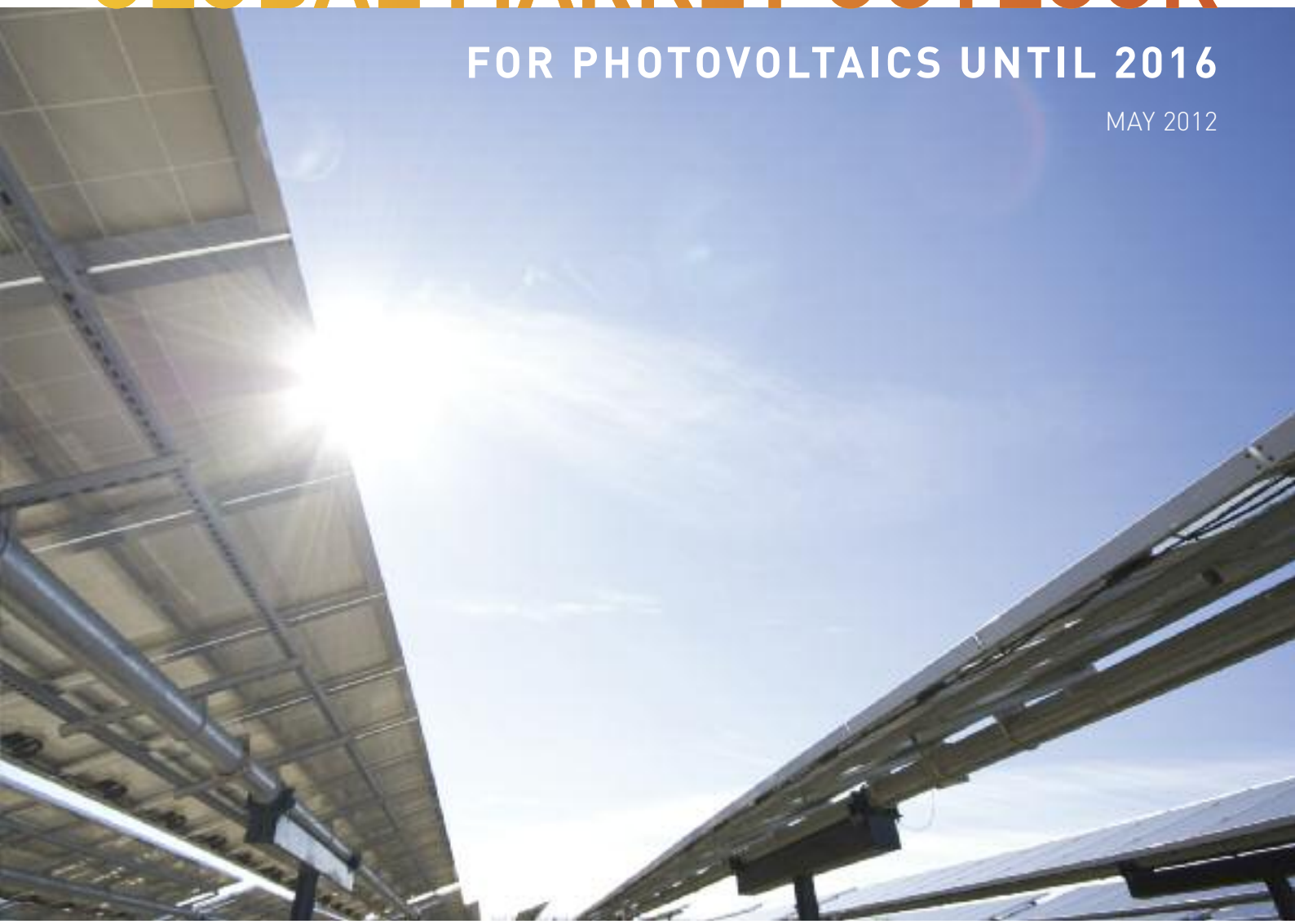
# GLOBAL MARKET OUTLOOK

## FOR PHOTOVOLTAICS UNTIL 2016

MAY 2012



EPIA

European Photovoltaic Industry Association

# 2016

## GLOBAL MARKET OUTLOOK FOR PHOTOVOLTAICS UNTIL 2016

**Disclaimer:** Please note that all historical figures provided in this brochure are valid at the time of publication and will be revised when new and proven figures are available. All forecast figures are based on EPIA knowledge at the time of publication. Please also note that cumulative forecast figures have been rounded.

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# 1

# INTRODUCTION

Solar photovoltaic (PV) electricity continued its remarkable growth trend in 2011, even in the midst of a financial and economic crisis and even as the PV industry was enduring a period of consolidation. As they have for the past decade, PV markets again grew faster than anyone had expected both in Europe and around the world. Such a rapid growth rate cannot be expected to last forever, however, and the industry is now weathering a period of uncertainty in the short-term. But over the medium- and long-terms the prospects for continued robust growth are good. The results of 2011 – and indeed the outlook for the next several years – show that **under the right policy conditions PV can continue its progress towards competitiveness in key electricity markets and become a mainstream energy source**.

This report assesses the European and global markets for PV in 2011, and makes forecasts for the next five years. It is based on an internal analysis of data from industry members, national associations, government agencies and electric utilities. The figures presented were discussed and analysed by key players from the PV industry at our 7th EPIA Market Workshop in Brussels in March 2012. A note on the methodology used in this report: EPIA bases its analysis on PV systems that have been connected to the grid; the implications of this choice for how market growth is assessed and the differences between installations and connections are discussed in the Methodology section.

Our major findings for 2011 include:

- **29.7 GW of PV systems were connected to the grid in 2011,** up from 16.8 GW in 2010; PV is now, after hydro and wind power, the third most important renewable energy source in terms of globally installed capacity
- **21.9 GW were connected in Europe in 2011**, compared to 13.4 GW in 2010; Europe still accounts for the predominant share of the global PV market, with 75% of all new capacity in 2011
- **Italy was the top market for the year, with 9.3 GW connected**, followed by Germany with 7.5 GW; Italy and Germany accounted for nearly 60% of global market growth during the past year

- **China was the top non-European PV market in 2011,** with 2.2 GW installed, followed by USA with 1.9 GW
- The number of markets achieving more than 1 GW of additional PV capacity during 2011 rose from three to six: Italy, Germany, France, China, Japan, USA

## An industry at the crossroads

European markets where PV has developed vigorously in recent years have reached, at least for the time being, a level that will be difficult to maintain in the two coming years. The market slowdown in Europe will not immediately be offset by market growth elsewhere in the world, but a rebalancing has begun. **New markets around the world will have to be opened up to drive PV development in the coming decade just as Europe accounted for it until now.**

Many existing markets – in particular China, the USA and Japan, but also India – have addressed only a very small part of their enormous potential for PV development. Moreover, several countries from large sunbelt regions like Africa, the Middle East, South East Asia and South America are on the brink of starting their development, pushed by an increasing awareness of solar PV potential. As a whole, the global PV market will grow more sustainably, driven by the competitiveness of PV solutions rather than mainly by financial support schemes. But this Paradigm Shift will not happen overnight.

## Lessons from key markets

The specific situations in some countries are worth examining for what they can teach us about how PV markets evolve. It is important, for example, to consider whether the factors that drove the strong growth numbers in some markets are sustainable over a longer period. In Italy, the Feed-in Tariff (FiT) was high – resulting in a high rate of return – and was not adapted sufficiently to cope with the price decrease; moreover, the country's "Salva Alcoa" legislation resulted in many installations from 2010 being connected in 2011 and receiving the 2010 FiT level.

In Germany, the situation was different. The annual update of the FiT did not come in time to offset the system price decrease. The resulting attractiveness of the return drew investors and there was a market boom before the January 2012 FiT decrease took effect. Again the message is clear: **A corridor concept is good if it can adapt the FiT with regular, measured updates**; otherwise it could trigger boom-and-bust cycles.

There were peculiarities in other countries as well. France's 2011 result was strong, but it included connections of installations done in 2010 and does not reflect the real market situation in the country. The UK market faced a situation similar to that of Germany: Investors were attracted by high FiT income and acted quickly after support cuts had been announced but before they took effect.

If any general lesson can be drawn from the various market analyses, it is this: Sudden, stop-and-start policies (making harsh and/or frequent changes in the FiTs, for example) can threaten PV's growth momentum by destroying investor confidence. What is needed is a more measured response to market developments. **This balanced approach will lead PV gradually out of the Feed-in Tariff era and into one in which the technology is competitive against all electricity sources and in which governments continue to support market development in other ways – for example by removing bureaucratic barriers, encouraging innovation, and ensuring grid access.**

## Where will new growth occur?

With the boom-and-bust cycles that have destroyed the Czech market and hindered the Spanish one, there are not many contenders to replace Germany and Italy as the two leading European markets. Germany, Belgium, Greece, Italy and the UK will, to varying extents, continue to draw investors. In all, there is a **potential for around 20 to 25 GW in Europe in the coming years with the right policies in place**. Otherwise, the market will collapse to possibly less than 10 GW a year. The effects of this will be felt globally: low demand, companies suffering from low prices, a negative effect on the global industry.

**Outside Europe**, however, the PV market is expanding quickly – with **more than 100% growth in 2011**. Another sign of important change in the PV market is the fact that China was, for the first time, the top non-European PV market. The US market doubled, and Japan is also making significant progress. The potential for future growth outside Europe is tremendous and PV will soon expand in dozens of countries thanks to its competitiveness. **This non-European market could top between 38 and 77 GW in 2016, with the right policies in place everywhere**.

## PV in the electricity mix

**PV is now a significant part of Europe's electricity mix, producing 2% of the demand in the EU and roughly 4% of peak demand**. In Italy, PV covers 5% of the electricity demand, and more than 10% of peak demand. In Bavaria, a federal state in southern Germany, the PV installed capacity amounts to 600 W per habitant. This is roughly three panels per capita – an astounding figure. Policy support has been crucial to getting PV to this place in its development – just as it was crucial to helping develop all other energy sources (fossil and fissile) in the past. But now PV needs to demonstrate that it is a mature industry, ready for the next stage of its development. The industry does not expect nor want FiTs to last forever. But for PV to realise its full potential, the PV sector needs them (and, eventually, other forms of policy support) to finish closing the competitiveness gap.

# 2

# METHODOLOGY AND SCENARIOS

As they have done for the last several years, PV markets in Europe and around the world are approaching competitiveness in the electricity sector. This momentum toward what is known as “grid parity” is reflected in the strong price decreases of PV technology in recent years and especially in 2011, combined with increased electricity prices across Europe.

Dynamic grid parity refers to the moment at which, in a particular market segment in a specific country, the present value of the long-term net earnings (considering revenues, savings, cost and depreciation) of the electricity supply from a PV installation is equal to the long-term cost of receiving traditionally produced and supplied power over the grid. While this situation appears within range in several EU countries, for now the market is still driven by incentives. That means PV market deployment still depends on the political framework of each country. The introduction, modification or phasing out of national schemes constitutes a significant element of our forecasts and scenarios as they have profound consequences on national PV markets and industries. In 2011 and early 2012, some decisions taken by national policymakers show that we have entered a transition phase to a post-incentive era for PV, especially in Germany. This has serious and complex implications for the forecasting of market evolution.

Indeed, the dynamics of PV development are well known in a context of a market driven by incentives. But what about the market potential when PV has to rely on electricity savings and/or potential sales on the wholesale electricity market? In March 2012, EPIA completed an extensive data collection exercise from among a highly representative sample of the PV industry, electric utilities, national associations and energy agencies. Based on the cross-checking of data and the consolidation of complementary market projection methods, EPIA has derived two scenarios for the future development of the PV industry:

The **Moderate scenario** assumes rather pessimistic market behaviour with no major reinforcement of existing support mechanisms, or strong decrease/limitation of existing schemes. In countries close to transition, customers are not reacting well to a PV market without FiTs.

The **Policy-Driven scenario** assumes the continuation or introduction of adequate support mechanisms, accompanied by a strong political will to consider PV as a major power source in the coming years. This also requires removing unnecessary administrative barriers and streamlining grid connection procedures. In some extreme cases, this scenario assumes market booms caused by inadequate support mechanisms as observed at the time of publication.

Under these two scenarios, this report analyses, on a country-by-country basis: the historical development of the PV market; existing support policies, their attractiveness and expected developments; administrative procedures in place; national renewable energy objectives; and the potential for PV. In this bottom-up approach, consolidated forecasts should be understood as a range of possible PV market developments, with a high probability between the Moderate scenario as the lower boundary and the Policy-Driven one as the higher one. Lower or higher forecasts are of course possible as the history of PV market development has shown, with a lower probability.

Historical data are presented without rounding. Projections are rounded as follows: Numbers below 1,000 are rounded to the nearest 10; numbers greater than 1,000 are rounded to the nearest 100.

## Installations and connections

EPIA's methodology includes only the systems connected to the grid and not those that have been installed but not yet connected. Therefore, the cumulative installed capacity refers to installations that can make a real contribution to meeting the energy demand. This also reflects both the energy system point of view and the regulatory point of view, as PV electricity tariffs are paid only to systems that are connected and producing electricity. The difference between installations and connections can be quite significant in some cases, as shown in this report.

## Including off-grid installations

Long before PV became a reliable source of power connected to the grid, it was largely used to provide electricity in remote areas that lay out of the reach of electricity grids. While off-grid systems in Europe account for less than 1% of the PV installed capacity, they represent a significant power source in many other countries. For this reason, off-grid systems are also taken into account in the total installed capacity. In the USA, off-grid systems represented 10% of the overall market in 2009 and declined since then. In Australia and Korea, dozens of megawatts of off-grid capacity are installed every year and are accordingly taken into account in the total installed capacity in those countries. In countries such as India, the development of PV in the coming years could originate at least partially from hybrid systems and micro-grid applications. In that respect the notion of on-grid or off-grid installations could be more difficult to assess outside Europe.

## AC-DC numbers: Counting comparable numbers

PV panels generate direct-current (DC) electricity; electricity systems are based on alternating-current (AC) electricity. Most countries refer to installed PV systems by counting DC power, but some report AC power. The major difference lies in the small percentage of energy lost during the DC-AC conversion in the inverters, which could deliver non-comparable data. We have chosen in this report to present data as they are produced by national authorities to ensure the compatibility of historical data, whatever the conventions used. However, in the case of countries reporting AC power, this report also calculates DC power numbers. All forecasts and consolidated data are presented in DC power, while electricity production data must consider AC power. In such cases, a 5% loss during conversion is assumed. In Europe, Belgium, Spain and Switzerland fall in this category.

# 3

# MARKET EVOLUTION

## 3.1. Historical PV market development

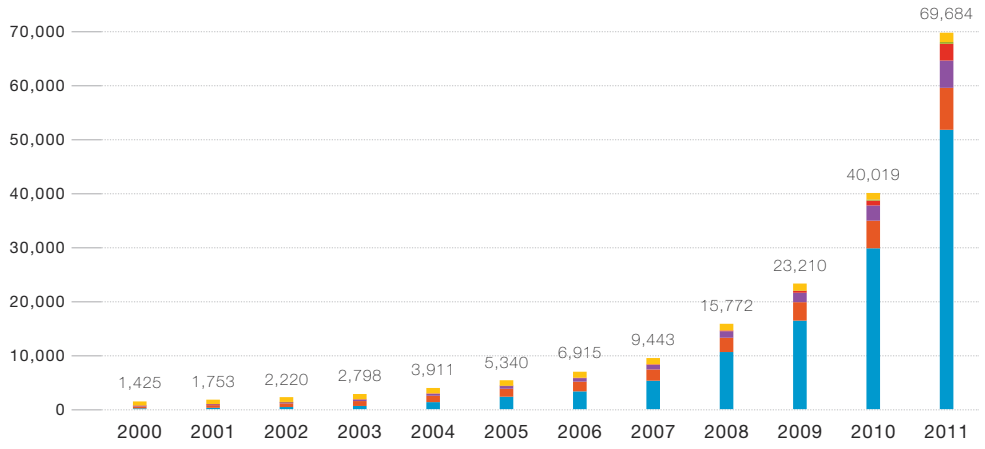
### 3.1.a. World

Over the last decade, PV technology has shown the potential to become a major source of power generation for the world – with robust and continuous growth even during times of financial and economic crisis. That growth is expected to continue in the years ahead as worldwide awareness of the advantages of PV increases. At the end of 2009, the world's PV cumulative installed capacity was approaching 23 GW. One year later it was 40 GW. **In 2011, more than 69 GW are installed globally and could produce 85 TWh of electricity every year. This energy volume is sufficient to cover the annual power supply needs of over 20 million households**.

PV is now, after hydro and wind power, the third most important renewable energy in terms of globally installed capacity. The growth rate of PV during 2011 reached almost 70%, an outstanding level among all renewable technologies.

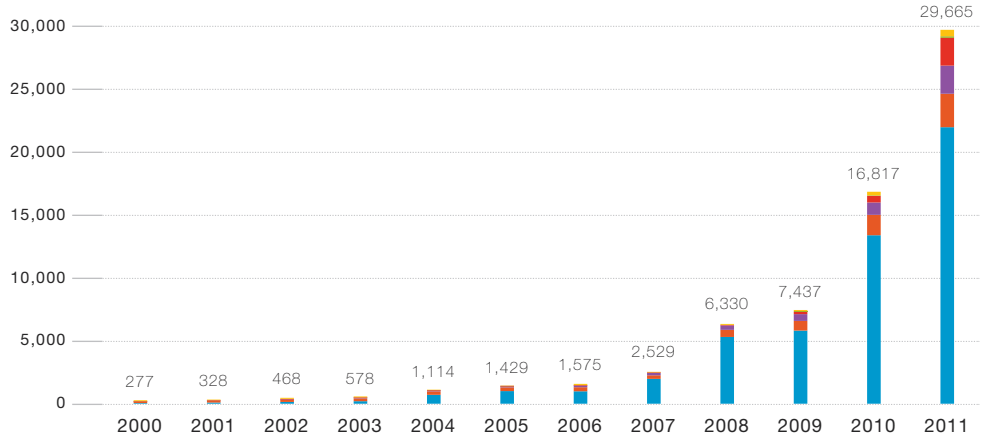
**In terms of global cumulative installed capacity, Europe still leads the way with more than 51 GW installed as of 2011.** This represents about 75% of the world's total PV cumulative capacity. Next in the ranking are **Japan (5 GW) and the USA (4.4 GW)**, followed by **China (3.1 GW)** which reached its first GW in 2011. Many of the markets outside Europe, in particular China, the USA and Japan, but also Australia (1.3 GW) and India (0.46 GW), have addressed only a very small part of their enormous potential; several countries from large sunbelt regions like Africa, the Middle East, South East Asia and Latin America are on the brink of starting their development. Even so, the cumulative installed capacity outside Europe almost doubled between 2010 and 2011, demonstrating the ongoing rebalancing between Europe and the rest of the world and reflecting more closely the patterns in electricity consumption.

**Figure 1** - Evolution of global cumulative installed capacity 2000-2011 (MW)




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ROW | 751 | 807 | 887 | 964 | 993 | 1,003 | 1,108 | 1,150 | 1,226 | 1,306 | 1,209 | 1,717 |
| MEA | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 21 | 205 | 336 |
| China | 19 | 30 | 45 | 55 | 64 | 68 | 80 | 100 | 145 | 373 | 893 | 3,093 |
| America | 146 | 177 | 222 | 287 | 379 | 496 | 645 | 856 | 1,205 | 1,744 | 2,820 | 5,053 |
| APAC | 355 | 491 | 677 | 902 | 1,178 | 1,475 | 1,797 | 2,080 | 2,643 | 3,409 | 5,116 | 7,769 |
| Europe | 154 | 248 | 389 | 590 | 1,297 | 2,299 | 3,285 | 5,257 | 10,554 | 16,357 | 29,777 | 51,716 |
| **Total** | **1,425** | **1,753** | **2,220** | **2,798** | **3,911** | **5,340** | **6,915** | **9,443** | **15,772** | **23,210** | **40,019** | **69,684** |

**Figure 2** - Evolution of global annual installations 2000-2011 (MW)




| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ROW | 88 | 56 | 80 | 77 | 29 | 10 | 105 | 42 | 76 | 80 | 284 | 508 |
| MEA | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 21 | 45 | 131 |
| China | 0 | 11 | 15 | 10 | 9 | 4 | 12 | 20 | 45 | 228 | 520 | 2,200 |
| America | 23 | 31 | 46 | 65 | 92 | 117 | 149 | 212 | 349 | 539 | 983 | 2,234 |
| APAC | 114 | 136 | 186 | 225 | 276 | 296 | 322 | 283 | 563 | 766 | 1,618 | 2,653 |
| Europe | 53 | 94 | 142 | 201 | 708 | 1,002 | 987 | 1,972 | 5,297 | 5,803 | 13,367 | 21,939 |
| **Total** | **277** | **328** | **468** | **578** | **1,114** | **1,429** | **1,575** | **2,529** | **6,330** | **7,437** | **16,817** | **29,665** |

*ROW: Rest of the World*
*MEA: Middle East and Africa*
*APAC: Asia Pacific*

Europe has developed from an annual market of less than 1 GW in 2003 to a market of over 13 GW in 2010 and 21.9 GW in 2011. Given the difficult economic circumstances and varying levels of opposition to PV in some countries, many expected a stabilisation of PV markets at best in 2011 compared to 2010. Looking at the newly connected capacity in 2011, one can consider that the PV market has again exceeded all expectations. However, due to variable delays in connecting PV systems to the grid depending on the country, some installations from 2010 were not connected until 2011. This has an impact on the market perception, as explained in the report.

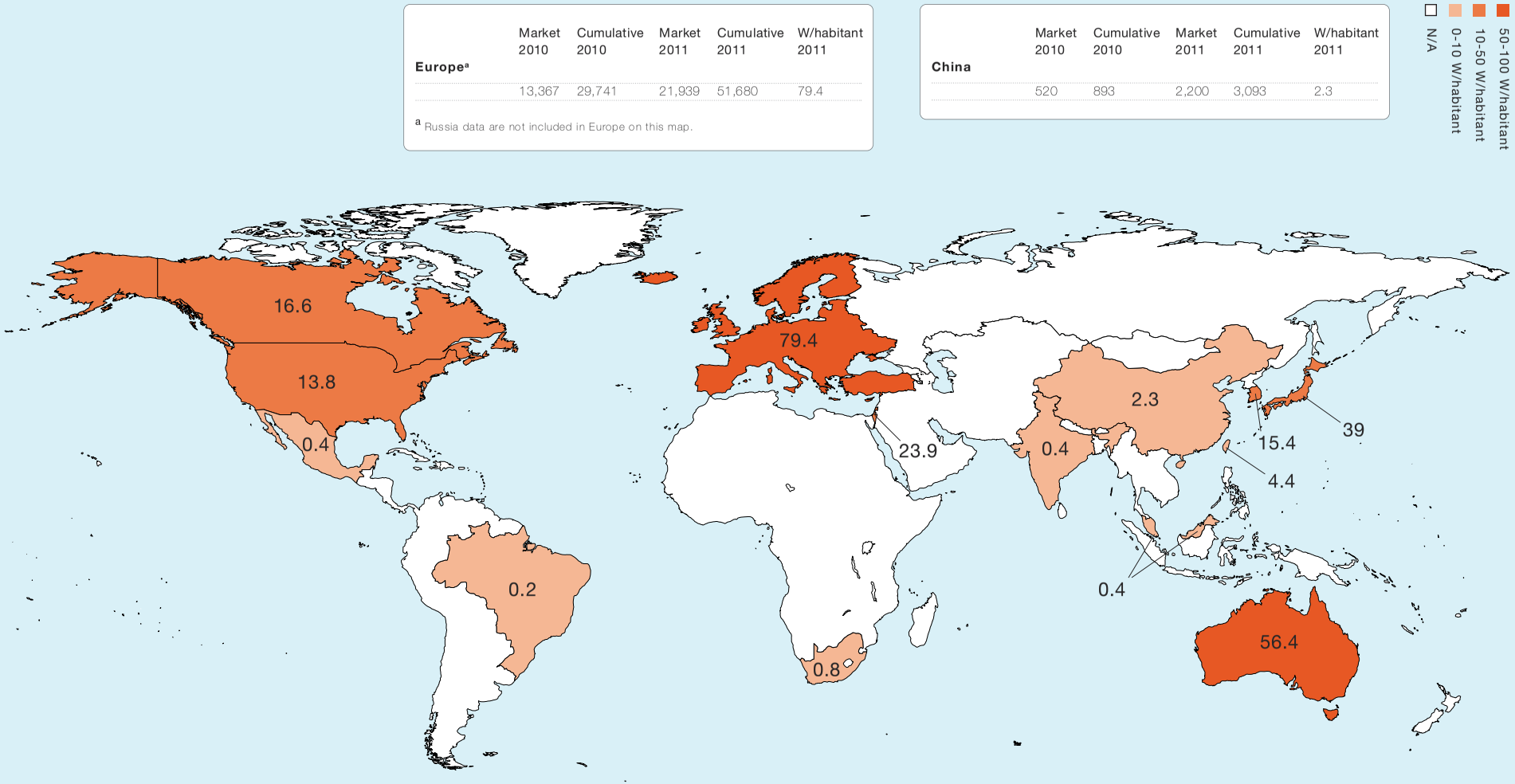
For the first time, **Italy in 2011 became the top PV market, with 9.3 GW of newly connected systems; Germany was second with 7.5 GW** reported by authorities, after having been either first or second in each of the last eight years. Together, Italy and Germany accounted for nearly 60% of global market growth during last year. **These two markets were followed by France (1.7 GW) and the United Kingdom (784 MW)**, which showed surprisingly strong growth in 2011. Many other markets have started to show significant development.

As it has for several years, Europe retains its leadership share of the global PV market, with four countries that have markets close to or above 1 GW. Outside Europe, China has joined Japan and the USA in the group of countries with more than 1 GW of newly PV installed capacity. India could also reach that threshold quickly, but other medium-sized markets will take several years to reach the same level of development.

Regionally, **Europe is followed by the Asia-Pacific region**, which in addition to Japan and China includes Korea, Australia (with more than 750 MW installed in one year), Taiwan and Thailand. **The third leading region is North America**, with Canada developing steadily alongside the USA. Elsewhere, the Middle East and North Africa region represents untapped potential for the medium-term. PV also shows great potential in South America and Africa, where electricity demands will grow significantly in the coming years.

Globally, Europe's development is rivaled only by the recent market uptake in Australia. The USA and Japan, once PV pioneers, are years behind Europe in terms of PV penetration. The rest of the world scores quite low. The development of PV has until now corresponded with economic development: After OECD countries (Europe, North America, Japan, Australia), it started to reach emerging countries. BRIC (Brazil, Russia, India, China) have not all started to develop PV, but China and India will show the way to Brazil and possibly to Russia. Africa scores last on the development list, though there is some short-term potential in South Africa.

## Figure 3 - Global PV power map (MW)




| Europe[a] | Market 2010 | Cumulative 2010 | Market 2011 | Cumulative 2011 | W/habitant 2011 |
|---|---|---|---|---|---|
| | 13,367 | 29,741 | 21,939 | 51,680 | 79.4 |

[a] Russia data are not included in Europe on this map.

| China | Market 2010 | Cumulative 2010 | Market 2011 | Cumulative 2011 | W/habitant 2011 |
|---|---|---|---|---|---|
| | 520 | 893 | 2,200 | 3,093 | 2.3 |

| America | Market 2010 | Cumulative 2010 | Market 2011 | Cumulative 2011 | W/habitant 2011 |
|---|---|---|---|---|---|
| Brazil[b] | N/A | 27 | 5 | 32 | 0.2 |
| Canada | 105 | 200 | 364 | 563 | 16.6 |
| Mexico[b] | N/A | 30 | 10 | 40 | 0.4 |
| USA | 878 | 2,528 | 1,855 | 4,383 | 13.8 |

[b] 2011 data are provisional.

| MEA | Market 2010 | Cumulative 2010 | Market 2011 | Cumulative 2011 | W/habitant 2011 |
|---|---|---|---|---|---|
| Israel | 45 | 66 | 130 | 196 | 23.9 |
| South Africa[b] | N/A | 40 | 1 | 41 | 0.8 |

[b] 2011 data are provisional.

| APAC | Market 2010 | Cumulative 2010 | Market 2011 | Cumulative 2011 | W/habitant 2011 |
|---|---|---|---|---|---|
| Australia | 387 | 524 | 774 | 1,298 | 56.4 |
| India | 60 | 161 | 300 | 461 | 0.4 |
| Japan | 991 | 3,618 | 1,296 | 4,914 | 39 |
| Korea | 138 | 662 | 92 | 754 | 15.4 |
| Malaysia | 0.5 | 11 | N/A | 11 | 0.4 |
| Taiwan | 13 | 32 | 70 | 102 | 4.4 |

### 3.1.b. Europe

Europe's market development is the result of a few countries that have taken the lead year after year, with Germany showing a constant commitment from policymakers to support the development of PV.

After the Spanish boom in 2008, Germany was the only leading market in 2009, and consequently European growth as a whole was limited. This can be seen in retrospect as a consequence of the first phase of the financial crisis but also a year of stabilisation after the boom PV experienced in 2008. Major growth returned in 2010, with Germany scoring unprecedented installation numbers, and Italy and Czech Republic adding together close to 4 GW of PV systems. As we have seen in Spain and Czech Republic, overheated market development can produce a boom in one year and a bust in the next, as a result of pressure from conventional energy producers and policymakers concerned about the rapid growth of the market. In 2011, the combined boom of Italy's connections and Germany's installations led again to huge growth. France's growth in 2011 was at least partly due to its connection of projects installed in 2010; prospects for the future are less certain.

**In order to maintain the market development trends we have seen until 2011, the PV industry will need to diversify markets across several countries, to relieve the pressure on Germany and allow markets that have gone bust to revive in a sustainable way**. The cumulative evolution shows a similar story, with countries stabilising their installed capacity after major growth events as Germany continues to expand its PV base.

**Figure 4** - Evolution of European cumulative installed capacity 2000-2011 (MW)

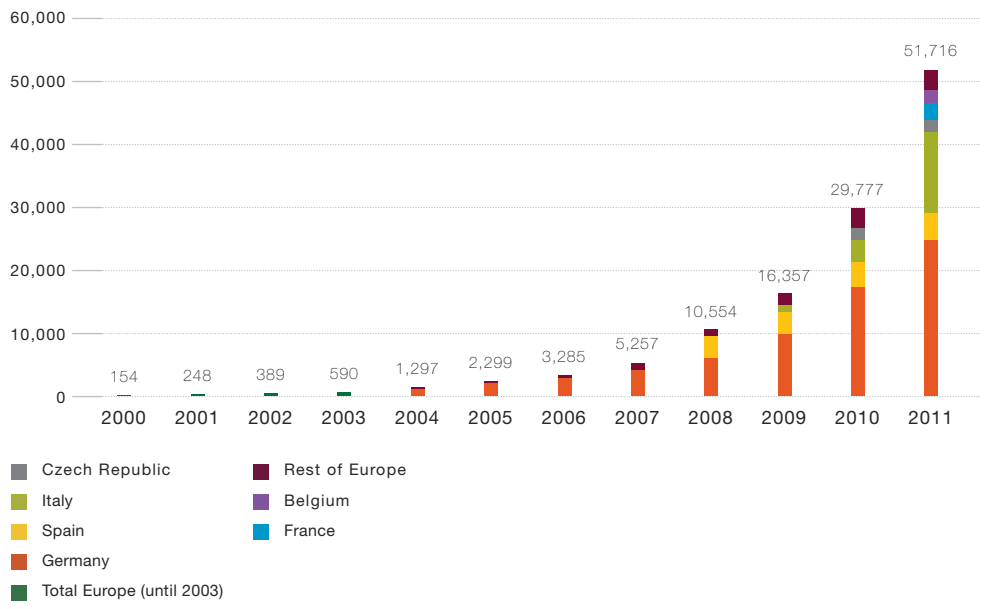
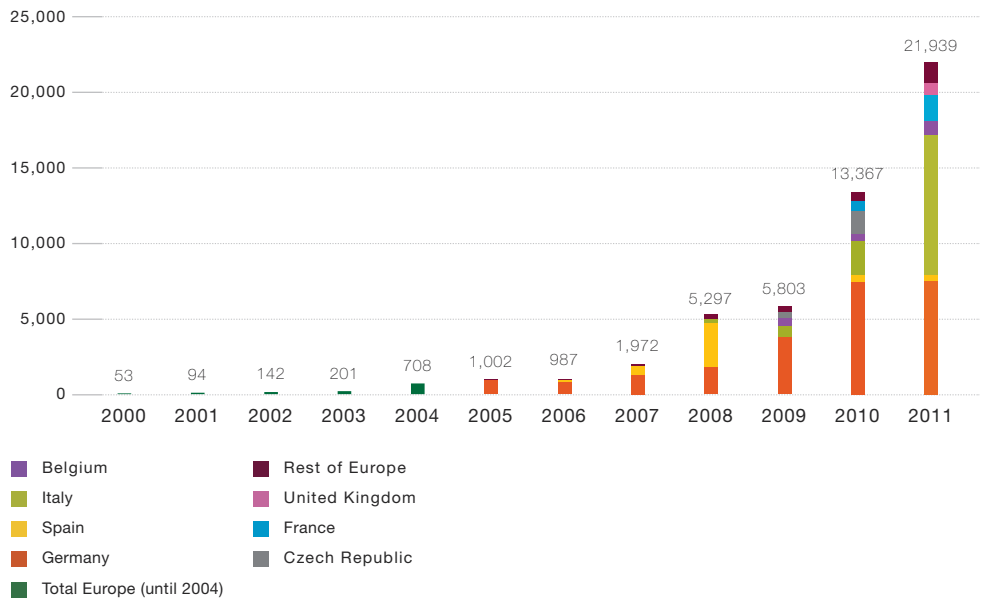
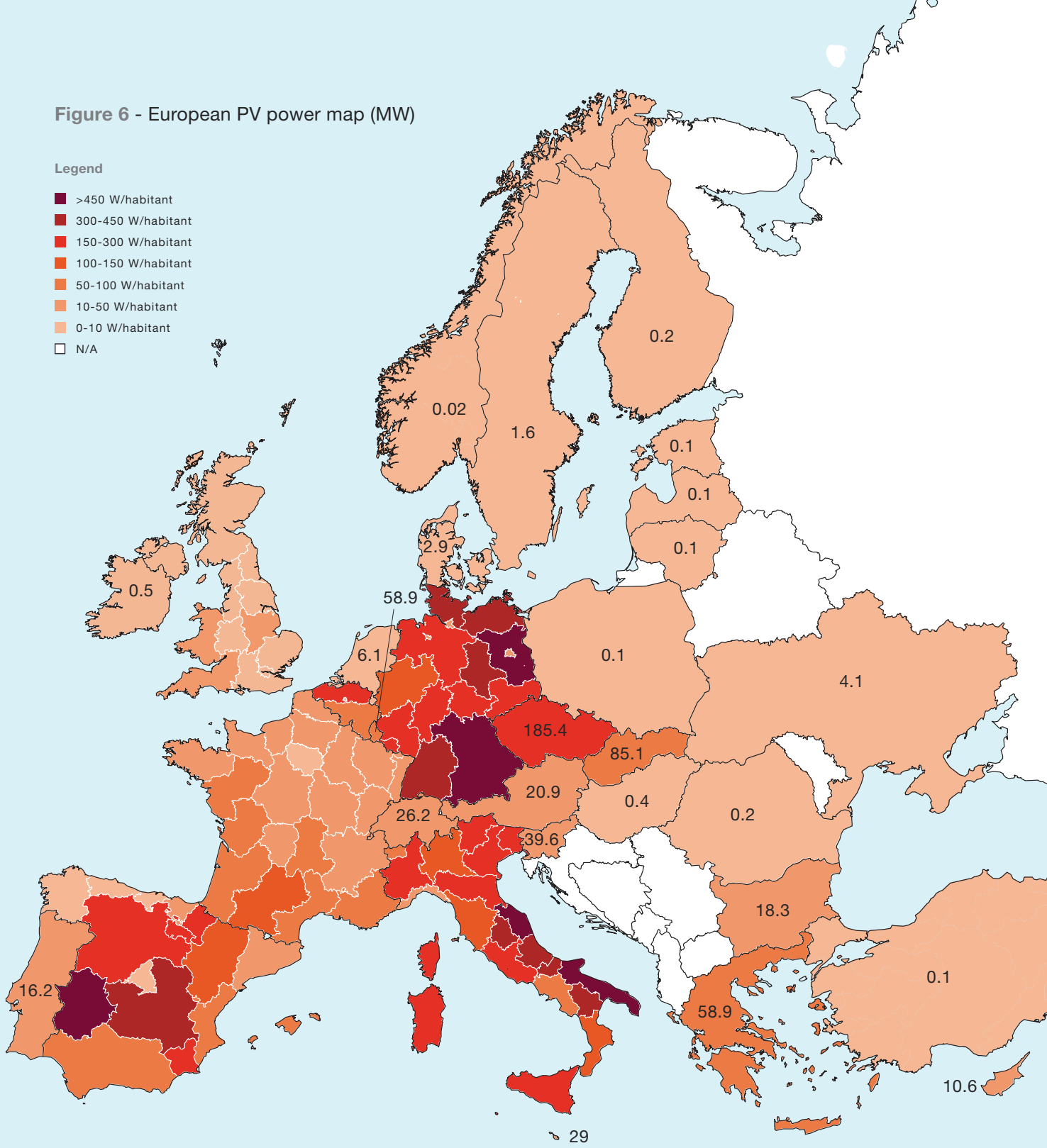


**Figure 5** - Evolution of European new grid-connected PV capacities 2000-2011 (MW)




The geographical split of the PV market in Europe is linked to the speed at which the technology developed in recent years. Germany saw steady growth for nearly a decade and represents clearly the most developed PV market. But some countries that got a later start – Czech Republic, Italy and Belgium – quickly reached high levels. Next to these leaders, Spain now appears quite low since its market has been constrained; the French and British results reveal an untapped potential in both countries.

## Figure 6 - European PV power map (MW)




| | Market 2010 | Cumulative 2010 | Market 2011 | Cumulative 2011 | W/habitant 2011 |
|---|---|---|---|---|---|
| Austria | 43 | 96 | 80 | 176 | 20.9 |
| Belgium[a] | 417 | 1,044 | 974 | 2,018 | 183.5 |
| Bulgaria | 28 | 35 | 100 | 135 | 18.3 |
| Cyprus | 3 | 6 | 3 | 9 | 10.6 |
| Czech Republic | 1,490 | 1,952 | 6 | 1,959 | 185.4 |
| Denmark | 2 | 6 | 10 | 16 | 2.9 |
| Estonia | 0 | 0.1 | 0.1 | 0.2 | 0.1 |
| Finland[b] | 0 | 0.1 | 1 | 1 | 0.2 |
| France | 719 | 988 | 1,671 | 2,659 | 40.3 |
| Germany | 7,408 | 17,193 | 7,485 | 24,678 | 302.8 |
| Greece | 150 | 205 | 426 | 631 | 58.9 |
| Hungary | 1 | 2 | 3 | 4 | 0.4 |
| Ireland[b] | 0 | 0.1 | 3 | 3 | 0.5 |
| Italy | 2,326 | 3,470 | 9,284 | 12,754 | 212.6 |
| Latvia | 0 | 0 | 0.2 | 0.2 | 0.1 |
| Lithuania | 0.1 | 0.2 | 0.1 | 0.3 | 0.1 |
| Luxembourg[b] | 0.9 | 25 | 5 | 30 | 58.9 |
| Malta | 0.1 | 1.5 | 10 | 12 | 29 |
| Netherlands | 21 | 83 | 20 | 103 | 6.1 |
| Norway | 0.1 | 0.1 | 0 | 0.1 | 0.02 |
| Poland | 0.4 | 2 | 1 | 3 | 0.1 |
| Portugal | 38 | 150 | 33 | 184 | 16.2 |
| Romania | 1 | 2 | 2 | 3 | 0.2 |
| Slovakia | 145 | 148 | 321 | 468 | 85.1 |
| Slovenia | 27 | 35 | 46 | 81 | 39.6 |
| Spain[a] | 441 | 4,029 | 372 | 4,400 | 93.6 |
| Sweden | 1 | 12 | 3 | 15 | 1.6 |
| Switzerland[a] | 39 | 111 | 105 | 216 | 26.2 |
| Turkey[b] | 0.1 | 1 | 5 | 6 | 0.1 |
| Ukraine | 3 | 3 | 188 | 190 | 4.1 |
| United Kingdom | 62 | 91 | 784 | 875 | 13.9 |

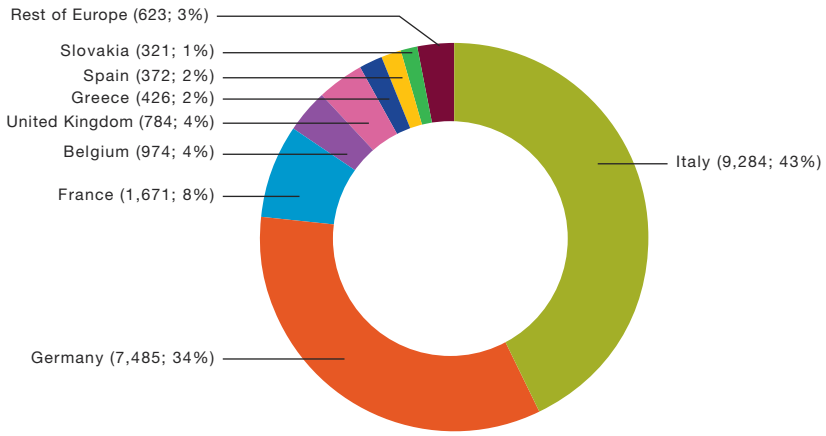
[a] Data here are installations in AC power, as officially reported.
[b] 2011 data are provisional.
**Note** Regional data for Belgium, France, Germany, Italy, Spain and United Kingdom can be found in Annex 3.

## 3.2. The European market in 2011 and forecast until 2016

### 3.2.a. General presentation

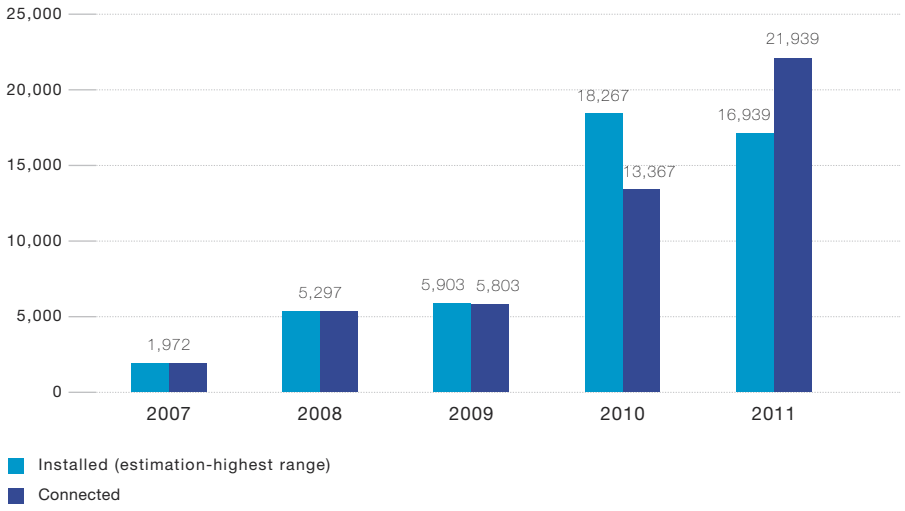
With almost 22 GW of grid connected PV installations in 2011, Europe has increased its cumulative capacity base by over 50% compared to 2010. This impressive figure was mainly driven by two markets: Italy and Germany, with Italy connecting 9,284 MW – a record in the history of the sector. France also performed well but mainly thanks to past installations that remained to be connected. United Kingdom (UK) for the first time entered the top 10 with a record of 784 MW of systems installed and connected.

**Figure 7** - European market split 2011 (MW; %)



### 3.2.b. Installations vs. connections in Europe

**Figure 8** - Annual difference between installations and grid-connections (MW)




While most market reports present installation figures, EPIA reports newly grid-connected capacities. The reason is simple: There is no reliable methodology for counting installations and most official bodies report systems connected to the grid. Installation figures are interesting for the PV industry (they describe the demand for PV systems), but grid-connection data are more relevant when considering the increasing share of PV in the electricity mix (and the expenditures in FiTs).

The gap between installations and connections is not new; discrepancies have been noted in Belgium and France in recent years. But it increased significantly in 2010 due to two specific country situations. The first was in Italy, where the so-called "Salva Alcoa" decree allowed system owners to receive the 2010 FiT if a system installed in 2010 was connected by June 2011; this led to a rush of installations by the end of 2010 of nearly 3.5 GW. The second country was France, where very long delays observed between end of the project commissioning and its actual connection by the main grid operator (ERDF) led to connection delays of longer than 18 months in some cases.

Had those numbers been confirmed, the European demand for PV systems would have shifted up by 5 GW in 2010, going from some 13 GW connected in 2010 in Europe to some 18 GW (reflecting the demand for PV systems). In 2011, only 16.9 GW would have then been counted instead of 21.9 GW – completely changing the interpretation of market evolution during those two years.

The reality looks more complex with installation numbers difficult to obtain. For example, reports from Italy indicate that a part of those 3.5 GW was not really *installed* in 2010, but *reported* as having been installed. And in Germany, the concept of "commercial commissioning" of PV systems – which can allow reporting systems that are not yet installed or connected – creates another complication in the counting of PV systems. It could be argued that part of the 3 GW reported in December 2011 in Germany was not really connected, lowering the 2011 connections, but this has not been taken into account since the situation has been known for years and has an impact on numbers that is not precisely identifiable. In other words, one can consider that the installation numbers (and thus the demand for PV systems) remained roughly stable in Europe between 2010 (16.4 to 18.4 GW) and 2011 (16.9 to 18.9 GW), depending on the assumptions. The report assumes then that in Italy between 1.5 and 3.5 GW were installed in 2010 and connected in 2011; in France that was the case for 1.5 GW. Figure 8 shows the extreme case for installations.

### 3.2.c. Market segmentation

**Figure 9** - European PV market segmentation 2011 (%)

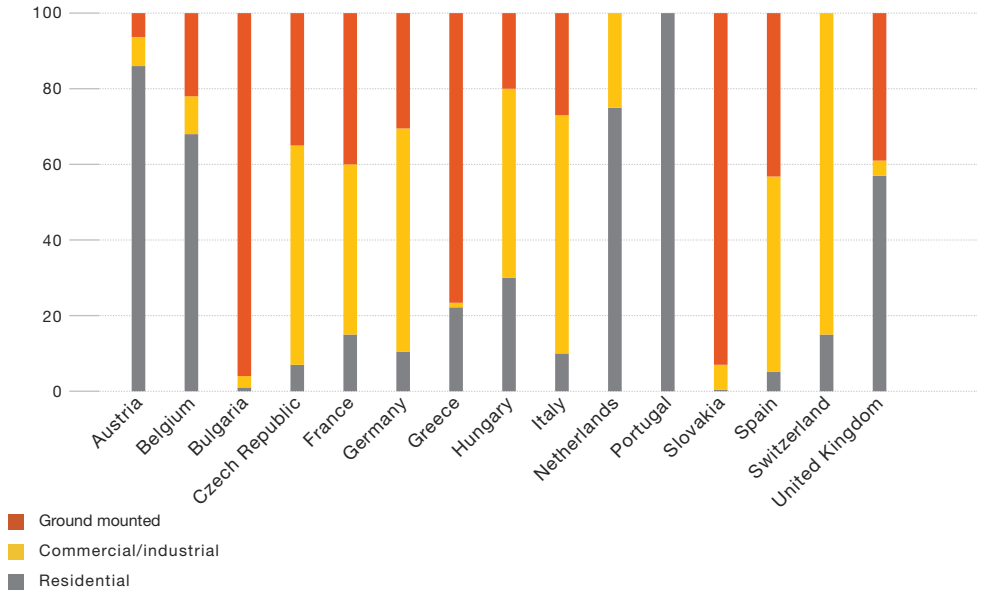



**Figure 10** - European PV cumulative capacity segmentation until 2011 (%)

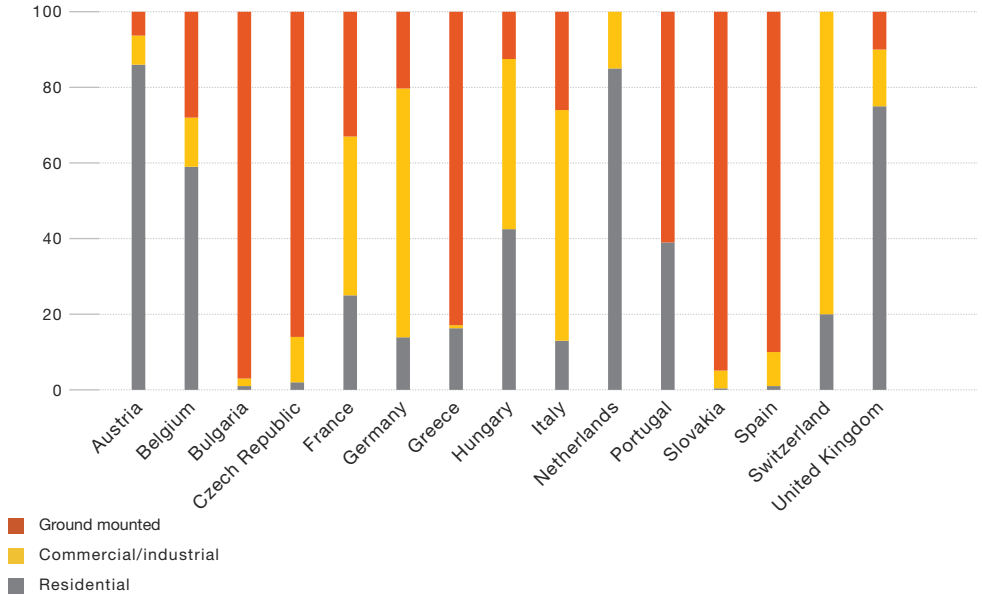



Figure 9 above shows how the 2011 market was shaped, distinguishing among ground mounted, commercial and industrial rooftop, and residential applications. The segmentation is not classified according to standard sizes, since the system size largely depends on the respective structure of support schemes. Overall **a very large share of the market in Europe is concentrated in the commercial rooftop segment**; this trend will continue, based on the foreseen evolution of the legal framework.

Figure 10 shows how the cumulative capacity in the reported countries is spread among the three main market segments considered. Comparison with the previous graph showing only the split for 2011, shows that markets which were originally mainly made up of ground-mounted systems and that have been constrained (e.g. Spain or Czech Republic) are moving towards the commercial rooftop markets.

### 3.2.d. European PV forecasts until 2016

**Figure 11** - European annual market scenarios until 2016 - Moderate and Policy-Driven (MW)

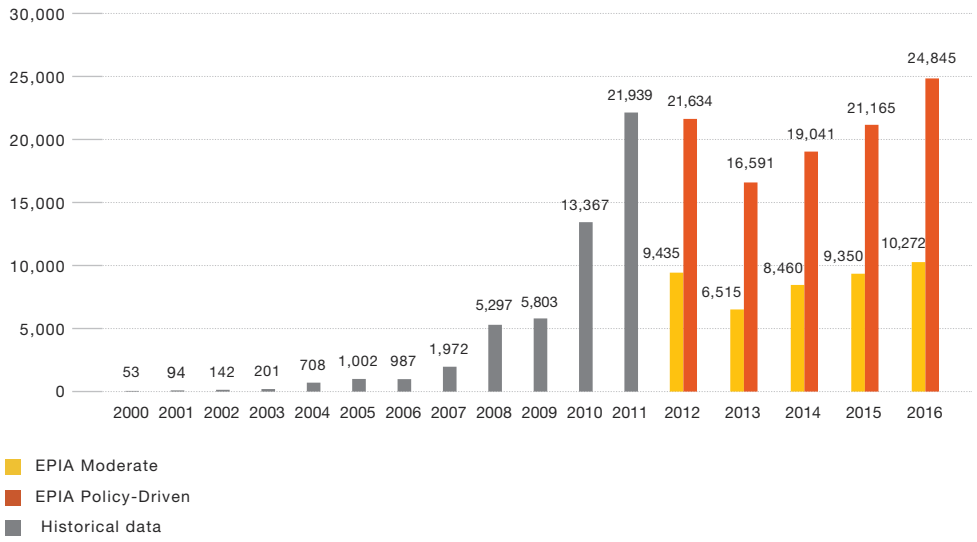
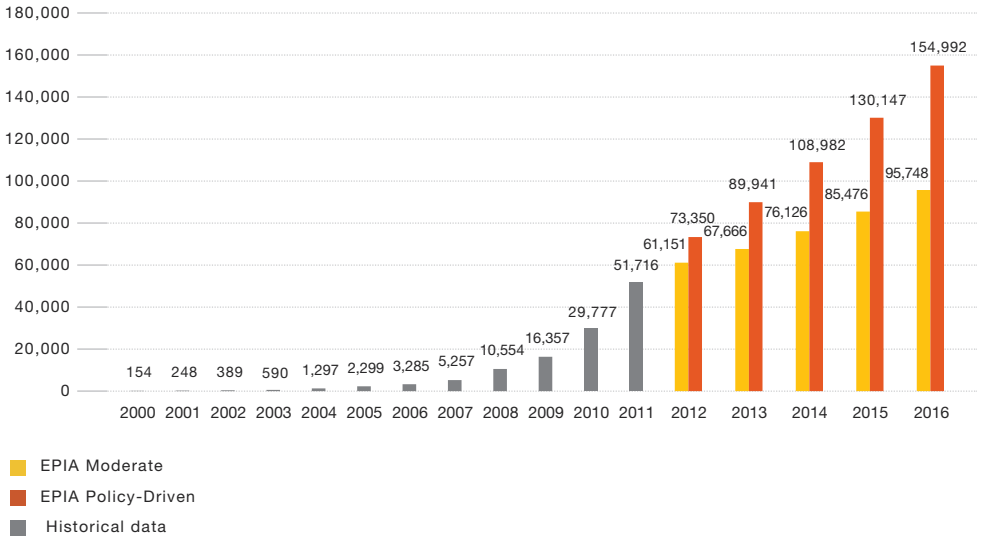



**Figure 12** - European cumulative scenarios until 2016 - Moderate and Policy-Driven (MW)




As already stated, when considering last year's newly connected systems, the major growth experienced by the European PV market in 2010 was largely repeated in 2011. In terms of new installations it was rather stable. The very dynamic growth observed at the beginning of 2012 suggests that the market could perform as well this year as last in terms of newly installed capacity. But the future is uncertain as PV enters the competitiveness era because of the potential early phase-out or drastic decrease of some FiT programmes. It is not yet clear how the market is going to react to these new conditions.

## PV Competitiveness?

PV electricity is cheaper than many people think. In the coming years the technology will become even more cost-effective and competitive — and qualify therefore as a vital part of Europe's energy future.

Competitiveness of PV electricity for final consumers is defined by EPIA as **"dynamic grid parity"** – the moment at which, in a particular market segment in a specific country, the present value of the long-term net earnings (considering revenues, savings, cost and depreciation) of the electricity supply from a PV installation is equal to the long-term cost of receiving traditionally produced and supplied power over the grid.

In the 2011 study "Solar Photovoltaics Competing in the Energy Sector", EPIA demonstrated that a certain level of competitiveness could be achieved as early as 2013 in Italy in the commercial segment and then spread all across the continent in the different market segments by the end of the decade. Further price decreases have since closed the competitiveness gap even more quickly. In the residential and commercial segments in Germany and Italy, some installations could already be competitive in 2012.

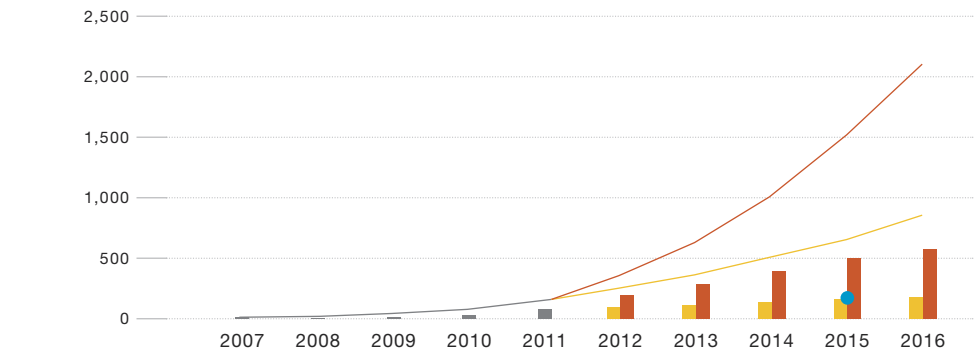
*Download the full study at www.epia.org/publications*

### 3.2.e. Scenarios by country

- **Austria**

Austria's policy framework to support PV largely improved in 2011, which allowed many projects that had been waiting to receive a FiT to go forward. As a result the **market grew to 80 MW in 2011**. Even if the yearly budget to support PV deployment has quadrupled, reaching €8 million, the market is still capped and not allowed to grow at its full potential. EPIA estimates that this potential could be at nearly 500 MW on average per year until 2020.

**Figure 13** - Austria (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 2 | 5 | 20 | 43 | 80 | 100 | 120 | 140 | 160 | 180 |
| EPIA Policy-Driven | | | | | | 200 | 300 | 400 | 500 | 600 |
| EPIA Moderate (cumulative) | 28 | 33 | 53 | 96 | 176 | 280 | 400 | 540 | 700 | 880 |
| EPIA Policy-Driven (cumulative) | | | | | | 380 | 680 | 1,100 | 1,600 | 2,200 |
| National target 2015 | | | | | | | | | 179 | |

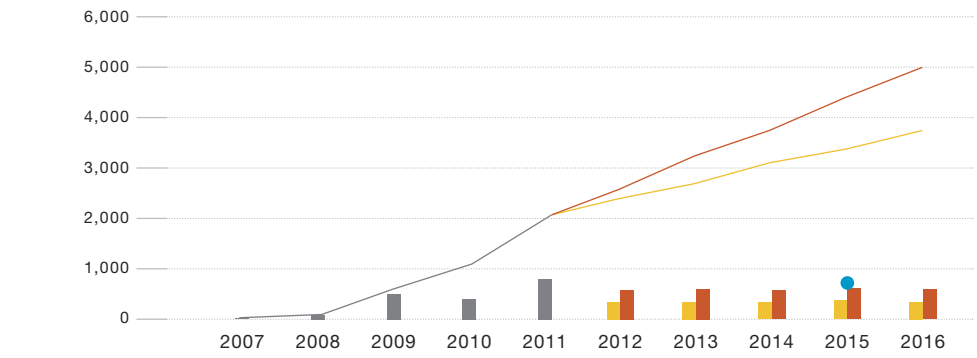
## • Belgium

Belgium is actually made up of three markets – Flanders, Wallonia and Brussels Region – with energy matters regulated at regional level.

**Last year Flanders made up at least 815 MW (AC) of the entire market, while over 107 MW were installed and connected in Wallonia**. The large majority of systems are in the residential segment, especially in Wallonia. The Brussels market is very low and is not considered in this document in detail. In Belgium, support schemes for residential systems include both green certificate (GC) schemes and net metering for systems below 10 kVA. In addition, until the end of 2011 individuals could recover a large part of their investment in a PV system through a tax credit advantage. This explains why the market is mainly concentrated in the residential segment. In Wallonia, anyone willing to install systems larger than 10 kVA are obliged to self-consume about 50% of the production and the building needs to undergo an energy audit. These two conditions considerably limit development of the commercial and industrial segments. For systems over 250 kW, the support is still insufficient; further reductions in the future will not help the development of this segment.

For the short- to medium-term, the Belgian market is likely to favour small-scale PV installations. Nevertheless, 2012 will probably be still quite dynamic. This is particularly true in Flanders, notwithstanding the tax credit cancellation. But experts in Flanders are not certain how the market will react from 2013, when the duration of GCs will drop from 20 to 15 years. Installed capacity in Belgium reached over 183.5 W per habitant in 2011, putting it in place behind Germany, Italy and Czech Republic by this measure; this is almost exclusively thanks to residential systems.

**Figure 14** - Belgium (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 23 [22]ª | 81 [77]ª | 519 [494]ª | 417 [397]ª | 974 [928]ª | 350 | 350 | 350 | 350 | 350 |
| EPIA Policy-Driven | | | | | | 600 | 600 | 600 | 600 | 600 |
| EPIA Moderate (cumulative) | 27 [26]ª | 108 [103]ª | 627 [597]ª | 1,044 [994]ª | 2,018 [1,922]ª | 2,400 | 2,700 | 3,100 | 3,400 | 3,800 |
| EPIA Policy-Driven (cumulative) | | | | | | 2,600 | 3,200 | 3,800 | 4,400 | 5,000 |
| National target 2015 | | | | | | | | | 713 | |

ª AC figures officially reported.

*Note: Statistics in Belgium are collected in AC power [figure in brackets], and have been converted into a DC number multiplying it by a factor of 1.05 in order to compare it to other countries.*

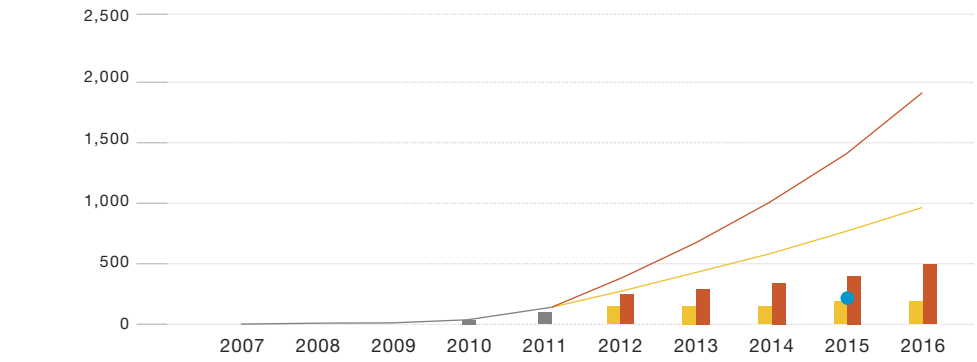
- **Bulgaria**

Bulgaria's new Renewable Energy Source (RES) Act was approved in May 2011 and allowed for the development and **connection of about 100 MW of PV in 2011**.

The new law has now fixed the FiT level, which had previously fluctuated. Now the market has a better long-term outlook, with strong interest again for PV. This resurgence of interest has raised concerns with the national electricity company and grid operators, who requested another revision of the RES Act at the end of November 2012. The objective of such revision would be to define schedules that would delay grid connection of all projects with preliminary grid connection contracts. The provision for determination of a maximum yearly capacity which can be connected to the grid remains valid for new projects started after 1 July 2012. The amendments to the RES Act were finally adopted in late March 2012, meaning that further development in Bulgaria could be challenging over the next few years. The most important changes concern the process for grid connection of projects. To control the available capacity to be connected to the electricity system, operators will regularly (every six months) update information on the already connected RES capacities and those that are yet to be connected.

The law also simplifies the administrative process for small systems up to 30 kW, reducing lead times for grid connections. The changes in the RES legislation were to take effect by the end of April 2012.

**Figure 15** - Bulgaria (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 0 | 1 | 6 | 28 | 100 | 150 | 150 | 150 | 200 | 200 |
| EPIA Policy-Driven | | | | | | 250 | 300 | 350 | 400 | 500 |
| EPIA Moderate (cumulative) | 0 | 1 | 7 | 35 | 135 | 280 | 430 | 580 | 780 | 980 |
| EPIA Policy-Driven (cumulative) | | | | | | 380 | 680 | 1,000 | 1,400 | 1,900 |
| National target 2015 | | | | | | | | | 220 | |

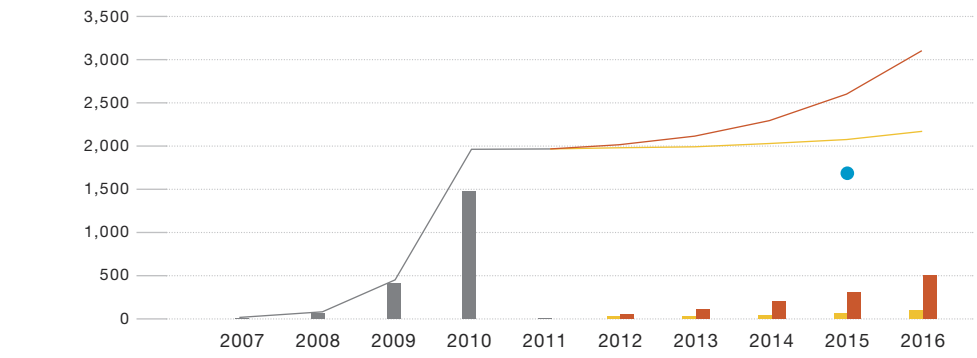
## • Czech Republic

After two very dynamic years, the PV market in Czech Republic was moribund in 2011. **Only 6 MW of new systems were connected to the grid**, compared to almost 1.5 GW in 2010. The key reasons are a fall of support of more than 45%, limiting it only for small rooftop systems, and a so-called grid freeze. Grid operators say this grid limit would almost have been reached, and therefore they have stopped connection of any additional PV and wind installations without exception since February 2010.

Starting this year the grid freeze has been released but the high voltage grid operator CEPS imposed a limit of 65 MW for new solar and wind installations in 2012. Up to this level new projects are assessed on a case-by-case basis.

Given the negative image of PV today in Czech Republic in the mind of politicians, grid operators and a majority of citizens, the future of PV is very uncertain. The key to re-starting such a market lies in the residential and small rooftop segments, which are socially more "acceptable" for electricity consumers and which can minimise transmission network congestion on very sunny days and during low-consumption periods. The grid operators claim a technical capacity of around 600 MW for PV and wind which has been reserved and unused. There have been some calls for a new law, but nothing has been proposed yet.

**Figure 16** - Czech Republic (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 3 | 61 | 398 | 1,490 | 6 | 10 | 20 | 30 | 60 | 100 |
| EPIA Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| EPIA Moderate (cumulative) | 3 | 64 | 462 | 1,952 | 1,959 | 2,000 | 2,000 | 2,000 | 2,100 | 2,200 |
| EPIA Policy-Driven (cumulative) | | | | | | 2,000 | 2,100 | 2,300 | 2,600 | 3,100 |
| National target 2015 | | | | | | | | | 1,680 | |

- **France**

France saw **over 1.6 GW of new systems connected last year**, mainly a result of installations done in 2010. Less than 10% of this capacity was installed during 2011.

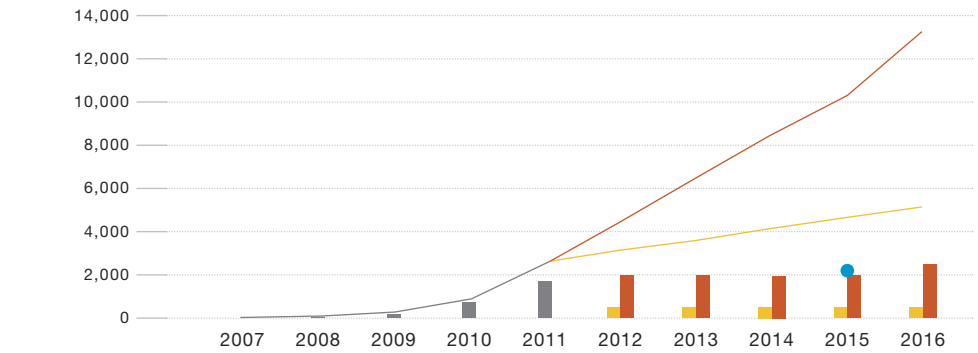
The new support framework in place since March 2011 aims to limit the annual market size to 500 MW. It allows systems of up to 100 kW to benefit from a remunerative FiT level; for systems larger than that the FiT is extremely low (slightly above 0.10 €/kWh). Alternatively larger projects can apply to calls for tenders. In 2011 developers had to wait until the summer to apply for several types of such calls. The results of the complex tendering scheme will not be known until 2012, shifting the market development by six months to more than a year and the connection of systems even later. This means a large part of the systems expected to be connected to the grid in 2012 will correspond to projects dating from the end of 2010 and installed in 2011 and 2012.

The national energy mix has been very much debated during this crucial electoral year for France. But in any case the energy-related mindset in France might not lead to a fundamental change in the way RES are developing. For most politicians, nuclear power remains the preferred low-carbon technology.

The hope mainly comes from the potential development of projects under Power Purchase Agreements (PPAs), in which a third-party developer owns and operates a PV system and which fall outside of the FiT scheme. Another obligation that new buildings be self-sufficient in terms of energy consumption by 2020 also adds some hope for a future re-development of PV in France.

Overseas departments of France accounted for some 300 MW of total capacity at the end of 2011.

**Figure 17** - France (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 13 | 58 | 185 | 719 | 1,671 | 500 | 500 | 500 | 500 | 500 |
| EPIA Policy-Driven | | | | | | 2,000 | 2,000 | 2,000 | 2,000 | 2,500 |
| EPIA Moderate (cumulative) | 26 | 84 | 269 | 988 | 2,659 | 3,200 | 3,700 | 4,200 | 4,700 | 5,200 |
| EPIA Policy-Driven (cumulative) | | | | | | 4,700 | 6,700 | 8,700 | 10,700 | 13,200 |
| National target 2015 | | | | | | | | | 2,151 | |

- **Germany**

With **7,485 MW of newly installed capacity in 2011**, Germany again beat its previous record. The fast decrease in system prices in 2011, combined with the absence of the expected FiT adjustment in July, led to an extremely strong fourth quarter with about 3 GW of new systems eligible for the FiT in December alone.

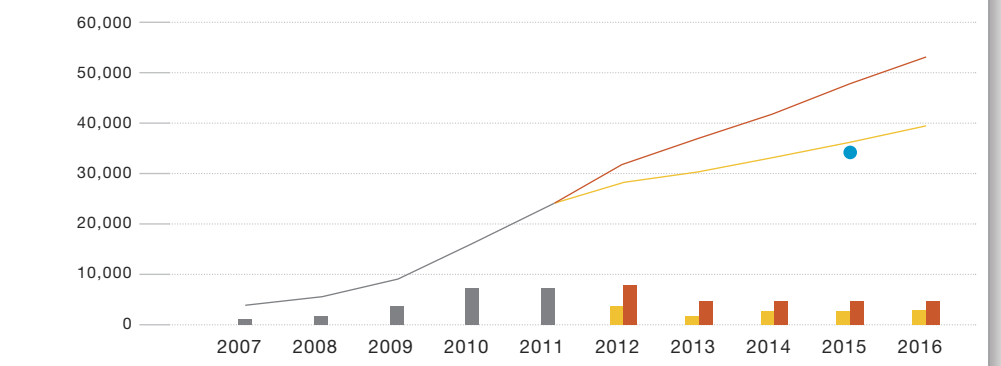
Even if it is still unclear whether these 3 GW have really been installed and connected in December 2011 (due to the concept of "commercial commissioning" that allows a system to be registered before its real connection to the grid), this shows once again the strong reactivity of markets in anticipation of further FiT reductions, and highlights the need for a tight and dynamic market control mechanism.

Again in 2012, already 1.9 GW were installed in the first quarter in reaction to the announcement of a major reduction of the FiT in April 2012 together with a transitional period. The market is then expected to boom again this year, despite the will of the government to constrain it.

Nevertheless, in several market segments the new FiT in Germany is now below the retail price of electricity. This very low level should favour self-consumption, if the industry can remain profitable with the low support levels that are now in place. Demand side management tools such as controlled heat-pumps could gain some market share in the rooftop segment, in order to maximise the return on investment. In the ground mounted segment, the low FiT level will push for installations in the sunniest regions of the country that have already experienced a high penetration of PV, and will favour low-cost manufacturers to ensure the profitability of the investments.

The effectiveness of the new mechanism adjusting FiTs on a monthly basis is still unproven, but should in principle allow for a more regular adaptation of support in accordance with the progressive reduction of prices. This could in future avoid the boom effect seen in 2011.

**Figure 18** - Germany (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 1,271 | 1,809 | 3,806 | 7,408 | 7,485 | 4,000 | 2,000 | 3,000 | 3,000 | 3,000 |
| EPIA Policy-Driven | | | | | | 8,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| EPIA Moderate (cumulative) | 4,170 | 5,979 | 9,785 | 17,193 | 24,678 | 28,700 | 30,700 | 33,700 | 36,700 | 39,700 |
| EPIA Policy-Driven (cumulative) | | | | | | 32,700 | 37,700 | 42,700 | 47,700 | 52,700 |
| National target 2015 | | | | | | | | | 34,279 | |

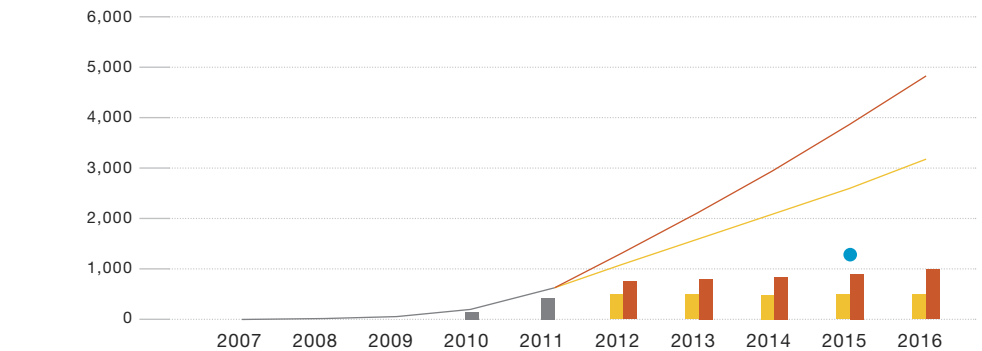
- **Greece**

Of the 426 MW of systems connected to the grid in Greece last year, over three-quarters were ground-mounted systems. If Greece were not going through a financial crisis it would certainly have faced a real PV market overheat in 2011. The difficulty to finance some projects is constraining the market. Nevertheless, **over 400 MW in a country going through a severe financial crisis is remarkable and can largely be attributed to a series of administrative simplifications** adopted at the end of 2010. These include:

- Large PV systems, frozen since 2008, can be filed again
- Removal of the requirement for a production license for systems below 1 MW
- Simpler environmental permitting both for residential and ground mounted systems
- Expanded authorisation of systems (in facades, carports, warehouses, agricultural land under certain conditions, etc.)

The future for PV in Greece looks promising. FiTs were adjusted at the beginning of 2012 but they are still generous, largely compensating for the very high cost of financing projects. By 2020 Greece has set an objective of 2.2 GW of PV cumulative installed capacity. At the current pace of PV development, this could be reached between 2014 and 2016. Independently from the standard market development, the Helios project announced in August 2011 aims at developing a large project of up to 10 GW by 2020 and at helping the Greek economy by taking advantage of its abundant sunshine. If realised, the project could also help Europe reach its 2020 RES target. But to succeed it will require the right financing structure, most probably outside the current FiT levy which is much higher in Greece than in other countries (i.e. Germany). It will also require major investments in new or existing transmission lines to connect to the main European electricity markets. Alternatively, the Helios project could also be used to reduce the burden for importing coal, gas and oil for power production, and to sell only a small fraction to neighbouring countries.

**Figure 19** - Greece (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 1 | 10 | 36 | 150 | 426 | 500 | 500 | 500 | 500 | 500 |
| EPIA Policy-Driven | | | | | | 750 | 800 | 850 | 900 | 1,000 |
| EPIA Moderate (cumulative) | 8 | 18 | 55 | 205 | 631 | 1,100 | 1,600 | 2,100 | 2,600 | 3,100 |
| EPIA Policy-Driven (cumulative) | | | | | | 1,400 | 2,200 | 3,000 | 3,900 | 4,900 |
| National target 2015 | | | | | | | | | 1,270 | |

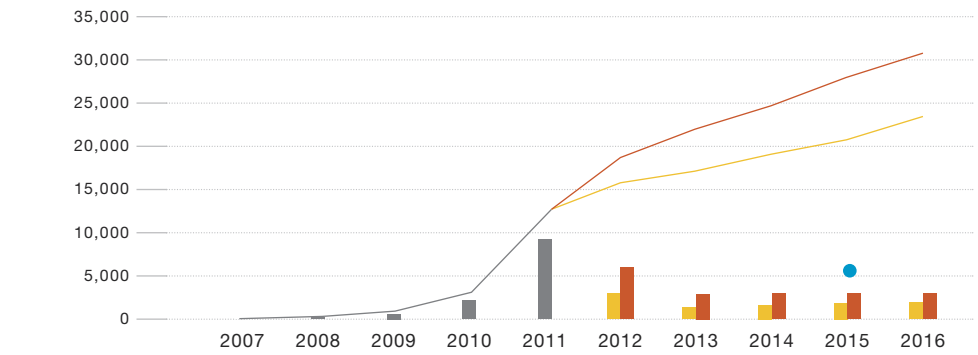
- **Italy**

From a regulatory standpoint, 2011 was a complicated year for the PV sector in Italy. The year started with a new 3rd *Conto Energia,* which was soon replaced by a 4th *Conto* from June 2011, expected to rule the evolution of the FiT until 2016. The new target was for 23 GW to be installed by that time, while the National Renewable Energy Action Plan (NREAP) submitted to the EU by the end of 2010 foresees reaching 8 GW by 2020 (5.5 GW by 2015).

**In 2011 9,284 MW of PV systems were connected to the grid**. As previously noted (see section *"Installations vs. connections in Europe"*), almost 3.5 GW were installed at the end of 2010 but connected in 2011, thus falling under the 2nd *Conto* in terms of incentives; another 1.5 GW corresponded to the 3rd *Conto* and the rest to the 4th *Conto Energia*. The 4th *Conto* still in force at the time of publication foresees that FiTs should not cost more than "€6 to €7 billion a year". At the end of 2011, given the rush observed, Italy's FiT costs were already at €5.5 billion per year.

A 5th *Conto* is under discussion and will likely lead to a huge rush in demand before it enters into force probably from July 2012, leading to potentially 6 GW of new connections in 2012. The outlook for the coming years is uncertain. Depending on the type of market control mechanism (a cap per type of systems is in discussion), the market will be either constrained or will grow rapidly again.

**Figure 20** - Italy (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 58 | 338 | 712 | 2,326 | 9,284 | 3,000 | 1,500 | 1,750 | 2,000 | 2,000 |
| EPIA Policy-Driven | | | | | | 6,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| EPIA Moderate (cumulative) | 93 | 432 | 1,144 | 3,470 | 12,754 | 15,800 | 17,300 | 19,000 | 21,000 | 23,000 |
| EPIA Policy-Driven (cumulative) | | | | | | 18,800 | 21,800 | 24,800 | 27,800 | 30,800 |
| National target 2015 | | | | | | | | | 5,500 | |

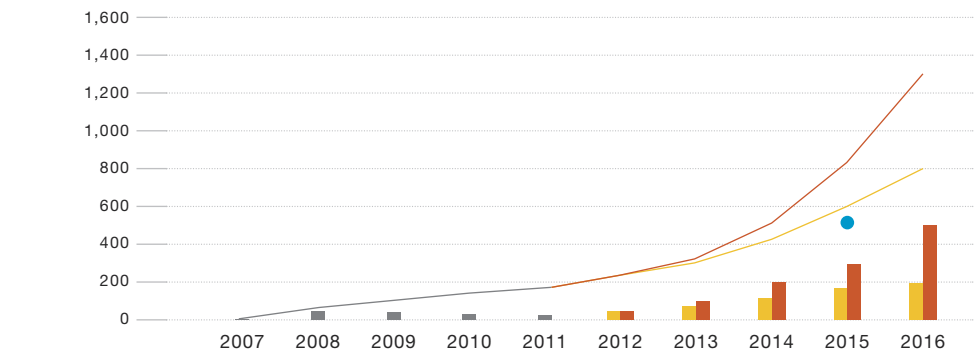
- **Portugal**

Only systems under the so-called "micro-generation" scheme developed in Portugal in 2011. "Micro-generation" refers to systems below 3.68 kW while "mini-generation" targets systems above that threshold. The mini-generation scheme, though adopted, is not operational since projects are awaiting inspection and thus the power cannot be counted. That means no commercial or industrial rooftop systems have yet developed in a way that can be quantified. No licenses for ground mounted systems were allocated last year.

With the financial crisis, drastic measures have been adopted affecting the RES sector. In 2012, caps per segment have been reduced as follows: 10 MW for micro-generation and 30 MW for mini-generation. **Little more than 50 MW of new added capacity can be expected for next year**.

The main hope for re-boosting the market lies in the potential adoption of a net-metering scheme that could launch the rooftop market both in the residential and commercial segments. Portugal, which has set an objective of only 1 GW of PV installed capacity by 2020 has clearly not yet assessed the true potential of PV. The country could triple its ambition and allow for a yearly market of about 300 MW per year.

**Figure 21** - Portugal (MW)



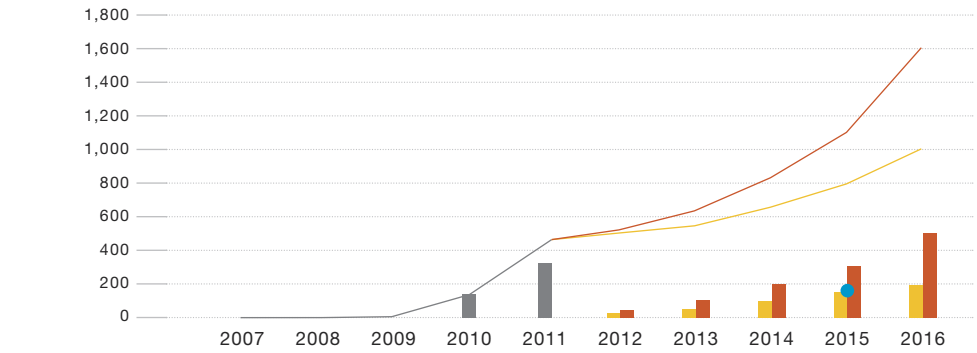

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 13 | 52 | 44 | 38 | 33 | 50 | 80 | 120 | 170 | 200 |
| EPIA Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| EPIA Moderate (cumulative) | 16 | 68 | 112 | 150 | 183 | 230 | 310 | 430 | 600 | 800 |
| EPIA Policy-Driven (cumulative) | | | | | | 230 | 330 | 530 | 830 | 1,300 |
| National target 2015 | | | | | | | | | 540 | |

## • Slovakia

Slovakia has been experiencing a situation similar to that of Czech Republic, shifted by one year and on a smaller scale. **In 2011, 321 MW were connected to the grid** mainly in the ground mounted segment. When publishing its National Action Plan in 2010 Slovakia clearly underestimated PV's potential; the 2020 target (160 MW) was already achieved at the beginning of 2011. At the end of 2011, 85 W per habitant were installed in Slovakia – about one panel for every two habitants.

Overwhelmed by the rapid development of large-scale systems, the government has since July 2011 limited the support scheme to systems up to 100 kW. The level of tariffs has been dramatically reduced in 2012 to slightly below 0.20 €/kWh over 15 years, making PV investment less attractive than in neighbouring countries.

**Figure 22** - Slovakia (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 0.3 | 0.3 | 0.1 | 145 | 321 | 30 | 50 | 100 | 150 | 200 |
| EPIA Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| EPIA Moderate (cumulative) | 2 | 2 | 3 | 148 | 468 | 500 | 550 | 650 | 800 | 1,000 |
| EPIA Policy-Driven (cumulative) | | | | | | 520 | 620 | 820 | 1,100 | 1,600 |
| National target 2015 | | | | | | | | | 160 | |

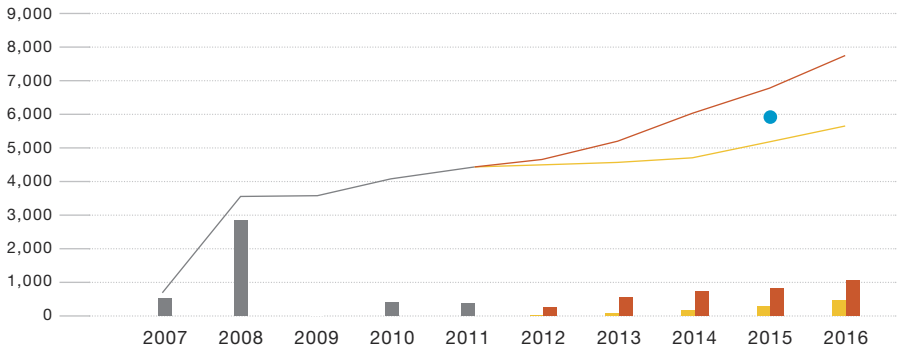
- **Spain**

Spain saw a decrease in new connections in 2011 compared to 2010. This is mainly due to the complex registration process, which makes it hard to foresee when a project will be completed, and due to the very low FiT support level compared to other European markets. The effect of the retroactive cut on FiT adopted at the end of 2010 could already be felt from September 2011: PV electricity producers started producing electricity without receiving any remuneration, since after this period PV plants had reached the number of hours for which they could receive support during the year.

Since the end of 2010, Spain has been awaiting a new net-metering regulation which should not add a financial burden on the already huge "tariff deficit". This deficit, which currently stands at around €30 billion, is the accumulated difference between the cost of generating, distributing and supplying electricity for regulated markets and the tariffs for those markets fixed by the government since 2000. The regulated tariffs have not increased sufficiently since 2000 and so the gap has increased. Renewables are held responsible for this gap, even though there is no correlation between the amount of incentives for renewable electricity and the tariff deficit, nor between the electricity production based on renewable energies and the tariff deficit. Nevertheless, early in January 2012, the Spanish government imposed a moratorium on the development of any new generation capacity (all energy technologies are affected) through a Royal Decree-Law (without requiring the approval of the Parliament), which has stopped all support to new PV systems.

It is hoped that the new net-metering scheme will allow for development of PV in the rooftop segments and in particular in the commercial one, since consumption and production align quite well in Spain thanks to the heavy use of air conditioning in sunny hours. Projections for Spain are not very optimistic; they take into account a potential progressive deployment from the moment grid parity will have been reached in each market segment.

**Figure 23** - Spain (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 569 *[542]*[a] | 2,843 *[2,708]*[a] | 20 *[19]*[a] | 441 *[420]*[a] | 372 *[354]*[a] | 50 | 100 | 200 | 300 | 500 |
| EPIA Policy-Driven | | | | | | 300 | 500 | 750 | 850 | 1,000 |
| EPIA Moderate (cumulative) | 724 *[690]*[a] | 3,568 *[3,398]*[a] | 3,588 *[3,417]*[a] | 4,029 *[3,837]*[a] | 4,400 *[4,191]*[a] | 4,500 | 4,600 | 4,800 | 5,100 | 5,600 |
| EPIA Policy-Driven (cumulative) | | | | | | 4,700 | 5,200 | 6,000 | 6,800 | 7,800 |
| National target 2015 | | | | | | | | | 5,918 | |

[a] AC figures officially reported.

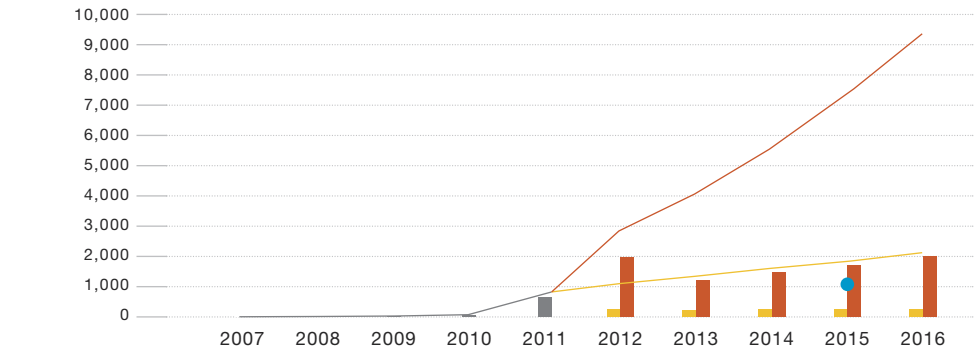
*Note: Statistics in Spain are collected in AC power [figure in brackets]; and have been converted into a DC number multiplying it by a factor of 1.05 in order to compare it to other countries.*

## • United Kingdom

The UK market boomed in 2011. The government's announcement in January 2011 that it would conduct a first fast-track review of FiTs triggered a rush to complete large-scale projects in Q1 and Q2. The expected review of all tariffs finally came earlier than foreseen, further accelerating the growth by the end of 2011. Consequently hundreds of megawatts were connected in the days leading up to the 12 December 2011 deadline for residential systems to benefit from a generous FiT. The new tariff, which decreases by over 50% the level of support for small-scale PV systems, remains workable and is likely to trigger a dynamic market again this year. An additional review will most likely reduce the tariffs again starting in July 2012.

Nevertheless the climate change minister has publicly announced that the government would like to revise the target upwards to 22 GW by 2020 (from 2.7 GW in the current plan). While this is just a political announcement, it reflects the increasing awareness of the potential of PV in the country. Also, the budget allocated for the Micro Certification Scheme (MCS) has been doubled to reflect the huge development of PV.

**Figure 24** - United Kingdom (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 4 | 6 | 7 | 62 | 784 | 250 | 250 | 250 | 250 | 250 |
| EPIA Policy-Driven | | | | | | 2,000 | 1,250 | 1,500 | 1,750 | 2,000 |
| EPIA Moderate (cumulative) | 16 | 22 | 29 | 91 | 875 | 1,100 | 1,400 | 1,600 | 1,900 | 2,100 |
| EPIA Policy-Driven (cumulative) | | | | | | 2,900 | 4,100 | 5,600 | 7,400 | 9,400 |
| National target 2015 | | | | | | | | | 1,070 | |

- **Other potentially relevant European markets**

Other European countries show significant potential for PV development that is not fully being addressed.

Denmark saw a market of 10 MW developing mainly in the residential segment. Today electricity prices are higher than the actual cost of generating PV in Denmark. With the full net-metering scheme in place since 2010 for systems up to 6 kW combined with a small FiT, it is more profitable to produce one's own electricity than to buy it from the grid. The market is likely to grow to 50 MW or even 100 MW in 2012. Nevertheless there is a risk that the net-metering scheme could be reviewed if it proves too successful. In fact the rapid development of PV is leading to some loss of revenues for grid operators (grid costs) and the State (taxes); since these account for over 50% of the electricity price in Denmark, it is feared that they might soon reconsider the current scheme if it becomes too attractive.

The Netherlands benefits from a similar situation to Denmark, since the main incentive for developing the market is a net-metering scheme for systems up to 15 kW. Above this size a small FiT does not allow for the development of many systems. Nevertheless the current scheme permitted the development and connection of about 20 MW in 2011 alone. This constrained 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 who may lose customers unless they are able to adapt their business models to this new market environment.

Poland is the largest electricity market in Europe that has not yet started to develop PV. Some MW projects benefiting from ad-hoc development plans have been announced, but they are yet to be completed. A new Renewable Energy Act is in discussion and should enter into force in 2013. It is likely to provide for two GCs per MWh of PV electricity instead of one today. This would increase the remuneration of PV systems and potentially start a market.

Romania also has a certain untapped potential. In October 2011 the new RES law providing six GCs for PV for each MWh produced finally entered into force. The announcement of a potential reduction in the number of GCs could produce a rush of development in 2012. It will be important for the Romanian government to provide long-term visibility to investors as to the evolution of support to PV if it wants to avoid creating a Czech-style bubble that puts a complete halt to market development.

Switzerland allowed for little more than 100 MW to be developed and connected in 2011; the country benefits from a generous though capped FiT with a yearly budget of about €400 million for all RES, of which the maximum share for PV is set at 30%. An additional 30 to 50 MW developed by mostly private investors is on the waiting list in a top-level position. The number of PV projects on the waiting list is increasing steadily; it had reached about 460 MW at the end of 2011. The decrease in system prices combined with a reduced FiT level in 2012 (-18%) might allow for a progressive growth of the market within the limit of the annual budget.

**Turkey's** market could be almost 800 MW per year if it were to develop at its actual potential. Apparently less than 5 MW were installed in 2011 in the country. The support scheme in place since December 2010 has yet to produce the expected effect. It was accompanied by a plan to develop 600 MW by 2015 in a selected number of regions. A simplification of authorisation processes for systems of up to 500 kW adopted in early 2012 is likely to allow finally for a take-off of the market this year.

**Ukraine** experienced impressive growth last year with almost 190 MW connected, thanks solely to the development of two very large power plants realised by one company. A strong local content rule gives more generous incentives to systems with at least 30% of the system value produced in Ukraine. This rate is expected to increase to 50% in 2014.

**Other European countries** offer little room for PV deployment, mainly because of the size of their potential markets. It is worth noting, though, that about 45 MW were connected in **Slovenia** last year, quite significant given the size of the country. This represents almost a doubling of the market compared to the previous year. **Sweden** connected 3 MW of new PV capacity outside of a national FiT scheme, thanks to some investment grants and private FiT schemes proposed by some utilities. In the future it is likely that some other European countries may announce utility-scale plans. **Serbia**, for example, is planning to develop 1 GW of PV by 2020 in partnership with one company that will equip carports with PV systems. As grid parity approaches, depending on the individual electricity needs of each country and the rapid decreases in PV prices, such large projects are likely to be announced in a random way. This will make it increasingly difficult to predict market development based on existing policy support schemes.

### 3.2.f. 2020 potential and targets in the EU 27

## PV potential vs. actual market in the EU 27

The SET For 2020 study, published by EPIA in 2009, identifies three possible PV deployment scenarios to 2020 that represent the technology's real potential:

The **Baseline scenario** envisages a business-as-usual case with 4% of the electricity demand in Europe provided by PV in 2020. This represents about 130 GW of cumulative capacity by 2020.

The **Advanced scenario**, with PV meeting 6% of the demand, is based on the maximum PV growth in Europe that is possible without major changes to the electricity infrastructure. This represents about 200 GW of cumulative capacity by 2020.

A third case, which assumes that all barriers are lifted and specific boundary conditions are met, is called the **Paradigm Shift scenario**. This foresees PV supplying up to 12% of EU electricity demand by 2020. This represents about 390 GW of cumulative capacity by 2020.

The table below shows the potential per country by 2020. In each case one of the three scenarios has been chosen, depending on how the market has developed until now and how it can continue to grow in the coming decade if appropriate policy measures are in place and barriers are removed. Corresponding linear annual market potential from now until 2020 has then been derived and compared to last year's market size. In blue are the countries which underperformed and in red the countries which exceeded this annual potential. Overall the EU market was at an appropriate level, but the results are not sustainably balanced, as we have already described.

**Table 1** - PV potential in the EU 27 until 2020 vs. actual market in 2011 (MW)

| | Potential cumulative installed capacity in 2020 | Type of scenario | Potential annual market until 2020 | Actual newly connected capacity in 2011 |
|---|---|---|---|---|
| Austria | 4,500 | Advanced | 480 | 80 |
| Belgium | 4,800 | Advanced | 309 | 974 |
| Bulgaria | 2,000 | Advanced | 207 | 100 |
| Czech Republic | 4,000 | Advanced | 227 | 6.2 |
| Denmark | 600 | Baseline | 65 | 10 |
| France | 30,000 | Advanced | 3,038 | 1,671 |
| Germany | 80,000 | Paradigm Shift | 6,147 | 7,485 |
| Greece | 6,000 | Paradigm Shift | 597 | 426 |
| Hungary | 2,000 | Baseline | 222 | 2.5 |
| Italy | 55,000 | Paradigm Shift | 4,694 | 9,284 |
| Netherlands | 6,000 | Advanced | 655 | 20 |
| Poland | 6,000 | Baseline | 666 | 1.3 |
| Portugal | 3,000 | Advanced | 313 | 33 |
| Romania | 3,000 | Advanced | 333 | 1.6 |
| Slovakia | 2,100 | Advanced | 181 | 321 |
| Spain | 17,000 | Advanced | 1,400 | 371,5 |
| Sweden | 750 | Baseline | 82 | 3,1 |
| United Kingdom | 11,000 | Advanced | 1,125 | 784 |
| Rest of EU 27* | 2,400 | Advanced | 267 | 68 |
| Total EU 27 | 240,150 | | 21,008 | 21,642 |

* Rest of EU includes Cyprus, Estonia, Finland, Latvia, Lithuania, Luxembourg, Malta, Slovenia and Ireland.

Market was lower than actual potential.
Market was at a right level according to potential.
Market exceeded the annual potential.

## NREAPS vs. reality of PV markets

The following table compares the cumulative installed capacity at the end of 2011 in most EU markets, the official National Renewable Energy Action Plan targets for PV by 2020 and the necessary yearly market to reach this 2020 target (linear projection).

**Table 2** - NREAPS vs. reality of PV markets in the EU 27 (MW)

| | Cumulative installed capacity in 2011 | NREAP target for 2020 | Necessary market until 2020 | Target reached in... | Market in 2010 | Market in 2011 |
|---|---|---|---|---|---|---|
| Austria | 176 | 322 | 16.2 | 2012-2014 | 43 | 80 |
| Belgium | 2,018 | 1,340 | N/A | 2011 | 417 | 974 |
| Bulgaria | 135 | 303 | 18.7 | 2012-2013 | 28 | 100 |
| Czech Republic | 1,959 | 1,695 | N/A | 2010 | 1,490 | 6.2 |
| Denmark | 16 | 6 | N/A | 2010 | 2.3 | 10 |
| France | 2,659 | 4,860 | 244.6 | 2013-2015 | 719 | 1,671 |
| Germany | 24,678 | 51,753 | 3,008.3 | 2016-2020 | 7,408 | 7,485 |
| Greece | 631 | 2,200 | 174.4 | 2014-2016 | 150 | 426 |
| Hungary | 4 | 63 | 6.6 | 2013-2015 | 1.1 | 2.5 |
| Italy | 12,754 | 8,000 | N/A | 2011 | 2,326 | 9,284 |
| Netherlands | 103 | 722 | 68.7 | 2015-2018 | 21 | 20 |
| Poland | 3 | 3 | N/A | 2012 | 0.4 | 1.3 |
| Portugal | 183 | 1,000 | 90.7 | 2016-2020 | 38 | 33 |
| Romania | 3 | 260 | 28.5 | 2013-2016 | 1.1 | 1.6 |
| Slovakia | 468 | 300 | N/A | 2011 | 145 | 321 |
| Slovenia | 81 | 139 | 6.4 | 2012-2014 | 27 | 46 |
| Spain | 4,400 | 8,367 | 440,8 | 2016-2020 | 441 | 372 |
| Sweden | 15 | 8 | N/A | 2011 | 1 | 3 |
| United Kingdom | 875 | 2,680 | 200.6 | 2013-2015 | 62 | 784 |
| Rest of EU 27* | 55 | 360 | 34 | 2016-2020 | 4 | 22 |
| Total EU 27 | 51,216 | 84,381 | 3,685 | 2013-2015 | 13,325 | 21,642 |

* Rest of EU includes Cyprus, Estonia, Finland, Latvia, Lithuania, Luxembourg, Malta and Ireland.

Target already reached in 2011-2012 : Country has significantly underestimated PV's potential.
Target to be reached by 2012-2015: Country has underestimated PV's potential.
Target to be reached by 2016-2020: Country has either properly estimated PV's potential (Germany) or has set measures constraining the market to meet the set target not earlier than 2020 (Netherlands, Portugal, Spain).

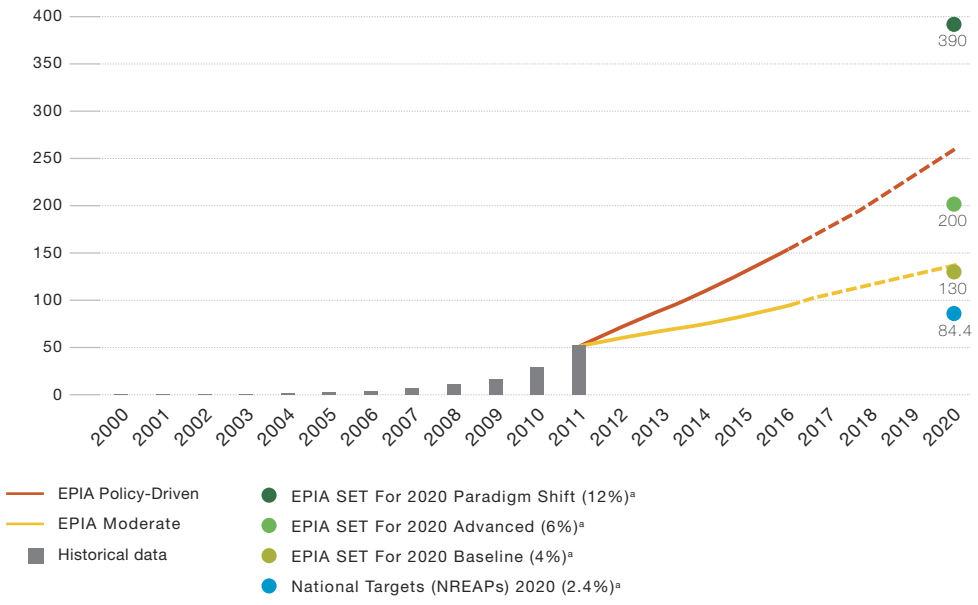
## PV potential, national targets and reality

EPIA has compared various PV market forecasts until 2016 against the three scenarios developed in the SET For 2020 study as well as the NREAPs targets:

- The Moderate scenario for PV until 2016 appears aligned with the 4% target (SET For 2020's Baseline scenario). This represents an improvement from previous EPIA forecasts, which estimated that growth under the Moderate scenario would not quite reach the 4% target by 2020. Thus, it looks reasonable to expect that 4% penetration for PV could be reached even in the low growth case
- The Policy-Driven scenario for PV until 2016 lies halfway between the Advanced and the Paradigm Shift scenarios (of the SET For 2020 study), covering about 8% of the electricity demand by 2020. While the Advanced scenario of reaching 6% by 2020 looks coherent and easily reachable from the Policy-Driven scenario until 2016 point of view, to reach 12% would require a real Paradigm Shift in the way PV is supported and incentivised, even after competitiveness is reached in many countries and market segments
- NREAPs are far from the reality of the PV market. Apart from in Germany and Greece, market evolution could easily overtake the action plans. Future expectations largely reflect the current balance of installations, with Germany and Italy dominating the market. In the EU forecasts, the NREAPs targets with the intermediary value for 2015 have been taken into account. The extent to which they have underestimated the market developments in 2010 and even further in 2011 is obvious

Put simply, **the potential for 2020 is at least twice as high as the levels foreseen in the NREAPs, pushing towards 200 GW capacity or even more in Europe by 2020**. Possible revisions of the action plans will have to take into account the very fast increases in installations over the last year.

**Figure 25** - European cumulative capacity forecasts compared with EPIA SET For 2020 scenarios and NREAPs targets (GW)




a The percentage indicates the share of electricity demand.

## 3.2.g. Support schemes in Europe

This table provides an overview of the support framework status in the most relevant European markets in early 2012.

**Table 3** - European support schemes assessment

| | Political support environment | General political support situation |
|---|---|---|
| Austria | Clear FiT evolution in 2012. Existing cap, even if increased still limits market growth. |  |
| Belgium | Clear visibility on PV policies. Reduced support to PV for larger segments. Improving administrative processes. |  |
| Bulgaria | Clearer visibility on PV policies in 2012. Improved administrative processes. Risk of grid saturation. |  |
| Czech Republic | Risk of FiT cancellation in 2012. Strong adverse lobbying from conventional stakeholders, including grid operators. Retroactive law passed in 2010. Grid operator blocking new licencing. |  |
| Denmark | No FiT but net-metering and high electricity prices. Grid parity for residential systems virtually already reached. |  |
| France | Clear FiT evolution in 2012 for systems up to 100 kW, however non-transparent and complex tendering scheme for larger systems. Strong adverse lobbying from conventional stakeholders. Willingness to limit development to control cost. Heavy and slow administrative processes still in place. |  |
| Germany | Clear FiT evolution in 2012 and beyond. Drastic measures taken to avoid market surge. Willingness to control market within defined ranges. Simple and lean administrative process. |  |
| Greece | Clear FiT evolution in 2012. Risk of late political reaction if market surges. Improving framework of administrative processes but long road to reduce costs and lead time. Adverse financial environment limiting development. |  |
| Italy | Clear FiT evolution in early 2012, no visibility on policies after July 2012. Willingness to limit development to control costs with the introduction of a register comparable to Spain. Improving administrative processes but long road to reduce costs and lead time. |  |
| Netherlands | No FiT but net-metering and high electricity prices allowing for a residential market to develop rapidly. |  |
| Portugal | Clear FiT evolution in 2012 for small to medium-size market segments. Reduced cap due to financial crisis limiting market growth. Simpler administrative process for smaller segments. No visibility for larger segments. |  |
| Romania | Favourable support framework since end of 2011 but lack of visibility. Risk of late political reaction if market surges. |  |
| Slovakia | Lack of visibility on PV policies, combined with adverse lobbying from conventional stakeholders, including grid operator. FiT reduced in 2012. Support limited to systems up to 100 kW. |  |
| Slovenia | Clear FiT evolution in 2012. Clear and lean administrative processes. |  |
| Spain | Support to PV cancelled. Unclear evolution of future support. New net-metering policy framework expected. Heavy and slow administrative processes. |  |
| Switzerland | Clear FiT evolution in 2012. Existing cap limiting market development. Support from regional government allowing for extra growth outside the FiT scheme. |  |
| United Kingdom | Unclear FiT evolution in 2012. Strong political reaction in 2011 leading to new scheme not favourable to all segments. Clear and lean administrative processes. |  |
| Ukraine | Lack of visibility on FiT evolution. Restrictive local content requirement, market closed to non-local players. |  |

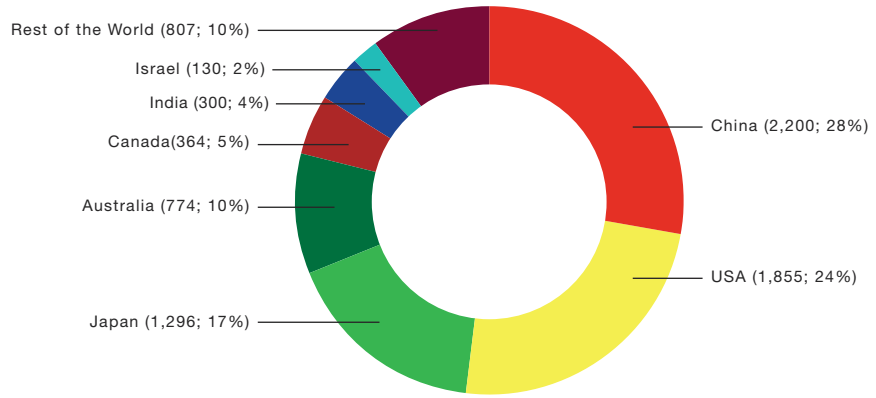
## 3.3. The global market in 2011 and forecast until 2016

### 3.3.a. General presentation

Europe has dominated the global PV market for years but the rest of the world clearly has the biggest potential for growth. Driven by local and global energy demand, the fastest PV growth is expected to continue in China and India, followed by Southeast Asia, Latin America and the Middle East and North African countries. **The PV potential of the sunbelt countries** – where PV can already compete with diesel generators for peak power generation without financial support – **could range from 60 to 250 GW by 2020, and from 260 to 1,100 GW in 2030**. And with the faster than expected price decrease that the industry experienced in 2011, even more countries will see PV becoming competitive before the end of this decade.

New PV installations in the rest of the world accounted for 7.7 GW in 2011, compared to 3 GW in 2010. **China took first place among these countries with 2.2 GW, followed by the USA with 1.9 GW and Japan with 1.3 GW**. All are expected to continue growing in 2012. Australia expanded rapidly in 2011, though its future growth remains constrained over the short-term by political decisions. Canada has expanded slower than some have expected. The potentially strong market in India seems to have taken off finally, with 300 MW installed in 2011.

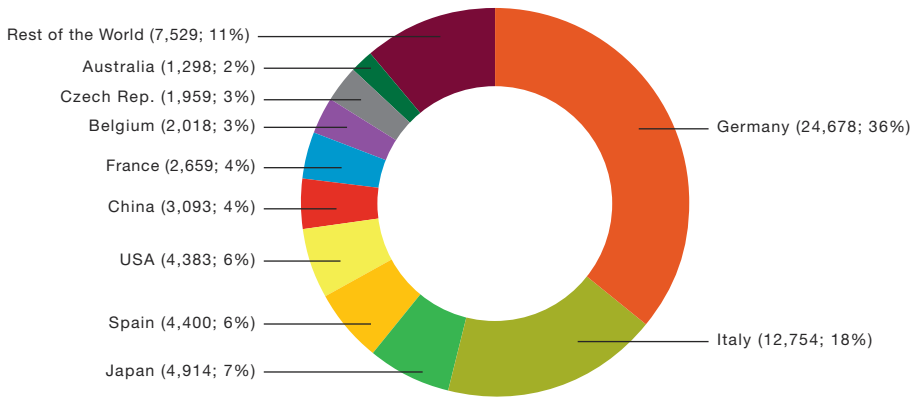
**Figure 26** - Market share outside Europe 2011 (MW; %)



An examination of the total installed capacity reveals greater contrasts. The development of the market outside Europe in recent years has not yet caught up with the existing installations in China, USA, Japan and Australia, but this time is near. Outside Europe, the market is well-balanced; three countries with a huge potential lead the pace, followed by an emerging secondary market. Except for the Australian boom in 2011, the market remains under control in most countries. With that potential progressively unleashed, the share of PV installations outside Europe can only increase, rebalancing in the right direction.

**At the beginning of 2012, Germany and Italy alone represent more than 50% of the world's installed capacity. But four non-European major GW markets are in the top 10 list: Japan, USA, China and Australia.**

**Figure 27** - Global cumulative installed capacity share 2011 (MW; %)



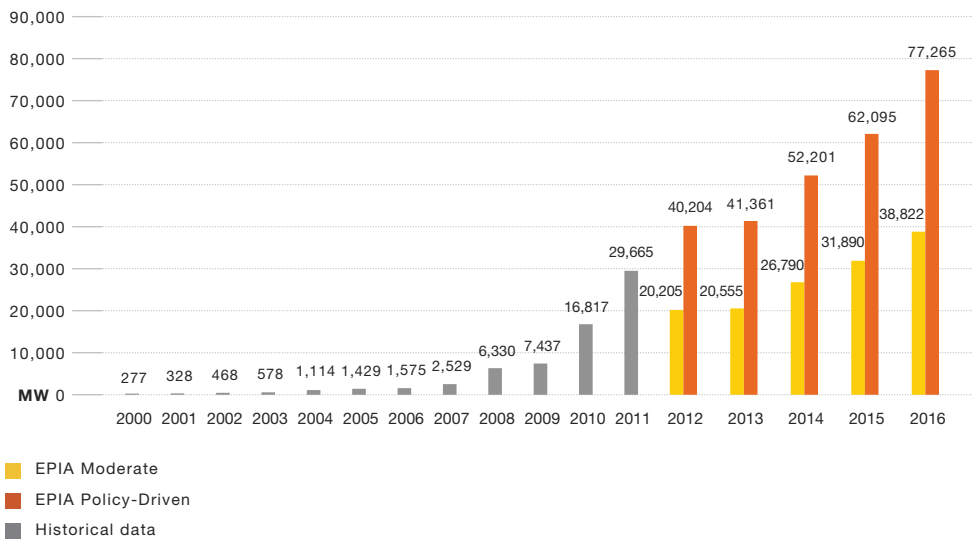
### 3.3.b. Global PV forecasts until 2016

After having added close to 30 GW of PV systems in 2011, the PV market is at the crossroads of its development. The expected growth of markets outside Europe will not compensate for a slowed down market in Europe before 2016 in the pessimistic Moderate scenario. This assumes a negative perspective in most markets in the five coming years, especially in Europe.

But what is the probability of such a negative evolution in the coming years? Two main drivers must be considered here: The existence of open markets that could absorb a part of the excess supply of PV systems; and the evolution of PV module and system prices. The acceleration of PV module price decreases that we experienced in 2011 comes from a huge imbalance between the high demand (close to 30 GW) and an even higher supply (around 50 GW). The inability of existing markets to absorb more gigawatts pushed prices even lower in the early months of 2012.

**A slower market should trigger new price decreases, at least in the short-term, favouring development in markets without regulatory restraints.**

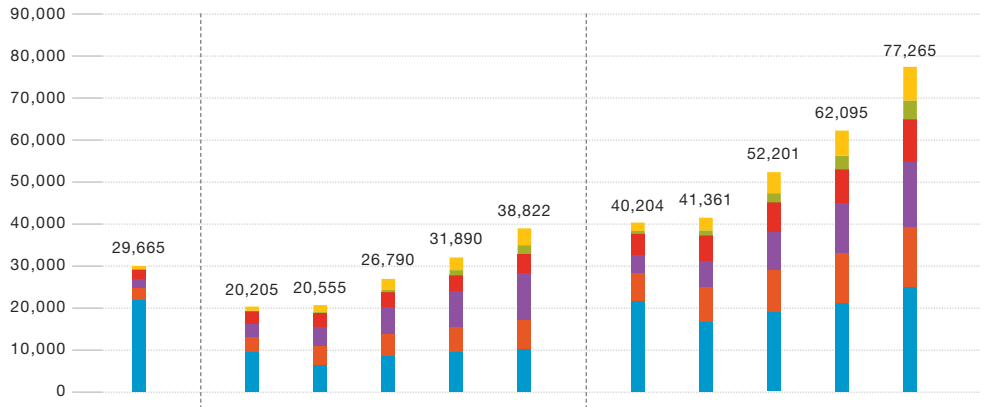
**Figure 28** - Global annual market scenarios until 2016 - Moderate and Policy-Driven (MW)



But for most of the industry, lowering costs is becoming less of an option. Moreover, the number of established markets with growth potential is limited, with more and more of them evolving to registries or caps. Further fast price decline could lead to production plant closures all over the world; in that case, prices would stabilise, with markets progressing less rapidly in Europe than they are today. So **this evolution will depend mainly on the evolution of markets in Europe and the ability of policymakers to maintain market conditions at an acceptable level**. In the Policy-Driven scenario, the European market would stabilise at around 20-25 GW in the coming years, accompanying the development of markets outside Europe. In that respect, **the market could top more than 75 GW in 2016, with two-thirds of this coming from new markets outside Europe**. The new markets could help ensure a major growth even in 2012, and power market development in the following years.

**Depending on the conditions of the Moderate scenario, the 100 GW mark could be reached in 2012 or 2013, while in the Policy-Driven scenario, more than 350 GW of PV systems could be connected to the grid over the next five years.**

**Figure 29** - Evolution of global annual market scenarios per region (MW)




| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROW | 508 | 1,000 | 1,500 | 2,500 | 3,000 | 4,000 | 2,000 | 3,000 | 5,000 | 6,000 | 8,000 |
| MEA | 131 | 160 | 350 | 650 | 1,250 | 2,100 | 700 | 1,250 | 2,200 | 3,250 | 4,500 |
| China | 2,200 | 3,000 | 3,250 | 3,500 | 3,750 | 4,500 | 5,000 | 6,000 | 7,000 | 8,000 | 10,000 |
| America | 2,234 | 3,250 | 4,650 | 6,650 | 8,650 | 11,150 | 4,350 | 6,250 | 9,200 | 11,900 | 15,700 |
| APAC | 2,653 | 3,360 | 4,290 | 5,030 | 5,890 | 6,800 | 6,520 | 8,270 | 9,760 | 11,780 | 14,220 |
| Europe | 21,939 | 9,435 | 6,515 | 8,460 | 9,350 | 10,272 | 21,634 | 16,591 | 19,041 | 21,165 | 24,845 |
| **Total** | 29,665 | 20,205 | 20,555 | 26,790 | 31,890 | 38,822 | 40,204 | 41,361 | 52,201 | 62,095 | 77,265 |
| | **Historical data** | **EPIA Moderate** | | | | | **EPIA Policy-Driven** | | | | |

**Figure 30** - Global cumulative scenarios until 2016 - Moderate and Policy-Driven (MW)

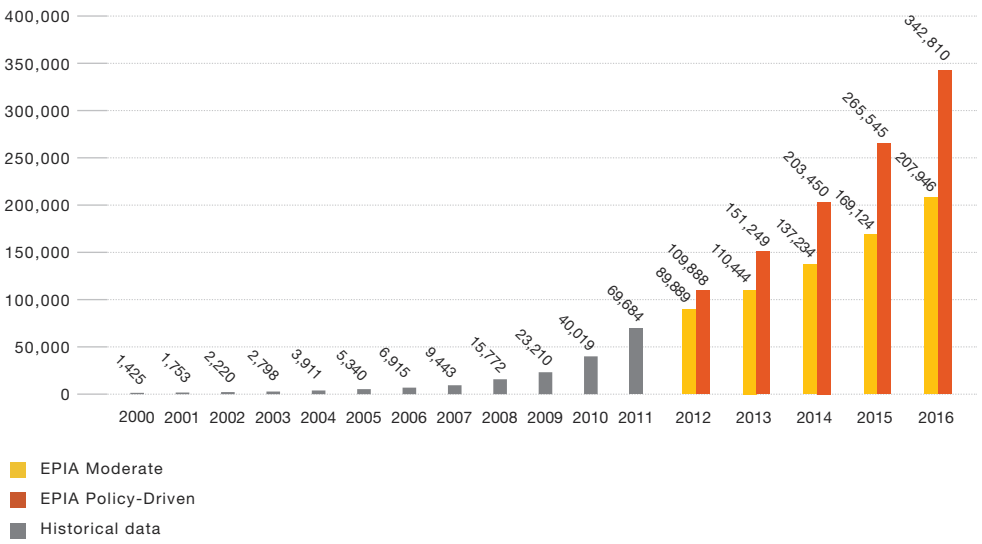



**Figure 31** - Evolution of global cumulative installed capacity per region 2011-2016 (MW)

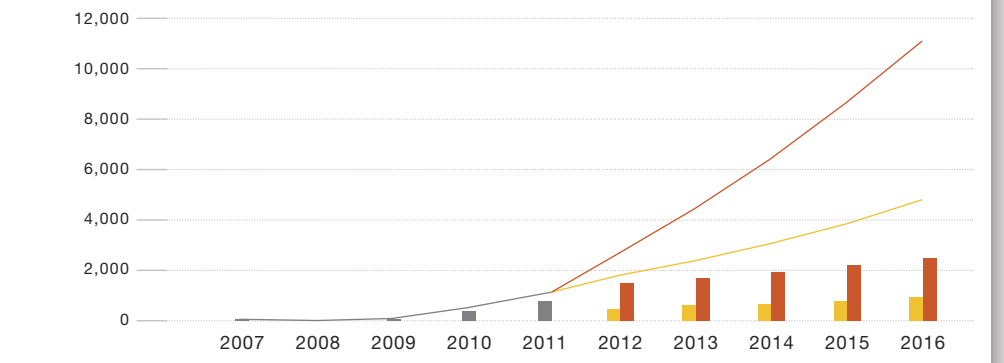

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROW | 1,717 | 2,700 | 4,200 | 6,700 | 9,700 | 13,700 | 3,700 | 6,700 | 11,700 | 17,700 | 25,700 |
| MEA | 336 | 500 | 850 | 1,500 | 2,700 | 4,800 | 1,000 | 2,30 | 4,500 | 7,700 | 12,200 |
| China | 3,093 | 6,100 | 9,300 | 12,800 | 16,600 | 21,100 | 8,100 | 14,100 | 21,100 | 29,100 | 39,100 |
| America | 5,053 | 8,300 | 13,000 | 19,600 | 28,300 | 39,400 | 9,400 | 15,700 | 24,900 | 36,800 | 52,500 |
| APAC | 7,769 | 11,100 | 15,400 | 20,400 | 26,300 | 33,100 | 14,300 | 22,600 | 32,300 | 44,100 | 58,300 |
| Europe | 51,716 | 61,200 | 67,700 | 76,100 | 85,500 | 95,700 | 73,400 | 89,900 | 109,000 | 130,100 | 155,000 |
| **Total** | 69,684 | 89,900 | 110,400 | 137,200 | 169,100 | 207,900 | 109,900 | 151,200 | 203,400 | 265,500 | 342,800 |
| | **Historical data** | **EPIA Moderate (cumulative)** | | | | | **EPIA Policy-Driven (cumulative)** | | | | |

### 3.3.c. Scenarios by country

- **Australia**

Australia's wide variety of state-level support schemes makes it a complex market. It is also a highly volatile one, as tariffs are often modified, but this support has resulted in a **PV market of 774 MW in 2011**. Given the size of the country, and the speed at which the market developed, no doubt this development is not sustainable. As opposed to many European countries, Australian FiT schemes are state-based. This has led to inconsistent policies, with tremendous variation among schemes from one state to another. The rapid growth has fuelled increasing opposition to PV, with policymakers criticising its legacy cost. Several stakeholders are pushing for a nation-wide FiT to replace all state FiTs and streamline the development of PV in the country. Meanwhile, some states are already considering phasing out the incentives. New South Wales has discussed retroactively reducing the FiT, while others simply drastically changed the level. All this goes against the necessary measures needed to ensure sustainable market development in the coming years. Participation in this market is complex, but the long-term trends point clearly towards a growing emphasis of PV technology. In the short-term, however, political inability to evolve towards a nation-wide sustainable FiT could temporarily slow down the market.

**Figure 32** - Australia (MW)

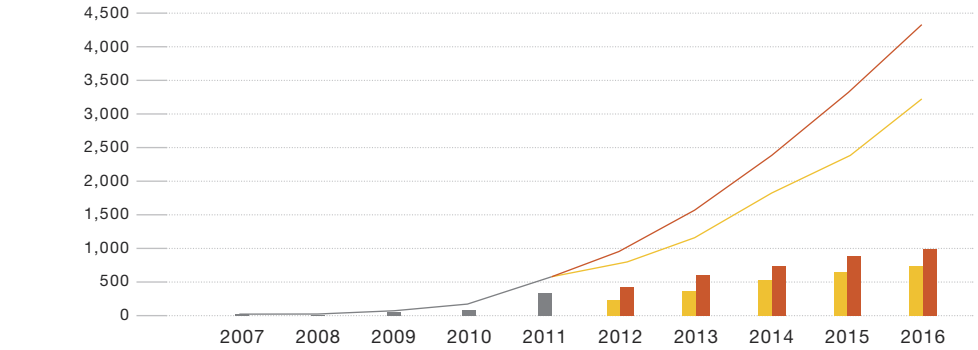



| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 6 | 12 | 79 | 387 | 774 | 500 | 600 | 700 | 800 | 1,000 |
| EPIA Policy-Driven | | | | | | 1,500 | 1,750 | 2,000 | 2,250 | 2,500 |
| EPIA Moderate (cumulative) | 46 | 58 | 137 | 524 | 1,298 | 1,800 | 2,400 | 3,100 | 3,900 | 4,900 |
| EPIA Policy-Driven (cumulative) | | | | | | 2,800 | 4,500 | 6,500 | 8,800 | 11,300 |

- **Canada**

**Canada's market rose by 364 MW in 2011, a dramatic 340% increase compared to 2010**. This growth was mainly driven by the province of Ontario, where 85% of the capacity was installed thanks to a generous FiT. The province introduced in 2010 a local-supplier obligation that requires developers to source at least 60% of their products and resources from Ontario-based goods and labour. Even if the FiT level were reduced in Ontario at the beginning of 2012, a certain number of other provinces are progressively developing support for PV, shifting the focus away from Ontario alone. **The Canadian market could reach up to 4.2 GW cumulative installed capacity by 2016 under a Policy-Driven scenario.**

**Figure 33** - Canada (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 5 | 7 | 62 | 105 | 364 | 250 | 400 | 550 | 650 | 750 |
| EPIA Policy-Driven | | | | | | 450 | 600 | 750 | 900 | 1,000 |
| EPIA Moderate (cumulative) | 26 | 33 | 95 | 200 | 563 | 810 | 1,200 | 1,800 | 2,400 | 3,200 |
| EPIA Policy-Driven (cumulative) | | | | | | 1,000 | 1,600 | 2,400 | 3,300 | 4,300 |

- **China**

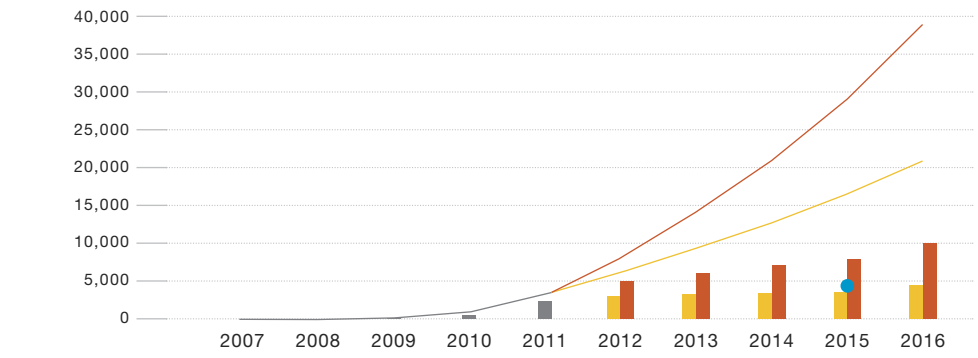
The world's largest PV module producer was until 2010 a market dwarf, especially considering its potential. The highly anticipated national FiT was dropped indefinitely until 2011 as PV generation cost was deemed too high. But the declining price of PV systems makes competitiveness closer in all countries, and China is no exception. The National People's Congress reiterated in 2011 the strategic importance of renewables in its 12th Five Year Plan (2011-2015), in order to cope with rising electricity prices and the growing demand for electricity in the country. Now the market is finally starting and the country is home to the largest PV power plant in operation (200 MW).

Three separate incentive schemes coexist in China for the time being:

- The Golden Sun programme for rural electrification and building projects, which allowed 140 MW of installations in 2011. Started in 2009, the Golden Sun programme is based on system capacity rather than electricity production (7 RMB/W) and will see around 1 GW of large installations being commissioned in 2012, according to the Chinese Renewable Energy Industry Association (CREIA)
- The PV building project, which focuses on BAPV and BIPV through subsidies based as well on the installed capacity (12 RMB/W in 2011; 9 RMB/W in 2012 for BIPV; 7.5 RMB/W for BAPV). This scheme allowed the installation of 128 MW in 2011
- The brand-new Feed-in Tariff law, which was released in July 2011 and triggered market development. Some local governments that launched FiT programmes before the central government are still complementing the national FiT with additional bonuses (Zhejiang, Shandong, Jiangsu in 2011; Liaoning in 2012) that should be reduced this year. Its level was decreased from 1.15 RMB/kWh to 1 RMB/kWh (€ 0.12 kWh) on 1 January 2012
- At provincial level, other programmes have been launched (Ordos 2 GW project, 280 MW by the National Development and Reform Commission for desert-based projects)

In 2012, China is now officially a multi-gigawatt market, driven by various national and provincial programmes. The NPC has set 5 GW as an official minimum PV target by 2015, with a longer-term target of 20 to 30 GW by 2020, but the reality has already outpaced this target. The **2,200 MW installed in 2011** (1.8 GW from large-scale ground mounted installations and 400 MW from rooftop projects) brought **cumulative capacity to 3,093 MW**. Authorities now forecast a 4 to 5 GW market in 2012, placing China in the global top three markets with an incredible potential for the years to come. The report estimates that the potential of the Chinese market, especially with the low prices currently available, will ensure a bright development of PV in the country in the coming five years. **The total installed capacity in 2016 could reach more than 35 GW, with an annual market that could reach 10 GW at that time horizon**. The question remains whether this market will be accessible on a wide scale to international developers and manufacturers.

## Figure 34 - China (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 20 | 45 | 228 | 520 | 2,200 | 3,000 | 3,250 | 3,500 | 3,750 | 4,500 |
| EPIA Policy-Driven | | | | | | 5,000 | 6,000 | 7,000 | 8,000 | 10,000 |
| EPIA Moderate (cumulative) | 100 | 145 | 373 | 893 | 3,093 | 6,100 | 9,300 | 12,800 | 16,600 | 21,100 |
| EPIA Policy-Driven (cumulative) | | | | | | 8,100 | 14,100 | 21,100 | 29,100 | 39,100 |
| National target 2015 | | | | | | | | | 5,000 | |

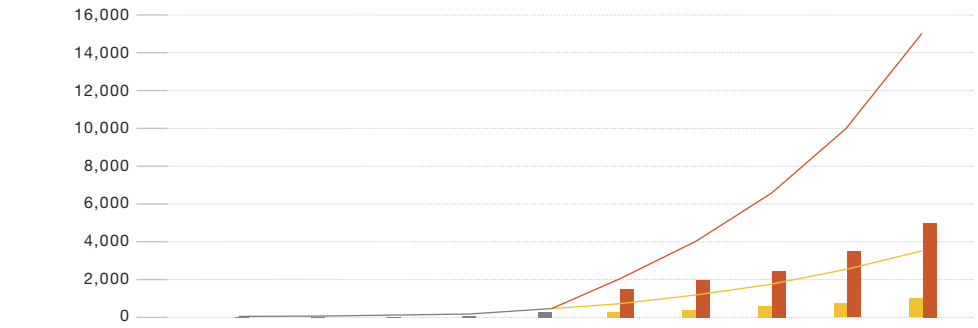
## • India

India's (Jawaharlal Nehru) National Solar Mission (JJNSM) was launched in January 2010 in order to achieve the government's target of generating 22 GW (20 GW on-grid; 2 GW off-grid) of solar power by 2022. It has had something of a slow start, particularly regarding its on-grid projects. The main reason is a combination of regional policies that led to the current fragmented market. With **around 300 MW installed in 2011 and a total cumulative capacity of 520 MW**, given the size of the country, it looks obvious there is no real PV market for the time being. It rather looks like an addition of projects supported by various programmes than a real market. The JJNSM programme plans between 1 and 2 GW of utility-size, grid-connected applications until 2013, followed by a second phase targeting to reach between 4 and 10 GW until 2017, and finally reaching 20 GW from 2017 to 2022.

At the state level, Gujarat looks to be the most attractive one, with a Renewable energy Portfolio Standard (RPS) of 5% for power-distribution companies to be increased to 7% for 2012-2013, out of which 1% is for solar. An additional PV incentive is in place. The state of Rajasthan has signed 1.5 GW of solar projects with developers so far despite a rather vague draft target of 10-12 GW at the time horizon of 10 years. PV features more prominently in some other states (Tamil Nadu, Andhra Pradesh, Punjab, Jharkhand, Karnataka and Maharashtra) that have taken positive steps and introduced their own solar programmes as well as FiTs, or will announce their solar ambitions in the course of this year.

In addition the JJNSM programme targets off-grid electrification, with some 200 MW expected by 2013, 1 GW until 2017 and a total of 2 GW until 2022. This should be viewed along with the huge potential market for hybrid systems in India, with a potential of dozens of gigawatts powered today by diesel generators. This market segment that is quite specific to emerging markets could kick-off PV installations faster than expected. All these support measures could lead to a GW market by 2012 and a 5 GW market by 2016.

**Figure 35** - India (MW)



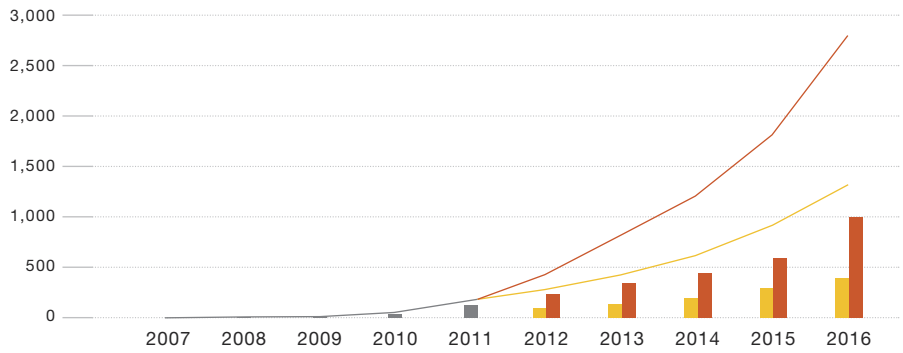

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 20 | 40 | 30 | 60 | 300 | 300 | 450 | 600 | 800 | 1,000 |
| EPIA Policy-Driven | | | | | | 1,500 | 2,000 | 2,500 | 3,500 | 5,000 |
| EPIA Moderate (cumulative) | 31 | 71 | 101 | 161 | 461 | 760 | 1,200 | 1,800 | 2,600 | 3,600 |
| EPIA Policy-Driven (cumulative) | | | | | | 2,000 | 4,000 | 6,500 | 10,000 | 15,000 |

- **Israel**

Since the adoption of a FiT in 2008, Israel's grid-connected market has been developing progressively, with **about 130 MW of systems newly connected last year**. This growth has mainly been driven until 2010 by the segment below 50 kW; above this size, PPAs are required. The government has set an objective of producing 10% of its electricity from RES by 2020. A governmental development plan to connect 300 MW of PV in medium to large systems (from 51 kW to 12 MW) is already in place and could be increased by a further 500 MW to be connected to the high-voltage grid.

Given its relatively small size, Israel has very good prospect for growth, with solar representing an opportunity for energy independence from its neighbours.

**Figure 36** - Israel (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | N/A | N/A | 21 | 45 | 130 | 100 | 150 | 200 | 300 | 400 |
| EPIA Policy-Driven | | | | | | 250 | 350 | 450 | 600 | 1,000 |
| EPIA Moderate (cumulative) | N/A | N/A | 21 | 66 | 196 | 300 | 450 | 650 | 950 | 1,300 |
| EPIA Policy-Driven (cumulative) | | | | | | 450 | 800 | 1,200 | 1,800 | 2,800 |

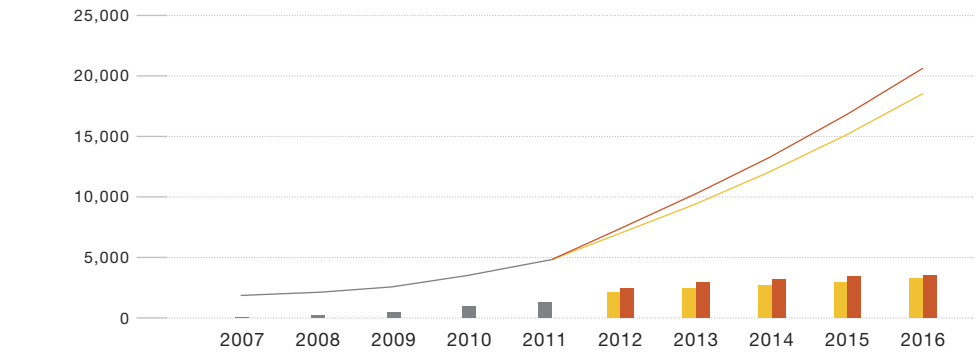
## • Japan

Japan developed PV before it became a mainstream technology. For years the country's market has progressed rapidly, with 990 MW installed in 2010. The nuclear disaster at Fukushima in March 2011 led the country to reshape its strategy for RES; despite some adverse conditions, **installations reached 1,296 MW in 2011** and more development is expected to come. The official target is of 28 GW in 2020, and the real market development could be higher than that. By 2030, the Japanese authorities plan that 40% of the country's electricity demand will come from RES, out of which solar PV should top 53 GW at least. The real potential in the country was estimated by the same authorities at around 230 GW.

Until 2010, residential systems represented around 95% of the Japanese market; but 2011 saw the beginning of a rebalancing with residential scoring around 80%, and commercial and industrial rooftops more than 16%. Ground mounted installations are also expected to grow, even in a country where free space is a luxury in densely populated areas. At least 12 megawatt-scale projects are foreseen to start in 2012, driven by either local utilities or private investors. Residential systems up to 10 kW and commercial/industrial systems up to 500 kW is to be eligible for the new FiT law that is to start in July 2012.

The lack of power generation following the destruction of many power plants that lasted until now will push forward PV development in the coming months and years. The rising electricity demand in the summer for air conditioning could also favour PV as a preferred energy source. **The market could easily pass the 2 GW mark in 2012 and grow slowly to reach around 3-3.5 GW by 2016**.

**Figure 37** - Japan (MW)



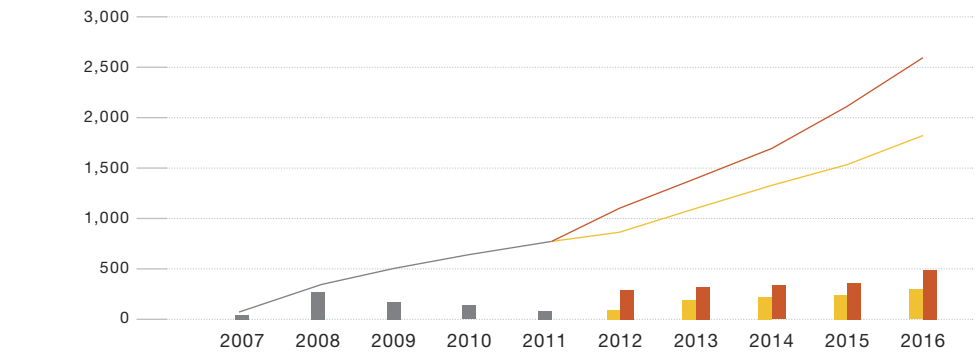

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 210 | 230 | 480 | 991 | 1,296 | 2,200 | 2,500 | 2,750 | 3,000 | 3,250 |
| EPIA Policy-Driven | | | | | | 2,500 | 3,000 | 3,200 | 3,400 | 3,600 |
| EPIA Moderate (cumulative) | 1,917 | 2,147 | 2,627 | 3,618 | 4,914 | 7,100 | 9,600 | 12,400 | 15,400 | 18,600 |
| EPIA Policy-Driven (cumulative) | | | | | | 7,400 | 10,400 | 13,600 | 17,000 | 20,600 |

- **Korea**

Once a top 10 market, Korea saw its market decline in 2009 and 2010 and again **in 2011** with **only 92 MW installed**. Despite its potential, the market will probably be constrained to 200 to 500 MW each year over the next five years due to the limiting regulation in place.

Since 2012 the FiT scheme has been replaced by a Renewable Energy Portfolio Standard (RPS). The RPS places an obligation for utilities to produce a quota of their electricity from RES, with a certain share allocated to PV.

**Figure 38** - Korea (MW)

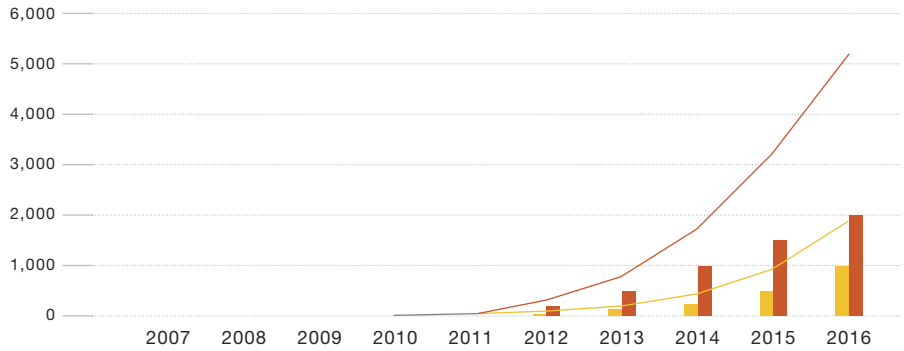



| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 45 | 276 | 167 | 138 | 92 | 100 | 200 | 225 | 250 | 300 |
| EPIA Policy-Driven | | | | | | 300 | 320 | 340 | 360 | 500 |
| EPIA Moderate (cumulative) | 81 | 357 | 524 | 662 | 754 | 850 | 1,100 | 1,300 | 1,500 | 1,800 |
| EPIA Policy-Driven (cumulative) | | | | | | 1,100 | 1,400 | 1,700 | 2,100 | 2,600 |

## • South Africa

With an increasing electricity demand and strong solar resources, South Africa is often seen as one of the most attractive emerging markets. But until now, the PV market has remained low, and most projects in the pipeline focus on large-scale utility-size installations through PPAs. In 2012, some large-scale projects should come to life, especially a 50 MW concentrated photovoltaic (CPV) project. **By 2014 the government expects to install at least 1,450 MW of PV systems**, under the Renewable Energy Independent Power Producer Procurement (RE IPP) programme. This programme is based on a bidding system that takes also into account socio-economic development objectives. For smaller systems, the government intends to introduce a separate Small Projects IPP Procurement programme for electricity generation projects of less than 5 MW, but nothing has been issued so far. The market take-off will allow **South Africa to reach 2 GW by 2016**. But some questions remain to be answered, especially the cost of financing, which appears to be a major issue for several bidders.

**Figure 39** - South Africa (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | N/A | N/A | N/A | N/A | 1 | 25 | 100 | 250 | 500 | 1,000 |
| EPIA Policy-Driven | | | | | | 200 | 500 | 1,000 | 1,500 | 2,000 |
| EPIA Moderate (cumulative) | N/A | N/A | N/A | 40 | 41 | 70 | 170 | 420 | 920 | 1,900 |
| EPIA Policy-Driven (cumulative) | | | | | | 240 | 740 | 1,700 | 3,200 | 5,200 |

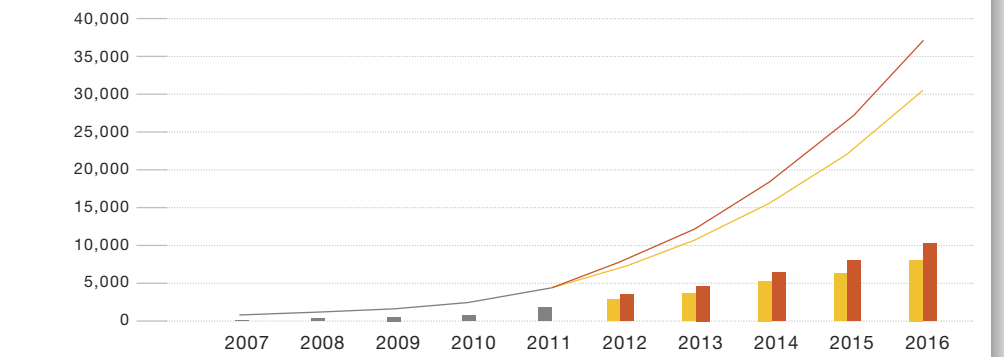
- **United States**

**The USA installed a record 1,855 MW of PV systems in 2011**. Most of the development was concentrated in the last quarter of the year, with almost 800 MW developed. In terms of policy support, the 1603 Treasury Program was cancelled, making access to financing for new PV projects more difficult. This partly explained the rush in the last three months of 2011. Many of these projects will also come online in 2012. In 2011, 80% of the market was concentrated in seven states: California (30%), New Jersey, Arizona, New Mexico, Colorado, Pennsylvania and New York.

The market developed evenly in the residential, commercial and utility-scale segments. The residential segment represented about 15% of the new capacity. Its development is increasingly driven by third-party ownership instead of customer-owned systems. The commercial segment grew very rapidly in 2011 to reach nearly 45% of the market. It mainly developed in California and New Jersey; other states expected to gain importance in the next years include Massachusetts, Maryland, North Carolina and Arizona. Utility-scale projects helped boost the market in 2011, representing 40% of the new added capacity. PPAs are driving the development of this segment. Many projects are in the pipeline: 9 GW of projects with signed utility PPAs are awaiting completion over the next five years (3 GW of these have already been financed and are in construction).

It is very probable that, as in previous years, the US market in 2012 will depend on development in Germany and Italy, since the USA is one of the only developed economies able to absorb PV projects in significant quantities. This could produce potentially rapid growth in the second semester of the year. In addition many utility-scale projects will be driving the market outside of any support-scheme framework. In all cases **the market is very likely to reach at least 3 GW in 2012. It could pass the landmark of 10 GW in 2016.**

**Figure 40** - USA (MW)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| EPIA Moderate | 207 | 342 | 477 | 878 | 1,855 | 2,800 | 3,700 | 5,100 | 6,400 | 8,100 |
| EPIA Policy-Driven | | | | | | 3,500 | 4,600 | 6,400 | 8,000 | 10,200 |
| EPIA Moderate (cumulative) | 831 | 1,173 | 1,650 | 2,528 | 4,383 | 7,200 | 10,900 | 16,000 | 22,400 | 30,500 |
| EPIA Policy-Driven (cumulative) | | | | | | 7,900 | 12,500 | 18,900 | 26,900 | 37,100 |

- **Middle East and Africa (MEA) countries**

In the MEA region, barriers to PV deployment persist, with the subsidised prices of electricity produced by fossil fuel plants and the lack of appropriate regulatory frameworks. Nevertheless, awareness among policymakers progresses significantly in several North African countries that are setting ambitious targets for RES for 2020.

The huge solar potential of these countries, and the growing need for new generation capacities, has not materialised yet in a real PV market, but the five coming years will be decisive to trigger that development. Already in Morocco current PV system prices are competitive with industrial electricity prices. Without subsidies on retail electricity prices, other segments in other countries of the region could have reached competitiveness already. The main obstacle to PV development lies then in the regulatory framework and the cost of financing PV investments.

Political instability in Egypt, Tunisia and other countries in the region could delay investments, especially in large projects, by increasing the risk premium sought by financing institutions. The risk of local content legislation could also slow down development. The current turmoil in many countries of the region could delay the set-up of the Mediterranean Solar Plan launched in 2010, while the prospects for Desertec beyond 2020 remain valid.

One part of the future of PV in the Middle East and North Africa (MENA) region will lie in large projects such as Desertec and MedGrid, which have long-term potential but face questions in the short-term. On the one hand, the concrete implementation of the so-called article 9 of the EU's RES Directive to buy electricity in the southern part of the Mediterranean region still requires some clarification; on the other hand, the local demand for electricity and the possible achievement of the EU 20% target without imports could redefine the whole concept. Meanwhile, the will at EU level to integrate some MENA countries in the EU electricity grids and markets could ease that development. Finally, the potential of rooftop PV applications has been clearly underestimated in the region so far, with a focus on large projects, hiding other perspectives that should be taken into account.

Morocco has launched a 2 GW solar plan with a dedicated implementing agency, under which PV and Concentrated Solar Power (CSP) technologies will compete openly. In parallel to the solar plan for large installations, there could be some room for smaller systems in the coming years.

Availability of financing and huge solar resources will help to develop the market in the United Arab Emirates. A place for innovative BIPV in large buildings could be found faster than expected. Off-grid installations for urban lighting and remote desert outposts could represent niche markets. Some 10 MW are already installed and connected in Abu Dhabi while a 100 MW project is still in the tender phase.

Jordan and Saudi Arabia are also promising, with a growing awareness and interest from policymakers, while the first large systems have been installed or planned (megawatt scale rooftops in Saudi Arabia, preliminary test site for large ground mounted installations in Jordan). In Jordan, ongoing discussions could lead this year to a new regulatory framework for PV.

In **other African countries**, the question of regulatory stability and cost of financing has so far prevented the take-off of the PV market. Regardless, the LCOE of PV has reached the retail price of electricity in several countries[1], which should herald its incoming competitiveness. Burkina Faso, Chad, Liberia, Madagascar, Mali, Senegal and Uganda already have reached this threshold. In the commercial/industrial segment, Burundi, Cameroon, Central African Republic, Ivory Coast, Gabon, Gambia, Ghana, Guinea, Rwanda, Senegal and Togo already have LCOEs for PV systems, in ideal financing conditions, that are below the retail prices of electricity[1]. While these results should be considered carefully, and while the real competitiveness point is always further than the traditional comparison with electricity prices, it is clear that the potential market for PV systems in those countries could be triggered under adequate regulatory frameworks and investment stability.

- **Rest of Asia**

The solar irradiation in South-East Asia, combined with growing electricity demand, creates an enormous potential for PV in the region. Moreover, part of global PV production is moving there, supported by favourable governmental frameworks. Next to China, India and Japan, some smaller markets with a real potential will emerge in the coming years. Countries where the cost of generating PV electricity has gone below the retail price of electricity include **Afghanistan**, **Cambodia** and **Philippines** for the residential segment and **Pakistan** for the commercial/industrial segment.

**Thailand's** support programme has been very successful and contributed to a huge flow of applications, in line with the government's decision to produce up to 25% of its energy consumption with RES by 2021. 950 MW of PPAs (which can be considered as FiT paid by electricity consumers) have already been approved as of March 2012, out of which around 150 MW have been installed, mostly in 2011, including the Lopburi 73 MW park. In total 2 GW of projects are in the pipeline, according to the ministry of energy – most of them large-scale projects in the MW range.

**Taiwan**, another large producer with a small market, aims for 1 GW of PV systems by 2025. So far the market has been quite limited, with some 70 MW installed in 2011.

**Malaysia** launched its FiT scheme in 2011 with a target of 1,250 MW of PV systems until 2020. But targets are defined on a yearly basis, with only 46 MW for PV projects foreseen in 2012 (149 MW in 2016). One third of the target should be devoted to systems smaller than 1 MW (11 MW in 2012, 19 MW in 2016). FiT differ per segment and a bonus is granted for BIPV systems and local production of modules and inverters.

**Philippines** is, after more than a year of delay, expected to release FiT rates in 2012.

1 Gerlach, A. and Breyer, Ch., 2012. Global Grid-Parity Dynamics on a National and Regional Level, 27th EU PVSEC, Frankfurt, September 24-28, 2012, accepted; Breyer, Ch. and Gerlach, A., 2012. Global Overview on Grid-Parity, Progress in Photovoltaics: Research and Applications, published online February 17

- **South and Central America**

Compared with other sunbelt regions, Central and South America have not shown a great deal of PV activity until now. Meanwhile the combination of growing economies, increased political stability (South America) and the availability of financing in some key countries could lead to a rapid market take-off in the coming years. According to research by A. Gerlach and Ch. Breyer[2], several countries already have the ability to produce PV electricity at a cheaper price than grid electricity. This is the case in the residential segment in **El Salvador**, **Guyana**, several Caribbean islands, **Surinam** and in the commercial/industrial segments in **Belize**, Brazil, Chile, **Guatemala**, **Honduras**, Mexico, **Nicaragua** and **Panama**.

In addition, the massive use of diesel generators in countries such as **Venezuela** to compensate for lack of hydro power in some years opens the door for PV. But political instability will be the major constraint to market development. The increasingly positive environment should be able to increase the awareness that PV can provide electricity at a cheaper cost than conventional solutions, providing the right regulations are in place. For the time being, the market development tends to evolve towards large-scale utility-size projects, driven by developers rather than residential or commercial applications. This trend is general all around the continent for the time being.

Despite a lack of interest from the current government, **Mexico** is showing signs of movement after a period with little PV market development. Several large projects have been announced but nothing really came out of the ground. This could change if the 450 MW CPV project expected to start this year in Baja California comes to life. In 2010 a new interconnection contract for RES for small- to mid-scale co-generation systems (up to 500 kW) has been approved, but this has not resulted in a real market development so far. We nevertheless estimate that Mexico's PV market could reach at least 1 GW in the five coming years, with the right regulatory framework in place.

The Brazilian National Electric Energy Agency is expected to introduce two regulations in 2012 designed to promote the deployment of solar power in **Brazil**. One of the regulations has introduced in April 2012 a net-metering system (for micro systems up to 100 kW and for mini systems up to 1 MW) that also works for remote production sites not located at the consumption site; the other should provide an 80% tax break to utilities that purchase electricity generated by large-scale solar parks (for systems up to 30 MW). The first 1 MW plant was commissioned in 2011 and could be expanded provided that the right regulation is in place. With a growing demand for electricity in the country and its high irradiation, the development of PV is simply a question of adequate regulation and awareness. The market could reach more than 1 GW by 2016.

Elsewhere in the region, **Ecuador** introduced in 2011 for the first time a FiT scheme that looks favourable for PV. **Argentina** has awarded at least 20 MW of projects in a public tender to be completed in 2012. In **Chile**, a 1.2 MW plant is currently being built in the Atacama Desert and more projects are planned, with sizes ranging from 75 to 250 MW, showing an increased interest for PV in the country. **Bolivia** is also looking in the PV direction, with a 50 MW project funded by the German development bank. And finally in **Peru**, some 80 MW are scheduled to come online in 2012, most of them again from large-scale installations.

2 Gerlach, A. and Breyer, Ch., 2012. Global Grid-Parity Dynamics on a National and Regional Level, 27th EU PVSEC, Frankfurt, September 24-28, 2012, accepted; Breyer, Ch. and Gerlach, A., 2012. Global Overview on Grid-Parity, Progress in Photovoltaics: Research and Applications, published online February 17

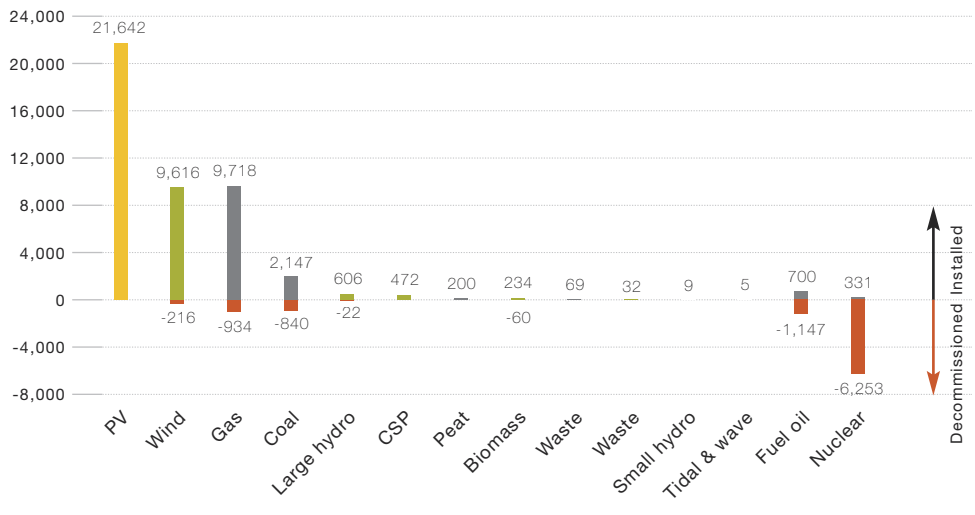
# 4

# PHOTOVOLTAICS IN THE ENERGY SECTOR

## 4.1. PV: The first new generation capacity in Europe in 2011

For the first time in history, **PV in 2011 was the number one electricity source in Europe in terms of added installed capacity**. With 21.9 GW connected to the grid, PV outscored gas and wind, both slightly below the 10 GW mark. If we count decommissioning (which remains marginal in the PV sector – less than 10 MW were fully replaced by new capacities according to the PV CYCLE association), wind comes slightly ahead of gas. All other production sources, renewables and conventional, are far behind. Nuclear lost the most in 2011, with the German decision to close immediately eight nuclear power plants.

**Figure 41** - Power generation capacities added in the EU 27 in 2011 (MW)



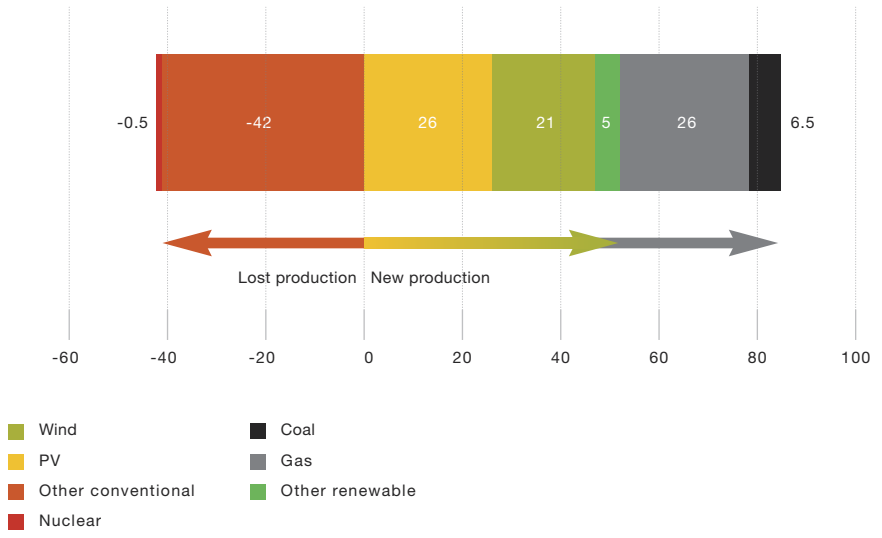

source: EPIA, EWEA

The progress made by PV over the last three years (it placed third among electricity sources for added capacity in 2009, and second in 2010) should be compared with the stability of wind penetration and the fluctuating development of gas power plant commissioning in Europe. Gas reached a peak in 2010, with more than 20 GW newly connected to the grid, before falling to slightly less than 10 GW in 2011.

The evolution of the electricity mix in Europe will depend on a series of parameters (including the decarbonisation agenda, the public acceptance of various technologies, and the need for additional power generation capacities or the increasing flexibility of the production). The Spanish PV market has shown in recent years that PV can quickly become a direct competitor to incumbent players, and notably gas. PV is especially entering in direct competition with other technologies during mid-day peak hours, one of the moments when flexible power plants run.

## 4.2. PV contributes almost 30% of new generation in 2011

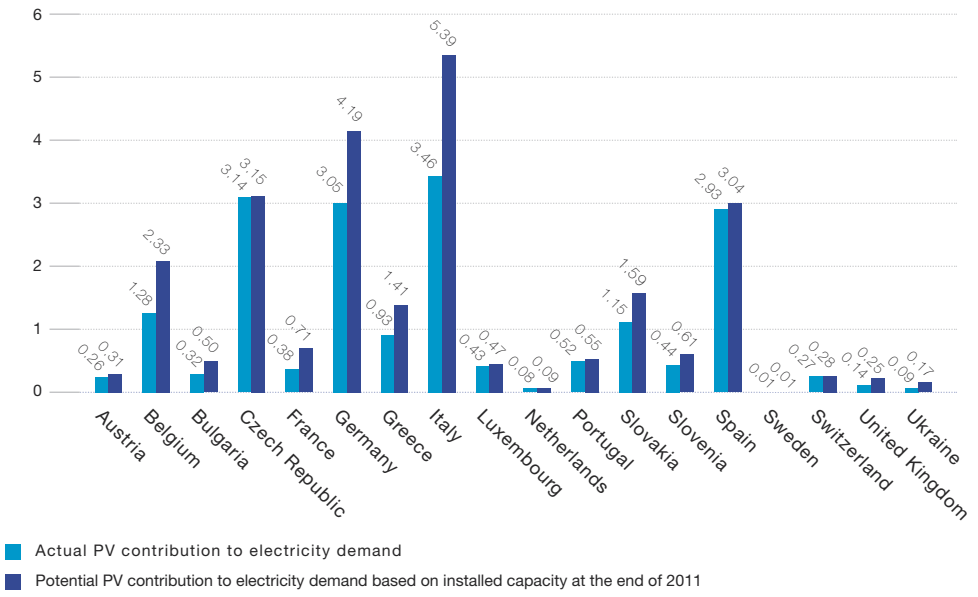
**Figure 42** - Theoretical balance of new electricity production in the EU 27 in 2011 (TWh)




source: EPIA analysis

When we look at the electricity production coming from those new generators connected in 2011, PV comes first as well, at the same level as gas. One could argue that gas power plants running 3,000 hours a year are being operated at less than their theoretical production level; this reflects the reality of the electricity market in Europe in 2011. More interesting, the energy that will be produced by new PV and wind installations in 2012 based on 2011 additions represents enough electricity to compensate for the closure of the nuclear reactors in Germany. **PV continues to prove its ability to compete in the energy sector as mainstream power generation source**.

**Figure 43** - Actual vs potential PV contribution to electricity demand in 2011 (%)



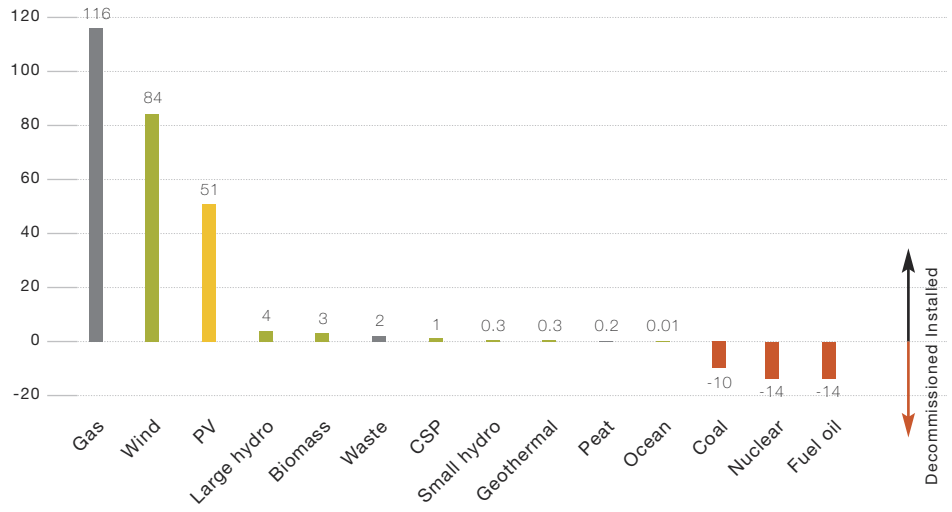

But how much electricity does PV currently provide in Europe? Based on the capacity installed and connected to the grid at the end of 2011, **PV can provide roughly 2% of the electricity demand in Europe**, up from 1.15 % at the end of 2010. In Italy, more than 5% of the electricity will come from PV systems connected until 2011. In Germany, this figure is more than 4%. Spain, Belgium and other countries are progressing rapidly as well.

In most European countries today, PV can be considered as peak power generation. Indeed, it produces during the day, at the time of the mid-day peak, competing directly with other peak generators. Peak power generation represents roughly 50% of the electricity demand in Europe, which means that **PV can produce today 4% of the peak electricity demand in Europe** and more than 10% in Italy, more than 8% in Germany, and so on. This achievement came in a few years and shows again how the development of PV electricity in Europe comes faster than what many had expected.

## 4.3. PV positioning in electricity generation capacity over the last 10 years

Looking at the trends over the last ten years, PV is positioning itself in Europe as a major player, gaining on gas and wind. With more than 51 GW installed, PV development is only at its beginning and more remains to be added in the coming years. Over the long-term, **PV market development forecasts show that PV will most probably stay in the top three technologies in Europe in the five coming years**. Indeed, no other technology has reached or will reach in the five coming years enough maturity to challenge PV, wind or gas.

**Figure 44** - Net generation capacity added in the EU 27 in 2000-2011 (GW)




source: EPIA, EWEA

## 4.4. Global PV electricity production

Globally, PV represented at the end of 2011 roughly 0.5 % of electricity demand and 1% of the peak power demand. Given the speed at which markets outside Europe can develop, PV could in the coming years score the same percentage as in the best European countries.

# 5

# CONCLUSION

The record market growth of PV in 2011 in Europe and around the world was driven by several factors, including:

- Renewable energy has continued to prove itself to be a mainstream energy source and a significant contributor to achieving energy, environmental and economic goals
- Some countries (especially Germany and Italy) have increased their focus on RES in the wake of the Fukushima nuclear disaster, requiring them to consider new policies that move the market in this direction
- PV modules have undergone significant price decreases, further increasing their attractiveness to investors and accelerating the technology's drive toward competitiveness with conventional electricity sources
- In some countries, questions about the future of support-scheme levels has produced boom-and-bust cycles

**Europe once again was the global leader in PV market growth, with 75% of all newly connected capacity in 2011 and about 75% of global installed capacity. But non-European markets are showing signs that they may soon shift this balance in their favour**. China, a production giant that has long had a relatively minuscule market, is fast becoming a source of increasing demand. The USA and Japan are also gaining momentum. Other countries, especially in the Sunbelt region, have enormous potential for solar development that has only just begun to be tapped.

This is significant, because if PV is to continue growing the balance of development will have to shift to new markets – both inside and outside of Europe. A situation in which Germany and Italy account for nearly 60% of global market growth is unsustainable. While those markets will continue to be important (also as exemplars of how government policy can condition proper growth), other countries will have to supply more of the growth. In other words, the recent deployment rates can no longer be taken for granted. Keeping and increasing the momentum of PV development will require smart, measured policy support that moves beyond FiTs and toward other incentives, such as removal of administrative barriers.

The challenge may seem daunting. But the fact that the global market for PV has continued to grow even in times of economic crisis shows there is a demand that can withstand a difficult period. **With proper policy support, balanced market development, and continued industry innovation, the world's most promising source of electricity can continue its remarkable growth rate over the short-, medium- and long-term, and even beyond.**

# ANNEX 1

**Table 4** - Detailed annual historical market data and outlook until 2016 (MW)

| Country | Scenario | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUROPE** | | | | | | | | | | | |
| Austria | Moderate | 2 | 5 | 20 | 43 | 80 | 100 | 120 | 140 | 160 | 180 |
| | Policy-Driven | | | | | | 200 | 300 | 400 | 500 | 600 |
| Belgium[a] | Moderate | 23 *[22]* | 81 *[77]* | 519 *[494]* | 417 *[397]* | 974 *[928]* | 350 | 350 | 350 | 350 | 350 |
| | Policy-Driven | | | | | | 600 | 600 | 600 | 600 | 600 |
| Bulgaria | Moderate | 0.01 | 1 | 6 | 28 | 100 | 150 | 150 | 150 | 200 | 200 |
| | Policy-Driven | | | | | | 250 | 300 | 350 | 400 | 500 |
| Czech Republic | Moderate | 3 | 61 | 398 | 1,490 | 6 | 10 | 20 | 30 | 60 | 100 |
| | Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| Denmark | Moderate | 0.2 | 0.1 | 1 | 2 | 10 | 25 | 30 | 35 | 40 | 50 |
| | Policy-Driven | | | | | | 50 | 75 | 100 | 100 | 100 |
| France | Moderate | 13 | 58 | 185 | 719 | 1,671 | 500 | 500 | 500 | 500 | 500 |
| | Policy-Driven | | | | | | 2,000 | 2,000 | 2,000 | 2,000 | 2,500 |
| Germany | Moderate | 1,271 | 1,809 | 3,806 | 7,408 | 7,485 | 4,000 | 2,000 | 3,000 | 3,000 | 3,000 |
| | Policy-Driven | | | | | | 8,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Greece | Moderate | 1 | 10 | 36 | 150 | 426 | 500 | 500 | 500 | 500 | 500 |
| | Policy-Driven | | | | | | 750 | 800 | 850 | 900 | 1,000 |
| Hungary | Moderate | 0.1 | 0.1 | 0.2 | 1 | 3 | 10 | 20 | 30 | 40 | 50 |
| | Policy-Driven | | | | | | 20 | 50 | 100 | 200 | 300 |
| Italy | Moderate | 58 | 338 | 712 | 2,326 | 9,284 | 3,000 | 1,500 | 1,750 | 2,000 | 2,000 |
| | Policy-Driven | | | | | | 6,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Netherlands | Moderate | 1 | 4 | 11 | 21 | 20 | 25 | 50 | 100 | 150 | 200 |
| | Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| Poland | Moderate | 0.2 | 0.3 | 0.3 | 0.4 | 1 | 2 | 50 | 100 | 150 | 200 |
| | Policy-Driven | | | | | | 2 | 100 | 200 | 300 | 500 |
| Portugal | Moderate | 13 | 52 | 44 | 38 | 33 | 50 | 80 | 120 | 170 | 200 |
| | Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| Romania | Moderate | 0.2 | 0.3 | 0.01 | 1 | 2 | 25 | 50 | 75 | 100 | 150 |
| | Policy-Driven | | | | | | 200 | 400 | 600 | 800 | 1,000 |
| Serbia | Moderate | N/A | N/A | N/A | 0.5 | N/A | 25 | 200 | 350 | 350 | 400 |
| | Policy-Driven | | | | | | 150 | 300 | 450 | 500 | 500 |
| Slovakia | Moderate | 0.3 | 0.3 | 0.1 | 145 | 321 | 30 | 50 | 100 | 150 | 200 |
| | Policy-Driven | | | | | | 50 | 100 | 200 | 300 | 500 |
| Slovenia | Moderate | 1 | 1 | 6 | 27 | 46 | 60 | 60 | 70 | 70 | 75 |
| | Policy-Driven | | | | | | 100 | 125 | 150 | 175 | 200 |
| Spain[a] | Moderate | 569 *[542]* | 2,843 *[2,708]* | 20 *[19]* | 441 *[420]* | 372 *[354]* | 50 | 100 | 200 | 300 | 500 |
| | Policy-Driven | | | | | | 300 | 500 | 750 | 850 | 1,000 |
| Switzerland[a] | Moderate | 7 *[6.3]* | 12 *[11.5]* | 27 *[25.5]* | 39 *[37.1]* | 105 *[100]* | 100 | 125 | 150 | 175 | 200 |
| | Policy-Driven | | | | | | 200 | 300 | 400 | 500 | 500 |
| Turkey | Moderate | N/A | 0.3 | 0.1 | 0.1 | 5 | 10 | 50 | 100 | 150 | 200 |
| | Policy-Driven | | | | | | 80 | 200 | 400 | 500 | 750 |
| Ukraine | Moderate | N/A | N/A | N/A | 3 | 188 | 100 | 150 | 200 | 250 | 300 |
| | Policy-Driven | | | | | | 350 | 500 | 700 | 900 | 1,200 |
| United Kingdom | Moderate | 4 | 6 | 7 | 62 | 784 | 250 | 250 | 250 | 250 | 250 |
| | Policy-Driven | | | | | | 2,000 | 1,250 | 1,500 | 1,750 | 2,000 |
| Rest of Europe[b] | Moderate | 5 | 14 | 5 | 5 | 26 | 63 | 110 | 160 | 235 | 467 |
| | Policy-Driven | | | | | | 182 | 391 | 691 | 990 | 1,595 |
| **TOTAL EUROPE** | **Moderate** | 1,972 | 5,297 | 5,803 | 13,367 | 21,939 | **9,435** | **6,515** | **8,460** | **9,350** | **10,272** |
| | **Policy-Driven** | | | | | | **21,634** | **16,591** | **19,041** | **21,165** | **24,845** |

[a] Data in parenthesis for Belgium, Spain and Switzerland are installations in AC power, as officially reported.

[b] Rest of Europe includes Croatia, Cyprus, Estonia, Faroe Islands, Finland, FYROM, Iceland, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Norway, Russia, Sweden.

| Country | Scenario | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASIA PACIFIC (APAC)** | | | | | | | | | | | |
| Australia | Moderate | 6 | 12 | 79 | 387 | 774 | 500 | 600 | 700 | 800 | 1,000 |
| | Policy-Driven | | | | | | 1,500 | 1,750 | 2,000 | 2,250 | 2,500 |
| China | Moderate | 20 | 45 | 228 | 520 | 2,200 | 3,000 | 3,250 | 3,500 | 3,750 | 4,500 |
| | Policy-Driven | | | | | | 5,000 | 6,000 | 7,000 | 8,000 | 10,000 |
| India | Moderate | 20 | 40 | 30 | 60 | 300 | 300 | 450 | 600 | 800 | 1,000 |
| | Policy-Driven | | | | | | 1,500 | 2,000 | 2,500 | 3,500 | 5,000 |
| Japan | Moderate | 210 | 230 | 480 | 991 | 1,296 | 2,200 | 2,500 | 2,750 | 3,000 | 3,250 |
| | Policy-Driven | | | | | | 2,500 | 3,000 | 3,200 | 3,400 | 3,600 |
| Korea | Moderate | 45 | 276 | 167 | 138 | 92 | 100 | 200 | 225 | 250 | 300 |
| | Policy-Driven | | | | | | 300 | 320 | 340 | 360 | 500 |
| Malaysia | Moderate | N/A | 0.8 | 0.3 | 0.5 | N/A | 10 | 20 | 30 | 40 | 50 |
| | Policy-Driven | | | | | | 100 | 200 | 300 | 400 | 500 |
| Taiwan | Moderate | 2 | 5 | 10 | 13 | 70 | 100 | 70 | 50 | 100 | 100 |
| | Policy-Driven | | | | | | 120 | 100 | 70 | 120 | 120 |
| Thailand | Moderate | N/A | N/A | N/A | 28 | 121 | 50 | 250 | 375 | 500 | 500 |
| | Policy-Driven | | | | | | 250 | 500 | 750 | 1,000 | 1,000 |
| Rest of APAC[c] | Moderate | N/A | N/A | N/A | N/A | N/A | 100 | 200 | 300 | 400 | 600 |
| | Policy-Driven | | | | | | 250 | 400 | 600 | 750 | 1,000 |
| **Total APAC** | **Moderate** | 303 | 608 | 994 | 2,138 | 4,853 | 6,360 | 7,540 | 8,530 | 9,640 | 11,300 |
| | **Policy-Driven** | | | | | | 11,520 | 14,270 | 16,760 | 19,780 | 24,220 |
| **AMERICA** | | | | | | | | | | | |
| Brazil | Moderate | N/A | N/A | N/A | N/A | 5 | 50 | 250 | 500 | 750 | 1,000 |
| | Policy-Driven | | | | | | 100 | 400 | 750 | 1,000 | 1,500 |
| Canada | Moderate | 5 | 7 | 62 | 105 | 364 | 250 | 400 | 550 | 650 | 750 |
| | Policy-Driven | | | | | | 450 | 600 | 750 | 900 | 1,000 |
| Chile | Moderate | N/A | N/A | N/A | N/A | N/A | 25 | 50 | 100 | 250 | 500 |
| | Policy-Driven | | | | | | 100 | 250 | 300 | 500 | 1,000 |
| Mexico | Moderate | N/A | N/A | N/A | N/A | 10 | 25 | 50 | 100 | 200 | 300 |
| | Policy-Driven | | | | | | 100 | 250 | 500 | 750 | 1,000 |
| USA | Moderate | 207 | 342 | 477 | 878 | 1,855 | 2,800 | 3,700 | 5,100 | 6,400 | 8,100 |
| | Policy-Driven | | | | | | 3,500 | 4,600 | 6,400 | 8,000 | 10,200 |
| Rest of America | Moderate | N/A | N/A | N/A | N/A | N/A | 100 | 200 | 300 | 400 | 500 |
| | Policy-Driven | | | | | | 100 | 200 | 500 | 750 | 1,000 |
| **Total America** | **Moderate** | 212 | 349 | 539 | 983 | 2,234 | 3,250 | 4,650 | 6,650 | 8,650 | 11,150 |
| | **Policy-Driven** | | | | | | 4,350 | 6,250 | 9,200 | 11,900 | 15,700 |
| **MIDDLE EAST AND AFRICA (MEA)** | | | | | | | | | | | |
| Israel | Moderate | N/A | N/A | 21 | 45 | 130 | 100 | 150 | 200 | 300 | 400 |
| | Policy-Driven | | | | | | 250 | 350 | 450 | 600 | 1,000 |
| Jordan | Moderate | N/A | N/A | N/A | N/A | N/A | 10 | 50 | 100 | 150 | 200 |
| | Policy-Driven | | | | | | 150 | 150 | 250 | 400 | 500 |
| South Africa[d] | Moderate | N/A | N/A | N/A | N/A | 1 | 25 | 100 | 250 | 500 | 1,000 |
| | Policy-Driven | | | | | | 200 | 500 | 1,000 | 1,500 | 2,000 |
| Rest of MEA | Moderate | N/A | N/A | N/A | N/A | N/A | 25 | 50 | 100 | 300 | 500 |
| | Policy-Driven | | | | | | 100 | 250 | 500 | 750 | 1,000 |
| **Total MEA** | **Moderate** | N/A | N/A | 21 | 45 | 131 | 160 | 350 | 650 | 1,250 | 2,100 |
| | **Policy-Driven** | | | | | | 700 | 1,250 | 2,200 | 3,250 | 4,500 |
| Rest of the World | Moderate | 42 | 76 | 80 | 312 | 629 | 1,000 | 1,500 | 2,500 | 3,000 | 4,000 |
| | Policy-Driven | | | | | | 2,000 | 3,000 | 5,000 | 6,000 | 8,000 |
| **TOTAL WORLD** | **Moderate** | 2,529 | 6,330 | 7,437 | 16,817 | 29,665 | **20,205** | **20,555** | **26,790** | **31,890** | **38,822** |
| | **Policy-Driven** | | | | | | **40,204** | **41,361** | **52,201** | **62,095** | **77,265** |

[c] Rest of APAC includes Bangladesh, Indonesia, New Caledonia, New Zealand, Philippines, Singapore, Sri Lanka and Vietnam.
[d] Data for South Africa in 2011 are provisional.

# ANNEX 2

**Table 5** - Detailed cumulative historical market data and outlook until 2016 (MW)

| Country | Scenario | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **EUROPE** | | | | | | | | | | | |
| Austria | Moderate | 28 | 33 | 53 | 96 | 176 | 280 | 400 | 540 | 700 | 880 |
| | Policy-Driven | | | | | | 380 | 680 | 1,100 | 1,600 | 2,200 |
| Belgium[a] | Moderate | 27 | 108 | 627 | 1,044 | 2,018 | 2,400 | 2,700 | 3,100 | 3,400 | 3,800 |
| | Policy-Driven | *[26]* | *[103]* | *[597]* | *[994]* | *[1,922]* | 2,600 | 3,200 | 3,800 | 4,400 | 5,000 |
| Bulgaria | Moderate | 0.1 | 1 | 7 | 35 | 135 | 280 | 430 | 580 | 780 | 980 |
| | Policy-Driven | | | | | | 380 | 680 | 1,000 | 1,400 | 1,900 |
| Czech Republic | Moderate | 3 | 64 | 462 | 1,952 | 1,959 | 2,000 | 2,000 | 2,000 | 2,100 | 2,200 |
| | Policy-Driven | | | | | | 2,000 | 2,100 | 2,300 | 2,600 | 3,100 |
| Denmark | Moderate | 3 | 3 | 4 | 6 | 16 | 40 | 70 | 110 | 150 | 200 |
| | Policy-Driven | | | | | | 70 | 140 | 240 | 340 | 440 |
| France | Moderate | 26 | 84 | 269 | 988 | 2,659 | 3,200 | 3,700 | 4,200 | 4,700 | 5,200 |
| | Policy-Driven | | | | | | 4,700 | 6,700 | 8,700 | 10,700 | 13,200 |
| Germany | Moderate | 4,170 | 5,979 | 9,785 | 17,193 | 24,678 | 28,700 | 30,700 | 33,700 | 36,700 | 39,700 |
| | Policy-Driven | | | | | | 32,700 | 37,700 | 42,700 | 47,700 | 52,700 |
| Greece | Moderate | 8 | 18 | 55 | 205 | 631 | 1,100 | 1,600 | 2,100 | 2,600 | 3,100 |
| | Policy-Driven | | | | | | 1,400 | 2,200 | 3,000 | 3,900 | 4,900 |
| Hungary | Moderate | 0.3 | 0.4 | 1 | 2 | 4 | 10 | 30 | 60 | 100 | 150 |
| | Policy-Driven | | | | | | 20 | 70 | 170 | 370 | 670 |
| Italy | Moderate | 93 | 432 | 1,144 | 3,470 | 12,754 | 15,800 | 17,300 | 19,000 | 21,000 | 23,000 |
| | Policy-Driven | | | | | | 18,800 | 21,800 | 24,800 | 27,800 | 30,800 |
| Netherlands | Moderate | 48 | 52 | 63 | 83 | 103 | 130 | 180 | 280 | 430 | 630 |
| | Policy-Driven | | | | | | 150 | 250 | 450 | 750 | 1,300 |
| Poland | Moderate | 1 | 1 | 1 | 2 | 3 | 0 | 50 | 150 | 300 | 500 |
| | Policy-Driven | | | | | | 0 | 100 | 300 | 600 | 1,100 |
| Portugal | Moderate | 16 | 68 | 112 | 150 | 183 | 230 | 310 | 430 | 600 | 800 |
| | Policy-Driven | | | | | | 230 | 330 | 530 | 830 | 1,300 |
| Romania | Moderate | 0.01 | 0.01 | 1 | 2 | 3 | 30 | 80 | 150 | 250 | 400 |
| | Policy-Driven | | | | | | 200 | 600 | 1,200 | 2,000 | 3,000 |
| Serbia | Moderate | N/A | N/A | N/A | 0.5 | 0.5 | 30 | 230 | 580 | 930 | 1,300 |
| | Policy-Driven | | | | | | 150 | 450 | 900 | 1,400 | 1,900 |
| Slovakia | Moderate | 2 | 2 | 3 | 148 | 468 | 500 | 550 | 650 | 800 | 1,000 |
| | Policy-Driven | | | | | | 520 | 620 | 820 | 1,100 | 1,600 |
| Slovenia | Moderate | 1 | 2 | 9 | 35 | 81 | 140 | 200 | 270 | 340 | 420 |
| | Policy-Driven | | | | | | 180 | 310 | 460 | 630 | 830 |
| Spain[a] | Moderate | 724 | 3,568 | 3,588 | 4,029 | 4,400 | 4,500 | 4,600 | 4,800 | 5,100 | 5,600 |
| | Policy-Driven | *[690]* | *[3,398]* | *[3,417]* | *[3,837]* | *[4,191]* | 4,700 | 5,200 | 6,000 | 6,800 | 7,800 |
| Switzerland[a] | Moderate | 34 | 46 | 72 | 111 | 216 | 320 | 440 | 590 | 770 | 970 |
| | Policy-Driven | *[32]* | *[43]* | *[69]* | *[106]* | *[206]* | 420 | 720 | 1,100 | 1,600 | 2,100 |
| Turkey | Moderate | 0.01 | 0.3 | 0.4 | 0.5 | 6 | 20 | 70 | 170 | 320 | 520 |
| | Policy-Driven | | | | | | 90 | 290 | 690 | 1,200 | 1,900 |
| Ukraine | Moderate | N/A | N/A | N/A | 3 | 190 | 290 | 440 | 640 | 890 | 1,200 |
| | Policy-Driven | | | | | | 540 | 1,000 | 1,700 | 2,600 | 3,800 |
| United Kingdom | Moderate | 16 | 22 | 29 | 91 | 875 | 1,100 | 1,400 | 1,600 | 1,900 | 2,100 |
| | Policy-Driven | | | | | | 2,900 | 4,100 | 5,600 | 7,400 | 9,400 |
| Rest of Europe[b] | Moderate | 56 | 70 | 74 | 132 | 158 | 220 | 330 | 490 | 730 | 1,200 |
| | Policy-Driven | | | | | | 340 | 730 | 1,400 | 2,400 | 4,000 |
| **TOTAL EUROPE** | **Moderate** | 5,257 | 10,554 | 16,357 | 29,777 | 51,716 | **61,320** | **67,810** | **76,190** | **85,590** | **95,850** |
| | **Policy-Driven** | | | | | | **73,470** | **89,970** | **108,960** | **130,120** | **154,940** |

[a] Data in parenthesis for Belgium, Spain and Switzerland are installations in AC power, as officially reported.
[b] Rest of Europe includes Croatia, Cyprus, Estonia, Faroe Islands, Finland, FYROM, Iceland, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Norway, Russia, Sweden.

| Country | Scenario | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ASIA PACIFIC (APAC)** | | | | | | | | | | | |
| Australia | Moderate | 46 | 58 | 137 | 524 | 1,298 | 1,800 | 2,400 | 3,100 | 3,900 | 4,900 |
| | Policy-Driven | | | | | | 2,800 | 4,500 | 6,500 | 8,800 | 11,300 |
| China | Moderate | 100 | 145 | 373 | 893 | 3,093 | 6,100 | 9,300 | 12,800 | 16,600 | 21,100 |
| | Policy-Driven | | | | | | 8,100 | 14,100 | 21,100 | 29,100 | 39,100 |
| India | Moderate | 31 | 71 | 101 | 161 | 461 | 760 | 1,200 | 1,800 | 2,600 | 3,600 |
| | Policy-Driven | | | | | | 2,000 | 4,000 | 6,500 | 10,000 | 15,000 |
| Japan | Moderate | 1,917 | 2,147 | 2,627 | 3,618 | 4,914 | 7,100 | 9,600 | 12,400 | 15,400 | 18,600 |
| | Policy-Driven | | | | | | 7,400 | 10,400 | 13,600 | 17,000 | 20,600 |
| Korea | Moderate | 81 | 357 | 524 | 662 | 754 | 850 | 1,100 | 1,300 | 1,500 | 1,800 |
| | Policy-Driven | | | | | | 1,100 | 1,400 | 1,700 | 2,100 | 2,600 |
| Malaysia | Moderate | N/A | N/A | N/A | 11 | 11 | 20 | 40 | 70 | 110 | 160 |
| | Policy-Driven | | | | | | 110 | 310 | 610 | 1,000 | 1,500 |
| Taiwan | Moderate | 4 | 9 | 19 | 32 | 102 | 200 | 270 | 320 | 420 | 520 |
| | Policy-Driven | | | | | | 220 | 320 | 390 | 510 | 630 |
| Thailand | Moderate | N/A | N/A | N/A | 28 | 149 | 200 | 450 | 820 | 1,300 | 1,800 |
| | Policy-Driven | | | | | | 400 | 900 | 1,600 | 2,600 | 3,600 |
| Rest of APAC[c] | Moderate | N/A | N/A | N/A | 79 | 79 | 180 | 380 | 680 | 1,100 | 1,700 |
| | Policy-Driven | | | | | | 330 | 730 | 1,300 | 2,100 | 3,100 |
| **Total APAC** | **Moderate** | 2,180 | 2,788 | 3,782 | 6,009 | 10,862 | 17,210 | 24,740 | 33,290 | 42,930 | 54,180 |
| | **Policy-Driven** | | | | | | 22,460 | 36,660 | 53,300 | 73,210 | 97,430 |
| **AMERICA** | | | | | | | | | | | |
| Brazil | Moderate | N/A | N/A | N/A | 27 | 32 | 80 | 330 | 830 | 1,600 | 2,600 |
| | Policy-Driven | | | | | | 130 | 530 | 1,300 | 2,300 | 3,800 |
| Canada | Moderate | 26 | 33 | 95 | 200 | 563 | 810 | 1,200 | 1,800 | 2,400 | 3,200 |
| | Policy-Driven | | | | | | 1,000 | 1,600 | 2,400 | 3,300 | 4,300 |
| Chile | Moderate | N/A | N/A | N/A | 4 | 4 | 30 | 80 | 180 | 430 | 930 |
| | Policy-Driven | | | | | | 100 | 300 | 600 | 1,100 | 2,100 |
| Mexico | Moderate | N/A | N/A | N/A | 30 | 40 | 70 | 120 | 220 | 420 | 720 |
| | Policy-Driven | | | | | | 140 | 390 | 890 | 1,600 | 2,600 |
| USA | Moderate | 831 | 1,173 | 1,650 | 2,528 | 4,383 | 7,200 | 10,900 | 16,000 | 22,400 | 30,500 |
| | Policy-Driven | | | | | | 7,900 | 12,500 | 18,900 | 26,900 | 37,100 |
| Rest of America[d] | Moderate | N/A | N/A | N/A | 32 | 32 | 130 | 330 | 630 | 1,000 | 1,500 |
| | Policy-Driven | | | | | | 130 | 330 | 830 | 1,600 | 2,600 |
| **Total America** | **Moderate** | 856 | 1,205 | 1,744 | 2,820 | 5,053 | 8,320 | 12,960 | 19,660 | 28,250 | 39,450 |
| | **Policy-Driven** | | | | | | 9,400 | 15,650 | 24,920 | 36,800 | 52,500 |
| **MIDDLE EAST AND AFRICA (MEA)** | | | | | | | | | | | |
| Israel | Moderate | N/A | N/A | 21 | 66 | 196 | 300 | 450 | 650 | 950 | 1300 |
| | Policy-Driven | | | | | | 450 | 800 | 1,200 | 1,800 | 2,800 |
| Jordan | Moderate | N/A | N/A | N/A | 1 | 1 | 10 | 60 | 160 | 310 | 510 |
| | Policy-Driven | | | | | | 150 | 300 | 550 | 950 | 1,500 |
| South Africa[e] | Moderate | N/A | N/A | N/A | 40 | 41 | 70 | 170 | 420 | 920 | 1,900 |
| | Policy-Driven | | | | | | 240 | 740 | 1,700 | 3,200 | 5,200 |
| Rest of MEA[f] | Moderate | N/A | N/A | N/A | 99 | 99 | 120 | 170 | 270 | 570 | 1,100 |
| | Policy-Driven | | | | | | 200 | 450 | 950 | 1,700 | 2,700 |
| **Total MEA** | **Moderate** | N/A | N/A | 21 | 205 | 336 | 500 | 850 | 1,500 | 2,750 | 4,810 |
| | **Policy-Driven** | | | | | | 1,040 | 2,290 | 4,400 | 7,650 | 12,200 |
| Rest of the World[g] | Moderate | 1,150 | 1,226 | 1,306 | 1,209 | 1,838 | 2,800 | 4,300 | 6,800 | 9,800 | 13,800 |
| | Policy-Driven | | | | | | 3,800 | 6,800 | 11,800 | 17,800 | 25,800 |
| **TOTAL WORLD** | **Moderate** | 9,443 | 15,772 | 23,210 | 40,019 | 69,684 | **89,900** | **110,400** | **137,200** | **169,100** | **207,900** |
| | **Policy-Driven** | | | | | | **109,900** | **151,200** | **203,400** | **265,500** | **342,800** |

[c] Rest of APAC includes Bangladesh, Indonesia, New Caledonia, New Zealand, Philippines, Singapore, Sri Lanka and Vietnam.
[d] From 2010 it includes Argentina, Bolivia, Colombia and Peru.
[e] Data for South Africa in 2011 are provisional.
[f] From 2010 it includes Algeria, Cape Verde, Egypt, Ethiopia, Kenya, Morocco, Nigeria, Senegal, Saudi Arabia, UAE and Uganda.
[g] Rest of the World includes countries not cited above. Value for 2010 is lower than value for 2009 because in 2009 more countries were included.

# ANNEX 3

**Table 6** - Regional distribution of PV cumulative installed capacity, market and installed capacity per habitant (MW)

| Country | Cumulative 2010 | Market 2011 | Cumulative 2011 | Installed capacity/ hab 2011 (W/hab) |
|---|---|---|---|---|
| **BELGIUM[a]** | | | | |
| Bruxelles/Brussel | 6 | 1 | 7 | 6.4 |
| Vlaanderen | 936 | 856 | 1,792 | 286.7 |
| Wallonie | 101 | 117 | 218 | 61.6 |
| **FRANCE[b]** | | | | |
| Alsace | 48 | 43 | 91 | 49.5 |
| Aquitaine | 95 | 170 | 265 | 83.4 |
| Auvergne | 26 | 52 | 78 | 58.1 |
| Bourgogne | 21 | 22 | 43 | 26.2 |
| Bretagne | 52 | 58 | 110 | 34.9 |
| Centre | 21 | 41 | 62 | 24.5 |
| Champagne-Ardenne | 16 | 47 | 63 | 47.1 |
| Corse | 14 | 45 | 59 | 194.7 |
| Franche-Comté | 13 | 11 | 24 | 20.6 |
| Ile-de-France | 25 | 30 | 55 | 4.7 |
| Languedoc-Roussillon | 106 | 142 | 248 | 96.1 |
| Limousin | 15 | 22 | 37 | 49.9 |
| Lorraine | 27 | 40 | 67 | 28.6 |
| Midi-Pyrénées | 84 | 200 | 284 | 100.1 |
| Nord-Pas-de-Calais | 24 | 23 | 47 | 11.7 |
| Basse-Normandie | 12 | 17 | 29 | 19.8 |
| Haute-Normandie | 8 | 23 | 31 | 17 |
| Pays de la Loire | 105 | 104 | 209 | 59.5 |
| Picardie | 26 | 10 | 36 | 18.9 |
| Poitou-Charentes | 54 | 81 | 135 | 77 |
| Provence-Alpes-Côte d'Azur | 122 | 244 | 366 | 75 |
| Rhone-Alpes | 103 | 97 | 200 | 32.7 |
| **GERMANY** | | | | |
| Baden-Württemberg | 2,741 | 840 | 3,581 | 333.5 |
| Bayern | 6,323 | 1,744 | 8,067 | 645.8 |
| Berlin | 31 | 15 | 46 | 13.4 |
| Brandenburg | 564 | 982 | 1,546 | 606.9 |
| Bremen | 14 | 11 | 25 | 38 |
| Hamburg | 14 | 8 | 22 | 12.8 |
| Hessen | 897 | 310 | 1,207 | 198.8 |
| Mecklenburg-Vorpommern | 249 | 271 | 520 | 306.7 |
| Niedersachsen | 1,511 | 773 | 2,284 | 286.1 |
| Nordrhein-Westfalen | 1,961 | 852 | 2,812 | 156 |
| Rheinland-Pfalz | 867 | 308 | 1,175 | 289.9 |
| Saarland | 163 | 60 | 223 | 213.9 |
| Sachsen | 527 | 361 | 888 | 209 |
| Sachsen-Anhalt | 408 | 448 | 856 | 350.5 |
| Schleswig-Holstein | 674 | 279 | 953 | 336.4 |
| Thüringen | 298 | 222 | 519 | 224.8 |

[a] Original data for Belgium and Spain regions have been converted from AC to DC power (factor 1.05).
[b] For France the sum of regional data is different from the national value because we are not considering here overseas regions (except Corsica).

| Country | Cumulative 2010 | Market 2011 | Cumulative 2011 | Installed capacity/ hab 2011 (W/hab) |
|---|---|---|---|---|
| **ITALY**[c] | | | | |
| Abruzzo | 67 | 383 | 450 | 335.4 |
| Basilicata | 50 | 172 | 221 | 376.8 |
| Calabria | 59 | 177 | 236 | 117.3 |
| Campania | 84 | 288 | 372 | 62.5 |
| Emilia Romagna | 364 | 902 | 1,267 | 285.9 |
| Friuli Venezia Giulia | 93 | 202 | 295 | 238.6 |
| Lazio | 244 | 622 | 866 | 150.4 |
| Liguria | 15 | 38 | 53 | 32.9 |
| Lombardia | 372 | 946 | 1,318 | 132.6 |
| Marche | 184 | 602 | 786 | 502.2 |
| Molise | 16 | 101 | 117 | 365.1 |
| Piemonte | 266 | 806 | 1,072 | 240.5 |
| Puglia | 683 | 1,503 | 2,186 | 534.4 |
| Sardegna | 102 | 301 | 403 | 240.3 |
| Sicilia | 156 | 704 | 860 | 170.3 |
| Toscana | 137 | 330 | 468 | 124.7 |
| Trentino Alto Adige | 170 | 127 | 297 | 287.4 |
| Umbria | 73 | 245 | 319 | 351.3 |
| Valle d'Aosta | 5 | 9 | 14 | 105.3 |
| Veneto | 330 | 830 | 1,160 | 235 |
| **SPAIN**[d, e] | | | | |
| Andalucia | 765 | 57 | 822 | 98.2 |
| Aragon | 142 | 5 | 146 | 108.4 |
| Asturias | 1 | 0 | 1 | 1 |
| Baleares | 60 | 6 | 66 | 59.8 |
| Canarias | 133 | 6 | 138 | 65 |
| Cantabria | 2 | 0 | 2 | 3.5 |
| Castilla-La Mancha | 897 | 26 | 923 | 440.4 |
| Castilla y León | 410 | 57 | 467 | 184.4 |
| Cataluña | 202 | 33 | 234 | 31.1 |
| Ceuta y Melilla | 0.1 | 0 | 0.1 | 1.4 |
| Comunidad de Madrid | 38 | 10 | 48 | 7.5 |
| Comunidad Valenciana | 277 | 36 | 313 | 61.2 |
| Extremadura | 492 | 66 | 558 | 507.9 |
| Galicia | 10 | 2 | 12 | 4.2 |
| La Rioja | 83 | 6 | 89 | 288.2 |
| Navarra | 142 | 13 | 155 | 249.9 |
| País Vasco | 20 | 3 | 23 | 10.7 |
| Región de Murcia | 357 | 47 | 404 | 283.7 |
| **UNITED KINGDOM**[f] | | | | |
| East Midlands | 5 | 39 | 44 | 10.5 |
| East of England | 7 | 45 | 53 | 9.8 |
| Greater London | 3 | 8 | 11 | 1.4 |
| North East | 1 | 12 | 13 | 5 |
| North West | 3 | 29 | 32 | 4.7 |
| Northern Ireland | 0 | 0 | 0 | 0 |
| Scotland | 2 | 40 | 42 | 8 |
| South East | 12 | 65 | 78 | 9.7 |
| South West | 12 | 79 | 91 | 18.5 |
| Wales | 3 | 28 | 30 | 10 |
| West Midlands | 4 | 29 | 33 | 6.2 |
| Yorkshire and the Humber | 8 | 42 | 50 | 9.6 |

[c] Regional data for Italy comes from GSE.
[d] Original data for Belgium and Spain regions have been converted from AC to DC power (factor 1.05).
[e] Regional data have been updated with March 2012 data.
[f] Regional data until 2011 provided for UK show publicly available data from OFGEM (around 403 MW). The other 472 MW are not attributed to any region or are subject to another incentive scheme.

# GLOSSARY

**Alternating Current (AC):** Electric current that periodically reverses its direction of flows - 50 times per second (Hz) for Europe, China, East Japan among others and 60 times per second for the USA, West Japan, Brazil. Solar PV power must be converted from DC (see below) to AC using a power inverter.

**Connected capacity:** Refers to generating systems (e.g. PV generators) that have been installed and allowed to inject electricity into the grid.

**"Corridor" system:** Dynamic market control mechanism that adjusts the FiT rate, based either on the amount of capacity installed during prior periods or future capacity additions. It is considered to be volume-responsive and mainly refers to FiT degression system. However there can be an increase of the FiT, when for instance a market under-performs compared to its potential. "Corridor" systems aim to promote sustainable market growth and manage increased connected capacity by keeping prices at a sustainable level.

**Direct Current (DC):** Electric current that flows only in one direction. Solar PV power starts as DC and is normally converted to AC using a power inverter.

**Dynamic grid parity:** Refers to the moment at which, in a particular market segment in a specific country, the present value of the long-term net earnings (considering revenues, savings, cost and depreciation) of the electricity supply from a PV installation is equal to the long-term cost of receiving traditionally produced and supplied power over the grid.

**Feed-in Tariff (FiT):** Policy mechanism created and regulated by government to promote investment in RES (e.g. PV technology). Under FiT schemes renewable electricity producers are offered long-term contracts under which a guaranteed fixed amount of money is paid to them, usually by the utility provider (national or local), for the energy fed into the grid. The FiT rate is typically set above market rates, offsetting inherent risks in renewable energy production.

**Green Certificate (GC):** Tradable certificate that represents the environmental or social benefits of (green) electricity generated from RES such as PV. Green certificates can be purchased both from electricity producers and consumers as a proof of producing or consuming renewable electricity.

**Installed capacity:** Refers to systems put in place but awaiting the approval of the grid operator to inject electricity into the grid. It should not be confused with connected capacity (see above).

**Net metering:** Compensation scheme that allows electricity consumers to reduce their electricity bills by giving them credit for the electricity produced by their PV system over a certain period of time (usually one year).

**Self-consumption:** The possibility for any kind of electricity producer to directly use/consume part or all of the electricity produced at the same location (on-site consumption), instantaneously.

**Power Purchase Agreement (PPA):** Financial arrangement in which a third-party developer installs, owns, operates, and maintains the PV system, while a "host" customer agrees to site the system on its property and purchases the system's electricity from the solar services provider for a predetermined period and a predetermined price.

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