Photo: Roger Huyssen/Corbis

Solar power in growing pains

The global market for solar cells is growing explosively, mainly thanks to lavish subsidy schemes. Is solar power the wave of the future – or is its success based on 'misguided political intervention'?

by Annemieke van Roekel

The production of solar cells across the globe is experiencing unprecedented growth. In 2007 production increased by 70%, as opposed to an average of 40% in previous years. Today, the installed worldwide capacity amounts to 10 GigaWatt-peak (GWp). Although this is still only about 10% of installed wind power in the world, the other good news is that the price of solar power is still going down. 'In about ten years' time, the price of solar will equal the price consumers pay for conventionally generated electricity,' says Paul Wyers, unit manager of Solar Energy at the Energy research Center of the Netherlands (ECN). 'Prices drop 20% with each doubling of cumulative production capacity.'

Wyers estimates the generation costs of solar electricity today at fifty eurocents per kilowatt hour (kWh) in northern Europe. If the current price trend continues, the price of one kWh of solar power in northern Europe will be around 20 eurocents in 2020, equal to the average price consumers in Europe pay for electricity today. 'In southern Europe, where thanks to the sunny climate the efficiency of solar cells is twice as high, this break-even point will already be reached within the next few years', says Wyers.

Kees van der Leun, board member and solar expert of the Dutch total solutions provider Econcern, says that solar energy is growing much faster than most policymakers and analysts realise. 'The most recent World Energy Outlook of the International Energy Agency has a solar target for 2020 which actually will already be reached next year. They doubled their target compared to a year earlier, but they are still way behind the reality.'

Expensive

The growth of solar power does come at a price. Consider Germany, the world's great solar success story. The country accounts for about half of the solar power capacity in the world, thanks to its Renewable Energy Act (Erneuerbare Energien Gesetz, EEG), which guarantees producers a fixed price for twenty years. This feed-in tariff is lowered each year. Thus, producers who have joined the system later, receive a lower subsidy, although the amount is maintained at the same level for the entire period of twenty years. Until recently, the tariff was lowered by 5% on average each year, but last summer the government decided to lower the rates by 8% in 2009 and 9% from 2010 onwards.

This decision did not come out of the blue. The costs of the German subsidy system have been rising rapidly and criticism has been growing. Economists at the research institute RWI (Rheinisch-Westfälisches Institut für Wirtschaftsforschung) in Essen have recently come to the conclusion that the German system of financing the photovoltaic (PV) sector amounts to 'misguided political intervention' and that 'producing electricity on this basis is among the most expensive greenhouse gas abatement options'.

The German consumer will pay about €26,5 billion in subsidies for the PV modules installed on German roofs between 2000 and 2007. If the rates remain as they are now, this amount will grow to €53 billion at the end of 2010.

In 2006, 20% of the German budget for renewables went to solar PV, which supplied only 3% of the total amount of sustainable electricity and 0.4% of total

Oil companies pull out

Specialised PV companies like Q-cells, Suntech Power, First Solar, Motech and SolarWorld, have come to dominate the top 10 of worldwide solar cell production. 'A clear trend towards specialisation can be seen among the producers of solar cells,' says Paul Wyers of Energy research Center of the Netherlands (ECN). 'The size of the market now makes it possible for a company to exist on the basis of solar power alone.'

German Q-cells has supplanted the Japanese diversified electronics firm Sharp as the world's largest solar cell producer, becoming the first PV specialist and European company to do so. The advantage of the specialists is that they can quickly seize opportunities in the market, says Wyers. The role of oil companies as producers of solar cells is on the wane. According to Wyers, they tend to be too slow and have not been able to keep up with developments. BP Solar, with factories in Spain, the US and Australia and a joint venture with Indian Tata, is probably the most active oil company on the PV market, although the company has dropped out of the top 10 producers. French Total concentrates on the rural market with stand-alone (off-grid) systems. Shell has largely pulled out of the PV market. According to Jan van der Eijck, chief technology officer at Shell, the company has chosen second-generation biofuels and wind energy (particularly onshore in the US) as priorities in the renewable energies market. 'We have opted for activities that are widely supported within the organisation,' says Van der Eijk by way of explanation. One of the few remaining solar activities of Shell is the CIS thin-film factory which it is building in the German town of Torgau in a joint venture with French glass producer Saint-Gobain. In Japan, Shell-subsidiary Showa Shell Sekiyu produces CIS solar cells for the Japanese market. Shell some years ago stopped producing crystalline solar cells, because, according to a spokesman, the company anticipated steep price rises of silicon.

electricity. Wind energy, which provides half of the sustainable power and 7.4% of the total, got 50% of the subsidy budget. The feed-in tariff for one kWh of solar power for roof systems in 2007 was 49.2 eurocents, for wind power 8.5 eurocents.

The RWI researchers doubt whether it is wise to so heavily subsidise a technology that cannot yet compete with conventional electricity. 'Subsidised market penetration of non-competitive technologies in their early stages of development diminishes the incentives to invest in the research and development necessary to achieve competitiveness,' says the report.

Furthermore, a regressive feed-in tariff rewards the 'hasty' installation of a technology that is not yet profitable enough, argues RWI. Nevertheless, according to Manuel Frondel, chief environment and resources at RWI, 'the sum invested in R&D by the PV industry during the past seven years has increased seventeen-fold' to €176 million euros in 2007, whilst total government spending on R&D for all renewables during that same period increased by one-fourth, from €156 million to €205 million in 2006. 'This considerable increase is clearly an indirect result of the substantial funding under the EEG regime', Frondel says.

Price drop

One uncertainty looming over the solar power industry is whether prices will continue to drop. It is generally assumed that prices drop 20% for each doubling of production of photovoltaic cells. This happened in the US, but in Germany prices fell by only 15% after a doubling of production. Prices for roof mounted modules fell 33% over the past decade until 2006 – to €5400 per kW. Recently, however, prices of modular systems have stagnated. The German Ministry of the Environment (BMU) ascribes the price stagnation to a shortage of raw materials and possibly also to the too favourable subsidy regime.

Detail of solar power panel. Photo: Solland Solar

But according to Van der Leun of Econcern, which is active in both the prodution of solar panels and of silicon, there is some good news here too. He expects consumer prices of solar PV to drop 20% in 2009 compared to 2008. 'What we have seen is that cost reduction has continued steadily at a rate of 7 to 10% per year. However, as a result of the shortage of silicon, end users did not profit from these lower costs. Now that the silicon shortage is more or less over, we will see a real drop in prices for the end user.'

To cope with the scarcity and high cost of silicon, the industry has been looking for ways to replace crystalline silicon with thin film technology. In the long term, the cost of thin films is expected to be lower than that of crystalline silicon. More than one hundred companies worldwide are currently active on the thin films market, of which more than twenty are located in Germany. 'Last year for the first time conventional solar cells lost market share to thin film technology, which now constitutes 10% of the total market,' says Wyers. Unlike crystalline silicon cells which consist of sliced wafers of silicon that generate electrical power under the influence of light, thin films consist of a very thin light-sensitive layer applied directly onto a substrate (e.g. glass, plastic or steel). The most important thin film technologies are CdTe (cadmium telluride), CIGS (copper indium gallium

disulphide/diselenide) and amorphous and microcrystalline silicon.

Most PV stations with CdTe technology in Europe can be found in Germany, such as in Dimbach (1.4 MWp) and Mombach (580 kWp) and the world's biggest one in Waldpolenz near Leipzig (40 MWp), that will be fully operational this year (2009). The solar cells are supplied by the American company First Solar, which specialises in CdTe and is the largest player on the market for thin films. The largest European CIGS station to date was opened last autumn in Albacete in Spain.

The conventional mono- and multicrystalline silicon solar cells still account for 90% of the market. Although crystalline silicon is considered a mature technology, the PV industry is working continuously to improve its efficiency to reduce costs. The efficiency of multicrystalline cells is approximately 15-16%, Wyers explains. Monocrystalline silicon cells have an efficiency of between 16% and 20%. Under laboratory conditions the efficiency of crystalline silicon solar cells can exceed 20% but that says little about their performance in industrial applications.
Some crystalline silicon cells achieve a higher efficiency, such as the HIT cell (Heterojunction with Intrinsic Thin layer), produced by the Japanese company Sanyo. Organic solar cells, made with synthetically manufactured flexible chains of carbon molecules (polymers), still have a long way to go before they become marketable. Some thirteen years of work have now gone into this technology. Production costs of organic cells could be low, but so is their efficiency at the present time.

The PV industry has also consistently tried to reduce its use of raw materials. Solar cell manufacturers have succeeded in halving the thickness of the silicon layer to less than 200 micrometres (a micrometre is one-thousandth of a millimetre) and they believe it can be reduced even further. Some 60% of the pure silicon is still lost during production when large silicon blocks are cut into thin wafers, says Wyers. ECN is currently working together with German SolarWorld and Dutch Sunergy Investco to further develop the RGS process (Ribbon Growth on Substrate), in which melted silicon is moulded directly into the shape of wafers, keeping the loss of silicon to a minimum.

According to Wyers there simply is no PV technology that can be classified as most promising. 'It is important to develop different technologies in parallel. Cost reduction is an ongoing process, but R&D alone is not enough to accomplish that. Implementation and volume increases are also required to reduce costs.'

'There simply is no PV technology that can be classified as most promising'

Too attractive

Like Germany, Spain has recently reduced the subsidies for solar power. The feed-in tariff was reduced from 45 cents per kWh to 34 cents for roof systems and 32 cents for ground systems. The new law limits the maximum capacity for roof systems to 2 MW and for ground-based solar PV arrays to 10 MW. There is an annual maximum of 500 MW of new capacity. The agreement was well received after a period of uncertainty that had threatened to paralyse the sector. Van der Leun says that feed-in tariffs in Spain were 'too attractive' and are now better in line with market requirements, but he feels that the annual cap discourages investments.

Over the past few years substantial feed-in tariffs have been introduced elsewhere in Europe as well, for example, in Italy, Greece, France and Flanders, countries in which the solar market has started to take off. In Turkey, subsidies are expected to be raised substantially in 2009. Both Portugal, with its extremely favourable sun regime, and the Netherlands subsidise solar power, but these countries have set strict limits on the size of individual projects. In addition, the Netherlands has a collective ceiling of only 18 MWp per year, increasing to 25 MWp in 2011, a fraction of the Spanish limit. 'This is one reason why the market doesn't grow very fast in the Netherlands,' says Joke Wessels of the Dutch trade organisation Holland Solar. 'Producers prefer to deal with countries where large projects can be built quickly and feed-in tariffs are favourable, such as in Germany and Spain.'

According to Gosse Boxhoorn, until recently chief executive of the German-Dutch producer Solland Solar, the success of the German PV market is owing not so much to the level of the subsidies, but even more to the consistency with which the German government has pursued its policy. He is convinced, moreover, that a successful market can only come into being if research is carried out in the vicinity of the production factories. 'You see this strong combination in Germany, in Japan, and increasingly also in China and Korea. Countries like Germany, but also Spain and France, pursue a strong industrial policy, which benefits domestic companies at the expense of foreign competitors.'

The researchers of RWI, however, point out that a large part of the German subsidies flow to Asian countries, since Germany imports at least half of its modules, particularly from Japan and China. According to Frondel, the world's leading PV module producer, China's Suntech Power, almost solely depends on Germany's subsidisation regime. RWI claims that the positive effects of German renewable energy policy on employment are exaggerated. Although it is estimated that 40,000 people now work in the PV sector, most of the employment involves a shift of jobs from one sector to the other, rather than new jobs. ■