

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**

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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 twenty participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), Finland (FIN), 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 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. Eight Tasks have been established, and currently seven are active.

The objective of Task 1 is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

This report is related to the status of PV power applications in Italy in 2002 and is intended for the use of IEA Photovoltaic Power System Programme experts. It has been prepared by:

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The authors are greatly indebted with several experts from ENEA, CESI, ENEL and PV Industries, who have supplied information on PV systems and components installed in Italy.

II INTRODUCTION

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic and environmental aspects of photovoltaic power systems for application by utilities and other users.

An important deliverable of Task 1 is the annual International Survey Report on PV power applications. This report gives information on trends in PV power applications in the twenty member countries, and is based on the information provided in the National Survey Reports which are produced annually by each Task 1 participant.

As the International Survey Report is based on the National Survey Reports, they have been prepared by national experts following guidelines adopted by Task 1 participants. The International Survey Report is an external publication of the IEA-PVPS Implementing Agreement so it must not contain confidential information. In contrast the National Survey Reports are classified as internal reports and are not published within the IEA-PVPS Implementing Agreement. When preparing National Survey Reports, experts have made their own arrangements with their sources on how to treat confidential information (e.g. by restricting circulation or ensuring anonymity of the data).

In Annex A an explanation is given about the method used in our country to gather the information and on the accuracy of data.

III DEFINITIONS, SYMBOLS AND ABBREVIATIONS

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

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

Installed 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 ‘Peak power’).

Peak power: Amount of power produced by a PV module or array under STC, written as Wp.

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 and all installation and control components with a PV power capacity of 40 Wp or more.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed in households and villages that are not connected to the utility grid. Usually a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'.

Off-grid non-domestic PV power system: System used for a variety of 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 power system'.

Grid-connected distributed PV power system: System installed on consumers' premises usually on the demand side of the electricity meter. This includes grid-connected domestic PV systems and other grid-connected PV systems on commercial buildings, motorway sound barriers, etc. These may be used for support of the utility distribution grid.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station.

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 telecommunication systems in a remote area are excluded).

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, utilities etc.

NC: National Currency

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

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 PV power.

1 EXECUTIVE SUMMARY

Since the early eighties, Italy is carrying out a comprehensive research, development and diffusion photovoltaic programme which cover both all the main aspects of the technology from the study of new materials up to plant operation and dissemination programme implementation. In this respect, the CO₂ emission reduction targets, the contribution to diversity and security of supply, the development of national competitive industries, the local and regional development, mainly in Southern Italy were greater is the solar resource, as well as the creation of new job opportunity represent, in the medium and long term, the most important strategic goals of the Programme.

This continuing strategic address has up to now allowed Italy to reach relevant results as:

- about 22 MWp of total cumulative PV power installed in Italy up to now. Rural electrification, off-grid non domestic application, on-grid centralized systems and on-grid distributed systems have constituted the most important sectors of the Italian market;
- a competitive industrial system based on two major Italian manufacture with a production capacity of about 13 MWp of both single-crystal and polycrystalline modules and several small and medium size company mainly involved in the design and the construction of photovoltaic plants;
- a big effort in research, development and demonstration, performed essentially by ENEA, CESI, Universities and ENEL Green Power (established by the largest Italian Utility for business on Renewable Energy market);
- an ambitious dissemination programme (the Italian roof-top Programme) devoted to the realisation of grid connected photovoltaic systems, installed or integrated on buildings and financed and managed (with the technical support of ENEA) by the MATT (Ministry for the Environment and Land Protection) and the Italian Regions;
- a market aligned at international level and characterized by prices for specific shipments of typical photovoltaic plants ranging from 14 €/Wp for offgrid applications to 7 – 8 €/Wp for grid connected systems, depending on categories of installation and excluding VAT/sales tax.
- a total thick budget for photovoltaics that during the last year has reached the sum of about 60 Millions of Euro (5 millions for R&D and 55 millions provided by both the MATT and the Italian Regions in the framework of the Italian Roof-top Programme);
- a growth of the popular acceptance for this attractive technology and of the real interest of end-users, photovoltaic operators and local Utilities.

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 Wp or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

2.1 Applications for photovoltaics

For the purposes of this report, the following four primary applications for PV power systems were identified and related data have been collected:

- *Off-grid domestic systems*, which provide electricity to isolated households in remote areas.
- *Off-grid non-domestic applications*, which were the first economic application for terrestrial PV systems.
- *On-grid distributed PV systems*, which are a relatively recent application where a PV system is installed to supply power to a building or other load that is connected to the utility grid.
- *On-grid centralized systems*, which are installed for two main purposes: as an alternative to centralized power generation from fossil fuels or nuclear, or for strengthening of the utility distribution-grid.

2.2 Total photovoltaic power installed

The total cumulative installed PV power by 31 December for the years 1992-2002 is reported in Table 1.

The total PV power installed in Italy at the end of 2002 was about 22 MWp, 2 MWp being installed in 2002.

Concerning the four different primary applications for photovoltaic:

- *Off-grid domestic systems*. This kind of application has been mainly promoted in the early phase (1983 – 1990) of the Italian photovoltaic programme through 80% incentive in order to provide electricity to 5000 isolated households in rural remote areas especially diffused in Southern Italy.
- *Off-grid economic industrial applications*. These applications still dominate with a share of about 30% Italy's cumulative installed capacity.
- *On-grid centralized systems*, as an alternative to centralized power generation from fossil fuels or nuclear, sharply increasing at the beginning of 1990's but after few years with declining annual growth rate, since 1999 around 0%. The basic scope was the identification and validation of satisfactory solutions for power generation by means of medium and large size grid connected plants, for utility applications, ranging from 100

kW to 3.3 MW. In this contest during the period 1991-1998, the most relevant results have been:

- the development of six standard 100 kW plants for small grid support such island and weak feeder (by ENEA);
 - the realization of the 3.3 MW Serre power station (by ENEL);
 - the construction of 3 modular plants (total power 2,2 MW) suitable for multi megawatt power generation (by ANIT PV company);
- On-grid distributed PV systems, which are a relatively recent application, enjoying strong growth (120%) over the last year as benefiting incentives, in the framework of the Italian roof-top Programme, aimed at increasing this kind of plants.

Up to now, the national PV market has been showing a behaviour variable from year to year and strongly dependent on subsidized projects. In particular, the sector of PV plants for power generation has been strongly boosted by the financial support coming from the European Community, ENEA and ENEL projects while the one of distributed generation by the incentives of the Italian Roof-top Programme.

Table 1: 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
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
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
on-grid distributed	100	100	150	335	404	677	780	905	1'155	1'635	3'620
on-grid centralised	680	3'480	4'590	5'850	5'850	6'166	6'590	6'715	6'715	6'715	6'715
TOTAL	8'480	12'080	14'090	15'795	16'008	16'709	17'680	18'480	19'000	20'000	22'000

2.3 Major projects, demonstration and field test programmes

In the field of National initiatives, the “Italian roof-top Programme”, devoted to realising small size (1 – 20 kW) grid connected plants, installed on building structures, has been officially

commenced on March 2001.

The starting phase of the initiative, aimed at tune programme procedures and check people consensus has been composed by a National” Programme and many smaller “Regional” Programmes, as consequence of energy devolution concerns.

In general, contribution up to 75% of the eligible investment cost has been provided by both Programmes with a maximum investment cost fixed from 7 to 8 €/W, depending on plant size.

The National Programme, funded by about 10.3 M€ and managed by the MATT, was addressed only to Public bodies, such as Local Authorities, Universities Public companies and Park areas. In the period July – October 2001, 587 applications submitted to the MATT have been evaluated and 460 out of them have been admitted to contribution.

The corresponding requested power sums up to about 5.5 MW with a demand, thanks to the incentive offered, more than three times the offer in terms of both power and public contribution requested. As a consequence, only 146 plants have been financed with the available resources (10.3 M€) corresponding to an capacity of 1.8 MW. During the year 2002 135 systems have been already installed, corresponding to an installed power of 1.7 MW.

However, because of this real success, additional funds amounting to about 20 M€ have been made available on March 2003 by the MATT and Regions to finance (fifty-fifty) the other 314 application already positively evaluated (for total power of about 3.6 MW).

The Regional Programmes are completely managed by the 19 Italian Regions and the 2 Autonomous Provinces. The budget, provided by the MATT in 2001 (i.e. 20.7 M€), constitute the 70% of the total incentives, while the remaining 30% (in total 9.3 M€) has been provided by the Regions and Autonomous Provinces, having agreed to participate to the initiative.

At the end of March 2002, all the Italian Regions have issued their own announcement. The only exception is constituted by Sicily Region that has issued its announcement only in December 2002. At the same time, a great amount of application has been submitted, amounting to about 6680, well beyond the objective to realize a total capacity around 5.5 MW, corresponding to about 2000 projects.

At the end of 2002, the Regional Programmes are well ongoing, although some delay occurred; most Regions have already evaluated the projects submitted. Some of these projects have been realised, for a total installed power of about 300 kW.

Following the great success recorded by both the National and Regional Programmes, in August 2002, the MATT and the Regions have approved a further commitment of about 55 M€ In this contest, priority will be given to fully integrated roof-top applications while a decrease of the economic incentive and of the maximum cost allowed is foreseen. Moreover, in this phase the feeding law is under evaluation and a simplification of technical and bureaucratic requirements is expected.

On the whole, MATT and Regions incentives are make active an investment amount of about 175 M€ to install a total capacity around 23 MW, 2 MW of them being installed in 2002.

In the sector of demonstration and field test programmes, activities are carried out directly by ENEA and by CESI (that has acquired from ENEL its R&D activities) both at their own test

facilities and on plants installed all over the Italian territory. All these activities are carried out in the framework of:

- the Demonstration Programme and
- the Italian Roof-top Programme

Since 1991 the Italian Demonstration Programme has been increasingly focused on power generation by means of medium and large size grid connected plants, for utility applications, ranging from 100 kW to 3.3 MW. The basic scope was identification and validation of satisfactory solutions. The activities currently performed in this contest regard the analysis, tests, long term performance evaluations as well as operation and maintenance procedures carried out by ENEA on its own PLUG plants at Delphos test facility and Casaccia Research Center. Furthermore performance evaluation of photovoltaic components and plants are carried out by CESI, in order to assess long term behaviour of PV technology in different climatic conditions and in different electric configurations.

The demonstration and field test activities of the Italian roof-top Programme are mainly focused on 20 small grid-connected pilot plants, as prototypes of roof mounted systems and are carried out by ENEA in Manfredonia test facility, in Portici Center and on public building of Municipalities and Universities in some important Italian cities. Data collection and performances of these plants are analyzed since the year 2000 in terms of energy output, energy losses, power quality, operation and maintenance procedures. Similar activities are carried out by CESI since 1999 on further 5 pilot plants located in Northern Italy and in Sardinia island. All these activities are carried out in the framework of preliminary actions foreseen by the Italian Roof-top Program with the aim of experimenting the integration of the photovoltaic generator into the architectural design of roofs, facades and shelters, to test new grid interface mode adopting simplified protection devices, to evaluate plant performance as well as to verify the effectiveness of the technical solutions adopted.

Table 2 summarizes the demonstration and field test programmes in Italy.

Table 2: Summary of main demonstration and field test programmes

Project Date plant start up	Technical data Economic data	Objectives	Main accomplishments until the end of 2001 Problems and lessons learned	Funding	Project management	Remarks
Buildings integrated PV plants 1999	25 PV systems for a total power of about 60 kWp, installed on the public buildings of Municipalities and Universities in some important Italian cities	<ul style="list-style-type: none"> - To assess the architectural integration of PV array on roofs and facades - to evaluate plant performance - to verify the effectiveness of the technical solutions adopted. 	The operation data of these systems are regularly collected Performance evaluation in progress	ENEA	ENEA	The plants have been installed in the framework of demonstration activities foreseen by the Italian rooftops programme
Medium and large size PV plants for utility applications 1991	10 grid connected plants, for utility applications, ranging from 100 kW to 3.3 MW	<ul style="list-style-type: none"> - to identify and to validate satisfactory solutions - to evaluate long term performance 	Data collection, long term performance evaluation and maintenance experience in progress	ENEA - CESI	ENEA - CESI	The plant have been installed in the framework of the Italian Demonstration programme

2.4 Highlights of R&D

The Italian RD&D Programme supports the development of new materials, devices and system components as well as the performance evaluation of photovoltaic plants. These activities are conducted by ENEA, CESI with the support, in some cases, of Universities and the National Council for Scientific Research (CNR).

Among the result of ENEA R&D activities, it is worth mentioning the realisation of a large area (900 cm²) double junction a-Si modules with confirmed efficiency in excess of 9% (NREL measurements). Further, a-Si/c-Si heterojunctions have been realised with $\eta= 16\%$ and $\eta= 14.7\%$ on areas of 1.26 cm² and 3.8 cm² respectively. A 51 cm² solar cell with an efficiency of 13% was the best result for a-Si/c-Si on large area devices.

In the Casaccia Research Center the Crystalline Silicon laboratory works in collaboration with major international research groups (IMEC, FhG-ISE, CNRS, ECN, ISFH, GeorgiaTech, JCT, etc) and photovoltaic industries (Eurosolare, ASE, Photowatt, Shell), on modelling, fabrication and characterization of crystalline silicon devices.

At present the most significant R&D activities are devoted to industrialize process steps (INDHI EU project) concerning laser assisted processes, buried contact and selective emitter technology, advanced screen-printing as well as the setup and optimization of fabrication processes of several kinds of innovative cells. The main results obtained so far on crystalline devices are: 18.5% efficiency on planar cells (selective emitter, laser doped), 17% efficiency on laser growth buried contact cells, 16% on large area fully screen printed cells.

Activities on poly-Si thin film cells on foreign substrates are also carried out, in the framework of the European V FP "SUBARO".

For the next future, polycrystalline thin film devices are a main line of ENEA activity: the re-crystallization techniques of amorphous thin film are developed with the aim to obtain medium high efficiency devices. Hot Wire CVD and VHF PECVD will be utilized to obtain device quality poly-Si with low process temperature and high growth rate. ENEA is also involved in the a-SiNET and PV-EC-NET European Network Programmes.

Moreover, in the field of a-Si/c-Si heterojunction, a cooperation between Eurosolare, ENEA and some other European operators, is currently carried out in the framework of the "MOPHET" Program, promoted by the European Community.

At the end of 2002 ENEA, in order to investigate concentrators technologies, has launched a new programme, the PhoCUS (Photovoltaic Concentrators to Utility Scale) Project. The Project is aimed at assessing the technical and economical feasibility of this application in Italy for centralised generation of electricity. During the first phase, lasting three years, activities on RD&D are mainly addressed to the optimisation of the most appropriate technologies for solar cells, optical devices and, in general, for the PV concentrator module. These activities are carried out in cooperation with important industrial operators (Galileo, Eurosolare).

CESI Spa is an institute for Research and Certification of components and systems for the electric sector. CESI, which comes from ENEL Group, is now owned by main electric operators in Italy (like as ENEL, TERNA, GRTN, Ansaldo, EDIPOWER, ABB, ENDESA Italia, SIEMENS, Pirelli, Electric Municipalities, etc.). As a consequence of the electrical market liberalization, in year 2000, CESI has acquired from ENEL its R&D activities in

generation, transmission, distribution, end-use of electricity, environment and renewable energies. CESI is, then, active in development and testing of advanced renewable energy systems. Within this field of activities, photovoltaic conversion plays an important role.

CESI R&D activities are application-oriented and aimed at the technological innovation of the electric sources, in order to promote and expand, for the next future, the utilisation of the photovoltaic technology, offering to the PV users the best and cheapest available solutions for an optimised generation of solar electricity. CESI has the experience, the expertise and the facilities to help the PV community to become confident in the new solar technologies.

Basically two types of R&D activities are carried out by CESI in photovoltaics:

- Development and industrial manufacturing of high efficiency solar cells for space and terrestrial applications, based on GaAs compounds;
- Analysis and testing of PV modules based on advanced solar cells (thin films, amorphous silicon, etc.) and innovative components (e.g. inverters);
- Analysis, design, implementation and evaluation of innovative PV plants (i.e. modular technology for remote communities).

In the frame of GaAs space solar cells, CESI is one of the leader companies in Europe having supplied bare solar cells for 24 small and medium size satellites, world-wide. CESI has been recently selected to supply 24.000 cells for the Italian Satellite Constellation named Cosmo Skymed. The Company experience in this field started in 1984 with the first European flight of a GaAs/Ge solar cell in space. GaAs solar cells are manufactured using metalorganic chemical vapour deposition (MOCVD) large size industrial equipment from Emcore and Aixtron. The development of triple junction solar cells (InGaP/GaInAs/Ge) is now completed and the cells commercially available. GaAs single junction and multijunction concentrator solar cells are also manufactured for terrestrial application. This development activity is aimed to investigate the expected cost of the Wp using advanced high efficiency solar cells derived from the space technology and suitable to convert the sunlight with an efficiency close to 30% at concentrator values above 300 suns. Several concentrator PV test modules are in manufacturing using composite Fresnel lenses. The RD activities of CESI in the field of space solar cells have been funded both by the Italian and European Space Agencies (ASI and ESA). The investments for the space solar cell production line come from the Company with the Italian Government support (MIUR).

The main source of investments for CESI researches is the Government Agency for the development of the National Electric System. In addition, CESI is involved in many projects supported by the European Community (i.e. in PV sector, HYBRIX, DISPOWER, ENIR DGNET).

ENEL, the largest Italian Electric Utility, is active in PV sector through ENEL Green Power, a branch of ENEL Generazione Spa, established for business on Renewable Energy market. ENEL Green Power is a RE worldwide leading company, confirming in the year 2002 its position of the world's largest company dedicated exclusively to renewable energy. The most important PV plant owned by ENEL is the biggest worldwide PV plant in operation: the 3.3 MWp of Serre.

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

Table 3 gives figures, for the year 2002, 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 Budgets for R&D, demonstration programmes and market incentives in Italy for the year 2002.

	R & D	Demo	Market
National/federal	5'000'000 EUR		27'500'000 EUR
State/regional			27'500'000 EUR
Total	5'000'000 EUR		55'000'000 EUR

3 INDUSTRY AND GROWTH

3.1 Production of photovoltaic cells and modules

The major PV module manufacturer is Eurosolare with a staff of about 70 people. Subsidiary of ENI, Italy's oil and gas giant, Eurosolare has scaled to manufacturing level, at the beginning of the 90's, a process for the realisation of multicrystalline silicon wafers. Recently, this technology has been transferred to a 50% Chinese-Italian joint venture based in Ningbo, China, for multicrystalline wafers production.

A second major line activity concentrates on cost efficient solar cell processing. In this framework a highly automated totally screen printed process has been developed and patented which enables high automation in the whole cell to module manufacturing, and the use of very thin wafers

Moreover in co-operation with the Centre for PV in Sydney, Eurosolare is developing a buried contact solar cell process tailored on multicrystalline Si wafers, with the aim of incorporating some screen printing steps in the sequence. In the last years Eurosolare has entered a new field of activities, polycrystalline silicon thin films on glass, by becoming a 25% shareholder of Australia's Pacific Solar and providing contribution to the feasibility study of the industrial phase.

Eurosolare facilities have a production capability of 8.5 MWp/year. Both single-crystal and polycrystalline silicon cells are currently produced. On the overall, in the last year the Eurosolare module production has been of 2.2 MWp. Concerning production quality, cell efficiency distribution is peaked at about 15% in the case of monocrystalline silicon and at about 13% in the case of polycrystalline wafers. Modules are designed to meet the IEC

norms. Eurosolare production includes also specially designed modules for roof tops and facades. The production facility is divided in “islands” which are completely automated and include sophisticated robotic equipment.

Another important Italian module manufacturer is Helios Technology. Its manufacturing facilities have a production capability of 4.5 MWp/year. In the last year Helios Technology module production has been of 2.9 MWp. Helios Technology module manufacturing process comprehends the fabrication of cells and modules from mono-crystalline silicon wafers. Modules produced range from 20 Wp to 90 Wp and meet the IEC norms.

Further other small companies assembling and encapsulating tailor-made and especially designed modules such as windows integrated cells or using coloured cells can be found in Italy.

Table 4: Production and production capacity information for the year for each module manufacturer

Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MWp)		Maximum production capacity (MWp)
		Cell	Module	
1 Eurosolare	sc-Si	0.2	0.2	8.5
	mc-Si	2	2	
2 Helios technology	sc-Si	2.9	2.9	4.5
TOTALS (where applicable)		5.1	5.1	13

Table 4a: Module prices for a number of years

Year	1993	1997	2000	2001	2002
Module price(s) – EUR/W	4.65	4.13	4.13	3.85 - 4.65	3.5 – 4.3

3.2 Manufacturers and suppliers of other components

An estimation of the total number of companies manufacturing **inverters** for on-grid and off-grid applications gives 15 units. Some of these manufactures have experience in inverters for large PV power plants, others, have produced 1.5-10 kVA inverters under Electric Utilities specifications. In Table 5, further information on the inverters sold for PV applications is given.

Table 5 Price of inverters for grid-connected PV applications.

Size of Inverter	<1 kVA	1-10 kVA	10-100 kVA	>100 kVA
Average Price per kVA (EUR)	1200 – 1800	700 – 1000	650	350

The main Italian **battery** manufacturers with a specific experience in the PV sector are four. All of them manufacturers produce stationary lead-acid batteries with a low content of antimony, in order to reduce the self-discharge. The rated capacity (C10) and the nominal voltage of produced batteries are in the range from few Ah to about 80 Ah at 12 V, from 80 to about 180 Ah at 6 V and from 180 to about 3000 Ah at 2 V.

The price paid for batteries is strongly dependent on the size of shipment or other specific situations.

3.3 System prices

An estimation of the number of companies that install PV systems in Italy is 100 units. These are specialist PV companies offering consultancy and installation services and component delivery. Table 6 gives the prices (excluding VAT/TVA/sales tax) in EUR/Wp for specific shipments of typical PV plants in the 5 categories of installation.

Prices do not include recurring charges after installation such as battery replacement or operation and maintenance. Additional costs, incurred due to the remoteness of the site or special installation requirements, are also not included.

Table 6: Prices of typical applications

Category/Size	Typical applications and brief details	Price per Wp in EUR
OFF-GRID Up to 1 kWp	Street lighting Rural electrification	13.5
OFF-GRID >1 kWp	Rural electrification Industrial application	13
GRID CONNECTED Specific case	1-3 kWp roof-mounted	14
GRID CONNECTED Up to 10 kWp	Distributed generation	7.5
GRID CONNECTED >10 kWp	Centralized power generation	7

Table 6a: National trends in system prices for 100kW grid connected systems (standard unit)

YEAR	1992	1993	1995	1996	2001	2002
Price EUR/Wp		9.04	8.78	8.52	6.7	6.5

3.4 Labour places

Full time labour places in the following activities during the year 2002:

- a) Research and development (not including companies): 100
- b) Manufacturing of PV system components, including company R&D: 70
- c) All other, including within electricity companies, installation companies etc.: 350

3.5 Business value

In the year 2002 the total module production of the Italian PV industry has been about 5.1 MW (corresponding to 20 M€) while in the same period has been installed a capacity of 2 MW. Of this capacity about 60% of the installed modules (1.2 MW) have been imported, as a consequence a rough estimation of the exported modules during the year 2002 lead to a figure of about 3,9 MW, mainly toward the German market. On the other hand, in the year 2002 have been installed about 170 inverters (average power 12 kW), corresponding to 1,5 M€. About 95% of them have been imported.

4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

4.1 New initiatives

Utility perception of PV

Both ENEL and Local Utilities have demonstrated their strong consensus to the Italian roof-top Program co-operating with ENEA to overcome some technical barriers, such as grid interface devices, grid connection requirements and plant maintenance.

Changes in public perceptions of PV

During this year the popular acceptance for this technology is sharply increased as well as the general environmental awareness. In particular, a wide interest to the Italian Roof-top Programme of both private and public end-users has been recorded.

Since long time ENEA and ISES, by means of Conference, Exhibitions, Handbooks and training courses and web sites provide a valuable source of information. In particular in the

year 2002 about 20 courses have been activated in different Italian cities and the participation of over 700 among installers, designers and architects has been recorded.

Major new projects or initiatives

Following the real success recorded by the National and the Regional Programmes additional funds have been made available by the Ministry of Environment and the regions to finance a second phase of the Programme

4.2 Indirect policy issues

The Italian Ministry of Environment is convinced that the development and the diffusion of renewable technologies constitute a significant opportunity perfectly in agreement with the White Paper issued by the European Union and the Kyoto commitments.

Today, in Italy, Renewables contribute to the primary energy supply with a share of about 6%. A doubling of the contribution of renewable energies to the Italian total energy demand is foreseen by 2010.

4.3 Standards and codes

During this year, any new standard, code and guidelines haven't been issued, although the feeding law is under evaluation and a simplification of the norms regarding the connection to the electric grid is under discussion

5 HIGHLIGHTS AND PROSPECTS

Because of the success of the Italian roof-top Program obtained up to now, and in accordance to the Italian and European strategy on CO₂ emission reduction, an additional support of the Italian Ministry of environment to finance the roof-top Program is expected in the next years.

ANNEX A METHOD AND ACCURACY OF DATA

a) **Table 1**

The value of the PV power installed in 2002 has been obtained, by summing the power of plants, whose installation was known to the several PV experts involved in the preparation of this report. In this way, we are relatively sure about the amount of PV power installed in applications like *on-grid distributed* and *on-grid centralised*, or medium-large *off-grid non-domestic* plants, but we are not sure about the real quantity of installed *off-grid domestic* PV plants, whose installation often is arranged directly by the user.

b) **Tables 5 and 6**

Prices are supplied only for specific shipments: average prices for different power ranges are impossible to be provided, because the price of PV systems and components are strongly dependent on the number of units per shipments and on their technical characteristics.