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 Mexico 2010

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May 2011

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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°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 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 Mexican Pesos

PV support measures:

Enhanced 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 somewhat higher 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 (usually characterized by a broad, least-cost approach favouring hydro, wind and

	biomass)
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	in effect the system owner receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and netted over the billing period
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity fed into the grid is valued at a given price
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 22 participating countries are Australia (AUS), Austria (AUT), 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.

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 Mexico National Survey Report for the year 2010. 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

1.1 Installed PV power

During 2010, the installed capacity in Mexico reached 30,606 kW. Since 2009, the installed capacity for grid connected systems superposed the off grid applications. The first 1 MW centralised installation was inaugurated by the end of 2010.

1.2 Costs & prices

PV module prices in the Mexican market fall during 2010. Two factors contributed to this situation: high inventories of PV modules, and the favourable exchange rate between the Mexican Peso and the US Dollar.

1.3 PV production

Two companies are assembling proprietary brands of PV modules in the country. Only one provided information about its PV module production for 2010, it was 2 MW. Also three international companies are assembling PV modules for the export market.

1.4 Budgets for PV

The budget for PV projects research during 2010 was around twenty million Mexican Pesos, and was provided by Federal government agencies. No funds has been allocated to promote PV production, installations, or feed-in tariffs

2 THE IMPLEMENTATION OF PV SYSTEMS

2.1 Applications for photovoltaics

Grid Connected PV systems become since 2009 the as the main application for PV in Mexico. During 2010 near to 4 MW were installed , and includes the first 1 MW centralized system.

2.2 Total photovoltaic power installed

Table 1 shows the total PV installed during 2010. Data was collected trough personal interviews or telephone calls with the main actors of the PV industry (PV products distributors, systems integrators, professional associations, and federal government agencies carrying out PV programs and projects).

Table 1: PV power installed during calendar year 2010 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 2010 (kW)	1022	620	2945	1000	5587

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

Total national (or regional) PV capacity (from Table 2) as a % of total national (or regional) electricity generation capacity	New (2010) PV capacity (from Table 1) as a % of new electricity generation capacity	Total PV energy production as a % of total energy consumption
0.057	0.44	No significant electricity production from PV

Data shown in Table 1a do not includes self consumption producers, whose consume all the electricity they produce.

A summary of the cumulative installed PV Power, from 1992-2010, broken down into four sub-markets is shown in Table 2.

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

	Cumulative installed capacity as at 31 December																
Sub-market	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Stand-alone domestic	7920	8270	9020	9870	10673	11228	11828	12349	12943	13595	14169	14476	14987	15487	16087	18037	19059
Stand-alone non-domestic	900	950	1000	1150	1347	1692	2092	2614	3208	3536	4003	4178	4594	4963.4	5163.4	5687.4	6307
Grid-connected distributed	0	0	0	1.8	1.8	1.8	8.6	8.6	9.6	9.6	9.6	39.6	149.6	299.6	499.6	1295.6	4240
Grid-connected centralised	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
TOTAL (kW)	**8220**	**9220**	**10020**	**11021**	**12021**	**12021**	**13928**	**14971**	**16160**	**17140**	**18181**	**18693**	**19730**	**20750**	**21750**	**25020**	30606

Some important action related with PV technology and its application took place during 2010

A 135 kW grid connected PV system was installed on roof of the hotel where the COP 16 summit took place in Cancun. Another example is the 30 kW PV grid connected system installed at the Technology Museum of the national electric utility CFE in Mexico City. The energy produced by the systems supplies partially the electricity needs of the General Director offices area of the national utility CFE . Meanwhile, megawatt size projects are at different stages of development at least eight regions of Mexico, either for electricity self-supply or for export of electricity to the US mainly for California market.

Federal government allocated budget for the installation of a testing bench for PV hybrid systems. The infrastructure will be used also for isolated micro-grids research activities.

The main action on the regulatory framework was a substantial increase in the allowable capacity of renewable technologies and cogeneration systems that can be connected to the grid (500 kW) that can receive the benefits of net metering. Former regulation allowed the connection of PV systems up to 30 kW for commercial and office buildings, and 10 kW for domestic systems.

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

No important projects to report in this area

2.4 Highlights of R&D

During 2009 The Energy Secretary constituted a fund to provide financial support for research activities in some fields of its interest. In 2010 at least 3 projects started: One is related with building capacities for testing Solar Home Systems. The facility will provide technical support to rural electrification projects and private companies involved with PV rural electrification projects. The other research activity that received funds is related with hybrid systems and micro grids.

The Energy Research Center of the National Autonomous University of Mexico received support for setting up a test bench for PV modules under controlled conditions. This installation will provide services for the characterization of PV modules, and also will offer services for the academic groups working in the development of solar cells.

Table 4: Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test	Market incentives
National/federal	8,000,000	12,000,000	-
State/regional	-	-	-
Total	20,000,000		

3 INDUSTRY AND GROWTH

3.1 Production of feedstocks, ingots and wafers

There is no production in the country of feedstock, ingots or wafers

3.2 Production of photovoltaic cells and modules

Three international PV modules makers have production facilities in Mexico. Also two national companies are assembling PV modules in the country.

Total PV cell and module manufacture together with production capacity information is summarised in Table 5 below.

Table 5: Production and production capacity information for 2010

Cell/Module manufacturer (or total national production)	**Technology** (sc-Si, mc-Si, a-Si, CdTe)	**Total Production (MW)**		**Maximum production capacity (MW/yr)**	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
Kyocera		a	120	b	150
Sanyo		c	50	e	50
ERDM			2		15
Total					
Thin film manufacturers					
UNISOLAR		-	*60*	-	*60*
2					
Cells for concentration					
1		g		h	
TOTALS		**-**	**232**	**-**	**275**

Production from Kyocera, Sanyo and Unisolar, is for the export market. These companies bring materials from abroad and ensembles the modules in Mexico .The assembled modules are sold in the international market.

ERDM and Solartec are Mexican companies. Their PV modules are sold mainly in the domestic market. Part of the ERDM production is exported to Central America and Caribbean countries

Solartec is assembling PV modules in Mexico, No information was provided about its production during 2010.

3.3 Module prices

During 2010 PV module prices in Mexico register a huge reduction. Two factors influenced the remarkable drop in prices. First, the high inventory levels of PV modules in the international market, and second, the favourable exchange rate between the Mexican Peso and the US Dollar.

Table 6: Typical module prices for a number of years

Year	1992			20047	2008	2009	2010
Standard module price(s): Typical				70.8	78	67.5	43.33
Best price				50.8	52	54	28.47
PV module price for concentration (if relevant)							-

EXCHANGE RATE NMX/USD 12.381

MANUFACTURERS AND SUPPLIERS OF OTHER COMPONENTS

No national production of Grid Connected PV Inverters. The inverter of the Mexican Electrical Research Institute inverter is still under development. For stand alone PV systems there are two manufacturers of inverters for capacities less than 1 kW

There are several battery manufactures of industrial batteries in the country. Solar batteries for SHS of around 100 Ah are supplied mainly by two national battery makers.

In the country there are at least three manufacturers of charge controllers used in small SHS. The market is also complemented with imported products

DC switchgear is a dedicated industry in Mexico but the market is mainly for electric motors control. The needs on DC switchgear for PV applications are covered trough imported products.

Supporting Structures for PV application is not a real market in the country, nevertheless there is industrial infrastructure for manufacturing metal structures for another proposes and uses no specialized manufacturing lines for PV application is at the moment available: This industry can be able to provide solutions for the PV industry.

3.4 System prices

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

Table 7: Turnkey Prices of Typical Applications

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW	Solar Home Systems	90
OFF-GRID >1 kW		124
ON-GRID Specific case	For example: 1-2 kW roof-mounted system, if relevant	80.5
ON-GRID up to 10 kW		
ON-GRID >10 kW		-
GRID – CONNECTED (centralized, if relevant)		123.8

Table 7a: National trends in system prices (current) for grid connected PV systems 1 - 2 kW roof mounted

YEAR	1992					2008	2009	2010
Price /W:	-	-	-	-	-	138.6	108	80.5

3.5 Labour places

Table 8: Estimated PV-related labour places in 2010

Research and development (not including companies)	20
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	120
Electricity utility businesses and government	6
Other	
Total	146

3.6 Business value

Table 9: Value of PV business

Sub-market	**Capacity installed *in 2010* (kW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	*1022*	*90*	*91980000*	*91980000*
Off-grid non-domestic	620	124	*76880000*	*76880000*
Grid-connected distributed	2945	80.5	*237072500*	*237072500*
Grid-connected centralized	1000	123.8	*123800000*	*123800000*
				529732500
Export of PV products *(including information from Tables 4 & 5)*				-
Change in stocks held *(including information from Tables 4 & 5)*				-
Import of PV products *(including information from Tables 4 & 5)*				-
Value of PV business				*529732500*

Currency NMX

4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

Table 10 lists the main support measures (definitions at start of guidelines) for PV during 2010. Further details on these are to be provided on the following pages.

Table 10: PV support measures

	On-going measures	Measures that commenced during 2010
Enhanced feed-in tariffs (gross / net?)	-	-
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 (national)	for systems up to 30 kW	for systems up to 500 kW
Net billing	-	-
Commercial bank activities e.g. green mortgages promoting PV	-	-
Activities of electricity utility businesses	-	-
Sustainable building requirements	-	-

No financial schemes are available for PV

Table 10a: PV financing scheme

PV financing scheme

4.1 Indirect policy issues

As result of the compromises arising from the COP 16 held in Cancun, it is though that the country will support activities focused on actions to mitigate the climate change, and PV could be benefit from government programs.

4.2 Interest from electricity utility businesses

A clear message form the national utility about its incipient interest on PV technology as a alternative for distributed generation is the installation of a PV grid connected at the General Director offices of the National Utility. Also the installation of MW size centralized system is on planning stage at the national utility.

4.3 Standards and codes

In August 2008 The national utility "Federal Commission of Electricity" released the Technical Specification G100-04 "Interconnection to the low voltage electric grid of photovoltaic systems up to 30 kW_p."

5 HIGHLIGHTS AND PROSPECTS

The estimation of the market growth for next year among the PV system integrators and installers is very optimistic. PV market for next year is estimated at 15 MW level, that is almost the triple of the 2010 size.

ANNEX A: COUNTRY INFORMATION

1) Retail electricity prices - household, commercial, public institution

Domestic	1.1327 NMX/kWh
Commercial	2.5691 NMX/kWh
Services	1.8611 NMX/kWh
Farms	0.4918 NMX/kWh
Medium size Industry	1.4327 NMX/kWh
Big Industry	1.1002 NMX/kWh

2) Typical household electricity consumption (kWh)

There is wide range of electricity consumption for all the regions in the country. The main difference is linked to the use of air conditioning equipment in the regions with high temperatures during summer time in north and south of the country

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

The interval metering only is applied to commercial and industrial customers. The classification are : base , intermediate, and peak. These intervals apply for Sunday trough Friday, weekends, and holidays, also its application is moved for summer and off summer months.

4) Typical household income

No data available

5) Typical mortgage interest rate

15-20%

6) voltage (household, typical electricity distribution network)

Typical voltage for domestic users is 127V. In the cities located in north west Mexico where air conditioning equipment is broadly used the voltage is 220V. Sub-distribution voltage is 13.2 KV

7) electricity industry structure and ownership

There is only one state owned national utility. There is also the figure of independent producers; these producers should sell all the electricity they generate to the national utility. Generation is allowed for self consumption any excess in electricity production should be sell to the utility. The law allows constitute self consumption societies, where all the partners consume the electricity they produce.

8) price of diesel fuel

8.68 MXN/litter

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

1750 kWh/kWp (national mean)