electrical system, and cell performance; developing module productivity prediction methods;
- Photovoltaic systems: reducing systems' costs; defining energy management strategies; developing innovative electronic components (a comprehensive approach, from the component to incorporation into the building; an INES micro-grid for assessing the performance of components under real-world conditions);

- Energy storage: defining storage strategies, assessing technological/economic performance, comparing alternative technologies;
- Buildings: measuring the energy yield of buildings and modeling their behavior, particularly when BIPV systems are integrated.

#### **2.4.4 National Conferences and Events**

Multiple demonstrations were held for the benefit of trade professionals and the general public. At the "Solar Event" held in June (with about 10 000 participants), a symposium was organized at Aix-les-Bains for French professionals in the trade. This meeting, which was attended by nearly 500 participants, was dedicated to the conditions of growing solar power in France, the market, industry, and R&D.

From November 17 to 19, 2008, SIREME (the International Exhibition for Renewable Energy and Energy Management), organized by SER (the Renewable Energy Syndicate) was held in Paris, in conjunction with Renewable Energy, Building, and Energy Efficiency Week, initiated by ADEME (15 000 visitors).

The international renewable energy expo ENERGIA, aimed at both professional visitors and the general public (20 000 people attended) was held from December 10-12 in Montpellier.

In addition, associations which drive the renewable energy sector (such as CLER and ENERPLAN) have organized "open-house" days allowing thousands to visit photovoltaic installations and meet professionals.

In general, the public has shown an interest, attracted by these opportunities, to learn more about the field, and has been encouraged by the national and regional incentives.

#### **2.4.5 Competitive Clusters**

Three of the 66 competitive clusters created in 2005/2006 deal with solar power:

- Tenerrdis in the Rhône-Alpes region
- Derbi ("Development of Renewable Energy in Construction and Industry") in the Languedoc-Roussillon region
- Capenergie in the Provence-Alpes-Côte d'Azur region.

Each cluster receives funding from OSEO/AII, ANR, ADEME and collectivities, depending on the interest shown in the submitted projects.

#### **2.4.6 PV Alliance Lab-Fab**

Created in September 2007, PV Alliance is a joint subsidiary of EDF ENR, Photowatt International and the CEA, whose task is the development, and ultimately the production, of high-efficiency cells. Initially, PV Alliance will operate a prototype unit (25 MW) whose purpose shall be to qualify and confirm technological innovations taken from laboratories, particularly those of INES, applied to industry-representative equipment in meaningful quantities.

The first products in the prototype line, known as Lab-Fab, should be available in autumn 2009.

In order to meet its goals, PV Alliance is a partner and leader of a five-year research program: Solar Nano Crystal. This project received backing from local collectivities and the French government, and includes seven partners. This project is expected to lead to the construction of sites intended to produce two types of cells: high-efficiency silicon cells made from purified metallurgical silicon, and very-high-efficiency cells using polysilicon, which implement nanotechnology.

## 2.5 Budget for R&D and market stimulus

ADEME and ANR's 2008 budget for R&D activities is EUR 10 to 12 million. OSEO grants a total of EUR 46,5 million to the Solar Nano Crystal research and development (R&D) programme in the form of grants (EUR 21,5 million) and repayable advances (EUR 25 million).

### 2.5.1 Market Stimulus

Since 2006, the development of the French market has been marked by an increase in the photovoltaic electricity purchasing tariff, instituted in 2002. This "purchasing bonus" price signal has suddenly placed France among the top 10 photovoltaic markets in the world. This incentive has been bolstered by the tax credit, which constitutes an additional tool for stimulating investment by individuals. These incentives have had numerous positive effects: strong development in the market and a commercial offering structure oriented towards integration of photovoltaic technology into buildings.

- **National Actions**

*The "Grenelle of the Environment": national strategies*

During the "Renewable Energy Week" event in autumn 2008, 50 operational measures approved by the government to encourage renewable energy were introduced.

With respect to the photovoltaic sector, the government reaffirmed the bonus for incorporating them into buildings (shown here in Table 5).

**Table 5 - Electrical power feed-in tariff in 2008 and forecast for 2009 (EUR/kWh)**

Tariff	Metropolitan France		Departments Overseas and Corsica	
	2008	2009 update		2009 update
Base tariff (PV installed)	<b>0.31193</b>	0.32823	<b>0.41591</b>	0.43764
Building incorporation bonus	<b>0.25594</b>	0.27353	<b>0.15596</b>	0.16412
Tariff with bonus included (PV integrated)	<b>0.57187</b>	0.60176	<b>0.57187</b>	0.60176

Source: EDF-Obligation d'achat

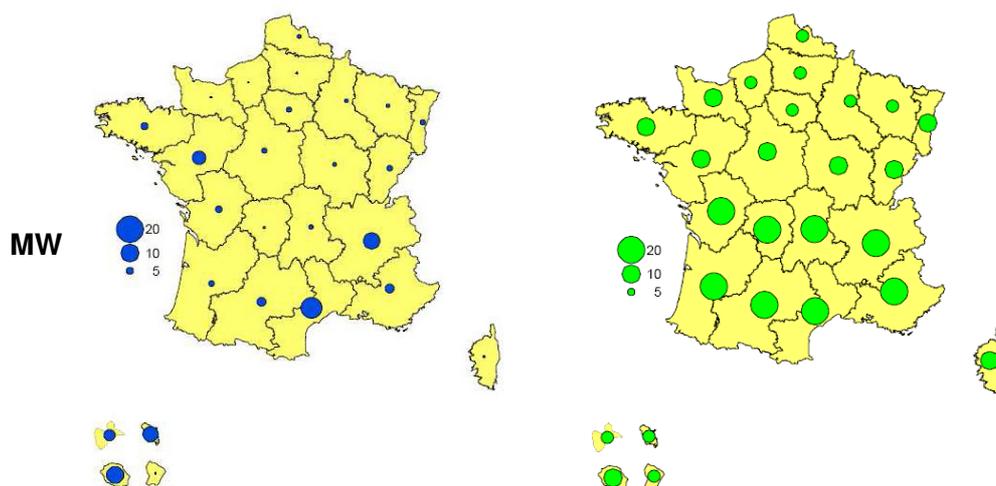
The government also wants to give incentives to outfit the rooftops of supermarkets and large industrial and agricultural buildings with photovoltaics by introducing a special tariff that shall be set at 0,45 EUR per kWh.

It reaffirms the stability of the tariff structure until 2012, which will assist in the current development of a French industry.

The amending finance act passed in December 2008 provides that the product of a photovoltaic electricity sale shall then be exempt from income taxes, provided that the power of the solar panels does not exceed 3 kWc.

*The "Grenelle of the Environment": Goals for each Region*

The government is encouraging the creation of photovoltaic power plants in every region, and in November 2008, announced its goal to have at least one in each region by 2011. Figure 5 depicts the change in photovoltaic power plants which the completion of this project will result in.



**Figure 5 - PV power connected as of 12/31/08 (left) and projection once regional projects will be completed (right)**

*The "Grenelle of Environmen": Simplification of administrative measures*

In Metropolitan France, requests for connection related to the development of individuals' photovoltaic installations have increased considerably. Measures have been instituted to hasten responses, particularly by reducing the number of necessary procedure steps from five to two.

• **Regional and Local Actions**

As noted by ENERPLAN, the role played by regions and local collectivities in the development of this market is a meaningful one. Because they are closer to the ground, they are capable of verifying which sorts of actions or assistance are truly effective. They also benefit from the development of the sector, not only by contributing to the local industrial activity, but also financially, or by building an image of doing their part for their environment.

The regions and numerous other territorial collectivities (communities of communes, communes) have been involved in financial assistance since 2006. This assistance may assume various forms, as depicted in the summary table created based on the assistance inventory conducted by the Association ENERPLAN ([www.enerplan.asso.fr](http://www.enerplan.asso.fr)).

**Table 6 – Summary of forms of regional and local aid to funding photovoltaic systems**

The forms of aid are distinguished by:	examples
<ul style="list-style-type: none"> <li>The public or type of project that receives them.</li> </ul>	Individual projects, group installations, off-grid sites, producing feed-in electricity
<ul style="list-style-type: none"> <li>The background for processing aid applications</li> </ul>	upon the recipient's request, only in response to a call for projects, once a group purchase has begun
<ul style="list-style-type: none"> <li>The parameters used to define the amount of assistance</li> </ul>	cost of installation, cost of labor, cost of the $W_c$ installed, % of installation cost, % of installation labor, expected annual energy production, expected energy production in the first year
<ul style="list-style-type: none"> <li>The conditions for granting assistance</li> </ul>	main residence, incorporation to the building,
<ul style="list-style-type: none"> <li>The data used to define a cap to the assistance, if any</li> </ul>	Resource conditions, amount of investment, power installed, amount per $W_c$

<ul style="list-style-type: none"> <li>Amount ranges</li> </ul>	<p>Example for an individual, depending on the forms of aid, and depending on the regions:</p> <ul style="list-style-type: none"> <li>from 700 EUR to 1 000 EUR for the total investment cost</li> <li>from 300 EUR to 1 300 EUR for installation labor</li> <li>10 % to 30 % of the installation cost</li> <li>1 EUR/ <math>W_c</math> to 2 EUR/ <math>W_c</math></li> <li>0,1 EUR/kWh/year to 0,2 EUR/kWh/year</li> </ul>
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### 3 The Industrial Sector

All of the trades which are involved in the photovoltaic value chain continue to fall into place. Table 7 depicts the distribution of activities carried out by French stakeholders in the field (certain stakeholders are involved in multiple steps).

**Table 7 – The value chain in the French PV sector in 2008**

Number of companies involved in the various steps of the value chain							
Silicon refinement	Ingot production	Cell production	Module production (mc-Si and a-Si)	Production of other PV components	Sales and Distribution	Studies, product development, system design	Installation
2 (investments underway)	2	2	4	~10	~100	~150	~ 2 500

#### 3.1 Silicon Production

Two industrial projects are underway: Silicium de Provence (SILPRO) and PHOTOSIL.

##### 3.1.1 SILPRO (Silicium de Provence)

The SILPRO project was initiated in 2007 by a consortium made up of Photon Power Technologies (PPT, France), Econcern (the Netherlands) and Norsun (Norway) with the goal of producing 4 500 tons per year (chemical process). It is expected to be located on the ARKEMA site in St Auban, but the project is currently being delayed due to funding difficulties.

##### 3.1.2 PHOTOSIL

The company FERRO PEM – INVENSIL (a metallurgical silicon producer), APOLLON SOLAR and CYBERSTAR are partnering under the PHOTOSIL project to develop a new silicon production chain for the photovoltaic industry that incorporates production costs significantly less than those of current processes.

A prototype pilot (200 T annual capacity) has been built in Bourget du Lac, near the facilities of INES (Institut National pour l'Énergie Solaire).

## 3.2 Production of Ingots and Wafers

Table 8 lists the industrial stakeholders involved in ingot production, and associated characteristics.

**Table 8 – Ingot and wafer production and production capacity - France 2008**

Producers	Technology	Production	Installed capacity	Product recipients
PHOTOWATT	sc-Si ingots	600 tons	1 000 tons	own needs for producing wafers and then cells
EMIX	mc-Si ingots	80	360	France and export
PHOTOWATT	mc-Si wafers	<i>equivalent of 40 MW</i>	<i>equivalent of 60 MW</i>	own needs

*mc-Si: polycrystalline silicon*

### 3.2.1 Photowatt International

Photowatt International S.A.S. is a subsidiary of the Canadian group ATS.

The company, located in Bourgoin-Jallieu, near Lyon, is celebrating its 30th anniversary in the field of photovoltaics, and currently employs 850 people (2008 turnover is 30% higher than in 2007).

Photowatt's business, launched in 1978, incorporates every step of the photovoltaic supply chain, and extends from the production of silicon in ingot molds to the design of systems and providing turnkey solutions. Photowatt uses all of the ingots produced in order to manufacture the equivalent of 60 MW of wafers.

The company is entering an important phase in its development with the inauguration of research programs intended to improve the efficiency of cells and reduce manufacturing costs. In particular, this direction is taking shape via the institution of the PV Alliance –Lab Fab Project, a consortium of companies which includes the manufacturer Photowatt, the CEA and EDF Energies Nouvelles. This consortium intends to create a pool of experts tasked with engineering next-generation cells. Three major work strategies have thereby been defined:

- Increase options for applications in the field of solar power;
- Improve efficiency;
- Distribute photovoltaics more broadly.

### 3.2.2 Emix

EMIX, located near La Souterraine (Creuse), is a company which employs 30 people in producing and selling silicon ingots (2008 turnover is 28% higher than 2007).

The principle of the crystallization process used by EMIX since 2004 is the continuous silicon pulling from an electromagnetic cold crucible. It can be used to create silicon ingots with a multicrystalline structure. Its continuous nature, high productivity and easy, highly automated operation distinguish it from traditional processes.

Recent investments have made it possible to increase annual production capacity by 360 tons a year.

### 3.2.3 New Stakeholders

TOTAL and GDF-SUEZ freely announced their intent to build a silicon wafer production unit on the Vernejoul site in Moselle.

A start-up (S'TILE) based in Poitiers is working on a new silicon manufacturing concept for the PV industry (sintering silicon powder).

## 3.3 Cells and Modules Production

Table 9 lists the main industrial cell and module stakeholders, and the associated production characteristics.

**Table 9 – Cell and module production and production capacity - Main stakeholders - France 2008**

Producer	Technology	Annual production (MW/year)		Annual production capacity (MW/year)	
		Cell	Module	Cell	Module
PHOTOWATT	mc-Si,	<b>60</b>	<b>55</b>	<b>60</b>	<b>60</b>
TENESOL (*)	mc-Si	-	<b>40</b>	-	<b>45</b>
FREE ENERGY	a-Si:H	-	<b>0,7</b>	-	<b>1,2</b>
<b>TOTAL</b>		<b>60</b>	<b>~96</b>	<b>60</b>	<b>~106</b>

(\*) for the Total Technologies facility in Toulouse (does not include the Cap plant in South Africa)

mc-Si: multicrystalline silicon; a-Si:H: amorphous silicon

### 3.3.1 Photowatt International

Using the silicon produced in its own plant, PHOTOWATT manufactures cells followed by modules (60 MW of annual capacity).

As part of the PV Alliance's Lab-Fab project, capacity and cell production should increase by 25 MW and a new 100 MW production facility should be built based on the new processes developed.

As part of the PV development policy underway in France, part of the production is devoted to BIPV (products to be integrated into rooftops/façades), under development partnerships with other companies (integrating PV into IMERYS tiles, using SOLRIF frames).

### 3.3.2 Tenesol

TENESOL (formerly known as Total-Energie) is a subsidiary of the TOTAL and EDF groups. TENESOL SA, which employs 120 people in France, is one of the companies in the TENESOL group (500 people in France), structured as industrial and sales subsidiaries.

TENESOL's activity stems from producing modules, designing electronic components, designing systems, installing systems, is selling projects, and producing electrical energy (2008 turnover is 45% higher than in 2007).

All activities increased in 2008, due to:

- a heavy increase in the French market (grid connection, incorporation into buildings);
- overseas investments to increase solar power production capacities operated by TENESOL;
- increased sales of systems for off-grid sites in developing countries, one of the TENESOL group's historic activities;
- a rise in international module sales;
- the entry into force of a subcontract for module production with an industrial cell-producing partner.

The average capacity of the Cap production plant in South Africa is 45 MW, and that of the one in Toulouse (TENESOL TECHNOLOGIES) is 20 MW; the Toulouse plant increased its annual baseline to 45 MW, and the system assembly and logistics infrastructure was built near Lyon.

### **3.3.3 Free Energy**

The FREE ENERGY production facility is located near Lens (Pas de Calais). Created in 1985, this facility employs 15 people for producing and selling thin-film photovoltaic modules. Initially geared towards designing products intended for electrifying off-grid sites, its activity has expanded to developing grid-connected systems, and more particularly to incorporating PV into buildings (2008 turnover is ~10% higher than in 2007).

### **3.3.4 Imerys-Toiture**

Imerys-Toiture is the French leader in clay tiles in France. Its product catalog includes photovoltaic tiles (made from mc-Si cells developed with Photowatt in 2002 as part of the European "PV Starlet" project), which are installed instead of traditional tiles.

In 2008, EDF ENR and Imerys announced the creation of a joint company to specialize in the production of photovoltaic systems integrated into buildings (creating an R&D and production site in Rhône Alpes).

### **3.3.5 Sunland 21**

Sunland 21 designs building enclosure systems which incorporate high-efficiency cells.

The annual capacity installed at its site in Anse is 8 MW. Investment projects are planned that would increase this production capacity to 35 MW.

### **3.3.6 New Stakeholders and Industrial Projects Being Developed**

A start-up (SOLARFORCE) has developed a process that makes it possible to divide the amount of silicon used in manufacturing cells by four (using ribbon technology).

A company was created in October 2008 (NEXCIS) to make industrially use of the thin-film cell technology developed under the R&D CISEL project by the Institute for Research and Development in Solar Energy (IRDEP).

SOLSIA was created in 2008 to design, produce, and sell module specially built for rooftops and ground power plants (1,4 m<sup>2</sup> modules). The technology is based on the one developed by the company SOLEMS (amorphous silicon in thin films).

The company SILLIA (which had initially specialized in manufacturing printed circuits) will begin constructing a production facility for multilayered silicon-based modules well-suited for incorporation into buildings (20 MW during construction).

FONROCHE, in partnership with the Spanish company PEVAFERSA, is building a module manufacturing facility (with an annual capacity of 40 MW) near Agen.

### 3.3.7 Outlook

Taking into account all of these current actions and short-term projects, an assessment of the modules' production capabilities for the coming year leads to the following orders of magnitude (Table 10):

**Table 10 – Estimate of the change in the installed module production capacity in France**

Industrial Stakeholder	Year			
	2006 MW	2007 MW	2008 MW	2009 MW
Photowatt	40	45	60	60
Tenesol (*)	15	15	45	45
Free Energy	1	1	1,2	1,2
Sunland 21	-	-	-	8
Fonroche	-	-	-	26
Sillia Energie	-	-	-	20
PV Alliance	-	-	-	25
Others				15
<b>Total capacity in France</b>	<b>~56</b>	<b>~ 61</b>	<b>~106</b>	<b>~190</b>

Source: ADEME and SER surveys

(\*) France Plant (Tenesol Technologies)

## 3.4 Components and Systems Production

### 3.4.1 Components

TENESOL, as part of its systems manufacturing activity, has inaugurated an inverter production line (1 to 5 kW) and developed monitoring systems.

One facility of the company PRYSMIAM was installed at Pont de Cheruy (Isère) for producing and selling special connectors for photovoltaic installations.

The group SCHNEIDER ELECTRIC is continuing its development in the industry by building special production sites for monitoring systems, connection stations specially designed for photovoltaics, cabinets and junction boxes.

Groups such as FERRAZ SHAWNUT (Carbone Lorraine), SOCOMEC, AINELEC, COMECA (low-voltage equipment) are producing components for PV systems in their French sites.

### 3.4.2 System Design and Construction

With a 2008 turnover 60% higher than in 2007, APEX BP SOLAR, the historic PV stakeholder in France, sold nearly 9 MW of photovoltaic modules as part of the development of projects in Metropolitan France (equipping 1 500 individual houses) and overseas (about 10 developments of hundreds of kilowatts). The company is continuing its development with respect to the building integration strategy. A network of installing partners has been set up. However, the company remains very active in developing off-grid sites, particularly in Africa (pumping, telecom, storing vaccines). After the first year of its partnership, APEX BP SOLAR agreed to start a new solar power plant program with SOLAR ENERGIES (with the participation of Caisse des dépôts and Aéro watt) on rooftops connected to the ERDF grid with a capacity of 3,7 MW, currently being installed.

Nearly 30 MW of systems were installed by TENESOL in 2008 (80% more than in 2007). TENESOL develops, industrializes, produces and sells turnkey feed-in solar systems to industrial firms,

agricultural firms, collectivities, and for off-grid sites (its historical market). With 865 employees, TENESOL has a strong presence in French overseas departments and territories, and had several locations in Europe, Africa, the Middle East, and the Americas. The group plans to continue its development in 2009 by creating locations in Italy, Spain, and Greece.

PHOTON TECHNOLOGIES, a subsidiary of EDF ENR (EDF Energies nouvelles réparties) created in 2006, quadrupled its 2007 turnover in 2008. 6 MW of systems were installed in Metropolitan France. Furthermore, PHOTON TECHNOLOGIES has been participating in the construction of a solar grade silicon plant managed by the Consortium SILPRO. PHOTON TECHNOLOGIES therefore wishes to be present along the entire PV chain.

Many other companies, including PHOTOWATT, CONERGY, SUNWATT, SOLARCOM, etc. are also present in the market as assemblers and providers of turnkey systems.

### 3.4.3 New Products

The heavy tariff support for systems that use photovoltaic components integrated into buildings encourages industrial firms to develop this sort of component.

In 2008, there were more than 70 products on the French market that were "eligible" to receive the incorporation bonus (*source: "Solar systems"*). Table 11 shows a summary of this range of products and their main characteristics.

**Table 11 - products available on the market for systems incorporated into buildings**

Type of product	Number of products available	PV technology used	Application
Shingles and slate	21	mostly mono-Si 20% of models deliverable as mono-Si or multi-Si 1 CIS model	100% roof with a few siding installation options
Modules incorporating a sealing function	13	50% mono-Si 50% multi-Si	mostly for roofs a few façade options
Plates (steel, zinc, alu, fibre cement)	11	50% mono-Si 50% amorphous Si	mostly for roofs 3 façade applications
Flexible membranes	6	Amorphous Si	Terrace roof
Canopies	15	80% as crystalline Si (60% available as multi-Si) 20% as amorphous Si	roof/façade
Others	5	80% as crystalline Si 1 model as amorphous Si	shade screen, awning

Many French industrial firms have contributed to this line:

PHOTOWATT has sold a photovoltaic tile, and is partnered with IMERYS. Other developments with BARUSCH and FISCH in Alsace led to the release of the photovoltaic tile that combines a tile-shaped rooftop panel (recycled polyethylene) with a photovoltaic module.

The group SORA (a manufacturer of composites) has also produced a photovoltaic tile since June 2008.

URBASOLAR, a company that specializes in photovoltaic watertight membranes, plans to build a production facility in France (planned to be 20 MW).

The group PHOTON POWER, created after the institution of feed-in tariffs in 2006, is developing and installing systems. In partnership with the group CORIALIS and SOLAR CONSTRUCT, 2 industrial facilities have been completed in 2006 to produce solar plates and a system for integrating them into canopies.

The companies KAWNEER and APEX BP SOLAR, have developed a photovoltaic solution that meets the needs of weather and shade protection. Furthermore, APEX BP SOLAR and DUPONT DE NEMOURS (an expert in building enclosures) are working together to develop a new rooftop incorporation product.

CLIPSOL, which has specialized in solar power since 1979, is manufacturing completed generators that are essentially incorporated into roofs (with a capacity of 50,000 m<sup>2</sup> / year). As part of its subsidiary CLIPS'HOLLE created with HIOLE Industries, CLIPSOL has developed an integration macrostructure installed as fields of pre-assembled 20m<sup>2</sup> solar panels.

HELIOPTIM, a young company created in 2008, has developed incorporation solutions especially for industrial and commercial buildings (Rufus-terraces), as well as ground solar power plants.

TENESOL has established partnerships with innovative industrial firms in the building sector (Arcelor MITTAL (steel plates), ETERNIT (construction materials for roofing) or SMAC (building envelopes) in order to develop special products suitable for incorporation into buildings.

#### **3.4.4 Research Firms, Associations**

Companies involved in consulting, market research, training, technical research, and project management accompany the development of the industry. The trade associations and unions such as ASDER, CLER, ENERPLAN, and SER are very active in promoting photovoltaics, and organize contacts with the market and government agencies.

### **3.5 Industrial Activity Outside of France**

This section gives a few examples of activities by French industrial companies in the PV sector doing business overseas:

#### **• Saint-Gobain and CIS**

The group SAINT GOBAIN, which holds 20% of the world's photovoltaic glass market, launched a CIS photovoltaic module plant with an annual capacity of 20 MW in Torgau, near Leipzig (Germany) with SHELL (which is providing the patents) in mid-October 2008. The 1 m<sup>2</sup> modules' planned sale price is 200 to 250 euros. Besides the planned openings of new plants, SAINT GOBAIN is not ruling out being present, via acquisitions, throughout the PV supply chain: from the modules' distribution to installation.

#### **• Total**

TOTAL announced that it was becoming a key industrial shareholder in the American startup KONARKA, with specializes in organic photovoltaic technology.

#### **• Total Photovoltech**

After investing in a new photovoltaic module production line in 2007 (crystalline Si) with an annual capacity of 80 MW in Tierlemont (Belgium), Photovoltech (Total, Suez-Electrabel - Soltech and IMEC) confirmed in September 2008 that it would move forward with its plans to increase its capacity to 140 MW in 2009.

#### **• Carbone Lorraine**

The photovoltaic industry has become a growth opportunity for the group CARBONE LORRAINE. In order to strengthen its position, CARBONE LORRAINE took over the Scottish company CALCARB, the worldwide number two in manufacturing rigid graphite used as insulation in very high temperature ovens, particularly for producing solar silicon.

### 3.6 System Prices

For bulk quantities, the sales price is in the vicinity of 3.20 EUR/W. Table 12 depicts the trend observed over the past few years.

**Table 12 – Average sales price of crystalline Si modules (not including tax) in EUR/W**

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
11,62	9,93	8,24	6,55	4,86	4,63	4,41	4,20	4,00	4,20	5,10	4,80	<b>3,17</b>

Table 13 illustrates turnkey market prices for various types of installations (EUR per watt, not including tax).

**Table 13 – Turnkey prices for typical applications (2008)**

Breakdown by application	Typical Application	Market prices EUR/W not including tax			
		2007		2008	
Year produced					
Type of rooftop placement		added-on	integrated	added-on	integrated
not grid-connected up to 1 kW	Rural electrification	11 to 19 depending on local restrictions		ditto	
not grid-connected > 5 kW	Rural electrification	13 to 15		unknown	
grid-connected up to 2 to 3 kW	Houses	7,70	8,40	7,50	8,30
grid-connected up to 10 kW	Houses	5,50 to 6,50	7,5		7
grid-connected > several 10 kW	Large systems or PV power plants (< or = 500 kW)	5,20	6,5 to 7	5,10	5,5 to 6
grid-connected several 100 kW	PV power plants (> 500 kW)	unknown			

According to a study conducted in late 2008 of about a hundred people who installed PV systems in 2006 and 2008, ([www.outilssolaires.com](http://www.outilssolaires.com)) the average observed turnkey price for 2 kW grid-connected systems, not including taxes, was estimated as indicated in Table 14:

**Table 14 – Turnkey price of typical 2 kW installations (late 2008)-  
EUR/Watt tax not included**

Type of system	2 kW “added-on”		2 kW “integrated”	
Year installed	2006	2008	2006	2008
Average installed price	7,82	7,58	8,56	8,35

Table 15 depicts a trend in the change of turnkey prices (market prices offered by a company, not a national average) since 1997. They are low-power rooftop systems (< 10 kW).

**Table 15 – Average turnkey price of installations- EUR/Watt not including taxes**

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
20,40	18,87	17,33	15,80	15,05	14,33	13,65	13,00	11,60	8,12	5,20	5,12

Table 16 shows the price levels given on websites for products deliverable in France from French distributors.

**Table 16 – Typical prices for PV systems and components (has offered on the Internet-  
2008)**

Components	Examples of public prices, tax not included (starting price)
1 to 5 kW feed-in system kit (including inverter)	6 to 7 EUR/W
Amorphous silicon modules (*)	1,40 to 2,90 EUR / W
Monocrystalline silicon module (160-180 W) (*)	3,40 to 3,70 EUR / W
Multicrystalline silicon module (*)	3,40 to 3,50 EUR / W
Inverter	0,35 to 0,40 EUR / VA

(\*) for quantities ordered less than 10 kW

### 3.7 Employment

According to surveys carried out by SER and ADEME, the change in direct jobs on the photovoltaic supply chain was very significant in 2008. Table 17 displays the movements in the industry since 2006.

**Table 17: change in direct jobs (production–installation) since 2006**

Year	2006	2007	2008
Estimate of the number of direct jobs	1 100	2 130	~4 000

2007/2006 growth rate		+ 94%	
2008/2007 growth rate			~+ 90 %
2008/2006 growth rate			~+260%

At the end of its member survey, the SER-SOLER Syndicate confirmed the analyses made by ADEME in its July 2008 study, which estimates that growth in the photovoltaic sector could create 13 400 jobs by 2012.

### 3.8 Quality Policy - Directives and Standards

The installation of systems at off-grid or grid-connected sites must comply with directives, practices, and recommendations issued by the UTE (Union technique de l'électricité), EDF and ADEME. The trade syndicate SER plays an important role in preparing these technical guides.

With heavy support from the profession and government authorities, quality approaches have been instituted. Since 2007, the "QualiPV" label ([www.qualit-enr.org/qualipv](http://www.qualit-enr.org/qualipv)) has been effective. With "QualiPV" label, each company agrees to comply with 10 points of the QualiPV charter established by the profession. In order to follow this quality approach, companies must prove their skills, particularly through generic "QualiPV" training modules given out across France. By the end of 2008, 2 500 Companies had received this label.

ADEME has published a "Guide to drafting technical specifications for consultation intended for builders". This guide primarily treats systems whose active power is less than 36 kVA, connected to the low-voltage grid, and offers a methodology to assist in drafting real estate project consultation documents. The basic framework relies on describing elements specific to photovoltaic systems which the project's designers must take into consideration, justifying their choices (technological, financial, architectural, etc.).

This document is intended for all stakeholders involved in developing a photovoltaic system connected to the grid and integrated to the building. Likewise, a "Guide to grid-connected photovoltaic installations: PERSEUS" has been made available to individuals.

Furthermore, ADEME is pursuing shared-cost projects with partners within the International Energy Agency (IEA), particularly in workgroups #1, 2, 9, 10 and 11. The International Electrotechnical Commission (IEC) receives the contributions of French teams supported by ADEME, particularly in the field of technical specifications regarding rural electrification using renewable energy sources.

With the announced development of ground solar power plants, work is also under way in order to determine the eligibility of the land where these plants are planned to be built.

### 3.9 Other Initiatives

142 communes took part in the 2008 edition of the "Commune Renewable Energy Championship". Organized annually for the past five years by CLER (the Renewable Energy Liaison Committee), this championship rewards communes that have invested in thermal solar installations, photovoltaic installations, or in wood energy. Three sizes of communes were rewarded in each category (< 2 000 residents, 2 000 to 50 000, > 50 000).

For photovoltaics, the 2008 winners are:

- (< 2 000 residents): Ilhes Cabardès, Aude, 31,5 kW 57 residents, or 550 W per resident;
- (2 000 to 50 000 residents): Baie Mahault, Guadeloupe, 1 299 kW for 27 371 residents, or 47 W per resident;
- (> 50 000 residents): Fort-de-France, Martinique, 1 178 kW for 95 000 residents, or ~12 W per resident.

It may also be noted that projects to install PV systems on the rooftops of schools are heavily encouraged by these Regional and Departmental Councils, for the purpose of introducing PV culture to young people as early as possible.

## 4 Conclusion and Outlook

With a goal of 20% renewable energy by 2020 set by the European Council, the growth of the photovoltaic market must develop without sacrificing the quality of the installations. Movement in the French market was very strong in 2008. By the end of December 2008, 23 000 projects combining more than 1 100 MW were pending (*source SER-SOLER, according to EDF and EDF SEI*). 2008 saw a tripling of installed power from 2007, with a trend that should continue. The increase of the feed-in tariff, the additional bonus granted to systems integrated to buildings, in the creation of the "sustainable development" tax credit were decisive elements. These incentives had numerous positive effects:

- the growth of the market;
- the structuring of industrial and commercial offerings;
- the development of technological R&D innovations for new products;
- the creation of qualified jobs.

The development of ground photovoltaic power plants is underway; between September 2007 and July 2008, 22 requests for authorization were filed with the administration for projects between 4,5 MW and 12 MW, for a total of 215 MW installed power. New electrical production stakeholders are entering the scene.

The French industrial sector is undergoing a total change, with the involvement of major French energy stakeholders (EDF, Total, GDF-SUEZ, CEA, etc.). Significant government backing has been provided to ambitious initiatives on the national level (PV Alliance, SILPRO, Competitiveness clusters, Institut de l'Energie Solaire), relayed by heavy support from the Regional and Departmental Councils.

The development of the crystalline silicon industrial supply chain is underway. Thin-film photovoltaic industries could start up in France, extending existing research projects into that field and partnerships made by French industrial firms. Shared actions between the photovoltaic and construction industries are developing, with respect to both research and industry.

The national ambition is to play an important role in the current technological revolution. The goal is to make solar energy a form of generation that can compete with the market price of electricity by 2020.

## **Appendix      Work Method**

This report was primarily based on information provided by industrial firms which were willing to reply to the questionnaire sent to them. This questionnaire contained tables, which are included in this report. Some of the companies have not always the time to fully contribute to this study as they are asked for a larger number of surveys from different institutional bodies. It was therefore necessary to gather information from multiple sources.

A great deal of information was also collected from the Renewable Energy Syndicate, solar branch (SER-SOLER) and trade associations (ENERPLAN, CLER, etc.).

The recounted events on industrial life and research activities were collected throughout the year 2008 from press releases issued by the companies in question, published studies, journal articles, and websites.

Quantitatively, this report emphasizes structures that were installed, not necessarily those which were connected. The goal was to give an overview of the sector, not to provide a photovoltaic energy balance.

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