IEA INTERNATIONAL ENERGY AGENCY

PVPS Report
Snapshot of Global PV 1992-2013

Preliminary Trends Information from the IEA PVPS Programme

PVPS

PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

Report IEA-PVPS T1-24:2014

ISBN 978-3-906042-19-0 A Snapshot of Global PV 1992-2013

What is IEA-PVPS

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The IEA carries out a comprehensive programme of energy cooperation among its 28 members and with the participation of the European Commission. The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative research and development agreements within the IEA and was established in 1993. The mission of the programme is to "enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems."

In order to achieve this, the Programme's participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct 'Tasks,' that may be research projects or activity areas. This report has been prepared under Task 1, which analyses market development and facilitates the exchange and dissemination of information arising from the overall IEA PVPS Programme.

The participating countries are Australia, Austria, Belgium, Canada, China, Denmark, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Thailand, Turkey, the United Kingdom and the United States of America. The European Commission, the European Photovoltaic Industry Association, the Solar Electric Power Association, the Solar Energy Industries Association and the Copper Alliance are also members.

A Snapshot of Global PV:
Introducing the Next "Trends in Photovoltaic Applications" Report 1992-2013

IEA-PVPS has distinguished itself throughout the years by producing unbiased reports on the development of PV all over the world. In addition to its trusted yearly publication "Trends in PV Applications," which has already been published 18 times, this second edition of the "Snapshot of Global PV" aims at providing preliminary information about how the PV market developed in the last year.

IEA-PVPS collects information from official governmental bodies and reliable industry sources. Information about countries outside the IEA-PVPS network is collected through the industry network and industrial associations.

The 19th edition of the PVPS "*Trends in Photovoltaic Applications*" report will be published in Q3 2014. It will once again deliver accurate information about the evolution of support policies for PV in the major markets, together with a clear analysis of best practices and updated numbers on market development.

2013 Highlights

Preliminary market data reported shows a growing market in 2013, for the first time in two years. **At least 36.9 GW** of PV systems have been installed and connected to the grid in the world last year. While these data will have to be confirmed in the coming months, some important trends can already be discerned:

- The global PV market grew to at least **36.9 GW** in 2013, compared to around 29 GW in the last two years.
- With additional installations not yet reported, the final number for the 2013 PV market could be above **38 GW.**
- Asia ranks in first place in 2013 with more than **59%** of the global PV market.
- The market in **Europe has decreased** significantly from 22 GW in 2011 to 17 GW in 2012 and 10.3 GW in 2013. For the first time since 2003 Europe is no longer the top PV market in the world.
- The **Asian markets experienced the highest growth** (+170%) and **China** took first place (with an estimated 11.3 GW of grid connected PV systems), ahead of Japan (6.9 GW[1]) and the USA (4.75 GW). The first European country ranked fourth, with 3.3 GW installed is Germany.
- In the top 10 countries, there are 4 Asia-Pacific countries (China, Japan, India, Australia), 5 European countries (Germany, Italy, UK, Greece and Romania), and one country in the Americas region (USA).
- Germany, Italy and Greece have now enough PV capacity to produce respectively **6.2%, 7.8%** and **5.8%** of their annual electricity demand with PV. **15** countries have enough PV to produce at least 1% of their electricity demand with PV.
- PV represents 3% of the electricity demand in Europe and 6% of the peak electricity demand.
- PV represents at least **0.85%**[2] of the global electricity demand and should reach the 1% mark in 2014.
- **17 countries had at least 1 GW** of cumulative PV systems capacity at the end of 2013 and 9 countries installed at least 1 GW in 2013.

[1]Japan reports officially AC figures. These are recalculated DC figures.
[2] IEA – Key World Energy Statistics 2013 – Based on 18 400 TWh of electricity consumption.

How much PV Capacity is Producing Electricity in the World Today?

The 24 IEA-PVPS countries represented 123.2 GW of cumulative PV installations together, mostly grid-connected, at the end of 2013. Additional countries that are not part of the PVPS programme represent at least 10.8 additional GW, mostly in Europe: The Czech Republic with 2.1 GW (stable in 2013), Greece with 2.6 GW, Romania with 1.1 GW, Bulgaria with 1 GW, and below the GW mark, Slovakia and Ukraine. After these countries, India has installed more than 2.2 GW. While other countries around the world have reached various PV installation levels, the total of these remains hard to quantify with certainty. At present it seems that 134 GW represents the minimum installed by end 2013 with a firm level of certainty. Remaining installations account for some additional GW installed in the rest of world (non-reporting countries, off-grid installations, etc.) that could bring the total installed capacity to more than 136 GW in total.

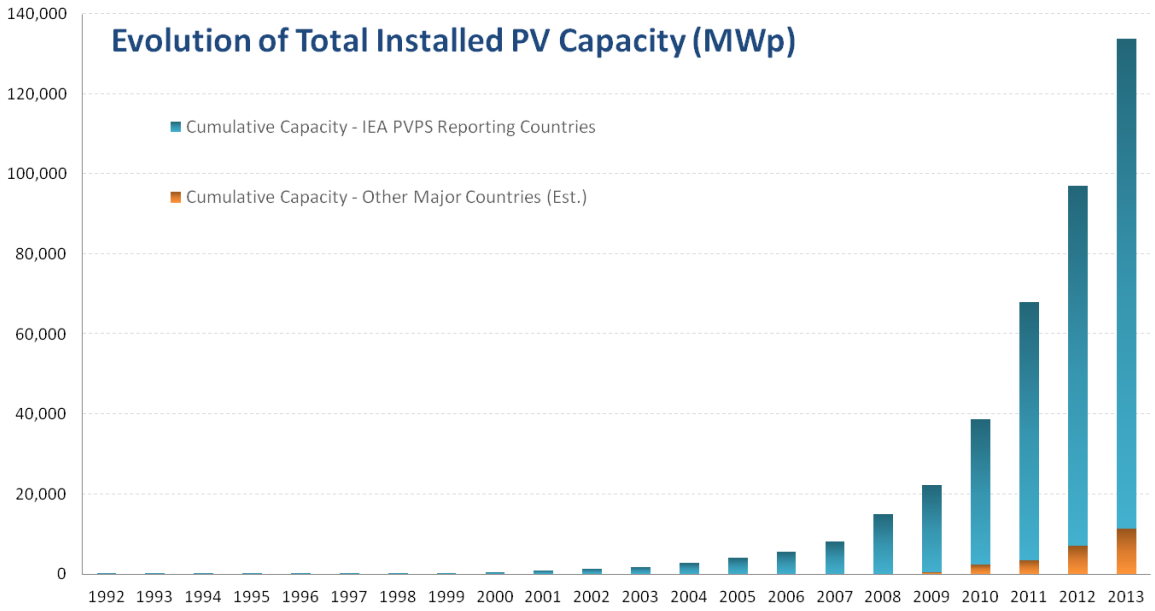

Figure 1 – Evolution of Total PV Installed Capacity from 1992 to 2013 - in MW

How Much was Installed in 2013?

The record level of installation in 2013 can be split between PVPS countries and the rest of the world. The PVPS countries have installed 33.1 GW of PV, and at least 3.8 GW have been reported in non-PVPS countries. The worldwide installed capacity totalled at least 36.9 GW at the end of 2013.

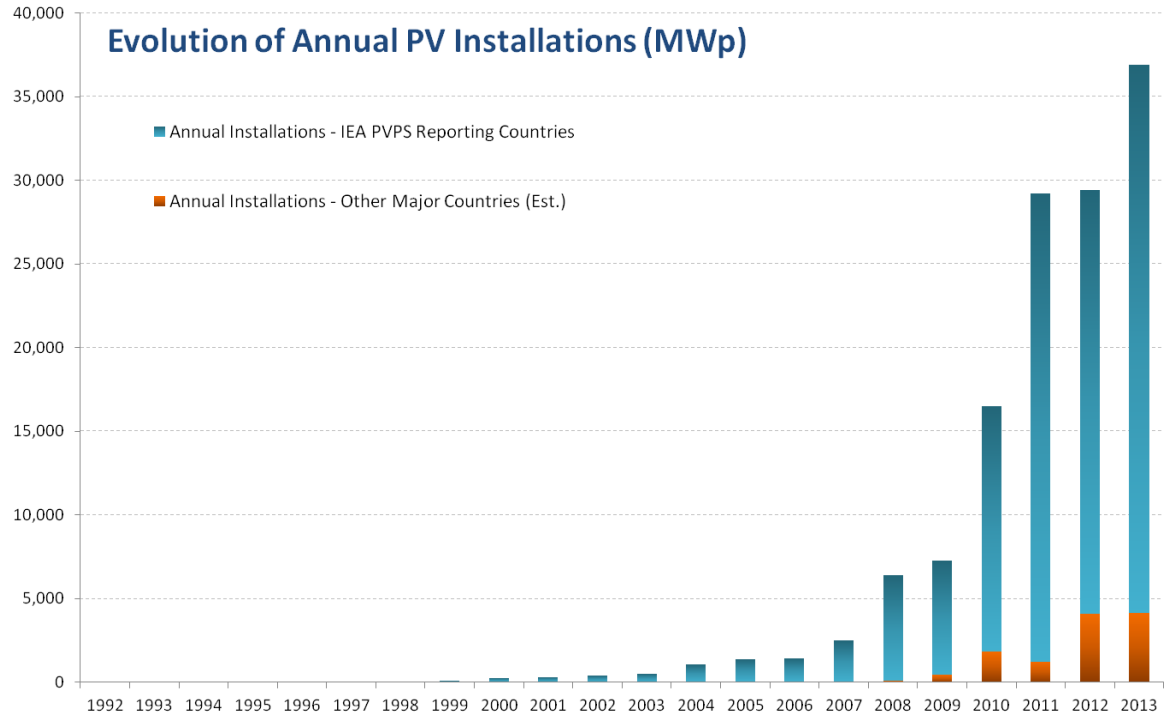

Figure 2 - Evolution of Annual PV Installations – 1992 to 2013 – in MW

China has announced the installation of 11.3 GW of grid-connected PV in 2013. According to Chinese figures, the installations could have been even higher than that but some uncertainty remains on whether these additional PV systems have been connected to the grid or not. In any case, Chinese PV installations have set a new record in terms of new installations, above the 9.3 GW reported in Italy in 2011. This performance is in line with the ambitions of the Chinese authorities to continue developing the internal PV market, pushing for 35 GW by the year 2015 and 100 GW by 2020. **Japan** was the second market for PV in 2013 with an estimated 6.9 GW of PV installations. While final numbers could slightly differ, this shows a dramatic increase in both countries compared to 2012. The **USA** took the third place in 2013 with 4.75 GW installed compared to 3.37 GW in 2012.

Germany installed 3.3 GW, after three years of around 7.5 GW per year. This happened in a context of reduced feed-in tariffs, more constraining regulations for utility-scale PV and the political will to reduce the cost of renewables for electricity consumers. The total installed PV capacity now tops more than 35.5 GW, which is still the highest capacity in the world.

Italy installed 1.5 GW of PV systems, compared to 9.3 GW in 2011 and 3.6 GW in 2012. A financial cap has now been set by the Italian authorities to limit the cost borne by electricity

consumers. Feed-in tariffs are not granted anymore for new PV installations but a self-consumption scheme and additional tax rebates are now in place.

Together, these five countries represent 75% of all installations recorded in 2013 and slightly less in terms of installed capacity. Behind them, several countries have installed close to 1 GW of PV systems in 2013: the **UK** is expected to have installed at least 1 GW and possibly more; **India** (with 1.1 GW), **Greece** (with 1.04 GW), and possibly **Romania** (with 1.1 GW to be confirmed) are the other countries where installations in 2013 rose above the GW mark. **France** (613 MW) and **Australia** (848 MW including 18 MW of off-grid systems) left the GW range with downsized markets. 88% of the 2013 world market has been covered by these 11 countries.

Smaller size country markets have grown quite significantly and raised their total installed capacity above the GW mark: **Korea** installed 442 MW and now has 1.45 GW of cumulative PV capacity and a more vigorous market than in the last few years. **Canada** installed about 444 MW and also crossed the GW of cumulative PV capacity in 2013.

In Asia, after the two market leaders, **Thailand** continued to grow, with 317 MW installed in 2013 and 704 MW of total capacity. Other markets continued to grow at a slower rate, such as **Taiwan** (170 MW), **Malaysia** for the second year of its feed-in tariff system (42 MW), as well as a few others.

In Europe, net-metering systems allowed the market to develop in several countries: Belgium experiences now the highest penetration of PV in the residential segment with 1 out of 13 households equipped with PV systems. In **Denmark,** about 160 MW were installed in 2013 after a change in the net-metering system that didn't allow repeating the 300 MW level of 2012. This was also the case in the **Netherlands** where 320 MW are expected to have been installed but final numbers are not known yet. In markets driven by either feed-in tariffs or tax incentives, significant additions were made in **Switzerland** (300 MW) and **Austria** (220 MW).

Some European countries that previously grew quickly have now stalled or experienced very small or significantly reduced additions: **Spain** totals now more than 5.56 GW of PV systems (DC capacity recalculated[3]) and reported less than 150 MW of new additions in a difficult context of economic crisis and power generation overcapacity. The market in **Belgium** went down from 600 to 215 MW in the context of a subsidy decline as well as with discussions on additional grid costs. The installed capacity has now reached close to 3 GW. In the **Czech Republic**, 88 MW were installed for a total capacity above 2.16 GW.

In the Americas, the announcements of PV plants in several Latin and Central America haven't transformed into a significant market yet. Several GW of PV plants have been validated in **Chile** but the real development hasn't materialized in 2013. Several countries adopted policies that could favour the development of PV in the coming years, especially **Mexico**, **Brazil** and **Peru** but the real PV market remained symbolic.
In the Middle East, **Israel** progressed rapidly, with 183 MW installed in 2013 while the PV installations in **Turkey** have started more slowly, with around 6 MW installed in 2013.

[3] Spain reports PV installations in AC while most countries report DC power.

Main Regulatory Changes

Retrospective Measures

In 2013, several countries introduced retrospective changes in the PV support policies for existing PV plants. The most important ones took place in Spain. In Belgium, the region of Flanders originally proposed a grid connection tax aimed at compensating for the losses in grid revenue linked to the existing net-metering scheme. While this tax was later considered illegal and subsequently suppressed, it shows that the question of grid financing is becoming an essential consideration; the question was raised by policymakers and grid operators in several countries. Other countries also applied retrospective measures that reduced the level of financial support or changed the conditions applying to already existing PV systems. Bulgaria, the Czech Republic, Italy and France have discussed or applied such measures in the last two years. These changes will be described in depth in the future Trends report 2014.

Support Policies Evolution

The main feature that can be extracted from policies evolutions is the decrease in financial support due to PV system price decline in recent years. Several countries have recently adopted a feed-in tariff system, mostly in Asia: China and Japan implemented such financial support scheme that developed the market rapidly. On the other side, several countries stopped their feed-in tariff policies: this was the case in Australia or Italy and several countries in Europe took indirect measures that stopped PV development (Bulgaria, Slovakia for instance) or reduced it (France, Belgium, and Germany, to mention only a few of them). Countries that adopted a quota-system with trading of green certificates are diminishing: Korea, Australia and to a certain extent Belgium are still using this support scheme to incentivize PV. Several countries are now supporting PV through a combination of incentives.

From producers to *prosumers*

The idea that PV producers could be considered as “prosumers” – both producers and consumers of energy – is evolving rapidly and policies are being adapted accordingly in several countries. Net-metering policies are being considered in some countries such as Mexico (these policies have previously supported market development in the USA, Denmark, The Netherlands and partially in Belgium) but discussions of the impact on utility businesses and grid management have started in 2013. In that respect, self-consumption policies have been adopted or are under discussion in Spain, France, Germany, Switzerland and several other countries, including Italy.

Utility-scale PV

Finally, for utility-scale PV systems, the trends point towards integration within electricity systems: Germany and the UK pushed for integrating PV into electricity markets through market premiums or similar financial instruments (CfD in the UK); while in other countries, the use of Power Purchase Agreements (PPA) to guarantee long term revenues for PV system owners is favoured. The use of Calls for Tender remains an important way to grant access to PV licences and financial support.

Evolution of Total Installed PV Capacity per Region

While Europe still represents a major part of all installations globally, the share of Asia started to grow rapidly in 2012 and this growth was confirmed in 2013. It reached 59% of 2013 installations while Europe went down from 82% in 2010 to 28% in 2013. Figure 3 shows the share of cumulated PV installations in four regional market segments.

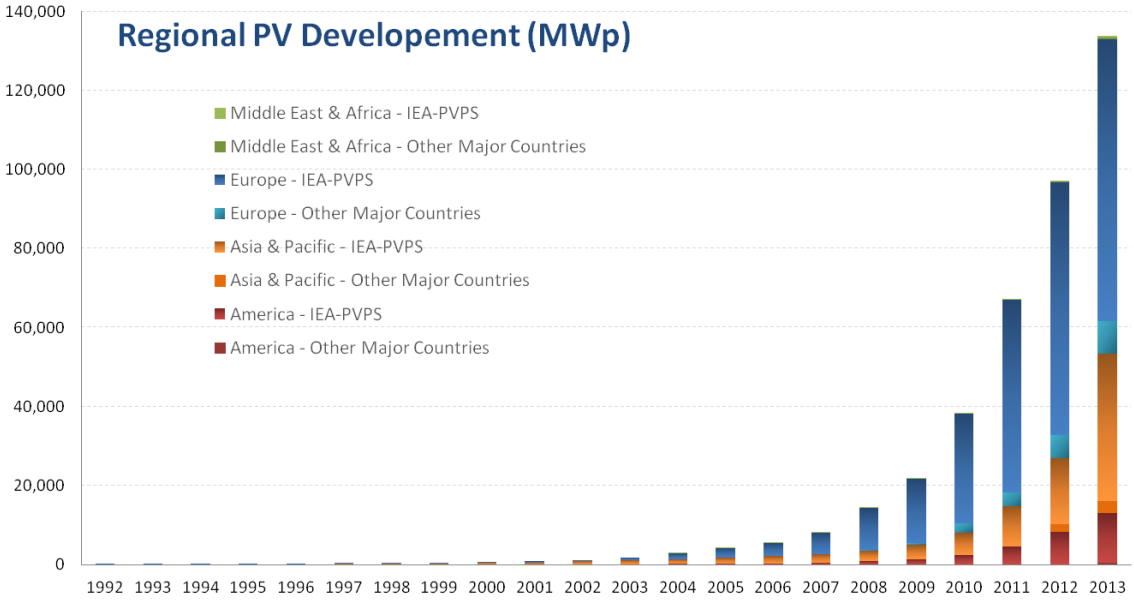

Figure 3 – Share of PV Installations per Region from 1992 to 2013 – in MW

AC & DC Numbers, Grid-tied and Off-grid

PVPS counts all PV installations, both grid-connected and off-grid. By convention, the numbers reported refer to the nominal power of PV systems installed. These are expressed in W (or Wp). Some countries, such as Spain, are reporting the power output of the PV inverter (the device converting DC power from the PV system into AC electricity compatible with standard electricity networks). The difference between the standard DC Power (in Wp) and the AC power can range from as little as 5% (conversion losses) to as much as 30%. For instance, some grid regulations in Germany limit output to as little as 70% of the peak power from the PV system. Spain and Japan (since 2012) report AC numbers. The numbers indicated in this report have been transformed to DC numbers to maintain the coherency of the overall report.

The Top 10 Countries in 2013

In the major evolutions, 9 of the top 10 markets for PV in 2013 have installed at least 1 GW of PV systems. Looking at the total installed capacity, 17 countries are entering the 1 GW club. Capacities for the few countries that report PV installations in AC power have been converted in DC power to ease comparison with DC-reporting countries.

	Installations -GW		Total Installed Capacity -GW	
1	CHINA	11.3	GERMANY	35.5
2	JAPAN**	6.9	CHINA	18.3
3	USA	4.8	ITALY	17.6
4	GERMANY	3.3	JAPAN**	13.6
5	ITALY	1.5	USA	12.0
6	INDIA*	1.1	SPAIN**	5.6
7	ROMANIA*	1.1	FRANCE	4.6
8	GREECE*	1.0	AUSTRALIA	3.3
9	UK	1.0	BELGIUM	3.0
10	AUSTRALIA	0.9	UK	2.9

9 "GW COUNTRIES" 17 "GW COUNTRIES"

* Non-PVPS Countries / ** Spain & Japan data delivered in AC, these numbers are a DC recalculation.

Table 1 – Top 10 Countries for Installations and Total Installed Capacity in 2013 – in GW

Electricity Production from PV

PV electricity production is easy to measure at a power plant but much more complicated to compile for an entire country. In addition, the comparison between the installed base of PV systems in a country at a precise date and the production of electricity from PV are difficult to compare: A system installed in December will have produced only a small fraction of its regular annual electricity output; systems installed on buildings may not be at optimum orientation, or may have partial shading during the day; the weather in 2013 may not have been typical of the long term average. For these reasons, the electricity production from PV per country as shown below estimates what the PV production could be based on the cumulative PV capacity at the end of 2013, close to optimum siting, orientation and average weather conditions.

In several countries, the PV contribution to the electricity demand has passed the 1% mark. Italy is at the top with 7.8% while the overall European PV contribution is around 3% of the European electricity demand. Australia has also passed the 1% mark but larger consumers of electricity such as Japan, China or the USA will require more installations to reach this threshold. In total, 15 countries already produce at least 1% of their electricity needs with PV (figure 4).

Figure 4 shows how PV theoretically contributes to the electricity demand in PVPS countries, based on the PV installed capacity at end 2013.

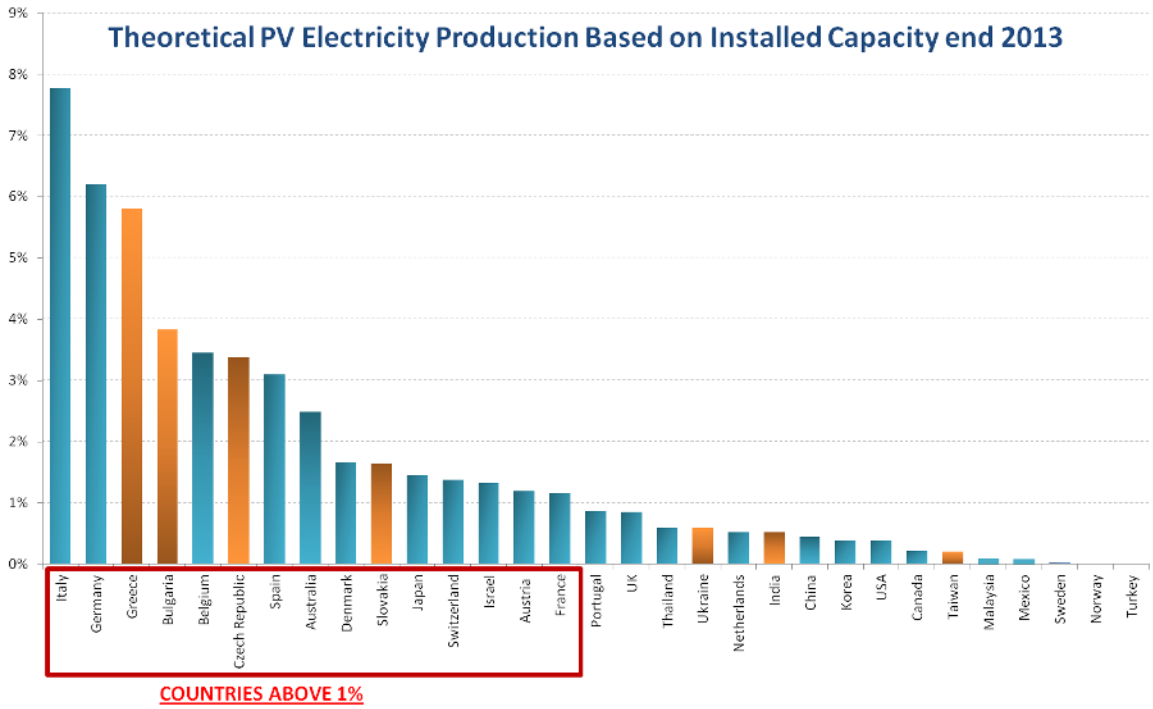

Figure 4 – Theoretical PV Electricity Production Based on Installed Capacity in 2013

Conclusion and Future Prospects in PVPS Countries

PV technology today has become a major actor in the electricity sector in several countries. Globally, at least 160 TWh, or 160 billion kWh will be produced in 2014 by PV systems installed and commissioned until January 2014. This represents about 0.85% of the electricity demand of the planet, though some countries have reached rapidly significant percentages.

This progressive growth of PV can be put in perspective with the development of renewable power sources in several developed countries in 2013. Last year, renewable electricity sources additions exceeded the level of conventional plant installations in some of the reporting countries: in Australia, PV and wind are progressing while conventional sources saw their cumulative capacity decreasing. In China, where they installed more than 90 GW of new power generation sources, coal and hydro dominated the electricity landscape but PV and wind together represented more than 24 GW of new installations, compared with 40 GW of new coal plants and 25 GW of hydropower. In Japan, PV installations were 10 times higher than new conventional power plants but additional capacities for other renewables were limited to some dozens of MW. In Korea, gas and coal power plant installations exceeded PV installations almost 10 times in 2013. And finally, in Europe, PV was the second source of electricity installed (power-wise), after wind and before hydropower (in 2011 and 2012, PV was first), and ahead of all other sources of electricity, from coal to nuclear.

In summary it is difficult to extract a global pattern and despite its growth in the last years, PV hasn't yet reached a widespread development. On the contrary, the development of PV remains driven by a handful of countries.

The 100 GW mark was finally crossed in the very first weeks of 2013 and the PV installed capacity continued to increase during the year 2013 reaching at least 133.8 GW and most probably slightly above 136 GW in total.

The growth of Asian markets in 2013 changes the PV market landscape radically. With declining prices in the last few years, PV appeared on the radar of policymakers in charge of energy policies in numerous countries and plans for PV development have increased rapidly all over the world. Meanwhile the development of PV remained concentrated in 2013 in less than 30 countries.

In PVPS countries, several Asian countries have announced their intention to continue developing PV, and the market remains steady in North America where it could continue to grow at a reasonable pace. In Europe, the picture is more contrasted with a complex process of transitioning from the current financially supported market to a more competitive PV market. All these elements considered together should maintain the PV market in an upward trend in the coming years.

Synthesis Table

This table compiles preliminary information valid as of 20 March 2014. PVPS countries' data are issued by national experts. Data related to IEA-PVPS non-member countries have been delivered by the European Photovoltaic Industry Association (EPIA) and the Solar Energy Industry Association (SEIA from the USA). Data for some countries may still be updated by national authorities. Updated data will be published in the next edition of the complete TRENDS report.

Solar irradiation data has been provided by member countries or GIS data providers.

Electricity production is a theoretical calculation based on average irradiation data and the installed capacity at 31 December 2013. Real production data could differ due to differences in irradiation across the countries themselves and the characteristics of the PV power plants considered.

Electricity consumption data has been provided by official authorities. In most cases, 2012 or older data have been used when 2013 data was not yet available.

PV MARKET DATA END 2013 - MW					
	Cumulative Capacity	Newly Added Capacity		Cumulative Capacity	Newly Added Capacity
AUSTRALIA	3,255	848	SPAIN**	5,566	152
AUSTRIA	580	220	SWEDEN	43	19
BELGIUM	2,983	215	SWITZERLAND	740	300
CANADA	1,210	444	THAILAND	704	317
CHINA	18,300	11,300	TURKEY	15	6
DENMARK	532	153	UK	2,900	1,000
FRANCE	4,632	613	USA	12,022	4,751
GERMANY	35,500	3,304			
ISRAEL	420	183	BULGARIA*	1,020	10
ITALY	17,600	1,461	CZECH REPUBLIC*	2,162	88
JAPAN**	13,643	6,900	GREECE*	2,579	1,043
KOREA	1,467	442	INDIA*	2,319	1,115
MALAYSIA	73	42	ROMANIA*	1,100	1,150
MEXICO	100	45	SLOVAKIA*	524	0
NETHERLANDS	650	320	TAIWAN*	376	170
NORWAY	11	0,6	UKRAINE*	616	290
PORTUGAL	284	60			

*: Non-PVPS Countries: Data reported by the European Photovoltaic Industry Association
**: Recalculated capacities for countries reporting in DC

Table 2: Preliminary PV installations in 2013 and cumulative capacities at the end of 2013 – in MW

Data and analysis:

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Images:

Cover picture: Utility-scale PV Systems - 8 MW Solar Frontier CIS - Kibbutz Neot Semadar, Israel

Pag. 11: 70 MW Utility-scale PV plant, Kyocera, Kagoshima, Japan

Pag. 16: SolarTAC test facility in Aurora, Colorado, USA - Dennis Schroeder / NREL

Disclaimer:

Please note that all historical figures provided in this brochure are valid at the time of publication and will be revised when new figures are available.

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