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FS-UNEP Collaborating Centre
for Climate & Sustainable Energy Finance

GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2016

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FOREWORD FROM BAN KI-MOON

Reducing the risks of climate change requires urgent action now. The Paris Agreement, universally adopted in December 2015 by all Parties to the UN Framework Convention on Climate Change, finally provides the policy signals the private sector has asked for to help accelerate the low-carbon transformation of the global economy.

We have entered a new era of clean energy growth that can fuel a future of opportunity and greater prosperity for every person on the planet. Governments, businesses and investors around the world are realising that the progression to low-emission, climate-resilient growth is inevitable, beneficial and already under way.

In 2015, significant strides were made in the financing of renewable energy technologies. Global Trends in Renewable Energy Investment 2016 increases our confidence that a low-carbon world is attainable and that we are on the right path to reach our objectives, including those under the Sustainable Development Goals.

In 2015, renewable energy set new records for investment and new capacity added. Investments reached nearly $286 billion, more than six times more than in 2004, and, for the first time, more than half of all added power generation capacity came from renewables.

In spite of these positive findings, to keep global temperature rise well below 2 degrees and aim for 1.5 degrees, we must immediately shift away from fossil fuels. Sustainable, renewable energy is growing, but not quickly enough to meet expected energy demand. For power sector development to be consistent with the goal of zero net greenhouse gas emissions in the second half of the century, it will be necessary to reduce or leave idle fossil-fuel power plant capacity, unless carbon capture technologies become widely available and are rapidly and fully utilised.

For the low-carbon transformation of the global economy to succeed, governments will need to create a level playing field for clean energy investment through carbon pricing, removing fossil fuel subsidies and strengthening stable and predictable regulatory and investment environments.

I commend *Global Trends in Renewable Energy Investment 2016* to readers in all sectors interested in reducing the risks of climate change and supporting a sustainable future for all.

Ban Ki-moon

Secretary-General, United Nations

JOINT FOREWORD FROM ACHIM STEINER, CHRISTIANA FIGUERES AND UDO STEFFENS


ACHIM STEINER


CHRISTIANA FIGUERES


UDO STEFFENS

In 2015, nearly 200 countries signed up to the 17 goals of the 2030 Agenda for Sustainable Development and the Paris Climate Change Agreement. The world's ability to deliver on those commitments depends on the speed with which we can achieve certain transformational changes, notably the transition to clean, sustainable and renewable energy that underpins so many of the goals. Global Trends in Renewable Energy Investment 2016 confirms that a transition to a low-carbon economy is entirely within our grasp.

Building on research that stretches back to 2004, the record figures in this year's report demonstrate a solid trend towards increasing investment and capacity, highlighting how far renewable energy has come from the days when it was all too readily dismissed as a niche sector.

Last year's 5% increase in investment is particularly remarkable given the shifting exchange rates that depressed the dollar value of investments in other currency zones and the sharp falls in oil, coal and gas prices that protected the competitive position of fossil fuels. Likewise, by showing that developing nations now invest more in renewables than developed countries and that an unprecedented 118GW of wind and solar photovoltaic capacity was added in 2015, the report conclusively dismisses any lingering assertions that such technologies are a luxury. In fact, last year, developing and emerging economies committed $156 billion to renewables; up by an impressive 19 per cent on 2014 and an astonishing 17 times 2004 levels. China has been a key contributor, lifting its investment by 17% to more than a third of the world total.

Overall, *Global Trends in Renewable Energy Investments 2016* underlines the increasing importance of renewable energy in tackling climate change and the wider sustainable development agenda. We hope that people from throughout the public-private spectrum will use this report to identify new opportunities, because the world must continue taking bold strides towards integrating clean energy across every aspect of our lives if we are to ensure a healthy planet with healthy people for 2030 and beyond.

Achim Steiner

UN Under-Secretary General and UNEP Executive Director

Christiana Figueres

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

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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 many tens of thousands of organisations (including start-ups, corporate entities, venture capital and private equity providers, banks and other investors), projects and 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, in this report.

The 2015 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 for the box on EVs at the end of Chapter 2 and the discussion of renewables and storage in Chapter 3.

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 brief coverage of large hydro in the Executive Summary and in the box at the end of Chapter 5.

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 historic figures, based on confirmed and disclosed investment.

Annual investment is estimate for small-scale commercial and residential projects such as rooftop solar. 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.

This 2016 report contains revisions to a number of investment figures published in the 2015 edition of Global Trends in Renewable Energy Investment. 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 2014 and before that have since come to light.

DEFINITIONS

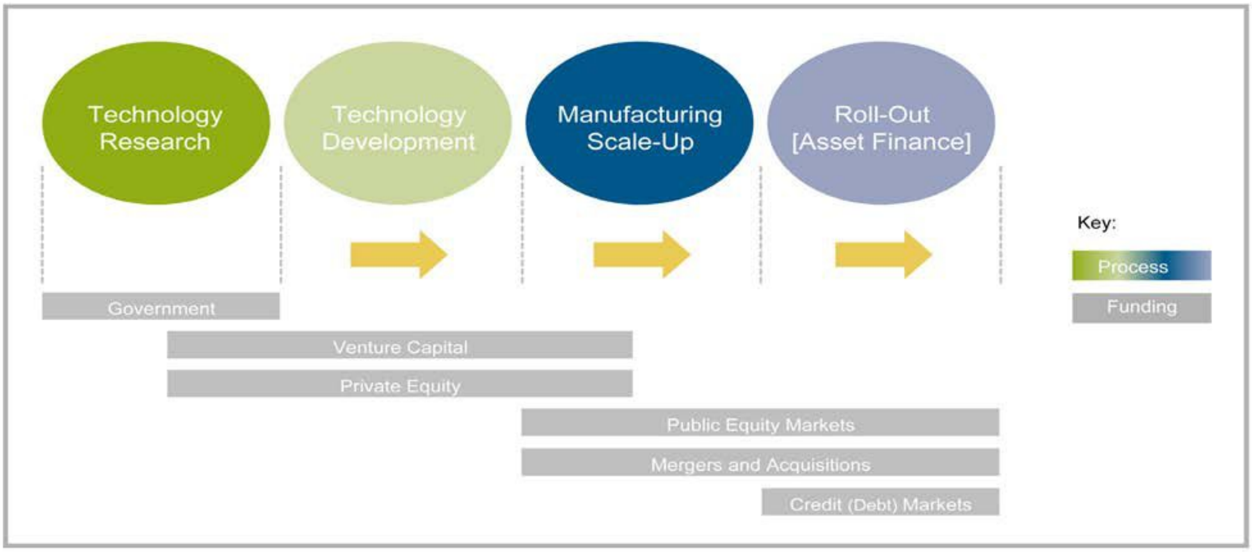
Bloomberg New Energy Finance tracks deals across the financing continuum, from R&D funding and venture capital for technology and early-stage companies, through to asset finance of utility-scale generation projects. Investment categories are defined as follows:

Venture capital and private equity (VC/PE): all money invested by venture capital and private equity funds in the equity of specialist companies developing renewable energy technology. 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 specialist 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 GSR grew out of an effort to portray the status of renewable energy worldwide. Over the past decade the GSR has grown in scope and depth, paralleling the tremendous advances in renewable energy policy, markets and industries. The report is the product of systematic data collection resulting in thousands of data points, the use of hundreds of documents and personal communication with experts from around the world. It draws on the expertise of a multi-stakeholder community of over 500 experts. The Global Status Report is the sister publication to UNEP Global Trends in Renewable Energy Investment; the latest edition will be released in June 2016.

KEY FINDINGS

- 2015 produced a new record for global investment in renewable energy. The amount of money committed to renewables excluding large hydro-electric projects rose 5% to $285.9 billion, exceeding the previous record of $278.5 billion achieved in 2011. This record was achieved despite exchange rate shifts that depressed the dollar value of investments in other currency zones, and despite sharp falls in oil, coal and gas prices that protected the competitive position of fossil fuel generation.

- Even more striking was that the amount of generating capacity added in wind and solar photovoltaics last year came to 118GW, far above the next highest annual figure, 2014's 94GW. Overall, renewables excluding large hydro made up 53.6% of the gigawatt capacity of all technologies installed in 2015, the first time it has represented a majority.

- Global investment in renewable power capacity[1], at $265.8 billion, was more than double dollar allocations to new coal and gas generation, which was an estimated $130 billion in 2015. However, the huge weight of conventional generation capacity already built meant that new, clean technologies only accounted for just over 10% of world electricity last year, as Chapter 2 shows. However, this did prevent the emission of some 1.5 gigatonnes of CO2 in 2015.

- Even though 2015 produced a record for overall investment, the sky is far from entirely blue. The United Nations climate change conference in Paris in December 2015, known as COP21, produced an unprecedented agreement among 195 countries to act for zero net emissions in the second half of the century. Nevertheless, the global emission trend remains worrying, as energy-related emissions are not forecast to peak until the late 2020s, at the earliest.

- Last year was also notable as the first in which investment in renewables excluding large hydro in developing countries outweighed that in developed economies. The developing world including China, India and Brazil committed a total of $156 billion, up 19% on 2014, while developed countries invested $130 billion, down 8%. A large element in this turnaround was China, which lifted its investment by 17% to $102.9 billion, or 36% of the world total.

- However, other developing countries also raised their game – India saw its commitments rise 22% to $10.2 billion, while Brazil ($7.1 billion, down 10%), South Africa ($4.5 billion, up 329%), Mexico ($4 billion, up 105%) and Chile ($3.4 billion, up 151%) all joined it in the list of the top 10 investing countries in 2015. The list of developing countries investing more than $500 million last year also included Morocco, Uruguay, the Philippines, Pakistan and Honduras.

- Investment in Europe slipped 21% to $48.8 billion, despite that continent's record year for financings of offshore wind, at $17 billion, up 11%. The US enjoyed a 19% bounce in renewable energy commitments to $44.1 billion, its highest since 2011, with solar accounting for just over two thirds of that total. Japan attracted $36.2 billion, almost the same as in 2014, thanks to its continuing boom in small-scale PV.

- Renewable generation costs continue to fall, particularly in solar photovoltaics. In the second half of 2015, the global average levelised cost of electricity for crystalline silicon PV was $122 per MWh, down from $143 in H2 2014. Specific projects are going ahead at tariffs well below that – the record-breaker so far being a 200MW plant in Dubai being built by ACWA Power International, awarded a contract in January 2015 at just $58.50 per MWh.

- Public market investment in renewable energy totalled $12.8 billion in 2015, down 21% on the previous year's figure but close to the average for the years since 2008. The 2015 figure was unusually lopsided, however, with North American 'yieldcos' and European quoted project funds accounting for $6.2 billion of new equity, and US manufacturer and project developer SunEdison issuing $2 billion of convertibles. The US yieldco equity raising spree came to an almost complete halt after July as a result of a sharp share price correction. Overall, clean energy shares edged down 0.6% in 2015, in line with the US S&P500 index.

- Policy support for renewables remains fickle. A less friendly turn by the new UK government after the May 2015 election has been one example, and another may be the US Supreme Court's decision in February 2016 to allow all legal objections to the Environmental Protection Agency's Clean Power Plan to be heard before it can be implemented. It is also possible that the recent big fall in coal, oil and gas prices may tempt some developing countries to keep relying on fossil-fuel capacity for longer.

- There is rising interest in battery storage as an adjunct to solar and wind projects and to small-scale PV systems. In 2015, some 250MW of utility-scale electricity storage (excluding pumped hydro and lead-acid batteries) were installed worldwide, up from 160MW in 2014. Announced projects reached 1.2GW. The potential for storage to help balance variable renewable electricity generation, in both developed countries and remote developing country locations off the grid, is this year's Focus topic and is discussed in Chapter 3.

[1] Investment in large hydro-electric dams is not included in that figure. It is estimated to have been $43 billion in 2015.

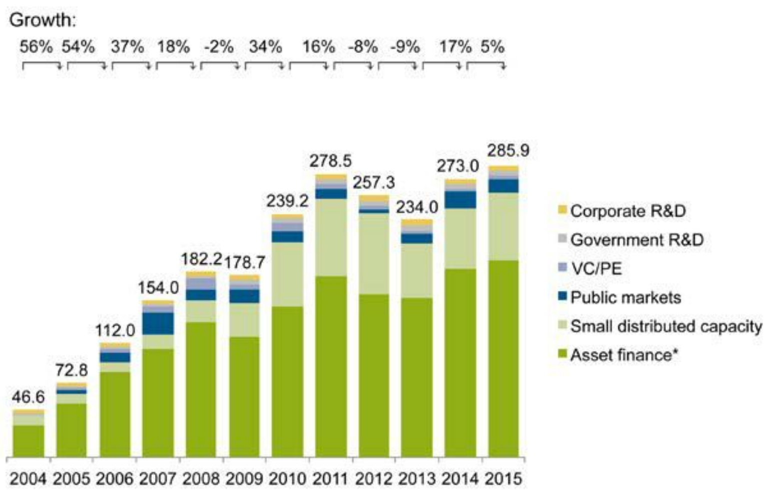
EXECUTIVE SUMMARY

Renewable energy set new records in 2015 for dollar investment, the amount of new capacity added and the relative importance of developing countries in that growth. All this happened in a year in which prices of fossil fuel commodities – oil, coal and gas – plummeted, causing distress to many companies involved in the hydrocarbon sector. So far, the drivers of investment in renewables, including climate change policies and improving cost-competitiveness, have been more than sufficient to enable renewables to keep growing their share of world electricity generation at the expense of carbon-emitting sources.

Last year saw global investment in renewables[1] rise 5% to $285.9 billion, taking it above the previous record of $278.5 billion reached in 2011 at the peak of the 'green stimulus' programmes and the German and Italian rooftop solar booms. Figure 1 shows that the 2015 total was more than six times the figure set in 2004, and that investment in renewables has been running at more than $200 billion per year for six years now. Over the 12 years shown on the chart, the total amount committed has reached $2.3 trillion.

More impressive in a way than the new dollar investment record set last year was the result in terms of gigawatts of capacity added. In 2015, some 134GW of renewables excluding large hydro were commissioned, equivalent to some 53.6% of all power generation capacity completed in that year – the first time it has represented a majority. Of the renewables total, wind accounted for 62GW installed, and solar photovoltaics 56GW, record figures and sharply up from their 2014 additions of 49GW and 45GW respectively.

FIGURE 1. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY ASSET CLASS, 2004-2015, $BN



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

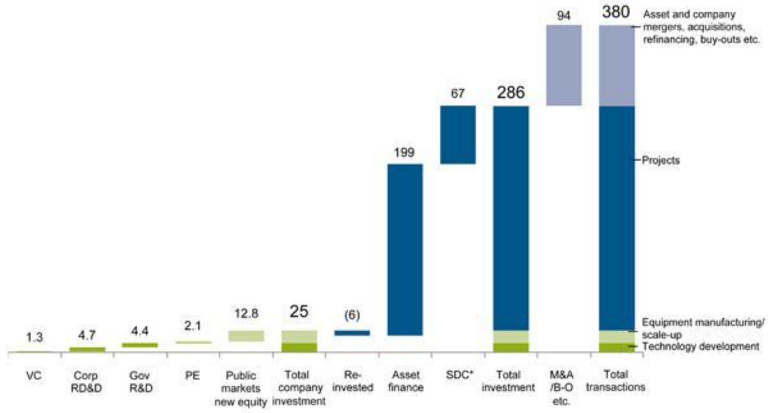
Figure 2 shows the make-up of the record investment figure in 2015. At the left edge of the chart are the categories relating to the backing of early-stage companies and technology. Venture capital investment in renewables was $1.3 billion last year, up 36% but still far behind its peak level of $3.2 billion in 2008. Next along is corporate and government research and

[1] Excluding large hydro-electric projects of more than 50MW. See later in the Executive Summary and the Box at the end of Chapter 5 for discussion of large hydro in 2015.

development spending on renewables. The former was up 3% on the previous year at $4.7 billion and the latter down 3% at $4.4 billion. Private equity expansion capital was $2.1 billion in 2015, up 32% on 2014 but less than a third of the peak, 2008 figure of $6.7 billion. The last part of that technology/corporate level funding is equity raising by specialist renewable energy companies on the public markets. This was $12.8 billion last year, down 21% on the previous 12 months but close to its average over the last eight years.

The biggest components of investment in 2015 were asset finance of utility-scale projects such as wind farms and solar parks, at $199 billion, some 6% above the previous year, and spending on small distributed capacity – local and rooftop solar projects of less than 1MW capacity – which was up 12% at $67.4 billion. There is also an adjustment of $5.8 billion for reinvested equity (money that was raised in the categories on the left of Figure 2 that then ended up going into asset finance or small projects). Finally, on the right of Figure 2 is acquisition activity of $93.9 billion, up 7%. This is a mix of asset acquisitions, refinancings, corporate mergers and takeovers, and buy-outs.

FIGURE 2. GLOBAL TRANSACTIONS IN RENEWABLE ENERGY, 2015, $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

FIGURE 3. GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2016 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	2014 $bn	2015 $bn	2014-15 Growth %	2004-15 CAGR %
1 Total Investment														
1.1 New investment	46.6	72.8	112.0	154.0	182.2	178.7	239.2	278.5	257.3	234.0	273.0	285.9	5%	18%
1.2 Total transactions	55.5	99.1	147.9	212.7	241.6	242.9	297.6	352.0	324.9	301.1	360.4	379.8	5%	19%
2 New Investment by Value Chain														
2.1 Technology development														
2.1.1 Venture capital	0.4	0.6	1.2	2.1	3.2	1.6	2.5	2.5	2.4	0.8	1.0	1.3	36%	13%
2.1.2 Government R&D	1.9	2.0	2.2	2.7	2.8	5.4	4.9	4.8	4.7	5.2	4.5	4.4	-3%	8%
2.1.3 Corporate RD&D	3.2	2.9	3.1	3.5	4.0	4.1	4.2	5.1	5.0	6.6	4.5	4.7	3%	3%
2.2 Equipment Manufacturing														
2.2.1 Private equity expansion capital	0.3	1.0	3.1	3.6	6.7	2.9	5.4	2.4	1.6	1.4	1.6	2.1	32%	18%
2.2.2 Public markets	0.3	3.6	9.3	21.4	10.9	12.9	11.2	10.0	3.8	10.1	16.2	12.8	-21%	42%
2.3 Projects														
2.3.1 Asset finance	32.0	52.6	84.5	109.8	135.8	120.2	152.9	181.4	163.3	158.0	188.4	199.0	6%	18%
Of which re-invested equity	0.0	0.1	0.7	3.2	3.6	1.9	4.4	3.4	2.8	1.9	3.7	5.8	59%	-
2.3.3 Small distributed capacity	8.5	10.2	9.4	14.1	22.3	33.5	62.6	75.7	79.3	53.9	60.4	67.4	12%	21%
Total Financial Investment	32.9	57.6	97.3	133.7	153.1	135.7	167.5	192.8	168.3	168.4	203.6	209.4	3%	18%
Gov't R&D, corporate RD&D, small projects	13.6	15.2	14.7	20.3	29.1	43.0	71.7	85.7	89.0	65.6	69.5	76.5	10%	17%
Total New Investment	46.6	72.8	112.0	154.0	182.2	178.7	239.2	278.5	257.3	234.0	273.0	285.9	5%	18%
3 M&A Transactions														
3.1 Private equity buy-outs	0.8	3.7	1.9	3.6	5.1	2.2	1.9	3.0	3.3	0.5	2.6	3.5	36%	14%
3.2 Public markets investor exits	0.4	2.4	2.7	4.0	0.9	2.5	4.9	0.2	0.4	1.7	1.8	1.8	1%	16%
3.3 Corporate M&A	2.4	7.6	11.9	20.4	16.9	21.8	19.4	29.7	10.2	16.3	11.8	19.2	63%	21%
3.4 Project acquistion & refinancing	5.3	12.5	19.5	30.7	36.4	37.7	32.3	40.6	53.7	48.6	71.2	69.3	-3%	26%
4 New Investment by Sector														
4.1 Wind	19.0	29.0	39.8	61.2	75.4	79.8	98.7	84.2	81.9	90.6	105.7	109.6	4%	17%
4.2 Solar	11.9	16.1	22.2	38.9	61.6	64.4	103.7	154.8	146.2	119.1	143.8	161.0	12%	27%
4.3 Biofuels	4.0	9.6	28.2	28.3	18.5	10.4	10.1	10.3	7.2	5.7	4.7	3.1	-35%	-2%
4.4 Biomass & w-t-e	7.7	9.7	11.9	16.2	17.1	14.7	15.7	18.0	13.5	10.5	10.4	6.0	-42%	-2%
4.5 Small hydro	2.6	7.3	7.6	6.7	7.6	6.2	7.9	7.2	6.4	5.5	5.5	3.9	-29%	4%
4.6 Geothermal	1.2	1.0	1.5	1.9	1.7	2.9	2.8	3.7	1.8	2.4	2.6	2.0	-23%	5%
4.7 Marine	0.0	0.1	0.9	0.8	0.2	0.3	0.3	0.3	0.3	0.2	0.4	0.2	-42%	14%
Total	46.6	72.8	112.0	154.0	182.2	178.7	239.2	278.5	257.3	234.0	273.0	285.9	5%	18%
5 New Investment by Geography														
5.1 United States	5.6	11.9	29.1	33.2	35.5	23.9	34.7	49.1	40.6	35.3	37.0	44.1	19%	21%
5.2 Brazil	0.8	3.1	5.2	11.4	11.8	7.9	7.2	10.2	7.7	4.4	8.0	7.1	-10%	21%
5.3 AMER (excl. US & Brazil)	1.7	3.3	3.7	5.0	6.1	5.5	12.0	9.3	10.1	12.0	13.3	12.8	-3%	20%
5.4 Europe	24.8	33.3	46.9	66.8	81.8	82.7	113.4	122.9	89.0	60.0	62.0	48.8	-21%	6%
5.5 Middle East & Africa	0.6	0.8	1.1	1.8	2.3	1.6	4.1	3.0	10.2	9.3	7.9	12.5	58%	32%
5.6 China	3.0	8.3	11.2	16.7	25.6	38.8	39.6	47.4	61.7	62.0	87.8	102.9	17%	38%
5.7 India	2.7	3.0	4.9	6.7	5.6	4.3	8.8	12.8	7.8	6.6	8.3	10.2	22%	13%
5.8 ASOC (excl. China & India)	7.3	9.0	10.0	12.4	13.6	13.9	19.3	23.8	30.2	44.4	48.8	47.6	-2%	19%
Total	46.6	72.8	112.0	154.0	182.2	178.7	239.2	278.5	257.3	234.0	273.0	285.9	5%	18%

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

The regional split of investment in 2015 is shown in Figure 3. The stand-out contribution to the rise in investment to a new record came from China, which lifted its outlays by 17% to $102.9 billion, some 36% of the global total. Investment also increased in the US, up 19% at $44.1 billion; in Middle East and Africa, up 58% at $12.5 billion, helped by project development in South Africa and Morocco; and in India, up 22% at $10.2 billion. However, it fell in Europe by 21% to $48.8 billion, that continent's lowest figure for nine years – despite record commitments to offshore wind projects. Investment fell 10% to $7.1 billion in Brazil, and was also slightly lower in the Americas excluding the US and Brazil, at $12.8 billion, largely due to a weaker Canadian figure; and in Asia excluding China and India, at $47.6 billion. Much more detail on the regional and country trends can be found in Chapter 1.

DEVELOPING WORLD AHEAD

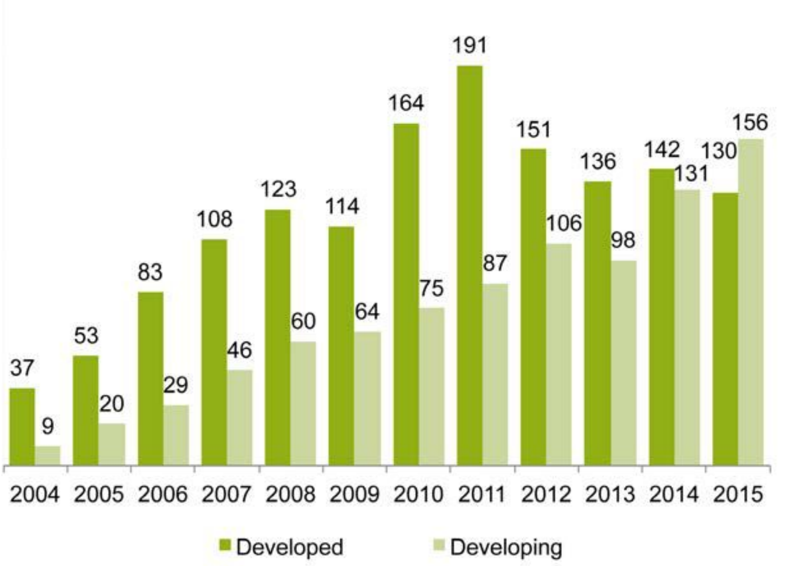
Renewable energy technologies such as wind and solar used to be seen by some critics as a luxury, affordable only in the richer parts of the world. This has been an inaccurate view for a long time, but 2015 was the first year in which investment in renewables excluding large hydro was higher in developing economies than in developed countries. Figure 4 shows that the developing world invested $156 billion last year, some 19% up on 2014 and a remarkable 17 times the equivalent figure for 2004, of $9 billion.[2] Developed countries invested $130 billion in 2015, down 8% and their lowest tally since 2009.

A large part of the record-breaking investment in developing countries took place in China. Indeed that country has been the single biggest reason for the near-unbroken uptrend for the developing world as a whole since 2004. However, it was not just China – India also raised its commitment to renewables in 2015, and developing countries excluding China, India and Brazil lifted their investment by 30% last year to an all-time high of $36 billion, some 12 times their figure for 2004.

Among those "other developing" economies, those putting the largest sums into clean power were South Africa, up 329% at $4.5 billion as a wave of projects winning contracts in its auction programme reached financial close; Mexico, 105% higher at $4 billion, helped by funding from

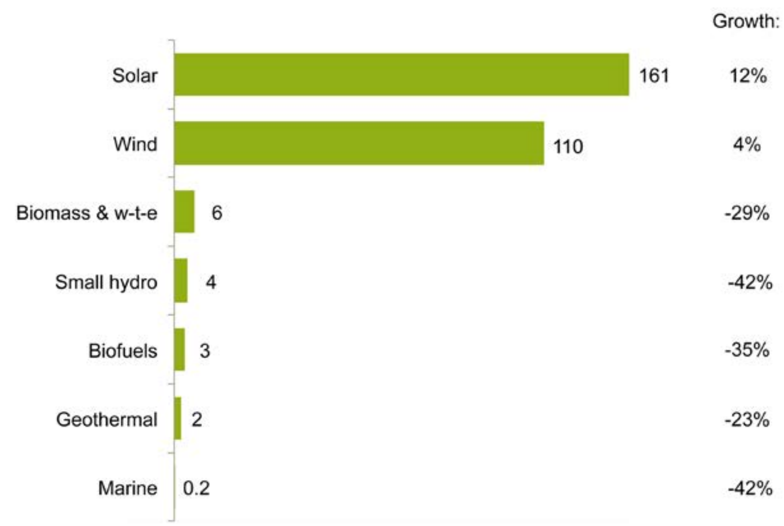
[2] The definition of developing world used in this report is all non-OECD countries plus Mexico, Chile and Turkey. Even on a simple OECD versus non-OECD countries comparison, the latter would still have invested more than the former in 2015.

FIGURE 4. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2004-2015, $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, 2015, AND GROWTH ON 2014, $BN



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

development bank Nafin for nine wind projects; and Chile, 151% higher at $3.4 billion, on the back of a jump in solar project financings. Morocco, Turkey and Uruguay also saw investment beat the $1 billion barrier in 2015.

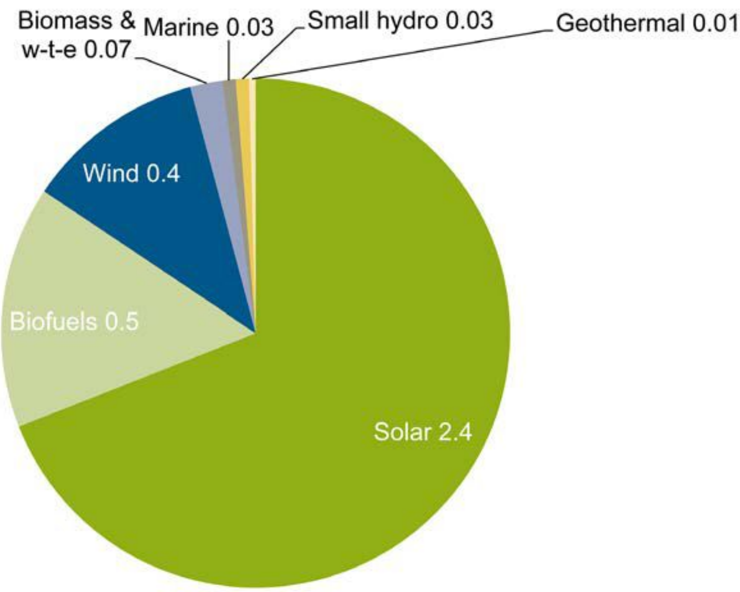
Investment in the developed world has been on a downward trend, more or less consistently, since 2011, when it peaked at $191 billion, some 47% higher than the 2015 outturn. This decline has been a little to do with the US, where there was a rush of investment in 2011 as projects and companies tried to catch the Treasury grant and Federal Loan Guarantee programmes before they expired; but much more to do with Europe, where allocations fell by 60% between 2011 and 2015. That big drop reflected a mix of factors including retroactive cuts in support for existing projects in Spain, Romania and several other countries, an economic downturn in southern Europe that made electricity bills more of a political issue, the fading of solar booms in Germany and Italy, and the big fall in the cost of PV panels over recent years. The two factors pushing in the opposite (positive) direction in Europe in recent years have been strong investment in the UK, and the growth of the offshore wind sector in the North Sea.

Figure 5 shows the sector split for global investment. Over recent years, renewables have become more and more dominated by wind and solar, with the smaller sectors losing relative importance, and in 2015 this process continued. Solar saw a 12% increase to $161 billion, and wind a 4% boost to $109.6 billion – both records, although not by as huge a margin as their gigawatt installation figures.[3] Biomass and waste-to-energy suffered a 42% fall to $6 billion; small hydro projects of less than 50MW a 29% decline to $3.9 billion; biofuels (the second-biggest sector behind wind back in 2006) a 35% drop to $3.1 billion; geothermal a 23% setback to $2 billion; and marine (wave and tidal) a 42% slip to just $215 million.

[3] There are several reasons why GW installations grew more quickly than dollar investment in 2015 for wind and solar. One was the rise in the US currency, which depressed dollar figures for projects in euro, yen, yuan and other currency zones. A second was lower costs per MW in solar. A third was the growing share of China in overall investment. Chinese wind and solar projects are typically at the low end of the global cost range.

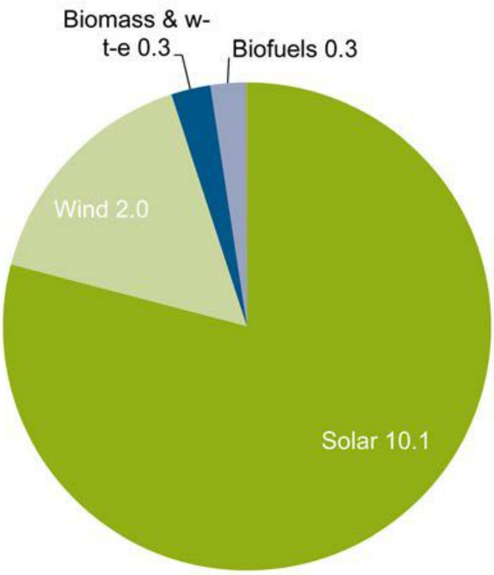
The split was somewhat different for venture capital and private equity funding specifically. This type of money tends to go to the newer technologies, rather than the more mature ones, so it is no surprise in Figure 6 to see solar dominating with $2.4 billion last year, up 58%, and biofuels – particularly second-generation based on non-food crops – come second with $523 million, down 3%. Solar also took the lion's share of public market investment in 2015, at $10.1 billion in Figure 7, up 21%, with wind second at $2 billion, down 69%. However, the public market figures were heavily influenced last year by equity issuance from North American 'yieldcos' and European quoted project funds, many of which own projects in both solar and wind, so the sector split for their fundraisings is somewhat arbitrary.

FIGURE 6. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2015, $BN



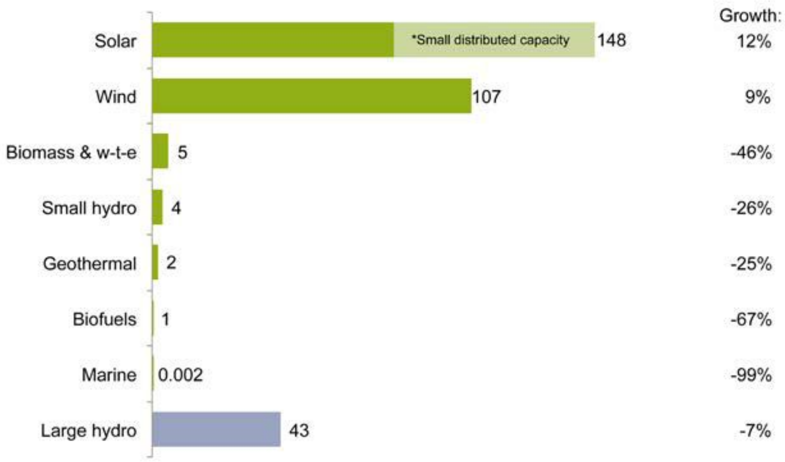
Source: UNEP, Bloomberg New Energy Finance

FIGURE 7. PUBLIC MARKETS NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2015, $BN



Source: UNEP, Bloomberg New Energy Finance

FIGURE 8. RENEWABLE ENERGY ASSET FINANCE AND SMALL DISTRIBUTED CAPACITY INVESTMENT BY SECTOR, 2015, AND GROWTH ON 2014, $BN



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

The really big financial flows to renewable energy in 2015 came at the roll-out stage, rather than the technology development stage. Figure 8 shows that solar (utility-scale and small-scale) was by far the largest sector for capacity investment, reaching $148.3 billion, up 12% on the year before. As well as conventional solar parks and rooftop installations, last year saw the financing of a number of floating solar photovoltaic projects on lakes and reservoirs, mostly in the single-digit MW range.

Commitments for new wind capacity rose 9% to $107 billion. Perhaps more interesting was the sub-sector split with onshore wind garnering $83.8 billion, up 3%, while offshore wind attracted a record $23.2 billion, up 39% compared to 2014, mostly in Europe but also including a first wave of Chinese sea-based projects. The offshore wind arrays financed worldwide last year were more than 20 in number, with eight of them having estimated project costs of between $1 billion and $2.9 billion. There was also a 30MW floating offshore wind project financed in Scotland. See Chapter 5 for details.

Figure 8 also shows the capacity investment comparison between wind and solar and the smaller clean energy sectors, the largest of which was biomass and waste-to-energy at $5.2 billion, and also between all of those and large hydro. Some $43 billion of large hydro-electric projects of more than 50MW are estimated to have reached the 'final investment decision' stage in 2015, down 7% on the previous year. This would put large hydro at 40% the size of wind in terms of new investment last year, and just 29% of the size of solar, although of course prior decades of development mean that the installed base of 50MW-plus hydro-electric dams is still, at around 925GW, much bigger than that of wind and solar (671GW combined).

ENERGY ABUNDANT, COMPETITION ON COSTS

The global energy sector has changed out of all recognition since the summer of 2014. Oil, as measured by the Brent crude contract, fell in price from a high of $115.71-a-barrel on 19 June of that year, to $27.10 on 20 January 2016, a decline of 76%. The ARA coal contract dropped from $84-a-tonne on 28 April 2014 to $36.30 on 17 February 2016, intensifying a downward trend that has been unfolding since its high of $135 in 2011. The US Henry Hub natural gas price slid from around $4.50 per MMBtu in June 2014 to $1.91 in mid-February 2016.

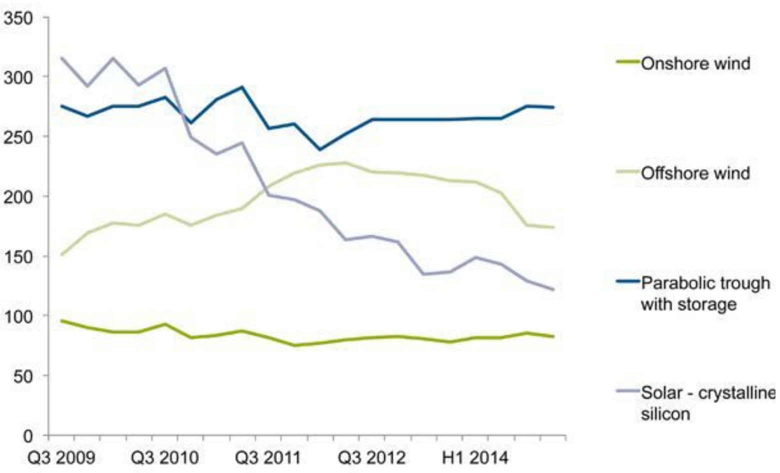
However, cheaper fossil fuels have not materially damaged prospects for renewables so far. Competition between fossil fuels and renewables is rarely a simple one-or-other choice. Oil does not compete directly with renewable power, except in a few crude-producing countries that burn oil to make electricity, and in remote regions using diesel generators. Gas does compete more directly with wind and solar, but while gas prices in Europe and Asia have fallen, they remain far above US levels. Coal also competes with renewables but, as with gas, decision-makers are unlikely to make power station choices on the basis of short-term spot commodity prices. In addition, new coal-fired plants may be more difficult to finance than those of cleaner technologies, given rising investor concern about exposure to stranded assets and the climate priorities of development banks.

Meanwhile, renewables have their own advantages. Wind farms can be built in nine months or so, solar parks in three-to-six months, whereas coal and gas plants take several years, and nuclear even longer. So developing countries in a hurry for new capacity may opt for speed. And, while fossil fuel costs have been falling, renewables and especially solar have also been getting more competitive.

Figure 9 shows the change in levelised costs of electricity[4] for four different renewable power technologies over a six-year period. Onshore wind has seen its average global LCOE decline from $96 per MWh in the third quarter of 2009 to $83 per MWh in late 2015, a reduction of 14%. The equivalent for offshore wind actually increased for

[4] Levelised costs of electricity include not just running costs but also the costs of development, construction and financing. LCOEs vary greatly by country, depending on the resource. The figures used here are global averages.

FIGURE 9. GLOBAL AVERAGE LEVELISED COST OF ELECTRICITY FOR WIND AND SOLAR, Q3 2009 TO H2 2015, $ PER MWH



Source: Bloomberg New Energy Finance

several years, as projects moved out into deeper water, but have started to come down more recently. Average costs were around $174 per MWh in the second half of last year. The LCOE for solar thermal parabolic trough plants has hardly changed and remains around $275 per MWh.

The spectacular mover has been solar photovoltaics, the biggest single sub-sector in renewables. The average global levelised cost for crystalline-silicon PV has plummeted from $315 per MWh in Q3 2009 to $122 in late 2015, a drop of 61%, reflecting deflation in module prices, balance-of-plant costs and installation expenses. And there is an advance guard of projects taking place in particular countries now at much lower figures – examples including the ACWA installation in Dubai that went ahead with a $58.50-per-MWh tariff in January 2015, and auctions in India in late 2015 and early 2016 that have seen solar projects win capacity with bids of $64 per MWh (Fortum Finnsuurya Energy in Rajasthan) and $68 (SunEdison and Softbank in Andhra Pradesh).

Many governments in developed and developing countries are moving towards auctions as a way of awarding capacity to renewable energy developers at relatively keen prices – continuing a trend that was discussed in last year's Global Trends report. In South Africa, for instance, the 2015 auctions awarded contracts to onshore wind at 41% less in local currency terms than the first auctions, back in 2011. In the UK, the first Contract-for-Difference auction, held in February 2015, saw winning bids for onshore wind at 11% below what was available under the preceding green certificate regime. Two contracts for offshore wind were awarded at 14% and 18% below the officially-set strike price. In Germany, the second PV auction in 2015 awarded contracts 7.5% below the previous feed-in tariff level.

None of this means that all obstacles for renewables have gone away, far from it. Challenges include national electricity monopolies in some developing countries that are not familiar with, or are resistant to, variable wind and solar generation. Then there are concerns in many developed economies about how variable generation can be balanced, and how it can be guaranteed that the lights will stay on (the subject of balancing and the potential of storage technologies are explored in Chapter 3). There are depressed wholesale electricity prices in many developed countries that are making it difficult to make a return on investing in any new generating plant, renewable or otherwise. There is a lack of investor confidence in a number of significant countries because of past political events or energy policy decisions, from Ukraine to Spain, and Argentina to Greece.

In some countries, local financing options are plentiful; in others they are few and far between – the sources of finance for renewable energy are discussed in Chapter 4. And some jurisdictions have local regulations that make renewables difficult to develop, even if the natural resource is good – small-scale solar in Turkey being one of the many examples. Finally, there are also issues resulting from rapid build-out of renewables. One important example is curtailment of new wind farms in China, as the grid struggles to match electricity demand that is growing less rapidly than before with increased power generation capacity.

INVESTMENT BY TYPE OF ECONOMY

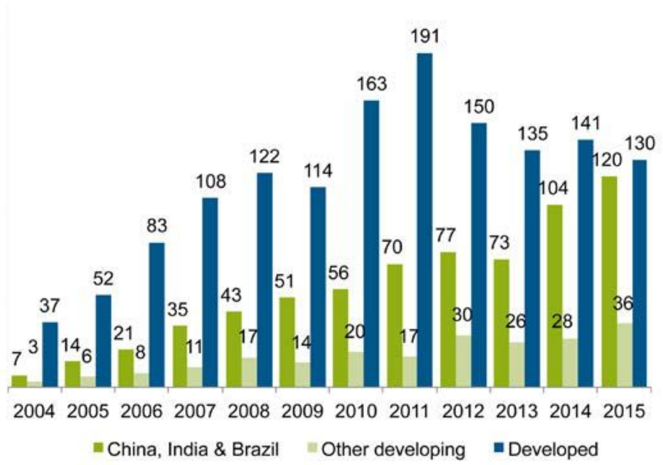
- Developing economies jumped ahead of developed countries for the first time in 2015 in terms of total new renewable energy investment.
- The share of global investment accounted for by developing countries rose from 49% in 2014 to 55% in 2015, with the dollar commitment at $155.9 billion, up from $131.5 billion the previous year. Developed economies invested $130.1 billion, compared to $141.6 billion in 2014.
- Within the developing-economy category, the "big three" of China, India and Brazil saw investment rise 16% to $120.2 billion, while "other developing" economies enjoyed a 30% bounce to $36.1 billion.
- China was by far the largest investing country for renewables excluding large hydro, its $102.9 billion for 2015, up 17%, representing well over a third of the global total. The US was a distant second, with $44.1 billion, up 19%.
- Japan was a clear third in the ranks of investing nations, its $36.2 billion, level with 2014, followed at a distance by the UK with $22.2 billion, up 25%, and India on $10.2 billion, up 22%. Germany recorded $8.5 billion, down 46%, and Brazil $7.1 billion, down 10%.
- Three "new markets" completed the top 10 investors – South Africa up 309% to $4.5 billion, as its auction programme crystallised into financed projects; Mexico doubling to $4 billion, and Chile rising 143% to $3.4 billion.

DEVELOPED VERSUS DEVELOPING ECONOMIES

Last year was a signal year for renewable energy because, for the first time, investment in developing economies out-weighed investment in developed countries. Commitments by the developing world amounted to $155.9 billion, up 19% to a new record, while those by the developed world slipped 8% to $130.1 billion (see Figure 4 and discussion in the Executive Summary).

In one way, this shift is unsurprising – after all, developing countries are generally those with fast-rising electricity demand and therefore likely to need the most new generating capacity. On the other hand, non-hydro renewables have been

FIGURE 10. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: SPLIT BY TYPE OF ECONOMY, 2004-2015, $BN

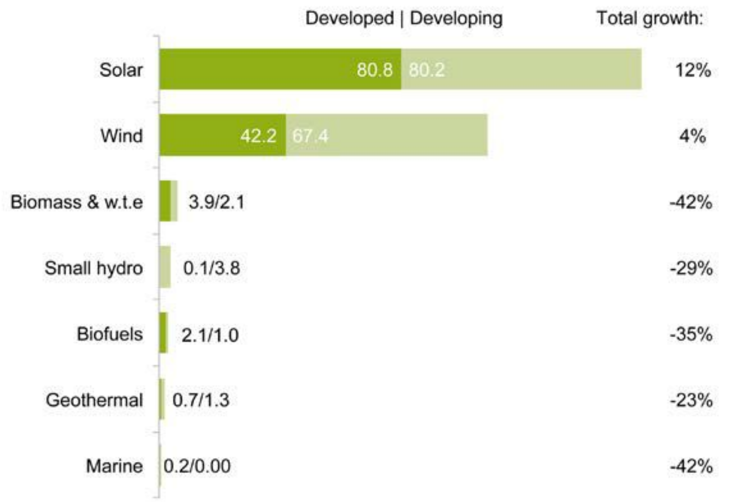


New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. Developed volumes are based on OECD countries excluding Mexico, Chile, and Turkey.

Source: UNEP, Bloomberg New Energy Finance

pioneered in richer countries over the last 30 years or so, and some of those nations provided generous subsidy support for deployment. What has changed in the last couple of years is that the much reduced cost of solar and wind technology has made projects viable in resource-rich emerging economies, while the wealthier countries have in many cases rowed back on subsidy support for renewables out of concern over the effect on electricity bills.

FIGURE 11. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY: DEVELOPED V DEVELOPING COUNTRIES, 2015, AND TOTAL GROWTH ON 2014, $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

Figures 10 and 11 look at the developing versus developed country split in two different ways. In Figure 10, the developing world is split into two – the "big three" of China, India and Brazil; and "other developing" countries. It shows that although the former are a huge part of global investment, the latter are growing in importance too. The "big three" saw investment rise 16% to $120.2 billion in 2015, while "other developing" economies enjoyed a 30% bounce to $36.1 billion, also a record.

Figure 11 examines the investment comparison by technology. Wind, originally pioneered in developed countries such as Denmark, Germany and the US, has seen a preponderance of activity in the developing world in recent years. The gap reached $25.2 billion in 2015, with the chart showing $67.4 billion of commitments in developing countries against $42.2 billion in developed nations.

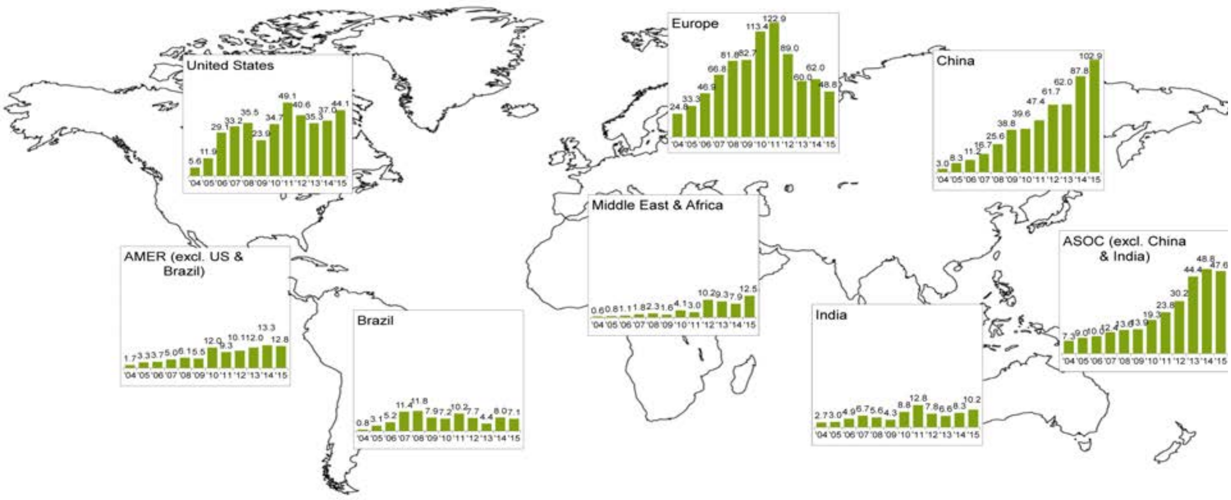
An even more striking change has happened in solar. Developed economies dominated with the successive small-scale booms in Germany, Italy and Japan, right up to 2014. However, Figure 11 shows that in 2015, the gap between developed and developing countries on solar investment was down to less than $1 billion, as China, India, Chile, South Africa and other nations ramped up PV, and to some extent solar thermal, or concentrated solar power (CSP), deployment.

On the other technologies, investment in biofuels in developed economies, at $2.1 billion, amounted to just over double that in developing nations in 2015, continuing a pattern seen in recent years. The US and Europe have recently taken most of the funding for second-generation ethanol companies and the corporate and government research and development spending in biofuels.

In biomass and waste-to-energy, the developed nations also dominated last year, with $3.9 billion of investment versus $2.1 billion in developing countries. There was asset finance of projects in China, Brazil and India, but also in the US, and the largest chunk of project spending was in Europe. The largest asset financing in geothermal in 2015 was in Turkey. There was a pause in geothermal asset investment in some developing countries that had seen big financings in previous years, such as Indonesia and Kenya.

In small hydro projects of less than 50MW, developing countries continued to be dominant, mainly thanks to China (see below). Finally, in marine, there was reduced investment generally but most of what there was took the form of company- and project-level fundings in northwest Europe and Australia.

FIGURE 12. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2015, $BN



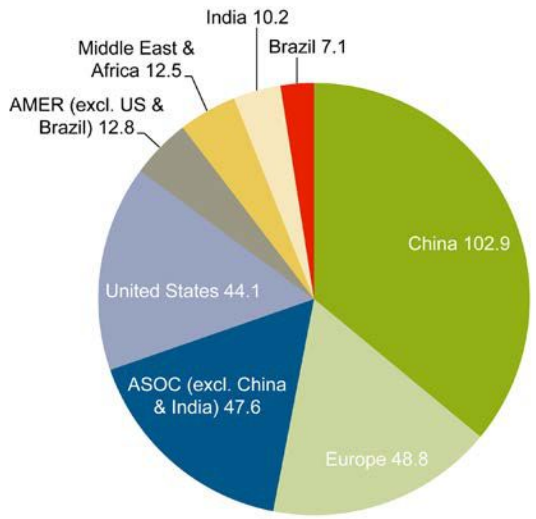
New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.
Source: UNEP, Bloomberg New Energy Finance

Figures 12 and 13 highlight the different trajectories of renewable energy investment by region in the 2004-15 period. The strongest and most consistent upswing in dollar commitments has come in China, which invested just $3 billion in 2004, then multiplied this 13-fold by 2010 and another two and half times by 2015, to a record $102.9 billion. Other regions have not trodden quite such a consistent upward path, although Asia-Oceania excluding China and India saw investment reach $47.6 billion in 2015 (largely thanks to Japan). This was slightly less than the previous year's $48.8 billion but far above 2004's $7.3 billion. And India enjoyed a second-successive year of increasing investment, breaching the $10 billion for the first time since 2011.

The Middle East and Africa saw investment gather pace from less than $1 billion in 2004 to a record $12.5 billion in 2015, thanks partly to South Africa's successful auction programme. The Americas excluding the US and Brazil have seen investment bobbing around the $10 billion to $13 billion range since 2010, but behind this has been a general upward trend in Spanish-speaking Latin America and volatile year-on-year figures from Canada.

Of the remaining large geographical areas in Figure 12, the US saw investment pick up in the last two years to reach its highest since the peak of "green stimulus" spending in 2011. The latest spurt has owed most to solar – both utility-scale and rooftop. Europe, meanwhile, recorded its biggest year for investment in dollar terms back in 2011, and has seen sharp falls since then, with 2015 the lowest figure since 2006.

FIGURE 13. GLOBAL NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2015, $BN



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

THE LEADING 10 COUNTRIES

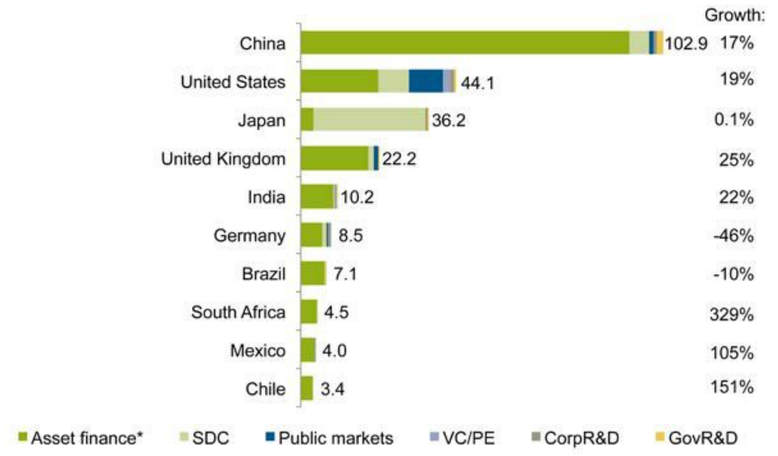
The top 10 investing countries in renewable energy excluding large hydro are displayed in Figure 14. China led the list for 2015 by a large margin, accounting for more than a third of global commitments, and with asset finance and small-scale projects (in its case, distribution-grid-connected solar rather than rooftop PV) the two main types of investment.

The next largest investing nations last year were the US and Japan, with the UK maintaining the fourth position it took for the first time in 2014. India moved up above Germany, which saw a sharp fall in investment (see section below), and into fifth place. Brazil maintained eighth place, while South Africa re-entered the top 10 at ninth, after dropping out in 2014, and Chile appears in the big league for the first time, with a 10th place slot.

Notable countries that failed to make the top 10 in 2015 but had featured there in previous years included Canada and France, where investment slipped back last year; Italy and Spain, where investment has shrunk to a fraction of its level a few years ago; and Australia, where it recovered a little in 2015 but remained at less than half peak (2011) levels.

Figures 15 and 16 identify the top countries in terms of asset finance and small-scale project investment. China heads the list for asset finance, and Japan for small-scale PV funding. Details of many of these shifts at the country level are explored in the next section.

FIGURE 14. NEW INVESTMENT IN RENEWABLE ENERGY BY COUNTRY AND ASSET CLASS, 2015, AND GROWTH ON 2014, $BN



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

FIGURE 15. ASSET FINANCE OF RENEWABLE ENERGY ASSETS BY COUNTRY, 2015, AND GROWTH ON 2014, $BN

	2015	% growth on 2014
Chile	3.4	141%
Japan	3.8	-49%
Mexico	3.9	109%
South Africa	4.5	337%
Germany	6.3	-46%
Brazil	7.7	40%
India	9.1	34%
United Kingdom	19.2	24%
United States	24.4	31%
China	95.7	18%

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

FIGURE 16. SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2015, AND GROWTH ON 2014, $BN

	2015	% growth on 2014
Italy	0.5	-34%
Taiwan	0.6	144%
France	0.7	-34%
Netherlands	0.8	22%
Germany	1.3	-57%
Australia	1.5	-14%
United Kingdom	1.8	29%
China	5.5	81%
United States	8.7	-11%
Japan	31.7	13%

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

FIGURE 17. RENEWABLE ENERGY INVESTMENT IN THE US BY SECTOR AND TYPE, 2015, $BN

	Asset finance	Re-invested Equity	SDC	Public markets	VC/PE	CorpR&D	GovR&D	Total
Solar	13.0	-2.2	8.7	8.2	1.8	0.5	0.1	30.2
Wind	10.6	-0.2	-	1.0	0.1	0.1	0.1	11.6
Biofuels	0.0	-	-	0.3	0.2	0.2	0.3	1.1
Geothermal	-	-	-	-	0.0	0.0	0.0	0.0
Biomass & w.t.e	0.7	-	-	0.3	0.0	0.0	0.0	1.1
Small hydro	-	-	-	-	-	0.0	0.0	0.0
Marine	-	-	-	-	0.0	0.0	0.0	0.1
Total	24.4	-2.4	8.7	9.7	2.2	0.9	0.7	44.1

Source: UNEP, Bloomberg New Energy Finance

DEVELOPED ECONOMIES

The US has not been the largest investing country in renewable energy in any year since 2011, but it remains the biggest in terms of company-level funding. Figure 17 shows that venture capital and private equity finance for renewables in that country reached $2.2 billion, while share issues for specialist companies on public markets was $9.7 billion in 2015. Both figures were up 41%.

Taking a high profile among the large deals in these categories were equity issues by US "yieldcos", set up to own operating-stage renewable energy assets (see discussion in Chapter 4). TerraForm Power, TerraForm Global, NRG Yield, Abengoa Yield, 8Point3 Energy Partners, Pattern Energy and NextEra Energy Partners were among the yieldcos that raised a total of $4.8 billion from sales of new equity on the stock market in the first seven months of 2015. There was a sharp downgrading of yieldco share prices in the third quarter, and this reduced their additional fundraising to less than $300 million in the last five months of the year.

The other big issuer of equity last year in the US was SunEdison, the solar manufacturer and project developer. It raised a total of $2.4 billion via a secondary share issue, convertible issues and some private equity capital for a subsidiary specialising in small-scale PV installation.

Asset finance of utility-scale renewable energy projects in the US rose 31% to 24.4 billion in 2015, with solar seeing a 37% increase to $13 billion, the highest since 2012, and wind seeing a 24% gain to $10.6 billion, its highest for two years. Among the big projects getting money last year were 294MW Silver State South PV plant in Nevada, costing an estimated $744 million, and the 400MW Grande Prairie wind farm in Nebraska, at an estimated $560 million.

The main factor behind the timing of US renewable power plant investment has been, for many years, the state of play on the two key tax incentives, the Production Tax Credit for wind and the Investment Tax Credit for solar. The incentives lapsed at the end of 2013, and were reinstated for just two weeks in mid-December 2014. Then they were unavailable for almost the whole of 2015, and not expected to be revived, perhaps ever, because of the opposition of many politicians in Congress. However, a deal on general government funding on Capitol Hill in December 2015 surprisingly included a clause extending the PTC and ITC for a full five years. The on-off saga on the tax credits during 2014 helped drive a 24% rebound in wind asset finance in 2015, and a bigger jump in utility-scale solar investment, of 37%. Bloomberg New Energy Finance has estimated that the latest, five-year extensions could lead to an incremental $73 billion in wind and solar investment in the 2016-21 period.[1]

[1] Bloomberg New Energy Finance: Tax extensions for US wind and solar, 21 December 2015.

FIGURE 18. RENEWABLE ENERGY INVESTMENT IN EUROPE BY SECTOR, 2015, $BN

	Asset finance	Re-inv. equity	SDC	Public markets	VC/PE	CorpR&D	GovR&D	Total
Wind	26.9	-0.1	0.7	-	0.0	0.6	0.2	28.4
Solar	3.7	-0.1	0.6	10.4	0.1	0.6	0.4	15.8
Small hydro	-	-	-	-	0.0	0.1	0.0	0.1
Marine	-	-	0.0	-	0.0	0.0	0.1	0.1
Geothermal	1.1	-	-	-	0.0	0.0	0.0	1.2
Biomass & w.t.e	2.3	-	0.0	-	0.0	0.1	0.1	2.5
Biofuels	-	-	0.0	-	0.1	0.2	0.4	0.7
Total	34.1	-0.2	1.3	10.4	0.3	1.7	1.2	48.8

Source: UNEP, Bloomberg New Energy Finance

Europe kept ahead of the US in terms of renewable energy investment in 2015, but only by a nose. A breakdown of its $48.8 billion total, down 21% on the previous year, is shown in Figure 18. Nearly half of the continent's tally last year ($22.2 billion, up 25%) came in just one country – the UK.

2015 was a bumper year for UK offshore wind 'final investment decisions', with the 580MW Race Bank project, the 336MW Galloper array, the 400MW E.ON Rampion project and the two 330MW parts of Walney Island Extension all reaching that milestone. Together, these amounted to an estimated $10.5 billion of capital spending, this flurry reflecting in part the impending expiry of the UK's Renewable Obligation support scheme in 2017. The fact that a majority Conservative government was elected in May 2015 may also have convinced some developers to get on with their projects rather than relying on future auctions that might or might not happen.

Offshore wind was not the only focus of activity in the UK, however. There were significant projects in onshore wind, such as the 239MW Kilgallioch installation in Scotland, costing $468 million; in biomass with undertakings such as the 40MW Tilbury Green Power plant, costing $263 million; and in utility-scale solar, one notable example being the 85MW SunEdison UK PV portfolio. There was also a continuation of the small-scale solar surge, with $1.8 billion of investment, up 29% on 2014 – spurred on by the prospect of cuts in the feed-in tariff.

Germany was the second biggest European market for investment in renewables in 2015, but its tally of $8.5 billion was the lowest for at least 12 years. This would have been lower still but for two large offshore wind financings, of $2.1 billion for the 402MW Veja Mate project, and $1.3 billion for the 332MW Nordsee 1. Onshore wind saw a sharp fall in commitments, reflecting a tightening in planning rules, and uncertainty ahead of a move in 2017 from guaranteed tariffs to auctions.

The only other European markets to see investment of more than $1 billion in 2015 were France, down 63% at $2 billion, Turkey (included in the developing country total), up 46% at $1.9 billion, and Netherlands, down 82% at $1.1 billion. The drop in French investment last year was a function partly of the sector waiting for the energy transition law, which was promulgated at the end of 2015, and partly of residual uncertainty over the onshore wind feed-in tariff, not cleared up until a decree by the European Commission in July. Finally, the existing tariff system for solar incorporated a 'degression' mechanism that led to sharp reductions in support for new projects not taking part in the auction programme.

Turkish wind investment was $941 million, some 19% less than in 2014, and there was one large geothermal project financed, the 170MW Guris Efeler plant. Of the other large European countries, Italy saw renewable energy investment of just under $1 billion, down 21% on 2014 and far below the peak of $31.7 billion seen during the PV boom of 2011. Retroactive cuts to feed-in tariff support for solar helped to dampen investor interest in Italy last year. Spain, scene of particularly painful retroactive revenue cuts imposed by the government during the 2011-14 period, and the end of all support for new projects, saw investment of just $573 million in 2014. This was marginally up on the previous year but miles below the $23.6 billion peak of 2008.

FIGURE 19. ASSET FINANCE AND SMALL-SCALE INVESTMENT BY SECTOR IN JAPAN, CANADA AND AUSTRALIA, 2015, $BN, AND GROWTH ON 2014

Country	Asset finance	% growth on 2014	Small-scale investment	% growth on 2014
Japan	3.8	-49%	31.7	13%
Canada	2.2	-59%	0.2	312%
Australia	0.8	239%	1.5	-14%

Source: UNEP, Bloomberg New Energy Finance

Among other developed economies, the markets that attracted $1 billion or more of investment in 2015 were Japan, at $36.2 billion, level with the previous year; Canada, at $3.1 billion, down 49%; Australia, at $2.4 billion, up 16%; and South Korea, down 44% at $1 billion. A breakdown of asset finance and small-scale project commitments for the first three of these countries is shown in Figure 19.

The mainstay of the Japanese renewable energy push remains small-scale solar, typically ground-mounted projects of less than 1MW. This type of investment rose 13% in 2015 to $31.7 billion, its highest annual figure yet, helped by the country's relatively generous feed-in tariff. In October last year, the Ministry of Economy, Trade and Industry proposed several policy options to provide support for PV in the future. These included a constant-rate annual reduction in the tariff, a flexible reduction rate depending on the amount commissioned, and an auction programme.

Japan, Australia and Canada all saw a few significant asset finance deals in 2015. These included the 240MW, $390 million Ararat wind farm in Victoria, the 96MW, $354 million Pacifico Energy Miyazaki Hosoe PV plant in southwest Japan, and the 184MW, $324 million Meikle wind farm in British Columbia.

CHINA, INDIA, BRAZIL

Figure 20 shows the detail of the increase in capacity investment in 2015 in the three largest developing economies – China, India and Brazil. The biggest jump in dollar terms came in China, with $14.7 billion of additional asset finance and $2.5 billion of extra small-scale project funding; but both Brazil and India managed to post higher-percentage gains in total capacity investment, at 40% and 33% respectively compared to China's 20%.

Offshore wind finally had a breakthrough year in China in 2015, with no fewer than nine projects financed, for an estimated cost of $5.6 billion. They were still on the small size compared to the bigger arrays being built in German, British, Belgian and Dutch waters of the North Sea, but they were significant enough to sit near the top of the list of Chinese renewable energy financings of the year. They included three 300MW projects, all with an estimated capital cost of around $850 million – the Longyuan Haian Jiangjiasha, the Datang and Jiangsu Guoxin Binhai, and the Huaneng Rudong H12 Baxianjiao.

They may have been trumped marginally, in terms of dollars committed, by one solar thermal project, the 200MW Qinghai Haixi Geermu Wutumeirenxiang Boliqi. But the greatest weight of utility-scale financings continued to be in onshore wind, with $42 billion secured, up 9% on

FIGURE 20. ASSET FINANCE AND SMALL-SCALE INVESTMENT BY SECTOR IN CHINA, INDIA AND BRAZIL, 2015, $BN, AND GROWTH ON 2014

Country	Asset finance	% growth on 2014	Small-scale investment	% growth on 2014
China	95.7	18%	5.5	81%
India	9.1	34%	0.4	12%
Brazil	7.7	40%	0.04	317%

Source: UNEP, Bloomberg New Energy Finance

2014, and in PV, with $43 billion, up 18%. Notable projects included the SDIC Hami Jingxia Number 5 wind farm, at 300MW, and the Dexin Taihe Dezhou Lingxian Yongzhou PV plant, also at 300MW.

In onshore wind, China is estimated to have commissioned a giant 29GW of capacity in 2015, as developers rushed to complete projects in regions where the feed-in tariffs are being reduced. The country, beset with the problem of urban pollution, announced a record number of pre-approved projects for commissioning in 2015-18, and an upward revision in the government's capacity target for 2020 is also expected. Grid congestion may, however, slow the build-out somewhat compared to the bumper total added in 2015.

In PV, China is likely to have installed some 16GW of new capacity in 2015. There was no cut in feed-in tariffs scheduled for the end of the year, so no repetition of the late 2014 commissioning rush. However, the National Development and Reform Commission was reported to be considering new tariff reductions in the run-in to 2020, and if so the approach of these could influence the future build-out rate.

The highlight of India's performance in 2015 was a jump in utility-scale solar financings to $4.6 billion, up 75% on the previous year, albeit still a little below the 2011 record of $4.9 billion. Among the big projects getting the financial go-ahead were the NTPC Kadiri PV plant phase one, at 250MW, and the Adani Ramanathapuram PV installation, at 200MW.

Capital costs for PV projects in India have fallen to among the cheapest in the world, at around $1.1 million per MW, and in January 2016, an auction in Rajasthan for 420MW of capacity produced winners at tariffs of just six US cents per kWh. The country has a 2022 solar target of 100GW, equivalent to some 12GW per year, far above its 2015 installation level of around 3GW. It is pursuing this target via auctions.

In wind, the $4.1 billion of asset finance in 2015 was 17% up on the previous year but below the $5 billion-plus figures of 2010 and 2011. One of the largest projects financed was the Hero Andhra

Pradesh project, at 150MW, but there were a sizeable number of others both sides of the 100MW mark. Project development times have been longer than expected in India of late, and some wind developers have diversified into solar, perhaps seeing a bigger opportunity there. There could be a rush in the wind sector in 2016, however, as accelerated depreciation and generation-based incentives are due to expire in March 2017.

Brazil saw record wind asset finance, of $5.7 billion in 2015, up 46% on 2014. Meanwhile, solar project financings came in at $657 million, the first year they have reached the hundreds of millions and potentially marking the start of a big new market for PV. Two of the largest projects receiving an investment decision last year were the 260MW Enel Ituverava PV portfolio and the 144MW Eletrosul Chui wind portfolio. There was one significant financing in biomass, with Klabin expanding its Ortiguera plant to 300MW as part of a $2.3 billion investment that also included a cellulose production plant.

Some 2GW of new wind capacity are estimated to have been installed in Brazil in 2015. Delays in the building of new transmission links limited this figure, and for the first time wind failed to win the majority of tariff contracts awarded in the country's auctions, losing that leadership to PV. In addition, development bank BNDES reduced the debt percentage it is prepared to offer projects. This may force developers to look for other borrowing options, including bonds. Solar should see a sharp upswing in financings this year, as some 2.1GW of auction-winning projects from 2015 secure debt and equity providers.

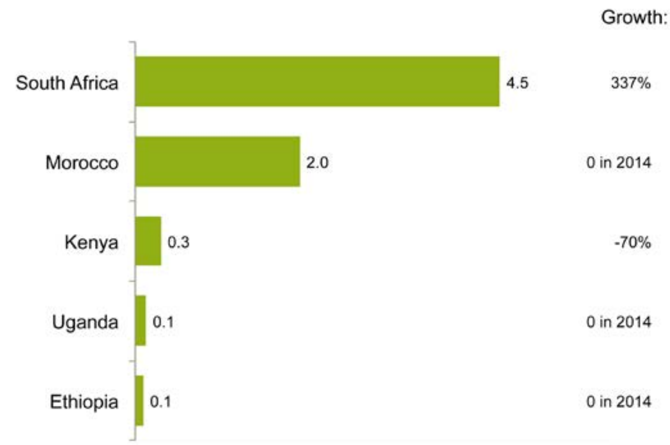
OTHER DEVELOPING ECONOMIES

Africa is one of the most promising markets for renewable energy over the next 10-20 years, with its growing population, urgent need for new generating capacity, lack of electricity access in remote areas, and its natural resources in sunshine, wind, biomass and geothermal. Figure 21 shows, however, that the march of utility-scale renewables is happening unevenly so far.

By a big distance, the two biggest centres for asset financings in 2015 were South Africa, which saw investment rebound back up to $4.5 billion from $1 billion in 2014, although it remained below its $5 billion-plus figures of 2012 and 2013; and Morocco, where investment leapt to $2 billion from almost nothing in 2014, thanks largely to the 350MW NOORo solar thermal portfolio. This made it a record year for the North African kingdom, beating its 2012 tally of $1.8 billion.

In South Africa, much of investment last year happened in the first quarter, with the delayed financial close of the remaining projects from the Round 3 auctions. In June, the government in Pretoria launched a tender for an additional 1.8GW for its renewables programme. One of the signal deals later in the year was the financing in September of the 100MW Redstone solar thermal project for an estimated $756m, helped by loans from the World Bank's International Finance Corporation and Overseas Private Investment Corporation of the US.

FIGURE 21. ASSET FINANCE IN RENEWABLE ENERGY IN AFRICA BY COUNTRY, 2015, $BN, AND GROWTH ON 2014



Source: UNEP, Bloomberg New Energy Finance

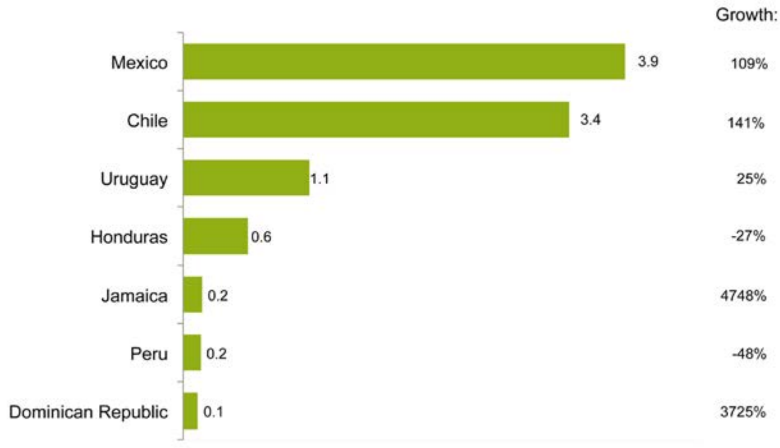
Kenya attracted $316 million of asset finance in 2015, well down on the 2014 figure of $1.1 billion that was buoyed up by the financing of the Lake Turkana wind project. The only other countries beating the $100 million mark were Uganda, with a record $134 million, and Ethiopia, recording exactly $100 million, well below its record of $839 million in 2013.

One caveat should be added to the African investment figures. Figure 21 shows asset finance only, but there was also significant activity in small-scale PV systems in 2015, with Kenya just one of the early movers. At the time Bloomberg New Energy Finance's 2015 data were collated, in January 2016, it was almost impossible to determine how much was spent on small-scale PV in specific African countries, although the research firm estimates that it was several billion dollars for the Africa and Middle East as a whole. So the total renewable energy investment figures for particular African countries may well be revised up in the months ahead, as more information becomes available.

Figure 22 shows the leading countries in renewable energy asset finance last year from Latin America excluding Brazil. Three countries surpassed the $1 billion barrier – Mexico, with asset finance up 109% at $3.9 billion, Chile with $3.4 billion, up 141%, and Uruguay with $1.1 billion, up 25% on the year. All three were records: Mexico and Chile by a big margin, Uruguay narrowly.

Chile's auction in October for around 500MW of capacity saw PV project bids coming in below wind farm bids. The country is by a large margin the leader in solar development in South America, with $2.2 billion of asset finance for that technology in 2015. Some of the projects under way in Chile are linked to mining facilities in the north that have restricted or no access to main grids.

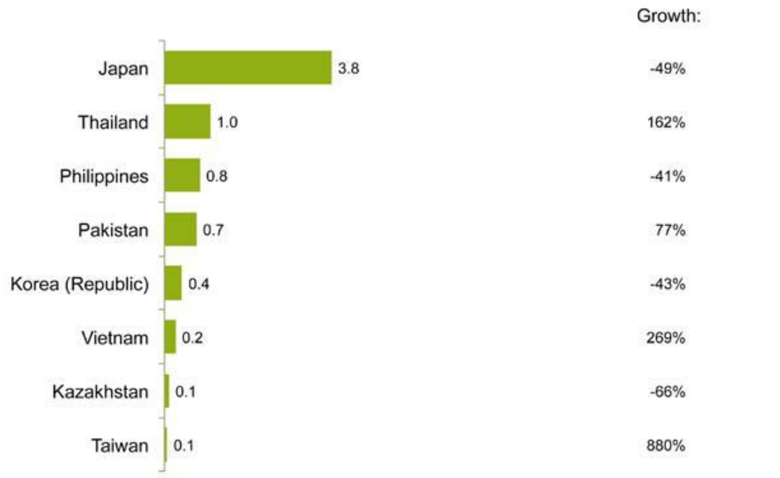
FIGURE 22. ASSET FINANCE IN RENEWABLE ENERGY IN LATIN AMERICA (EXCLUDING BRAZIL) BY COUNTRY, 2015, $BN, AND GROWTH ON 2014



Source: UNEP, Bloomberg New Energy Finance

Some other countries failed to match commitments to utility-scale projects achieved in earlier years, including Honduras, at $567 million in 2015, down 27%; Peru, at $155 million, down 48%; and Panama, Costa Rica and Guatemala, all of which invested less than $100 million, down from figures of around half a billion each in 2014.

FIGURE 23. ASSET FINANCE IN RENEWABLE ENERGY IN ASIA (EXCLUDING CHINA AND INDIA) BY COUNTRY, 2015, $BN, AND GROWTH ON 2014



Source: UNEP, Bloomberg New Energy Finance

In Asia outside China and India, Thailand was the only country other than Japan to reach $1 billion in asset finance for renewables excluding large hydro (see Figure 23). Thailand's total of exactly that figure being 162% up on 2014. It saw the go-ahead last year on several PV projects either side of the $100 million mark, including the 73MW Energy Serve Tabkang 1. The Philippines, which has become an active market for both wind and solar in recent years, saw a 41% dip in asset finance to $798 million last year – more likely reflecting the timing of particular financings rather than a downward shift in its investment trend.

Pakistan was the scene for a record $723 million of asset finance in 2015, up 77% on the previous year. This could be a precursor to much larger figures in the future, given that country's need for new power capacity and the plans afoot for PV projects of up to 1GW in size. Among the investors announcing specific project proposals last year were Scatec Solar (150MW), Desert Tech (180MW) and China Zonergy (900MW).

Vietnam and Indonesia, with asset finance of $248 million and less than $100 million, both attained much lower asset finance totals than in some earlier years. Vietnam is the focus for both wind and solar project development, but this did not lead to large-scale financings in 2015.

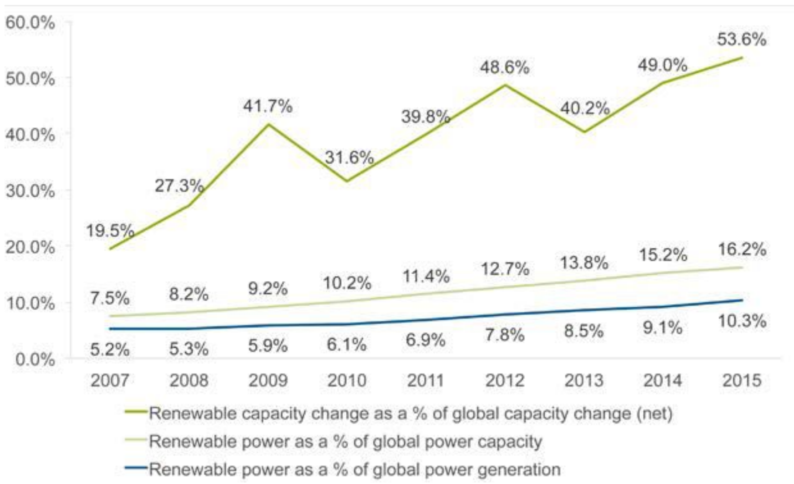
PUTTING RENEWABLE ENERGY INTO PERSPECTIVE

- Renewable energy excluding large hydro made up 53.6% of the new power generating capacity installed in 2015, the first time it has ever represented the majority of additions.
- Its contribution to global electricity generated was lower, at 10.3%, from 9.1% in 2014. This prevented the emission of an estimated 1.5 gigatonnes of CO2 last year.
- Improved figures for dollar investment show that renewables attracted more than double the $130 billion committed to new coal- and gas-fired power stations in 2015. This was the largest differential in favour of renewables to date.
- Nevertheless, the fact that most of the world's power generation fleet consists of fossil fuel plants, and that more of these are being added every year, means that the outlook for emissions and the climate remains worrying.
- Leading forecasting organisations project that power sector emissions will grow more than 10% between now and 2040, with no prospect of a peak being reached until the late 2020s at the earliest. The CO2 content of the atmosphere looks set to rise sharply beyond the 2015 average of 401 parts per million.
- One factor that could affect both emissions and electricity demand over the next 25 years is the growth of electric vehicle sales. These jumped 60% in 2015 to a new record of 462,000. EVs, via the recharging of their batteries, could also offer new opportunities for balancing renewables output.

RENEWABLES VERSUS FOSSIL

Renewable energy excluding large hydro accounted for the majority of gigawatts of new generating capacity installed in 2015 – for the first time ever. Last year's percentage was 53.6%, compared to 49% in 2014 and 40.2% in 2013. However, Figure 24 also shows that the weight of the capacity already installed in fossil fuels meant that 2015's additions of wind, solar and other renewable energy technologies made a much smaller impact on the mix of electricity generated worldwide last year.

FIGURE 24. RENEWABLE POWER GENERATION AND CAPACITY AS A SHARE OF GLOBAL POWER, 2007-2015 %



Renewables figure excludes large hydro. Capacity and generation based on Bloomberg New Energy Finance totals.
Source: Bloomberg New Energy Finance

Renewables excluding large hydro made up 16.2% of established power capacity last year, up from 15.2% in 2014. They accounted for 10.3% of global electricity generation – the difference between

those percentages reflecting the fact that wind and solar generate power for a lower percentage of the year than other sources such as coal, gas, oil, nuclear, hydro, geothermal and biomass.

The 10.3% share of global generation means that renewables excluding large hydro prevented the emission of 1.5 gigatonnes of CO2 equivalent last year. This is estimated using figures for total power sector emissions from the International Energy Agency for 2013, extrapolated to 2015 according to the IEA's average 2013-20 average annual growth rate, and assuming that – if that renewables capacity did not exist – the equivalent electricity would have been produced by the same mix (coal, gas, oil, nuclear and large hydro) as the other 89.7% of generation.[1]

More detail on the breakdown of the gigawatts added last year is displayed in Figure 25. Renewables excluding large hydro saw some 134GW commissioned, with 62GW of that wind, 56GW of photovoltaics and more modest amounts of biomass and waste-to-power, geothermal, solar thermal and small hydro.

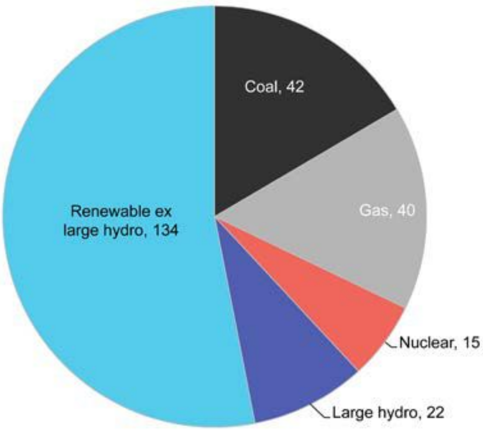
Another 22GW consisted of large hydro-electric projects, and there were an estimated 15GW of nuclear power added in 2015. More concerning in climate terms was that there were a net 42GW of coal-fired capacity installed last year, and 40GW of gas-fired generators.[2 3]

Figure 26 shows the comparison between the amounts invested in new capacity in the four main power technology categories. Renewables excluding large hydro attracted $265.8 billion of asset finance and small-scale project investment in 2015, excluding the small amount going to biofuels. This was far higher than the the coal and gas power figure of $130 billion gross investment.

Note that Bloomberg New Energy Finance has made substantial revisions to the estimates for gross investment in fossil fuel generation since the 2015 edition of the Global Trends report. These reflect two main improvements in methodology.

One is that the fossil fuel figures in this report make use of specific country-level capital cost estimates for new coal and gas capacity, rather than a global average. This makes a lot of difference in the case of coal, because China has been the largest installer of coal-fired power stations for many years and has also got by some margin the lowest average capital cost per GW for new coal capacity. The second change is that the analysts involved have reduced their estimate for the amount of coal and gas capacity going out of service each year – since the net amount being added is a fairly widely accepted figure, this means that the gross amount being added before closures must be lower, and hence gross investment must be lower.[4]

FIGURE 25. NET POWER GENERATING CAPACITY ADDED IN 2015 BY MAIN TECHNOLOGY, GW



Source: Bloomberg New Energy Finance

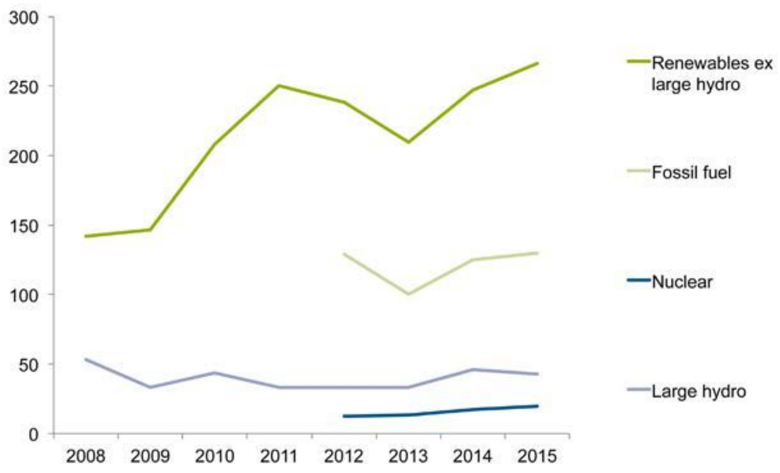
[1] Power sector emissions data are from IEA World Energy Outlook 2015. Note that the IEA's report includes an estimate that renewables including large hydro "helped avoid" 3.1 gigatonnes of emissions in 2013, with hydro (large and small) responsible for about three quarters of this.

[2] Net figures, after taking into account closures. See discussion in the section on "ageing process" below.

[3] Note that the 134GW of renewables excluding hydro shown in Figure 25 will not produce exactly the 53.6% share of new capacity added shown in Figure 24. This is because of roundings to the nearest GW, and because Figure 25 does not show oil-fired capacity, which shrank in 2015.

[4] The fossil fuel investment estimates are based on a top-down methodology, unlike the renewable energy investment figures in this report, which are bottom-up, drawing on a database of deals and projects.

FIGURE 26. INVESTMENT IN POWER CAPACITY – RENEWABLE, FOSSIL-FUEL AND NUCLEAR, 2008-2015, $BN



Source: Bloomberg New Energy Finance

The upshot of these changes is that the line in Figure 26 for gross fossil fuel capacity investment is now only about half as high over the last three years as that for renewables excluding large hydro. The fossil fuel line is only shown for the years since 2012, because of a shortage of data using the same methodology for years before that. But it would appear likely from the chart that there was an investment "crossover" between renewables excluding large hydro and fossil fuel in about 2008 or 2009, and that since then the former has been increasing its dominance.

In one way, this is less surprising than it sounds. Renewable sources such as wind and solar (but also geothermal and small hydro) have lifetime costs that are heavily concentrated at the development and construction stage and, by comparison, very modest during the operating stage – because the feedstock is essentially free and the ongoing labour requirement is limited to monitoring and maintenance. Fossil fuel generation, however, has a cost profile that is much more spread-out during project life, with the upfront capital cost a much lower fraction of the total and the feedstock itself, and the transport and handling of that feedstock, a much higher fraction of the total.

Of the other two generation sources in Figure 26, large hydro took $43 billion of asset finance (see Box at the end of Chapter 5 for more discussion), while nuclear attracted just $20 billion in 'final investment decisions' in 2015. As with the other technologies, the nuclear figure is the value of new projects getting the go-ahead last year, not the dollars sunk over recent years in new capacity that came online during 2015.

AGEING PROCESS

One of the major differences between the non-hydro renewables capacity in the world, and that for coal, gas, nuclear and hydro, is the age of the established fleet. This will have an impact on the rate at which old capacity reaches the end of its life and has to be replaced by something and, in the case of fossil fuel plants, it will influence the chances of the world getting emissions under control. If many hundreds of gigawatts of existing coal capacity, for instance, have significant operating lives ahead of them, it will be more difficult to curb emissions than if most of the coal plants are coming up for 'retirement'.

According to the Global Wind Energy Council, there were just 17.4GW of wind power capacity installed in the year 2000, but this had grown to 432GW by 2015. Well over half of the world's wind fleet is less than six years old and, assuming a turbine lifetime of at least 20 years, has a good 14 years left to operate – even excluding the possibility of refurbishment or repowering to extend project lifetime. The age profile of PV installations worldwide is even more youthful.

The age profile of fossil fuel power stations is more slippery, since large amounts of capacity have been in place for decades. The World Coal Association estimates that some 900GW of coal generation were operating in 1992, and that this had increased to around 1.9TW by 2015. This must mean that at least half – and possibly a significantly higher proportion – of world coal-fired power station capacity is less than 23 years old. Coal plants often have 40-year lifetimes, and the costs of running them once built is much less than the cost of constructing new fossil fuel or renewable capacity, particularly since seaborne coal prices have fallen by more than 70% since 2011.[5] So, without strong policy intervention or fierce competition from another fuel – such as cheap natural gas in the US – the proportion of coal capacity closing each year would be modest, probably at only 20GW or so.

In fact, Bloomberg New Energy Finance estimates that, while 85GW of new coal-fired power stations went into service in 2015, some 43GW closed due to a combination of age, tightening regulations and the US gas effect. Some gas-fired capacity also closed in 2015: an estimated 4GW, some of it in Europe due to low capacity factors that made plants uneconomic. This compared to the gross addition of 44GW worldwide.

Looking at where the new coal and gas capacity went online in 2015, China accounted for almost exactly a half of the 85GW of new coal, with India representing another quarter, and the rest of Asia another 10%. As far as gas-fired generation is concerned, nearly a quarter of the 44GW of new capacity came into service in the US, with China and the Middle East and North Africa responsible for another 15% each.

Faced with a large, established coal power station fleet, countries will face three choices in the years ahead if they want to bring down emissions. One is to change the workings of power markets so that coal plants generate for fewer hours in the year, another is to tighten regulation to the point at which coal capacity has to close and be replaced with renewables or gas, and the final one is to retrofit carbon capture and storage. So far, progress on equipping coal capacity with CCS has been much slower than the technology's supporters had hoped.

THE EMISSIONS OUTLOOK AND RENEWABLES

The outlook for power sector emissions remains alarming – despite the agreement at COP21 in Paris, and despite the growth of renewables detailed in this report. Bloomberg New Energy Finance's projection for generation emissions is that they will increase for another decade, finally peaking only in 2026. At that point, emissions will be almost 15.3 gigatonnes, some 12.5%, or 1.7 gigatonnes, higher than in 2015. Equally worrying, even in 2040, according to this forecast, they will still be 9% higher than they were in 2015.

Given that even the current rate of global emissions are sufficient to push the carbon dioxide content of the atmosphere up by more than two parts per million per year, then the higher rate of emissions forecast above for the 2020s and 2030s would be likely to increase atmospheric CO2 at an even faster rate.

Figures from the US National Oceanic & Atmospheric Administration, taken at the Mauna Loa Observatory in Hawaii, show that the CO2 content increased from 316ppm in 1959, to 339ppm in 1980 and 370ppm in 2000, before climbing to an average of 401 in 2015. In January 2016, the figure was 2.5ppm higher than in January 2015.

None of the major forecasting organisations see a lasting peak in power sector CO2 emissions this decade, or even early in the next one. The International Energy Agency, in its 2015 World Energy Outlook, predicted that they would rise from 13.4 gigatonnes in 2013 all the way to 15.1 gigatonnes in 2040, without any peak in between. More than half of the increase in 2013-40 would be due to increased coal-firing, according to the IEA.

[5] Benchmark index for steam coal delivered to the ARA (Amsterdam, Rotterdam, Antwerp) region of north west Europe.

BP, in its Energy Outlook 2016, said that carbon emissions would rise 0.9% per year between 2014 and 2035, reaching a level 20% higher than now – although the rate of increase would be down from 2.1% per year now. ExxonMobil was a little less pessimistic in its Energy Outlook 2016, forecasting that energy-related CO2 emissions would peak around 2030, and that the carbon intensity of the global economy would be "cut in half" over the next 25 years, as the power sector moved towards gas, the transport sector improved fuel economy and energy efficiency took hold across the board. However Exxon predicted that emissions would still be 11% higher in 2040 than they were in 2014.

There are two main sources of hope. One is the fact that most countries now appear to be focused on the issue of climate change and reducing emissions, thanks to the United Nations COP21 conference in December 2015. Some 188 countries published Intended Nationally Determined Contributions, setting out measures they would take to limit emissions, in the run-up to Paris, and then 195 nations agreed to aim "to keep a global temperature rise this century well below two degrees Celsius". There was a commitment to "pursue efforts to limit the temperature increase to 1.5 degrees above pre-industrial levels". Countries also agreed to submit updated plans every five years, and to have their efforts independently reviewed.

The second is that demand for energy, particularly electricity, is showing signs of coming under strong pressure from technological advances. In January to November 2015, electricity supplied in the OECD countries was 9,413TWh, according to the IEA, up 0.7% on the same period of 2014 but only the same percentage above the figure for the same 11 months of 2007 – eight years earlier. Part of the reason for this small increase must represent economic sluggishness since the financial crisis, and part offshoring of industrial production to Asia. However, the spread of more efficient devices, such as LEDs for lighting, will also have exerted a strong impact. Estimates are that LEDs reduce electricity use by more than 50% in the case of street lights. At a smaller scale, the US Department of Energy cites the electricity saved by switching to a 15W halogen compact fluorescent bulb from a 60W incandescent as 75%.

In the UK, average household electricity demand for lighting has plunged from more than 700kWh to less than 500kWh per year. In the same country, the average fridge-freezer has gone from consuming 620kWh per year in 1990 to 480kWh in 2000 and 300kWh in 2015. In IT, the electricity used per trillion computations has been in steep decline since the 1940s, and in the last 25 years has fallen from 1kWh to just a thousandth of a kWh.[6]

[6] However, the number of computations done per machine has increased substantially.

ELECTRIC VEHICLES

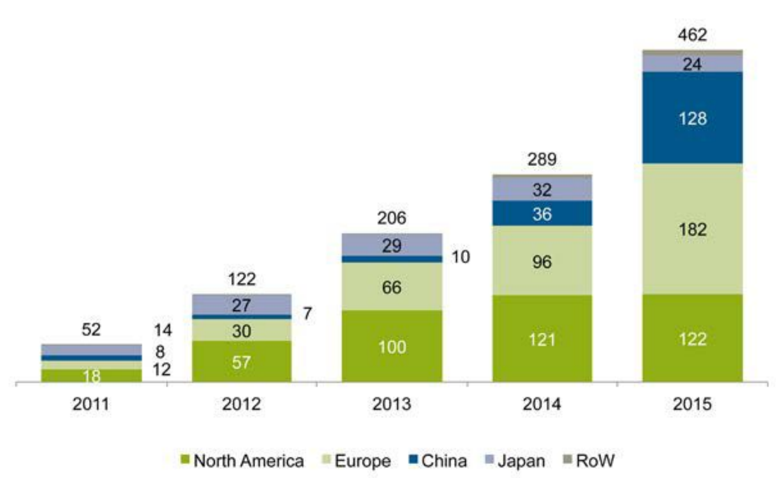
One of the developments that could have an impact on global emissions over the next 25 years is the growth of electric vehicles. Their effects could, in fact, be complex – reducing emissions from transport, but leading to more electricity use, and also providing new opportunities for balancing variable renewable power (see Chapter 3 on the balancing issue). Another consideration is the underlying source of electricity used in particular countries to charge EVs: if EVs are charged by coal-fired electricity, then the net effect on emissions of using electric cars rather than gasoline cars will be much less than if the EVs are charged with electricity from wind, solar or hydro-electric.

Figure 27 shows that global sales of battery electric vehicles, or BEVs, and plug-in hybrid electric vehicles, or PHEVs[7], jumped 60% in 2015, from 290,000 to 462,000 – despite the sharp fall in oil prices that reduced the running costs of gasoline and diesel cars. Last year saw the US EV market flat-line, due partly to that gasoline effect and partly to a pause in the flow of new electric models, but this was far more than offset by surges in sales in China and European countries such as Norway, the UK and the Netherlands. Improvements in range, reductions in battery prices, and the availability of tax and other incentives, have combined with increasing familiarity to propel sales forward.

Forecasts for the EV market vary widely. OPEC published a report late last year predicting that vehicle range and charging infrastructure would continue to be major barriers to adoption, and forecasting EV sales between now and 2023 to be around 200,000 to 300,000 per year.[8] Its figure for total EVs on the road worldwide in 2020 is 1.7 million, compared to Bloomberg New Energy Finance's prediction of 7.4 million. In a study published in February 2016, Bloomberg New Energy Finance forecast that sales of EVs would soar, to hit 2 million in 2020 alone, and 41 million in 2040, by that time making up 35% of the total light duty vehicle market.[9] The gap between these two forecasts reflects, in part, widely differing assumptions on the rate of battery price reductions and the rate of expansion of charging infrastructure.

How much impact could EVs make on electricity demand? In the next few years, the answer is very little – because of the fact that the existing vehicle fleet is overwhelmingly fossil fuel based. On one estimate, by the UK Royal Academy of Engineering in 2010, EVs equivalent to a small petrol or diesel four-seat car use around 0.2kWh per kilometre in normal city traffic.[10] Let us say that the average vehicle travels 15,000km in a year. Even if battery EVs fulfil the more bullish forecasts and the number on the road amounts to six million worldwide by 2020 (some 13 times the level of new EV sales in 2015), then that would be 9TWh of consumption in that year. That would be equivalent to just 0.08% of the IEA's figure for world electricity generation in 2013, of 23,318TWh. However if they represented a quarter of all light duty vehicles on the road in 2040, their electricity use would be likely to be equivalent to about 11% of current global electricity demand. [11]

FIGURE 27. TOTAL ELECTRIC VEHICLE (BEV+PHEV) SALES, 2011-2015 THOUSANDS



Source: Bloomberg New Energy Finance

[7] Battery electric vehicles derive their power purely from a chemical battery that needs recharging. Plug-in hybrid electric vehicles have both batteries that can be recharged from an external source, and an internal combustion engine.

[8] OPEC World Oil Outlook 2015

[9] Bloomberg New Energy Finance, research note Global EV sales outlook to 2040, February 2016

[10] Royal Academy of Engineering, Electric Vehicles: charged with potential

RENEWABLES AND STORAGE

- Energy storage is one of four ways of providing fast-responding balancing to the grid, whether to deal with demand spikes or variable renewable power generation from wind and solar. The other options are fast ramp-up plants, typically gas- or diesel-fired; interconnectors linking countries or regions; and demand-response, in which electricity consumers reduce their usage in return for payments.
- Storage is exciting particular interest for two reasons. One is the rapidly falling cost of batteries, spurred on by the growth of the electric vehicle market. Since 2010, the average electric vehicle (EV) battery pack price has fallen from $1,000 per kWh, to $350 per kWh.
- The other is that local storage could enable wind and solar projects to provide electricity for a larger number of hours, with less in the way of fluctuation. This could be a powerful combination at both utility-scale and in developing economy microgrids.
- New utility-scale energy storage capacity commissioned in 2015 (excluding pumped hydro and old-style methods such as gas holders and lead-acid batteries) reached a record 250MW, up from 160MW the previous year, while announced projects totalled more than 1.2GW.
- The biggest challenge facing this "dream team" of renewables and storage is cost, despite the recent improvements. In 2015, adding batteries to a wind farm to provide more consistent and longer-lasting power would have raised a project's levelised cost of electricity per MWh by an estimated 25% or more.

THE NEED FOR BALANCING

Variable renewable energy sources such as wind, solar, wave and tidal produce electricity only when the resource conditions are right. In the case of onshore wind, a project may have nameplate capacity of, for instance, 100MW, but output over a year is likely to be only about 20-35% of the number of kWh that a 100MW installation would produce if it operated at full throttle 24 hours a day, 365 hours a year. This percentage is known as the capacity factor.

For a solar PV park, the capacity factor may be in the 10-20% range, and for rooftop solar it may be towards the bottom of this zone. For wave and tidal projects, it may be 20-40% – although these technologies are mostly early-stage, so actual data points are few and far between.

The issue of how to make up for the lost generation when power stations are not producing electricity is also relevant, to varying extents, to other technologies. [1] But it is particularly pertinent for wind and solar, since these power sources are growing rapidly in the world electricity system and because there can be a lot of short-term variation in power output – caused by fluctuations in wind speed or cloud cover in front of the sun.

These fluctuations mean that some sort of balancing is required in the system, in order for electricity generation to meet consumption on a consistent basis without there being sharp changes in grid frequency or, in extreme cases, black-outs. [2] This challenge has mostly been handled well so far by national grid system operators, at current levels of renewables penetration. One reason is that techniques for forecasting wind and solar output have improved enormously, so grids have become able to anticipate when to call on extra generating plant.

[1] Some hydro-electric projects, particularly those in areas subject to seasonal droughts or large variation in rainfall, will have capacity factors of 50% or less. Even nuclear, coal- and gas-fired generation never have 100% availability either: regular maintenance and unscheduled outages will reduce their capacity factors over a year. Similar considerations apply to biomass, waste-to-power and geothermal plants.

However, the balancing issue will be even more important in the future, as the percentage of wind and solar generation in the mix increases. California, for example, has a renewable portfolio standard for its utilities of 50% by 2030, and the European Union target for 2030 is 27% of overall energy, equivalent to about 45% of electricity. Also, the amount of spare fossil-fuel capacity available is likely to fall, as units close due to restrictions on emissions or fail to make an economic return. Many gas- and coal-fired power stations in developed economies are already sitting idle for part of the year because their output is not needed or the wholesale electricity price in the market is too low to prompt their owners to fire up their turbines.

There are four different ways in which variable wind and solar generation could be balanced, and national governments are likely to consider different combinations of these. The first is via conventional generation such as gas, coal or diesel. The second is via interconnectors that pipe electricity from locations that have surplus power to those that need it at that time. The third is via demand response, usually involving large industrial and commercial users being paid by the grid to switch off machines or turn down air conditioning when electricity supply is in danger of falling short of demand.

The fourth option is energy storage. This can hold surplus electricity produced when it is windy or sunny, and generation exceeds demand, and then release it to the grid when renewable power resources are insufficient to satisfy consumption.

However, which of the four is the best bet depends greatly on whether the balancing need is very short-term (measured in milliseconds to minutes), medium-term (measured in hours) or long-term (measured in days or weeks). In the case of long-term balancing, the grid may be able relatively easily and cheaply to schedule fossil fuel and hydro generation to step up output to meet the need.

For the medium-term need, all four may be viable options, in which case costs per MWh will be the crucial factor in deciding which to use. Demand response or, in the future, smart devices such as electric vehicles that charge when the electricity price is low and do not charge when it is high, or thermostats that turn down air conditioners when power prices are high, could be strong contenders in this time slot. So could certain types of storage, or gas-fired power stations.

For the very short-term, conventional fossil fuel plant may be too slow in its ramp-up to prevent undesirable swings in system frequency, and it may also be uneconomic to keep powering it up and powering it down at short notice. Modern gas-fired engines will do better, but may still not the best option. Some storage technologies may be the quickest of all to respond, and could out-compete alternatives as long as they are not required to supply electricity for long (and as long as clear pricing signals are provided by the market for ancillary grid services).

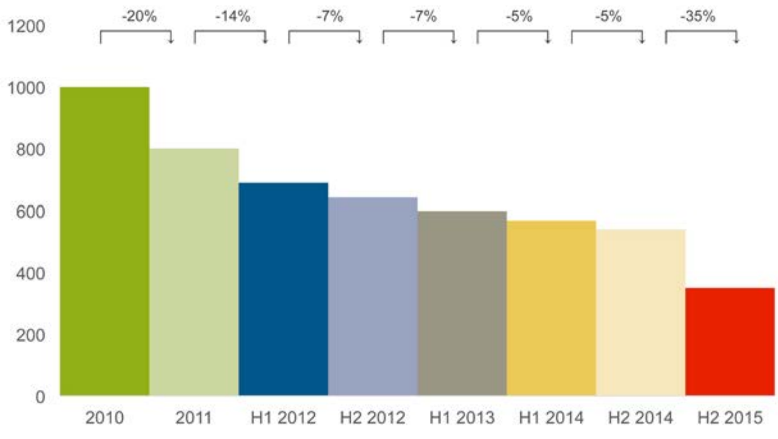
THE STORAGE LANDSCAPE

Energy storage has taken a number of guises over many years (see also Box on next page). Gas holders and oil storage tanks have been around for decades, and contain fuel that could, if necessary, be used to generate electricity. Pumped hydro-electric stations can be replenished when power is plentiful, and the water released to generate when it is in short supply. Examples currently under construction include the 1GW Limmern project in the Swiss Alps and the 600MW Hainan Qiongzhong plant in China. Total world pumped hydro capacity is more than 100GW.

Other technologies are also being used or demonstrated, and one of these is compressed air. Surplus electricity is used to compress air that can later be released to drive a turbine and generate power. In Alabama, Power South Energy

[2] To prevent this instability, the grid will also have to balance its load curve (variation in demand).

FIGURE 28. AVERAGE EV BATTERY COSTS, $ PER KWH AND PERCENTAGE CHANGE BETWEEN PERIODS, 2010 TO H2 2015



Source: Bloomberg New Energy Finance

Compressed air projects often promise low costs on a dollar-per-MWh basis, but several large-scale projects have been put on hold or cancelled in the last five years, including the 270MW Iowa Stored Energy Plant, the 150MW Watkins Glen Project and the 317MW Dresser-Rand Apex Bethel Energy Center project.

However, the main focus of investor interest in storage at the moment is on batteries, including those based on sodium sulphur or sodium nickel chloride but predominantly those using lithium-ion structures. [3] The latter technology has the advantage of also being used in the burgeoning electric vehicle industry, with fierce competition among manufacturers helping to drive down costs.

Cooperative's 110MW system, built in 1991, stores enough energy from nearby generating plants to power 110,000 homes. Newer projects under development include Pacific Gas & Electric's 300MW Bakerfield site in California, and in July 2015, the European Union announced EUR 6.5 million of funding for a compressed air energy storage project in underground caverns in Northern Ireland.

A 2014 white paper published by the Geneva-based International Electrotechnical Commission grouped storage technologies into three groups. The first group was those with short discharge time of seconds to minutes: double-layer capacitors, superconducting magnetic energy storage and flywheels, all with an energy-to-power ratio of less than one (less than 1kWh for power capacity of 1kW). The second was those with medium discharge time of minutes to hours, and included lead-acid, lithium-ion and sodium sulphur batteries, all with energy-to-power ratios of between one and 10 (1-10KWh for capacity of 1kW). The third was those with long discharge time of days to months, including hydrogen and synthetic natural gas, with energy-to-power ratios of much greater than 10. The IEC study put pumped hydro storage and compressed air somewhere between the second (medium discharge time) and third (long discharge time) categories. [4]

The cost declines per kWh for lithium-ion batteries used in electric vehicles have been spectacular, as Figure 28 shows. They reflect improvements in battery chemistry and in manufacturing processes, economies of scale as factories get larger, and aggressive pricing by large battery makers looking to defend market share. Electric car sales worldwide have been expanding rapidly, reaching some 462,000 in 2015, up from 290,000 in 2014, but there are no signs yet of bottlenecks in the manufacturing chain.

Lithium-ion batteries are also seeing significant entrepreneurial effort. Tesla Motors, the US-based electric vehicle maker, is building a "gigafactory" in Nevada, US, to produce lithium-ion batteries in greater volume (35GWh per year) and at lower cost ("more than 30%" below previous Tesla figures). In May 2015, it launched the Powerwall, a rechargeable lithium-ion battery that mounts on the wall and comes in 7kWh or 10kWh versions, with prices from $3,000 upwards. Another example is the 1.2kWh modular system from Enphase, selling for around $500.

Prices for stationary battery storage vary depending on the size of the system, and on location, but the trend – like that for EV batteries

[3] Lead-acid batteries are widespread in places such as India to provide back-up against power cuts. However, this technology is not expected to be able to compete long-term with newer chemistry, in cost, performance or environmental respects.

[4] International Electrotechnical Commission, white paper on Electrical Energy Storage, 2014.

– is firmly downward. In Australia, for instance, average residential system costs fell from $2,700 per kWh in October 2014 to $1,000 per kWh in November 2015. Note that prices of residential storage systems typically include inverters and balance of plant as well as the basic battery pack.

Much of the investment in battery storage that is going on around the world at the moment is aimed at improving grid performance, providing back-up in case of demand spikes or supply problems, and frequency regulation. However, the desire to balance wind or solar generation is also emerging as an explicit reason for investing in battery storage – both "behind the meter" (storing electricity in residential or commercial premises, for use by those buildings), and at grid-scale.

BEHIND-THE-METER STORAGE

Looking first at behind-the-meter applications, in 2013, Germany introduced a subsidy programme for small-scale PV with storage. This was scheduled to finish at the end of 2015, but was reprieved in November and may now run for several years more. There were some 27,000 systems sold up to 30 September 2015, amounting to a total of 136MWh. Another approach has been promoted by MVV, a German utility, with its StromBank project. This uses a central energy storage system from ADS-Tec to pool excess electricity produced by the solar panels of multiple households.

In Japan, a subsidy programme started in 2012 to encourage the installation of behind-the-meter lithium-ion batteries in the residential and small business market, and by late last year some 50,000 units had been installed, totalling 277MWh.

Australia has also seen strong interest in behind-the-meter storage, to balance small-scale PV. In June 2015, utility AGL Energy started to market a 7.2kWh battery, and it added larger units later in the year. Other utilities are also trialling sales of storage for solar electricity. Last summer, Adelaide City Council introduced an incentive for households, businesses, schools and community groups to install a storage system.

In December last year, Duke Energy and Green Charge Networks said they would offer solar energy and battery storage to businesses in California and Hawaii. The idea, they stated, was to allow business to reduce their demand from the grid during the hours of the day when electricity prices were highest.

The biggest prize in emerging markets for storage may be in conjunction with solar mini-grids, or with residential-scale PV. A number of African countries are pursuing this as a way of extending electrification and cutting down on hazardous kerosene use in remote areas far from the central power network. One of the first concrete initiatives in this area is Powerhive's partnership with Enel in Kenya. In April 2015, the California based microgrid developer said it expected to offer electricity to more than 200,000 homes in Kenya from off-grid solar systems. One mini-grid in western Kenya, for 100 villages, running on solar panels and wind turbines, with battery storage and diesel generators for back-up, was due to start construction in early 2016. In Tanzania, a partnership dubbed Jumeme Rural Power Supply is building a 5MW minigrid for 16 villages in the nation's northwestern region.

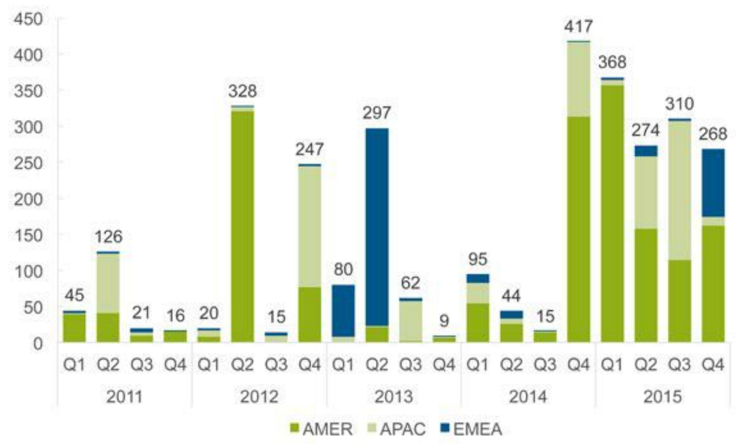
At the smaller-scale end, Tanzania-based developers of residential solar systems such as Off-Grid Electric and Mobisol have installed tens of thousands of their rooftop technologies. Their photovoltaic panels and batteries can power lights, a small refrigerator, a television set or radio and also charge mobile phones. Off-Grid Electric, which raised $25 million of venture capital in October 2015, aims to electrify one million homes in the next three years.

UTILITY-SCALE BATTERY STORAGE

Among the utility-scale storage projects announced with a specific beef to balance renewable power sources have been a 12MW solar farm in Hawaii commissioned last November by Duke Energy, and containing in addition a 6MW lithium-ion battery; and a 10.6MW solar plant under construction at DeGrussa Copper Mine in Western Australia, with 6MW of battery storage and backed by funding from the Australian Renewable Energy Agency and the Clean Energy Finance Corporation.

In June 2014, GS Yuasa said it would build a 1MW solar park with a 100kWh storage system in Gunma

FIGURE 29. ANNOUNCED UTILITY-SCALE ENERGY STORAGE PROJECTS WORLDWIDE, MW



Source: Bloomberg New Energy Finance

prefecture, northwest of Tokyo, and earlier the same year Saft Groupe and Ingeteam Power Technology won a contract to build a 9MW solar plant with a 9MWh lithium-ion battery system on the Indian Ocean island of Reunion. The previous year, Duke Energy began operating what was then the world's largest battery storage system, of 36MW, at 153MW Notrees wind farm in Texas.

There are also projects happening where the link to renewables is more indirect. Younicos of Germany, for instance, commissioned in late 2014 a 5MW, 5MWh battery system in Schwerin, West Mecklenburg for utility Wemag, which operates a grid heavy with wind power. In February 2016, AES commissioned a 10MW battery storage array at Kilroot in Northern Ireland, which has a higher proportion of renewable electricity in its mix than the UK as a whole.

Figure 29 shows the MW capacity of utility-scale energy storage projects announced worldwide (excluding pumped hydro). The total has been increasing markedly, with lithium-ion batteries dominating – accounting for instance for 79% of the megawatts announced in the first three quarters of 2015, against 7% for sodium sulphur batteries and 11% for compressed air energy storage.

POLICY PUSH

Policy-makers are becoming increasingly aware of the fact that a high percentage of variable renewable generation in the mix will require various sorts of balancing. What is less clear is how costly this will be. There is a wide range of estimates in the market. BP, for instance, said last year that taking into account the "integration costs" of wind and solar in North America would add between $8 and $30 per MWh to their levelised cost of electricity. [5]

For medium- and long-term balancing, there will be a need for "flexible generation" that can supply electricity when there is insufficient production from wind and solar to meet demand. In its New Energy Outlook 2015, projecting power supply and demand trends out for the next 25 years, Bloomberg New Energy Finance estimated that the flexible generation capacity worldwide would need to grow from some 58GW in 2015 to 858GW in 2040. This will be some combination of quick ramp-up gas-fired power, interconnectors, demand response and storage.

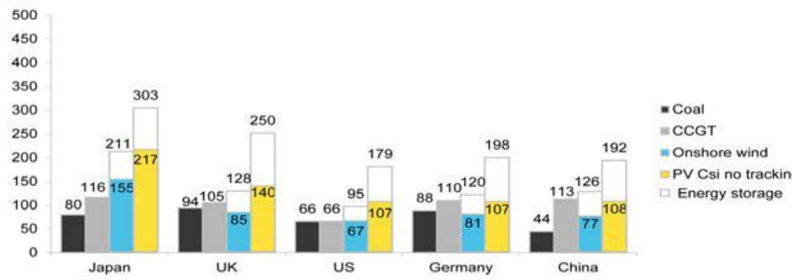
Governments have started to provide incentives for such flexible generation plants to remain open, notably those in the UK and France, via their "capacity market" auctions. The first two UK auctions, in 2014 and 2015, ended up providing contracts, denominated in pounds per kW per year, for a mixture of technologies, including existing coal power stations, new and existing gas-fired plants, demand response and interconnectors. Storage was allowed to bid, too, but has so far been unsuccessful at winning contracts.

For very short-term balancing, the emphasis will be on renewable energy installations to do the work themselves, by providing some element of storage – onsite or close to site.

Puerto Rico is among the first jurisdictions to require that renewable energy projects provide an element of short-term balancing. In December 2013, Puerto Rico Electric Power Authority issued

[5] BP Technology Outlook 2015

FIGURE 30. H2 2015 LEVELISED COST OF ELECTRICITY BY COUNTRY AND TECHNOLOGY, WITH STORAGE NOMINAL $ PER MWH



For storage, the estimate is based on it providing 50% of total capacity, two hours of storage, with $800/kWh total installed cost, 1% O&M.
Source: Bloomberg New Energy Finance, annual reports

minimum technical requirements mandating that new PV and wind projects provide frequency and ramping control for 30-45% of their nominal generation capacity.

Japan's Ministry of Economy, Trade and Industry, or METI, meanwhile has launched a new subsidy programme for installation of energy storage systems at solar and wind farms, applicable to systems above 10kWh in size. Under the new curtailment rules for solar and wind, project developers are allowed to use energy storage systems to store electricity that would otherwise be curtailed, and resell the electricity later at the feed-in tariff rate. Ghana has been mooting a higher feed-in tariff for solar projects offering some degree of grid stability than for those without.

In an interview in November, Francesco Starace, chief executive of Enel, the Italian utility, said: "There is a stupid kind of storage that is putting energy away in the night and using it during the day, but this is too expensive. But the other kind of storage, for balancing local temporary issues, is very interesting. That is where the battery industry is focussing. We will be putting batteries into some renewable energy plants in Italy, as soon as the regulator comes up with the relevant decree. The Germans are also doing it. This will also happen in totally new, emerging markets that have no grid. As soon as Tesla produces its [low-cost] battery, we will buy the first 10." [6]

The big question is to what extent adding batteries will impact the levelised cost of electricity for wind and solar projects. One hint came last year from Hawaii. In September 2015, Kaua'i Island Utility Cooperative signed a power purchase deal with SolarCity for electricity from a 13MW solar array with 52MWh of battery storage. The utility said that under the 20-year contract it would "pay SolarCity a lower rate than the current cost of conventional generation and only slightly more than the cost of energy from KIUC's two existing 12MW solar arrays, whose output is available only during the day".

The cost for renewable power projects will depend greatly on how long their batteries have to store power. Bloomberg New Energy Finance estimates that a US onshore wind farm would have a levelised cost of electricity of more than $200 per MWh, if it had to provide batteries sized to 50% of total capacity and lasting for four hours, compared to just over $67 if it had no storage. However, in the more realistic scenario where the requirement was for storage equivalent to 20% of generating capacity lasting for two hours, the levelised cost of electricity would be $95 per MWh. This is some 42% more than for a project without any storage (see Figure 30), but it is already a historical figure since it is based on second half 2015 battery costs, and those costs are likely to come down substantially in the years ahead.

[6] "We Will Turn Enel Into Green Power: Starace", Bloomberg New Energy Finance, 7 December 2015

INVESTMENT SOURCES

- The all-in cost of debt for renewable energy projects in developed economies remained low by historical standards in 2015. This helped to safeguard the competitiveness of wind and solar – both technologies where most of the costs are incurred upfront rather than during operation.
- Development bank financing of "broad" clean energy was $83.9 billion in 2014. Indications from the first such lenders to publish figures for last year are that the total may have ended up close to that level once again in 2015.
- Yieldcos and quoted project funds sold a record $7 billion of equity, mainly to institutional and retail investors in 2015, to acquire operating-stage renewable energy projects. A sell-off in yieldco shares in the late summer put a question mark over their future equity-raising.
- Innovation in the provision of finance for clean energy in 2015 included platforms managed by banks to pool project-oriented investment from pension funds and other institutions, share issues to fund wind projects in Uruguay, and index-linked notes to back solar projects in the UK.

DEBT

Debt makes up the majority of the investment going into many utility-scale renewable energy projects, either at the project level in the form of non-recourse loans, bonds or leasing; or at the corporate level in the form of borrowings by the utility or specialist company that is developing the project.

In 2015, debt remained plentiful in many of the core markets for renewable energy with, in some places, further downward pressure on its cost. In Europe, the all-in cost of debt for an onshore wind project fell to less than 3.5% in France, less than 3% in Germany and less than 4.5% in the UK, helped by reductions both in the margin charged by banks and in the cost of interest rate swaps (in turn reflecting reductions in long-term government bond yields). Back in 2012, at the time of the European sovereign debt crisis, the equivalent figures would have been around 5% for France, 4.5% for Germany and around 5.5% for the UK. [1]

In India, the benchmark repurchase rate was cut by 50 basis points by the Reserve Bank in early 2015, taking the all-in cost of rupee debt down to the 11-13% range, and there were further cuts totaling 50 basis points in the remainder of the year. In the US in December, the Federal Reserve implemented the first increase in its interest rates since the 2008 financial crisis, but the size of the hike was only 25 basis points and the 10-year government bond yield ended 2015 close to where it began. Short-term construction debt for a medium-sized renewable energy project in the US tended to be available late in 2015 at about 150-200 basis points over Libor, or between 2.5% and 3% all-in.

In China, the benchmark one-year lending rate fell by more than one percentage point during the year. There were some other markets, such as South Africa, where there were significant increases in interest rates (both short-term and long-term) but these changes have yet to have a noticeable impact on the supply of, or demand for, debt for renewable energy projects.

Commercial banks provided most of the project-level debt last year for wind farms and solar parks in established markets such as Europe, North America, China and India. Big bank-led financings

[1] Bloomberg New Energy Finance, Analyst Reaction H2 Europe Asset Finance: Offshore Dominates, 18 November 2015

included the provision of EUR 1.3 billion worth of debt for the 402MW Veja Mate offshore wind farm in German waters, a deal that involved six commercial lenders led by Deutsche Bank as well as development bank KfW, which alone lent EUR 430 million; and the award of $601 million in debt by a group of lenders led by Standard Bank of South Africa for the 100MW Ilangalethu Karoshoek solar thermal plant.

Bonds have been an alternative to conventional bank project finance for many years, but their use has been sporadic. The US had a big year for project bond issuance in 2013, with $1 billion worth issued for instance by MidAmerican Energy Holdings to back its Solar Star project in California. The North American market has been quieter since and, in fact, the biggest bond deals to back renewable energy projects in 2015 were on the other side of the Atlantic.

In December, Blackstone sold EUR 978 million worth of bonds to repay bank loans taken out to finance the 288MW Meerwind offshore wind project in the German North Sea. Five months earlier, German insurers led by Talanx agreed to buy EUR 556 million worth of bonds issued by Global Infrastructure Partners to help pay for a 50% stake in the 330MW Gode Wind 1 offshore wind farm being built by Dong Energy.

Japan, Brazil and Mexico are emerging as new locations for bond issues to back renewable energy projects. Since 2013, Goldman Sachs has arranged bonds for seven solar projects in Japan with a combined capacity of more than 50MW, its most recent move being to sell bonds backing a 10MW PV park being developed in that country by Canadian Solar.

In Brazil in September 2015, developer Casa dos Ventos Energias Renovaveis sold the local currency equivalent of $129 million of one-year bonds to refinance five wind projects. In Mexico in October, National Financiera issued $500 million worth of five-year bonds to contribute towards the development of nine wind farms with a total capacity of 1.6GW.

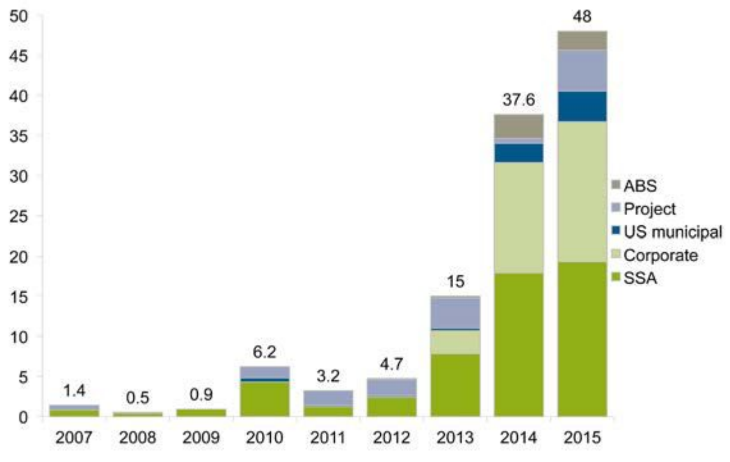
Project bonds make up only a relatively small fraction of the world market for 'green bonds', although they do have the potential to grow significantly if institutions become more comfortable with holding fixed-interest paper secured on the revenues of a project. In 2015, project bonds were heavily outweighed in volume by other categories such as climate-friendly bonds issued by supranational, sovereign and agency bodies (including development banks), and by corporate issues by commercial banks, industrial companies and utilities.

Figure 31 shows the upward trend in green bond issuance to a new peak of $48 billion, up 28% on 2014.[2] A significant slice of the green bond issuance by development banks, commercial banks and utilities will have found its way into financing clean power projects, but it would already be included in the asset finance total discussed in the Executive Summary and Chapter 5 of this report.

Apart from commercial banks and bond issues, the other major source of debt for renewable power assets is borrowing directly from the world's array of national and multilateral development banks.

In 2015, development banks were active in eye-catching renewable power financings, including EBRD's provision of $200 million for the 170MW

FIGURE 31. GLOBAL GREEN BONDS ISSUED 2007-2015, $BN



SSA is supranational, sovereign & agency, ABS is asset-backed security.
Source: Bloomberg New Energy Finance

[2] Note that many green bonds are used to finance climate mitigation, water or other environmental work, rather than renewable energy.

Efeler geothermal plant in Turkey, International Finance Corporation's loan for the 36MW Malvern wind farm in Jamaica, and the offer of $175 million for wind parks in Bahia state, by Brazil's Banco Nacional de Desenvolvimento Economico e Social. There were also a number of indirect commitments, such as European Investment Bank's $55 million allocation to the Capenergie 3 fund aimed at developing at least 500MW of renewables in France; and KfW's provision of $125 million to Tunisia to build solar and other projects towards the country's clean power target of 30% by 2030. And there were loans to manufacturers, as opposed to projects, including JinkoSolar's $51 million credit line from China Development Bank.

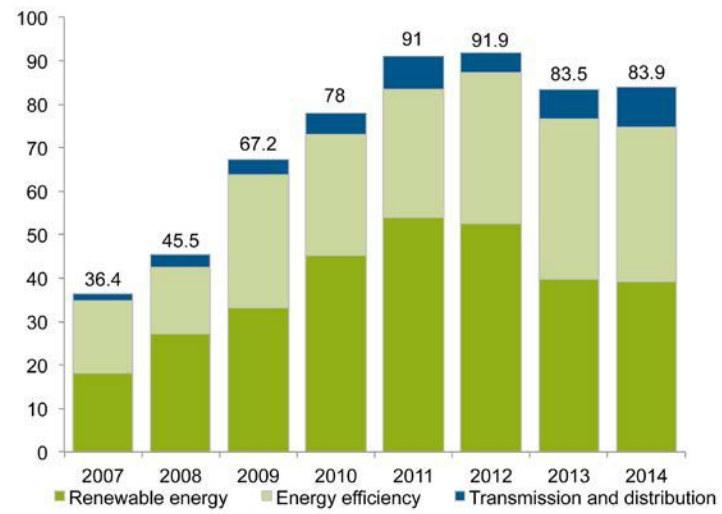
Aggregate figures for development bank lending to renewables in 2015 are not yet available – with some of these lenders yet to publish their figures for the year. Among those that have released preliminary figures, the European Investment Bank lent EUR 3.4 billion to renewable energy in 2015, down 42% on the 2014 total, a change that the EIB attributed to year-on-year variation in the completion of big deals, rather than the start of a downward trend. KfW said that its renewable energies programme was EUR 4.5 billion in 2015, up from EUR 4.1 billion in the previous year. Brazil's BNDES said it lent BRL 6.1 billion ($1.8 billion) to wind projects in 2015, up 85% on the 2014 figure.

The way that development banks define their lending to renewables and other low-carbon and environmental projects differs widely, and it is easiest to compare them in terms of their provision of finance to a "broad" definition of clean energy. On this basis, they provided $83.9 billion in 2014, as Figure 32 shows. This was up slightly from $83.5 billion in 2013, and took the cumulative investment by these organisations to $577.5 billion between 2007 and 2014.

"Broad" clean energy covers a wider span of financing than the definition of renewable energy investment used in this report. It includes loans to energy efficiency projects, which accounted for $35.5 billion, or 42% of the total, and allocations to transmission and distribution projects, which represented a further 11%. It also covers loans to large hydro-electric schemes, and loans to manufacturers of clean energy equipment.

Taking that "broad" spec, the development bank most active in the sector was KfW of Germany, which provided $28.3 billion of finance, followed by the European Investment Bank ($11.7 billion), the World Bank Group ($9.4 billion), Brazil's BNDES ($6.3 billion) and China Development Bank ($6 billion). Completing the top 10 were Asian Development Bank, European Bank for Reconstruction and Development, African

FIGURE 32. DEVELOPMENT BANK FINANCE FOR "BROAD" CLEAN ENERGY, $BN



Source: Bloomberg New Energy Finance, development bank annual reports

Development Bank, Japan Bank for International Cooperation or JBIC, and Export-Import Bank of China – all with commitments in 2014 of between $1.6 billion and $3 billion.

If we look at the extent to which development banks are contributing to North-South flows, and if we define as "North" those lenders majority or fully controlled by OECD countries, then there was a total flow southward of $15.1 billion in 2014, up 14% on the 2013 figure but below the peak of $16.2 billion in 2011.

EQUITY

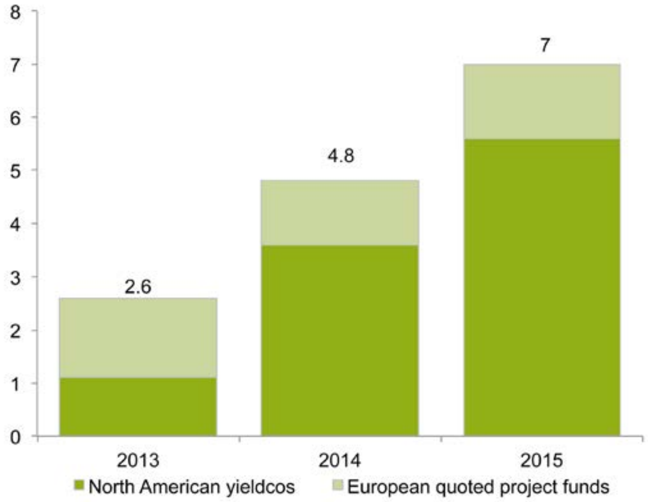
Equity for renewable energy projects can come from a utility that is financing the whole cost on balance sheet; or from a developer that is contributing equity to cover a fraction (often 20% to 40%) of the investment cost, with the rest of the money coming from non-recourse project debt; or it may come from outside investors such as infrastructure funds, private equity funds, insurance companies and pension funds.

As with debt, the precise role played by equity may change over time if the project is refinanced. One possibility, for instance, is that the construction of a project might be financed 100% on balance sheet by a utility in the first instance, but then refinanced later with new debt providers or equity investors coming in to buy some of the interest of the utility. In the US, there is the variant of tax equity providers coming in to replace construction debt once the project is built.

The clutch of Chinese offshore wind projects reaching 'final investment decision' in 2015 are thought to have gone ahead on the basis of about 80% debt, with 20% equity coming from the developer – so in the case of the 300MW Binhai project, the equity providers were Datang Renewable and Jiangsu Guoxin Investment. In the case of the two 330MW halves of the Walney Extension offshore wind project off the UK, the finance is coming initially entirely from Dong Energy, the developer. A refinancing by Dong at a later date would, however, be in keeping with its approach on other projects.

In the case of one of the largest PV project financings of 2015, the 257MW Tranquillity installation in California, developer Recurrent Energy secured $337 million of loans from six banks, and also equity finance estimated at nearly $200 million from itself and from Southern Power.

FIGURE 33. EQUITY SOLD BY YIELDCOS AND QUOTED PROJECT FUNDS, 2013-2015, $BN



The figures above include not just new equity but also existing equity sold to investors by former parent companies.
Source: Bloomberg New Energy Finance, yieldco public statements

Utilities continue to be an important source of equity for renewable energy projects at the development or pre-construction stage (see the on-balance-sheet component of asset finance in Figure 34 in the next chapter). In 2014, the latest year for which full figures are available, nine of the largest European utilities invested a total of $11.9 billion in renewable energy, some 6% more than in 2013 but 19% less than the $14.6 billion record set in 2010. [3] The amounts committed by individual utilities have shown divergent trends – in 2014, for instance, Iberdrola and SSE were investing less than a third of the amount they did in 2010, EDP around a half, Enel one and a half times and EDF about 40% more.

However, the fastest evolving aspect of equity provision for renewables is at a post-construction stage, when new and more risk-averse institutional investors have been looking to get involved in order to access the predictable cash flows of an operating-stage project.

One obvious manifestation of this has been the emergence of the "yieldco" in North America and its London-listed cousin, the quoted project funds. These vehicles, pioneered by NRG Yield in the US and Greencoat UK Wind in the UK, buy operating-stage renewable energy projects either on the market or from a former parent that is involved in developing them. They then own the projects through to the end of their lives, paying out a high proportion of cash flows to their stock market investors.[4] Yieldcos and quoted project funds sold more than $14 billion to stock market investors on both sides of the Atlantic from 2013 to the end of 2015, attracting institutions such as hedge funds and wealth managers, plus individual investors hungry for dividends.

Figure 33 shows the amount of new capital raised by these entities in each of the last three years.[5] One of the new departures last year was an attempt to interest developed-economy stock markets in yieldcos holding projects in developing countries. TerraForm Global, set up by SunEdison to own assets in India, Brazil, China, South Africa and other emerging markets, raised $675 million in an initial public offering in New York at the end of July.

In the third quarter of 2015, yieldcos in North America suffered sharp share price falls, putting in question their ability to raise significant new equity in the short term. The rollercoaster ride of yieldco share prices is examined in more detail in Chapter 7.

[3] These figures are drawn from the annual reports of SSE, Iberdrola, Enel, E.ON, RWE, EDP - Energias de Portugal, EDF, Dong Energy and Vattenfall.

[4] The eight North American yieldcos were all born out of development companies, as were two of the European equivalents. They buy 'drop-down' assets from their former parents, and also have the option to buy projects from third parties. Six other European quoted project funds are independent and buy assets on the market.

[5] Note that the quoted project fund total includes Saeta Yield, a European yieldco.

Another way in which new sources of equity are finding their way into renewable energy projects is via direct commitments by institutional investors. In Europe, this totalled $1.1 billion in 2015, down from a peak of $2.8 billion in 2014, with German insurer Allianz once again one of the most active direct investors, buying onshore wind projects in both Austria and Sweden, although the biggest single move was Swedish pension fund AMF buying a 49% stake in the 150MW Ormonde offshore wind farm in UK waters for GBP 237 million. One reason for this year-on-year decline in the total may be that institutions found new ways to invest in renewable energy projects in Europe in 2015 – including via project bonds and via platforms (see Box on innovations below).

INNOVATIONS IN 2015

Last year saw several intriguing new approaches for channeling debt and equity finance into renewable power projects worldwide. One of these, in Europe, involved the establishment of platforms through which institutional investors could have exposure to the equity of clean energy assets but with the reassurance of having a technically experienced bank involved alongside them. These are akin to unquoted funds, except that the manager is an investment bank that puts its own capital to work, rather than a conventional private equity or infrastructure fund manager.

In April, the UK's Green Investment Bank said it had raised GBP 463 million, or nearly half its eventual target, for a platform that will take equity stakes of 10-30% in offshore wind projects and hold them for up to 25 years. The institutions subscribing to the platform included several unnamed pension funds and a sovereign wealth manager. In a separate move, in December, Swiss Life said it would contribute EUR 300 million to a platform with French bank Natixis, set up to invest in the debt of an unnamed offshore wind project.

Another innovation in Europe since 2012 has been the appearance of inflation-linked notes as a way for institutions to access the cash flows of wind and solar projects. Last year the transactions included GBP 29.5 million of 19-year index-linked notes to cover the debt capital portion of 2,300 commercial and domestic rooftop solar installations in the UK, totaling nearly 12MW. The proceeds went to Armstrong Energy, and the issue was arranged by specialist company Independent Debt Capital Markets.

In Uruguay, one of South America's leading wind markets, 2015 saw equity being raised on the Montevideo stock market to help finance the development and construction of individual wind projects. In March, wind energy trust Fideicomiso Financiero Pampa raised $77.6 million in two rounds of equity financing, heavily oversubscribed by investors, towards the $321 million, 141MW Pampa wind farm. In December, the same trust raised $53.6 million via the issue of shares to retail investors and institutions, to provide equity for the 70MW Colonia Arias wind farm.

December last year saw the first leasing platform for off-grid solar in Africa, with specialist company Off Grid Electric raising $45 million in debt from the David and Lucile Packard Foundation and a number of other family offices plus the US Agency for International Development's Innovation Ventures programme.

If we stretch 2015 by one month, January 2016 saw the first bond issue (of $500,000) for residential solar in Africa. Oikocredit, BBOXX and Persistent Energy bundled 2,500 active contracts for solar energy in Kenya, offering an interest rate of 21% and an average maturity of 2.5 years.

ASSET FINANCE

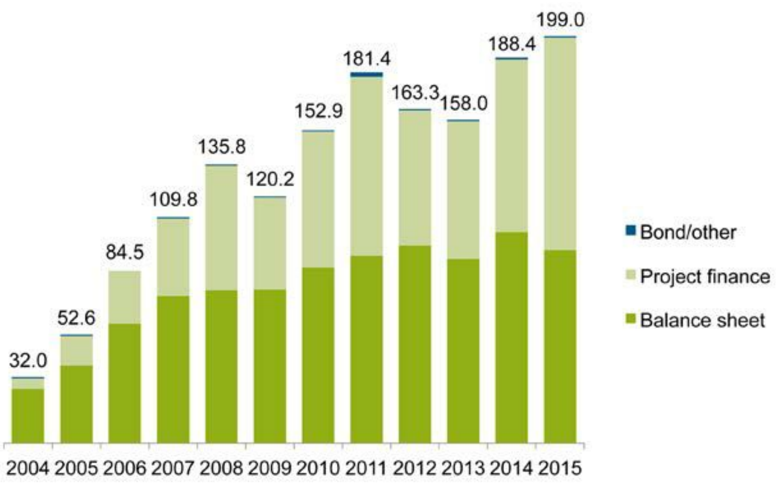
- Asset finance of utility-scale renewable energy projects (capacity of more than 1MW) reached $199 billion in 2015, the highest level ever recorded and an increase of 6% on the previous year.
- Within that total, there was a swing towards non-recourse project finance and away from on-balance-sheet funding. The former made up 52% of total asset finance in 2015, the first time it has represented a majority in the last 12 years.
- China accounted for the largest proportion of global renewable energy asset finance for the fourth year running, its aggregate for 2015 reaching $95.7 billion, up 18% year-on-year.
- Offshore wind saw investment rise almost 40% year-on-year to reach $23.2 billion, as China's market had its first busy year and eight $1 billion-plus European projects reached the "final investment decision" stage.
- Investment in solar thermal rose more than 130% year-on-year to $6.8 billion, the second highest annual figure ever, as large projects in Morocco and South Africa reached financial close.

Asset finance of utility-scale projects is the largest category of renewable energy investment, and reached a record $199 billion in 2015, up 6% on the previous year. This total includes the financing of new wind farms, solar parks, biofuel plants, biomass and waste-to-energy power stations, geothermal installations, small hydro-electric dams of 50MW or less, and wave and tidal arrays. It excludes large hydro-electric schemes of more than 50MW – although these are discussed in the box at the end of this chapter.

Figure 34 shows the split in asset finance between on-balance-sheet funding by utilities and specialist developers, and non-recourse deals involving project-level debt and equity. There is also a small category of 'other' transactions, such as turbine leasing. In 2015, the balance of transactions swung more heavily towards project finance, which made up $104 billion, or 52% of the total, up from 45% in 2014 and the first time it has represented more than half.[1]

Influences on the provision of capital for asset finance are discussed in Chapter 4. However, among the reasons for the recent shift away from on-balance-sheet funding towards debt-equity

FIGURE 34. ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY BY TYPE OF SECURITY, 2004-2015, $BN



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

[1] Note that BNEF has changed its methodology on Chinese asset finance deals with no disclosed financing type. A larger number of these for 2015, and earlier years, are now assumed to be project-financed rather than on-balance-sheet funded.

at an estimated cost of $856.7 million for 300MW, while in onshore wind, the 300MW-Hami Wind Base Phase II Jingxia wind farm was financed at a cost of $420 million. In photovoltaics, the largest project by way of investment was the Dexin Taihe Technology Dezhou Lingxian Yongzhou PV plant, at an estimated cost of $480 million for 300MW.

project finance deals, seen in Figure 34, have been the increased importance in the overall mix of China, where term loans are the usual funding method; and the presence near the top of the big deals list of projects in South Africa, Morocco and Chile, all countries where debt-equity transactions are also the most common approach.

REGIONS

China was by far the largest location for renewable energy asset finance in 2015, as shown in Figure 35. The country accounted for the largest proportion of global investment for the fourth year in a row. China's total of $95.7 billion was nearly three times Europe's utility-scale funding of $34.1 billion and almost four times that of the US, at $24.4 billion, in third place.

The Chinese total was some 18% higher than in 2014, reflecting the country's strategy of expanding electricity generation in a less coal-intensive way, to reduce carbon intensity and pollution. Wind and solar investment dominated the market in almost equal measure – with capital committed of $47.6 billion and $44.3 billion respectively, while small hydro drew some $2.7 billion.

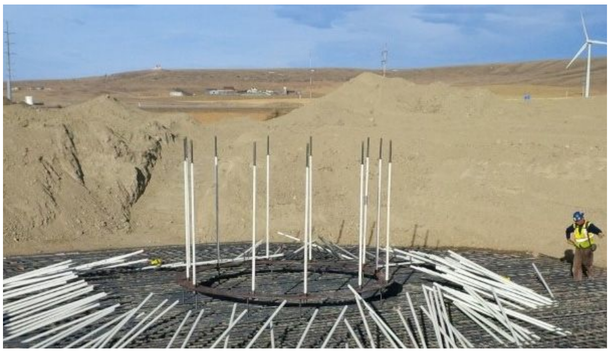
Offshore wind projects topped China's investment leaderboard last year, on the back of a new feed-in tariff for the sector and international players entering the market. The Longyuan Haian Jiangjiasha offshore wind farm led the running,

Europe maintained its position as the second most significant region for renewable energy asset finance last year, although total investment fell by 24% in 2015, in dollar terms. Among the reasons for this setback were the lower cost of solar technology, uncertainty about future policy in Germany and a pause in commitments in France as developers waited for the energy transition law to be passed and for legal issues over the wind tariff to be cleared up. The continent's $34.1 billion total was led by wind investment at $26.9 billion, with much of that attributed to large offshore wind deals.

A flurry of wind projects reached financial close in the UK, as developers rushed to build under the expiring Renewables Obligation scheme, including the Race Bank offshore wind farm at a cost of $2.9 billion for 580MW and the 336MW-Galloper project, costing $2.3 billion. Also high on the list of big deals, Germany's Veja Mate offshore wind farm reached financial close, at $2.1 billion in equity and debt, for a capacity of 402MW.

The high proportion of debt in many European projects reflects the increased confidence of commercial banks in offshore wind. Experience in this market has spread to more and more lenders, and some banks prefer the large ticket sizes available on offshore to the smaller ones on onshore wind or PV.

Germany, the UK, Scandinavia, Ireland, France and Turkey were important locations for the



asset finance of onshore wind last year. But policy uncertainty clouded several other markets, including Italy, Spain and Poland, and policy changes meant the pace of development slowed in Germany from the rush of 2014.

Project financing of utility-scale solar in Europe dropped by more than half in 2015 from the preceding year, to a total of $3.7 billion, partly due to impending cuts to feed-in tariff support in the UK, and an upcoming transition to an auction-based mechanism in Germany. The largest PV plants financed included the UK's MOD Lyneham PV plant, at an estimated cost of $111 million for 70MW.

A number of significant, long-term off-take agreements for renewable energy spurred growth in the US market last year, helping to drive asset finance there up 31% to some $24.4 billion, the highest level since 2012. Corporations became increasingly aware of the stable, predictable costs of clean energy generation and also the expected expiry of federal tax credits. Solar led the way in terms of asset finance, with $13 billion, up 37%, followed by wind, up 24% at $10.6 billion.

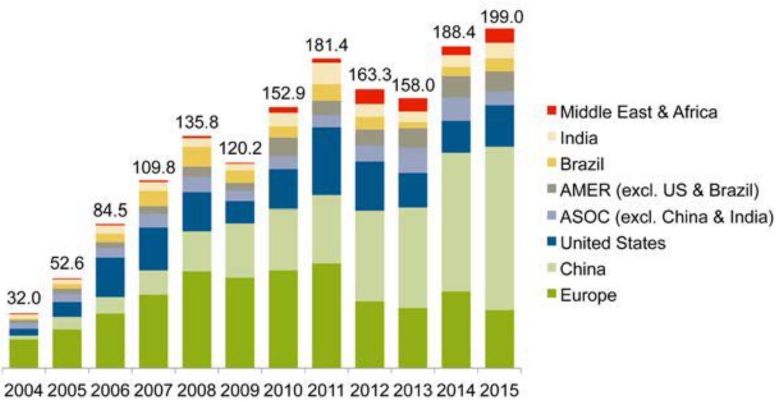
In the event, in December, the US Congress extended subsidies to wind and solar projects until 2019 and beyond – a move expected to produce about $73 billion in incremental investment for the two technologies over the next five years, according to Bloomberg New Energy Finance estimates.

India was an important focus of new-build renewable energy financing last year, with a total of $9.1 billion raised – the most since 2011, and an increase of 34% on 2014. Solar investment surpassed commitments to the country's wind sector for the first time. This reflected three things – PV bids prevailing over wind in a number of state and federal auctions, the Modi government's higher target for solar (100GW by 2022, as opposed to 60GW for wind), and concerns about a relatively high curtailment rate at wind projects. The 250MW Kadiri PV plant was the largest financing of a solar asset, at a cost of $300 million.

Among other regions shown in Figure 35, investment in Brazil picked up momentum last year, with $7.7 billion invested in new renewable energy assets. Competition for solar PV contracts was fierce in Brazilian tender rounds – some 2.2GW was contracted via auctions, where the average price was BRL 297.37 per MWh ($77.24/MWh). Strict local content rules for wind components did not quell the strength of investment in the sector, at a total of $5.7 billion – up almost 50% on the previous year and the highest ever. The depreciation of the real against the dollar did not damage the economics of Brazilian wind projects because there was an increase in local currency tariffs agreed for wind projects at auctions.

The Middle East and Africa was another region of note in utility-scale asset finance, with outlays rising 65% to $8.4 billion. South Africa was

FIGURE 35. ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2015, $BN

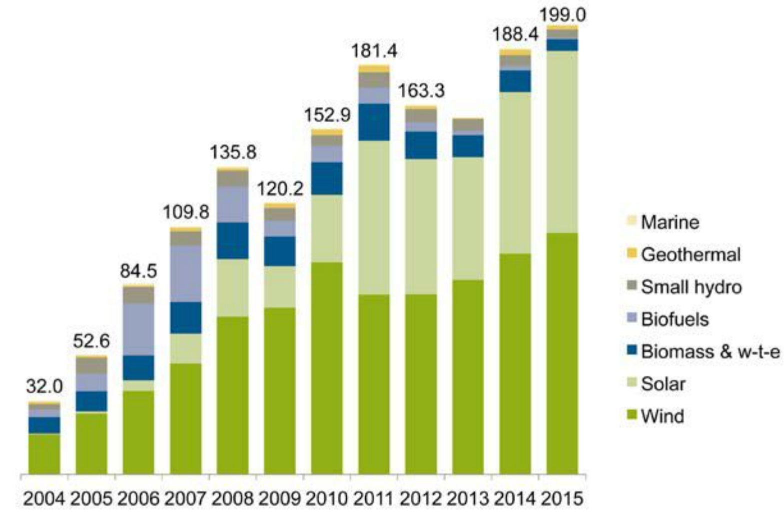


Total values include estimates for undisclosed deals.
Source: Bloomberg New Energy Finance, UNEP

the biggest contributor to this figure – with investment exceeding $4.5 billion – more than quadruple the country's 2014 total. Africa's second largest economy is auctioning renewable power capacity to help meet its growing energy demand and reduce the frequency of outages. A number of large-scale solar thermal projects and wind farms played their part, with the Ilangalethu Karoshoek Solar Valley plant raising the most by way of asset finance, at $1.1 billion for 100MW. This project was beaten to the regional top spot by Morocco's NOORo solar thermal portfolio, at an estimated cost of $1.8 billion for 350MW. For further analysis of deals in other countries in the region, see Chapter 1.

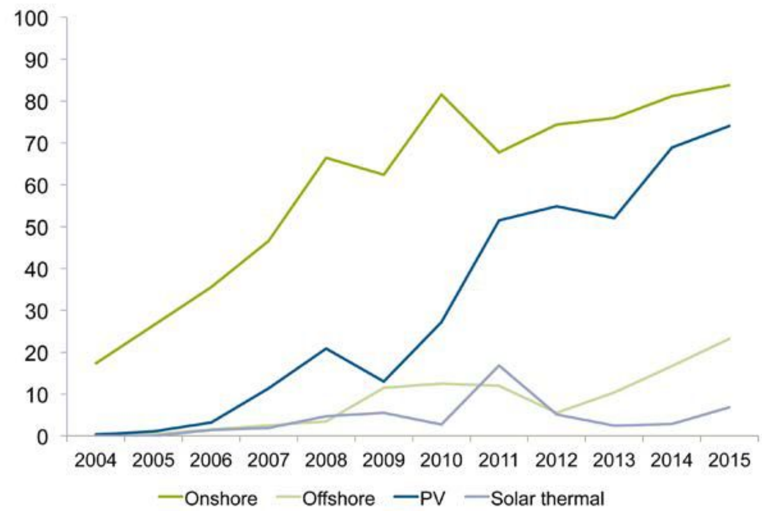
Asia-Oceania excluding China and India recorded the lowest investment figure since 2011 last year, at $8 billion – a drop of 42% on 2014. This was largely due to Japan, where utility-scale investment declined 49%, and Indonesia, where investment decreased by almost 100%. Declining electricity demand, growing small-scale PV penetration, and grid capacity limits for solar and wind generation were among the reasons for the reduction in Japanese asset finance last year.

FIGURE 36. ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2015, $BN



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

FIGURE 37. ASSET FINANCE OF WIND AND SOLAR PROJECTS WORLDWIDE, BY SUB-SECTOR, 2004-2015, $BN



Source: Bloomberg New Energy Finance

TECHNOLOGY

Both wind and solar hit record levels of utility-scale asset finance in 2015, as shown by the technology-level breakdown in Figure 36. Wind investment increased by 9% to a total of $107 billion worldwide, thanks to higher investment levels in both the onshore and offshore sub-sectors, while the financing of solar assets increased 13%, reaching a total of $80.9 billion.

Six of the top 20 global wind deals were for offshore projects in China – reflecting that country's rising interest in a sub-sector pioneered over the last few years in the North Sea by the UK, Germany and the Low Countries. Nevertheless, offshore wind in Europe still dominated the higher rankings in 2015 as several long-anticipated deals reached financial close, including the $728 million Nobelwind offshore wind farm in Belgian waters, with a capacity of 165MW.

In capacity terms, Europe's top 10 offshore wind farms reaching 'final investment decision' last year totaled almost 3GW – five of which were in UK waters, four in the sea off Germany and one off Belgium's coast. UK projects – Race Bank and Galloper – nabbed the top spots at a cost of $2.9 billion and $2.3 billion respectively, while Germany's 402MW Veja Mate offshore wind farm followed closely in their footsteps with investment of $2.1 billion.

Globally, offshore wind financings worldwide amounted to $23.2 billion – almost 40% up on the previous year's total, and more than double 2013's total (see Figure 37).

The larger market of onshore wind grew more slowly last year – rising just 3% to reach a total investment value of $83.8 billion in 2015. Among the largest projects were Mexico's Nafin wind farm portfolio, at an estimated $2.2 billion for 1.6GW, the US-based Grande Prairie wind farm at an estimated $740 million for 400MW and the UK's Kilgallioch wind farm at $468 million for 239MW.

Solar thermal electricity generation, or CSP, featured heavily in the leaderboard rankings for 2015 solar deals – investment rising by 139% on 2014 levels to reach some $6.8 billion, the highest level since 2011. Globally, the five largest solar deals were all for CSP and were located in South Africa, Morocco and China at a total cost exceeding $5.4 billion. The NOORo portfolio in Morocco was by far the largest, at $1.8 billion for 350MW, followed by the Ilangalethu Karoshoek Solar Valley Plant in South Africa at $1.1 billion for 100MW.

There were only nine deals in solar thermal last year, in comparison to the vast number of PV projects financed at a lower comparative cost per megawatt. Concentrated solar power with thermal energy storage is becoming an accepted option in South Africa and China, as a way to help maintain grid reliability. The technology is also free of the trade disputes seen in the photovoltaic sector.

Solar PV's top 14 deals were all financed for $300 million or more, and had an average capacity of 214MW. Higher-ticket projects were on the whole US-based, although Chinese projects took the lion's share of deal numbers, and India, Europe and Brazil also contributed significantly to the $74 billion asset finance total. This was an increase of 7% on 2014's figure for PV.

At an estimated cost of $744 million for 294MW, the Silver State South PV plant in the US raised the largest amount of investment, followed by SolarCity's Kronor PV portfolio at $500 million, financed through a consortium of commercial banks.

Sectors outside wind and solar fared less well in 2015, with biomass and waste-to-power asset finance seeing a decrease of 46% to $5.2 billion, small hydro dropping by 26% to $3.5 billion and geothermal shrinking 25% to $1.8 billion. Biofuels too, decreased some 67% to just shy of $700 million, influenced by the oil price collapse and a US proposal in June to reduce biofuel quotas.

In these sectors, significant deals included Indonesia's Guris Efeler geothermal project at an estimated cost of $717 million for 170MW, the Klabin Ortigueira biomass plant in Brazil at 330MW and the Henan Tianguan Ningde bioethanol plant in China, at $283 million for 380MW.

LARGE HYDRO

Investment in large hydro-electric projects of more than 50MW is not included in the main totals in this report. However, it represents another important, growing source of renewable electricity, third in size in total investment behind solar and wind in 2015.

Estimating the value of large hydro dams reaching 'final investment decision' stage in any one year is complicated by the fact that many projects begin initial construction many years before the point of no return, or even the award of full permitting, is reached. Some also run into delays during the long construction process, and in extreme cases work can be interrupted for a prolonged period because of political issues.

However, Bloomberg New Energy Finance estimates that large hydro projects totalling some 26.3GW got financial go-ahead last year, equivalent to around $43 billion of asset finance. This compared to 16.3GW reaching final investment decision in 2014, worth $46.2 billion. Costs per MW for large hydro vary significantly from region to region, and this is why investment was lower in 2015 than in 2014 even though the capacity financed was significantly higher. In particular, 2014 saw the go-ahead on three Canadian projects, which have relatively high dollar values per MW, while 2015 was dominated by Chinese projects, which have much lower stated costs per MW.

Last year, by far the largest hydro-electric project to reach final investment decision was the 10.2GW Wudongde dam on the Jinsha river in China. Developer China Three Gorges said in a statement in December that the main works on Wudongde had started, and that the dam would use 850MW turbine units and cost a total of CNY 100 billion ($15.5 billion at the average exchange rate in that month).

Other significant large hydro projects reaching milestones in 2014 included the 969MW WAPDA Neelum Jeelum plant in Pakistan, the 750MW West Seti project in Nepal and the 1.7GW, $4.5 billion Nestor Kirchner and Cepernic projects in Argentina. A comparison of asset finance in large hydro with that in other renewable energy sectors is shown in Figure 8 of the Executive Summary of this report.

SMALL DISTRIBUTED CAPACITY

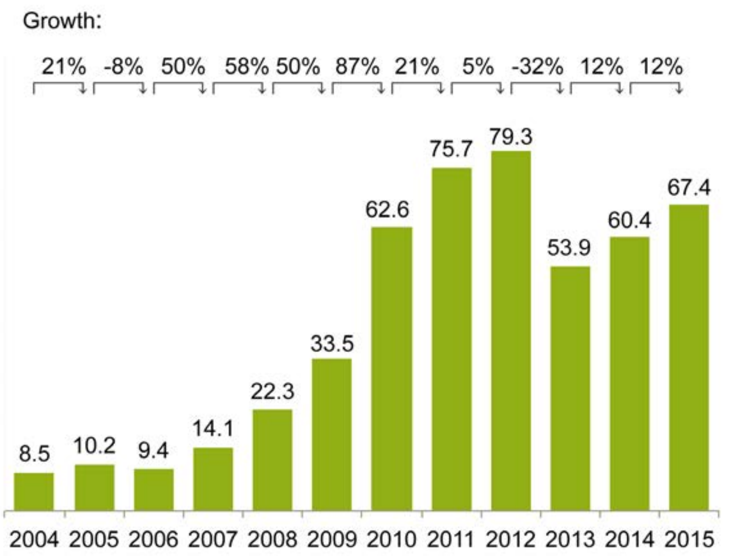
- Falling costs and innovative financing mechanisms are putting small-scale distributed solar within reach of more people, in both developed and emerging economies.
- A quarter of all new investment in new renewable energy capacity in 2015 went to small-scale projects – some $67.4 billion.
- Japan remains by far the largest small distributed power market in the world, thanks to still-generous feed-in tariffs and falling PV system costs.
- In the US, the boom in residential solar looks set to continue. The number of customers with PV is predicted to more than double nationally between 2015 and 2020.
- Subsidy curtailment will hit the UK market in 2016, just as it dampened demand in Germany in 2015, sending small distributed capacity investment there down 57%.
- Australia has one of the highest penetrations of residential rooftop PV in the world – around 1.4 million systems have been installed so far.

Small distributed power systems are at the forefront of a transformation in the way we think about energy generation. Utility-scale wind and solar projects mimic the traditional model of a large, centralised generating plant, whereas small-scale systems take the opposite approach – they involve millions of people directly in the production of electricity for their own use (and sometimes profit), whether they be in rural Tanzania or US suburbia.

In 2015, a total of $266 billion was invested in new renewable power generating capacity globally. Of this, one quarter, or $67.4 billion, went towards projects of less than 1MW – typically rooftop and small ground-mounted solar PV installations. This was an increase of 12% on the $60.4 billion invested the previous year, and 25% higher than the 2013 total of $53.9 billion, but still below levels seen in 2011 and 2012 during the peak of the German and Italian PV booms, as shown in Figure 38.

There are a number of factors driving activity

FIGURE 38. SMALL DISTRIBUTED CAPACITY INVESTMENT, 2004-2015 $BN



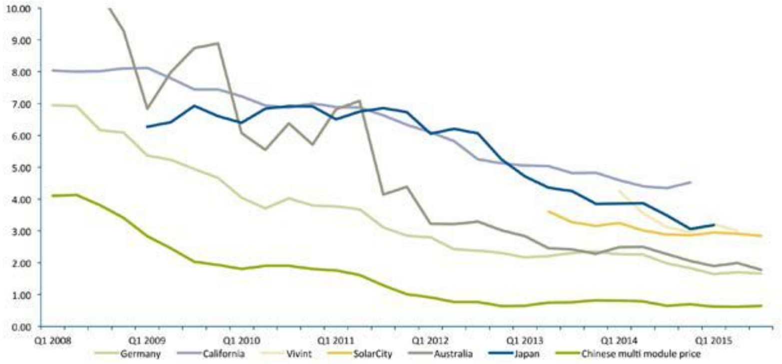
Represents investments in solar PV projects with capacities below 1MW
Source: Bloomberg New Energy Finance

in the small distributed sector. The first is the continued decline in the price of solar systems in certain key markets, albeit at a slower pace than in recent years. Japan has become by far the largest small distributed renewables market in the world thanks to generous solar incentives introduced in 2012 and a fall of almost 50% in the cost of small-scale solar in that country to an average of $3.18 per Watt in Q1 2015, from $6.05/W in the first quarter of 2012, as Figure 39 shows.

The US, Australia and Germany have also seen recent price falls. In the two years leading up to the third quarter of 2015, US solar installer and financier SolarCity reported a decline in average system costs of $0.43/W to $2.84/W. Over the same period, the price of a 3kW residential system in Australia fell by $0.65/W to $1.77/W, and in Germany the cost of a sub-10kW system dropped by a similar amount to $1.66/W, the lowest among the major markets.

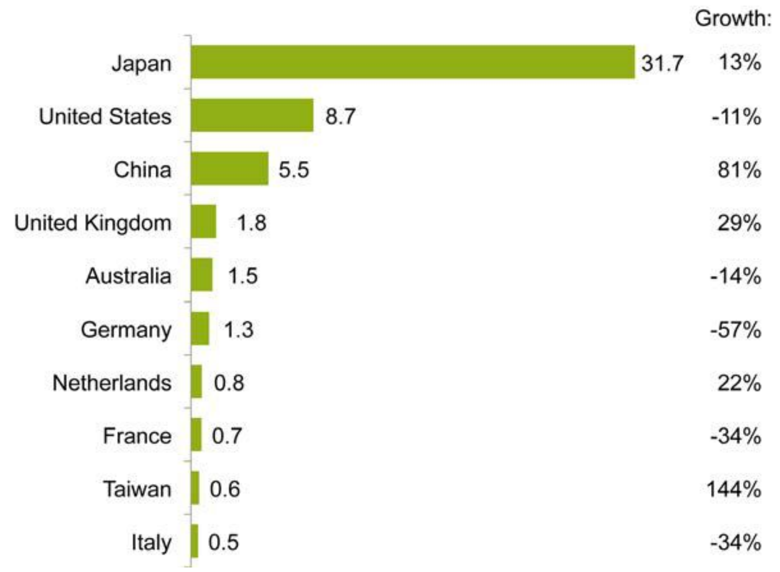
Further cost reductions are on the way. These will come from technological and manufacturing improvements, rather than from squeezing manufacturers' margins. Manufacturers are setting up new production lines and upgrading their existing facilities with improved technologies. There could be a reduction of at least 36% in module costs within 10 years, while average efficiency will rise by 20%, according to

FIGURE 39. PUBLIC CAPEX BENCHMARKS FOR RESIDENTIAL PV SYSTEMS, $/W



Source: Bloomberg New Energy Finance

FIGURE 40. SMALL DISTRIBUTED CAPACITY INVESTMENT BY COUNTRY, 2015, AND GROWTH ON 2014, $BN



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

Bloomberg New Energy Finance estimates. As technology costs fall, labour costs will account for a larger slice of the overall cost of installing a residential PV system.

Another catalyst driving growth of small-scale solar is the proliferation of innovative financing mechanisms that help make panels more affordable. Under third-party leasing, for instance, homeowners pay nothing up front. Instead, the solar company enters into a long-term contract to lease the roof and sell the power to the householder, usually for much less than they would normally pay the utility. This financing method is behind a rooftop solar revolution in the US, where annual home installations have increased 16-fold since 2008, according to the Solar Energy Industries Association.

Similar financing models have spread elsewhere. SolarCity recently bought a developer in Mexico that was offering the first leases to businesses in that country, and now plans to expand it to homes there. Businesses in China are so keen to replicate California's success that Trina Solar said it had to come up with a rough Chinese translation for "third-party leasing".

Innovative financing is also helping people in emerging economies to buy or lease small solar systems. A growing number of private companies now offer microfinance to consumers with no formal credit. Off Grid Electric and Bboxx, for instance, are active in East Africa and have recently secured venture capital and private equity backing.

Japan was by far the largest market for small distributed power in 2015. As Figure 40 shows, small-scale project investment in the Asian nation increased 13% in 2015 to $31.7 billion, more than three and a half times the $8.7 billion invested in the US, the next largest market. One development in 2015 saw Japanese supermarket chain Trial Company install 32 300kW-400kW PV systems on its stores. Trial will lease its roofs to Canadian project developer Solar Power Network, which will sell the electricity to local utilities under the feed-in tariff (FiT) programme.

The Japanese market is expected to expand further this year before falling back in 2017, according to a forecast by Bloomberg New Energy Finance. An estimated 9.1GW of new sub-1MW PV will be added in 2016, up from approximately 8.2GW in 2015. Thereafter, the rate of new capacity additions will drop as the government gradually reduces the subsidy. The most recent adjustment, effective as of 1 July 2015, reduced the FiT for 10kW-plus PV systems from JPY 29/kWh to JPY 27/kWh. As of April 2015, some 34.1GW of small (sub-1MW) PV applications had been approved, but it is thought that 23-35% of these will not be commissioned.

In the US, the boom in residential solar looks set to continue. The number of customers with PV is predicted to more-than-double nationally between 2015 and 2020. Build rates will average 1.7GW per year until the end of the decade, while the commercial and industrial sectors are expected to grow at a rate of 1.5GW per year over the same period. Small solar is supported by a combination of federal subsidies, most notably the 30% Investment Tax Credit (ITC), in conjunction with state support mechanisms, such as the Renewable Portfolio Standard and the California Solar Initiative.

One area of concern is the friction over net metering rules in a number of states. These generally require utilities to pay rooftop solar customers the retail rate for electricity they put onto the grid. Utilities argue that those fees are overly generous, and that solar owners are piggybacking on the electrical grid without paying a fair share of its costs. At the end of 2015, the Nevada Public Utilities Commission imposed changes that dramatically reduced net metering fees and increased the fixed charges that solar owners must pay for their grid service. The move prompted Sunrun and others to lay off workers and shut down operations in the state.

Offsetting this piece of bad news, California regulators voted to let home solar customers receive full credit for their excess power, providing an important boost to installers in the biggest US rooftop market. Nearly half the states out of the more than 40 that offer net metering have enacted changes or are considering doing so, according to the North Carolina Clean Energy Technology Center, which tracks the policy. More than 600,000 homes and businesses in the US have on-site solar, with California making up nearly half of the residential market.

China's small distributed market did take off in 2015 – investment grew by 81% to $5.5 billion – although this was not as much as some had been predicting given that this is an important aspect of Chinese government policy. During the first half of the year, distributed generation accounted for just 15% of total installations in China, while it accounted for over 40% of total installations in the US, according to the Solar Energy Industries Association. A number of factors are dampening development, including a lack of financing options for small-scale projects, permitting and regulatory hurdles, a lack of suitable rooftops and property rights issues between developers and rooftop owners.

The UK residential PV market was rocked by the announcement mid-year of drastic cuts to the FiT, prompting a boom in the autumn that increased

the country's year-on-year investment in small distributed capacity by 29% to $1.8 billion. The government later agreed to a smaller reduction than originally proposed, at 64% rather than 86%, effective from 8 February 2016. New caps on the amount of capacity allowed will limit the FiT for rooftop projects to a total of 350MW to 410MW of capacity per year, equivalent to 54% of average deployment since 2011.

These changes will doubtless signal the end of the road for some business models, but not kill off the market entirely. Banco Santander, for instance, announced in early 2016 that it is considering investing in the UK's rooftop solar power market. The UK solar market is an attractive proposition because homeowners also receive an export tariff that pays them for electricity generated by the panels but not used, said Alejandro Ciruelos, Santander's managing director and head of project finance for the UK.

Ongoing subsidy curtailment is continuing to take its toll elsewhere in Europe. Germany, once the engine of growth for small-scale distributed renewables on the continent, contracted by 57% in 2015 to $1.3 billion, while France fell 34% to just $748 million. The Netherlands was an exception to this trend, with small distributed capacity investment there rising 22% to $765 million. Householders flocked to install solar on their roofs in 2015 after the government clarified rules on net metering. In addition, several downstream solar companies have recently announced partnerships with utilities, including E.ON and Trianel, to introduce a leasing option for residential customers.

Taiwan saw an estimated $586 million of small-scale solar commitments in 2015, helped by the Bureau of Energy's decision to increase its capacity quota for support from 270MW to 500MW. Australia has one of the highest penetrations of residential rooftop PV globally – around 1.4 million systems have been installed, meaning one in six voters is now a stakeholder in the industry. The Australian Federal Government had proposed scrapping the small-scale solar scheme and reducing the threshold at which commercial projects qualify for the subsidy programme, but backed down in the face of opposition in March 2015. No changes are now expected.

EMERGING MARKETS AND SMALL PV

Small solar systems of less than 1MW have become less and less rare in emerging economies outside the established terrain of China. However, at the time this report went to press, it was not possible to be sure whether any of these promising new markets in Africa and South Asia had broken through to join the list of those worth hundreds of millions of dollars a year alongside India and Thailand. Nevertheless, anecdotal evidence points to flurries of activity in a wide range of countries.

Pakistan is one of those best placed to move into the upper ranks, with its unmet demand for power and its high insolation. In April 2015, the country inaugurated a 1MW PV system at its parliament building, financed by China; and by July last year, some 208kW of an eventual 350kW had been installed at Shalamar Hospital in Lahore. In Kenya, scene of much entrepreneurial activity to bring small solar systems and the accompanying finance to residential rooftops, there are also somewhat larger projects underway – last year including a 13.5kW system supplying the trading centre, shops, schools and churches at Kitonyoni village in Makueni County.

In Jordan, a 412kW system began generating 70% of the power for Amman Academy in the nation's capital city, while the European Union financed a 10.5kW installation at Al Rwadah school. In Egypt, the Ministry of Agriculture installed a rooftop system of 140kW, with battery storage.

In Costa Rica, a 260kW PV project on the roof of the Estadio Alejandro Morera Soto football stadium reached operation in August last year, while in Jamaica, the Honey Bun bakery said it woud invest in a 100kW solar system at its factory in Kingston.

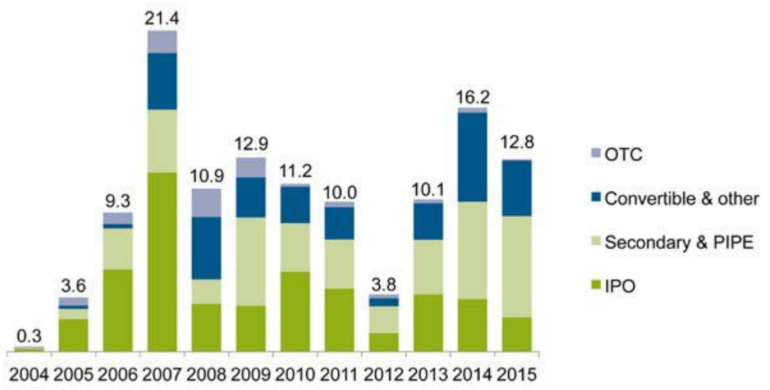
PUBLIC MARKETS

- Public market investment in renewable energy companies and funds fell 21% to $12.8 billion in 2015, but remained three times higher than at its last trough, in 2012.
- Individual renewable energy company shares saw fairground volatility in 2015 but, collectively, they ended the year almost where they began it. The WilderHill New Energy Global Innovation Index, or NEX, fell 0.6%, almost exactly matching the move in the S&P 500 index over the year. The wind sector fared better, however, with the NYSE Bloomberg Global Wind Energy Index gaining 27% in 2015.
- Funds raised as a result of initial public offerings, or IPOs, fell by 35% to $2.3 billion, while issuance of convertibles dropped 38% to $3.7 billion, but secondary issues and private investment in public equity, or PIPE, deals inched up 4% to $6.7 billion – a new record.
- Solar investment on public markets jumped 21% to $10.1 billion, its second consecutive annual record, helped by $2 billion of convertible issuance from SunEdison. Investment in wind plunged 69% to $2 billion, less than a fifth of its peak in 2007, and that in biofuels halved for the second year running, to just $292 million.
- The respectable overall figure for public markets investment in 2015 disguises the fact that it was a lopsided year for equity raising by renewable energy companies, with North American 'yieldcos' and their European equivalents accounting for nearly half the total. Cash calls by technology oriented green power firms were relatively modest in number and size.

After two years of strong growth, public market investment in renewable energy fell back in 2015 by 21% to $12.8 billion, as shown in Figure 41. At this level, it was still three times greater than the most recent trough, in 2012, but far short of the 2007 peak. The drop in public market equity raising in 2015 might appear surprising at first sight given that the year saw the highest ever worldwide additions of PV capacity (56GW) and wind (62GW), but a bigger influence was probably the behaviour of stock markets generally, and of the share prices of specialist clean power companies in particular.

Figure 41 shows that IPO funding fell by over a third in 2015. Only 10 companies managed to float, of which seven were solar. Aside from yieldcos, the largest new IPO was that of Sunrun, the US domestic PV installer, which raised almost $245

FIGURE 41. PUBLIC MARKET NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2015, $BN



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

million on Nasdaq for expansion. The company operates a leasing model under which the homeowner pays nothing up front but signs a long term power purchase agreement, a formula that has proved successful for market leader SolarCity since it floated in 2012.

Among the non-solar flotations, Enviva Partners, a supplier of wood pellets, raised $230 million on the Berlin stock exchange, and Green Plains Partners, an Omaha-based ethanol storage and distribution provider, raised $172 million on Nasdaq. Amyris, the bio-jet fuel developer backed by Total, raised almost $58 million in a convertible issue on Nasdaq, and Gevo, an ethanol and isobutanol producer, raised almost $26 million in three separate secondary issues.

Enviva's IPO in April 2015 raised money to build a warchest for future acquisitions and to repay borrowings incurred in the acquisition of the 650,000-tonnes-per-year Cottondale wood pellet production plant in Florida. Green Plains Partners floated partly to "pay a distribution" to its parent company, Green Plains, an owner and operator of ethanol plants in the US.

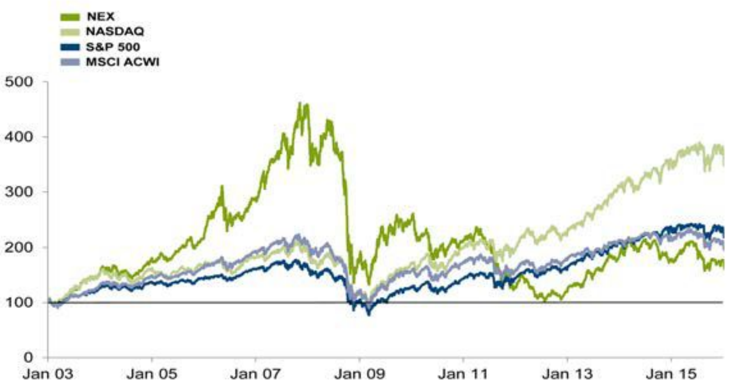
Renewable energy shares started the year well, with the WilderHill New Energy Global Innovation Index, or NEX, rising 9% in the first quarter, and a further 8% during the next, but then going into a slide during the second half. So the NEX ended the year almost exactly where it began, down 0.6% at 177.55, matching the percentage change in the US S&P 500 index and the MSCI ACWI world index, but underperforming the Nasdaq Composite by nearly 6% (see Figures 42 and 43). There was variation between individual renewable energy sectors, with for instance the NYSE Bloomberg Global Wind Energy Index gaining 27% over the course of last year, helped by the firm order books for manufacturers such as Vestas Wind Systems and Gamesa Corporacion Tecnologia, and the NYSE Bloomberg Global Solar Energy Index edging up just 3% (Figure 44).

There was huge variation at the individual stock level with, for instance, 10 members of the 104-strong NEX falling between 55% and 86% during 2015, and 10 members rising by anywhere between 62% and 238%. The most extreme story was that of Chinese solar company Hanergy Thin Film, which saw its shares jump from HKD 2.81 to

FIGURE 42. NEX VS SELECTED INDICES, 2003 TO 2015

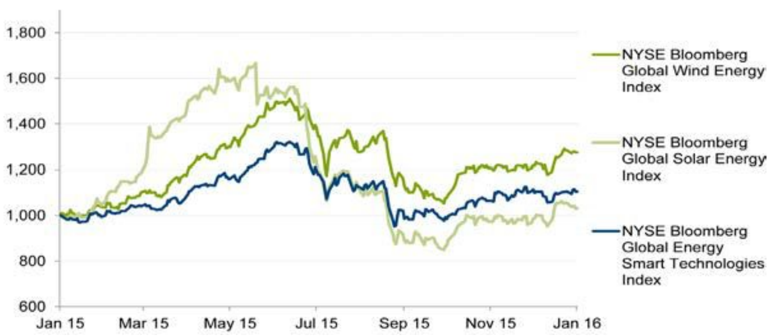
Index values as of 12 January 2016; Nasdaq and S&P 500 rebased to 100 on 1 January 2003
Source: Bloomberg New Energy Finance

FIGURE 43. NEX VS SELECTED INDICES, JANUARY TO DECEMBER 2015



Index values as of 12 January 2015; Nasdaq, MSCI ACWI world equity index and S&P 500 rebased to 100 on 1 January 2015
Source: Bloomberg New Energy Finance

FIGURE 44. NYSE BLOOMBERG WIND, SOLAR AND EST INDICES, JANUARY TO DECEMBER 2015



Index values as of 12 December 2016; Indices rebased to 1000 on 1 Jan 2015
Source: Bloomberg New Energy Finance

an end-of-day peak of HKD 7.88 in late April, at which point its market capitalisation reached the Hong Kong dollar equivalent of $42 billion, before trading in them was suspended in May, not to resume for the rest of the year.

Public market investment in wind, despite that sector's good share price performance, slumped 69% in 2015 to $2 billion, while that in solar jumped 21% to $10.1 billion (Figures 45 and 46). Investment in biofuels halved for the second year running, falling to $292 million.

Of the 21 fundraising deals worth more than $200 million each for quoted specialist renewable energy companies last year, 17 were in the solar sector, 12 were by yieldcos – stock market vehicles that own portfolios of generating assets – and nine were secondary issues. Of the 14 biggest deals in 2015, six combined all three themes.

Figure 47 shows that US share issues dominated renewable energy public market investment in 2015, with $9.7 billion out of the global total of $12.8 billion. A large part of this was due to New York quoted yieldcos, and another big chunk to one solar company, SunEdison. The latter develops solar projects and manufactures polysilicon, and raised $2 billion via convertible issues during 2015 to help fund growth. This expansion included the joint $1.9 billion takeover (with its yieldco TerraForm Power) of US wind developer First Wind and then, in July, the proposed $2.2 billion acquisition of rooftop PV systems company Vivint Solar.

SunEdison shares, which soared 71% from the start of 2015 to a peak in late July, dropped even more quickly after news of the Vivint plan, losing 85% of their value by year end amid investor concerns about the size of the company's borrowings.

Chinese companies were the second most prolific behind American ones, raising $1.2 billion, while UK firms raised $1.1 billion, Canadian businesses $353 million and German ones $182 million. Among the Chinese money-raisers were polysilicon producer GCL-Poly Energy Holdings, which issued $225 million of convertibles, and solar glass maker Xinyi Solar Holdings, which carried out a $148 million secondary share sale.

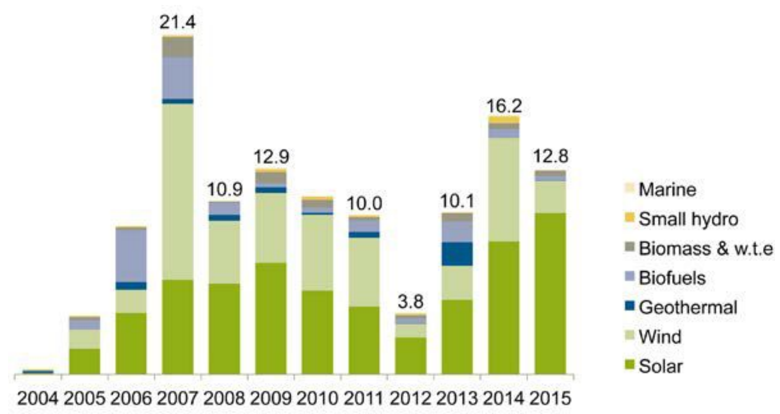
YIELDCO ROLLERCOASTER

Yieldcos started to emerge back in 2013 as publicly listed platforms owning operating-stage assets, both in North America and in the UK (although in the latter, they tended to be called quoted project funds). The North American yieldcos, unlike most of the UK ones, were spun out of independent power producers or project developers and, by bringing in the capital of outside investors, provided those former parents with capital to recycle into their businesses. For investors, yieldcos offered a source of relatively predictable dividend income at a time of rock-bottom interest rates.

At the start of 2015, yieldcos were riding high in share price terms in the US, and the six listed had market capitalisations in the billions of dollars. NRG Yield, the first yieldco, saw its shares rise more than 100% from its IPO in 2013 to a peak in January 2015, while several of its peers saw gains of more than 50%.

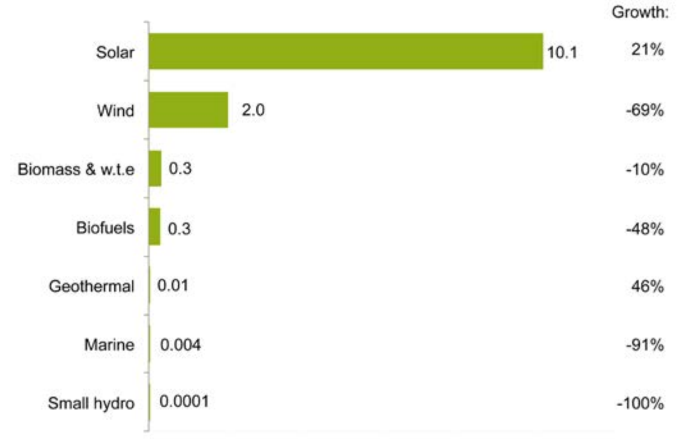
The largest public market deal in renewable energy in 2015 was a

FIGURE 45. PUBLIC MARKETS INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2015, $BN



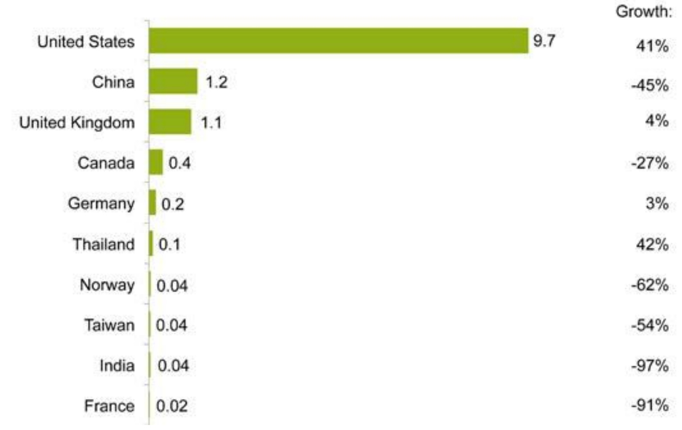
Source: Bloomberg New Energy Finance, UNEP

FIGURE 46. PUBLIC MARKETS INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2015, AND GROWTH ON 2014, $BN



Source: Bloomberg New Energy Finance, UNEP

FIGURE 47. PUBLIC MARKETS INVESTMENT IN RENEWABLE ENERGY BY COMPANY NATIONALITY, 2015, AND GROWTH ON 2014, $BN



Top 10 countries
Source: Bloomberg New Energy Finance

secondary issue worth $688 million for TerraForm Power, a yieldco floated the previous year to take on the North American assets of SunEdison. The second largest deal was the IPO of TerraForm Global, another yieldco this time floated to hold SunEdison's foreign assets. It raised $675 million. Both went on to make further secondary share issues. Abengoa Yield, the offshoot of the Spanish solar, biofuel and transmission developer Abengoa, raised $656 million from outside investors in two secondary issues in the US; NRG Yield raised $620 million through another; and 8Point3 Energy Partners, yet another solar yieldco, set up as a joint venture between the two largest US panel makers, First Solar and SunPower, raised $420 million in an IPO. Of a total $12.8 billion new equity issued on public markets in 2015, North American yieldcos secured some $4.8 billion and their more subdued European equivalents another $1.4 billion. In addition, yieldco parent companies sold $800 million of shares to outside investors, transactions that are not counted in new investment but are included in Figure 33 on page 46.

A sudden reassessment by investors of whether yieldcos were really growth stocks, and a sell-off in the related market for energy Master Limited Partnerships, caused the North American yieldco model to come under tougher examination from July 2015 onwards. TerraForm Power, having touched a high of almost $43 per share, ended the year at less than $13, while TerraForm Global sank from its flotation price of $15 to less than $6.

Quoted project funds in the UK did not suffer the same share price fall-out, although there was modest impact from a decision by the country's Chancellor to withdraw renewable energy's exemption from the Climate Change Levy, and two European flotations were delayed. Greencoat UK Wind, the pioneer among the UK quoted funds, saw its shares slip 4% in 2015. In Spain, Saeta Yield, a vehicle floated in February 2015 to hold the renewables assets of infrastructure company ACS, plotted a middle course between its US and UK peers, suffering an 18% decline from its IPO price.

With yieldco equity raising depressed from the third quarter onwards as a result of the share price falls, and unlikely to recover to 2015 levels in the short run, public market investment levels in renewable energy are likely to fall in 2016 unless a new source of large equity issues emerges. One possibility is a resurgence in IPOs and secondary issues by renewable energy equipment manufacturers. There were far fewer cash calls on stock markets by this type of company in 2015 than in 2014, when Vestas Wind Systems, Suzlon Energy, LDK Solar, Trina Solar and Canadian Solar were among those raising money.

A second possibility would be the flotation of large renewable energy divisions from utilities. There were no such transactions in 2015, and in fact Italian utility Enel announced in November an intention to buy back the 31% it did not own in Enel Green Power, its wind, solar, hydro and geothermal offshoot, for EUR 3 billion.

VENTURE CAPITAL AND PRIVATE EQUITY INVESTMENT

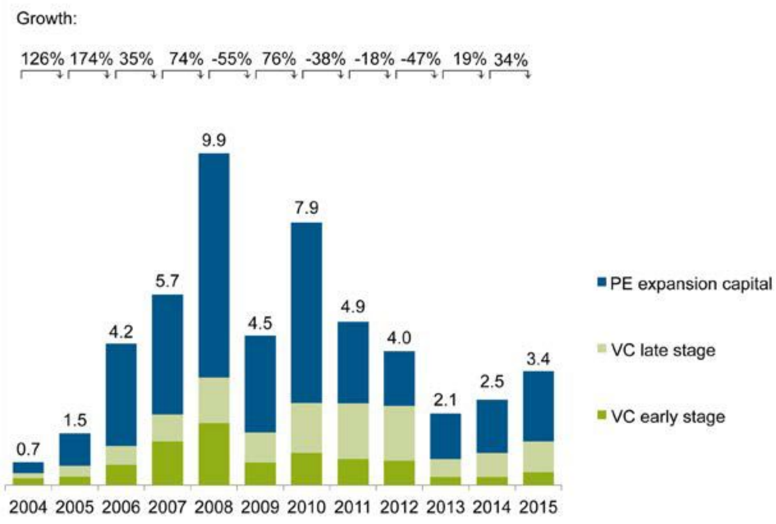
- Venture capital and private equity investment in renewable energy increased by 34% to $3.4 billion in 2015, the second successive year of growth.
- Investment in early-stage venture capital jumped 60%, albeit from a very low base. There was a more modest, 28% uptick in the amount of late-stage venture capital, while private equity made solid gains of 32%.
- Funding for the solar sector rose to its highest level for seven years thanks to a number of substantial deals involving US residential PV firms.
- Next-generation biofuel manufacturers continued to attract investment, despite a steep fall in the price of oil and a lack of a clear policy in the US for most of 2015.
- The US remained the global centre for venture capital investment in renewables. There was a sharp rise in the volume of VC/PE investment in Indian clean power firms, although mostly these were project-oriented businesses rather than technology plays.

Renewable energy appears to have regained some of its former lustre in the eyes of the venture capital and private equity community after two lean years. Deals worth $3.4 billion were recorded by Bloomberg New Energy Finance in 2015, an improvement on 2013 and 2014 when just $2.1 billion and $2.5 billion was invested the sector.

The increase will have been welcomed by cash-hungry start-ups and private businesses eager to expand. Yet to those with longer memories (and who can recall that $9.9 billion flooded into this asset class in 2008 followed by $7.9 billion in 2010), the recent uptick will have looked modest. Nevertheless, it suggests that confidence is seeping back into a sector that was badly shaken by a number of high-profile VC-backed failures.

The rise in investment in renewables was part of a much larger growth story for venture funds generally – 2015 was a stand-out year for the asset class across many different sectors and in numerous countries around

FIGURE 48. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2004-2015, $BN

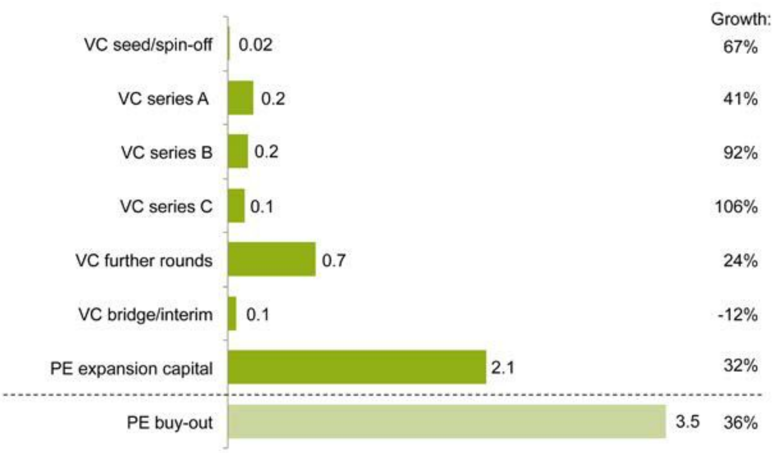


Buy-outs are not included as new investment. Total values include estimates for undisclosed deals
Source: Bloomberg New Energy Finance, UNEP

the globe. The aggregate value of venture capital deals in all economic sectors globally increased for the third successive year to $138.8 billion, up from $93.5 billion in 2014 and more than double the $57.1 billion recorded in 2013, according to data published by Preqin, an alternative assets research firm.

It was also part of the wider clean energy investment growth story. A surge in new money – driven by buoyant markets in China, Africa, the US, Latin America and India – defied media predictions that investment would be choked off by falling oil, gas and coal prices. Against that, VC/PE investors in renewables had to ply their trade against the backdrop of a skittish stock market unlikely to be conducive to exits.

FIGURE 49. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY STAGE, 2015, AND GROWTH ON 2014, $BN



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

Source: Bloomberg New Energy Finance, UNEP

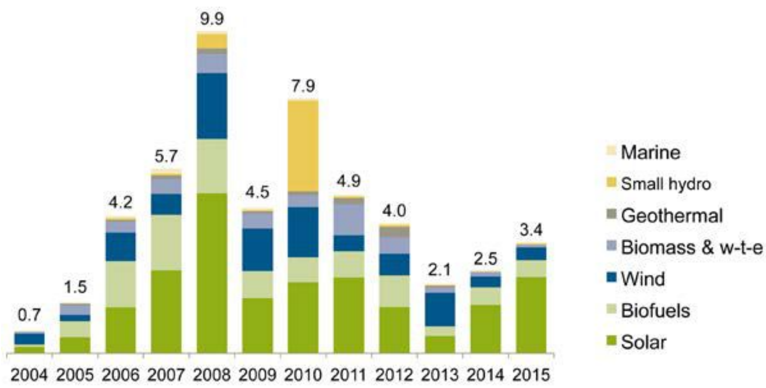
A closer look at VC/PE deals by type, as shown in Figures 48 and 49, reveals modest increases across all three main categories – early and late-stage VC and PE – albeit from low bases for each. Investment in seed and early-stage venture capital investments (Series A and B rounds) recovered to $384 million, having fallen to around $240 million in both 2013 and 2014. This 2015 figure was still only about half the average of the last decade.

Investment in later-stage venture capital (Series C, D and pre-IPO rounds) also rose, ending the year one-third higher at $923 million, having fallen as low as $535 million in 2013. However, the biggest improvement in 2015, at least in dollar terms, was the $500 million jump in private equity commitments to $2.1 billion, its highest level since 2011.

As in previous years, solar companies led the field (see Figures 50 and 51). The $2.4 billion in VC and PE funding commitments for solar was the most seen since 2008, and represented an increase of almost $1 billion on 2014. This was the only sector to see a major improvement – biofuel trailed a distant second with just $523 million, unchanged on the previous year, while investment in wind increased slightly to $390 million. Biomass and waste-to-energy, though it garnered less than $100 million, was still ahead of small hydro, geothermal and marine, which produced a handful of small deals each.

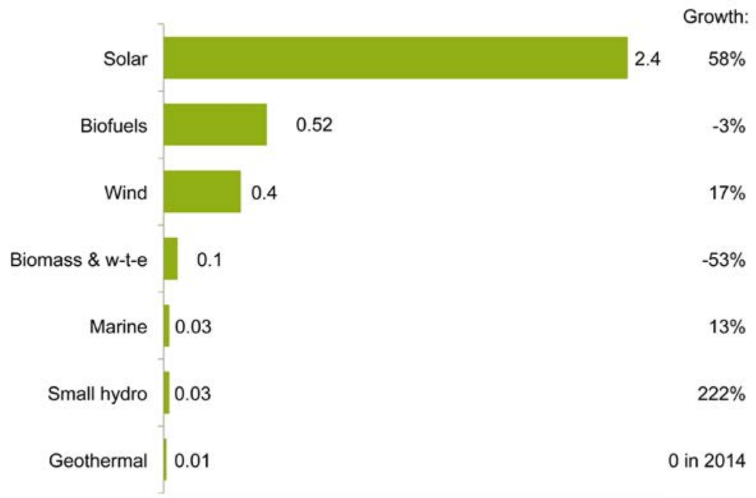
The falling cost of solar panels over the last few years has dramatically increased the number of potential users of that technology. As a result, venture investors have shifted their focus away from improving the performance of hardware, to technologies that are designed to help make solar available to new markets and previously unreachable sections of society. Fenix International, for instance, raised $12.6 million in Series B funding to help it supply mobile-enabled solar systems to off-grid communities in Africa.

FIGURE 50. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY SECTOR, 2004-2015, $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, 2015, AND GROWTH ON 2014, $BN



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

"ReadyPay Solar is an innovation at the intersection of renewable energy, mobile communications and microfinance that empowers East Africa residents to light their homes, grow their businesses and improve their quality of life," said Fenix International founder and CEO Mike Lin. The deal also illustrates the importance of corporate venturing in getting renewable start-ups off the ground. Investors in the Fenix Series B funding round included GDF Suez, operator of Europe's biggest natural-gas network and now renamed Engie, plus power management firm Schneider Electric and telecoms giant Orange.

Boston-based Yeloha is also about enabling access, but in the developed world. The company secured

$3.5 million in Series A funding to launch an online platform that enables people who cannot put up their own panels (such as residents of an apartment block) to buy solar energy through an online subscription. The power they buy is supplied by 'sun hosts' who receive free installation of solar panels in return for sharing access to the energy they generate.

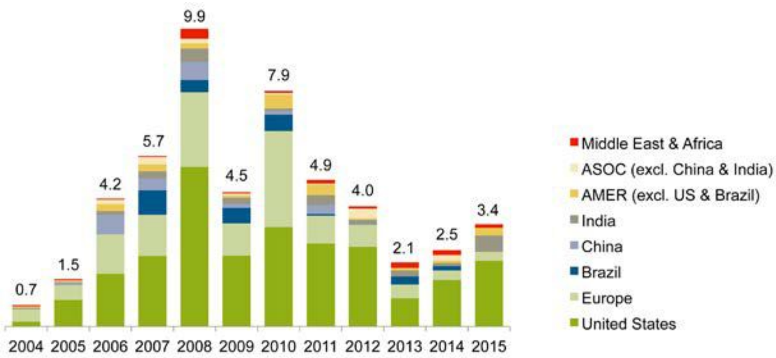
Software is also being used to help reduce the cost of solar installations. Twitter co-founder Evan Williams, for instance, committed $3.5 million of Series A funding to US-based Sighten through his venture capital firm Obvious Ventures. The company has developed a platform for solar developers and financiers to help reduce 'soft costs' such as administration, processing, sales leads and customer relations, which it says are the priciest single part of installations in the US residential solar market.

Private equity players continue to be interested in the fast-growing US solar market, but unlike venture investors they are mainly focused on backing the many residential solar companies that have sprung up in recent years. Sunnova Energy, for instance, closed a $300 million debt and equity funding round led by Franklin Square Funds in 2015. The company provides third-party financing for solar leases or power purchase agreements through a network of local solar installers.

Third-party ownership remains the dominant model for financing residential solar installations in the US, but that is changing. Direct ownership via loans is gaining popularity as costs continue to fall and financing options improve. One such loan provider is New Jersey-based company Sunlight Financial. It secured PE expansion capital of $80 million from Hudson Clean Energy Partners, an existing investor, and new backer Tiger Infrastructure Partners, as well as $220 million in debt finance.

The great quest within the biofuel sector remains the production of commercial volumes from non-food crops or waste that can compete with sugar or corn-based ethanol and conventional fuels. One of the major challenges facing developers of conversion technologies is financing. The fall in the price of oil over the course of 2015, uncertainty on policy in the US, as well as the length of time and money needed, have deterred all but a

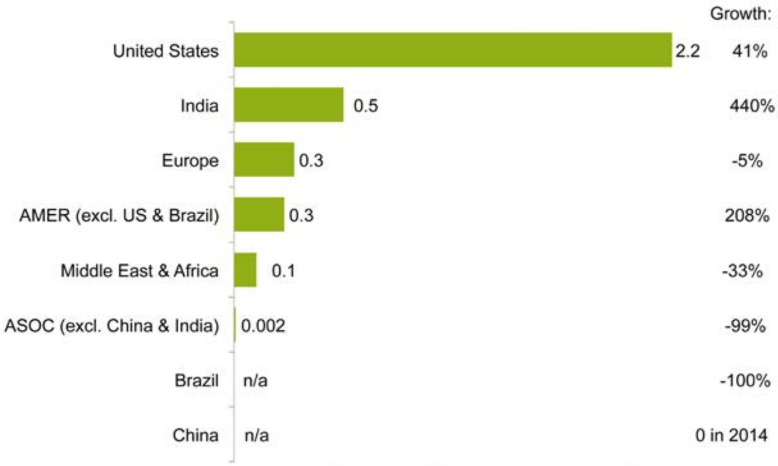
FIGURE 52. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2004-2015, $BN



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

Source: Bloomberg New Energy Finance, UNEP

FIGURE 53. VC/PE NEW INVESTMENT IN RENEWABLE ENERGY BY REGION, 2015, AND GROWTH ON 2014, $BN



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

Source: Bloomberg New Energy Finance, UNEP

few investors. It is significant that the four main cellulosic ethanol plants in the US were developed by large corporations such as DuPont, which commissioned a 30 million-gallon facility in 2015.

Nevertheless, there were a few private equity investments in the next-generation biofuel sector last year. In one such deal, Enerkem, a Quebec-based company that produces cellulosic bioethanol from non-recyclable household waste, secured $115.4 million to fund a methanol-to-ethanol unit at its production facility in Edmonton. Key to the project's viability is the CAD 75 that the city will pay Enerkem for every tonne of municipal waste it uses, plus the fact that the city has agreed to maintain the supply of waste for 25 years. The company has plans to develop a similar project in Montreal.

2015 also saw the largest single investment by an airline in a renewable fuels company. United Continental Holdings, owner of the world's second-biggest airline, invested $30 million in Fulcrum BioEnergy, a producer of jet fuel and renewable diesel from household waste. It is thought that the company will begin supplying United as early as 2018, with deliveries increasing to 90 million gallons (340 million litres) annually by 2021. The target, enough for about 20,000 flights, would be the equivalent of approximately 2% of the 3.9 billion gallons the carrier used in 2014.

The wind sector took $390 million in VC/PE in 2015, more than half of which was invested in a single deal. London-based private equity firm Actis created Ostro Energy, an Indian wind developer, with an investment of $230 million. It is already building a 50MW wind project in Rajasthan and aims to provide 800MW of capacity across several Indian states by 2019. The investment took place against a backdrop of pro-renewable policies introduced by India's BJP government. These include a target to almost-triple wind capacity to 60GW by 2022.

Venture capital investment in new wind technology is something of a rarity, given that it is a mature energy source and most R&D is undertaken in-house by the large turbine manufacturers. In early 2015, however, French start-up Ideol, a designer of floating foundations for offshore wind farms, received $4.4 million in a second seed funding

round. The company recently signed a deal with the China Steel Corporation, the largest integrated steel maker in Taiwan, to jointly develop turbines using Ideol's technology.

The distribution of VC/PE investment is shaped by, among other things, national renewable energy policies and countries' changeable economic fortunes. While the US remains the spiritual home of the venture capital and private equity investor – the country accounted for 65% of the global total in 2015, a 38% increase on the year before – there has been a marked decline in Europe since 2012, as shown in Figures 52 and 53. At the same time, there has been a rise in venture investing in Asia.

These trends are part of a wider picture, rather than something specific to renewable energy. The US deployed a total of $58.8 billion of early-stage finance across all sectors in 2015, which was the second highest full year total of the last 20 years, according to a report by PwC and the US National Venture Capital Association. Asia is occupying an ever-larger share of the market – for the first time ever, Greater China recorded more deals in a year than Europe. India, meanwhile, produced 927 deals, according to Preqin, almost twice the number seen in 2014.

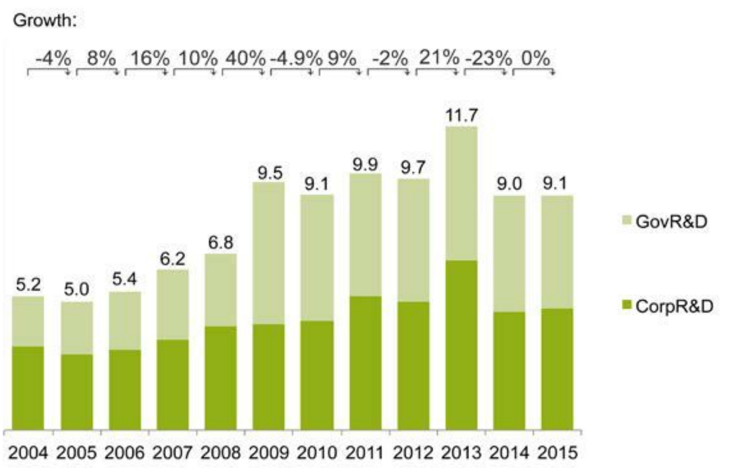
Indian renewable energy companies attracted $548 million in VC/PE funding in 2015, more than all of Europe ($301 million) and second only to the US. This was up sharply on the previous year thanks to two large deals – the $230m investment in Ostro and a $165 million private equity investment in Welspun, a New Delhi-based wind developer. While two big deals do not make a trend, the signs are that more will follow. Significantly, India made a commitment at the Paris climate conference in November 2015 to raise the share of non-fossil-fuel power capacity in the country's power mix to 40% by 2030, from its current level of 30%.

RESEARCH AND DEVELOPMENT

- Research and development spending on renewable energy technologies was almost unchanged at $9.1 billion in 2015, in spite of falling fossil fuel prices and policy instability during the year. But it was 23% below its 2013 high of $11.7 billion.
- Government R&D was 3% lower than in 2014 at $4.4 billion, but the fall was just offset by a 3% rise in corporate R&D to $4.7 billion.
- China's R&D spending challenged Europe's for the first time, each investing $2.8 billion. Spending in Europe fell 8% compared to 2014 while that in China rose 4%. In third place, the US edged up 1% to $1.5 billion.
- Solar continues to dominate renewable energy R&D, with spending rising 1% to $4.5 billion and equal to that in all the other sectors combined. Solar secured two and a half times as much investment as wind, at $1.8 billion, unchanged on 2014, and three times more than biofuels, at $1.6 billion, down 3%.
- The year ended on a high note at the Paris climate conference as governments and billionaire investors announced two major initiatives to raise investment in clean energy R&D.

Investment in renewable energy research and development held up in 2015 in spite of some significant headwinds, including falling fossil fuel prices and some reduction in policy support. The collapse in the oil price – from $115 per barrel in June 2014 to just $27 by the end of 2015 – was directly relevant only to the biofuel sector, but natural gas prices also fell – the US Henry Hub benchmark dropped from $4.70/MMBtu to $2.34/MMBtu over the same period – stiffening the competition for wind and solar too. At the same time, there was a broader move away from subsidies for renewable generation and towards auctions, which in countries such as Britain, Germany and South Africa squeezed prices lower than under the previous systems.

FIGURE 54. R&D INVESTMENT IN RENEWABLE ENERGY, 2004-2015, $BN



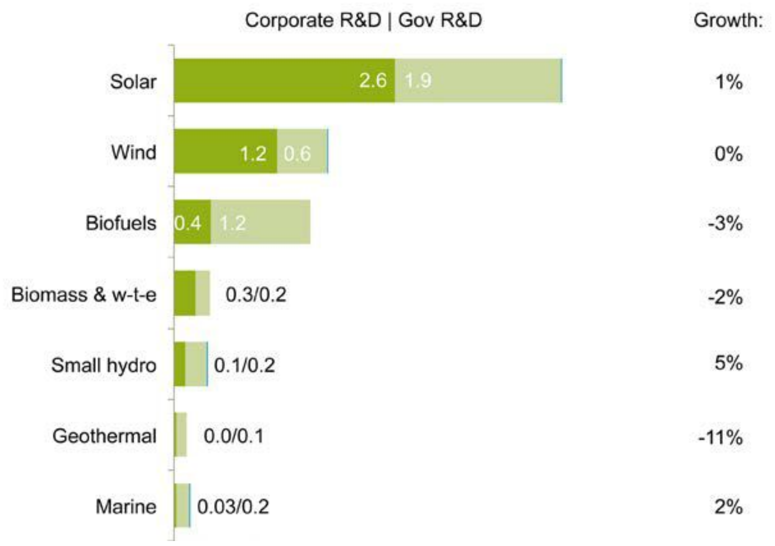
Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

Despite the more challenging backdrop, total spending on renewable energy R&D remained steady at $9.1 billion, as shown in Figure 54, although 23% lower than its 2013 peak of $11.7 billion, which was largely caused by higher investment in solar R&D in Europe. R&D investment in individual sectors also changed by only small percentage figures compared to

the previous year, as shown in Figure 55.

Note that the 2014 R&D figures shown in this report show a significant downward revision from those published in the 2015 edition of Global Trends in Renewable Energy Investment. This reflects the improved information that became available during the course of last year on both government commitments and research spending by specialist renewables companies. The trend, shown in Figures 54 and 55, now shows that there was a setback to R&D spending after 2013 – something that will concern those energy policy-makers and advisors who see research into new renewables technologies as vital in the battle to curb climate change. [1]

FIGURE 55. CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY TECHNOLOGY, 2015, AND GROWTH ON 2014, $BN

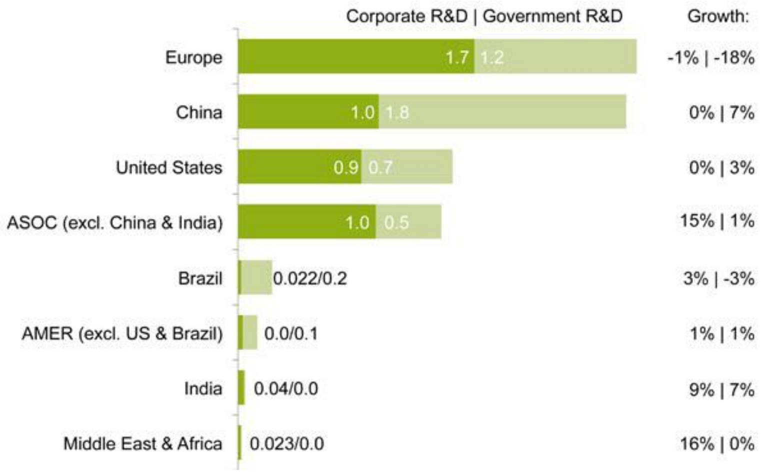


Source: Bloomberg, Bloomberg New Energy Finance, IEA, IMF, various government agencies

Beneath the relatively steady headline figures for 2015, there lie some more significant regional changes, as shown in Figure 56. China matched Europe's spending on renewable energy R&D for the first time, with the two territories both deploying $2.8 billion. In 2015, European research and development fell 8% and Chinese rose 4%, the latest step in a longer-term shift. European R&D spending last year was lower than in any year since the financial crisis in 2008, while China's new record was the result of a decade-long march in which R&D investment has risen every year since 2005. US spending was up 1% at $1.5 billion, but only half its

[1] The corporate R&D figures in this and previous Global Trends reports are those published by specialist renewable energy companies. In the case of most conglomerates and diversified industrial groups active in renewables, there is no disclosure on the proportion of R&D spent on clean energy as opposed to other sectors.

FIGURE 56. CORPORATE AND GOVERNMENT R&D RENEWABLE ENERGY INVESTMENT BY REGION, 2015, AND GROWTH ON 2014, $BN



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

level in 2009 at the peak of its "green stimulus" programme.

The other significant change was the growth of renewable energy R&D spending in areas beyond the traditional heavyweight regions, including India, where investment jumped 8%; in the "other APAC" region (Asia-Pacific excluding China and India), up 10%; and "other EMEA" (Africa and the Middle East) where it leapt 16%.

RESEARCH INITIATIVES

R&D spending remained below its 2013 levels last year, but there were some encouraging policy moves that could lead to higher commitments in the future. The US renewed its Investment Tax Credit (solar) and Production Tax Credit (wind) through to 2020, and also introduced a new Clean Power Plan designed to cut the country's generating emissions by 32% by 2030, while in India Prime Minister Narendra Modi committed the country to installing 100GW of solar by 2022. Both developments underpin the case for further R&D in renewable energy, but the biggest boost came at the end of the year during the Paris climate conference with the announcement of two major new initiatives.

US President Barack Obama launched Mission Innovation, an inter-governmental organisation of 20 countries intended to raise the pace of renewable energy innovation to match the scale of the challenge. Member countries – including Australia, Brazil, Canada, Chile, China, Denmark, France, Germany, India, Indonesia, Italy, Japan, Mexico, Norway, South Korea, Sweden, the UK, the US, United Arab Emirates and, surprisingly, Saudi Arabia – committed to double their clean energy R&D spending within five years. If members make good on this promise, government R&D on renewable energy alone could perhaps reach $10 billion by 2020.

At the same time, Microsoft founder Bill Gates launched a sister organisation aimed at tackling private sector barriers to R&D. The Energy Breakthrough Coalition is supported by high profile investors such as Vinod Khosla and George Soros, and plans to mobilise long-term capital to help commercialise the results of an expanded public sector R&D pipeline. The group will provide seed, angel and Series A investments in electricity generation and storage, transport, industry, agriculture and energy efficiency. The eventual size of the fund is unclear, but Gates has reportedly committed to invest $2 billion through the fund, and the University of California $1 billion.

While the arrival of a big new investor in early-stage clean energy technologies is of course most welcome, it is not yet clear how much impact the Energy Breakthrough Coalition will make, or whether renewables will receive the lion's share of its investments, as opposed to energy-smart technologies, nuclear, carbon capture and storage, or other low-carbon areas. The group seeks to back "truly transformative" novel technologies, whereas the day-to-day business of clean energy innovation is more prosaic – relentlessly to reduce costs so that renewables undercut fossil fuels in more and more locations, not simply the sunniest or windiest, where they are often already competitive. This sort of innovation has produced dramatic cost reductions over the past few years.

R&D PRIORITIES

Innovation can improve the competitiveness of renewable energy technologies either by cutting their capital cost, often by reducing the energy and raw materials required to produce them, or by raising their efficiency, so increasing the amount of energy produced by each nominal MW of capacity. Both approaches reduce the levelised cost of electricity, or LCOE, per MWh.

In solar, capital costs are being shaved at every stage of production. Silicon raw material is increasingly being produced through a new fluidised-bed reactor process that cuts the electricity required by three quarters and the cost by half. The widespread adoption of diamond wire saws allows manufacturers to cut the blocks of silicon into thinner wafers and also reduce the amount lost to 'kerf' or sawdust. Savings have also been generated by the introduction of stencil printing, which reduces the amount of silver required for the 'fingers' and 'busbars' that collect the electricity and feed it to external cables.

At the same time, design improvements are steadily raising the efficiency of solar PV. One example is the widespread switch to producing cells with four busbars, rather than two or three, so reducing electrical losses. Another is the introduction of 'black silicon' anti-reflective coatings based on the nano-structure of moth eyes, increasing the amount of sunlight converted into electricity. Yet another is the recently developed 'passivated emitter rear cell', or PERC, technology, which helps reduce the amount of energy lost to the unwanted 'recombination' of electrons.

These kinds of developments have reduced the cost of solar modules by four fifths since 2008, with the promise of more to come. Bloomberg New Energy Finance forecasts that the average cost of crystalline silicon cells will fall by well over a third over the next decade, from $0.47 per Watt in 2015 to $0.30 per Watt in 2025. Roughly half the reduction will be driven by a rise in efficiency, and half from capital cost reductions. As a result of this innovation, the research firm expects that by 2030 solar will undercut fossil electricity generation in all but the least promising locations.

In the wind sector, there have also been gains. In onshore wind, the LCOE has fallen by 14% over the past six years and is forecast to fall a further 18% over the next 10 years. Again, relentless innovation has delivered both reduced capital cost and higher efficiency. The load factor – the amount of energy produced as a percentage of nameplate capacity – continues to rise as technology improves, turbine heights grow, and operators optimise wind farm performance through 'big data' analysis. The average load factor of new wind farms has risen from less than 20% in 2008 to 25% in 2015, and is forecast to rise to 37% by 2025. [2]

A perennial target of wind R&D has been to reduce the weight of the nacelle at the top of the tower – because weight at the top requires the entire structure to be made with additional strong material, pushing up the expense. This imperative has produced a number of hybrid drive trains which reduce both weight and cost compared to conventional three-stage gearboxes. These include the HybridDrive system from Winergy, FusionDrive from Moventas and the Digital Displacement hydraulic system now integrated into the 7MW Mitusubishi Sea Angel turbine.

In offshore wind, the potential to reduce the capital cost of a turbine is somewhat limited by the fact that some its elements, such as 'monopile' or 'jacket' foundations, are mature technologies adopted from the oil and gas industry. Nevertheless, with advances expected in areas such as blade length, turbine size, and construction time, the LCOE of offshore wind is forecast to fall 30% over the next five years, from $176/MWh in 2015 to $122/MWh in 2020. [3]

One way to grow the offshore wind industry is to open new markets, particularly in those regions where sea depths make conventional fixed-bottom projects impossible. This requires the development of floating wind turbines. These are currently in their infancy, but R&D spending is now gathering pace. Some 15MW of floating capacity was installed worldwide at the end of 2015, with pilot projects installed or planned in Scotland, Portugal, Japan, France and Germany. Floating wind is still expected to be twice as expensive as conventional offshore in 2020, but supporters argue that the technology has inherent advantages that could make it cost-competitive. One is that since the turbines float, there is no need to design an individual foundation tailored to the condition of the seabed in each location, and entire wind farms could be built with a standardised substructure design. Another is the potential for dramatic reductions in the weight of those substructures; the Hywind 30MW demonstration array off Scotland, due to be completed in 2018, will be 74% lighter per MW than its first demonstration turbine in 2008. Yet another is that the turbine can be fully assembled at the dockside and towed into position without the need for expensive specialist installation vessels.

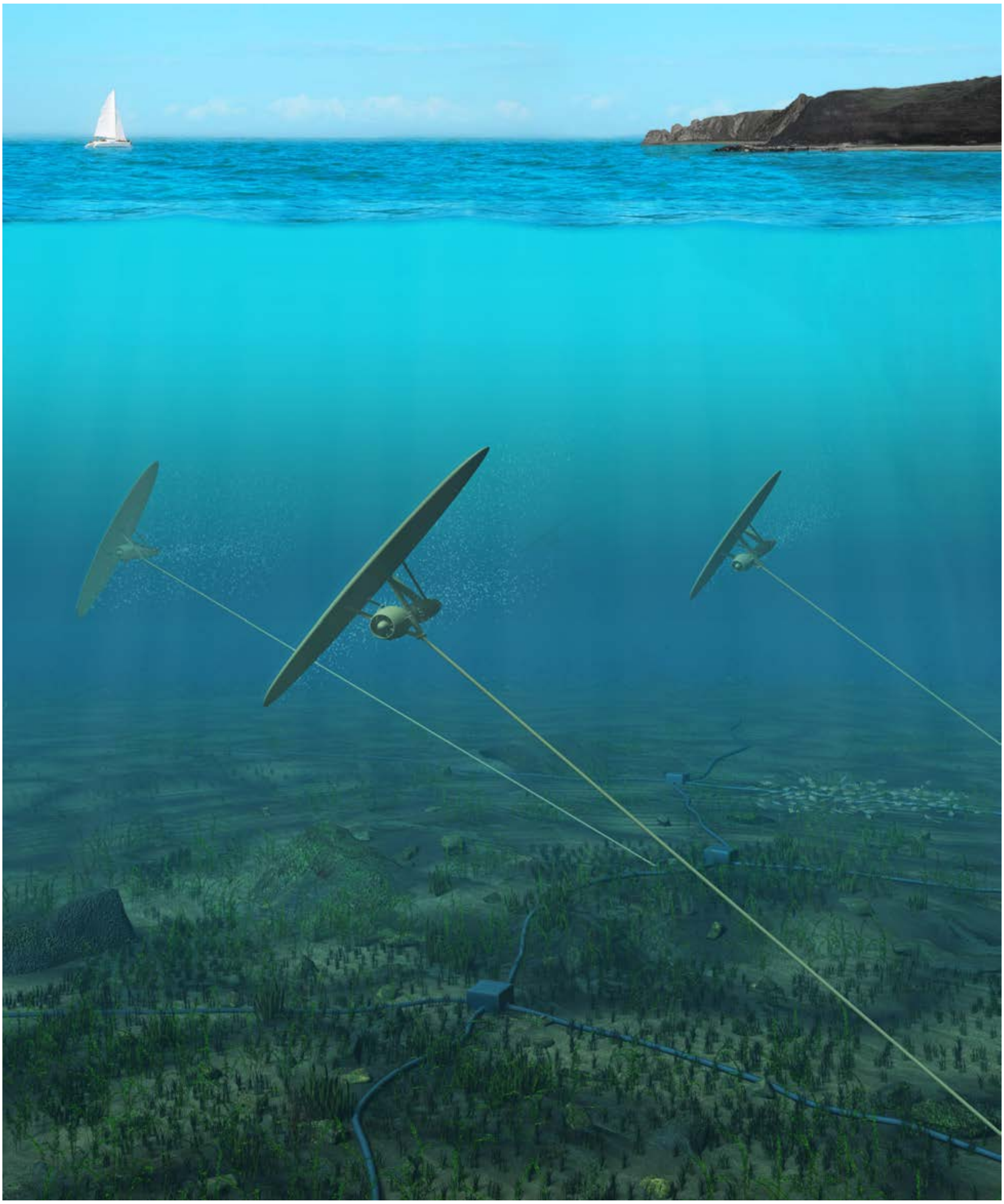
Investment in biofuels R&D fell just 3% in 2015, a resilient performance given their exposure to the collapsing oil price. In practice, the position of ethanol in countries such as the US and Brazil is safeguarded by blending mandates, but it would have been unsurprising if the fall in crude had led to some hesitation over biofuel research projects on the part of both companies and governments. Confidence was helped in the US in December 2015 by a statement from the Environmental Protection Agency announcing an unexpectedly high biofuel blending mandate for 2016.

For most of the year, however, the sector in the US faced conflicting regulations – the 10% 'blend wall' and the Renewable Fuel Standard (RFS2) biofuel production mandates – that pitted pit (non-food) cellulosic ethanol against a glut of cheaper corn ethanol. In recent years this has forced second-generation biofuel developers such as Amyris, Solazyme and Gevo to focus on biochemicals, where they are potentially more competitive. As a result, three quarters of the way through 2015, US cellulosic ethanol production capacity was just 86 million gallons, and actual production only 1.6 million gallons. Bio jet-fuel was a relative bright spot, with US Department of Defense funding for the construction of production plants by companies including Fulcrum Bioenergy, Emerald Biofuels and Red Rock with a total capacity of 100 million gallons.

Marine energy continues to be another area for busy entrepreneurial and R&D efforts. Bloomberg New Energy Finance estimates that specialist wave and tidal stream technology companies have had

[2] Bloomberg New Energy Finance, Research Note: The future cost of onshore wind, 9 October 2015.
[3] Bloomberg New Energy Finance, Research Note: Route to offshore wind 2020 LCOE target, 20 August 2015.

cash burn of nearly $1.2 billion, either recorded as accumulated losses or as capitalised R&D. [4] Not all of that spending has been successful: for instance, three wave companies (Oceanlinx, Pelamis Wave Power and Aquamarine Power) went out of business in 2014-15 having spent more than $100 million each. In general, tidal stream technology has advanced further and faster than wave, to the point where companies such as Atlantis Resources and OpenHydro were hoping to complete the installation of demonstration arrays of several megawatts during the course of 2016.



[4] Bloomberg New Energy Finance, Research Note: Analyst Reaction Tidal and wave H1 2016 – the gulf widens, January 2016.

ACQUISITION ACTIVITY

- Acquisition transactions in renewable energy jumped to a record $93.9 billion in 2015, up 7% on the previous year, a sign of how large the sector has grown in terms of both annual sales and installed capacity.
- Corporate mergers and acquisitions were worth $19.2 billion, some 63% higher than in 2014 and the highest figure since the record year of 2011.
- The largest category of acquisition activity was, as usual, asset purchases and refinancings. These totalled $69.3 billion in 2015, down 3% from the all-time high reached the previous year.
- Private equity buy-outs came to $3.5 billion, some 36% higher than in 2014 and the biggest tally since the record year of 2009.
- The only category not to show relative strength last year was public market investor exits, which were worth $1.8 billion, just 1% up on 2014 and less than half the figure reached in 2010.
- The biggest individual deals involving the purchase of pure-play renewable energy assets and companies included Macquarie's $2.7 billion takeover of E.ON's Spanish and Portuguese clean power businesses; and yieldco TerraForm Power's $2 billion acquisition of more than 90% of the 1GW North American wind portfolio of Invenergy.

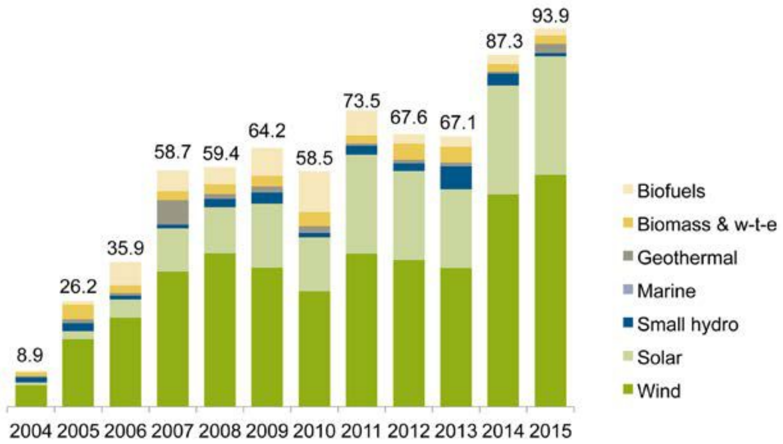
Figure 57 shows a strong upward trend in acquisition activity in renewable energy, the total rising just over 10 times from 2004's $8.9 billion, to the record $93.9 billion seen in 2015. In a sense, this is to be expected – the sector has grown strongly over that 12-year period, with new investment multiplying nearly sixfold and cumulative installed GW capacity more than sevenfold in the case of wind (to 426GW), and from almost zero to nearly 240GW in the case of solar. More projects operating, and higher annual sales, mean greater opportunities for asset owners to consolidate portfolios and for manufacturers to look to build revenue and profits by taking over rivals.

Wind is still the largest sector for acquisition transactions, as Figure 58 shows. In 2015, wind assets and companies worth an estimated $57.6 billion were subject to purchase, the largest figure ever and up 9% on the previous year. A big majority ($42.9 billion, down 9%) was made up of asset

FIGURE 57. ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY TYPE, 2004-2014, $BN

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

FIGURE 58. ACQUISITION TRANSACTIONS IN RENEWABLE ENERGY BY SECTOR, 2004-2015, $BN



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

transactions, but the piece that grew most sharply in dollar terms in 2015 was corporate M&A, up 161% on the year at $10.7 billion, the third highest figure ever for wind. Public market exits and private equity buy-outs were up more than 100%, but to totals of just $1 billion and $3 billion respectively.

Solar was the only other sector seeing acquisition deals of more than $3 billion. Its total for 2015, of $29.4 billion, was up 9% and a record figure. This was dominated by the purchase of solar farm assets, some 16% higher at $23.7 billion. Corporate M&A in solar fell 12% to $4.4 billion, while public market exits and PE buy-outs both came to less than $1 billion.

Among the other sectors, geothermal saw acquisition activity worth $2.2 billion, up fivefold from 2014 and the second highest figure ever, behind only 2007. Corporate M&A dominated the 2015 total, with a tally of $1.8 billion, up from almost nothing in 2014. Biomass and waste-to-energy produced acquisition deals worth $2.1 billion, up 10% on the previous year, while biofuels generated transactions worth $1.7 billion, down 24% and the lowest total since 2005.

CORPORATE M&A

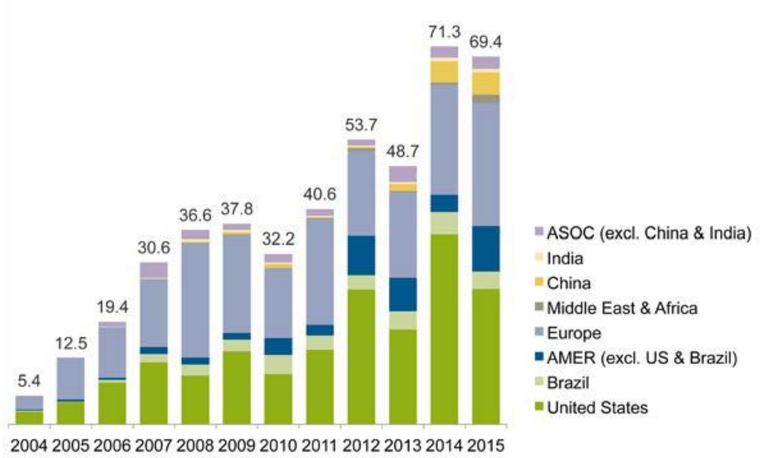
Takeovers were in the air in the renewable energy sector in 2015, with events such as the completion of General Electric's $9.5 billion purchase of the energy business of French group Alstom, and German wind turbine maker Nordex's plan to buy the wind business of Spain's Acciona for $880 million. There was also Enel's bid late in the year to buy out the minority shareholders in its Enel Green Power offshoot for $3.3 billion, and SunEdison's $1.9 billion purchase of fellow US company Vivint Solar.

However, none of these four made it into the corporate M&A figures for 2015 – GE/Alstom because it involved gas, coal and nuclear turbines and grid businesses as well as wind and hydro, and Nordex-Acciona, Enel-EGP and SunEdison-Vivint because they did not complete in the calendar year.

Instead, the 2015 data are dominated at the top end by M&A deals for project-related businesses, such as Macquarie's $2.7 billion takeover of E.ON's Spanish and Portuguese clean power businesses, the $1.9 billion purchase of US project developer First Wind Holdings by SunEdison and TerraForm Power, and First State Wind Energy Investments' $956 million deal to buy Finerge-Gestao de Projectos Energeticos, a Portguese operator of wind farms and co-generation plants.

The First Wind transaction was particularly noteworthy, since it brought a solar developer and polysilicon maker (SunEdison) with 1.6GW under its belt into the wind business. Part of the motivation for the move was to accelerate the growth of SunEdison's yieldco spin-off, TerraForm

FIGURE 59. ASSET ACQUISITIONS AND REFINANCINGS BY REGION, 2004-2015, $BN



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

Power, by handing it the operating-stage assets of First Wind. The move also gave SunEdison itself a portfolio of wind farm development assets adding up to more than 1GW.

In the category of more classical M&A, there was a slew of interesting transactions completed, mostly in the hundreds of millions of dollars rather than larger. These included China-owned Bluestar Elkem Investment's purchase of Singapore-based PV panel manufacturer REC Solar for $462 million, Motech Industries' takeover of Taiwanese PV cell maker Topcell Solar, and Bluewater Power Distribution's acquisition of Unconquered Sun Solar Technology, a Canadian lightweight PV panel maker, both of the last two for undisclosed sums.

One transaction with particular symbolic significance was the purchase by Engie, the newly renamed French gas and electric utility GDF Suez, of Solairedirect, a Paris-based solar project developer, for $223 million. The move was part of Engie's plan to double renewable energy capacity in Europe within a decade, and to expand in emerging markets. Engie's chief executive, Gerard Mestrallet, greeted the Solairedirect transaction with the words "solar is becoming totally competitive". In its statement two months earlier, announcing the change of company name, Engie said: "The energy transition has become a global movement, characterised by decarbonisation and the development of renewable energy sources, and by reduced consumption thanks to energy efficiency and the digital revolution."

PROJECT ACQUISITIONS

Of the $69.4 billion of asset acquisitions and refinancings last year, some $42.9 billion were for projects in the most mature technology, wind, some 9% down in the 2014 figure. There were $23.9 billion in solar, up 16%, and the only other renewable energy technology excluding large hydro to see asset deals of more than $1 billion was biomass and waste-to-energy with $1.2 billion, down 13% on the 2014 figure.

Europe saw a 12% increase in asset acquisitions and refinancings in 2015, to $23.2 billion – nearly catching up the US figure of $25.6 billion, down 28% on the year. The next largest regions for these transactions were the Americas excluding the US and Brazil, up 160% at $8.5 billion; China, up 5% at $4.2 billion; and Brazil, down 22% at $3.3 billion. See Figure 59.

The largest deals were scattered through different developed economies, and included yieldco TerraForm Power's $2 billion acquisition of 91% of the 1GW North American wind portfolio of Invenergy, and Blackstone's $1.1 billion refinancing of its 288MW Meerwind Sud und Ost offshore wind farm phase one in German waters. The latter was particularly significant as it was by far the largest renewable energy project bond issue in Europe in recent years – coming after a period in which project bonds have been commonplace in the US but hardly used at all on the other side of the Atlantic.

Overall, there were 599 asset acquisitions and refinancings logged in renewable energy in 2015. Many of these were relatively small, and there was a big representation of projects bought at the operating stage by North American yieldcos or their London-based equivalents, quoted project funds.

OTHER TYPES OF ACQUISITION

The biggest public market investor exits of 2015 also had a strong yieldco flavour – the sale by Actividades de Construccion y Servicios, or ACS, of 51% of its project-owning arm, Saeta Yield, to stock market investors for $503 million; and the $328 million sale of a stake in Abengoa Yield by its former parent, Spanish infrastructure company Abengoa.

The top private equity buy-out of the year was Suzlon Energy's sale of its Germany-based wind turbine manufacturing arm, Senvion, to Centerbridge Capital Partners for $1.2 billion.

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 or may not be commissioned in the same year.
CAPITAL EXPENDITURE	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.
FEED-IN TARIFF	A premium rate paid for electricity fed back into the electricity grid from a designated renewable electricity generation source.
FINAL INVESTMENT DECISION	Moment at which the project developer, or group of investors and lenders, decide that the investment will definitely go ahead. The asset finance figures in this report are based on money committed at the moment of final investment decision.
GREEN BOND	A bond issued by a bank or company, the proceeds of which will go entirely into clean energy and other environmentally-friendly projects. The issuer will normally label it as a green bond.
INITIAL PUBLIC OFFERING (IPO)	A company's first offering of stock or shares for purchase via an exchange. Also referred to as "flotation".
INVESTMENT TAX CREDIT (ITC)	Allows investment in renewable energy in the US to be deducted from income tax.
LEVELISED COST OF ELECTRICITY (LCOE)	The all-in cost of generating each MWh of electricity from a power plant, including not just fuel used but also the cost of project development, construction, financing, operation and maintenance.
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.
ON-BALANCE-SHEET FINANCING	Where a renewable energy project is financed entirely by a utility or developer, using money from their internal resources.
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.
TAX EQUITY	Tax equity investors invest in renewable energy projects in exchange for federal tax credits.
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.

[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.

THE UNITED NATIONS ENVIRONMENT PROGRAMME

The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system and serves as an authoritative advocate for the global environment. Established in 1972, UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP
United Nations Environment Programme

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