SARASIN

Renewable energies: evolving from a niche to a mass market

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Fossilised thinking does more harm than fossil fuels

Our shocking, but in no way surprising, impotence in the face of the forces of nature unleashed by the oil disaster in the Gulf of Mexico will make 2010 a turning point for the global energy business.

But amid all the tragedy, there are a few rays of hope. For more clearly than ever before, and for the entire world to see, nature has held up a mirror to our insatiable hunger for fossil fuels. The fossilised thinking that has encouraged the wasteful plundering of our fossil fuel resources over the last fifty years has left us walking on increasingly thin ice. Over the coming years we would have seen a boom in technologically questionable deep-sea drilling, a type of activity that should be entirely unnecessary, as we still waste scarce resources through antiquated technologies and flawed environmental policies without drawing the slightest benefit from them. Whether it is electricity, water or food: too often our society loses up to 80% of the original energy extracted between the point of extraction and end consumption. Such enormous losses are the result of simply looking the other way, as typified by the Japanese folklore of the three wise monkeys: "see no evil, hear no evil, speak no evil". And it is here in particular that 2010 could bring about a change. This is supported on the one hand by a relentless rise in commodity prices and, on the other, by the increasing market maturity of many forms of renewable energy, which we look at in more detail in this study.

In any case, investors should prepare themselves for three important consequences:

1) Fossil fuel resources will become far more expensive due to rising extraction costs and an overestimation of reserve levels over many years. While the oil price averaged 14 US dollars between 1890 and 1970, it may well climb above 200 US dollars by 2020 at the latest. Even today, absorbed extraction costs for some new crude oil reserves are around USD 140 per barrel.

2) Greater energy efficiency and the extraction of renewable energy will become an important economic cost-saving potential. Many small innovations offer attractive business potential. The speed at which a large number of small advances can herald a rapid, global change is frequently underestimated. But Moore's law, which describes exponential advances in computing power, can equally be applied to accelerating technological development in the field of renewable energies.

3) A sustainable asset management style is becoming increasingly popular. To the same extent that the world is becoming a village, investors too must invest in a holistic, sustainable manner. Success is no secret: while the global MSCI World share index lost 30% over the last decade, our largest sustainably managed, global equities strategy gained an astonishing 45%. Of course, sustainability alone is no guarantee of the success of an investment – technical competence and well-practised investment processes are also decisive factors. But the trend is comparable with the force of a compelling idea whose time has finally come.

Yours sincerely

Dr. Burkhard P. Varnholt, Chief Investment Officer
Member of the Executive Committee

Summary

The expansion of renewable energy capacities continued at a brisk pace during 2009, despite the challenging environment. The mature technologies of wind and solar energy are currently going through significant changes that are resulting in the structural consolidation of the market. With highly automated mass production, these technologies are therefore achieving the type of low cost structure they need to make them less reliant on state support. Thanks to these improvements, the future prospects for renewable energies still look very bright. Increased involvement by energy utility companies should also help to overcome the challenges presented by power grid integration and stabilisation. Other technologies, such as ocean and geothermal power, are relatively young but are poised to further increase their share of the renewables market. The biofuel industry is also counting on the development of environmentally friendly and socially compatible technologies of the second and third generation.

Renewables continue to make good progress

The installation of new renewable energy capacity has gone well in 2009, despite the economic crisis, low oil price and lack of progress in climate protection policies. Both in Europe and the USA, more electricity production capacity based on renewable energy sources was installed than from conventional sources. Not just wind power (+31%), solar energy (+13%) and small hydro (+7%), but other forms of renewable energy such as ocean (+2%) and geothermal (+4%) managed to gain ground despite weaker growth rates overall. Total global renewable energy capacities have risen to 305 GW. Including large-scale hydroelectric plants (925 GW), around 25% of total global electricity production capacity (4,800 GW) now comes from renewables (1,230 GW).

So far, however, this solid market growth has not been reflected in higher share prices. The shares of many renewable energy companies are currently sitting at a relatively low level, mainly because of uncertainties regarding the future level of state subsidies. Pressure is also mounting on costs and margins as global competition intensifies.

Radical changes in the solar and wind industry

As an expanding commercial sector, renewable energies are currently evolving into a more mature and established industry, with photovoltaics moving more in the direction of the electronics industry, while wind energy shifts more towards the area of mechanical engineering and construction. In doing so, they are losing their pioneering role and their special status, instead following general industry trends (mass production, OEM solutions, concentration and offshoring of production to low-cost countries). At the same time, more and more industrial conglomerates from the electronics and mechanical engineering industries are entering the field of renewables. This is resulting in a streamlining of market structures and is accelerating the consolidation process.

Joining forces with EUCs to master grid integration

Large energy utility companies (EUCs) have ramped up their investments in renewable energies over the past year. The wind energy capacity operated by EUCs increased by 25% in 2009, for example. The utility companies play a key role when it comes to future power storage, grid integration and stabilisation. Only with their help will it be possible to construct the necessary intelligent networks.

Positive market outlook

This year photovoltaics experienced dynamic growth of around 50%, despite steep drops in feed-in tariffs. Further cuts to subsidies in 2011 have already been announced and these will result in a slower rate of global growth (26%) – especially in Germany. As early as 2012 it should be possible to generate solar energy at a competitive price without state subsidies in attractive markets such as California and Italy.

Wind energy will experience higher than average growth in Asia especially, and in new markets such as Australia, Canada, Brazil and India. Additional incentives and higher gas prices are needed in the USA to make wind energy more attractive. In Europe there are high hopes of a more dynamic expansion of offshore wind parks. Cumulative wind energy capacity totalling 500 GW will be installed worldwide up to 2015.

Biofuels – hopes placed on new technologies
There are still a number of uncertainties surrounding the future of biofuels. On the one hand sustainability criteria imposed on first-generation biofuels are being tightened up in many countries, while on the other hand more environmentally friendly technologies of the second and third generation are currently in a critical development phase, making it difficult to estimate their potential.

India – a booming market for renewables
In the years ahead India will develop into an important market for renewable energies. The Indian government wants a higher proportion of its future energy requirements to be met by local forms of renewable energy (20% quota by 2020) and less by imported fossil fuels. India offers attractive overall conditions for renewable energies. An increasing number of Indian technology companies are becoming active in this area.

Investments in renewables still make sense
The long-term prospects are still intact for the investor. Share prices – especially of companies in the mature wind and solar industries – will however increasingly fall into line with general stock market performance in the years ahead. When selecting renewable energy stocks in future, it will become increasingly important to pick out the promising technologies, without overlooking the potential risks.

Sarasin's definition of sustainability
For Bank Sarasin, sustainable business management entails a commitment to the provision of goods and services in a socially responsible way, using production methods with the lowest possible environmental impact and creating the least possible conflict.

2009 – Renewable energies resilient to the crisis

Despite the economic crisis, renewable energies continue to grow. Both in Europe and the USA, more energy from renewable sources was installed than from conventional sources during the course of 2009. Global installed capacity for all renewable energies has now reached 305 GW. Photovoltaics gained 13% in 2009, equivalent to newly installed solar power capacity of 7.2 GW. Total global capacity now stands at 21 GW. Last year newly installed wind energy capacity climbed 31% to 37.4 GW, resulting in a cumulative global capacity of 159 GW. Geothermal power increased to 10.7 GW of installed capacity, while the figure for ocean energy was around 0.3 GW at the end of 2009. Biofuels became less attractive due to tougher rules imposed on the sustainability of the raw materials used in their production.

Renewable electricity capacity at y/e 2009

In 2009 newly installed capacity was 50 GW, bringing the cumulative global capacities of all renewables (including small hydro) to 305 GW by the end of the year (Fig. 1). This represents a year-on-year increase of 16% in global capacity. Taking into account large-scale hydro power as well (925 GW) around 25% of total electricity generation capacity worldwide (4,800 GW) is now provided by renewable energies (1,230 GW).[1]

For the second consecutive year, more renewable energy capacity was installed than conventional fossil or nuclear power stations – both in the EU and the USA. In the USA the proportion was 50% in 2009, and in Europe as high as 60%.

As demand has grown, so too have production capacities for renewable energy technologies (solar cells & modules, wind turbines etc.) been significantly expanded during the course of 2009.

Last year a total of EUR 130 billion was invested worldwide in expanding renewable energy capacities. This is equivalent to an increase of 23% on 2008. R&D spending by governments and corporations in the field of renewable energies also increased in 2009, from EUR 19.6 billion to EUR 20.4 billion.

This relatively stable growth in renewable energies in the face of the current economic recession clearly demonstrates that the sector was (and is) not simply experiencing a short-lived bubble, but will be an important investment theme for the future.

Fig. 1: Global renewable electricity capacities at y/e 2009

Technology (gigawatt)	Total world	3rd world	EU-27	CN	US	DE	ES	IN	JP
Wind	**159**	40	75	26	35	26	19	11	2
Small hydro	**60**	40	12	33	3	2	2	2	4
Biomass	**54**	24	16	3.2	9	4	0.4	1.5	0.1
Photovoltaics	**21**	0.5	16	0.4	1.2	10	3.4	~0	2.6
Geothermal	**11**	5	0.8	~0	3.2	-	-	-	0.5
CSP plants	**0.7**	-	0.2	-	0.5	-	0.2	-	-
Ocean	**0.3**	-	0.3	-	-	-	-	-	-
Total renewables	**305**	**110**	**120**	**62**	**52**	**42**	**25**	**14**	**9**

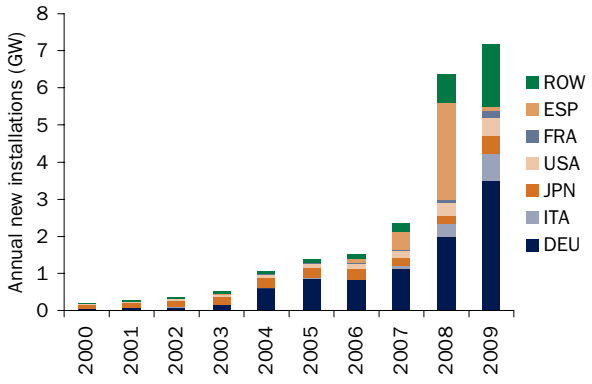
Source: REN 21, Aug. 2010

PV installations grow despite adverse conditions

Despite problems in project financing crated by the financial and economic crisis, and the collapse of the Spanish market following the cap introduced in autumn 2008 on state subsidies for new installations up to an annual limit of 500 MW, newly installed global PV capacity still managed to increase by 13% to 7.2 GW in 2009. This is much lower than the growth achieved in 2008 (170%), but is still quite impressive given the challenging environment. The biggest PV market, Germany, recorded a particularly strong growth (75%) to reach a market share of almost 50%. The reductions in feed-in tariffs scheduled for 1 January as well as 1 July and 1 October 2010 have created strong pre-emptive or pull effects.

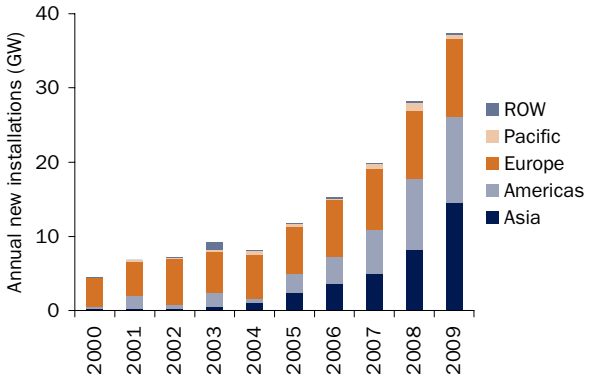
[1] REN21. Renewables 2010 Global Status Report. Paris: REN21 Renewable Energy Policy Network, 2010

Fig. 2: New PV capacity installed annually



Source: Bank Sarasin, Aug. 2010 (ROW: Rest of the World)

Fig. 3: New wind capacity installed annually



Source: BTM Consult, GWEC, Bank Sarasin, Aug. 2010

Stable growth for the wind industry

Wind energy also experienced growth, despite the difficult economic climate. 31% more wind energy capacity was installed in 2009 than in the previous year. This corresponds to 37.4 GW of new wind capacity and a market volume close to EUR 45 billion. At the end of the year the total amount of wind energy capacity in service was therefore 159 GW, which currently corresponds to 1.5% of global electricity capacity. The highest rate of new installations was recorded in China (13 GW) USA (9.9 GW), Spain (2.5 GW) and Germany (1.9 GW).

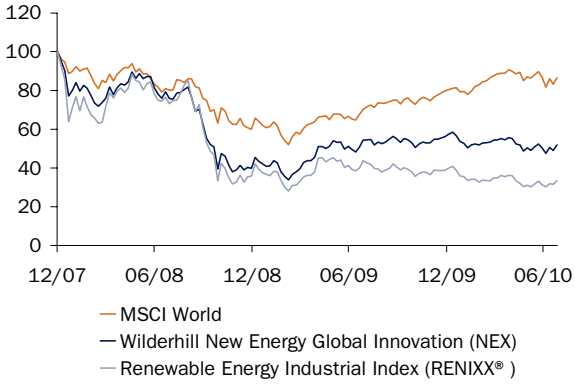
The main beneficiaries of the surprisingly strong growth in China were local suppliers such as Goldwind, Sinovel and Dongfang, whose share of the Chinese market increased from 74% to 80%. Wind energy investments in China exceeded 10% of the total investments in the energy sector.

Wind energy has also experienced a boom in recent years in the USA (CAGR[2] 45% during the period 2006-2009), as more and more electricity providers have entered the marketplace. The independent power producers (IPPs) play a pivotal role in the US wind energy market. They operate 85% of all newly constructed wind parks. Only 15% belong to the large energy utility firms. IPPs are far more dependent than utility companies on financing from banks and were therefore more badly affected by the financial crisis. In recent months the availability of loans has certainly improved, but is still a long way off from the comfortable situation before September 2008.

Margin pressure and uncertainty for all

The share prices of companies from the renewable energies sector stabilised for the most part in 2009 following the heavy losses of 2008, and even recovered slightly.

Fig. 4: Comparison of NEX, RENIXX® and MSCI World



Source: Datastream, IWR, Bank Sarasin, Aug. 2010

The Wilderhill New Energy Global Innovation Index (NEX), for example, declined 59% in 2008, and the Renewable Energy Industrial Index (RENIXX®) fell by as much as 64%. In the following year, however, both indexes managed to recover, with the NEX gaining 37% and the RENIXX® 7%. But they reversed direction again in 2010, with both the NEX (-11%) and RENIXX® (-19%) losing ground until the end of July. The generally weaker performance of the RENIXX® compared with the NEX is mainly because it has a higher quota of solar company shares. Solar stocks have underperformed over the entire period.

[2] CAGR: Compound annual growth rate

One reason for the current negative share price performance of renewable energy companies is the general uncertainty felt by investors following discussions about reducing state subsidies in a number of European countries, including Germany, Spain, Italy, Belgium and the Czech Republic. The ongoing debate in Spain about a retroactive cut in the rates of remuneration paid for existing installations is causing particular concern. Any cuts to subsidy programmes will inevitably undermine demand. This is putting additional price and margin pressure on companies. This pressure is already high due to tougher competition from Asia and excess supply in the market following the significant expansion of production capacities.

In the USA as well, the swift introduction of subsidy programmes for renewables has taken longer than expected when the new government came into power. The Climate Conference held in Copenhagen in December 2009 also failed to provide any impulses for renewable energies.

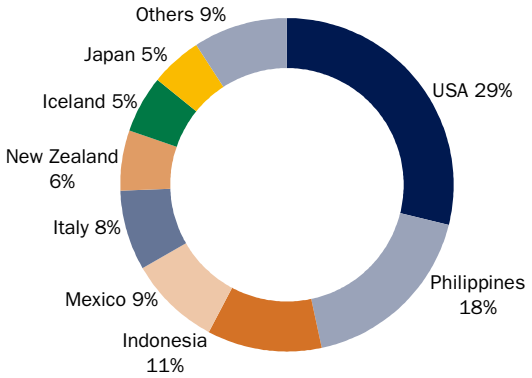
More renewables in the pipeline

Not just solar and wind power, but other renewable energy technologies managed to increase their volumes over the course of the past year.

Geothermal energy

According to the latest report from the Geothermal Energy Association (GEA) newly installed geothermal capacity reached 10,715 MW by the end of 2009.[3] Over 67,000 GWh of electricity was produced. Geothermal capacities in the USA rose by 176 MW, or 6%, to a total of 3,087 MW. This increase is substantial when compared with 2007 and 2008 (79 and 61 MW respectively), but in absolute terms is much less than for photovoltaics (480 MW) and wind power (10,000 MW). Overall the electricity generation capacities for geothermal power globally have grown by 20% between 2005 and 2010. At the same time the number of countries with geothermal projects has risen sharply. In 2007 the figure was just 46 countries, but last year this had already risen to 70.

Fig. 5: Cumulative geothermal capacity at y/e 2009



Source: Geothermal Energy Association (GEA), Bank Sarasin, Aug. 2010

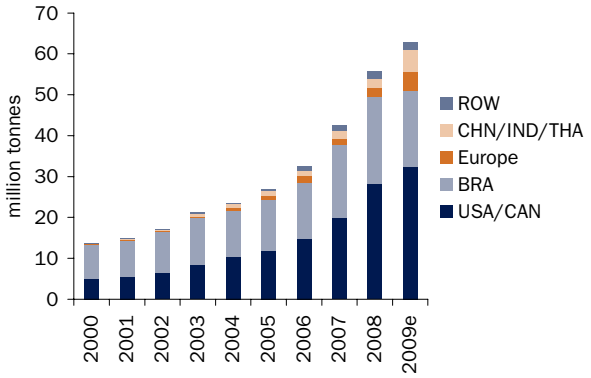
Ocean power

So far most of the technologies for harnessing ocean power are not yet commercially viable. Higher levels of investment are required, along with the sort of supportive policies provided for the wind offshore segment. At the end of 2009 globally installed ocean power capacity amounted to around 300 MW.

Biofuels

Global production of bioethanol and biodiesel has grown by around 20% p.a. on average in the past few years. In 2009 a total of 63 million tonnes of bioethanol were produced: 50% in the USA and 30% in Brazil (Fig. 6). Europe was once again the leader in biodiesel production with a market share of 50% or 8.4 million tonnes in 2009. It was followed by Brazil & Argentina with 19%, and the USA & Canada with 18% (Fig. 7).

Fig. 6: Global bioethanol production 2000 - 2009

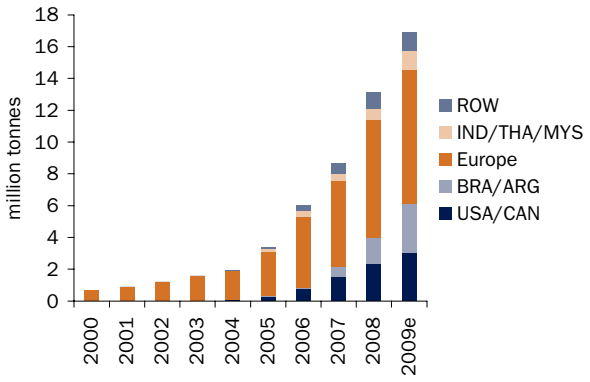


Source: OECD-FAO, Agricultural Outlook 2009-2018

[3] www.geo-energy.org; Geothermal Energy: International Market update, May 2010

Despite the steady increase in production, growth rates have slowed significantly over the past three years for both bioethanol and biodiesel. Given the current tensions between crude oil and commodity prices, the profits from biofuels are currently very modest. This is also reflected in the poor share price performance of many biofuel companies.

Fig. 7: Global biodiesel production 2000 - 2009

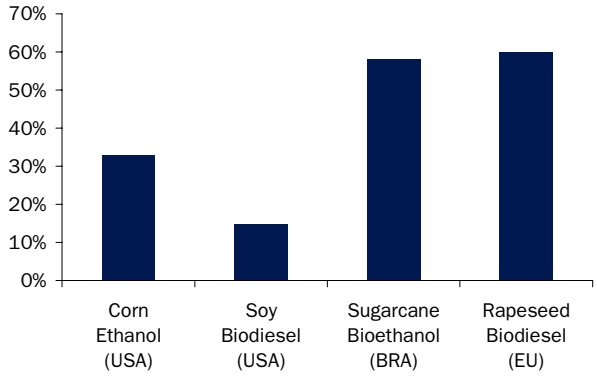


Source: OECD-FAO, Agricultural Outlook 2009-2018

In 2008 bioethanol only accounted for 3.7% of global fuel production. Biodiesel made an even smaller contribution to total sales of diesel, at just 1.5%. This is very little compared with the quantity of raw materials or crops used as feedstock.

In the USA, for example, roughly 33% of the maize crop was used to produce bioethanol in 2008 (Fig. 8). Palm oil, along with soya and rape, is a vital resource for biodiesel. This has only been used in small quantities to date, but production volumes have recently doubled (in Malaysia and Indonesia). This is mainly attributable to higher demand for biodiesel.[4]

Fig. 8: Percentage of total harvest used in biofuel production 2008



Source: GTM Research; Biofuels: Spotting the Next Wave, Dec. 2009

[4] UNEP, Assessing Biofuels, 2009

Challenges and opportunities for renewables

Renewable energies face significant challenges: dwindling government support, severe price and cost pressures, increasing competition and the sector's rapid globalisation. Nevertheless, production capacity continues to be expanded across all technologies, and the solar and wind industries in particular are evolving from a niche into a mass market. In this highly competitive environment, a low cost structure and an international presence seem key to achieving high profitability. The opportunities that are emerging as energy technologies rapidly become competitive remain attractive. At the same time, there needs to be a public debate with the utilities on the further standardisation and storage of renewable energies and their integration into the grid.

Current trends affecting supply and demand

The short- and long-term outlook for renewable energies is shaped by various factors and trends on both the demand and the supply side:

- On the demand side, much depends not only on developments across the economy and in the oil and energy markets, but also on how government support programmes change going forward and the extent to which utilities invest in renewable energies. Photovoltaics are heavily dependent on government support programmes, wind power on the energy markets and the actions of utilities.
- On the supply side, the sector is being severely affected by a combination of growing competitive pressures, temporary overcapacity and the globalisation of production.

Negative impact of the economic climate and oil price

Due to low oil and gas prices, demand for wind farms has been more subdued than expected, particularly in the USA. It has also been negatively impacted by the credit crisis. In many cases, the necessary project finance has been delayed due to the strains in the financial markets. Wind turbine manufacturers have therefore been working at low capacity, which has had an adverse impact on operating margins. Only the Danish company Vestas, with its better cost structure, has been able to buck this negative trend in margins.

Governments start to withdraw support

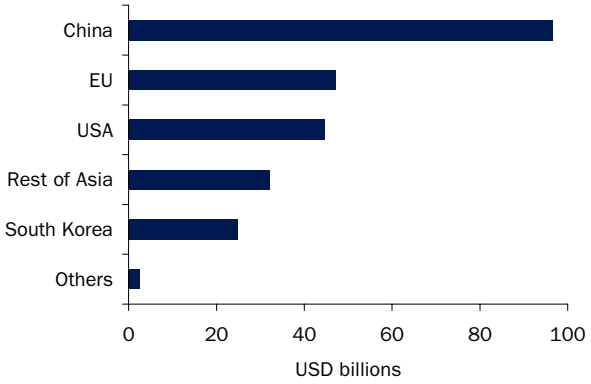
Due to the current cost of power generation, photovoltaics in particular are more dependent on government support programmes than wind power or solar-thermal generation. In various countries, disapproval of measures to support the sector is mounting, as renewable energies make up a growing proportion of the production portfolio as a whole and in recent years have yielded high returns. The huge debt burden of many countries is only increasing this criticism, even though most subsidy schemes are financed not out of the general budget but via a levy on the electricity price (pay-as-you-go system).

In the USA, the new version of the climate bill no longer contains federal mandates for the percentage of renewable energies in utilities' generation mix (Renewable Portfolio Standard, RPS), instead limiting itself to introducing a plan to reduce CO_2 emissions (by 17% compared with 2005 levels by 2010 and by 80% by 2050) and a cap-and-trade system. However, it also includes incentives to promote nuclear power, carbon capture and storage at coal-fired power stations and offshore drilling. Due to other political priorities, it may be 2011 before the climate bill is passed. At the same time, however, political pressure for a stronger shift in energy policy has increased considerably following the sinking of the Deepwater Horizon oil platform in the Gulf of Mexico in April and its devastating effects on the environment.

Continuing effect of green stimulus packages

The green stimulus packages introduced by various governments in an effort to revive the economy continue to support the renewable energy market. Since our last report, these packages have grown in volume to represent a total investment of USD 521 billion. We estimate that roughly USD 82 billion, or just 16% of the total amount, was spent in 2009, as a result of which spending may to rise to around USD 248 billion (48% of the total amount) in 2010.

Fig. 9: Spending on green stimulus packages in 2010



Source: Governments, Bank Sarasin, March 2010

China accounts for the lion's share of the total at 39%, followed by the EU (19%) and the USA (18%) (Figure 9). There will still be USD 146 billion available for green infrastructure projects worldwide in 2011 and around USD 28 billion available in 2012. China's new 10-year clean energy plan aims to use carbon-neutral sources for 15% of energy consumption by 2020, requiring the construction of 250 to 300 GW of hydro, nuclear, solar and wind power capacity.

Utilities ramp up investments

Especially in the wind power segment, large utilities are increasingly active investors and, due to their financial strength, an important source of market support, even in times of crisis. These investments are being driven partly by government requirements regarding the percentage of renewable energies in the generation mix that apply in individual US states, particularly the RPS mandates. Looking worldwide, large utilities and independent power producers (IPPs) are the leading operators of wind farms. The 15 biggest wind farm operators controlled around 35% of total capacity in service at the end of 2009. There have not been any significant changes in the rankings since last year. Following its acquisition of Endesa, Enel's portfolio now includes Endesa's wind farms.

Fig. 10: Leading global wind farm operators

Company (country)	In operation in 2009 (GW)
1. Iberdrola Renovabl./Scottish Power (ES)	10.35
2. FPL Energy/NextEra (US)	7.54
3. Acciona Energy (ES)	6.23
4. EDP Renovaveis/Horizon (PT)	6.23
5. Long Yuan Electric Power (CN)	4.84
6. Datang Corporation (CN)	3.02
7. E.On Climate and Renewables (GE)	2.87
8. EDF Energies Nouvelles (FR)	2.65
9. Invenergy (US)	2.02
10. Eurus Energy Holding (JP)	1.90
11. Babcock Brown Wind Partners (AU)	1.74
12. RWE Innogy (GE)	1.57
13. Huaneng New Energy (CN)	1.55
14. Enel/Endesa (IT)	1.51
15. GDF Suez (FR)	1.49
Top 15 total	**55.51**

Source: BTM Consult, March 2010

In the USA, a number of utilities are also investing in solar power, both photovoltaics and solar-thermal plants. Figure 11 shows the ten largest US utilities and their solar power capacity in operation at the end of 2009 in MW. Around 63% of the output is PV-based, while 37% is generated by solar-thermal plants.[5] Last year, the capacity of the solar power plants increased by 66% compared with 2008 levels.

Several utilities are also active in ocean power, either through investments in individual technologies or (pilot) projects. Swedish utility Vattenfall and Scottish company Pelamis Wave Power are investing EUR 70 million in a joint venture to build a 20 MW wave power plant off the Shetland Islands, for example. German utility E.On is also interested in this technology. Like wind power, ocean power is a large-scale power plant technology. It is very capital-intensive and suited to the grid structure of major utilities, which is based on large centralised plants.

However, most of the technologies used to exploit ocean power (wave or tidal power plants) are at the pilot stage and therefore still expensive. UK consultancy The Carbon Trust estimates that tidal power costs around EUR

[5] 2009 Utility Solar Ranking, American Solar Electric Power Association (SEPA), May 2010

0.18/kWh compared with EUR 0.11/kWh for offshore wind power. Wave power is even more expensive, at EUR 0.30/kWh.

Fig. 11: Leading solar power players among US utilities

Company (US state)	In service in 2009 (MW)
1. Southern California Edison (CA)	515.6
2. Pacific Gas & Electric Co. (CA)	314.6
3. NV Energy (NV)	87.9
4. San Diego Gas & Electric Co. (CA)	66.4
5. Publ. Serv. Co. of Colorado-Xcel En. (CO)	43.2
6. Public Service Electric & Gas Co. (NJ)	42.7
7. Florida Power & Light Co. (FL)	30.5
8. Arizona Public Service Co. (AZ)	21.5
9. Los Ang. Dept. of Water and Power (CA)	18.6
10. Sacramento Municipal Utility Distr. (CA)	14.2
Other utilities	143.2
Total	**1,298.4**

Source: 2009 Utility Solar Rankings; SEPA USA

The challenge of grid integration

The rapid growth of renewable energies raises new questions about their integration into the power grid. The fluctuations in output from renewable energy sources that are caused by changing weather conditions have to be smoothed out in order to ensure a steady and stable supply of power. Accurate forecasting and rapid-response management systems are designed to help with this. In addition, a number of pilot projects are already under way to link up different renewable energy units to form virtual power plants, enabling energy demand to be mapped over time. Energy storage and demand response management technologies also play a key part in efforts to match supply with demand. Installing a suitable smart grid infrastructure is becoming ever more important for the large-scale expansion of renewable-energy generation capacity, opening up business opportunities for companies such as EnerNoc, Comverge, Quanta Services and ESCO Technologies which provide these smart grid technologies.

Challenges presented by competition and price pressure

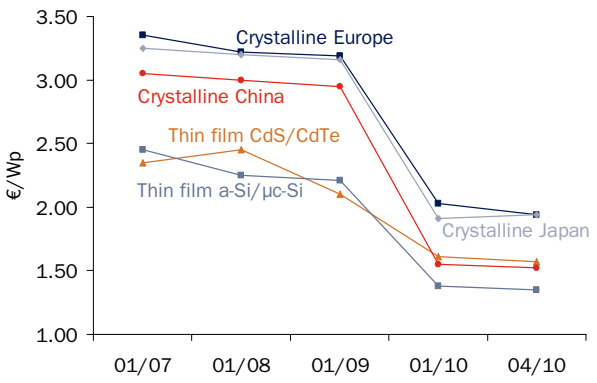
On the supply side, manufacturers of renewable energy technologies face increasing global competitive pressure.

Severe margin pressure in the solar industry

In 2009, solar module prices fell by 30-50%. In previous years, they had dropped by just 5-10% on average. This slump in prices was caused partly by the sharp downturn in the Spanish PV market and also by the growing surplus of solar modules. Consumer prices also fell because the raw material polysilicon had become cheaper. This surplus transferred market power from the seller to the buyer.

In 2008, the price differential between Chinese solar modules and European or Japanese modules was 10%. Last year, the price advantage of Chinese modules increased to 20%, allowing them to penetrate the segment for thin-film modules (Figure 12).

Fig. 12: Solar module prices slump

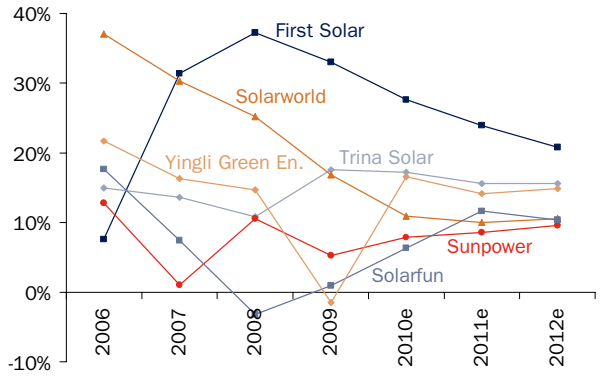


Source: PVXchange, Bank Sarasin, Aug. 2010

The slump in prices put pressure on companies' margins, although not to the same extent for all cell and module manufacturers. Figure 13 shows the change in the EBIT margin of six leading solar companies for the period 2006 to 2012. What stands out from this is the sharp decline suffered by some in 2009. With the exception of First Solar, all companies saw their EBIT margin fall compared with 2006. This was due to the rapid rise in the number of providers, which jumped from just under 20 to 200 within a very short period. The overall effect was that, in order to gain market share, companies reduced their prices at a faster pace than they were able to cut generation costs.

Competitive pressure has also increased due to the entry into the market of Asian and in particular Chinese providers, which have certain cost advantages over European providers. Following the abrupt transition from a market supported by generous subsidies in 2008 to slower growth in 2009, almost all companies were forced to introduce extensive restructuring programmes, which should bear fruit in 2010 and beyond. Demand may pick up and margins may rise slightly. Although they are unlikely to top 20% again, as they did during the boom years: We believe that operating margins of between 10% and 15% are achievable over the longer term and should be realistic for both western and Asian producers. This is a normal pattern in a maturing industry with competitive mass production.

Fig. 13: EBIT margin of six PV companies

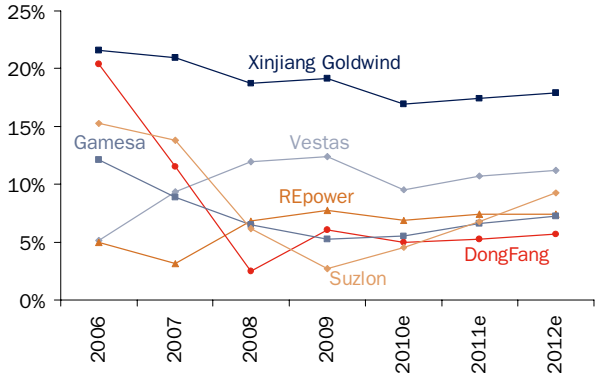


Source: Datastream, Bank Sarasin, Aug. 2010

Wind turbine prices also falling

Manufacturers of wind turbines and components are operating in a slightly more stable environment than PV companies. However, wind turbine prices have also fallen: after rising to EUR 1.26 m/MW in mid-2008, they had dropped by more than 20% by the end of the first quarter of 2010.[6] Over the year as a whole, average prices could fall by a further 7% to 10% to EUR 0.85 m/MW (Europe: EUR 0.95 m/MW; Asia: EUR 0.70 m/MW). This decline in prices was attributable primarily to the lower cost price of key components. On the whole, wind turbine manufacturers suffered less severe margin erosion than the PV sector. However, it is important to stress that margins in the wind industry have been lower and less volatile than those in the solar sector for some years already. This is mainly because the wind sector is less dependent on feed-in tariffs, the technology is more mature and the value chain is broader based.

Fig. 14: EBIT margin of six wind turbine manufacturers



Source: Datastream, Bank Sarasin, Aug. 2010

For 2010 and beyond, we predict a turnaround in margins. A rise in demand due to higher fossil fuel prices, a better environment for project finance and the fruits of the restructuring measures that have been introduced are likely to result in higher capacity utilisation rates, improved efficiency and therefore better operating profits. Over the longer term, we expect big manufacturers of wind power plants to achieve EBIT margins of around 10%, putting them on a par with large machinery and systems manufacturers such as ABB, Alstom, Schneider Electric and Siemens.

Shifting production structures

PV industry: concentration and globalisation

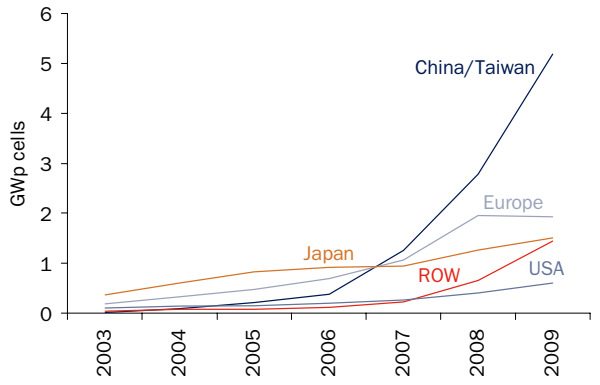
As the market increases in size and competition grows, the PV industry is evolving from a niche into a mass market. Solar cells and modules are relatively standardised products. Rivals are therefore competing increasingly on price. To remain competitive, cell and module producers primarily need to cut their costs. The industry's production structures are therefore moving in the following directions:

- towards bigger units in order to exploit economies of scale;
- to Asia and other emerging markets in order to benefit from lower costs.

[6] New Energy Finance Wind Turbine Price Index; www.newenergymatters.com

The trend towards larger production units means that financially strong companies able to finance the rapid installation of significant production capacity will succeed in the market over the longer term. For example, big players in the electronics industry, such as Samsung and LG Electronics, are currently investing in the construction of their own industrial-scale production facilities. Big Japanese conglomerates such as Sharp and Sanyo likewise intend to maintain a foothold in the mass production of solar modules. Meanwhile, established specialist manufacturers such as First Solar are also expanding and treading new ground. This company, the largest module manufacturer, is now represented on the S&P 500 share index. We also expect the trend towards concentration to increase merger and acquisition activity in the sector.

Fig. 15: Shift in global cell production



Source: GTM Research, IEA-PVPS, Bank Sarasin, Aug. 2010

As regards the relocation of production to low-cost countries, almost half of all solar cells (49%) are already produced in China and Taiwan. The rapid expansion of the region's production capacity has taken place mainly at the expense of Europe and Japan. Last year, Europe failed to increase production for the first time, causing its global market share to decline from 28% (2008) to 18% (2009). Although Japanese producers increased their cell output by 250 MW, their global market share dropped to 14%. By contrast, five years ago, half of all solar cells still came from Japan.

The significant shifts in production among the regions reflect the current cost differential.[7] Even established European producers suffered heavy losses in 2009 and were unable to keep up with Chinese manufacturers' aggressive pricing policy. However, it is uncertain whether the cost advantages enjoyed by Chinese manufacturers will last. The current exchange rate trend, for example, has reduced the cost differential considerably. The weakness of the euro puts European production locations in a more favourable position than China. Although the Chinese government officially removed its currency's peg to the US dollar at the end of June, the central bank continues to closely monitor the exchange rate. The advantages China gains from other cost components could also decline in the near future. For example, there is now upward pressure on labour costs. Cheap labour is in short supply in some regions and there have recently been an increasing number of labour disputes, with workers demanding better working conditions and higher wages. After companies such as Foxconn and Honda were forced to increase the basic wages they pay to their workers, other manufacturers are also feeling mounting pressure. The government's energy price subsidies are likewise coming under increasing fire. Due to growing domestic market demand, China certainly remains an attractive location for the solar industry. For companies that operate internationally, however, it will become increasingly important to have a local manufacturing presence in all three of the main markets, North America, Europe and Asia. Especially in light of rising oil prices and transport costs, it still makes sense to produce modules in Europe, for example. In a further trend in the relocation and streamlining of production, the PV industry is following the lead of the electronics industry by outsourcing production to specialist contract manufacturers. US company SunPower has entered into a cooperation arrangement with AU Optronics of Taiwan, for example, and German company Q-Cells is collaborating with Flextronics, one of the world's largest contract manufacturers in the electronics industry.

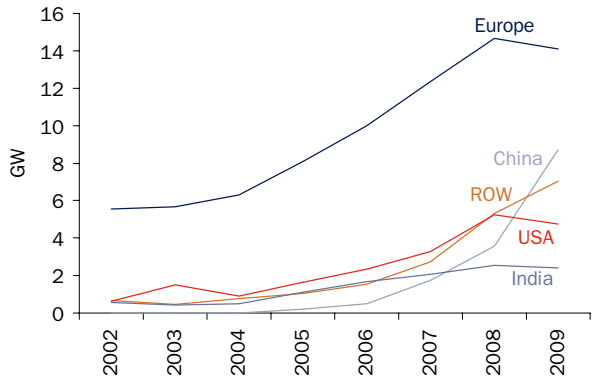
Wind turbines: a local presence in major markets

The wind energy industry is already more advanced than the solar industry in terms of maturity and consolidation. Industry heavyweights such as Siemens and General Electric are already present in the wind turbine sector. In contrast to the photovoltaics (PV) industry, the wind energy industry is inherently closer to the mechanical engineering and construction sector because of its industrial manufacturing component. Project management, product innovation and product engineering play a key role, and the selection of production locations is determined less by cost advantages than by market proximity.

[7] LBBW, 2009

As is the case in the PV industry, Chinese manufacturers are on the march in the wind turbine business too, albeit for different reasons – namely because of the strong growth in the local Chinese market. Local Chinese providers enjoy advantages over foreign companies in the awarding of contracts.

Fig. 16: Growth of Chinese wind turbine manufacturers



Source: BTM Consult, Bank Sarasin, Aug. 2010

There are now five Chinese wind turbine manufacturers represented in the top 15 of the world's largest producers, led by Sinovel (9.2% market share), Goldwind (7.2%) and Dongfang (6.5%). Although the Danish company Vestas and the American firm GE Wind are still the largest suppliers of wind turbines, with global market shares of 12.5% and 12.4% respectively, they dropped 7.3 and 6.2 percentage points during 2009. The other European and Indian wind turbine manufacturers also lost market share.

With continuing market growth in China and new sales markets, the structures of production will continue to become more globalised, no matter what the manufacturer's country of origin. Thus Vestas, GE Wind and Gamesa are already producing a substantial portion of their wind turbines in China, along with components such as blades, towers, generators and gondolas.

Conclusion: the next phase of development for renewables

At present, the energy policies of many countries are sending out mixed signals about future subsidies for renewable energies. While nothing has changed in relation to the principle of support through green stimulus programmes, the uncertainties surrounding government subsidies and feed-in tariffs have increased considerably.

This situation highlights how important is for renewables – particularly photovoltaics – to wean themselves off any kind of state support.

From the viewpoint of the industry as a whole, the rise in global competition leads to attractive price cuts, which will in turn make individual renewable technologies competitive more quickly. From the point of view of an individual enterprise, however, this presents major challenges in terms of purchasing and cost structure. Their margins will come under considerable pressure, and only those companies which are best adapted to these circumstances will survive. In future, the margins will settle at similar levels to those typically found in mechanical engineering and construction, i.e. around 8 to 12%. In addition, new forms of collaboration in production will be required, as the examples of Q-Cells and SunPower demonstrate. This next level of development, which will bring changes to the PV industry in particular, has much in common with the mass production processes familiar from the semiconductor and electronics industry.

India – a booming market for renewable energy

A number of factors have made India an attractive market for renewable energy in recent years. The country already has a deficit in terms of energy provision (11% in 2009), with demand for energy set to increase sharply over the next 20 years. The present electricity generation mix is based to a large degree on imported fossil fuels. The Indian government has set itself the target of producing around 20% of its energy requirements from renewable sources by 2020. A number of federal states are implementing this target by means of 'renewable purchase obligations'. In the national budget for 2010/11, economic development measures for clean technologies worth around USD 1 billion are envisaged. In addition, a National Clean Energy Fund is being introduced to finance clean energy projects and research. India has also set itself the goal of reducing greenhouse gas emissions relative to economic output by 20 to 25% of their 2005 levels by the year 2020. The greenhouse effect is a highly relevant topic for India, as a number of different forecasts warn that it will be affected more than most other countries.

India offers attractive overall conditions for renewable energies. In terms of wind energy, only a quarter of its potential is being utilised. The expectation is that by 2030, 15% of India's energy requirements will be met by wind energy. This will require the installation of on average 1,400 MW annually (1,271 MW was installed in 2009) with investments of around USD 1.4 billion. The Indian wind turbine manufacturer Suzlon will benefit from this, with a 12% share of the global market and 50% of the Indian market. Solar energy, too, has a bright future in India thanks to abundant sunshine and government subsidies. Bank Sarasin expects the installation of solar panels in India to show an annual growth rate of 100% between 2010 and 2012 – albeit from a comparatively low base. Small, off-grid PV systems (solar home systems) will play a role here too. As prices fall, these will become affordable for broad sections of the rural population. Solar-thermal plants are also being promoted in India. Examples of companies which will participate in the success of solar energy include Moser Baer, a leading Indian technology company which also produces solar cells, along with Tata BP Solar, a joint venture between Tata Power Company and BP Solar. In addition, a number of smaller energy project developers such as Greenko, Indian Energy and Azure Power are throwing their weight behind renewable energy and driving forward the development of sustainable energy in India.

Update on the biofuel debate

The most important challenge for biofuels is the question of environmental benefit. This varies depending on the raw material and production technology. First-generation biofuels are produced using conventional fermentation or esterification processes from the edible parts of maize, sugar cane, grain or rapeseed, soya or palm oil. Alternative sources include cooking oil residues or oil from special plants (e.g. jatropha). Second-generation biofuels are extracted using the biomass-to-liquid (BtL) process, or with the help of enzymes (cellulosic ethanol) from plant feedstock not used for food production. Third-generation biofuels are primarily fuels extracted from algae cultivated in water.[8]

Sustainability

First-generation fuels in particular, which use the edible parts of plants, are in competition with food production and tend to inflate food prices. This does not apply directly to fuels from other sources, although special energy-producing plants and algae production facilities are in competition with agriculture for available land. The total demand for agricultural land area for both applications has increased so sharply over the last ten years that a new phenomenon has arisen: land grabbing. Countries such as China and multinational companies are acquiring large areas of land in Africa, in order to secure their future land requirements. While it is true that these investments can also have positive effects (e.g. expansion of infrastructure, access to technology and jobs), NGOs rightly criticise the negative impacts on the local population (e.g. expulsion or relocation of inhabitants and exporting the resulting harvest) and demand international regulation of these land purchases. The limited availability of land, and the fact that even today a major portion of the total harvest of maize, soya, sugar cane and rapeseed is used for biofuels, significantly limits the potential of this first generation of biofuels.

The environmental benefit of biofuels compared with petrol and diesel made from mineral oil is calculated using an environmental life cycle analysis (LCA). If just the CO_2 emissions from biofuels over the entire life cycle are taken into consideration, then in nearly all cases there is a benefit when compared with fossil fuels. (one exception is soy-based biodiesel from Brazil, which emits more CO_2). However, a life cycle analysis that takes into

[8] UNEP, Assessing Biofuels, 2009

account not only CO_2, but all the associated environmental impacts produces a positive result for only a small percentage of biofuels. Here, relevant considerations include overfertilisation and loss of biodiversity, but also effects of indirect land use change (ILUC).

Fig. 17: Challenges to the sustainability of biofuels

	1st Generation			2nd Gen.	3rd Gen.
	convent. sources	**biofuel crops (Jatropha)**	**cooking oil residues**	**cellulosic ethanol**	**algae**
Direct competition with foodstuffs	high	none	none	none	none
Competition for arable land	high	medium	none	none	low
CO_2 saving over fossil fuels	10-70% (Soya – 5%)	40-50%	70-80%	60-90%	10-70%
Environmental impact compared with fossil fuels	high	medium	low	low	low-medium

Source: EMPA, in-house estimates, Aug. 2010

An LCA report by the Swiss Federal Laboratories for Materials Science and Technology (EMPA) concludes that on the basis of existing production processes, only biofuels made from waste and plant residues reduce environmental impact and CO_2 emissions.[9] Bioethanol from Brazilian sugar cane still scores the best from an environmental viewpoint out of all the conventional raw materials. Third-generation biofuels are a new alternative. However, technologically speaking the manufacturing processes are still in their infancy, and the environmental impacts have not been sufficiently investigated. Typical problems here include the use of energy-intensive fertilisers, high water consumption and land use for greenhouses or water tanks.

State of development of the various technologies:

Up to now, the production of biofuels has been based almost exclusively on first-generation technologies. Second-generation technologies for the manufacture of cellulosic ethanol are still in their pilot phase. Specific challenges in relation to logistics lead to high production costs, which meant that only around 20 million litres of cellulosic ethanol were produced in pilot plants in 2008.[10]

The development of biofuels made from algae is still a few years further behind, and production will not become commercially viable until 2016 at the earliest.[11] With the rising oil price and falling prices for biofuels, demand by refineries has grown. However, as long as production costs do not fall below those of fossil fuels, government directives and subsidy programmes will remain the primary economic driver.

Government targets and standards

In 2009 the European Union agreed on a target of increasing the use of renewable fuels in transportation by 10% by 2020. Now, for the first time, sustainability criteria have been incorporated into the EU directives. These must be implemented in all member states by the end of 2010. Thus the biofuel used must cause at least 35% less greenhouse gas emissions than fossil fuels, and indirect land use change (ILUC) effects must be taken into account. It would seem that this would exclude biodiesel made from soya and palm oil, but not biodiesel from rapeseed in Germany or bioethanol from sugar cane in Brazil. Because soya and palm oil represent only a small percentage of European consumption, these criteria will not have a major impact on the biofuel industry in the EU. Not until the introduction of more stringent sustainability criteria, due to come into force in 2017, will bring relevant changes.

The US has also defined target quotas. In 2022, a total of 136 billion litres of fuel are to be produced from renewable sources – more than three times as much as is currently the case. Cellulosic ethanol is to account for 45% of the target, with the remainder provided by «advanced biofuels» with emission reductions of at least 50%.[12] Bioethanol made from sugar cane qualifies for this, according to the USA's Environmental Protection Agency (EPA), but not biofuel made from maize, which is currently America's biggest source of bioethanol.

[9] EMPA (Eidgenössische Materialprüfungs- und Forschungsanstalt), LCA of energy products, 2007

[10] as footnote 1

[11] GTM Research, Biofuels 2010: Spotting the next wave, Dec 2009

[12] www.epa.gov/renewablefuels

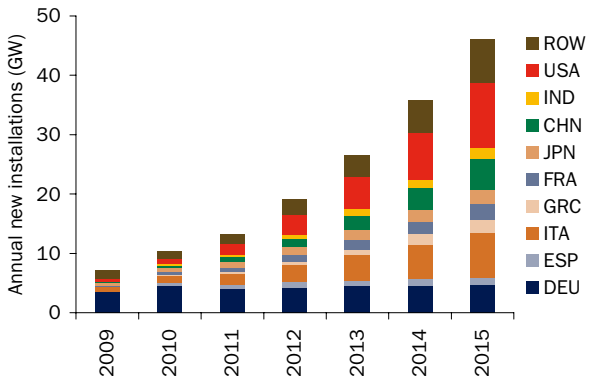
Market outlook

Falling prices in the PV industry have weakened companies' profitability, but at the same time helped to cushion the announced cuts in government subsidy programmes and quickly make photovoltaics competitive again. We expect volume to go on rising and forecast average annual growth in newly installed PV capacity of 35% up to 2015, resulting in a cumulative capacity of 170 GW. For the wind power industry over the same period we expect average growth of 13% p.a. leading to a cumulative capacity of 500 GW. Including geothermal energy (total capacity 18 GW) and ocean power (2 GW), renewable energies will further increase their share of the power generating market by 2015. In the transport sector, environmentally friendly and socially compatible biofuels of the second and third generation should achieve a market share equivalent to more than 10% of petrol and diesel consumption by 2020.

PV industry growing strongly

Although the PV industry faces major uncertainties regarding future government subsidies, the simultaneous price fall has rapidly improved the competitiveness of solar power. In certain countries such as Italy or California, grid parity (the point at which self-generated photovoltaic electricity becomes competitive for the end-customer compared with grid power price) will be achieved as early as 2012. Due to continuing pressure on margins, the solar market as a whole remains competitive and the industry will undergo further consolidation and rationalisation. Technological advances will further reduce costs.

Fig. 18: PV market forecast up to 2015 (GW)



Source: Bank Sarasin, Aug. 2010

We therefore anticipate strong growth for the PV industry over the coming years, with newly installed capacity increasing by an average of 35% p.a. Newly installed module capacity should therefore reach approximately 46 GW by 2015 (Fig. 18). This amounts to a cumulative PV capacity of 170 GW.

Short-term outlook

The figures published by the solar module manufacturers for the first two quarters of 2010 mostly contained positive surprises. Sales climbed sharply. At the world's largest PV conference and trade fair, Intersolar in Munich, the industry expressed great optimism for the second half of the year. The module manufacturers announced that demand remained strong, despite the 16% tariff reduction which is planned to take effect in Germany by 1 October 2010. The German solar market is set for another record year, with more than 5 GW of newly installed capacity. Demand is also strong this year in other European markets such as Italy, France, the Czech Republic and Greece. For the whole of 2010 we expect global growth of 48%, corresponding to newly installed capacity of 10.6 GW.

Demand continues to be driven by the still attractive returns achievable with PV installations in the countries mentioned. Investors have an insatiable appetite for these low-risk investments. However, the strong demand is greatly accentuated by pre-emptive effects, not least in the biggest market of Germany, due to the further reduction of feed-in tariffs expected next year. We therefore expect worldwide growth to ease to 26% in 2011. The declining momentum of the German market will to a large extent be offset by booming non-European markets such as China, Japan, South Africa and the USA.

The competitive disadvantage of European manufacturers compared with Chinese cell and module producers is di-

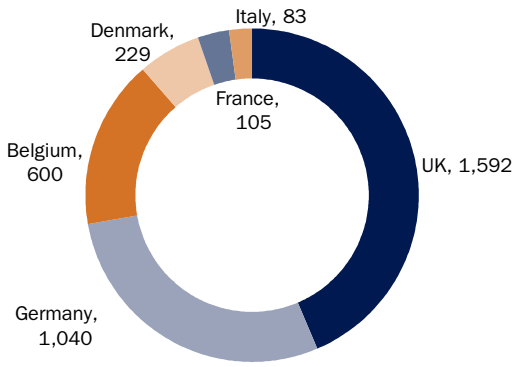
minishing due to the weak euro. Module prices could increase by around 5% in the third quarter as a result. The European PV companies are also likely to reduce the price differential compared with their Asian counterparts through further cost-cutting measures. However, margins will remain under pressure in the medium term. Solar modules will soon be sold for an average of 1.2 EUR/Wp. In other words, a vertically integrated cell/module manufacturer with total costs of 1.0 EUR/Wp could achieve a gross margin of around 17%.

Wind energy: more moderate growth in a maturing industry

Offshore wind as a key driver in Europe

0.6 GW of new wind energy capacity was installed offshore in Europe in 2009. This corresponds to around 6% of new installations. Offshore installations will increase to at least 1 GW in 2010. According to the European Wind Energy Association (EWEA), offshore wind farm projects of around 3.5 GW are currently under construction (Fig. 19). Siemens is the largest supplier of offshore turbines with a market share of over 70%, followed by Vestas with around 20%. The next generation of such wind turbines will have a capacity of 5 to 6 MW and mostly work without gearbox.

Fig. 19: Offshore wind farms under construction (MW)



Source: EWEA (Jan. 2010), Bank Sarasin

In the long term, offshore wind projects of nearly 100 GW are planned in Europe. Once these come on stream they could meet around 10% of European electricity demand. By 2020, some 40 to 55 GW will be connected to the grid. As well as the necessary expansion of the grid, more and larger crane vessels will be needed. As a result, installation capacity will increase by 50% as early as 2011.

In April the US authorities approved a first offshore wind farm with a capacity of 0.42 GW on the East Coast. This could trigger the construction of at least six more offshore wind farm projects with a total capacity of 2.0 GW.

Strong expansion of wind capacity in China

By the year 2020 the Chinese government plans to meet around 15% of its electricity needs through renewable energies and nuclear power. This objective means huge growth potential for wind energy in particular. In addition, EUR 45 billion has already been invested in increasing the transmission capacity of the power grids, so as to connect the wind-rich areas more effectively with the industrial centres in the south-west of the country. This previously posed an obstacle to the further expansion of domestic wind energy.

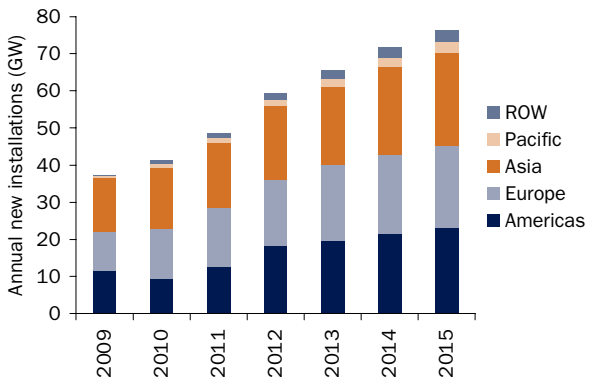
USA needs further incentives

Sustainable growth of the US wind market demands either higher electricity and gas prices or further legal regulation such as a country-wide RPS. Since 2008 gas prices have fallen by 65%, making wind energy far less competitive. At the same time, many utilities have largely fulfilled their obligation to expand renewable energies in line with the RPS in several American US states. Although grants are already available under the green stimulus packages, growth of the US wind market is set to weaken over the next two years.

Wind energy to reach a total of 500 GW by 2015

We therefore expect the average annual rate of growth for newly installed wind energy capacity to ease to around 13% by 2015. This means that new capacity of 76 GW will be installed in 2015, bringing the global wind power capacity in operation to over 500 GW. By then the three biggest markets of America, Europe and Asia will all be achieving annual figures of 22 to 25 GW. US growth will only begin to grow with a certain delay to the other markets from 2012 onwards.

Fig. 20: Wind energy market forecast up to 2015 (GW)



Source: Bank Sarasin, Aug. 2010

Ocean power

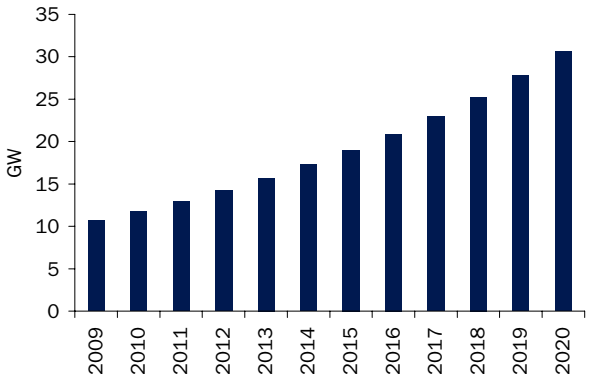
A roadmap recently published by the European Ocean Energy Association shows how installed ocean energy could reach 3.6 GW by 2020. By 2050 it could be as high as 188 GW.[13] This equates to 15% of Europe's future electricity requirement. Globally the potential exists for annual production of 750 to 2000 TWh, or 10% of worldwide electricity demand. Though at an early stage of development, ocean power could develop in a similar way as wind energy becoming a major pillar of a new energy industry.

The UK in particular is making great efforts to remain at the forefront of ocean energy development. In the spring of this year the government granted licences for the construction of ocean energy plants at 20 coastal locations, for which about a dozen companies had bid, including Scottish Power (Iberdrola), Scottish & Southern Energy, E.On and Pelamis Wave Power. It will cost EUR 6 to 12 million to develop the projects. With the right financial support, some 1000 MW of ocean power capacity could be installed around the coast of Great Britain by 2020. Approximately 5 MW is currently in operation.

Geothermal

Geothermal energy currently seems to enjoy growing support from the financial industry. Several geothermal projects in countries such as Australia, China, Germany, Iceland, Italy, Japan and the USA are supported through funding, technological assistance, training or geological investigation. Despite the growth trend, the potential of geothermal sources appears to be under-exploited. GEA has identified 39 countries worldwide which have the potential to meet 100% of their electricity needs through geothermal plants. The forecast of the International Geothermal Association (IGA) that cumulative capacity will reach approx. 18.5 GW by 2015 is in line with our expectation of around 30.6 GW by 2020.

Fig. 21: Worldwide geothermal forecast (cumulative)



Source: Geothermal Energy Association, Bank Sarasin, Aug. 2010

Biofuels

The critical conclusions reached in our last sustainability report on biofuels[14] have been clearly borne out. In view of the limited availability of arable land and their doubtful environmental benefits, first-generation biofuels have limited potential as a fossil-fuel substitute, either now or in the future. The only exception is bioethanol made from Brazilian sugar cane, which meets the sustainability criteria of the main consuming countries and, thanks to low production costs, is already profitable.[15]

Second-generation biofuels will start to be commercially produced in 2012 at the earliest. A quarter of agricultural and forestry residues will be enough to meet 10% of fuel consumption with cellulosic ethanol by 2030. But first it will be necessary to develop more efficient processes.

Production of biofuels from algae may also have considerable potential: if large-scale production can be realised and the anticipated high yields per hectare achieved, then algae-based biodiesel could be available on the market from 2016 onwards and account for one third of biofuel production by 2022.[16]

[13] www.eu-oea.org; European Ocean Energy Roadmap 2010 - 2050

[14] "Biofuels – transporting us to a fossil-free future?", Bank Sarasin, July 2006

[15] OECD/IEA, Sustainable Production 2nd-Generation Biofuels, Feb. 2010

[16] GTM Research; Biofuels 2010: Spotting the next wave, Dec. 2009

These new technologies therefore show considerable promise. On the whole, though, biofuels are currently fraught with too many uncertainties: apart from question marks over the technical, economic and environmental viability of future biofuels, new competition is emerging due to the development of electric vehicles. Moreover, the raw material and product prices on which the profitability of biofuels depends are subject to large fluctuations. For example, until 2008 Brazil's biofuel industry grew by around 9% p.a. and exported large quantities to Europe and the USA. However, last year exports of bioethanol from Brazil to the EU dropped by 50% due to the high price of sugar cane.

Renewable energies gearing up to a new level

The world economy will return to growth in 2010, expanding by over 4%. As a result global energy demand will also rise, particularly in developing countries. The oil disaster caused by BP and Transocean has once again drawn attention to the environmental risks entailed by fossil fuels. This is likely to delay deep-sea oil exploration and increase the upward trend of oil prices. By 2011 the oil price could again increase to well above USD 100 per barrel. This would provide a further boost for renewable energies.

Maturing of the renewable energy industry

This means long-term market growth for the renewable energy sector. At the same time, though, the high margins and turnover growth seen in the past will tend to move closer to those of the traditional industrial sectors. Falling prices mean that the industry's dependence on subsidies and energy-policy objectives will steadily diminish. This will allow market growth to stabilise.

Long-term vision: 100% renewable power generation

In the long term there is no alternative to renewable energies. A study by the European Climate Foundation[17] involving European electricity companies and grid operators has produced a scenario for climate-neutral power supply. It suggests that all power in Europe could be generated from renewable resources by the year 2050. This would allow fulfilment of the national and international treaties under which industrial countries have to reduce their CO_2 emissions by 80 to 95% by 2050 in order to limit global warming to 2°C. The study also shows that this progressive scenario will not be significantly more expensive than continuing to generate electricity by conventional means with fossil fuels and nuclear energy.

A new study by the European Renewable Energy Council (EREC) even concludes that all energy production could be switched to renewables by 2050.[18] This would also have the advantage of reducing Europe's dependence on energy imports: Europe currently imports more than 55% of its energy needs. By 2030 Europe will be importing 80% of its natural gas, 60% of its coal and 94% of its crude oil. Expansion of renewable energies can be partly financed through lower consumption of increasingly expensive imported fuels, while at the same time creating new jobs.

[17] www.roadmap2050.eu; Roadmap 2050 – a practical guide to a prosperous, low-carbon Europe, European Climate Foundation, ECF, 2010

[18] www.rethinking2050.eu; A 100% Renewable Energy Vision for the European Union; EREC, European Renewable Energy Council, April 2010

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