TIMOTHÉE BONGRAIN/OBSERVER

The Topaz Solar Farm produces sufficient electricity to power 160 000 California homes.

**100 935 MWp**

**in the European Union at the end of 2016**

# PHOTOVOLTAIC BAROMETER

*A study carried out by EurObserv'ER*

EurObserv'ER

**Not just a wave, it's a breaker that has made landfall on the global solar power market, driven by strong Asian and American demand. The global solar photovoltaic market surged past the 76 GW mark in 2016, with peak growth at 50%. The European market seems to have drifted into slack water. It connected only 6.1 GW of additional capacity in 2016 and in doing so slipped below the previous year's figure of 7.9 GW. The sector's regulatory framework is being overhauled with a view to integrating more renewably-sourced electricity into the market.**

**105.3 TWh**

*Photovoltaic electricity generated in the EU in 2016*

**6 122.8 MWp**

*Photovoltaic capacity connected in the EU in 2016*

Templin solar power plant, 128.5 MW, located in Brandenburgin, Germany.

BELECTRIC

Global market growth peaked in 2016. Preliminary estimates from Solar Power Europe suggest that global on-grid capacity exceeded 76 GW, which amounts to 50% growth over 2015 (50 655 MW according to the IEA PVPS). Part of this global explosion market is down to a combination of events relating to the announcement of swingeing cuts to solar power payments in the main lead markets, starting at the beginning of 2017 compounded by the Chinese panel manufacturing industry's overcapacity that has depressed photovoltaic panel prices. The additional on-grid capacity has taken global photovoltaic capacity to more than 300 GW (about 304 GW, on the basis of a 227.7 GW base at the end of 2015, MW according to the IEA PVPS). The Chinese, American and Indian markets are riding on the crest of this breaker… each having more or less doubled their annual installed capacity.

## *THE GLOBAL MARKET IS OVERHEATING*

Overheating in 2016 could make way for a slight dip in 2017 or stabilization at best. China's market could be hit by a sharp drop in tariff rates and by the government's resolve to limit the deployment of large ground-based photovoltaic parks (see further on). The US market could also rebalance following investment regulation in large ground-based plants by electricity operators after a breakneck year in 2016. This contrast with India's market, which has risen to No. 3 in the world rankings and should remain very buoyant in 2017 thanks to the announcement of major tenders in the offing and the drop in photovoltaic panel prices observed caused by Chinese manufacturers having to find outlets for their production and also reduce their inventories.
According to GTM Research, the global market could contract by about 7%, in which case sales would be in the 74–69 GW range. PV Market Alliance, a consortium of international energy research bodies, estimates that the 2017 installation level could be similar to that of 2016, presuming the established markets maintain a reasonable level of development and the difference is made up for by growth coming from the emerging markets. However PV Market Alliance does not rule out a more pessimistic scenario, with a capacity installation level of under 65 GW. Slight decline or stabilisation of the 2017 market could then give way to years of more modest growth. GTM Research reckons that the global market should return to growth as soon as 2018 and goes so far as to forecast that from 2016 to 2021, it is likely to grow by an average of 8%, i.e. 499 GW of capacity installed worldwide over the 5 year period.

## NEWS FROM AROUND THE MAIN MARKETS

### China aims for more decentralized photovoltaic

Official National Energy Administration (NEA) data shows that installed photovoltaic capacity rose to 77.42 GW in China, namely 34.54 GW of additional capacity in 2016. The new installation figure should be compared with the 2015 and 2014 figures of 15.13 GW and 10.56 GW respectively. The main reason for the Chinese market's surge is the announced sharp drop in Feed-in Tariffs which came in on 1 January 2017. Any projects approved prior to that date will benefit from the 2016 tariffs. The outcome should be that installation levels will be even higher for at least the 1st six months of 2017. The tariff cuts revealed in December turned out to be not so drastic after all. For large ground-based plants, they dropped by 25% in the sunniest regions (from 0.80 to 0.60 RMB in zone 1), and by 18% in the less sunny regions (from 0.98 to 0.80 RMB in zone 3) although the previously announced cuts were 37% in zone 1 and 23% in zone 3.
The agency points out that 66.2 TWh of solar electricity was generated in 2016 (a 72% rise) – a little over 1% of the country's electricity consumption – which increased to 5 920 TWh (5% year-on-year). Officially the NEA's 13th five year solar power development plan (2016-2020) announced in December 2016 was downsized by planning 110 GW (60 GW of decentralized solar capacity and 50 GW of major ground-based infrastructure projects including 5 GW of CSP plants), namely 27% less than the initial 150 GW figure. Solar power output should increase from 40 TWh in 2015 to 150 TWh in 2020. Thus the plan is to redirect solar investments to the major electricity consumption areas near the major cities and put the accent on decentralized solar power by promoting low voltage small-capacity on-grid installations (small solar ground-based and roof-mounted plants) and limiting investments in very large plants in less populated areas that call for very costly high voltage grid infrastructures to transmit the electricity over long distances. Frank Haugwitz of the research company AECEA says that limiting the number of large plants will be a real challenge, as decentralized solar only accounts for about 15 GW of the current installed capacity figure and that installed centralized solar capacity already exceeds 50 GW. It is thus more than likely that the 110 GW target will be outperformed. According to AECEA, the installation volume will probably be in the region of 135–147 GW.

### Large solar plants in the US enjoy a boom

United States' solar power had a great year in 2016, when according to the SEIA (Solar Energy Industries Association), the American market installed 14 762 MW of solar photovoltaic capacity (i.e. 1 MW installed every 36 minutes), almost doubling the 2015 installation level of 7 501 MW – a 97% rise. The SEAI claims that for the first time solar power was the top electricity source connected to the grid, with a 39% share of the newly installed electricity capacity in the USA, ahead of gas (29%) and wind energy (26%). The main driving force behind the American market is the connection of major plants developed by the electricity companies (10 593 MW, a 148% rise) followed by residential (2 583 MW, with a 19% rise) and non-residential installations (1 586 MW, a 49% rise). Like China, the US market expanded because the developers and electricity companies had pre-empted the slash in the federal investment tax credit (ITC) measure announced for the end of 2016. To be eligible for the maximum level of ITC, the projects had to be commissioned before the end of the year. When it was announced that the ITC measure would be extended at the end of the 2015, a number of major projects were postponed, but the majority stuck to their initial schedules, creating a one off installation peak in 2016 in the large plant segment. Over the next two years, the pace should settle down. GTM Research, the research company that had a hand in drawing up these statistics, believes that the market should contract by 10% in 2017 to 13.2 GW. Nonetheless




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the sector should remain buoyant. GTM Research forecasts that installed capacity should increase threefold over the next 5 years running at as much as 18 GW of newly-installed capacity per annum by 2022. The reason for investors' interest is the sharp drop in the price of solar power. In the sunniest regions, and factoring in tax incentives, the average power purchase agreement (PPA) price is tending to fall below $ 50 per MWh (to about $ 47 per MWh). The record for the lowest price in the USA has been entered into by NV Energy which will buy the electricity output of the 100 MW "Boulder Solar" photovoltaic facility at Boulder City scheduled for 2018, at $ 38.7 per MWh, which is much lower than the price levied by a new coal, gas or nuclear power plant.

**India becomes the No. 3 global market**

The country is forecast to have the highest population in under a decade has changed gear as regards photovoltaic. Data released by the Ministry of New and Renewable Energy reveals that India had 12 289 MW of installed capacity on 31 March 2017. This figure is almost double the 6 763 MW registered capacity on 31 March 2016. India connected 5 526 MW During the relevant tax year (1 April 2016 – 31 March 2017) taken into account by the government, compared to 2 803 MW over the previous period. According to IRENA (the International Renewable Energy Agency), using official sources, India passed the symbolic 10 GW threshold at the end of 2016 with 10 081 MW (9 658 MW on-grid and 423 MW off-grid) compared to 5 578 MW of installed capacity at the end of 2015 (5 271 on-grid and 307 MW off-grid). Furthermore in September 2016, the country completed construction of the world's largest solar photovoltaic park, Kamuthi, in Tamil Nadu, southern India. It has 648 MW of capacity and covers a 10 km² site and will supply electricity to 150 000 households. India's market should continue to drive up its capacity over 2017. The research company Bridge to India reckons that connected capacity could increase by 8.8 GW (7.7 GW from major ground-based plants and 1.1 GW from roof-mounted solar plants). It believes that the market is currently buoyed by a drop in photovoltaic panel costs of about 20%, essen-

## Tabl. n° 1

*Photovoltaic capacity installed and connected in European Union during the years 2015 and 2016* (in MWp)*

| | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|
| | On-grid | Off-grid | Total | On-grid | Off-grid | Total |
| United Kingdom | 3 763.4 | 0.0 | 3 763.4 | 2 374.6 | 0.0 | 2 374.6 |
| Germany | 1 456.0 | 0.0 | 1 456.0 | 1 476.0 | 0.0 | 1 476.0 |
| France** | 903.4 | 0.4 | 903.8 | 559.2 | 0.5 | 559.7 |
| Netherlands | 467.0 | 0.0 | 467.0 | 525.0 | 0.0 | 525.0 |
| Italy | 297.8 | 0.0 | 297.8 | 369.0 | 0.0 | 369.0 |
| Belgium | 225.0 | 0.0 | 225.0 | 173.0 | 0.0 | 173.0 |
| Austria | 151.8 | 0.0 | 151.8 | 140.0 | 0.0 | 140.0 |
| Hungary | 91.0 | 4.0 | 95.0 | 110.0 | 5.0 | 115.0 |
| Poland | 81.0 | 0.0 | 81.0 | 84.8 | 0.0 | 84.8 |
| Denmark | 180.6 | 0.4 | 181.0 | 71.4 | 0.3 | 71.7 |
| Romania | 79.5 | 0.0 | 79.5 | 68.7 | 0.0 | 68.7 |
| Spain | 36.1 | 12.9 | 49.0 | 40.7 | 14.3 | 55.0 |
| Sweden | 45.8 | 1.6 | 47.4 | 25.1 | 1.6 | 26.7 |
| Slovenia | 15.0 | 0.0 | 15.0 | 20.0 | 0.0 | 20.0 |
| Portugal | 33.0 | 0.0 | 33.0 | 14.0 | 0.0 | 14.0 |
| Malta | 19.2 | 0.0 | 19.2 | 8.0 | 0.0 | 8.0 |
| Lithuania | 5.0 | 0.0 | 5.0 | 7.0 | 0.0 | 7.0 |
| Luxembourg | 6.3 | 0.0 | 6.3 | 6.3 | 0.0 | 6.3 |
| Croatia | 10.5 | 0.2 | 10.6 | 5.5 | 0.1 | 5.5 |
| Finland | 4.0 | 0.0 | 4.0 | 5.0 | 0.0 | 5.0 |
| Slovakia | 2.0 | 0.0 | 2.0 | 5.0 | 0.0 | 5.0 |
| Cyprus | 4.7 | 0.0 | 4.7 | 3.3 | 0.0 | 3.3 |
| Estonia | 2.0 | 0.0 | 2.0 | 3.0 | 0.0 | 3.0 |
| Bulgaria | 3.0 | 0.0 | 3.0 | 3.0 | 0.0 | 3.0 |
| Ireland | 1.0 | 0.0 | 1.0 | 3.0 | 0.0 | 3.0 |
| Greece | 8.5 | 0.0 | 8.5 | 0.4 | 0.0 | 0.4 |
| Czech Republic | 7.5 | 0.0 | 7.5 | 0.0 | 0.0 | 0.0 |
| Latvia | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| European Union | 7 900.1 | 19.5 | 7 919.5 | 6 101.1 | 21.7 | 6 122.8 |

*Estimate. **Overseas departments included for France (ie 21 MWp in 2015 and 5 MWp in 2016). Note: Decommissioning was recorded in the Czech Republic, Greece, Hungary and Spain. **Source: EurObserv'ER 2017***

## Tabl. n° 2

*Connected and cumulated photovoltaic capacity in the European Union countries at the end of 2015 and 2016* (in MWp)*

| | 2015 | | | 2016 | | |
|---|---|---|---|---|---|---|
| | On-grid | Off-grid | Total | On-grid | Off-grid | Total |
| Germany | 39 799.0 | 65.0 | 39 864.0 | 41 275.0 | 65.0 | 41 340.0 |
| Italy | 18 892.1 | 13.0 | 18 905.1 | 19 261.1 | 13.0 | 19 274.1 |
| United Kingdom | 9 187.6 | n.a. | 9 187.6 | 11 562.2 | n.a. | 11 562.2 |
| France** | 6 574.9 | 30.2 | 6 605.1 | 7 134.2 | 30.6 | 7 164.8 |
| Spain | 4 656.0 | 117.9 | 4 773.9 | 4 669.0 | 132.2 | 4 801.2 |
| Belgium | 3 252.0 | n.a. | 3 252.0 | 3 425.0 | n.a. | 3 425.0 |
| Greece | 2 604.2 | n.a. | 2 604.2 | 2 603.7 | n.a. | 2 603.7 |
| Czech rep | 2 074.9 | 0.4 | 2 075.3 | 2 047.0 | 0.4 | 2 047.4 |
| Netherlands | 1 515.0 | n.a. | 1 515.0 | 2 040.0 | n.a. | 2 040.0 |
| Romania | 1 302.4 | 0.0 | 1 302.4 | 1 371.1 | 0.0 | 1 371.1 |
| Austria | 931.6 | 5.5 | 937.1 | 1 071.6 | 5.5 | 1 077.1 |
| Bulgaria | 1 029 | n.a. | 1 029.0 | 1 032.0 | n.a. | 1 032.0 |
| Denmark | 784.4 | 2.2 | 786.6 | 855.8 | 2.5 | 858.3 |
| Slovakia | 540.0 | 0.1 | 540.1 | 545.0 | 0.1 | 545.1 |
| Portugal | 451.0 | 5.0 | 456.0 | 465.0 | 5.0 | 470.0 |
| Hungary | 168.0 | 7.0 | 175.0 | 276.0 | 12.0 | 288.0 |
| Slovenia | 239.0 | 0.1 | 239.1 | 259.0 | 0.1 | 259.1 |
| Poland | 108.0 | 2.9 | 110.9 | 192.8 | 2.9 | 195.7 |
| Sweden | 115.8 | 11.0 | 126.8 | 140.9 | 12.6 | 153.5 |
| Luxembourg | 116.3 | 0.0 | 116.3 | 122.6 | 0.0 | 122.6 |
| Malta | 74.0 | 0.0 | 74.0 | 82.0 | 0.0 | 82.0 |
| Lithuania | 73.0 | 0.1 | 73.1 | 80.0 | 0.1 | 80.1 |
| Cyprus | 50.5 | 1.1 | 51.6 | 53.8 | 1.1 | 54.9 |
| Croatia | 44.0 | 0.9 | 44.8 | 49.5 | 0.9 | 50.4 |
| Finland | 15.0 | n.a. | 15.0 | 20.0 | n.a. | 20.0 |
| Estonia | 7.0 | 0.1 | 7.1 | 10.0 | 0.1 | 10.1 |
| Ireland | 1.2 | 0.9 | 2.1 | 4.2 | 0.9 | 5.1 |
| Latvia | 1.5 | 0.0 | 1.5 | 1.5 | 0.0 | 1.5 |
| European Union | 94 607.3 | 263.4 | 94 870.7 | 100 649.9 | 285.1 | 100 935.0 |

*Estimate. ** Overseas departments included for France (ie 362 MWp in 2015 and 367 MWp in 2016). **Source: EurObserv'ER 2017***





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tially driven downwards by Chinese manufacturing overcapacity. The price of producing solar power is expected at less than 4 rupees per kWh (about € 0.055 per kWh) at the beginning of 2017, with grid parity already achieved in many regions for the industrial and commercial sectors. The market is also driven by the many tenders. Thus 9 GW went out for tender in 2016 including 10% for roof-mounted plants. The Indian government also grants financial aid to electricity distribution companies to support the deployment of solar power.

### The European market adapts to a new regulatory framework

While Asia and the USA are taking full advantage of solar power's price competitiveness, the European Union markets are in the throes of a transition phase that aims to introduce new renewable electricity production support mechanisms. The latter are outlined by the new European Commission guidelines set out in 2014, to promote greater integration of renewable energies into the electricity system by subjecting them to market-based regulation. They primarily hit the development of medium- and high-capacity power plants that form the mainstay of European growth.

Since 1 January 2016, these new guidelines force >500 kW capacity installations to use market payment mechanisms with premium, or for the wind energy sector from the 3 MW threshold (or 3 production units). From 1 January, they provide for an obligation to go through technology neutral calls for tender for all >1 MW capacity installations, or for wind energy from the 6 MW threshold (or production units). Even so, provisions are made in the guidelines for exceptions to technology neutrality criteria that enable a country to waive this rule depending on its specific situation. The call for competition procedure can actually be limited, bearing in mind the specific need of each country to diversify its electricity mix, grid stability constraints, system (integration) costs, or even the longer term potential of an identified new and innovative technology.

For example, on 20 December 2016 the European Commission approved the German tendering system that starting on 1 January 2017 plans to organize specific calls for tender to select >750 kW solar installations, offshore wind turbines and >750 kW onshore wind turbines. Europe considers that Germany has demonstrated that by organizing specific auctions for each technology it will achieve better cost-effectiveness than a competition procedure encompassing all or several technologies, and does so bearing in mind the country's particular electricity market conditions. In particular, Germany has shown that its electricity market is characterized by instability and grid integration issues that result from the rapid deployment of renewables combined with the closure of its nuclear power plants and the delays in deploying the grid. Thus in line with the guidelines, Germany is authorized to organize specific bids for each technology.

The European Union countries do not all agree on this principle of technology-neutral calls for tender, and a number of them, like France, would like to renegotiate it when the next legislative package comes up for adoption, which will steer renewable energy development after 2020. In particular these countries point out that the choice of energy mix is a prerogative of the Member States as enshrined in article 194 of the Treaty on the Functioning of the European Union. Another argument posited is that technology-neutral tenders lead to selecting production means solely on the criteria of their mean cost. However the electricity system's reliability also depends on production methods complementing each other – for instance, the solar power variability profile fits well with that of wind power. Therefore technological diversity is needed to ensure the stability of the electricity system depending on weather conditions and the security of supply. Other countries, such as Spain, welcome technology-neutral calls for tender. In April 2017, the Spanish Ministry of Energy, Tourism and Digital Agenda announced it was preparing a call for tenders of this type for a capacity of 2 000 MW, to which a further 1 000 MW could be added if the competitive prices came out of it.

The data gathered by EurObserv'ER, which wherever possible is based on official data, and for the less structured markets on the estimates made by the solar photovoltaic energy industry associations, indicates that the European Union connected up 6.1 GW during 2016 **(table1)** which took the EU's installed base past the 100 GW mark (100.9 GW at the end of 2016) **(table2)**. Thus annual connected capacity contracted by 22.7% compared to 2015. The British market's lower connection figures are largely responsible for this decline.

As for energy output, 2016 will not make the history books. Across the European Union, the weather was generally unfavourable to solar electricity, with lower production observed in several countries (Germany, Spain, Italy, Belgium and the Czech Republic). Naturally output increased in the most active markets (the UK and France), with Germany being a notable exception. EurObserv'ER reckons that European Union output

## Tabl. n° 3

*Electricity production from Solar photovoltaic power in European Union in 2015 and 2016* (in GWh)*

| | 2015 | 2016 |
|---|---|---|
| Germany | 38 726 | 38 171 |
| Italy | 22 942 | 22 545 |
| United Kingdom | 7 561 | 10 292 |
| France | 7 748 | 8 790 |
| Spain | 8 266 | 7 948 |
| Greece | 3 900 | 3 930 |
| Belgium | 3 045 | 2 945 |
| Czech Republic | 2 264 | 2 128 |
| Romania | 1 982 | 1 845 |
| Netherlands | 1 122 | 1 530 |
| Bulgaria | 1 383 | 1 286 |
| Austria | 937 | 1 077 |
| Denmark | 604 | 858 |
| Portugal | 799 | 816 |
| Slovakia | 506 | 500 |
| Slovenia | 274 | 300 |
| Hungary | 123 | 174 |
| Poland | 57 | 130 |
| Sweden | 97 | 115 |
| Malta | 93 | 103 |
| Luxembourg | 104 | 98 |
| Cyprus | 126 | 94 |
| Lithuania | 73 | 67 |
| Croatia | 57 | 61 |
| Finland | 9 | 9 |
| Ireland | 2 | 4 |
| Estonia | 0 | 0 |
| Latvia | 0 | 0 |
| European Union | 102 799 | 105 324 |

**Estimate. **Overseas departments included for France (ie 481 GWh in 2015 and 490 GWh in 2016).*
***Source: EurObserv'ER 2017***

## Graph. n° 1

***Photovoltaic capacity** per inhabitant (Wp/inhab.) for each EU country in 2016*




** French overseas departments included.* ***Source: EurObserv'ER 2017***




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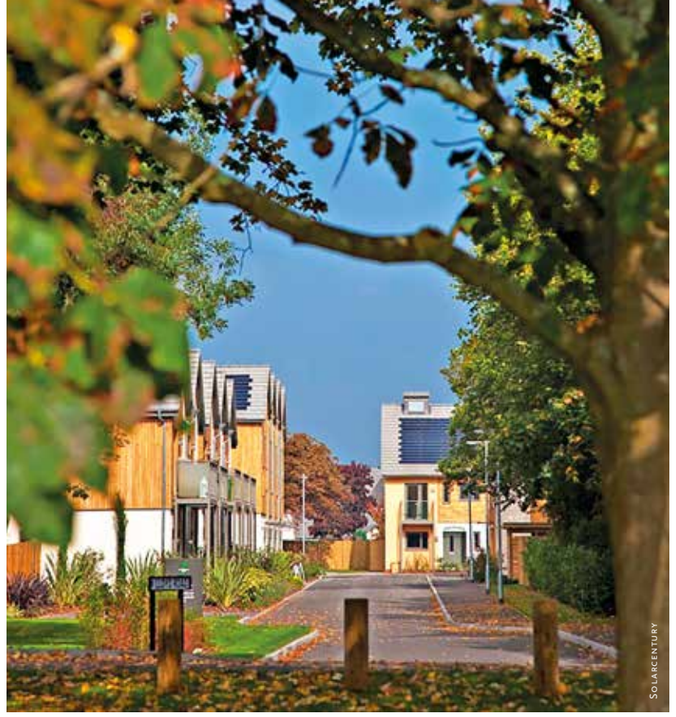



should rise to 105.3 TWh in 2016 **(table3),** i.e. 2.5% growth over the twelve month period. After increasing by almost 10 TWh between 2014 and 2015, output only grew by 2.5 TWh between 2015 and 2016. Solar power amounts to about 3.2% of the European Union's electricity production. This share is logically higher in the countries most involved in photovoltaic technology, namely Germany (5.9%), Italy (7.9%) and Greece (7.4%).

### United Kingdom – solar is left out of the second CfD allocation round

For the third year running the UK topped European photovoltaic league. According to the BEIS (Department for Business, Energy & Industrial Strategy), solar photovoltaic capacity increased by 2.4 GW in 2016 albeit with a 36.9% drop in the number of connections in comparison with the previous year. Most of the new connections came from sites accredited under the Renewable Obligation system and were made during the 1st quarter of the year, prior to 1 April 2016 when the system closed to all new generating capacity. The connection pace was much slower over the following three quarters as it mainly switched to connecting much smaller sites that could take up the Feed-in Tariff system. The new Contracts for Difference (CfD) system for >5 MW installations is hardly used by solar systems. Only a handful of photovoltaic solar parks were accredited by the system in the first CfD allocation round (i.e. 5 plants for combined capacity of 71.55 MW). The first of them, the 14.67 MW Charity Solar Park project went on stream at the end of June 2016 with a strike price of £ 79.23 per MWh (€ 94.83 per MWh). The incumbent government shows little inclination to encourage the development of very large power plants having announced that solar will be excluded from the launch for the second CfD allocation round scheduled for April 2017. Nonetheless the British market should be able to rely on smaller plants. The National Grid plans to connect 150 MW on average every month from March 2017 to February 2018 and forecasts that 13 500 MW will be installed over that period. This equates to a base of about 13 200 MW by the end of 2016. Solar power output, on the strength of the year's newly-installed generating capacity, increased by 36% to 10.3 TWh.

### Germany finally stabilizes its market

Germany finished the year with a flourish (more than 441 MW of capacity was installed in December), which allowed it to stem the steady decline in its annual capacity connection figure that started in 2013. According to the German environment agency that now coordinates the Working Group on Renewable Energy Statistics (AGEE-Stat), Germany added 1 476 MW of new capacity in 2016 (compared to 1 456 MW in 2015) taking its total installed capacity connected to the grid to date to 41 275 MW. The reasons for the rise in the number of connections at the end of the year are the sharp drop in photovoltaic panel costs on the markets and a change in the regulations. The new provisions of the EEG 2017 law that came into force on 1 January stipulate that all >750 kW power plant projects, regardless of whether they are ground – or roof-mounted, have to be selected via a tendering procedure. The Feed-in Tariff system still applies to <750 kW capacity systems. As the annual target of 2 500 MW has not been exceeded, the tariffs, which have remained unchanged since 1 September 2015, will be pegged until at least the end of April 2017. However the Feed-in Tariff reference period will shorten to six months, down from the previous twelve month period, to ensure that tariffs respond quickly enough to market momentum. So until the end of April, the rate for roof-mounted systems will stay at € 123 per MWh for <10 kW, € 119.6 per MWh for <40 kW and at € 106.9 per MWh for <100 kW. The output of >100 to <750 kW installations must be sold directly on the market. The sales revenue and premium guarantee payment of € 110.9 per MWh for roof-mounted systems and € 89.1 per MWh for other systems. This price stabilization should encourage the <750 kWp market to pick up, as the drop in panel prices observed on the German market has tended to increase installation profitability. According to pvXchange platform data, the wholesale price for photovoltaic on the German market was € 0.047 per Wp in February 2017, which is 19% lower than the price observed a year earlier (i.e. € 0.058 per Wp).

As stated just above, a tendering system applies to the Feed-in Tariff for >750 kW systems. Bidding for the first allocation round for photovoltaic plants arising from the new EEG 2017 law closed on 1 February 2017, and in March, the Federal Network Agency (Bundesnetzagentur) announced the results. Thirty-eight projects were selected for a total volume of 200 MW. The average Feed-in Tariff was € 65.8 per MWh between the highest and lowest tariffs of € 67.5 and € 60 per MWh respectively. A new 200 MW round was launched early in April with bids closing on 1 June. The ceiling price for this allocation round has been set at € 89.1 per MWh. Last December the country also published the results of its first cross-border auction for photovoltaic with Denmark (for 50 MW), which is a first in the European Union. Five projects, all based in Denmark, were retained and all were allotted a Feed-in Tariff of € 53.8 per MWh, which is € 12 per MWh lower than the average price reported for the last auction on German soil. The electricity produced will count towards achieving Germany's rather than Denmark's renewable energy targets. Germany's BSW Solar interest group is crying foul, arguing that the projects retained in Denmark distort competition because they are all sited on farming land, whereas this practice is forbidden in Germany. Therefore it has demanded the removal of this restriction for upcoming cross-border auctions. The physical import of electricity and principle of reciprocal opening of cross-border tenders are admissible under the terms of an international agreement between the two countries, on the basis of the order of 1 June 2016.

Turning to solar power output, the AGEE-Stat data points to a slight drop from 38 726 GWh in 2015 to 38 171 GWh in 2016. The working party reckons that direct self-consumption accounted for 9.4% of the 2016 output... up from 9.1% in 2015.

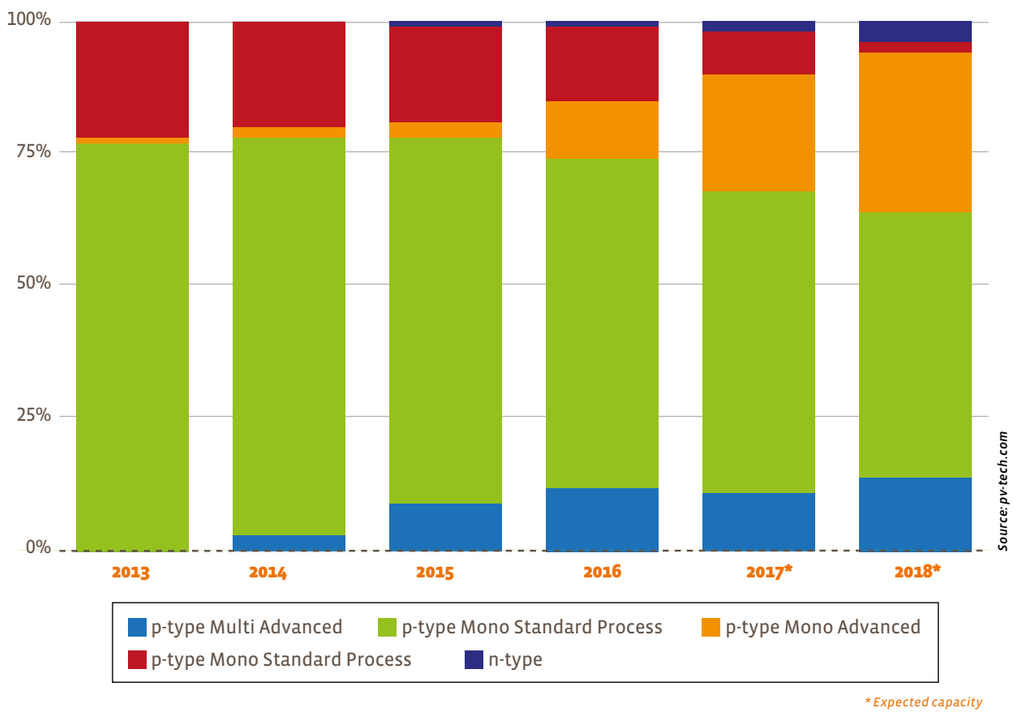
### France sheds light on its roadmap

France should just manage to hang onto its No. 3 ranking in the European solar market, despite the dramatic drop in the amount of capacity connected during 2016. The Observation and Statistics Department's (SOeS) provisional photovoltaic scoreboard that tracks connections puts installed French solar photovoltaic capacity at 7 134 MW at the end of December 2016 of which 6 767 MW was produced in continental France. According to the SOeS breakdown, only 559 MW was connected in 2016 (555 MW in Continental France). It is the lowest annual volume recorded since 2009, which the 2016 Panorama of renewable electricity analysis puts down to the dearth of development project starts over the 2014–2015 winter period and the erratic timing of the tendering rounds.

Nonetheless the French market appears to be coming out of the doldrums with the announcement in the second half of the year of specifications for two major tenders for a cumulated capacity of 4 350 MW, which provides the sector with visibility for the next three years. The biggest

## Graph. n° 2

*Cell capacity by technology*




** Expected capacity*





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tender, devoted to “Ground-mounted plants of 500 kWp–17 MWp capacity”, was published on 24 August 2016 for a total capacity of 3 000 MW. It extends over six bidding periods each for 500 MW between January 2017 and June 2019. This tender is intended for three different types of installations: 5–17 MWp ground-mounted plants, 500 kWp–5 MWp ground-mounted plants and 500 kWp–10 MWp solar carports. Bidding for the first tranche ended on 1 February 2017, and the winning bids have been declared with 79 projects retained for combined capacity of 534.8 MW and an average electricity price of € 62.5 per MWh for 5–17 MWp systems, € 68.1 per MWh for 500 kW–5 MW systems and € 105.6 per MWh for solar carports. More than 60% of them have undertaken to use crowdfunding and will be eligible for a premium increased by € 3 per MWh.

A second auction round was published on 9 September 2016 and covers “Plants on buildings, greenhouses, farm hangars and carports with capacity ranging from 100 kWp to 8 MWp”. It is divided into two distinct packages, >100–<500 kWp plants that will be eligible for purchase contracts and 500 kWp–8 MWp plants, that will be eligible for a remuneration top-up contract. The combined capacity open for bidding is 75 MWp per package for each of the 9 periods (between 10 March 2017 and 4 November 2019), for a planned total of 1 350 MWp.

This arrangement was boosted in 2017 by new auctions. The one for innovative solar installations announced in February 2017 was published on 6 April. It covers a volume of 210 MW, segmented over three bidding periods each for 70 MW and split over the following five innovation categories (new integration concepts, new materials and components; improved technical, economic or environmental performance; optimization and operating innovations; “agrivoltaics” that aims to improve agricultural production using photovoltaic technologies). The closing dates for bidding will extend from 2 October 2017 to 30 September 2019. The new specification for the second tender for self-consumption from 100–500 kW, this time open to all renewable energies, was published on 24 March 2017. It covers a total capacity of 450 MW extending over nine 50 MW bidding periods (from 25 September 2017 to 18 May 2020). The successful bidders for the first self-consumption round were named in November 2016 and March 2017. They will be eligible for non-indexed remuneration top-up for 10 years. This remuneration top-up is based on a premium (expressed in € per MWh) proposed by the bidders and was part of the competitive procedure. It will be added to the savings on the electricity bill achieved through self-consumption and the sale of electricity injected into the electricity market. The remuneration top-up also factors in a financial penalty for injection that is calculated using the ratio of the maximum capacity injected over the year to installed capacity. In the first tranche, 72 projects were successful (primarily solar) for a total capacity of 20.59 MW. The average premium awarded is € 40.88 per MWh. For the second tranche 62 projects were successful for a total capacity of 20 MW. The average premium awarded is € 19.35 per MWh. Twenty-eight of the successful bidders have undertaken to use crowdfunding and will be eligible for a premium increased by € 5 per MWh. The Renewable Energy Association (SER) has greeted these recent announcements very positively.

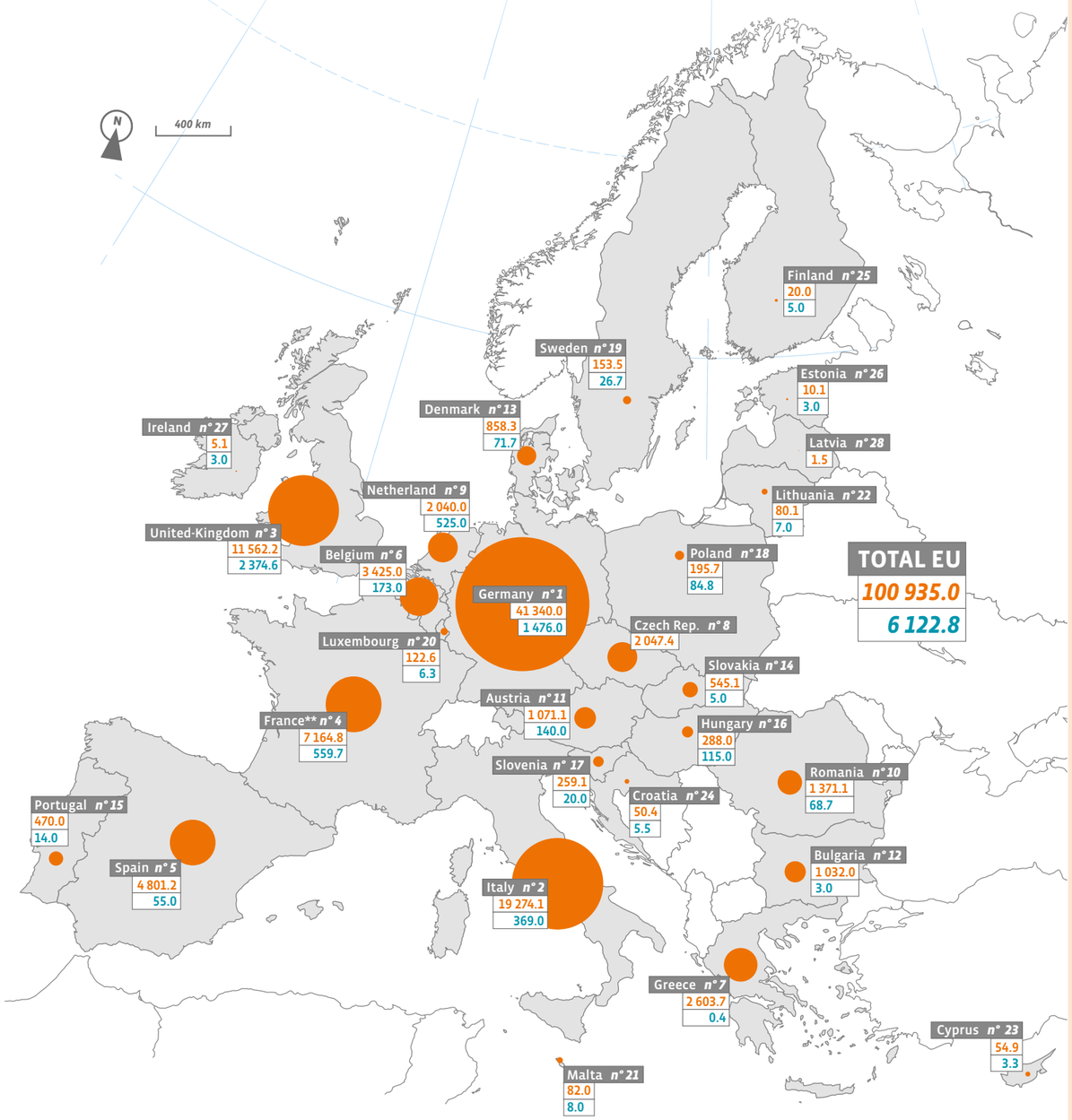
## PANORAMA OF THE GLOBAL INDUSTRY

### CHINA’S COMPANIES CONTINUE TO SET THE TONE

China’s demand structures the global photovoltaic market. Likewise its companies dominate the upstream side of production. So nine of the top 10 global photovoltaic module manufacturers ranked by production capacity are Chinese, and one solitary American company is in their ranks. This top 10 supplies 50% of all the photovoltaic panels used worldwide. While the main market for these Chinese manufacturers is their domestic market, they are still capable of exporting to all 5 continents.

The company with the top production capacity is Jinko Solar, which can turn out 8 GW per annum from its plants. This volume is higher than the capacity that the whole of the European Union connected to the grid in 2016. Its 2014

*Photovoltaic capacity connected in the European Union in 2016* (MWp)*




*Key*

100 935,0 Connected and cumulated photovoltaic capacity in the European Union countries at the end of 2016* (MWp)

6 122,8 Photovoltaic capacity installed and connected in the European Union countries during the year 2016* (MWp)

**Estimate. **Overseas departments included for France.* ***Source: EurObserv’ER 2017***





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capacity was 3.2 GW and 6.5 GW in 2015. The company Canadian Solar has annual capacity of about 6 GW having risen from 4.3 GW in 2015. A groundswell change in quality has been achieved along with this expanding production capacity. Not only are the various photovoltaic cell manufacturing technologies making progress, but companies are increasingly turning to the most efficient technologies. In one of its surveys, the American research firm PV Tech shows that manufacturers are tending to use monocrystalline technology more and phasing out the less efficient multi-crystalline solar panels.

Trina Solar is also in the top 3 Chinese export companies. The company has established its position as a market leader in just a few years both for production capacity and business results. However in the fourth quarter of 2016, it made a fundamental strategic move that could well be imitated by others. Trina decided to delist from the American stock exchange. The company's shares can no longer be bought. It should be noted that its shares have traded at a very low level in recent years and did not rise when the company made a profit. The direct consequence of this move is that Trina Solar no longer has to make its quarterly and annual financial results public and has effectively become a "black box". The sequel to this withdrawal could be its registration on one of the Asian stock exchanges, where different transparency rules apply.

Behind the leading trio, Yingli Solar has failed to post a net profit so far and has been operating in the red for more than five years. It can no longer invest to expand its production capacity and its sales are declining along with its market shares which have contracted sharply in Europe. Its main outlets are in China and Japan. Financial analysts are awaiting the expected announcement of a massive company restructuring plan.

The PV Tech site also reports on companies' investment policies around the world. It follows that the Chinese companies have spent the most on investment, primarily to open new production plants. Investment peaked in 2016 when the top 100 global photovoltaic concerns ploughed in almost six billion dollars. The previous year's figures were slightly lower. According to company announcements, investment levels should be lower in 2017 and 2018, primarily because of a drop in silicon and crystalline cell production. In contrast, investments in thin-layer technologies and ingot and wafer production are slated to grow.

## EUROPEAN ANTIDUMPING MEASURES

In 2013, the European Union introduced antidumping measures to protect its industry from Chinese competition. This took the form of customs duties on products of Chinese origin to encourage project bearers to use European equipment. The European Commission extended the measures through to 4 September 2018 on 1 March 2017. They apply to the Chinese companies' main locations, i.e. China, Taiwan and Malaysia.

The measures have been unsuccessful in protecting the European photovoltaic industry since they came into force. The only company to represent Europe internationally is SolarWorld. Total European manufacturing capacity is dwindling, according to SolarPower Europe, dropping from 6.9 GW in 2015 to 6.7 GW in 2016. What is more, the plants are idling as they produced just 3.2 GW of photovoltaic panels in 2015 and only 2.7 GW in 2016. The reason for this difference between capacity and actual output is explained by the widespread and lasting phenomenon of overproduction. The research body Energy Trend, claims that photovoltaic panel supply should outstrip demand by 18–35% until 2018. The issue of these protection measures divided Europe and the photovoltaic industry in 2016. Countries that preach free competition and had no direct interest in solar panel manufacturing advocated lifting the sanctions. In contrast, other countries including France and Germany tipped the balance towards extending the restrictions. Business interests govern the industry members' diverging views. European cell and module manufacturers obviously have a negative view of this aggressive competition, whereas project developers welcome the opportunity to acquire cheaper panels and thus reduce their project costs. The proponents of the antidumping measures are supported by the EU Prosun initiative while SolarPowerEurope is arguing for lifting the restrictions.

## Tabl. n° 4

*Representative photovoltaic module manufacturers in 2016*

| Company | Country | Manufacturing capacity (MWp) | Shipment (MWp) | Revenues 2016 ($M) |
|---|---|---|---|---|
| Jinko Solar | China | 6 500 | 6 656 | **3 082** |
| Trina Solar | China | 5600* | 5 924 | **3428*** |
| Canadian Solar | Canada, Chine | 6 170 | 5 232 | **2 853** |
| JA Solar | China | 5 500 | 4 607 | **2 267** |
| Hanwha Q-cells | South Korea, Germany | 4 150 | 4 583 | **2 427** |
| First Solar | USA | n.c. | 3 300 | **2 951** |
| Yingli Green Energy | China | 4000** | 2 170 | **1 206** |
| SunPower | USA | 1 900 | 1 339 | **2 560** |
| Talesun | China | 2 800 | n.c. | **n.c.** |
| Risen Energy | China | 3 100 | n.c. | **n.c.** |

** As of the 30th of June 2016. **As of December 2015. *** Fourth quarter revenues have been calculated based on 3rd quarter outlook. Definitive results may change* **Source: Observ'ER 2017**

**Overall view of the new UC Davis West Village on Hutchison Drive in Davis, California.**

## AMERICA'S COMPANIES RESTRUCTURE

Across the Atlantic, 2016 was a tough year for manufacturers SunPower and First Solar. SunPower embarked on a vast restructuring plan which resulted in a net loss of 471 million dollars for 2016 and the closure of its plants in the Philippines, which will eventually relocate to Mexico.

At the end of 2016, First Solar also announced that it was restructuring as it could no longer resist the pressure of its rivals' lower module prices. The plan will entail job lay-offs and fast-forwarding the manufacture of its more modern panel, the S6, to make it the company's standard product by 2019. First Solar also pulled out of the yieldco created with SunPower, 8point3, to underpin the

## Tabl. n° 5

*Main European developers in 2016*

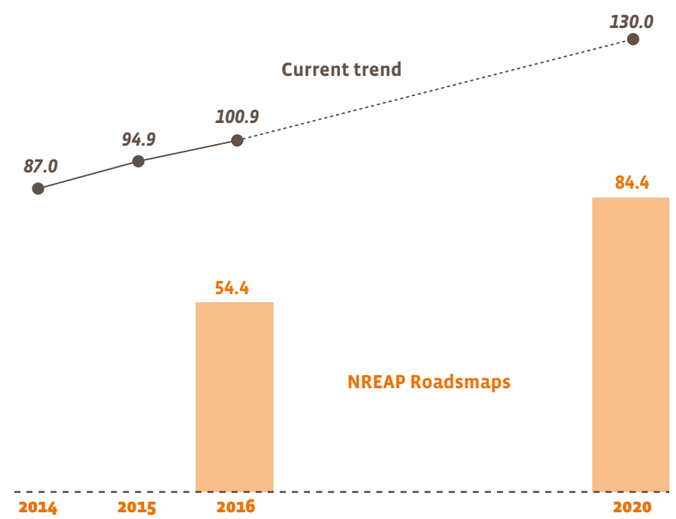
| Companies | Country | Installed photovoltaic capacity(MWp) |
|---|---|---|
| Juwi AG/MVV Energie AG | Germany | > 1 600 |
| Enerparc | Germany | > 1 600 |
| Belectric | Germany | > 1 500 |
| Lightsource Renewable Energy | United Kingdom | 1 300 |
| EDF énergies nouvelles | France | 900 |
| Hanwha Q CELLS GmbH | Germany/South Korea | 850 |
| Saferay | Germany | 778 |
| Voltalia/Martifer | Portugal | 700 |
| Activ Solar | Austria | 535 |
| GP Joule | Germany | > 500 |
| Elecnor | Spain | < 250 |
| Engie | France | 522 |

**Source: Observ'ER 2017**

restructuring, and enable it to release cash to fund the necessary reengineering investments. Incidentally, this decision probably signals the end of the golden age of yieldcos… organisations listed on the stock exchange, whose revenues are based on the production of renewable electricity. The yieldcos' assets are safe and the profits are paid back to shareholders in the form of dividends. This model had a few exponents in the USA but the idea hardly took off in Europe.

## Graph. n° 3

*Comparison of the current trend of photovoltaic capacity installed against the NREAP (National Renewable Energy Action Plans) roadmap (in GWp)*




*Source: EurObserv'ER 2017*

### DEVELOPERS: THE ADDED VALUE FOR THE EUROPEAN UNION

While European manufacturers may be rare on the ground, the developers' environment is much more dynamic **(table5)**. For instance, Voltalia, which focused on wind energy projects, has bought out Portugal's Martifer Solar, a former subsidiary of the solar project specialist Martifer. The acquisition enables Voltalia to diversify and increase its sales from 60 to almost 200 million euros and claim to be a truly international actor.

### *CONSUMERS AT THE HEART OF THE FUTURE ENERGY UNION*

Current developments in support measures geared to market mechanisms affect the volume of connections. They will diver their focus from developing very large ground-based plants to concentrate on decentralized photovoltaic which directly addresses consumers' needs at least for the next few years. The tendering system, which is becoming the norm for medium – and high-capacity facilities, gives Member States more control over their markets, curbs electricity price increases for consumers, and helps prepare the ground for the next installation waves needed to achieve their European Renewable Energy directive targets. It also satisfies the major electricity utilities' demand for limiting the financial impact on the profitability of their production facilities that generate variable renewable electricity. The influx of solar or wind power on the market at zero marginal cost, depresses the electricity price and could lead to negative prices during overproduction periods.

For many countries, the targets set for the Directive no longer serve as a development accelerator for their sectors. According to Eurostat, 11 of the 28 Member States had already achieved their renewable targets for 2020 by the end of 2015 (Sweden, Finland, Denmark, Croatia, Estonia, Lithuania, Romania, Bulgaria, Italy, the Czech Republic and Hungary), and others have made considerable headway on their energy trajectories to achieve these targets (Austria, Slovakia).

As for the specific photovoltaic targets defined in the National Renewable Energy Action Plans, development has been faster than expected in most Member States, which has led most of them to exceed forecast. If the 2020 photovoltaic targets of all the European Union countries are added together, the targets were outstripped at the end of 2015 and could reach 130 GW by 2020 compared to the 84.4 GW initially planned **(graph 3)**.

The photovoltaic sector is adjusting to a new market structure, where the "prosumers" (producer-consumers) will play an increasingly important role. This move is motivated not only by an eco-citizen initiative to produce the electricity needed to satisfy their needs locally but by economic interest. It is in consumers' interest to produce their own electricity at lower cost than the price invoiced by the network, and to cash in on any surplus electricity they produce on the electricity market.

The aim of the European Commission's Clean Energy Package presented on 30 November 2016 is to encourage and formalize the implementation of this framework. The formulated proposals have three main aims: give priority to energy efficiency, enter the world's top renewable energy ranks and offer consumers equitable conditions… consumers who throughout the EU will be authorized to produce electricity for their own consumption, store it, share it, use it or sell it on the market. The system will enable them to take advantage of the drop in roof-mounted photovoltaic panel prices or other small-scale generating units and thus reduce their energy bills. Self-consumption is also bound to become stronger as storage means develop.

To achieve this, the Commission aims to accelerate the deployment of smart meters and guarantee access to proactive electricity prices that are essential for bridging the gap between consumers and the market. These modifications will ease the way for greater participation in the energy system by households and companies. They will give them better control over their energy consumption and respond to price signals better. With consumers' consent, the market players will have access to precious data, and thus be in a position to tailor their offers to consumers' needs. Better regulated and non-discriminatory access to data will lead to increased competition between the market players and in turn benefit consumers. If these consumer-friendly proposals are legally enshrined, they will place solar energy at the centre of the future Energy Union. □

***Sources table 1 and 2: AGEE-Stat (Germany), Anie Rinnovabili (Italy), REE and UNEF (Spain), SOeS (France), BEIS (United Kingdom), PVAUSTRIA, Transelectrica (Romania), Polderpv.nl (Netherlands), University of Miskolc (Hungary), PA Energy Ltd (Denmark), SAPI (Slovaquie), ZSFV (Slovenia), DGGE (Portugal), APERE (Belgium), PTPV (Poland), Swedish Energy Agency (Sweden), CERA (Cyprus), CRES (Greece), University of Zagreb and HROTE (Croatia), Ministry of Industry and Trade (Czech Republic), Litgrid (Estonia), Aalto University (Finland), SEAI (Ireland Republic), Observ'ER (Others).***

*The next barometer will focus on solar thermal*

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