

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*
2007

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

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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.

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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 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 about 500 kW during 2007.** Typical applications remain the same, the majority not grid-connected: Remote homes, agriculture, security and alarm systems, communications and exterior lighting. The legislation permitting grid-connection was not completed in 2007, therefore even grid-connected projects are not reported as such.
- **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 100 000 on R&D in 2006.

NOTE: Currency usually quoted remains the USD, though in one case the Euro was used, and was quoted as such. The local currency vis-à-vis foreign currency fluctuated radically.

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	31 Dec 2007
	kW	kW	kW	kW	kW	kW	
off-grid domestic				653	809	1 084	1 584
off-grid non- domestic				210	210	210	210
grid-connected distributed				9	11	11	11
grid-connected centralized				14	14	14	14
TOTAL				886	1 044	1 319	1 819

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 2007 which affected the market during this year;

- There were no electricity utility and public **stakeholder** developments that were important during the year.

FOLLOWING ARE A FEW EXAMPLES OF NEW, LARGER GRID-CONNECTED PHOTOVOLTAIC PROJECTS



Tene Farm – installation of Israel's current largest grid-connected PV, designed to be 50 Kw. This is an addition to the sun tracking system at the same location reported last year (Photo credit: SolarPower)



Hazeva, farm for decorative fish. 10 kWp grid-connected system
(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 2007.

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	\$100,000	--	--
State/regional			
Total	\$100,000	--	--

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	Farm	NA
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); **NA**
- 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: **NA**
 - 2. Utilities & Govt: **NA**
- d) PV Research Start-ups: **NA**

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 2007 (kW)	Price per W (from table 5)	Value	Totals
Off-grid domestic	500	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)				
			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,
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

During 2007, there were no enactments of proposed clean energy initiatives. The real news is from 2008, and how it will affect future markets.

Announced in 2008:

- **In February 2008, the Ministries of National Infrastructures and Finance finally announced the public tender for large solar energy plants at the Ashalim site.** The BOT tender is for solar thermal (up to 2 plants, each ranging from 80-125 MW) AND for photovoltaics (up to 2 plants, up to 15 MW each). There was great interest on the part of both local Israeli and overseas companies, and following questions submitted to the Tender Committee, the tender will be revised. The new final date for submission of "Pre-Qualification Documents for the PV plant is August 21, 2008."
 - **Some notes from a public meeting for potential applicants to the tender regarding photovoltaic section:**
 - **Q:** When a major benefit of PV is its "distributiveness", why is 15MW PV included in the Ashalim project?
 - **A.** It's the intention of the project designers to learn about the effects on the grid of solar energy, and 15 MW is the smallest size which would be noticeable.

- **As of July 1, 2008**, it is now legal to connect even “**Small distributed PV projects for own use, and transfer of extra to the grid**”, under terms designed to encourage the public to participate in this project. Ever since the formal announcement, on June 3, 2008, the public and the media have demonstrated great interest and support. Almost daily, there are announcements of large scale projects in the planning stages.

The basic terms are:

- The arrangement is designed to achieve up to 50 MW grid-connected, distributed PV, through small, grid-connected installations.
- **Eligibility:** Household, up to 15 kW per consumer. Other clients, up to 50 Kw installed in a business or manufacturing plant. A quota of 30% is reserved for the household sector.
- **System installation requirements:** the installers are responsible for obtaining all the required permits from the municipality, prior to installation; system elements must meet current and future Israel Standards Institute Standards.
- **Tariffs:** NIS 2.01/ kWh fed to the grid. The price is linked to both the USD (50%) and Euro (50%), and will be reduced at a rate of 4% / year starting from the third year (2011). The Tariff is guaranteed for 20 years. For every kWh consumed by the consumer, the local tariff for consumption will be employed.
- After 20 years, the tariff per kWh will be according to the tariff relevant to the consumer at that time.
- **Taxation:** Government decision no. 2935, January 13, 2008 - installations smaller than 4 kW, will be exempt from taxes, up to a ceiling of NIS 18 000 year.
- **Metering:** Two meters will be installed:
 - showing production of the particular installation;
 - two-directional meter which will keep track of the quantity of electricity consumed from the net, and the quantity transferred to the net.
- **Licensing:** No license will be required by the Israel Electric Corporation. The only permit will be a standard building permit by the local municipality, the same as required for TV satellite dishes or solar hot water heaters.

Several positive early responses:

- One bank has already announced a special credit arrangement. No details available yet.

- One importer/distribution company has already announced a 100% credit arrangements, to be paid back over 10 years.
- At least one solar company, which had been quiescent for several years, has announced that it is getting back into the PV game; and at a recent conference, contact was made with 4 new players who are now intending to try to attract the Israeli market.

Several criticisms which have already surfaced:

- The special feed-in-tariff, which is intended to encourage consumers to enter the program by reducing the pay-back period, is linked to foreign currency only. Just since the announcement was made, the value of the tariff has dropped.
- There is no public “easy-credit” to allow the consumer to purchase systems.
- The terms discriminate against kibbutzim and other small cooperative communities, where individual families don’t have their own meters. Kibbutzim, with land, rooftops, and awareness, can’t take part in this system.

Large photovoltaic projects: The last few months have seen a flurry of announced large-scale photovoltaic projects, intending to take advantage of the special premium payments offered to clean energy projects. Upon checking at the official site listing ALL licensees and applications for licensing any kind of electricity production plant, no company has yet applied for a SOLAR plant. Therefore, this current report will not include reference to pronouncements.

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; NA
- b) the introduction of any favourable environmental regulations; NA
- c) studies relating to externalities and hidden costs of conventional energy generation when compared to renewable energy; NA
- 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.
NA

4.3 Standards and codes

Several new standards, relevant to PV, 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 2007 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).