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 2007

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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.

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 2007 national survey report for France presented here is prepared by Mr André Claverie, from ADEME (*Agence de l'Environnement et de la maîtrise de l'énergie*, www.ademe.fr), IEA/PVPS/Task 1 participant and includes contributions from Mr Philippe Jacquin, consultant (www.phkconsultants.com).

The views expressed are purely those of the writers and may not in any circumstances be regarded as stating an official position of the ADEME.

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/m², cell junction temperature of 25 ^{o}C, AM 1,5 solar spectrum).

EUR: euro currency unit (ISO code). MEUR means million euro (10^6 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 of photovoltaic power under STC conditions (kWh/kW).

1 Executive summary

• Overview

The overall power of installed PV systems in France in 2007 was 31,3 MW which represents a significant growth compared to 2006**.** This increase is mainly due to the national fiscal measures (new feed-in tariff and tax credit) launched in 2006. The implemented feed-in tariff model application supports building integration of photovoltaic generators with a much higher financial incentive than other type of photovoltaic installations.

In the same way, local authorities like regional councils and departmental councils developed new policies to promote photovoltaics through specific grants.

As the building integration of photovoltaic generators is encouraged by a feed-in tariff bonus, innovative products are appearing on the market or are under development. In parallel, actors like architects, designers, engineers are now paying attention to building integration of photovoltaic components (BIPV).

New actors such as financial institutions, energy operators, and private investors have developed ambitious projects. With the increase of the market, new firms have been created including engineering, consultancies, electricity producers, PV products distributors and retailers, installation and maintenance companies.

Photovoltaic industrial sector is getting stronger and large investments have been undertaken in order to develop a vertical integration of the photovoltaic value chain, from feedstock silicon production to final photovoltaic products. A new private-public consortium called "PV Alliance Lab Fab" has been set up and an important R&D project under the name of "Solar Nano Crystal" should start by the end of 2008.

At the same time, R&D activities focus on photovoltaic silicon cells/modules conversion efficiency and long term reliability, production costs, new materials and device design, yield, environmental impact of industrial processes and optimisation of control and monitoring of photovoltaic systems.

In addition to the ADEME and ANR research programmes (*Agence nationale de la recherche*, www.agence-nationale-recherche.fr), OSEO national Agency (*Organisme de financement des entreprises pour les projets de création, innovation et développement*, www.oseo.fr) and regional authorities have integrated into their R&D policies support for the PV field.

In October 2007, the French government launched a series of initiatives under the '*Grenelle de l'environnement'*. One of the working groups dealing with renewables sources of energy proposed to the government a development programme for photovoltaics. Some of the objectives are the reinforcement of R&D and a cumulative PV installed capacity of 5,4 GW in France by 2020.

• Installed photovoltaic power

The overall power of the PV installed systems in France[1] during year 2007, is estimated at 31,3 MW of which 30,3 MW represents grid-connected systems. A significant growth compared to 2006 (10,9 MW total and 9,4 MW grid-connected). The impact on growth of feed-in tariffs and local authorities' incentives can be seen on Figure 1. Operational photovoltaic capacity at the end of 2007 is 75,2 MW of which 70 % is grid-connected. This accounts for an annual electricity production of around 70 GWh.

[1] France means continental France and Corsica and the four French overseas departments (DOM) i.e.: Guadeloupe, Guyane, Martinique and Réunion that are large users of photovoltaic systems.

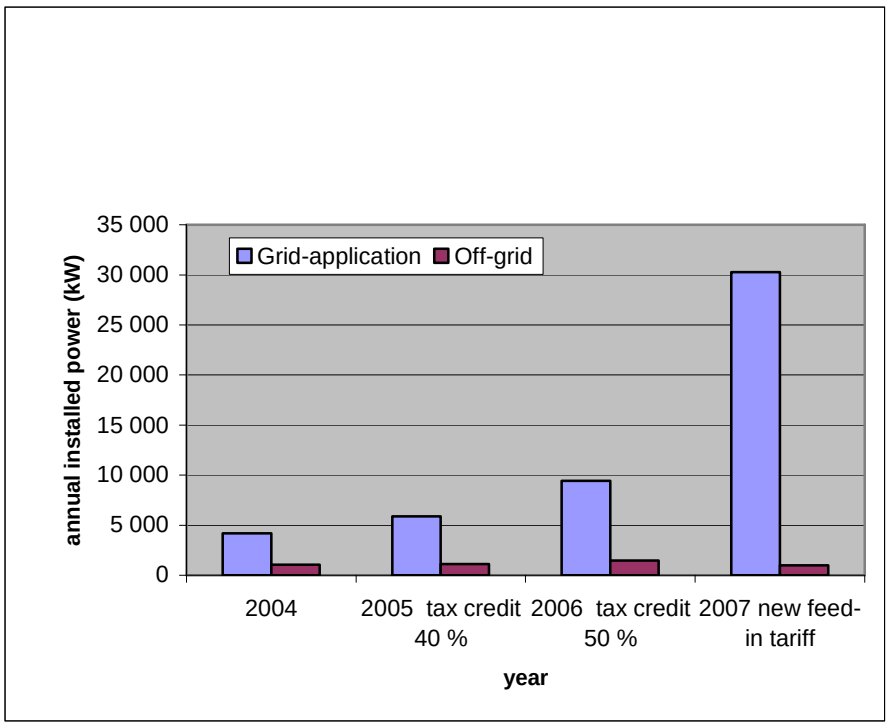

Figure 1 – PV power installed annually in France 2004-2007

• Costs and prices

Concerning system turn-key prices a decrease was observed during 2007 but the variety of module integration of in buildings does not allow drawing a clear picture of the situation.

Grid-connected systems which installed power exceeded 10 kW were proposed on the market at the turnkey price of 5,5 to 7 EUR per watt (without VAT).

For large quantities, the selling prices of photovoltaic modules can be negotiated at 3 EUR per watt.

Concerning manufacturers of materials, cells and modules, direct production costs decreased because the production volume increased and because innovations in the manufacturing processes were introduced thanks to R&D results transferred to production.

• Production of photovoltaic cells and modules

Photowatt International manufactures multicrystalline silicon ingots, wafers, cells and modules. The production of photovoltaic modules by Photowatt International Company was 38,5 MW in 2007. Annual production capacity is 45 MW for modules and 60 MW for PV cells. Photowatt is part of the new PV Alliance Fab-Lab consortium along with EDF EN and the public research organization CEA.

Tenesol is operating a wafer-based crystalline silicon photovoltaic module manufacturing line (15 MW capacity) in its subsidiary Tenesol Technologies in Toulouse.

The Emix production of multicrystalline silicon ingots using the cold crucible continuous electromagnetic casting process has reached 70 tonnes (6 MW PV cell equivalent) with the implementation of two new furnaces. The installed capacity is now reaching 360 tonnes per year.

Free Energy is producing thin film hydrogenated amorphous silicon photovoltaic modules on glass substrate at a rate of 0,5 MW per year with a capacity of 1 MW per year.

• Public budgets for R&D

During the three-year period 2005-2007 the ADEME and ANR intervention budget on photovoltaic R&D remained stable at an average of 9 million EUR per year. Nine new three-year research projects were granted as a result of the 2007 ANR–ADEME common call for proposals. OSEO Agency and other financing partners are going to fund in 2008 the Fabrication Laboratory included in an ambitious industrial project called Solar Nano Crystal, based on a partnership between crystalline silicon industry (from feedstock to modules) and public research institutions.

• Market stimulation

Since 10 July 2006, feed-in tariff for photovoltaic-generated electricity is set as indicated in Table 1.

Table 1 – Feed-in tariff for photovoltaic electricity in France from 10 July 2006 (EUR/kWh)

Feed-in tariff	Mainland France		French overseas departments and Corsica	
	2007	**2008** (value corrected of price index)	**2007**	**2008** (value corrected of price index)
Basic tariff	0,30	0,31193	0,40	0,41591
Building integration premium	0,25	0,25594	0,15	0,15596
Feed-in BIPV	0,55	0,57187	0,55	0,57187

Feed-in tariff contracts are signed for a 20 year period and will be revised every year on the basis of a specific inflation index. This measure confirms the governmental and ADEME policy of promoting the BIPV concept

French government decided through this “boosting” policy to put a special focus on building-integrated photovoltaics (BIPV) and thus to include photovoltaics as an element of buildings.

Other incentive measures are:

- Tax credit for 50 % of photovoltaic modules and other equipments costs with an 8 000 EUR cap per income-tax contributor.
- For off-grid isolated dwellings the specific EDF-ADEME contract has been maintained (FACE fund).

Market stimulation factors include tax credit and financial contributions of regional and departmental councils. The total amount of these contributions is not available in time for this report. Some regional and departmental councils are very active in PV promotion and offer direct grants to PV installations through regional calls for proposals.

• Outlook

The year 2007 has seen two important initiatives take place. In October 2007, in his conclusion speech of the ‘*Grenelle de l’environnement’* – (a series of public meetings involving stakeholders from the environment sector), the government has stressed his willingness to promote the development of renewable energies.
In March 2007, the European Commission has launched a fresh strategic plan (SET plan) covering new energy technology. One of its objectives is to achieve a 20% contribution of

renewable energies in the energy package by 2020. The French government has adopted these objectives.
A total operational photovoltaic power of 5,4 GW in France by 2020 is advocated by working groups of '*Grenelle de l'environnement'*. At the same time the government has decided to reinforce R&D activity on crystalline silicon materials and new products for building integration.

2 Implementation of photovoltaic systems

2.1 Applications for photovoltaics

Before 2000, photovoltaic applications in France were mainly focused on rural electrification.

Grid connection is now the major application of PV as well in continental France as in Corsica and overseas French departments (DOM). The main application is roof-top systems either with a few kW (< 10 kW) for private owners or with larger installations (> 10 kW) for public buildings like schools or commercial buildings. A strong emphasis is placed on building integration as reflected by the high feed-in tariff of 0,55 EUR/kWh.

The average power of a grid connected photovoltaic installed in France-mainland in 2007 is 3,7 kW (3,2 kW at end of 2006).

There are more and more installations in the 10 kW-100 kW range of and the largest photovoltaic system installed on a roof during 2007 (256 kW) is the Geoffroy Guichard stadium in Saint-Étienne.

During 2007, no large photovoltaic plant (several MW) was installed in France but some major projects are under preparation (see section 2.3).

The regional councils have launched calls for projects in 2007 representing several megawatts. The large majority of these photovoltaic installations are on buildings in urban environment.

According to a recent survey made by a private consultancy and based on a questionnaire sent to French installers, BIPV accounts for over 80 % of the grid connected applications in continental France in 2007 primarily in the residential sector. On the other hand in the overseas departments (DOM) where the basic PV feed-in tariff is higher, the installations on large roofing surfaces account for the majority of the market (building added-on applications). Several large PV power plants projects (between 1 MW and 15 MW) are being finalized in these departments.

2.2 Total photovoltaic power installed

Operational photovoltaic capacity recorded in France[2] at the end of 2007 was estimated at 75,2 MW which accounts for the annual production of about 70 GWh of electricity.

According to a survey carried out by ADEME the overall power of PV systems installed in France during the year 2007 is estimated at 31,3 MW, of which 96 % (30,3 MW) is a grid-connected application, which represents a significant increase against the previous year (10,9 MW in 2006).

The installed power of off-grid systems decreased, with around 1 MW. This figure includes the replacement of installations at the end of their life and the reinforcement of existing installations as well as the installation of new equipment.

The results of ADEME's survey (see annex A) differ from other figures published elsewhere. The SER (*Syndicat des énergies renouvelables,* www.enr.fr) proposes a market figure in the range of

[2] France means here, mainland France and Corsica Island and the four French overseas departments: Guadeloupe, Guyane, Martinique and Réunion that are important users of photovoltaic energy systems.

30 MW to 35 MW. ENERPLAN (*Association professionnelle de l'énergie solaire*, www.enerplan;asso.fr) speaks of 45 MW. ERDF, the national grid operator (www.erdfdistribution.fr) considers physically grid-connected systems which amounted to 12 MW in 2007 and claims a waiting list of contracts to be signed of 62 MW (end 2007). ERDF recognizes a160 days delay to get effective connection of PV system to the grid.

Table 2 and Table 3 show figures of the observed trend over the last five years

Table 2 – Annual installed photovoltaic power in 4 sub-markets in France (ADEME survey)

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

As seen on Figure 2 the impact of July 2006 feed-in tariffs and 2007 local authorities' incentives has been strong and has boosted grid connected applications which represents 96 % of the 2007 photovoltaic installed capacity.

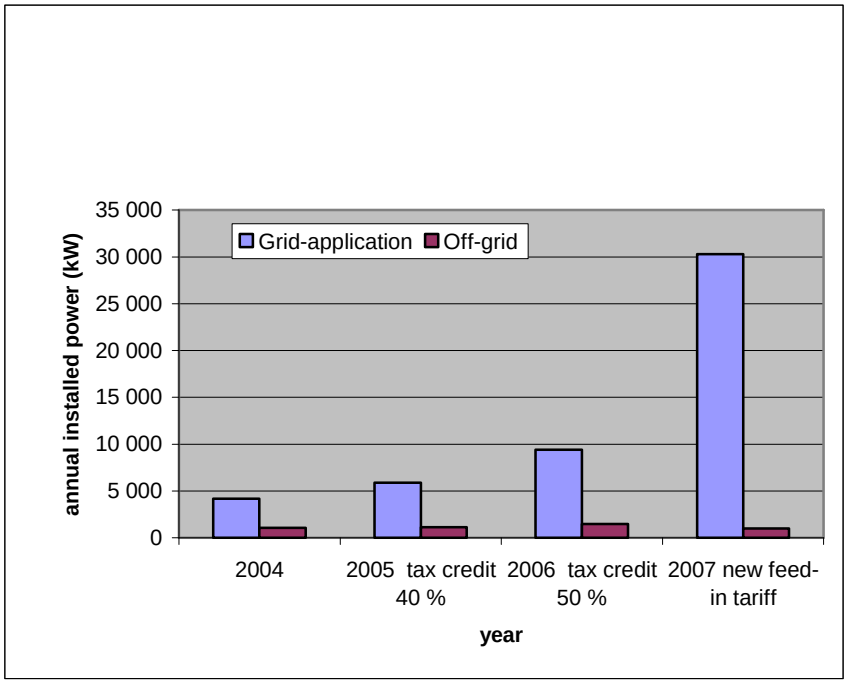

Figure 2 – PV power installed annually in France 2004-2007

Table 3 – Cumulative installed photovoltaic power in 4 sub-markets in France (ADEME survey)

Sub-market/ application	31 Dec. 2002 kW	31 Dec. 2003 kW	31 Dec. 2004 kW	31 Dec. 2005 kW	31 Dec 2006 kW	**31 Dec 2007 kW**
off-grid domestic	10 437	11 924	13 024	13 844	15 015	**15 881**
off-grid non-domestic	4 862	5 332	5 932	6 232	6 539	**6 666**
grid-connected distributed	1 942	3 817	7 067	12 967	22 379	**52 685**
grid-connected centralized	0	0	0	0	0	**0**
TOTAL	17 241	21 072	26 023	33 043	43 933	**75 232**

2.3 National photovoltaic implementation highlights in France, major projects

2.3.1 Highlights

French photovoltaic modules manufacturers have increased their share of the national market. New investments in production equipment have been undertaken to increase production capacity.

The company SECHILIENNE-SIDEC operates 2 MW PV systems in overseas departments and has installed 5 MW in 2007.

Another positive aspect of year 2007 is the strong involvement of the regional and departmental councils which have financially supported PV installations. Different support strategies have been implemented to stimulate the market (as detailed in section 2.5.1).

2.3.2 Other developments

The Energy group POWEO has announced a project dedicated to a 12 MW solar plant in Toreilles (south of France near Perpignan). A first phase of 2,2 MW is under design. The implementation of a PV plant on a 6 ha area should start mid 2008. It will be the first private PV plant on continental France.

SOLAIRE DIRECT (Demeter, Techfund and Schneider Electric Ventures) is the first French electricity operator totally dedicated to solar energy. The company has contracted a project with the financial actor "*Caisse des Dépôts*" to create a new company "SOLAR DURANCE", a subsidiary which will build and operate five solar parks along the Durance for a total installed power of 32 MW. EDF Energies Nouvelles (EDF EN) has ordered Photowatt c-Si modules dedicated to projects in France, Spain, Greece and Italy. On another hand, the company has contracted First Solar to supply thin film CdTe/CdS modules from mid 2007 to end 2012 in order to secure new programmes that EDF EN intends to develop in Europe and the United-States.

The company SECHILIENNE-SIDEC has signed in September 2007 an agreement with the city of Saint-Laurent-du-Maroni (Guyane) to implement a 12 MW PV plant whose production in 2009.

AEROWATT which is an independent electricity producer from wind energy is entering the photovoltaic market in partnership with APEX BP SOLAR; AEROWATT has signed an agreement for a programme of PV plants to be connected to the grid.

PHOTON POWER TECHNOLOGIES (PPT) who intends to sale, install and operate systems is expanding with the present favourable conditions for PV grid connection; PPT is also partner of EDF for the supply and installation of 2 kW and 3 kW household systems.

The Ministry of Defence is studying the opportunity to install a very large photovoltaic park (60 ha) on the military aeroplane facilities of Istres in the south of France. The project could include two plants of 12 MW each and additional roof photovoltaic generators for a total production capacity of 30 GWh per year. The equipments should be installed and operated through a partnership with a private company during 20 years and then restored to the Ministry of Defence.

The town of Paris adopted a programme *Plan Climat pour Paris* in October 2007. One of the first realisation will be a PV roof equipment of 3 000 m².

Many public bodies promote PV via demonstration projects: as an illustration of this policy, the regional council of Midi-Pyrénées has installed a 39 kW photovoltaic plant on the council building roof.

As previously mentioned a roof of 216 kW has been installed on the Geoffroy Guichard stadium in Saint-Étienne (Rhône-Alpes region). This stadium has hosted the World Rugby Cup. The product used for this installation is an innovation developed through a RTD project partially funded by ADEME.

2.3.3 Difficulties and delays in implementation

One difficulty to be mentioned is the lack of skilled installers resulting from the quickly increasing demand. Large efforts on education and training provided by ADEME, INES (*Institut national de l'énergie solaire* www.ines-solaire.fr), professional associations and industry have been undertaken (see also section 4.3)

Another difficulty is generated by the non-technical and administrative entities that are legally involved in any building construction or modification project and which are not prepared to deal with photovoltaic systems. As a consequence, they show a tendency to ask for excessive guarantees and to delay their agreement. This administrative burden should decrease with photovoltaics becoming an ordinary building component. In the same way, discussions are undertaken with environment protection authorities to solve conflicts in many areas where roofs and façades are part of the historical patrimony.

The number of application forms for grid connection licence has increased over 120 % in the last 9 months of 2007 (source SER). Consequently 5 to 8 months were necessary to obtain the grid connection contract. In order to solve these difficulties the SER is promoting actions to simplify the administrative and technical constraints. If agreed, it is expected to reduce the average delay from 155 days to 80 days, which would be a strong factor for the PV market to increase in 2008.

2.4 Highlights of R&D

2.4.1 The National R&D management

Photovoltaic R&D activity is now financed by two public organizations ADEME (historical backer) and ANR (*Agence nationale de la recherche*) created early 2005 (www.agence-nationale-recherche.fr). A third National Agency called OSEO will also fund PV industrial R&D from 2008.

The ADEME's Solar *Photovoltaic electricity* programme includes five activities managed by different divisions and departments:

- Support for industrial R&D related to PV components and systems. Note that the funds are complementary to those provided by other National Agencies;

- Market stimulation (with the help of the regional delegations of ADEME and often in collaboration with the regional councils);
- Training of electricians and project sponsors (professional training course) and training through research (doctorate grants);
- International collaborations with similar agencies on specific research projects;
- Dissemination of information (conferences, publication of proceedings, technical guides, fact sheets for the general public, etc.).

These activities match ADEME's four tasks which are specified in the new objectives ADEME-STATE contract (2007-2010): know, convince and mobilize, advise and, help to realize.

ANR aims to support fundamental R&D as well as applicative R&D projects. ANR and ADEME promote partnerships between public and private sectors and are contributing to the dissemination of public R&D results to the industry.

For the last two years (2006 and 2007) ADEME and ANR agencies have launched a common call for proposals. Proposals are evaluated by independent experts and are selected by a committee involving experts of which half have an industrial background and half are academics.

Objectives 2005-2007 are the following:

1) to give priority to silicon and thin-films (Si and CIS) projects;

2) to continue support on new concepts (3rd generation);

3) to optimize photovoltaic power system (interfaces, storage, BIPV products, modelling) and,

4) to support organic materials research particularly in the framework of European collaborations.

BIPV projects can also be supported by another research programme called PREBAT, a national programme devoted to R&D for buildings and managed by ADEME and ANR. Also, projects that are mostly a proof of concept can be submitted to the ANR basic research programme named "*programme blanc*".

The projects run from two to three years. Project evaluation and review is shared between both agencies, near market pre competitive development projects being especially taken into account by ADEME.

In the 2007 joint call for proposals nine new projects were selected. These projects have been agreed by ANR and ADEME to be supported through a global budget of 8,8 MEUR. These projects are:

- CRISILAL (thin film on metallic alloys),
- DLD photovoltaic (fault detection and localisation on photovoltaic systems),
- ESPRIT (grid-connected inverter issues)
- MULTIXEN (low cost / high efficiency multicrystalline silicon),
- PHYSIPO (photovoltaic hybrid Si polymer cells),
- POLYSIVERRE (polycrystalline Si thin film photovoltaic cells on glass-ceramics substrate),
- SEG-Si (electromagnetic silicon process),
- SiNPA (silicon nitride deposition at atmospheric pressure)
- SPARCS (photonic structures for photovoltaic cell efficiency improvement),

Other R&D projects were directly funded by ADEME without going through the joint annual call for proposals (SILEQ, a study of light element, contribution to IEA PVPS programme and particularly Task 10 and Task 11, contribution to IEC programme dedicated to Technical Specifications for rural electrification (IEC 62257), etc.).

In December 2007 was held in Chambéry a contractors' seminar in order to follow-up the on going R&D 2005 projects funded by ANR which are split in three categories: silicon and thin films, new concepts and systems.

2.4.2 Development of the National Institute of Solar Energy (INES)

The National Institute of Solar Energy (INES), based in Le Bourget-du-Lac (near Aix-les-Bains, Savoie department) is growing fast. The INES Research, Development Innovation (RDI) division counts now (mid 2008) 160 staff stemming from founder organizations CEA, CNRS and University of Savoie. The RDI photovoltaic platform encompasses activities from components to systems with five laboratories: Silicon materials, PV cells, PV modules, PV systems and electrochemical storage.

Other INES-RDI activities include solar thermal projects and building integration of components (solar PV and solar thermal).

INES-RDI and INES-EDUCATION (the second division dealing with training and dissemination of information) are receiving grants for initial investments from the departmental council of Savoie (buildings), the regional council of Rhône-Alpes (equipments) and research grants from national public agencies. CEA and CNRS also contribute to their budget. By 2010 the Institute will cover an area of 17 000 m² and will count 250 people.

INES-RDI participates in several projects funded by ANR and is also a partner of a new European Commission project called HETSI on high efficiency silicon cells. INES will be a partner of the new Solar Nano Crystal project described below (see PV Alliance Lab-Fab).

2.4.3 National conferences and PV events

Several PV conferences concerning photovoltaics were organized by ADEME in 2007.

The first one, "Sustainable Construction with Photovoltaics" was held in Lyon on 15 February 2007. Approximately 500 people attended.

Following the "*Grenelle de l'Environnement*" recommendations "to build another way" ADEME and ENERPLAN (French solar energy professional association) have organised in November 2007 the 4th colloquium dedicated to "Solar energy and construction" at the *Palais de la Bourse* in Paris. This colloquium, common to solar photovoltaics and solar thermal was meant to attract professionals from the construction industry (some 30 % of the attendees). It will be held again in 2008 under the name "Renewable Energies and Construction" with the introduction of biomass and heat pumps.

In March 2007, a national "Solar photovoltaic electricity" conference dealing with R&D, materials, products and systems was organised by the SOLAR PV programme and PREBAT programme of ADEME and ANR. In order to allow participants to visit the newly installed laboratories of INES, the event was organised in Aix-les-Bains. Proceedings of the photovoltaic colloquiums (on CD-ROM) are available (in French only) upon request to ADEME or ANR.

On 8 December 2007 was held in Montpellier, on the initiative of the Languedoc-Roussillon regional council the *Salon Energaia* International exhibition on renewable energies. Professionals from 63 different countries attended the exhibition, with a high participation from the Mediterranean area.

Mid-December was held in Chambéry the ANR R&D projects evaluation seminar open to all the PV community.

2.4.4 Competitiveness clusters

Three of the 66 competitiveness clusters launched in 2005/2006 all over the country are dealing with photovoltaic projects:

- Tenerrdis in Rhônes-Alpes region: 9 partners are developing a competitive solution for grid-connected photovoltaic system: architecture, components, monitoring and fault detection;
- Derbi (acronym for *Développement des énergies renouvelables dans le bâtiment et l'industrie* ») in Languedoc-Roussillon region;
- Capenergies in Provence – Alpes – Côte d'Azur region: projects on new cell technologies, photovoltaic equipment, test platform, photovoltaic plants.

Each cluster can get funding from OSEO Innovation, ANR, ADEME and local authorities.

2.4.5 PV Alliance Lab-Fab

The PV Alliance Lab-Fab consortium between PHOTOWATT, EDF (EDEV EnR REPARTIES) and CEA/VALORISATION was launched in November 2007. The principal goal is to share knowledge and know-how from R&D and industry through a common manufacturing laboratory "Lab-Fab" (a pilot production line for PV cells prototypes). This pilot will be implemented in Bourgoin-Jallieu (where Photowatt is located) in order to validate innovations at an industrial scale. The planned annual capacity of the production line will be 25 MW. A five-year R&D project called SOLAR NANO CRYSTAL including PV Alliance partners and all the main actors of silicon based industry in France was submitted to national Agency for Innovation OSEO. Regional, departmental and local authorities will financially participate to the construction of facilities.

2.5 Budgets for R&D and market stimulation

The 2007 public photovoltaic R&D intervention budget of both ADEME and ANR amounts to 8,8 MEUR. Own contribution of public laboratories such as CEA, CNRS, universities and institutions (up to 50 % of personnel costs are covered by ADEME and ANR projects) to national or European EC/FP R&D contracts are not included in the above figure.

Public budget for market stimulation was not available when this report was written since it was difficult to evaluate the amount of tax credit attributed to private PV installations and the various subsidies granted from regional and departmental councils. Feed-in tariffs are not considered as public subsidy since they are funded through the CSPE tax (a fund based on an electricity tax paid by consumers through their bills) managed by ERDF.

2.5.1 Market stimulation

Since 10 July 2006, feed-in tariff for photovoltaic-generated electricity is set as indicated in Table 4.

Table 4 – Feed-in tariff for photovoltaic electricity in France from 10 July 2006 (EUR/kWh)

Feed-in tariff	Mainland France		French overseas departments and Corsica	
	2007	**2008** (value corrected of price index)	**2007**	**2008** (value corrected of price index)
Basic tariff	0,30	0,31193	0,40	0,41591
Building integration premium	0,25	0,25594	0,15	0,15596
Feed-in BIPV	0,55	0,57187	0,55	0,57187

Feed-in tariff contracts are signed for a 20 year period and will be revised every year on the basis of a specific inflation index. This measure confirms the governmental and ADEME policy of promoting the BIPV concept

French government decided through this “boosting” policy to put a special focus on building-integrated photovoltaics (BIPV) and thus to include photovoltaics as an element of buildings.

Other incentive measures are:

- Tax credit amounts for 50 % of photovoltaic modules and other equipments costs with an 8 000 EUR cap per income-tax contributor.
- For off-grid isolated dwellings, the specific EDF-ADEME contract has been maintained (FACE fund).

Market stimulation factors include tax credit and financial contributions of regional and departmental councils. Total amount of this contribution was not available in time for this report.

Different strategies and support models have been implemented to stimulate the market. As an illustration, several examples are mentioned here.

The support of the Rhône-Alpes regional council for the implementation of industrial facilities and R&D laboratories is strong. Rhône-Alpes region is considered as the most important location in France for PV activities: 38 % of the national PV industrial activities are located there (source Regional council). More than 1 000 installations have been implemented in 2007 (three times more than in 2006). In addition to household projects support, the regional council has launched a call for projects for collective bodies. To be selected, projects must be of an interest for the development of the PV value chain, or dedicated to PV system implementation or energy efficiency improvement in public buildings. Subsidies are allocated from 0,5 to 3 EUR per watt with a maximum contribution of 150 000 EUR per project.

Provence – Alpes – Côte d’Azur regional council has implemented a programme called “AGIR” for the promotion of energy management and renewables. PV installed capacity has been multiplied by ten between 2006 and 2007.

Languedoc-Roussillon regional council is also very active supporting the renewable energy sector; as an illustration a special item of the regional budget is dedicated to it and more specifically to the development of renewable energies in the social building sector. Since 2005 the regional council has launched several calls for projects: 90 projects have been selected, for a total of 2,2 MW.

Midi-Pyrénées regional council launched in 2007 a call for projects for 3 kW to 36 kW installations for a total capacity of 300 kW.

Pays-de-la-Loire regional council has initiated a new strategy to cut down costs, i.e. a scale economy process: the council promotes projects where partners work together in order to negotiate higher volumes of equipment from the suppliers as well as to optimise installation costs via a common plan of action. Subsidies are given to operators who are able to manage such organisation.

The Alpes-Maritimes Departmental council has launched in 2007 a project called “100 blue roofs”. The objective is to be able to install in the next period of ten years 100 grid-connected PV systems from 5 kW to 50 kW on public buildings such as schools, libraries and administrative buildings. Selected projects will receive subsidies from 20 % to 80 % of the investment.

Of the total financial grants allocated by cities, cluster of cities, departments and regions (source CLER, *Comité de liaison des énergies renouvelables,* www.cler.org) which have been identified:

- 45 % of grants are based on a fixed amount contract;
- 55 % of grants are proportional to characteristics of the project (W or m² or kWh, or EUR).

Table 5 gives an overview of the project's characteristics considered by the local authorities to calculate the proportional subsidies.

Table 5 – Evaluation basis for proportional subsidies attributed through local authorities

System characteristic	Percentage of projects using this characteristics as a basis to calculate the subsidies
Power of the system (W)	50 %
Amount of the investment costs (EUR)	38 %
Expected annual energy production (kWh)	9 %
Area of the installed PV modules (m²)	3 %

The fixed subsidies are from 100 EUR up to 1 500 EUR and 2 000 EUR per system in some situations if the building hosting the PV system is already energy efficient. The highest identified subsidy is 2 500 EUR for an installed power superior to 2 kW.
Some other specific conditions can be required such as an annual energy production exceeding 1 000 kWh.

3 Industry and growth

An overview of the complete photovoltaic value chain in France 2007 is illustrated in the Table 6.

Table 6 – Photovoltaic value chain actors in France 2007

Number of actors involved in the PV sector from photovoltaic material to photovoltaic installed systems							
Si feedstock	**mc-Si Ingots**	**PV Cells**	**PV Modules (mc-Si & a-Si)**	**Other PV products and BOS manufacturers**	**Distributors***	**Consulting/ Planning/ Engineering/ System integrators***	**Installers***
2 (on going industrial investment)	2	1	4	~10	~ 20 French distributors ~30 distribution subsidiaries of international producers / wholesalers	~ 45 companies	~ 630 firms all over the territory

(*) source portail-solaire.com)

The French photovoltaic industry relies upon a few motivated actors acting since the early 1980s: Photowatt International (multicrystalline silicon ingots/wafers/cells/modules and systems), Apex BP Solar (photovoltaic components and systems), Tenesol (previously called Total Energie, photovoltaic modules, components and systems), Free Energy (amorphous silicon modules and systems) and Solems (amorphous silicon modules for OEM).

New firms have recently become involved in this industry: Emix (multicrystalline silicon ingots), FerroPem (feedstock Si material), Apollon (multicrystalline Si casting process and photovoltaic module process), Solarforce (silicon ribbon) alongside equipment manufacturers: ECM, Semco, Vesuvius, etc. and storage batteries manufacturers.

Construction components manufacturers have also entered the field: Imerys-Toiture, Lafarge-Couverture, Arcelor, Sunland21, Kawneer, Schueco France, etc.

Large groups, either in energy business such as EDF and TOTAL or in glass business such as Saint-Gobain, have traditionally been involved in photovoltaic activities both as stakeholders in medium-size companies, and as sponsors and/or partners in R&D projects.

3.1 Feedstock production

Two industrial silicon feedstock production facilities are under development under the names of Silpro and Photosil

3.1.1 SILPRO (Silicium de Provence)

In March 2007 the SILPRO company in Saint-Auban (in Provence area) was launched.

SILPRO is a European consortium of three companies: Photon Power Technologies (PPT, France), Econcern (The Netherlands) and Norsun (Norway). The production plant is under construction near ARKEMA and Degussa facilities (for the chlorosilane production). The licence to operate could be issued in 2008 for an annual full year capacity of 4 000 tonnes of silicon.

3.1.2 PHOTOSIL

The companies Invensil/Ferropem and Apollon Solar have completed the construction of a silicon feedstock manufacturing pilot plant (annual capacity of 200 tonnes) in 2007. This project, called PHOTOSIL, in which CEA and CNRS are collaborating, has received funds from ADEME and the local communities. Based in Bourget-du-Lac, the pilot is located near the INES institute (National Institute of Solar Energy).
The PHOTOSIL project (2005-2008) aims at demonstrating the production of solar photovoltaic grade silicon (SOG) by the metallurgical route. Based on the FerroPem know-how for high quality metallurgical grade silicon, Apollon Solar new ingot casting technique, and EPM/CNRS inductive plasma purification experience, PHOTOSIL investigates fusion-segregation and plasma purification to reach the SOG required purity.

3.2 Ingots and wafers production

Table 7 presents a list of the main silicon ingots and wafers manufacturers and the type of process they use.

Table 7– Ingot and wafer production and capacity in France (2007)

Producers	Process & technology	Total annual production	Maximum annual production capacity	Product destination
PHOTOWATT	Ingots (mc-Si)	500 tonnes	500 tonnes	In-house
PHOTOWATT	Wafers (mc-Si)	40 MW (cell equivalent)	45 MW (cell equivalent)	In-house
EMIX	Ingots (mc-Si)	70 tonnes	360 tonnes (with on going invests)	Export FR and abroad

mc-Si: cast multicrystalline silicon

3.2.1 Photowatt International

Photowatt International S.A.S. is a subsidiary of Automation Tooling Systems Inc. (ATS) a Canadian company.

Photowatt is a vertical integrated company located in Bourgoin-Jallieu near Lyon (495 employees) and manufactures multicrystalline silicon ingots, wafers, photovoltaic cells and modules with a 3-shift manufacturing capacity of 45 MW per year.

Photowatt International has been manufacturing photovoltaic cells and modules since 1978. The Company manufactures multicrystalline silicon square wafers and cells of 12,5 cm x 12,5 cm (currently in production) and 15 cm x 15 cm. Standard photovoltaic cells are blue in colour but Photowatt manufactures brown-grey cells suitable for tiled roof integration.

The main features of the production process are the following:

- Ingot casting based on the Heat Exchange Method. The multicrystalline material is obtained by directional solidification from off-grade electronic silicon scraps (ingot up to 400 kg);
- Wire slicing of ingots into bricks and bricks into wafers, a technology pioneered by Photowatt;
- Automated cell process including surface passivation by plasma enhanced CVD and silk screen printing of front and rear contacts;
- Module manufacturing (glass/glass laminate, or glass/tedlar), aluminium frame

The company has on-going R&D contracts with ADEME (4-year, 2004-2008 “REDUCOP” project), ANR and the European Commission (partner of “Crystal-clear” project). R&D projects include larger and thinner cells, higher conversion efficiency and development of new processes to reduce production costs and to recycle effluents and wastes.

3.2.2 Emix

Emix Company (25 persons) has developed a semi-continuous electromagnetic ingot casting technology with a cold crucible based on the work achieved at SIMAP/EPM, a CNRS laboratory located on the Grenoble campus.

Two machines with a 120 tonnes annual capacity were put into operation in 2007. Each machine produces a continuous ingot with a 34 cm x 34 cm cross-section. Ingots are cut every 50 cm and divided into four 15 cm x 15 cm x 50 cm bricks, ready to be sawed by clients. The casting is only slightly purifying and thus requires high purity grade silicon feedstock, but an important R&D project “NEPSOS” (ANR funding) has been initiated to include a purification step through inductive plasma torch. This investment will boost the annual capacity up to 360 tonnes.

3.3 Photovoltaic cells and modules production

Table 8 lists photovoltaic cells and photovoltaic modules manufacturers based in France.

Table 8 – Photovoltaic cell and module production and capacity in France (2007)

Cell/module manufacturer	Technology	Total production (MW/year)		Production capacity (MW/year)	
		Cell	Module	Cell	Module
PHOTOWATT	mc-Si	**38,5**	**38,5**	**60**	**45**
TENESOL	mc-Si	**0**	**15**	**0**	**15**
FREE ENERGY	a-Si:H	**0,5**	**0,5**	**1**	**1**
TOTALS		**39**	**71**	**61**	**146**

sc-Si: single crystalline silicon; mc-Si: cast multicrystalline silicon; a-Si:H: thin film amorphous silicon

3.3.1 Photowatt International

Photowatt module technology is based on glass/glass laminate and on glass/tedlar with aluminium frame. Photovoltaic modules specially designed for utility applications in the range of 80 W, 125 W and 165 W (high insulation modules, façade and roof top modules) are produced to satisfy specific demands of customers. The firm offers a 25-year warranty on its photovoltaic modules.

Photowatt has implemented the ISO 9002 quality procedure and the modules they produce are certified within the International Electrotechnical Commission Standard IEC 61215 and the ESTI 503 European specification.

Photowatt is also a photovoltaic system integrator. The company offers a range of standardized systems.

In the field of BIPV modules, Photowatt is working on new products of its own design or together with Imerys Toiture and Clipsol companies.

3.3.2 Tenesol

Tenesol, formerly Total-Energie is a subsidiary of the oil company Total and the electricity utility EDF. Tenesol is a photovoltaic system installer and photovoltaic system components developer.

A new subsidiary called Tenesol Technologies has started in 2006 production of large photovoltaic modules (200 W range) in Toulouse. The crystalline silicon photovoltaic cells are mainly purchased in Germany. The new factory's building (inaugurated at the end of the year 2006) integrates a 20 kW BIPV system

With an on going investment for new production lines the annual production capacity of Tenesol technologies will reach 45 MW early 2008.

Tenesol holds also a photovoltaic module factory in Cape Town, South Africa (capacity 45 MW per year).

3.3.3 Imerys-toiture

Imerys-Toiture is the first French fire-clay tiles manufacturer.

Imerys has introduced a new photovoltaic module which presents the same height as standard flat interlocking clay tiles and can be inserted into tiled roofs without requiring a modification of the roof frame. The tiles are made from multicrystalline silicon cells and can be delivered in different colours and are marketed as a 1 kW kit (inverter, wiring and modules).

3.3.4 Free energy

Free Energy manufactures thin film hydrogenated amorphous silicon photovoltaic modules (31 cm x 92 cm). The manufacturing plant, located in Lens (North of France) produces around 0,5 MW per year with an annual capacity of 1 MW (3 shifts). The amorphous silicon technology is derived from the initial Chronar Corp. process with a few modifications. Modules of 5 W, 7 W, 14 W and 19 W are IEC 61646 certified and their power output is guaranteed for 10 years.

3.4 Manufacturers and suppliers of other components

• Photovoltaic inverters

Tenesol developed inverters with different options in order to satisfy specific user's needs (remote control, etc.). Grid-connection inverters commercialized by other companies are mainly purchased outside of France.

• Storage batteries

Main automotive battery makers are commercialising "solar" types for photovoltaic applications: Oldham/Hawker, CEAC/Exide, etc. The main technology is lead-acid, stationary or monobloc type, with a tubular positive electrode (capacity C10 ranging from 100 Ah to 900 Ah) or valve regulated (gelified electrolyte or glass mat absorbed) for small capacities. The companies have designed batteries that are more suitable for the charging regimes associated with photovoltaics and hybrid applications.

SAFT Company manufactures and commercializes Ni-metal-hydride and lithium-ion batteries. Some Li-ion accumulators are tested for photovoltaic applications in the frame of public research laboratory cooperation (CEA/INES) under an ADEME contract.

The storage batteries must refer to French standards NF C 58400 and/or to the recent NF C 58510 for photovoltaic accumulators. In addition, technical rules recommend that for all stand-alone photovoltaic systems used for rural electrification and receiving FACE funding (rural electrification scheme), storage accumulators must be installed in a purposely-built shed.

• Battery charge controllers

Most of the active companies in photovoltaics have their own type of multi-function charge controllers. Tenesol and Apex BP Solar have developed and still continue to improve their custom-made controllers with a central processor unit allowing detailed monitoring of photovoltaic systems and pre-payment facility. The controllers are designed to match the specific requirements of storage batteries manufacturers. Such an adaptation prolongs the life-time of lead-acid batteries.

• Consultancies, associations

Consulting companies involved in market survey, new products development, project management, standardization contribute to the benefit of photovoltaic activity in France. The companies Cythélia, IED, PHK, Sert, Tecsol, Transénergie and a non-governmental organization Fondem are involved in project management and strategic marketing studies funded by ADEME, the European Commission, development banks and utilities. ASDER, CLER, ENERPLAN and Hespul, associations along with SER (French Industry Federation for renewable energies) are also very active in promoting photovoltaics. SER holds every June a well attended colloquium gathering ministers and decision makers.

New small local engineering companies have been created and a large movement of staff going from one company to another has been observed.

• Photovoltaic system companies

There are two photovoltaic system companies in France which have an annual turnover superior to 30 MEUR: Tenesol and its overseas Departments subsidiaries (Solelec Caraïbes, Solelec Réunion) and, Apex BP Solar and its overseas department offices (Caraïbes, Indian Ocean and Guyane). Photowatt is also involved in grid-connected photovoltaic systems: its activity is described above. Apex BP Solar, a subsidiary of BP-France, installs photovoltaic modules manufactured by BP-Solar in Spain or other places. Tenesol, Apex BP Solar and Photowatt are also active in installing photovoltaic systems abroad. Other active companies are Naps-France, Solarcom-Lyon, Sunwatt-

France, 3T France, Conergy France, etc. They use any source of photovoltaic modules and inverters available on market.

• Building components and new products

A few companies develop and commercialize photovoltaic modules adapted to building integration: Imerys-toiture, Clipsol, Lafarge-Couverture, Schueco-France, Sunland21, Arcelor/Tenesol, Kawneer/Apex, Rheinzink France, Quick step, etc. Roofing membranes are sold by Conergy France, 3T France and Urbasolar.

The new metallic-PV tile developed by Tenesol and Arcelor Mittal Construction is designed to be used on large industrial roofs. A gold medal was awarded to this product during the last BATIMAT fair held in Paris in November 2007.

APEX BP SOLAR sells especially designed roof-integrated solutions and has developed products in collaboration with façade specialist Kawneer.

New metallic-PV tiles (crystalline silicon based) from Sunland 21, with integrated electric connectors, have been highlighted during the 2007 fair BATIMAT in Paris.

Since it has been approved that PV roof membranes are to be considered as BIPV products, systems using these products are eligible to the bonus feed-in tariff (see www.industrie.gouv.fr/energie): this is an opportunity to develop the market of this product for the large commercial/warehouses building roofs. Some projects are in preparation for 2008.

3.5 French industry groups with industrial plants outside of France

The following examples below illustrate the growing difficulty to assess national contributions to the development of the photovoltaic industry since most companies (and for France, all companies quoted in this report) are subsidiaries of large international groups. The right scale to consider is now clearly the European scale. However, markets are still very different in each European country. It is confirmed that they strongly depend on national policies and in some less apparent way, on national cultures. Indeed, national industries are sensitive to local markets and large groups tend to rely upon their subsidiaries in the countries where the market is growing faster and seems to be more sustainable.

• Saint-Gobain – Shell CIS Initiative

Saint-Gobain, one of the largest world glass-maker has been involved in the past in different photovoltaic projects, including amorphous silicon thin-films with Solems. The two companies have engaged a new joint project with the construction of a CIS factory. The plant is located in Torgau, Germany. The CIS technology comes from Shell who bought it from Siemens Solar, which itself bought it from Arco Solar where it was initially developed in the eighties. Saint-Gobain has a large know-how in thin-film deposition on very large glass surfaces used in building façades.

• Total Photovoltech crystalline silicon cell/module

Total oil and gas company, GDF Suez/Electrabel/Soltech and IMEC have created Photovoltech Company. The company based in Tirlemont (Belgium) produces photovoltaic cells and modules. A new production line has been inaugurated in November 2007. The annual production capacity has increased from 20 MW to 80 MW. Future investments are expected to extend the capacity to 140 MW.

• Carbone Lorraine

In October, Carbone Lorraine, the second worldwide industrial producer of isostatic graphite has inaugurated a new plant in Chongqing (China) in order to double its capacity for this material, useful for the silicon industry.

3.6 System prices

Photovoltaic module manufacturers are not keen on publishing figures including their best price. For large quantity superior to 100 kW, the average selling price of photovoltaic module is between 3,1 EUR/W and 3,5 EUR/W. Table 9 gives a trend for PV module prices for the last ten years.

Table 9 – Typical photovoltaic module prices in EUR/W

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

Table 10 shows turnkey prices (EUR per watt, excluding VAT/sales tax) for various categories of installation.

Table 10 – Turnkey prices of typical applications (2007)

Category/Size	**Typical applications**	**Current prices EUR/W** (excluding VAT)
OFF-GRID system up to 1 kW	Rural electrification	11 to 19 depending on the local constraints
OFF-GRID system >1 kW	Rural electrification	13 to 15
GRID-CONNECTED up to 10 kW	Building added-on photovoltaic	5,5 to 6,5
	Building integrated photovoltaic	7 to 8
GRID-CONNECTED >10 kW	Building added-on photovoltaic	5,5 widely depends on the size

According to a private survey (end of year 2006) (www.outilssolaires.com) based on 300 systems installed (2 kW each), average observed turnkey prices (excluding VAT) are given in Table 11:

Table 11 – Turnkey prices of typical applications (end 2006)

Type of systems	2 kW “added-on”	2 kW “integrated”
average turnkey prices	7,80 EUR/W	8,60 EUR/W

Source outilssolaires.com

For 15 different systems (added-on and integrated) supported by the Regional council Lorraine, from 5,3 kW to 62 kW, the average turnkey price of the systems is 7,75 EUR per watt (excluding VAT).

Table 12 presents a trend of average turn-key prices (photovoltaic roof added-on and not BIPV) from 1997 to 2006 as seen by one of the photovoltaic companies in France (does not necessarily reflect national trend).

Table 12 – Trends in system prices (photovoltaic roof added-on) (EUR/W) (2007)

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
20,40	18,87	17,33	15,80	15,05	14,33	13,65	13,00	11,60	8,12	6,00

As mentioned above the demand for photovoltaic modules, components and systems has increased in 2007. A consequence of this situation is a growing number of Internet commercial websites (in

French language) where photovoltaic kits or photovoltaic components can be purchased. Typical prices as seen on Internet websites are given in Table 13.

Table 13 – Typical prices of photovoltaic components (available on Internet) (2007)

Components	**Price EUR/W** (excluding VAT)
photovoltaic system 1 to 5 kW (with inverter)	7 EUR/W
photovoltaic modules (25-250 W)	3 to 6 EUR/W (widely dependent on the volume)
photovoltaic inverters	0,5 EUR/W

3.7 New companies

French market is still dominated by major companies such as Tenesol, Apex BP Solar and Photowatt but their leadership is challenged by new actors entering the market, both coming from abroad and their home country.

Today's tendency is for these new actors to develop a wholesale structure. It is particularly true for distributors which have a foreign mother company.

New companies are offering photovoltaic projects planning, finance and installation services. The number of installers is estimated to 600 firms; most of the installation companies that are active in photovoltaics at the moment are newly founded, and specialized in the renewable energy business.

French financial institutions (*Caisse des dépôts, Crédit Agricole*) are developing financial support for PV projects.

3.8 Employment

According to figures given by the members of the SER (*Syndicat des énergies renouvelables*) around 1 500 jobs have been created in France in the PV sector from July 2006 to December 2007.

The introduction of Label Quali PV in November 2007 is an important step to structuring the network of photovoltaic installers (electricians and roofers).

4 Framework for deployment

Table 14 presents the different measures which are used in France to develop photovoltaic applications.

Table 14– Photovoltaic support measures in France (2007)

Support measure	National	Regional	Local
Increased feed-in tariffs	available	-	-
Direct capital subsidies	available for communities and industry projects	Yes, for private roof-top investors and industry/communities projects	
Tax credits	available for private investors paying income tax	-	-
Net metering	No more available since 2005	-	-
Commercial bank activities	Measures in development		
Green electricity schemes	label “EVE” (see 4.3)		

4.1 New Initiatives

The measures designed for boosting the PV market aim at diversifying energy sources that help mitigating greenhouse gas emissions.

In parallel, since 2005, the government has extended its budget for funding research and technological development (RTD) in the photovoltaic field. ADEME, the historic PV R&D sponsor, is now sharing its research interventions with two other agencies: the National Research Agency (ANR) and the OSEO Agency (Innovation in the industry).

Year 2007 has seen two important initiatives:

In October 2007, in his conclusion speech of the “*Grenelle de l’environnement”* – (a series of public meetings involving stakeholders from the environment field), the President of the Republic has stressed his willingness to promote the development of renewable energies.

In parallel, the European Commission has launched a fresh strategic plan covering the new energy technologies in March 2007. One of the objectives of their plan is to achieve a 21 % contribution of renewable energies in the energy package by 2020. This would represent a total operational photovoltaic power of around 5 GW in France.

Specific tools have been implemented to select projects in order to be granted by regional councils on a case-by-case basis in the frame of calls for projects. As an example Table 15 illustrates a tool used by ADEME to assess projects to be supported by the Regional council Centre.

Table 15 – Example of BIPV projects assessment tool (Region Centre and ADEME)

Assessment criteria	Quotation basis
Quality of the building on which the system is installed	3
Quality of the integration: building functionalities integrated in the system	5
Visual positive impact of the system	5
Ability to be seen by the public	2
Economical appeal (pay back time)	2
Potential of duplication of the solution	3
Total	**20**

4.2 Indirect policy issues

The main policy initiative influencing the implementation of photovoltaic power systems in France is the European Commission target of 21 % of electricity generation from renewable energy sources by 2020.

During the year 2007, ADEME has implemented a tool called "Eco-prêt" (publicly available) in order to list and compare the different loans proposed by the different banks to finance energy savings projects, including photovoltaic installations (www2.ademe.fr/servlet/KBaseShow?cid=96&m=3&catid=20409).

4.3 Standards and codes

In France, installation of stand-alone photovoltaic systems and grid-connected systems refer to a set of codes of practices and recommendations issued by UTE, EDF and ADEME. The professional syndicate SER played an important role in developing the regulatory aspects such as connection contracts and electricity purchase contracts.

At the beginning of November 2007 a label called 'QualiPV' (www.qualit-enr.org/qualipv) has been introduced. This label dedicated to photovoltaic grid connected systems installers is managed by the label 'Qualit EnR' (dedicated to renewable energy systems).

Having passed prescribed training sessions (presently 14 training centres) and pay a fee, the candidate can sign the Installer charter and can carry the label 'QualiPV'. Another alternative is for the installers to prove they have had an experience of at least five PV installations within the past three years. Labellised installation companies commit themselves to respect the 10 items of the QualiPV charter. When choosing a labellised installer, customers may be confident in his abilities level.

With the introduction of international companies in the French market, French installers can benefit from the knowledge that has been gained in more advanced PV markets (Germany or Spain for example).

Another label called "EVE" (Electricité VErte), which is a green electricity label, has been launched by the WWF and the CLER (Association for the promotion of renewable energies (www.cler.org).

On another hand, ADEME has published two brochures in 2007: "*Guide de rédaction des cahiers de charges techniques* (Guide for writing the technical specifications)" and "*Photovoltaïque intégré au bâti* (Building integrated photovoltaics)", downloadable from ademe.fr, and has contributed to the new edition of the Guide Perseus ("How to manage a private individual photovoltaic project").

4.4 Other initiatives

A “renewable energies championship” for cities has been organised by ADEME and CLER (*Comité de liaison des énergies renouvelables*); the 112 candidates were ranked according to the installed power vs number of inhabitant ratio. For the PV category, the three winners are:

- (very small cities category < 2 000 inhabitants): Ilhes-Cabardès in Aude department, a city of 57 inhabitants, for 31,5 kW i.e. 550 W per inhabitant;
- (small and medium cities, 2 000 to 50 000 inhabitants): Sainte-Anne, in Guadeloupe department, 4 901 inhabitants, for 196 kW, i.e. 40 W per inhabitant;
- (large cities > 50 000 inhabitants): Fort-de-France in Martinique, 94 000 inhabitants, for 556 kW, i.e. 6 W per inhabitant.

PV projects for schools are widely supported by the regional councils in order to introduce the “PV culture” as soon as possible among the young people.

In the framework of an international project, Hespul, association promoting PV, has designed and filled a database dealing of worldwide photovoltaic systems installed in urban environment (www.upscale.org).

5 Highlights and prospects

There has been an important growth of the photovoltaic market fuelled by the new feed-in tariffs and fiscal measures and the active policies of regional councils. A first estimation at the beginning of 2008 shows that during the year 2007, the volume of the installations has tripled in relation to the previous year.

The ADEME’s strategy of building integration of photovoltaics encourages the development of new integrated PV products.

French PV industry is growing through a vertical integration, from feedstock production to PV system installation.

New partnerships between industrial and financial bodies are under development.

Regarding the materials, the silicon sector is the most dynamic for its R&D projects as well as for the investments made in new production equipment. It includes new projects involving the solar photovoltaic grade silicon production of feedstock and an important private-public R&D partnership called Solar Nano Crystal.

In July 2006, a national decree relative to pluriannual investments for energy has set the target for photovoltaics at 160 MW (cumulative installed capacity) by 2010 and 500 MW by 2015. In October 2007, the government launched a series of initiatives under the *Grenelle de l’environnement*. One of the working groups dealing with renewables sources of energy proposed to the government a development programme for the photovoltaics. The main objectives are the reinforcement of R&D and a strong development of the whole PV chain value for a cumulative installed PV power capacity of 1 100 MW by 2012 and 5 400 MW by 2020. From the SER point of view, the target could be set at 7 000 MW by 2020.

Annex A Method and accuracy of data

The procedure to gather data was conducted as follows. ADEME, author of the National Survey Report 2007, sent a questionnaire to its industrial partners participating to photovoltaic RTD projects and market deployment initiatives. The questionnaire written in French included the tables provided in the report. *The photovoltaic industry and operators are very busy facing the important growth of the market and found it difficult to answer ADEME's questionnaire. Nevertheless ADEME is grateful to partners who have participated to the survey.*

Commentary: there are other figures circulating for French "market". SER is speaking of a market of 30 to 35 MW (ADEME's figure corresponds to the lowest part of the estimated range), ENERPLAN publishes 45 MW, and another study mentions 75 MW. ERDF, the national grid operator considers physically grid-connected systems only 12 MW in 2007 and claims a waiting list of 62 MW (end 2007). ERDF recognizes a160 days delay to get effective connection of PV system to the grid.

ADEME is looking at what is installed and not necessarily effectively grid-connected. It is a picture of the industry activity and not an assessment of energy (kWh) actually injected into the electricity grid, a figure of interest for the ministry of Industry gathering the contribution of renewables in the national energy landscape. It is expected that ERDF figures will catch up with installed system figures and within two years ERDF figures will be the reference for the French PV National Survey Report (IEA-PVPS programme).

The accuracy of the ADEME's gathered data is estimated to be ± 15 % for the installed photovoltaic capacity and 5 % for the ingot/cell/module production.

The power capacity of PV system installed by small photovoltaic firms (less than 5 persons) –some of them new– which have not answered the questionnaire or which were not approached are not included in the Tables.

Annex B Country information

This information gives the reader an idea of the national background in which photovoltaics are being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the readers should do their own research if they require more detailed data.

1) retail electricity prices:

   – household : 0,1325 EUR/kWh (includes VAT and subscription);

   – commercial:0,09 EUR/kWh (includes VAT and subscription);

   – NOTE: CSPE tax added to household electricity bill (*Contribution aux charges de service public de l'électricité*): 0,45 eurocent per kWh. The tax supports feed-in tariffs mechanisms and other measures of *péréquation*.

2) typical household electricity consumption (kWh):

   - household without electric heating 2 500 kWh to 3 000 kWh per year;

   - energy efficient household: 1 500 kWh to 1 800 kWh per year;

   - household with electrical heating 10 000 to 15 000 kWh per year.

3) typical metering arrangements and tariff structures for electricity customers: two month interval metering, time-of-use tariff.

4) typical household income: 1 500 to 2 300 EUR net per month.

5) typical mortgage interest rate 4 % to 6 %.

6) voltage (household, typical electricity distribution network): 230 V a.c.

7) electricity industry structure and ownership: **Production**: EDF (*Électricité de France*) which does not hold the monopoly any more. Other producers: Direct Energie, Electrabel/Suez, Enercoop, Gaz de France, Poweo, etc. **Transport**: RTE (*Gestionnaire du réseau de transport d'électricité*). **Distribution**: principally ERDF (*Électricité Réseau Distribution France*) also various Municipal utilities (Strasbourg, Grenoble for example).

8) electricity industry regulator: CRE (Energy Regulation Commission, *Commission de régulation de l'énergie)*. Independent administration in charge of regulating the French electricity and gas markets.

9) price of diesel fuel for household: 0,65 EUR per litre. (end of year 2007), 0,96 EUR per litre (January 2008)

10) typical values of kWh/kW for photovoltaic systems in parts of France: fixed photovoltaic array: 770 kWh/kW in the North of France, 1 260 kWh/kW in the South of France.

11) cost of photovoltaic electricity: 0,50 EUR/kWh to 0,60 EUR/kWh (2 kW photovoltaic system): 0,30 EUR/kWh to 0,40 EUR/kWh (centralized photovoltaic plant).

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