IEA INTERNATIONAL ENERGY AGENCY

TRENDS 2014

IN PHOTOVOLTAIC APPLICATIONS

Survey Report of Selected IEA Countries between 1992 and 2013

PVPS

PHOTOVOLTAIC
POWER SYSTEMS
PROGRAMME

Report IEA-PVPS T1-25:2014

COVER IMAGE
SunPower PowerGuard rooftop
solar electric system.

REPORT SCOPE AND OBJECTIVE

Annual surveys of photovoltaic (PV) power applications and markets are carried out in the reporting countries, as part of the IEA PVPS Programme's work. The Trends reports objective is to present and interpret developments in the PV power systems market and the evolving applications for these products within this market. These trends are analyzed in the context of the business, policy and non-technical environment in the reporting countries.

This report is prepared to assist those who are responsible for developing the strategies of businesses and public authorities, and to support the development of medium term plans for electricity utilities and other providers of energy services. It also provides guidance to government officials responsible for setting energy policy and preparing national energy plans.

The scope of the report is limited to PV applications with a rated power of 40 W or more. National data supplied are as accurate as possible at the time of publication. Accuracy of data on production levels and system prices varies depending on the willingness of the relevant national PV industry to provide data. This report presents the results of the 19th international survey. It provides an overview of PV power systems applications, markets and production in the reporting countries and elsewhere at the end of 2013 and analyzes trends in the implementation of PV power systems between 1992 and 2013.

DISCLAIMER

Numbers provided in this report, "Trends 2014 in Photovoltaic Applications", are valid at the time of publication. Please note that all figures have been rounded.

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FOREWORD

What you have in your hands is the 19th edition of the international survey report on Trends in Photovoltaic (PV) Applications up to 2013.

The "Trends Report" is one of the flagship publications of the IEA PVPS Programme, documenting the evolution of PV applications within its member countries as well as worldwide. Providing detailed insight and analysis of the PV market development, the series of trends reports published since 20 years are a unique repository of the evolution of the global PV market and its framework. During this period of time, PV has evolved from a pure niche market of small scale applications towards becoming a mainstream electricity source. Following the difficult year of 2012 in terms of market growth, industry consolidation, policy uncertainty and ongoing fast cost reduction, 2013 has seen a slower evolution on the cost side but also a growing worldwide market again, although with a different split of dominant markets compared to the past. The fast rise of PV markets in Asia and America has been confirmed as has the decline of the total market in Europe. Overall, 35 GW of PV were installed in IEA PVPS member countries during 2013 (2012: 25 GW), whereas the global PV market is estimated to be at least 39 GW, translating to more than an average of 100 MW installed on a daily basis throughout the year. The global installed total PV capacity is estimated at least 137 GW at the end of 2013. PV system prices have seen a slower decline than in the years before or even small increases, indicating that the speed of future cost reduction may be reduced. On the supply side, the indicators suggest that the consolidation phase in the industry starts to be overcome although competition remains high. At the same time, at the present comparatively low prices, some price flexibility for different applications can be expected. With PV life cycle costs of electricity reaching socket parity with electricity grids in some countries, Self-consumption and new business models gain importance while Feed-in Tariffs continue to evolve. Overall, this is an encouraging sign for the growing competitiveness of PV and the increasing occurrence of self-sustained markets. Clearly, policy support is changing over time but is still considered essential for the near term development of PV markets worldwide. Quantitatively, the number of countries experiencing PV as an essential part of their electricity supply is increasing, with Italy in first place with close to 8% of annual electricity demand coming from PV, followed by Germany (> 6%) and Greece (close to 6%). In terms of peak capacity, these high shares of PV start to affect and pose challenges to the integration in the electricity system. New business models and market designs will emerge in response to this development. All of these developments are clear signs that PV is becoming more mature and a relevant part of the electricity supply system. Becoming mainstream is not always easy but certainly exciting and I do hope that you will find our most recent insights interesting!

Stefan Nowak
Chairman
IEA PVPS Programme

PV HAS EVOLVED FROM A PURE NICHE MARKET OF SMALL SCALE APPLICATIONS TOWARDS BECOMING A MAINSTREAM ELECTRICITY SOURCE.

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Canyonlands Needles Outpost, PV powers Needles general store and campground. © NREL

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PV TECHNOLOGY AND APPLICATIONS

PV TECHNOLOGY

Photovoltaic devices convert light directly into electricity and shouldn't be confused with other solar technologies (such as concentrated solar power - CSP or solar thermal for heating and cooling). The key components of a photovoltaic power system are various types of photovoltaic cells (often called solar cells) interconnected and encapsulated to form a **photovoltaic module** (the commercial product), the **mounting structure** for the module or array, the **inverter** (essential for grid-connected systems and required for most off-grid systems), the **storage battery** and **charge controller** (for off-grid systems but also increasingly for grid connected ones).

CELLS, MODULES AND SYSTEMS

Photovoltaic cells represent the smallest unit in a photovoltaic power producing device, typically available in 12,5 cm, 15 cm and up to 20 cm square sizes. In general, cells can be classified as either wafer-based crystalline (single crystal and multicrystalline silicon), compound semi-conductor (Thin-film), or organic. Currently, crystalline silicon technologies account for about 80% of the overall cell production in the IEA PVPS countries. Single crystal silicon (sc-Si) PV cells are formed with the wafers manufactured using a single crystal growth method and have commercial efficiencies between 16% and 24%. Multicrystalline

PV TECHNOLOGY / CONTINUED

silicon (mc-Si) cells, usually formed with multicrystalline wafers manufactured from a cast solidification process, are becoming increasingly popular as they are less expensive to produce but are less efficient, with average conversion efficiency around 14-18%. Quasi-monocrystalline silicon PV cells, manufactured using similar processes as multicrystalline silicon PV cells, have been gaining recent attention. III-V compound semiconductor PV cells are formed using materials such as GaAs on the Ge substrates and have high conversion efficiencies of 40% and more. Due to their high cost, they are typically used in concentrator PV systems with tracking systems or for space applications. Thin film cells are formed by depositing extremely thin layers of photovoltaic semi-conductor materials onto a backing material such as glass, stainless steel or plastic. Thin film modules have lower conversion efficiencies but they are potentially less expensive to manufacture than crystalline cells. The disadvantage of low conversion efficiencies is that larger areas of photovoltaic arrays are required to produce the same amount of electricity. Thin film materials commercially used are amorphous and micromorph silicon (a-Si), cadmium telluride (CdTe), and copper-indium-gallium-diselenide (CIGS). Organic thin film PV cells, using dye or organic semiconductors, have created interest and research, development and demonstration activities are underway.

Further research and development is being carried out to improve the efficiency of all the basic types of cells with laboratory efficiency levels of 25% for single crystal cells, and 20% for thin film technologies being achieved.

Photovoltaic modules are typically rated between 50 W and 315 W (72 cells) with specialized products for building integrated PV systems at even larger sizes. Wafer-based crystalline silicon modules have commercial efficiencies between 14 and 21%. Crystalline silicon modules consist of individual PV cells connected together and encapsulated between a transparent front, usually glass, and a backing material, usually plastic or glass. Thin film modules encapsulate PV cells formed into a single substrate, in a flexible or fixed module, with transparent plastic or glass as the front material. Their efficiency ranges between 7% (a-Si) and 14% (CIGS and CdTe). Quality PV modules are typically guaranteed for up to 25 years by manufacturers and are type approved to IEC 61215 Ed. 2, IEC 61646 Ed. 2.0 and IEC 61730 International Standards. CPV modules offer now efficiencies up to 36%.

A PV System consists in one of several PV modules, connected to either an electricity network (grid-connected PV) or to a series of loads (off-grid). It comprises various electric devices aiming at adapting the electricity output of the module(s) to the standards of the network or the load: inverters, charge controllers or batteries.

A wide range of mounting structures has been developed especially for building integrated PV systems (BIPV), including PV facades, sloped and flat roof mountings, integrated (opaque or semi-transparent) glass-glass modules and 'PV roof tiles'. Single or two-axis tracking systems have recently become more and more attractive for ground-mounted systems, particularly for PV utilization in countries with a high share of direct irradiation. By using such systems, the energy yield can typically be increased by 25-35% for single axis trackers and 35-45% for double axis trackers compared with fixed systems.

GRID-CONNECTED PV SYSTEMS

In grid-connected PV systems, an inverter is used to convert electricity from direct current (DC) as produced by the PV array to alternating current (AC) that is then supplied to the electricity network. The typical weighted conversion efficiency – often stated as "European"' or "CEC" efficiency of inverters is in the range of 95% to 97%, with peak efficiencies reaching 98%. Most inverters incorporate a Maximum Power Point Tracker (MPPT), which continuously adjusts the load impedance to provide the maximum power from the PV array. One inverter can be used for the whole array or separate inverters may be used for each "string" of modules. PV modules with integrated inverters, usually referred to as "AC modules", can be directly connected to the electricity network (where approved by network operators) and play an increasing role in certain markets.

OFF-GRID PV SYSTEMS

For off-grid systems a storage battery is required to provide energy during low-light periods. Nearly all batteries used for PV systems are of the deep discharge lead-acid type. Other types of batteries (e. g. NiCad, NiMH, LiO) are also suitable and have the advantage that they cannot be over-charged or deep-discharged, but are considerably more expensive. The lifetime of a battery varies depending on the operating regime and conditions but is typically between 5 and 10 years.

A charge controller (or regulator) is used to maintain the battery at the highest possible state of charge (SOC) and provides the user with the required quantity of electricity while protecting the battery from deep discharge or overcharging. Some charge controllers also have integrated MPP trackers to maximize the PV electricity generated. If there is the requirement for AC electricity, a 'stand-alone inverter' can supply conventional AC appliances.

PV APPLICATIONS AND MARKET SEGMENTS

There are six primary applications for PV power systems starting from small pico systems of some watts to very-large-scale PV plants of hundreds of MW.

Pico PV systems have experienced significant development in the last few years, combining the use of very efficient lights (mostly LEDs) with sophisticated charge controllers and efficient batteries. With a small PV panel of only a few watts essential services can be provided, such as lighting, phone charging and powering a radio or a small computer. Expandable versions of solar pico PV systems have entered the market and enable starting with a small kit and adding extra loads later. They are mainly used for off-grid basic electrification, mainly in developing countries.

Off-grid domestic systems provide electricity to households and villages that are not connected to the utility electricity network (also referred to as the grid). They provide electricity for lighting, refrigeration and other low power loads, have been installed worldwide and are often the most appropriate technology to meet the energy demands of off-grid communities. Off-grid domestic systems in the reporting countries are typically up to 5 kW in size.

Generally they offer an economic alternative to extending the electricity distribution network at distances of more than 1 or 2 km from existing power lines. Defining such systems is becoming more difficult where, for example, mini-grids in rural areas are developed by electricity utilities.

Off-grid non-domestic installations were the first commercial application for terrestrial PV systems. They provide power for a wide range of applications, such as telecommunication, water pumping, vaccine refrigeration and navigational aids. These are applications where small amounts of electricity have a high value, thus making PV commercially cost competitive with other small generating sources.

Hybrid systems combine the advantages of PV and diesel generator in mini grids. They allow mitigating fuel price increases, deliver operating cost reductions, and offer higher service quality than traditional single-source generation systems. The combining of technologies provides new possibilities. The micro-hybrid system range for use as a reliable and cost-effective power source for telecom base stations continues to develop and expand. The development of small distributed hybrid generation systems for rural electrification to address the needs of remote communities will rely on the impetus given by institutions in charge of providing public services to rural customers. Large-scale hybrids can be used for large cities powered today by diesel generators.

Grid-connected distributed PV systems are installed to provide power to a grid-connected customer or directly to the electricity network (specifically where that part of the electricity distribution network 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 residential, commercial or industrial buildings, or simply in the built environment on motorway sound-barriers, etc. Size is not a determining feature – while a 1 MW PV system on a roof-top may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized systems perform the functions of centralized power stations. 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 network other than the supply of bulk power. These systems are typically ground-mounted and functioning independently of any nearby development.

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MARKET DEVELOPMENT TRENDS

More than twenty years of PV market development have seen the deployment of at least 137 GW of PV systems all over the world. However the diversity of PV markets calls for an in-depth look at the way PV has been developing in all major markets, in order to better understand the drivers of this growth.

METHODOLOGY

This report counts all installations, both grid-connected and reported off-grid installations. By convention, the numbers reported refer to the nominal power of PV systems installed. These are expressed in W (or Wp). Some countries 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 W) 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). Conversion of AC data has been made when necessary (Spain, Japan and Canada for instance), in order to calculate the most precise installation numbers every year. Global totals should be considered as indications rather than exact statistics.

THE GLOBAL INSTALLED CAPACITY

The IEA PVPS countries represented more than 125 GW of cumulative PV installations all together, mostly grid-connected, at the end of 2013. Eight countries that are not part of the IEA PVPS Programme represented 10,7 additional GW, mostly in Europe: Greece with 2,56 GW, Czech Republic with 2,17 GW installed, Romania with 1,15 GW and Bulgaria with 1,02 GW and below the GW mark Slovakia and Ukraine. Next to these countries, India installed more than 2,3 GW while Taiwan reached 376 MW. Numerous countries all over the world have started to develop PV but few have yet reached a significant development level in terms of installed capacity at the end of 2013.

The European Photovoltaic Industry Association believes that an additional 3,6 GW of PV systems have been installed in the last twelve years. Other sources indicate only 1 GW.

Presently it seems that 136,5 GW represents the minimum installed by end of 2013 with a firm level of certainty. Adding 3,6 GW of additional capacity spread all over the world would increase the total to 140 GW.

THE MARKET EVOLUTION

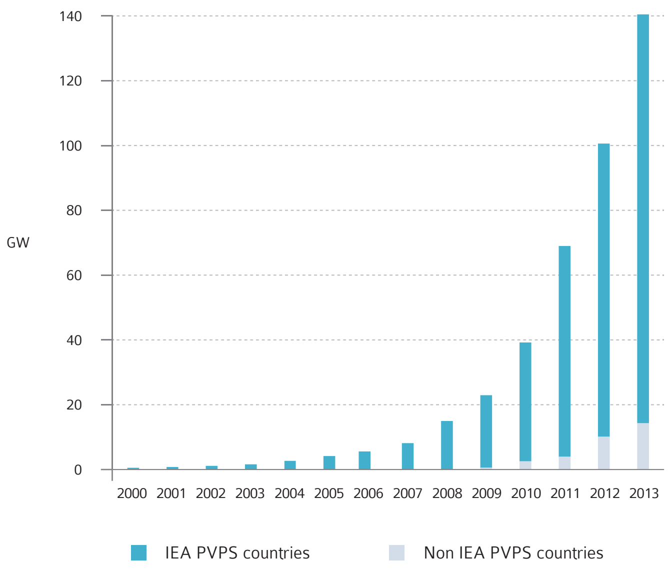
The IEA PVPS Programme's 24 countries have installed at least 35 GW of PV in 2013, with a minimum worldwide installed capacity amounting to 39 GW. While they are hard to track with a high level of certainty, installations in non IEA PVPS countries pushed the installed capacity to around 40 GW in 2013 in the most optimistic case. It is certain that between 39 and 40 GW have been installed in 2013. The most remarkable trend of 2013 is the growth of the global PV market after a year of relative stagnation in 2012, compared to 2011. With close to 40 GW, the market grew in 2013 by around 35%, again the highest installation ever for PV.

China installed 12,92 GW in 2013, according to various sources, setting an absolute record that places the country in first place with regard to all time PV installations. This is perfectly in line with their political will to develop renewable sources and in particular PV in the short to medium term.

The second place goes to Japan, with 6,97 GW installed in the country in 2013.

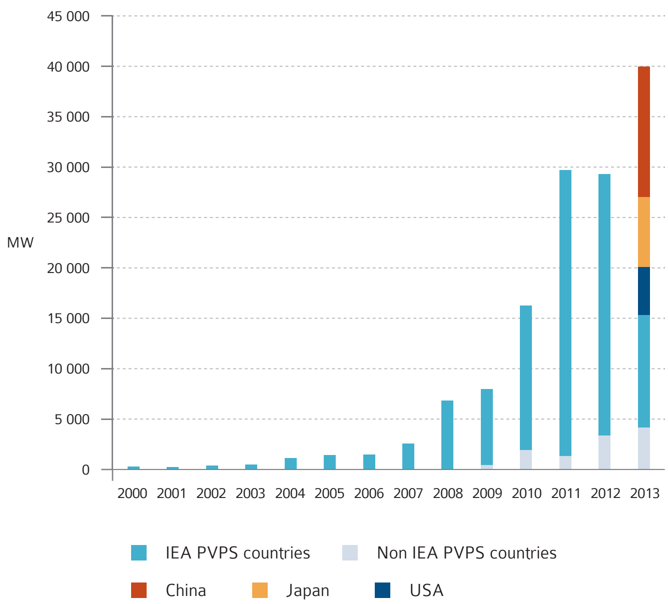
The USA installed 4,75 GW of PV systems in 2013, with a balanced share between large utility-scale PV and rooftop installations.

FIGURE 1: EVOLUTION OF PV INSTALLATIONS (GW)



SOURCE IEA PVPS, EPIA.

FIGURE 2: EVOLUTION OF ANNUAL PV INSTALLATIONS (MW)



SOURCE IEA PVPS, EPIA.

THE MARKET EVOLUTION / CONTINUED

Germany installed 3,3 GW, after three years at levels of PV installations around 7,5 GW. This occurred in the context of reduced Feed-in Tariffs (FiTs), and the German authorities' aim to control the development of PV in the country where the total installed PV capacity is now more than 35 GW, still the world record in absolute value.

Italy installed 1,6 GW in 2013, down from the 9,3 GW in 2011 and 3,6 GW in 2012.

Together, these 5 countries represent 73% of all installations recorded in 2013 and slightly less in terms of installed capacity.

The following five places go to the **UK** (1,5 GW), **India** (1,11 GW), **Romania** (1,1 GW), **Greece** (1,04 GW) and **Australia** (0,81 GW). Together these 10 countries cover 87% of the 2013 world market.

France left the top 10 and installed 643 MW in 2013. **Korea**, **Canada** and **Thailand** installed around 440 MW. They have respectively reached a capacity of 1,47 GW, 1,2 GW and finally 0,82 GW.

Smaller countries have performed in various ways: **Belgium** installed 236 MW and has now reached more than 3 GW. Some countries that grew dramatically over recent years have now stalled or experienced limited additions: **Spain** (102 AC-MW) now totals 4,6 GW-AC of PV systems followed by the **Czech Republic** (88 MW) at 2,1 GW.

In Europe, net-metering systems allowed the market to grow quickly in **Denmark** (156 MW added) and the **Netherlands** (360 MW reported). 2013 saw also significant additions in **Switzerland** (319 MW) and **Austria** (263 MW).

Malaysia installed 48 MW for the second year of its FiT system. **Taiwan** installed 170 MW in a growing market.

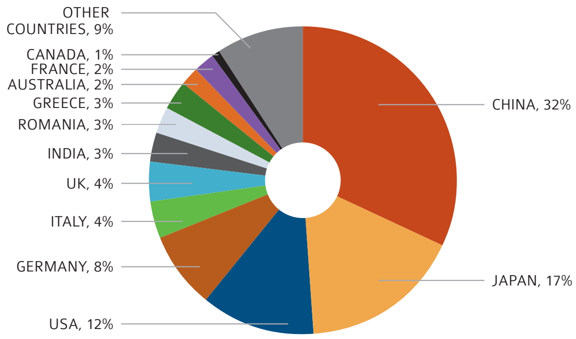
In North America, preliminary data for **Canada** shows the installation of 444 MW while the appetite for PV in Latin and Central America hasn't transformed into a real market yet. Several GW of PV plants have been validated in **Chile**. The real PV development of grid-connected PV plants hasn't started yet in the region but much more is expected in 2014.

In the Middle East, **Israel** progressed rapidly (244 MW), with 1,5% of its electricity already coming from PV while the PV installations in **Turkey** have started more slowly with around 6 MW installed in 2013

A GLOBAL MARKET

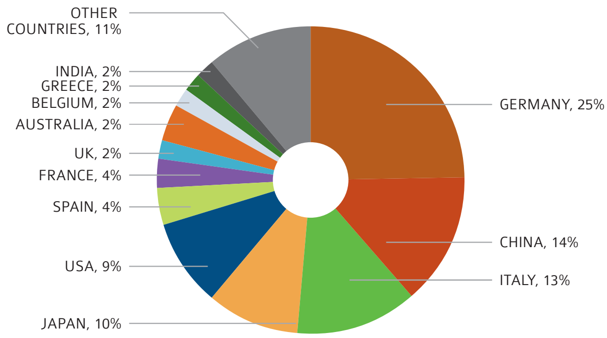
While large markets such as Germany or Italy have exchanged the first two places from 2010 to 2012, China, Japan and the USA scored the top 3 places in 2013. Most top 10 leaders haven't changed except Romania which entered the top 10 in 2013 and France that left it. The number of small-size countries with impressive and unsustainable market evolutions remains stable. In 2013, Greece and Romania installed more than 1 GW of PV. The Czech Republic experienced a dramatic market uptake in 2010, immediately followed by a collapse. Belgium and Greece installed hundreds of MW several years in a row. 2013 started to show a more reasonable market split, with China, Japan and the USA climbing up to the first places, while India, UK and Australia confirmed their market potential. The market level necessary to enter this top 10 grew quite fast then stabilized in 2012, with 811 MW in 2013 against 912 MW in

FIGURE 3: THE GLOBAL PV MARKET 2013



SOURCE IEA PVPS, EPIA.

FIGURE 4: CUMULATIVE CAPACITIES AT THE END OF 2013



SOURCE IEA PVPS, EPIA.

2012. It can be seen as a fact that the growth of the PV market took place in countries with an already well-established market. In parallel, the downsizing of several European markets was largely compensated by the growth in Asian and American markets.

PROJECTS ARE POPPING UP

The most remarkable trend of 2013 is probably the emergence of interest in PV in dozens of new countries around the world. Projects are popping up and even if many won't be realized in the end, it is expected that installation numbers will start to be visible in countries where PV development was limited until now.

LARGEST ADDITIONS EVER

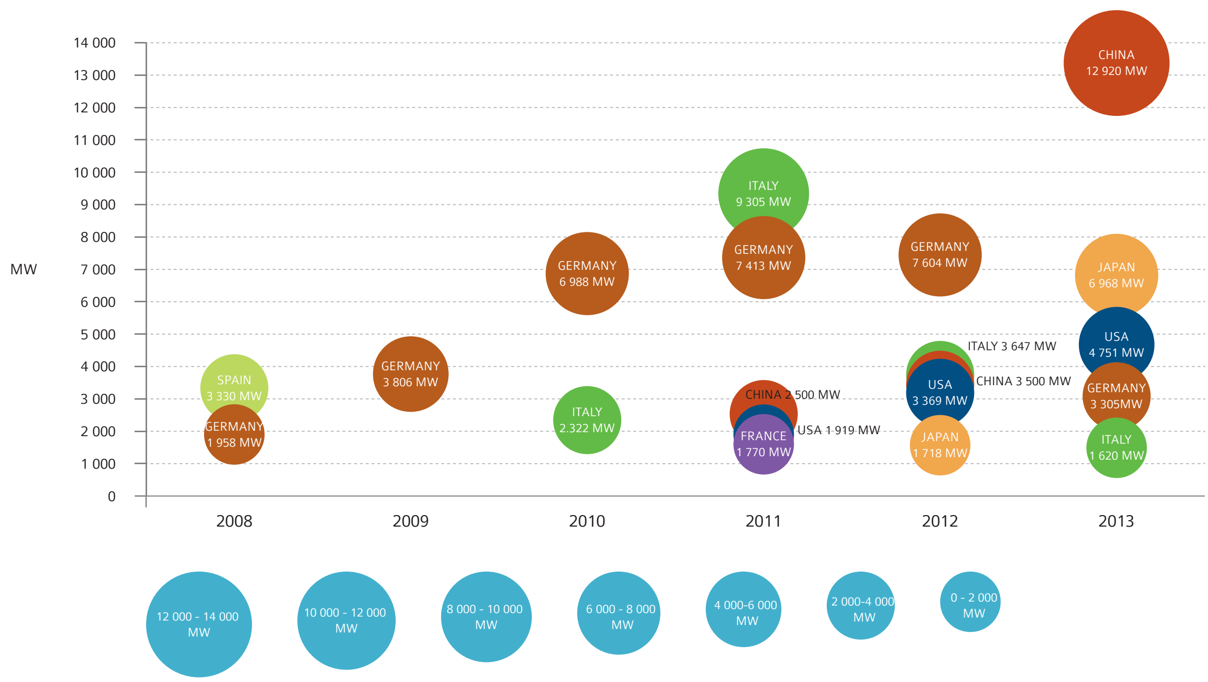
The record from Italy with 9,3 GW has been beaten in 2013 by China with its 12,92 GW. Japan with 6,97 GW represents the 2nd entry in this list. Even with 3,3 GW, Germany's installations in 2013 position the country in the top 10. Countries that installed at least 1 GW of PV system in one year are increasing and their number is growing every year.

TABLE 1: EVOLUTION OF TOP 10 MARKETS

RANKING	2011	2012	2013
1	ITALY	GERMANY	CHINA
2	GERMANY	ITALY	JAPAN
3	CHINA	CHINA	USA
4	USA	USA	GERMANY
5	FRANCE	JAPAN	ITALY
6	JAPAN	FRANCE	UK
7	BELGIUM	AUSTRALIA	INDIA
8	UK	INDIA	ROMANIA
9	AUSTRALIA	UK	GREECE
10	GREECE	GREECE	AUSTRALIA
MARKET LEVEL TO ACCESS THE TOP 10			
	425 MW	912 MW	811 MW

SOURCE IEA PVPS, EPIA.

FIGURE 5: 20 LARGEST ADDITIONS OF CAPACITIES 2008-2013 (MW)



SOURCE IEA PVPS.

THE MARKET EVOLUTION / CONTINUED

OFF-GRID MARKET DEVELOPMENT

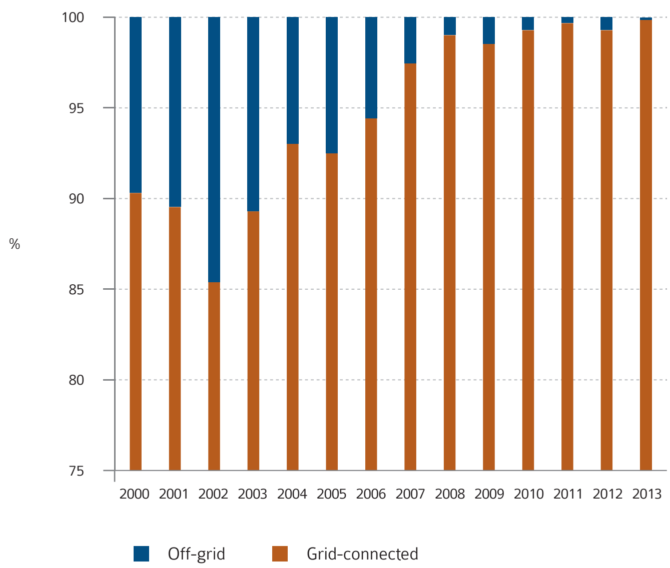
The off-grid market can hardly be compared to the grid connected market: the rapid deployment of grid-connected PV dwarfed the off-grid market as Figure 6 clearly shows.

Nevertheless, off-grid applications are developing more rapidly in several countries than in the past and some targeted support has been implemented.

In Australia 28 MW of off-grid systems have been installed in 2013 and in Japan 14,1 MW. In China, some estimates showed that 500 MW of off-grid applications have been installed in 2013, with an unknown percentage of hybrid systems. It can be considered that most industrial applications and rural electrification systems are most probably hybrid.

In most European countries, the off-grid market remains a very small one, mainly for remote sites, leisure and communication devices that deliver electricity for specific uses. Some mountain sites are equipped with PV as an alternative to bringing fuel to remote, hardly accessible places. However this market remains quite small, with at most some MW installed per year per country, with 1,2 MW in Sweden.

FIGURE 6: SHARE OF GRID-CONNECTED AND OFF-GRID INSTALLATIONS



SOURCE IEA PVPS.

In Japan, some MW have been installed, bringing the installed capacity above 100 MW, mainly in the non-domestic segment.

In some countries, off-grid systems with back-up (either diesel generators or chemical batteries) represent an alternative to bringing the grid to remote places. This trend is specific to countries that have enough solar resource throughout the year to make a PV system viable. In most developed countries in Europe, Asia or America, this trend hasn't been seen and the future development of off-grid applications will most probably be seen first on remote islands. The case of Greece is rather interesting in Europe, with numerous islands not connected to the mainland grid that have installed dozens of MW of PV systems in the previous year. These systems, providing electricity to some thousands of customers will require rapid adaptation of the management of these mini-grids in order to cope with high penetrations of PV. The French islands in the Caribbean Sea and the Indian Ocean have already imposed specific grid codes to PV system owners. PV production must be forecasted and announced in order to better plan grid management. As an example, the island of La Reunion (France) operated more than 150 MW of PV at the end of 2013 for a total population of 840 000. While this represents roughly 50% of the penetration of PV in Germany, the capacity of the grid on a small island to absorb fast production and consumption changes is much more challenging.

Outside the IEA PVPS network, Bangladesh installed an impressive amount of off-grid SHS systems in recent years. Around three million systems were operational by the end of 2013 with an average size of 60 W. This represents a total installed capacity of around 180 MW, quite significant in the South-East Asia region.

India has foreseen up to 2 GW of off-grid installations by 2017, including 20 million of solar lights in its National Solar Mission. These impressive numbers show how PV now represents a competitive alternative to providing electricity in areas where traditional grids have not yet been deployed. In the same way as mobile phones are connecting people without the traditional lines, PV is perceived as a way to provide electricity without building complex and costly grids first. The challenge of providing electricity for lighting, communication, including access to the Internet, will see the progress of PV as one of the most reliable and promising sources of electricity in developing countries in the coming years.

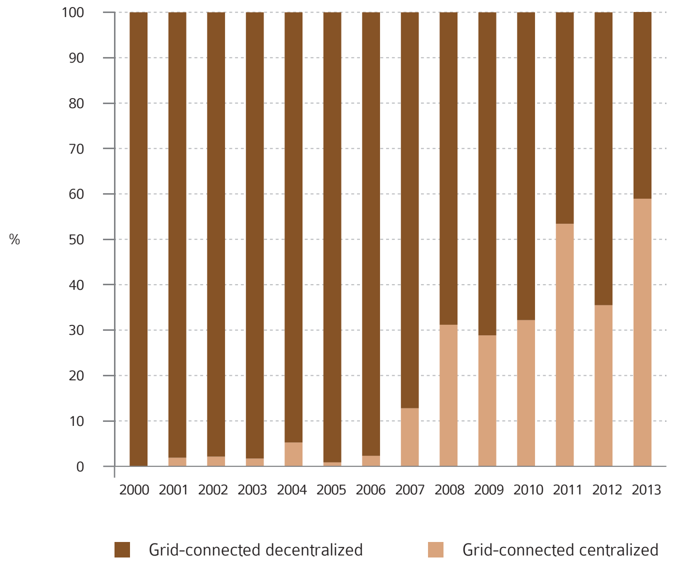
PV DEVELOPMENT PER REGION AND SEGMENT

The evolution of grid-connected PV towards a balanced segmentation between centralized and decentralized PV has reversed course in 2013. Centralized PV has evolved faster in spite of several countries deciding to discontinue the support for utility-scale PV in Europe. This evolution has different causes; for example, environmental concerns about the use of agricultural land, difficulties of reaching competitiveness with wholesale electricity prices in this segment and grid connection issues. This doesn't imply the end of development in the utility-scale segment in these countries but at least a rebalancing towards Self-consumption driven business models. Globally, centralized PV represented more than 50% of the market in 2013, mainly driven by China and the USA.

The same pattern between decentralized and centralized PV is visible in the Asia Pacific region and in the Americas, with a domination of centralized PV installations. This shouldn't change in the coming years, with the arrival of more developing countries that could focus on pure electricity generation rather than Self-consumption driven business models. The availability of cheap capital for financing large-scale PV installations could also reinforce this evolution and reduce even further the development of rooftop PV.

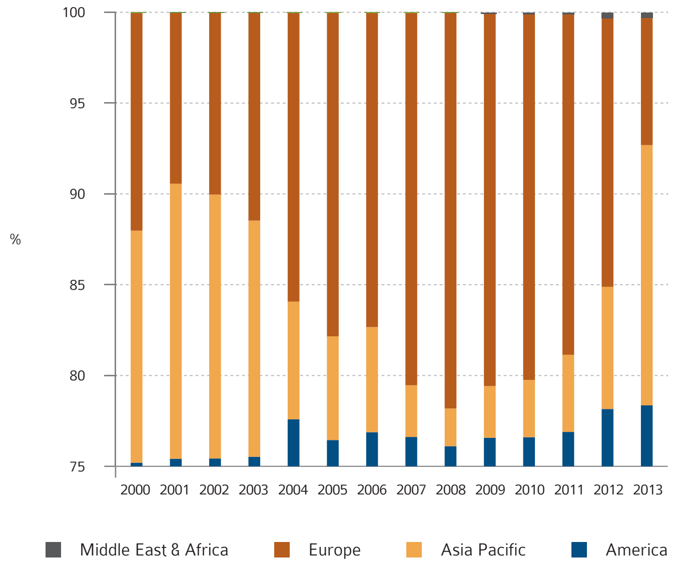
Figure 8 illustrates the evolution of the share of grid-connected PV installations per region from 2000 to 2013. While Asia started to dominate the market in the early 2000s, the start of FiT-based incentives in Europe and particularly in Germany caused a major market uptake in Europe. While the market size grew from around 200 MW in 2000 to close to half a GW in 2003, the market started to grow very fast, thanks to European markets in 2004. From around 1 GW in 2004, the market reached close to 2,5 GW in 2007. In 2008, Spain fuelled market development while Europe achieved more than 80% of the global market: a performance repeated until 2010.

FIGURE 7: EVOLUTION OF GRID-CONNECTED PV MARKET SEGMENTATION



SOURCE IEA PVPS.

FIGURE 8: SHARE OF GRID-CONNECTED PV MARKET PER REGION 2000-2013



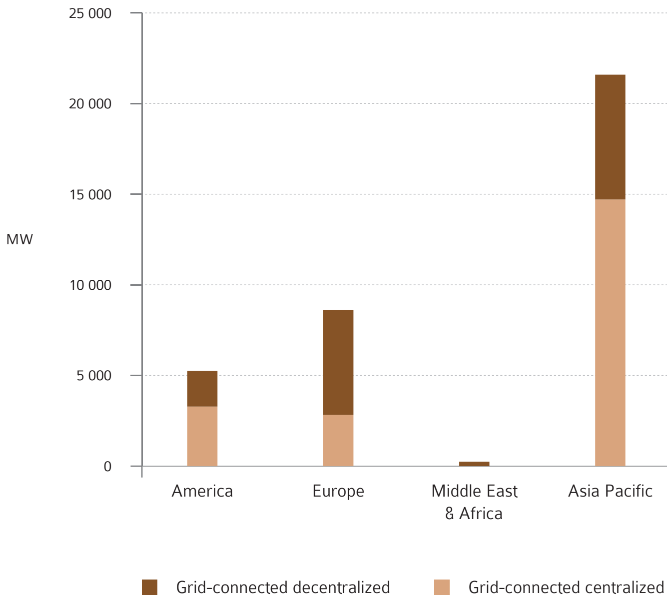
SOURCE IEA PVPS, EPIA.

PV DEVELOPMENT PER REGION AND SEGMENT / CONTINUED

While Europe still represented a major part of all installations globally in 2013, the share of Asia and America started to grow rapidly in 2012 and in 2013, with Asia taking the lead. This evolution is quite visible from 2010 to 2013, with the share of the Asia Pacific region growing from 17% to almost 60%, whereas the European share of the PV market went down from 82% to 28% in three years. This trend shows that the development of PV globally is not anymore in the hands of European countries.

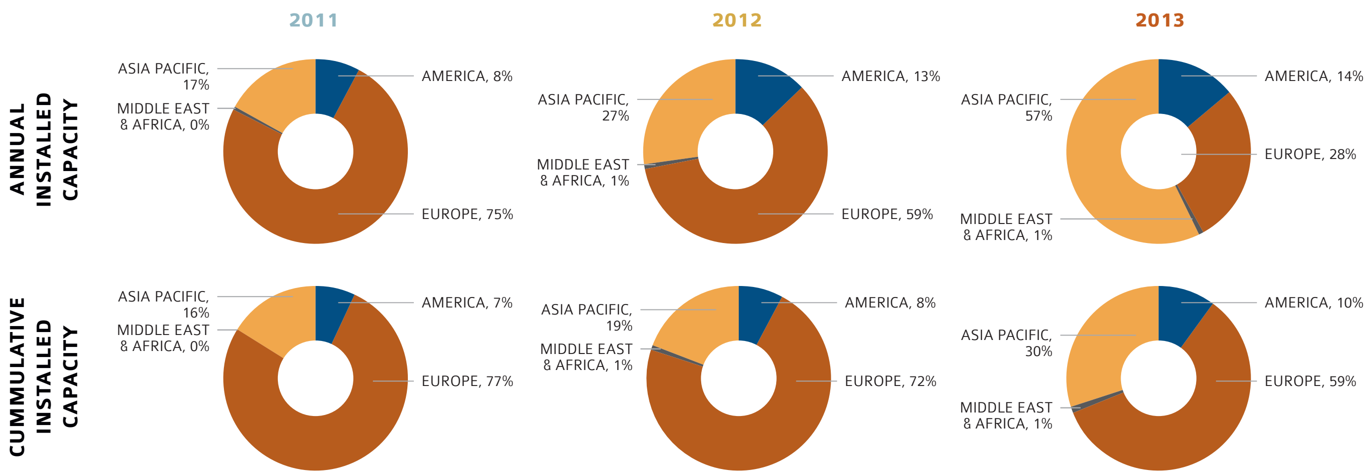
Finally, the share of the PV market in the Middle East and in Africa remains relatively small compared to other regions of the world.

FIGURE 10: GRID-CONNECTED CENTRALIZED & DECENTRALIZED PV INSTALLATIONS BY REGION IN PVPS COUNTRIES IN 2013 (MW)



SOURCE IEA PVPS, EPIA.

FIGURE 9: EVOLUTION OF ANNUAL INSTALLATIONS AND TOTAL CAPACITIES PER REGION 2011/2013 (MW)



SOURCE IEA PVPS, EPIA.

THE AMERICAS

The Americas represented 5,3 GW of installations and a total cumulative capacity of 13,7 GW in 2013. If most of these capacities are located in the USA, and in general in North America, several countries have started to install PV in the centre and south of the continent.

CANADA

FINAL ELECTRICITY CONSUMPTION	530	TWh
HABITANTS	35	MILLION
IRRADIATION	1 150	kWh/kW
PV INSTALLATIONS IN 2013	445	MW
PV INSTALLED CAPACITY	1 210	MW
PV PENETRATION	0,3	%

At the end of 2013, the installed capacity of PV systems in Canada reached more than 1,2 GW, out of which 445 MW were installed in 2013. Decentralized rooftop applications amounted to 55 MW (down from 87 MW in 2012) while large-scale centralized PV systems more than doubled from 181 MW to 390 MW in 2013. The market was dominated by grid-connected systems.

Prior to 2008, PV was serving mainly the off-grid market in Canada. Then the FiT programme created a significant market development in the province of Ontario. These installations are still largely concentrated in the province of Ontario and driven mostly by a FiT system.

Ontario's FiT Programme

While net-metering support schemes for PV have been implemented in most provinces, the development took place mostly in Ontario. This province runs a FiT system in parallel with net-metering opportunities for systems up to 500 kW.

This FiT programme is North America's first comprehensive guaranteed pricing structure for electricity production from renewable energy sources (RES). The first part targets generators above 10 kW and up to 500 kW (the "FiT Programme") while the second part focuses on systems below 10 kW ("MicroFiT programme"). Eligible PV systems are granted a FiT or microFiT for a period of 20 years.

In 2013, the FiT levels were reviewed and tariffs were reduced to follow the PV system costs decrease.

Ontario's Long Term Energy Plan aims to install 10,7 GW of non-hydro RES sources by 2021 (revised in 2013 Long Term Energy Plan) in the province. The LTEP outlines the following annual procurement targets from 2014 to 2017:

- 50 MW microFiT (below 10 kW)
- 150 MW FiT (below 500 kW)
- Large Renewable Procurement programme development (above 500 kW): competitive, non-FiT scheme with a target of 140 MW for 2014 and 2015.

Net-metering in Ontario allows PV systems up to 500 kW to self-consume part of their electricity and obtain credits for the excess electricity injected into the grid. However, since the FiT scheme remains more attractive, the net-metering remains marginally used.

PV remained marginal in other provinces in 2013 despite the existence of support schemes in a number of provinces and territories.

MEXICO

FINAL ELECTRICITY CONSUMPTION	234	TWh
HABITANTS	122	MILLION
IRRADIATION	1 780	kWh/kW
PV INSTALLATIONS IN 2013	60	MW
PV INSTALLED CAPACITY	112	MW
PV PENETRATION	0,1	%

Around 60 MW of PV systems were installed in Mexico in 2013, increasing the total capacity in the country to about 112 MW. At the end of 2013, a 30 MW plant was being built in Baja California, the largest so far in Central and Latin America, and 2 GW of request for permits have been filled to the authorities.

In the long term, the Mexican government has announced a target of 2 GW of PV systems in 2025 and the market is starting to take-off.

The regulatory framework for PV evolved in 2013 and the 2013-2017 National Energy Strategy prioritizes now the need to tap into the RES potential.

The possibility to achieve accelerated depreciation for PV systems exists at the national level (companies can depreciate 100% of the capital investment during the first year) and some local incentives such as in Mexico City could help PV to develop locally.

A net-metering scheme (Medición Neta) exists for PV systems below 500 kW mainly in the residential and commercial segments. The price of PV electricity for households with high electricity consumption is already attractive from an economic point of view since they pay more than twice the price of standard consumers. In 2013, the possibility was added for a group of neighbouring consumers (for instance in a condominium) to join together to obtain a permit to produce PV electricity. This net-metering scheme resulted in around 5 000 new systems installed in 2013.

A Self-consumption scheme exists for large installations, with the possibility to generate electricity in one point of consumption at

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several distant sites. In this scheme, the utility charges a fee for the use of its transmission and distribution infrastructure.

In December 2012, the National Fund for Energy Savings announced the start of a new financing scheme for PV systems for DAC consumers: 5 year loans with low interest rates can be used to finance PV systems.

Rural electrification is supported through a Solar Villages programme. Large power plants have been announced that could increase the PV market to several hundreds of MW a year.

USA

FINAL ELECTRICITY CONSUMPTION	3,889	TWh
HABITANTS	316	MILLION
IRRADIATION	1 300	kWh/kW
PV INSTALLATIONS IN 2013	4 751	MW
PV INSTALLED CAPACITY	12 079	MW
PV PENETRATION	0,4	%

Total PV capacity in the USA surpassed 12 GW at the end of 2013 with 4 751 MW added during that year. The total installed solar power capacity in the USA is now 12 079 MW – or more than 445 000 distributed installations. Once dominated by distributed installations, the US market is now lead by large-scale installations, representing 60% of the installed capacity in 2013.

The US PV market has been mainly driven by tax credits granted by the federal US government for some years (that will continue at least until 2017) with net-metering offered in some states as a complementary measure. Meanwhile at least 6 states and 17 utilities are offering power purchase agreements similar to FiTs. 22 states are offering capital subsidies, 29 states have set up an RPS (Renewable Portfolio Standard) system out of which 17 have specific PV requirements. Finally net-metering policies now exist in 43 states. In 2013, some jurisdictions had disputes between utilities and solar advocates that were concluded in favour of net-metering policies. Meanwhile, several state public utility commissions and utilities are in the process of developing a Value-of-Solar Tariff (VOST) as an alternative to net metering.

In most cases, the financing of these measures is done through public funding and/or absorbed by utilities.

Third party financing is developing fast in the USA, with for instance 69% of residential systems installed under the Californian Solar Initiative being financed in such a way. Third parties are also widely used to benefit from tax breaks in the best way. These innovative financing companies cover the high up-front investment through solar leases for example.

With regard to utility-scale PV projects, these are developing under Power Purchase Agreements (PPAs) with utilities.

PACE programmes have been introduced in more than 30 states as well; PACE (Property Assessed Clean Energy) is a means of financing renewable energy systems and energy efficiency measures. It also allows avoiding significant upfront investments and eases the inclusion of the PV system cost in case of property sale.

With such a diverse regulatory landscape, and different electricity prices, PV has developed differently across the country.

In December of 2012, in an effort to settle claims by U.S. manufacturers that Chinese manufacturers "dumped" products into the U.S. market and received unfair subsidies from the Chinese government, the U.S. Department of Commerce issued orders to begin enforcing duties to be levied on products with Chinese made PV cells. The majority of the tariffs range between 23%-34% of the price of the product. In December 2013 new antidumping and countervailing petitions were filled with the U.S. Department of Commerce and the United States International Trade Commission (ITC) against Chinese and Taiwanese manufacturers of PV cells and modules with conclusion expected in 2014.

OTHER COUNTRIES

Several countries in Central and South America have experienced PV market development in 2013.

In Chile, a boom in PV projects announcements has started to materialize in real developments. Some MW have been installed, mostly in the north of the country, and several hundred are expected in 2014 and later. PV development takes place in a context of high electricity prices and high solar irradiation, the necessary conditions for reaching parity with retail electricity prices. The market is mostly driven by PPAs for large-scale plants.

Brazil, by far the largest country on the continent, has started to include PV in auctions for new power plants while a net-metering system is in place but without great success for smaller installations. Many expects that the PV market in Brazil will take-off through these auctions, with competitive prices. In addition Brazil runs net-metering systems but with limited results so far.

In Argentina, the Government has set-up renewable energy targets for 2016 of 3 GW. This includes 300 MW for solar PV systems. However, so far the development was quite small, with only a few MW installed in the country.

In Peru, two 20 MW plants that have been operational since end 2012 were inaugurated at the beginning of 2013. Other plants are foreseen until 2014. Several programmes related to rural electrification should be started.

Several other countries in Central and Latin America have put support schemes in place for PV electricity. Ecuador is becoming a promising market with FiT legislation (0,40 USD/kWh – 15 years) in place and several ground mounted projects (up to 30 MW) have been announced as being built in the coming years.

Other countries such as Uruguay have launched a call for tender for 200 MW of PV with a PPA in early 2013 at the low 90 USD/MWh rate and projects were approved. The net-metering system launched in 2010 failed to develop the market so far. Several other countries including islands in the Caribbean are moving fast towards PV deployment.

In the region, French overseas departments have seen an important increase of PV penetration in the last years, with 34 MW in French Guyana, 60 MW in Martinique and 64 MW in Guadeloupe and some smaller numbers in Saint Martin. They represent so far the largest density of PV installations in the Caribbean region per inhabitant.

ASIA – PACIFIC

The Asia Pacific region installed close to 23,3 GW in 2013 and more than 42 GW are producing PV electricity. This region experienced the fastest market development in 2013 and will most probably continue in the same way.

AUSTRALIA

FINAL ELECTRICITY CONSUMPTION	199	TWh
HABITANTS	23	MILLION
IRRADIATION	1 400	kWh/kW
PV INSTALLATIONS IN 2013	811	MW
PV INSTALLED CAPACITY	3 226	MW
PV PENETRATION	2,3	%

After having installed 806 MW in 2011, 1 038 MW in 2012, Australia continued in 2013 with 811 MW installed. The country has more than 3,2 GW of PV systems installed and commissioned, mainly in the residential rooftops segment (1 million homes have now a PV system, an average penetration of 15%, with peaks up to 30%), with grid-connected applications. Only a mere 24 MW can be considered as large scale centralized power plants while new off-grid applications amounted in 2013 to 9 MW in the domestic sector and 5 MW for non-domestic applications.

Market Drivers

Australian Government support programmes impacted significantly on the PV market in recent years.The 45 000 GWh Renewable Energy Target (RET) (a quota-RPS system) consists of two parts – the Large-scale Renewable Energy Target (LRET) of 41 000 GWh by 2020 and the Small-scale Renewable Energy Scheme (SRES). Liable entities need to meet obligations under both the SRES and LRET by acquiring and surrendering renewable energy certificates created from both large and small-scale renewable energy technologies. The SRES covers small generation units (small-scale PV up to 100 kW, small wind turbines and micro hydroelectric systems) and solar water heaters, creating small-scale technology certificates (STCs). Certificates are granted based on 15 years of deemed solar production. The number of certificates granted is equal to those produced by other technologies from January 2013 onwards; down from a factor 5 multiplier in 2009. The Solar Cities programme has been completed and is not supporting any further installations.

Large scale PV benefited from an auction (ACT programme) in January 2012 for up to 40 MW and at least 70 MW were under construction at the end of 2013. But only 2 MW were installed in 2013 in this segment. The Solar Flagship Programme announced a successful project with 150 MW of large-scale PV planned. In addition, numerous solar cities programmes are offering various incentives that are complementing national programmes.

The market take-off in Australia accelerated with the emergence of FiTs programmes in several states to complement the national programmes. All FiT programmes were closed at the end of 2013. In general, incentives for PV, including FiTs, have been removed by State Governments and reduced by the Federal Government.

Self-Consumption

No promotion of Self-consumption as such exists in Australia. However, zero FiTs for new connections automatically favour Self-consumption.

There is increasing customer interest in onsite storage. Although not yet cost effective for most customers, a market for storage is already developing.

Outlook

Despite the reduction and removal of most government support schemes, the solar industry has stabilized at high volumes (>150,000 systems per year). This situation will be affected by the government's review of the Renewable Energy Target, which has recommended both SRES and LRET be wound back or scrapped.

ASIA – PACIFIC / CONTINUED

CHINA

FINAL ELECTRICITY CONSUMPTION	4 600	TWh
HABITANTS	1 357	MILLION
IRRADIATION	1 300	kWh/kW
PV INSTALLATIONS IN 2013	12 920	MW
PV INSTALLED CAPACITY	19 720	MW
PV PENETRATION	0,6	%

With 12,92 GW installed in 2013 alone, the Chinese PV market has beaten all previous records of yearly installations. The fast growth drove the market from 3,5 GW in 2012 to more than triple in one single year. With these installations, the PV installed capacity rose to close to 20 GW, making it the second in the world so far, behind Germany and ahead of Italy.

Since 2008, utility-scale PV has become the main segment developing in China and this was again the case with 12,1 GW installed in 2013. More recently rooftop PV has received some interest and starts to develop, in both BAPV (PV on rooftops) and BIPV (PV integrated in the building envelope) segments, but at a really slower pace. Only 800 MW were installed in 2013. The growth of centralized PV applications in 2013 shows the ability of the FiT regime to develop rapidly PV markets. This rapid growth can be explained by the willingness of developers to obtain the FiT at 1,0 CNY/kWh guaranteed until January 2014.

Several schemes are incentivizing the development of PV in China. They aim at developing utility-scale PV through adequate schemes, rooftop PV in city areas and micro-grids and off-grid applications in un-electrified areas of the country. The following schemes were in place in 2013:

- A FiT scheme for utility-scale PV that is financed by a renewable energy surcharge for electricity consumers.
- A capital subsidy for PV on buildings (the PV Building Project), financed through a special fund for renewable energy.
- The so-called "Golden Sun Programme" fund that also aims to develop PV on buildings and off-grid applications. The 4th phase started in 2012 with 1 709 MW of projects receiving the capital subsidy.
- The total funding for these last two programmes amounts to between 10 and 20 BCNY each year.
- In total, the existing programmes are covering up to 10,5 GW of projects already installed or approved for future installations.

From December 2012, FiT levels will be adjusted according to the solar resources and a Self-consumption subsidy has been introduced. In case of Self-consumption, the excess electricity can be acquired by the grid operator and a bonus can be paid on top of the wholesale electricity price. Additionally, it is expected that the FiT will progressively take over the subsidy programmes while Self-consumption driven applications will be more incentivized than utility-scale ones.

The market is mostly concentrated in the grid connected systems, with a low market for off-grid applications. In total, distributed applications now represent much less than 50% of the total, as opposed to the 2013 situation.

Grid connection, especially for large scale PV became more difficult in 2013, due to inadequate grid regulations and management in some regions. This has led to curtailment issues already in 2012 and 2013 and will be the key to further PV development. In addition, PV requires adequate funding solutions that will require also more transparency from the PV sector with regard to quality. Solutions could be found through third party financing and the use of adequate insurance in order to better the perception of financing parties and lower the cost of capital and therefore the cost of PV electricity.

Comments

China has finally become the very first market in the world. Adequate policies are being put in place progressively and will allow the market to continue at a high level.

JAPAN

FINAL ELECTRICITY CONSUMPTION	979	TWh
HABITANTS	127	MILLION
IRRADIATION	1 050	kWh/kW
PV INSTALLATIONS IN 2013	6 968	MW
PV INSTALLED CAPACITY	13 599	MW
PV PENETRATION	1,4	%

Total annual installed capacity of PV systems reached 6 968 MW (DC) in 2013 in Japan, a 400% increase compared to 2012. The total cumulative installed capacity of PV systems in Japan reached 13,6 GW in 2013.

With the start of the FiT programme in July 2012, the market for public, industrial application and utility-scale PV systems grew fast. Most installations took place under this FiT programme in 2013. The breakdown of PV systems installed in 2013 is 14,1 MW for off-grid application, 6,95 GW for grid-connected distributed plus centralized application.

While the PV market in Japan developed in the traditional rooftop market (with 1,5 million systems installed), 2012 and 2013 have seen the development of large-scale centralized PV systems, especially in 2013 with 1,8 GW of centralized plants.

Investment Subsidy

The subsidy programme, restarted in 2009, aims to promote the dissemination of high-efficiency (depending on the technology, efficiency must be above in between 8,5% and 16%) and low-price PV systems below 10 kW. A specific certification scheme has to be met. This instrument was abandoned at the end of the fiscal year 2013 (April 2014).

FiT

On July 1st 2012, the existing scheme that allowed purchasing excess PV production was replaced by a new FiT scheme. Its cost is shared among electricity consumers with some exceptions from electricity-intensive industries. This scheme has led to the fast market development seen in Japan in 2013, and more is expected in 2014.

The market was balanced between residential below 10 kW, commercial below 50 kW, industrial and large-scale centralized plants in 2013.

Self-Consumption

The FiT programme is used to remunerate excess PV electricity not Self-consumed for systems below 10 kW. However with tariffs above the retail electricity prices, Self-consumption is not incentivized.

Other Support Schemes

Other schemes exist in Japan, with various aims. The "project supporting acceleration of introduction of new and renewable energy", the METI, was launched in 2011 and supports among other technologies, PV in the regions damaged by the Great East Japan Earthquake of 2011. Another subsidy comes from the Ministry of Environment and supports climate change enabling technologies for local authorities' facilities, industrial facilities, schools, local communities and cities. Such projects are also promoting the use of local storage (batteries) to favour the development of renewable sources of energy. Other schemes can be found as well, showing how Japan is seriously considering the development of PV as an alternative source of electricity for the future.

KOREA

FINAL ELECTRICITY CONSUMPTION	475	TWh
HABITANTS	50	MILLION
IRRADIATION	1 258	kWh/kW
PV INSTALLATIONS IN 2013	445	MW
PV INSTALLED CAPACITY	1 475	MW
PV PENETRATION	0,4	%

Since the record-breaking year of 2008, that saw 276 MW of PV installations, the PV market remained stagnant in Korea during the next three years. This was mainly due to the limited FiT scheme which played initially an important role in the PV market expansion. However, 295 MW in 2012 and 445 MW in 2013, respectively, were installed, reaching the highest level of installations so far; breaking the record of annual installation. Thanks mainly to the newly introduced RPS scheme (with PV set-aside requirement), the market started to react in 2013.

At the end of 2013, the total installed capacity was about 1,47 GW, among those the grid-connected centralized system accounted for around 82% of the total cumulative installed power. The grid-connected distributed system amounted to around 18% of the total cumulative installed PV power. The share of off-grid non-domestic and domestic systems has continued to decrease and represents less than 1% of the total cumulative installed PV power.

The Korean government continued to support strongly R&D, PV deployment, infrastructure building and market promotion. Among these, the government-driven RPS scheme and R&D support played major roles in boosting PV deployment and industry development.

Various incentives have been used to support PV development. In 2008, the "Third Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy" based on the "First National Energy Basic Plan" was issued. This plan includes the construction of "One Million Green Homes" and "200 Green Villages" by 2020. Based on this plan, the RPS (Renewable Portfolio Standards) scheme has replaced the previous "FiT" scheme in 2012. The RPS was launched in 2012 as planned and will be active until 2020. Currently the "Fourth Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy" based on the "Second National Energy Basic Plan" is about to be issued. The new plan will include expansion of yearly PV set-aside requirement, shortening the target year by one year (now 2015 from originally 2016).

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Home Subsidy Programme (One Million Green Homes Programme)

This programme was launched in 2004 that merged the existing 100 000 rooftop PV system installation programme, and it aims at the construction of one million green homes utilizing PV as well as solar thermal, fuel cells, wind, bioenergy and geothermal until 2020. In general, single-family houses and multi-family houses including apartments can benefit from this programme. The Government provides 60% of the initial PV system cost for single-family and private multi-family houses, and 100% for public multi-family rent houses. The maximum PV capacity allowed for a household is 3 kW. At the end of 2013, more than 150 000 households (total 142,6 MW of PV capacity) benefited from this programme. In 2013, the installed capacity was about 20,6 MW.

RPS Programme

The RPS is a mandated requirement that the electricity utility business sources a portion of their electricity supplies from renewable energies. In Korea, electricity utility business companies exceeding 500 MW are required to supply a total of 10% of their electricity from NRE (New and Renewable Energy) sources by 2022, starting from 2% in 2012. Before beginning the formal RPS programme from 2012 onwards, the Government initiated the RPS demonstration programme for three years from 2009 until 2011. Six Korean electricity generation companies have signed the 'RPA (Renewable Portfolio Agreement)' with the Government in order to increase the share of renewable energy electricity generation. The total capacity was fixed at 101,3 MW. The six electricity companies constructed their own PV power plants or purchased PV electricity from the private source. In 2011, 31,7 MW were approved under this programme. PV has its own set-aside amount in the RPS of 1,2 GW for the four years covering 2012 to 2015. The plan was shorten by one year in order to support the local PV industry. In 2013, about 409 MW were installed under this programme.

Building Subsidy Programme (Formerly General Deployment Subsidy Programme)

The Government supports up to 50% of installation cost for PV systems below 50 kW. In addition, the Government supports 80% of initial cost for special purpose demonstration and pre-planned systems in order to help the developed technologies and systems to diffuse into the market. This is the "Test-period deployment subsidy program." In 2013, a total of 3,7 MW were installed by this program. Until the end of 2013, about 20 MW benefited from this program. Various grid-connected PV systems were installed in schools, public facilities, welfare facilities as well as universities.

Regional Deployment Subsidy Programme

The government supports 50% of installation cost for PV systems owned and operated by local authorities. Until the end of 2013, about 71 MW benefited from this programme.

NRE Mandatory Use for Public Buildings

The new buildings of public institutions, the floor area of which exceeds 1 000 square meters, are obliged by law to use more than 10% of their total expected energy from newly installed renewable energy resource systems. Public institutions include state administrative bodies, local autonomous entities, and state-run companies. The building energy mandate percentage will increase up to 20% by 2020.

MALAYSIA

FINAL ELECTRICITY CONSUMPTION	119	TWh
HABITANTS	30	MILLION
IRRADIATION	1 200	kWh/kW
PV INSTALLATIONS IN 2013	48,3	MW
PV INSTALLED CAPACITY	73,3	MW
PV PENETRATION	0,1	%

The PV market grew significantly in 2013 at 48,28 MW, up from 22,5 MW in 2012. The total installed capacity in Malaysia now tops 73,3 MW. The residential sector now represents 15,5 MW compared to 57,8 MW for commercial installations. Past off-grid installation numbers have been questioned and will not be mentioned here anymore. It is estimated that around 8 MW of off-grid projects are installed.

The residential segment grew significantly in 2013 with 13,33 MW installed compared to 2 MW in 2012. The installations in the commercial segment amounted to 34,95 MW with 57 new systems. The average size of systems in the commercial and industrial segment are rather high, around 600 kW while it is close to 10 kW in the residential segment; a rather high level as well.

The National Renewable Energy Policy and Action Plan (NREPAP) provides long-term goals and commitment to deploy renewable energy resources in Malaysia. The objectives of NREPAP include not only the growth of RES sources in the electricity mix but also reasonable costs and industry development.

The Sustainable Energy Development Authority Malaysia or SEDA Malaysia was established on 1st September 2011 with the important responsibility to implement and administer the FiT mechanism.

At end of December 2012, SEDA Malaysia had approved a total of 914 applications for 168,98 MW) for PV and these constituted 95,2% of the total applications approved under the FiT programme. Solar PV constituted around 25% of the total installed capacity approved under the Programme in 2012 but this number increased to 98% in 2013 with 48,28 MW out of 49,4 MW. The FiT Programme is financed by a Renewable Energy Fund (RE Fund) funded by electricity consumers via a 1% collection from the consumers' monthly electricity bills. Small consumers with a consumption below 300 kWh per month are exempted from contributing to the fund. Due to the limited amount of the RE Fund, the FiT is designed with a cap for each technology.

BIPV installations are incentivized with an additional premium on top of the FiT.

THAILAND

FINAL ELECTRICITY CONSUMPTION	162	TWh
HABITANTS	67	MILLION
IRRADIATION	1 372	kWh/kW
PV INSTALLATIONS IN 2013	437	MW
PV INSTALLED CAPACITY	824	MW
PV PENETRATION	0,7	%

At the end of 2013, the cumulative grid-connected PV power reached 824 MW, with around 30 MW of off-grid applications. 437 MW have been installed in 2013.

The introduction of a Feed-in premium or "adder" in Thailand in 2007 aimed at promoting the development of grid-connected solar energy. This "adder" comes in addition to the regular tariff of electricity, around 3 THB/kWh. While the government planned initially 500 MW of solar installations (PV and CSP together) by 2020, the target was rapidly overshot, with more than 3 000 MW of solar project proposals that have applied for the financial support scheme, out of which 50% regard PV.

New applications for the Very Small Power Producer (VSPP) and the Small Power Producer (SPP) scheme was stopped by the government due to the huge number of projects received.

At the end of 2011, the solar power generation target was increased to 2 000 MW, in order to cope with the new Energy Development Plan. This one targets 25% of renewable energy under the 10-Year Alternative Energy Development Plan (2012-2021).

In 2013, the solar power generation target was increased to 3 GW together with the reopening of the solar PV rooftop VSPP scheme with a new FiT (100 MW for small rooftops below 10 kW; 100 MW for commercial and industrial rooftops between 10 and 250 kW and large scale rooftops between 250 kW and 1 MW). FiT prices have been fixed at 6,96 THB per kWh (0,2245 USD per kWh) for residential size, 6,55 THB per kWh (0,2113 USD per kWh) for medium buildings and industrial plants and 6,16 THB per kWh (0,1987 USD per kWh) for large buildings and industrial plants. The FiT will be paid during 25 years.

In addition, the Thai Government also approved the so-called "community solar" power generation scheme of 800 MW. This scheme will be implemented by cooperation between the Ministry of Energy and the National Village and Urban Community Office, under the Prime Ministry Office. The stepwise FiT prices for this scheme will decrease from 9,75 THB per kWh for the first three years, down to 6,5 THB per kWh in the seven following years and finally 4,5 THB per kWh until the 25th year. These 800 MW are planned to be completed by the end of 2014. Apart from these two promotion schemes, the Government also approved 25 MW of rooftop PV installations for Government buildings.

With these schemes, Thailand aims at continuing the deployment of grid-connected PV in the rooftop segments, after a rapid start in the utility-scale segment.

OTHER COUNTRIES

2013 has seen PV developing in more Asian countries in such a way that Asia is now the very first region in terms of new PV installations. Several countries present interesting features that are described below.

India, with more than 1 billion inhabitants, has experienced severe electricity shortages for many years. The Indian market amounted to around 1 GW in 2012 and 1,1 GW in 2013, powered by various incentives in different states. The PV market in India is driven by a mix of national targets and support schemes at various legislative levels. The Jawaharlal Nehru National Solar Mission aims to install 20 GW of grid-connected PV system by 2022 and an addition 2 GW of off-grid systems, including 20 million solar lights. Some states have announced policies targeting large shares of solar photovoltaic (PV) installations over the coming years. Finally, 2 GW of off-grid PV systems should be installed by 2017.

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In 2013 Taiwan installed about 170 MW mostly as grid-connected roof top installations. The total installed capacity at end of 2013 is estimated around 376 MW. The market is supported by a FiT scheme guaranteed for 20 years and managed by the Bureau of Energy, Ministry of Economic Affairs. This scheme is part of the Renewable Energy Development Act (REDA) passed in 2009 that drove the development of PV in Taiwan. The initially generous FiT was combined with capital subsidy. It has later been reduced and now applies with different tariffs to rooftops and ground-mounted systems. Larger systems and ground based systems have to be approved in a competitive bidding process based on the lowest FiT offered. Property owners can receive an additional capital subsidy. It is the intention to favour small scale roof-tops at the expense of larger systems, in particular ground based installations. So far, agricultural facilities and commercial rooftops have led the market. The country targets 747 MW of PV installations in 2015 and 3,1 GW in 2030. In 2012, Taiwan launched the "Million Roof Solar Project" aiming at developing the PV market in the country, with the support of municipalities. The authorization process has been simplified in 2012 in order to facilitate the deployment of PV systems and will most probably ease the development of PV within the official targets as the progress of the market shows for 2013.

The Government of Bangladesh has been emphasizing developing solar home systems (SHS) as about half of the population of 150 million has no access to mains electricity. Under the Bangladesh Climate Change Strategy and Action Plan 2009 and supported by zero-interest loans from the World Bank Group as well as support from a range of other donors, the government is promoting incentive schemes to encourage entrepreneurs who wish to start PV actions; at present lead by the Infrastructure Development Company Ltd. (IDCOL) working with about 40 NGOs. Thanks to the decrease in prices of the systems and a well-conceived micro-credit scheme (15% of the 300 USD cost is paid directly by the owner and the rest is financed through a loan), off-grid PV's deployment exploded in recent years. The number of systems in operation is estimated around 3 million SHS. And more are expected after some financing from the World Bank. The average size of the system is around 50-60 W; for lighting, TV connections and mobile phone charging. Local industries are involved in the process and could replicate this in other countries. IDCOL also targets 10 000 irrigation PV pumps (80 MW).

Other Asian countries are seeing some progress in the development of PV. Pakistan has approved a 700 MW solar plant in the Punjab region in September 2013. This comes in addition to a previous memorandum of understanding signed with various providers in order to develop hundreds of MW in several places in the country. Brunei Darussalam has announced that a FiT policy should be put in place over the next 18-24 months. The Philippines have set up a FiT scheme capped at 50 MW. As it happened in many countries, the tender was oversubscribed and it is expected that in 2014 the cap will be increased to 500 MW (for PV and CSP). The first large-scale project (13 MW) is expected to be connected in 2014. In 2013 Indonesia has put in place a new solar policy: Under this regulation solar photovoltaic power is bought based on the capacity quota offered through online public auction by the Directorate General of New Renewable Energy and Energy Conservation. The plant that wins the auction will sign a power purchase agreement with the National Electric Company at the price determined by the regulation. The maximum purchase price is 0,25 USD/kWh increased to 0,30 USD/kWh in case of a local content requirement of 40%. 172,5 MW are foreseen in this competitive auction. In addition large-scale power plants have been announced (around 500 MW at the end of 2013), sometimes already with financing agreements. Myanmar has signed a memorandum for building several large-scale plants. In Singapore, the total PV installed capacity was 14,7 MW at the end of 2013. 4,9 MW of PV on rooftops have been installed in 2013, mostly in the commercial and industrial segments. Uzbekistan has the intention to develop 100 MW of PV developed by the Asian Development Bank and Korea and announced ambitious plans to install 4 GW of solar capacity by 2030. In Kazakhstan, the Zhambyl Province has announced aiming for 300 MW by 2016.

EUROPE

Europe has led the development of PV for almost a decade now and has represented more than 50% of the global PV market until 2012. Since 2013, European PV installations went down while the rest of the world has been growing rapidly. Europe accounted for 27% of the global PV market with 11,1 GW in 2013. European countries installed close to 82 GW of cumulative PV capacities.

AUSTRIA

FINAL ELECTRICITY CONSUMPTION	56	TWh
HABITANTS	8	MILLION
IRRADIATION	1 027	kWh/kW
PV INSTALLATIONS IN 2013	263	MW
PV INSTALLED CAPACITY	626	MW
PV PENETRATION	1,1	%

Austria's support for PV relies on a mix of capped FiT and investment grants. Due to a cap on the tariffs, the development of PV in Austria remained quite low, with a market below 100 MW until 2011. With 176 MW in 2012 and 263 MW in 2013, the market progressed faster. Off-grid development amounted to 0,5 MW installed in 2013.

Systems below 5 kW are incentivized through a financial incentive that can be increased for BIPV installations. Above 5 kW, the Green Electricity Act provides a FiT that was reduced in 2013. The FiT is guaranteed during 13 years and financed by a contribution of electricity consumers. Some financial grants can be added for specific buildings. In addition to federal incentives, most provinces are providing additional incentives through investment subsidies.

Self-consumption is allowed for all systems. Self-consumption fees have to be paid if the Self-consumption is higher than 25 000 kWh/y.

Rural electrification in remote areas not connected to the grid is incentivized through an investment subsidy up to 35% of the cost.

BELGIUM

FINAL ELECTRICITY CONSUMPTION	82	TWh
HABITANTS	11	MILLION
IRRADIATION	950	kWh/kW
PV INSTALLATIONS IN 2013	237	MW
PV INSTALLED CAPACITY	3 009	MW
PV PENETRATIO	3,5	%

Belgium is a complex case with different PV incentives in the three regions that compose the country, but an electricity market that covers the entire country. Organized as a federation of regions (Flanders, Wallonia and Brussels region), the country set up regulations that are sometimes regional, sometimes national.

Despite this organisation, all three regions selected an RPS system, with quotas for RES that utilities have to provide, and set-up three different trading systems for green certificates. In addition, the price of green certificates is guaranteed by the national TSO that charges the cost to electricity consumers.

For small rooftop installations below 5 or 10 kW, a net-metering system exists across the country. And until 2010, further grants were paid in addition to other support schemes while the tax rebates have been cancelled in November 2011.

Flanders started to develop first and installed more than 2 GW of PV systems in a few years. In Wallonia, the market started with a two year delay and remains largely concentrated in the residential and small commercial segments with more than 700 MW at the end of 2013. In Flanders, large rooftops and commercial application have developed from 2009. In Wallonia, conditions of Self-consumption and energy efficiency considerably limit development of the commercial and industrial segments. So far in Brussels, the city landscape limits PV development but the market grew significantly in 2013 with 24 MW installed.

The market grew very rapidly at quite a high level in both Flanders and Wallonia over the years, mainly due to a slow adaptation of all support schemes to declining PV system prices. The market boom that occurred in Flanders in 2009, 2010 and 2011 was followed by a rapid growth in Wallonia in 2011 and especially 2012 with 272 MW (AC) installed solely in the residential segment of the 3 million inhabitants region. In 2013 the market went down following the decrease of the number of green certificates allowed and changing policies about grid costs compensation.

At the end of 2013, a grid injection fee (to be paid annually and power-based) that was introduced in Flanders for systems benefiting from the net-metering scheme was cancelled. However discussions about compensating the losses in the revenues of grid operators remains vivid.

In general, the cost of support schemes has started to cause some growing discontent in the population, and most policy makers are still pushing to reduce the already granted revenues from the green certificate schemes, which led to a decrease in installations in 2013 and most probably in 2014. At the end of 2013, slightly more than 3 GW of PV systems were operational in Belgium.

EUROPE / CONTINUED

DENMARK

FINAL ELECTRICITY CONSUMPTION	32	TWh
HABITANTS	6	MILLION
IRRADIATION	1 000	kWh/kW
PV INSTALLATIONS IN 2013	156	MW
PV INSTALLED CAPACITY	563	MW
PV PENETRATION	1,8	%

By the end of 2011, only 17 MW were installed in Denmark. While grid-connected installations were the majority, off-grid was installed for instance in Greenland for stand-alone systems for the telecommunication network and remote signalling.

The net-metering system set by law for private households and institutions led to a rapid market expansion in 2012 that continued partially in 2013: 156 MW were installed in 2013 and 563 MW were connected to the grid end of 2013. The high electricity prices combined by decreasing system costs for PV systems made this fast development possible.

In November 2012, the government reacted to this high level of market development and modified the net-metering law. While the compensation between PV electricity production and local electricity consumption occurred during the entire year, the new regulation allows compensation to take place during only one hour. This change reduced the number of installations in 2013. In addition to these changes, the duration of the old net-metering system for existing systems has been reduced to 10 or 15 years depending on the installation time. In 2013, PV was incentivized by the new net-metering and the FiT for the excess electricity guaranteed during 20 years, with a decreasing value after 10 years. The net-metering system has now a cap of 800 MW (+20 MW for municipal buildings) until 2020. The Danish PV market is presently acting very slowly due to uncertainties related to the new incentive scheme, again due to missing approval of the new scheme by the European Commission (EC). Furthermore, it is reported that the EC is investigating the lawfulness of the entire Danish Public Service Obligation (PSO) funding mechanism, which for years has supported renewable energy deployment in the country – again adding to market uncertainties.

The EU directive on energy consumption in buildings was minted into a revised national building code in 2005 – and moved into force early 2006 – which specifically mentions PV and allocates PV electricity a factor of 2,5 in the calculation of the "energy footprint" of a building. However, due to the inertia in the construction sector, it was possible to detect some real impact on PV deployment only in 2009, as developers, builders and architects openly admitted the inclusion of BIPV in projects due to the building codes.

This trend was markedly strengthened during 2012. Ongoing political discussions both on the EU level and nationally indicate an upcoming further tightening of the building codes, which may further promote BIPV; and the future energy requirements in the building codes are now known up to 2020 with many new buildings in compliance with these future codes.

EUROPEAN UNION

In addition to all measures existing in Member States, the European Union has set up various legislative measures that aim at supporting the development of renewable energy sources in Europe.

The most well-known measure is the Renewable Energy Directive that imposes all countries to achieve a given share of renewable energy in their mixes so as to reach an overall 20% share of renewable energy in the energy mix at European level. Since that directive from 2009 let all Member States decide about the way to achieve their binding 2020 targets, PV targets were set up in various ways. Currently, the European Commission works on possible 2030 targets in order to continue promoting the development of renewables after 2020.

Besides the Renewable Energy Directive, the so-called Energy Performance of Building Directive defines a regulatory framework for energy performance in buildings and paves the way for near-zero and positive energy buildings.

The grid development is not forgotten: dedicated funding scheme (TEN-E) have been created to facilitate investments in specific interconnections, while several network codes (e.g. grid connection codes) are currently being prepared. This will have a clear impact on PV systems generators when finally approved and adopted.

In addition, the question of the future of electricity markets is central in all electricity sector's discussions. The growing share of renewables imposes to rethink the organisation of the electricity markets in Europe in order to accompany the energy transition in a sustainable way for new and incumbent players. Meanwhile, it has been made rather clear that the huge losses of several utilities in 2013 can rather be attributed to cheap lignite pushing gas out of the market and other similar elements rather than the impact of a few percent of PV electricity. While the role of PV was sometimes questioned due to the observed price decrease during the mid-day peak that is attributed to PV power production, it is absolutely not obvious whether this decrease during a limited number of hours every year really has an impact on the profitability of traditional utilities.

After more than a decade of rapid increase of production capacities (more than 100 GW of gas power plants have been connected to the grid since 2000), several utilities suffer from reduced operating hours and lower revenues due to these overcapacities in a stagnating market: the demand has hardly increased in the last decade in Europe.

Fearing for generation adequacy issues in the coming years due to gas power plants decommissioning, some are pushing for Capacity Remuneration Mechanisms in order to maintain the least competitive gas plants on the market. While the impact of PV on this remains to be proven with certainty, the future of the electricity markets in Europe will be at the cornerstone of the development of PV.

The debate about the future of renewables grew again in 2013 with the revision of the state-aid rules, through which the European Commission pushed Member States to shift incentives from FiT to more market based instruments, including possible technology-neutral tenders.

Finally, in order to answer complaints from European manufacturers, the Council of the European Union adopted final measures in the solar trade case with China in December 2013.

This decision confirms the imposition of anti-dumping and countervailing duties on imports into the European Union of crystalline silicon photovoltaic modules and cells originating from China. These duties, which are valid for a period of two years, will not apply retroactively.

Meanwhile, the acceptance of the undertaking offer submitted by China to limit the volumes and to set a threshold for prices has been accepted. The companies covered by this undertaking will be exempted from the general imposition of duties but will have to comply with minimum prices for modules and cells sold in Europe, within a certain volume.

FRANCE

FINAL ELECTRICITY CONSUMPTION	464	TWh
HABITANTS	66	MILLION
IRRADIATION	1 100	kWh/kW
PV INSTALLATIONS IN 2013	643	MW
PV INSTALLED CAPACITY	4 733	MW
PV PENETRATION	1,1	%

France initially supported the PV development through a pure FiT system, paid by a contribution of electricity consumers. The specifics of this system were to support BIPV systems rather than conventional BAPV systems only. Due to a surge in the demand at the very end of 2010, the government decided to constrain the PV development to 500 MW a year. This new support framework was put in place in March 2011 after a moratorium. It still allows systems of up to 100 kW to benefit from a FiT system. For systems larger than 100 kW the FiT has decreased significantly (slightly above 0,10 EUR/kWh) and induces the development of very competitive projects. Alternatively, projects starting at 100 kW can apply to calls for tenders.

The installation level in France went down to 1 115 MW in 2012 and to 643 MW in 2013; below the 800 MW suggested by policymakers. A part of PV installations has occurred in the overseas department of France, around 300 MW out of 4,7 GW. The rooftop market represented more than 60% in 2013, and the utility-scale segment around 40%. Off-grid installations in 2013 were around 0,1 MW while the total capacity is close to 30 MW.

The support to BIPV explains the relatively high cost of support schemes in France in general. In addition, France has introduced a 5 to 10% increase of the FiT levels at the end of 2012 if the system uses components produced in the European Economic Area (larger than the European Union). This local content requirement was accompanied in 2013 by a simplification of the tender’s process and at the end of the year the end of tax credits for private persons.

EUROPE / CONTINUED

GERMANY

FINAL ELECTRICITY CONSUMPTION	525	TWh
HABITANTS	81	MILLION
IRRADIATION	936	kWh/kW
PV INSTALLATIONS IN 2013	3 305	MW
PV INSTALLED CAPACITY	35 766	MW
PV PENETRATION	6,4	%

With 3 years in a row above 7 GW of PV systems connected to the grid, Germany installed more than 32 GW of PV systems until the end of 2012. This has been achieved thanks to a combination of several elements:

- A long term stability of support schemes;
- The confidence of investors:
- The appetite of residential, commercial and industrial building owners for PV.

In 2013, the market went down to 3,3 GW, in line with the political will to frame the development of PV within a 2,5-3,5 GW range each year.

FiT with a Corridor

The EEG law has introduced the FiT idea and has continued to promote it. It introduces a FiT for PV electricity that is mutualised in the electricity bill of electricity consumers. Exemption is applied to energy-intensive industries, a situation that was challenged by the European Commission in 2013. With the fast price decrease of PV, Germany introduced the "Corridor" concept in 2011; a method allowing the level of FiTs to decline according to the market evolution. The more the market was growing during a defined period of time, the more the FiT levels were lowered. In the first version, the period between two updates of the tariffs was too long (up to 6 months) and triggered some exceptional market booms (the biggest one came in December 2011 with 3 GW in one single month). In September 2012, the update period was reduced to one month, with an update announced every three months, in an attempt to better control market evolution. The government targets remain around 2,5 to 3,5 GW per year.

In September 2012, Germany abandoned FiT for installations above 10 MW in size and continued to reduce FiT levels in 2013.

Self-Consumption

The Self-consumption premium that was paid above the retail electricity price was the main incentive to self-consume electricity rather than injecting it into the grid. The premium was higher for Self-consumption above 30%. In 2012, the premium was cancelled when FiT levels went below the retail electricity prices. In the same idea, for systems between 10 kW and 1 MW, a cap was set at 90% in order to force Self-consumption. If the remaining 10% have to be injected anyway, a low market price is paid instead of the FiT.

A newly installed programme of incentives for storage units was introduced 1st of May 2013, which aims at increasing Self-consumption and reducing the share of FiT-driven PV in Germany. This programme financed around 2 700 small installations in 2013 out of an estimated 10 000 battery storage systems installed in Germany in 2013.

Market Integration Model

In contrast to Self-consumption incentives, Germany pushes PV producers to sell electricity on the electricity market through a "market premium". The producer can decide to sell its electricity on the market during a period of time instead of getting the fixed tariff and receives an additional premium on the top of the market price. The producer can go back and forth to the FiT system or the market as often as necessary.

Grid Integration

Due to the high penetration of PV in some regions of Germany, new grid integration regulations were introduced. The most notable ones are:

- The frequency disconnection settings of inverters (in the past set at 50,2 Hz) has been changed to avoid a cascade disconnection of all PV systems in case of frequency deviation.
- Peak shaving at 70% of the maximum power output (systems below 30 kW) that are not remotely controlled by the grid operator.

ITALY

FINAL ELECTRICITY CONSUMPTION	317	TWh
HABITANTS	60	MILLION
IRRADIATION	1 326	kWh/kW
PV INSTALLATIONS IN 2013	1 620	MW
PV INSTALLED CAPACITY	18 074	MW
PV PENETRATION	7,6	%

Implemented since 2005, the "Conto Energia" scheme has allowed for an increasing market development, resulting in a boom in installations in 2010 and 2011 and connections to the grid in 2011 and 2012. It was closed in June 2013, once the financial cap set by Italian authorities for the total yearly cost at 6,7 BEUR was reached.

A Capped Cost for PV Financial Support

Italy had made the choice of FiTs to develop the PV market, with additionally a Self-consumption regulation introduced in 2011 (the "Scambio Sul Posto"). The cost of the FiT for PV electricity is mutualised in the electricity bill of electricity consumers and was subject to a cap. Since the FiT was not active anymore in the second part of the year, tax credit was the remaining alternative incentive measure that is used as well.

Italy installed 1,6 GW during the year 2013, including 430 MW of systems not supported by the FiT. In total, more than 18 GW of PV systems were operational in Italy at the end of 2013. This represented 590 500 systems, with in total 2,57 GW of BIPV and 6,56 GW of BAPV systems supported by the FiT. As a whole, 8,47 GW of centralized systems and 27 MW of CPV have benefited from targeted incentives.

Self-Consumption

The Scambio Sul Posto is an alternative support scheme that favours Self-consumption through an economic compensation of PV production and electricity consumption for systems up to 200 kW. This net-billing scheme was revised in August 2012: New PV systems can benefit from a Self-consumption premium in complement to the FiT for the injected electricity, pushing PV systems to be progressively adjusted to the consumption pattern of users.

Comments

From a market evolution perspective, Italy holds the world record when looking at the number of systems connected to the grid in 2011: 9,3 GW were officially granted an access to the electricity network that year. While a part of these 9,3 GW could have been installed in 2010 and connected in 2011, this high level has been reached mainly due to the decline in PV system prices that was accompanied by a late FiT decrease. With high solar resources, especially in the south and relatively high retail electricity prices, Italy could become a haven for Self-consumption-driven installations. It should be mentioned that Italy is the country that incentivized BIPV and CPV systems the most (in terms of volume).

NETHERLANDS

FINAL ELECTRICITY CONSUMPTION	109	TWh
HABITANTS	17	MILLION
IRRADIATION	950	kWh/kW
PV INSTALLATIONS IN 2013	360	MW
PV INSTALLED CAPACITY	723	MW
PV PENETRATION	0,6	%

Until 2003, the Dutch PV market developed thanks to an investment grant that was extremely successful. Due to budget reallocation, the grant was cancelled and the market went down to a low level.

From 2008-2009 the government introduced a new FiT programme with a financial cap. This revitalized the market until the end of the programme in 2010.

Since 2011, the main incentive in the Netherlands is a net-metering scheme for small residential systems up to 15 kW and 5 000 kWh. This triggered an important market development in 2012 with 220 MW installed in the country, pushing the installed capacity up to 365 MW. In 2013, 357 MW were installed and the total capacity at the end of the year reached 722 MW.

The different tax incentives for companies continued and were joined by a specific incentive for households in 2013. It aims to replace roofing asbestos in homes and at the same, install solar panels. In August 2013, the solar subsidy scheme for households came to an end which was prolonged from 2012 and mounted to a total of 50,8 MEUR. It reached almost 90 000 households in the Netherlands and lowered the upfront investment significantly with a maximum of 600 EUR. However, there are no intentions to renew this subsidy scheme. Therefore in the latter half of 2013 only the direct subsidies scheme "SDEplus" existed for solar systems larger than 15 kW.

Although few in number, these medium sized systems are increasing in the Netherlands, especially on publicly owned buildings and in the agricultural sector. The main incentive for households at large is now net metering which was before limited

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to 5 000 kWh for each connection but as of the first of July 2013 this upper boundary was removed. How long this situation will remain is the subject of public debate.

This environment is triggering the development of new business models. For example, contracts to purchase electricity from neighbours are developing, resulting in new "community-based" systems. The Dutch market is very competitive and it will be interesting to observe the fast evolution of net-metering and the potential reaction from grid operators, while high electricity prices are making grid parity accessible in the residential segment.

NORWAY

FINAL ELECTRICITY CONSUMPTION	117	TWh
HABITANTS	5	MILLION
IRRADIATION	800	kWh/kW
PV INSTALLATIONS IN 2013	1	MW
PV INSTALLED CAPACITY	11	MW
PV PENETRATION	0,0	%

The PV market in Norway continues to be stable at a low level. A total of approximately 620 kW of PV power was installed during 2013. Most installations are off-grid systems. The total installed capacity reached 10,6 MW at the end of 2013.

The country is rather known for its PV producers rather than its market but the development of niche markets in this Nordic country is an indication of the potential of PV for off-grid applications all over the world, whatever the weather conditions. The market refers to both the leisure market (cabins, leisure boats) and the professional market (primarily lighthouses/lanterns along the coast and telecommunication systems). Exceptions are a few business and public actors who have integrated PV in large buildings, and some private homebuilders who installed PV systems in their private grid-connected houses.

The specifics of Norway are making the PV market quite odd. Without specific support schemes, PV develops at a low level mainly in the fields of pico and hybrid PV systems. With already close to 60% of the energy mix coming from renewables and close to 100% of the electricity mix coming from hydro, the room for developing PV in Norway will most probably stay in the off-grid market for a while.

PORTUGAL

FINAL ELECTRICITY CONSUMPTION	48	TWh
HABITANTS	10	MILLION
IRRADIATION	1 500	kWh/kW
PV INSTALLATIONS IN 2013	53	MW
PV INSTALLED CAPACITY	281	MW
PV PENETRATION	0,9	%

Around 53 MW were installed in Portugal in 2013, bringing the total installed capacity to around 281 MW. The market remains driven by the FiT scheme. The current support is split between micro-generation (below 5 kW) and mini-generation schemes (up to 250 kW) most of which are commercial or industrial rooftop systems. No licenses for ground-mounted systems in the scope of the Independent Power Producer (IPP) scheme were allocated since 2013.

In the meantime, the government is preparing a new framework oriented for Self-consumption systems, with and without power injection in the public grid, to be adopted in 2014, which will replace the former frameworks (IPP, micro and mini-generation).

In 2013, given the difficult financial situation of the country, the government decided to revise targets under the National Renewable Energy Action Plan for 2020 and the official goal for PV was reduced from 1,5 GW to 720 MW in 2020.

Off-grid systems are estimated at around 4 MW, with less than 0,1 MW added in 2013.

SPAIN

FINAL ELECTRICITY CONSUMPTION	234	TWh
HABITANTS	47	MILLION
IRRADIATION	1 600	kWh/kW
PV INSTALLATIONS IN 2013	102	AC MW
PV INSTALLED CAPACITY	4 640	AC MW
PV PENETRATION	3,6	%

In 2007 and 2008, Spain's FiT programme triggered a rapid expansion of the PV market. Large PV installations developed fast and drove Spain to the very first place in the world PV market in 2008. In October 2008, a moratorium was put in place in order to control the growth and the FiT was granted only after a registration process capping the installations at 500 MW a year. After a low year in 2009, due to the necessary time to put the new regulation in place, the market went down to between 100 and 450 MW a year. In 2013, 102 MW (AC) were installed in Spain.

Capped Retail Electricity Prices

Spain chose to finance the FiT costs by mutualising them on all electricity consumers, as many other countries have done. In addition, Spain caps the price of retail electricity and in case of a difference with the generation costs, the deficit is finally paid by electricity consumers. The cumulated deficit of such a policy amounts now to 34 BEUR and it is estimated that the cost of renewables paid by electricity consumers has contributed to around 25% of this amount. In order to reduce this deficit, retroactive measures have been taken to reduce the FiTs already granted to renewable energy sources.

Some measures were taken that have affected retroactively PV electricity producers. The most visible one is the cap on hours during which PV installations received the FiT. The consequence is that FiTs are granted for a part of yearly production only, since the number of operating hours has been defined well below the real production hours of PV systems in Spain.

This was done in a context of overcapacity of electricity plants in the country, combined with limited interconnections. This situation leads to the opposition of conventional stakeholders and grid operators in such a way that it forced the government to decide a moratorium for all new renewable and cogeneration projects benefiting from FiTs ("Special Regime") from January 2012. Since then, several taxes and retroactive measures took place in order to reduce the amount of money paid to PV producers.

In July 2013, the FiT system was ended and the new schemes should be based on the remuneration of capacities rather than production. The new system is based on estimated standard costs, with a legal possibility to change the amounts paid every four years. This has caused many projects to be in a state of default.

Net-metering was considered at a certain moment but never adopted. On the contrary, discussions were ongoing in 2013 with regard to allowing Self-consumption, under a constraining framework and especially additional fees that would make Self-consumption hardly competitive.

SWEDEN

FINAL ELECTRICITY CONSUMPTION	140	TWh
HABITANTS	10	MILLION
IRRADIATION	950	kWh/kW
PV INSTALLATIONS IN 2013	19	MW
PV INSTALLED CAPACITY	43	MW
PV PENETRATION	0,0	%

The PV power installation rate in Sweden continued to increase in 2013 and a total of 19,1 MW was installed, more than twice as much as the 2012 installations.

The off-grid market grew from 0,82 MW in 2012 to 1,16 MW in 2013. As in 2012, and in the same way as in many European countries, the large increase of installed systems occurred within the submarket of grid-connected systems. Around 18 MW were installed in 2013. The strong growth at a low market level in the Swedish PV market is mainly due to lower module prices, a growing interest in PV and the direct capital subsidy that was in place in 2012.

Historically, the Swedish PV market has almost only consisted of a small but stable off-grid market where systems for recreational cottages, marine applications and caravans have constituted the majority. This domestic off-grid market is still stable and is growing slightly. However, in the last seven years, more grid-connected capacity than off-grid capacity has been installed and grid-connected PV largely outscores off-grid systems. The grid-connected market is almost exclusively made up of roof mounted systems installed by private persons or companies. So far, only a couple of relatively small systems can be seen as centralized systems (0,66 MW installed in 2013, less than in 2012 in a doubling market).

Incentives

A direct capital subsidy for installation of grid connected PV systems that have been active in Sweden since 2009 was first prolonged for 2012 and in December 2012 the government announced that it would be extended until 2016 with a budget of 210 M SEK for the years 2013-2016.

The waiting time for a decision about the investment subsidy is quite long; generally about 1-2 years.

Net-metering has been discussed and investigated three times since 2007. The latest investigation has instead proposed a tax credit system for the excess electricity from micro producers. However, this has not yet been introduced. In the meantime, some utilities have decided to put different compensation schemes in place. Self-consumption through net-metering is one example of these kind of schemes.

Additionally, a tradable green certificates scheme exists since 2003, but only around 12% of PV installations are using it so far, because of the insufficient level of support for solar PV installations.

Self-consumption through net-metering is offered by some local utilities and discussions are expected in 2014.

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SWITZERLAND

FINAL ELECTRICITY CONSUMPTION	59	TWh
HABITANTS	8	MILLION
IRRADIATION	1 100	kWh/kW
PV INSTALLATIONS IN 2013	319	MW
PV INSTALLED CAPACITY	756	MW
PV PENETRATION	1,4	%

Around 319 MW were connected to the grid in Switzerland in 2013. Almost 100% of the market consists of rooftop applications and the few ground mounted PV applications are very small in size. Large scale ground mounted is non-existent in Switzerland. More than 750 MW of grid-connected applications are producing electricity in the country next to some 4,7 MW of off-grid applications.

This was achieved in 2013 thanks to a decrease of the FiT levels, in line with the PV system cost decrease, that allowed for raising the cap on installations.

Besides the (capped) national FiT scheme there are still many regional, local and utility support schemes. These are either based on direct subsidies or FiTs equal or below those on the federal level.

BAPV represented 75% of the market in 2013, with BIPV around 25% and large-scale PV almost negligible. Nevertheless, the size of PV installations increased in average in 2013, with the 100 to 1 000 kW segment progressing faster than the smaller ones. Agriculture buildings represent a very large share, with more than 15% of the number of installations in 2013.

The system size of residential buildings increased from around 3 kW to 15 kW while the average for single family houses is quite high with 7,5 kW. This is encouraged by the absence of size limit for the FiT scheme that allows covering of the entire roof rather than delivering the same amount of electricity as the yearly consumption. The current schemes also allow east and west facing PV roofs to be profitable, which could be seen as a way to ease grid integration.

In the same way as in many countries, the nuclear disaster in Japan in 2011 has increased the awareness of electricity consumers concerning the Swiss electricity mix. This pushed policy makers in 2011 not to replace existing nuclear power plants at the end of their normal lifetimes. Consequently, PV, with other sources of electricity is being perceived as a potential source of electricity to be developed. Preliminary new goals for PV electricity in Switzerland show levels of 15% and above, but this will have to be confirmed in the coming years. The recognition of positive energy buildings in the future could help to further develop the PV market in Switzerland, using regulatory measures rather than pure financial incentives.

UK

FINAL ELECTRICITY CONSUMPTION	329	TWh
HABITANTS	64	MILLION
IRRADIATION	970	kWh/kW
PV INSTALLATIONS IN 2013	1 546	MW
PV INSTALLED CAPACITY	3 377	MW
PV PENETRATION	1,0	%

1,55 GW of PV systems have been installed in 2013 in the UK, bringing the total installed capacity to 3,38 GW. The growth was significant after two years of installations close to the GW mark.

The market is driven by two main support schemes: A generation tariff coupled with a Feed-in premium and a system of green certificates linked to a quota (called ROC, for Renewable Obligation Certificates). The generation tariff is granted for small size PV systems. Systems below 30 kW receive in addition to the generation tariff, a bonus for the electricity injected into the grid (the so-called export-tariff, a Feed-in premium above the generation tariff), while the self-consumed part of electricity allows for reducing the electricity bill. This scheme can be seen as an indirect support to Self-consumption: The export tariff being significantly smaller than retail electricity prices (up to 0,14 GBP/kWh). Above 30 kW, excess electricity is sold on the electricity market.

For larger systems, the UK has implemented its own RPS system, called ROC: In this scheme, PV producers receive certificates with a multiplying factor. This scheme applies to buildings and utility-scale PV systems. This system could be replaced in 2014 by a market premium using a Contract for Differences to guarantee a fixed remuneration based on a variable wholesale electricity price.

In addition, PV system owners can benefit from tax breaks and VAT reduction.

OTHER COUNTRIES

Bulgaria experienced a very fast PV market boom in 2012 that was fuelled by relatively high FiTs. Officially 1 GW of PV systems were installed in this country with 7 million inhabitants in a bit more than one year, creating the fear of potential grid issues. In addition to possible retroactive measures aiming at reducing the level of already granted FiTs, Bulgarian grid operators have opted for additional grid fees in order to limit market development: the consequence is that the market went down to 10 MW in 2013.

In the Czech Republic, driven by low administrative barriers and a profitable FiTs scheme, the Czech PV market boomed in 2009 and especially in 2010. With more than 2 GW installed, only some 88 MW of installations occurred in 2013 in the country. Composed mainly of large utility-scale installations, the Czech PV landscape left little place to residential rooftop installations that are now the only installations that can benefit from a FiT system. The reason for this sharp market decline was a freeze of grid connection licensing decided in 2010 and released partially in 2011. The Czech TSO imposed a limit of 65 MW for new solar and wind installations in 2012. Up to this level, new projects were assessed on a case-by-case basis.

After having installed 912 MW in 2012, Greece installed 1,04 GW of PV systems in 2013, and reached 2,58 GW of installed capacity. The market is driven by FiTs that were adjusted downwards several times. The installations are mainly concentrated in the rooftop segments (commercial and industrial segments mainly). With dozens of islands powered by diesel generators, the deployment of PV in the Greek islands went quite fast in 2012 and 2013. Due to the rapid market uptake, grid operators asked in 2012 to slow down the deployment of PV, in order to maintain the ability of the grid to operate within normal conditions. The project to send PV power from Greece to Germany was considered in 2012 but little progress have been made since then.

Romania experienced a rapid market development with 1,1 GW installed in one year, driven by an RPS system with quotas paid during 15 years. Financial incentives can be granted but reduce the amount of green certificates paid.

Other European countries have experienced some market development in 2013, most of the time driven by FiT schemes. Poland is still waiting for an adequate scheme that could trigger PV deployment. Slovakia experienced very fast market development in 2011 with 321 MW installed but less than 1 MW with reduced incentives and a rather negative climate towards PV investments in 2013. Ukraine has seen a spectacular market development from 2011 to 2013 with 616 MW of large installations. However the political instability will have long term impacts on the PV development in the country.

In total, the European markets represented more than 11 GW of new PV installations and close to 82 GW of total installed capacity in 2013.

MIDDLE EAST AND AFRICA

Despite excellent solar irradiation conditions, few countries have yet stepped into PV development. However the potential in the region is tremendous in the medium to long term. Several countries are defining PV development plans and industry has started to appear in some of them.

ISRAEL

FINAL ELECTRICITY CONSUMPTION	46	TWh
HABITANTS	8	MILLION
IRRADIATION	1 450	kWh/kW
PV INSTALLATIONS IN 2013	244	MW
PV INSTALLED CAPACITY	481	MW
PV PENETRATION	1,5	%

In 2013, Israel installed 244 MW of new PV systems, with 0,1 MW of off-grid applications, up from 120 MW in 2011 and 47 MW in 2012. Most installations were rooftop based in all market segments, from residential households, to farms, industries, commercial buildings and municipalities. Only one unique very large scale system was operational in 2012, in the Arava Valley. Out of 8 800 systems installed in the country, 4 900 were on residential rooftops and the remaining on commercial and industrial buildings. But this changed in 2013 with most installations ranging from 300 kW to several MW.

In total, more than 481 MW of PV systems were operational in Israel at the end of 2013.

RPS and FiT

The first FiT system was enacted in 2008 by the government and led to a dramatic increase of PV system installations. A quota system (RPS) was defined in 2009 in Israel, but it took until 2011 to complete it with the right quota for each technology. In 2013, the second commercial quota was ended mid-year; this led to a consequent lack of progress of medium-sized projects due to regulatory issues.

With the decline of PV system costs, the FiT began to be perceived as too costly and rigid. A new rationalization methodology was developed, sometimes referred to as "VOR" (for Value of Renewable). This VOR can be understood as the value of RES electricity for the community, including the internalisation of some benefits such as energy security, environmental benefits and savings of energy imports.

In the meantime, the FiT were updated considering a global PV system cost index, rather than a local one, with semi-automatic FiT levels updates.

MIDDLE EAST AND AFRICA / CONTINUED

The FiT policies have been replaced by tenders and Self-consumption schemes, depending on the size of the installation: a net-billing system exists in Israel, with a quota of 400 MW and a maximum size of 5 MW per installation.

In 2013, the government introduced two new fees that could impact PV system owners using the net-billing scheme:

- A back-up fee that aims to cover the need to back-up PV systems with conventional power plants. This fee is technology dependent and will grow for solar from 0,03 ILS/kWh when the installed capacity will reach 1,8 GW and then 0,06 ILS/kWh when 2,4 GW is installed.
- A balancing fee (0,015 ILS/kWh) for variable renewable sources.
- A grid fee use that depends on the time of day and day of the week and ranges from 0,01 and 0,05 ILS/kWh.

TURKEY

FINAL ELECTRICITY CONSUMPTION	243	TWh
HABITANTS	75	MILLION
IRRADIATION	1 420	kWh/kW
PV INSTALLATIONS IN 2013	6	MW
PV INSTALLED CAPACITY	18	MW
PV PENETRATION	0,0	%

The PV market remained very low in Turkey with an estimated 6 MW installed in 2013 pushing the total installed capacity for grid-connected applications to around 8,5 MW.

In 2013, the most positive prospects were found in the small-scale PV market, since projects under 1 MW are not required to obtain a production license. 199 PV power projects covering about 62 MW in total were applied to the Turkish Distribution Corporation (TEDAS) and 6 MW of them received the preliminary acceptance at the end of 2013. These 62 MW of projects could be installed in 2014. A small market exists above 1 MW for unlicensed PV plants, with for instance a 1,8 MW system installed in 2013.

The Renewable Energy Law 6094 has introduced a purchase guarantee of 0,133 USD/kWh for solar electric energy production paid during ten years. In case of the use of local components for the PV system, additional incentives can be granted:

- PV module installation and mechanical construction, (+0,008 USD/kWh)
- PV modules, (+0,013 USD/kWh)
- PV cells, (+0,035 USD/kWh)
- Inverter, (+0,006 USD/kWh)
- Material focusing solar energy on PV modules, (+0,005 USD/kWh)

The Energy and Natural Resources Ministry Strategic Plan aims to reach a 30% share of renewables (incl. hydro) in electric energy production by 2023. Although there is not a certain target for solar electricity generation by 2023, Turkey is willing to use its high potential. Cumulative grid-connected installed PV power in Turkey by the end of 2013 is estimated at about 8 MW. Additionally, off-grid applications (about 6 MW cumulative capacities) account for around 70% of the cumulative installed PV capacity. However, the share of the grid-connected PV power systems grows year by year and 2014 is expected to be a critical year for the development of PV in Turkey. The most positive prospects are expected to be found in the small-scale PV market, since projects under 1 MW are not required to obtain a production license. Additionally, in the first license application round for a total of 600 MW PV projects larger than 1 MW has been completed by exceeding the proposed capacity by 15 times with 496 applications made to Energy Market Regulatory Authority (EPDK) reaching 8,9 GW in total. Turkish Electricity Transmission Company (TEIAS) is expected to soon publish the list of grid connection points and capacity of all the projects and announce the date, place and time for the tender.

Within this context, a rapidly growing market in Turkey, in near future, will not be surprising.

OTHER COUNTRIES

South Africa remains the most promising market so far. The expected growth failed to happen in South Africa in 2012 with only some MW installed in such a way that the country had 30 MW at the beginning of 2013. Due to political decisions, projects that were supposed to be validated in 2012 took more time to be approved. In 2013, several hundreds of MW started to be built, in such a way that 500 MW should be online mid-2014.

The REIPPP (Renewable Energy Independent Power Producer Procurement) programme to develop renewables in South Africa is a bidder programme that has granted PV projects in already two rounds. A third round of projects has been closed in 2013.

In MENA countries, the development of PV remains modest but almost all countries saw a small development of PV in the last years. There is a clear trend in most countries to include PV in energy planning, to set national targets and to prepare the regulatory framework to accommodate PV. Dubai, UAE announced that it aims for at least 1 GW of PV in 2030 with 13 MW being built in 2013. Qatar launched its first tender for 200 MW in October 2013.

In North Africa, the interest is growing fast. In Morocco, PV could play a role next to CSP. In Algeria, a new FiT scheme is expected for 2014 with an 800 MW target in 2020 and at least 233 MW received a positive bid notice at the end of 2013.

At the end of 2012, Jordan confirmed that it will launch a new FiT scheme for PV systems. The residential and commercial segments are targeted but the government would like local industrial players to take also the opportunity to develop PV. Its first large-scale project of 52,5 MW is finally going to be built and 200 MW of projects should receive a PPA. Saudi Arabia has drafted a master solar energy plan aiming for 40 GW of Solar Power by 2032, of which 15 GW could be PV.

In several other African countries, the interest for PV is growing, while the market hasn't really taken off yet. At least large-scale plants are planned in several countries to replace or complement existing diesel-generators, from 1,5 to 155 MW in size; these plants are planed in Ghana, Mali, Ivory Coast, Burkina Faso, Cameroon, Gambia, Mauritania, Benin and Sierra Leone. In 2014, Nigeria has signed a memorandum to install 3 GW of PV in the coming years. In Zimbabwe the energy authority was commissioned to plan a FiT and plans for a 300 MW have been discussed. In Ethiopia, the government has signed an agreement to equip 25 000 homes with pico solar PV systems (8 to 130 W) in rural areas of the country. In addition, 300 MW of utility-scale PV have been awarded at the end of 2013.

The Desertec project, aiming at providing solar electricity from MENA to Europe is pushing to adapt national frameworks in set demo projects in several countries in the MENA region. Meanwhile the evolution of the electricity demand in the region shifts away the moment where it will be able to really export to Europe. The previously-called "Desertec Industrial Initiative", renamed "DII" is working to open markets for PV in the region, in an attempt to accelerate the development of renewables, including PV and to set up the right framework that will allow in the future cross-continent electricity delivery.

TABLE 2: NON IEA PVPS INSTALLED CAPACITY IN 2013

COUNTRY	2013 INSTALLATIONS	CUMULATIVE CAPACITY
BULGARIA	10	1 020
CZECH REPUBLIC	88	2 175
GREECE	1 043	2 579
INDIA	1 115	2 320
ROMANIA	1 100	1 151
SLOVAKIA	0	524
TAIWAN	170	376
UKRAINE	290	616

SOURCE IEA PVPS.

TABLE 3: 2013 MARKET STATISTIC IN DETAIL

COUNTRY	2013 INSTALLATIONS (MW)					2013 CUMULATIVE CAPACITY (MW)				
	GRID-CONNECTED		OFF-GRID			GRID-CONNECTED		OFF-GRID		
	CENTRALIZED	DECENTRALIZED	DOMESTIC	NON-DOMESTIC	TOTAL	CENTRALIZED	DECENTRALIZED	DOMESTIC	NON-DOMESTIC	TOTAL
AUSTRALIA	3	794	9	5	811	24	3070	74	58	3 226
AUSTRIA	0	263	0	0	263	0	621	5	0	626
BELGIUM	46	190	0	0	237	640	2 369	0	0	3 009
CANADA	390	55	0	0	445	937	273	0	0	1 210
CHINA	12 120	800	0	0	12 920	16 512	2 996	102	111	19 720
DENMARK	5	150	0	0	156	5	557	0	1	563
FRANCE	251	392	0	0	643	1 248	3 455	30	0	4 733
GERMANY	1 157	2 148	0	0	3 304	9 239	26 709	0	0	35 766
ISRAEL	0	244	0	0	244	0	477	4	0	481
ITALY	698	921	0	1	1 620	11 097	6 961	4	12	18 074
JAPAN	1 771	5 183	0	14	6 968	1 840	11 636	9	115	13 599
KOREA	390	55	0	0	445	1 199	270	1	5	1 475
MALAYSIA	0	48	0	0	48	0	73	0	0	73
MEXICO	60	0	0	0	60	67	20	19	6	112
NETHERLANDS	3	357	0	0	360	8	715	0	0	723
NORWAY	0	0	1	0	1	0	0	10	1	11
PORTUGAL	20	32	1	0	53	143	134	4	0	281
SPAIN[1]	47	50	2	3	102	1 833	2 714	28	65	4 640
SWEDEN	1	17	1	0	19	2	33	8	1	43
SWITZERLAND	0	319	0	0	319	3	749	4	0	756
THAILAND	437	0	0	0	437	794	0	0	30	824
TURKEY	0	6	0	0	6	0	18	0	0	18
UK	603	943	0	0	1 546	2 229	1 148	0	0	3 377
USA	2 847	1 904	0	0	4 751	5 802	6 277	0	0	12 079
TOTAL IEA PVPS	20 848	14 871	15	24	35 757	53 622	71 274	301	404	125 418
8 MAJOR NON IEA PVPS MARKETS (SOURCE EPIA)					3 826					10 770
REST OF THE WORLD ESTIMATES (SOURCE EPIA)					371					3 607
TOTAL					39 953					139 795

NOTE:
1 DATA FOR SPAIN ARE IN AC.

SOURCE IEA PVPS.

SunPower PowerGuard rooftop solar electric system. © Sun Power, NREL

PV development has been powered by the deployment of support policies, aiming at reducing the gap between PV's cost of electricity and the price of conventional electricity sources over the last ten years. These support schemes took various forms depending on the local specificities and evolved to cope with unexpected market evolution or policy changes.

In 2013, the price of PV systems, as seen, and accordingly the cost of producing electricity from PV (LCOE) had dropped to levels that are in some countries close to or even below the retail price of electricity (the so-called "grid parity").

In several countries, the so-called "fuel parity" has been reached: This means that producing electricity with a PV system is now in some cases cheaper than producing it with a diesel-generator.

However, PV systems are not yet fully competitive in all markets and segments, while the development of PV still requires adequate support schemes as well as ad hoc policies with regard to electricity grids connections, building use and many others. This chapter focuses on existing policies and how they have contributed to develop PV. It pinpoints, as well, local improvements and examines how the PV market reacted to these changes.

MARKET DRIVERS IN 2013

Figure 11 shows that about 4% of the world PV market has been driven by Self-consumption or the sole competitiveness of PV installations in 2013.

MARKET DRIVERS IN 2013 / CONTINUED

A large part of the market remains dominated by FiT schemes (more than 70%) while subsidies aimed at reducing the upfront investment represent around 16% of the incentives. With some success in Belgium, the Netherlands, Denmark and the USA, net-metering was the main incentive in 2012 for 2% of the world market. In 2013, this situation didn't change much and net-metering schemes stayed below 3%. Various forms of incentivized Self-consumption schemes exist in other countries (and are often called improperly "net-metering"), such as Italy where the *Scambio Sul Posto* installations in 2013 were around 430 MW.

Historically the dominance of FiTs and direct subsidies is similar but even more visible in Figure 12.

The emergence of calls for tender has been confirmed in 2013, with new countries using this legal tool to attribute remunerations to PV projects under certain conditions. France and the Netherlands, but also emerging markets such as South Africa or Brazil, are developing in this direction. The result of these calls for tender (see next page 37) is a guaranteed payment for PV electricity, or in other words, a FiT. Such tenders represented around 4% of the world market in 2013.

Incentives can be granted by a wide variety of authorities or sometimes by utilities themselves. They can be unique or add up to each other. Their lifetime is generally quite short, with frequent policy changes, at least to adapt the financial parameters. Next to central governments, regional states or provinces can propose either the main incentive or some additional ones. Municipalities are more and more involved in renewable energy development and can offer additional advantages.

In some cases, utilities are proposing specific deployment schemes to their own customers, generally in the absence of national or local incentives.

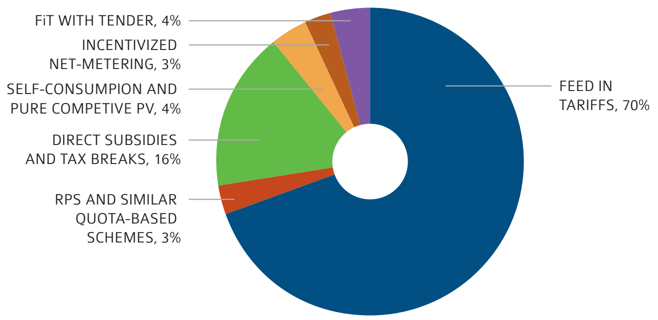
FEED-IN TARIFFS

The concept of FiTs is quite simple. Electricity produced by the PV system and injected into the grid is paid for at a predefined price and guaranteed during a fixed period. In theory, the price could be indexed on the inflation rate but this is rarely the case. This assumes that a PV system produces electricity for exporting into the grid rather than for local consumption. The most successful examples of FiT systems can be found in China, Germany, Italy (until 2013) and Japan, to mention a few.

Levy on Electricity Consumers or Tax Payers Money

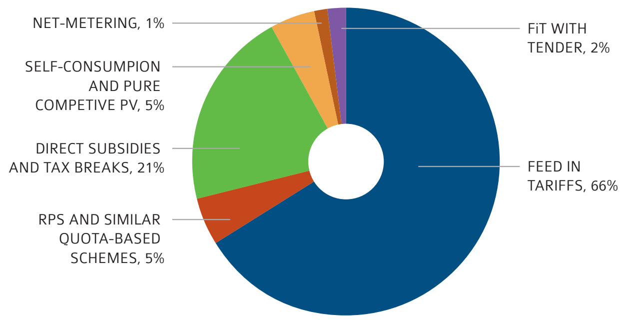
The cost of the FiT can be supported through taxpayers money or, and this is the most common case, at least in Europe, through a specific levy on the electricity bill (Austria, Germany, France, Italy etc.). This levy is then paid by all electricity consumers in the same way, even if some countries, Germany for instance, has exempted some large industrial electricity consumers for competitiveness reasons. The amount of cash available per year can be limited and in that case, a first-in first-served principle is applied (Austria, Switzerland). Most countries didn't impose a cap on FiT expenditures, which led to fast market development in Germany, Italy, Spain and many others.

FIGURE 11: 2013 MARKET INCENTIVES AND ENABLERS



SOURCE IEA PVPS.

FIGURE 12: HISTORICAL MARKET INCENTIVES AND ENABLERS



SOURCE IEA PVPS.

When the budget available for the FiT payments is not limited, market regulation must come from another control measure. It is assumed that most market booms in countries with unlimited FiT schemes were caused by an imbalance between the level of the tariffs and the declining cost of PV systems. With the rapid price decrease of PV systems over the last years, the profitability of PV investments grew very quickly when the level of the FiT wasn't adapted fast enough. This situation caused the market boom in Spain in 2008, in Czech Republic in 2010, in Italy in 2011 and in many other countries.

National or Local

Depending on the country specifics, FiT can be defined at national level (Spain, Germany, Japan, etc.), at a regional level (Australia, Canada) with some regions opting for and others not, or with different characteristics. In 2011, the French FiT law introduced a geographical parameter in the FiT level, in order to compensate for the difference of solar resource in its regions. Up to 20% more was paid for northern installations.

FiT can also be granted by utilities themselves (Sweden, Switzerland), outside of the policy framework.

Market Control Systems

The "corridor" principle has been experimented in Germany since 2011 and was effective in 2013. The level of the FiT can be adapted on a monthly basis in order to reduce the profitability of PV investments if during a reference period (one year), the market has grown faster than the target decided by the government. The first attempt was hardly successful in Germany, with long delays between the FiT updates that allowed PV investment to remain highly profitable during several months, leading for instance to the tremendous December 2011 market boom where 3 GW were installed in Germany.

In the last years, other countries adopted the principle of decreasing FIT levels over time, with sometimes (France, Italy) a clear pattern for the future.

FIT remains a very simple instrument to develop PV, but it needs to be fine-tuned on a regular basis in order to avoid uncontrolled market development.

Calls for Tender

Calls for tender are another way to use FiT schemes with a financial cap. This system has been adopted in Spain and France for some market segments (from 250kW onwards). In order to get the FiT contract, a PV system owner must go through a tendering process. This process can be a competitive one (France) or simply an administrative procedure (Spain). It can be used to promote specific technologies (e.g. CPV systems in France) or impose additional regulations to PV system developers. Tenders have been set-up in emerging markets such as Brazil or India.

Additional Constraints

The ease of implementing FiT allows its use when PV is approaching competitiveness: Germany added a 90% cap in 2012 to the amount of electricity that could benefit from the FiT system, pushing for either selling the excess on the electricity market (at a quite low price, around 4 to 5 USDcents in 2013), or Self-consumption. For systems where Self-consumption is incentivized, a FiT can be used for the excess electricity not consumed locally and injected into the grid. This was done in Italy in the first *Scambio Sul Posto* system.

In summary, FiT remains the most popular support scheme for all sizes of grid-tied PV systems; from small household rooftops applications to large utility scale PV systems.

DIRECT CAPITAL SUBSIDIES

PV is by nature a technology with limited maintenance costs, no fuel costs but has a high upfront investment need. This has led some countries to put in place policies that reduce that up-front investment in order to incentivize PV. This took place over the years in Australia, Belgium, Sweden, Japan, the USA, Italy and China. These subsidies are, by nature, part of the government expenditures and are limited by their capacity to free up enough money. Off-grid applications can use such financing schemes in an easier way, than for instance FiT that are not adapted to off-grid PV development.

RENEWABLE PORTFOLIO STANDARDS-RPS

The regulatory approach commonly referred to as "Renewable Portfolio Standard" (RPS) aims at promoting the development of renewable energy sources in competitive electricity markets. The authorities define a share of electricity to be produced by renewable sources that all utilities have to adopt, either by producing themselves or by buying specific certificates on the market. These certificates are sometimes called "green certificates" and allow renewable electricity producers to get a variable remuneration for their electricity, based on the market price of these certificates. This system exists under various forms. In the USA, some states have defined regulatory targets for RES, in some cases with PV set-asides. In Belgium's regions and Korea, PV receives a specific

MARKET DRIVERS IN 2013 / CONTINUED

number of these green certificates for each MWh produced. A multiplier is used for PV, depending on the segment and size in order to differentiate the technology from other renewables. Korea, which used to incentivize PV through a FiT system moved to a RPS system in 2012 with a defined quota for PV installations. In Belgium, all three regions are using a RPS system that comes in addition to other schemes such as net-metering and in the past, direct capital subsidies and tax credits. The region of Brussels has introduced a specific correction factor that adapts the number of certificates in order to always get the return on investment in 7 years. Romania uses a quota system as well while UK still uses a system called ROC (Renewable Obligation Certificates) that are used for large-scale PV. It must be noted that Sweden and Norway share a joint, cross-border, Green Electricity Certificate system.

Since 2010, the European Union lives under a directive (law) that imposes on all European countries to produce a certain percentage of their energy consumption with renewable energy sources. This directive, sometimes known as the 20-20-20 (20% RES, 20% less Green House Gases and 20% energy efficiency) translates into a target of around 35% of electricity coming from RES sources in 2020, but with differentiated targets for all member states. It is expected that these targets will be met by 2020. This overarching directive doesn't impose utilities to meet these targets directly but allows European countries to decide on the best way to implement the directive and reach the target. This explains the variety of schemes existing in Europe and the very different official targets that have been defined for PV, depending on the country. For instance, Germany alone targets 52 GW of PV installations in 2020.

TAX CREDITS

Tax credits can be considered in the same way as direct subsidies since they allow reducing the upfront PV investment. Tax credits have been used in a large variety of countries, ranging from Canada, USA to Belgium (until 2010), Switzerland, France, Japan, Netherlands and others. Italy used a tax credit in 2013 in the commercial segment. These are highly dependent on the government budgets, and are highly sensitive to the political environment, as the USA political debate has shown for wind tax credits in 2012.

SUSTAINABLE BUILDING REQUIREMENTS

With around 70% of PV installations occurring on buildings, the building sector has a major role to play in PV development. Sustainable building regulations could become a major incentive to deploy PV in countries where the competitiveness of PV is close. These regulations include requirements for new building developments (residential and commercial) and also, in some cases on properties for sale. PV may be included in a suite of options for reducing the energy footprint of the building or specifically mandated as an inclusion in the building development.

In Korea, the NRE Mandatory Use for Public Buildings Programme imposes on new public institution buildings with floor areas exceeding 1 000 square meters to source more than 10% of their energy consumption from new and renewable sources. In Denmark, the national building code has integrated PV as a way to reduce the energy footprint. Spain used to have some specific regulations but they never really succeeded in developing the PV market.

Two concepts should be distinguished here:

- Near Zero Energy Buildings (reduced energy consumption but still a negative balance);
- Positive Energy Buildings (buildings producing more energy than what they consume).

These concepts will influence the use of PV systems on building in a progressive way, once the competitiveness of PV will have improved.

ELECTRICITY COMPENSATION SCHEMES

With around 70% of distributed PV installations, it seems logical that a part of the PV future will come from its deployment on buildings, in order to provide electricity locally. The declining cost of PV electricity puts it in direct competition with retail electricity provided by utilities through the grid and several countries have already adopted schemes allowing local consumption of electricity. These schemes are often referred to as Self-consumption or net-metering schemes.

These schemes simply allow self-produced electricity to reduce the electricity bill of the PV system owner, on site or even between distant sites (Mexico, Brazil). Various schemes exist that allow compensating electricity consumption and the PV electricity production, some compensate real energy flows, while others are compensating financial flows. While details may vary, the bases are similar.

Self-Consumption

Pure Self-consumption exists in Germany: For instance, electricity from a PV system can be consumed by the PV system owner, reducing the electricity bill. The excess electricity can then benefit from the FiT system. Until 2012, Germany incentivized Self-consumption by granting a bonus above the retail price of electricity. This bonus was increased once the threshold of 30% of self-consumed PV electricity was passed. With the decline of FiT levels, these are now below the price of retail electricity and the bonus has disappeared.

Excess PV Electricity Exported to the Grid

Traditional Self-consumption systems assume that the electricity produced by a PV system should be consumed immediately or within a 15 minute timeframe in order to be compensated. The PV electricity not self-consumed is therefore injected into the grid. Several ways to value this excess electricity exist today:

- The lowest remuneration is 0; excess PV electricity is not paid while injected.
- Excess electricity gets the electricity market price, with or without a bonus (Germany).
- A FiT remunerates the excess electricity (Germany, Italy) at a pre-defined price. Depending on the country, this tariff can be lower or higher than the retail price of electricity.
- Price of retail electricity (net-metering), sometimes with additional incentives or additional taxes.

A net-metering system allows such compensation to occur during a longer period of time, ranging from one month to several years, sometimes with the ability to transfer the surplus of consumption or production to the next month(s). This system exists in several countries and has led to some rapid market development in 2012 in Denmark and in 2013 in The Netherlands. In Belgium, the system exists for PV installations below 10 kW. In Sweden, some utilities allow net-metering while in the USA, several states have implemented net-metering policies. In 2013, the debate started in the USA about the impact of net-metering policies on the financing of utilities, especially vertically integrated distribution actors. The conclusion so far was to either do nothing until the penetration of PV would reach a certain level (California) or to impose a small fee (Arizona) to be paid by the prosumer.

Other Direct Compensation Schemes

While the Self-consumption and net-metering schemes are based on an energy compensation of electricity flows, other systems exist: Italy, through its Scambio Sul Posto attributes different prices to consumed and produced electricity and allows a financial compensation with additional features (guaranteed export price for instance). In Israel, the net-billing system works on a similar basis.

Grid Costs and Taxes

In 2012 and 2013, the opposition from utilities and in some cases grid operators (in countries where the grid operator and the electricity producers and retailers are unbundled as in Europe) grew significantly against net-metering schemes. While some argue that the benefits of PV for the grid and the utilities cover the additional costs, others are pledging in the opposite direction. In Belgium, the region of Flanders introduced a specific grid tax for PV system owners in order to maintain the level of financing of grid operators and the region of Wallonia was expected to do the same in 2013. While these taxes were cancelled later, they reveal a concern from grid operators in several countries. In Germany, the debate has started in 2013 about whether prosumers should pay an additional tax. In Israel, the net-billing system is accompanied by grid-management fees in order to compensate the back-up costs and the balancing costs. In general, several regulators in Europe are expected to introduce capacity-based tariffs rather than energy-based tariffs for grid costs. This could change the landscape in which PV is playing for rooftop applications and delay its competitiveness in some countries.

MARKET BASED INCENTIVES

Most countries analysed here have a functional electricity market where at least a part of the electricity consumed in the country is traded at prices defined by the laws of supply and demand of electricity. In order to further integrate PV into the electricity system, Germany set the so-called "market integration model" in 2012.

A new limitation of 90% (for systems between 10kW and 1 MW) of the amount of PV electricity that can benefit from the FiT scheme has been introduced in Germany in 2012. It has pushed PV system owners to sell the remaining PV electricity on the market. This can be done at a fixed monthly price with a premium. In addition, the German law allows selling PV electricity directly on the market, with variable, market-based prices, the same management premium and an additional premium to cover the difference with FiT levels, with the possibility to go back and forth between the FiT scheme and the market. At the end of 2013, an average 3 GW of PV (out of 36 GW installed) were traded on a regular basis on the electricity market.

Market premiums can use existing financial instruments. The current project in the UK to replace the ROC system by a market-based model could introduce a variable premium above the wholesale market price through the Contract for Difference products (CfD). They would have the advantage of fixing the revenues of large PV system owners.

MARKET DRIVERS IN 2013 / CONTINUED

ADMINISTRATIVE AND LEGAL COSTS

Financial support schemes haven't always succeeded in starting the deployment of PV in a country. Several examples of well-designed FiT systems have been proven unsuccessful because of inadequate and costly administrative barriers. Progress has been noted in most countries in the last years, with a streamlining of permit procedures, with various outcomes. The lead time could not only be an obstacle to fast PV development but also a risk of too high incentives, kept at a high level to compensate for legal and administrative costs.

GRID INTEGRATION POLICIES

With the share of PV electricity growing in the electricity system of several countries, the question of the integration to the electricity grid became more acute. At the European level, 2013 saw the continuation of the revision of the grid codes.

In China, the adequacy of the grid remains one important question and could lead to favour more the development of decentralized PV in the future rather than large utility-scale power plants.

In addition, the development of net-metering and Self-consumption measures has led some countries to start revising their grid costs policies. Belgium and Bulgaria are clear examples of such countries. Israel, as mentioned before has planned to impose new taxes to prosumers in order to cover at least partially some grid costs.

Grid integration policies will become an important subject in the coming years, with the need to regulate PV installations in densely equipped areas.

THE COST OF SUPPORT SCHEMES

Growing discontent towards the historical cost of support schemes continued to grow in 2013 in several countries, pushing governments to either reduce the support for PV deployment or to opt for retroactive changes. Australia, Germany, Italy, Belgium and Spain are some of the countries where such events occurred. In Spain, the electricity tariff deficit (the difference between the retail price and electricity and its real cost) that is paid by taxpayers, reached a high level that forced the government to change retroactively some characteristics of the FiT schemes granted to existing PV plants. In Belgium, and also outside the IEA PVPS network in Bulgaria and Czech Republic, retroactive measures have been taken or discussed and could weaken the investor's confidence in PV.

In Italy, the total annual cost of FiT being paid to existing systems has theoretically reached the 6,7 BEUR limit in 2013. At the same time in Germany, the levy used to finance FiT schemes (not only for PV) reached more than 6,24 EURcents/kWh in 2014, increasing the price of electricity by more than 20% and creating an important debate in the German political arena. Finally in Australia, there was one attempt by a state government to make retroactive changes to a FiT, but a backdown was forced by overwhelming public response.

TRENDS IN PV INCENTIVES

Again in 2013, the most successful PV deployment policies were based on either FiT policies (most of the time without tendering process) or direct incentives (including tax breaks). The growth of Japan (FiT), China (FiT+direct incentives) and the USA (tax breaks, net-metering) shows how important these incentives remain. Other support measures remained anecdotic in the PV development history.

With declining costs of PV electricity generation, the question of "alternative" support schemes has gained more importance in several countries. The emergence of schemes promoting the local consumption of PV electricity is now confirmed and some countries rely on these schemes only to ensure PV deployment.

Instead of national support schemes, several countries favour private contracts to purchase PV electricity (PPA) from utility-scale power plants, while in several European countries the same plants are being banned from official support schemes.

BIPV has lost ground, with few countries maintaining adequate support schemes to favour their development, but a market for architectural BIPV still exists in Europe and to a lesser extent in Japan, Korea and the USA.

Calls for tender are gaining ground in several countries, and especially emerging countries for cheap large-scale PV systems. In parallel, the European Commission is pushing for market based incentives for systems above 1 MW, in order to favour the integration of PV into electricity markets through Feed-in premiums or similar instruments.

Policies targeting the entire electricity system remain marginal, with several countries running RPS systems but few with real PV obligations.

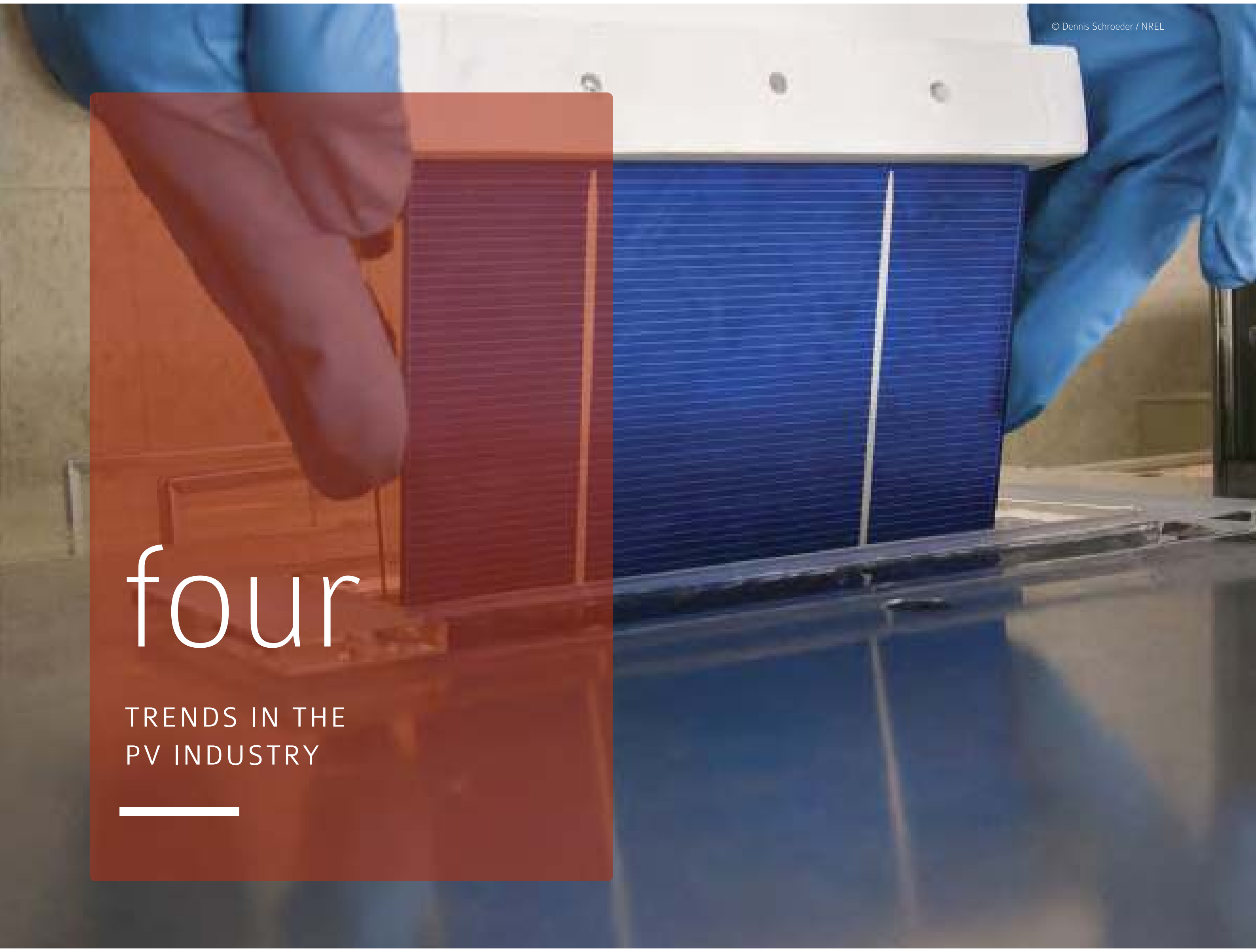
Finally, the arrival of local content policies in several countries that seemed to be an official answer to the local industry difficulties hasn't seen much development in 2013.

TABLE 4: OVERVIEW OF SUPPORT SCHEMES IN SELECTED IEA PVPS COUNTRIES[1]

	AUS	AUT	BEL	CAN	CHN	DEN	FRA	GER	ISR	ITA	JPN	KOR	MYS	NLD	SWE	SWI	THA	TUR	UK	USA
LOWEST FEED-IN TARIFFS LEVELS (USD/kWh)	0,06	0,22	-		0,08	0,07	0,10	0,13	-	-				-	-	0,21	0,21	0,13	0,11	+
HIGHEST FEED-IN TARIFFS LEVELS (USD/kWh)	0,56	0,24	-	0,14	0,10	0,11	0,42	0,22	-	-				-	-	0,42	0,23	0,13	0,25	+
INDICATED HOUSEHOLD RETAIL ELECTRICITY PRICES (USD/kWh)	0,23	0,27	0,25		0,08	0,39	0,19	0,38	0,18	0,23	0,24	0,16-0,61	0,10	0,25	0,21	0,27	0,12	0,19	0,23	0,12
DIRECT CAPITAL SUBSIDIES	+	R	R					+			+	+		+	+	R	+			+
GREEN ELECTRICITY SCHEMES	+	+	R					+		+	-			+		+			+	+
PV-SPECIFIC GREEN ELECTRICITY SCHEMES	+		R													+				
RENEWABLE PORTFOLIO STANDARDS	+			R							+	+			+	U			+	+
PV SPECIAL TREATMENT IN RPS												+				+			+	+
FINANCING SCHEMES FOR PV / INVESTMENT FUND	+	+		+				+			+			+						+
TAX CREDITS			+	+			+			+	+		+	+		+	+	+	+	+
NET-METERING / NET-BILLING / SELF-CONSUMPTION INCENTIVES	R		R	+	+	+		+	+	+	+			+	U	U/*		+	+	+
COMMERCIAL BANK ACTIVITIES	+		+	+	+			+			+		L	+	+		+			+
ELECTRICITY UTILITY ACTIVITIES	+			+	+	*		+			+	+		+		U	+			+
SUSTAINABLE BUILDING REQUIREMENTS	+			+	+	+		+			*	+	+	+		+			+	U

NOTES:
1 NUMBERS ARE ROUNDED VALUES IN USD ACCORDING TO AVERAGE EXCHANGE RATES.
U SOME UTILITIES HAVE DECIDED SUCH MEASURES.
R SUCH PROGRAMMES HAVE BEEN IMPLEMENTED AT REGIONAL LEVEL.
L SUCH PROGRAMMES HAVE BEEN IMPLEMENTED AT LOCAL LEVEL (MUNICIPALITIES).
* THIS SUPPORT SCHEME IS STARTING IN 2014.
+ THIS SUPPORT SCHEMES HAS BEEN USED IN 2013.
- THIS SUPPORT SCHEMES HAS BEEN CANCELED IN 2013.

SOURCE IEA PVPS.



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TRENDS IN THE PV INDUSTRY

This section provides a brief overview of the industry involved in the production of PV materials (feedstock, ingots, blocks/bricks and wafers), PV cells, PV modules and balance-of-system (BOS) components (inverters, mounting structures, charge regulators, storage batteries, appliances, etc.) during 2013. Reference is made to the relevant National Survey Reports for a more detailed account of PV production in each IEA PVPS member country.

A national overview of PV material production and cell / module manufacturing in the IEA PVPS countries during 2013 is presented in Annex 3 in the annex and is directly based on the information provided in the National Survey Reports of each IEA PVPS member country.

2013 was a year of renewed growth for the PV industry after two years of stagnation. In these two years, the industry faced declining prices, negative profitability and bankruptcies. Thanks to the strong demand development, mainly in China, Japan and the USA, the growth restarted in 2013. However, the price level remained rather low due to production overcapacity, although the price range was stabilized in comparison to the previous year. While new capacity enhancement plans were announced, companies without strong cost structure continued to face a severe business environment. Trade conflicts over polysilicon and PV cells/modules affected the prices and business operations in several regions.

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FEEDSTOCK, INGOTS AND WAFERS (UPSTREAM PRODUCTS)

Wafer based crystalline silicon remains the dominant technology for making PV cells and the discussion in this section focuses on the wafer-based production pathway. Although some IEA PVPS countries reported on feedstock, ingot and wafer production, the pictures from the national survey reports of these PV industry supply chain segments are not complete, and moreover represent only a part of the global value chain. Consequently, this section provides more background information on the upstream part of the value chain.

Since January 2011 when the spot price was around 70-80 USD/kg, the polysilicon price dropped by more than 70% and the downward trends continued throughout 2012. The spot price of polysilicon decreased from about from 30-35 USD/kg in January 2012 to 15-21 USD/kg in December 2012. Following the demand growth, the spot price showed an upward trend throughout 2013. It increased from a 15 USD/kg level in January 2013 to a 20 USD/kg level at the end of 2013. Global total name plate production capacity of polysilicon in 2013 was around 380 000 tonnes.

In 2013, it has been estimated that about 230 000 tonnes of polysilicon were produced and that the top 4 producers, namely Wacker Chemie (Germany), GCL-Poly Energy (China), OCI (Korea) and Hemlock Semiconductor (USA) accounted for more than half of the global polysilicon supply. Considering that 5,5 to 6 g of polysilicon are used for 1 W of solar cells, its production capacity remains higher than 1,5 times the actual global demand for crystalline silicon PV cells. Despite the gap between the capacity and demand, new plans for manufacturing polysilicon have continued to be reported and new capacity was added in 2013.

Most of major manufacturers have adopted conventional technologies such as Siemens and FBR processes, which are used to supply silicon for the semiconductor industry. To address lowering prices, major manufacturers are working on improvement of production efficiency. New technologies such as metallurgical processes have not yet become a major technology, mainly due to impurity issues. Some companies in IEA PVPS member countries that worked on new processes closed their plants or exited from the business because of the lack of cost competitiveness.

As in the previous year, major polysilicon producing IEA PVPS countries in 2013 were China, Germany, Korea, USA, Japan and Malaysia. Canada and Norway also reported activities of polysilicon producers working on metallurgical processes.

China is the largest producer and consumer of polysilicon in the world. China produced 82 000 tonnes of polysilicon, with 160 000 t/year of production capacity and imported 79 000 tonnes of polysilicon in 2013. The imported ratio among the consumed polysilicon amount slightly decreased from 52,7% in 2012 to 49,1% in 2013. The largest Chinese producer, GCL-Poly Energy, produced 65 000 t/year in 2013. Other major manufacturers in China are Daqo New Energy, TBEA and ReneSolar Silicon. Small scale polysilicon producers in China maintained their operations in 2013 due to overcapacity.

Germany produced 46 130 t of polysilicon in 2013; Wacker Chemie (46 000 t) and two other small producers had 53 980 t/year of production capacity. Wacker Chemie is constructing a new plant with 18 000 t/year capacity in Tennessee, USA; scheduled to start in 2015. Korea had 70 000 t/year of manufacturing capacity and produced an estimated 40 000 t. OCI, the largest Korean producer had 42 000 t/year of production capacity. Hanwha Chemical constructed a polysilicon plant with an annual production scale of 10 000 t/year and started production in 2013. The USA had over 70 000 t/year of production capacity with three major manufacturers (Hemlock Semiconductor Corporation, REC Silicon and SunEdison) and produced 39 988 tonnes, an 18% decrease from the previous year (48 500 tonnes). In Japan, about 4 500 tonnes of polysilicon for solar cells were produced in 2013. Tokuyama started production in its new polysilicon plant located in Malaysia with a production capacity of 6 200 t/year. Tokuyama plans to increase its total production capacity up to 20 000 t/year.

To make single-crystalline silicon ingots or multicrystalline silicon ingots, the basic input material is highly purified polysilicon. The ingots need to be cut into bricks or blocks and then sawn into thin wafers, whereas the ribbons are cut directly to wafers of desirable size. Conventional silicon ingots are of two types: Single-crystalline and multicrystalline. The first type, although with different specifications regarding purity and specific dopants, is also produced for microelectronics applications, while multicrystalline ingots are only used in the PV industry. Quasi-mono type silicon that has fewer grain boundaries compared to multicrystalline silicon that provides higher efficiency of PV cells was developed and commercialized mainly by Chinese producers but its share remained lower because performance of conventional multicrystalline wafers has been continuously improved. Ingot producers are in many cases also producers of wafers. Major PV module manufacturers such as Yingli Green Energy (China), ReneSola (China), Trina Solar (China), SolarWorld (Germany), Panasonic (Japan), Kyocera (Japan), etc, also manufacture silicon ingots and wafers for their in-house uses. This situation makes it difficult to track down the entire picture of ingot and wafer production.

FEEDSTOCK, INGOTS AND WAFERS (UPSTREAM PRODUCTS) / CONTINUED

As in the previous year, China is the world's largest producer of wafers for solar cells. Reported solar wafer production capacity in China is 40 GW/year in 2013. According to the Ministry of Industry and Information Technology of China, Chinese manufacturers produced about 29,5 GW of solar wafers in 2013; about a 5,4% increase from 2012 (28 GW). China exported about 7 GW of solar wafers to overseas solar cell manufactures. GCL-Poly Energy is the largest producer in China as well as in the world and its manufacturing capacity reached 10 GW/year in 2013. Other major wafer producing countries in IEA PVPS member countries are Korea, Japan, Germany, Malaysia, Norway and the USA.

Korea had 2,94 GW/year and 2,59 GW/year manufacturing capacity for ingots and wafers respectively. Woongjin Energy has an annual capacity of 1 GW in silicon ingots. Nexolon has a capacity of 1,5 GW in silicon wafers. In Japan, about 1,2 GW of wafers were produced in 2013. In Germany, 800 MW of solar wafers were produced in 2013 with 1,8 GW/year of production capacity. Malaysia reported at least 397 MW of wafer production by SunEdison (former MEMC). Comtech Solar (China) started construction of 1 GW/year wafer factory in Sarawak and Panasonic (Japan) has a 300 MW/year of wafer manufacturing capacity in Malaysia.

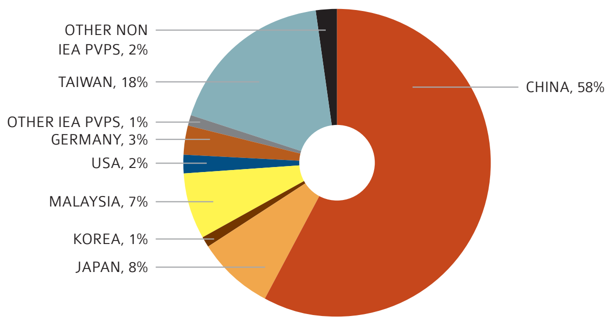
The wafer price dropped about 40% during 2012 (from 1,13 USD/piece in January 2012 to 0,81 USD/piece in December 2012). The price in 2013 was somehow stabilized within the range of 0,81 to 0,85 USD/piece. However, the price remained lower and the margin is the lowest in the entire value chain of crystalline silicon PV modules. This explains why large-scale producers have been increasing their shares. Many solar cell manufacturers having wafer manufacturing capacity started outsourcing wafers. To address the cost pressure, some wafer manufacturers adopted a new process using diamond wire saws to improve production efficiency. Startup companies in the USA and Europe are developing new processes to manufacture wafers without conventional wire-sawing.

In non IEA PVPS countries, Taiwan is the major producer of solar wafers with more than 7 GW/year of production capacity in 2013. In Singapore, the Norwegian company REC Solar produces solar wafers for its own use in its Singaporean factory.

PV CELL & MODULE PRODUCTION

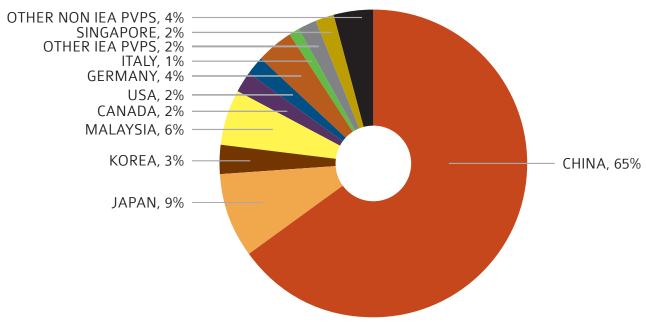
Total PV cell (crystalline silicon PV cell and thin-film PV cell) production in the IEA PVPS countries in 2013 is estimated to be 39,1 GW. As in previous years, China reported the largest production of PV cells. Total estimated production of PV cells in China is about 22 GW in 2013; a 7% increase from the previous year. As shown in Figure 13, China had more than 58% of the global share in 2013. The largest solar cell producer in the world in 2013 was Yingli Green Energy with 2,3 GW of production followed by Trina Solar (2,1 GW), JA Solar (2 GW) and Jinko Solar (1,7 GW).

FIGURE 13: SHARE OF PV CELLS PRODUCTION IN 2013



SOURCE IEA PVPS, RTS CORPORATION.

FIGURE 14: SHARE OF PV MODULE PRODUCTION IN 2013



SOURCE IEA PVPS, RTS CORPORATION.

Other major IEA PVPS countries producing PV cells are Japan, Malaysia, Germany, the USA, and Korea. In 2013, the IEA PVPS countries accounted for around 79% of the global solar cell production. Major non IEA PVPS countries manufacturing solar cells are Taiwan, the Philippines, Singapore and India. Major PV module producers in China started to buy solar cells made in Taiwan to avoid the antidumping duties for Chinese solar products in the USA and this brought a growth to solar cell production in Taiwan. Solar cell production in Taiwan was about 8 GW in 2013, a 32% increase compared to 5,4 GW in 2012. Figure 15 shows the evolution of PV cell production volume in selected manufacturing countries. It clearly suggests that the manufacturing base of solar cells has shifted to Asian countries.

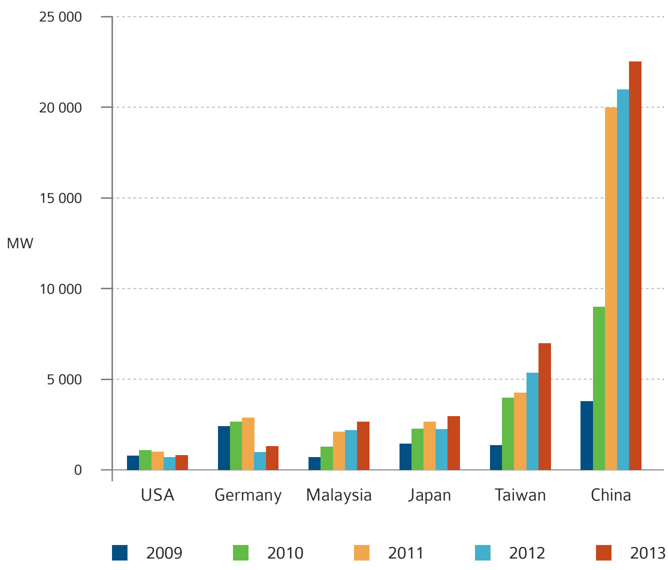
As in the previous year, the picture for PV module production is similar to the one for cell production. About 39,9 GW of PV modules (wafer based and thin-film PV modules) were produced in 2013. IEA PVPS member countries increased production by about 10% year from 33,7 GW in 2012 to 37,4 GW in 2013. PV module production in IEA PVPS countries accounted for more than 90% of the modules produced globally. Figure 16 shows that the estimated global production capacity reached close to 59 GW in 2013, almost the same level of the previous year. Estimated utilization of global PV manufacturing capacity in 2013 was approximately 63%, about a 9% increase from the previous year. In total, the IEA PVPS countries produced around 37,4 GW of wafer based modules and 3,9 GW of thin-film modules (Thin-film silicon, CdTe and CIGS) in 2013.

The largest producing country was China that accounts for 65% of global PV module production, delivering about 26 GW as shown in Figure 15. Chinese manufacturers kept their share supported by the strong demand in their domestic market. While the Chinese government continued support policies for PV deployment, it also formulated a policy to promote the selection of companies which do not meet the requirements set by the government, and promoted a policy to support competitive companies.

Other major IEA PVPS countries producing PV modules were Japan, Malaysia, Germany, Korea and the USA. Australia, Austria, Canada, Denmark, France, Italy, Sweden, Turkey and Thailand also have PV module production activities.

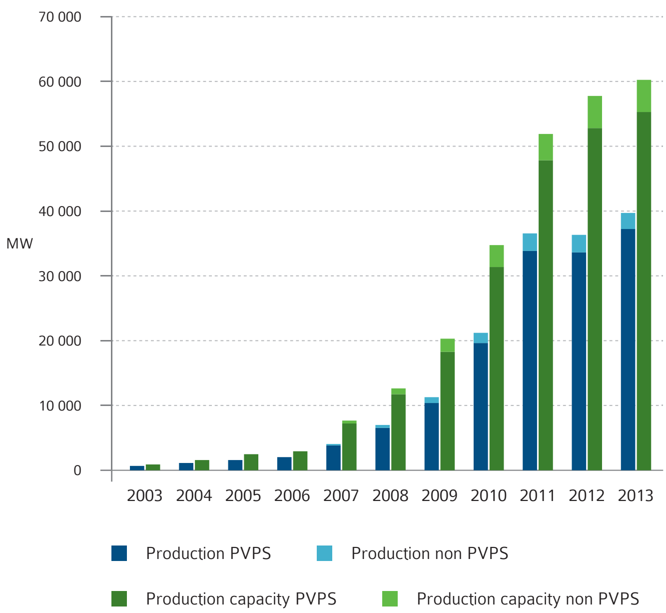
Japan produced 3,6 GW of PV modules. Although many of the Japanese PV manufacturers were operating at full capacity in 2013, new capital investment is limited by existing PV manufacturers. Therefore, Japan's imports of PV cells and

FIGURE 15: EVOLUTION OF THE PV INDUSTRY IN SELECTED COUNTRIES - PV CELL PRODUCTION (MW)



SOURCE IEA PVPS, RTS CORPORATION.

FIGURE 16: YEARLY PV MODULE PRODUCTION AND PRODUCTION CAPACITY (MW)



SOURCE IEA PVPS, RTS CORPORATION.

PV CELL & MODULE PRODUCTION / CONTINUED

modules are sharply increasing to satisfy a strong demand. Malaysia delivered crystalline Si PV modules and CdTe PV modules totaling 2,4 GW in 2013. Germany reported 1,41 GW of PV module production. USA manufactured 988 MW of PV modules in 2013. In addition, the two largest US based PV module manufacturers (First Solar and SunPower) have a majority of their manufacturing operations outside of the country.

In Canada, nine companies produced PV modules with a total production of 634 MW in 2013. It is notable that all the companies have their facilities located in the province of Ontario where the FiT programme that introduced local content requirements was implemented. In Turkey, China Sunergy (CSUN) set up a manufacturing facility in Istanbul in partnership with a local company. It is assumed that CSUN expects to enjoy the benefit of the FiT bonus for locally manufactured products and to avoid trade conflicts between Europe and China.

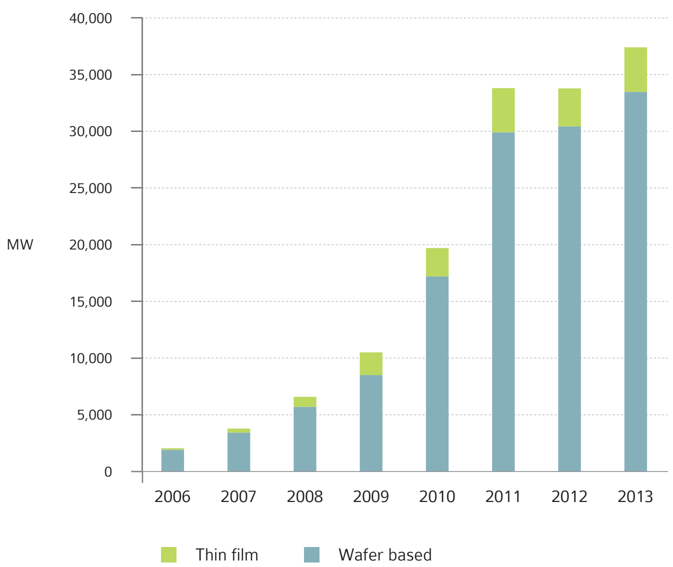
In non IEA PVPS members, major producing countries are Singapore, Taiwan and India. In 2013, new manufacturing plans were reported in emerging PV markets such as South Africa, Qatar, Saudi Arabia, Algeria, Brazil and more.

As shown in Figure 17, thin-film PV module production volume accounts for 10,4% in IEA PVPS countries in 2013.

Thin-film PV modules are mainly produced in Malaysia, Japan, China, Germany, Italy and the USA. Among the US thin-film PV manufacturers, First Solar produced about 1,63 GW of CdTe PV modules in its factories in the US and Malaysia in 2013. The company is ranked as the largest thin-film PV module producer and the fifth largest solar cell producer in the world in 2013. The USA reported 371 MW of thin-film PV module production in 2013. In Japan, a total of 1 012 MW of thin-film PV modules were produced mainly by Sharp, Kaneka and Solar Frontier. Solar Frontier established a 980 MW/year of CIS PV module manufacturing capacity and produced 929 MW in 2013. Thin-film PV manufacturers continued to be struggling in the cost competition with crystalline silicon PV products. Consolidation is also on-going among thin-film PV manufactures. As well as in 2012, efforts on R&D and commercialization of CIGS PV modules were continuously implemented in a number of IEA PVPS member countries aiming at higher conversion efficiency and higher throughput.

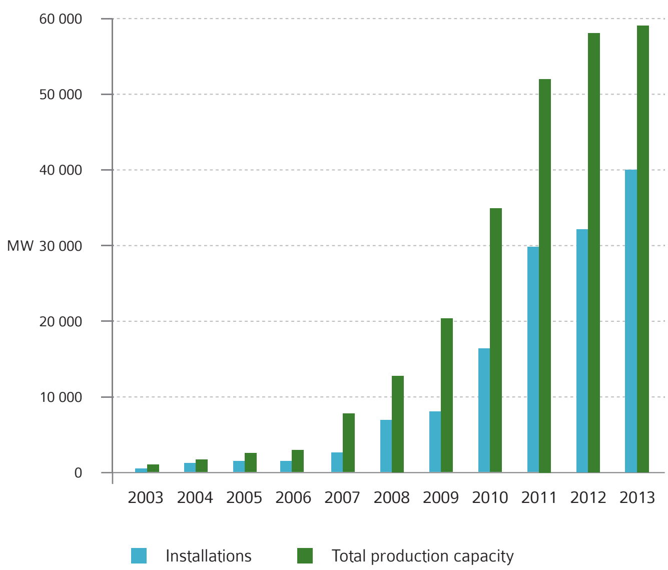
In 2013, activities on concentrator PV (CPV) cell/modules have been reported from several member countries. This technique is mainly based on specific PV cells using group III-V materials, such as GaAs, InP, etc. Germany, Australia, the USA, France and Spain are active in this area. France reported 29 MW of PV cell production for this application in 2013.

FIGURE 17: PV MODULE PRODUCTION PER TECHNOLOGIES IN IEA PVPS COUNTRIES 2006-2013 (MW)



SOURCE IEA PVPS, RTS CORPORATION.

FIGURE 18: PV INSTALLATIONS AND PRODUCTION CAPACITIES (MW)



SOURCE IEA PVPS, RTS CORPORATION.

Although the global PV module demand recovered in 2013, PV module manufactures continued to suffer from overcapacity and lower level module prices. PV module spot price dropped by 40% to 0,66 USD/W in 2012 and in the last half of 2013, the price rose to around 0,7/0,73 USD/W. However, in this situation, only cost competitive producers can manage to continue operation so that a number of PV module manufacturers announced insolvency or closure of factories together with drastic business reorganisation. This continued to be the case especially in Europe, where the market decreased significantly. Germany reported that there were only around 40 photovoltaic companies with around 11 000 employees in Germany operating at end of 2013 compared to 2008 with 62 companies with more than 32 000 employees. It is also reported that the number of Chinese PV module and cell manufacturers decreased from 300 to less than 100 companies.

TABLE 5: EVOLUTION OF ACTUAL MODULE PRODUCTION AND PRODUCTION CAPACITIES (MW)

	ACTUAL PRODUCTION			PRODUCTION CAPACITIES			
YEAR	IEA PVPS	NON IEA PVPS	TOTAL	IEA PVPS	NON IEA PVPS	TOTAL	UTILIZATION RATE
1993	52		52	80		80	65%
1994							
1995	56		56	100		100	56%
1996							
1997	100		100	200		200	50%
1998	126		126	250		250	50%
1999	169		169	350		350	48%
2000	238		238	400		400	60%
2001	319		319	525		525	61%
2002	482		482	750		750	64%
2003	667		667	950		950	70%
2004	1 160		1 160	1 600		1 600	73%
2005	1 532		1 532	2 500		2 500	61%
2006	2 068		2 068	2 900		2 900	71%
2007	3 778	200	3 978	7 200	500	7 700	49%
2008	6 600	450	7 050	11 700	1 000	12 700	52%
2009	10 511	750	11 261	18 300	2 000	20 300	52%
2010	19 700	1 700	21 400	31 500	3 300	34 800	57%
2011	34 000	2 600	36 600	48 000	4 000	52 000	65%
2012	33 787	2 700	36 487	53 000	5 000	58 000	58%
2013	37 398,5	2 470	39 868,5	55 394	5 100	60 494	63%

NOTE: CHINESE PRODUCTION AND PRODUCTION CAPACITY ARE INCLUDED SINCE 2006 EVEN THOUGH CHINA PARTICIPATES IN PVPS SINCE 2010.

SOURCE IEA PVPS, RTS CORPORATION.

TRADE FRICTIONS

The trade frictions that emerged between PV module supplying countries and consuming countries continued in 2013. The outcome of trade conflicts is expected to affect various aspects of the market development and according to some experts, could impact the growth of the global PV market and the industry.

The US Department of Commerce (DOC) confirmed that there was dumping of PV products using solar cells made by Chinese manufacturers and exported to the USA, then issued an official order to impose anti-dumping duties (AD) and countervailing duties (CVD) on PV modules using solar cells made in China. The European Union (EU) also started investigation on dumping and unfair subsidies from Chinese PV manufacturers exporting to Europe in September 2012. In the USA, a new AD investigation for PV cell/ modules made in China and Taiwan was filed to DOC in December 2013 to close the loopholes. DOC announced a provisional CVD for Chinese PV products in June 2014 and provisional ADs against Chinese and Taiwanese products. At the time of writing this report, the DOC did not announce final results but the related PV module suppliers started to reconsider manufacturing locations and strategies for overseas business. Downstream players in the USA also need to prepare the outcome of the results.

The European Commission decided to impose provisional AD duties in June 2013. The EU decided not to impose AD in early August 2013 after the European Commission and the Chinese PV industry reached an agreement on minimum prices and shipping volume for companies accepting the agreement. Although the detailed conditions were not disclosed, it is reported that the price and volume would be reviewed according to the European market situations. Companies that haven't approved the agreement are subject to AD and CVD.

In China, the Ministry of Commerce (MoC) started antidumping investigation on polysilicon imported from the USA, Korea and Europe and decided to impose provisional AD on the USA and Korean made polysilicon in July 2012. MoC announced provisional AD to USA and Korean made polysilicon in July 2013 and CVD to polysilicon imported from USA in September 2013. Then MoC announced final results in January 2014 and set AD for USA manufacturers from 53,3% to 57% and AD for Korean manufacturers from 2,4 to 48,7%. MoC also started an anti-dumping survey for polysilicon imported from Europe in November 2012. However, MoC concluded not to impose AD to products of Wacker Chemie, a German producer. It is assumed that MoC decided considering the agreement on PV module export between EU and China. While the impact of AD was limited because Chinese importers took advantage of "processing rules" that allows exemption of import duties for imported materials processed in China for export, Wacker and OCI with lower AD increased their share among the imported polysilicon in China. From September 2014, China introduced new rules for duties for imported polysilicon to close loopholes. It seems that the supply chain would be more affected by the new measure.

In India, the Ministry of Commerce and Industry started an investigation on dumping of PV modules made in the USA, China, Taiwan and Malaysia in January 2012. In May 2014, the Ministry concluded that antidumping of PV products from those countries damaged Indian PV manufacturers and proposed ADs ranging from 0,11 to 0,81 USD/W. However, the Ministry of Finance did not announce the final enforcement of ADs by the predetermined data (22nd August 2014). It is assumed that the Indian government dropped the plan to impose tariffs considering its negative impacts on the growth of the Indian market

BALANCE OF SYSTEM COMPONENT MANUFACTURERS AND SUPPLIERS

Balance of system (BOS) component manufacturing and supply are important parts of the PV system value chain and are accounting for an increasing portion of system costs as PV module prices fall. Accordingly, the production of BOS products has become an important sector of the overall PV industry.

Inverter technology is currently the main point of interest because the demand for grid-connected PV systems has continued to increase. In several countries, new grid codes require the active contribution of PV inverters to grid management and grid protection: New inverters are currently being developed with sophisticated control and interactive communications features. With the help of these functions, the PV plants can actively support grid management; for example, by providing reactive power and other ancillary services.

The products dedicated to the residential PV market have typical rated capacities ranging from 1 kW to 10 kW, and single (Europe) or split phase (the USA and Japan) grid-connection. For larger systems, PV inverters are usually installed in a 3-phase configuration with typical sizes of 10 to 250 kW. With the increasing number of utility-scale PV projects, larger inverters have been developed with rated capacities over 2 MW.

PV inverters are produced in many IEA PVPS member countries: China, Japan, Korea, Australia, the USA, Canada, Germany, Spain, Austria, Switzerland, Denmark and Italy. Unlike PV modules, the supply chains of PV inverters are influenced by national grid codes and regulations in such a way that domestic manufacturers tends to dominate domestic PV markets. For example, it is reported that top 10 PV inverters suppliers in China in 2013 were all domestic companies. China reported that there were more than 100 manufacturers of inverters. In Japan, the share of domestic inverter manufacturers (more than 15 companies) accounts for more than 90% of the market. In the USA, US companies shipped up to 3,6 GW (AC) of inverters in 2013. With the shift of major PV markets from Europe to Asia, established inverter manufacturers are extending their sales bases and establishing manufacturing plant in the emerging markets such as India and South Africa. However, the decrease in the European markets had an impact on European manufacturers.

The micro-inverters market (inverters attached directly to the PV module) is expanding. The USA accounted for more than 70% of the global micro-inverter shipments in 2013. Those were mainly used for residential applications.

As well as PV module suppliers, inverter manufacturers also suffered from the significant price reduction and tighter competition. The consolidation of the inverter manufacturers has begun, as well. In 2013, an US inverter manufacturer, Advanced Energy Industries (AEI) acquired REFUsol in Germany. A Swiss company, ABB bought-out Power-One, a US/Italian inverter manufacturer.

Production of specialized components, such as tracking systems, PV connectors, DC switchgear and monitoring systems, is an important business for a number of large electric equipment manufacturers. Dedicated products and solutions are now also available in the utility-scale power range. Along with product development of Home Energy Management Systems (HEMS) and Building Energy Management Systems (BEMS), package products consisting of storage batteries, new and renewable energy equipment and PV systems are now on the rise, but at a very low level. In Europe, inverters with storage batteries were commercialized aiming at developing the Self-consumption market. Meanwhile this market remains very small for the time being. In Japan, with the national subsidy for residential storage batteries, residential PV systems are sold with storage batteries.

CONCLUSIONS ON INDUSTRY

With the recovery of the global PV market, the supply and demand gap narrowed in 2013 and the price levels of polysilicon, wafer and PV modules stabilized in comparison to 2012. However, the price range remained in the lower range and the PV industry had to deal with lower margins in 2013.

Companies with a strong treasury and competitive costs increased their production and/or shipping volume in 2013. However, many companies which suffered from worsened business environment reduced production, closed factories and reduced workforce, sold or withdrew from the PV business and even filed for insolvency.

China became the number one country in terms of PV cell/module production and consumption. But the number of Chinese PV manufactures also significantly decreased due to the consolidation. While China enjoyed the number 1 position in PV module production, Chinese PV module manufactures had to reorganize their strategy. They shifted from a vertically integrated business model to a more flexible manufacturing framework to avoid trade conflict consequences over PV cells and modules. In order to avoid anti-dumping and countervailing duties, Chinese companies started producing outside of China, and many PV module producers started outsourcing of wafers and solar cells to compose with lower margins and price pressures.

Due to oversupply, new market entries have largely decreased. However, there were some new entries into PV module manufacturing in emerging PV markets and some new companies appeared to take over bankrupted European ones.

While manufacturers suffered from lower margins, price reduction contributed to increase competitiveness of PV power against conventional energy. In the established PV markets, especially in Europe, reduced incentives or termination of support measures started to change business models: PV players are now seeking opportunities through, for instance, Self-consumption-based business models and third party ownership, etc.

R&D ACTIVITIES AND FUNDING

The public budgets for research and development (R&D) in 2013 in the IEA PVPS countries are outlined in Table 6.

Expenditure for the PV R&D of IEA PVPS member countries shows great difference in scale. While most countries kept the same budget level as in the previous year, Australia and Germany reported significant increase. On the contrary, budgets of Japan and the USA decreased.

It is interesting to note that while a significant cost reduction of PV applications has been observed, grid parity and sustainable markets are rapidly approaching and PV is now being regarded as a mainstream electricity supply option. More governments are clearly identifying the benefits of this technology's further development, better integration with existing energy systems and the benefits of innovations. Another interesting point is that the scale of the budget does not indicate the industry scale in terms of production. The most significant reporting countries in terms of R&D budget are the USA, Australia, the European Union (and especially Germany), Japan, China, and Korea. A brief overview of the R&D sector in key countries and other IEA PVPS member countries is presented below.

TABLE 6: R&D FUNDING IN 2013

COUNTRY	R&D IN USD	INCREASE / 2012
AUSTRIA	14,8 M	↑
AUSTRALIA	170,2 M	↑
BELGIUM	4,2 M (2012 ONLY WALLONIA)	NA
DENMARK	5,3 M	↑
CANADA	11,7 M	↓
CHINA	79 M (2012)	NA
FRANCE	5,3 M	↓
GERMANY	250,6 M	↑
ISRAEL	0,9 M	NA
ITALY	7,7 M	↑
JAPAN	89,8 M	↓
KOREA	118 M (2012)	NA
NETHERLANDS	35 M (2012)	NA
NORWAY	12,8 M	↓
SPAIN	23,9 M	NA
SWEDEN	10,8 M	↓
USA	194,4 M	↓

SOURCE IEA PVPS.

However, it should be noted that analysis or comparison of public budget for R&D is not simple, due to several reasons. Definition of R&D and demonstration programmes vary among countries. The allocation of annual budget does not show the entire scale of multi-year R&D programmes (the first year's budget tends to be larger). European Union (EU) member countries can access the funding from the EU that conducts PV R&D projects and it is getting more and more difficult to distinguish PV system technological research conducted under the renewable energy research from research on grid-integration or applications for energy storage systems. For a better understanding of each member country's activities, please refer to the National Survey Reports (NSRs) on the IEA PVPS website. NSRs present a comprehensive summary of R&D activities in each country as well as more detailed information on specific R&D activities and public budgets.

The USA has been a clear leader in terms of R&D public funding for PV. The US Department of Energy (DOE) has accelerated the research, development, and deployment of all solar energy technologies through its Solar Energy Technologies Office (SETO). In February 2011, DOE launched the SunShot Initiative, a programme focused on driving innovation to make solar energy systems cost competitive with other forms of unsubsidized energy. To accomplish this, the DOE is supporting efforts by private companies, academia, and national laboratories to drive down the cost of solar electricity to about 0,06 USD/kWh by 2020. This, in turn, would enable solar-generated power to account for 15% to 18% of America's electricity generation by 2030. By funding selective R&D concepts, the SunShot Initiative promotes a genuine transformation in the ways the USA generates, stores, and utilizes solar energy. SETO-funded major development activities include the following: i) PV technology R&D with the potential to yield significant cost reductions, efficiency improvements, and improved reliability standards, ii) systems integration funding supports strategies to dramatically increase solar penetration in the nation's electrical grid and enable safe, reliable, cost-effective, and widespread solar deployment, iii) technology to market funding supports commercialization, market readiness, and domestic manufacturing supply chains, iv) SunShot Soft Costs funding supports market transparency, workforce training, local solutions, and process improvements to make solar deployment faster, easier, and cheaper. In addition to the national budget on R&D, the USA reported that substantial research also occurs in the private sector with companies such as First Solar contributing heavily to in-house research and development. First Solar spent 134 MUSD on R&D in 2013, roughly 15% of its gross profit. IBM, GE and Boeing also made strides in PV module efficiency in 2013.

In Australia, PV research, development and demonstration are supported at the national, as well as the state and territory level. In 2013, research grants were available through the Australian Research Council and the Australian Renewable Energy Agency (ARENA). ARENA invested 168 MAUD in 2013 on 3 new PV R&D projects, with a further 78,5 MAUD provided for the Solar Flagship project that supports two large scale PV projects totaling 155 MW. The Australian Research Council supports the highest-quality fundamental and applied research and training. In 2013, approximately 7,6 MAUD was provided for R&D projects and fellowships related to PV. Key research activities were conducted by CSIRO PV Performance Laboratory, Australian National University, universities and companies including Dyesol, Solar Systems and Suntech R&D Australia.

In Germany, R&D is conducted under the new 6th Energy Research Programme called *Research for an Environmental Friendly, Reliable and Economically Feasible Energy Supply* which came into force in August 2011. Within this framework, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Federal Ministry of Education and Research (BMBF) support R&D activities. In 2013, the BMU supported 242 projects amounting about 48,7 MEUR in total. BMU's priorities are Si wafer technology, thin-films (Si and Chalcopyrites (CIS/CIGS)), system technology, concentrated solar power and other alternative concepts and cross-cutting issues such as building integrated PV (BIPV), recycling or ecological impact of PV systems. BMBF supported development of organic solar cells and cluster *Solarvalley Mitteldeutschland* as part of the Federal High-Tech Strategy. BMU and BMF also conducted two joint initiatives: *Innovation Alliance PV and FuE for Photovoltaic*. Under the Innovation Alliance PV, cooperation between PV industry and PV equipment suppliers is promoted to achieve significant reduction of production costs to enhance the competitiveness of Germany industry. *FuE for Photovoltaic* launched in 2013 aims at supporting R&D with participation of the PV industry. Three focal areas are i) economical operation of grid-connected and off-grid PV system solutions including energy management and storage systems, ii) Efficient and cost effective production concepts including the introduction of new materials and production monitoring systems, and iii) introduction of new PV module concepts with a special focus on quality, reliability and life time.

Japan reported various activities concerning PV R&D. New Energy and Industrial Technology Development Organisation (NEDO) continued the *R&D for High Performance PV Generation System for the Future and R&D on Innovative Solar Cells programmes* with funding from the Ministry of Economy, Trade and Industry (METI). Under the programme *R&D for High Performance PV Generation System for the Future*, 4 new projects including development of the CZTS solar cell were started in 2013. Under the *R&D on Innovative Solar Cells*, 4 research projects focusing on higher efficiency devices continued in 2013 including a joint research between the EU and Japan. NEDO also conducted the *Development of Organic Photovoltaics toward a Low-Carbon Society* under the FIRST Programme. In October 2013, the National Institute of Advanced Industrial Science and Technology (AIST) established the *Fukushima Renewable Energy Institute (FREA)* in Koriyama City, in the Fukushima Prefecture. Technological development of crystalline silicon solar cells and demonstration of PV systems are conducted in the new research center. In 2013, NEDO started a new 3-year demonstration project called *Demonstration Project for Diversifying PV Application*, in order to extend the application area of PV systems. Selected projects cover installation in agricultural lands, tilted slopes, water surface, BIPV technologies and more. Other programmes exist with the financing from the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

In China, the Ministry of Science and Technology (MOST) is in charge of national PV R&D. The average annual investment in R&D from MOST is about 500 MCNY and the supported fields cover all of the manufacturing chain: Poly-Si, wafer, solar cells, PV modules, thin-film technology, CPV, energy storage, BOS components and system engineering.

In Korea, the government budget in 2013 for renewable energy R&D amounted to 276,2 BKRW. The programme mostly consists of industry-oriented research works in the PV area. With regard to short-term commercialization, many projects have been implemented in the field of high efficiency crystalline silicon solar cells, CIGS Thin-film solar cells, and PV modules for long-term and innovative goals. In the area of quantum dot, organic, and dye-sensitized solar cells, many projects have been implemented. Korea also promote the *Solar Energy Test-bed* as a national programme to support new companies struggling to commercialize their productions due to their lack of testing facilities.

In Canada, NRCan's CanmetENERGY is responsible for conducting PV R&D activities. Canada reported two R&D networks: The PV Innovation Research Network, funded by the Natural Sciences and Engineering Research Council (NSERC) and NSERC Smart Net-Zero Energy Buildings Strategic Network (SNEBRN).

In Austria, the Federal Ministry of Transport, Innovation and Technology (BMVIT) and the Austrian Climate and Energy Fund are the major organisations and facilitators for public R&D activities. There are no national PV specific programmes but PV R&D activities are funded under *e!MISSION.at* and the *City of Tomorrow*.

R&D ACTIVITIES AND FUNDING / CONTINUED

R&D in **Belgium** is a very active sector. For many years, the Belgian PV research activities have mostly been focused on national and international projects on nano-materials, organic PV, thin-film crystalline Silicon PV cell/modules, among other with the IMEC research center.

Denmark reported that R&D efforts in the fields of organic dye sensitized PV cells (PEC), polymer cells, *PV cells-architecture-lights* and nano-structured PV cells as continued activities in 2013.

In **France**, R&D programmes are mostly funded by public agencies: ADEME (French Environment and Energy Management Agency), ANR (French National Research Agency) and Bpifrance. ADEME is in charge of the *AMI PV* programme with nine projects. In 2013, ADEME issued a call for R&D projects on the subject of *Optimized integration of renewables and demand-side management*. ANR is conducting the Progelec programme with seven new research projects selected in 2013. French research institutes, the Institut National de l'Energie Solaire (INES) and the Institut Photovoltaïque d'Île-de-France (IPVF) are strengthening cooperation with industry on a variety of projects.

PV R,D&D activities are conducted in **Italy** mainly by ENEA (the Italian Agency for New Technology, Energy and the Environment) and RSE (a research company owned by GSE, the manager of electricity services). ENEA's most significant fields of interest are crystalline silicon, Cu2O solar cells, microcrystalline Si devices, micromorph tandem solar cell as well as concentrators technologies. RSE is carrying out activities on high efficiency single and InGaP/InGaAs/Ge solar cells in the frame of Italian electric system research programme RdS (Ricerca di Sistema) and in the European projects.

Norway focuses mainly on the silicon value chain from feedstock to PV cells, but also fundamental material research and production processes with the fund from the Norwegian Research Council (NRC). The Norwegian Research Centre for Solar Cell Technology has completed its fourth year of operation in 2013. Leading national research groups and industrial partners in PV technology participate in the center.

Spain promotes R&D activities across the value chain. About 10 research groups are working on crystalline silicon. In 63 work areas, 155 institutions are engaged in PV R&D. Highlighted topics in 2013 were: Development of silicon purified via metallurgical process and 40% reduction in radiation losses in the Siemens reactor through the use of heat shields.

Sweden's PV research consists largely of fundamental research in new types of solar cells and photovoltaic materials. Before 2013, no research on the world-dominant silicon technology has been conducted, but now Karlstad University has initiated activities within this topic. Furthermore, there are some smaller groups that focus on PV systems and PV in the energy system oriented research.

In **Switzerland** more than 75 projects, supported by various national and regional government agencies, the European Commission and the private sector, were conducted in the different areas of the photovoltaic energy system in 2013. Innovative solutions, cost reduction, increased efficiency and reliability, industrial viability and transfer as well as adequate market orientation are the main objectives of the technical R&D. R&D covers organic and dye-sensitized solar cells, thin film micromorph silicon solar cells, CIGS cells on glass and metal foils, high-efficiency hetero-junction silicon solar cells, etc.

The **European Commission** promotes PV research and development under the European Union's 7th Framework Programme (FP7) (2007-2013) that finished in 2013 and the new *Horizon 2020* programme (2014-2020) that has started in 2014, which replaced FP7. FP7 received a higher budget than the previous programme for seven years (195 MEUR). Seven calls for proposals have been published in the years from 2007 to 2013, including the last call in 2013. Material development for wafer-based silicon devices, photovoltaics based on solar concentration, and manufacturing process development have attracted relevant European funding. Significant funding has also been made available for thin-film technology and for the development and demonstration of new concepts and new approaches for building construction elements based on photovoltaics.

In **Israel**, the Ministry of Infrastructures, Energy and Water supports national R&D. Israel also participates in EU FP 7 programme and ISERD. US-Israel Binational Science Foundation (BSF) also funds R&D activities.

Malaysia's PV R&D activities are conducted by eight universities. Research area covers devices such as Thin-film Si, CdTe, CIGS and organic PV cells including dye-sensitized solar cell and PV system technologies including BOS, CPVs and demonstration.

In **Thailand**, since the late 1980s the research activities of PV cell and module production are carried out by the private sector to improve their module productivity whilst the research activities of universities and government research institutes work towards building a knowledge base. Current R&D activities are divided into 3 groups such as i) solar cells and related materials covering silicon ingot, TOC glass, Thin-film Si, CIGS, organic and dye sensitized solar cells, ii) PV components and iii) PV applications. Solar cells and related materials are major topics. PV applications consist of system evaluation and techno socio-economic management of PV systems in rural areas. In addition the research of inverters in grid and stand-alone hybrid systems is carried out.

VALUE FOR THE ECONOMY

The growth of the PV installations in 2013 and the relative stability in prices, caused the business value of PV to increase again in 2013 from around 75 Billion USD in 2012 to 86 Billion USD in 2013.

Figure 19 shows the estimated business value for PV in IEA PVPS reporting countries and the major markets. The value corresponds to the internal PV market in these countries, without taking imports and exports into account. For countries outside the IEA PVPS network or countries that didn't report a specific business value, this is estimated based on the average PV system price.

Some countries have benefited from exports that have increased the business value they obtained through the PV market while huge imports in other countries have had the opposite effect. Some countries could still be seen as net exporters, creating additional value next to their home PV market, such as China or Taiwan. The European and American markets, on the other hand, are net importers.

Denmark, Norway, Sweden, Canada or Switzerland are net exporters. In the case of Switzerland, the balance that was highly positive in 2012 was significantly reduced in 2013. 550 MCHF of exports compensated some 400 MCHF of imports. Other countries, such as Germany, France and Italy, with less industrial players and/or a large PV market in 2013, reduced the business value of PV due to imports. Italy shows only a small deficit compared to the value of the market.

The business value of PV should be compared to the GDP of each country. In most cases, the business value of PV represents less than 0,5% in the most developed PV countries.

TRENDS IN EMPLOYMENT

Employment in the PV sector should be considered in various fields of activity; research and development, manufacturing, and also deployment, maintenance and education.

PV labour places are evolving rapidly in several countries due to the changes in the PV markets and industry. The decrease of the market in several key European countries has quickly pushed the installation jobs down while some other countries where the market was growing experienced an opposite trend.

The consolidation of the industry, together with market stagnation at the global level, has caused the employment in the PV sector to decrease in several countries in 2012 but industrial jobs went up again in 2013 in countries where manufacturing increased.

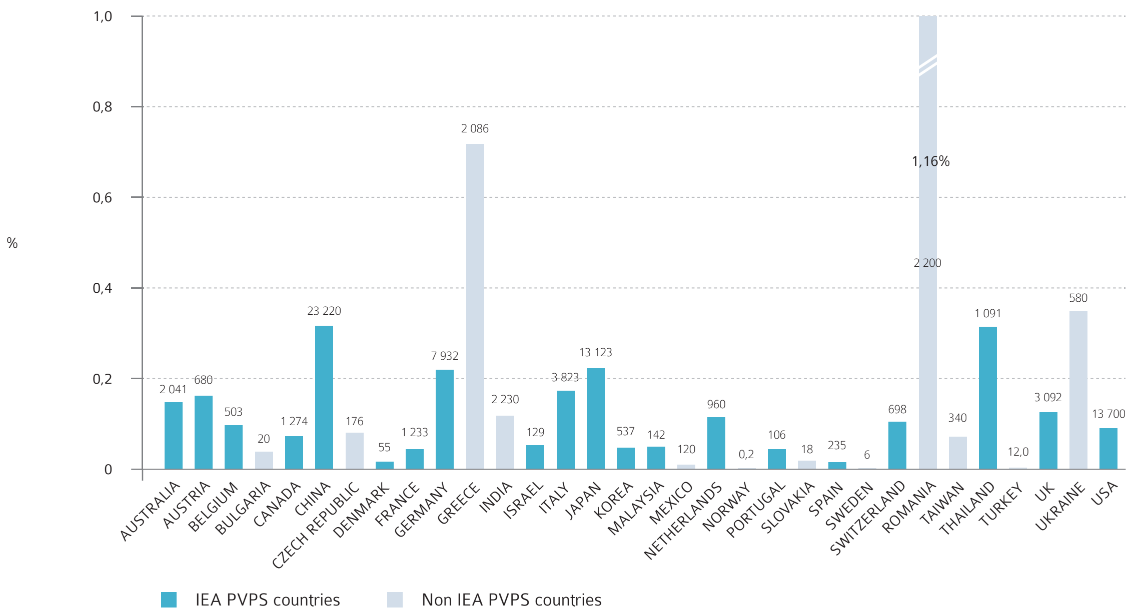
In general, the evolution of employment is linked to the industry and market development, with important differences from one country to another due to the local specifics. It remains difficult to estimate the number of jobs created by the development of PV since a part of them stands in the upstream and downstream sectors of the value chain, mixed with others.

TABLE 7: EMPLOYMENT IN IEA PVPS REPORTING COUNTRIES

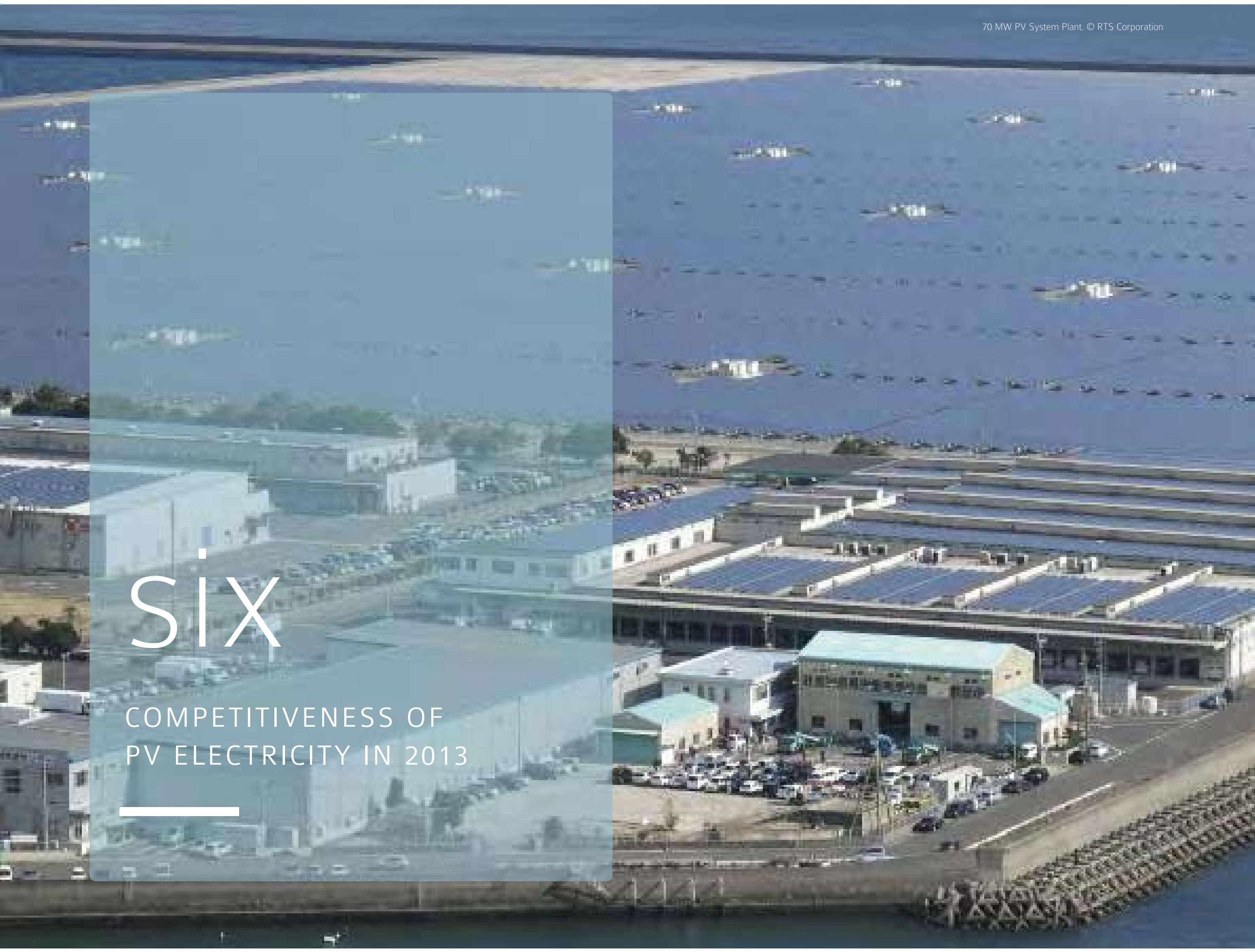
COUNTRY	LABOUR PLACES	DIFFERENCE WITH 2012
AUSTRALIA	11 700	1%
AUSTRIA	4 843	0%
BELGIUM	7 500	-63%
CANADA	5 925	52%
CHINA	N/A	N/A
DENMARK	3 650	-48%
FRANCE	12 130	-33%
GERMANY	60 000	-40%
ITALY	10 000	-39%
JAPAN	101 300	116%
KOREA	N/A	N/A
MALAYSIA	10 667	47%
NORWAY	N/A	N/A
SWEDEN	655	7%
SWITZERLAND	6 400	-26%
USA	142 698	20%

SOURCE IEA PVPS.

FIGURE 19: BUSINESS VALUE OF THE PV MARKET COMPARED TO GDP IN % AND IN MILLION USD



SOURCE IEA PVPS.



70 MW PV System Plant. © RTS Corporation

six

COMPETITIVENESS OF PV ELECTRICITY IN 2013

The fast price decline that PV experienced in the last years opens possibilities to develop PV systems in some locations with limited or no financial incentives. However, the road to full competitiveness of PV systems with conventional electricity sources depends on answering many questions and bringing innovative solutions to emerging challenges.

This section aims at defining where PV stands with regard to its own competitiveness, starting with a survey of system prices in IEA PVPS reporting countries. Given the number of parameters involved in competitiveness simulations, this chapter will mostly highlight the comparative situation in key countries.

SYSTEM PRICES

Reported prices for PV systems vary widely and depend on a variety of factors including system size, location, customer type, connection to an electricity grid, technical specification and the extent to which end-user prices reflect the real costs of all the components. For more detailed information, the reader is directed to each country's national survey report at www.iea-pvps.org.

On average, system prices for the lowest priced off-grid applications are significantly higher than for the lowest priced grid-connected applications. This is attributed to the fact that off-grid systems require storage batteries and associated equipment.

Additional information about the systems and prices reported for most countries can be found in the various national survey reports; excluding VAT and sales taxes. More expensive grid-connected system prices are often associated with roof integrated slates, tiles, one-off building integrated designs or single projects.

SYSTEM PRICES / CONTINUED

In 2013, the lowest system prices in the off-grid sector, irrespective of the type of application, typically ranged from about 2,5 USD/W to 20 USD/W. The large range of reported prices in Table 8 is a function of country and project specific factors. In general, the price range decreased from the previous year.

The lowest achievable installed price of grid-connected systems in 2013 also varied between countries as shown above. The average price of these systems is tied to the segment. Large grid-connected installations can have either lower system prices depending on the economies of scale achieved, or higher system prices where the nature of the building integration and installation, degree of innovation, learning costs in project management and the price of custom-made modules may be considered as quite significant factors. In summary, system prices continued to go down in 2013, in spite of module prices stagnation, through a decrease in soft costs and margins, but the highest prices went down faster than the lowest ones. Prices below 1,3 USD/W are now common for large-scale installations.

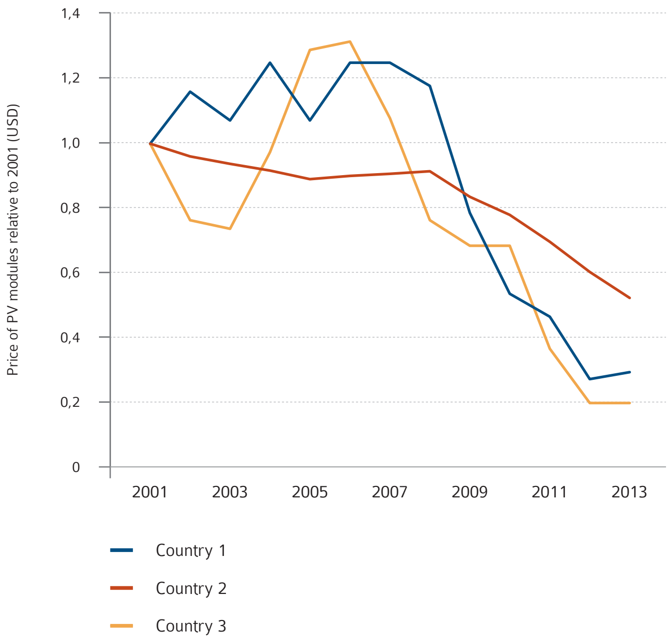
TABLE 8: INDICATIVE INSTALLED SYSTEM PRICES IN IEA PVPS REPORTING COUNTRIES IN 2013

	OFF-GRID (LOCAL CURRENCY AND USD PER W)				GRID-CONNECTED (LOCAL CURRENCY AND USD PER W)							
	<1 kW		>1 kW		RESIDENTIAL		COMMERCIAL		INDUSTRIAL		GROUND-MOUNTED	
COUNTRY	LOCAL CURRENCY/W	USD/W	LOCAL CURRENCY/W	USD/W	LOCAL CURRENCY/W	USD/W	LOCAL CURRENCY/W	USD/W	LOCAL CURRENCY/W	USD/W	LOCAL CURRENCY/W	USD/W
AUSTRALIA	5 TO 10	4,8 TO 9,7	5 TO 15	4,8 TO 14,5	2,5 TO 3,5	2,4 TO 3,4	2 TO 4	1,9 TO 3,9	2 TO 4	1,9 TO 3,9	1,5-2,5	1,56 TO 2,59
AUSTRIA	5	6,7	5	6,7	1,93	2,7	< 1,55	< 2	N/A	-	N/A	-
BELGIUM	N/A	-	N/A	-	1,8	2,4	1,4	1,8	1,1	1,5	N/A	-
CANADA	N/A	-	N/A	-	3,44	2,9	3,27	3	3,27	3	2,88	2,62
CHINA[1]							1,2	1,6				
DENMARK	15 TO 30	2,7 TO 5,3	30 TO 55	5,3 TO 9,8	15 TO 25	1,8 TO 4,5	10 TO 25	1,7 TO 4,4	10 TO 15	1,7 TO 2,6	8 TO 10	1,4 TO 1,8
FRANCE	10 TO 15	13,3 TO 20	N/A	-	3,3 TO 3,7	4,4 TO 4,9	1,8 TO 3,3	2,4 TO 2,7	N/A	-	1,4 TO 1,6	1,80 TO 2,07
GERMANY	N/A	-	N/A	-	1,8 TO 2,03	2,3 TO 2,6	1,46-1,8	1,9 TO 2,3	N/A	-	N/A	-
ISRAEL	N/A	-	N/A	-	13	3,6	5,78 TO 7,94	1,6 TO 2,2	N/A	-	N/A	-
ITALY	3 TO 5	4 TO 6,7	N/A	-	2 TO 2,4	2,7 TO 3,2	1,2 TO 2	1,6 TO 2,7	N/A	-	1 TO 1,4	1,3 TO 1,8
JAPAN	N/A	-	N/A	-	413	3,9	369	3,44	342	3,2	275	2,6
KOREA[1]					2,3 TO 3,1	2,9 TO 3,9	1,8 TO 2,3	2,3 TO 2,9				
MALAYSIA	N/A	-	N/A	-	7,5	2,38	7,1	2,18	6,85	2,12	6,28	1,94
NETHERLANDS[1]					1,3 TO 1,4	1,68 TO 1,74	1,15 TO 1,20	1,47 TO 1,55				
NORWAY	N/A	-	N/A	-	21	3,28	18	2,81	15	2,34	12	1,88
SPAIN	5	6,5	4	5,18	2,4	3,11	1,7	2,2	1,4	1,81	1,2	1,56
SWEDEN	27	3,79	N/A	-	16	2,25	14	1,97	14	1,97	13	1,83
SWITZERLAND	8 TO 15	8,6 TO 16	6 TO 12	6,5 TO 13	3 TO 4,5	3,2 TO 4,9	2,1 TO 3,3	2,3 TO 3,6	2,1	2,3	N/A	-
THAILAND	N/A	-	162,8[2]	5	79	2	60	1,9	55	1,71	60 TO 100	1,9 TO 3,1
USA	N/A	-	N/A	-	4,59	4,59	3,57	3,57	N/A	-	1,96	1,96

NOTE:
1 FOR CHINA, KOREA AND NETHERLANDS 2012 PRICES HAVE BEEN CONSIDERED.
2 INCLUDING BATTERY AND OTHER BOS

SOURCE IEA PVPS.

FIGURE 20: EVOLUTION OF PV MODULES PRICES IN 3 INDICATIVE COUNTRIES (NORMALIZED TO 2001, IN USD)



SOURCE IEA PVPS.

MODULE PRICES

On average, the price of PV modules in 2013 (shown in Table 9) accounted for approximately 45% of the lowest achievable prices that have been reported for grid-connected systems. In 2013, the lowest price of modules in the reporting countries was about 0,52 USD/W. While many believe such a price is below the production cost, most reporting countries recorded lower average module prices than in 2012. Most countries reported module prices less than 1 USD/W. After having experienced prices so low that many companies lost money in 2012, PV modules prices stabilized and even slightly increased in 2013. Figure 20 shows the evolution of normalized prices for PV modules in selected key markets. Figure 21 shows the trends in actual prices of modules and systems in selected key markets. It shows that while module price stagnated in 2013, system prices continued to go down, at a slower pace.

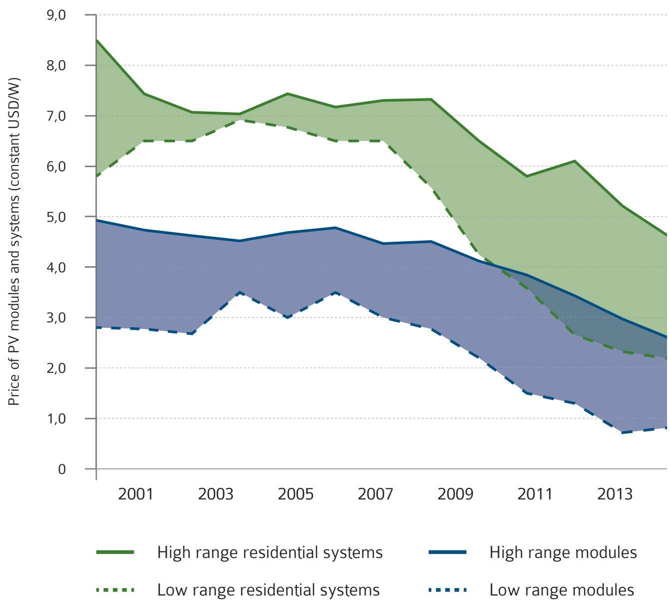
TABLE 9: INDICATIVE MODULE PRICES (NATIONAL CURRENCY AND USD PER WATT) IN SELECTED REPORTING COUNTRIES

COUNTRY	CURRENCY	NATIONAL CURRENCY/W	USD/W
AUSTRALIA	AUD	0,5 TO 0,75	0,5 TO 0,72
AUSTRIA	EUR	0,54 TO 0,75	0,72 TO 1,0
CANADA	CAD	0,95	0,92
DENMARK	DKK	5 TO 10	0,89 TO 1,78
FRANCE[1]	EUR	0,72	0,96
GERMANY	EUR	0,69	0,92
ISRAEL	NIS	2,16 TO 2,53	0,60 TO 0,70
ITALY	EUR	0,50 TO 0,65	0,67 TO 0,87
JAPAN	JPY	242	2,48
KOREA[1]	KRW	800 TO 1 000	0,73 TO 0,91
MALAYSIA	MYR	6	1,91
NETHERLANDS[1]	EUR	1,04	1,39
SPAIN	EUR	0,55	0,73
SWEDEN	SEK	10	1,54
SWITZERLAND	CHF	0,80 TO 1	0,86 TO 1,08
USA	USD	0,65 TO 0,82	0,65 TO 0,82

NOTE:
1 MODULE PRICES REFER TO 2012. RED = LOWEST PRICE. GREEN = HIGHEST PRICE.

SOURCE IEA PVPS.

FIGURE 21: EVOLUTION OF PRICE OF PV MODULES AND SMALL-SCALE SYSTEMS IN SELECTED REPORTING COUNTRIES - YEARS 2001-2013 (2013 USD/W)



SOURCE IEA PVPS.

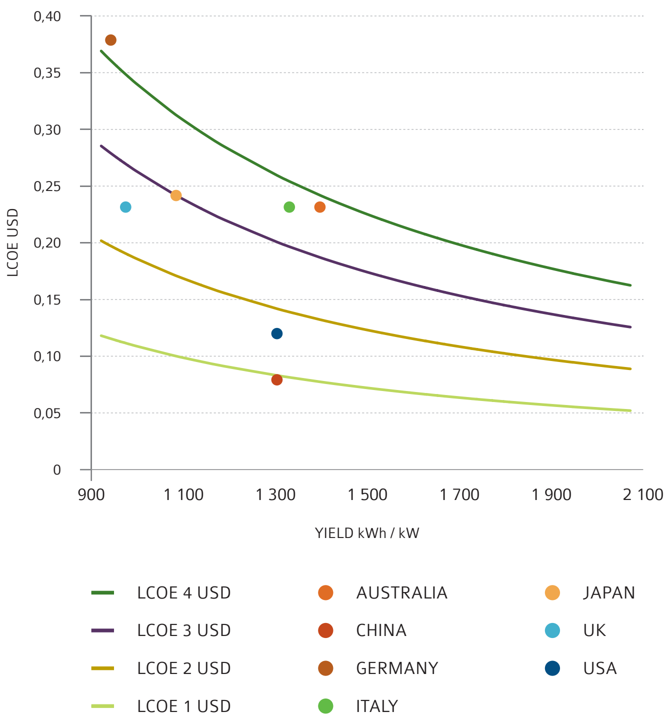
SYSTEM PRICES / CONTINUED

COST OF PV ELECTRICITY

In order to compete in the electricity sector, PV technologies need to provide electricity at a cost equal to or below the cost of other technologies. Obviously, power generation technologies are providing electricity at different costs, depending on their nature, the cost of fuel, the cost of maintenance and the number of operating hours during which they are delivering electricity.

The competitiveness of PV can be defined simply as the moment when, in a given situation, **PV can produce electricity at a cheaper price than other sources of electricity that could have delivered electricity at the same time**. Therefore the competitiveness of a PV system is linked to the location, the technology, the cost of capital, and the cost of the PV system itself that highly depends on the nature of the installation and its size. However, it will also depend on the environment in which the system will operate. Off-grid applications in competition with diesel-based generation won't be competitive at the same moment as a large utility-scale PV installation competing with the wholesale prices on electricity markets. The competitiveness of PV is connected to the kind of PV system and its environment.

FIGURE 22: LCOE OF PV ELECTRICITY (USD) AS A FUNCTION OF SOLAR IRRADIANCE (kWh/kW/YEAR) & RETAIL PRICES IN 10 MAJOR MARKETS



SOURCE IEA PVPS.

GRID PARITY – SOCKET PARITY

Grid Parity (or Socket Parity) refers to the moment when PV can produce electricity (the Levelised Cost Of Electricity or LCOE) at a price below the price of electricity. While this is valid for pure players (the so-called "grid price" refers to the price of electricity on the market), this is based on two assumptions for *prosumers* (producers who are also consumers of electricity):

- That 100% of PV electricity can be consumed locally (either in real time or through some compensation scheme such as net-metering);
- That all the components of the retail price of electricity can be compensated.

However, it is assumed that the level of Self-consumption that can be achieved with a system that provides up to the same amount of electricity on a yearly basis as the local annual electricity consumption, varies between less than 30% (residential applications) and 100% (for some industrial applications) depending on the country and the location.

Technical solutions will allow for increases in the Self-consumption level (demand-side management, local storage, reduction of the PV system size, etc.).

If only a part of the electricity produced can be Self-consumed, then the remaining part must be injected into the grid, and should generate revenues of the same order as any production of electricity. Today this is often guaranteed for small size installations by the possibility of receiving a FiT for the injected electricity. Nevertheless, if we consider how PV could become competitive, this will imply defining a way to price this electricity so that smaller producers will receive fair revenues.

The second assumption implies that the full retail price of electricity could be compensated. The price paid by electricity consumers is composed in general of three main components:

- the procurement price of electricity on electricity markets plus the margins of the reseller;
- grid costs and fees, partially linked to the consumption partially fixed;
- taxes.

If the electricity procurement price can be obviously compensated, the two other components require considering the system impact of such a measure; with tax loss on one side and the lack of financing of distribution and transmission grids on the other. While the debate on taxes can be simple, since PV installations are generating taxes as well, the one on grid financing is more complex. Even if self-consumed electricity could be fully compensated, alternative ways to finance the grid should be considered given the loss of revenues for grid operators or a better understanding of PV positive impacts on the grid should be achieved.

COMPETITIVENESS OF PV ELECTRICITY WITH WHOLESALE ELECTRICITY PRICES

In countries with an electricity market, wholesale electricity prices at the moment when PV produces are one benchmark of PV competitiveness. These prices depend on the market organisation and the technology mix used to generate electricity. In order to be competitive with these prices, PV electricity will have to be generated at the lowest possible price. This will be achieved with large utility-scale PV installations that allow reaching the lowest system prices today with low maintenance costs and a low cost of capital. The influence of PV electricity on the market price is not yet precisely known and could represent an issue in the medium to long term.

FUEL-PARITY AND OFF-GRID SYSTEMS

Off-grid systems including hybrid PV/diesel can be considered as competitive when PV electricity can provide electricity at a cheaper cost than the conventional generator. For some off-grid applications, the cost of the battery bank and the charge controller should be considered in the upfront and maintenance costs while a hybrid system will consider the cost of fuel saved by the PV system.

The point at which PV competitiveness will be reached for these hybrid systems takes into account fuel savings due to the reduction of operating hours of the generator. Fuel-parity refers to the moment in time when the installation of a PV system can be financed with fuel savings only. It is assumed that PV has reached fuel-parity based on fuel prices in numerous Sunbelt countries.

Other off-grid systems are often not replacing existing generation sources but providing electricity in places with no network and no or little use of diesel generators. They represent a completely new way to provide electricity to hundreds of millions of people all over the world.

COMMENTS ON GRID PARITY AND COMPETITIVENESS

Finally, the concept of Grid Parity remains an interesting benchmark but shouldn't be considered as the moment when PV is competitive by itself in a given environment. On the contrary, it shows how complex the notion of competitiveness can be and how it should be treated with caution. Countries that are approaching competitiveness are experiencing such complexity. Germany, Italy or Denmark for instance have retail electricity prices that are above the LCOE of a PV system. But considering the Self-consumption and grid constraints, they haven't reached competitiveness yet. For these reasons, the concept of Grid Parity should be used with caution and should take into consideration all necessary parameters. Finally, PV remains an investment like many others. The relatively high level of certainty during a long period of time shouldn't hide the possible failures and incidents. Hedging such risks has a cost in terms of insurance and the expected return on investment should establish itself at a level that comprises both the low project risk (and therefore the low expected return) as well as hedging costs.


Aspen Skiing Co., PV system at Aspen Mountain Ski Resort. © NREL

seven

PV IN THE POWER SECTOR

PV ELECTRICITY PRODUCTION

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. For these reasons, the electricity production from PV per country that is showed here is an estimate.

How much electricity can be produced by PV in a defined country?

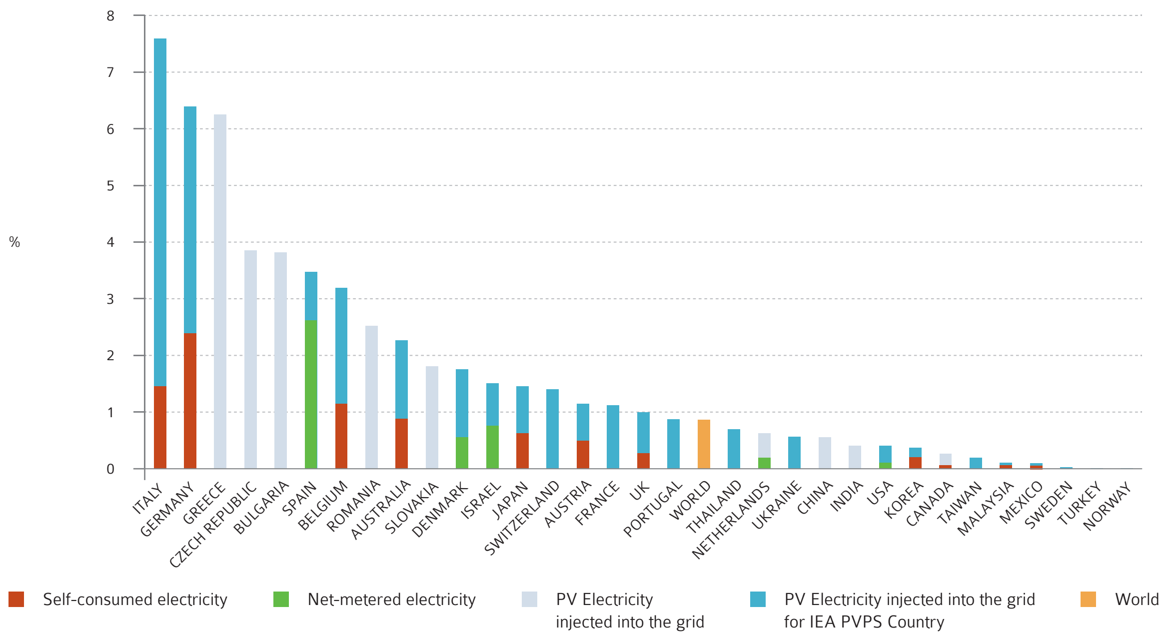
- Estimated PV installed and commissioned capacity on 31-12-2013
- Average theoretical PV production in the capital city of the country (using solar irradiation databases: JRC's PVGIS, SolarGIS, NREL's PVWATT or, when available, country data)
- Electricity demand in the country based on the latest available data.

Figure 23 shows how PV theoretically contributes to the electricity demand in IEA PVPS countries, based on the PV base at end 2013.

Italy remains the number one country with close to 8% of its electricity that will come from PV in 2014 based on 2013 installations. This number can be translated into 15 to 16% of the peak electricity demand. In Germany with more than 6,3%, the 36 GW installed in the country produce up to 50% of the instantaneous power demand on some days, and around 13% of the electricity during the peak periods.

Three countries outside the IEA PVPS network have the ability to produce more than 3% of their electricity demand: Greece (that will most probably be around 6% based on the 2013 installed capacity), Bulgaria and the Czech Republic. Belgium is producing 3,5% of its electricity thanks to PV and Spain remains below the 4% mark. Romania and Australia are above the 2% mark. Slovakia and Denmark are approaching the 2% mark, while Israel, Japan, Switzerland, Austria, France and the UK have passed the 1% mark. Many other countries have lower production numbers.

FIGURE 23: PV CONTRIBUTION TO THE ELECTRICITY DEMAND IN 2013



SOURCE IEA PVPS.

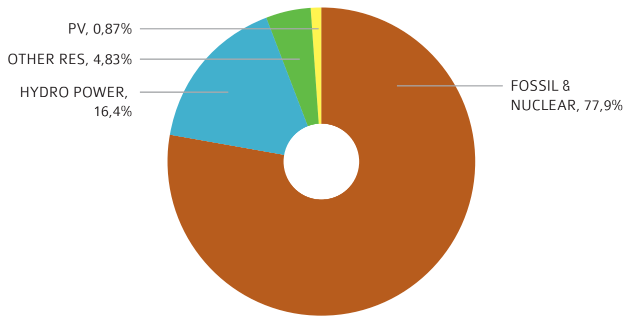
PV ELECTRICITY PRODUCTION / CONTINUED

GLOBAL PV ELECTRICITY PRODUCTION

With around 140 GW installed all over the world, PV could produce around 165 TWh of electricity on a yearly basis. With the world's electricity consumption at 19 000 TWh in 2012, this represents 0,87%. Figures 24 and 25 (source: REN21 and IEA PVPS) compare this number to other electricity sources, and especially renewables.

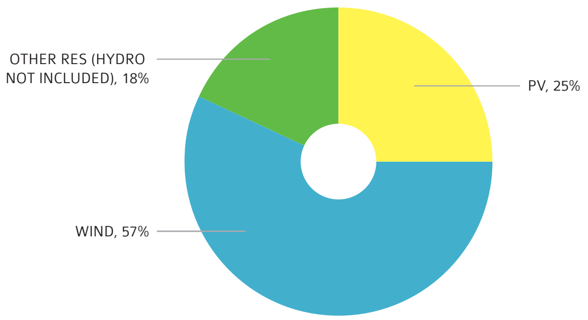
PV represents 25% of the world's installed capacity of renewables, excluding hydropower. In the last twelve years in Europe, PV's installed capacity ranked third with 82 GW installed according to the European Photovoltaic Industry Association, after gas (103 GW) and wind (105 GW), ahead of all other electricity sources, while conventional coal and nuclear were decommissioned. This translated in 2013 into more than 25% of the European electricity demand being covered by renewables (including hydro).

FIGURE 24: SHARE OF PV IN THE GLOBAL ELECTRICITY DEMAND



SOURCE REN21, IEA PVPS.

FIGURE 25: SHARE OF PV IN THE TOTAL RES INSTALLED CAPACITY (GW) IN 2013



SOURCE REN21, IEA PVPS.

The trend is not so different outside of Europe; For instance, Japan installed around 7,4 GW of new power generation capacity in 2013, out of which 6,9 GW was from PV. In Australia, 1,3 GW of power generation capacity were installed in 2013, out of which 62% were PV systems.

In 2013, China installed more renewables capacities than conventional sources for the very first time. The same trend could be seen in the USA until 2012, but the lack of Wind installations in 2013 pushed renewables to around the 40% mark, with 6 GW out of 15 GW of all new power generation capacities.

TABLE 10: PV ELECTRICITY STATISTICS IN IEA PVPS REPORTING COUNTRIES

COUNTRY	FINAL ELECTRICITY CONSUMPTION (TWH)	HABITANTS (MILLION)	NOMINAL GDP (BILLION USD)	SURFACE (KM^2)	PV INSTALLATIONS IN 2013 (MW)	PV INSTALLED CAPACITY (MW)	PV ELECTRICITY PRODUCTION (TWH)	2013 INSTALLATIONS PER HABITANT (W/HAB)	TOTAL CAPACITY PER HABITANT (W/HAB)	TOTAL CAPACITY PER KM^2 (KW/KM^2)	DEMAND ELECTRICITY (%)
AUSTRALIA	199	23	1 379	7 692 024	811	3 226	4,5	35,1	139,5	0,4	2,3%
AUSTRIA	56	8	418	83 879	263	626	0,6	31,0	73,9	7,5	1,1%
BELGIUM	82	11	514	30 528	237	3 009	2,9	21,1	268,8	98,6	3,5%
BULGARIA	33	7	54	110 879	10	1 020	1,3	1,4	140,5	9,2	3,8%
CANADA	530	35	1 736	9 984 670	445	1 210	1,4	12,6	34,4	0,1	0,3%
CHINA	4 600	1 357	7 318	9 596 961	12,920	19 720	25,6	9,5	14,5	2,1	0,6%
DENMARK	32	6	334	43 094	156	563	0,6	27,7	100,3	13,1	1,8%
FRANCE	464	66	2 773	640 294	643	4 733	5,2	9,7	71,7	7,4	1,1%
GERMANY	525	81	3 601	357 114	3,305	35 700	33,4	41,0	442,8	100,0	6,4%
ISRAEL	46	8	243	22 072	244	481	0,7	30,3	59,6	21,8	1,5%
ITALY	317	60	2 194	301 336	1,620	18 074	24,0	27,1	302,1	60,0	7,6%
JAPAN	979	127	5 867	377 930	6,968	13 599	14,3	54,7	106,8	36,0	1,4%
KOREA	475	50	1 116	99 828	445	1 475	1,9	8,9	29,4	14,8	0,4%
MALAYSIA	119	30	288	330 803	48	73	0,1	1,6	2,5	0,2	0,1%
MEXICO	234	122	1 153	1 964 375	60	112	0,2	0,5	0,9	0,1	0,1%
NETHERLANDS	109	17	836	37 354	360	723	0,7	21,4	43,0	19,3	0,6%
NORWAY	117	5	486	323 782	1	11	0,0	0,1	2,1	0,0	0,0%
PORTUGAL	48	10	237	92 090	53	281	0,4	5,1	26,9	3,1	0,9%
SPAIN[1]	234	47	1 477	505 992	102	4 640	7,4	2,2	99,5	9,2	3,2%
SWEDEN	140	10	540	450 295	19	43	0,0	2,0	4,5	0,1	0,0%
SWITZERLAND	59	8	659	41 277	323	756	0,8	40,0	93,5	18,3	1,4%
THAILAND	162	67	346	513 120	437	824	1,1	6,5	12,3	1,6	0,7%
TURKEY	243	75	775	783 562	6	18	0,0	0,1	0,2	0,0	0,0%
UK	329	64	2 445	242 900	1,546	3 377	3,3	24,1	52,7	13,9	1,0%
USA	3 889	316	14 990	9 371 175	4,751	12 079	15,7	15,0	38,2	1,3	0,4%

NOTE:
1 DATA FOR SPAIN PV INSTALLED CAPACITY ARE IN MW-AC

SOURCE IEA PVPS, EPIA.

UTILITIES INVOLVEMENT IN PV

In this section, the word "Utilities" will be used to qualify electricity producers and retailers. In some parts of the world, especially in Europe, the management of the electricity network is now separated from the electricity generation and selling business. This section will then focus on the role of electricity producers and retailers in developing the PV market.

In **Europe**, the involvement of utilities in the PV business remains quite heterogeneous, with major differences from one country to another. In **Germany**, where the penetration of PV provides already more than 6% of the electricity demand, the behaviour of utilities can be seen as a mix of an opposition towards PV development and attempts to take part in the development of this new business. Companies such as E.ON have established subsidiaries to target the PV on rooftop customers but are delaying the start of their commercial operations. In **France**, EDF, the main utility in the country has set-up a subsidiary that develops utility-scale PV plants in Europe and North America. Mid 2014, EDF-EN owned some 700 MW of PV systems. In addition, another subsidiary of EDF, EDF-ENR took over the integrated producer of PV modules, Photowatt, present along the whole value chain and restarted its activities. The same subsidiary offers PV systems for small rooftop applications, commercial, industrial and agricultural applications. Two other major French energy actors are present in the PV sector: GDF Suez, the French gas and engineering company develops utility-scale PV plants while Total, the French oil and gas giant, has acquired SunPower and merged its activities.

In **Italy**, the main utility owns a RES-focused subsidiary, ENEL GREEN POWER, which invests and builds utility-scale PV power plants all over the world, including in its home country. At the end of 2013, EGP had around 300 MW of PV power plants in operation. In addition, it produces amorphous silicon PV modules through a joint venture with Sharp and STMicroelectronics in Italy.

In several European countries, small local utilities are taking a positive approach towards the development of PV, as in **Sweden** or **Switzerland**. In **Denmark**, EnergiMidt made use of capital incentives for a couple of years for its customers willing to deploy PV.

In **Japan**, utilities are engaging into the development of PV systems across the country and have started using PV in their own facilities.

In **Canada**, the Calgary Utility developed its Generate Choice Programme where it offers customers a selection of pricing programmes for 1,3 kW systems or more. In Ontario, several utilities are offering solar installations and maintenance programmes for their customers. Roof leasing exists in parallel to the offering of turnkey solutions. Utility involvement offers them a better control on the distribution systems that they operate and the possibility to offer additional services to their customers.

In the **USA**, in addition to similar offerings, some utilities are starting to oppose PV development, and especially the net-metering system. In Arizona and California, the debate was quite intense in 2013, concerning the viability of net-metering schemes for PV. But utilities are also sizing opportunities for business and are starting to offer products or to develop PV plants themselves.

In **Australia**, the fast development of PV has raised concerns about the future business model of utilities. Established generators are losing market share, especially during the daytime peak load period where electricity prices used to be quite high. However, the two largest retailers have stepped into the PV business, capturing significant market share.

In addition to conventional utilities, large PV developers could be seen as the utilities of tomorrow; developing, operating and trading PV electricity on the markets. A simple comparison between the installed capacity of some renewable energy developers and conventional utilities shows how these young companies have succeeded in developing many more plants than older companies.

SURVEY METHOD Key data for this publication were drawn mostly from national survey reports and information summaries, which were supplied by representatives from each of the reporting countries. These national survey reports can be found on the website www.iea-pvps.org. Information from the countries outside IEA PVPS are drawn from a variety of sources and, while every attempt is made to ensure their accuracy, the validity of some of these data cannot be assured with the same level of confidence as for IEA PVPS member countries.

CONCLUSION – A BRIGHT AND CHALLENGING FUTURE AHEAD

The year 2013 experienced a renewed growth of the PV market and for the first time in a decade, the loss of European leadership. With less than 30% of the market located in Europe and Asia becoming the clear market and industry leader, PV enters into a new era. The top three markets in 2013 were located outside of Europe, with China taking the lead, followed by Japan and the USA.

This trend should be confirmed in 2014, with Asia becoming the core of the PV market, followed by Europe and the Americas. It becomes clear that in the short term, all continents should see PV development. It is important to note that new markets spots have popped up in Chile and South Africa and this shall also aid in driving the PV market to new heights.

In Asia, next to China and Japan, Thailand, Korea, Taiwan and of course India are starting or continuing to develop. However, Indonesia, the Philippines and many other countries will appear soon on the Asian PV map. The Americas are following at a slower pace, with Latin America starting to engage in PV development in Mexico, Peru, Brazil and of course Chile, the number one market in the region.

The price decrease that has been experienced in 2011 and 2012 continued at a slower pace in 2013. It has brought several countries and market segments close to a certain level of competitiveness. This is true in Germany or Italy, where the retail price of electricity in several consumers segments is now higher than the PV electricity's production cost. This is true in several other countries for utility-scale PV or hybrid systems. These declining prices are opening new business models for PV deployment. PV is more and more seen as a way to produce electricity locally rather than buying it from the grid. Self-consumption opens the door for the large deployment of PV on rooftops, and the transformation of the electricity system in a decentralized way. In parallel, large scale PV continued to progress, with plant announcements well above 300 MW. The largest one opened in 2013 in China with 320 MW and the second one in the USA with 250 MW. Each year, larger plants are connected to the grid and plans for even bigger plants are being disclosed. However, PV is not only on the rise in developed countries, it also offers adequate products to bring electricity in places where grids are not yet developed. The decline of prices for off-grid systems offers new opportunities to electrify millions of people around the world who never benefited from it before.

The challenges are still numerous before PV can become a major source of electricity in the world: The way how distribution grids could cope with high shares of PV electricity, generation adequacy and balancing challenges in systems with high shares of variable renewables, and the cost of transforming existing grids will be at the cornerstone of PV deployment in the coming years. Moreover, the ability to successfully transform electricity markets to integrate PV electricity in a fair and sustainable way will have to be scrutinized.

Finally, the ability of the PV industry to lower its costs in the coming years and to present innovative products gives little doubt. The price of PV electricity will continue to decline and its competitiveness increases. The quest for PV installation quality will continue and will improve PV system reliability together with lowering the perceived risk of owning and maintaining PV power plants.

The road to PV competitiveness is open but remains complex and linked to political decisions. Nevertheless, the assets of PV are numerous and as seen in this edition of the IEA PVPS Trends report, the appetite for PV electricity grows all over the world. The road will be long before PV will represent a major source of electricity in most countries, but as some European countries showed in the last years, PV has the ability to continue progressing fast.

ANNEXES

WHAT IS THE IEA PVPS?

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organisation for Economic Cooperation and Development (OECD). The IEA carries out a comprehensive programme of energy cooperation among its 29 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 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.

EXCHANGE RATES

Currencies are either presented as the current national currency (where it is considered that the reader will receive most benefit from this information) or as euros (EUR) and/or US dollars (USD) (where direct comparisons between countries' information is of interest). Care should be taken when comparing USD figures in this report with those in previous reports because of exchange rate movements. The exchange rates used for the conversions are given at the end of this report.

SYMBOLS, ABBREVIATIONS AND DEFINITIONS

Standard ISO symbols and abbreviations are used throughout this report. The electrical generation capacity of PV modules is given in watts (W). This represents the rated power of a PV device under standard test conditions of 1 000 $W \cdot m^2$ irradiance, 25°C cell junction temperature and solar reference spectrum AM 1,5.

The term PV system includes the photovoltaic modules, inverters and all associated mounting and control components as appropriate. Supply chain refers to the procurement of all required inputs, conversion into finished PV products, distribution and installation of these products for final customers. The value chain looks at how increased customer value can be created across a company's business activities, which can include design, production, marketing, delivery and support functions.

ANNEX 1: CUMULATIVE INSTALLED PV POWER (MW) FROM 1992 TO 2013

COUNTRY	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
IEA PVPS COUNTRIES																						
AUSTRALIA	7,3	8,9	10,7	12,7	15,9	18,7	22,5	25,3	29,2	33,6	39,1	45,6	52,3	60,6	70,3	82,5	104,5	187,6	570,9	1376,8	2 415,0	3 226,0
AUSTRIA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	34,9	21,1	24,0	25,6	28,7	32,4	52,6	95,5	187,2	362,9	626,0
BELGIUM	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	23,7	108,4	649,0	1 067,2	2 087,8	2 772,4	3 009,0
CANADA	1,0	1,1	1,5	1,9	2,6	3,4	4,5	5,8	7,2	8,8	10,0	11,8	13,9	16,8	20,5	25,8	32,7	94,6	281,1	558,3	766,0	1 210,5
CHINA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	19,0	23,5	42,0	52,1	62,1	69,9	79,9	99,9	139,9	299,9	799,9	3 299,9	6 799,9	19 719,9
DENMARK	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,6	1,9	2,3	2,7	2,9	3,1	3,2	4,6	7,1	16,7	407,5	563,1
FRANCE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	26,0	36,5	74,5	178,9	369,2	1 204,3	2 974,4	4 089,6	4 732,7
GERMANY	2,9	4,3	5,6	6,7	10,3	16,5	21,9	30,2	89,4	206,5	323,6	473,0	1 139,4	2 071,6	2 918,4	4 195,1	61 53,1	9 959,0	17 372,2	24 857,5	32 461,6	35 765,5
ISRAEL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,8	24,3	69,9	189,5	236,2	480,6
ITALY	8,5	12,1	14,1	15,8	16,0	16,7	17,7	18,5	19,0	20,0	22,0	26,0	30,7	37,5	50,0	120,2	458,3	1 181,3	3 502,3	12 806,9	16 454,3	18 074,0
JAPAN	19,0	24,3	31,2	43,4	59,6	91,3	133,4	208,6	330,2	452,8	636,8	859,6	1 132,0	1 421,9	1 708,5	1 918,9	2 144,2	2 627,2	3 618,1	4 913,9	6 631,7	13 599,2
KOREA	0,0	0,0	1,7	1,8	2,1	2,5	3,0	3,5	4,0	4,7	10,0	11,0	13,8	19,2	41,8	87,2	362,8	529,7	656,3	735,2	1 030,3	1 475,3
MALAYSIA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,8	1,1	1,5	2,5	25,0	73,3
MEXICO	0,0	0,0	8,8	9,2	10,0	11,0	12,0	12,9	13,9	15,0	16,2	17,1	18,2	18,7	19,7	20,7	21,7	25,0	30,6	40,1	52,4	112,4
NETHERLANDS	0,0	0,1	0,1	0,3	0,7	1,0	1,0	5,3	8,5	16,2	21,7	39,7	43,4	45,4	47,5	48,6	52,8	63,9	84,7	142,7	362,7	722,8
NORWAY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,6	6,9	7,3	7,7	8,0	8,3	8,7	9,1	9,5	10,0	10,6
PORTUGAL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0	2,0	2,0	4,0	15,0	56,0	99,0	135,0	169,0	228,0	281,0
SPAIN[1]	0,0	0,0	1,0	1,0	1,0	1,0	1,0	2,0	2,0	4,0	7,0	11,5	24,1	49,0	148,0	705,0	3 463,0	3 523,0	3 915,0	4 260,0	4 538,0	4 640,0
SWEDEN	0,8	1,1	1,3	1,6	1,8	2,1	2,4	2,6	2,8	3,0	3,3	3,6	3,9	4,2	4,9	6,3	7,9	8,8	11,5	15,8	24,1	43,2
SWITZERLAND	4,7	5,8	6,7	7,5	8,4	9,7	11,5	13,4	15,3	17,6	19,5	21,0	23,1	27,1	29,7	36,2	47,9	73,6	110,8	210,9	437,0	756,0
THAILAND	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,9	4,2	10,8	23,9	30,5	32,5	33,4	43,2	49,2	242,7	387,6	823,8
TURKEY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,3	0,6	1,0	1,5	2,0	2,5	3,0	3,7	4,7	5,7	6,7	11,7	17,7
UK	0,0	0,1	0,1	0,2	0,2	0,4	0,5	0,9	1,9	2,9	3,9	5,9	7,9	10,9	13,9	17,9	23,9	30,9	92,9	905,9	1 830,9	3 376,9
USA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	111,0	190,0	295,0	455,0	753,0	1 188,0	2 040,0	3 959,0	7 328,0	12 079,0
TOTAL IEA PVPS	44,2	57,7	82,9	102,1	128,7	174,4	231,4	329,1	542,6	809,0	1 160,3	1 628,5	2 720,3	4 130,6	5 557,7	8 008,4	14 193,7	21 048,6	35 730,9	63 968,8	89 662,7	125 418,2
TOTAL NON IEA PVPS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	16,7	21,1	22,2	35,3	47,3	52,5	60,9	72,0	165,6	628,9	2 582,6	4 037,2	10 180,2	14 377,0
TOTAL	**44,2**	**57,7**	**82,9**	**102,1**	**128,7**	**174,4**	**231,4**	**329,1**	**559,3**	**830,1**	**1 182,5**	**1 663,9**	**2 767,6**	**4 183,1**	**5 618,6**	**8 080,4**	**14 359,2**	**21 677,5**	**38 313,5**	**68 006,0**	**99 842,9**	**139 795,2**

NOTE:
1 DATA FOR SPAIN ARE IN AC.

SOURCE IEA PVPS, EPIA.

ANNEX 2: ANNUAL INSTALLED PV POWER (MW) FROM 1992 TO 2013

COUNTRY	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
IEA PVPS COUNTRIES																						
AUSTRALIA	7,3	1,6	1,8	2,0	3,2	2,8	3,8	2,8	3,9	4,4	5,6	6,5	6,7	8,3	9,7	12,2	22,0	83,1	383,3	805,9	1 038,2	811,0
AUSTRIA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	4,0	7,0	7,6	3,0	1,6	3,1	3,7	22,0	42,9	91,7	175,7	263,1
BELGIUM	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	23,7	84,7	540,6	418,3	1 020,6	684,6	236,5
CANADA	1,0	0,1	0,4	0,4	0,7	0,8	1,1	1,4	1,3	1,7	1,2	1,8	2,1	2,9	3,7	5,3	6,9	61,9	186,6	277,2	268,7	444,5
CHINA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	19,0	4,5	18,5	10,1	10,0	7,8	10,0	20,0	40,0	160,0	500,0	2 500,0	3 500,0	12 920,0
DENMARK	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	4,2	7,0	5,1	0,4	0,2	0,2	0,1	1,4	2,5	9,6	390,8	155,6
FRANCE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	7,1	7,0	10,9	37,6	104,4	191,3	835,1	1 770,1	1 115,2	643,1
GERMANY	2,9	1,4	1,3	1,1	3,6	6,2	5,4	8,3	59,2	117,1	117,0	149,4	666,4	932,2	846,7	1 276,8	1 958,0	3 805,9	7 413,3	7485,2	7 604,2	3 303,9
ISRAEL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	21,5	45,6	1 19,6	46,7	244,4
ITALY	8,5	3,6	2,0	1,7	0,2	0,7	1,0	0,8	0,5	1,0	2,0	4,0	4,7	6,8	12,5	70,2	338,1	723,4	2 322,0	9 304,6	3 647,4	1 619,7
JAPAN	19,0	5,3	7,0	12,1	16,3	31,7	42,1	75,2	121,6	122,6	184,0	222,8	272,4	289,9	286,6	210,4	225,3	483,0	991,0	1 295,8	1 717,7	6 967,5
KOREA	0,0	0,0	1,7	0,1	0,3	0,4	0,5	0,5	0,5	0,7	0,7	0,6	2,6	5,0	22,3	45,3	275,7	166,8	126,7	78,8	230,0	445,0
MALAYSIA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,1	0,3	0,5	1,0	22,5	48,3
MEXICO	0,0	0,0	8,8	0,4	0,8	1,0	1,0	0,9	1,0	1,0	1,2	1,0	1,0	0,5	1,0	1,0	1,0	3,3	5,6	9,5	12,0	60,0
NETHERLANDS	0,0	0,1	0,1	0,2	0,4	0,3	0,0	4,3	3,2	7,7	5,5	18,0	3,7	2,0	2,1	1,1	4,2	11,1	20,8	58,0	220,0	360,1
NORWAY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,6	0,3	0,4	0,4	0,3	0,4	0,3	0,4	0,4	0,5	0,6
PORTUGAL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0	0,0	0,0	2,0	11,0	41,0	43,0	36,0	34,0	59,0	53,0
SPAIN[2]	0,0	0,0	1,0	0,0	0,0	0,0	0,0	1,0	0,0	2,0	3,0	4,5	12,6	24,9	99,0	557,0	2 758,0	60,0	392,0	345,0	278,0	102,0
SWEDEN	0,8	0,2	0,3	0,3	0,2	0,3	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,4	0,6	1,4	1,7	0,9	2,7	4,4	8,3	19,1
SWITZERLAND	4,7	1,1	0,9	0,8	0,9	1,3	1,8	1,9	1,9	1,2	4,1	7,2	5,1	4,0	2,7	6,5	12,1	25,7	37,2	104,1	226,3	319,0
THAILAND	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,9	1,3	6,6	13,1	6,6	2,0	0,9	9,8	6,1	193,5	144,9	437,3
TURKEY	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,2	0,3	0,4	0,5	0,5	0,5	0,5	0,7	1,0	1,0	1,0	5,0	6,0
UK	0,0	0,1	0,0	0,1	0,0	0,2	0,1	0,4	1,0	1,0	1,0	2,0	2,0	3,0	3,0	4,0	6,0	7,0	62,0	813,0	925,0	1 546,0
USA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	111,0	79,0	105,0	160,0	298,0	435,0	852,0	1 919,0	3 369,0	4 751,0
TOTAL IEA PVPS	44,2	13,4	25,3	19,1	26,6	45,7	57,0	97,7	213,5	267,3	355,5	452,5	1 127,7	1 390,9	1 427,2	2 450,3	6 185,9	6 858,1	14 683,3	28 241,9	25 754,9	35 757,0
TOTAL NON IEA PVPS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	16,7	4,4	1,1	13,1	11,9	5,0	8,1	10,9	94,5	464,3	1 954,5	1 370,5	3 397,3	4 196,7
TOTAL	**44,2**	**13,4**	**25,3**	**19,1**	**26,6**	**45,7**	**57,0**	**97,7**	**230,2**	**271,7**	**356,5**	**465,6**	**1 139,6**	**1 395,9**	**1 435,3**	**2 461,2**	**6 280,4**	**7 322,4**	**16 637,9**	**29 612,4**	**29 152,2**[1]	**39 957,3**

NOTES:
1 REST OF THE WORLD DATA HAVE BEEN INCORPORATED IN THE CUMULATIVE CAPACITIES ONLY.
2 DATA FOR SPAIN ARE IN AC.

SOURCE IEA PVPS, EPIA.

ANNEX 3: REPORTED PRODUCTION OF PV MATERIALS, CELLS AND MODULES IN 2013 IN SELECTED IEA PVPS COUNTRIES

									MODULE PRODUCTION (MW)		
COUNTRY[1]	SOLAR PV GRADE SI FEEDSTOCK PRODUCTION (TONNES)	SOLAR PV GRADE SI FEEDSTOCK PRODUCTION CAPACITY (TONNES/YEAR)	PRODUCTION OF INGOTS (TONNES)	INGOTS PRODUCTION CAPACITY (TONNES/ YEAR)	PRODUCTION OF WAFERS (MW)	WAFER PRODUCTION CAPACITY (MW/YEAR)	CELL PRODUCTION (ALL TYPES, MW)	CELL PRODUCTION CAPACITY (MW/YEAR)	WAFER BASED (SC-SI & MC-SI)	THIN FILM (A-SI & OTHER)	MODULE PRODUCTION CAPACITY (ALL TYPES, MW/YEAR)
AUSTRALIA									4		60
AUSTRIA	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	74,5		242
CANADA	NA								634		1 121
CHINA[2]	8 200	160 000	-						25 500	500	
DENMARK	NA	NA	NA	NA	NA	NA			12,5		24,5
FRANCE								135			600[3]
GERMANY	46 130	53 980			800	800	1 230	2 440	1 282,5	130	2 735
ITALY			NONE		NONE	NONE	20	40	400		600
JAPAN	> 1 000		5		1 200	1 200	2 992[4]	3 499[5]	2 597[5]	1 012[4]	4 266[4]
KOREA[6]	40 000				1 800	1 800	1 000	1 490	1 700		2 670[5]
MALAYSIA[7]					> 397	> 397		1 585			2 130
NETHERLANDS[6]								135			
NORWAY			450 MW		250	250	NONE		NONE	NONE	
SPAIN							350			75	
SWEDEN	NONE		NONE		NONE	NONE			34		100
SWITZERLAND	NONE		NA		NA	NA			MAX. 50		MAX. 100
THAILAND									120	67	NA
USA	39 988				103	103	478	670	617	371	1 612

NOTES:
1 ALTHOUGH A NUMBER OF IEA PVPS COUNTRIES ARE REPORTING ON PRODUCTION OF FEEDSTOCK, INGOTS AND WAFERS, CELLS AND MODULES, THE PICTURE FROM THE NATIONAL SURVEY REPORTS.
2 PRODUCTION INFORMATION FOR 2013 IS ESTIMATED FIGURE. SOURCE: ANNUAL REPORT 2013.
3 APPROXIMATE FIGURE.
4 SOURCE: JPEA.
5 SOURCE: RTS CORPORATION.
6 PRODUCTION INFORMATION AS OF 2012.
7 SOME MANUFACTURERS WERE UNDER CONSTRUCTION, FINANCING NEGOTIATION OR TRIAL OPEATION OF SI FEEDSTOCK AND INGOT MANUFACTURING IN 2013.

SOURCE IEA PVPS, RTS CORPORATION.

ANNEX 4: AVERAGE 2013 EXCHANGE RATES

COUNTRY	CURRENCY CODE	EXCHANGE RATE (1 USD =)
AUSTRALIA	AUD	1,0
CANADA	CAD	1,0
CHINA	CNY	6,2
DENMARK	DKK	5,6
ISRAEL	NIS	3,6
JAPAN	JPY	97,6
KOREA	KRW	1 095,0
MALAYSIA	MYR	3,1
MEXICO	MXN	12,8
NORWAY	NOK	5,8
SWEDEN	SEK	6,5
SWITZERLAND	CHF	0,93
THAILAND	THB	32,03
UNITED KINGDOM	GBP	0,64
UNITED STATES	USD	1
AUSTRIA, BELGIUM, FRANCE, GERMANY, ITALY, THE NETHERLANDS, PORTUGAL, SPAIN	EUR	0,75

SOURCE XE.

ANNEX 5: EVOLUTION OF ANNUAL INSTALLATIONS AND TOTAL CAPACITIES PER REGION 2011/2013

	ANNUAL INSTALLATIONS (MW)			TOTAL CAPACITIES (MW)		
COUNTRY	2011	2012	2013	2011	2012	2013
AMERICA	2 235	3 779	5 378	4 587	8 306	13 683
EUROPE	22 201	17 648	11 209	52 309	69 957	81 166
MIDDLE EAST & AFRICA	126	370	450	211	581	1 031
ASIA PACIFIC	5 135	8 004	22 916	10 898	18 902	41 817

SOURCE IEA PVPS, EPIA.

LIST OF FIGURES & TABLES

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