

IEA International Energy Agency

CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS

TASK 1

Exchange and dissemination of information on PV power systems

NATIONAL SURVEY REPORT ON PV POWER APPLICATIONS IN ITALY

2007

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i Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the Organisation for Economic Co-operation and Development (OECD) which carries out a comprehensive programme of energy co-operation among its 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 21 participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia, Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey, the United Kingdom (GBR) and the United States of America (USA). The European Commission and the European Photovoltaic Industry Association are also members.

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

This report is related to the status and trends of PV power applications in Italy in 2007 and is intended for the use of IEA Photovoltaic Power System Programme experts. It has been prepared by:

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ii Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme 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. In parallel, National Survey Reports are produced annually by each Task 1 participant. The public PVPS website also plays an important role in disseminating information arising from the programme, including national information. These guidelines are intended to assist national experts and other participants of Task 1 in the preparation of their annual PVPS National Survey Reports.

The National Survey Reports are now presented on the public PVPS website and Task 1 participants should make their own arrangements with their sources on how to treat confidential information (e.g. by ensuring anonymity of the data). National Survey Reports should be produced at least by the middle of the year following the reference year (ie within six months of the collected information).

When preparing their national reports, experts must ensure that all the data are as accurate and correct as possible and follow the definitions given in these guidelines. All sections should be completed as comprehensively as possible.

iii Scope and objectives of the template

The guidelines specify the data to be collected for inclusion in the National Reports. The principles are intended to ensure that the data collected are compatible for each country. The guidelines are issued as an internal report for use by IEA-PVPS Task 1 participants.

iv Definitions, Symbols and Abbreviations

For the purposes of the National Survey Reports, the following definitions apply:

Demonstration Programme: Programme to demonstrate photovoltaic (PV) electricity production to various potential users/owners.

Field Test Programme: Programme to test the performance (eg yield and reliability) of photovoltaic (PV) systems/components in real conditions.

Final annual yield: Total photovoltaic (PV) electricity delivered to the load during the year per kW of rated PV power installed.

Grid-connected centralized PV 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 customer, and the system is not located to specifically perform functions

on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Grid-connected distributed PV system: System installed to provide electricity to a grid-connected customer or directly to the electricity grid (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 on or integrated into the customer's premises often on the customer (demand) side of the electricity meter, on public and commercial buildings, or simply in the built environment. They may be specifically designed for support of the utility distribution grid.

Market deployment initiative: Set of means to encourage the market deployment of PV through the use of market instruments such as green pricing, feed-in tariffs, tax credits, capital subsidies etc. These may be implemented by government, the finance industry, utilities, etc.

Off-grid domestic PV system: System installed to provide power mainly to a household or village not connected to the (main) electricity utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'micro-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV 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. Usually a means to store electricity is used. Also referred to as 'stand-alone PV system'.

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 kW of installed rated PV power.

Photovoltaic (PV) module manufacturer: An organisation carrying out the encapsulation of PV cells in the process of the production of PV modules.

Photovoltaic (PV) power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m², cell junction temperature of 25°C, AM 1,5 solar spectrum – (also see 'Rated power').

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

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

Rated power: Available power delivered by a PV module or array under standard test conditions (STC), written as W.

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

1 Executive summary

Photovoltaic is becoming more and more important in Italy. Feed-in tariffs introduced with the last decree seem to be adequate, large obstacles for the growing market are smoothed and Italian firms are planning to extend their capacities.

In this context:

- during the year 2007 the total power of the photovoltaic system that have been installed in Italy sums to about **70 MWp**; taking into account the cumulative power reached during the previous years, a **total power** of about **120 MWp**, with an increase around 140%, results installed in Italy at the end of 2007.
- Costs & prices are slowly going down;
- production of PV cells and modules in Italy is growing;
- expenditure on PV research and demonstration have been about 5 M€, remaining essentially flat with respect to the previous years, while the ones for market stimulation have been around 20 M€.

2 The implementation of PV systems

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

2.1 Application of PV systems

In Italy can be identified four sectors of PV power system applications:

- Off-grid domestic systems: have reached a saturation value in the late nineties; at the end of 2007 an amount of **5,4 MWp** has been evaluated for this sector;
- Off-grid non-domestic applications: slowly, but constantly increasing, it is difficult to be assessed in terms of total installed power; this sector represents with **7,7 MWp** a share of few percentages of the cumulative installed capacity in Italy;
- On-grid centralized systems: boosted in the nineties and now growing again, this sector is being allowed to benefit feed-in tariffs; at the end of 2007 an amount of **23,2 MWp** has been counted for this application;
- On-grid distributed systems: growing up to a 53,4 MWp over the last year and to **83,9 MWp** as cumulative installed power, this sector is now dominating with a share of about 70% Italy's cumulative installed power. These systems firstly promoted by the Italian roof-top Programme are continued to be supported by feed-in tariffs.

2.2 Total photovoltaic power installed

During the year 2007 the total power of the photovoltaic system that have been installed in Italy sums to about 70 MWp. Taking into account the cumulative power reached during the previous years, at the end of 2007 a total capacity of about 120 MWp, with an increase around 100%, results installed in Italy. Most of this increase has been due to the expansion

of on-grid distributed systems market that now account for about 70% of the total power installed.

The PV power installed in 4 sub-markets during 2007 should be entered in Table 1.

Table 1 - The PV power installed in 4 sub-markets during 2007.

Sub-market/ application ##	off-grid domestic	off-grid non- domestic	grid- connected distributed	grid- connected centralized	total
PV power installed in 2007 (kW)	100	200	53 400	16 500	70 200

The total cumulative installed PV power for each sub-market on the 31 December of each year from 1992 onwards is presented in Table 2.

Table 2 - The cumulative installed PV power in 4 sub-markets.

Sub-market/ application	31/12/ 92 kWp	31/12/ 93 kWp	31/12/ 94 kWp	31/12/ 95 kWp	31/12/ 96 kWp	31/12/ 97 kWp	31/12/ 98 kWp	31/12/ 99 kWp	31/12/ 00 kWp	31/12/ 01 kWp	31/12/ 02 kWp	31/12/ 03 kWp	31/12/ 04 kWp	31/12/ 05 kWp	31/12/ 06 kWp	31/12/ 07 kWp
off-grid domestic	3 950	4 350	4 700	4 830	4 962	5 052	5 210	5 220	5 240	5 300	5 300	5 300	5 300	5 300	5 300	5 400
off-grid non- domestic	3 750	4 150	4 650	4 780	4 792	4 814	5 100	5 640	5 890	6 350	6 365	6 400	6 700	7 000	7 500	7 700
on-grid distributed	100	100	150	335	404	677	780	905	1 155	1 635	3 620	7 600	12 000	18 500	30 500	83 900
on-grid centralised	680	3 480	4 590	5 850	5 850	6 166	6 590	6 715	6 715	6 715	6 715	6 700	6 700	6 700	6 700	23 200
TOTAL	8 480	12 080	14 090	15 795	16 008	16 709	17 680	18 480	19 000	20 000	22 000	26 000	30 700	37 500	50 000	120 200

Notes

- The cumulative installed power include power installed before 1992.
- Most of the power installed during 2007 regards grid-connected distributed and centralized promoted in the framework of the “conto energia” market stimulation programme. The only exception is represented by few hundred kW concerning off-grid non domestic applications.

2.3 PV implementation highlights, major projects, demonstration and field test programmes

In February 2007 a new edition of the feed-in decree has established:

- an increase of the national objective from 1 GW to 3 GW by 2016;
- an increase of the supported capacity from 500 MW to 1200 MW at which must be added the power of plants that will be built within 14 months after the supported capacity has been reached;
- the elimination of the annual limit (85 MW) and of the plant upper size limit (1 MW);
- simplified procedure: applications for admission to feed in tariffs can be submitted only after the start of plant operation;
- no permission necessary for plant installation, at least in area without environmental constraints;
- Utilities compelled to pay penalties for delays in regard to grid connection of PV systems.
- new tariffs for the produced energy by PV plants.

The new tariffs result increased in values, if compared with previous decrees, accordingly to the degree of PV integration in the building (up to 49 c€/kWh), and higher for small size plants but reduced for large plants, especially free standing (36 c€/kWh)

Tariffs remain valid for a period of 20 years at constant remuneration and decreased by 2% each calendar year, for applications submitted after 2008. At the tariffs must be added the further value deriving from the sale of the energy produced (about 9-13 c€/kWh) or the self consumption (about 15 c€/kWh) also through net metering.

A further novelty regards the energy efficiency interventions in buildings: in this cases tariffs are increased up to 30%, depending on energy saving level achieved.

Finally, a 5% tariff increase is instead allowed to self-producers, public schools and hospitals, small Municipalities or in case of asbestos roofs substitution.

New PV policy initiatives starting in 2007 concern the obligation of installing at least 1 kW PV in new buildings. This obligation will be operating in 2009.

Moreover, an interesting initiative of the public stakeholder AEEG (National Authority for Electric Energy and Gas) regard the simplification of the procedure for the connection of plants to the grid. It is expected that this scheme will considerably reduce the time for the completion of PV plants.

2.4 Highlights of R&D

Research, development and demonstration activities on photovoltaics devices and systems are mainly conducted by ENEA (the Italian Agency for New Technology, Energy and the Environment), CESI RICERCA (a research company owned by ENEA and CESI, the Institute for Research and Certification of Electric Components and Systems), some Universities, CNR (the National Council for Scientific Research) and private Laboratory.

ENEA is the main PV Research organization operating in Italy. Its most significant fields of interest regard: crystalline silicon, Cu_2O solar cells, microcrystalline Si devices, micromorph tandem solar cell as well as concentrators technologies. In this last contest, in order to

assess the technical and economical feasibility of this application is carrying out experimental activities on standard units of 5 kW.

CESI RICERCA is carrying out activities in research and development on high efficiency single and triple junction solar cells (InGaP/InGaAs/Ge) for terrestrial applications and for concentrator applications. Furthermore, is involved in components' characterization and performance evaluation of PV systems. In the field of PV systems, CESI RICERCA is involved on research and demonstration activities for electrification of remote communities.

2.5 Public budgets for market stimulation, demonstration / field test programmes and R&D

Public budget for R&D and market incentives totalled about 25 M€ in the year 2007. In particular, expenditure on PV research and demonstration have been about 5 million of Euro, remaining essentially flat with respect to the previous years while the ones for market stimulation have been around 20 M€. Table 3 gives figures, for the year 2007, on budgets in National Currency from the authorities for R&D, demonstration and market incentives (public subsidies, fiscal incentives, and amounts collected) on the national/federal level, and on the state/regional level.

Table 3 - Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test	Market
National/federal	5 M €	0.2 M€	20 M€
State/regional			
Total	5 M €	0.2 M€	20 M€

3 Industry and growth

3.1 Production of feedstocks, ingots and wafers

Although some initiatives announced, during the year 2007 have not been produced ingots nor wafers in Italy.

3.2 Production of photovoltaic cells and modules

In the year 2007, four producers of cells and modules have been active in Italy. The two historical producers of cells and module are Enipower (ENI group), and Helios Technology (Kerself group). Two other emerging manufacturers of cells are constituted by Ominia Solar and Xgroup, strongly determined to expand their production facilities in the next years.

Further companies assembling and encapsulating standard or tailor-made and especially designed modules can be found in Italy. During 2007, the module production of such companies sums to about 70 MW with a capacity of 170 MWp, as indicated in table 4.

Table 4 - Production and production capacity information for the year 2007, for each manufacturer

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total production (MW)		Annual maximum production capacity (MW)	
		Cell	Module	Cell	Module
Silicon wafer based manufacturers	mc-Si				
Enipower	sc-Si, mc-Si	3	3	10	10
Helios technology	sc-Si, mc-Si	8	8	30	30
Xgroup	sc-Si, mc-Si	2	2	25	60
Omiastar	sc-Si, mc-Si			1	
SE Project	sc-Si, mc-Si		25		25
Soluxia	sc-Si, mc-Si		2		4
Renergies	sc-Si, mc-Si		6		10
Solarday	mc-Si		15		15
Pa Sol	sc-Si, mc-Si		1		3
Ancora	sc-Si		0,3		2
Elettrosun	sc-Si, mc-Si		1,7		1,5
Gloabal Service	sc-Si		8		12
TOTALS		13	72	66	172

Notes

- a) The manufacturers that produce only modules, purchase cells on the international market. As a consequence a total of 59 MW of cells have been imported. The other manufacturer that produce cells and modules from wafer have imported 13 MW of wafer.
- b) Taking into account that only 15% of the installed module have been produced by Italian manufacture (corresponding to about 11 MW), the other 61 MW (72 - 11) of modules produced in Italy have been exported from the country.

In Table 5 are shown the typical module prices (excluding VAT/TVA/sales tax) and the best prices achieved. In particular, the typical prices derive from an average on about 1000 plants (both small and large) while the best price are the lowest ones.

Table 5 - Typical module prices for a number of years

Year	1993	1997	2000	2001	2002	2003	2004	2005	2006	2007
Standard Module price(s) Typical	4.65	4.13	4.13	4.25	3.9	3.5	3.3	3.6	3.4	3.8
Best price				3.85	3.5	3.1	3	3.2	3.2	3

3.3 Manufacturers and suppliers of other components

In Italy, about 10 companies manufacture inverters for on-grid and off-grid applications. Some of these have experience in inverters for large PV power plants, while others have produced 1,5 -10 kVA inverters under Electric Utilities specifications for the connection to the grid. About 45% of the inverter installed in 2007 have been produced in Italy (31,5 MW). More or less the same figure has been exported. As a consequence, in Italy during 2007 have been produced about 70 MW of inverter. As far as the prices of inverter an average value of 450-650 €/kW has been obtained on a sample of small and medium size plants.

3.4 System prices

Table 6 gives the prices (excluding VAT/TVA/sales tax) in €/Wp for specific shipments of typical PV plants in the various categories of installation.

Table 6 - Turnkey Prices of Typical Applications

Category/Size	Typical applications and brief details	Current prices per W (to one decimal point)
OFF-GRID Up to 1 kW	Street lighting	10 - 14
OFF-GRID >1 kW		
GRID-CONNECTED Specific case	1-3 kW roof-mounted system	6,0 – 7,0
GRID-CONNECTED (distributed) Up to 10 kW		
GRID-CONNECTED (distributed) >10 kW		
GRID – CONNECTED (centralized, if relevant)	250 kW – 1 MW	5,0 – 6,0

Table 7 - National trends in system prices for small roof-mounted system (1-3 kW)

YEAR	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Price €/Wp	9,3	8,8	7,75	7,4	7,5	7,3	6,8	7,0	6,4	6,5

3.5 Labour places

Full time labour places in the following activities during the year 2007 are:

- a) Research and development: 80
- b) Manufacturing of PV system components: 300
- c) All other, including electricity companies, installation companies etc.: 700.

3.6 Business value

An estimate of the value of PV business in Italy by the Gross Domestic Product approach is reported in table 8

Table 9 - PV support measures

	Ongoing measures	Measures that commenced during 2007
Enhanced feed-in tariffs (state)	36 - 49 c€/kWh	Feed-in tariffs increased up to 30% in case of energy saving in building
Capital subsidies for equipment or total cost (regional)		up to 20% and only for BIPV in some regions
Green electricity schemes (state)		9 c€/kWh added to feed-in (renewable energies, excluded PV in “conto energia”)
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)		
PV requirement in RPS		
Funds for investment in PV		
Income tax credits		
Net metering (state)	added to feed-in	
Net billing		
Commercial bank activities eg green mortgages promoting PV		
Electricity utility activities eg network support		
Sustainable building requirements		

4.2 Indirect policy issues

Policy initiatives that may influence the implementation of PV power systems in Italy:

- a) Spring European Council of the action plan “An energy policy for Europe” and the consequent Position Paper of the Italian Government of September 2007 (8 500 MW by 2020);
- b) Programme “Conto energia” of the Italian Government of DM 19.02.2007 (3 000 MW by 2016);
- c) National law (Finanziaria 2008) to promote the use of PV (at least 1kW) in new buildings.

4.3 Standards and codes

During this year, the Technical Committee 82 of CEI has updated the guide for the design, installation and test of PV plants connected to low and medium voltage grid. This guide includes all the technical regulations for PV plant construction and operation (d.c. working voltage, safety and control devices, supporting structures, connection to the grid, etc.)

At international level, Italy has actively participated to the works on new and revised standards carried out within both IEC and CENELEC working groups. In this contest, the Technical Secretariat of CENELEC TC 82, is managed by the Italian Electrotechnical Committee (CEI).

5 Highlights and prospects

The new edition of the feed-in decree seems to ensure a stable situation providing the basis for the expansion of PV market in Italy followed by an adequate growth of the national PV industry. Counting on a market growth of 70 MW in 2007 and of about 150 MW in the following year, Italian producers of crystalline cells and modules are planning to extend their capacities in the next two years up to 400 MW/years and some initiatives have been announced to realize production lines of polysilicon and thin films modules, as well as production of silicon ingots.

Moreover a recent government call foresees the financial support of industrial projects, aimed at creating innovative process and products also for the photovoltaic sector.

Annex A Method and accuracy of data

Data of grid connected PV plants installed in Italy have been obtained by means of the database of the Manager of Electric Services (GSE), which manages the feed-in Programme. In particular the data of the value of the PV power installed and put in operation in 2007 have been used.

Moreover, the following data have been collected by authors among Italian PV operators through direct interview:

1. Module and cell production data (obtained from the industrial operators).
2. Prices of PV systems and components (declared by the installer of the plant after plant construction)
3. The quantity of imported modules and inverter installed in 2007

The obtained accuracy of these data is rather high.

Uncertainty around 20% is instead associated to the real quantity of installed *off-grid* PV plants, whose installation often is arranged directly by the user.

Annex B Country information

This annex provides some background about the national environment in which PV is being deployed. The data are not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they require more detailed data.

Source of the information: author's estimate.

1) retail electricity prices:

household (17 c€/kWh)

commercial, public institution (17.5 c€/kWh)

2) typical household electricity consumption (kWh) 2 700 kWh

3) typical metering arrangements: net metering (for the new electronic installed metering)

tariff structures for electricity customers: the distribution-supply tariffs include a fixed charge, a demand charge (€/kW) and an energy charge (cent €/kWh) with several tiers

4) typical household income 36 000 €/year

5) typical mortgage interest rate 5%

6) voltage (household, typical electricity distribution network): 220 Vac

7) electricity industry structure and ownership

separate generation, transmission, distribution;

private owned or municipal

8) price of diesel fuel: 130 c€/l

9) typical values of kWh / kWp for PV systems in parts of your country.

North 1000 -1200 kWh / kWp

South 1300 -1500 kWh / kWp