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 2012

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Sponsored by

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Definitions, Symbols and Abbreviations

For the purposes of this and all IEA PVPS 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/m^2, cell junction temperature of 25^{o}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.

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

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 system 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, electricity utility businesses 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.

Currency: The currency unit used throughout this report is NIS (New Israel Shekel)

PV support measures:

Feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh that may be higher or lower than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies

	(often called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams
Net metering	allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes 'green power' schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development

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 23 participating countries are Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), China (CHN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission, the European Photovoltaic Industry Association, the US Solar Electric Power Association and the US Solar Energy Industries Association are also members. Both Thailand and the International Copper Association are pending members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, 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

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. This document is the Israel National Survey Report for the year 2012. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website www.iea-pvps.org also plays an important role in disseminating information arising from the programme, including national information.

1 EXECUTIVE SUMMARY

To differentiate the National Survey Report from the Annual Report the Executive summary should focus clearly on national numbers and trends. For consistency, each Executive summary should contain the following sub-headings:

1.1 Installed PV power: during 2012, 46.74 MW grid-connected PV was installed (0.5% of national electricity generating capacity); and an estimated 0.2 MW new off-grid domestic was installed.

1.2 Costs & prices: Costs and prices of modules and systems continued to decline during 2012, reaching "grid parity". The **average** cost of a standard module during 2012 was in the range of NIS 3.12/Wp, and the best price NIS 2.35 by the end of the year.

1.3 PV production – there is still no PV cell or production in Israel. The Israeli company manufacturing BoS, has further penetrated the world market with its PV inverters, reaching production levels of 315 MW. Other Israeli companies have demonstrated successful prototypes and are going to market: CPV, PV glass (for windows), and floating PV structures.

1.4 Budgets for PV demonstrations – Total Budget is not available yet, a significant increase over the previous years. There has been a new approach, with the effort in funding prototype and start-up stage projects – to encourage local industry.

1.5 Even though this report is a summary of actual 2012 installations, already approved projects for 2013 will add such a significant amount of electricity to the grid that we deem it important to add to this report the current (mid-2013) status[1]: "within a few months an additional 240 MW of medium-sized PV systems will be connected to the grid; and in little over one year there will be 180 MW large systems. These systems are all ones who have already begun installation. In addition, there will be some dozens MW from small PV systems that have already been approved. Therefore, it is likely that by the end of summer 2014, total PV capacity will be close to 2%.

[1] PUA (May 20, 2013).

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.

For the purposes of this report, **PV installations are included in the 2012 statistics if the PV modules were installed between 1 January and 31 December 2012, although commissioning may have taken place at a later date**.

2.1 Applications for photovoltaics

The main application in Israel is again overwhelmingly, grid-connected distributed photovoltaics. All projects were still in the area of roof-tops, with farms, industry and municipalities being the major areas for installing systems – with a new addition of shopping center roof tops. During 2012, there was still only one ground-installed, very large PV field, that in the Arava Valley that went online in 2011. The major application of what few stand-alone systems installed remained, as in the past, providing electricity for isolated farms, mobile military units, and the Bedouin population who are still not connected to the grid.

By the end of 2012, there were a total of 8 789 systems installed in the country, including 4 941 on homes and the remaining 3 848 small and medium systems.

Some examples of roof-top systems (typical applications)

Figure 1: : Faran 400 kWp – roof top system installed on top of a large dairy farm. (Photocredit: Solarpower)

Figure 2: Faran 400 kWp – roof top system installed on top of a large dairy farm. (Photocredit: Solarpower)

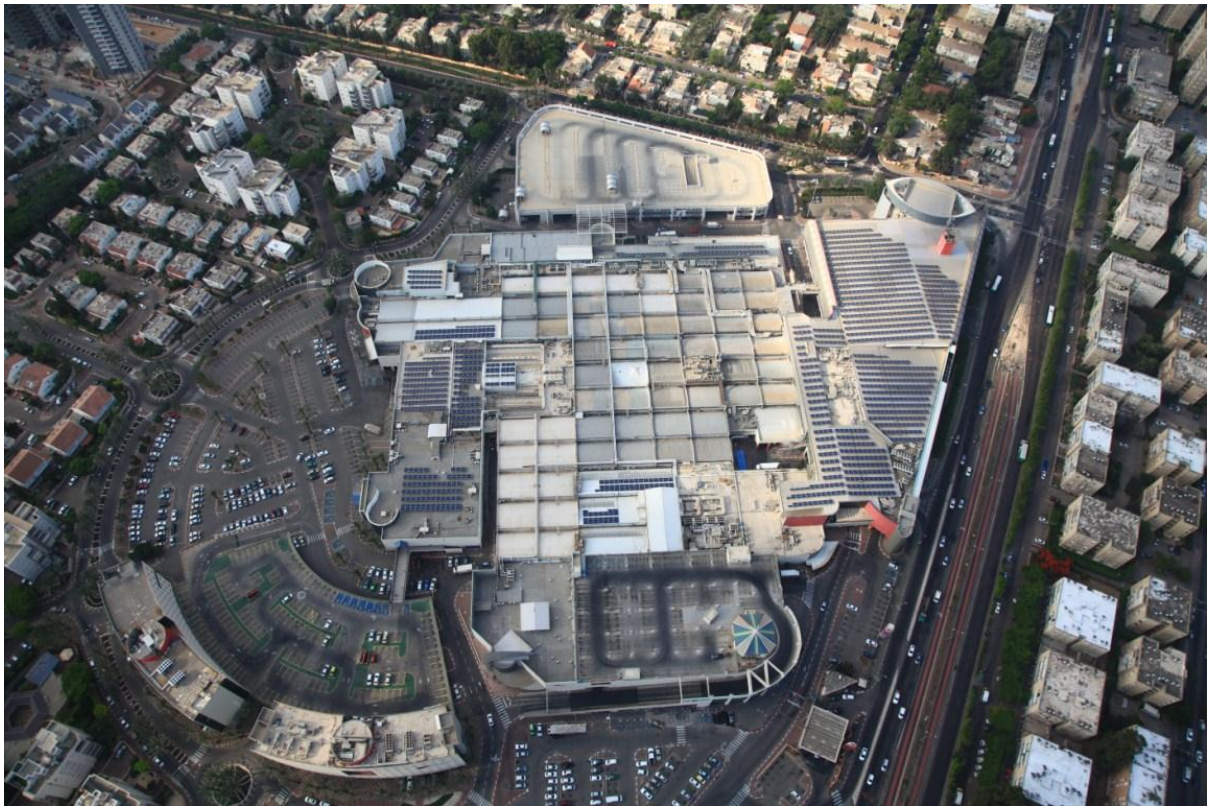

Figure 3: Renanim Mall (Photocredit: SBY Solutions)

Figure 4: Chicken coops of Kibbutz Tzofar-Faran, in the Arava(Photocredit: SBY Solutions)

2.2 Total photovoltaic power installed

The PV power installed in 4 sub-markets during 2012 should be entered in Table 1. If possible, please provide published figures or estimates concerning the role of PV in the broader national energy market in Table 1a.

It is necessary to know the accuracy of the data provided in section 2.2. Please provide a very brief summary here of the methods used to collect, process and analyze these data. If, in your estimation, the accuracy of any of the data in this section is worse than ±10 % you may provide the data as a range and also provide a statement explaining why there are difficulties in achieving accuracy. Also, if a country cannot provide any of the required data please give the reason here.

The figures we used for PV grid-connected systems are considered very reliable: whether they were provided by the Israel Electric Corp (IEC), which is considered very accurate as they monitor actual grid-connection by law; and the head of the Renewable Energies Department of the Public Utilities Authority Electricity – PUA.

Table 1: PV power installed during calendar year 2012 in 4 sub-markets.

Sub-market/ application	off-grid domestic	off-grid non-domestic	grid-connected distributed	grid-connected centralized	Total
PV power installed in 2012 (MW)	0.2[2]		46.74[3]	--	46.94
Amount of CPV in the above (MW)	0	(0)	(0)	(0)	0
Amount of PV in hybrid systems (MW)	(NA)				NA

Table 2a: PV power and the broader national energy market 2012.

Total national (or regional) PV <u>capacity</u> (from Table 2) as a % of total national (or regional) electricity generation capacity	<u>New</u> (2012) PV capacity (from Table 1) as a % of new electricity generation capacity	Total PV <u>electricity</u> production as a % of total electricity consumption
~0.5%[4]	NA	0.7%

<u>Notes:</u>

1. For historic reasons, Israel is unique in the extent its use of solar *thermal* power. Therefore our total use of solar energy is actually 5% of our primary energy sources, of which most is used for heating water.

2. Even though this report is a summary of actual 2012 installations, already approved projects for 2013 will add such a significant amount of electricity to the grid that we report here current status[5]: "within a few months an additional 240 MW of medium-sized PV systems will be connected to the grid; and in little over one year there will be 180 MW large systems. These systems are all ones who have already begun installation. In addition, there will be some dozens MW from small PV systems that have already been approved. Therefore, it is likely that by the end of summer 2014, total PV capacity will be close to <u>2%.</u>

[2] Estimated, discussions with private companies

[3] Israel Electric Corporation, dated January 31, 2013

[4] *Energy [r]evolution, Towards Sustainable Energy in Israel*, Greenpeace Report, April 2013, confirmed by Public Utilities Authority PUA (May 20, 2013)

[5] PUA (May 20, 2013).

A summary of the cumulative installed PV Power, from 2004-2012, broken down into four sub-markets is shown in Table 3.

Table 3: The cumulative installed PV power in 4 sub-markets.

Sub-market	2005	2006	2007	2008	2009	2010	2011	2012
Stand-alone domestic (estimated)	809	1 084	1 584	2 144	2 644	3 260	3 460	3 660
Stand-alone non-domestic	210	210	210	260	260	260	260	260
Grid-connected distributed	11	11	11	611	21 611	66 611	186 000	232 738[6]
Grid-connected centralized	14	14	14	14	14	14	14	14
TOTAL (kW)	1 044	1 319	1 819	3 029	24 529	69 885	189 734	236 672

Please provide at least three paragraphs of text following Table 2:

- Details of key PV deployment activities in 2012, including any major projects, demonstration and field test programmes, and market stimulation programmes in operation during the year (one paragraph for each item). Provide if possible additional discussion on the strengths and weaknesses of key items.
- A descriptive outline of key PV policy initiatives, promotional activities (commercial and non-commercial), public stakeholder developments or any other market drivers of significance starting in 2012.

Israel's overall electricity policy is decided by an autonomous office, the Public Utilities Authority Electricity (PUA). It is PUA that has the responsibility for implementing government decisions on such matters as sustainable energy targets, which fuels will be used in power plants, setting tariffs and so on. There were two significant government decisions regarding RE:

- January 2009, decision #4450, setting the objective of 10% electricity production from RE sources by 2020.
- July 2011, decision #3484, ratifying the 2009 objective, and expanding it to define specific quotas for installations of each technology.

In accordance, PUA published quotas for small, medium and large scale RE systems, and adopted the Feed-in-Tariff as the method for providing public incentive to invest in such plants. As part of its policy, the FiT provided for a fixed and subsidized tariff for any kWh produced by a private producer selling to the grid.

However, PUA has since decided that the FiT scheme is no longer the optimum method for future projects, and with the unexpected, sharp decline in standard PV costs, has decided to re-evaluate the situation. FiT will be replaced by the concept of "Value of Renewable" (VOR) to the Israeli economy as a whole, taking into account the following benefits: energy

[6] Israel Electric Corp, 31/1/2013

security, environmental benefit, Fuel+Capacity savings. These calculations lead to a sum which is the maximum the country is "willing to pay" for RE.

Since most of the quotas have already been commissioned, the decision will only be applied to ~350-400 MW of new PV (mainly Utility Scale), with potential savings of billions of NIS.

Therefore, three steps have been taken for future projects:

1. Updating FiTs by using an external global standard as reference, not local costs.
2. Linking FiTs to a formula including an external global PV cost-index (Bloomberg) – thereby creating an automatic tariff update.
3. Moving away from FiT, to Tenders and Self-consumption (net metering) structures.

PUA considers this adjustment and linkage process, which forces local industry to improve and settle with global cost standards, to be an important part of its policy towards achieving grid parity in the near future.[7]

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

Please provide quantitative details of PV implementation highlights in 2012, including major projects, demonstration and field test programmes, and market stimulation programmes in operation during the year (one paragraph for each item).

2.4 Highlights of R&D

Research in the entire range of photovoltaic related subjects is continuing at all Israeli academic centers.

Ben-Gurion University

The National Solar Energy Center – established in 1985, it continues to support basic research on the part of its academic staff, as well as provide infrastructure and logistical support for Israeli and overseas industry who may install their systems here.

- Eugene A. Katz: 1. light-induced degradation of fullerene/conjugated-polymer solar cells; 2. Synthesis of fullerenes and nanotubes by concentrated sunlight; 3. PV characterization of high-efficient solar cells under ultra-high concentrations of sunlight; 4. carbon nanotube / polymer blends and solar cells.
- Daniel Feuermann: Characterization of high-concentration PV cells; physics under high concentration and cell parameters as a function of temperature and concentration.
- Iris Visoly-Fisher: Organic solar cells – light trapping in P3HT:PCBM
- David Faiman: 1) smart-grid; 2) electricity storage modelling; 3) evaluation of a Vanadium Redox Battery for solar applications; 4) Precise monitoring of DNI
- Sergey Biryukov: 1) solar production vis-à-vis meteorological conditions; 2) waterless dust removal
- Jeffrey M Gordon – CPV, optics for solar energy, ultra-efficient solar cells
- Rafi Shickler – Organic PV

[7] Public Utilities Authority Electricity, Environmental Division, current status report, April 1, 2013. More information on formulae for calculations and other specific are available.

- Yona Siderer and Shoshana Dann – PV data and information accumulation for IEA PVPS

The Technion Institute of Technology

- Gideon S. Grader: sol-gel chemistry for fabrication of transparent conductive oxide (TCO) films as well as the formation of ceramic nano-fibers
- Carmel Rothschild: light up-conversion in PV
- Efrat Lifshitz: Quantum dot solar cells
- Gitti Frey: Organic solar cells
- Nir Tessler: Organic solar cells
- Guy Bartal: Nano-photonics
- Yaron Paz : organic solar cells
- Avner Rothschild: electro-ceramic devices

Weizmann Institute of Science

- David Cahen: optoelectronic materials
- Gary Hodes: nanoporous solar cells using inorganic semicondutors
- Michael Bendikov: Conjugated polymers for organic PV

Tel Aviv University

- Avraham Kribus – concentrator photovoltaics (CPV)
- Yossi Rosenwaks: Organic solar cells

ORT-Braude College (Carmiel)

- Rona Sarfaty: Vertical multi-junction (VMJ) silicon solar cells with radial junctions

Bar-Ilan University

- Arie Zaban – Dye sensitized nano-crystaline

Hebrew University of Jerusalem

- Isaac Balberg and Oded Millo: Properties of grain boundaries in thin film solar cells
- Etgar Lioz – Hebrew University - Organic–inorganic hybrids for excitonic solar cells

Jerusalem College of Technology (JCT)

- Naftali Eisenberg: n-Si based solar cells

INDUSTRIAL R&D

- 3GSolar Photovoltaics Ltd., Dr. Jonathan Goldstein: Photovoltaic dye cells
- Bsolar Ltd, Naftali Eisenberg: bi-facial modules

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

Please complete Table 3 giving figures for the year on budgets from the public authorities for R&D, demonstration/field test programmes and market incentives (public subsidies, fiscal incentives) on the national/federal level, and on the state/regional level.

Table 4: Public budgets for R&D, demonstration/field test programmes and market incentives. WAITING FOR INFO FROM OUR MINISTRY

	R & D	Demo/Field test	Market incentives
National/federal	NA Yet	NA Yet	
State/regional			
Total			

The primary funder of Research and Development is the Israel Ministry of Energy and Water. The office of the Chief Scientist assists R&D activities during the most crucial steps of the R&D Life cycle[8]:

- Funding academic R&D
- The Startergy fund for early stage start-up companies
- Pilot and demonstration projects
- International R&D collaboration

Some of their projects of relevance to photovoltaics:

Startergy Fund

1. **P.V. Nanocell**. Develops a unique nano-ink for printing the conductive grid on PV wafers using inject technology
2. **Solarbead Ltd.** Improving the efficiency of energy harvesting of solar PV systems.
   a. InverBead – development of a decentralized system architecture (microinverter) avoiding the need for a central inverter
   b. DC Bead – development of an electronic circuit that will allow connection of any number of panels to the inverter, and will not be limited to complete strings.
3. **Burning Solar Ltd**. Multi-junction, carbon based solar cell, with high efficiency, based on controlled deposition process of carbon layers.

Pilot and Demonstration Projects

1. **Solaris Synergy**'s flagship product is a floating photovoltaic (F-PV) system. A viable renewable energy alternative to land-based solar energy systems, the system features a modular design that supports power output ranging from several kilowatts to dozens of megawatts. Thanks to this innovative design, the solution dramatically lowers the cost of energy production to a level far below national feed-in tariffs (FITs). Available for industrial implementation, the platform is a self-contained system that operates on any fresh, salt or waste water surface. The F-PV plant is also a low-profile system that does not impact the environment or surrounding areas. The company started work with concentrator PV (CPV) and is now working on a prototype with standard PV. (Below are several photos. Photo credits to Solaris Synergy).

[8] *Research and Development 2011-2012*, published by the Ministry of Energy and Water Resources, office of the Chief Scientist. November 2012.

Figure 5: Solaris prototype at Tekuma, bird's eye view (photocredits: Solaris Synergy)

Figure 6: Visit by Minister of Energy Dr. Landau at Tekuma site (photo: Solaris)

Figure 7: Close up of floating prototype

2. **Sunboost** installation comprises optical boosting using proprietary static, glass or plastic, add-on panels that are set in the gaps between rows at opposite tilt to the PV panel row to redirect the light insolating the gaps onto the adjacent PV modules.
3. **Matalon** comprises two systems: 1) Concentrates light onto photovoltaic cells arranged in a panel, that uses moderate concentration and doesn't require cooling; 2) tracker, based on solar cells, that requires no use of battery or micro-processor, but generates its own power.

ADDITIONAL SOURCES OF R&D FUNDING

Israel-US Binational Industrial Research and Development Foundation (BIRD) approved funding during 2012 for two PV related projects:

Ben-Gurion University and Southwest Solar Technologies Inc. will be investigating a new approach to concentrator photovoltaics. This is the first time that BIRD is funding collaboration when one of the partners is academic.

Pythagoras Solar Ltd. And BISEM Inc. will be studying unitized UL Certified **BIPV Glazing systems.**

INDUSTRY AND GROWTH

2.5 Production of feedstocks, ingots and wafers

Still inapplicable

2.6 Production of photovoltaic cells and modules

Still inapplicable.

Describe briefly the overseas activities of any key companies also operating in other countries.

Several Israeli companies are active in installing PV projects in other countries, including many African countries but also Greece, Italy (Photo follows) and others. None of the PV module elements of the systems are manufactured in Israel.

Figure 8: PV project in Italy installed by the Israeli company SBY Solutions (photo-credit SBY)

2.7 Module prices

In Table 6 please add year 2012 module prices (excluding VAT/TVA/sales tax): for small (typical?) and large (best price?) orders, if possible; OR an indicative national figure. Please clarify whether you are reporting an average price, a representation of all known prices, a typical example, or so on.

Also, if possible, please report separately the minimum price that has been achieved in 2012, noting whether this is an import or locally manufactured.

Table 5: Typical module prices for a number of years (in NIS/W)*

Year	2009	2010 Q1	2010 Q4	2011	2012 avg*	2012 Q1	2012 Q4
Standard module price(s): Typical	20	7.462	6.16	5.04	**3.12**	**3.16**	2.35
Best price	14	7.462	6.16	3.96	**2.31**		
PV module price for concentration (if relevant)	NR	NR	NR	NR	NR	NR	

*Average price from several vendors

2.8 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:

- **PV inverters (for grid-connection and stand-alone systems) and their typical prices**

Manufacturer: SolarEdge
Products: PV inverters, module-level power optimizers and monitoring systems.
Average Price level: USD 0.45/w
Production Jan-Dec 2012: 315MW
Export/local use ratio: 90% Export
Employment: 230 employees worldwide

- **Storage batteries**

EnStorage Inc. was founded in 2008 to commercialize low cost flow batteries based on Hydrogen Bromine Technology. The technology has advanced into fully functioning, demonstration stage, energy storage systems. They have demonstrated: high cyclic endurance; energy storage solution scalability; fully integrated, self-compressing system, and compelling cost profiles enabled by low cost materials. They now have a grid-connected 50 kW battery, providing up to 100 kWh of energy, and are developing modular grid scale energy storage systems.

- Battery charge controllers
- DC switchgear
- **Supporting structures**

Pythagoras Solar, an Israeli founded company, has begun manufacture and marketing of photovoltaic glass units, for application in Building-Integrated PV projects. These windows provide a number of advantages: energy efficiency (extremely low solar heat gain, low U-values and daylighting); energy generation (high power density and cost efficient using sunlight concentration; and aesthetics.

MST, another Israeli company, has focussed on developing a concentrator Photovoltaic system. They successfully constructed their 45 kW system, which is now operating grid-connected. Their business plan calls for sale of technological know-how to overseas partners who will undertake manufacturing of the systems.

2.9 System prices

Please give in Table 7 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 7a)

Additional information should also be provided, if applicable, on the price of home PV system kits (marketed in some countries through retail outlets). Please also specify what components are sold as part of the kit.

NO DO-IT-YOURSELF KITS ARE AVAILABLE. OCCASIONALLY SOMEONE WILL PURCHASE A SMALL QUANTITY OF PANELS, EVEN DAMAGED ONES, FOR STAND-ALONE SMALL PROJECTS. NO PRICE IS AVAILABLE.

A summary of typical system prices is provided in the following tables.

Table 6: **Turnkey Prices of Typical Applications (in NIS)**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW		
OFF-GRID >1 kW	none	
GRID-CONNECTED Specific case		
GRID-CONNECTED >10 kW	**AVERAGE 2012**	**9.95**
GRID-CONNECTED >10 kW	beginning of 2012	9.89
GRID-CONNECTED >10 kW	end of 2012*	7.47
GRID – CONNECTED (utility-scale plant, if relevant)	none installed during 2012	not relevant

***Important Note:** The very large decline in PV system costs during 2012, continuing the trend from the previous year, had its effect on policy and led to two significant changes starting with 2013 installations: 1) a new way to calculate tariff for FiT for Large projects, and 2) replacement of FiT with Net Metering for most future medium and large projects. For more information, see section 3 "Framework for Deployment".

Table 7a: National trends in system prices (current) for … (specify application, for example from table 7 above)

YEAR				2011	2012 Avg	2012 Q4
Price /W:				10.8-12.6	**9.95**	7.47

2.10 Labour places

- The general PV data we were able to collect is mainly from the IEC, who are only interested in the amount of power delivered to the grid. No companies are willing to reveal or share their business information, including number of employees.
- Number of employees involved in R&D would necessarily be those in academia, and here, too – data are unreliable since many of those involved in PV R&D are not necessarily funded by PV-labelled projects, including students and senior staff.

Table 7: Estimated PV-related labour places in 2012

Research and development (not including companies)	
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	
Electricity utility businesses and government	
Other	
Total	unavailable

2.11 Business value

Provide an estimate of the value of PV business in your country (similar to Gross Domestic Product estimations) using Table 7.

Table 8: Value of PV business

Sub-market	**Capacity installed *in 2012* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic			*a = X x Y x 1 000 000*	
Off-grid non-domestic			*b*	
Grid-connected distributed	**46.74**	**9.95**	*c*	*465 063 000*
Grid-connected centralized			*d*	
Export of PV products *(including information from Tables 4 & 5)*				*NA*
Change in stocks held *(including information from Tables 4 & 5)*				*NA*
Import of PV products *(including information from Tables 4 & 5)*				
Value of PV business in NIS				***465 063 000***

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.

3 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

If not already covered in section 2.2, please identify and give a brief description of any support measures from Table 10 that have been launched or identified in your country during 2012 (or early 2013). Please indicate whether the measures were in place at the national, regional (state) or local levels.

Table 9 lists the main support measures (definitions at start of guidelines) for PV during 2012. Further details on these are to be provided on the following pages.

Table 9: PV support measures

	On-going measures	Measures that commenced during 2012
Feed-in tariffs (gross / net?)	yes	
Capital subsidies for equipment or total cost		
Green electricity schemes		
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)		
PV requirement in RPS		
Investment funds for PV		
Income tax credits		
Net metering		commencing early 2013
Net billing		
Commercial bank activities e.g. green mortgages promoting PV		
Activities of electricity utility businesses		
Sustainable building requirements		

If relevant, please provide a brief description of **one** interesting PV financing scheme currently operating in your country in Table 10a.

Table 10a: PV financing scheme

PV financing scheme
With the decline in costs to grid-parity, no special commercial PV financing schemes are currently significant for the FiT model. However, it remains to be seen whether the transfer to the net-metering model, which is particularly attractive to commercial interests such as malls, will bring with it a return to bank financing under special terms for the PR value.

3.1 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:

The discovery of natural gas reserves off the coast of Israel in the past few years has become the most significant issue in Israel's energy security for the coming decades. The commercial quantities of gas have come on-line at a fortuitous moment, when supplies from Egypt were suddenly cut off due to terror attacks on the pipelines in the Sinai desert serving Israel and Jordan. The current heated debate in Israel is now whether or not to allow export of any natural gas, and if so – how much. The programs of all the energy conferences in Israel (except for the Sede Boqer Symposium on Solar Electricity Production) demonstrate just how this subject has affected our national consciousness. For six decades Israel was 100% dependent on imported fossil fuels, a great burden on its national security.

3.2 Interest from electricity utility businesses

Please briefly report on the key drivers and barriers for PV activity by electricity utility businesses in your country (you may also wish to list references for relevant studies that have been published in your country).

The Israel Electric Corporation (IEC) is still the monopoly electricity supplier and transmitter in the country. Policy is decided, however, by the Public Utilities Authority-Electricity (PUA).

Regarding the experience the IEC has already had with adjusting to the penetration of PV to the grid, please see the end of section "highlights and comments", below.

3.3 Interest from municipalities and local governments

Please briefly report on the key drivers and barriers for PV activity by municipalities and local governments in your country (you may also wish to list references for relevant studies that have been published in your country). Please outline key models that have been implemented or are being considered by these authorities.

There are two types of municipal authorities in Israel: Urban cities and towns, and the "regional council":

The standard urban model since implementation of the FiT model has been to provide rooftops of public buildings (offices, schools) to entrepreneurs, and in most cases the space is rented out for a set fee, providing easy income. The entrepreneur took care of all funding and risk; this method was deemed most appropriate since most municipalities did not have capital to invest in projects.

In the case of the regional councils, the situation is different: here, the local government is often looking for sources of income and employment for their residents; and they have access to lots of open land with minimal population. RE is considered a good source of income, and in some cases agricultural land has been rezoned to allow RE plants.

3.4 Standards and codes

Please give one paragraph maximum on any new issues relating to Standards and Codes of Practice. Areas to be considered include:

The Standards Institute of Israel (SII) has continued its work of establishing standards for all elements of PV systems. In July 2012 they officially published Standard #62548 for system design; and standard 61683 for inverters: the process for measuring efficiency.

All permitted inverters are listed on the website of the Israel Electric Corp.

4 HIGHLIGHTS AND PROSPECTS

Please highlight key aspects of PV deployment or production in your country during 2012.

Please give one paragraph maximum on forward looking issues within your country such as:

- Details from industry of planned increases in PV module production capacity. NOT RELEVANT
- Any significant developments in technologies. Several Israeli companies have been working on CPV, however – the inundation of the world market by inexpensive Chinese conventional modules has had a deleterious effect on investment in new technologies.

Please specify any long-term targets for installed PV power capacity that exist, or future energy scenarios that are being discussed, within your country.

The long-term target for RE (PV, CPS and wind) has remained unchanged: 10% by 2020, with an interim target of 5% by 2014.

Future R&D – by the Government

The Ministry of Energy and Water Resources (MEWR) has decided to make significant investments in Excellence, providing NIS 24 million during 2013 for energy research. This will be for 11 academic studies, 9 demonstration and prototypes and 10 "Startergy" for early-stage start up companies. Of these there are 2 PV and 3 smart-grid projects.

Future Regulation

PUA, as mentioned above, is responsible for all aspects of policy implementation. Several significant decisions were made in late 2012 and early 2013, which may (will probably) have significant effects on the local market.

- The Ministerial committee for RE Promotion voted to shift 300 MW to a new PV quota, away from the wind quota. The justification: procedural and statutory processes of wind promotion are too slow and the chance of full deployment was weak.
- Future policy of Grid-parity regulations that are intended to further integrate RE without additional costs to the Israel consumer.
    - Net Metering regulation. Self-consumers will be able to save their electricity retail tariff through self-consumption minus grid "balancing costs". Production surplus will be injected into the grid and rewarded by "credit" which is to be reduced from the consumer's electricity bill at the end of each month. Credit may be accumulated and transferred (including to other consumers) for up to 2 years. This option is intended to reduce risks and increase bankability of RE systems.
    - Grid Parity regulation for all RE technologies, based on the maximal value which the market is willing to pay per kWh (estimated to be ~ NIS 0.45-0.5/kWh).[9]

One sign of the importance given to the subject of RE by the Israeli government is the establishment of the "Kandel commission" for evaluating "grid flexibility for accepting RE and the capacity credit of solar systems. The background of this commission should be viewed

[9] PUA, April 21, 2014

as balancing between the wish to increase use of RE, for the reasons given above (energy security, environmental issues etc.) AND the push to convert most of Israel's electricity capacity to natural gas following the discovery (and now availability) of large, off-shore supplies. Two main issues are being addressed:

- Grid flexibility: Ability of the grid to accept the intermittent energy supplied by RE, risks to the grid and how to make improvements. On this subject, the participants agreed that implementation of RE has to be accompanied by improvements in system management, mainly: early warning systems, improved monitoring and control systems, pumped storage and other storage. The representative of the IEC provided the information that they are already preparing detailed project on the ramifications of large scale RE.
- Capacity credit: and the results of over expansion.

As follow-up to the discussions of the Kandel commission, in May 2012, PUA initiated a working group consisting of representatives of three government ministries (Energy, environment and prime minister), IEC, PUA, industry and academia. Participants in the meeting expressed concern about the ability of the grid to absorb the *intermittent* input from RE, without harming the reliability of grid supply to consumers. There were four speakers at this workshop. Two speakers expanded on the subject of grid-connection:

- Prof. Faiman (Former director of the National Solar Energy Center, Ben-Gurion University) presented a model expressing the flexibility factor of the grid, defining the extent of RE that can be introduced to the grid considering ramping requirements, without the need to dump any part of the electricity. The results of this model show that it is possible to absorb between 9.8%-12.1% of PV electricity (in Israel that would be 3 GW capacity). Prof. Faiman presented various methods for enhancing absorption capacity.
- Prof. Faiman's findings were confirmed by Dr. David Elmakias, the head of the IEC's Department of Planning and Technologies in pointing out that experience in other countries and based on grid characteristics, 10% is the upper reasonable limit for absorbing RE, without significant other infrastructure investments. On the other hand, Mr. Dov Strolovits (also IEC, head of systems operations) pointed out that the current level of PV supply (200 MW) is already "felt" by the grid, and he estimated a maximum of 500-600 MW current potential.

The committee will continue its activities, focusing on ways to manage the system to handle intermittency.

ANNEX A: 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.

Rates of Exchange[10]:

Date	NIS/ 1 USD	NIS / 1Euro
January 2012	3.809	4.917
April 2012	3.751	4.935
July 2012	3.991	4.909
October 2012	3.851	4.998
December 2012	3.771	4.956
Average for the year used in this report as reported by the official Bank of Israel site	**3.856**	**4.995**

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 – greatly fluctuated during 2012 due to: fluctuating international fuel costs; government intervention in the tax burden

2) typical household electricity consumption (kWh)

3) typical metering arrangements and tariff structures for electricity customers (for example, interval metering? time-of-use tariff?)

4) typical household monthly income: NIS 12 345[11]

5) typical mortgage interest rate

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

7) electricity industry structure and ownership: A single company, monitored and controlled by the government.

8) price of diesel fuel

9) typical values of kWh / kW for PV systems in parts of your country. . **In the area of Ramat Negev 1 kWp → 1,700 kWh/y annually[12]**

[10] **http://www.boi.org.il/he/Markets/ForeignCurrencyMarket/Pages/average.aspx**

[11] 2011 figures. Israel Central Bureau of Statistics, most recent figure as of April 2013. http://www.cbs.gov.il/reader/?MIval=cw_usr_view_SHTML&ID=313

[12] Prof. David Faiman. More extensive reports have been prepared as part of the Negev Radiation Survey and the Design Guide for Solar Project planners, sponsored by the Israel Ministry of Energy and Water.