INVESTMENT OVER THE DECADE 2010-2019

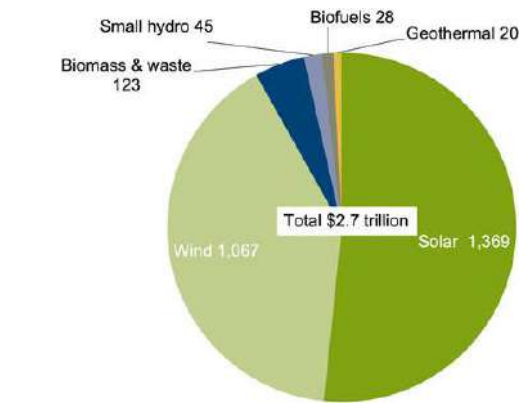
Last year's Global Trends report included a Focus Chapter looking at the likely outturn for investment in renewable energy capacity over the decade that was just ending. Here, we can revise those figures to take account of how 2019 finished up.

Figure 19 shows that nearly $2.7 trillion was invested globally in renewables excluding large hydro over the 2010-2019 period. This was more than three times, and possibly four times, the equivalent amount invested in 2000-2009 (data for the years 2004-2009 are available but not those for 2000-2003).

Solar was comfortably the largest recipient of finance for new projects in the decade just finished, attracting nearly $1.4 trillion, while wind took nearly $1.1 trillion. Biomass and waste-to-energy received $123 billion, small hydro $45 billion, biofuels $28 billion, geothermal $20 billion and marine less than $400 million.

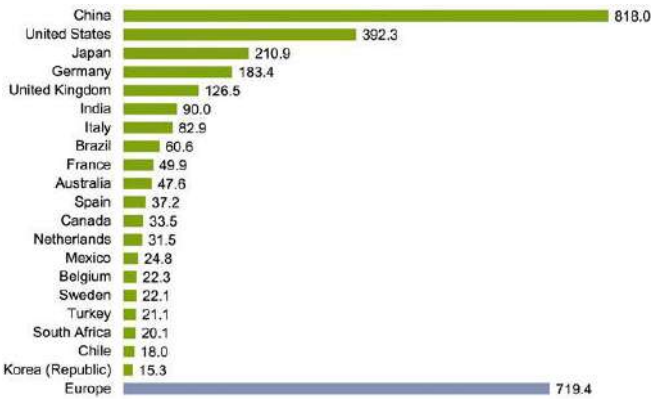
The decade saw no fewer than 72 countries each invest more than $1 billion in 'new renewables', and 26 of these invested more than $10 billion. Figure 20 shows the top 20 markets, ranging from China at a total of $818 billion to South Korea at $15.3 billion. Ironically, the top three countries – China, the U.S. and Japan – have all been criticized at times for not doing enough to decarbonize quickly. This table shows that they pumped $1.4 trillion between them into green energy over 2010-2019.

FIGURE 19. RENEWABLE ENERGY CAPACITY INVESTMENT OVER THE DECADE, 2010-2019, $BN



Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

FIGURE 20. RENEWABLE ENERGY CAPACITY INVESTMENT FROM 2010 TO 2019, TOP 20 MARKETS, $BN



Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

Europe invested $719.4 billion in renewables excluding large hydro during the decade, putting it about $100 billion behind China but more than $300 billion ahead of the U.S. Within Europe, Germany was by far the largest destination for investment dollars, at $183.4 billion, followed by the U.K. at $126.5 billion.

CAPACITY INVESTMENT – GLOBAL

- Global investment in new renewable energy capacity (excluding large hydro-electric projects) was $282.2 billion in 2019, up 1% on the previous year, thanks to a jump in spending on small-scale solar systems.
- Asset finance of utility-scale projects fell 5% to $230.1 billion, the lowest figure for any year since 2014. This was despite a late rush in offshore wind financings in the final quarter of the year.
- Investment in small-scale solar projects of less than 1MW leapt 37% to $52.1 billion, helped by the increasing cost-effectiveness of electricity from commercial and residential systems in key markets such as the U.S., China, Brazil, the Netherlands and Germany.
- Global offshore wind financings increased 19% to a record $29.9 billion last year. There was a rush of projects going ahead in Chinese waters to take advantage of a soon-to-expire feed-in tariff, together with the first financial close in France, and three large Taiwanese deals.
- Investment in onshore wind advanced 2% to $108.3 billion, the highest ever, with the U.S. one of the busiest markets as developers sought to qualify projects for the Production Tax Credit.
- However, investment in solar PV globally slipped 6% to $126.5 billion on a combination of slowdown in China and further reductions in unit costs.
- The biggest asset financing of the year came in solar thermal, in the shape of a $3.9 billion equity and debt package for the 700MW Al Maktoum IV trough and tower complex in Dubai. The project also has a 250MW photovoltaic component. Together, the two represented the largest ever non-hydro renewable energy project financing.
- Last year produced runaway records for the amount of green power capacity auctioned by governments around the world, at 78.5 gigawatts; and for the amount of capacity covered by corporate power purchase agreements, or PPAs, at 19.5GW.

Chapter 1 discussed the headline trends in the financing of renewable energy worldwide in 2019, and over the last decade. This chapter looks at the same subject in more detail, exploring the balance between utility-scale projects and small systems, the split between individual technologies, the modes of finance used, the role of government auctions in setting tariffs, and the importance of decisions made by private companies to buy green power.

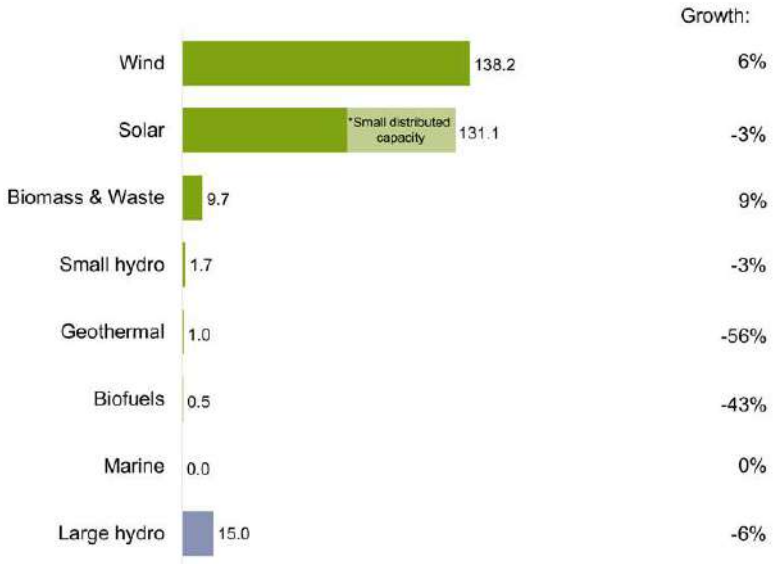
The following two chapters (3 and 4) look at the geographical profile of capacity investment, highlighting the particular issues affecting activity in all the different major markets.

TECHNOLOGY SPLIT

Figure 21 shows the year-on-year change in renewable energy capacity investment worldwide, with two additional elements. One is the split in solar between utility-scale projects of more than 1MW, at $79 billion, and spending on small distributed PV systems.

In 2019, overall solar capacity investment slipped 3% globally to $131.1 billion, but within this utility-scale asset finance dropped 19% – due in large part to a sharp slowdown in the financing of PV projects in China. However, money committed to small-scale solar systems around the world, including commercial and residential installations, jumped 37% to $52.1 billion, its highest

FIGURE 21. RENEWABLE ENERGY ASSET FINANCE AND SMALL DISTRIBUTED CAPACITY INVESTMENT BY TECHNOLOGY, 2019, AND GROWTH ON 2018, $BN



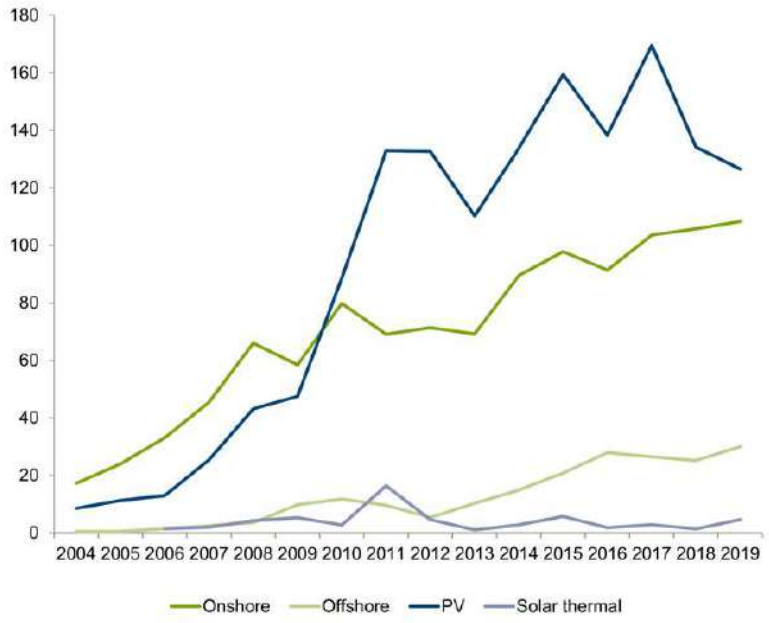
Total values include estimates for undisclosed deals. Small distributed capacity consists of solar systems of less than 1MW.

Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

level since 2012. The latest declines in the cost per MW of small solar systems made them more cost-competitive, and are discussed later in this chapter.

Figure 21 also puts activity in "new" renewables such as wind and solar into perspective compared to that in the oldest low-carbon power generation option, large hydro-electric dams. These hydro projects (of more than 50MW) are outside the scope of this report, for reasons stated in the box at the end of this chapter. Nevertheless, the chart here illustrates that, even if they were included, their level of investment in 2019 would be dwarfed by that in wind and solar.

FIGURE 22. NEW INVESTMENT IN WIND AND SOLAR PROJECTS WORLDWIDE, BY SUB-SECTOR, 2004-2019, $BN



Total values include estimates for undisclosed deals.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

What is also clear from Figure 21, however, is that other sectors of renewable energy (apart from wind and solar) attracted few capital spending commitments in 2019. Small hydro projects of less than 50MW and geothermal plants saw investment of $1.7 billion and $969 million respectively, well down on historic peaks in 2011 ($7.3 billion for small hydro, $3.1 billion for geothermal). Marine energy continued to languish, with wave power still to solve technology challenges and megawatt-scale tidal stream projects blocked by lack of specific policy support in the key markets of the U.K. and France. Biofuels saw capacity investment of just $500 million, far below the peak of $22.9 billion way back in 2007, as the industry stagnated without fresh government purchasing mandates.

Only biomass and waste-to-energy of the smaller sectors enjoyed significant investment in 2019, at $9.7 billion, up 9% on 2018. This was in line with its five-year average, albeit well down on the 2011 peak of $16 billion. Waste-to-energy is the more dynamic part of this sector, with projects worth several hundred million dollars each reaching financial close in countries such as China and the U.K.

The split between onshore and offshore wind, and between photovoltaics and solar thermal (also known as concentrated solar power, or CSP) is shown in Figure 22. Offshore wind saw investment surging 19% to a record $29.9 billion in 2019. Behind this was a fourth-quarter rush of deals, including one in U.K. waters but also the first financial close in the French offshore program and a third transaction in Taiwan's, to add to two earlier in the year. But the biggest factor was a stampede of mainland China offshore wind projects, brought to financial close in order to qualify for a feed-in tariff soon to expire.

Onshore wind investment edged up 2% to $108.3 billion in 2019, also an all-time high. The two main reasons for this were a 7% advance in deal volume in China to $41 billion, and a 42% leap in U.S. financings to $31.5 billion – the latter to take advantage of the Production Tax Credit incentive, which was due to finish its qualifying period at the end of 2019. Further discussion of the dynamics in both countries is featured in Chapters 3 and 4.

PV continued to dominate solar investment, as the cheapest option by far, and also the simplest. Dollars committed to it worldwide slipped 6% to $126.5 billion, with the biggest factor being a 32% slump in investment in China as that country's government limited access to its feed-in tariff. On the other hand, investment in PV in Europe gained 25%, partly due to the spread of subsidy-free projects backed only by private sector power purchase agreements.

Solar thermal investment roared up by an eye-catching 256% to $4.6 billion, its highest since 2015. Most of this was thanks to the go-ahead on the $3.9 billion solar thermal portion of the Al Maktoum IV complex in Dubai – discussed further below, and in Chapter 3.

ASSET FINANCE

This section looks specifically at aspects of the $230.1 billion financing of utility-scale renewable energy projects. A later section in this chapter covers the $52.1 billion of investment in small distributed solar capacity.

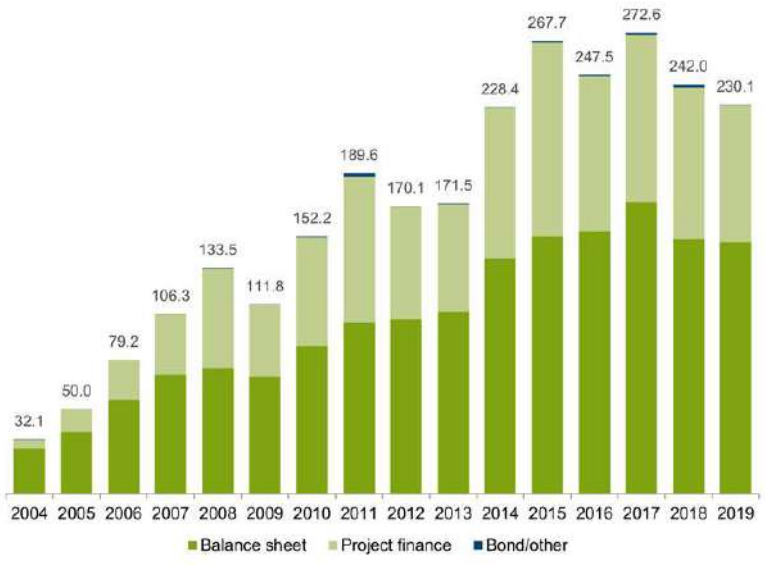
Figure 23 highlights the two main ways in which projects are financed – either on-balance-sheet by utilities, energy companies and developers, or on a non-recourse basis via a special purpose vehicle, or SPV, set up for that specific project (non-recourse project finance). In the first approach, the company or companies that own the project may raise bond or other debt finance to help pay for construction, but this will be done via their own corporate balance sheets. They will therefore bear the whole risk of project execution.

In the second approach, the developer is likely to own all or part of the equity in the SPV, but this will usually be supplemented by the raising of debt – so that only a proportion of the project risk will reside with the developer. In both cases, the project may well be refinanced once it is operational, since the financing terms available at this lower-risk stage of the life of a renewable energy plant are usually more advantageous than those available pre-construction. However, Figure 23 deals only with the financing mode used for construction, not the one used later in the operating phase.

In 2019, on-balance-sheet financing made up $148.6 billion, or 65%, of the renewable energy asset finance total of $230.1 billion, while non-recourse project finance accounted for $81.1 billion, or 35%. The bond/other category, which includes leasing, continued to be only a tiny proportion of the total, at $327 million last year significantly down on 2018's $2 billion.

The split between on-balance-sheet and non-recourse finance has always favored the former during the period since 2004. This is partly because many of the largest investors in renewables are utilities or independent power producers that prefer to take this approach for ease of execution, and then possibly refinance the project later. Also, the non-recourse structure that is very familiar in Europe, North America and China may be less easy to adopt in newer markets where risks are less well understood by domestic and international banks.

FIGURE 23. ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY BY MODE OF FINANCE, 2004-2019, $BN



Total values include estimates for undisclosed deals.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

FIGURE 24. LARGEST ASSET FINANCE DEALS IN RENEWABLE ENERGY IN 2019

Project	Country/market	Technology	MW	Estimated cost ($bn)
Al Maktoum IV tower and parabolic trough plant	United Arab Emirates	Solar thermal	700	3.9
EDF and ESB Neart na Gaoithe	United Kingdom	Offshore wind	432	3.4
Wpd & Starwind Yunlin	Taiwan	Offshore wind	640	3.0
Orsted Greater Changhua Portfolio	Taiwan	Offshore wind	900	2.7
EDF Enbridge Saint Nazaire	France	Offshore wind	480	2.5
Swancor & Macquarie Formosa II Miaoli	Taiwan	Offshore wind	376	2.0
SPIC Zhanjiang Xuwen	China	Offshore wind	600	1.5
Fujian Funeng & Haixia Power Generation Fuzhou Changle C	China	Offshore wind	500	1.5
Enercon Markbygden Phase II	Sweden	Onshore wind	844	1.1
SPIC Zhejiang New Energy Investment Zhoushan Shengsi 2#	China	Offshore wind	402	1.0
Haixia Power Fuzhou Changle A	China	Offshore wind	301	1.0
NBT Zofia Phase II and Phase III	Ukraine	Onshore wind	750	1.0
Fryslan	Netherlands	Offshore wind	383	0.9
Huadian Fuqing Haitan Haixia	China	Offshore wind	300	0.9

The table shows the largest deals on the basis of disclosed values, or BNEF estimates.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

Figure 24 shows the largest asset financings of 2019. Inevitably, the list does not give an accurate picture of the mix of investment overall, because it tends to favor those sub-sectors that typically have large investment volumes per project. Consequently, last year, there were 11 offshore wind arrays in the 14 top projects, due to the size of these investments, even though onshore wind and PV are both much larger than offshore in terms of global investment dollars allocated.

The biggest-ticket project reaching financial close in 2019 was the Al Maktoum IV solar thermal complex in Dubai, at $3.9 billion for 700MW, consisting of 100MW of tower technology and 600MW of the more established parabolic trough technology. Not shown in the list, because the BNEF database counts it as a separate project, is that Al Maktoum IV has a PV element – of 250MW and $400 million.

The overall package for Al Maktoum IV, at $4.3 billion, signed in March 2019, was the largest ever asset finance deal in solar, and the largest non-recourse project finance package in any renewable energy technology.

The list highlights the extent of the surge in offshore wind activity in East Asia. It includes the first three Taiwanese arrays to get financed, each of them involving a mix of local and European finance players. It also includes five projects from mainland China. Another 13 from there got the investment go-ahead in 2019, but were not big enough to get into Figure 24.

BECOMING 'BANKABLE'

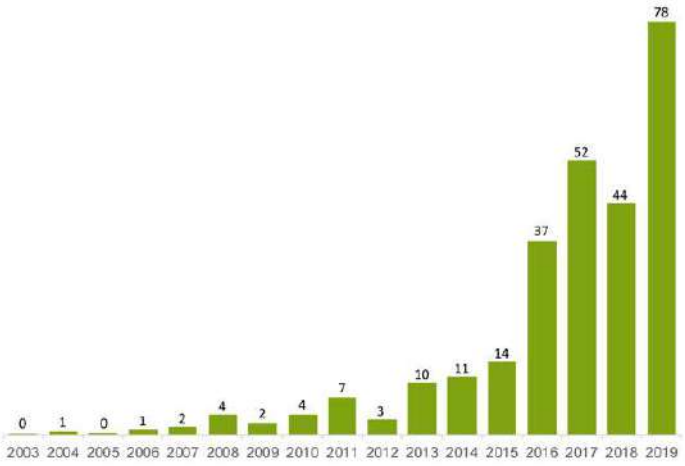
During the first half of the 2010-2019 decade, renewable power project developers relied almost exclusively on government-set incentives to secure their revenues, and become 'bankable' – in other words sufficiently predictable in their cash flows to convince lenders to provide debt.

These incentives came in three flavors: feed-in tariffs that locked in the price of electricity for projects for 10-20 years; green certificates that supplemented the income projects could get from selling electricity at market rates; and tax incentives that reduced the net capital costs of building new capacity.

As the costs of wind and solar power have fallen precipitously (see Chapter 1), the role played by these incentives has gradually faded. In 2019, they remained important in some markets – for instance, the feed-in tariff in China and the Production Tax Credit for wind in the U.S. In parallel, other ways of facilitating acceptable returns for renewable energy projects continued to grow in significance.

The first of these 'other ways' is the auction. As Figure 25 shows, the amount of renewable energy capacity winning fixed tariffs in government-run auctions has soared from just 2.8GW in 2012 (in early-adopter countries such as Brazil) to 44GW in 2018, and a runaway record of 78.5GW in 2019. The latter figure was equivalent to nearly half of the new renewable power capacity added worldwide last year.

FIGURE 25. GLOBAL AUCTIONED RENEWABLES CAPACITY, 2003-2019, GW



Excludes 60.8TWh of renewable electricity auctioned in Chile between 2006 and 2019, because it was not allocated on a GW basis.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

FIGURE 26. GLOBAL VOLUME OF CORPORATE POWER PURCHASE AGREEMENTS SIGNED, BY REGION, 2008-2019, GW

Onsite PPAs with captive installations not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. The cumulative total is shown on the right-hand axis.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

The majority of last year's capacity awarded in auctions (50.7GW) was for solar, with onshore wind accounting for 14.7GW and offshore wind 11GW. The most important region for renewable energy auctions was Asia, with 53.6GW awarded, led by India, followed by Europe with 17.4GW.

Auctions have contributed to the rapid decline in renewable energy levelized costs (shown in Figure 16 in Chapter 1), by intensifying competition among developers for the available capacity. This in turn has pushed the whole supply chain, from landowners to equipment suppliers and financiers, to cut their costs.

A second way of securing electricity revenues for a significant part of the project life is to conclude a private sector power purchase agreement, or PPA. This can be with a utility, but the sharpest growth has been in corporate PPAs, as shown in Figure 26. These have snowballed from covering just 300MW of global capacity in the deals signed in 2012, to 4.7GW in 2015, to 13.6GW in 2018 and a record 19.5GW in 2019. By the end of last year, a cumulative 52.4GW of global renewables were subject to corporate PPAs signed at some point during the decade.

The U.S. made up by far the largest slice of this global PPA volume in 2019, at 13.6GW, up from 8.5GW in 2018. Europe also saw a record year, but at a more modest 2.6GW, up from 2.3GW. The largest corporate buyers of new renewable electricity contracts in 2019 were Google (2.7GW, consisting of 1.7GW of solar and 1GW of wind), Facebook (1.1GW) and Amazon (925MW).

There is starting to be a third option for new-build projects in locations with good resources for solar or wind and a low-cost supply chain, and that is to construct them without any long-term electricity price fixing at all – in other words, without a government-set incentive, a tariff set by a government-run auction, or a private sector PPA. That is to rely purely on short-term electricity prices.

Building on such a basis – "merchant" to use the industry term – means a high level of unpredictability in terms of revenues, and will not be to the taste of many debt providers. Developers adopting this approach are likely to construct entirely using equity, or else with only a small proportion of debt. Some 1.3GW of solar projects were built worldwide without subsidy or long-term contract in 2019, and this total is expected to increase rapidly as PV costs continue to decline and new financing models evolve.[19] New ways of financing may include shorter tenors on loans, much lower debt-equity ratios, 100% equity finance, and the use of debt-equity hybrid products.

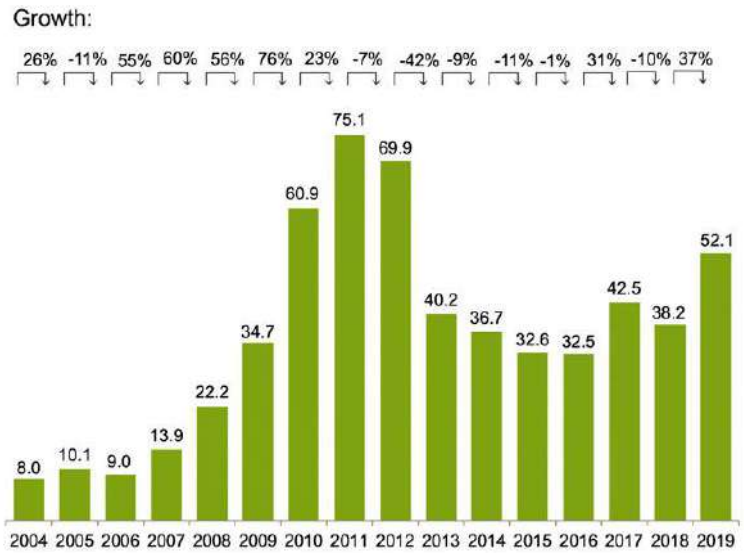
SMALL DISTRIBUTED CAPACITY

Figure 27 highlights the complex trend in investment in small-scale solar systems over the last decade. This category of capacity investment covers all PV installations of less than 1MW – in other words everything from residential rooftops with one, two or three panels to large warehouses and car park shelters with hundreds of panels, to commercial ground-mounted plants of several hundred kilowatts.

Small distributed capacity (SDC) investment hit its peak way back in 2011, at $75.1 billion, at a time of frenetic activity in Europe, especially Germany and Italy, as subsidies stimulated the purchasing of panels at what was then high costs per kW compared to what is available today. Investment then went into decline as solar costs fell and subsidies were either removed or cut sharply, reaching a low of $32.5 billion in 2016. However, last year saw a new upswing, with some $52.1 billion of new small-scale systems purchased globally, up 37% on 2018.

A geographical breakdown shows that the U.S. and China were the two biggest markets in 2019, with the former recording $9.6 billion of small-scale solar outlays, up 8% on 2018, and the latter $5.3 billion, up 176%. Other major markets were Brazil, 337% higher at $2.1 billion; India 40% higher at $1.5 billion; Germany, up 12% at $3.1 billion; the Netherlands, up 93% at $2.9 billion; and Australia, up 15% at $2.4 billion. There were also an estimated $5 billion deployed on small-scale solar in the Middle East and Africa, but details on exact location are yet to emerge.

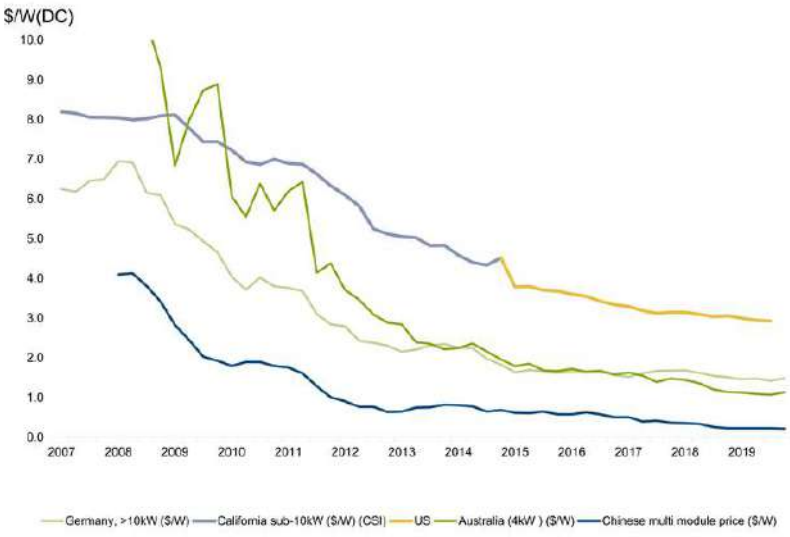
FIGURE 27. SMALL DISTRIBUTED CAPACITY INVESTMENT, 2004-2019, $BN



Represents investments in solar PV projects with capacity below 1MW.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

[19] https://about.bnef.com/blog/energy-vehicles-sustainability-10-predictions-for-2020/

FIGURE 28. SMALL PV SYSTEM COST IN GERMANY, THE U.S. AND AUSTRALIA, AND TREND IN CHINESE MODULE PRICES, $ PER WATT



$/W(DC) is cost per Watt in direct current terms.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

The country-specific reasons for these increases will be explored in Chapters 3 and 4, which look at renewable energy investment by country. But the factor in common was the further fall in the capital costs of solar equipment, as displayed in Figure 28.

The chart shows the cost reductions respectively for a German small PV system of less than 10kW – down from $6.25 per Watt in early 2007, to $4.04 per Watt in early 2010, to an average of $1.59 per Watt during 2018, and $1.47 per Watt in 2019. In the U.S., the typical cost reduction has been from $7 per Watt in 2010 to $2.96 per Watt in 2019. Installation and balance-of-plant costs have fallen during the decade, but the most dramatic reduction has been in the modules themselves, with the Chinese multi-module price tumbling from $1.85 per Watt, to just 23 cents per Watt.

Among the many sub-1MW solar projects making the news in 2019 were an 852kW system on the roof of Autronic Plastics in Central Islip, New York State, U.S., a 540kW installation on the Carros Centre, Singapore, a 192kW rooftop system on the Indian Academy Dubai School in the United Arab Emirates, and a 531kW plant for Izumo Togo Electronics in Shimane Prefecture, Japan.

LARGE HYDRO PROJECTS

As shown in Figure 21, final investment decisions for large hydro-electric dams of more than 50MW are estimated to have been worth $15 billion in 2019, down 6% from the previous year. Investment in both 2018 and 2019 was far below the $40 billion-plus annual totals recorded several times during the preceding decade.

A major reason for the lower large hydro investment totals recently has been the absence of mega projects reaching financial close, or the start of full-scale construction. The most recent such project to reach that stage was the 16GW, $28 billion Baihetan dam in China in 2017. More fundamentally, some big projects in Africa and South East Asia have been delayed by environmental or political concerns.

Nevertheless, 2019 did see important milestones reached for a number of projects. Voith got a contract to supply four 250MW Francis turbines and generators for the 1GW Pakal Dul hydropower plant in Indian state of Jammu and Kashmir. The Asian Infrastructure Investment Bank approved a $90 million loan to Nepal for the construction of the 216MW Upper Trishuli 1 hydropower plant.

Tanzania's government said that it would pay in full for the 2.1GW Stiegler's Dam, otherwise known as the Rufiji project, which is expected to cost $3 billion and controversially is being built in a wildlife reserve. At the smaller end of the size range, Statkraft committed in 2019 to build the 52MW Los Lagos project in Chile.

In China, the government permitted the 2GW Lawa hydro project on the Jinsha river, between Sichuan and Tibet. This undertaking will involve investment of $4.6 billion, according to China Daily. Also getting the go-ahead for construction was the 392MW Chuosijia dam in Sichuan.

Meanwhile, new capacity entered operation in 2019 – relating to projects financed and started earlier in the decade. For instance, some 3.6GW of power were added to the giant Belo Monte installation in Brazil, and government figures showed that China commissioned some 3.8GW of new hydro capacity (large and small) in 2019.

RusHydro opened the 320MW Nizhne-Bureyskaya plant and also added 142MW to the Ust-Srednekanskaya installation, both of them in the Russian Far East. Uganda commissioned the 188GW Isimba dam on the White Nile, built by China International Water & Electric.

In Asia, the 1.3GW Xayaburi hydro plant in Laos began operations, selling power to the Electricity Generating Authority of Thailand. India commissioned the 111MW Sawra Kaddu plant in Himachal Pradesh, and Tajikistan put into operation 600MW of the multi-phase Rogun complex. Nepal launched the 60MW Upper Trishuli 3A installation, while leaders of both India and Bhutan attended the inauguration of the 720MW Mangdechhu run-of-the-river project in Bhutan. India is set to purchase the dam's surplus electricity.

In the Americas, the local subsidiary of Spanish energy group Iberdrola inaugurated the 350MW Baixo Iguacu hydropower project in the state of Parana, Brazil.

Large hydro is not included in the main investment figures in this report, for two main reasons. One is that it is a long-established technology, dating back a century or so, and therefore does not share the same dynamics as "new renewable" technologies such as wind, solar and biomass. The other is that investment is hard to estimate with any precision, since big projects tend to unfold over many years, even a decade or more, will often stop and start, and may be part-financed at different times.

CAPACITY INVESTMENT – DEVELOPING COUNTRIES

- Renewable energy capacity investment in developing countries was $152.2 billion in 2019, down just a fraction from $152.7 billion in 2018. Dollars invested in the developing world made up 54% of the global total, outweighing developed economies for the fifth year running.
- The almost flat total for developing countries as a whole disguised big differences at the level of individual economies. Capacity investment in developing markets excluding mainland China and India gained 17% last year, reaching a record $59.5 billion.
- One of the highlights was Taiwan, where financial close for three large offshore wind projects drove a 390% jump in outlays to a record $8.8 billion. Another was United Arab Emirates, which boasted a 12-fold rise in investment, thanks to the largest solar financing ever – the Al Maktoum IV complex, with $3.9 billion for the solar thermal element, and $400 million for the PV component.
- However, investment fell back in both China and India. There was a steep drop in Chinese solar commitments, brought about by policy change in Beijing. Overall, investment in China slipped 8%, with increased wind activity offsetting some of the solar decline.
- India saw investment drop 14% to $9.3 billion, largely due to delays in financing projects brought about by the problems of their main electricity buyers, the distribution companies or 'discoms'. Lower capital costs per megawatt also contributed to the reduction in dollars invested in both India and China.
- Renewables capacity investment increased handsomely in Brazil and, in particular, Chile. But several formerly active developing country markets saw outlays decline in 2019 – notably South Africa, Vietnam and Morocco.

Global capacity investment in renewables excluding large hydro continues to be split relatively evenly between developed and developing countries, with the latter making up the small majority. In 2019, developing economies made up 54% of the global total against 46% for developed economies.[20] This ratio was also 54:46 in 2018, but it got as high as 62:38 in 2017 at the peak of China's solar boom. The last time developed economies invested more than developing countries was back in 2014.

[20] In this report, developing countries are defined as all non-OECD markets, plus Mexico, Turkey and Chile.

Figure 29 splits the world into three groups. China and India between them invested $92.7 billion in new green energy capacity in 2019, down 9% on the previous year and the lowest since 2014. Other developing countries committed a record $59.5 billion, up 17% on the 2018 total. Developed economies (covered in Chapter 4) invested $130 billion, some 2% higher than the year before and their highest aggregate since 2016.

The upswing in investment in 'other developing countries', from just $24.3 billion in 2010 and $39.6 billion in 2015 to $59.5 billion in 2019, underlines the way wind and solar technology, in particular, have spread through more markets in recent years, thanks in large part to improved cost-effectiveness. One enabling mechanism has been auctions, discussed in Chapter 2, now the favoured tool for many countries for setting tariffs and allocating capacity.

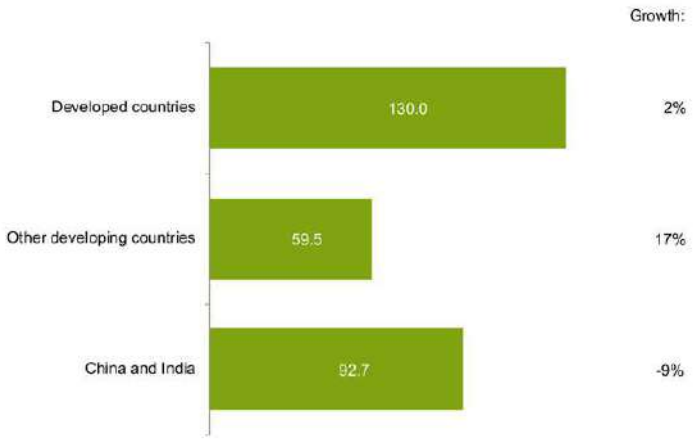
This chapter will look in turn at investment in China, India, the Middle East and Africa, Latin America and emerging Asia-Pacific.

CHINA

China has been the dominant investing country in renewables, excluding large hydro, since over-taking the U.S. in 2012, and the largest investing region on the definition used in this report since surpassing Europe in 2013. However, its investment volumes have not gone up in a straight line. They advanced every year up to 2015, before slipping back from $119.3 billion to $105.3 billion in 2016, jumping again to $143 billion in 2017 thanks to runaway solar project development, and then slipped back, first to $91.1 billion in 2018 and then to $83.4 billion in 2019.[21]

Figure 30 shows the split by technology for China's investment in renewables in 2019. The majority of the dollars committed – $55 billion – were to the wind sector, up 10% on 2018 and an all-time high. Within that, offshore wind attracted $14 billion, a 17% increase on the previous year, and onshore wind $41 billion, up 7%. Solar saw investment slide 33% to $25.7 billion, the lowest since 2012 and less than one third of the 2017 peak. Biomass and waste-to-energy secured $1.5 billion of investment, up 2%, while small hydro was unchanged at $1.2 billion.

FIGURE 29. CAPACITY INVESTMENT IN RENEWABLES: DEVELOPED COUNTRIES, CHINA AND INDIA, OTHER DEVELOPING ECONOMIES, 2019, AND CHANGE ON 2018, $BN



Total values include estimates for undisclosed deals. Developed countries are all OECD members, excluding Chile, Mexico and Turkey.
Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

FIGURE 30. RENEWABLE ENERGY CAPACITY INVESTMENT IN CHINA BY SECTOR AND SUB-SECTOR, 2019, AND CHANGE ON 2018, $BN

	2019	% growth on 2018
Biofuels	**0.0**	**(0 in 2018)**
Biomass & waste	**1.5**	**2%**
Geothermal	**0.0**	**(0 in 2018)**
Marine	**0.0**	**(0 in 2018)**
Small hydro	**1.2**	**0%**
Solar	**25.7**	**-33%**
(of which PV)	25.7	-32%
(and solar thermal)	0.0	-100%
Wind	**55.0**	**10%**
(of which offshore)	14.0	17%
(and onshore)	41.0	7%
Total	**83.4**	**-8%**

Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

[21] The full time series for China, the U.S. and Europe is shown in Figure 12 in Chapter 1.

Looking at those sector performances in turn, the central government's decision last year to end dedicated subsidies for onshore and offshore wind after 2020 has led developers to speed up project financing and commissioning times. Other changes are afoot in Chinese onshore wind that will encourage developers. For instance, building more ultra-high-voltage transmission lines is helping China to integrate renewables, and curtailment rates are falling. Subsidy-free wind farms are also starting to be financed, to take advantage of lower turbine prices and the best wind locations.

Among the largest onshore wind projects reaching financial close in 2019 were the Huolinhe Wulanchabu Siziwang number one installation, at 600MW and an estimated $780 million, and the Inner Mongolia Wudalai New Energy Xilinguole Xilinhaote plant, at 475MW and an estimated $481 million.

In offshore wind, the rush to finance in time to qualify for the expiring feed-in tariff was even more obvious than in onshore. No fewer than 17 sea-based wind projects of more than 100MW got the go-ahead in 2019, with 12 of them reaching that milestone in the fourth quarter of the year. The two largest were the 600MW SPIC Zhanjiang Xuwen array, at $1.5 billion, and the 500MW Fujian Funeng & Haixia Fuzhou Changle C project, also estimated at $1.5 billion.

In solar PV, the country's decision in May 2018 to suspend solar subsidies had a delayed impact on growth. The policy revamp and subsequent uncertainty stopped developers from originating new pipelines. The market freeze, together with the prolonged subsidy payment delays, forced many smaller developers to exit. There was an auction for new capacity in July 2019, but some developers ran into land permit problems or grid delays.

Two highlights in the otherwise sluggish market were distribution-grid-connected solar, which was over half the new build during the first three quarters, often built without subsidy; and residential solar, where the government allocated subsidies for 3.5GW of new projects.

Overall, the amount of new PV capacity commissioned in China in 2019 is estimated to have been just over 30GW, down from 44.3GW in 2018. Among the biggest projects financed last year were the China Power International Chaoyang plant, at 500MW and an estimated $424 million, and the Jiangsu Tianhe Heilongjiang Hegang site, at 500MW and $363 million. The sub-$1 million per MW capital cost figures for these plants underline that, along with slower capacity growth, the continuing fall in PV equipment costs contributed to the decrease in the dollar investment total for Chinese solar.

Waste-to-energy is going through a dynamic period in China, with a string of incineration plants being built, particularly near coastal cities, though their main objective is to take the pressure off landfill sites, with energy production a secondary benefit. Official figures show that the country added 7GW of biomass and waste capacity between 2015 and 2018. Capital costs per MW for waste-to-energy plants are significantly lower in China than in the West.

The solar sector in India is notable for the fierce competition for projects among developers, and for capital costs that are among the lowest in the world. India awarded 12.7GW of utility-scale projects in the second half of 2019 alone, led by the 8GW project capacity auctioned under the PV manufacturing-linked tender. This is 1.7 times the previous half-yearly record. The country's government has set an ambitious target of 100GW by December 2022, up from the 37GW it had installed by the end of 2019.

There were 9GW of solar projects installed in 2019, including utility-scale projects, grid-connected rooftop solar and off-grid solar. However, the growth of solar faces an obstacle, in the shape of the distribution companies, or "discoms", which buy the electricity. Many of the discoms are financially stressed. Some of them tried to re-set agreed tariffs in 2019, and others were slow to sign power purchase agreements.

The problem has been hard to solve so far because of a lack of agreement between federal government and the state governments about how to reduce, or eliminate, the liabilities of the discoms – which have been built up by providing subsidized power to consumers. Some privatization of distribution is taking place, but this has yet to make a big impact on the problem.

INDIA

Figure 31 shows the breakdown of India's renewable energy capacity investment in 2019. Solar PV, up 8% at $6.6 billion, and onshore wind, down 48% at $2.2 billion, continued to dominate the statistics, with trace contributions from biomass and waste, biofuels and small hydro. India also made its strongest noises yet in 2019 about starting an offshore wind program, although this is still probably several years away from resulting in actual financings.

FIGURE 31. RENEWABLE ENERGY CAPACITY INVESTMENT IN INDIA BY SECTOR AND SUB-SECTOR, 2019, AND CHANGE ON 2018, $BN

	2019	% growth on 2018
Biofuels	**0.2**	**(0 in 2018)**
Biomass & waste	**0.3**	**-32%**
Geothermal	**0.0**	**(0 in 2018)**
Marine	**0.0**	**(0 in 2018)**
Small hydro	**0.1**	**-14%**
Solar	**6.6**	**8%**
(of which PV)	6.6	8%
(and solar thermal)	0.0	-100%
Wind	**2.2**	**-48%**
(of which offshore)	0.0	(0 in 2018)
(and onshore)	2.2	-48%
Total	**9.3**	**-14%**

Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

Among the larger PV parks financed last year were the Azure Power Rajasthan SECI plant, at 600MW and $432 million, and the ACME Maharashtra project, at 250MW and $193 million.

The Indian wind sector saw a severe slowdown in the second half of 2019 as financing activities, the awarding of new projects, and execution of under-construction plants all took a hit. Permitting and project execution challenges, and the financial difficulties of turbine manufacturers, also caused delays. The country added just 2.4GW of wind capacity in 2019.

The forward pipeline is, meanwhile, not nearly as healthy as it should be. A total of 8.7GW of projects could have been allocated through various tenders in 2019, but only 2.3GW were awarded due to under-subscription or cancellation of tenders.

Gujurat is likely to be the first Indian state to host offshore wind activity, and its administration was working on a tender during 2019. Key details are still to be ironed out. Firstly, it is unclear whether the state of Gujarat or the federal government will foot the subsidy bill. Secondly, India has relatively low wind speeds, so the turbines that are industry-standard may not be suitable for its wind resource. In addition, who will pay for the subsea cabling and offshore transformer is still to be determined.

MIDDLE EAST AND AFRICA

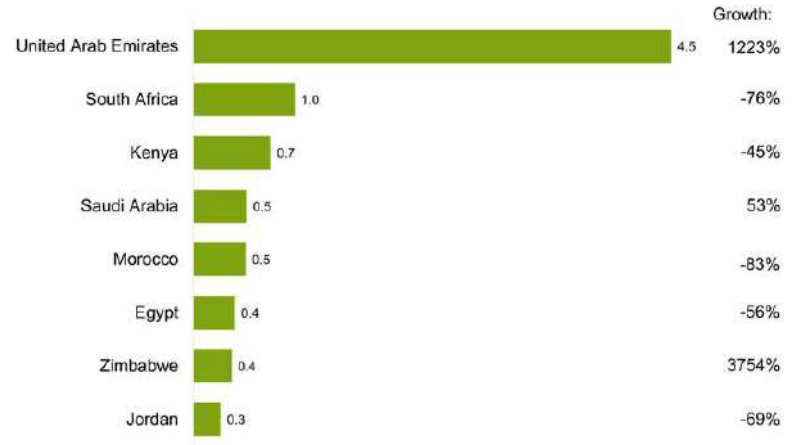
Renewable energy capacity investment in Middle East and Africa slipped 8% to $15.2 billion in 2019, from the record total of $16.5 billion reached in 2018. Several countries that had become significant investors in previous years, including South Africa, Jordan, Egypt, Morocco and Kenya, had sizeable falls in investment, due in large part to gaps in auction programs, and this was overall the main reason for the decline in the region as a whole. Trade data suggest that some $5 billion of small-scale solar systems were sold to undisclosed customers in Middle East and Africa last year. The location of these is likely to become clearer in due course.

Figure 32 highlights the fact that United Arab Emirates (U.A.E) was, by a big margin, the star performer in renewables investment in the region in 2019. Its pre-eminence owed everything to one giant project – the $4.3 billion Al Maktoum IV, made up of 600MW of solar thermal power from a 'parabolic basin complex' and 100MW from a solar tower, with a further 250MW from PV panels.

It will cover an area of 44 square kilometres, and the tower will be 260 meters high. The thermal storage of the project is planned to be 15 hours, far longer than for most solar thermal plants in operation around the world. The financing package, in March 2019, was the biggest ever in solar, and the largest to date of the non-recourse project finance type in any renewable energy technology, excluding large hydro.

The total cost is $4.3 billion, with the debt portion at $2.6 billion, a debt-equity ratio of 60%. The 27-year project loans came from five Chinese banks, three Emirati lenders, plus Natixis of France and U.K.-headquartered Standard Chartered Bank. Of the approximate $1.7 billion of equity, 51% came from Dubai Electricity and Water Authority, 25% from developer ACWA Power and 24% from China's Silk Road Fund.

FIGURE 32. RENEWABLE ENERGY CAPACITY INVESTMENT IN MIDDLE EAST AND AFRICA BY COUNTRY, 2019, AND CHANGE ON 2018, $BN



Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

The U.A.E. is likely to continue to feature strongly in solar in the years ahead, with for instance a 900MW, fifth phase of the Al Maktoum program under development, this time entirely made up of PV. Its neighbor, Saudi Arabia, is just starting to scratch the surface of its renewables potential, with $502 million invested in 2019, the country's highest yet. The largest Saudi deal last year was not in solar but in wind, via the financing of the 416MW EDF Dumat Al Jandal project.

Many of the other leading renewable energy players in Middle East and Africa ran into, at least temporary, delays with their investment programs. In South Africa, where commitments fell 76% to $1 billion, momentum has slowed as the government wrestles with financial problems at the energy utility, Eskom. With a long gap persisting between auctions, the only big project to get the investment go-ahead last year was the 100MW ACWA Redstone solar thermal plant, at an estimated $697 million.

However, there is a long-term intention to build a lot more renewables. South Africa's latest Integrated Resource Plan, mapping out the energy mix for the next decade and published in October 2019, envisions the nation's total electricity production capacity rising to 77.8GW by 2030 – with the bulk of the increase coming from some 52.1GW of renewable sources.


BURGER

Kenya saw investment fall 45% to $727 million, one of its few large transactions being the Frontier Investment Management Eldosol and Radiant PV portfolio, at 80MW and $148 million. Meanwhile, Zimbabwe emerged for the first time as a location for non-hydro renewables investment, with two PV parks totalling some 350MW and an estimated $342 million, financed by Chinese money.

The three most active renewables markets in North Africa and the Levant (Morocco, Egypt and Jordan) saw a total of $15.7 billion invested during the five years from 2015 to 2019, but last year was a relatively weak one for all of them. The biggest asset financings were $302 million for the 420MW ONEE Morocco PV portfolio, and $325 million for the 250MW Lekela Power West Bakr wind farm in Egypt.

In all these countries, there were gaps between the auction rounds that have fueled the momentum of their renewable energy build-out. The fact that equipment prices, particularly for PV, have been falling so fast has tended to increase policy-makers' caution over the right timing for new capacity. Nevertheless, governments continue to voice support for renewables – Egypt, for instance, saying in October 2019 that it was cancelling a giant coal project, and looking at the possibility of 500MW of additional renewables capacity.

LATIN AMERICA

This report splits the Americas into three – the U.S., Brazil and 'Other Americas' regions (for instance in Figure 11 in Chapter 1). However, looking at Latin America and the Caribbean as a region (by excluding Canada and including Brazil) we see that it raised renewable energy capacity investment by 43% to a record $18.5 billion.

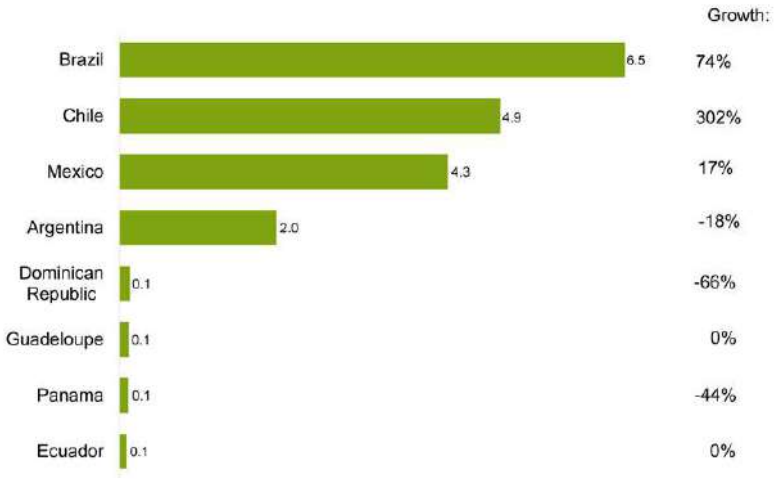
Latin America has three particular advantages over some other parts of the developing world when it comes to attracting investment. The first is excellent resources for wind, solar and biomass generation, in particular. The second is policy development that has emphasised the role of auctions in allocating new capacity, building on expertise that has been built up in the region over many years. The third, connected to the first two, has been the confidence of international developers such as Enel, EDF and Mainstream Renewable Power, and also of international lenders.

Figure 33 shows the quantum of renewables capacity investment in 2019 in Latin America and the Caribbean, by country. It is noticeable that activity last year was concentrated in just four countries, with other markets that either have been important in the past (e.g. Uruguay) or are now establishing credible auction programs (e.g. Colombia) not showing up in terms of actual dollars committed during the period.

Brazil re-established a clear lead in 2019 among investing countries in Latin America, after two years in which Mexico came close to overtaking it. Within its total of $6.5 billion, up 74% on the previous year, Brazil saw a 148% rise in wind financing to $3.4 billion and a 30% advance in solar to $2.5 billion.

On June 2019, Brazil held its 29th energy auction, securing power-delivery contracts for solar, wind, hydro and biomass. The auction had a record low solar average price of $17.5/MWh for 204MW from

FIGURE 33. RENEWABLE ENERGY CAPACITY INVESTMENT IN LATIN AMERICA BY COUNTRY, 2019, AND CHANGE ON 2018, $BN



Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF

six PV plants. Wind secured 95MW from three plants at $20.71/MWh, the second-lowest average wind price ever. A second auction, in October, secured power-delivery contracts from 3GW of wind, solar, hydro, biomass and gas plants, with slightly higher tariffs awarded than in June for both solar and wind.

Chile enjoyed a 302% jump in renewables capacity investment to $4.9 billion, its highest ever. Wind deals galloped to $2.7 billion, from almost nothing the previous year, while solar increased 85% to $2.2 billion. Much of the reason for Chile's increase came down to the timing of particular large financings, relating to projects that won capacity in previous years' auctions.

The Mexican total regained 17% to $4.3 billion, albeit still below the peak tally of $6.1 billion from 2016. Wind fell 15% to $887 million, but solar increased 31% to $3.4 billion. However, there was uncertainty over energy policy under the presidency of Andres Manuel Lopez Obrador, and there were no fresh auctions during 2019.

Argentina was the only one of the big four to suffer a drop in investment in 2019. It recorded a total of $2 billion, down 18%. The sector split showed solar almost halving to $268 million, while wind slipped 9% to $1.7 billion. The country held only one mini-auction during 2019.

Among the largest financings in the four countries last year were the Ventos De Santa Angela wind portfolio in Brazil, at 510MW and an estimated $578 million; the Loma Blanca & Miramar wind portfolio in Argentina, at 348MW and $558 million; the Mainstream Andes Renovables Phase I Condor wind projects in Chile, at 425MW and $835 million; and the FRV Potrero PV project in Mexico, at 297MW and $336 million.

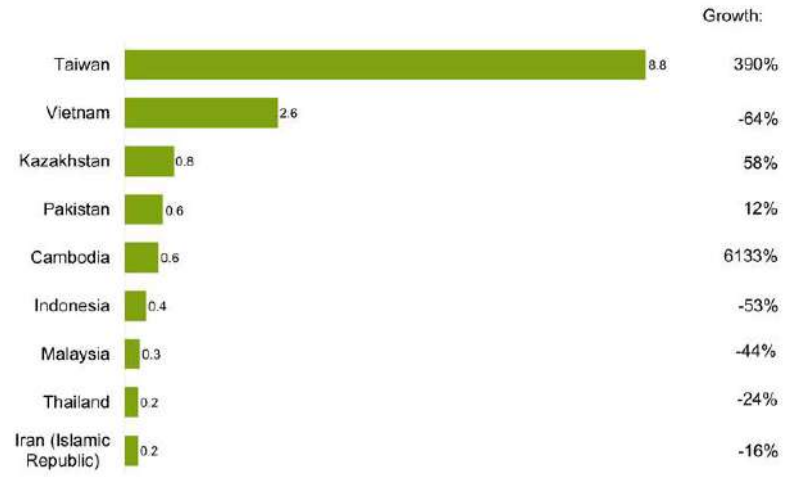
EMERGING ASIA-PACIFIC

Investment in non-OECD Asia-Pacific (excluding China and India) reached $15.2 billion in 2019, a record tally and up 17% from the previous year. However, as Figure 34 shows, more than half that total was accounted for by just one market – Taiwan. Renewables investment volumes in other parts of the region were distinctly mixed last year.

The all-time high tally for Taiwan in 2019, at $8.8 billion, owed something to $1 billion worth of small-scale solar, but the main contribution was from the financing of three large offshore wind arrays – the 640MW Wpd & Starwind Yunlin, the 900MW Orsted Greater Changhua, and the 376MW Swancor & Macquarie Formosa II Miaoli – together costing an estimated $7.8 billion.

These deals were notable for involving a large number of both local Taiwanese and international financial and supply chain players. The Yunlin project, for instance, got debt from 19 banks, including four from France, three from Germany, one loan each from the U.K. and the Netherlands, and three from Japan. Siemens Gamesa secured the turbine contract, and Dutch company Van Oord the engineering, procurement and construction work.

FIGURE 34. RENEWABLE ENERGY CAPACITY INVESTMENT IN NON-OECD ASIA (EXCLUDING CHINA AND INDIA), 2019, AND CHANGE ON 2018, $BN



Source: UNEP, Frankfurt School-UNEP Centre, BloombergNEF