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4 Concentrator and Space Applications
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6 PV Applications and Integration
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Session Type

P = Plenary Session
O = Oral Session
V = Visual Session

Day Codes

A = Monday, 20 June 2016
B = Tuesday, 21 June 2016
C = Wednesday, 22 June 2016
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7DO.14.1 A SNAPSHOT OF GLOBAL PV MARKETS - THE LATEST SURVEY RESULTS ON PV MARKETS AND POLICIES FROM THE IEA PVPS PROGRAMME 2016

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ABSTRACT: This snapshot report gives information on the development of PV power applications in the PVPS member and non-member countries and is largely based on the information provided by the 24 IEA PVPS countries plus the European Union through its European Commission. The report includes information on national market developments and comments about the most important changes and trends in PV support policies at the end of the former year, in this case 2015. The International Energy Agency – Photovoltaic Power System Programme (IEA PVPS)'s Task 1 is responsible for strategy and outreach within the IEA PVPS program. This includes market and industry analysis. A key deliverable of Task 1 is the annual ***Snapshot of Global PV Markets*** publication, together with the TRENDS IN PV APPLICATIONS.

This paper presents the latest survey results for the calendar year 2015 concerning PV markets and policies, as well as other key issues. An increasing number of national markets experienced notable growth in 2015 with impacts on policy development. While the final figures for 2015 will continue to be refined in the coming months, preliminary figures show that close to 51 GW of PV systems have been installed in the world last year. Some important trends observed are as follows:

- The **global PV market grew to at least 50.7 GW** in 2015, compared to around 39.7 GW in 2014 (revised figure).
- **Asia** scored the very first place again in 2015 with more than 57 % of the global PV market.
- The market in **Europe** grew to 8 GW for the first time in years. It has decreased significantly from 22.5 GW in 2011 to 17.5 GW in 2012, 11 GW in 2013 and 7 GW in 2014. But in 2015 it grew for the first time in years at 8 GW.
- The **Asia Pacific** region installing close to 31 GW in 2015 has experienced the fastest market development in 2013 as well as 2014. China took the first place (with 15.2 GW installed), ahead of Japan (10.8 GW) and the USA (7.3 GW). The first European country ranked fourth, with the 3.8 GW installed in United Kingdom.
- In the top 10 countries, there are 3 European countries (UK, Germany and France), 5 Asia-Pacific countries (China, Japan, Korea, Australia, India), no country in Africa (South Africa installed relatively small amounts of PV in 2015) and two countries in the Americas region (USA and Canada).
- **Germany, Italy and Greece** have now enough PV capacity to produce respectively **7.1 %, 8.0 %** and **7.4 %** of their annual electricity demand with PV. 15 countries have enough PV to produce at least 1.3 % of their electricity demand by PV.
- PV represents **3.8** % of the electricity demand in Europe and **7**% of the peak electricity demand.
- **22 countries had at least 1 GW** of cumulative PV systems capacity at the end of 2015 and 7 countries installed at least 1 GW in 2015.
-

1 INTRODUCTION

1.1. Purpose of The Work

The objective of the series of annual Snapshot and Trends reports – which have been published since 1992 (Trends) and 2013 (Snapshot) – is to present and interpret developments in both the PV systems and components being used in the PV power systems market and the changing applications for these products within that market. These trends are analyzed in the context of the business, policy and non-technical environment in the reporting countries.

These reports are prepared to assist those responsible for developing the strategies of businesses and public authorities, and to aid 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. Finally, it represents the most comprehensive and complete PV market analysis on a global level.

1.2. Approach

Key data for this publication were drawn mostly from national survey reports (up to 2014) and information summaries, which were supplied by representatives from

each of the reporting member countries of IEA PVPS (for 2015 data). These national survey reports and the annual Snapshots 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, with every attempt made to ensure their accuracy.

The 24 countries currently participating in the IEA PVPS programme are Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), China (CHN), Denmark (DNK), Finland (FI), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Thailand (THA) Turkey (TUR) and the United States of America (USA). The European Commission (EC), the Solar Power Europe association (SPE), the US Solar Electric Power Association (SEPA) and the US Solar Energy Industries Association (SEIA) and Copper Alliance are also members.

1.3. Results And Conclusion

Trends in photovoltaic applications is currently being compiled and the following results are based on the snapshot of global PV data collected in 2015, together with data published in National Survey Reports.

2 MARKET DEVELOPMENT

2.1. Cumulative Global Installed Capacity

The 24 IEA PVPS countries represented around 197 GW of cumulative PV installations altogether, mostly grid-connected, at the end of 2015. The other 39 countries that have been considered and are not part of the IEA PVPS programme represented 30 additional GW, mostly in Europe: UK with close to 9.1 GW, Greece with 2.6 GW, Czech Republic with 2.1 GW installed, Romania with 1.3 GW and Bulgaria with 1.0 GW and below the GW mark Slovakia. Outside of Europe, the major non-IEA PVPS countries that accounted for the highest cumulative installations in 2015 were India with more than 5.1 GW, South Africa with 1 GW, Taiwan with 1 GW and in Chile with 0.8 GW. Other countries installed significant amounts of PV but their tracking is not easy since they are not reporting official numbers. Pakistan for instance has installed around 800 MW cumulative, based on PV modules import numbers but this remains to be verified. Ukraine has also installed more than 800 MW so far, despites the losses of Crimean installations to Russia.

Meanwhile a difference of 1 or 2 GW out of 227 GW represents an error margin less than 2% that can be considered as scientifically acceptable. It must be noted that several countries are reporting officially AC numbers. These AC numbers refer to the theoretical output of PV systems connected to the grid, with a methodology that can differ according to the country and the segment. The correction factor to transform these AC numbers into DC numbers (that are compiled here) differs according to the country and the market segment. While for residential installations, the ratio between DC power and AC power is relatively small (and sometimes close to 1 or even below 1 in case of an inverter slightly larger than the PV installation itself, for ground-mounted installations, the ratio DC/AC can go up to 1.4 for utility-scale applications. While such a number seems high, ratios around 1.3 are mentioned by First Solar in 2016 (Annual report 2015). In that respect, AC reporting countries are mentioned below with their AC market size. Japan that reports in AC, reports also the equivalent DC number according to the Japanese grid connection regulations: 9797.4 MW AC correspond in Japan to 10811.4 MW DC.

The reporting in AC amounts to at least 40 GW (34 GW in Japan, 5 GW in Spain, plus Canada and Austria for instance). Assuming an average correction factor of 10% instead of 15%, these 40 GW could generate a difference of 2 additional GW. These uncertainties correspond today to less than 1% of the total installed capacity. Meanwhile, it is important to consider AC and DC numbers since most tenders (for instance in Chile or UAE) consider AC number. The 200 MW_{AC} tender in Dubai that got the 58.5 USD/MWh PPA corresponds in fact to a 250 MW_{DC} PV plant.

Finally the question of the non-reporting countries is at the core of the debate on the final numbers. In this paper, we build on data produced by a consortium of researchers (Ch. Werner & All) that estimated the installations in non-reporting countries from this paper to 228 GW.

The figure 1 below illustrates the evolution of cumulative installed PV power in the world.

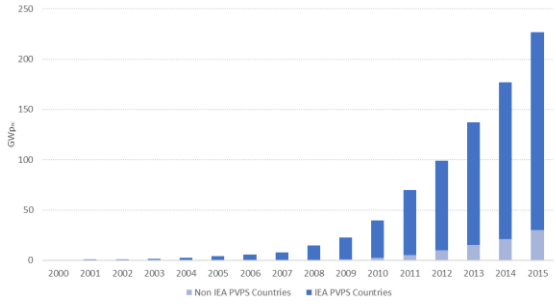

Figure 1: Cumulative installed PV power in the World (GW-DC)

2.2. Annual Installed Capacity in 2015

The IEA PVPS countries have installed 40 GW of PV. While they are difficult to track with a high level of certainty, installations in non-IEA PVPS countries were pushing the installed capacity above 50 GW in 2015.

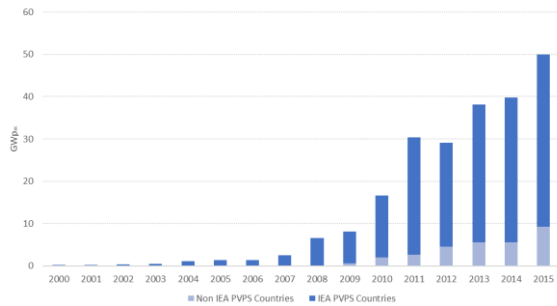

Figure 2: Annual installed PV power in the World (GW-DC)

With around 50.7 GW, the market grew in 2015 by around 25%, again the highest installation ever for PV. China installed 15.2 GW in 2015, according to the National Energy Administration, a record level significantly higher than the 10.6 GW and 10.95 GW from the last two years (2014, 2013) that placed the country in first place with regard to all time PV installations in 2013. This is perfectly in line with their political will to develop renewable sources and in particular PV in the short to medium term. Meanwhile more was initially planned for and the lower level reached can be explained by local difficulties to ramp up the distributed PV market and probably the beginning of rather high curtailment rates in some provinces far from consumption centers.

The second place goes to Japan for the second year in a row, with 10.8 GW installed in the country in 2015, up from 2014 numbers. The USA installed 7.3 GW, up from 6.2 GW of PV systems in 2014, with a growing share of large utility-scale PV compared to rooftop installations.

The UK grew significantly again in 2015, becoming the first country for PV installations in Europe with 3.8 GW. The market has been powered by the rather unique set of support schemes in Europe still favoring ground-mounted installations. More than half of all 2015 installations occurred anyway in the first quarter of the year, which predicts a market decline in 2016.

India installed 2.1 GW in 2015, while a growing number of installations are reported, amidst huge expectations powered by the policy decision to install up to 100 GW before 2022.

Together, these 5 countries represent 77% of all installations recorded in 2015, roughly the same percentage as in 2014 while the top 5 of cumulative capacities reached 70% in terms of installed capacity (China, Germany, Japan, USA, Italy).

Germany installed 1.46 GW, a major decline after the three years with PV installations around 7.5 GW, followed by 2013 at 3.3 GW and 2014 at 1.9 GW. The total installed PV capacity in Germany is now more than 39.6 GW but the country was for the first time passed by China that became number one with more than 43 GW of cumulative PV capacity at the end of 2015.

The following four places go to the France (0.9 GW), Korea (1.0 GW), Australia (0.9 GW) and Canada (0.6 GW). Together these top 10 countries cover 88% of the 2015 world market, a percentage that is decreasing slowly.

Amongst countries that in the past installed significant levels of PV, Italy installed only 300 MW, down from the 9.3 GW in 2011, 3.6 GW in 2012 and 1.7 GW in 2013. It has reached a capacity of 18.9 GW.

Several other countries where the PV market used to develop in the last years have performed in various ways: Belgium installed only 95 MW and has now reached more than 3.2 GW. Some countries that grew dramatically over recent years have now stalled or experienced limited additions: Spain (56 MW) now totals 5.4 GWDC of PV systems followed by Czech Republic (2 MW) at 2.1 GW.

In Europe, net-metering systems allowed the market to grow quickly in Denmark but the transition to self-consumption pushed the installations down despites a significant market improvement in 2015 (180 MW) thanks to utility-scale plants. In the Netherlands (500 MW estimated), 2015 saw significant additions while the market stabilized in Switzerland (300 MW) and in Austria (150 MW).

Malaysia installed 63 MW for the fourth year of its Feed-in Tariff (FiT) system. Taiwan installed around 400 MW in a growing market. In Latin America, official data for Chile shows the installation of 800 MW in two years, a first step towards PV deployment in the region. Several additional GW of PV plants have been validated in Chile, while projects are popping up in Brazil and Honduras (400 MW). The real PV development of grid-connected PV plants has finally started in the region but much more is expected in 2016, especially with the competitive tenders that have been won in Mexico, Peru or Brazil.

In the Middle East, Israel continued in a similar way (200 MW), while the PV installations in Turkey have finally started but slower than expected with around 208 MW installed in 2015. Many new projects have been announced, especially in the UAE and in Egypt and other countries are rapidly building PV plants, such as Jordan or Algeria (268 MW in 2015).

PV installations have been reported in dozens of countries in the world, with 2.3 GW installed in non-reporting countries (source: Ch. Werner and all, op. cit.). Since this number comes mainly from imports of modules in these countries, it should be considered as the maximum maximorum. To the 40.7 GW in IEA-PVPS countries, 7.7 GW can be added in other countries where PV installations are followed properly (those mentioned in this document with installation numbers) and 2.3 GW additional installations, pushing the 2015 installations numbers up to 50.7 GW.

2.3. Shift to Asia

While Europe represented a major part of all installations globally in 2011, the share of Asia and America started to grow rapidly from 2012, with Asia taking the lead. This evolution is quite visible from 2011 to 2014, with the share of the Asia Pacific region growing from 18% to close to 60% in 2014 and 2015, whereas the European share of the PV market went down from 74% to 15% in five years. This trend shows that the development of PV globally is no longer in the hands of European countries but rather has become global, powered by the demand for electricity and the population per region rather than only policy decisions.

Finally, the share of the PV market in the Middle East and in Africa remains relatively small compared to other regions of the world, despite the growth of the South African market and the numerous projects in UAE or Egypt.

2.4. Utility-scale PV in progress

The evolution of grid-connected PV towards a balanced segmentation between centralized and

decentralized PV has reversed course in 2013 and continued its trend in 2014 and 2015: centralized PV has evolved faster and most of the major PV developments in emerging PV markets are coming from utility-scale PV. Globally, centralized PV represented more than 60% of the market in 2015, mainly driven by China, the USA, and emerging PV markets.

In 2014, utility-scale represented more than 55% of the market and 64% in 2015 (32.6 GW out of 50.7 GW). Prospects for the coming years are going in the same direction with many countries targeting large-scale ground-mounted PV (Brazil, Chile, South-Africa, Indonesia…). Europe was in 2015 the only region where the share of distributed PV was higher than centralized in 2015 and higher than 50%. Moreover distributed installations have stagnated in 2015 compared to 2014 in absolute terms (18 GW compared to 19 GW) and declined significantly in relative terms.

3 POLICY FRAMEWORK

PV development over the last ten years has been powered by the deployment of support policies, aimed at reducing the gap between PV's cost of electricity and the price of conventional electricity sources. These support schemes took various forms depending on the local situations and evolved to cope with unexpected market evolution or policy changes. The figure 3 below shows that only 0.2% of the world PV market has been driven by pure self-consumption or the sole competitiveness of PV installations in 2015. Tenders granting PPAs have represented less than 6% of the new PV capacities in 2015. Self-consumption represented, together with similar schemes such as net-billing or net-metering close to 15% of the new installations. It also means 78.3% of the global PV market depends on financial support schemes. In 2014 and 2015 a large part of the market remained dominated by FiT schemes (more than 59%) outside of tendering processes. Subsidies aiming at reducing the upfront investment (or tax breaks) represent around 16% of the incentives. Incentivized self-consumption including net-billing and net-metering was the main incentive in 2015 for 16% of the world market. Various forms of incentivized self-consumption schemes exist, such as in Italy with the *Scambio Sul Posto*, Israel, or Germany.

The emergence of calls for tenders has been confirmed again in 2015, with new countries using this legal tool to attribute remunerations to PV projects under certain conditions. Germany, France, Peru, Brazil, Mexico, Dubai (UAE), Jordan and many others have joined the list of countries using calls for tenders to grant PPAs for PV plants. The result of these calls for tenders is a guaranteed payment for PV electricity, or in other words, a FiT. Such tenders represented around 5.6% of the world market in 2015 and is increasing.

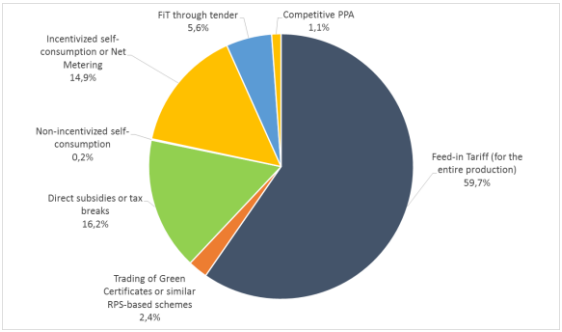

Figure 3: Market Incentives and Enablers in 2015

Historically the dominance of feed-in tariffs and direct subsidies is similar but even more visible in Figure 6 that compiles installations until the end of 2014. Incentives can be granted by a wide variety of authorities or sometimes by utilities themselves. They can be unique or add to each other. Their lifetime is in general 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, in general in the absence of national or local incentives.

Figure 4: History of PV market drivers and Enablers until 2014 (IEA-PVPS Trends report 2015)

4 PV IN THE POWER SECTOR

Figure 5 shows how PV theoretically contributes to the electricity demand in the IEA PVPS countries, based on the PV base at end 2015. Italy remains the number one country with 8% of its electricity that will come from PV in 2016 based on 2015 total level of installations. This number can be translated into 15 to 16% of the peak electricity demand.

In Germany, with more than 6.7%, the 39.7 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. Several countries outside the IEA PVPS network have the ability to produce significantly more than 3% of their electricity demand: Honduras (not featured in the figure below) with 12% of its electricity demand, Greece (around 7.6% based on the 2014 installed capacity), Bulgaria and the Czech Republic. Spain remains below the 4% mark as

well as Belgium, which is producing 3.6% of its electricity thanks to PV. Romania, Japan, Australia, Switzerland, Slovenia and Israel are above the 2% mark. Denmark and the UK are approaching the 2% mark, while Austria, France, Portugal and Chile are still below the 1.5 % mark. Thailand and the Netherlands passed the 1% of the electricity demand mark in 2015. Many other countries have lower production numbers.

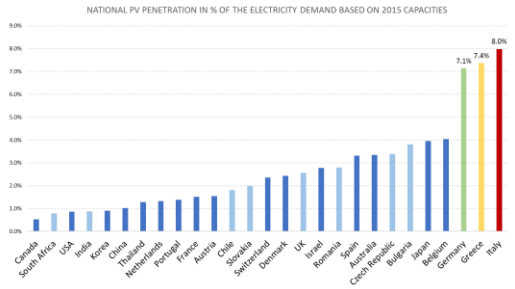

Figure 5: Theoretical PV production share by country based on 2015 cumulative installed capacity.

5 CONCLUSION

The year 2015 experienced a renewed growth of the PV market and confirmed the Asian leadership on the PV market and industry. PV is entering rapidly into a new era where the PV market will be concentrated in countries with energy needs. Two of the top three markets in 2015 were located in Asia (China and Japan), followed by Europe as a whole and the US PV market. This trend should be confirmed again in 2016, with Asia consolidating the core of the PV market, followed by the Americas and Europe, while India is going to modify these results in the coming years.

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, the evolution of energy storages technologies 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.

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 Snapshot 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 have shown in recent years, PV has the ability to continue progressing fast.

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