

International Energy Agency
CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER
SYSTEMS

Task 1
Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in *Israel*
2006

Prepared by
Dr. Yona Siderer and Roxana Dann
Ben Gurion National Solar Energy Center
Blaustein Institutes for Desert Research
Ben-Gurion University of the Negev
84990 Midreshet Ben Gurion, Israel

May 2007

Sponsored by the Israel Ministry of National Infrastructures

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 W 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 ‘Rated power’).

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

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 W 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 to provide power mainly to a household or village not connected to the (main) 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 ‘mini-grid’, often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. 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 to provide power 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 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 for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

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

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.

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.

Please specify the currency that is used throughout the NSR - countries of Euroland must use the euro (EUR). Please ensure that your NSR follows the recommendations of the internal PVPS report *Writing numerical values, quantities, units and symbols according to International Standards*. This will reduce confusion when preparing the **Trends** report, and will reduce the need for editing of material for consistency before loading on to the website.

Table of Contents

Table of Contents		Error! Bookmark not defined.
i	Foreword	7
ii	Introduction	5
1	Executive summary	5
2	The implementation of PV systems	8
2.1	Applications for photovoltaics	8
2.2	Total photovoltaic power installed	6
2.3	PV implementation highlights, major projects, demonstration & field test programmes	9
2.4	Highlights of R&D	9
2.5	Public budgets for market stimulation, demonstration / field test programmes and R&D ...	9
3	Industry and growth	10
3.1	Production of feedstocks and wafers	10
3.2	Production of photovoltaic cells and modules	10
3.3	Manufacturers and suppliers of other components	13
3.4	System prices	13
3.5	Labour places	15
3.6	Business value	15
4	Framework for deployment (Non-technical factors)	16
4.1	New initiatives	16
4.2	Indirect policy issues	16
4.3	Standards and codes	16
5	Highlights and prospects	17
Annex A	Method and accuracy of data	18
Annex B	Country information	19

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 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 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 research projects (tasks) is the responsibility of Operating Agents. Ten tasks have been established and currently six are active. Information about these tasks can be found on the public website www.iea-pvps.org. A new task concerning PV environmental safety and health is now being developed.

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.

ii Introduction

Explains the purpose of the National Survey Report (see section b above).

1 Executive summary

- **Installed PV power: We identified new PV installations totaling 275 kW during 2006.** Typical applications remain the same, the majority not grid-connected: Remote homes, agriculture, security and alarm systems, communications and exterior lighting.
- **Costs & prices:** Typical module prices range from USD 8-12/kW installed, depending on type of application.
- **PV production.** There is still no PV production taking place in Israel.
- **Budgets for PV.** The Israel Ministry of National Infrastructures spent USD 75 000 on R&D in 2006.

NOTE: The US Dollar (USD) is used throughout this report again this year.

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 Applications for photovoltaics

Typical applications remain the same as in previous years: remote homes; agriculture (computerized irrigation); security and alarm systems; communications and exterior lighting. Access to grid-electricity is almost universal, dependable and relatively inexpensive.

2.2 Total photovoltaic power installed

The total **cumulative** installed PV power for each sub-market on the 31 December of each year from 1992 onwards should be entered in Table 1.

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

Sub-market/ application ##	31 Dec. 1992	31 Dec. 1993	31 Dec. 1994	31 Dec. 2004	31 Dec. 2005	31 Dec 2006
	kW	kW	kW	kW	kW	kW
off-grid domestic				653	809	1 084
off-grid non- domestic				210	210	210
grid-connected distributed				9	11	11
grid-connected centralized				14	14	14
TOTAL				886	1 044	1 319

Please provide **at least two** paragraphs of text following table 1:

- There were no key PV policy initiatives, promotional activities (commercial and non-commercial) or any other **market drivers** of significance in 2006 which affected the market during this year;
- There were no electricity utility and public **stakeholder** developments that were important during the year.



A pilot project of Nortel in the city of Ariel, Israel to provide free wireless LAN to the public. (Photo credit: SolarPower)



Kibbutz Lotan

800 Wp grid connected system, installed over an education classroom in the ecological community of Kibbutz Lotan (Photo credit: Solarpower)

Kibbutz Lotan's Center for Creative Ecology has installed an 8 panel, 640 watt photovoltaic solar panel array on the reception building and classroom of its Ecokef (*kef* is fun in Hebrew) Education Park. The system, purchased from SolarPower (Israel), and is grid connected. The Ecokef park is a demonstration and activity center where youth and adults receive hands-on practice in responsible recycling, building with recycled waste such as used plastic containers and car tires, and natural materials such as straw bales and adobe. At the heart of the Ecokef park is an organic vegetable garden where composting, grey water treatment, mulching and other permaculture techniques are taught. All of the site's toilets are waterless composting units and food preparation is by solar ovens.

The Bustan (Orchard) Neighborhood that is currently under construction will serve to house participants in the kibbutz's Green Apprenticeship program. The Green Apprenticeship is an Ecovillage and Permaculture Design training course which includes construction of earth plastered straw bale insulated geodesic dome houses. The electricity for the first unit is supplied by a pair of off grid PV panels. The goal is to purchase 60 100 Watt PV panels which will supply all of the neighborhood's electrical needs and when grid connected will offset all the CO₂ connected to travel and cooking fuel during the course.



1500W PV system installed in late 2006 at a large water control station. PV in water supply and irrigation control are widespread applications of PV here (Photo credit: Interdan Ltd.)

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

We identified no new implementation highlights or major projects during 2006.

2.4 Highlights of R&D

Research and Development takes place at most Israeli universities and a growing number of start-up companies. Research is supported by private investors or companies, and therefore the total sum of investments is higher than that revealed in table 2, which only refers to government sponsored R&D.

New Materials Research: Research in materials is taking place at the Weizmann Institute of Science in Rehovot (thin film and nano-crystalline solar cells); Hebrew University of Jerusalem (polycrystalline silicon films); Technion Institute of Technology in Haifa (organic/inorganic hybrid solar cells); Jerusalem Institute of Technology (improved Si solar cell fabrication technologies; new technologies for anti-reflective coatings); Ben Gurion University (fullerene based solar cells, carbon nanotube/polymer solar cells), and Bar Ilan University with Orionsolar Co. (dye sensitized nano-crystalline solar cells).

Concentrator photovoltaics: various approaches in this area are being applied at a number of different institutions: Ben Gurion University in collaboration with Tel Aviv University (*PETAL*, the 400 m² very large dish; mini-dish concentrators; ultra high flux PV characterization of concentrator solar cells); Tel Aviv University in collaboration with the Technion, BGU and Di.S.P. Ltd (MCPV and Combined Heat and Power (CHP) systems); Israel Aircraft Industries (CPV for space and terrestrial applications) and SRS Engineering (Cassegrainian solar concentration).

Photovoltaic related research: Ben-Gurion University (Inverters); private industry (DC powered air conditioners).

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

The Israel Ministry of National Infrastructures provided USD 75 000 for PV related research during 2006.

Table 2 Public budgets for R&D, demonstration/field test programmes and market incentives. (USD)

	R & D	Demo/Field test	Market
National/federal	\$75,000	--	--
State/regional			
Total	\$75,000	--	--

3 Industry and growth

3.1 Production of feedstocks, ingots and wafers

THERE WAS STILL NO PV MATERIALS PRODUCTION IN ISRAEL DURING 2006.

Table 4a: Typical module prices for a number of years

Year	2003	2004	2005	2006
Module price(s): Typical	5-6.3	4.48-6.1	5.4	NO REPORTED CHANGE
Best price				

Also, if possible, please report separately the minimum price that has been achieved in 2006, noting whether this is an import or locally manufactured. **Distributors unwilling to divulge this information directly.**

3.3 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain. Please briefly comment on the nature of this industry in your country, paying particular attention to recent trends and industry outlook, under the headings of:

There is still no local manufacture of PV devoted BOS components.

3.4 System prices

Please give in Table 5 turnkey prices (excluding VAT/TVA/sales tax) per W for the various categories of installation. Prices should 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 should not be included. Please indicate whether you are reporting an average price, a range of all known prices, a typical example, or so on.

Additional information should also be provided, where possible, regarding national trends in the turnkey prices of selected applications (in Table 5a)

There are no new trends to report, as there has still not been any major growth in the market.

Additional information **no kits are sold, only through distributors who are then also responsible for all legal connections to the grid (where applicable)**

Table 5: Turnkey Prices of Typical Applications

Category/Size	Typical applications in your country and brief details	Current prices per W (to one decimal point)
OFF-GRID Up to 1 kW	Communications, security, agriculture	USD 10 – 13.6
OFF-GRID >1 kW	Remote homes	> USD 10
GRID-CONNECTED Specific case		
GRID-CONNECTED Up to 10 kW		
GRID-CONNECTED >10 kW		

Table 5a: National trends in system prices (current) for (specify application, for example from table 5 above)

YEAR			2004	2005	2006
Price /W:			8.8	8-10	8-13

3.5 Labour places

Provide an estimate of labour places in the following (where these are mainly involved with PV):

- a) Research and development (not including companies); **60**
- b) Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D; **0**
- c) All other, including within electricity companies, installation companies etc.
 - 1. PV distributors: **25**
 - 2. Utilities & Govt: **5**
- d) PV Research Start-ups: **20**

3.6 Business value

Provide an estimate of the value of PV business in your country by the Gross Domestic Product approach, using Table 6 and as described in the Swiss discussion paper previously circulated (further copies from Task 1 OA).

Table 6: Value of PV business

Sub-market	Capacity installed in 2006 (kW)	Price per W (from table 5)	Value	Totals
Off-grid domestic	275	11 (AVG)	$a = X \times Y \times 1\,000$	USD 3 025 000
Off-grid non-domestic			b	
Grid-connected distributed			c	
Grid-connected centralized			d	
				USD 3 025 000
Export of PV products (including information from Table 3)				0
Change in stocks held (including information from Table 3)				0
Import of PV products (ALL INSTALLATIONS ARE IMPORTED)				
				USD 3 025 000
			Value of PV business	USD 3 025 000

If possible, please provide some brief comment on the industry value chain in your country or provide references to articles, reports dealing with this topic.

4 Framework for deployment (Non-technical factors)

Please complete the following table to summarize what PV support measures were in place in your country during 2006:

Table 7: PV support measures

	National / Regional (State) / Local
Enhanced feed-in tariffs	yes, >100 kW
Direct capital subsidies	no
Green electricity schemes	yes, >100 kW
PV-specific green electricity schemes	no
Renewable portfolio standards (RPS)	no
PV requirement in RPS	no
Investment funds for PV	no
Tax credits	no
Net metering	no
Net billing	no
Commercial bank activities	no
Electricity utility activities	no
Sustainable building requirements	no

4.1 New initiatives

In August 2006, the Israel Public Utility Authority – Electricity (PUA), issued its decision on solar rates, relevant for all solar technologies. The tariffs are normative, based on analysis of the costs of a solar-thermal plant: A well-known technology with low costs. Tariffs were established for installations of two different sizes: above 20 MW and between 100 kW to 20 MW. Tariffs are ensured for 20 years, and will only be updated according to an automatic update formula. Additional support mechanisms are not calculated into the tariffs. A fossil element up to 30% will be allowed. A manufacturer may sell to the Israel Electric Corporation or directly to a private customer. The assumption in formulating the tariffs was that after the first 250-300 MW installed, accumulated experience and new technological developments will be expressed in lower costs.

Announced in 2007:

- In June 2007, the Minister of National Infrastructures announced a policy change regarding small installations for own-use (up to about 20 kW), with transfer of surplus to the grid. This change was a result of lobbying in favor of facilitating private users' connection to the grid, and is expected therefore to have a great effect on the future of this market. The Minister declared that he wishes to promote installation of about 50 MW over a period of 5 years. PUA has therefore been instructed to establish the mechanism and tariffs, and have set a target to be ready by the end of 2007. The PUA has already prepared a draft proposal, and made it available to the public for review and response.

- In April 2007, the Israel Ministry of National Infrastructures announced its new “pre-seed fund” for support of start-up in the field of clean energy, *Startery*. It is part of a new policy approach announced by the minister regarding all renewable energies, photovoltaics included. Minister Ben Eliezer announced that, "Israel must lie in the van of the countries developing alternative energy sources as an alternative to crude oil and external pollutant sources. The Ministry of National Infrastructures will locate the most promising projects in order to achieve this aim." He ordered the intensification of the efforts of his Ministry to add alternative energy sources, and ordered a series of three major steps be taken in this direction.

The first was the appointment of a senior manager who would head the field of alternative and renewable energy and would coordinate the work of the Ministry in this field.

A second step presented was the three-fold increase of the budgets allocated to initiatives in this field and the assignment of greater resources for support of new initiatives aimed at the development of alternative and renewable energy sources.

The third step was the setting up of a fast track for the selection of projects in advanced stages of the development of alternative energy sources, possessing commercial potential and of interest to the private market.

4.2 Indirect policy issues

Please give one paragraph on any policy initiatives that may influence the implementation of PV power systems in your country. This could include details of:

- a) international policies affecting the use of PV Power Systems; Not issued
- b) the introduction of any favourable environmental regulations; Preliminary steps for regulations taken, policy introduced in 2007.
- c) studies relating to externalities and hidden costs of conventional energy generation when compared to renewable energy; Not issued
- d) taxes on pollution (e.g. carbon tax) – INCORPORATED IN THE PUA'S PREMIUM PAYMENT TO RENEWABLE ENERGY PRODUCERS.
- e) national policies and programmes to promote the use of PV in foreign non-IEA countries. Not issued.

4.3 Standards and codes

Several new standards, relevant to PV, are TO be adopted by the Israel Standards Institute:

- IEC standards:
- **IEC 60904-1 Ed. 2.0** – Photovoltaic devices – Part 1: Measurement of photovoltaic current-voltage characteristics;
- **IEC 60905-2 Ed. 2.0** – Photovoltaic devices – Part 2: Requirements for reference solar devices
- Australian standards:
- **AS 4777.1-2005** Grid connection of energy systems via inverters. Part 1: Installation requirements.
- **AS 4777.2-2005** Grid connection of energy systems via inverters. Part 2: Inverter requirements.
- **AS 4777.3-2005** Grid connection of energy systems via inverters. Part 3: Grid protection requirements.

5 Highlights and prospects

Please highlight key aspects of PV deployment or production in your country during 2006 that you consider should be reported in the **Trends** report.

Please give one paragraph maximum on forward looking issues within your country (not covered elsewhere in your report) such as:

- *Any significant developments in technologies*: many products still under development, and did not yet enter the market during 2006.
- *(Long term targets for installed PV power capacity, or future energy scenarios):*

Annex A *Method and accuracy of data*

When preparing the **Trends** report, it is necessary to know the accuracy of the data provided in the NSRs. Therefore, in this Annex please give:

- a) Actual market figures are those provided by all known PV distributors and installers.
- b) If a country cannot provide the necessary data please give the reason here.

Annex B Country information

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

Please provide the following, including a short reference as to the source of the information (for example, author's estimate, electricity supply association etc etc):

- 1) retail electricity prices **IN LOCAL CURRENCY** - household **NIS 0.4812** commercial, public institution: **NIS 0.5447**
- 2) typical household electricity consumption (kWh) : **500 kWh**
- 3) typical metering arrangements and tariff structures for electricity customers (for example, interval metering? time-of-use tariff?) **Private household consumers typically use the standard tariff. One increasingly hears of promotions for time-of-use in the home as a means for saving money. The new regulations which will allow PV in household size systems, grid-connected, net-metering require time-of-use.**
- 4) typical household income: GROSS MONTHLY INCOME: **USD 2 780** (UP BY 2.8% OVER LAST YEAR. (STATISTICS FOR THE YEAR 2005, Central Bureau of Statistics)
- 5) typical mortgage interest rate: **5-7%**
- 6) voltage (household, typical electricity distribution network) **220**
- 7) electricity industry structure and ownership (eg vertically integrated or separate generation, transmission, distribution?; retailers and network businesses – integrated or separate?; state owned or municipal or private etc?; electricity industry regulator?) **single vertically integrated monopoly, “island economy”, state owned, with independent regulator (PUA)**
- 8) price of diesel fuel (May 2007) **USD 1.38/liter**
- 9) typical values of kWh / kW for PV systems in parts of your country. **1 kWp PV would give ~ 1750 kWh/year** (Source: Prof. David Faiman, National Solar Energy Center, Ben-Gurion University of the Negev).