Frankfurt School
FS-UNEP Collaborating Centre
for Climate & Sustainable Energy Finance

GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2014

Bloomberg
NEW ENERGY FINANCE

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FOREWORD FROM BAN KI-MOON

The science is clear: climate change is happening; the effects are widespread and consequential; the risks to lives, infrastructure and sustainable development are increasing daily. Urgent action is necessary to reduce emissions and promote sustainable low-carbon growth.

Renewable energy is a key element of this transformation. Some argue that renewable energy can only serve as a supplement to our existing energy system. Global Trends in Renewable Energy Investment 2014 explodes that myth and shows that a clean energy future is possible.

Diminishing technology costs, innovative financing models and new market players are laying the foundations for increased investment in clean power. In 2013, for the second year in a row, renewables accounted for almost half of new global power generation capacity. While investment declined somewhat due to technology cost reductions and some policy uncertainty, the geographical distribution of renewables continues to widen, particularly in the developing world. In Latin America, the Middle East and Africa, countries are installing projects that produce electricity at costs per megawatt-hour that challenge conventional power sources, often with no subsidy support. Investments are also growing in Asia-Oceania and the Americas.

To expand on these trends, we need better policy mechanisms, more public finance and more private investment. That is why, on 23 September 2014, I am convening a Climate Summit at United Nations Headquarters in New York. The Summit will engage world leaders at the highest level – from governments, business, finance and civil society – to catalyse ambitious action on the ground as well as accelerate political momentum for a universal, legal climate agreement.

The Climate Summit is an opportunity for public and private actors to rise to the challenge and work together in a 'race to the top' to develop the policies and solutions that will reduce greenhouse gas emissions and support adaptation and resilience. Renewable energy has an important role to play, and this report shows that it is well-placed to take centre stage. I commend its findings to all interested in contributing to creating the low-carbon economy we need for a sustainable future.

Ban Ki-moon

Secretary-General, United Nations

JOINT FOREWORD FROM ACHIM STEINER, CHRISTIANA FIGUERES AND UDO STEFFENS


ACHIM STEINER


CHRISTIANA FIGUERES


UDO STEFFENS

Prospects for a new and universal climate agreement have been given a boost in the latest analysis of renewable energy investments and trends.

Sharply falling prices for solar panels and wind turbines meant renewable energies in 2013 accounted for over 43% of new generating capacity globally while raising the share of renewables to 8.5% of the global electricity supply.

In respect to climate change, emissions of greenhouse gases would have been 1.2 gigatonnes higher if the same electricity had been generated by other sources – this would have further widened the gap between where emissions are heading and where they need to be in 2020 if the world is to have a realistic prospect of staying under a two degree Centigrade temperature rise.

Global Trends in Renewable Energy Investment 2014 also points to an easing of the market volatility which has recently accompanied the clean energy market: this in turn bodes well for further penetration and expansion over the coming years and decades in developed and developing countries alike.

The WilderHill New Energy Global Innovation Index, which tracks clean energy stocks worldwide, gained more than 50% in 2013 – an improvement that took place as many companies in the solar and wind manufacturing chains moved back towards profitability after a period of over-capacity and corporate distress in 2011-12.

Other bright spots were further gains in cost-competitiveness of the two leading renewable power technologies: solar photovoltaics and onshore wind. Lower costs have enabled subsidies for new projects to be reduced, and brought wind and solar much closer to full competitiveness with fossil-fuel alternatives. Meanwhile various significant projects – many of them in Latin America but others also in the Middle East and Africa – have attracted investments of hundreds of millions of dollars in wind and solar energy without any subsidy support, or because they can generate more cheaply than the available fossil fuel options.

Hydro-electric energy has for decades competed head-on with coal and gas. The new report shows that in an increasing number of locations – generally those with strong wind resources or sunshine, an expanding need for power and an absence of cheap indigenous fossil fuel reserves – wind and solar are doing the same.

Some may point to the fact that overall investment in renewables fell for the second year running, to $214 billion, and that policy uncertainty was partly to blame. However investment also declined in fossil-fuelled power generation and for renewables the drop masks the many positive signals of a dynamic market that is evolving and maturing rapidly.

Overall the report underlines the increasingly positive role renewable energies are playing towards an increasingly low-carbon electricity and power supply that can build the confidence of nations to adopt a meaningful new agreement in Paris 2015. The multiple benefits that are accruing should also be celebrated, from overcoming poverty in developing countries to enhanced energy security and reducing air pollution and ill health in major cities.

Achim Steiner

UN Under-Secretary General and UNEP Executive Director

Christiana Figueres

Executive Secretary of the United Nations Framework Convention on Climate Change (UNFCCC)

Udo Steffens

President and CEO, Frankfurt School of Finance & Management

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METHODOLOGY AND DEFINITIONS

All figures in this report, unless otherwise credited, are based on the output of the Desktop database of Bloomberg New Energy Finance – an online portal to the world's most comprehensive database of investors, projects and transactions in clean energy.

The Bloomberg New Energy Finance Desktop collates all organisations, projects and investments according to transaction type, sector, geography and timing. It covers 69,600 organisations (including start-ups, corporate entities, venture capital and private equity providers, banks and other investors), 45,000 projects and 42,100 transactions.

METHODOLOGY

The following renewable energy projects are included: all biomass and waste-to-energy, geothermal, and wind generation projects of more than 1MW; all hydropower projects of between 1MW and 50MW; all wave and tidal energy projects; all biofuel projects with a capacity of one million litres or more per year; and all solar projects, with those less than 1MW estimated separately and referred to as small-scale projects, or small distributed capacity.

The 2014 Global Trends report concentrates on renewable power and fuels and does not cover energy-smart technologies such as smart grid, electric vehicles and power storage – except in the box at the end of Chapter 2.

The main body of the report also does not cover large hydro-electric projects of more than 50MW, since this technology has been mature for decades and is at a very different stage of its roll-out than, for instance, wind or solar. However there is coverage of large hydro in the box at the end of Chapter 5, and briefly in the Executive Summary.

Where deal values are not disclosed, Bloomberg New Energy Finance assigns an estimated value based on comparable transactions. Deal values are rigorously back-checked and updated when further information is released about particular companies and projects. The statistics used are historical figures, based on confirmed and disclosed investment.

Annual investment in small-scale and residential projects such as rooftop solar is estimated. These figures are based on annual installation data, provided by industry associations and REN21. Bloomberg New Energy Finance continuously monitors investment in renewable energy. This is a dynamic process: as the sector's visibility grows, information flow improves. New deals come to light and existing data are refined, meaning that historical figures are constantly updated.

Figures of more than $1 billion are stated to nearest billion in the text of the Key Findings and Executive Summary sections. They are stated to nearest $0.1 billion in the chapters that follow.

This 2014 report contains revisions to a number of investment figures published in the 2013 UNEP Global Trends In Renewable Energy Investment report. Revisions reflect improvements made by Bloomberg New Energy Finance to its data during the course of the last 12 months, and also new transactions in 2012 and before that have since come to light.

DEFINITIONS

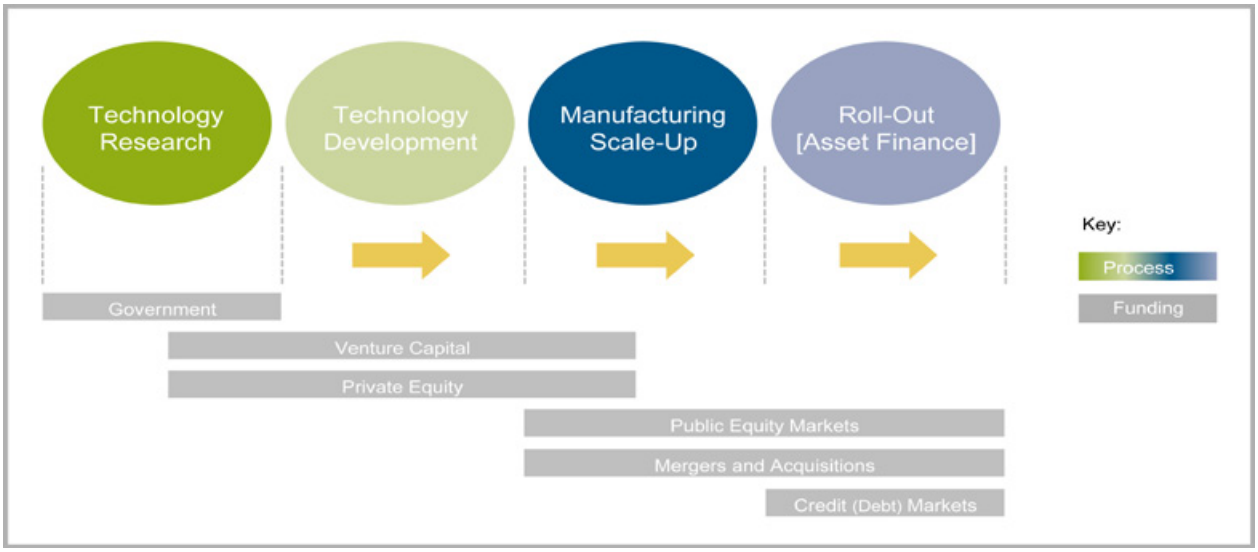
Bloomberg New Energy Finance tracks deals across the financing continuum, from R&D funding and venture capital for technology and early-stage companies, through to public market financing for projects and mature companies. Investment categories are defined as follows:

Venture capital and private equity (VC/PE): all money invested by venture capital and private equity funds in the equity of companies developing renewable energy technology. Similar investment in companies setting up generating capacity through special purpose vehicles is counted in the asset financing figure.

Public markets: all money invested in the equity of publicly quoted companies developing renewable energy technology and clean power generation.

Asset finance: all money invested in renewable energy generation projects (excluding large hydro), whether from internal company balance sheets, from loans, or from equity capital. This excludes refinancings.

Mergers and acquisitions (M&A): the value of existing equity and debt purchased by new corporate buyers, in companies developing renewable energy technology or operating renewable power and fuel projects.



REN21's annual **Renewables Global Status Report (GSR)** was first released in 2005. The Global Status Report is the sister publication to UNEP Global Trends in Renewable Energy Investment report, and its latest edition will be released in June 2014. It grew out of an effort to comprehensively capture, for the first time, the full status of renewable energy worldwide. Over the years, the GSR has expanded in scope and depth, in parallel with tremendous advances in renewable energy markets and industries. The report has become a major production that involves the amalgamation of thousands of data points, hundreds of reports and other documents, and personal communications with experts from around the world.

KEY FINDINGS

- Total investment in renewable power and fuels (excluding large hydro-electric projects) fell for the second year running in 2013, reaching $214 billion worldwide, some 14% lower than in 2012 and 23% below the 2011 record. The decline reflected a sharp fall in solar system prices, and the effect of policy uncertainty in many countries. The latter issue also depressed investment in fossil fuel generation in 2013.

- If the drop in investment was a cloud, it had several silver linings. One was the sharply reduced cost of solar photovoltaic systems, which meant that a record amount of PV capacity (some 39GW) was constructed in 2013, and for less money than the smaller 2012 total of 31GW. A second silver lining was that 2013 brought a 54% recovery in clean energy share prices, stimulating equity raising by specialist companies on the public markets.

- A third was that in 2013 cost reductions and efficiency improvements enabled onshore wind and PV projects to be built in a growing number of locations around the world without subsidy support. Wind and PV may be able to out-compete fossil-fuel options as long as there are plentiful local sunshine or wind resources, low capital costs, and no cheap, indigenous coal or gas feedstocks.

- A fourth was that, renewable energy excluding large hydro made up 43.6% of the new power capacity added in all technologies in 2013 (the same figure as in the previous year), and raised its share of total generation worldwide to 8.5% from 7.8%. Global energy-related CO2 emissions would have been some 1.2 billion tonnes higher but for this contribution.

- Investment in wind was relatively resilient in 2013, falling just 1% to $80 billion, while that in solar tumbled 20% to $114 billion. Biofuels saw a 26% drop in investment to $5 billion, the lowest for nine years, while biomass and waste-to-energy fell 28% to $8 billion, and small hydro-electric (projects of less than 50MW) declined 16% to $5 billion. Geothermal was the only riser, investment in it gaining 38% to $2.5 billion.

- 2013 also saw an interruption to the previously rising trend of renewable energy investment in developing economies as a whole. After eight years of increases, this fell 14% last year to $93 billion. Investment in developed economies also retreated 14%, to $122 billion.

- Last year was the first ever that China invested more in renewable energy than the whole of Europe. The Chinese total, although down 6% to $56 billion, finished well ahead of Europe's shrunken $48 billion, down 44%. The US saw a fall of 10% to $36 billion, while India moved 15% down to $6 billion, and Brazil 54% down to $3 billion, the lowest since 2005.

- The only regions gaining ground in 2013 were the Americas excluding the US and Brazil, with a 26% increase to $12 billion, helped by positive trends in several Hispanic countries and in Canada, and Asia-Oceania excluding China and India, with a 47% rise to $43 billion. Japan was the biggest contributor to the latter move, as its solar boom helped to drive an 80% increase in renewable energy investment to $29 billion (excluding R&D).

- Among the different types of investment, asset finance of utility-scale wind farms, solar parks and other new installations fell 13% to $133 billion, while outlays on small-scale projects such as rooftop solar lurched downwards 25% to $60 billion – mostly due to the decline in PV system costs.

- Venture capital and private equity investment in specialist renewable energy companies slumped 46% to $2 billion, the lowest figure since 2005, as funds took a cautious view of young high-technology enterprises and of the chances of securing a profitable exit. Government research and development spending on renewables rose 3% to $5 billion, while corporate R&D was 6% lower at $5 billion.

- The star performer among investment types was public market equity raising by renewable energy companies. This jumped 201% to $11 billion, the highest since 2010, spurred on by the rally in clean energy share prices and by institutional investors' increased appetite for funds offering solid yields on portfolios of operating projects.

- Large hydro-electric projects, of more than 50MW, were another important area of renewable energy activity, albeit outside the main scope of the statistics in this report. At least 20GW of capacity are estimated to have come on stream in 2013, equivalent to approximately $35 billion of investment.

- Although investment in renewable energy capacity including all hydro in 2013 was once again below gross investment in fossil-fuel power, at $227 billion compared to $270 billion, it was roughly double the net figure for investment in fossil-fuel power excluding replacement plant.

EXECUTIVE SUMMARY

Some foundations for future growth in the renewable energy market fell into place in 2013, even as investment levels declined for the second successive year. Lower costs, a return to profitability on the part of some leading manufacturers, the phenomenon of unsubsidised market uptake in a number of countries, and a warmer attitude to renewables among public market investors, were hopeful signs after several years of painful shake-out in the sector.

Renewable energy continued to build up its share of the global electricity market. Renewables excluding large hydro projects accounted for 43.6% of the new generating capacity installed worldwide in 2013, raising its share of world electricity generation from 7.8% in 2012, to 8.5%. If this capacity were not present, world energy-related CO2 emissions would have been an estimated 1.2 gigatonnes higher in 2013, adding about 12% to the 2020 projected emissions gap that needs to be closed to remain within a two degrees Celsius global temperature increase.[1]

New investment in renewable energy excluding large hydro-electric projects slipped 14% in 2013 to $214 billion, but even this disguised one major positive development. One of the two main reasons for this fall in 2013 was a reduction in costs in photovoltaics – even as the dollar investment in solar went down, the number of gigawatts of PV systems added went up.

Nevertheless, the decline in investment was disappointing for the industry and those hoping to see investors and financiers increasing their dollar commitments to the decarbonisation of the energy system.

There were setbacks to investment in many important geographical areas, including China (down 6% at $56 billion), the US (down 10% at $36 billion) and – most of all – Europe (down 44% at $48 billion). The biggest exception to the downward trend was Japan, where investment excluding research and development soared 80% to $29 billion.

FIGURE 1. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY ASSET CLASS, 2004-2013, $BN

*Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals

Source: UNEP, Bloomberg New Energy Finance

[1] The Emissions Gap Report 2013, UNEP, Nairobi.

BEHIND THAT $214 BILLION FIGURE

Worries about policy support, and reductions in technology costs, were the two main reasons for the fall in global financial commitments to renewable energy in 2013. Both factors were also instrumental in the drop in investment in 2012 from its record in 2011, so the decline in 2013 could be seen as the second half of a two-year downward trend amounting to 23%. Investment in fossil fuel generation was also somewhat lower in 2013 than a year earlier.

Last year's total of $214 billion was the lowest since 2009 and some $65 billion below the 2011 peak, although still five and a half times the 2004 tally of $40 billion and one and a half times the 2007 figure of $146 billion.

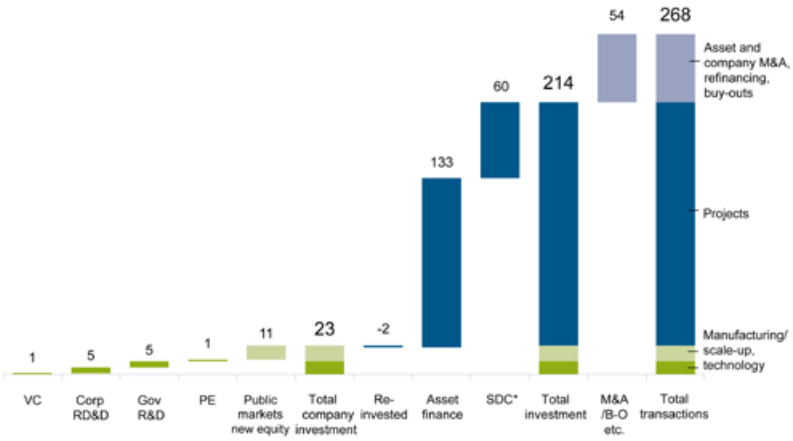
The make-up of the 2013 investment total is shown in Figure 2. The figure for new investment, $214 billion, is shown alongside a $54 billion number representing acquisition activity – corporate mergers and takeovers, asset purchases, buy-outs and refinancings. These acquisitions do not represent new investment but are important for recycling finance in the sector, and are covered in this report in Chapter 10.

The new investment total consists of all the elements to the left of the $214 billion figure in Figure 2, starting with early-stage technology support through venture capital and government and corporate research and development, via assistance for more mature businesses from private equity and public market investors. Finally, there is the roll-out of utility-scale wind farms, solar parks and other projects via asset finance, and the deployment of small-scale distributed capacity such as rooftop solar. The year-by-year changes in each of these aggregates, and the headline sector and regional shifts, are shown in Figure 3.

Looking at the reasons for the decline in overall investment in 2013, worries about future policy support for renewables delayed investment decisions in countries such as the US, Germany, India, the UK, France, Sweden, Romania and Poland. In some other countries, such as Spain and Bulgaria, retroactive subsidy cuts for existing projects almost killed off investment entirely, while in Italy, the amount of PV capacity eligible for support quickly ran up against a government-set cap. The issues in these countries are explored in more depth in Chapter 1.

Technology costs were a second big reason for the latest fall in investment. Although PV module prices bottomed out in early 2013 as the industry's severe over-capacity eased, balance-of-plant costs for PV systems continued to fall. In addition, there was a shift in the global mix of PV installations in 2013, with a lower share of relatively high-cost per MW residential systems and a higher share of relatively low-cost per MW utility-scale systems, particularly in China. The result was that although PV capacity installed was up from 31GW in 2012 to a record 39GW in 2013, dollar investment in solar capacity was down 23% at $104 billion.

FIGURE 2. GLOBAL TRANSACTIONS IN RENEWABLE ENERGY, 2013, $BN



SDC = small distributed capacity. Total values include estimates for undisclosed deals. Figures may not add up exactly to totals, due to rounding.

Source: UNEP, Bloomberg New Energy Finance

There were other, local reasons for the lower investment figure in 2013. For instance, the Chinese wind market was held back by grid connection delays and by cash shortages as a result of a nationwide credit squeeze. In some other developing countries, there was a pause in the flow of investment decisions. Financings in Brazil, for instance, were affected by the delay between auction rounds (in

FIGURE 3. GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2013 DATA TABLE, $BN

Category / Year / Unit	2004 $bn	2005 $bn	2006 $bn	2007 $bn	2008 $bn	2009 $bn	2010 $bn	2011 $bn	2012 $bn	2013 $bn	2012-13 Growth %	2004-13 CAGR %
1 Total Investment												
1.1 New investment	39.5	64.5	99.6	145.9	171.2	168.4	226.7	279.4	249.5	214.4	-14%	21%
1.2 Total transactions	48.3	90.8	135.3	204.3	230.6	232.7	285.2	352.8	309.9	268.2	-13%	21%
2 New Investment by Value Chain												
2.1 Technology development												
2.1.1 Venture capital	0.4	0.6	1.2	2.2	3.3	1.6	2.5	2.5	2.4	0.8	-67%	9%
2.1.2 Government R&D	1.9	2.1	2.3	2.7	2.8	5.1	4.6	4.6	4.5	4.6	3%	10%
2.1.3 Corporate RD&D	3.2	2.9	3.1	3.5	4.0	4.1	4.2	5.1	5.0	4.7	-6%	4%
2.2 Equipment Manufacturing												
2.2.1 Private equity expansion capital	0.3	1.0	3.0	3.6	6.7	2.9	3.1	2.6	1.7	1.4	-16%	17%
2.2.2 Public markets	0.3	3.7	9.0	22.0	11.5	13.0	11.4	10.7	3.7	11.1	201%	51%
2.3 Projects												
2.3.1 Asset finance	24.8	44.1	72.3	100.9	124.3	109.8	144.2	180.3	154.2	133.4	-13%	21%
Of which re-invested equity	0.0	0.1	0.7	3.0	3.6	1.7	5.8	3.7	1.8	1.5	-18%	-
2.3.3 Small distributed capacity	8.6	10.3	9.5	14.1	22.3	33.6	62.5	77.2	80.0	59.9	-25%	24%
Total Financial Investment	25.8	49.3	84.7	125.7	142.2	125.5	155.4	192.4	160.1	145.3	-9%	21%
Gov't R&D, corporate RD&D, small projects	13.7	15.3	14.8	20.2	29.0	42.9	71.3	87.0	89.4	69.2	-23%	20%
Total New Investment	39.5	64.5	99.6	145.9	171.2	168.4	226.7	279.4	249.5	214.4	-14%	21%
3 M&A Transactions												
3.1 Private equity buy-outs	0.8	3.7	1.8	3.6	5.5	2.2	1.9	3.2	3.2	0.6	-81%	-3%
3.2 Public markets investor exits	0.4	2.4	2.7	4.1	1.0	2.5	4.9	0.2	0.4	1.7	286%	19%
3.3 Corporate M&A	2.4	7.6	12.6	20.6	18.0	21.7	18.7	29.8	7.9	11.5	45%	19%
3.4 Project acquistion & refinancing	5.3	12.5	18.6	30.2	34.8	37.8	32.9	40.2	48.8	39.9	-18%	25%
4 New Investment by Sector												
4.1 Wind	14.5	25.1	32.1	56.6	69.3	73.0	94.8	85.9	80.9	80.1	-1%	21%
4.2 Solar	12.1	16.3	21.7	38.7	59.5	62.9	100.3	157.8	142.9	113.7	-20%	28%
4.3 Biofuels	3.7	9.2	27.6	29.3	19.2	10.4	8.9	9.4	6.6	4.9	-26%	3%
4.4 Biomass & w-t-e	6.2	8.0	10.6	13.2	14.1	13.6	14.2	15.5	11.1	8.0	-28%	3%
4.5 Small hydro	1.7	4.9	5.4	5.5	7.2	5.4	4.8	6.8	6.0	5.1	-16%	13%
4.6 Geothermal	1.3	1.0	1.4	1.9	1.8	2.7	3.5	3.7	1.8	2.5	38%	8%
4.7 Marine	0.0	0.1	0.9	0.7	0.2	0.3	0.2	0.3	0.2	0.1	-41%	11%
Total	39.5	64.5	99.6	145.9	171.2	168.4	226.7	279.4	249.5	214.4	-14%	21%
5 New Investment by Geography												
5.1 United States	5.5	11.7	28.2	33.6	35.9	23.5	34.7	53.4	39.7	35.8	-10%	23%
5.2 Brazil	0.6	2.6	4.6	11.0	12.2	7.8	7.7	9.7	6.8	3.1	-54%	21%
5.3 AMER (excl. US & Brazil)	1.4	3.3	3.2	4.9	5.8	6.1	11.5	8.7	9.9	12.4	26%	27%
5.4 Europe	19.7	29.4	39.1	61.8	73.4	75.3	102.4	114.8	86.4	48.4	-44%	10%
5.5 Middle East & Africa	0.5	0.5	0.9	1.6	2.3	1.4	4.3	3.2	10.4	9.0	-14%	37%
5.6 China	2.4	5.8	10.1	15.8	24.9	37.1	36.7	51.9	59.6	56.3	-6%	42%
5.7 India	2.5	2.9	4.4	6.3	5.4	4.2	8.7	12.6	7.2	6.1	-15%	10%
5.8 ASOC (excl. China & India)	6.8	8.2	9.0	10.9	11.4	12.9	20.7	25.3	29.5	43.3	47%	23%
Total	39.5	64.5	99.6	145.9	171.2	168.4	226.7	279.4	249.5	214.4	-14%	21%

New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

which large amounts of new wind capacity were awarded power purchase agreements last year) and the subsequent signatures on debt and equity deals for those projects.

A consequence of all these issues was that, for the first time for at least a decade, there was a fall in investment in renewable energy in developing countries. The 14% reduction in dollar commitments to $93 billion in 2013 is shown in Figure 4, along with a similarly-sized slippage in investment in developed economies.[2]

As well as the $214 billion global figure mentioned above, there were additional sums of money committed to large hydro-electric projects of more than 50MW. These projects are mature in terms of technology and fall outside the main scope of this report. However, at least 20GW of large hydro capacity are estimated to have been commissioned in 2013, equivalent to approximately $35 billion of investment. There is a box on large hydro investment at the end of Chapter 5.

IMPROVEMENT IN FUNDAMENTALS

Although renewable energy investment in 2013 was some 14% down on 2012, there were more hopeful signs for investment in 2014 and beyond. The first sign was the further gain in the cost-competitiveness of the two leading renewable power technologies – solar PV and onshore wind. Chapter 3 explains how over a five-year period to the first quarter of 2014, the worldwide average levelised cost of electricity has declined by 53% for crystalline silicon PV systems, and 15% for onshore wind turbines. Over the same years, the cost per MWh of coal- and gas-fired generation has increased in many countries, with the notable exception of the US where gas prices remain much lower than elsewhere.

The cost reductions for the two leading renewable technologies have enabled subsidies for new projects to be reduced, and brought wind and solar much closer to full competitiveness with fossil-fuel alternatives – even where the latter are not encumbered by carbon emission charges.

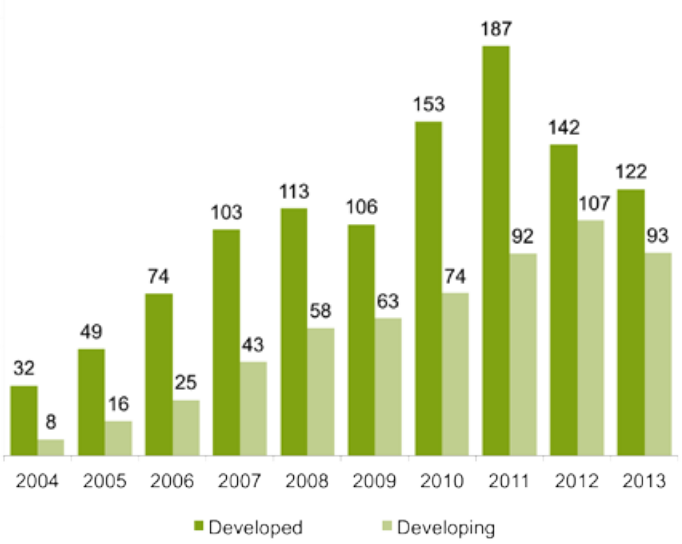
[2] In this report, developed economies are defined as all member countries of the OECD, other than Chile, Mexico and Turkey. Developing economies are defined as all non-OECD countries plus those three.

That brings us to the second patch of brightness in 2013. The year brought a trickle of significant projects – many of them in Latin America but others in the Middle East and Africa – in which hundreds of millions of dollars' worth of investment was being made in wind and solar without any subsidy support. Hydro-electric has for decades competed head-on with coal and gas. Now, in an increasing number of locations – generally those with strong wind resource or sunshine, an expanding need for power and no cheap indigenous fossil fuel reserves – wind and solar are doing the same.

The third shaft of light for renewables in 2013 came from investors themselves. After a four-and-a-half-year bear market in clean energy stocks that brought share prices down by a total of 78%, the WilderHill New Energy Global Innovation Index, or NEX, bottomed out in July 2012. This bottoming developed into a strong rally during 2013, with the NEX, which tracked 96 clean energy stocks worldwide last year, gaining 54%. The improved share price performance took place as many companies in the solar and wind manufacturing chains moved back towards profitability after the painful period of over-capacity and corporate distress in 2011-12. The impact of this on public market investment flows is examined in Chapter 7.

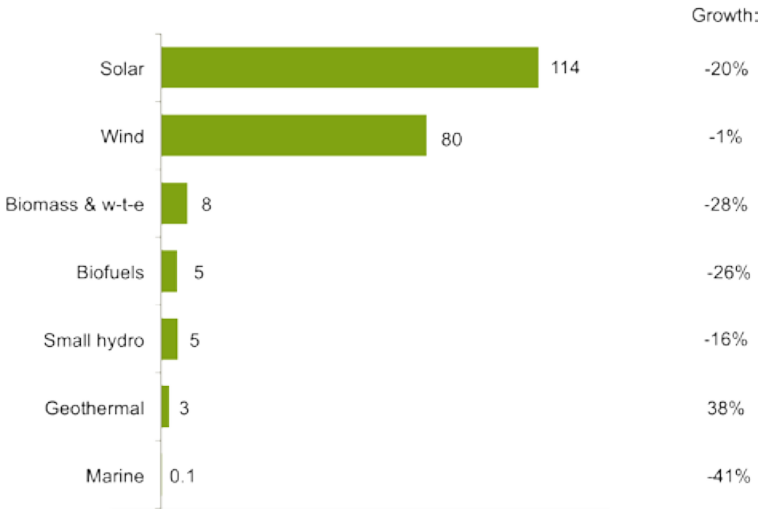
There has also been a deepening in the involvement of long-term investors such as pension funds, insurance companies, wealth managers and private individuals in the equity and debt of wind and solar projects. This process is at a relatively early stage, and renewable energy still makes up only a tiny fraction, for instance, of pension fund assets. Both the developments of 2013 and some of the remaining obstacles are discussed in Chapter 4.

FIGURE 4. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2004-2013, $BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. Developed volumes are based on OECD countries excluding Mexico, Chile, and Turkey.
Source: UNEP, Bloomberg New Energy Finance

FIGURE 5. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2013, AND GROWTH ON 2012, $BN

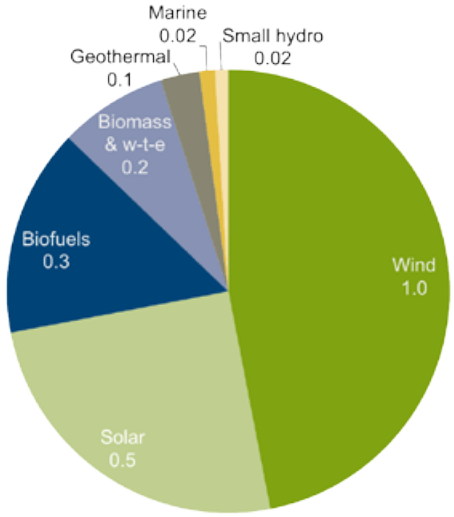


New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

WHERE INVESTMENT WENT IN 2013

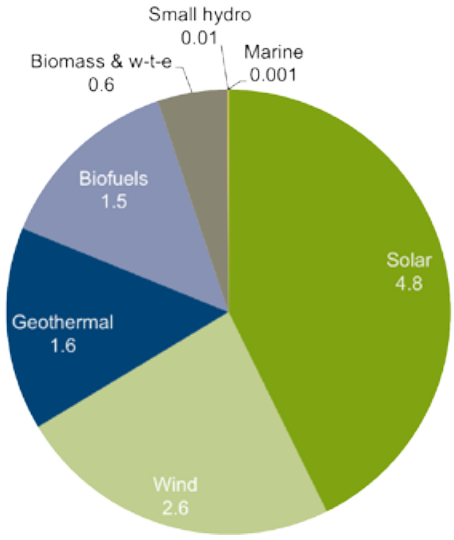
Figure 5 shows that investment in renewable power and fuels was dominated by wind and solar in 2013. Both generation sources saw reductions in their financial flows, of 1% and 20% respectively, but they still accounted for 90% of investment in renewables excluding large hydro.

FIGURE 6. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2013, $BN



VC/PE new investment excludes PE buy-outs. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

FIGURE 7. PUBLIC MARKETS NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2013, $BN



Source: UNEP, Bloomberg New Energy Finance

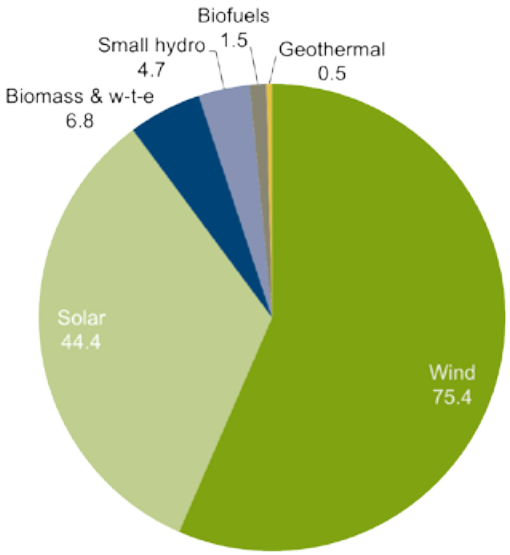
In earlier years, other technologies such as biofuels and biomass and waste-to-energy accounted for much bigger slices of the overall cake, but in 2013, those two sectors saw investment of just $5 billion and $8 billion respectively, down 26% and 28% respectively. The figure for biofuels was the lowest in any year since 2004, and for biomass the lowest since 2005. Small hydro and geothermal remained small features in the overall renewable energy investment picture last year, accounting for $5 billion (down 16%) and $3 billion (up 38%) of outlays respectively.

Venture capital and private equity investment in renewable energy was depressed in 2013, down 46% at $2.2 billion, the lowest figure since 2005. VC/PE investors were held back by a lack of available capital, as there has been a dearth of successful exits for venture-backed clean energy companies in recent years and it has been difficult to raise new funds; and by general wariness after a tough few years for early-stage technology players in renewable power.

The shrunken VC/PE flow of 2013 was allocated as shown in Figure 6. Surprisingly, given that it is generally seen as a mature technology, wind was the largest recipient, at $1 billion. Much of the explanation was that wind attracted a significant amount of new private equity capital into project development businesses. Solar soaked up $549 million of VC/PE investment, far down on the peak year of 2008 when it took $5 billion, while biofuels took $333 million.

There was a very different outcome for public markets investment, which was buoyed up by the share price gains discussed above and recorded a 201% jump in 2013 to its highest level since 2010. Figure 7 reveals that solar took nearly half the $11 billion total last year,

FIGURE 8. ASSET FINANCE OF RENEWABLE ENERGY ASSETS BY SECTOR, 2013, $BN



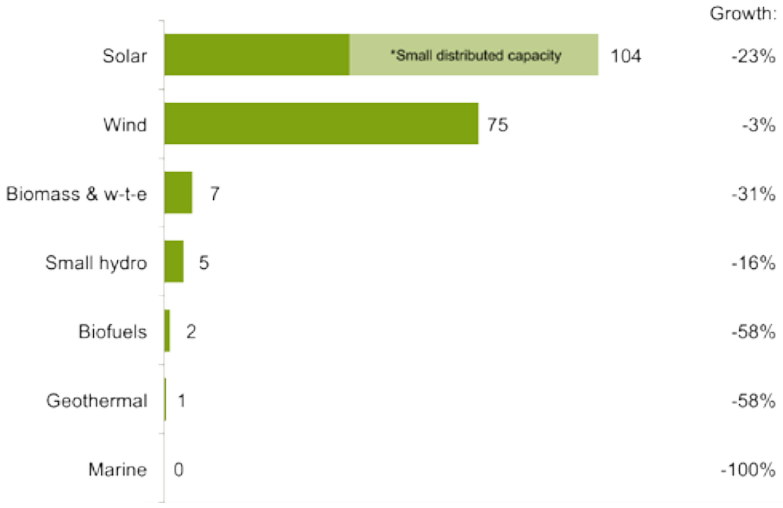
Total values include estimates for undisclosed deals
Source: UNEP, Bloomberg New Energy Finance

with wind second and important contributions also by geothermal and biofuels.

The largest single part of overall investment in renewable energy is the asset finance of utility-scale projects of 1MW or more. In 2013, this fell 13% to $133 billion, with the sector make-up displayed in Figure 8. Wind made up the largest part of this and suffered only a 3% decline, while solar, second largest, saw dollar commitments fall 20% even though the number of utility-scale megawatts installed actually increased.

Adding small-scale projects of less than 1MW to the comparison for capacity investment shows that solar was by some distance the leading renewable energy sector in 2013, just as it was in 2012 (see Figure 9). The last year in which

FIGURE 9. ASSET FINANCE OF RENEWABLE ENERGY ASSETS AND SMALL DISTRIBUTED CAPACITY BY SECTOR, 2013, AND GROWTH ON 2012, $BN



Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

there was higher dollar investment in wind capacity than in solar capacity was 2010.

There is, however, a difference between how those two top technologies compare in developed countries, and developing countries. Despite the PV boom taking place in China, the dominant share of solar capacity investment in 2013 still occurred in developed economies, while developing economies took the lion's share of spending on wind power projects. Developing countries also led in small hydro while, last year at least, developed countries made up most of the investment in biofuel, biomass and geothermal capacity. A full geographical analysis of investment flows follows in Chapter 1.

In summary, it could be said that 2013 for renewable energy was the flip-side of 2011. In the earlier year, investment hit a record worldwide of $279 billion. However, there were many dark clouds, including collapsing share prices, severe pressure on solar and wind manufacturers caused by over-capacity, the fading of the green stimulus programmes, and the imposition of retroactive feed-in tariff cuts in Spain. In 2013, investment was down at $214 billion, but the mood was more cheerful, with share prices up, manufacturers rebuilding margins, and renewable energy being chosen for projects around the world on the back of its improved cost-competitiveness.

INVESTMENT BY TYPE OF ECONOMY

- The proportion of world renewable energy investment accounted for by developing economies was 43% in 2013, equalling the record share recorded in 2012.
- However, absolute investment levels in both developing and developed countries fell back, the former to $92.7 billion from $107.4 billion and the latter to $121.7 billion from $142.1 billion, a second successive decline.
- In 2013, China outweighed Europe for the first time as a centre for renewable energy investment, even though Chinese investments declined by 6% to $56.3 billion.
- Asia-Oceania excluding China and India, up 47% at $43.3 billion thanks partly to the solar boom in Japan, pushed the US (down 10% at $35.8 billion) into fourth place among investing regions.
- Among the countries defying the general trend and raising investment last year were Japan, Uruguay, Chile, Canada, Israel, New Zealand and the UK.

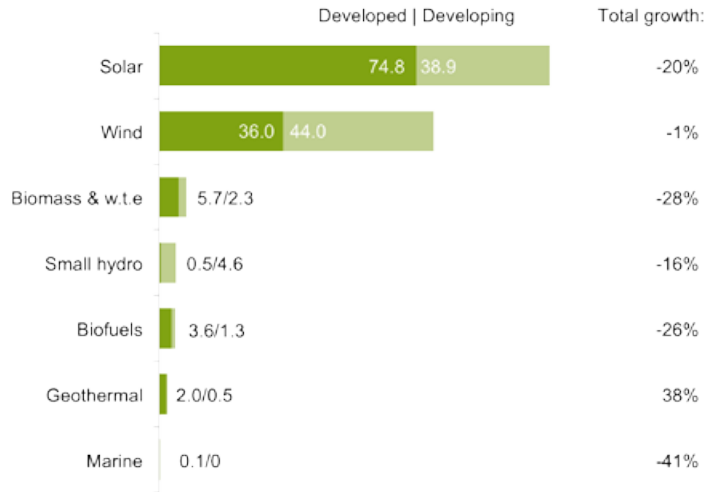
DEVELOPED VERSUS DEVELOPING COUNTRIES

In 2013, investment in renewable energy fell back in both developed countries and developing economies. There were exceptions at the country level, but the overall trend was down for both types of economy as Figure 4 in the Executive Summary shows.

This development was particularly disappointing in the case of developing countries, in that it brought to an end a steady trend of year-on-year increases in their absolute investment levels, reaching a peak of $107.4 billion in 2012. The optimistic slant on 2013's figure of $92.7 billion would be that some of the decline reflected lower PV costs and that the percentage of world renewable energy investment remained at 2012's record figure of 43%. The equivalent share was down at 33% as recently as 2011, and was 25% in 2006.

Figure 10 shows that the split between developed and developing economies varies very much depending on the technology chosen. The developing economies continued to account for the majority of investment in wind power and also small hydro, although their dollar commitments increased in the former and fell back in the latter. Developing countries were significantly

FIGURE 10. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2013, AND TOTAL GROWTH ON 2012, $BN



Total values include estimates for undisclosed deals. New investment volume adjusts for re-invested equity. Includes estimates for small distributed capacity, corporate and government R&D. Developed volumes are based on OECD countries excluding Mexico, Chile, and Turkey.
Source: UNEP, Bloomberg New Energy Finance

FIGURE 11. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2013, $BN

New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

outweighed by developed countries in the other technologies. This was particularly the case in solar, where the developing economy share of total investment was $38.9 billion, down 19%, against $74.8 billion for developed economies, down 21%. In 2013, three of the top four investing countries in solar were developed economies, with Japan at $28.7 billion, the US on $18.7 billion and Germany on $5.4 billion – the sequence only broken by China on $24 billion.

In wind, the top five investors in 2013 were China on $28.4 billion, the US on $14.1 billion, the UK on $6 billion, Germany on $5.4 billion and Canada and India, both on $3.6 billion. In the previous year, the order was similar with China first, followed by the US, Germany, India and Brazil.

The smaller technologies showed contrasting trends. Investment in biomass and waste-to-energy edged up 2% to $5.7 billion in developed economies, but slumped 58% to $2.3 billion in the developing world. In biofuels, both types of economy showed 20%-plus falls in investment, while in geothermal there was a 115% gain in outlays in developed countries to $2 billion, while developing countries saw a 42% fall to $528 million. Small hydro suffered a 19% drop in developing nations to $4.6 billion, while developed economies managed a 40% rise in investment to $507 million.

Figure 11 shows the way investment in renewable energy has evolved over recent years in the major regions. Perhaps the most striking chart is the one for Europe, displaying a more-than-halving of investment between 2011 and 2013 as the effects of policy uncertainty and retroactive tariff changes in some countries hit home.

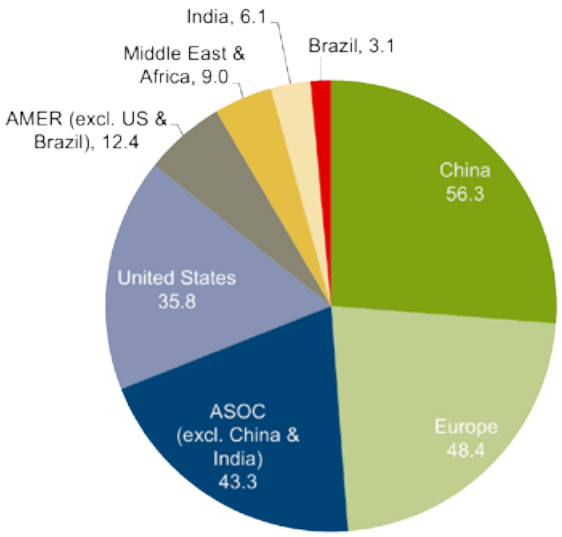
The US chart shows a very bumpy pattern, investment reaching a peak of $54.3 billion in 2011 and then dropping sharply. This reflected first of all the expiry of the federal loan guarantee and Treasury grant programmes in 2011 and then worries about the possible expiry of the Production Tax Credit for wind. The Americas excluding the US and Brazil display a generally strong trend, helped by the emergence of several Hispanic American countries as important locations for wind and solar. The Brazil chart shows the fading of the biofuel boom of 2007-08 and more recent ups and downs due to the timing of wind power auctions and financings.

The China chart shows consistent high volumes of investment, at more than $50 billion in each of the last three years. However, the most impressive trend is that for Asia and Oceania excluding China and India, with year-on-year increases in investment so far uninterrupted. The 2013 figure for that region was up 47% on 2012 and almost four times the 2007 total – principally due to the solar boom in Japan.

Among the other regions, the Middle East and Africa chart shows the impact of South Africa's emergence as an important investing country in the last two years.

There are two major changes in Figure 12 compared to the equivalent chart in last year's report. One is that China has taken over from Europe as the largest investing region, enjoying a clear lead in 2013 with $56.3 billion against $48.4 billion. The other is that third and fourth positions have also changed around, so that in 2013, Asia and Oceania excluding China and India accounted for $43.3 billion against the US's $35.8 billion. Last year, there was just a $5.1 billion gap between Europe in second place, and Asia-Oceania excluding China and India in third.

FIGURE 12. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2013, $BN



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

Small, but still significant, slices of world renewable energy investment were accounted for by the Americas excluding the US and Brazil, on $12.4 billion in 2013, by the Middle East and Africa on $9 billion, and by India on $6.1 billion.

DETAILED COMPARISONS BY COUNTRY

Figure 13 highlights the fact that while China was again the dominant investor in renewable energy in 2013, most of the top 10 countries were developed economies. It is important to note that the figures in Figure 13 exclude corporate and government research and development (for which a clean split by country is often hard to obtain, particularly in the European Union). By contrast, the totals in Figure 3 in the Executive Summary, and in Figures 11 and 12 in this chapter, covering regions and some large countries such as the US and China, do include R&D.

Also shown in Figure 13 is the make-up of investment in each country. So, for instance, asset finance of utility-scale projects was the dominant form of investment in China, while small distributed capacity was the main type in Japan. Public markets investment was relatively important in the US and the UK in 2013, but not in most of the other top countries.

Figures 14 and 15 identify the top 10 countries for, respectively, asset finance and small distributed capacity investment. China was by far the largest location for spending on large projects, followed in distant second by the US, with the UK rising from fifth in 2012 to third last year.

In small-scale, Japan was the pre-eminent investing country in 2013, at $23 billion, with the US second and Germany – the runaway top destination for this sort of investment in 2011 and narrower leader in 2012 – down in third place. Italy held on in fourth place, but with much reduced commitment levels, reflecting the new government cap on the amount of PV capacity eligible for feed-in tariff support. Australia continued to be a significant location for small-scale PV, helped by its strong solar resources and an active installation industry.

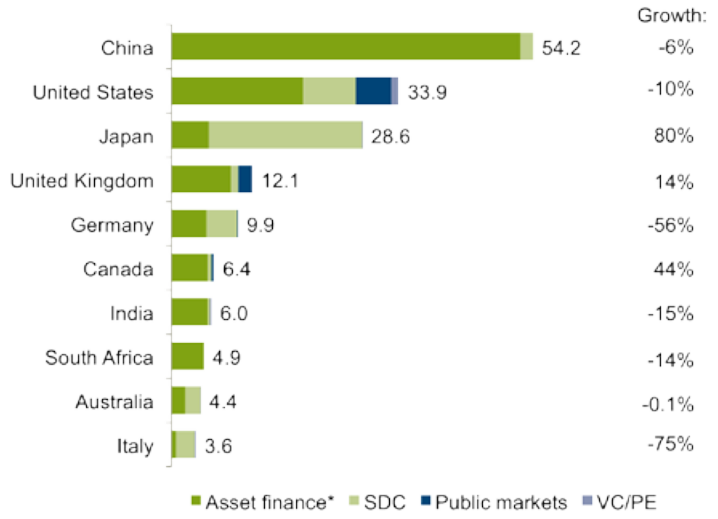
DEVELOPED ECONOMIES

The US was yet again the largest investor in renewable energy among developed economies, at $33.9 billion excluding research and development. This was down 10% from the 2012 total, due partly to the depressing effect on clean energy investment of the low natural gas prices brought about by the shale boom, and also to uncertainty over the continuation of policy support for renewables.

Investment in US wind was strong in the first half of 2012 as developers rushed to take advantage of the Production Tax Credit (PTC) before its scheduled expiry at the end of that year. The PTC was not extended as 2012 drew to a close, so even though there was a flurry of construction activity to complete wind farms on time, new financings stopped almost dead. In the end, the PTC was extended for another year, this time with more flexible rules on the deadlines for project commissioning, as part of the US Congress' "fiscal cliff" deal in January 2013, but it then took several months for investors and developers to restart their efforts. The result was a weak first half of last year for wind investment in the US, but then a sharp rebound in the fourth quarter. The full-year figure was $13.3 billion, down from $14.5 billion (see Figure 16).

Solar asset finance was also down, at $5.9 billion from $10.1 billion, in the face of lower costs per MW for PV systems and also a shift from utility-scale to small-scale deployment. Venture capital and private equity investment in renewable energy in the US was just $1 billion in 2013, the lowest figure since 2005 and indicative of a loss of confidence among early-stage investors in

FIGURE 13. NEW INVESTMENT IN RENEWABLE ENERGY BY COUNTRY AND ASSET CLASS, 2013, AND GROWTH ON 2012, $BN



Top 10 countries. *Asset finance volume adjusts for re-invested equity. Excludes corporate and government R&D
Source: UNEP, Bloomberg New Energy Finance

FIGURE 14. ASSET FINANCE OF RENEWABLE ENERGY ASSETS BY COUNTRY, 2013, AND GROWTH ON 2012, $BN

	2013	% growth on 2012
Australia	2.1	97%
Brazil	2.6	-60%
South Africa	4.9	-15%
Germany	5.2	-29%
Canada	5.4	44%
India	5.4	-21%
Japan	5.6	98%
United Kingdom	8.9	18%
United States	19.8	-27%
China	53.3	5%

Top 10 countries. Total values include estimates for undisclosed deals
Source: UNEP, Bloomberg New Energy Finance

FIGURE 15. SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2013, AND GROWTH ON 2012, $BN

	2013	% growth on 2012
France	1.1	-50%
United Kingdom	1.2	-59%
Denmark	1.4	-4%
Greece	1.8	-18%
China	2.0	-70%
Australia	2.3	-29%
Italy	2.8	-79%
Germany	4.6	-69%
United States	7.9	11%
Japan	23.0	76%

Top 10 countries. Represents investments in solar PV projects with capacities below 1MW
Source: UNEP, Bloomberg New Energy Finance

FIGURE 16. VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN THE UNITED STATES BY SECTOR, 2013, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	13.3	0.4	0.3	14.0
Solar	5.8	3.6	0.4	9.8
Biofuels	0.3	1.3	0.2	1.8
Biomass & w.t.e	0.2	0.003	0.04	0.2
Small hydro	0.1	-	0.004	0.1
Geothermal	-	-	0.06	0.1
Marine	-	-	0.01	0.01
Total	19.7	5.3	1.0	26.0

*Asset finance volume adjusts for re-invested equity. Small distributed capacity is not included here

Source: UNEP, Bloomberg New Energy Finance

the chances of achieving lucrative exits from companies in this sector. However public markets investment in renewable energy rallied strongly, from just $949 million in 2012 to $5.3 billion in 2013, the highest figure on record and a significant contributor to the overall figure for US renewable energy investment. Among the big deals were an $874 million issue by biofuels company Darling International and a $600 million convertible issue by solar supplier SunEdison.

Japan was the second largest investor among developed countries in 2013, at $28.6 billion, up 80% on the previous year's figure. The bulk of that commitment ($23 billion) took the form of small commercial and residential PV projects, taking advantage of a generous feed-in tariff introduced in 2012 as the country moved away from nuclear after the Fukushima emergency of March 2011. Asset finance was also significant, at $5.6 billion, one of the big transactions being the Eurus Energy Rokkasho PV plant, at 148MW and $497 million.

The UK invested $12.1 billion (up 14%), with $2 billion of that coming in the public markets where a new breed of fund owning operating-stage wind and solar assets raised money during the year. Greencoat UK Wind was just the first of these vehicles to carry out initial public offerings, in its case for GBP 260 million ($394 million). Asset finance was however the main component of UK investment, at $8.8 billion, with the Westermost Rough offshore wind farm, at 210MW and $1.4 billion leading the field in terms of size.

Germany invested $9.9 billion in renewable energy in 2013, enough to put it in fifth place in the country league, but a far cry from its peak figure of $33.7 billion in 2010. To some extent, the low number last year was the result of policy uncertainty ahead of the September 2013 general election, but there were other factors at work too, including much reduced costs for PV and a shortage of good quality, unexploited onshore wind sites. Leading the list of deals in Germany in 2013 were the financing of two offshore wind farms, Butendiek at 288MW and $1.9 billion, and Baltic II at 288MW and $1.6 billion.

Canada was perhaps a surprising feature at sixth in the 2013 all-countries investment league, given its high-profile tar sands investments and the controversy over the Keystone pipeline to the US. However, it has been a steady investor in renewable energy over recent years, deploying between $2 billion and $6 billion each year from 2007 to 2012, and then beating that with $6.4 billion in 2013. Most of this ($5.4 billion) was asset finance, with two of the largest transactions being the South Kent wind project at 270MW and $717 million, and the Grant Renewable PV plant in Ontario at 130MW and $473 million. Both these are in Ontario.

Australia and Italy occupied positions nine and 10 in the investor country list last year. The former's figure of $4.4 billion was roughly bisected between small-scale PV, encouraged by the country's combination of relatively high electricity prices, plentiful hours of sun and enterprising installation industry; and utility-scale asset finance, with the Boco Rock wind farm phase one, at 113MW and $334 million one of the larger deals. Italy was noteworthy because of the sharp fall in investment there – down 75% year-on-year due to the government's cap on PV capacity eligible for feed-in tariffs and, to some extent, high financing costs left behind by the 2011-12 euro area sovereign debt crisis.

Other OECD economies showing investment of more than $1 billion in 2013 were France, at $2.8 billion compared to $4.9 billion in 2012, Greece at $1.8 billion from $2.5 billion the previous year, New Zealand at $1.6 billion from $219 million largely as a result of one geothermal IPO, Denmark at $1.4

billion from $2 billion, Switzerland at $1.2 billion from $912 million, Sweden at $1.1 billion from $2.4 billion, the Netherlands at $1.1 billion from $1.2 billion, Israel at $1.1 billion from $535 million, and South Korea at $1 billion from $1.1 billion.

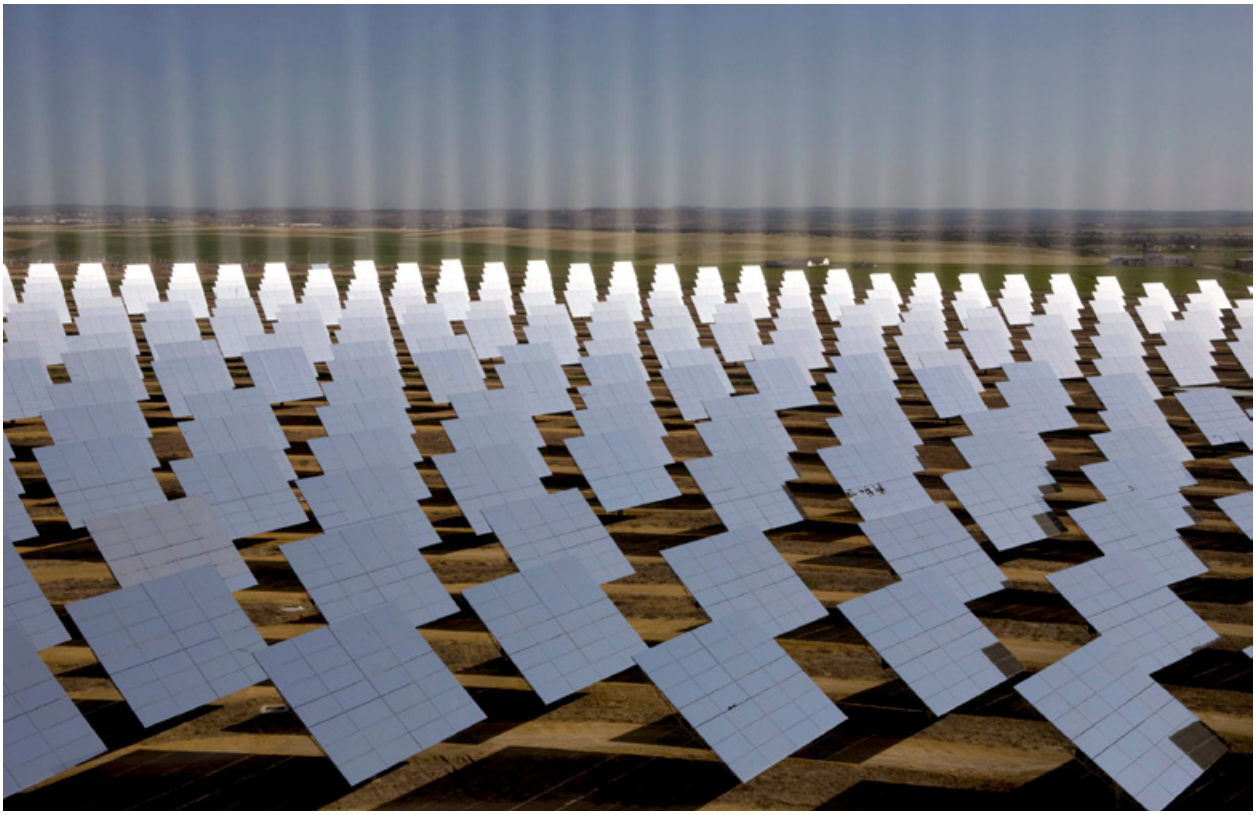
CHINA, INDIA, BRAZIL

Figure 17 highlights that China had a lopsided year for renewable energy investment in 2013, with asset finance (and small distributed capacity spending) staying strong, but almost no contribution from public markets or venture capital and private equity. Asset finance of wind projects was up from $24.7 billion to $28 billion, almost matching 2010's record figure. Among the bigger transactions were the financing of the Longyuan Jiangsu Dafeng offshore wind farm, at 200MW and $570 million, and that for the Huaneng Guazhou Anbei Number 3 wind farm at 400MW and $560 million. Solar asset finance was down slightly on the year, at $20.6 billion, including the Huanghe Hydropower Gonghe Longyangxia PV plant, at 320MW and $570 million.

Small hydro accounted for $2.7 billion of asset finance in 2013, as China drove on with the largest programme in the world of sub-50MW hydro-electric installation. Biomass and waste-to-energy asset finance, at $900 million, was down sharply from $2.4 billion in 2012.

In 2013, for the first time, new-build renewable generation surpassed thermal additions in China, and the wind sector began to overcome its problems of grid connection and shortage of cash flow for manufacturers. Wind installation may also have been spurred on last year by discussions about cutting China's wind feed-in tariff, because this gave developers reason to move quickly. Solar is being supported by way of a target – for the installation of 35GW of PV by 2015 – by feed-in tariffs and by regulations to ensure that grid companies buy all the solar power produced in their regions.

Investment in India in 2013 was $6 billion, towards which the contributions from asset finance, public markets and VC/PE are shown in Figure 18. Last year's total was just under half the peak figure of $12.5 billion in 2011, and almost all of that decline



has come about through a slowing in asset finance, to $5.4 billion in 2013 from $11.8 billion in 2011 and $6.7 billion in 2012. The asset finance setback was particularly apparent in solar, down from $2.1 billion to $943 million.

In 2013, there were big projects in India reaching financial close, including the 130MW Welspun Neemuch PV plant, costing $221 million and the CLP Jath wind farm, weighing in at 130MW and $169 million. One indicator moving upward in India, albeit still at a modest level, was small-scale project investment, which reached $400 million in 2013, the highest yet.

India has a five-year plan to add 29.5GW of renewable energy capacity during the 2012-17 period, but has made a slow start and

FIGURE 17. VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN CHINA BY SECTOR, 2013, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	28.0	-	-	28.0
Solar	20.6	-	-	20.6
Small hydro	2.7	-	-	2.7
Biomass & w-t-e	0.9	-	-	0.9
Total	52	-	-	52

*Asset finance volume adjusts for re-invested equity
Source: UNEP, Bloomberg New Energy Finance

FIGURE 18.VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN INDIA BY SECTOR, 2013, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	3.2	-	0.2	3.3
Solar	0.9	-	0.01	1.0
Small hydro	0.7	-	0.01	0.7
Biomass & w-t-e	0.5	-	0.02	0.6
Biofuels	0.03	-	-	0.03
Total	5.4	-	0.2	5.6

*Asset finance volume adjusts for re-invested equity
Source: UNEP, Bloomberg New Energy Finance

may struggle to reach that figure. Only relatively late in 2013 did the country restore its Generation-based Incentive for wind and invite bids for a 750MW PV auction under its National Solar Mission. Several states held their own solar auctions during the year but did not sign power purchase agreements promptly. The silver lining is that analysts expect 2014 to bring a higher level of financings and project commissioning than 2013 for both wind and solar.

FIGURE 19. VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN BRAZIL BY SECTOR, 2013, $BN

	Asset finance*	Public markets	VC/PE	Total
Wind	2.1	0.2	0.04	2.3
Biofuels	0.5	-	-	0.5
Biomass & w-t-e	-	-	0.1	0.1
Small hydro	0.03	-	-	0.03
Solar	0.01	-	-	0.01
Total	2.6	0.2	0.2	3.0

*Asset finance volume adjusts for re-invested equity
Source: UNEP, Bloomberg New Energy Finance

Brazilian investment in renewable power and fuels has been highly volatile over the years, soaring to a peak of $12.2 billion in 2008 on the back of the sugarcane ethanol boom. Biofuels have since subsided in terms of new capacity building, but there have been flurries of investment in wind, as the country held a succession of auctions. However, as Figure 19 shows, overall investment in Brazil was down at $3 billion in 2013. This made it the weakest year since 2005 and compared to $6.7 billion in 2012 and $9.5 billion in 2011.

Last year's total was dominated by asset finance, with $2.1 billion of that happening in wind and $477 million in biofuels. Among the wind deals was the CPFL Renovaveis Complexo Sao Benedito Wind Portfolio, worth $270 million for 116MW. In biofuels, the biggest financing was for the GranBio Alagoas next-generation bioethanol plant, at $149 million.

Among the problems holding back wind investment in Brazil last year were transmission and sub-station construction delays, affecting the connection of several hundred MW of projects. In addition, the local economy entered a weak patch, and the disbursement cycle for development bank BNDES to finance wind projects that have won capacity in the most recent crop of auctions was long. There remains a question mark over whether some of the auction winners, with very low likely rates of return, will go ahead and build their projects.

Nevertheless, wind continued to do well in power auctions as 2013 dragged to a close. In November's "A-3" tender for capacity to be online by 2016, some 830MW of wind projects got power purchase agreements. In December's much larger auction, coal and natural gas again lost out as wind, biomass and small and large hydro clinched 3.5GW of PPAs, adding to optimism for higher renewable energy investment in the next three years than in 2013.

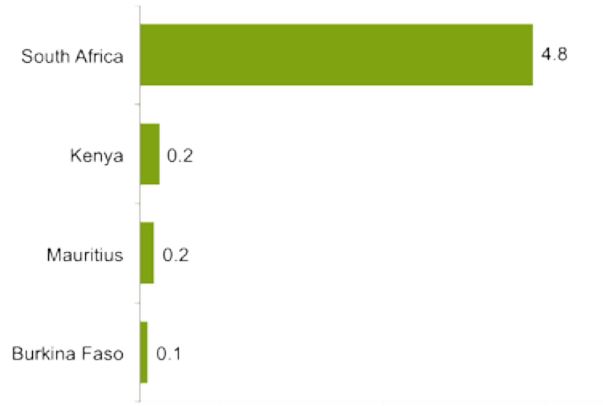
OTHER DEVELOPING ECONOMIES

South Africa was once again the stand-out performer among developing countries outside the Big Three, in 2013 recording renewable energy investment excluding research and development and small-scale projects of $4.8 billion – albeit down from $5.7 billion the previous year. This figure consisted entirely of asset finance of wind and solar plants, $1.9 billion for wind and $3 billion for solar. The largest of these financings included the Eskom Upington solar thermal plant, at 100MW and $818 million, and the Cennergi Amakhala Emoyeni wind farm, costing $412 million for 134MW.

Solar thermal, in fact, found South Africa to be its most active market in 2013. This range of technologies, which attracted more than $10 billion worth of investment worldwide in 2011, mainly in the US and Spain, was reduced to a handful of new project financings last year – two of them in South Africa and one each in China, Oman and Chile.

In November 2013, the South African Department of Energy awarded preferred-bidder status to 17 projects for round three of its renewable energy procurement programme. The winners for wind

FIGURE 20. TOTAL VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN AFRICA BY COUNTRY, 2013, $BN



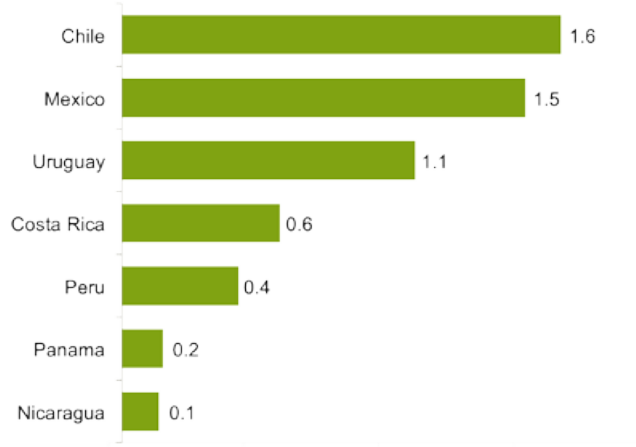
Omits countries with less than $0.1bn investment. Investment volume adjusts for re-invested equity
Source: UNEP, Bloomberg New Energy Finance

made average bids worth the equivalent of $72.80 per MWh for a total of 787MW, while the equivalent for PV made average bids of $98 per MW for 435MW, and for solar thermal $162 per MWh for 200MW. Wind and PV are on course to account for 10% of South Africa's energy mix by 2020.

Figure 20 shows the extent to which South Africa dominated its continent's renewable energy investment in 2013. Morocco, which had been a significant investor in the previous year with $1.9 billion, reached a pause in its financing activity for wind and solar in 2013. Kenya saw investment of $249 million, up from $226 million in 2012, but well below 2010's peak of $1.7 billion. Financial close on its flagship Lake Turkana wind project remained tantalisingly just out of reach.

Investment was much more widely distributed in Latin America outside Brazil, as Figure 21 illustrates. Chile saw $1.6 billion worth of investment, up from $931 million in 2012 and narrowly edging Mexico's $1.5 billion (down from $1.9 billion) into second place. Both countries are

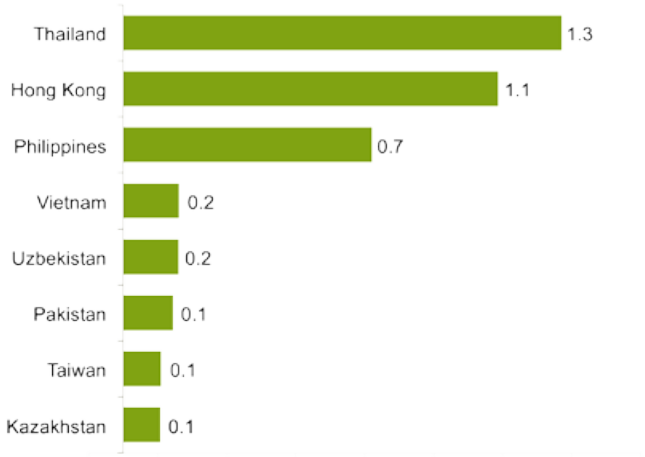
FIGURE 21. TOTAL VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN LATIN AMERICA (EXCL. BRAZIL) BY COUNTRY, 2013, $BN



Omits countries with less than $0.1bn investment. Investment volume adjusts for re-invested equity

Source: UNEP, Bloomberg New Energy Finance

FIGURE 22. TOTAL VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY IN NON-OECD ASIA (EXCL. CHINA & INDIA) BY COUNTRY, 2013, $BN



Omits countries with less than $0.1bn investment. Investment volume adjusts for re-invested equity

Source: UNEP, Bloomberg New Energy Finance

benefitting from strong natural resources for wind and solar, and the ability to generate cost-competitively with fossil fuel (there is more on this in Chapter 3).

Uruguay and Costa Rica were also surprisingly strong performers in 2013, with investment totalling respectively $1.1 billion, up from $155 million, and $584 million, up from $212 million. Among the large projects financed last year in these two countries were the ICE Las Pailas II geothermal plant in Costa Rica, at 55MW and $347 million, and the COFUSA Pintado wind portfolio in Uruguay, at 90MW and $187 million.

Figure 22 shows that Thailand, Hong Kong and the Philippines dominated investment in renewable energy in emerging Asia outside China and India. Thailand's $1.3 billion was level with the 2012 total, continuing to reflect solar projects but also an IPO by biofuel company Energy Absolute PCL; Hong Kong's $1.1 billion (up from $609 million) owed much to secondary share issues by wind developer Huaneng Renewables; and the Philippine total included the EDC Burgos wind farm, at 87MW and an estimated $122 million.

PUTTING RENEWABLE ENERGY INTO PERSPECTIVE

- Renewables excluding large hydro accounted for 43.6% of new GW power capacity installed worldwide in 2013, and raised their share of total generation from 7.8% to 8.5%.
- In terms of investment, renewable power attracted $192 billion for deployment on new capacity. This compared to the $270 billion that went to construct new fossil fuel power stations.
- However, if you take only the additional fossil fuel capacity, and exclude spending on replacement plant, then investment amounted to $102 billion – substantially less than that going to renewables.
- The installed capacity worldwide of renewables excluding large hydro was responsible for preventing the emission of an estimated 1,220 million tonnes of CO2 in 2013.

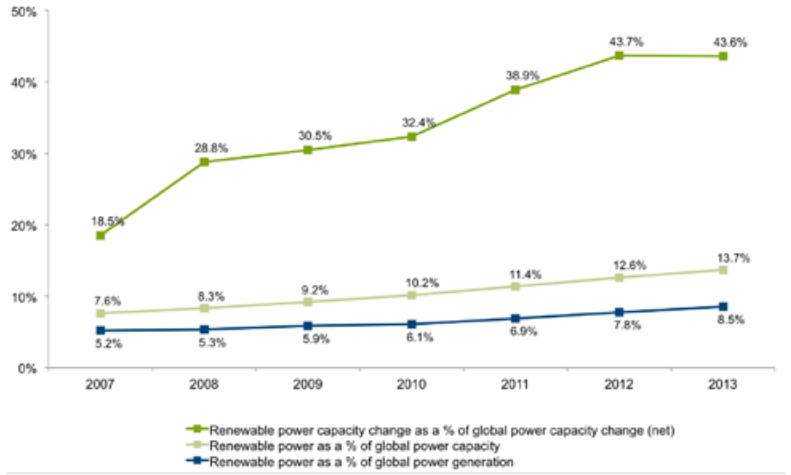
This chapter looks at investment in renewable power and fuels in the context of capital expenditure and generation by the rest of the power sector. It also sets those investment and energy use figures against efforts to curb world carbon emissions. It shows the trend in carbon dioxide levels and examines some forecasts for future energy-related emissions. Finally, it examines briefly the latest figures for financial flows into two other emission-reduction options – energy-smart technologies such as smart grid, efficiency and advanced transportation; and carbon capture and storage.

RENEWABLES VERSUS FOSSIL

Figure 23 shows that renewable power excluding large hydro accounted for 43.6% of total new generation capacity added in 2013. This year's Global Trends report is estimating that the previously rising trend for this percentage flattened out last year, with the 2013 figure almost identical to that in 2012.

These percentages are based on estimates that some 81GW of new renewable energy capacity (excluding large hydro) were added in 2013, down from 88GW in 2012. PV capacity additions went up, to 39GW from 31GW, but wind capacity additions fell to 31GW in 2013 from 44GW in 2012 – much of that setback due to the hiatus in US wind installations caused by the expected expiry of the Production Tax Credit. Meanwhile, fossil-fuel capacity worldwide increased in 2013 by a somewhat higher figure, 95GW, although this was also down on the previous year, when 111GW were added.

FIGURE 23. RENEWABLE POWER GENERATION AND CAPACITY AS A SHARE OF GLOBAL POWER, 2007-2013, %



Renewables figure excludes large hydro. Renewable capacity figures based on Bloomberg New Energy Finance global totals.

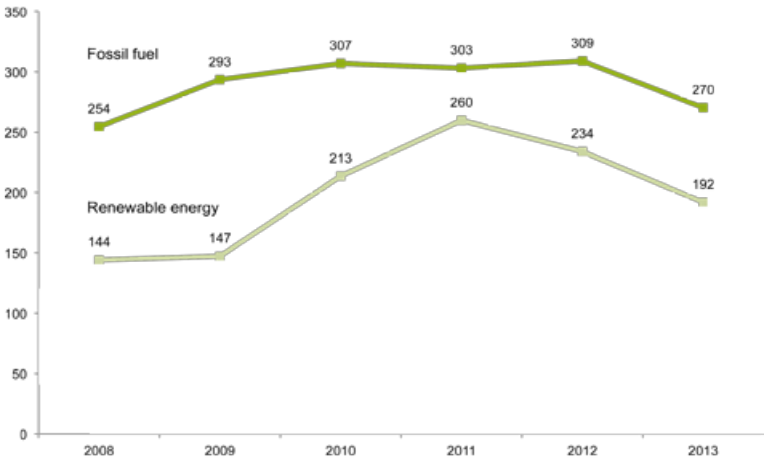
Source: Bloomberg New Energy Finance

This flattening of the curve in Figure 23 might arouse suspicions that the rise of renewable energy is tailing off, but the chart also shows that this 43.6% of GW capacity added in 2013 was still large enough to push renewable energy's share, excluding large hydro, of overall installed capacity worldwide to 13.7% last year, up from 12.6% in 2012 and 7.6% back in 2007. Note that Bloomberg New Energy Finance has revised its estimates upwards for the historical installed base of renewable power to reflect the incorporation of improved figures for small hydro worldwide.

The third, and perhaps most important, line on Figure 23 shows the share of world electricity generation represented by renewable energy excluding large hydro. This rose in 2013 to 8.5%, compared with 7.8% in 2012 and 5.2% in 2007. In other words, renewable power is steadily increasing its foothold in overall generation, and there is no sign of this trend changing, the incremental change from one year to the next notwithstanding.

Figure 24 addresses the comparison between investment in renewables excluding large hydro on the one hand, and fossil-fuel power on the other. It shows that in 2013, investment in new renewable generation capacity amounted to $192 billion[1], down from $234 billion in 2012, due to the factors explained in earlier chapters of this report (such as lower technology costs and policy uncertainty).

FIGURE 24. RENEWABLE POWER INVESTMENT COMPARED TO GROSS FOSSIL-FUEL POWER INVESTMENT, 2008-2013, $BN



Renewable energy total excludes large hydro. Fossil fuel is gross investment in coal, gas and oil capacity and assumes retired fossil capacity is replaced. We assume capacity retirement of 3.3%/yr for coal, 4%/yr for gas and 2.5%/yr for oil. The numbers in this chart for 2012 and before are shown in 2013 prices, in other words, adjusted for movements in world inflation.
Source: Bloomberg New Energy Finance, EIA

[1] This is renewable power asset finance and small-scale projects. It differs from the overall figure for renewable energy investment given in the Executive Summary, of $214 billion in 2013, because it excludes biofuels and types of non-capacity investment such as equity raising on public markets and research and development.

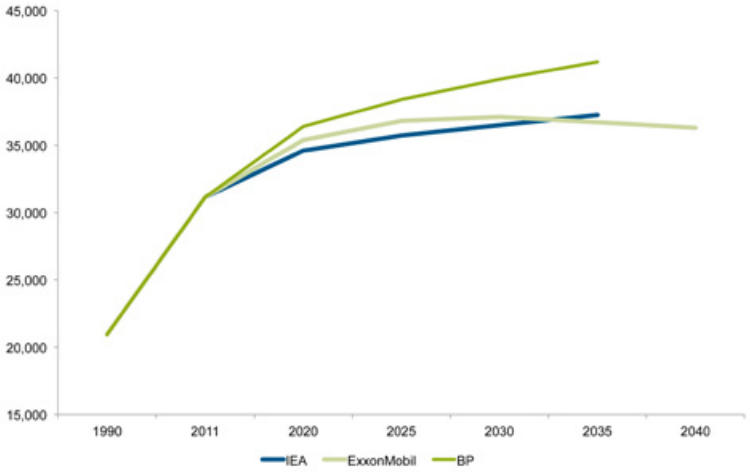
Fossil-fuel capacity investment also fell in 2013, to $270 billion from $309 billion in the previous year, but it stayed well ahead of investment in renewables.

That, however, is only one way of looking at the comparison between renewable energy and fossil-fuel power investment. The $270 billion fossil-fuel figure is gross investment, much of which went to replacing coal-, oil- and gas-fired power stations that were taken out of service or closed. What actually went into establishing additional fossil-fuel capacity, the net investment, was much lower, at just $102 billion. This was well below renewables' gross (and net) investment of $192 billion.

The comparison skews even more in the direction of renewables if investment in additional large hydro-electric capacity is included. As the box in Chapter 5 discusses, the amount of new large hydro capacity added in 2013 is likely to have been at least 20GW. The average capital cost for large hydro is some $1.5 million to $2 million per MW, so that 20GW is likely to have reflected approximately $35 billion of investment. Adding that to the renewables (excluding large hydro) figure of $192 billion in 2013 would produce an all-renewables total of $227 billion, which is below the gross fossil-fuel investment figure of $270 billion, but far above the net fossil-fuel tally of $102 billion.

The future trend in renewables versus fossil-fuel power investment will hinge, in large part, on the evolution of capital and generating costs for the

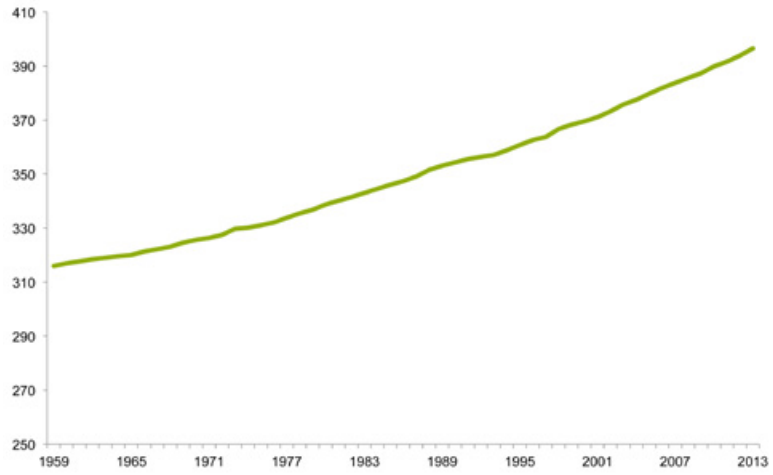
FIGURE 25. HISTORICAL AND FUTURE GLOBAL ENERGY SECTOR EMISSIONS, MILLION TONNES OF CO2 EQUIVALENT, 1990-2040



The IEA projections are from its New Policies Scenario.
Source: International Energy Agency, ExxonMobil, BP

different technologies. This issue will be addressed in detail in Chapter 3.

FIGURE 26. ANNUAL MEAN ATMOSPHERIC CARBON DIOXIDE AT MAUNA LOA OBSERVATORY, HAWAII, PARTS PER MILLION



Source: US National Oceanic and Atmospheric Administration

EMISSIONS AND RENEWABLES

Figure 25 shows the projected trend in world energy-related CO2 emissions according to three leading forecasters – the IEA, ExxonMobil and BP. The three organisations predict slightly different trajectories, with Exxon the most optimistic about the possibility of emissions peaking around 2030. However all three show significant further increases in annual emissions, of the order of nearly 20% compared to the 2011 level.

The actual trend in the carbon dioxide content of the atmosphere to date is shown in Figure 26. According to the US National Oceanic and Atmospheric Administration's measuring station at Mauna Loa in Hawaii, the CO2 proportion in the atmosphere has grown from 316 parts per million in 1959 to an average of 396.5ppm in 2013. The amounts vary by season, but in the summer of last year, CO2 briefly touched 400ppm. In the opening months of 2014, the carbon dioxide proportion has been running above 2013 levels.

The worrying projections for CO2 emissions from the IEA, Exxon and BP come despite the fact that all three organisations expect to see large increases in renewable energy penetration. The IEA, for instance, predicts that electricity generation from non-hydro renewables will grow from 7% in 2011 to 21% by 2035.[2]

It is sometimes argued that the billions spent on investment in renewable energy are unjustifiably expensive and relatively ineffective at curbing emissions. Dieter Helm, professor of energy policy at Oxford University, wrote in October 2013: "There have been three main renewable technologies deployed: wind, solar panels and biomass. It is important to recognise that none of these can make much difference to climate change. The first two are low-density and intermittent – and there is not enough land and shallow seas to provide sufficient aggregate energy output against the growth of world energy demand."[3]

However, the figures for investment in this report show that renewable power is accounting for a growing (if still small minority) share of world electricity generation. There is therefore an impact on emissions that can be estimated. The IEA said late last year that 12,954 million tonnes of CO2 were emitted by power generation in 2011[4], and predicted an annual increase of 0.7% per year. That implies an estimated 13,136 million tonnes emitted in 2013. Since according to Figure 23, 8.5% of world power generation last year came from renewables excluding large hydro, those 13,136 million tonnes were caused by the remaining 91.5% of generation. Had renewables excluding large hydro been absent from the generation mix, world emissions would have been some 14,356 million tonnes. In other words, these renewable power technologies prevented the emission of 1,220 million tonnes of CO2 in 2013.[5]

UNEP in its 2013 Emissions Gap Report found that even if nations meet their current climate pledges, greenhouse gas emissions in 2020 are likely to be 8 to 12 gigatonnes of CO2 equivalent above the level needed to remain within a two degrees Celsius global temperature increase. Without the new renewables capacity, mostly installed during the past decade, the gap identified by UNEP would have been around 12% bigger.

[2] IEA World Energy Outlook 2013, New Policies Scenario.
[3] Dieter Helm: The current situation and mid-term prospects for electricity markets, 30 October 2013.
[4] This figure is solely for power sector emissions, and does not attempt to capture "life-cycle" emissions from building and operating power plant.
[5] This estimate assumes that the same mix of other technologies was used to cover the 8.5% not produced by renewables excluding large hydro.

No one is expecting renewables to play the only part in curbing power sector emissions in the years ahead. Other key roles will need to fall to energy efficiency and – more controversially – to the replacement of high-carbon fossil fuel generation with lower-carbon generation, via coal-to-gas switching, increased nuclear capacity and perhaps carbon capture and storage.

ENERGY-SMART TECHNOLOGIES

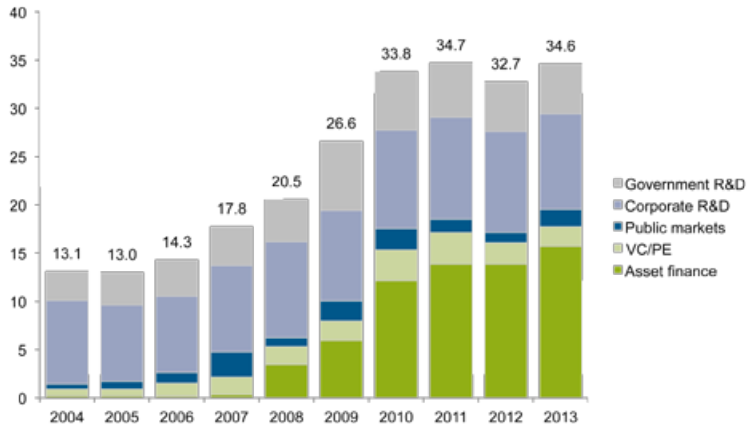
Energy-smart technologies consist of four categories – smart grid, energy efficiency, power storage and advanced transportation. They are not renewable energy, so are outside the main remit of this report, but they do also make an important contribution to the quest to curb emissions. Figure 27 shows that global new investment in energy-smart technologies, or EST, edged up 6% to $34.6 billion in 2013, almost matching the 2011 record.

These statistics cover equity capital raised by specialist EST companies from venture capital, private equity and public market investors, plus government and corporate research and development in these technologies, and asset finance of projects such as smart meters, fuel cells and battery storage. They do not cover the roll-out of products such as roof insulation, energy-efficient light bulbs or electric vehicles.

In 2013, the biggest components of the $34.6 billion figure were corporate and government R&D, at $9.9 billion and $5.2 billion, followed by asset finance of smart meters at $15 billion. The R&D numbers were little changed from 2012, but smart meter financing was up 9%. The biggest deals within public markets investment in EST were a convertible issue and a secondary issue by electric car company Tesla Motors, at $660 million and $360 million respectively.

In early 2014, Google's acquisition of energy-efficient thermostat company Nest for $3.2 billion excited investors in energy-smart technologies generally.

FIGURE 27. NEW INVESTMENT IN ENERGY-SMART TECHNOLOGIES, 2004-2013, $BN



Asset finance includes smart grid and power storage only, excludes roll-out of efficiency and advanced transportation products

Source: Bloomberg New Energy Finance

CARBON CAPTURE AND STORAGE

CCS is another area of technology that could help to curb emissions, if applied to coal- or gas-fired power stations or to carbon-intensive industrial plants such as cement works. Progess with carbon capture has, however, been disappointing in recent years. Five projects at demonstration scale (1MtCO2/yr) have started construction or operations but this is still short of 2005 G8 targets of 20 operational projects by 2020.

In 2013, investment fell to just $1.8 billion, down 59% from 2012's $4.3 billion. Last year's total was split between government and corporate R&D spending, steady at $1.6 billion, and asset finance, at just $128 million compared to $2.7 billion the previous year.

One particular setback for CCS was the fact that in July 2013, only one European CCS project – Drax's White Rose in the UK – applied for funding from the European Union's New Entrants' Reserve 300 programme. White Rose did later win some UK government funding and is eligible for a share of a GBP 1 billion pot, but the GBP 2 billion project will need a great deal more outside finance in order to be completed.

In November 2013, energy ministers from more than 20 countries said that research and development in CCS should be accelerated. So far, enhanced oil recovery in North America has been the most promising enabler of CCS, since the CO2 captured from power stations can be put to paid-for use when injected into depleted oil fields.

TOWARDS COST-COMPETITIVE CLEAN ENERGY

- The costs of generating electricity via onshore wind turbines and crystalline silicon PV systems have fallen by some 15% and 53% respectively since the third quarter of 2009.
- This has sharply improved the competitiveness of these generation sources compared to conventional options such as power stations burning coal, gas or diesel, or nuclear reactors.
- In many cases, these conventional options have seen costs per MWh increase over recent years, reflecting higher capital costs and feedstock price rises in some parts of the world for gas and oil.
- An increasing number of wind and solar projects are now being built without any subsidy support. Latin America, the Middle East and Africa are in the vanguard of this trend.

Editions of the Global Trends Report from five or six years ago did not need to cover cost-competitive renewable energy – for the simple reason that the main emerging technologies were far from being cost-competitive, and significant subsidies were required to make virtually every project viable.

Two things have changed since the 2006-08 period. The most significant, by far, is that costs have come down sharply for the two leading technologies – onshore wind and PV.

The other is that project developers have become much more adept – and imaginative in some cases – at finding locations and applications for renewables that enable them to generate electricity at costs per MWh that challenge rival power sources.

EVOLUTION OF TECHNOLOGY COSTS

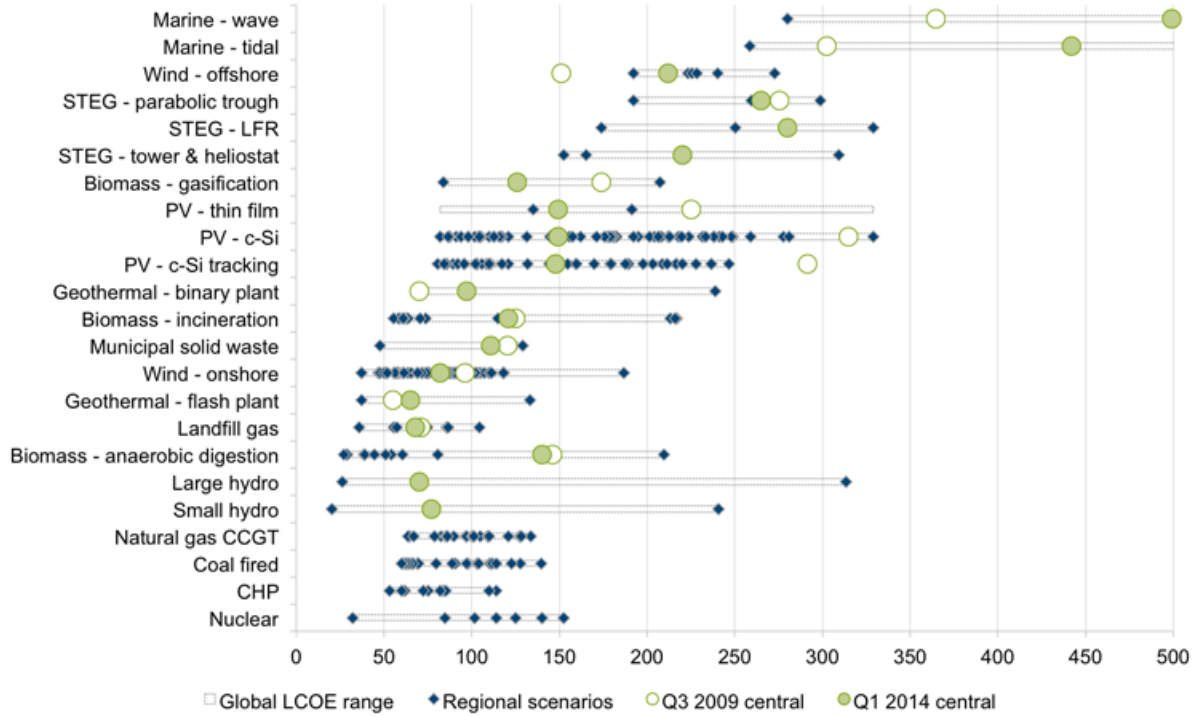
Figure 28 shows how the levelised cost of electricity (LCOE) has changed for 23 generation technologies over the period from the second quarter of 2009, when this model was initiated, to the first quarter of 2014. Levelised costs per MWh include estimates for the cost of development, construction, operation, maintenance, feedstock purchasing and the financing that made the project possible. The chart shows worldwide averages for the central figure in the case of each technology, and also the range of levelised costs for each depending on issues such as location, land cost, size of project and availability of resources.[1]

What is clear is that the levelised cost of onshore wind per MWh has fallen – by around 15% – over the five years (see Figure 29), so that the central estimate is close to competitiveness with combined-cycle gas turbine and coal-fired generation even without taking into account the environmental and social costs of carbon attributed to fossil-fuel firing. The chart also shows a wide range for onshore wind, gas and coal – so for instance in the US, the low price of gas is making it difficult for either wind or coal to compete.

The biggest cost reductions of all have come in PV. Figure 29 shows that between 2009 and the beginning of 2014, levelised costs of generation for crystalline silicon PV, the same types of panel but with tracking, and thin-film PV fell by 53%, 49% and 34% respectively. This reflects a combination of technology improvements, economies of scale in module manufacturing, savage competition for market share among those manufacturers, cost efficiencies in inverters and in "balance of plant" items such as mounting systems and cables, and improved productivity in rooftop installation and utility-scale PV project construction.

[1] Averages are not shown for the fossil-fuel generation technologies. This reflects the fact that costs around the world have diverged sharply, in response to contrasting prices for gas and coal feedstocks.

FIGURE 28. LEVELISED COST OF ELECTRICITY FOR DIFFERENT GENERATION TECHNOLOGIES, Q3 2009 TO Q1 2014, $ PER MWH



CHP = combined heat and power; c-Si = crystalline silicon; STEG = solar thermal electricial generation or concentrated solar power; CCGT = combined cycle gas turbine

Source: Bloomberg New Energy Finance

Not all renewable power technologies have improved their cost-competitiveness since 2009. Offshore wind, for instance, has seen costs rise 41% per MWh – as projects have moved into deeper water and pressure has grown on the supply of installation vessels, cables and other items. Others have shown modest progress at best – for instance solar thermal electricity generation, or CSP. Developers of relatively expensive technologies such as offshore wind, solar thermal and the early-stage marine sources, tidal stream and wave, will be working hard to try to squeeze out costs over the remaining years of the decade.

Conventional generation sources have mostly seen costs per MWh increase over the five years, with the important exception of gas-fired plant in the US. The price of gas in Europe is much higher than in the shale-glutted North American market, and in Asia it is higher still, boosted by Japan's sudden demand for it as it moved away from nuclear power after the 2011 Fukushima crisis. Capital costs for building coal-fired, gas-fired and nuclear power stations have also generally increased over recent years, reflecting labour expenses and the cost of materials such as steel.

MOVING AWAY FROM HIGH SUBSIDIES

One tell-tale sign of renewables' improving competitiveness is that subsidies have been consistently reduced over recent years in every country, and this has not killed the industry – although uncertainty about these changes has often frayed investor nerves and caused projects to be delayed.

To take two examples: the feed-in tariff on German ground-mounted PV projects was down at 9.38 euro cents per kWh in February 2014, compared to its rate of 35 euro cents per kWh in 2008. At the other end of the scale, the tariff for rooftop projects of less than 10kW has been cut from 46.75 euro cents in 2008, to 13.55 euro cents per kWh in February

FIGURE 29. PERCENTAGE CHANGE IN LEVELISED COST PER MWH, Q3 2009 TO Q1 2014, SELECTED TECHNOLOGIES, %

PV - c-Si	-52.7
PV - c-Si tracking	-49.2
PV - thin film	-33.9
Biomass - gasification	-27.6
Wind - onshore	-14.7
Municipal solid waste	-7.8
Landfill gas	-4.4
Biomass - anaerobic digestion	-4.2
STEG - parabolic trough	-3.8
Biomass - incineration	-3.3
Geothermal - flash plant	18.4
Marine - wave	36.8
Geothermal - binary plant	38.1
Wind - offshore	40.6
Marine - tidal	46.2

C-Si = crystalline silicon, STEG = solar thermal electricity generation. Other technologies have been omitted due to widely varying data points, depending on location
Source: Bloomberg New Energy Finance

this year (see the per-MWh equivalent in Figure 30), although now rooftop owners use at least some of this electricity in their buildings to replace power priced at over 27 euro cents per kWh.

In the UK, onshore wind enjoyed a banding of one Renewable Obligation Certificate per MWh until April 2013, when it was shaved to 0.9 ROCs per MWh. Under the new contract-for-difference feed-in tariff, which is being phased in during 2014-17, the proposed "strike price" for onshore wind projects qualifying in 2017-18 and 2018-19, of GBP 90 per MWh (down from GBP 95 per MWh for projects finished in earlier years) is below the GBP 92.50 per MWh that the government agreed with EDF for the 3.2GW Hinkley Point nuclear reactor, which is due to be completed in 2023. In addition, the onshore wind tariff would only last for 15 years, while the nuclear one would last for 35.

Another sign is that auctions of new generating capacity have proved effective at attracting renewable energy developers with very low bids, sometimes undercutting fossil-fuel rivals such as gas-fired plants.

In Brazil, recent federally-managed power auctions have seen clean power project developers win capacity with aggressively priced bids, in some

RENEWABLES AND MARKET POWER PRICES

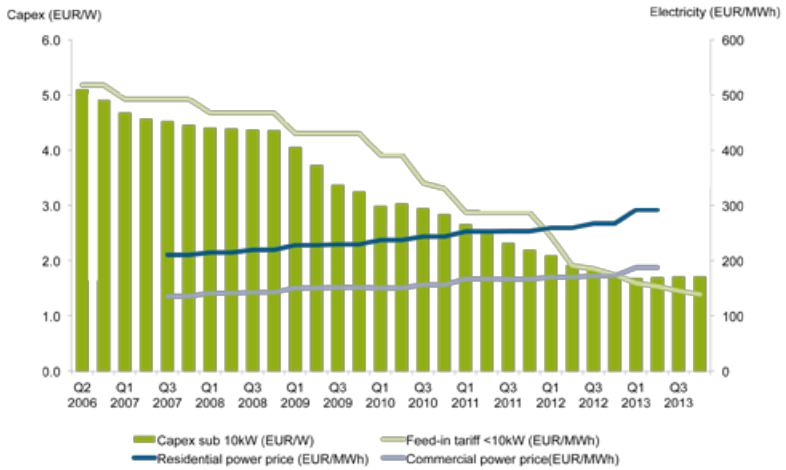
Many critics of subsidies call for wind and solar projects to be exposed to the disciplines of the electricity market as soon as possible. This may not be as straightforward as it appears, however.

For one thing, the fact that feed-in tariffs and green certificates have provided a high degree of certainty over the future revenues of renewable energy projects has helped to reduce financing costs – and therefore the total costs per MWh of wind and solar. Without that certainty, financing costs might go up, and the downward trend in total costs might be jeopardised.

Second, the effect of large amounts of wind and solar capacity in developed country power systems, such as those of Germany, Denmark and Texas, is often to push wholesale electricity prices towards zero at times when it is windy or sunny. If wind and solar projects had to rely exclusively on wholesale prices, then developers would be likely to find that it was uneconomic to build new capacity. A high degree of price certainty – whether via established subsidy arrangements or via long-term power purchase agreements – would appear to be necessary in order to make investment possible.

cases out-bidding the fossil-fuel competition. And since these auctions started in 2009, the average winning price from wind developers has declined, in terms of the Brazilian currency, from just under BRL 150 per MWh to BRL 119.10 per MWh, via what was probably an unrealistic low at less than BRL 90 per MWh at one auction at the end of 2012.

FIGURE 30. GERMAN TARIFFS AND CAPEX FOR SUB 10KW PV SYSTEMS, EUR/MWH



Source: Bloomberg New Energy Finance

On 13 December 2013, the reverse auction resulted in the go-ahead for 97 wind projects totalling 2,338MW of capacity, 16 small hydro projects adding up to 308MW, one large hydro scheme at 700MW and five biomass-to-power projects totalling 162MW. All the coal and natural gas project developers that participated in the tender failed to clinch any power purchase agreements.

In dollar terms, the average price for contracts signed was $55 per MWh, with the winning wind bids averaging $51.50 per MWh. The large hydro project at Sao Manoel was won by Furnas Centrais Eletricas and EDP at the equivalent of $35.83 per MWh. Developers of four coal-fired generation projects totalling 2,140MW and a developer of a gas-fired project of 1,238MW did not bid below $59.77 per MWh.

In South Africa, auctions have also been taking place since 2012. In November 2013, for instance, the country awarded power-purchase agreements to 1,456MW of renewable power projects, with wind averaging $71.89 per MWh, and PV plants $97 per MWh. Both prices were well below the value of winning bids in previous auction rounds, below Bloomberg New Energy Finance's LCOE estimates for the two technologies, and also below those awarded in most other auction processes around the world (although not below the Brazilian auctions, in the case of wind).

THE ASSOCIATED COSTS DEBATE

Sceptics of wind and solar argue that LCOE models do not show the full picture for comparative costs of generation, and that other things should be taken into account. First, these models often do not show associated grid infrastructure costs. Wind projects are generally sited in windy locations and these may be along coasts or up in mountains, and therefore far from the main population centres or the existing electricity network. Utility-scale solar projects may be located in deserts or other dry areas inland, a long way from cities or existing transmission hubs.

Second, rooftop PV projects now produce power at prices competitive with residential electricity prices in some countries (see below), but their owners rely on the main grid to provide power when the sun is not shining. Those owners should pay some sort of access charge for continuing to use the grid, so the argument goes. This issue has led to a number of recent changes in different countries. In the US late last year, regulators granted Arizona Public Service the power to impose a monthly charge of $0.70 per kW on new solar customers. The APS had originally proposed a high fee of $8/kW. On 24 January 2014, the German cabinet backed plans to charge operators of new renewable energy plants larger than 10kW in size a fee of EUR 0.044 per kWh for electricity they have generated themselves and then consume. Spain has also passed a charge on domestic PV owners in its latest energy bill. Charges like this are likely to spring up in many

jurisdictions as regulators allow utilities and transmission service operators to pass on at least some of the fixed costs of operating the system to PV owners.

Third, sceptics argue that since wind and solar produce variable amounts of electricity over the day and the year and lack the consistency or "dispatchability" of coal-fired, gas-fired or indeed biomass-fired or geothermal power, there is an inherent balancing cost associated with them. In other words, the electricity system needs to maintain back-up capacity – whether that is gas-fired peaking plants or electricity storage or indeed demand response contingencies, such as large electricity consumers that can earn money by switching off when required.

In the 2013 edition of its Outlook for Energy 2040, oil and gas company ExxonMobil said: "At the same time, the [power] sector will also need to manage reliability challenges associated with increasing penetration of intermittent renewables, like wind and solar. These renewables have a cost, which is often overlooked, related to reliability for times when the wind is not blowing and the sun is not shining."

There are also counter-claims on other issues that are not reflected in LCOE models. One of these is the costs of the carbon dioxide emissions created by fossil-fuel generation. At the time of writing the cost of carbon in the European Emission Trading System was between EUR 6 and EUR 7 per tonne, and it was somewhat higher in the California system at $12 per ton. ExxonMobil, in its Outlook for Energy, assumes a carbon cost of $80 per tonne in OECD countries by 2040. A second is health effects of other pollutants created by fossil fuels and resulting in problems such as the Beijing smog of recent years. A third is disaster insurance on nuclear power stations, which is effectively borne by governments rather than by developers via conventional insurance policies.

RENEWABLES INSTALLED WITHOUT SUBSIDY

The arguments above are all complex, and it is beyond the scope of the Global Trends report to adjudicate on them. What is beyond dispute is that in a number of places around the world, renewable power plants are now being installed without the support of subsidies.

There are some cases where this is not a new thing. Hydro-electric dams are being built in many emerging economies, and some developed ones too, without subsidies. One caveat is that many of the developers are public sector – research by Bloomberg New Energy Finance last year found that 14 of the 19 largest owners of hydro capacity worldwide were wholly state-owned. So they may not be subject to the same rate-of-return pressures as private-sector players.

In geothermal too, projects in Iceland, New Zealand, Kenya and the Philippines have gone ahead without any subsidy support. One recent example was the 36MW Ormat Olkaria III project expansion phase one in Kenya, financed in August 2012, another was the 20MW Dantean project in Djibouti, financed in June 2013. Both of these projects benefitted from the involvement of development banks. Certain waste-to-power projects have also gone ahead without subsidy, helped by the ability to collect gate fees in return for accepting feedstock as well as electricity prices for their output.

However, the big change in the last couple of years has been that some projects in the fast-growing but supposedly expensive sectors of onshore wind and PV have started to happen without any subsidy support.

The region that is furthest ahead in this regard is Latin America. The 70MW Solventus PV plant, developed by Total and Etrion Corporation in Diego de Almagro in the Atacama Desert of Chile, will at least initially sell electricity to Chile's central power grid. It is receiving no subsidy (though the US government's Overseas Private Investment Corporation is supplying 70% of the project cost as debt) and does not have a power purchase agreement. Prices on Chilean spot power markets often exceed $100 per MWh, and the region is one of the sunniest places in the world.

In wind, Enel Green Power's Valle de los Vientos and Talinay projects in Chile, at 90MW each and a total cost of $335 million, have also gone ahead without any subsidy support. The same is true of Mainstream Renewable Power's $70 million, 33MW Negrete Cuel wind farm, financed in February 2013 with debt from China Development Bank and equity from the developer, and relying on merchant power prices rather than a power purchase agreement.

Enel Green Power has said that key to executing without subsidy support wind projects such as those in Chile, and its Stipa Nayaa and Zopiloapan wind projects in Mexico, at 74MW and 70MW respectively and costing a total of $320 million, is the quality of the wind resource. Its chairman, Luigi Ferraris, told Bloomberg New Energy Finance in February 2014: "If you can build a wind power plant with 3,500 to 4,000 working hours per year, and a capacity factor close to 40-45%, you can be competitive with combined-cycle gas generation, as the results of the last Brazilian tenders have clearly demonstrated."

Akuo Energy, a French project developer, is building two wind farms in Uruguay, one of 42MW and the other of 50MW. Chief executive Eric Scotto said in February this year: "Uruguay is a very windy country, and it is possible to have wind projects that are competitive with, or in some cases cheaper than, the fossil-fuel alternatives. Our wind projects there do not receive subsidies. Instead the projects won a tender by offering a power price that is lower than that from thermal generation, in this case, coal. The 20-year PPA also gives the utility confidence that there will not be fluctuations in the power price due to external events."

The Middle East and Africa are other parts of the world where renewable power projects are starting to pop up, at lower cost per MWh than the available fossil fuel options. In February 2014, Scatec Solar and Norfund of Norway secured $23.7 million for a PV plant at Agahozo-Shalom Youth Village, Rwanda, East Africa's first such financing deal. "Environmentally friendly solar energy is far less expensive than diesel" was the comment from the developer, Gigawatt Global Cooperatief.

In Jordan, in November 2013, the International Finance Corporation, a unit of the World Bank, led a group of lenders providing $221 million for a 117MW wind farm to be built by Jordan Wind Project Company in Tafila in the country's south west. The IFC statement said: "The Tafila wind farm is expected to produce electricity at a price up to 25% less than that of thermal power." Jordan is diversifying into renewables from diesel generation, following attacks on the Egyptian pipeline bringing it gas.

Both Rwanda and Jordan have the characteristic that the main alternative to solar or wind was diesel generation, a fossil-fuel technology that is low-cost in terms of upfront capital but high-cost in terms of operating expenses, and also

high-emitting. This same diesel-versus-renewables choice may also start to become important in some island economies, which are either too small to merit a coal- or gas-fired power station or find that the costs of importing these fossil fuels from afar are unaffordable. Wind turbine maker Gamesa said in February this year: "In isolated areas, such as mining sites and islands, gensets [diesel generators] may be in use with electricity prices well above $250 per MWh, and wind can be competitive at $85 to $90 per MWh."

In developed economies, conditions are very different. In many cases, power demand is not rising fast or at all, in some cases the natural resource for wind and solar may be moderate rather than outstanding, and gas, coal and nuclear generation are much more likely to be the competition facing renewables. Also, many of these markets have had subsidies – feed-in tariffs, green certificates or tax incentives – and developers have relied on those to top up the investment case. However, in Spain, a country that removed feed-in tariff support altogether in 2012, some modest-sized PV projects are still taking place.

In December 2013, Grupo Enerpro, a Spanish developer, completed the country's first megawatt-scale solar park without public subsidies. The 1MW plant will sell its electricity at market prices, and Enerpro said it plans to start building a 1.5MW extension to the plant, near Seville, and five 2MW projects in 2014.

As far as rooftop solar is concerned, the cost per MWh has now fallen below retail electricity prices in a number of countries, including Denmark, Germany, Italy, Australia and Brazil, and is set to follow suit in other places if costs continue to fall. However, this is not the same as saying that PV is being installed in those places without subsidies – many of them still have subsidies, and some are starting to consider "anti-subsidies" such as grid access charges. There are unsubsidised panels being installed in many countries, especially in developing economies, but the totals are still too small to be measured. Kenya is one example – local solar financing company M-KOPA said in February 2014 that it is selling 1,000 systems per week and has provided solar power to over 50,000 Kenyan households to date with its part down-payment, part mobile-phone payment model.

In the poorest countries, the most popular form of unsubsidised solar by far, for the moment, remains solar lanterns.

SOURCES OF INVESTMENT

- Clean energy funds had a strong year overall in 2013, with an asset-weighted average growth of 17.1% compared with a 1.5% increase in 2012. The best performer saw its share price more than double thanks to a concentration on solar stocks.
- New financing vehicles are growing in popularity. Two 'yield companies' generated $631 million in 2013, and a US real estate investment trust raised $167 million. Crowd-funding is becoming a more mainstream way to raise financing for small-scale projects, in particular solar.
- Clean energy project bond issuance set a new record in 2013: some $3.2 billion raised through 10 confirmed transactions, of which seven related to solar projects, and one to offshore wind transmission. Many bond issues allowed the refinancing of operating assets, providing an exit path for lenders and project investors.
- Institutional finance is increasingly moving into clean energy, with 2013 seeing record volumes. However, those volumes remain small compared to overall institutional asset allocation, due to political, regulatory and practical hurdles.
- Development banks were again a robust source of clean-energy investment in 2013. Several also cut their funding for fossil fuels. Some countries and companies have taken the same step, in the face of increasing pressure particularly in relation to investing in coal.

FUNDS

In 2013, clean energy equities had their best year since 2007, with the WilderHill New Energy Global Innovation Index (NEX) seeing a 54% jump. As discussed in Chapter 7 on public markets, this increase was in large part driven by solar stocks, which gained over 70% last year. In contrast, the funds focusing on renewable energy and energy smart technologies tracked by Bloomberg New Energy Finance had a more modest year, though assets under management grew 17.1% compared with a 1.5% gain in 2012.

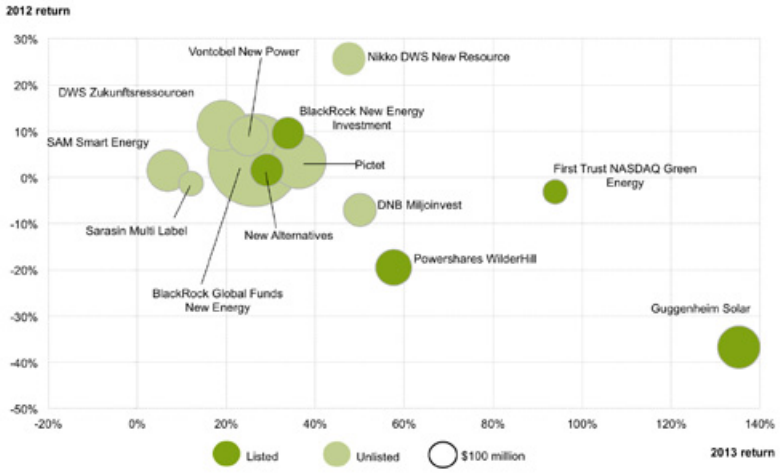
Nearly all clean energy, environment and climate change funds grew in share price, with the best performers being those with the most exposure to the clean energy sector, in particular solar (see Figure 31). Of particular note was the US-based Guggenheim Solar Fund, which saw its share price climb 138% last year and its assets under management gain a spectacular 590%. This growth was thanks to its holdings in solar stocks such as SunPower, SolarCity and SunEdison – all of which rose by over 300% in 2013.

Much of the fund-raising of 2013 involved project-oriented funds and took place in Europe: the Dutch Infrastructure Fund raised EUR 800 million ($1 billion) at final close for its fourth fund, exceeding its goal. About a quarter of the fund will go to renewable power projects in western Europe and North America. The UK in particular saw a healthy share of fund-raising: UK asset manager Glennmont Partners won a EUR 50 million ($69 million) equity investment from the European Investment Bank for its Clean Energy Fund Europe II, which targets onshore wind, solar, biomass and small hydropower projects. This announcement increases commitments in the private equity fund to EUR 250 million. London-based investor, the Environmental Technologies Fund, amassed GBP 60

million ($95.7 million) for its second fund; and Bluefield Solar Income Fund raised GBP 130 million in an initial public offering (IPO) on the London Stock Exchange in July.

Outside Europe, Nereus Capital Management raised as much as $100 million from Northern Lights Capital Group and the US Agency for International Development for its clean energy fund. The finance will be used in the construction of up to 400MW of clean-energy capacity in India. Meanwhile the Armstrong Southeast Asia Clean Energy Fund raised a similar amount in its final closing to take funds under management to $164 million[1]. Renewables plants in Latin America are also set to benefit from the $7 billion raised in the world's second-biggest infrastructure fund. Canada's Brookfield Asset Management intends to allocate 60% of the Brookfield Infrastructure II fund to projects in Brazil, Peru, Colombia and Chile.

FIGURE 31. CLEAN ENERGY FUND PRICE PERFORMANCE, 2012 AND 2013, %



Data only covers price return and funds with at least $100 million under management. Bubble size indicates market cap of fund

Source: Bloomberg New Energy Finance

Few new clean energy funds were launched last year, however, apart from in the solar sector. A $34 million fund was formed in the US by Altus Power America Management with backing from Catlin Group to finance commercial solar plants. The model is similar to the solar leases offered by companies such as SolarCity that are driving a boom in the residential sector. SolarCity itself said in September it would start a fund with Centrica to finance as much as $124 million of solar projects. The fund will make solar power available to the utility's Direct Energy business customers in North America at little or no upfront cost, meaning they will pay less for clean power than they do for electricity from fossil fuels. SolarCity also teamed up with Honda Motor in February 2013 to create a $65 million investment fund to finance rooftop projects for car buyers and dealers.

NEW SOURCES

If fund-raising was primarily limited to Europe, then North America has seen the emergence of innovative yield-oriented financing vehicles, which pass a high share of earnings to shareholders. 'Yield companies' (yield cos) enable developers to shift renewable power generation to a pure-play dividend-oriented company and provide stable, long-term cash flows. Two came to market last year: NRG Yield, a US-based entity with 1.3GW of rated generation (including solar and wind), became the first pure-play power yield co to execute an IPO on a US exchange, raising $431 million in July. One month later, TransAlta Renewables, a vehicle with Canadian wind and hydro generation assets, raised $200 million.

Other types of vehicle generating interest are the real estate investment trust (REIT) and foreign asset income trust (FAIT). The former is a business entity primarily engaged in real estate ownership and financing, and the latter is an income trust incorporated in Canada that only owns foreign assets. These vehicles help developers to convert their assets into cash, recycling capital and creating a liquid secondary market for renewable power projects while, in some cases, offering investors tax advantages. While yield cos and FAITs are currently legal options for renewable energy, REITs are awaiting government action to legalise them. April 2013 saw US-based Hannon Armstrong issue shares of its clean energy REIT, raising $167 million, but a FAIT, Threshold Power, withdrew its IPO in August, citing market conditions. It had planned to raise $140 million to buy stakes in wind assets from JPMorgan's tax equity portfolio and EDP Renewables North America.

[1] http://www.armstrongam.com/news

Crowd-funding has become more mainstream over the last year, allowing small companies and start-ups to raise capital from many small investors, in return for an equity stake, structured payments and/or products. It has become so mainstream that the UK government believes such schemes could be crucial to meeting its goal of 3GW of renewable-energy capacity under community ownership by 2020.

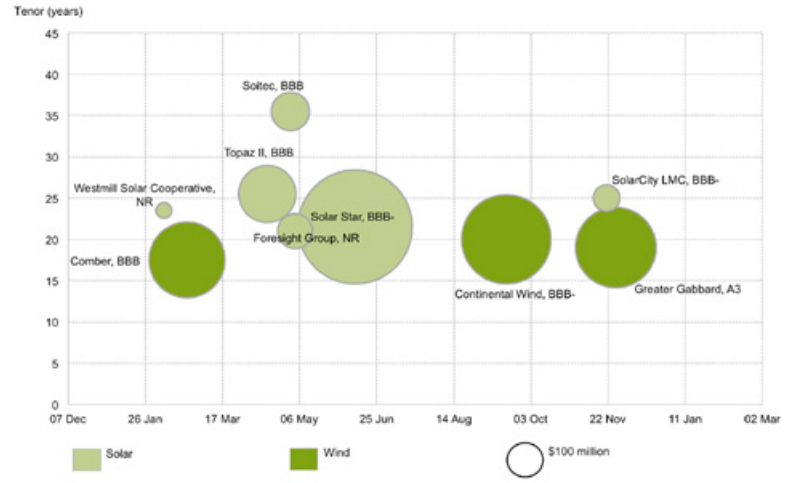
UK-based Abundance Generation raised GBP 1.6 million ($2.7 million) for four solar projects in 2013, and offered returns of between 6% and 8.6%. This compares with yields of 5.5-7% from US site Mosaic, which has raised $5.6 million for solar projects since it opened its online platform in January 2013. Singapore's CarbonStory also started its crowd-funding platform last year, where participants can contribute as little as a few dollars a month to clean-energy projects, while SunFunder closed its first note issuance in September 2013, raising $250,000 from four investors.

PROJECT AND GREEN BONDS

Clean energy project bond issuance had a record year in 2013, with $3.2 billion raised through nine confirmed transactions (see Figure 32). US-based MidAmerican Energy alone issued two project bonds worth a combined $1.25 billion, of which $1 billion was for its 579MW Solar Star PV project and $250 million for its Topaz project. Solar projects dominated the top 10 bonds by size, accounting for just under 50% of the aggregate issuance.

Perhaps the most noteworthy development was the GBP 305 million ($496 million) bond issued to fund the transmission link that will connect the 500MW Greater Gabbard offshore wind farm to the mainland grid. This was the first offshore-transmission bond and the first clean energy bond to use credit enhancements from the EU's Project Bond Credit Enhancement. This initiative aims to enhance the credit quality and standing, partially de-risking bonds, to attract capital-market investors to infrastructure projects in the region.

FIGURE 32. CLEAN ENERGY PROJECT BONDS, 2013, AND THEIR RATINGS



Tenor is years from issue to maturity. Bubble size indicates size of bond
Source: Bloomberg New Energy Finance, company filings

in their investment decisions. Subsidiary EDF Energies Nouvelles will use 25% of the funds for PV projects and 75% for wind.

Due to the lack of guidance on what constitutes a green bond, a consortium of major banks, including eight of the top 10 corporate bond underwriters, released the 'Green Bond Principles' in January this year. These voluntary guidelines outline the criteria for what should qualify as a green bond, potential types, the issuance process and the need for companies to detail their plans for the proceeds. They do not define "green" but point to suitable third party resources to help with that.

The other project bonds in the top five in 2013 by size were for onshore wind endeavours: $613 million for Exelon's Continental Wind portfolio of operating wind farms in the US; and $440 million for Brookfield Renewable Energy's Comber wind farm in Ontario.

The broader category of green bonds also saw a new high in 2013, with issuance hitting nearly $14 billion. This was primarily driven by a surge in supranational bank issuance and the emergence of 'self-labelled' corporate green bonds. The latter category comprises corporate bonds where the proceeds are explicitly ring-fenced and labelled for green purposes. But it remains a somewhat nebulous category, as until this year there were no clear guidelines for companies seeking to self-label.

The largest self-labelled corporate green bond in 2013 was EDF's EUR 1.4 billion ($1.9 billion) issue. The issue was twice oversubscribed, with 60% of the issuance allocated to investors with environmental, social and governance criteria

DEVELOPMENT BANKS

Development banks are likely to have increased their investment in clean energy in 2013, although not all have yet released final figures and so no overall total is available. One thing that could help to push the trend in the future is that several development banks in 2013 curtailed funding for coal power: the World Bank, European Investment Bank and Bank for Reconstruction and Development have said they will only support coal in rare circumstances

and if no other fuel is viable. They have been joined by the overseas aid departments of countries including the US, UK, Denmark, Finland, Iceland, Norway and Sweden. Grassroots movements like 350.org are also having increasing influence on this issue.[2] And some commercial banks are ahead of the development banks: for example Norway-based insurer Storebrand said in July it would divest from fossil-fuel firms and HSBC has committed no longer to finance coal-fired power plants with a carbon intensity exceeding 850g CO2/kWh in developing countries and 550g CO2/kWh in developed countries.

Looking at individual development banks, KfW – the biggest clean-energy development bank lender in 2012 – slightly decreased its commitments for climate and environmental protection to EUR 28 billion ($38 billion) in 2013, a EUR 1 billion ($1.4 billion) reduction on the preceding year's level. Within the organisation, the picture was mixed: the bank's business unit responsible for small and medium-sized enterprises increased its energy-efficiency programme to EUR 4.7 billion ($6.4 billion) last year from EUR 3.5 billion ($4.8 billion) in 2012. However, its renewable-energy programme shrank by 41% to EUR 4.7 billion ($6.2 billion) in 2012, due to "changes in the framework conditions". DEG, the KfW subsidiary financing private-sector companies in developing markets, increased its funding for environmental and climate protection by EUR 71 million ($97 million) to EUR 649 million ($886 million) in 2013. At the project level, KfW led the development finance arrangements for eight renewable-energy projects in Uganda under its 'Global Energy Transfer Feed-in Tariffs' programme. The small hydro and biomass projects have a combined capacity of 85MW and will receive some $56.7 million from the programme.

The European Investment Bank, another of the biggest players, raised its lending to renewables by 98% in 2013 to EUR 6.4 billion ($8.5 billion), just above the previous record figure, for 2010. Its total lending for the wider-defined area of "climate action" was EUR 18.9 billion in 2013, up from EUR 13.3 billion in 2012 but somewhat below the 2010 record of EUR 20.5 billion.

[2] http://gofossilfree.org/

The EIB lent EUR 500 million ($684 million) to EnBW's 288MW wind farm in the Baltic Sea, off the coast of Germany; and announced it will give $72 million to the first large-scale renewable independent power producer in Jordan – a 117MW wind farm. Lending to the latter project was led by the World Bank's International Finance Corporation, which also joined forces with Overseas Private Investment Corporation of the US to lend $100.4 million to SunEdison for a 50.7MW solar project in Chile, and provided EUR 38.8 million for Acciona's 30MW Jelinak wind farm in Croatia. Brazil's development bank BNDES approved financing of $51 million for the wind portfolio of Martifer and Santander in the Latin American country, and also contributed $42 million of equity for 12 biomass projects being built by Energias Renovaveis do Brasil.

INSTITUTIONAL INVESTORS

Long-term institutions such as pension funds, insurance companies and wealth managers have been showing increasing appetite for clean energy. Last year saw an acceleration of this trend in Europe, with a record volume of investment thanks to project yields of some 6% – compared with government bond yields of 2-3% – plus a high level of predictability, some inflation protection and regulatory guarantee. In this region alone, over the first nine months of last year, institutions had invested some $3.3 billion into renewable-energy private equity and infrastructure funds, quoted funds, project bonds, or directly into project equity or debt. This compares with a little over $1 billion in the whole of 2008.

While it is on the up, clean energy investment by institutions remains small compared with overall flows into European renewables of $48.4 billion in 2013. The obstacles that remain are various: some 'big' institutions such as pension funds and insurance companies may see barriers in terms of size of opportunity, in-house knowledge, conflicting approaches to portfolio investments, size of institution, concerns about the policy context, or financial regulatory issues.

In addition, many countries across the globe have been blighted by uncertainty over clean-energy policy in recent years, causing overall investment flows to tumble. Sometimes, the incentives on offer may not be suitable: for example, pension funds would likely not be interested in the tax credits on offer in the US as they are tax exempt. In some jurisdictions, pension funds are not allowed to invest in infrastructure, and in the EU, regulations prevent funds from directly financing generation as well as transmission and distribution. In Europe, there is also a question mark over what happens if and when interest rates on government securities go up, while capital-adequacy regulations such as Solvency II may limit insurers' appetite for illiquid investments.

The renewable energy sector excluding large hydro saw investment levels rise 443% between 2004 and 2013, reaching $214 billion, early chapters of this report recount. However, much larger sums than this are needed for the wider transition to a low-carbon economy – an estimated $6 trillion a year needs to be invested for this purpose in infrastructure up to 2030, according to the World Economic Forum. Of this, nearly $1 trillion is over and above the business-as-usual trajectory. Clean-energy investment can generate positive financial returns, but is disadvantaged by the current rules governing investor behaviour, according to the WEF. These often lead to short-termism and prevent environmental and resource risks from being effectively counted, resulting in a misallocation of capital towards high-risk, unsustainable and ultimately unprofitable investments. The required increase in investment to accelerate the transition to a green economy can only be unlocked by improving the financial regulatory framework – in particular, the rules and incentives governing financial markets that can disadvantage long-term sustainable behaviour.

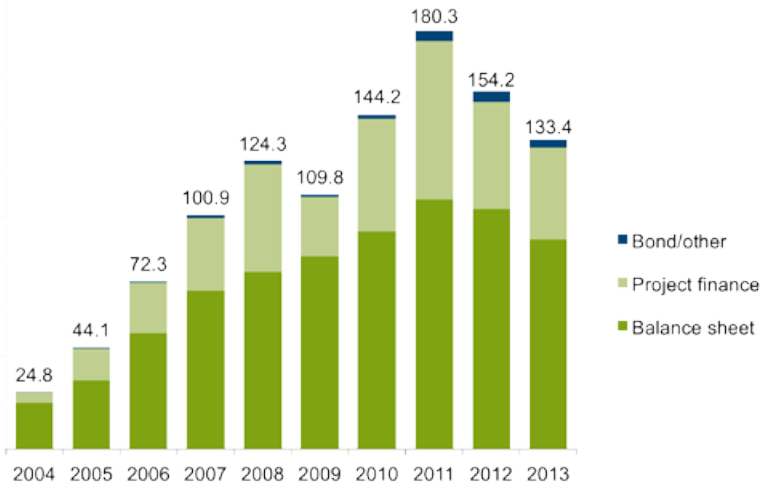
ASSET FINANCE

- Asset finance of utility-scale renewable energy projects declined 13.5% in 2013 to $133.4 billion, largely because of falling equipment costs, uncertainty over future energy support policies and reduced investment by utilities.
- Project funding dropped in Europe and the US, Brazil and India, but made modest gains in China, the rest of the Americas, Asia (excluding China and India) plus the Middle East and Africa. China saw by far the largest asset finance figure, at $53.3 billion, up 5%.
- Wind accounted for $75.4 billion, more than half of the asset finance recorded in 2013, even though its dollar figure was down for the third consecutive year. It stayed ahead of solar, at $44.4 billion, down for the second year in a row, reflecting lower costs per MW installed.
- Biofuels, the second biggest sector for asset finance back in 2006-07, saw asset finance slump to just $1.5 billion, down 58% as demand for new first-generation capacity stalled and second-generation projects progressed only slowly.
- Some 68% of renewable energy asset deals were done on-balance-sheet by utilities and energy companies, while 30% took the form of non-recourse project finance and the remainder included bond financings, leasing and other mechanisms.

Global investment in new, utility-scale renewable power infrastructure peaked in 2011 and has been in decline since then. In 2013, as Figure 33 shows, a total of $133.4 billion was channelled into development and construction of wind, solar and other renewable power projects of more than 1MW and biofuel plants with a capacity of more than one million litres per year.[1] This was 13.5% less than in the previous year and 26% down on the record $180.3 billion invested in 2011.

The volume of renewable power asset financing reflects in large part the number and scale of investment opportunities and how attractive they are to investors. This varies according to the quantity and quality of natural resources in each country, the availability and cost of other sources of power, plus the level and stability of national and regional government support for the sector. The last-named includes renewable energy targets, the efficiency

FIGURE 33. ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY TYPE OF SECURITY, 2004-2013, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

[1] Hydroelectric projects of 1-50MW are included in this total, those of more than 50MW are excluded.

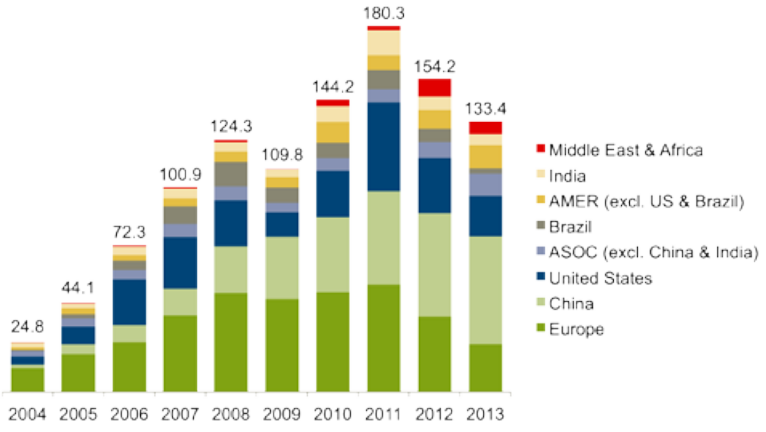
of the planning regime and the all-important subsidies, and is known to fluctuate as politicians come and go.

The ability of investors – including commercial banks, institutional investors, utilities and large corporations – to continue funding capital-intensive renewable power projects is another key factor governing the level of investment in the sector. The financial rollercoaster of recent years, both in Europe and beyond, has diminished the strength of some major players and ushered in a new era of tighter regulation.

Figure 33 makes clear that all three major types of asset finance declined in 2013. On-balance-sheet financing by utilities and energy companies slipped 13% to $90.4 billion last year, while non-recourse project finance (in which lending and equity provision is to the project itself, not to the developer) fell 15% to $39.4 billion and bond and other financing methods dropped 20% to $3.6 billion. Mostly, these declines reflected circumstances in countries round the world rather than pressures specifically on banks and utilities – although in Europe, there were cutbacks in investment by some important utilities such as E.ON and RWE as they strove to bolster weak balance sheets.

The 2013 renewable energy map can be divided into those countries where the volume of asset finance declined and those where it increased. As Figure 34 shows, the biggest falls were in the traditional markets of Europe and the US, with less pronounced slippages in the newer centres of Brazil and India; while the group showing

FIGURE 34. ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2013, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

increasing investment was led by China, the rest of Asia, the Americas (except Brazil and the US) plus the Middle East and Africa. Few markets have managed to maintain high levels of investment for long periods of time, although China appears to be the exception.

While asset finance in the US and Europe fell away, China was left standing head and shoulders above the rest of the world. Investment increased in the Asian nation but only modestly in percentage terms, by 5%. A total of $53.3 billion was recorded, up from $51 billion in 2012. This was the country's highest level yet and was equal to some 40% of global asset finance investment in renewables, thus consolidating China's position as the world leader in deployment as well as manufacturing.

Solar installation in China jumped to around 12GW in 2013 from 3.6GW in 2012, while wind power additions were unchanged from the previous year at about 14GW. Given such a vast increase in new solar capacity, it is surprising that financing levels did not increase by more. It helped that a shift towards utility-scale assets, which are cheaper to build per MW than residential or commercial projects, and have generally lower system costs, exerted downward pressure on average prices per MW.

A nationwide credit squeeze also took its toll on overall asset financing levels in 2013. China's central bank, the People's Bank of China, bumped up the lending rate on loans of more than five years a total of five times between the end of 2010 and July 2012, to just over 7%. These increased financing costs poured cold water on the renewable power market, which saw asset finance fall to just $4 billion in the first quarter of 2013, compared with $5.8 billion in the equivalent period in 2012. Investment recovered as the year progressed and interest rates declined.

The cost of debt has persuaded some Chinese power companies to begin using other financing strategies such as structured loans and bond issues to help meet their liquidity needs. In December 2013, for instance, China Longyuan Power Group, the nation's biggest wind project developer, finalised a CNY 1.7 billion ($279 million) offshore syndicated loan between three banks. The loan has an interest rate of 110 basis points above the three-month Hong Kong Inter-bank Offered Rate, with an interest rate floor of 3.75%. The lowest rate offered to a company for a one-year-plus loan by a Chinese state-owned bank in 2012 was 5.9%. China Longyuan also raised CNY 6.8 billion ($1.1 billion) through two bond issues last year.

Europe saw just $23.5 billion of asset financing last year, down 37% and the lowest level since 2005. This was partially due to falling prices for renewable energy hardware, notably PV panels and

onshore wind turbines, but was also a consequence of sharp declines in development of both new solar and wind power generating capacity. In Spain, for instance, onshore wind capacity additions in 2013 are estimated to have been just over 200MW, compared to 1.1GW in 2012, while in Germany, although additions may have increased to 2.6GW in 2013 from 2.4GW the previous year, the slowdown in financings last year is likely to reduce installation to just 1.2GW in 2014. A narrowing of the European pipeline for utility-scale wind and PV reflected cuts in investment by some of the power utilities – for instance, RWE, one of the largest German utilities, said in March 2013 that it would reduce spending on renewables by half to about EUR 500 million ($685 million).

It also reflected uncertainty over future energy support policies in countries such as Germany, the UK, France, Sweden and Poland and a lack of investor confidence in southern and southeast Europe owing to disorderly changes of policy in the recent past. Nevertheless, there were some significant financings in 2013, including the 288MW Butendiek offshore wind farm ($1.9 billion) in German waters of the North Sea in February, the 228MW Pen y Cymoedd onshore wind farm ($609 million) in Wales in June and the 60MW Dalkia biomass plant portfolio ($308 million) in France in May.

The decline in European asset finance in 2013 did not stem from a shortage of project debt; for instance, in countries where investor confidence is intact, there is strong competition between banks to lend to wind and solar projects. Institutions such as pension funds, insurance companies and wealth managers are also displaying heightened interest in providing equity or debt to operating-stage projects.

2013 saw record flows of institutional money into specialist, quoted project funds and also directly into European projects. Allianz, Europe's largest insurer, pioneered the latter approach in the early part of the last decade, and now has a renewable energy portfolio of more than 1GW. A number of Danish pension funds were active in the European offshore sector last year, and PensionDanmark pledged $200 million in funding to the proposed 468MW Cape Wind offshore wind project in Nantucket Sound, which may become the first offshore project in the US.

In the US, asset financing fell to $19.8 billion in 2013, less than half of the record $43.7 billion achieved in 2011 and its lowest level since 2009. Political wrangling over the extension of the wind energy subsidy, the Production Tax Credit, was largely to blame. Deadlock on Capitol Hill saw the PTC expire briefly at the turn of the year 2012-13 before a last-ditch effort revived it for a further 12 months; however, by then the damage had already been done. The weight of uncertainty meant developers front-loaded their projects into calendar years 2011 and 2012, leaving the pipeline for 2013 almost empty. Installation duly plummeted to around 1.5GW in 2013 from 13.6GW in 2012, yet financings picked up towards the end of the year and developers of some 11GW of wind projects have announced off-take agreements for 2014-15.

Despite this uptick in power purchase agreements with utilities, US wind and solar developers continued to face the challenge of the boom in cheap shale gas. This has reduced the amount that utilities were prepared to pay for renewable power and, consequently, average power purchase agreement prices have plummeted. Unsurprisingly, there is some scepticism in the industry about the economic viability of renewable power projects

supported by extremely cheap PPAs. In the solar sector there have even been reports of developers struggling to find a buyer or financier for projects because internal rates of return are too slim under contracted PPA terms.

Asset finance in the Asia-Oceania region excluding China and India rose 38% to $11 billion, with Japan, Australia and Thailand the three countries recording $1 billion or more of activity. Japan's attractive solar feed-in tariffs ensured that it was a growth market in 2013, financing of utility-scale projects doubling to $5.6 billion. There were a few large deals, such as the JPY 39.4 billion ($497 million) project finance syndicate led by Bank of Tokyo Mitsubishi UFJ for the 148MW Eurus Energy Rokkasho PV project, and JPY 23 billion ($297 million) for the 70MW Kyocera Nanatsujima PV plant, but most of the deals were much smaller in both yen and MW terms. Government lenders such as the Japan Finance Corporation were a major source of funds, while private lenders focused on smaller-scale asset-based lending, which is similar to project finance. More sophisticated methods look set to emerge in the year ahead. For instance, Japan Asia Group, a solar developer, raised JPY 1.5 billion ($15 million) by securitising the non-recourse loan portion of three solar projects.

Japan's renewable power market is expected to keep on growing. A further 10GW of utility-scale and small-scale capacity is forecast both this year and in 2015, which will bring to 30GW the total added between the Fukushima disaster in 2011 and the end of 2015. By then, PV will represent around 4% of electricity generation, close to the grid's limit in many regions. If the market is to continue to expand in the second half of the decade, more attention will have to be paid to the challenge of integration, that is to say grid management, flexible generation capacity, energy storage and smart meters.

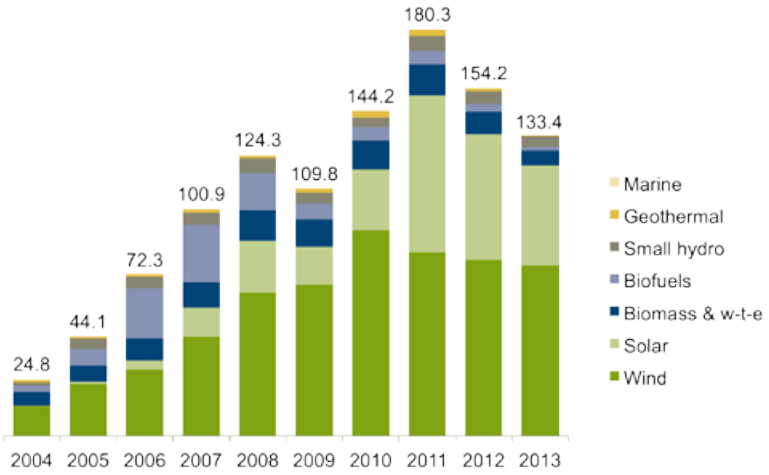
In Australia, asset finance moved up to $2.1 billion in 2013, from $1.1 billion the previous year. Among the main transactions were $406 million for the 182MW AGL Nyngan & Broken Hill PV portfolio, and $334 million for the 113MW Boco Rock wind farm phase one. Thailand's largest deal was $348 million for the 90MW Energy Absolute Nakhon Sawan PV plant.

India saw asset finance slip 21% to $5.4 billion in 2013, and relied for that figure on a stream of medium-sized and small transactions, rather than huge projects. Among the larger ones financed last year were the 130MW Welspun Neemuch PV plant, at a cost of $221 million.

A breakdown of last year's global asset financing activity into the various different technology groups – as shown in Figure 35 – reveals that the money committed was lower in 2013 than in 2012 for all the technologies. New wind infrastructure once again accounted for the largest share of the global total, despite the fact that it has declined every year since 2010, when it peaked at $91.1 billion. The $75.4 billion recorded in 2013 represented 56.5% of investment across all sectors, compared with $44.4 billion for solar, equal to 33.2% of the overall total.

The biggest wind deals related to offshore projects in Western Europe – the Butendiek offshore wind farm (discussed above), the Baltic II offshore wind farm ($1.6 billion) and Westermost Rough offshore wind farm ($1.4 billion) – all of

FIGURE 35. ASSET FINANCING NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2013, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

which were completed in the first quarter of the year. Since then, Dutch offshore wind project Luchterduinen secured financing in September, but the rest of Europe has been silent, giving rise to worries that developers and financiers are backing away from the sea-based wind sector owing to exorbitant costs.

In February 2014, E.ON, a German utility, together with Dong Energy and Masdar Abu Dhabi Future Energy abandoned plans to expand the London Array offshore wind farm beyond the 630MW installed. While developer E.ON highlighted concerns about disrupting the wintering grounds of the red-throated diver, the broader threat to the industry is its failure to bring down costs quickly enough in nations that are increasingly concerned about the price of electricity.

In the three months since 26 November 2013, when RWE walked away from the Atlantic Array, a GBP 4.5 billion ($7.3 billion) wind farm in deep seas off south-west England, each of the six largest UK utilities has retreated from offshore projects, scrapping as much as 5.7GW of planned capacity. The UK government says offshore wind ambitions remain on track, though the Department of Energy and Climate Change cut its forecast in December. It expects there will be about 10GW of capacity by 2020, down from a 2011 prediction of 18GW. In November 2013, Germany's newly elected coalition government slashed the country's 2020 target to 6.5GW from 10GW.

The decline in solar asset finance in 2013 reflected lower costs per MW rather than declining activity, but this was not the case for the other technologies. Biomass and waste-to-energy asset finance retreated 31%, biofuels 58% and geothermal also 58%. The causes included policy uncertainty and low carbon prices in Europe (in the case of biomass), the lack of new market opportunities in biofuels in the US or Brazil, and a temporary pause in the flow of investment decisions in important geothermal locations such as East Africa and South East Asia.

LARGE HYDROPOWER

Large hydropower projects of more than 50MW represent the third most important destination for investment within renewable energy, after solar and wind. A mature technology, with average construction period of four years or so per project, large hydro tends to be less sensitive to swings in international policy and financial market conditions than the newer renewable generation technologies.

Figures on the amount of capacity added in 2013 were still being calculated as this report went to press, but it looks likely to be at least 20GW, close to the 22GW total estimated for 2012.

Timing differences make it hard to infer much from company sales about the actual level of hydro project commissioning in any one year. However, sales do give clues on the trend in the sector. Statements from leading equipment providers have mostly pointed to firm sales in 2013. Andritz said that hydropower sales were up 5% year-on-year in the first three quarters of the year, while Voith reported a 6% rise in the year to September 2013 and Dongfang Electric a 10% rise in the first half of 2013. Only Harbin Electric of the main suppliers that report separate figures for hydro revealed a fall in sales, of 11% in the first half of 2013.

However, even if sales of equipment held up, forward-looking indications were less rosy. Andritz said its hydropower order intake was down 19% year-on-year in the first three quarters of 2013, while Voith reported a 10% fall in orders in the year to September 2013, describing the global hydropower market as continuing to "cool off".

Project milestones reached during 2013 included the start of generation at the first 770MW unit of China's 13.9GW Xiluodu project, China Exim's $500 million loan to the 270MW Soubre Dam project in Cote d'Ivoire, and turbine orders for the 700MW Cambambe II project in Angola and the 636MW Upper Kalekoy plant in Turkey. Congo started efforts to finance the $11.9 billion, 4.8GW Inga III dam.

SMALL DISTRIBUTED CAPACITY

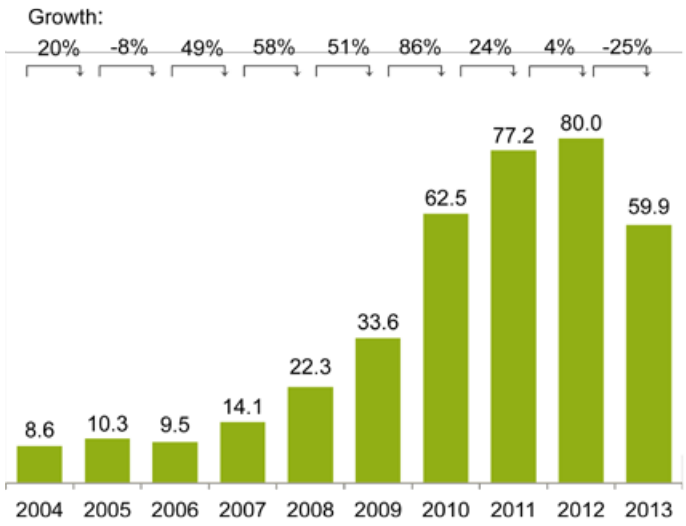
- Investment in small-scale solar capacity fell by 25% to $59.9 billion in 2013, ending a six-year run of uninterrupted growth, as subsidies in Europe continued to be cut and average system prices fell.
- Most of the major markets saw large declines in new investment: Germany, Italy, France and the UK all recorded falls of between 50% and 80%. Investment in small PV systems in China also declined as the 'Golden Sun' rooftop incentive scheme tailed off.
- The outstanding exception was Japan, where a generous solar feed-in tariff introduced mid-2012 led to an increase in small-scale investment of 76% to $23 billion. This made Japan by far the largest market, almost three times bigger than the US, the next largest, which grew 11% to almost $8 billion.
- Although average PV module prices rose slightly over the year, particularly in the second half, installers and engineering firms continued to cut other costs, so each dollar of investment bought more capacity than previously.
- New additions of residential and commercial PV capacity shrank 5% to an estimated 18.3GW, compared with 19.3GW in 2012.

Investment in small-scale generating capacity slumped by a quarter from $80 to $59.9 billion in 2013, as shown in Figure 36. At a country level, there were several large declines, offset partly by a couple of notable increases, in Japan and the US.

Growth in global small-scale capacity shrank by a lower percentage than did dollar investment. Capacity additions in 2013 were down 5% to 18.3GW – as falling solar system prices made each investment dollar stretch further. Figure 37 shows that system costs for PV units of less than 1MW continued to come down in several important markets even though the module price stabilised in 2013 after several years of savage falls.

Amid the global contraction of small-scale investment, Japan stood out with a 76% increase to $23 billion in 2013 (see Figure 38). Japan is now the largest market by far, and almost three times bigger than its nearest rival, the US. Small-scale capacity growth in Japan jumped from 2.1GW in 2012 to 5.3GW in 2013, a two-and-a-half-fold increase driven largely by commercial installations. Utility-scale projects are proceeding more slowly as land rights and other obstacles

FIGURE 36. SMALL DISTRIBUTED CAPACITY INVESTMENT, 2004-2013, $BN



Represents investments in solar PV projects with capacities below 1MW
Source: Bloomberg New Energy Finance

hold up inexperienced developers, but commercial installations increased more than six-fold to 3.2GW. The strong growth is due to the generous subsidies introduced by the government to replace nuclear capacity shut down after the Daiichi-Fukushima disaster: the 10-10,000kW commercial sector earns $0.38 per kWh, while the residential sector receives a capital expenditure subsidy of $0.20 per Watt and gets $0.35 per kWh for any surplus electricity in the first 10 years. The capital subsidy is due to be scrapped this year, but analysts do not expect this to stall the market, since Japan has some of the highest system prices in the world and therefore plenty of potential for cost reductions. They forecast 6.9GW of new-build residential and commercial installations in Japan in 2014.

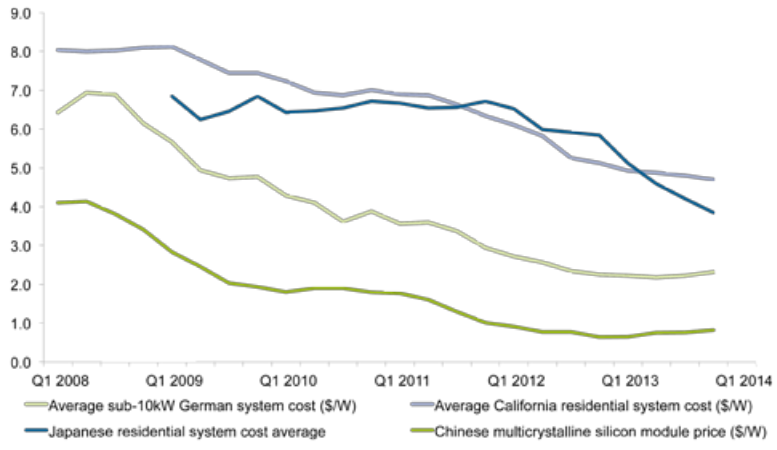
The US market in small-scale renewables also grew in 2013, up by 11% to $7.9 billion, while capacity additions increased by 26% to almost 2GW. The federal Investment Tax Credit, which allows 30% of system capital costs to be deducted from the owner's tax bill, is in place until 2016, and business models set up to take advantage of it are gaining momentum, with successful fundraisings by third-party financiers of residential projects such as Sunrun, SolarCity and SunPower. In the biggest US market, California, the economics of residential and commercial solar remain favourable, despite the winding down of the California Solar Initiative, the state's performance-based support scheme. The price of a residential system in California fell from $6 per Watt in 2012 to $5 per Watt in 2013, including 'soft costs' and profits, and commercial systems were even cheaper. This compares with German systems well below $2.50 per Watt.

Across the US, as elsewhere, subsidies are being revised, but Bloomberg New Energy Finance analysts expect strong growth in the US market for the next three years driven by the Investment Tax Credit and widespread net metering – when the PV unit exports to the grid, the owner's meter runs backwards – although the latter is being challenged by utilities in the courts. Further resistance to net metering rules may emerge as PV uptake grows.

In the European Union as a whole, small-scale investment fell steeply to $15.9 billion in 2013, from $42.8 billion in 2012, itself a reduction from the record of $55.4 billion in 2011.

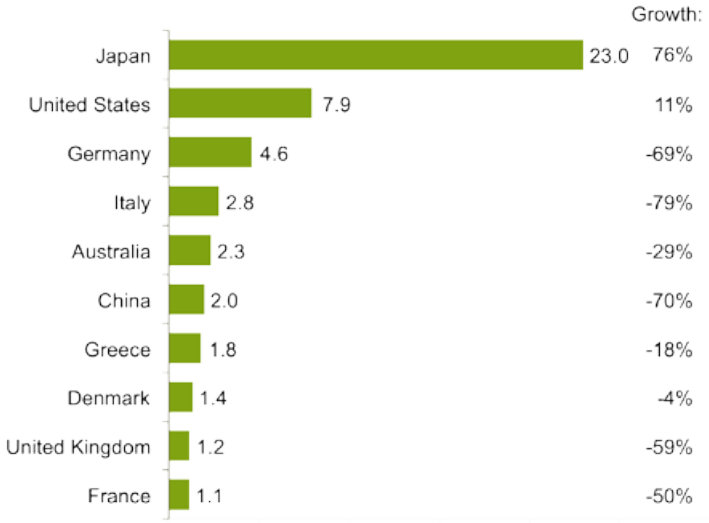
Germany and Italy each saw investment slump by more than $10 billion. Another $4.7 billion of decline took place between three other EU states – Belgium, France and the UK. New investment

FIGURE 37. SMALL PV SYSTEM COST IN JAPAN, GERMANY AND CALIFORNIA, AND TREND IN CHINESE MODULE PRICES, $ PER WATT



Source: Bloomberg New Energy Finance

FIGURE 38. SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2013, AND GROWTH ON 2012, $BN



Top 10 countries. Represents investments in solar PV projects with capacities below 1MW
Source: Bloomberg New Energy Finance

declined as continuing cuts and reforms to subsidy regimes finally tamed demand. In Europe, most countries are well on track for the 2020 solar installation targets laid out in their National Renewable Energy Action Plans, and with grid parity already present in places at the residential and commercial level, are trying to avoid paying unnecessary subsidies (see Chapter 3).

Investment in small-scale projects in Germany slumped by almost 70% to $4.6 billion, as shown in Figure 38, scarcely a fifth of its peak level in 2010, as the repeated cuts to previously generous solar feed-in tariffs finally found a level that doused demand. German annual new installations fell to 3.3GW, finally within the government's "acceptable corridor" of 2.5-3.5GW after three years at more than 7GW – although residential consumers continued to build at a steady rate, partly to generate electricity for their own consumption. From August 2014, it is likely that PV systems over 10kW in Germany will have to pay a small tax on auto-consumed electricity.

In Italy, investment in small-scale projects plunged almost 80% to $2.8 billion, little more than an eighth of its peak in 2011. Again, the fall in capacity additions was not quite so great – down by 64% from 3.3GW to 1.2GW – as solar systems got cheaper. In Italy, the feed-in tariff budget for newly connected systems ran out in the middle of 2013, although there are still a range of tax incentives to invest in solar. The capital cost of systems of up to 20kW, for example, can be offset against income tax over 10 years. Italy also supports PV through a form of net metering – power exports to the grid are refunded at the wholesale power price, which is much less attractive than auto-consumption but worthwhile if all power cannot be used immediately by the system owner. The tax breaks will be phased out over the next two years. Bloomberg New Energy Finance estimates that Italy installed around 1.5GW of solar in total in 2013, but again expects utility-scale projects to dry up, leaving an annual market of some 600MW in small-scale residential and commercial installations from 2014.

In Belgium, investment dropped by more than three quarters to $570 million, while in the UK, it fell almost 60% to $1.2 billion, and in France it halved to $1.1 billion. As elsewhere, these declines partly reflected a shift to less generous tariff support, in the French case a 25% cut in tariffs for building-integrated PV systems of less than 36kW, and partly the effect of lower system prices.

In Spain, 2013 was another year of policy retrenchment, and in July the government scrapped all FiTs for existing plants and replaced them with a guaranteed return of 7.5%. Investment in residential and commercial PV fell from $390 million to $320 million, less than a third of its peak in 2010. An increasing number of Spanish projects were built on a 'grid parity' basis, without recourse to subsidy. The German solar company Conergy developed over 50 small projects in Spain with a total capacity of around 1MW on this basis. The first was on the roof of an organic restaurant on the beachfront in Barcelona, an establishment that consumes large amounts of electricity during the day. Conergy designed the system to ensure the restaurant consumed almost 100% of the power generated, so maximising the saving on its electricity bill, and it was this that

made the economics work. However, in August Spain started to tax auto-consumption of solar power, ending the market for the foreseeable future in that country.

Spending in China on small-scale projects slumped from $6.5 billion to just $2 billion, as capacity additions fell from 1.6GW to 1GW. This was entirely due to a temporary drop in commercial installations as the Golden Sun capex subsidy programme ended, while at the same time solar companies rushed to complete utility-scale projects connected to the transmission grid in order to meet a FiT deadline. Commercial installations fell from 1.4GW to 800MW, while utility-scale projects soared from 2GW to more than 10GW. The new incentive programme for Chinese distribution-grid-connected commercial rooftop PV systems came in only late in the year, and there is still some uncertainty about its implementation but it will drive some commercial build-out in 2014. Small-scale renewable investment is expected to recover in China this year, even though residential installations are expected to remain modest.

Many other businesses around the world with large roofs and high daytime power demand are starting to take advantage of lower prices. NEXTDC M1, a data centre in Melbourne, installed almost 1,600 solar panels across 3,000 square metres of roof space to produce around 550MWh per year – enough to power 88 average Australian households – and cut its electricity bill significantly. The project will also save 670 tonnes of CO2 per year. Meanwhile in Singapore, the supermarket group Sheng Siong installed the country's largest PV array on the roof of its distribution centre. The installation covers 11,000 square metres and has a generating capacity of 1.2MW, which should supply at least 15% of the centre's electricity and save 730 tonnes of CO2 per year. It expects a payback period of 7-10 years.

In another record-breaking installation, SunWize Technologies, the solar developer wholly owned by Mitsui, agreed to develop the largest solar system in Samoa. The 546kW system, financed by Japan through the Pacific Environment Community Fund, was designed to be built across three sites on two islands, to produce 700,000kWh per year in a country that currently generates 60% of its power from expensive imported diesel. The system is designed to withstand 124mph typhoon winds and highly corrosive sea air; the canopy and ground-mounted frames are galvanised to extend the system's life to the usual 25 years.

PUBLIC MARKET INVESTMENT

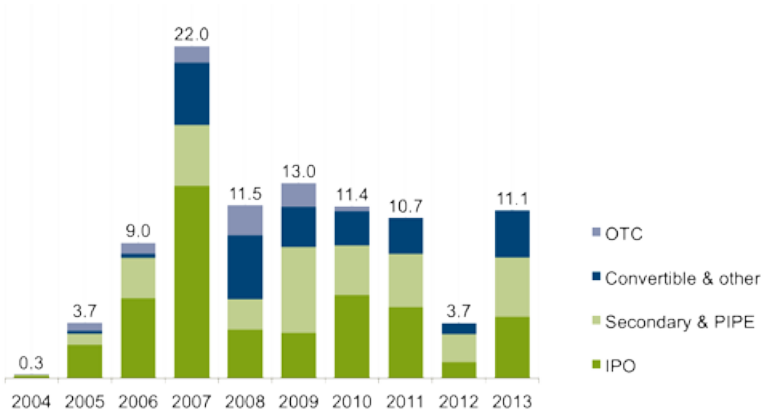
- Public market investment in renewable energy companies and funds recovered to average levels for the previous five years in 2013, at $11.1 billion, after a slump the previous year to just $3.7 billion.
- Solar companies raised $4.8 billion, more than any other sector. Wind trailed behind with $2.6 billion.
- US companies raised more than any other nationality, with activity centred on the New York Stock Exchange. The London Stock Exchange narrowly beat Nasdaq Global Select Market to second place.
- The WilderHill New Energy Global Innovation Index, or NEX, which tracked 96 clean energy companies in 2013, rose 53.9% in 2013, its best year since 2007.

Resurgent interest in clean energy shares paved the way for a rebound in renewable stock offerings in 2013. As shown in Figure 39, there was $11.1 billion of investment in public equity last year across all deal types globally, sharply higher than the previous year's $3.7 billion and comfortably within the range established in the years 2008-11. This uptick ran contrary to the downturn in overall renewable energy finance last year. Activity was fairly evenly split between three main deal types – new and secondary share sales and convertible bond issues, with the latter two categories making up a larger share of the total than, for instance, in the peak IPO year of 2007. For the second year running, there was no over-the-counter issuance by renewable energy companies.

Clean energy share prices had their best year since 2007. The WilderHill New Energy Global Innovation Index, or NEX, which tracked 96 clean energy companies in 2013 worldwide, rose 53.9% to 184.73, but even then was still about 13% below its level eight years earlier, at the end of 2005. The NEX's all-time high was 468.75 in November 2007. Taking 2013 on its own, the NEX's performance outshone even the heady annual returns of broad market measures: the technology-centric Nasdaq Composite Index swelled 38.3%, while the S&P500 Index of large-capitalisation stocks surged 29.6%. Figures 40 and 41 show how clean energy stocks have sharply under-performed, and out-performed, wider markets at different times.

The rally in clean energy share prices was a broad one. Solar shares kicked into a strong upward trend almost from the very start of the year, as Figure 42 illustrates. That chart shows that while the NYSE Bloomberg Global Solar Energy Index climbed strongly during the year, so did its equivalent wind index and the NYSE Bloomberg Global Energy Smart Technologies Index, which tracks the performance of companies in areas

FIGURE 39. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2013, $BN



PIPE = private investment in public equity, OTC = over-the-counter
Source: Bloomberg New Energy Finance, UNEP

such as smart grid, efficiency and advanced transportation. The only clear difference is that the upturn in solar started a few months later than it did for the wind or EST indices, probably reflecting a later improvement in profit margins in that sector.

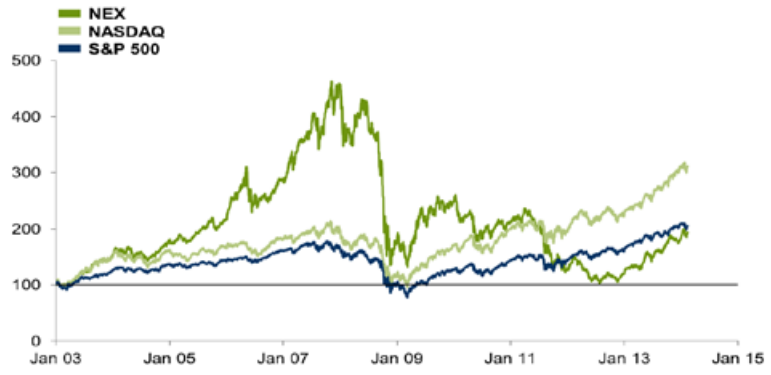
Renewed interest in renewable energy echoed the recovery in public equity across a broad range of sectors in both Europe and the US. Thanks to a rising stock market, low interest rates, reduced volatility and increased risk tolerance among investors, 2013 was the best year for the US IPO market since the dotcom bubble of 2000, while European IPO proceeds more than doubled the total raised in 2012. Investors in Europe breathed a collective sigh of relief as the long-running euro area sovereign debt crisis abated.

Fund-raising by renewable power and fuel companies got off to a slow start last year, but soon accelerated thanks to a handful of large IPOs in the second quarter. It subsequently declined in the third quarter before rallying strongly in the final three months of the year.

The first sign that confidence was starting to return to the sector came at the end of 2012 with an IPO by California-based solar installer and financier SolarCity, which raised $92 million. The stock subsequently surged 376% in 2013. Momentum across the wider clean energy sector increased in March when California-based Silver Spring Networks, a maker of networking equipment for smart electricity grids, raised $80.8 million from an IPO.

Investment really took off in the second quarter as a number of IPOs came to market. The latest wave of enthusiasm felt very different from the clean energy mania that gripped public market investors back in 2006 and 2007. Back then, investors were buying into technology-led growth companies in what was then a young, niche sector. This time around, they are after something altogether more tangible – yield.

FIGURE 40. NEX VS SELECTED INDICES

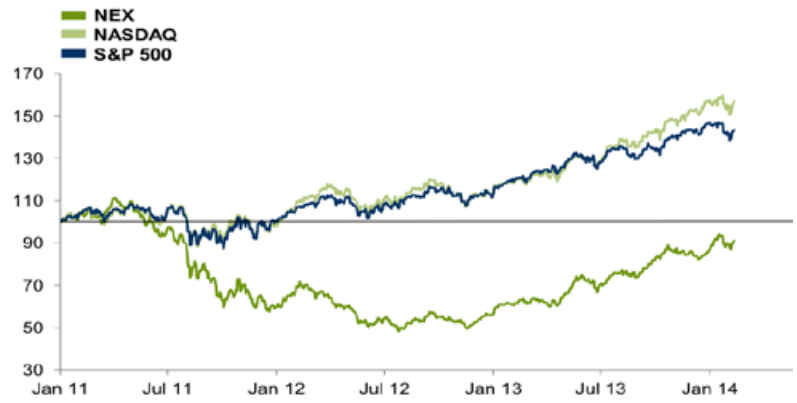


Index values as of 11 February 2014; Nasdaq and S&P 500 rebased to 100 on 1 January 2003
Source: Bloomberg New Energy Finance

In July 2012, the yield on UK 10-year government bonds reached a low of 1.4%, having been 5.6% in July 2007. Meanwhile, in the US, the 10-year Treasury bond yield slumped to 1.4% at the end of July 2012, down from 5.3% in June 2007. Although both these rates had more than doubled to just over 3% by the end of 2013, they were still well below their averages for the last 20 years of 4.8% and 5.1% respectively.

Such low rates have prompted investors to search elsewhere for stable, low-risk investments that

FIGURE 41. NEX VS SELECTED INDICES



Index values as of 11 February 2014; Nasdaq and S&P 500 rebased to 100 on 1 January 2011
Source: Bloomberg New Energy Finance

offer higher yields. One area that fits the bill is clean energy infrastructure – it offers predictable cash flows, often backed by governments, with an element of inflation-proofing and yields nearer to 6%. Thus, when IPO prospectuses from renewable energy infrastructure funds started to land on investors' door mats last year, the latest phase in clean energy investing began to take shape.

Greencoat UK Wind set the ball rolling in March when it raised GBP 260 million ($395 million) from an IPO on the London Stock Exchange. The premise was simple – it would begin by acquiring 127MW of operating on- and offshore wind farms in the UK, and aim for an annual return of between 8% and 9%, plus a six-pence annual dividend rising in line with inflation. It raised a further $135 million from a follow-on offering in December.

In July 2013, The Renewable Infrastructure Group, or TRIG, wooed investors with plans to buy 300MW of operating wind and solar assets in the UK, Ireland and France. It raised GBP 300 million ($478 million), a record for a British clean energy IPO. Next, Bluefield Solar Income Fund raised GBP 130 million ($196 million) in July and three months later, Foresight Group, a London-based asset manager, raised GBP 150 million ($242 million), also for a solar-focused fund. This was less than initially mooted, possibly due to a mild case of investor indigestion after seven months in which UK-quoted renewable energy project funds raised a total of $1.3 billion. Nevertheless, investor appetite appears to be still intact and this year is likely to see the launch of similar funds.

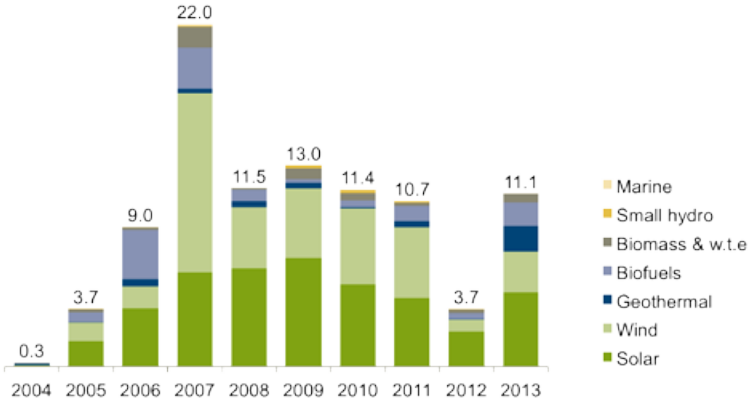
Investors in vehicles such as these yield vehicles have included blue-chip institutions with no prior record of involvement in clean energy. CCLA Investment Management, the UK's biggest money manager for charities and religious organisations, bought 20% of Bluefield's offering. Investec Wealth and Investment took a large stake in Greencoat, while Henderson Global Investors invested GBP 2.4 million ($3.8 million) in TRIG.

North America saw a flurry of similar activity –there were three IPOs by shell vehicles created specifically for flotation on the public markets, so-called "yield cos", entities set up specifically to provide investors with a relatively high dividend yield from a portfolio of operating-stage assets. NRG Yield, a US-based yield co operating 2.9GW of rated generation (568MW of which is renewable), raised $431 million from an IPO in July. TransAlta Renewables, a yield co operating 1.1GW of Canadian wind and hydro

FIGURE 42. NYSE BLOOMBERG WIND, SOLAR AND EST INDICES

Index values as of 17 February 2014; Indices rebased to 1000 on 1 July 2012
Source: Bloomberg New Energy Finance

FIGURE 43. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2013, $BN



Index values as of 17 February 2014; Indices rebased to 1000 on 1 July 2012
Source: Bloomberg New Energy Finance

allow inclusion of renewable power assets in REITs, there has been no further movement in this direction.

Not all renewable energy infrastructure offerings involved specially-created funds. One of the highest-profile IPOs of the year, both inside and outside clean energy circles, was by Infinis Energy. The UK's largest generator of power from landfill gas, owned by private equity firm Terra Firma Capital Partners, raised GBP 238 million ($389 million) on the London Stock Exchange last November.

Figures 43 and 44 explore the trends in public market fundraising by sector. Solar companies, including manufacturers and installers and financing companies, raised $4.8 billion in 2013, an increase of 111% on the previous year and almost twice the volume raised by the next largest sector, wind. Most activity was by US firms on exchanges in that country. Indeed, the biggest issuer was SunEdison, a US-based polysilicon supplier formerly known as MEMC Electronic Materials. It raised a total of $850 million last year from a convertible bond issue and a secondary offering as part of a debt restructuring.

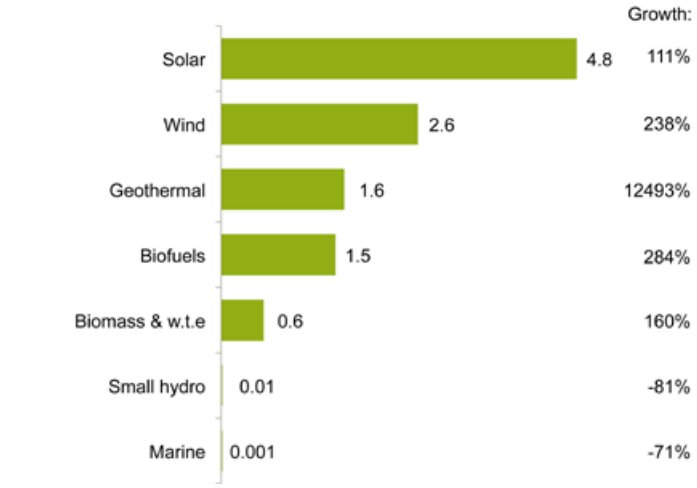
generation assets, raised $200 million in August and at the end of September, Pattern Energy Group, a subsidiary of US wind project developer Pattern Energy Group, raised $352 million.

Two more companies – Silver Ridge Power and Threshold Power – attempted listings in Canada but withdrew the offerings. A sixth, Hannon Armstrong Sustainable Infrastructure, converted itself from a renewable energy financing company into a real estate investment trust in April 2013, a structure that has features in common with a yield co, and raised $167 million when it floated on NYSE. Despite initial hopes that this presaged a general decision by the US Internal Revenue Service to

Two other well-established names in US solar also raised substantial sums last year. First Solar, a thin-film PV module and system manufacturer, raised $448 million via a secondary share placement in June, while SunPower Corporation, a manufacturer of mono-crystalline silicon cells and modules, raised $300 million via a convertible bond issue. The latter firm, which is 65% owned by French oil major Total, saw its stock appreciate 430% in 2013, the best performance on the NEX. It is thought to be well positioned to benefit from increasing project demand in Asia.

An important source of future IPO activity in the solar sector may be de-consolidation. Norwegian

FIGURE 44. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2013, AND GROWTH ON 2012, $BN



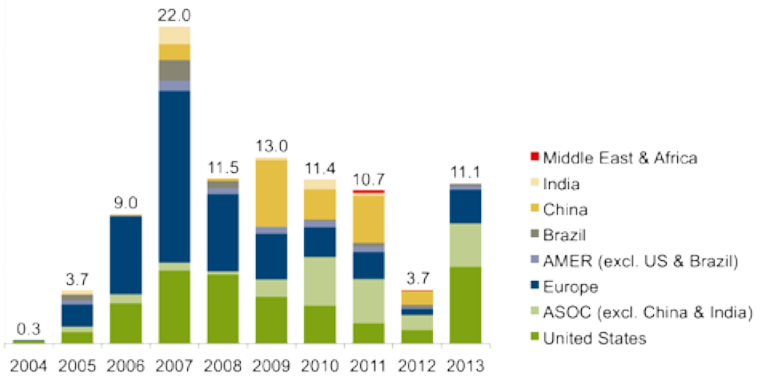
Source: Bloomberg New Energy Finance, UNEP

polysilicon maker Renewable Energy Corporation spun off its solar unit, which manufactures photovoltaic wafers and cells in Singapore and develops projects. It raised NOK 800 million ($134 million) from an IPO on the Oslo Stock Exchange in October. SunEdison has said it plans to separate out operating-stage PV assets in a "yield co" IPO this year.

The wind industry lagged behind solar with a total of $2.8 billion, mainly accrued through the sale of stock in asset-backed funds, as already discussed, and issuance by developers such as CPFL Energias Renovaveis, South America's biggest owner of wind farms. The latter completed an IPO in July last year that raised BRL 900 million ($410.6 million) to fund new projects including solar power plants.

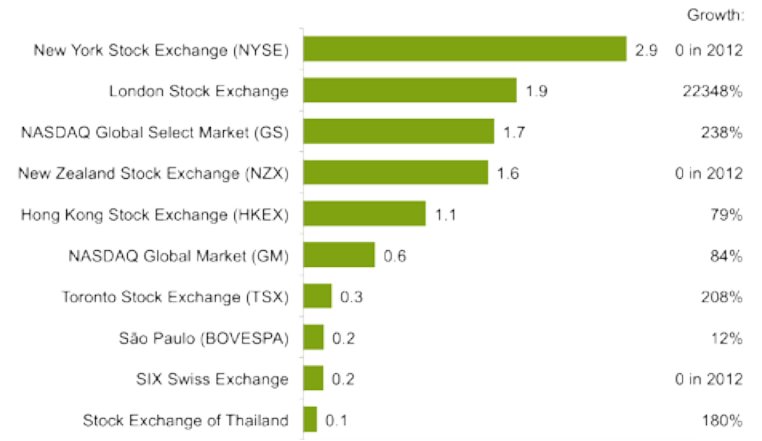
The geothermal sector posted a fundraising total of $1.6 billion, thanks mainly to the $1.4 billion IPO by Mighty River Power, New Zealand's state-owned geothermal and hydro electricity generator. Biofuel companies followed closely behind with $1.5 billion, up 284% on the previous year, as companies with next-generation diesel-substitute technology, mainly in the US and UK, raised money in follow-on offerings or by issuing convertible bonds. The largest of these saw Darling International, a US food waste recovery company with renewable diesel interests, raise $874m in December from a secondary offering on NYSE.

FIGURE 45. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY REGION OF EXCHANGE, 2004-2013, $BN



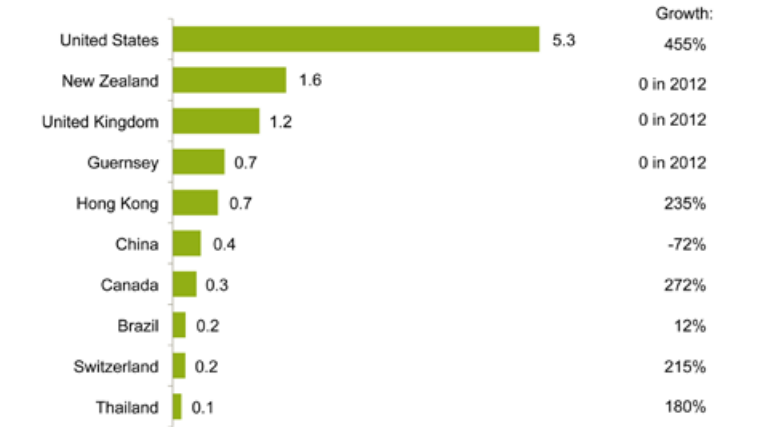
Source: Bloomberg New Energy Finance, UNEP

FIGURE 46. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY EXCHANGE, 2013, AND GROWTH ON 2012, $BN



Top 10 exchanges
Source: Bloomberg New Energy Finance

FIGURE 47. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY COMPANY NATIONALITY, 2013, AND GROWTH ON 2012, $BN



Top 10 countries
Source: Bloomberg New Energy Finance

Another way of analysing the public market data is to look at equity raising by exchange (see Figures 45 and 46), to highlight the appetite of investors in different locations. New York took pride of place in 2013, investors ploughing $2.9 billion into offerings there. This was a billion dollars more than was raised on the London Stock Exchange, the next highest. is the NYSE's performance was in stark contrast to the year before when it saw no deals at all. Nasdaq constituents sold equity worth $1.7 billion, while the New Zealand Stock Exchange followed closely with $1.6 billion, thanks to the Mighty River IPO. The Hong Kong Stock Exchange saw the largest volume in Asia.

One of the most notable changes in 2013 was the absence of fundraising on the Chinese markets after the government imposed a moratorium on new listings at the end of 2012. In that year, the Shanghai Stock Exchange saw more than $1 billion raised by renewable power companies. Those markets are now open for business in 2014 – amid warnings from the regulator that it will intervene if it deems prices to be excessive.

Figure 47 confirms that the trend for money raised by exchange was broadly reflected in that for company nationality. US renewable power and fuel companies raised the lion's share of new equity in 2013, at $5.3 billion, while Chinese companies languished far behind at $401 million.

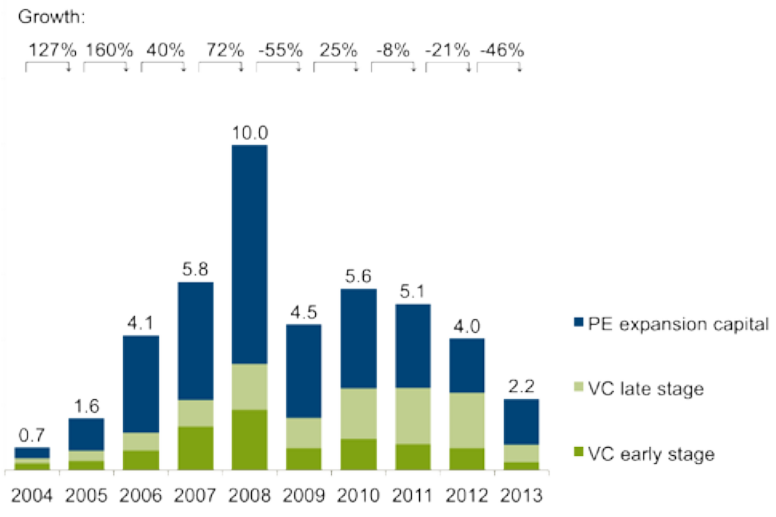
VENTURE CAPITAL AND PRIVATE EQUITY INVESTMENT

- Venture capital and private equity, or VC/PE, investment in renewable energy collapsed by almost half in 2013, down 46% to $2.2 billion, its third consecutive annual decline.
- Most of the fall was due to late-stage venture capital, where investment slumped 70% from $1.7 billion in 2012 to just $500 million, although early-stage VC also more than halved to $300 million. Private equity expansion capital held up better, sliding only 16% to $1.4 billion.
- For the first time in a decade, wind outstripped solar. VC/PE investment in wind rose by 70% to $1 billion, while it fell by around two thirds both in solar, down $1 billion to $500 million, and in biofuels, down $700 million to $300 million.
- The US suffered by far the largest loss, falling from $2.8 billion to $1 billion, but remained the biggest VC/PE market and twice as large as its nearest competitor, Europe, down $100 million to $500 million.
- Smaller sectors including biomass and waste-to-energy, marine, geothermal and small hydro, all fell between 50% and 80%.

New investment in renewable energy via venture capital and private equity, or VC/PE, fell by almost half (46%) to $2.2 billion in 2013. The fall, the third annual decline in a row, took VC/PE to its lowest level since 2005, as shown in Figure 48. It came in spite of the improving economic backdrop and a storming performance by publicly quoted renewable energy stocks (see Chapter 7). It reflected the shortage of successful exits by VC/PE-backed companies in recent times and the fact that many clean energy venture funds have depleted their cash holdings.

The downturn in clean energy VC/PE was not mirrored in every other business sector. Venture funding was up 7% to $29 billion across all sectors, according to figures from the US National Venture Capital Association, but those investors preferred to back internet and biotechnology companies. By contrast, VC/PE investment in renewable energy shrank with every passing quarter, from $903 million in the last quarter of 2012 to just $316 million in the same period of 2014, a fall of 65%.

FIGURE 48. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2013, $BN

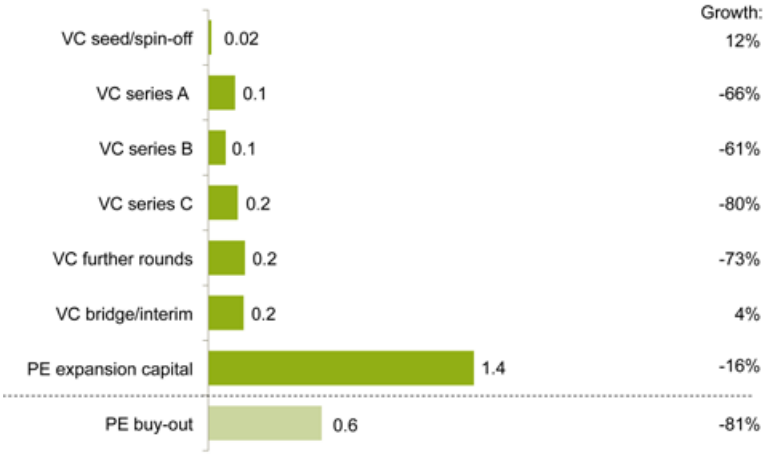


Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

Investors remain scarred by the destruction of billions of dollars in capital from the clean energy insolvencies of the last few years, especially in solar energy and low-carbon vehicles. Finding an exit for surviving VC/PE investments also remained difficult, in spite of a 54% rise in the WilderHill New Energy Global Innovation Index, or NEX. Several IPOs were pulled, particularly in biofuels, where regulatory uncertainties in the US stymied investment.

FIGURE 49. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2013, AND GROWTH ON 2012, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals
Source: Bloomberg New Energy Finance, UNEP

VC/PE funds whose investee companies go bust or struggle to find an exit have less money to invest, and may also find it harder to raise new funds. VantagePoint Capital Partners abandoned fundraising for a $1.25 billion clean technology fund it had launched in 2010 due to lack of interest last year, and many others have reduced their exposure, including Kleiner Perkins Caufield & Byers, and Draper Fisher Jurvetson, Mohr Davidow, NEA and Silver Lake. Perhaps most tellingly, CalPERS, the California public employees' pension fund, which led many investors into the market by launching a dedicated clean energy fund in 2007, has now 'dialled back'

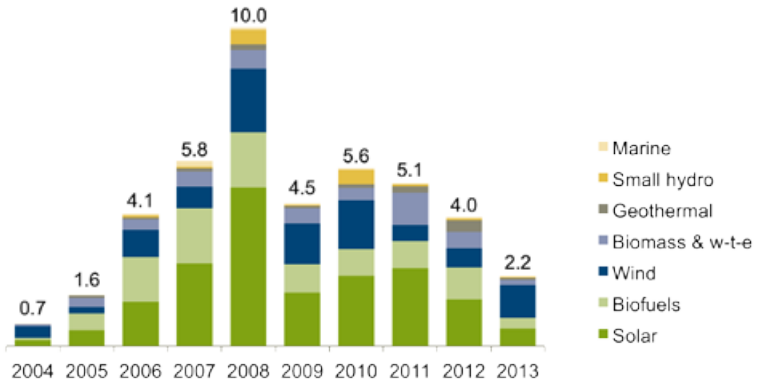
its exposure according to its chief investment officer, after making annualised losses of almost 10% since the start of the fund.[1]

As a result, venture capital funding fell across most stages of investment, with funding rounds A, B and C falling between 60% and 80%, as shown in Figure 49. Seed or angel funding was a bright spot, however, rising 12% to $20 million. Most of the identified seed funding was accounted for by a handful of deals, including $3.5 million for PV Nano Cell of Israel, and a total of $4.4 million between a trio of French companies. These comprised COGEBIO, a biomass boiler manufacturer, Ideol, which is developing floating foundations for offshore wind (see also Chapter 9), and Sunna Design, a solar lighting business. Bridge funding edged up 4% to $20 million, boosted possibly because investments struggling to find an exit required additional interim funding. Private equity expansion capital fell for the third year running, down 16% to $1.4 billion, its lowest level since 2005.

Among the sectors, solar was by far the biggest loser, falling two thirds to $500 million, as shown in Figures 50 and 51, reflecting the brutal squeeze and rash of insolvencies caused by chronic global overcapacity since 2008. Solar VC/PE investment was its lowest since 2004, but venture investors are likely to have gained some reassurance from recovering share prices for quoted firms in 2013, and from signs that solar module prices are finally beginning to stabilise at apparently sustainable levels.

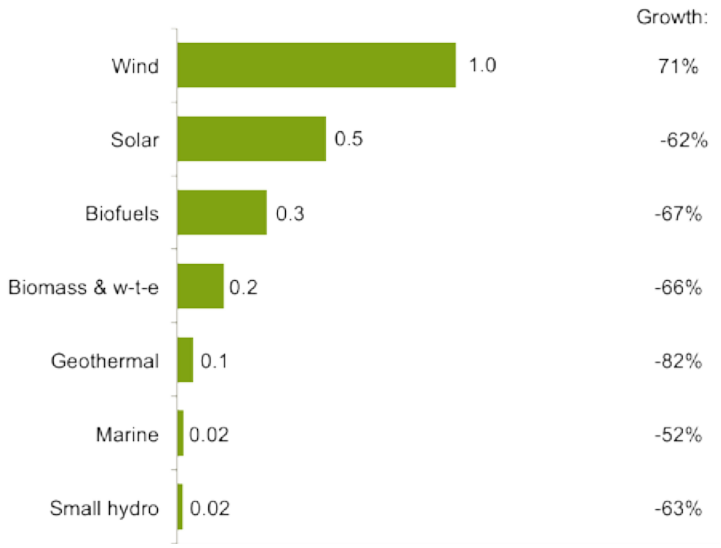
While solar investors may be nursing sunburn, there were still some sizable deals in less capital-intensive, web-focussed solar companies – so-called 'cleanweb'. For example, Sungevity, a California-based solar leasing company whose 'iQuote' system uses satellite data to produce quotes for homeowners without a home visit, raised $55 million in two private equity rounds, along with a further $85 million in project financing. In the same neck of the woods, Clean Power Finance, which operates a platform to match solar consumers, installers and financiers, raised $37 million in a

FIGURE 50. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2013, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

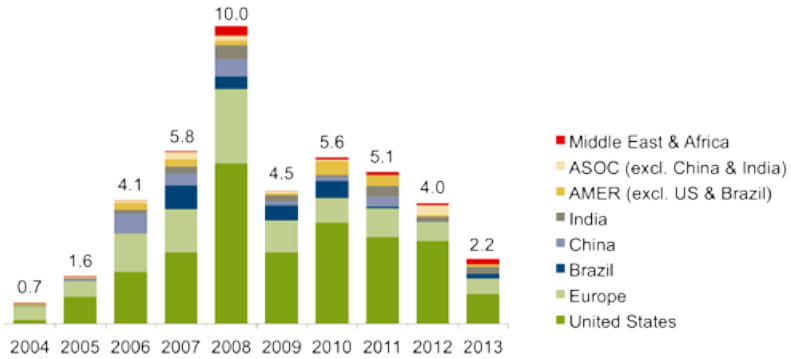
FIGURE 51. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2013, AND GROWTH ON 2012, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals
Source: Bloomberg New Energy Finance, UNEP

[1] http://online.wsj.com/news/articles/SB10001424127887324557804578374980641257340

FIGURE 52. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2013, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals

Source: Bloomberg New Energy Finance, UNEP

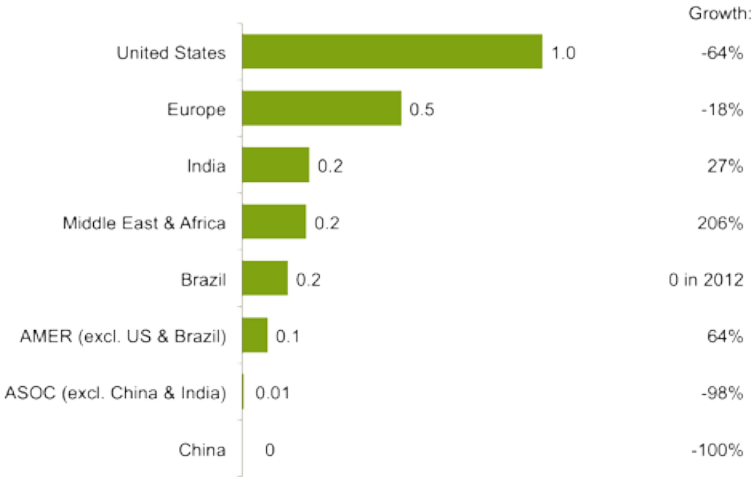
Series C funding round. Both companies secured funding from major corporations – General Electric invested in Sungevity, and Duke Energy and Edison International in Clean Power Finance – suggesting they may detect greater potential than do wary VC/PE investors.

In one small but potentially significant solar deal, 1366 Technologies raised $17.5 million[2] in a Series C funding round, taking the total amount the company has raised to more than $60 million. It has developed a process to produce photovoltaic wafers directly from molten silicon, eliminating the ingot and cutting stages altogether, which it claims cuts capital costs by two thirds and operating costs by half. 1366 opened a demonstration factory in Massachusetts, and funds will go towards building a new facility to produce up to 250MW per year.

Biofuel investment also fell sharply, from $1 billion in 2012 to $300 million, its lowest level since 2004. The sector's biggest market, the US, was still recovering from the severe drought of 2012, and was paralysed by uncertainty about the amount of biofuel that would be required under the Renewable Fuel Standard (RFS2 – see Chapter 9 for more detail). In the circumstances there was

[2] $15m according to the company's website: http://www.1366tech.com/1366-technologies-secures-15m-in-series-c-funding-to-drive-next-phase-of-growth/

FIGURE 53. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2013, AND GROWTH ON 2012, $BN



Buy-outs are not included as new investment. Total values include estimates for undisclosed deals
Source: Bloomberg New Energy Finance, UNEP

little incentive to invest in early-stage ventures, particularly as investors struggled to find an exit for their existing commitments. Several IPOs were pulled, including those of Coskata and Mascoma, both backed by Vinod Khosla, and Enerkem and Fulcrum BioEnergy. The performance of some previous biofuel IPOs did little to help the mood; Gevo peaked at almost $26 per share soon after its launch in 2011, but early in 2014 the share price was languishing at little more than $1.

Wind was a surprising winner, however, with investment jumping from $600 million to $1 billion in 2013, a rise of 70%. The three largest VC/PE deals were all in wind companies, as were six of the top 10.

In the biggest wind deal, Greenko Mauritius, a project developer part owned by the Indian turbine manufacturer Regen Powertech, raised $151 million of private equity to expand its generating portfolio. Greenko Group, its other parent, based in Hyderabad, now has more than 420MW of renewable capacity and expects to reach 600MW this year.

In another large deal, the International Finance Corporation invested $100 million in InterEnergy, an Italian engineering and consultancy firm, to develop wind, solar and liquefied natural gas import capacity in countries such as Haiti and the Dominican Republic, to reduce oil dependency. In the US, AMP Capital Investors committed $100 million to Capistrano Wind Partners, a project developer which already operates of 400MW of capacity in Nebraska, Texas and Wyoming.

Private equity deals do not often make it onto the front pages, but one wind-related deal dominated the news in Denmark for months, after Goldman Sachs announced it would take an 18% stake in Dong Energy, the state-owned utility, for $1.5 billion. Dong needed additional capital to fund oil and gas exploration and offshore wind projects, after losing money on gas trades. Denmark's two largest pension funds, ATP and PFA, would take much smaller stakes, and the buyers agreed with the government to try to float Dong through an IPO when 'conditions are right'. Meanwhile the Wall Street investment bank would have veto powers over strategic decisions by Dong's management. The deal provoked a huge public outcry and, in early February 2014, caused the collapse of Denmark's coalition government and a sweeping cabinet reshuffle. A petition against the sale gathered 200,000 signatures, around 3.5% of the population, but the deal has now been completed.

Less controversially, Goldman also invested $46 million in ReNew Wind Power, an Indian project developer, and announced a further investment of $135 million two months later.

In the largest non-wind VC/PE investment, Energias Renovaveis do Brasil, a biomass and waste combined-heat-and-power developer, raised $97 million, almost all of it from BNDESPAR, the private investment arm of Brazil's national development bank.

Among the smaller sectors, VC/PE investment in small hydro fell 63%, marine by 52% and biomass

and waste-to-energy by 66%, each to around $20 million. Geothermal dropped 82% to $10 million.

The biggest transactions in these sectors included a PE expansion round of $96.9 million for biomass developer Energias Renovaveis do Brasil, a $20.5 million expansion round for geothermal developer Gradient Resources, and $12 million of expansion capital for Scotrenewables, a UK tidal stream turbine company.

Regionally, the US was by far the largest loser, as VC/PE investment slumped 64% to $1 billion – as shown in Figures 52 and 53. Investment in the US is now lower than at any time since 2009, although still twice the level of its nearest rival, Europe, down $100 million to $500 million. Half the US decline, or $890 million, was due to solar, and almost all (97%) of solar's global slump took place in the US.

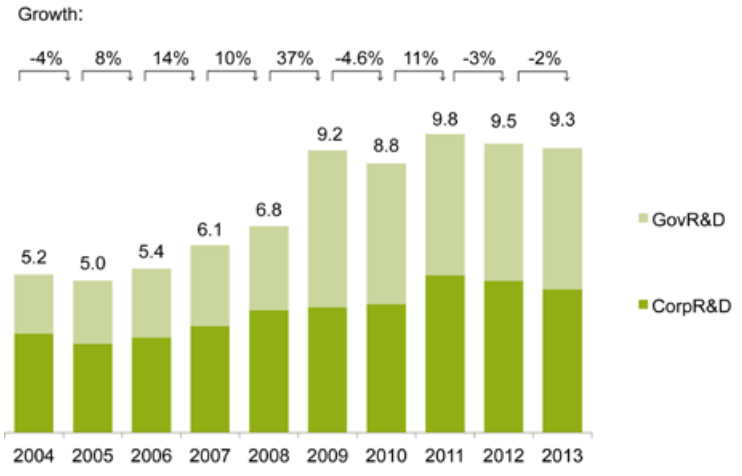
RESEARCH AND DEVELOPMENT

- Global research and development spending on renewable energy technologies fell 2% to $9.3 billion in 2013.
- This could be seen as a modest decline given that most of the post-2008 "green stimulus" programmes had expired in 2011-12 and many companies remained under margin pressure.
- Companies spent more than governments for the third year running: corporate R&D fell by $300 million to $4.7 billion, while government spending rose by $100 million to $4.6 billion.
- Solar R&D fell by 2% to $4.7 billion, but received more funding than all other sectors combined. Wind dropped 5% to $1.7 billion, while biofuels stayed flat at $1.5 billion.
- R&D spending was flat or mildly positive in all regions except for ASOC – Asia and Oceania excluding China and India – where it fell 12%.

Research and development, or R&D, spending on renewable energy was little changed in 2013, falling by just 2% on the previous year. R&D spending has now held steady at the higher levels established in 2009, when 'green stimulus' programmes were introduced in response to the financial crisis for five years running, despite the fact that the vast majority of those programmes expired in 2012. The private sector outspent the public sector for the third consecutive year in 2013, but its lead has shrunk. Corporate and government R&D were almost exactly balanced, at $4.7 billion and $4.6 billion respectively, as shown in Figure 54.

R&D spending on solar fell 2% to $4.7 billion dollars, as shown in Figure 55, but the sector still received more research dollars than all others combined, as it has for the past three years, and seven of the last 10. After five years of brutal contraction, industry conditions finally started to brighten during 2013, even as subsidies continued to shrink in Europe: product prices stabilised, and the stock prices of several of the surviving manufacturers doubled over the course of the year. The rationale for R&D changed from simple survival amid massive overcapacity, to winning business in a market where Bloomberg New Energy Finance analysts expect volumes to rise by a further 25% this year. The European Photovoltaic Industry Association expects global solar capacity to double to almost 200GW in the three years to 2015, driven by growth in Europe, China and the US.[1]

FIGURE 54. R&D INVESTMENT IN RENEWABLE ENERGY, 2004-2013, $BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

Brightening conditions encouraged solar manufacturing equipment suppliers such as Applied Materials of the US and Meyer Berger of

[1] http://www.bloomberg.com/news/2013-12-18/abb-basks-in-1-billion-bet-on-solar-that-saw-siemens-get-burned.html

Switzerland to keep spending on product improvement, in the hope of new orders from Chinese manufacturers. Applied Materials spent $1.3 billion on R&D during 2013, although solar makes up a small percentage of its business. The manufacturers themselves continued to spend on incremental innovation to make better and cheaper modules. Yingli, Trina and Jinko, for example, continued work on developing thinner wafers and higher efficiency cells. Inverter manufacturers such as SMA and Power-One – acquired for $1 billion by electrical engineering giant ABB in April 2013 – continued to develop cheaper and more robust units to convert the DC output of solar panels to AC grid-compatible power.

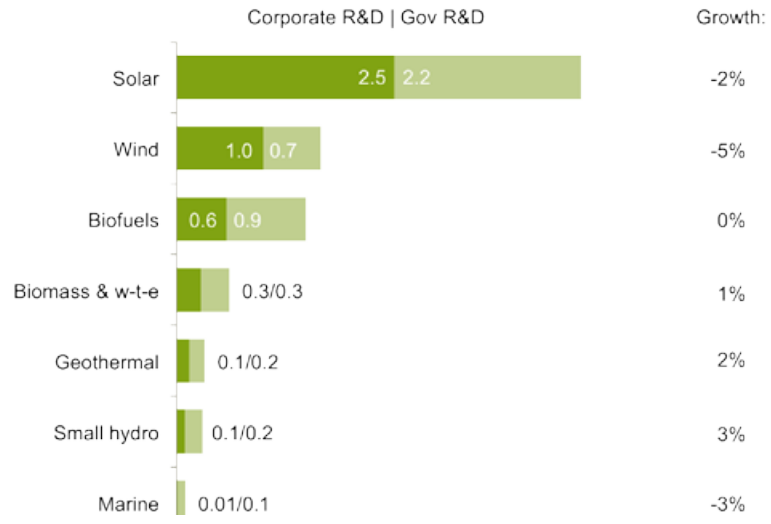
Solar R&D was also supported by the continuing growth of Chinese government spending. China's state investment in renewable energy R&D in 2013 was $1.5 billion, as shown in Figure 56, of which two thirds ($995 million) was devoted to solar. State support for solar in China has more than doubled over the past decade, and is now higher than public spending in either the EU or the US. BNEF analysts say much of this spending is accounted for by support for practical research into production processes carried out at a large number of universities, such as the 48th Research Institute of the China Electronics Technology Corporation.

China's corporate spending on solar R&D ($364 million) remains much lower than in Europe ($793 million) or the US ($584 million), but may have been increased by an unexpected impact of the agreement ending its trade war with the EU. The agreement imposes minimum prices on Chinese module exports to Europe, which some producers in Taiwan, India and Southeast Asia have been able to undercut by 10%, giving Chinese companies a stiff incentive to improve the efficiency and reliability of their products.

R&D in wind fell by 5% from its 2012 peak to just under $1.7 billion. At this level, wind spending remains close to its historical high, but is still the worst funded of the major renewable sectors relative to its research and development needs, according to an analysis by the International Energy Agency. The study, *Global Gaps in Clean Energy RD&D, 2010*, found that in order to hit the IEA's BLUE scenario, in which global emissions fall 50% by 2050, wind required R&D spending of $1.8-$3.6 billion per year.[2] According to the figures presented here, wind – unlike solar and bioenergy – has persistently fallen short of its target range.

Nevertheless, wind companies and governments are investing significant sums in R&D to cut costs, particularly in offshore wind, and

FIGURE 55. CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY TECHNOLOGY, 2013, AND GROWTH ON 2012, $BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

[2] See *Global Trends in Renewable Energy Investment, 2012*

particularly in the UK. The British government hopes to increase capacity from around 2GW today to 10-18GW in 2020, while reducing the cost of offshore generation from about GBP 140 per MWh to GBP 100 per MWh, and has funded several programmes to help achieve it.

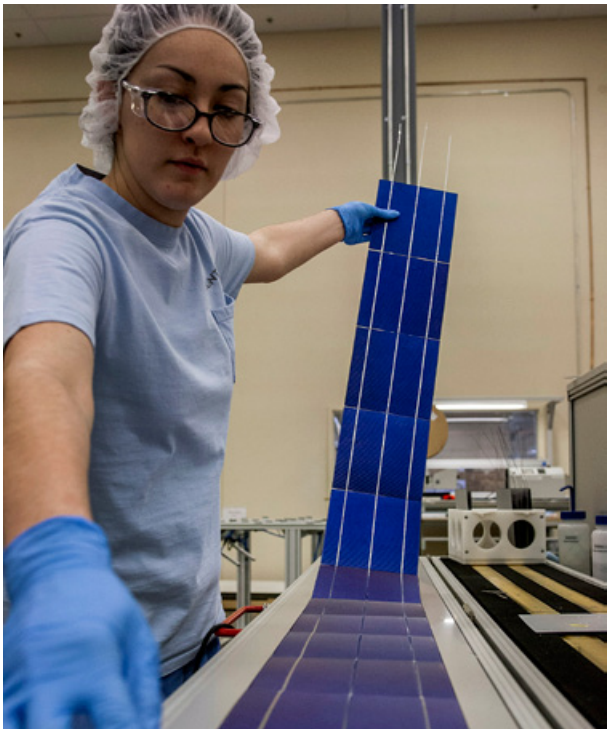
Raising capacity will mean building larger turbines in deeper water, and this in turn requires R&D to reduce the cost of turbine foundations, which can represent 30% of capital costs. The UK's Carbon Trust has an Offshore Wind Accelerator programme with a budget of GBP 10 million for R&D and GBP 30 million for demonstration projects. This is developing a range of innovative foundations with eight developers including Mainstream Renewable Power, SSE Renewables and Dong.

One way to reduce the cost of foundations is to do away with them altogether, and replace them with turbines that float. The UK's Energy Technology Institute has funded a GBP 4 million project to design a floating 'tension leg' wind turbine, based on established oil and gas production platform technology, but there is now an armada of competing and innovative designs.

Statoil's Hywind project is developing a 'spar buoy' concept, in which a floating tower extends below the water line, and is held in place with ballast and three mooring lines to the seabed. Statoil has already demonstrated the turbine off Norway, and has now won approval for a $120 million demonstration wind farm off the coast of Maine. Sway, another Norwegian company, is working with the US National Renewable Energy Laboratory on another spar buoy design.

The Windfloat design being tested off Portugal is based on a semi-submersible triangular pontoon, supporting the turbine tower at one corner, which the developers – Principle Power of the US, Energias de Portugal and Repsol – say is extremely stable. The design has also won funding from the UK's Offshore Wind Component Technologies Development and Demonstration programme, which aims to bring down the sector's costs.

Ideol of France has won EUR 7 million funding from the European Commission to support a 2MW demonstration of its design – a rectangular raft

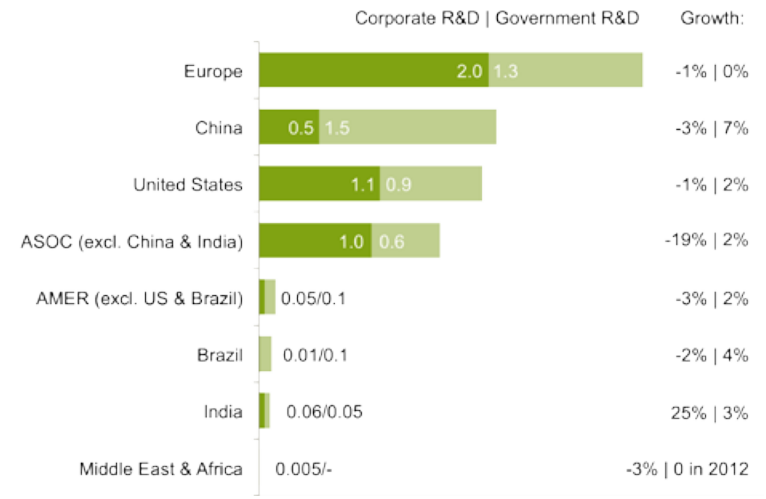


made of concrete with a hole in the middle to damp wave action, which the company claims will cost half as much as other floating platforms.

One promising design at an earlier stage of development dispenses not only with the foundations, but also the tower. The TetraFloat invented by Professor Seamus Garvey of Nottingham University supports the turbine at the top of a floating lopsided tetrahedron – a triangular pyramidal structure. Because of its shape the TetraFloat can be made of much thinner and lighter tubing, and might therefore be a fraction of the weight of a tower-mounted design. Another advantage is that the turbine does not need to swivel or 'yaw' on its support to face into the wind; the entire floating structure yaws over the surface of the sea, pivoting around a single anchor on the seabed. A single anchor ought to be cheaper than three or more required by other floating designs.

R&D spending on biofuels was essentially flat at $1.5 billion in 2013, a creditable performance given the torrid conditions prevailing in the sector's biggest market, the US. Corporate R&D slipped 2% from 2012 levels, while government spending rose 2%. However, these shifts contrasted with longer-term trends – corporate R&D on biofuels in 2013 was 18% higher than in 2009 while government R&D

FIGURE 56. CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY REGION, 2013, AND GROWTH ON 2012, $BN



Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

was down 46% over those four years. The latter decline has been entirely due to a 75% reduction in US government support, from $1.1 billion in 2009 to less than $300 million in 2013.

The US biofuel market has been badly battered by the vagaries of the weather and policy uncertainty recently. In 2012, it suffered the worst drought in 50 years, which sent corn prices soaring to twice current levels, and in 2013 it was paralysed by uncertainty about the amount of biofuel that would be required under the Renewable Fuel Standard (RFS2). The Environmental Protection Agency (EPA) has found itself caught between enforcing the RFS2's rising volumetric targets for biofuel blending – the billions of gallons that refiners are obliged by law to absorb each year – and the 10% 'blend wall' cap that some say is needed to protect engines from damage. The two rules have come into increasing conflict as gasoline consumption has fallen, putting refiners, conventional and advanced biofuel producers at loggerheads. The EPA, which has been juggling the problem for years, finally proposed a permanent reduction in both conventional and advanced biofuel blending obligations for 2014 in November 2013, although a final ruling is not expected until this summer. Meanwhile, the uncertainty not only hammered early-stage investment in the sector (see Chapter 8), but also undermined the incentive to spend on further R&D. The saga goes some way to explaining the sharp drop in US government R&D spending on biofuels, along with tighter Federal budgets, and disenchantment with the performance of cellulosic ethanol.

Biofuel R&D is far from moribund, however, and the buzz in 2013 was around whether enzymatic hydrolysis would finally deliver the long-awaited promise of second-generation biofuels. The process is a form of cellulosic ethanol production that breaks down inedible plant matter – such as corn stover, elephant grass and wood chips – into sugars to be fermented into fuel. Cellulosic ethanol has a long history of disappointment, but now at least three companies are investing significant R&D to take enzymatic hydrolysis from laboratory to commercial scale.

For example, Abengoa, Spain's biggest biofuel company, is using the process to produce ethanol from municipal solid waste at a demonstration plant in central Spain. Poet, America's largest corn ethanol producer, formed a joint venture with Royal DSM to build a $250 million plant in Iowa and then licence the technology more widely. Beta Renewables opened a plant in Italy to produce ethanol from local biomass or energy crops. Once enzymatic hydrolysis has been proved to work at scale, however, further R&D will be needed to bring costs down to competitive levels.

ACQUISITION ACTIVITY

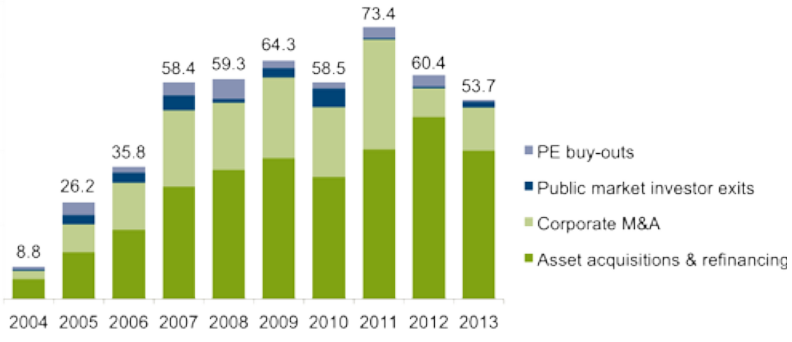
- Total acquisition spending fell 11% to $53.7 billion in 2013, the second consecutive annual decline and the lowest volume since 2006.
- After a record year in 2012, the value of renewable asset acquisitions and debt refinancing sank 22% to $39.9 billion.
- Corporate M&A – the buying and selling of companies – bucked the trend, jumping 45% to $11.5 billion from a low of $7.9 billion the previous year.
- Overall acquisition activity in the wind sector slipped 4% to $32.2 billion, while that in solar fell 18% to $15.1 billion.
- Acquisitions in biofuels dropped 17% to $1.5 billion, while those in biomass and waste-to-energy tumbled 58% to $1.4 billion. Small hydro saw a 45% increase to $2.7 billion.
- Activity in the Americas declined by 27% to $27.4 billion, while it flatlined in Europe at $18.2 billion, just under half the record 2011 figure. The biggest increase was in Asia-Oceania excluding China and India, where it more than doubled to $4.4 billion.

The value of acquisitions in the renewable energy sector fell for the second consecutive year in 2013. Activity peaked at $73.4 billion in 2011, dropped to $60.4 billion in 2012 and then continued its slide to $53.7 billion last year, the lowest level since 2006 (see Figure 57). These statistics cover corporate M&A, private equity buy-outs, power infrastructure acquisitions and debt refinancing, plus the sale of equity stakes in listed companies by investors.

The overall downward trend may have been consistent with the previous year, but the underlying causes differed. The nominal value of renewable power assets acquired declined by 22% to $39 billion. By contrast, the bill for corporate purchases increased by 45% to $11.5 billion, a reversal of the dynamic the previous year. Trade in renewable power projects still comfortably accounted for the largest share of overall activity – some 75% of the total – but this was down from 81% in 2012. The proportion of corporate M&A, meanwhile, climbed to 21.4% from 13.1%.

The sector activity was again dominated by wind and solar. As illustrated by Figures 58 and 59, wind claimed $32.2 billion worth of transactions, marginally less than its tally in 2012, while solar

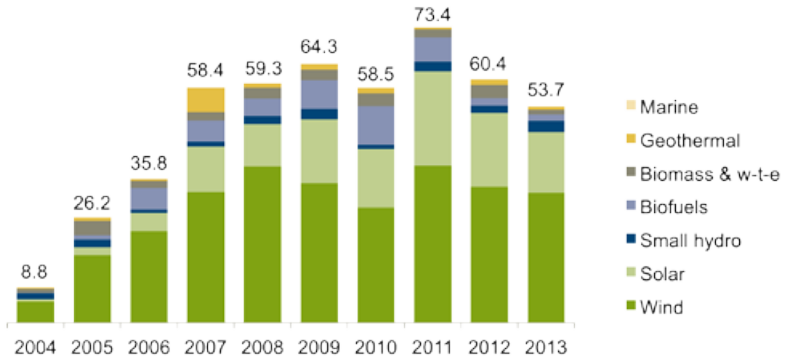
FIGURE 57. ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY TYPE, 2004-2013, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

deals sank to $15.1 billion from $18.3 billion the previous year. All other sectors lagged far behind. Small hydro led the rest of the field with $2.7 billion worth of transactions, a 45% increase on 2012, while the biofuel and biomass & waste-to-energy energy sectors were more subdued, with just $1.5 and $1.4 billion, respectively.

FIGURE 58. ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY SECTOR, 2004-2013, $BN

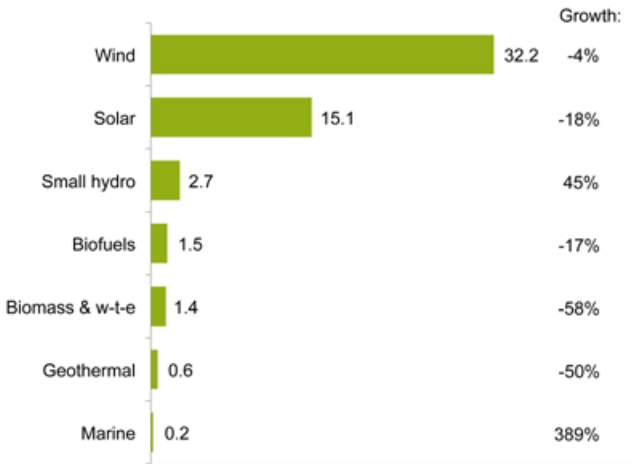


Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

The year's activity is best understood by looking at each of the various deal types – corporate M&A in which specialist renewable energy companies are bought by other companies; asset acquisition and refinancings in which projects such as wind farms or biofuel plants change ownership or swap one financial structure for another; and private equity buy-outs of specialist companies. In 2013, corporate M&A regained some of the momentum of old after a very weak year in 2012. Nevertheless, it remained muted compared with the longer-term average thanks partly to falling prices along both the solar and wind value chains, and some additional high-profile failures. The prevailing conservative macroeconomic environment also dampened acquisition activity.

The uptick in corporate M&A was not driven by demand for renewable energy technology developers and equipment manufacturers, but rather by acquisitions of project developers and power generators.

FIGURE 59. ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY SECTOR, 2013, AND GROWTH ON 2012, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance

A diverse range of investors bought up companies with portfolios of assets because they offer that rare thing – attractive, stable, long-term income in regulated markets. Indeed, the biggest M&A transaction of 2013 was Italian energy group ERG's acquisition of an 80% stake in wind developer IP Maestrale Investments, a unit of French utility GDF Suez, for $1.1 billion, including debt and equity.

Other large transactions occurred throughout the year. For instance, in January, Canadian pension and insurance fund manager Caisse de Depot et Placement du Quebec paid $500 million for a stake in a 1.5GW portfolio of operating US and Canadian wind assets owned by Chicago-based Invenergy Wind. In June, China Three Gorges International Hong Kong invested EUR 359 million ($467 million) in Madrid-based EDP Renovaveis, one of the world's largest wind energy generators. The latter deal was part of a strategic partnership between the two entities' parent companies.

As many of these deals targeted wind developers, that sector gained a substantial lead over all other renewable energy technologies. In total, corporate M&A in the wind sector amounted to $5.4 billion in 2013, an increase on the previous year's $4.1 billion, which was similarly dominated by large acquisitions of developers. In one of the few deals involving equipment manufacturers, the wind turbine unit of David Brown Gear Systems was bought by Finnish turbine gear manufacturer Moventas Gears for an undisclosed amount at the end of August.

The solar sector trailed wind with $3.5 billion of corporate takeovers, yet fielded a greater variety of deals. For instance, corporate failures provided rich pickings for some buyers. In early November, Shunfeng Photovoltaic International, a Chinese solar company owned in part by businessman Cheng Kin Ming, announced it would buy Wuxi Suntech Power, the main unit of bankrupt Suntech Power Holdings, once the world's largest photovoltaic equipment maker, for CNY 3 billion ($492 million). Last July, Miami-based private equity firm Kawa Capital Management agreed to buy Conergy, formerly Germany's biggest solar company, two weeks after it filed for bankruptcy.

Consolidation was another major theme in solar last year. In the US, there was considerable manoeuvring among developers of small-scale distributed systems, with the likes of SolarCity buying up direct marketing companies to get access to customers. It acquired Paramount Energy Solutions, which has about 150 employees in Sacramento, California, and struck a marketing partnership with Crius Energy Trust that will give it access to that firm's customer base in the northeast of the US.

Power utilities are also waking up to the importance of distributed solar as it begins to eat into their market share. Last year, Edison International, owner of California's second-largest electric utility, bought solar rooftop developer SoCore Energy for an undisclosed price and a stake in Clean Power Finance to expand its online solar financing service. NextEra Energy, owner of Florida Light & Power and the largest generator of solar and wind power in the US, entered the distributed solar market in May when it acquired Smart Energy Capital.

The inverter market is another area in transition. In the first half of 2013, there were some substantial

takeovers, including Swiss electronics giant ABB'S purchase of the world's second largest inverter manufacturer, Power-One, for about $1 billion. The company said it is looking to tap into a market that is forecast to grow by more than 10% annually, and its purchase of Power-One will give it 12% of that global market. Inverters convert the direct current generated by solar panels into the alternating current needed to run appliances on power grids.

Other inverter deals included US-headquartered Advanced Energy Industries' purchase of REFUsol for EUR 69.8 million ($89.6 million) to get access to the German and Italian markets, while market leader SMA, which alone supplied 28% of global demand in 2012, gained a foothold in China with its acquisition of Jiangsu Zeversolar.

The small hydro sector made a bigger splash than both the biofuel and biomass and waste-to-energy sectors, with total recorded corporate M&A of $1.1 billion, thanks mainly to one large deal. In June, Voimapiha, a consortium of three Finnish energy companies, signed an agreement to acquire Danish power major Dong Energy's 25.7% stake in Swedish hydro power company Kraftgarden for SEK 5.2 billion ($770 million). The purchase will transfer ownership of seven hydro power plants with a total capacity of 626MW.

In contrast to the rise in corporate M&A, the volume of money spent on renewable power generation and transmission assets worldwide declined. As mentioned above, there were $39.9 billion worth of deals, down from $48.8 billion the previous year. The largest transaction was the purchase by Brookfield Asset Management, Canada's biggest manager of alternative assets, of 19 hydroelectric generation stations in the US from NextEra Energy Resources, a Florida-based independent renewable power producer, for $760 million.

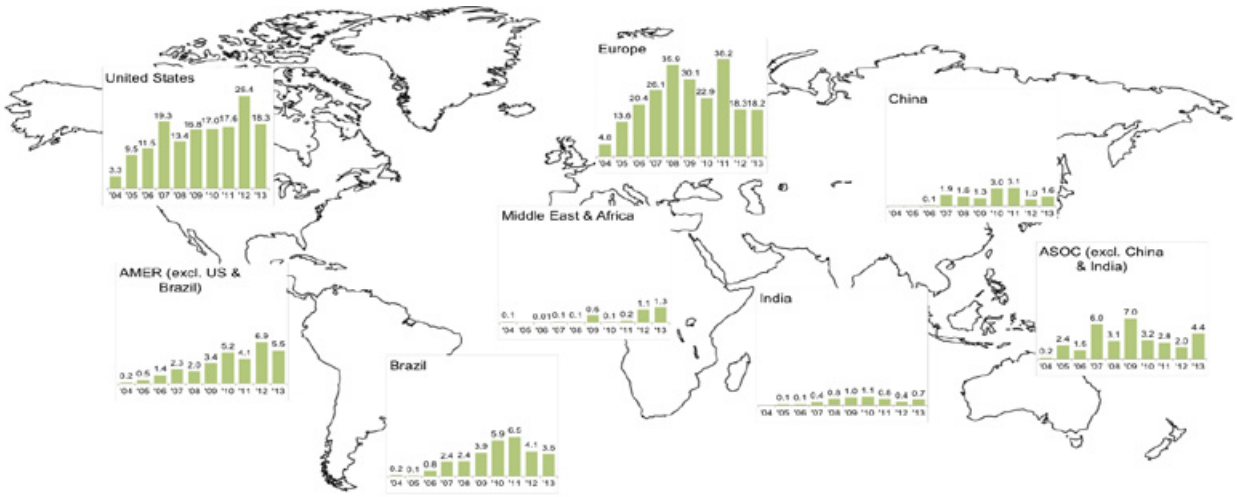
Although the value of asset acquisitions shrank, the diversity of buyers expanded, with – for instance – Ikea Group, the world's biggest home-furnishings retailer, buying a wind farm in Ireland from Mainstream Renewable Power as part of plans to invest GBP 1.5 billion ($2.3 billion) in wind and solar by 2015. A growing number of institutional investors also began to show interest in the sector. Faced with yields from 10-year government securities in the US and UK of between 2.5% and 3%, insurance and pension funds are showing interest in yields of between 6-7% from solar and wind investments.

Last summer, Aviva Investors, a unit of insurer Aviva, bought operating solar power installations on 4,000 UK homes from installer Ecovision Renewable Energy for about GBP 51 million ($78 million); while last February two Danish pension funds, PKA and Industriens Pensions, invested in Germany's 288MW Butendiek offshore wind farm. Other owners of the EUR 1.3 billion ($1.8 billion) project include Siemens Project Ventures and the Marguerite Fund.

In addition, a number of specialist renewable asset funds raised money on the stock markets in 2013 to buy projects. For instance, NRG Yield, a US-based 'yield co' operating 2.9GW of rated generation (568MW of which is renewable), scooped $431 million from an initial public offering in July. In August, TransAlta Renewables, a Canadian yield co operating 1.1GW of wind and hydro generation assets, raised $200 million. Then, at the end of October, Foresight Group, a London-based asset manager focused on UK solar, raised GBP 150 million ($242 million) in an IPO.

Wind and solar deals made up 91% of the total value of asset purchases in 2013. The decline in global renewable energy asset sales was largely due to a sharp fall in the value of solar deals, in particular large-scale solar thermal acquisitions. The overall value of solar projects changing hands (including debt refinancing transactions) fell to $10.7 billion from $16 billion the year before. There was also a dearth of offshore wind acquisitions (yet overall wind project acquisitions dropped only slightly to $25.7 billion from $27.9 billion).

FIGURE 60. ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY REGION, 2004-2013, $BN



Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

The small hydro sector accounted for the largest share of the remainder, with $1.3 billion worth of acquisitions, followed by the biofuel sector with $1 billion. In one of the larger clean fuel deals, Green Plains Renewable Energy, the fourth-largest US ethanol maker, bought two plants from BioFuel Energy Corporation for $101 million. The biomass and waste-to-energy sector trailed the rest with transactions valued at just over $600 million, a decline from the previous year's $1.5 billion.

Other categories of acquisition activity – private equity buy-outs and investor exits from public companies – accounted for just 4.3% of the renewable energy total in dollar terms. The former declined steeply to $600 million from $3.2 billion the year before. The largest deal of this type was Profit Icon Investments' purchase of an 8% stake in a China-based rooftop solar project developer, China Merchants New Energy Holdings, for HKD 2.1 billion ($273 million).

Investor exits from listed companies, on the other hand, jumped to $1.7 billion from $435 million in 2012, helped by rising share prices. Chengdong Investment Corporation, a subsidiary of China Investment Corporation, sold 1.2 billion shares of Chinese polysilicon manufacturer GCL-Poly Energy Holdings for $289 million. Both this deal and the acquisition of China Merchants New Energy helped that country to rebound from the low levels of M&A seen in 2012. There was $1.6 billion worth of deals there in 2013 compared with $1 billion a year earlier.

Figure 60 shows a comparison of the trend in all types of acquisition activity transactions by region. Activity also rose in India and increased in the fledgling renewable power markets of Africa and the Middle East. In the US, however, the value of deals declined after a bumper year in 2012, and transaction value hit a seven-year low in Europe. Renewable energy projects in these areas lost some of their appeal as concerns about policy changes and subsidy cuts depressed investor confidence, while oversupply among equipment manufacturers, particularly in the solar sector, dented the corporate M&A figures.

GLOSSARY[1]

ASSET FINANCE	All money invested in renewable energy generation projects, whether from internal company balance sheets, from debt finance, or from equity finance. It excludes refinancings. The project may not be commissioned in the same year.
CAPITAL EXPENDITURE – CAPEX	Funds used by a company to acquire or upgrade physical assets such as property, industrial buildings or equipment. Some investment will translate into capacity in the following year.
CONVERTIBLE BOND	A bond that can be exchanged for a fixed number of shares in the issuing company.
DISTRIBUTED GENERATION	Generation of power from small-scale technologies close to where it is used.
FEED-IN TARIFF (FIT)	A premium rate paid for electricity fed back into the electricity grid from a designated renewable electricity generation source.
GREEN BONDS	Any bond issued to finance a clean energy, low-carbon or climate project, or to finance a company supplying related products or services.
INITIAL PUBLIC OFFERING (IPO)	A company's first offering of stock or shares for purchase via an exchange. Also referred to as "flotation".
MERGERS & ACQUISITIONS (M&A)	The value of existing equity and debt purchased by new corporate buyers in companies developing renewable technology or operating renewable energy projects.
NON-RECOURSE PROJECT FINANCE	Debt and equity provided directly to projects rather than to the companies developing them.
OVER-THE-COUNTER (OTC)	Trading of stocks, bonds, commodities or derivatives directly between buyers and sellers as opposed to via a formal exchange.
PRIVATE INVESTMENT IN PUBLIC EQUITY (PIPE)	The purchase of securities directly from a publicly traded company by private investors.
PRODUCTION TAX CREDIT (PTC)	The support instrument for wind energy projects at federal level in the US.
PUBLIC MARKETS	All money invested in the equity of publicly quoted companies developing renewable energy technology and generation.
RENEWABLE PORTFOLIO STANDARD (RPS)	A regulation that requires that a minimum of electricity or heat sold is from renewable sources. Also called Renewable Electricity Standard (RES) at the US federal level and Renewables Obligation in the UK.
VENTURE CAPITAL AND PRIVATE EQUITY (VC/PE)	TAll money invested by venture capital and private equity funds in the equity of companies developing renewable energy technology.
YIELD CO	Corporate entity created specifically to hold high-yielding investments in operating-stage projects.

[1] Further definitions and explanations can be found in Private Financing of Renewable Energy – a Guide for Policymakers. S. Justice/K. Hamilton. Chatham House, UNEP Sustainable Energy Finance Initiative, and Bloomberg New Energy Finance, December 2009 and in the REN21 2014 Renewables Global Status Report, which is to be released in June 2014.

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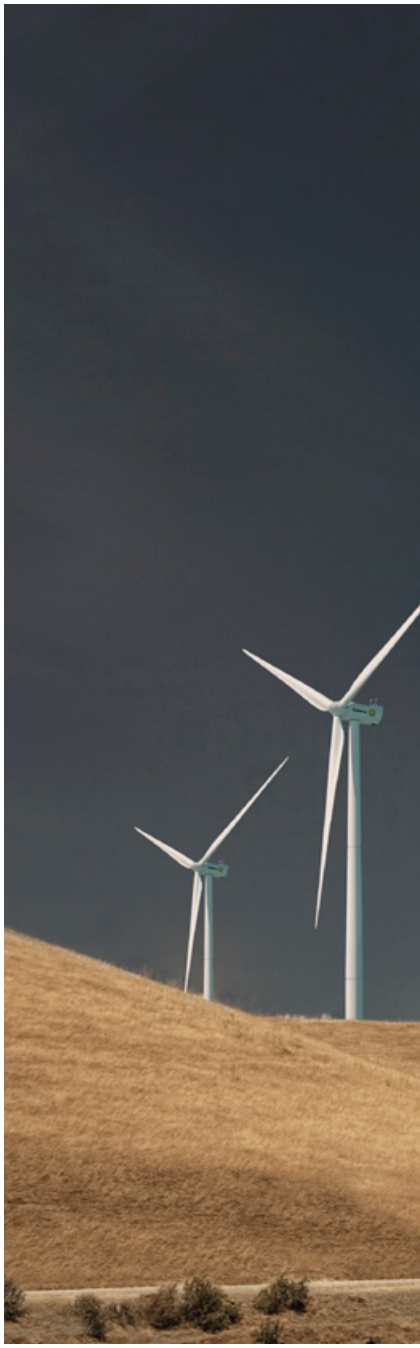

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