Capgemini Consulting

# Cleantech Tracker 2011-2012 – 3rd edition

Challenges for the European renewables industry amidst worldwide competition

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# Editorial by Alain Chardon

**2005-2010 was characterized by a faster development pace. Growth rates were particularly high for onshore wind and solar photovoltaic (PV) with 27% and 49% CAGR worldwide, respectively**

**Renewable energies are now a mainstream electricity generation industry.**

Cleantechs, especially renewable energies, are a key provider of sustainable jobs in Europe, with already over a million "green jobs" at the end of 2011. 2012 may be at crossroads with on the one hand, the potential for additional job creation by 2020[1] and, on the other, the European financial crisis and its impacts.

But cleantech markets are not just European or national markets. Utilities and Manufacturers are now playing in the global market. That is why, in order to complement our work on the renewable energy markets published every year since 2006[2], we launched a new annual study called Cleantech tracker in 2009. This study aims to monitor the development of renewable energies as well as new energy technologies on a global scale. Our definition of cleantechs includes renewable energies (e.g. solar, wind, marine, biomass, etc.) and technologies that may enable saving, producing or distributing greener energy (e.g. energy storage, carbon capture and storage, etc.). To make it easier to compare, we chose to focus exclusively on technologies that produce electricity, consequently, the production of heat is out of our scope[3]. Our approach mixes different types of analyses and viewpoints:

- Markets and technologies: installed capacity and potential development, levels of R&D, technological maturity and expected breakthroughs;
- Manufacturing & industry: global rankings and perspectives at a global level;
- Utilities and consumers' view: cost components and regulatory drivers.

While the preceding decade, 1995-2005 was characterized by relatively slow development (8-9% CAGR in terms of global renewable generation[4]), 2005-2010 was characterized by a faster development pace. Growth rates were particularly high for onshore wind and solar photovoltaic (PV) with 27% and 49% CAGR worldwide, respectively[5]. Some technologies have reached a commercial and industrial stage characterized by a high level of technological maturity, fair costs of production, installation and maintenance. Renewable energies are now a mainstream electricity generation industry. The global cleantech market proved to be resilient during the 2008-2009 financial and economic crisis (+0.4% in 2009 on 2008 for global new investment in renewable energy and +32% in 2010 on 2009[6]). And while the pioneer markets were Europe and the US, Asian countries, led by China (+29 GW of grid-connected renewable capacity in 2010 and the leading market in terms of global investments since 2009[7]) are developing quickly and have ambitious plans (China targets 200 GW of onshore wind capacity by 2020 to generate 440 TWh of electricity annually[8]). Not only has China become

[1]650,000 additional jobs compared to a business-as-usual scenario according to the European Commission

[2]In Capgemini's European Energy Markets Observatory (EEMO), an annual report that tracks the progress in establishing an open and competitive electricity and gas market in EU-27
(+ Norway and Switzerland) as well as the progress on the EU Climate-Energy package objectives

[3]We fully acknowledge that renewable thermal energy is as strategically important – if not more – as renewable electricity. Yet heat markets are highly fragmented and therefore difficult to study

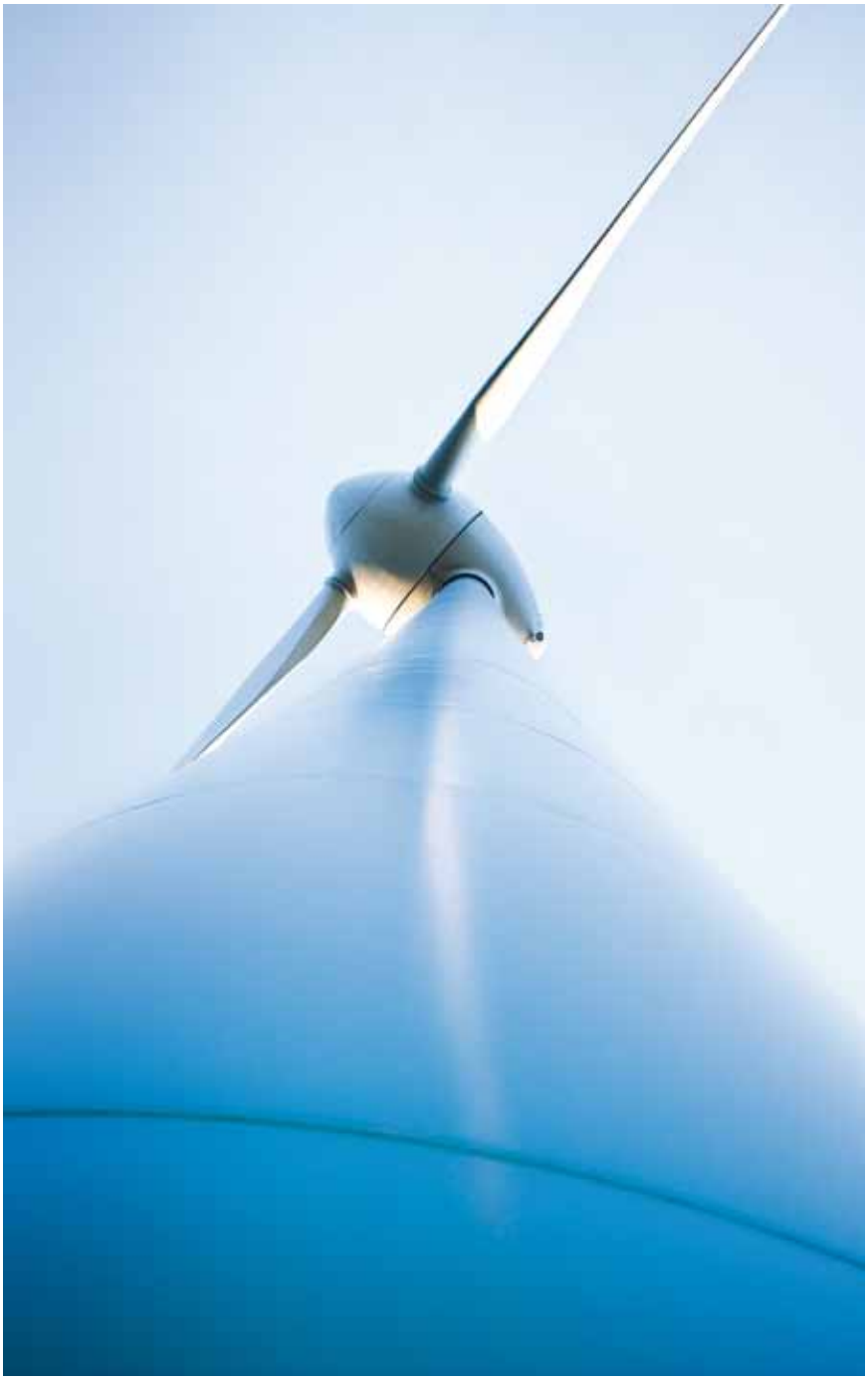
a leading installer of renewable energy, but also its Manufacturers have surpassed those of Western companies with, for example, Sinovel receiving first place in 2010 for being the top solar PV Manufacturer.

What factor will most influence the European players – the European crisis or the worldwide renewable market growth? In both cases, it is no longer about the market size but rather about winning the three industrial challenges listed below:

1. **Innovation:** for European players, how to grab new markets wherever in the world, to position in the top leading vendors and operators and to compete successfully against international players
2. **Operational excellence:** how to streamline the whole chain from purchasing, manufacturing, installation to operation and maintenance (O&M) to gain cost efficiency while improving operational performance and innovation capability
3. **Smart grids:** how to manage an efficient integration of renewable energy into the grid and what transformations in terms of market design should be implemented

In this paper, we will provide a summary of our Cleantech tracker study as well as provide some clues relating to these crucial questions.

We wish you an enjoyable read.



[4]Hydro excluded

[5]Renewables 2011 Global Status Report – REN21, August 2011

[6]Global trends in renewable energy investment 2011, UNEP – Bloomberg New Energy Finance, July 2011

[7]Renewables 2011 Global Status Report – REN21, August 2011

[8]Country profile China – GWEC, 2011

# Cleantechs are now a fully-fledged industry engaged in worldwide competition

## Key metrics (global installed capacity and investments, generation costs and number of competitors) show that solar PV and wind energy are now mainstream industries

### Renewable energy (hydro excluded) accounted for almost a third of the estimated 194 GW of new electricity capacity added globally in 2010[9]

Installation of new renewable energy capacities progressed on almost all fronts in 2010, with wind and solar energy having almost met or surpassed the most optimistic short-term yearly forecasts (onshore wind: 38.3 GW realized vs. 40.8 GW forecasted[10] or solar PV: 16.6 GW realized vs. 10.1 GW forecasted[11]). China alone developed huge onshore wind capacities, representing 50% of the world's newly installed capacity in 2010 (vs. 36% in 2009). In Europe, 2011 and 2010 have been outstanding years for solar PV installations (especially roof-top), which come second after gas in terms of new installed capacities (see Table 1).

### Investments have increased more than six-fold between 2004 and 2010, reaching US$260 billion in 2011

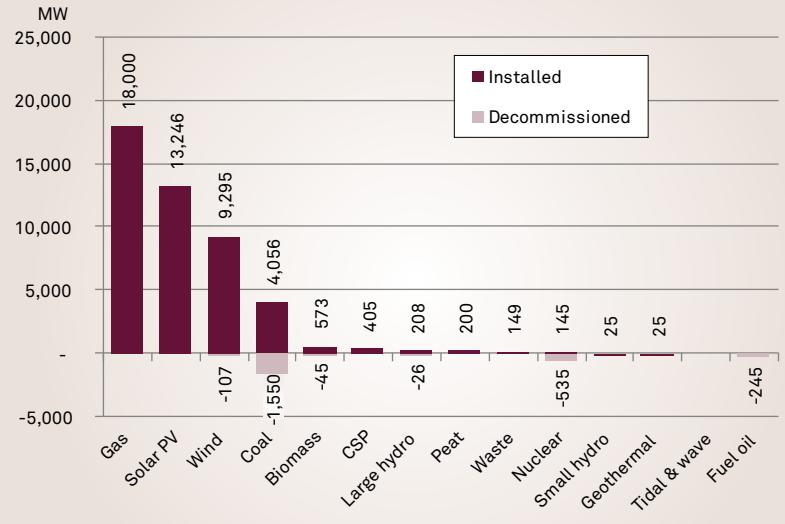
From 2004 to 2008, global new investments in renewable energy showed outstanding growth rates: almost 50% on average even though the evolution was different from one type of renewable to the other (see Table 2), making industry players envisage the "green market" as a bubble. However, these investments weathered the 2008-2009 financial crisis remarkably well, which demonstrates, if need be, that renewable energy is a mainstream industry. In 2009, globally, new investments in large hydro and other renewable energies even surpassed new investments in fossil fuel capacities. It is also worth noting that the 2008-2009 financial crisis was a turning point in the geographical polarization of investments. Prior to the crisis, Europe and the US attracted the majority of investments (mainly in wind projects); during the crisis, emerging countries, in particular Brazil and China, took over the US and Europe and lately, China confirmed its position of top investor. In 2011, however, the US moved back ahead of China[12].

### Costs of renewable energies have decreased, competing sometimes with fossil fuel and nuclear generation costs

Drop in raw material prices, technological improvements and manufacturing on a larger scale have pushed costs of some renewable energies down. In particular, onshore wind costs (long run generation costs between €42 and €80/MWh) are now close to fossil fuel (€48/MWh to €76/MWh) and nuclear generation (€34/MWh to €62/MWh) costs[13].

Solar PV still remains the most expensive renewable energy even if costs of modules have dropped by 80% in only eight years. In certain sun-rich regions of the world with high electricity prices, grid parity is reached or very nearly reached. Experts expect that due to

**Table 1 – Generation capacities added in 2010 in EU-27**




*Source: Market outlook for photovoltaics until 2015, EPIA – April 2011*

further technological progress and the continuous increase in electricity retail prices, grid parity will be a reality for all European countries by 2020.

Moreover, wind and solar PV capacities now significantly impact the marginal price of electricity in organized markets. Their marginal costs being close to €0/MWh, when these capacities produce a substantial amount of electricity, the most inefficient and expensive fossil marginal plants are not run which therefore lowers the spot marginal cost of electricity . This was illustrated in July 2010 in Germany: the sunny weather led the 10 GW of solar capacity to produce a high output of electricity[14]. This lowered the spot prices which benefited buyers, but decreased the margin of the hydro peak generators in neighboring countries (who usually make their profits during the summer).

**Table 2 – Year-on-year evolution of global new investments per type of renewable**

| | 2008 | 2009 | 2010 |
|---|---|---|---|
| **Wind** | 23% | 16% | 30% |
| **Solar** | 55% | 4% | 52% |
| **Biomass** | -11% | 14% | -4% |
| **Biofuels** | -7% | -63% | -20% |
| **Small hydro** | 16% | -29% | -22% |
| **Geothermal** | -16% | -13% | 43% |
| **Marine** | -75% | 100% | -50% |
| **Total** | 23% | 0% | 32% |

*Source: Global trends in renewable energy investments 2011, UNEP, Bloomberg New Energy Finance – July 2011 / Capgemini Consulting analysis*

### Renewable Manufacturers and operators as well as diversified Manufacturers and Utilities are battling over market shares on the cleantech market

Renewable Manufacturers (German Q-Cells or Enercon, Danish Vestas, Spanish Gamesa, etc.) have first emerged on the market and have been followed by large and long-standing Manufacturers (Siemens who has recently revisited its strategy towards renewable energies after the German government's decision to phase out nuclear energy, Areva, GE, etc). On the operators' side, the same can be observed with specialized or early adopters operators (Spanish Fotosolar, Iberdrola, Acciona, French Compagnie du Vent) now followed or bought by larger Utilities (EDF, GDF SUEZ, E.ON, Enel, EDP or RWE Innogy) who all have ambitious plans to further develop their renewable energy capacities. It is worth noting that the last few years have seen many of the independent players absorbed by large Utilities or renewables subsidiaries (EDF EN, Iberdrola Renovables) being reintegrated by the mother company. Even oil majors (Petrobras, BP, Total) are selectively investing in cleantechs. Tender processes for significant projects such as the offshore wind tenders in the North Sea and France, attract all of these players who, for submitting their bids, get organized into consortiums gathering specialized companies in design, development, construction and operation of renewable energy projects, turbine manufacturers, engineering and construction companies, power cables manufacturers and installers for a market of 140 GW, which is estimated to be between €400 and €500 billion by 2030.

[9]Renewables 2011 Global Status Report, August 2011 – REN21

[10] Global Wind report 2010, 2nd ed., April 2011 and Global Wind report 2009, April 2010 – GWEC

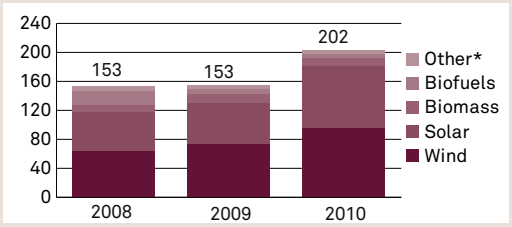
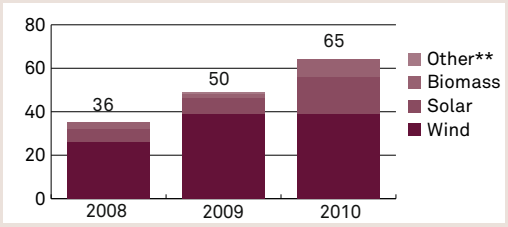
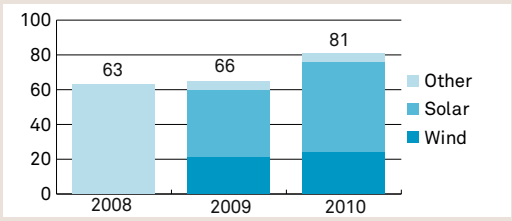
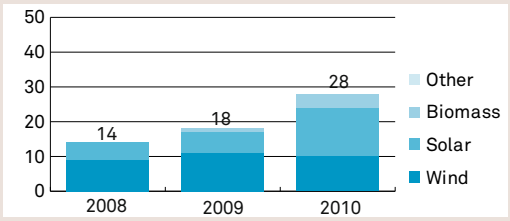
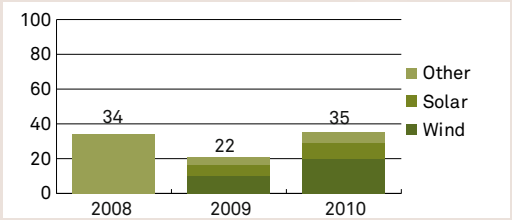
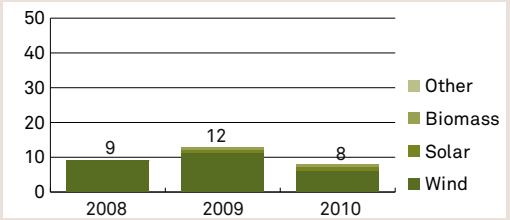
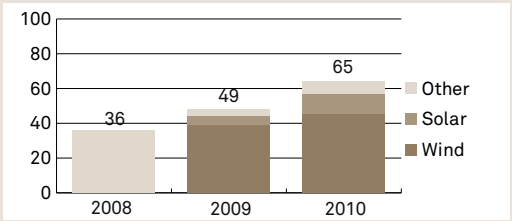
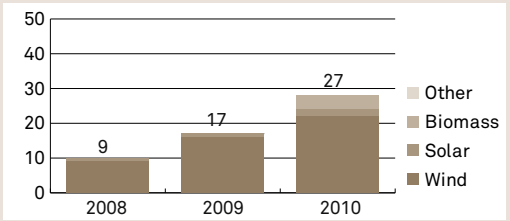
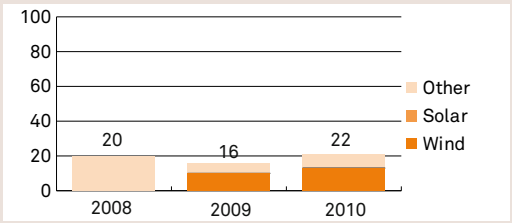
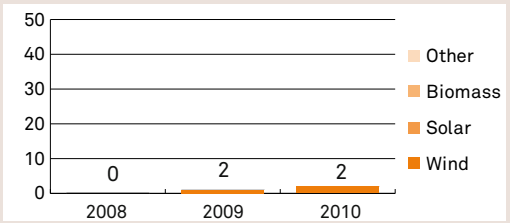
[11]Market Outlook for Photovoltaics until 2015, March 2011 and Market Outlook for Photovoltaics until 2014, May 2010 – EPIA

[12]Global investment in clean energy, January 2012 – Bloomberg New Energy Finance

[13]Refer to the 13th edition of Capgemini's European Energy Markets Observatory

[14]From €4 to €6/MWh according to a German research institute (IZES), i.e. a price decrease for large industrials between €520 and €840 million in Germany in 2011

**Table 3 – Annual new financial investments in renewable energies worldwide and per region**

| | **New financial investments (US$ bn)** *excluding Corporate and Government R&D, including distributed solar* PV | **Capacity added (GW)** *excluding biofuels and small hydro* |
|---|---|---|
| World |  |  |
| EU-27 |  |  |
| North America |  |  |
| Asia & Oceania |  |  |
| Rest of World *Middle East, Africa and South America* |  |  |

*Note: *Other: small hydro, geothermal, marine; **Other: Geothermal, marine*
*Source: Global trends in renewable energy investments 2011, UNEP, Bloomberg New Energy Finance – July 2011 / Capgemini Consulting analysis*

## Developing countries are catching up to the pioneer cleantech markets (Europe and the US)

**From a geographical standpoint, the potential for development has shifted from Western Europe and the US to Central Eastern Europe and the BRICs**

Mirroring the investments' trend, the potential for development of renewable energies projects is now mainly located in areas presenting high economic growth perspectives, favorable governmental support and the need for competencies. The situation in Europe has evolved unfavorably, with an expected slowdown in capacity added and investments, and weaker economic perspectives for the coming years.

The playing field has thus become international and many players have well understood this shift as reflected in their strategy:

- Global wind Manufacturers shift their investment focus from Europe to the USA and China,
- Enel wants to pursue its growth in renewable energies in Latin America, Russia and Eastern Europe,
- GDF Suez or EDF are competing in their home market, both candidates for the offshore wind projects in France, but eye also foreign markets,
- Iberdrola continues its development in Latin America and in renewable energies (investments for the period 2010-12 amounted to €5.3 billion, e.g. one-third of its whole investment program).

**Asian Manufacturers are now taking the lead over their European peers, which have been pioneers and industry leaders for the last two decades**

On the manufacturing front, there is a clear shift in production from the Western countries to Asia. Historical European leaders now face a new and fierce competition from Chinese (and also Korean) players, for both solar PV cells and modules and onshore wind turbines. Furthermore, most European and American Manufacturers are progressively developing production capacities out of their home countries in order to reduce costs and address new markets efficiently. Manufacturing solar PV has clearly become a global market. As Europe is the lion share of the global solar PV market (80%), cells and panels are massively imported to it from Asia. Asian players have managed to establish large companies which produce at low prices. As Asia now represents a major (and growing) share of the global onshore wind market, there is a trend for installing local/regional production sites in this region, for both Western and Asian Manufacturers, in order to reduce shipping costs. The cards are reshuffled both in the wind and solar PV industries: there are some bankruptcies (Solon in Germany, Photowatt in France), companies in difficulty (Danish Vestas or German Q-cells, which are laying off employees), Western companies investing in Asia (Gamesa conquering the Indian wind market), Asian Manufacturers receiving the top rank (JA Solar gaining four ranks in only one year).

# Wind: a global competition with regional supply chains where Asian competitors are starting to emerge

## Onshore wind: a mature technology in a large size market

### On a global scale, on-track with aggressive targets

The aggressive targets established by the Global Wind Energy Council (GWEC) for 2010 have almost been met despite the economic crisis, with 38.3 GW of capacity added globally (vs. a forecast of 40.8 GW) and 197 GW of cumulative installed capacity (vs. a forecast of 200 GW). Long-term forecasts announced in May 2011 are lower than those of 2009, but remain very high, with cumulative installed capacity expected to double by 2014 (388 GW, instead of 409 GW targeted in 2009 forecasts).

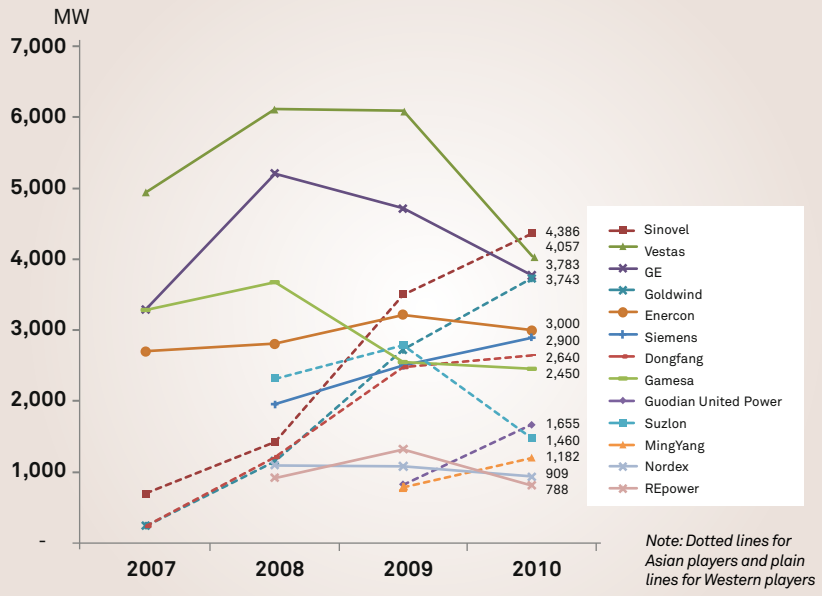
### Europe leading the way, though less dynamically, the US with ups-and-downs and China catching-up rapidly

Europe (EU-27) has remained the biggest installer of onshore wind, with 84 GW of cumulative installed capacity in 2010. This position is due to pioneer countries such as Germany and the Nordics that have developed capacities since the early 1990s. They have been caught up recently by massive adopters in Southern Europe such as Spain. These are now mature markets with stabilized yearly growth compared to the past decade (around 10 additional GW per year in Europe in the past three years). The best sites have been taken and projects often encounter public opposition. The new growth area for onshore wind in EU-27 is Eastern Europe (for example Poland plans 3,350 MW by 2015 and 5,600 MW by 2020 and Romania has currently 2,624 MW of capacity covered by connection contracts[15] ).

In the US, onshore wind installations slowed down in 2010 after two record years, due to the improved profitability of gas-fired plants and a lack of long-term investor confidence with unpredictable federal policies (no Production Tax Credit extension expected and no Federal Renewable Energy Standard). However, 2011 ended better than 2010 in terms of installations (6,810 MW vs. 5,116 MW) as new generation wind electricity costs progressively became affordable. In addition, the State governments have been supporting the deployment of wind energy which is reflected by the increased number of projects under construction (over 100 projects for 8,300 MW).

Contrary to Europe and the US, China has been booming in the last few years (with a cumulative onshore wind installed capacity doubling every year between 2006 and 2009 and a record level of investment of US$20 billion in 2009[16] ). This trend was reinforced in 2010, with 50% of global capacity added in 2010 (vs. 36% in 2009). As a result, China now has a cumulative capacity of 42 GW, higher than that of the US and half of that of the EU-27. The country plans to continue this same trend in 2012.

**Table 4 – Annual onshore wind capacity sold per manufacturer**




*Note: Dotted lines for Asian players and plain lines for Western players*

*Source: Companies' annual reports and websites, Eur'Observer, BTM Consult / Capgemini Consulting consolidation*

[15]Wind Barometer – Eur'Observer, February 2011

[16]Country profile China referring to UNEP/Bloomberg analysis – GWEC, 2011

### China emerging as a major manufacturing base for onshore wind turbines

China has become a major onshore wind turbines manufacturing country, with four Chinese companies in the Top 10 (see Table 4). American (GE) and European Manufacturers (Vestas, Enercon, Gamesa) are strongly challenged by Sinovel, Goldwin, Dongfang and United Power. They benefit from a booming domestic market and manage to provide turbines of fair quality and prices. The growth of China's wind energy sector is supported by the government's commitment through implementation of national renewable energy policies and roll out of well-defined medium and long term development plans. Since 2008, due to a short supply of wind turbines, a new breed of Manufacturers emerged in the market creating an oversupply in 2010 and making the market price extremely competitive. India also appears as a promising market, with initiatives pushed by the Indian government[17] .

### Western players adapting to a changing industrial landscape

In a move to adapt to the changing manufacturing environment, Western companies such as Vestas align their business strategy to focus more on markets like China and the US due to the sluggish pace of development in mature European markets. As a step to maintain cost competitiveness and to increase presence in growing markets, companies rebalance their workforce geographically (Vestas closed four factories in Denmark and one in Sweden in 2010 and shifted part of its production to Asia). Other top European Manufacturers tried to adapt to the changing market focus towards China and Eastern Europe: Gamesa is investing heavily in China and India and RePower signed contracts in Turkey and Bulgaria[18].

[17]Third quarter results 2011 and the years to come – Vestas, November 2011

[18]Renewables 2011 Global Status Report – REN21, August 2011

**Offshore wind has a lot of advantages in the European context, with a higher social acceptance than for onshore wind projects, favorable natural conditions and strong competencies from wind turbine Manufacturers and Oil & Gas offshore platforms operators. The trend for bigger and bigger wind turbines and more concentrated wind farms could allow bigger economies of scale than for onshore wind in the future, bridging the current cost gap.**

## Offshore wind: the next frontier

### Until now, Europe remains the only continent with significant offshore wind installed capacities

The European cumulative installed capacities stands at 3.8 GW installed vs. 84 GW for onshore wind. Historically, the UK and Denmark have been pioneer countries, with installed capacities of 1.3 GW and 0.9 GW, respectively, in 2010. The UK is changing scale with new projects in the North Sea, amounting to 33 GW planned as part of its "Round 3 expansion". Other European countries also have large plans to develop offshore wind capacities in the North Sea, the Netherlands and Germany, and more recently in France (see Table 5).

### Higher costs, but nice perspectives and higher social acceptance

Today, offshore wind remains costly, with an average long run generation cost of €100-170/MWh (vs. €42-80/MWh for onshore wind). Actually, installing wind turbines in sea areas requires additional investments to assess the geological constraints and to evaluate the environmental risks as well as higher O&M costs. Still, offshore wind has a lot of advantages in the European context, with a higher social acceptance than for onshore wind projects, favorable natural conditions and strong competencies from wind turbine Manufacturers and Oil & Gas offshore platforms operators. The trend for bigger and bigger wind turbines and more concentrated wind farms could allow bigger economies of scale than for onshore wind in the future, bridging the current cost gap.

Injecting electricity within the grid from offshore wind will also be easier than from onshore wind electricity, as it is more predictable and has steadier regimes through day/night periods and winter/summer seasons.

### Will major offshore wind projects emerge in the rest of the world?

Offshore wind projects, outside of Europe, depend on the success of flagship projects. Shanghai Donghai (East Sea) Bridge project is currently the only offshore wind farm outside Europe. Four other projects have also been launched by China and may be completed by 2014. China's offshore wind potential is estimated to be the equivalent of the North Sea's. Some analysts predict a strong development in China by the end of the decade, with an installed capacity of 30 GW by 2020[19] (the official target set by the Chinese authorities). North America is also developing pilot projects: Cape Wind (US, 468 MW) and Nai Kun (Canada, 1,750 MW).

[19]Offshore Wind Power report – Pike, October 2011

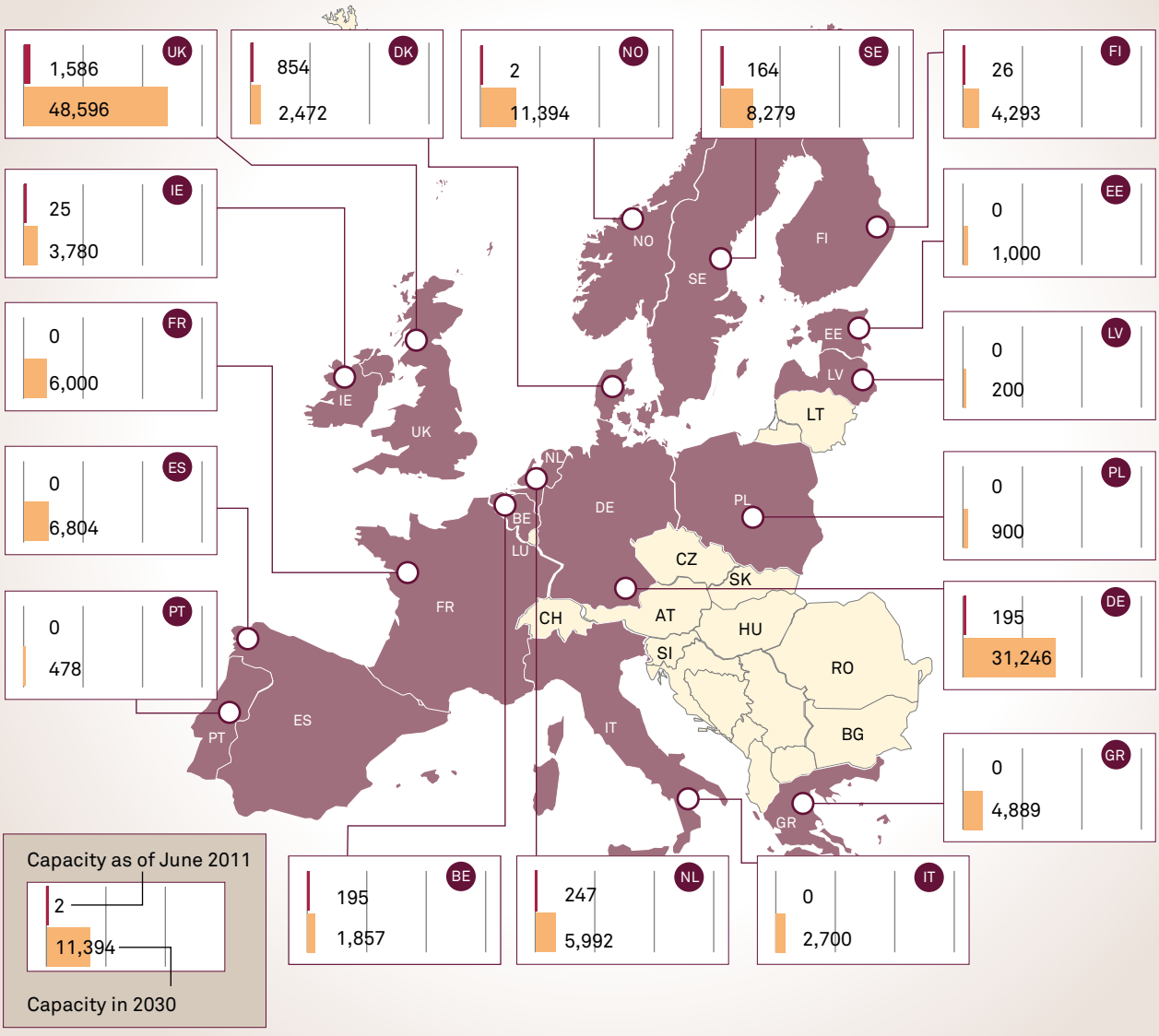
[20]The Worldwatch Institute's Climate and Energy Blog, August 2011

### A first-mover advantage for European Manufacturers

Today, European wind turbine Manufacturers benefit from a first-mover advantage on their domestic markets. With no doubt, the US and European players have a competitive advantage on advanced/complex technologies and components that remain core elements for offshore wind turbines.

Still, Chinese Manufacturers have started developing prototypes of a large-size (5-6 MW) offshore wind turbines: XEMC, Sinovel, Goldwind and Guodian United Power, to be launched in early 2012[20].

**Table 5 – Existing and future offshore wind capacity (MW)**




*Source: EWEA / Capgemini Consulting consolidation*

# Solar PV: an overheated market in 2008-2010 which should stabilize in the short term before grid parity takes over

### Too much success kills success, costly national feed-in-tariff schemes revised down

Solar PV has experienced by far the largest increase in global installed capacity due to favorable support schemes implemented by governments over the last four years and the dramatic drop in the costs of modules from 2009 onwards. In 2010 and 2011, the bulk of this rapid and unexpected growth came from Western Europe, mostly Germany and Italy (both countries accounted for nearly 60% of global market growth in 2011). However, this growth proved to be very costly for countries' budgets driving several European Member States (Germany, Italy, Spain, France, Czech Republic and the UK) to reduce their subsidies strongly to the solar PV industry which led to a market downturn. Globally, capacity of solar panels manufacturing is now exceeding demand by 38%[21], after a record capacity addition of 60% in 2011.

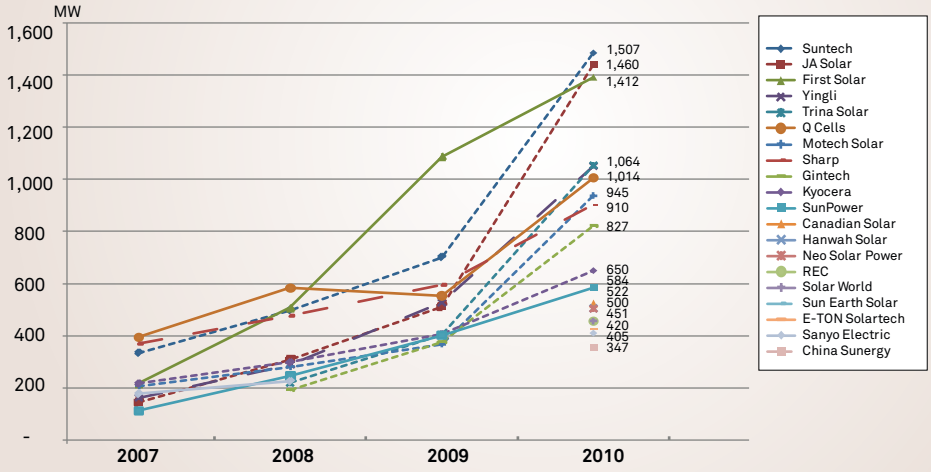
### A progressive increase in the US, benefiting from sun-rich regions

The situation is less gloomy in the US, with solar PV installations that have progressively increased in the past few years, thanks to federal schemes (declined at a State-level) of production tax credit (PTC), investment tax credit (ITC), the treasury grant program (TGP) along with the economic stimulus package. Additionally, the high solar radiation coupled with the high electricity prices in States like California is expected to make solar PV quickly competitive. The shift in projects from Concentrating Solar Power (CSP) to solar PV also stimulated the market.

### Chinese Manufacturers now leading the world market and benefiting from a promising domestic market

China has emerged as a leading manufacturer by taking the Top 2

**Table 6 – Annual solar PV capacity sold per manufacturer**




*Note: Dotted lines for Asian players and plain lines for Western players*
*Source: Companies' annual reports and websites, Eur'Observer, European Commission / Capgemini Consulting consolidation*

global positions in 2010 in terms of manufacturing capacity (see Table 6). European Manufacturers were taken short and did not actually benefit from the rapid growth of their home market, and the majority of solar PV panels were imported from China (China & Taiwan reached ca. 60% of global production in 2010 compared to 19% in 2006). Suntech, JA Solar, Yingli and Trina Solar more than doubled the capacity supplied in 2010 compared to 2009. China's aggressive move to become a global manufacturing hub is witnessed by its increased capacity and reduced module price. Factory gate prices were down 33% year-on-year in early 2011 and are expected to fall further should the supply and demand imbalance continue. The Chinese Manufacturers have managed to attain low prices due to many reasons, including advantageous loans from Chinese State-owned banks.

China is also planning to install solar PV capacities on its own land: the country launched the "Golden Sun" program in 2009 (providing subsidies to solar PV power generation projects)[22] and is now catching up with 2 GW of solar PV power installed capacity in 2011 (China's total installed capacity of solar power reached almost 3 GW by the end of 2011), increasing its installed capacity three-fold.

### A trend for consolidation and a shift to Asia for Western Manufacturers

As a consequence of increased supply in the global market, the trend towards sector consolidation through M&As and the move of a manufacturing base to Asia is evident. For example:

- Q-Cells, German manufacturer of crystalline silicon cells, almost doubled its production and moved about 50% of the production to its new factory in Malaysia between 2009 and 2010;
- The Norwegian manufacturer REC closed three factories in Norway and opened one in Singapore;
- First Solar and SunPower have also opened facilities in Malaysia.

### Grid parity is already a reality in very sunny regions with high electricity prices

When will grid parity happen? It is a matter of cost, insulation and the level of local end-user electricity prices. The European Photovoltaic Industry Association (EPIA) estimates that grid parity is already a reality in sunny regions such as Los Angeles or Dubai and that grid parity may be generalized in Europe by 2020 to less sunny regions such as Berlin[23] (see Table 7). Solar PV may even be already at grid parity in the sunniest regions of Italy (Sicilia or Sardinia) since Italian residential electricity prices are amongst the highest in Europe.

**Table 7 – Solar PV grid parity per customer segment in selected European countries**

| | | FR | DE | IT | ES | UK |
|---|---|---|---|---|---|---|
| **Residential** | 3 kW | 2016 | 2017 | 2015 | 2017 | 2019 |
| **Commercial** | 100 kW | 2018 | 2017 | 2013 | 2014 | 2017 |
| **Industrial** | 500 kW | 2019 | 2019 | 2014 | 2017 | 2019 |

*Source: Solar PV – Competing in the energy sector, September 2011, EPIA*

[21] According to the Norwegian manufacturer REC, cited in « Solaire : les acteurs européens luttent pour leur survie », Les Echos, November 15, 2011

[22] China Golden Sun Programme (2009, revisited in 2011) – IEA, Policies

[23] Solar PV: Competing in the energy sector – EPIA, September 2011

# The next blockbuster cleantechs: their development could be hampered by the economic crisis and the lack of political momentum

**The three main regions active in developing CSP are the sunny US States (California, Florida …), Spain and the Sahara desert.**

### With major projects ahead, CSP could take off in the next three to four years

Today, CSP remains small in scale compared to solar PV with only 1.1 GW of installed capacity globally and 2.6 GW of additional capacity planned to be operational by 2014[24].

The three main regions active in developing CSP are the sunny US States (California, Florida …), Spain and the Sahara desert. The US was a pioneer market for CSP in the 2000s but recently has changed in that some planned projects have been converted into solar PV projects over the last few months, due to dramatic reductions in solar PV costs. Spain developed its CSP capacities in 2009 and 2010 at a very fast pace, taking the lead over the US. The favorable feed-in-tariff scheme in Spain provided the regulatory push for technological development, but this move is now hampered by the financial crisis and fewer investments. The Sahara desert could be a promising area for the development of CSP (Desertec project in Morocco and Saudi Arabia, Masdar City…). Plans for CSP development are also being considered in Australia, China and India.

### Marine energy is the next focus of Utilities and Manufacturers

Today, marine (or ocean) installed energy capacities are still rather small. Besides the French tidal barrage of La Rance (240 MW) implemented in the 1960s, none of the other marine energy systems have been successful at a large scale until now. However, as 75% of the world's surface is covered by oceans, marine energy represents one of the largest renewable energy sources. The IEA estimates the ocean energy's global potential to range between 20,000 and 90,000 TWh/year. Demonstration projects are under operation across Europe, North America and Asia. More than 45 wave and tidal prototypes have been tested in the ocean[25]. Governments' interest is rising in the UK, France and Portugal. In France, a national partnership initiative, Ipanema, was created to promote the creation of marine energies. The UK government gives Utilities that buy electricity from projects such as SeaGen double credit towards meeting their renewable energy targets. Additionally, financial incentives are available in the form of capital grants, exemption from the Climate Change levy and the opportunity to sell renewable obligation credits.

### Biomass remains under-exploited

In 2010, global power biomass installed capacity was 62 GW[26], e.g. 1.5 times the solar PV installed capacity. The US and Brazil continue to lead the power biomass segment, while Europe focuses on ensuring the sustainable development of this source of energy. The biomass market for electricity generation picks up slowly. Major reasons stem from the fact that:

[24]Renewables 2011 Global Status Report – REN21, August 2011

[25]Emerging Energy Research – IHS, October 2010

[26]Direct firing or co-firing (with coal or natural gas) of solid biomass, municipal organic waste, biogas, and liquid biofuels

- Sustainability benefits and social acceptance are not always so easy to establish;
- Arbitrating between producing heat or electricity from biomass is not always obvious neither at the investment stage nor at the operating stage for CHPs;
- It is a complex market and supply chain with many stakeholders and actors to align;
- Its development time is longer than that for wind or solar PV energy, for example.

### Carbon Capture and Storage (CCS) is still in a demonstration phase

Although strongly pushed by the IEA and all the stakeholders involved in the low-carbon economy, CCS is not taking off due to difficulties to reach performing technologies and too low carbon prices (short-term certificate prices plunged from €14/t on average, in 2010, to €7/t in January 2012), while the long-term perspective of a worldwide post-Kyoto agreement on climate change policies and higher global costs for $CO_2$ flies away. This explains why there has not been noticeable development over the last two years.

### On the contrary, the hydro storage is rejuvenating

The increasing share of intermittent renewable energy sources coupled with the volatility of electricity grids is also strengthening the need for additional energy storage capacities. Pumped hydro is the only conventional and commercially mature grid scale storage option with a capacity of 136 GW worldwide at the end of 2010, while the other energy storage systems account for 2 GW. In order to support a growing share of intermittent renewables, a number of European countries are rediscovering pumped hydro; this trend has been reinforced in countries that decided to reduce national exposure to nuclear power after the Fukushima events. In total there are around 17 GW of pumped storage projects planned and under construction as of May 2011 in Europe. The leading countries are Switzerland, Portugal, Spain, Austria and Germany. For instance, in Germany, new pumped storage power stations have been added, bringing the total new capacity in fast response technologies to over 3 GW.

# Key challenges ahead: innovation, operational excellence, smart grid integration

### European players are more than ever engaged in an innovation race – which requires not only internal competition, but also cooperation

The playing field is now global. This is a threat to the home market (as on the solar PV market) but also an opportunity to position oneself in new markets and to gain market shares (as the onshore and offshore wind markets). To be competitive, the European industry needs a strong domestic market to gain the operational, financial and innovation momentum required to build its international competitiveness.

The latest developments on the offshore wind markets reveal the competitive spirit in Europe. In the UK, France and other European countries, governments, local ports and public authorities are getting organized to attract OEM and to build the Tier 1 and Tier 2 supply chains. All the elements are there to initiate the emergence of a powerful industry that would see order books filled up, employment revitalized and operators positioned on high technology products and services. Technical entry barriers to the international market of offshore wind equipment and components are higher but international competition should not be underestimated, as Asian Manufacturers are also developing their own products. To that end, transformation programs launched by some European Manufacturers are a move in the right direction to professionalize their marketing & sales processes and organizations, in order to boost international sales and provide comprehensive offerings to key accounts.

A key challenge for the European industry is to build "coopetition", i.e. internal competition but also cooperation between European players. However, in a context of crisis, projects opposing European players and Member States can lead to value destruction making this competition adversarial and counterproductive. Innovation needs to be fostered by actively leveraging the know-how and research capabilities not only of the established European cleantech supply chain, but also of the other European hi-tech industries (spatial, aeronautic, automotive, etc).

On the international front, European operators explore new markets and entry strategies to gain market shares. Obviously, the best target countries are those combining significant GDP growth, a stable and favorable regulatory framework supporting the development of renewable energies and a favorable economic and legal framework allowing the setting up of foreign companies. The organizational structure of these companies should adapt to this international expansion making it mandatory to have clear commercial and partnership strategies with efficient processes and aligned management.

### The European players need more than ever to look for operational performance

European Utilities and Manufacturers need to engage in the most efficient and performing way of manufacturing their products and piloting their services and operations. Improving the total cost of ownership from manufacturing to service is now a must have, both to demonstrate to governments seeking budget optimization that renewable energies are cost-competitive, against conventional power generation, and to gain new markets abroad.

This suggests, for example, that operations should be streamlined, as Enel Green Power has done by reviewing its global portfolio management process to identify improvement opportunities and to design new processes and organization accordingly. Other Utilities are taking the same route: EDF has engaged in a transformation program of its Generation and Engineering Division to improve processes and better make us of digital tools, E.ON is now organized into five global units amongst which are "managing generation fleet", "renewables business" and "new build and technology" and Iberdrola launched a program to improve the efficiency of its operations, in particular its O&M operations. On the Manufacturers' side, Vestas is implementing a transformation plan with shared services and a new marketing & sales organization, with more focus on key accounts and a cost reduction target of €150 million in 2012.

European Manufacturers are continuously focusing on quality management and supply chain optimization, in order to compete with low-cost Asian players. To maintain competitiveness and acquire complementary know-how, major Western Manufacturers have also undergone structural consolidation and acquired a series of smaller companies in the last few years. As an example, Vestas improved lost production factor from 4.5% in 2009-2010 to ~2% in 2011, and GE Wind acquired Scanwind in 2009 and Wind

Systems Tour in February 2011. Yet lessons should be learned, for instance, from the automotive industry. Too much pressure on cost optimization and a simplistic way of addressing purchasing processes, led to a loss of long-term relationships between players and to a destruction of the innovative capacity. As mentioned above, innovation capability both on products and processes is a must have to maintain an advantageous position within Europe and abroad.

In the onshore wind industry, developing O&M services is an integral part of the strategies of European wind turbines Manufacturers, benefitting from a large installed base in Europe and their long-lasting experience and knowledge. Today, Vestas clearly leads the global market in terms of cumulative installed base, with 48 GW (~25% of existing cumulative capacity in the world and a market share of new added capacity of ~10% in 2010). Vestas proved to be pro-active and successful in the field of services, since its "Service business" now accounts for ~9-10% of its total revenues and should amount to €700 million in 2011. It has developed new offerings across the value chain ("SiteHunt", "SiteDesign", "Electrical PreDesign", "Power Plant Controller", "VestasOnline Business – SCADA v.3.9") and built partnerships with specialized companies (Caterpillar). Now that the renewable installed fleets have reached large sizes, much can be learned from benchmarks from other decentralized industries such as automotive, air or rail services, etc.

### Solving the smart grid challenges is key to the success of the European cleantech industry

The share of renewable energies in the European electricity mix is increasing significantly. However, grids were not designed to receive a high production of intermittent electricity. To that extent, experimentations are on their way in several countries around the world to design the processes and technical means (the so-called smart grids) to integrate renewable energies in an efficient manner into the existing and future electricity grids. The exceptional UK and German incidents of early December 2011 showed how rough measures could be implemented. High wind speed led to a high wind electricity production in both countries. UK and German operators were asked to shut down their wind turbines. UK operators received a £1 million compensation from the TSO, while Germany tapped into its Austrian reserve capacity.

The smart grid technological and market design developments should improve the grid efficiency and enable better integration of intermittent renewable energies through an array of levers, ranked by increasing costs:

- Predictability of wind and sun generation;
- Industrial and commercial flexible demand response;
- Increased modulation of fossil power plants;
- Hydro storage;
- Residential flexible demand response and;
- Other physical and chemical storage technologies.

# Conclusion

To conclude, markets are moving quickly, segments have their own specificities, competition is fierce and European public support is becoming more selective. Yet renewable energies are here to stay for a long time, and opportunities have to be seized in and outside Europe. European Utilities and Manufacturers have developed competencies, they are often present in all the value chain segments and can compete internationally assuming that:

- They articulate cooperation with competition;
- Drive innovation;
- Develop the proper strategy;
- Implement it thoroughly;
- Operate efficiently.

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