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the broader market in 2013.

### 25 February 2014

# H1 2014 CLEAN ENERGY POLICY & MARKET BRIEFING

Clean energy in 2013: Costs sink along

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### with investment The global clean energy sector finished 2013 near or at parity with conventional fossil sources in more locations than ever. Yet the next wave of market penetration is proving to be uneven, as some national governments reduce their financial support for the sector. The industry enters 2014 having worked off some excess

photovoltaic production capacity, and its publicly traded companies outperformed

- Global new investment in 2013 in clean energy, including renewables, biofuels and 'energy smart technologies' such as efficiency, smart grid and electric vehicles, was \$254bn - 11% less than the \$286bn recorded in 2012. The decline was due both to falling technology prices and reduced government subsidisation.
- Performance varied widely by geography, with Japan and Europe at the extremes. Low carbon investment in the former surged 55% to \$35.4bn in 2013, while in the latter it endured a 41% slump to \$57.8bn.
- China installed a record 12GW of PV in 2013, and a December push may have taken the total past 14GW. Prior to that feat, no country has ever added more than 8GW of solar power in a year.
- Asset finance of utility-scale renewable projects in 2013 fell 14% to \$133bn worldwide, a consequence of receding subsidies in Europe and the rapidly falling cost of generation hardware.
- Last year was the best for clean energy equities since 2007. The WilderHill New Energy Global Innovation Index (NEX), which tracks global clean energy stocks, leapt 55%.
- The US proposed for the first time limits on power-plant greenhouse gas emissions that effectively require new coal-fuelled generating units to incorporate carbon capture and storage.
  - China set aggressive renewable energy targets for 2014: 14GW of solar PV capacity (of which 8.4GW is to be distributed projects), 20GW of hydro and 18GW of wind.
- A new European Union energy and climate policy framework seeking a 27% renewables share of final energy consumption was proposed. The framework's release is likely to start a long negotiation process.
- Greater balance of technology supply and project demand contributed to modest increases in the levelised cost of energy for solar photovoltaics and wind entering 2014.
- The market for operation and maintenance services on existing wind turbines, which was 15% of the total market for turbine sales in 2012, is expected to increase to EUR 10.7bn, or 20% of the total market for turbine sales, by 2016.
- A continuing production capacity overhang in electric vehicle batteries and slow growth in biomass and geothermal development drove declines in those technologies' levelised costs of electricity (LCOE).

Prepared by Bloomberg New Energy Finance for the Clean Energy Solutions Center. an initiative of the Clean Energy **Ministerial** 

#### INVESTMENT 1.

Global new investment in 2013 in clean energy, including renewables, biofuels and 'energy smart technologies' such as efficiency, smart grid and electric vehicles, was \$254bn, 11% less than the \$286bn recorded in 2012. The investment record for clean energy remains 2011's \$318bn.

The reduced investment in 2013 reflected two main influences: a continued sharp reduction in the cost of photovoltaic (PV) systems and the impact on investor confidence of shifts in policy towards renewable power in Europe and the US.

The taper of investment occurs at a pivotal time. According to Bloomberg New Energy Finance's latest levelised cost of electricity (LCOE) assessments, best-in-breed onshore wind generation has arrived near cost parity with coal in Australia, Europe and the US, while the best PV's levelised cost still cannot compete with coal or nuclear in most of the industrialised world.

In contrast to the investment declines, values of low-carbon stocks soared on public markets last year, driven by investor belief that the sector's wave of overcapacity-driven consolidation is receding.

Year-on-year comparisons diverged markedly on a geographic basis. Investment in Japan's lowcarbon sector surged 55% to \$35.4bn in 2013, from \$22.7bn in 2012, while Europe experienced a 41% slump, from \$97.8bn in 2012 to \$57.8bn last year. Japan's boom was driven largely by smallscale solar installation, as the country struggles to fill the supply gap left by its shuttered nuclear plants. In Europe, major economies Germany, Italy and France either restricted subsidy payments for new projects or failed to assuage investor uncertainty over future support.

The two biggest investing countries, China and the US, both saw their dollar commitments fall in 2013. China invested \$61.3bn in clean energy last year, 3.8% less than the \$63.8bn in 2012. The US saw investment slip a more significant 8.4%, from \$53bn to \$48.4bn.

A simple comparison of annual investment totals fails to paint the full investment picture, however. In spite of its smaller financial outlay, China installed a record 12GW of PV systems in 2013, and a December push may have taken the total past 14GW. Prior to that feat, no country has ever added more than 8GW of solar power in a year.

### Figure 1: Global new investment in clean energy by region, 2004-2013 (\$bn)







Source: Bloomberg New Energy Finance Note: Adjusted for re-invested Source: Bloomberg New Energy Finance equity. Does not include proceeds from acquisitions. Totals may differ from text due to rounding.

Year-on-year comparisons diverged markedly on a geographic basis

6 1.8 <sup>2.0</sup> <sup>2.4</sup> <sup>2.1</sup> 1.9 1.8 <sup>1.9</sup> 1.21.4 1.6

2011

2013

2012

### 1.1. Asset finance and venture capital/private equity

As in most years, asset finance of utility-scale renewable projects represented the largest overall percentage of clean energy investment in 2013. The full-year total of \$133bn was 14% less than 2012's \$155bn, a consequence of receding subsidies in Europe and the rapidly falling cost of renewables generation hardware.

Among the projects financed in H2 2013 were the 100MW Eskom Upington solar thermal plant in South Africa, which obtained an \$818m term loan and the 267MW Tucannon River Wind Farm in Washington State. It captured \$535m of developer balance-sheet financing.





Source: Bloomberg New Energy Finance. Note: Total values include Source: Bloomberg New Energy Finance. Note: Total values include estimates for undisclosed deals. Figures from prior periods have been estimates for undisclosed deals. Figures from prior periods have been revised to reflect new data. Small distributed capacity excluded.

revised to reflect new data.

01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04 01 02 03 04

-Four quarter running average

2010

2008 2009

Venture capital and private equity investment in clean energy was \$4.4bn in 2013 versus \$6.3bn the previous year. The decline in VC/PE financing, which the US historically dominates, represents a troubling potential trend for the industry that needs constant investment in the newest technologies to produce future cost reductions.

2007

2006

0.6 0.3 0.3 0.6 0.7 0.4 0.7 1.1

2005

2004

Bloomberg New Energy Finance recorded 149 low-carbon VC/PE completions in H2 2013. Among the largest venture capital deals was \$50m raised by Massachusetts-based biodiesel technology company Joule Unlimited in a \$50m Series D round. Achates Power Inc., a California-based developer of efficient, light weight clean diesel engines raised \$35.2m in a Series C round. WiTricity, which is developing power transmission devices in Massachusetts, raised \$25m in Series E funding.

### 1.2. Small-scale financings

Global investment in new small-scale distributed capacity fell 25% in 2013 to \$60bn marking the first decline in this investment segment since 2007. Thanks to declining technology costs, however, smallscale installations as measured in nameplate capacity fell by a substantially smaller percentage. Bloomberg New Energy Finance, using mid-range estimates for the installation of distributed solar capacity in 2013, estimates that worldwide installations declined 4.5% from the previous year, to 18,438MW. (BNEF will publish final capacity edition totals for 2013 in March 2014).

Figure 4: Global venture capital and private equity investment in clean energy, Q1 2004-Q4 2013 (\$bn)



#### Figure 5: Clean energy financings by asset class Q1 2004-Q4 2013 (\$bn)

Source: Bloomberg New Energy Finance. Note: Small distributed capacity category consists primarily of financings for small-scale residential or commercial PV systems. Red line indicates trailing four-quarter average investment level. Note: quarterly totals do not include some financings included in the global. Total values include estimates for undisclosed deals. Excludes corporate and government R&D, and spending for digital energy and energy storage projects (reported in annual statistics only).

### 1.3. Public markets

Last year was the best for clean energy equities since 2007. The WilderHill New Energy Global Innovation Index (NEX), which tracks the valuations of clean energy stocks traded on markets around the world, recorded a 55% jump. Three US-based companies led the top performers: solar manufacturer SunPower, distributed solar financier/installer SolarCity and electric vehicle maker Tesla Motors. European wind turbine manufacturers Vestas and Gamesa rounded out the top five.

#### Figure 6: Global public market new investment in clean energy, Q1 2004-Q4 2013 (\$bn)



Figure 7: WilderHill Global New Energy Innovation (NEX) Index vs. MSCI World & Emerging Index, 2013



Source: Bloomberg New Energy Finance. Note: Market data as of 2 January 2012. Indexes rebased to 1,000 at 1 January 2013.

Source: Bloomberg New Energy Finance

A trio of technology-focussed low-carbon indexes also prospered. The NYSE Bloomberg Global Solar Index was up 71.6% as solar issues rebounded from historic lows. The NYSE Bloomberg Energy Smart Technology Index gained 51.7% as Tesla nearly guintupled its market capitalisation, from \$4bn to near \$19bn. The NYSE Bloomberg Global Wind Energy Index finished the year up 43.5%, with manufacturers booking healthy order volumes as the industry geared up for growth in the next couple of years.

### 2. POLICY

China, India and the European Union reaffirmed and strengthened technology targets and fiscal support for containing the growth of emissions during the second half of 2013. Meanwhile the US focussed on power plant regulations, which could indirectly benefit renewable energy development. Governments in developing world nations in Latin America and Asia accelerated adoption of reverse tenders, or auctions, as a market-based means of growing their clean energy portfolios.

### 2.1. AMER

The US Environmental Protection Agency proposed for the first time limits on power-plant greenhouse gas emissions that effectively require new coal-fuelled generating units to incorporate carbon capture and storage. Separate standards for natural gas would promote the ongoing proliferation in the country of combustion turbine power plants burning that fuel.

With the arrival of 2014, a number of US tax code provisions benefiting low-carbon energy expired. Among them: the Renewable Energy Production Tax Credit (PTC), the Business Energy Investment Tax Credit (ITC), the '48C' Advanced Energy Manufacturing Tax Credit and incentives for energyefficient residences, commercial buildings and appliances. While each has been extended by Congress in years past, such an outcome is less assured this year due to efforts to rein in federal deficits and rising policy sentiment against technology-focussed subsidisation.

One example is a December 2014 proposal by the chairman of the Senate Finance Committee, Max Baucus, to overhaul energy tax incentives. Baucus's blueprint would replace technology-focused schemes with two benefits: a clean electricity tax credit and a clean transportation fuel tax credit. Their size would be determined by the degree to which a creditable activity emits fewer pollutants, on a lifecycle basis, than do conventional generation and fuels. The task of shepherding tax-code changes through Congress must fall to other lawmakers, however, because Baucus this year will leave the Senate to become the next US ambassador to China. Baucus's successor, Ron Wyden, Democrat of Oregon, has suggested that he will take a more comprehensive approach to tax reform.

Two provinces of Canada maintained momentum on clean energy policymaking. The Ontario government in October announced plans to create green bonds to finance low-carbon infrastructure projects as early as this year, subject to the passage of necessary legislation. Hydro-Québec, that province's power provider, in December issued a call for tenders of 450MW of wind power to come online before 2018.

Brazil conducted four reverse auctions for clean power between August and December 2013, contracting 7,108MW in new capacity from project developers. Wind captured more than half of the solicitations, 4,673MW. Other technologies contracted were large hydro (1,100MW), small hydro (526MW) and biomass (809MW). Deliveries are to commence between 2015 and 2018.

As of year-end 2013, six new wind turbine manufacturing projects gualified for low-interest financing from development bank Banco Nacional de Desenvolvimento Economico e Social (BNDES) by virtue of meeting the country's local-content requirements. The six – Acciona, GE, IMPSA, Alstom, Wobben and Gamesa - agreed to domestic-production preferences for blades, towers, nacelles and hubs.

Pursuant to Brazil's Inova Energy Plan, in November 61 projects were selected to receive \$1.5bn to support business development for innovative R&D projects in low carbon 'themes.' Thirty-seven of the projects fit the smart grids and transmission theme; 14 qualify under the renewable energy theme; the

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**Brazil conducted four** clean power tenders between August and December 2013

**Policies exercised** included technology

targets, fiscal support

and tenders for power

Mexico began setting fossil taxes based on carbon content

remaining 10 apply to alternative and efficient vehicle-related projects. INOVA is financed by BNDES, Brazil innovation finance body FINEP and electricity regulator ANEEL.

Mexico in November 2013 approved a tax bill that sets levies on the sale and import of fossil fuels based on their carbon content. The baseline fuel against which carbon content is to be determined is natural gas, which is exempt from the tax. Mexican companies will be able to use UN offsets to cover all or part of their tax liability; further regulation must be developed to establish the tax rate and mode of collection.

On 20 December 2013, Mexico enacted reforms of the oil & gas and power sectors allowing for participation by private companies via production-sharing and licensing agreements. The reforms constitute the end of a seven-decade monopoly of Mexico's petroleum sector by state-owned Pemex.

On the power side, the reforms open a way for the participation of private generators, ending the monopoly of state-owned integrated utility Comision Federal de Electricidad (CFE). Grid operation will be transferred from CFE to a newly created independent grid operator, who will guarantee open and non-discriminatory access to transmission and regulate a new wholesale power market. All generators, including CFE, are to compete for new power supply contracts. Assessing the impact on renewable energy project development awaits further clarification on contracts, tariffs and incentives, which is expected in secondary legislation.

Peru energy regulator Osinergmin on 12 December 2013 awarded contracts to 19 small hydro projects with a total capacity of 240MW. Despite official intentions, the auction failed to contract any biomass projects. On 12 September 2013, Peru announced its first off-grid renewable energy auction, which is to be concluded by 8 April 2014 with a goal of 500,000 distributed PV systems.

As of October 2013, Uruguay's UTE closed the acceptance of bids for its solar energy tender to contract up to 200MW of PV capacity on the national grid. Project capacities are divided into ranges: projects smaller than 1MW, projects between 1MW and 5MW and projects between 5MW and 50MW, with PPAs between 20 to 30 years. Tender winners have not yet been disclosed.

Chile on 14 October 2013 revised its renewable energy target upward, mandating that electric utilities with more than 200MW of operational capacity generate 20% of their electricity from renewable resources by 2025, up from 10% by 2024. The new target is valid for contracts established from 1 July 2013 onwards and sets interim targets up to 2025.

Biodiesel from Argentina was slapped with anti-dumping duties imposed in November 2013 by the European Union. The case was first brought to the European Commission in August 2012. In May 2013, the Commission set provisional duties ranging from EUR 65 to EUR 105 per ton. The final fiveyear duties set in November are more than twice as high, at EUR 217 to EUR 246 per ton. Following the duties imposition, the Argentine government increased the biodiesel blending mandate with regular diesel to 10% from 8% and made mandatory the use of biodiesel in the fuel mix for thermoelectric power plants.

On 22 September 2013, Guatemala's National Electricity Commission announced its 2nd Energy Auction, which is to contract 250MW of capacity under 15-year PPAs to supply distribution utilities DEOCSA and DEORSA. Eligible technologies include biomass, coal, diesel, large hydro, natural gas, small hydro, solar and wind, with deliveries to begin by May 2017.

On 27 September 2013, El Salvador opened a renewable power tender to contract 40MW of wind capacity and 60MW from solar, with deliveries to start by October 2016 and 2017, respectively.

### 2.2. ASOC

China's National Energy Administration (NEA) set aggressive renewable energy targets for 2014: 14GW of solar PV capacity - of which 8.4GW is to be distributed projects and 5.6GW is to be utility scale projects - 20GW of hydro and 18GW of wind.

Chile set a 20% renewables target for large electric utilities

## Most of China's 2014 solar target is to be met

with distributed projects

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NEA also made grid operators responsible for the necessary investment in transmission lines to connect the solar projects and ordered them to buy all the solar power produced in their regions until 2016.

In its annual Energy Work Meeting held on 13-14 January 2014, the NEA said that China would aim for a slower annual growth of 3.5% in total energy consumption in 2014, with a cap of 3,890 million tonnes of coal equivalent. In comparison, China's total energy consumption of 3,760Mtce in 2013 was 3.9% higher than in 2012.

Japan began addressing grid constraints on renewables development

Japan in November 2013 began the process of comprehensive electricity market reform for its JPY 15 trillion (\$150bn) retail power market. The first step is to establish a national grid operator to oversee supply-demand balance. The government has also started addressing grid constraints on the expansion of renewables. Specific tariff rates for onshore wind projects are in development, with disclosure expected in the spring of 2014.

Japan's Ministry of Economy, Trade and Industry (METI) committed to expend JPY 25bn (\$250 million) for a feasibility study of new transmission lines to serve two wind resource-rich areas in Hokkaido.

South Korea finalised its target for nuclear generation, setting an upper limit of 29% by 2035. It was lower than the target of 41% in 2008 but higher than the 26% decided in 2012. The government also decided to tax coal used for power generation, with an initial levy set at KRW 18/kg, and it cut the tax for liquefied natural gas and kerosene. South Korea is the world's second largest buyer of LNG and imports are used to meet almost all its energy needs.

Korea Exchange will begin carbon trading trials in August 2014, with the objective of a fully functional carbon market by January 2015. About 500 companies, including POSCO and Korea Electric, will eventually participate.

India introduced a subsidy of up to 30% of a clean project's cost

India launched the first tender of Phase II of its flagship Jawaharlal Nehru Solar Mission in October 2013. The auction for the first time will offer "Viability Gap Funding," which is a capital subsidy of as much as 30% of the project cost, and a fixed tariff of INR 5.45/kWh for 25 years. A total of 750MW of capacity will be contracted, half of which will have to use cells and modules manufactured in India.

Outside of the national solar mission, individual Indian states are pushing forward with their own solar initiatives. Madhya Pradesh in November 2013 solicited 100MW of tenders from developers to be selected through tariff-based competitive bidding. States including Andhra Pradesh, Kerala, Tamil Nadu and Uttarakhand have established net-metering policies for rooftop solar projects.

For wind, India announced that generation-based incentives restored from April 2013 would be offered to all projects commissioned after 31 March 2012 for which accelerated depreciation has not been claimed. The incentive itself is kept constant at INR 500/MWh, but the overall cap per MW has been raised from INR 6.2m to INR10m.

India's Ministry of New and Renewable Energy (MNRE) is working on a National Offshore Wind Energy Policy. India, with a coastline of 7,600 kilometres, has a large opportunity to develop offshore wind farms.

### Malaysia boosted the surcharge feeding its renewables fund by 60%

In Malaysia, the government raised the electricity surcharge from 1% to 1.6% as of 1 January 2014 to top up its renewable energy fund for future years. As of October 2013, Sustainable Energy Development Authority (SEDA) of Malaysia had approved 428MW of feed-in tariff projects since its FiT scheme started in late 2011. Of this, 119MW is for 2014 and 38MW is for 2015.

Indonesia's Ministry of Energy and Mineral Resources launched a solar auction on 31 October 2013, with an initial plan for 80 solar projects of 140MW, mostly in the east of the country. The auction policy, having a ceiling price of \$0.25/kW, was approved in June 2013. For projects using at least 40% locally sourced equipment, the ceiling is \$0.30/kWh.

**Europe's new climate** policy framework shakes up established business models

### 2.3. EMEA

A new European Union energy and climate policy framework, revealed on 22 January, shakes up the well-established business models and policy incentives for European renewable generation to 2030. If implemented as proposed, the framework would not extend binding national renewable energy targets beyond 2020. Instead, only an EU-wide target of 27% renewables share of the bloc's final energy consumption was proposed. The framework's release is likely to start a long negotiation process.

The UK enacted its Energy Bill, which includes the outline of the new "Contracts for Difference" - a form of market premium that will be available later in 2014, gradually replacing the current green certificate scheme - as part of its Electricity Market Reform. The law passed without a 2030 power sector decarbonisation target, despite two close parliamentary votes. In line with the EU's overall direction, the UK is introducing competition to the way it allocates renewable energy subsidies earlier than planned.

After a national debate, France is moving towards a new energy bill in 2014 that will revisit the choice of support schemes for renewables. In late 2013, the government unveiled a range of new energy efficiency incentives and a new carbon tax on fuels for transport and domestic heating. It also launched a tender for tidal pilot projects.

The new coalition government of Germany has made reform of its 'EEG' (Erneuerbare Energien Gesetz) renewable energy law a core priority for 2014. A November coalition agreement set out the direction of reforms. That document includes a suggested lower capacity target for offshore wind in 2020 of 6.5GW instead of the current 10GW, phase out of feed-in tariffs for large scale projects in favour of market premiums, lower overall remuneration levels for onshore wind, auctioning of support from 2016-17 and balancing responsibilities for renewable generators. The government intends for the reforms to become effective as early as 1 August.

In December 2013, Spain's Congress passed a power bill aiming to eliminate the so called 'tariff deficit' - the difference between power-system revenues and costs resulting from the governmentmandated subsidisation of ratepayers. The bill will be followed by secondary decrees determining the exact rules for the renewable energy sector. Under the July proposals, the projects would have their return level guaranteed at 300 basis points above the average yield on 10-year government bonds over a 10-year period.

Italy has opened up a market for power-purchase agreements, which should drive PV investment. With solar feed-in tariffs no longer available, small-scale projects can benefit from net metering and new income tax deductions. In December 2013, the government also allowed clean energy projects between 200kW and 20MW of capacity to sell electricity under bilateral contracts, which appears likely attract some PV investment to Europe's second-largest solar market.

The Netherlands revived offshore wind in a new energy agreement passed last autumn. It now aims to add 4.5GW of offshore wind capacity by 2023, having turned away from the technology in previous years due to cost concerns. The agreement also marks a retreat to a 14% renewable energy target for 2020, from the higher 16% committed to by the coalition government a year previously. It includes 10 pillars ranging from a limit on biomass co-firing and the closure of five old coal plants to incentives for distributed generation and a new energy efficiency fund.

#### **TECHNOLOGY** 3.

Record installations in China and robust growth elsewhere allowed the solar sector to narrow the gap between photovoltaic equipment manufacturing capacity and demand. Meanwhile, demand for wind turbines grew faster than supply in late 2013. Those developments, combined with a persistent surplus in electric vehicle battery production capacity and low growth in biomass, geothermal and marine deployment, contributed to mixed outcomes in comparative levelised cost of electricity costs as 2014 arrived.

Spain took steps to address its looming 'tariff deficit'

**Record installations in** China drew down an oversupply of PV components

**PV prices levelled off** while manufacturers improved efficiency

### 3.1. Solar

PV manufacturers in H2 2013 continued to boost efficiency via engineering improvements. For both multi- and monocrystalline silicon wafers, power yield increased while material consumption dropped. The average efficiency of cells produced from both types of wafers increased in the year ending December 2013, while the average polysilicon needed to produce them at year-end 2013 was 5.45 grams/Watt - 2.2% less than at the end of 2012.

Still, silicon prices began rising as 2013 came to a close, with polysilicon at the new year selling on average about 15% above the level of December 2012. Downstream manufacturers' concerns on even higher future price, and even a temporary undersupply, led to the sudden price rise.



Figure 8: Spot price of solar-grade silicon, Jan 2012-December 2013 (\$/kilogram)





submitted to Bloomberg New Energy Finance survey. Dates in chart ie, 8 August represents average for the week 8-14 August.

Source: Bloomberg New Energy Finance. Note: Average of all prices Source: Bloomberg New Energy Finance. Note: Dates in chart represent first day of the week over which the price has been averaged. Prior to the represent first day of the week over which the price has been averaged - weekly updates, the Index collected price of c-Si modules without differentiating between mono and multi crystalline silicon technology.

> System prices in the world's lowest-cost market for small-scale solar, Germany, rose slightly in the second half of 2013 after trending downward from the start of 2011. Despite that increase, German solar system costs remain lower than other solar-friendly jurisdictions, such as California and Japan (Figure 10). This is attributable to a larger and more-competitive base of installers in Germany and that country's longer experience with solar-system installations. Installed system prices in California and Japan continued to fall over the same period as their solar sector makes progress down the experience curve.

### **Global solar thermal** generation reached 3GW

The worldwide level of solar thermal electricity generation (STEG), in which solar energy is harnessed to produce steam, reached 3GW in 2013. STEG has become bankable, although dramatic breakthroughs in cost or performance are unlikely. While STEG's price premium over PV won't be eliminated, STEG offers some advantages: power output that is stable from minute to minute because the turbines continue to turn for a while when the sun is obscured by clouds, plus the possibility of longer term storage or hybridisation with fossil fuels to offer power that can be scheduled and dispatched by grid operators. New STEG projects were disclosed since mid-2013 in Chile, China and South Africa.



Figure 10: Small PV system costs in California, Germany and Japan, Q1 2008-Q3 2014 (\$/Watt)

### 3.2. Wind

Wind turbine design and production continues to make great strides in efficiency, output and reliability, and wind increasingly boasts the attributes of a mature generation technology. It is instructive to examine the operations and maintenance (O&M) of installed generators as a global gauge of the market.

At the outset of 2014, Bloomberg New Energy Finance analysed confidential contract data from 28 developers and service providers in Europe, the Americas and Asia except China and found prices for full-service O&M contracts rebounded in the first half of 2013 from lows in 2012. Such contracts signed between January and July 2013 increased 22% to EUR 20.8k/MW/yr, from a low of EUR 17.3k/MW/yr in 2012.

The market for O&M services, which was EUR 7.3bn, or 15% of the total market for turbine sales in 2012, is expected to increase to EUR 10.7bn, or 20% of the total market for turbine sales by 2016. In 2013, O&M services reached 22% of the turbine market at EUR 7.9bn, on the back of a temporary downturn in new wind capacity additions.

The inclusion of 'availability guarantees,' in which the O&M service vendor assures the operator of a minimum operating level, increased in 2013 to 93% of all contracts. Guarantees ranged from 93% to 98%, with 97% 'time-based' guarantees most common. Bonus provisions that reward maintenance providers for better turbine performance also increased in 2013, while variable pricing provisions declined. One in five contracts included a bonus provision, while just 4% included a variable pricing component.

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Figure 11: Average annual price for full-service O&M contracts by signing date, 2008-2013 (EUR 000/MW)







### 3.3. Electric vehicle batteries

Prices of electric vehicle batteries continue to fall as competition remains fierce in an oversupplied market. The average price of lithium-ion battery packs used in plug-in electric vehicles (plug-in hybrids and pure battery electric vehicles) has fallen to \$568/kWh – a 5.1% reduction from \$599/kWh in H1 2013.

The prices of EV batteries continue to be influenced by overcapacity been built up over the past few years. Bloomberg New Energy Finance expects an overcapacity of 29GWh (eight times higher than demand) in 2014 and 26GWh in 2015 (3.6 times demand).

Figure 13: EV lithium-ion battery short-term supply and demand (GWh)





### 3.4. Levelised cost of electricity

The levelised cost of electricity (LCOE) is the long-term offtake price required to achieve a required return on equity for a project. The model used to calculate LCOEs is based on a pro-forma project finance schedule that runs through the full accounting of the project, based on a set of project inputs. It captures the impact on costs of the timing of cash flows, development and construction costs,

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multiple stages of financing, interest and tax implications of long-term debt instruments and depreciation, among other drivers. The outputs of the model include sponsor equity cash flows, allowing calculation of the internal rate of return.

### Solar

As a result of gains in module prices in late 2013, the central scenario LCOE for solar PV with tracking increased up to \$148/MWh for the first quarter of 2014. In 2013, it fell to \$124/MWh amid a global surplus of PV panels.

The addition of single-axis tracking, which permits the module to remain optimally aligned with the sun for a longer period each day, can improve a plant's capacity factor up to 25% from that of a comparable non-tracking system in certain ideal locations (closer to the equator; significant and unobstructed sunlight). However, the cost premium for tracking systems and their operation and maintenance expense counteract part of the capacity factor gain.

LCOEs for thin-film PV and PV without tracking are reaching parity

LCOEs for thin-film PV and for PV without tracking are reaching parity as the technologies' performance converges. A fall in the number of thin-film equipment manufacturers resulted in a slower decline in the cost of that technology vis-à-vis PV.

### Wind

Recent increases in onshore turbine prices resulted in a corresponding increase of the onshore wind central scenario LCOE to \$82/MWh for the first quarter of 2014. It was \$78/MWh in 2013 and \$77/MWh in 2012. Offshore wind LCOEs remain stable at \$212/MWh, reflecting the scenario for a German offshore farm costing \$5.9m/MW and producing at a capacity factor of 42%. The previous year level was \$213/MWh.

### **Biomass and geothermal**

Biomass and geothermal LCOEs remain stable due to the maturity of their underlying technologies and, especially for geothermal, limited recent deployment. The central scenario LCOE for biomass employed via gasification in Q1 2014 is \$126/MWh. The central scenario LCOE for flash plant geothermal is \$65/MWh.

#### Marine

Central scenario marine technology LCOEs remain stable as developers seek to begin commercial deployment in 2014-2015. Tidal marine's LCOE is \$442/MWh for Q1 2014, while that of wave-derived energy is \$499/MWh.



### Figure 15: Global range and central scenarios of levelised cost of electricity technologies, Q1 2012, 2013, 2014 (\$/MWh)

Source: Bloomberg New Energy Finance Note: Coal and natural gas prices from the US Department of Energy EIA Annual Energy Outlook. Note: 'STEG' means solar thermal generating capacity, 'CCGT' means combined cycle gas turbine and 'CHP' means combined heat and power.