CLIMATESCOPE

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Emerging Markets Outlook 2018.

Energy transition in the world's fastest growing economies

UKaid
from the British people

BloombergNEF

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Section 1. Key findings

114GW

Zero-carbon capacity added in emerging markets in 2017

20.4%

Increase in year-on-year clean energy deployment across emerging markets

103

Markets covered in Climatescope 2018, up from 71 in 2017

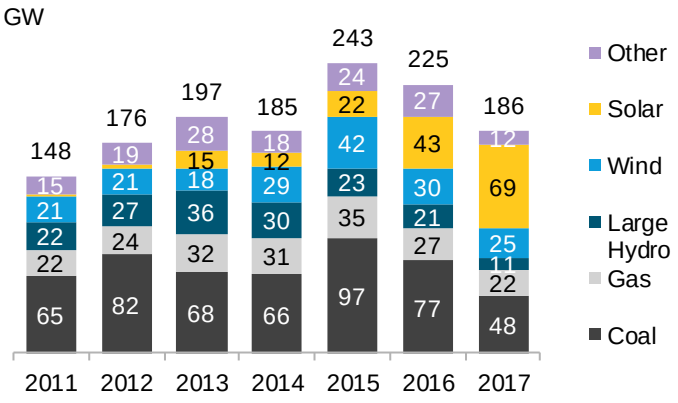
Fuelled by surging electricity demand and sinking technology costs, developing nations are today leading a global clean power transition. This marks a remarkable turnabout from a decade ago when the world's wealthiest countries accounted for the bulk of renewable investment and deployment activity. Developing nations at the time were viewed as holding enormous promise only; wind, solar, geothermal and other clean technologies were regarded as too expensive for mass deployment.

Last year's Climatescope documented how the locus of clean energy activity had shifted noticeably from "North" to "South", from OECD to non-OECD countries. This year's survey goes one step further by illustrating how less developed nations are now very much *driving* the energy transition.

Leadership is an elusive quality to quantify. Still, this year's Climatescope offers compelling evidence that developing nations are at the forefront of change toward a cleaner-powered future. Consider:

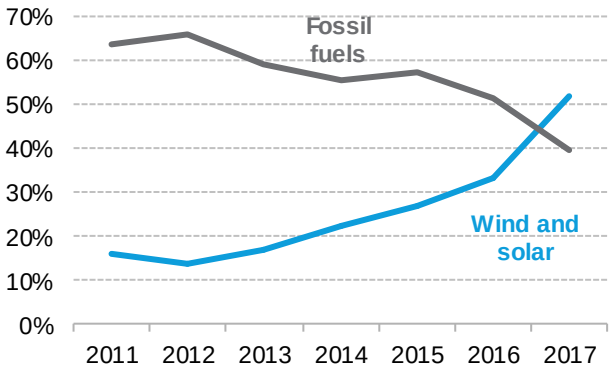
- **In 2017, the large majority of the world's new zero-carbon power capacity was built in developing countries.** A total of 114GW (including nuclear and hydro as well as "new renewables") was added in these nations, compared with approximately 63GW added in wealthier nations.
- **In a first, renewables accounted for the majority of all new power-generating capacity added.** Developing countries added 186GW in 2017 to their grids with wind and solar alone accounting for 94GW – just over half.
- **Clean energy deployment is growing fastest in developing nations.** New-build additions rose 20.4% year-on-year in these countries. By contrast, new build in wealthier nations fell by 0.4%.
- **Coal build has fallen sharply in developing countries.** After peaking at 97GW of new capacity built in 2015, coal additions slipped to 48GW in 2017. New coal in India has crashed from 17GW per year 2012-16 to 4GW in 2017, suggesting the country is plotting a lower-carbon course to expand energy access.
- **Developing countries are driving down clean energy costs, making these technologies more competitive with fossil generation.** Over 35 emerging markets have held reverse auctions for clean power-delivery contracts to date, including Mexico ($21/MWh for PV) and India ($41/MWh; wind), procuring 140GW vs. 41GW in OECD countries. BNEF's estimated levelized cost of electricity for wind and solar is below $50 for many developing nations.
- **Clean energy investment is being deployed in more nations than ever.** As of year-end 2017, 54 developing countries had recorded investment in at least one utility-scale wind farm and 76 countries had received financing for solar projects. That's up from 20 and 3, respectively, a decade ago.

Figure 1: Total annual capacity additions by technology in emerging markets



Source: BloombergNEF, Climatescope. Note: includes data from 100 non-OECD nations, plus Chile, Mexico, and Turkey. Other includes biomass and waste, geothermal, nuclear, small hydro, oil and other fossil fuels.

Figure 2: Share of annual capacity additions by technology in emerging markets

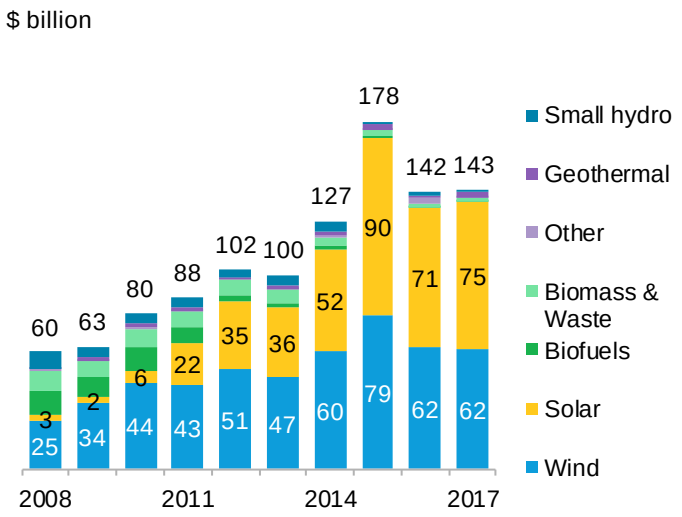


Note: non-fossil fuel and non-wind/solar capacity additions were accounted for by nuclear, geothermal, biomass, and large hydro projects.

Progress has of course been fueled by investment. In 2017, new clean energy financings in emerging markets totaled $143 billion. That was roughly level with 2016 and a far cry from the $178 billion in 2015. However, it came against a backdrop of continued price drops for renewables technologies. A heterogeneous mix of funding sources have supported growth. Consider:

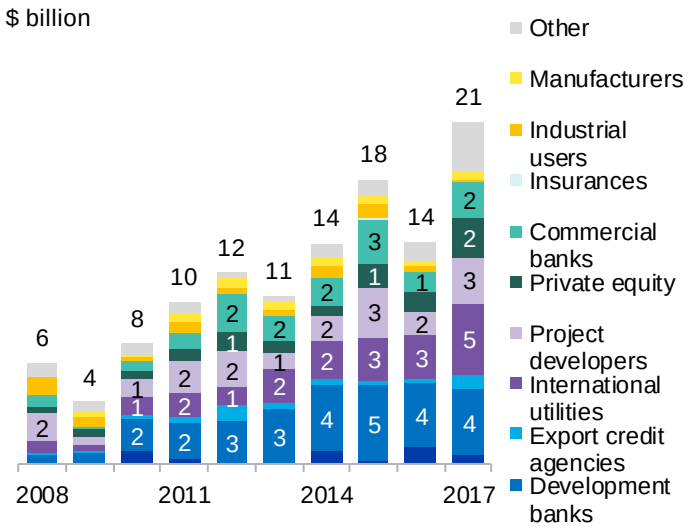
- **The vast majority of clean energy capital deployed in emerging markets came from local sources.** This was largely due to the heavy influence of domestic development banks and credit agencies in China and Brazil.
- **Foreign direct investment (FDI) supporting clean energy rose to an all-time high.** It jumped to $21.4 billion in 2017 from $13.9 billion in 2016. EU-based sources provided the largest share at $9.6 billion, followed by the U.S. with $5.1 billion and Asia with $4.8 billion.
- **Private capital is playing a growing role in clean energy FDI.** While funding from development banks and export credit agencies remained flat from 2016 to 2017, funding from international utilities, project developers and commercial banks surged to $9.8 billion.
- **The largest international funder of non-hydro renewables in developing nations over the last decade is Enel – by far.** The Italian utility and independent power producer has provided $7.2 billion to projects mainly in Latin America. Other EU-based utilities have also been very active.

Figure 3: Developing country clean energy investment



Source: BloombergNEF. Note: Includes 100 non-OECD nations, plus Chile, Mexico and Turkey.

Figure 4: Emerging market foreign direct investment by investor group



Source: BloombergNEF

The progress achieved has been all the more impressive in light of rising U.S. interest rates, shrinking global liquidity, and a reduced appetite for international risk among some investors.

Project updates

This year's Climatescope Emerging Market Outlook represents the collective effort of 42 BloombergNEF analysts who made 54 country visits to collect data and conduct interviews. Once again, the study has been graciously supported by the U.K. Department for International Development.

For 2018, the project has been expanded and updated in two key ways. First, the total number of countries surveyed was expanded significantly to 103. This includes 100 nations classified by the Organisation for Economic Co-operation and Development (OECD) as less developed. It also includes three countries – Chile, Mexico, and Turkey – that are an important part of the developing-nation story but are not technically classified as non-OECD. As a result of this expansion, Climatescope now offers a comprehensive snapshot of virtually *all* developing nations.

Second, the Climatescope methodology has been streamlined and updated. While the number of underlying data indicators remains approximately the same as last year at 165, these have now been grouped under three overarching *Topics*: Fundamentals, Opportunities, and Experience. The weightings of underlying indicators as they count toward the overall score have also been updated slightly. Market conditions have changed dramatically since BNEF first conducted Climatescope seven years ago. These methodology updates are intended to make the data we have collected more accessible to users and the scoring system more reflective of current market realities.

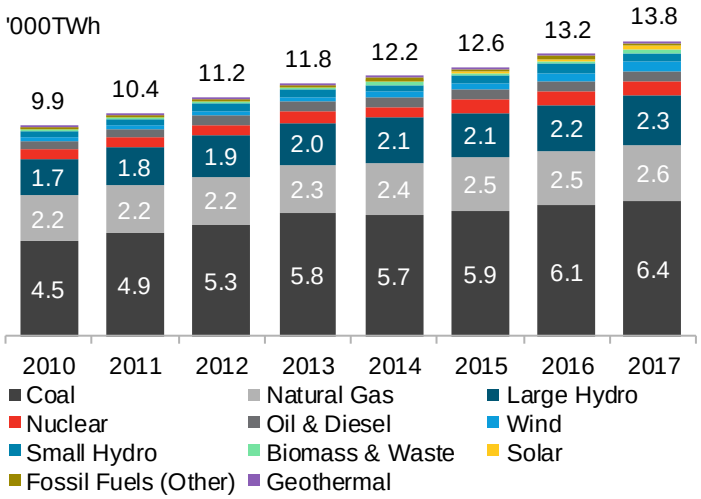
As in past years, Climatescope scored and ranked individual nations. While many of the countries that have appeared near the top of the survey's leaderboard in years past are up there again this year, there are have been some notable changes:

- **Chile is the top scorer in this year's Climatescope survey.** The Andean nation fared well on all three parameters thanks to strong government policies, a demonstrated track record of clean energy investment, and a commitment to de-carbonization despite grid constraints.
- **India is the close second.** The Indian market is home to the largest and most competitive auctions in the world, which contracted over 10.5GW from wind and solar in 2017 alone. The country aims to reach 175GW of clean energy capacity by March 2022, with 100GW coming from solar alone. The country's solar market almost doubled in size in 2017, making it a record year with annual PV installations touching 8GW.
- **Jordan is in third position.** The country's policy framework, clean energy targets, auctions, and renewable portfolio standard led to 730MW of wind and solar plants added in 2015-2017. Jordan also has over 1GW of clean energy currently under construction.
- **Brazil finished fourth, despite slumping clean energy investment and cancelled auctions.** Brazil has pioneered competitive auctions to contract clean energy, which led to over 24.8GW of renewable energy contracted in 2009-2017. With the worst of its economic crisis now behind it, clean energy appears poised for new growth.
- **Rwanda rounds out the top five thanks to its unprecedented progress in expanding generation capacity and electrification over the last decade.** Since 2010, approximatively 4.3 million of the country's 11.8 million inhabitants have gained access to electricity.
- **China remains critical to the global clean energy story but fell to seventh in the survey from top of the table last year.** While China remains the largest market for clean energy build by far, curtailment issues and the halting of subsidies to solar generators dented its score. Climatescope's updated methodology also places greater emphasis on countries' openness to international investors over the availability of local manufacturing. While these changes contributed to China's drop, its unrivaled clean energy investment and potential for de-carbonization ensured it remained in the survey's top ten.

Despite successes achieved by clean energy to date in developing countries, it is far from certain these nations will de-carbonize their power sectors going forward. While new coal-fired capacity additions fell to their lowest level in over a decade in 2017, actual *generation* from coal-fired plants rose 4% year-on-year to 6.4TWh. Natural gas generation posted a similar 3% rise. And despite ample evidence that new-build renewables can underprice new-build coal-fired plants, 193GW of coal are currently under construction in developing nations today according to Coalswarm data. Some 86% of that is due to come online in China, India, Indonesia and South Africa.

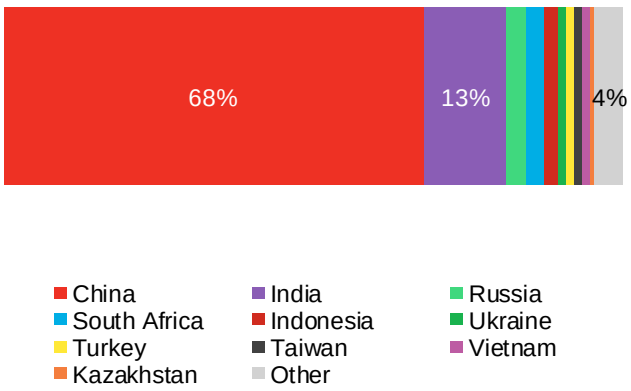
Moreover, there is the longer-term challenge for clean energy to displace *existing* coal-fired plants. The question is particularly relevant for China and India, which get approximately two thirds and three quarters of their power from coal, respectively. Combined, these two countries added 432GW of coal capacity in just 2010-2017 (by comparison, the U.S. has a total of 260GW of coal on line today). Faced with significant pressure to expand energy access (India) and keep power affordably priced (China), policy-makers will be reluctant to de-commission these relatively new plants anytime soon. And no less than 81% of all emerging market coal-fired capacity is located in these two nations.

Figure 5: Annual generation by technology in emerging markets



Source: BloombergNEF, Climatescope

Figure 6: Coal cumulative installed capacity in emerging markets by country



Finally, there is the fundamental question of how to accommodate large volumes of intermittent clean generation into existing power markets. As they require no fuel inputs, renewables projects operate at effectively zero marginal cost. Thus when they flood the grid in liberalized power markets, they can potentially decimate wholesale power prices for all generators.

In the short run, this can hasten the demise of older, less efficient fossil plants and help keep CO2 emissions in check. But when not properly managed, high clean energy penetration can de-stabilize markets, particularly if the clean output does not overlay neatly with electricity demand. Such situations can also result in clean energy projects becoming highly reliant on the goodwill of grid operators. In China, where over-capacity is acute in some regions for example, wind and solar projects have at times found their production curtailed in favor of coal-fired power plants.

Developing nations are not alone in confronting the challenges posed by rising levels of clean power generation. Germany, other countries, and parts of the U.S. have all grappled with how to respond. Among the options on the table: wholesale power market reforms to adjust incentives for generators; expanded demand-response programs to incentivize customers to reduce consumption at key hours; deployment of energy storage technologies such as batteries to extend the hours when clean electrons are available; or more transmission capacity to accommodate greater capacity from remote regions with the best wind or solar resources.

Some developing countries are now actively seeking to implement these solutions. Brazil plans auctions to develop transmission lines into regions with strong natural resources. The World Banks's Scaling Solar program in Madagascar's includes incentives to build power storage and South Africa's state-owned utility has stated an 800MWh storage goal for 2019. Meanwhile, countries such as Algeria and Tajikistan have aggressively promoted the use of smart meters, which are vital to demand-response programs.

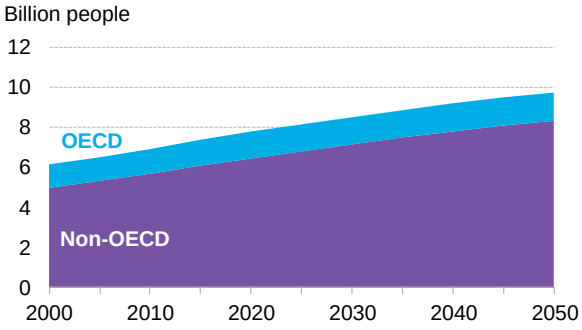
Nonetheless, substantial additional work remains. As clean energy costs continue to drop and deployment continues to rise, developing country grids must do more than match the sophistication of wealthier nations' grids, but surpass it. This will no doubt take concerted efforts, including further policy development, investment, and deployment of the newest technologies. But that also inevitably spells enormous opportunities for companies and financial institutions ahead.

Section 2. Introduction

The release of this year's Climatescope Emerging Markets Outlook comes amid a period of international uncertainty, as new and powerful voices have emerged to challenge the longstanding trend toward a globalized economy. The most prominent of these has been U.S. President Donald Trump, who has sought to rebalance his country's trade relationship with China through trade tariffs while countering its influence in emerging markets. The creation of a new U.S. International Development Finance Corporation in November 2018 signaled a direct response to China's "One Belt, One Road" foreign investment initiative.

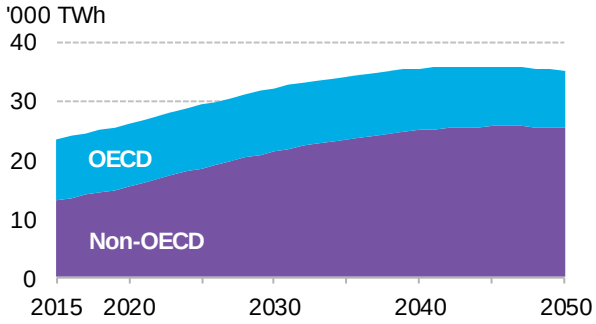
Robust U.S. economic growth and record low unemployment are also making waves abroad as changes in the value of the dollar and demand for key commodities such as oil impact the rest of the world. In developing nations with financial markets heavily influenced by global dynamics, these trends have combined with domestic issues to undermine confidence in the outlook for economic growth. Those jitters have prompted steep drops in the value of developing nations' currencies, fueled concerns of "contagion", and raised the prospect of a fully-fledged crisis of confidence for investors.

Figure 7: Projected global population growth



Source: World Bank

Figure 8: Projected global power demand



Source: BloombergNEF 2018 New Energy Outlook

Beyond the headlines, however, many developing nations are enjoying the longest period of rapid economic growth in history. The same fundamental factor that has propelled their growth in recent years remains: rapidly growing populations that are urbanizing, advancing, and demanding more access to energy (Figure 7 and Figure 8). This dynamic has created the greatest infrastructure investment boom in history and continues to offer long-term opportunities for investors.

This Climatescope Emerging Market Outlook begins with a review of Climatescope 2018's new methodology (Section 4) and scores (Section 5), followed by analysis on how economic and financial trends are affecting dynamics for emerging market clean energy investors (Section 4). It then analyzes trends in clean energy investment (Section 6) and assesses the successes and challenges developing countries face as they transition to lower-carbon, more modern sources of power generation (Section 7).

This Outlook represents the culmination of BNEF's annual Climatescope project, which involves 42 of our analysts compiling detailed data on 103 developing nations, including making visits to 54 countries in spring and summer 2018. Readers are encouraged to explore complete datasets

and profiles each of these nations on the Climatescope web site to leverage fully this deep dive into how world's fastest growing economies are driving the energy transition.

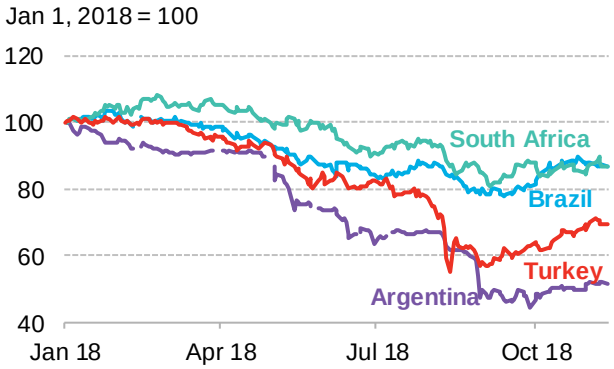
Section 3. Context

3.1. Concerns over contagion

2016 and 2017 were largely positive for emerging market currencies as they recovered from 18 months of depreciation against the dollar prompted by rising U.S. interest rates. This had the effect of keeping inflation and the cost of servicing debt in check for such countries. However, things took a turn for the worse in 2018 with developing country indices slipping badly.

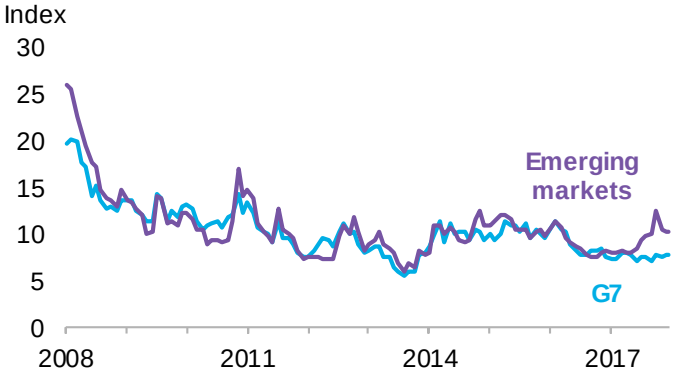
Matters appeared to come to a head on August 10, 2018, when the U.S. imposed steel and aluminum tariffs on Turkey. The move sharply reduced the value of the Turkish lira against the dollar while causing shockwaves across South Africa, Argentina, India, Indonesia, and Mexico (Figure 9). Developing nation currencies were at their most unstable since 2011, according to the JPMorgan Index (Figure 10). This in turn spooked investors, fueled capital outflows, and prompted talk of an emerging economy crisis.

Figure 9: The value of select emerging market currencies vs. the U.S. dollar



Source: Bloomberg Terminal

Figure 10: The JPMorgan Volatility Index



Source: Bloomberg Terminal. Note: turnover-weighted index of G7 and emerging market volatility, based on three-month at-the-money forward options.

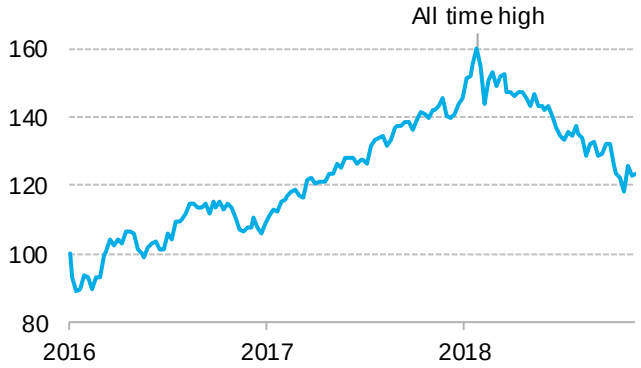
While current volatility is a far cry from that in the wildest days of 2008, traders appear generally pessimistic, with concerns homing in on the Argentinian peso, Turkish lira, Brazilian real and South African rand, in particular. The instability has fed fears of a repeat of previous emerging market routs, with the contagion experienced during the Asian financial crisis of the late 1990s looming particularly large.

Specific to clean energy, the fear is that a broader retreat from emerging markets could siphon credit from renewable energy projects, compounding difficulties facing developers trying to secure financing in countries already perceived as vulnerable. Furthermore, falling exchange rates complicate the task of paying obligations denominated in hard currencies.

To cap it all, the globalization of securities markets has exacerbated the potential for herd behavior. With many portfolios treating emerging markets as a homogeneous asset class, particular attention has centered on MSCI emerging market equity and currency indices

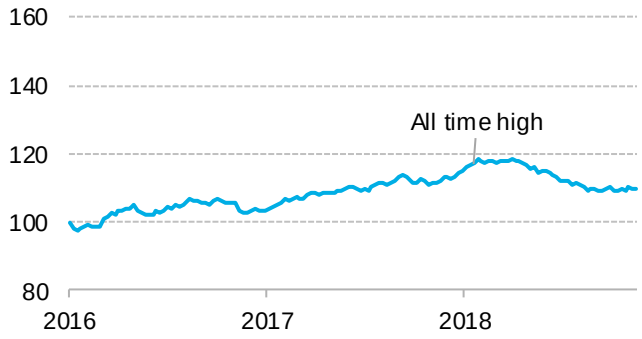
measuring performance across a basket of 24 leading emerging markets. Both indicators in 2018 have gone through their longest routs since their founding in the 1990s (Figure 11 and Figure 12).

Figure 11: MSCI Emerging Markets Equity Index



Source: Bloomberg Terminal. Note: the MSCI equity index covers 85% of the free float-adjusted market capitalization of 24 leading emerging markets across the world.

Figure 12: MSCI emerging market currency index



Source: Bloomberg Terminal. Note: the MSCI currency index covers 24 leading emerging markets across the world.

3.2. Economic fundamentals

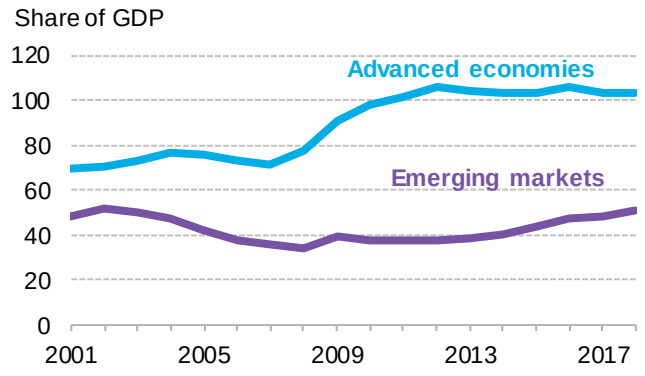
With the U.S. Federal Reserve signaling it plans to raise rates again in coming months, further tightening of global liquidity and further strengthening of the dollar are likely. Yet developing economies appear better equipped to weather macroeconomic headwinds than ever before.

In the wake of the 2008 financial crisis, countries capitalized on quantitative easing and low interest rates to accumulate significant piles of what was then cheap debt. Companies in emerging markets also waded into the fray, racking up $3.8 trillion of overseas bonds outstanding as of the end of March 2018, up from $1.3 trillion at the start of 2010. Economies as diverse as China, Peru, Chile and Vietnam were among those most active in taking advantage of the abundance of cheap funding.

Past profligacy may now be starting to catch up with borrowers, both in wealthy and less developed nations. With dollars accounting for more than three quarters of foreign currency debt in emerging markets, developing nations are said to be on the brink of an unprecedented refinancing peak, with up to $2.9 trillion of emerging market bonds set to mature by year-end 2019.

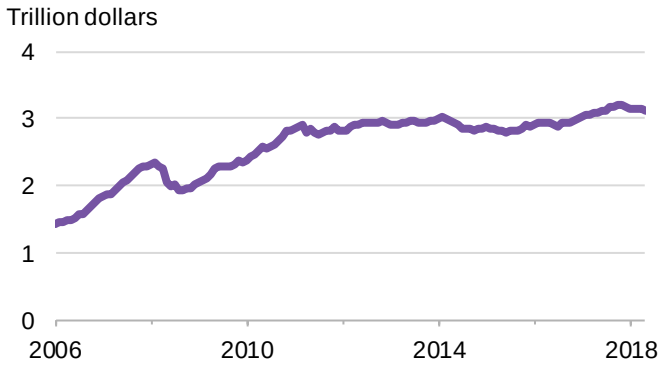
Still, levels of developing country indebtedness have remained largely stable for the last two decades. Following the 2008 financial crisis, such nations notably took on far fewer liabilities than wealthier nations (Figure 13). There is also the more optimistic view that today's borrowing from emerging countries reflects improved access to financial markets and countries' greater ability to issue bonds unilaterally in support long-term investments, such as infrastructure projects.

Figure 13: Global debt to GDP ratios



Source: International Monetary Fund, BloombergNEF. Note: For a full list of countries included in the IMF's "Advanced Economies" classification see here.

Figure 14: Top 12 emerging market foreign currency reserves (excluding China)



Source: Bloomberg Terminal Note: For a full list of countries included in the IMF's "Advanced Economies" classification see here.

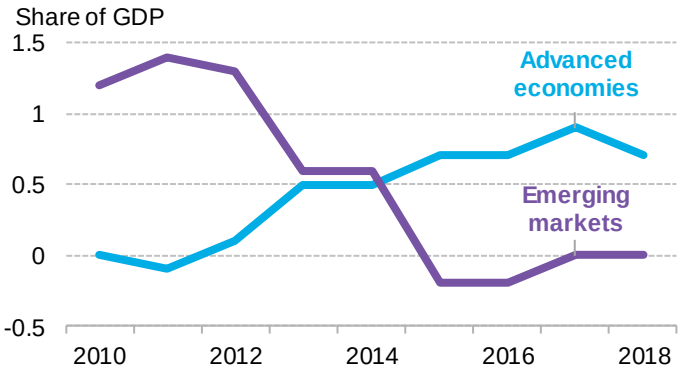
Emerging markets also have more control over their currencies than ever as the vast majority of these are no longer directly pegged to the dollar. Moreover, these nations have higher foreign exchange reserves, putting their domestic central banks in better position to take action to weather economic downturns, if needed. As of April 2018, foreign reserves for the 12 largest developing economies (excluding China) were up 40% from 2010 levels and surpassed $3.2 trillion for the first time (Figure 14).

This is good news for some particularly renewables-friendly markets. Mexico's foreign reserves, for example, nearly doubled between 2010 and 2018 to $178 billion. Still, there are major disparities. Countries whose economies heavily rely on commodity exports can burn through such reserves extremely quickly. Saudi Arabia alone, for instance, used almost $1 trillion from 2015 to 2018 to shore up its economy and finance its government budget.

Current account balances, which broadly measure a country's exports minus its imports, can also serve as a barometer of a nation's economic health. Countries that rely heavily on exports of natural resources such as metals, timber, or other products can see their current account balances dwindle during global economic downturns. Compensating for shortfalls requires greater foreign capital inflows, which can be a difficult feat during periods of low confidence. Another option for countries is to tap into foreign exchange holdings.

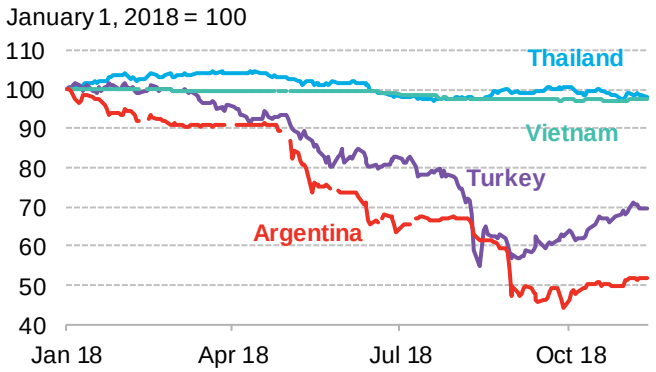
Taken as a group, developing nations' account balances stopped deteriorating in 2015 and have even rebounded slightly since (Figure 15). At a country level, Indonesia, South Africa, Argentina and Turkey – countries whose currencies have suffered the most in 2018 – all have significant current account deficits. Meanwhile, countries like Thailand and Vietnam that each run large current account surpluses have seen their currencies remain stable through the volatility of 2018 (Figure 12).

Figure 15: Global current account balances



Source: International Monetary Fund Note: For a full list of countries included in the IMF's "Advanced Economies" classification see here.

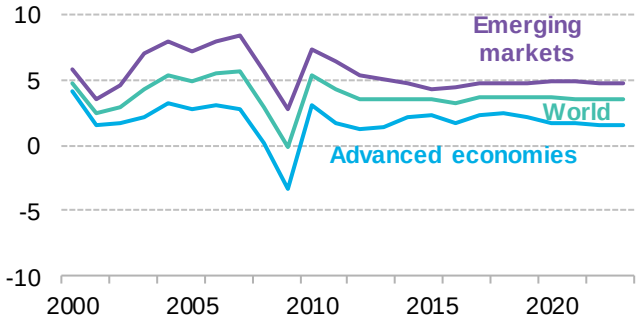
Figure 16: Normalized U.S. dollar exchange rates for select emerging market currencies



Source: Bloomberg Terminal. Note: gaps in data are due to market closures.

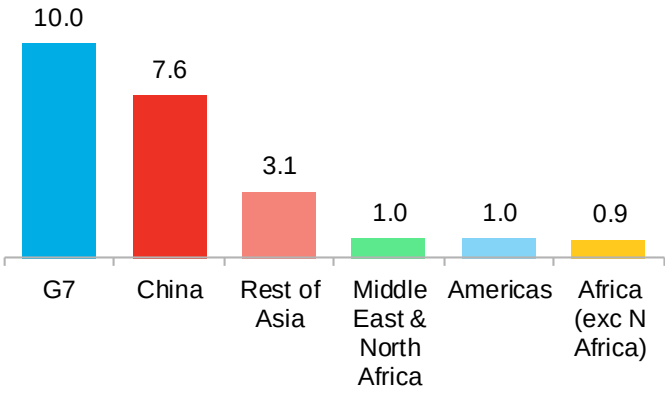
While not achieving growth levels seen prior to the financial crisis, emerging markets are now picking up the pace: average real GDP growth rates have been firm each year since 2015 (Figure 17). Looking ahead, the International Monetary Fund predicts that the current growth will continue apace through 2023 and provide a sizeable buffer against the expected continuing decline of global liquidity. Developed nations, meanwhile, are set to see their collective annual growth rate decelerate from 2.5% in 2018 to 2.2% in 2019. Together, emerging markets are anticipated to add $3.5 trillion more GDP to the world economy between 2017 and 2023 than are G7 nations (Figure 18).

Figure 17: Global economic growth rates, % year-on-year



Source: International Monetary Fund Note: For a full list of countries included in the IMF's "Advanced Economies" classification see here.

Figure 18: 2017-2023 anticipated GDP growth in G7 economies and emerging markets, $trillion (nominal)



Source: International Monetary Fund

Inflationary pressures have also broadly eased even with the recent turmoil. A recent International Monetary Fund (IMF) study showed that despite periods of sustained dollar appreciation, sharp

fluctuations in commodity prices and the 2008 financial crisis, consumer prices in emerging countries have remained low and stable since the mid-2000s. This stands in sharp contrast to the inflationary chaos of the 1990s. Inflation in developing nations has been improving in recent years and hit a record low of 2.8% in August 2018, just as markets were roiling from Turkey's misfortune, suggesting that fears of impending, widespread contagion may well be overstated.

3.3. Diverging outlooks

Investors' tendency to view all emerging market investments monolithically can obscure important nuances between nations. Each country that has been part of the contagion conversation in recent months has its own unique story to tell.

Prior to the recent crisis, Turkey's economy was showing signs of weakness, with its current-account balance down and inflation rate up. Turkish businesses have enjoyed a glut in dollar borrowing, boosting private debt to 70% of GDP as of the summer of 2018, up from 40% in 2010.

Figure 19: Economic indicators for select emerging markets, Japan, the U.S. and France

	GDP growth 2018	Inflation Q3 2017-18	Current account balance 2018	External debt 2018	Five-year YoY average 2013-17: Generation growth	Five-year YoY average 2013-17: Electricity demand growth
Rwanda	7.2%	3.3%	-8.9%	37.6%	9.5%	8.7%
Philippines	6.5%	4.9%	-1.5%	23.3%	5.9%	5.2%
Kenya	6.0%	5.0%	-5.6%	29.7%	7.7%	6.1%
India	7.3%	4.7%	-3.0%	32.5%	6.3%	4.2%
U.A.E.	2.9%	3.5%	7.2%	61.2%	4.5%	5.0%
Malaysia	4.7%	1.0%	2.9%	69.3%	4.7%	4.4%
Thailand	4.6%	0.9%	9.1%	32.8%	0.9%	1.9%
Peru	4.1%	1.4%	-1.8%	31.5%	3.9%	4.8%
Senegal	7.0%	0.4%	-7.7%	75.1%	8.1%	1.6%
Chile	4.0%	2.4%	-2.5%	38.1%	3.7%	3.4%
Uruguay	2.0%	7.6%	0.9%	65.4%	6.3%	2.1%
Morocco	3.2%	2.4%	-4.3%	48.0%	3.8%	3.2%
Mexico	2.2%	4.8%	-1.3%	19.7%	2.7%	2.7%
Kazakhstan	3.7%	6.4%	-0.2%	105.1%	2.5%	3.3%
Jordan	2.3%	4.5%	-9.6%	65.5%	4.6%	3.0%
Brazil	1.4%	3.7%	-1.3%	73.1%	1.3%	2.3%
Namibia	1.1%	3.5%	-6.0%	60.6%	-1.0%	3.4%
Argentina	-2.6%	31.8%	-3.7%	36.8%	1.4%	3.2%
Japan	1.1%	1.1%	3.6%	74.0%	0.0%	-1.0%
U.S.	2.9%	2.6%	-5.1%	94.0%	0.0%	-3.0%
France	1.7%	2.3%	-6.0%	213.0%	0.0%	0.0%

Source: BloombergNEF, International Monetary Fund

As medium-term investors, renewables project developers must pay heed to a mixed bag of fundamental economic and energy sector indicators (Figure 19). Focusing on countries BNEF deems ripe for future renewable energy investment, the economies investigated display the full range from febrile to strong. The diversity of conditions and challenges facing different developing nations serves as a warning against taking a broad-brush approach.

Figure 20: Fundamental renewables sector indicators for select emerging markets

	Offtaker risk	Policy score	Gap to target	Bankable PPAs	Five-year Investment to GDP	Five-year Investment in billion $
Jordan	Low	7	Medium	Yes	8.4%	3.4
India	Very low	6	Large	Yes	1.7%	45.1
Philippines	Very low	5	Large	Yes	1.8%	5.7
Mexico	Very low	5	Large	Yes	1.4%	15.6
Malaysia	Very low	6	Medium	Yes	0.3%	0.9
Chile	Very low	4	Small	Yes	4.4%	12.2
Thailand	Very low	5	Small	Yes	0.6%	2.7
Uruguay	Low	3	No target	Yes	9.1%	5.4
Kazakhstan	Low	5	Large	Yes	0.4%	0.6
Morocco	Very low	3	Small	Yes	2.5%	2.7
U.A.E.	Very low	2	Large	Yes	0.7%	2.7
Rwanda	Low	2	Large	Yes	4.5%	0.4
Senegal	Very low	3	No target	Yes	2.5%	0.5
Argentina	Low	4	Large	Yes	0.4%	2.3
Peru	Very low	3	No target	Yes	1.5%	3.2
Brazil	Low	4	No target	Yes	2.3%	46.6
Kenya	Low	3	No target	Yes	3.5%	2.8
Namibia	Low	3	No target	Yes	0.6%	0.1

Source: BloombergNEF, International Monetary Fund Note: Offtaker risk is defined as the probability that the entities responsible for electricity procurement fail to meet their contractual obligations. Policy score ranks countries on the diversity of renewable energy-oriented policies across seven areas. Gap to target rates the progress yet to be made in meeting a country's national clean energy target. Bankable PPAs confirms the possibility of concluding power purchase agreements of a tenor of 15 years or greater. The two investment metrics track renewables asset finance-related investments over five years (2013-2017).

Strong or weak economies do not necessarily correlate with strong/weak clean energy investment, Climatescope shows. As part of the survey, BNEF analysts sought to assess the relative levels of risk presented by offtakers (buyers of power, often state utilities) in specific nations. A selection of these is shown above.

In theory, offtaker risk should be comparatively low in countries that demonstrate strong economic data because utilities there enjoy plentiful and growing demand for electricity. Utilities in such countries should also be less likely to fall behind on tariff payments back to generators for the same reason. But economic conditions are by no means the only factors behind public utilities lapsing into arrears: political priorities and administrative inertia are often to blame.

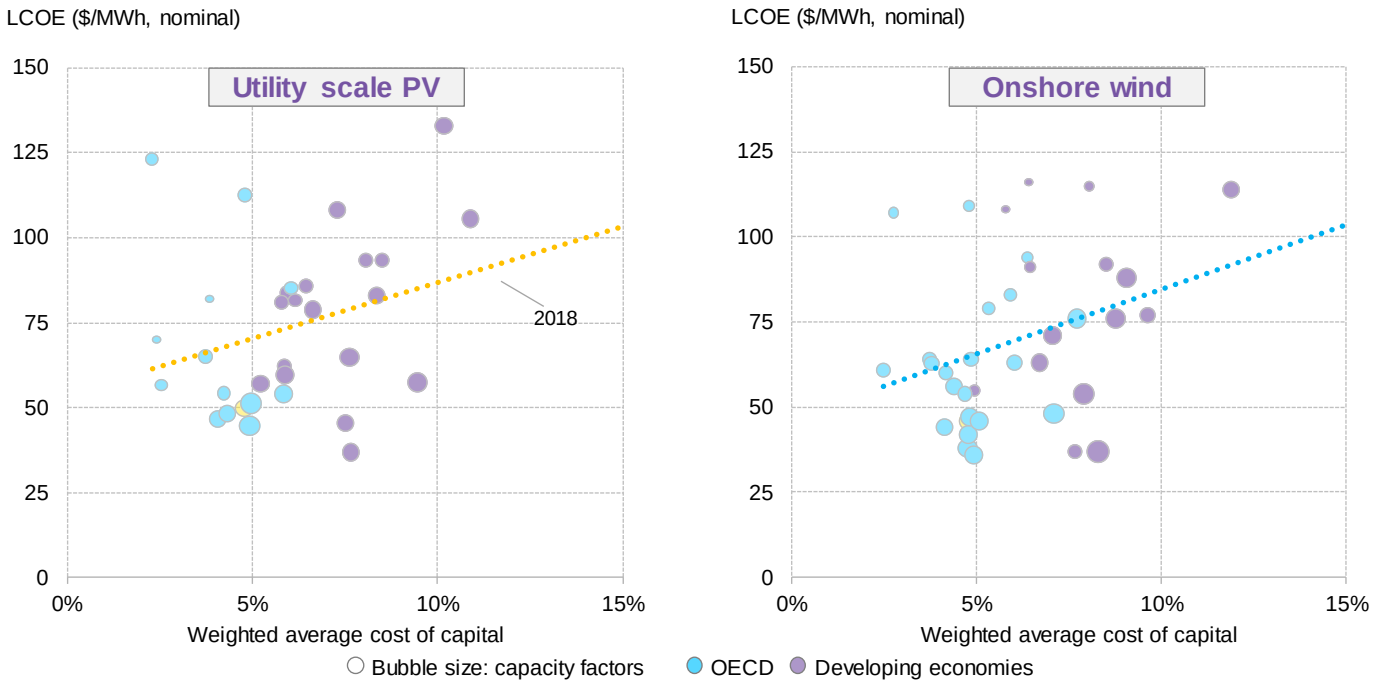
3.4. Risks and mitigation techniques

However favorable the economic conditions or strong the demand, renewable energy developers operating in developing countries must navigate risk by evaluating opportunities while employing hedges to minimize exposure. While renewable technology costs have dropped dramatically over the last several decades, upfront expenses remain high.

There are also the higher costs of capital typically involved with financing clean energy in developing nations and this has historically resulted in a segregation between wealthy and less developed countries. In OECD countries, the benchmark weighted average cost of capital (WACC) to finance a typical wind or solar project for 2017-18 ranged from 2.5-6.5%. Meanwhile, in emerging economies, the benchmark ranged from 5-11% (Figure 21).

Differences in financing terms translate directly into higher total estimated levelized costs for projects (and should dictate the price at which developers can promise to deliver power to the grid). As a result, developing economies have tended to be home to some of the highest LCOEs across the world.

Figure 21: Impact of financing costs on country LCOE benchmarks for utility-scale PV (left) and onshore wind (right)

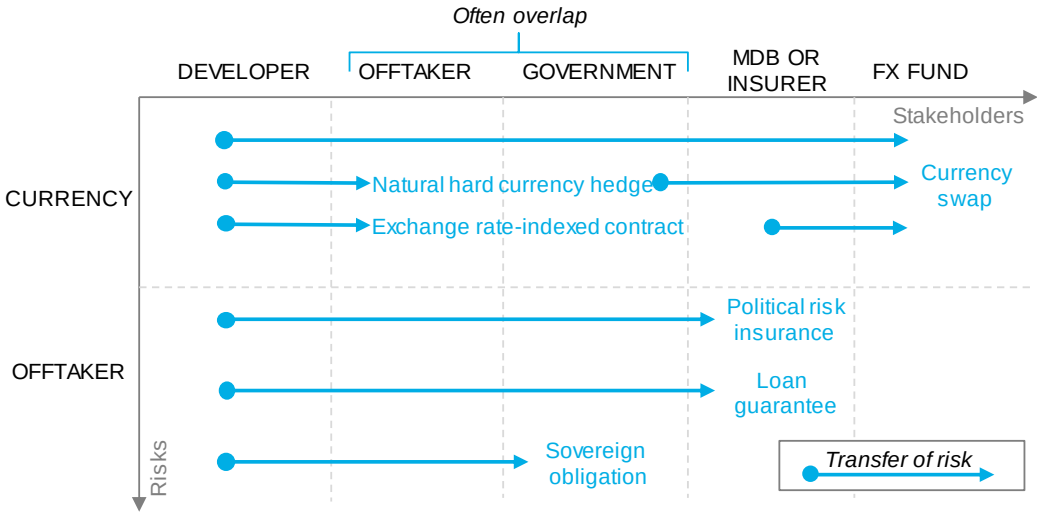


Source: BloombergNEF. Note: The weighted average cost of capital it is a measure of how much it costs to finance a project.Notes: analysis based on 1H 2018 BNEF LCOE estimates.

Lower system costs or better renewable resources can to some degree compensate for an unfavorable investment environment. A good example for this is India, which despite its relatively high average WACC for renewables (around 8% today for wind and solar, down from 12% in 2017) has some of the lowest levelized costs for solar and wind at around $40/MWh. This is mainly due to India's very competitive environment, which forces renewable developers to achieve comparatively low capex and opex by global standards.

A variety of measures and instruments to mitigate developer risk in emerging markets have been deployed to date (Figure 22).

Figure 22: Risk mitigation pathways



Source: BloombergNEF

Offtaker risk

Among these are financial de-risking instruments, most often offered by multilateral development banks (MDBs). These include:

- **Partial loan guarantees:** Issued by the likes of the World Bank Group's International Development Association, partial loan guarantees involve the multilateral development bank, or MDB, assuming part of the risk of default that would otherwise have to be shouldered by a local financial institution. This tool has proven effective in opening additional funding streams stemming from domestic and international lenders who might otherwise be skeptical of clean energy projects due to lack of experience. Loan guarantees are particularly effective in countries with shallow, immature capital markets.

  Yet partial loan guarantees often depend on a government's goodwill, as they typically require the host government to reimburse the MDB should the borrower default on its obligations. This has the added consequence of limiting the scope of action to that afforded by the government's solvency – guarantees are hard to countenance when state coffers are in the red. Moreover, due to their administrative complexity, partial loan guarantees can take a significant amount of time to evaluate and process.

- **Political risk insurance (PRI):** With the risk of upheaval very real in many developing countries, PRI indemnifies against losses incurred by a range of eventualities. Typical policies cover areas such as expropriation, war and civil disturbance, and breach of contract – the latter can apply to unforeseen policy changes affecting the terms of a power purchase agreement (PPA).

  PRI policies are underwritten by institutions ranging from MDBs to private actors. The Multilateral Investment Guarantee Agency of the World Bank Group is one of the more prominent providers. Compensation provided by PRI offers a strong layer of protection that can facilitate a project's access to finance.

  But financial risk cannot be entirely removed from the equation. Insurance pay-outs can take a long time to be disbursed, as they are often only awarded if the insured party has sought redress through arbitration. The loss of revenue incurred in the meantime can be substantial.

- **Sovereign guarantees:** Given the, at times, shaky standing of local offtakers, governments can play a critical role in reducing developer risk by guaranteeing PPA payments. In many developing countries, state-owned utilities serve as the only buyers of clean power from producers. Sovereign guarantees see the government backstopping such PPAs and shoring up state-owned electricity companies to protect their credit standing.

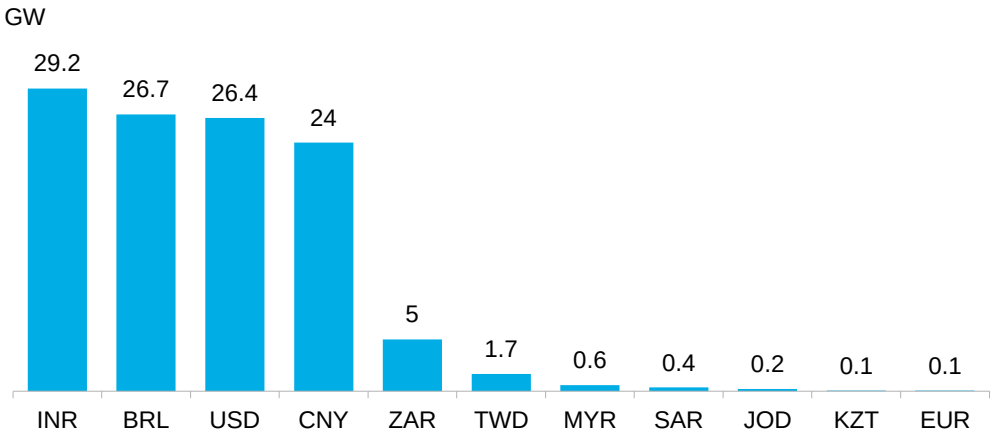
  When sovereign guarantees have been offered, default rates on PPAs have been shown to be quite low, at least in the African context. Governments typically apply a high degree of scrutiny to contracts before offering them. However, sovereign guarantees do not prevent payments being delayed as they are typically only triggered as a last resort.

Currency risk

Currency exchange risks are inherent in most clean energy projects in developing nations. These are inextricably bound to broader risks countries face such as economic downturns, policy shifts and security worries. But there are methods for specifically addressing currency fluctuations. These include:

- **Power-delivery contracts signed in hard currencies:** The simplest currency risk mitigation tool is to allow developers of projects to be compensated not in local currency but in U.S. dollars, or another hard currency. Under some reverse auction schemes, developers simply sell their power and receive payment in greenbacks. In other cases, such as in Mexico, they sell in local currency but with indexation to pre-agreed dollar exchange rate. Figure 23 highlights the volume of contracts signed in developing countries split by currency.

Figure 23: Emerging market auctioned clean energy delivery contracts by currency in which they are denominated, 2003-1H 2018



Source: BloombergNEF. Note: INR = Indian Rupee, BRL = Brazilian Real, CNY = Chinese Yuan, USD = US Dollar, ZAR = South African Rand, TWD = Taiwan New Dollar, MYR = Malaysian Ringgit, SAR = Saudi Riyal, JOD = Jordanian Dinar, KZT = Kazakhstani Tenge, EUR = Euro.

- **Hedging strategies:** As many offtakers refuse to sign contracts in currencies other than their own, other strategies have been devised to protect project owners from currency fluctuations. These can include derivatives for hedging, for instance currency swaps agreed with third-parties. Such exchanges take a variety of forms, but all hinge on the same basic concept: one party borrows one currency from another party, lending another currency in return. The

amount of repayment is fixed at a rate determined at the start of the contract, allowing an emerging market investor protection against future local currency devaluations.

While the tenor of such deals ranges from one to 30 years, swaps typically mature within a decade. This offers developers a strong hedge against currency fluctuations across much of a PPA's duration. However, such derivatives are not just used by independent power producers (IPPs) – currency swaps are widely employed by governments as well as MDBs. Despite the existence of myriad variations of either category, such derivatives typically come in two main forms.

- A currency option gives its owner the right – but not obligation – to buy or sell a given amount of currency at a set price. The terms of the option can differ: some allow the owner to use the option at any time until the expiry date, while others will only be accessible on the expiry date. Given their inherent flexibility, options charge an additional premium that reflect factors such as the option's tenor and the volatility of the currencies involved.
- In the case of currency swaps concluded as forwards or futures, both parties agree to perform a swap, locking into repayment disbursed at a predetermined date and exchange rate. While cheaper than options, such derivatives come with a degree of inflexibility. Their owners have no choice but to commit to making the swap, regardless of the fact that changing exchange rates may leave them with little to gain in carrying out the transaction.

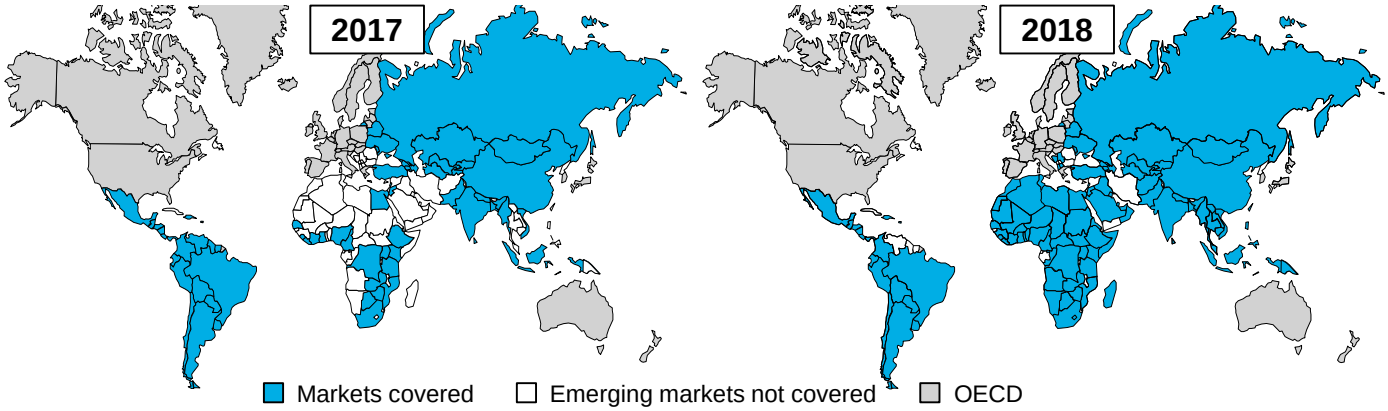
Hedging derivatives may be highly useful as a means of mitigating local currency risk, but they do not come cheap. Researchers at Stanford University using Bloomberg Terminal data found the average yearly cost of currency hedging in India, where most PPAs are invoiced in rupees, totalled approximately 7%. That extra debt cost adds up, not least because such instruments involve getting charged twice for risk – for the premium on the swap's default risk plus the costs already levied on the underlying debt.

Section 4. Scope and methodology update

4.1. Scope

This year's Climatescope covers an expanded universe of nations. In spring 2018, the team set out to research every non-OECD market with over 2 million inhabitants, plus Chile, Mexico and Turkey, which are defined as OECD countries but are among the most attractive emerging markets for clean energy. Cuba, Iran, North Korea and Yemen are not in the coverage due to local conflicts or international sanctions affecting them. The result is a country-level assessment of clean energy sector activity in 103 markets, up from 71 in 2017 (Figure 24).

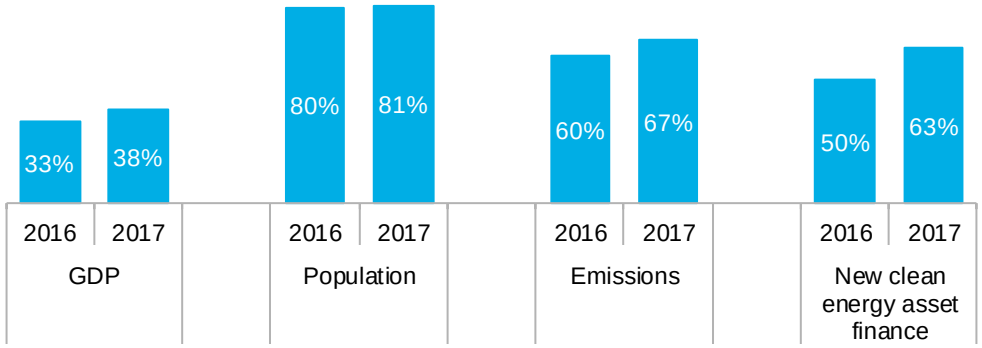
Figure 24: Countries covered in Climatescope



Source: BloombergNEF

The presence of demographic and economic giants Brazil, China, India and Nigeria in previous editions means that the change to the world GDP and population coverage of this year's Climatescope is not as significant as the expansion in geographic coverage suggests (Figure 25). However, the inclusion for the first time of important clean energy markets such as Thailand, Morocco and the United Arab Emirates has led to jump in the share of global renewables asset finance covered.

Figure 25: Share of world totals covered in this year's Climatescope vs. last year



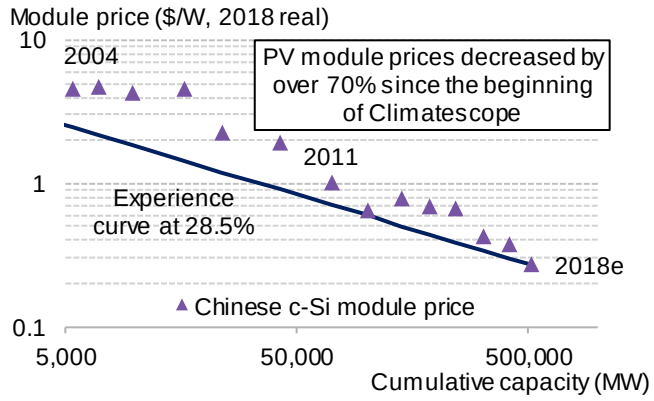
Source: BloombergNEF.

4.2. Methodology

After six editions built around Climatescope's original methodology conceived in 2011, and complemented with off-grid indicators from the 2014 edition on, we have made significant updates to the methodology for 2018. The main driver behind this decision is the transformation of the energy sector brought about by a renewables revolution.

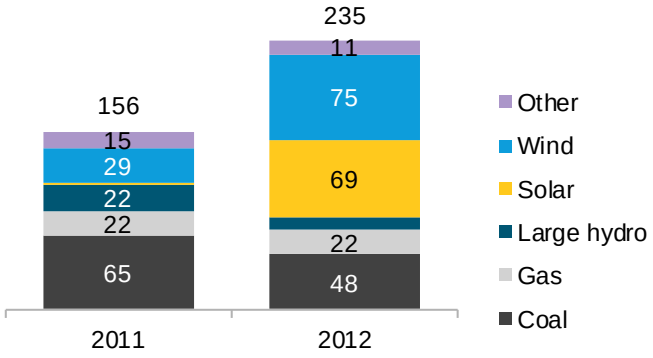
The clearest representation of how much the world has changed since 2011 is the 70% drop in the cost of Chinese-made PV modules (Figure 26). This in turn has transformed clean energy activity around the world. The 103 countries included in this year's Climatescope installed 29GW of onshore wind in 2011, which was then a mature sector in some key markets like Brazil, but just 2GW of solar (Figure 27). This compares to 75GW of wind and 69GW of solar net capacity additions in 2017, the first year emerging markets installed more renewables than fossil capacity.

Figure 26: PV module experience curve



Source: BloombergNEF

Figure 27: Net capacity additions in emerging markets (GW)



Source: BloombergNEF

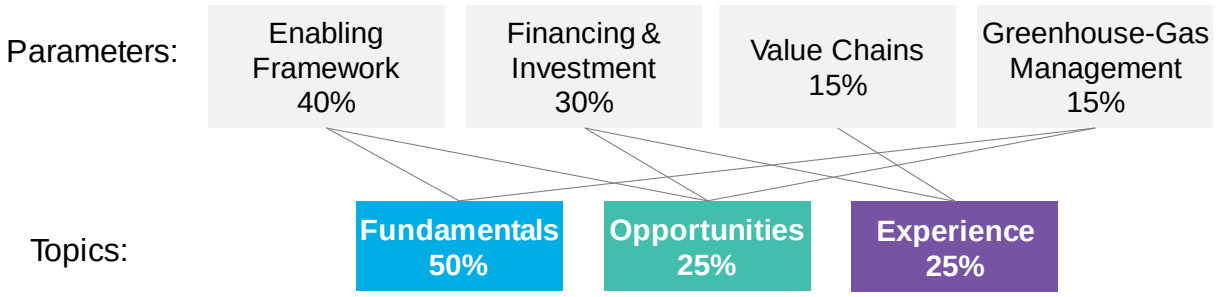
This update also gave BNEF the opportunity to incorporate learnings from our last seven years of conducting research in emerging markets. The result is a more streamlined methodology, moving from four *Parameters* to three *Topics*:

1. **Fundamentals.** This Topic encompasses a country's clean energy policies, power sector structure and regulation as well as any local barriers that might obstruct renewable energy development. A country with comprehensive and strong policies and a more liberalized power sector tends to be more welcoming to private investment than one with weaker frameworks and less liberalization. This Topic seeks to assess the fundamental structures that can help clean energy flourish.
2. **Opportunities.** This includes a country's current and future electricity demand, its energy consumption, and its CO2 emissions from the power sector, along with overall price attractiveness, short- and medium term opportunities for renewable energy procurement, history of corporate commitment with sustainability and existing electrification rates. This Topic seeks to encapsulate the future opportunities for clean energy growth available in a country.
3. **Experience.** This includes a country's volume of installed clean energy, historical levels of renewable energy investment and the comprehensiveness of its non-manufacturing clean energy value chains. Markets with greater experience deploying renewable energy capacity typically offer lower risks, lower technology costs and lower costs of capital for investors.

This Topic seeks to reflect a country's track record in successfully hosting clean energy development.

Aside from improving overall clarity, the main objective of the reorganization of indicators was to better isolate information on each country's achievements to date. That information could then be better used to assess the country's short- to medium-term potential.

Figure 28: Previous Climatescope Parameters vs. current Climatescope Topics and weightings



Source: BloombergNEF. Note: percentage refers to the weight of each topic and paramater in building the total score.

It is important to note that several key indicators are levelized against a country's gross domestic product, population, installed capacity and generation. The methodology seeks to take into account and then discount the fact that some nations attract larger volumes of capital simply because they are bigger. The new methodology includes a total of 165 indicators and sub-indicators, down from 195 in 2017.

Table 1: List of indicators (no formatting**) and sub-indicators (***italic***) in order of appearance in Climatescope 2018 – indicators only applied to off-grid countries are underscored**

Fundamentals	Opportunities	Experience
Policy score (auctions, FiT, taxes,etc)	*Emissions from the power sector* - New	Clean energy investment
Ambition of NDC	*Share of emissions from energy* - New	Growth of clean energy investment
NDC target coverage	*Share of fossil fuels in generation* - New	Foreign investment – New
NDC target type	*Coal plant pipeline* - New	Availability of finance
Long term strategy	*GDP growth - 5 year IMF outlook* - New	Clean energy installed capacity
Climate change mitigation incentives	*10 year demand growth projections* - New	Growth of clean energy installed capacity
Climate change mitigation regulation	*Growth rate of generation* - New	Clean energy generation
Domestic climate change law	*Growth rate of peak demand* - New	Growth of clean energy generation
Scope of domestic climate policy	*Power plant modernization program* - New	Biofuels production capacity
PPAs of sufficient duration	Electrification rate	Dedicated off-grid team at utility
Standardized PPAs	Reliability of power supply	Off-grid market building
Retail market liberalization	Population using solid fuels for cooking	Financial institutions in clean energy
Transparent grid extension plan	*Gap to target* - New	Clean energy service providers
Clear rules on interconnection	*Upcoming renewables auctions* - New	Value chains by sector
Wholesale power market – Updated	*Light-handed regulatory framework*	Distributed value chains by sector
Utility privatization	*Offgrid financing facilities*	Distributed clean energy service providers
Utility unbundling	*Rural electrification agency*	
Concentration of generation market	*Rural electrification budget*	
Independent power transmission	*Rural electrification program*	

Interconnection	*SPPs can deliver financial services*	
Wholesale price distortions	*Tax / duty reductions*	
Purchase obligation	Average retail electricity prices	
Clear rules on arrival of the main grid	Average diesel prices	
Cost reflective retail tariffs	Average kerosene prices	
Duration of tariffs	New retail connection cost	
Energy access targets	Import duties for renewables	
Mini-grids: concessions	VAT for renewables	
Mini-grids: licensing	Mobile money penetration	
Mini-grids: threshold	Kerosene and diesel subsidies	
Offgrid energy access target	Corporate emission reduction policies	
PAYG availability	Corporate energy efficiency initiatives	
Tariff deregulation	Investor pressure – PRI signatories	
Currency variation – New	Voluntary GHG reporting by corporates	
Curtailment risk		
Offtaker risk		
Other import barriers		
Other project development barriers		
Other retail barriers		

Note: NDC = Nationally Determined Contribution, SPP = small power producer, PAYG = pay as you go, PRI = Principles for Responsible Investment

Of the main changes made to indicators and their specific methodology, two deserve to be described in more detail:

- **Policy scores.** In previous years, BNEF turned to an external panel of over 60 energy policy experts to review clean energy policies for countries. Each policy in each nation was assessed and scored by multiple experts. Those scores were then combined and blended with third-party indicators on a country's political stability and level of corruption to produce a country's overall policy score. As BNEF expanded Climatescope's coverage to 103 nations and sought to deliver a more harmonized assessment of policy environments, the scoring of individual policies was taken in house. Each BNEF analyst who covered a country scored policies for that country based on their ambition, success in delivering renewables investment, stability, and ease of use by market participants. Analysts' scores were then calibrated during a workshop where all involved in the report and senior staff discussed and, when necessary, adjusted scores.
- **Value chains.** Climatescope 2018 no longer includes indicators associated with a country's manufacturing value chain. This effectively acknowledges that clean energy manufacturing has reached such sufficient scale that some nations are now and likely to remain major producers and exporters, while others are primarily consumers/importers. In previous Climatescopes, the scores of small to medium-sized countries were effectively punished for lacking local manufacturing, regardless of whether establishing such value chains was practical. In fact, such countries may be making the wisest, most cost-effective decisions by procuring low-cost clean energy from elsewhere. We recognize that national governments continue to promulgate policies to support local clean energy manufacturing in the name of economic development. We pass no judgement on whether those efforts have merit. This year's Climatescope methodology update on value chains is simply intended to recognize the

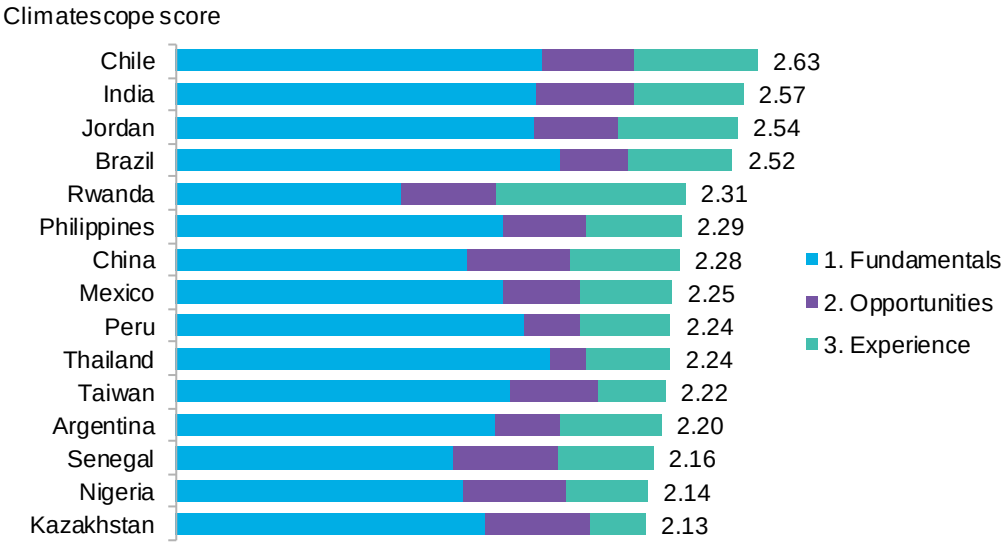
globalized market as it stands today and reward countries that are taking the best steps to promote investment and deployment of renewables as quickly as possible.

For a full description of Climatescope's updated methodology, visit the website.

Section 5. Score review

Rapidly changing market circumstances and an updated methodology produced a very novel set of country scores in this year's Climatescope. A new country topped the overall leader board, while others saw their scores and rankings decline somewhat. Chile ranked first for the first time ever, followed by Jordan, Brazil, India and Rwanda (Figure 29).

Figure 29: Climatescope score of top 15 countries



Source: Climatescope

Chile's ascension to the top slot for the first time was driven by high scores in all three Topic areas. A strong policy environment led by a government committed to accelerate de-carbonization of its energy sector, along with a liberalized power sector structure, put Chile in the third position globally on Topic 1 (*Fundamentals*; Figure 30). With 54% of electricity generated from fossil fuel plants and over a third of the nation's emissions coming from the electricity sector, but strong opportunities for clean energy procurement in the short term, Chile ranked 12th on Topic 2 (*Opportunities*). The country's good enabling environment led to a jump in clean energy capacity and investment over 2014-2017 and great progress in the development of its clean energy value chain. This combined to land Chile 8th on Topic 3 (*Experience*). Despite decelerating clean energy investment caused by lack of transmission between the country's two main power systems, the government remains determined to deal with the complexities generated by high penetration of wind and solar while continuing to reduce power sector emissions and fight climate change.

Figure 30: Top 10 scorers by Topic

Source: Climatescope

India's ambitious clean energy policies and extremely competitive renewable energy market pushed the country to 2nd position. The Indian market is home to the largest and most competitive auctions in the world, which contracted over 10.5GW from wind and solar in 2017 alone. India has also one of the world's most ambitious renewable energy targets. It aims to reach 175GW of clean energy capacity by March 2022, with 100GW coming from solar, 60GW from wind, and 15GW from other sources. The country's solar market almost doubled in size in 2017, making it a record year with annual PV installations touching 8GW.

Jordan's wide portfolio of stable clean energy policies and transparent incentives have propelled the country to 3rd overall in Climatescope 2018. Jordan's clean energy policy framework includes clean energy targets, auctions, renewables portfolio standards that apply specifically to regulated utilities, net metering, and tax and debt incentives. This has facilitated 730MW of wind and solar capacity additions in 2015-2017, with another 1GW currently under construction.

Clean energy investment in **Brazil** has declined in recent years due to the economic crisis, a hiatus in power contract tenders, and a first-ever contract *cancellation* auction. Nonetheless, the country remains one of the main emerging markets for renewable energy deployment and leads on Topic 1 due to a comprehensive and inviting clean energy policy framework, securing the country's 4th place overall. Brazil has pioneered the use of competitive auctions to contract clean energy, and these led to over 24.8GW of renewable energy contracted between 2009 and 2017.

Rwanda rounds out the top five thanks to its unprecedented progress in expanding generation capacity and electrification over the last decade. The country has quadrupled its electrification rate from 10% in 2010 to over 44% in 2018 and increased generating capacity from 85MW to 216MW over the same period. The off-grid sector is expected to make up 48% of Rwanda's electrification rate by 2024, and a healthy group of solar home system providers are now successfully doing business in the country.

China continues to play a major part of the clean energy story globally but fell to seventh in the survey from top of the table last year. The main causes for China's decline were its temporary halt to awarding of subsidies to PV developers, which has left a third of commissioned PV projects without contracts, and its curtailment of renewables in favour of high emitting coal-fired generators. China also continues to be a market that is relatively closed to international investors, especially smaller ones. With a fast growing market that accounted for 68% of the total coal capacity installed in emerging markets in 2017, China scores best in the *opportunities* Topic. On the other hand, due to a not fully transparent, liberalized and standardized power market,

fundamentals is China's weakest Topic. The country continues to have a comprehensive clean energy policy framework, but policy scores and offtaker risk were affected by a major revamp of feed-in tariffs supporting wind and solar. Additionally, Climatescope's updated methodology places greater emphasis on countries' openness to international investors, and less on the availability of local manufacturing capacity. While these changes contributed to China's drop, its unrivaled clean energy investment and potential for de-carbonization ensured it remained in survey's top ten.

Table 2: Top 5 Climatescope scorers

Country	Climatescope rank		Strongest 2018 Topic area	Weakest 2018 Topic area
	Last year	This year		
Chile	7	1	Fundamentals	Experience
India	5	2	Fundamentals	Experience
Jordan	3	3	Fundamentals	Opportunities
Brazil	2	4	Fundamentals	Opportunities
Rwanda	16	5	Experience	Fundamentals

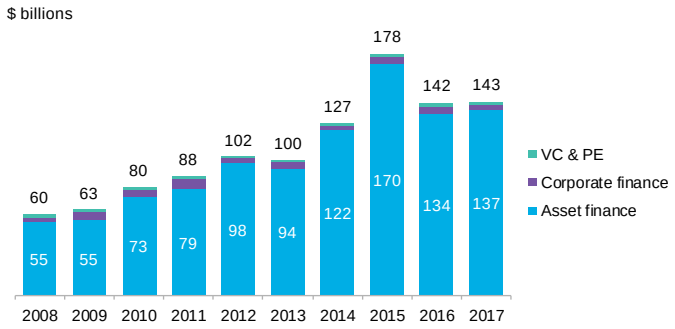
Source: Climatescope

Section 6. Investment

6.1. Global trends

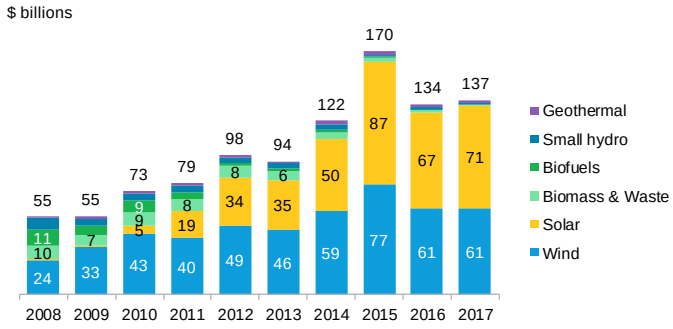
Topline emerging market clean energy investment has remained broadly flat since dropping from the $178.3 billion record witnessed in 2015. The $143.4 billion deployed in the sector last year was just $1.2 billion above the level reached in 2016. Asset financing (investment in large-scale projects and distributed resources such as PV) continues to dominate, accounting for 95% of all flows. This compares to 62% in OECD nations where capital for specialist clean energy companies is often raised at scale over the public exchanges.

Figure 31: Developing country clean energy investment



Source: BloombergNEF. Note: Includes 100 non-OECD nations, plus Chile, Mexico and Turkey.

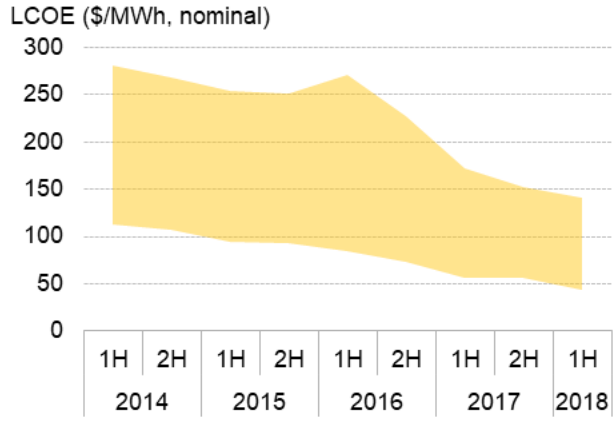
Figure 32: Developing country clean energy asset finance



Source: BloombergNEF. Note: Includes 100 non-OECD nations, plus Chile, Mexico and Turkey. Excludes large hydro.

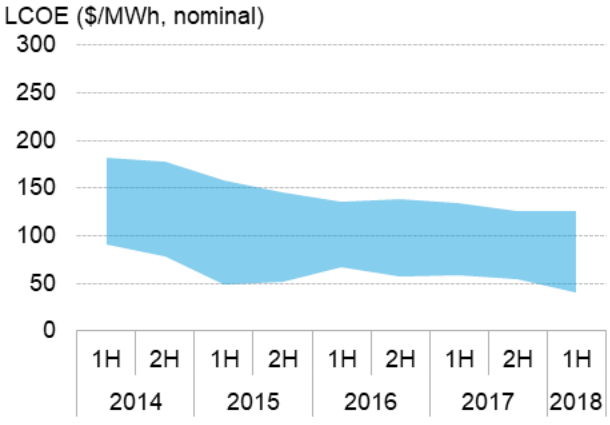
Breaking asset finance flows into sectors reveals the continued dominance of solar and wind over all other technologies. Together, they accounted for 96% of clean energy asset finance in emerging markets. Last year also firmed up PV's place as the most popular renewables technology in emerging markets, recording $10.5 billion more investment than wind – the largest the gap between the technologies since solar leaped ahead in 2016.

Figure 33: Levelized cost of energy benchmarks for utility-scale PV in select developing nations



Source: BloombergNEF. Note: Emerging markets include

Figure 34: Levelized cost of energy benchmarks for onshore wind in select developing nations



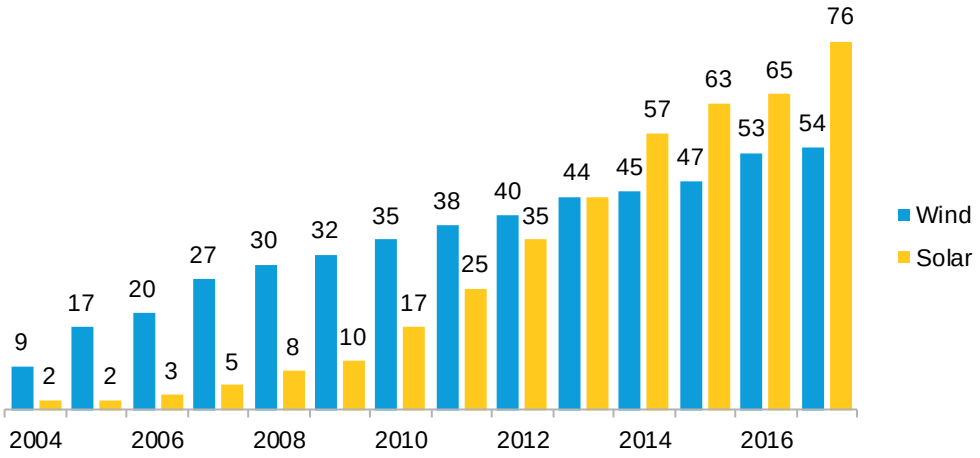
Source: BloombergNEF. Note: Emerging markets include

Argentina, Brazil, Honduras, Panama, Jamaica, Peru, South Africa, United Arab Emirates, India, China, Indonesia, Malaysia, Philippines, Thailand, Vietnam	*Argentina, Brazil, Honduras, Panama, Jamaica, Peru, Kenya, South Africa, India, China, Indonesia, Malaysia, Philippines, Thailand, Vietnam*

The flat-lining of investment in recent years is certainly not a positive trend considering the urgency of scaling up climate change mitigation activities. However, it comes against a back-drop of continued price drops for renewables technologies (Figure 33 and Figure 34). The lower bound of BNEF's benchmark LCOE estimates for both solar and wind broke through the $50 dollar mark per MWh for the first time in the first half of 2018. Meanwhile, the maturing of the renewables sector, its growing international reach and the use of competitive procurement mechanisms such as auctions has compressed the overall LCOE range in emerging markets. This has allowed emerging markets that recorded their first renewables investment to lock in prices that are often close to, or as attractive as, those recorded in more mature markets. Argentina and Armenia's inaugural renewable energy auctions in 4Q 2017 and 1Q 2018 recorded prices below $50 per MWh, for instance.

PV is the clean energy technology that has taken the lead in the race for cost reductions, in particular in emerging markets. Solar offers developers the opportunity to tap into the potential of the most competitive, internationalized and modular energy technology today. This has broadly allowed such projects to avoid the delays and infrastructural challenges that have affected some iconic wind projects in emerging markets such as the record-breaking 352-turbine Lake Turkana complex in Kenya. These trends are most noticeable in the slow opening of new wind markets in developing countries when compared to recent leaps for solar (Figure 35).

Figure 35:Number of developing nations with at least one utility-scale solar/wind clean energy financing, 2004-2017

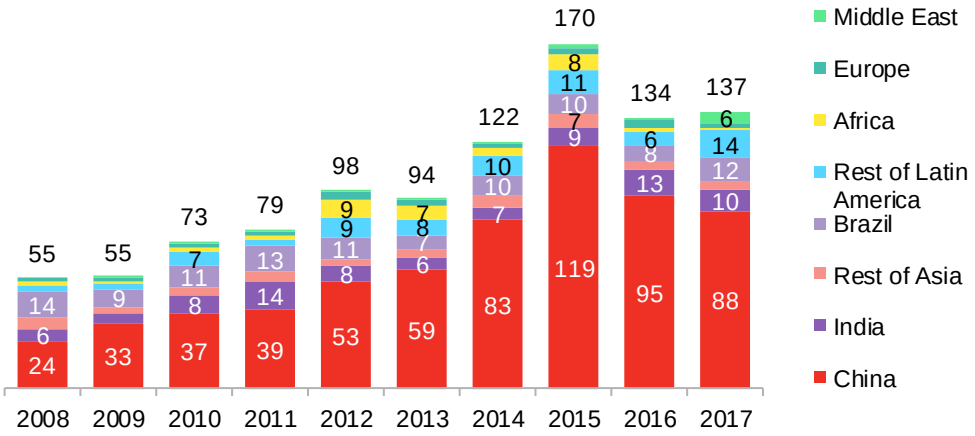


Source: BloombergNEF. Note: utility scale projects are typically larger than 1.5MW. Includes 103 non-OECD nations, plus Chile, Mexico and Turkey.

Solar's growth also resulted in a somewhat more even distribution of clean energy investment across emerging markets in 2017. While China continued to account for the lion's share, its percentage of the total and the absolute amounts invested in the country both dropped, to 64% of the $136 billion invested in 2017, down from 71% of $133 billion a year earlier (Figure 36). Latin America stood out for its dynamism in 2017, recording an $11 billion year-on-year increase thanks to record activity in Brazil, Chile and Mexico, in particular. The Middle East is the other region that stood out, quadrupling investment to $5.7 billion from 2016 to 2017. Egypt, the United Arab

Emirates and Jordan are the region's leaders, recording first financings for assets that had bid into their auctions.

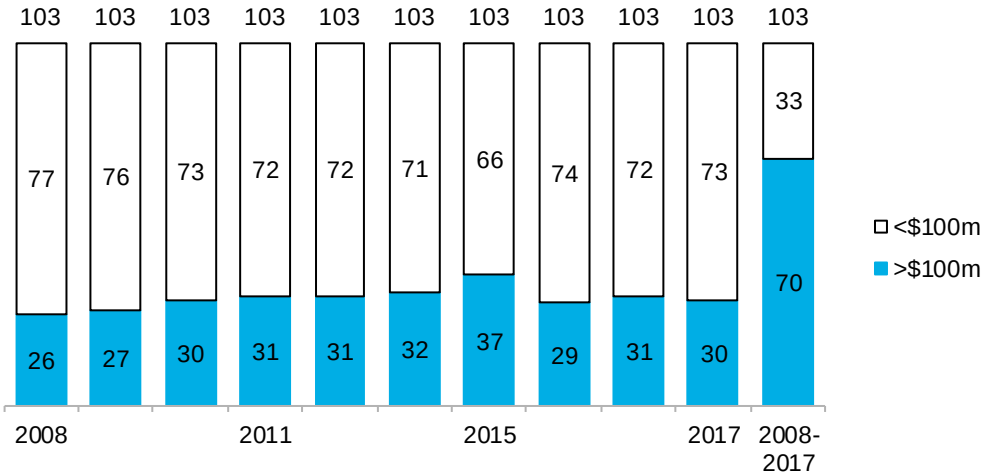
Figure 36: Developing country clean energy asset finance, $ billion



Source: BloombergNEF. Note: Includes 100 non-OECD nations, plus Chile, Mexico and Turkey.

Europe and Africa saw investment drop from 2016 to 2017. Beneath those figures, however, were more nuanced stories. Some 15 out of the 37 countries surveyed in Africa recorded a year-on-year increase in investment while only five recorded drops. But those gains measured in dollars could not overcome declines in the region's two largest renewables markets, South Africa and Kenya. Eastern Europe is the only region BNEF surveyed where fewer countries recorded investment in 2017 than they did in 2016.

Figure 37: Number of countries recording more than $100 million in clean energy asset finance



Source: BloombergNEF. Note: Includes 100 non-OECD nations, plus Chile, Mexico and Turkey.

Despite significant progress, clean energy investment in emerging markets today remains too patchy, too concentrated and too low (Figure 37). Of 103 countries analyzed, only 30 recorded more than $100 million invested. That represents just enough to finance one larger solar or wind project and is a far cry from the levels needed to significantly accelerate energy transition.

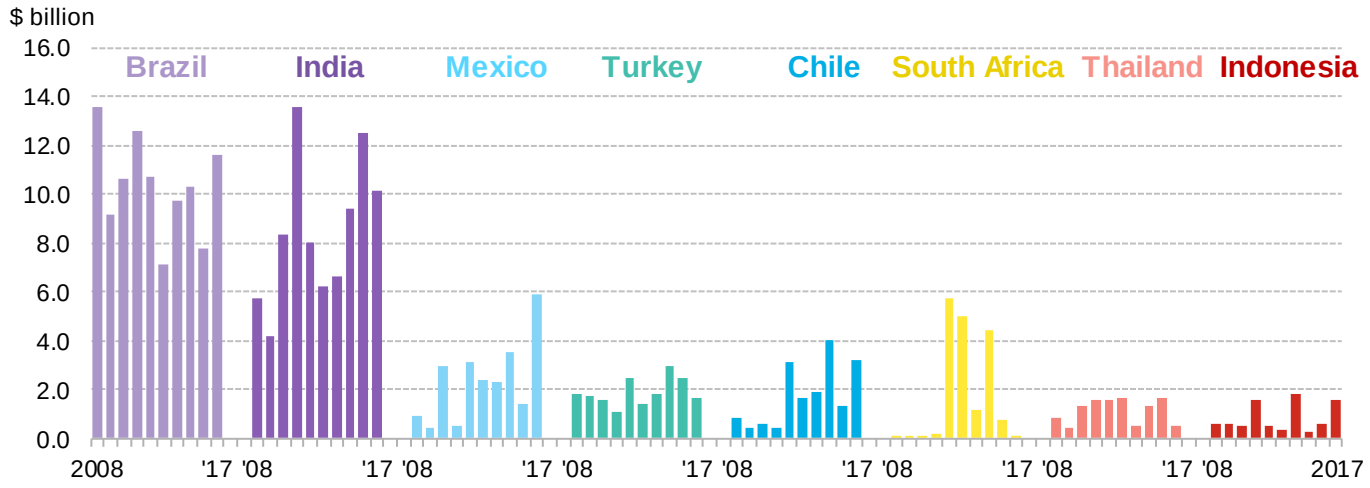
6.2. Leading markets

China will remain the world's largest market for clean energy investment for years to come despite the slowdown seen there since 2015 (Figure 36). However, 2018 was a critical year in the history of the country's clean energy sector and marks the first time China has not placed first in the Climatescope global ranking.

In previous editions of Climatescope, BNEF reported that China was accumulating an unsustainable subsidy budget deficit, which meant that a national fund intended to pay renewables developers above-market tariffs was not receiving sufficient capital injections to cover its obligations to the sector. Drawing parallels with the subsidy budget crisis recorded in a number of European markets between 2010 and 2015, we highlighted that China would either have to resort to unpopular levy increases on retail electricity prices, or inject funds directly from the government's budget, if it was to meet its obligations to the renewables sector.

On June 1, 2018, as one third of commissioned renewables assets still awaited their first subsidy payment, China's government announced it was restricting new solar installations that would require the national subsidy, until a solution to funding the deficit was found. The consequences were enormous. BNEF cut its China new solar installation forecast for 2018 from 37-65GW, to 32-42GW. The move also puts considerable pressure on panel prices as manufacturers try to preserve sales. BNEF now expects module prices to fall 34% in 2018 alone thanks to the change. While we anticipate the price drop will fuel demand outside of China, it will not be of sufficient scale to overcome the installations decline in China created by the policy move.

Figure 38: Clean energy asset finance in top eight emerging markets (ex-China)



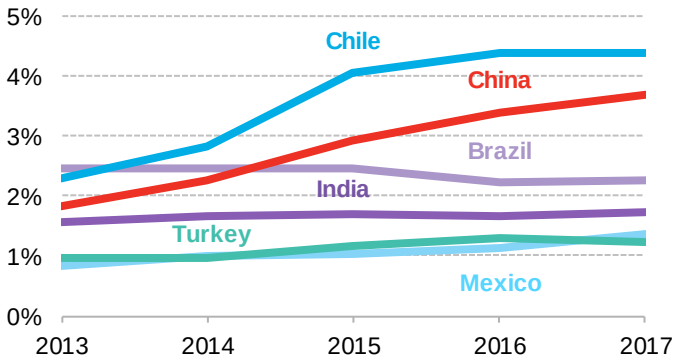
Source: BloombergNEF

Brazil and India deserve important recognition alongside China, having each attracted significantly more clean energy investment than other larger emerging markets over the last decade (Figure 38). In 2017, Brazil's clean energy sector celebrated the end of a severe recession in the country by posting its second-highest year of investment on record, and the government reopened its renewables auction program.

In India, investment actually declined to $10.1 billion from $12.6 billion in 2016. But this is not necessarily a negative as the country has held a series of reverse tenders that have produced cut-throat competition among developers (see next section). Turkey and Chile, which round out

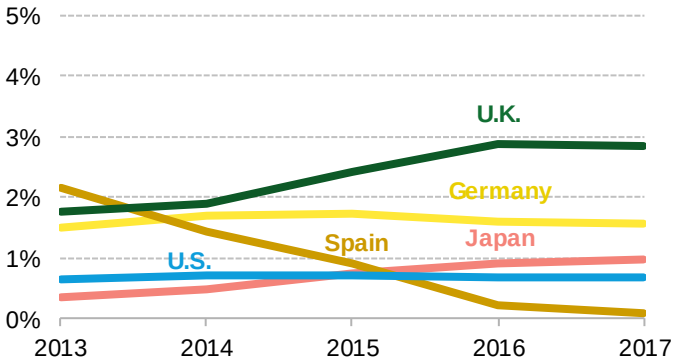
the top five most dynamic markets behind China, have also employed reverse auctions as their main mechanism for fostering development. This is also true of South Africa, but recent political and economic turmoil in the country has particularly debilitated national utility Escom and the energy sector generally. As a result, investment essentially ground to a halt there in 2017. Thailand and Indonesia are two of Asia's most promising markets, but investment continues to be subdued in these nations as they lack ambitious clean energy goals.

Figure 39: Five-year renewable energy asset finance as a share of 2017 GDP in leading developing nations



Source: BloombergNEF. Note: nominal yearly investment figures used against 2017 GDP.

Figure 40: Five-year renewable energy asset finance as a share of 2017 GDP in major OECD nations



Source: BloombergNEF. Note: nominal yearly investment figures used against 2017 GDP.

Comparing the most active clean energy markets in developing countries with their OECD peers on a percentage of 2017 GDP basis, they appear to be advancing their energy transitions faster as a result of the higher investment requirement their growing power markets need. Overall, the largest clean energy markets in emerging economies show higher levels of investment relative to the sizes of their economies than the five largest renewables markets in the OECD (Figure 40).

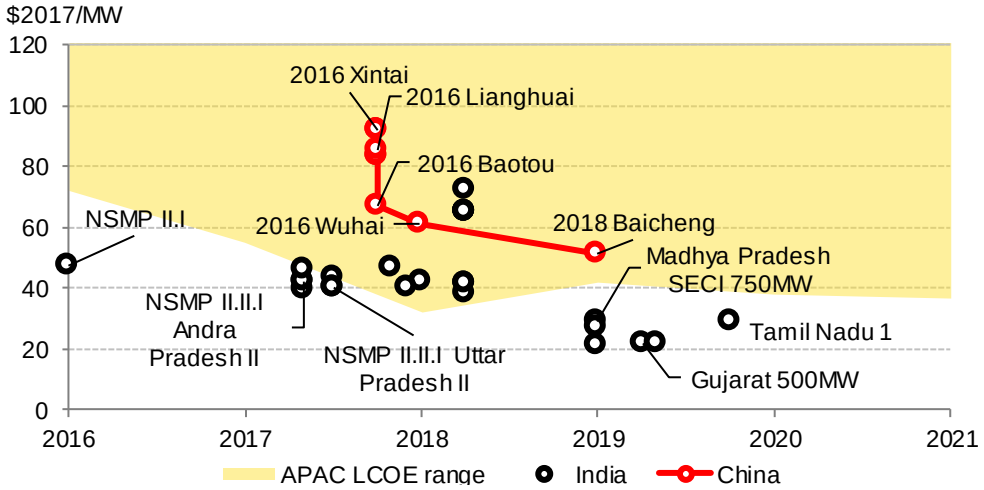
These high levels of clean energy investment have led to similar technical and financial integration challenges in emerging markets as in more developed more markets. China has failed to ensure that its renewables fund received enough capital to cover its commitments to renewables developers. Chile has found that delivering large volumes of new renewables generation to the main demand centers would require major investments in grid infrastructure. And markets like Kazakhstan and Senegal have seen their feed-in tariffs submerged with so many applications that it took both countries several years to pick the best projects. Auctions have become a staple for policy makers to better control renewables deployment and minimize cost, squeezing the cost of projects, and investment figures, in the process.

Clean energy auctions

Hoping to better manage overall build while keeping a lid on public liabilities, governments have increasingly turned to reverse tenders or auctions for procuring new clean energy supply. Auctions have repeatedly proven effective at driving down clean-energy tariffs awarded to projects while giving regulators better control over volumes of renewables added to the grid. As a result, they are often policy-makers' mechanism of choice and the primary way contracts get awarded globally today. Countries that have opted for auctions were able to look across Latin America to learn about tenders, but particularly at Brazil, Chile and Mexico. There, regulators have been using auctions in parallel with wholesale power markets to drive investment in generating capacity from both renewables and fossil-fuel technologies for decades.

An important lesson to draw from Brazil's experience is that regulators were comfortable with auction prices moving in both directions as market conditions shifted. However, today, there are signs that certain regulators are not countenancing this eventuality. In India, for instance, the state of Uttar Pradesh cancelled a 1GW PV auction held in July 2018 because the clearing price of 3.48 Rs/MWh was much higher than the 2.44 Rs/MWh tariff discovered in the federal solar auction held concurrently. The decision came as the national government was rolling out 25% duties on imported solar modules, which not surprisingly resulted in higher auction bids.

Figure 41: Levelized auction bids for India and China, and BNEF Asia Pacific 1H 2018 levelized cost of energy forecast



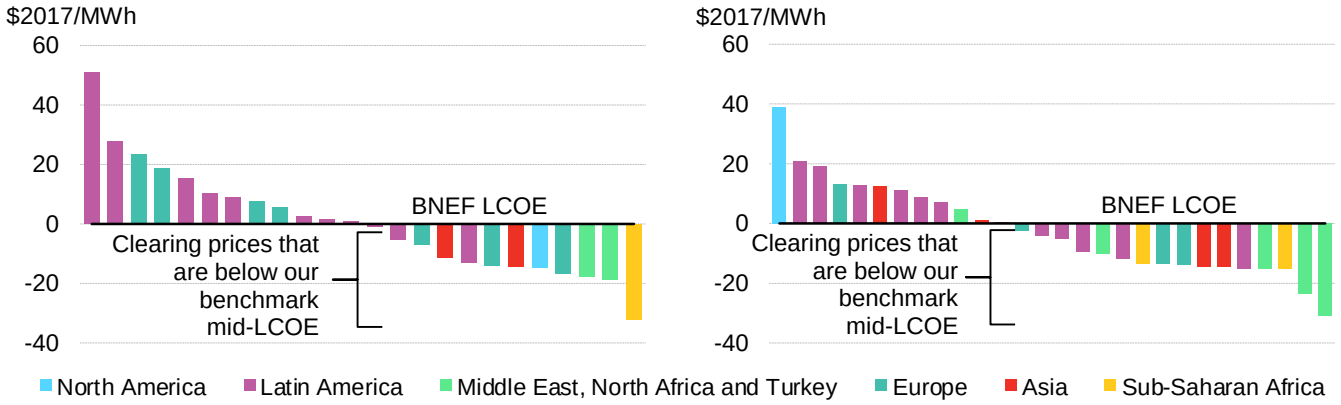
Source: BloombergNEF

In general, India has seen cutthroat competition between solar developers. So much so that projects behind the most aggressive bids are unlikely to withstand a sudden adverse change in market conditions, such as an unexpected increase in equipment costs.

Indeed, the main caveat of auctions is that they ask developers to submit bids that reflect their projections of how the costs and revenues of projects will evolve over their lifetime, from development all the way to decommissioning. Figure 41 plots the lowest bids submitted by projects in auctions in India and China by their anticipated commissioning dates against the BloombergNEF 1H 2018 levelized cost of electricity (LCOE) forecast range for the APAC region. Plotting bids against LCOEs requires analysts to correct for the construction date, the asset's lifetime revenue, and for inflation if the tariff awarded to the project is inflation-linked (which the India tariffs are not).

The chart indicates that several Indian bids are well below our most aggressive LCOE estimates for the region. Developer bets in auctions have often played out in their favor in the past as they have capitalized on renewable technology cost declines, and costs of capital have fallen. However, a growing number of auctions are now clearing at prices way below BloombergNEF estimates of the tariffs needed to ensure project profitability. Figure 42 shows the deviation of levelized auction clearing prices from our benchmark mid-case LCOEs at time of anticipated project delivery for 52 auctions across the globe, for projects to be delivered by 2023.

Figure 42: Levelized PV (left) and wind (right) bids vs. BloombergNEF mid-case LCOE benchmarks at dates of planned project completions



Source: BloombergNEF. Note: sample of 52 auction results across 21 markets in Latin America, Europe, Africa, the Middle East and Asia, with project delivery deadlines ranging from 2017 to 2023. Regional benchmarks used for four countries.

The most extreme deviations from our LCOE benchmarks have almost all been a result of policy design. For example in the U.K., a single auction was used to contract projects across three delivery years. This allowed developers to bid projects for the latest delivery window on offer and bet on continued technology cost declines to increase the profitability of their projects.

Conversely, Turkey and a number of countries in the Middle East (in light green in Figure 42) have reported record low bids that are the result of incentives offered to developers allowing them to bid below what would be an all-in cost reflective bid. This can include the provision of concessional finance by a public bank, agreements on investment in manufacturing capacity or other projects, all of which can push developers to sweeten their bids.

Some extreme bids are also a result of market conditions not playing out the way developers had envisioned. Bidders in South Africa's auctions, for example, had bet on an appreciation of the rand against hard currencies as the country was showing good prospects of economic growth. However, the rand almost halved in value between 2010 and 2016. The fact that the contracts were linked to inflation somewhat softened the impact on project profitability but the country's levelized bids still fell below our LCOE benchmark for the expected time of commissioning.

In India, regulatory risk arising from the sudden announcement of import tariffs on PV modules plus the insolvent status of off-takers (distribution companies, or "discoms") have caused solar project economics to diverge sharply from developer expectations.

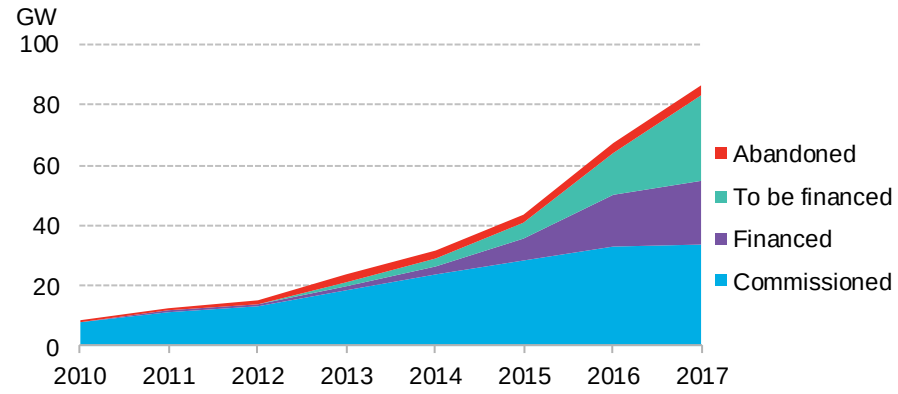
Capital requirements

Auctions have been a critical contributor to the growth of the renewables pipeline globally. BNEF tracked 57.7GW of new capacity contracted via auctions in 32 countries in 2017 alone, with two thirds in non-OECD nations. This is equivalent to all of the world's annual solar and wind installations for 2010, or what was the global cumulative installed capacity of solar and wind in 2005.

The bulging pipeline of tender-contracted projects has also substantially expanded the need for financing. As of 1H 2018, BNEF was aware of 29GW of renewables projects seeking financing after winning contracts in auctions (Figure 43). Several nations, including Mexico, have attracted

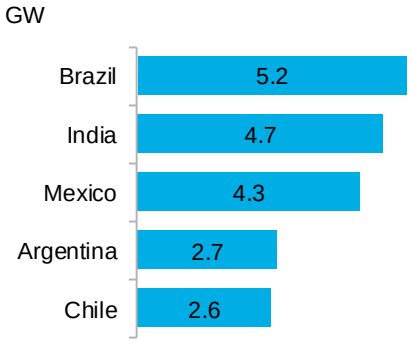
high investor interest as a result of energy market reforms and auction designs. They have built up pipelines of projects to be financed that are larger than their current installed renewables capacity (Figure 44). Outside of auctions, 2018 is set to beat the 2017 record of new project announcements. As of 1H 2018, BNEF tracked 41GW of wind project announcements in developing countries against a 2017 total of 57GW, and the approximately 39GW of PV project announcements over the same period already exceeded the 38GW of 2017. A bit over half of this pipeline is located in China.

Figure 43: Development stage of auction-winning projects



Source: BloombergNEF

Figure 44: Top five countries with largest auction pipelines to finance, 1H 2018



Source: BloombergNEF

With capital requirements of the clean energy sector in emerging markets today at an all-time high, it is certainly an open question as to who will provide the required funding. The following sections review which international investor groups have been the most involved in developing countries to date, and which markets have been able to attract them the most.

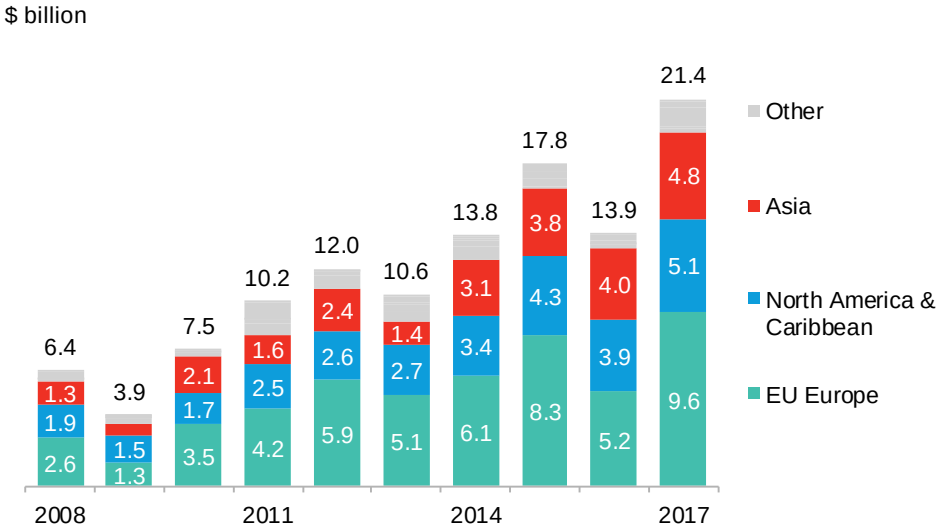
6.3. Foreign investment

Outflows

Regions of origin

International investors based in the EU continue to play a central role in delivering foreign investment into clean energy in emerging markets (Figure 45). Capital outflows from the region nearly doubled between 2016 and 2017, reaching an all-time high of $9.6 billion. Over the last decade, EU-based investors delivered 45% of foreign asset finance in emerging markets.

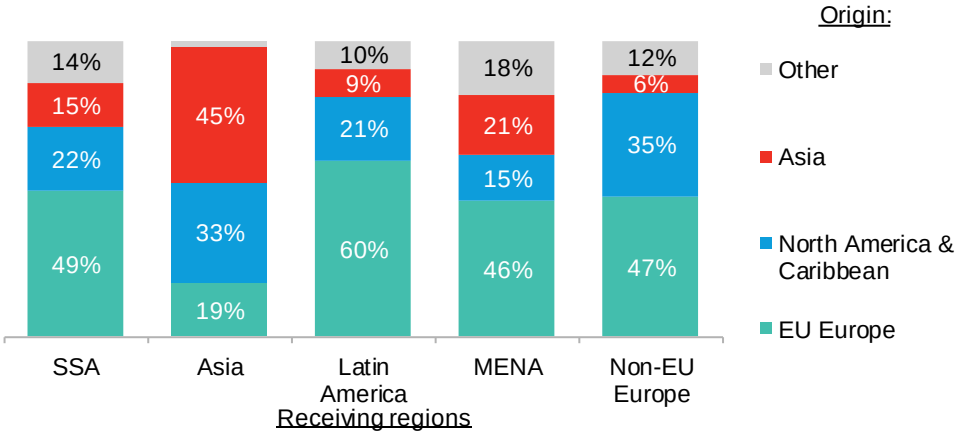
Figure 45: Region of origin of emerging market foreign direct investment



Source: BloombergNEF. Note: Includes 100 non-OECD nations, plus Chile, Mexico and Turkey.

Leading the charge are the region's major international utilities, such as Enel of Italy and EDF of France. However, these are not the only European-based funders and the group is quite diverse, including commercial banks, private equity firms, project developers and industrials, all of which have deployed significant capital to renewables globally. European capital accounts for the largest share of direct clean energy investment in the 103 countries reviewed (Figure 46). Spain, France, the U.K., Italy and Germany all feature in the top 10 of the countries of origin thanks to the companies that have ventured from home, either because their domestic markets were saturated or simply to leverage the experience they gained domestically.

Figure 46: Emerging market foreign direct investment by region of origin

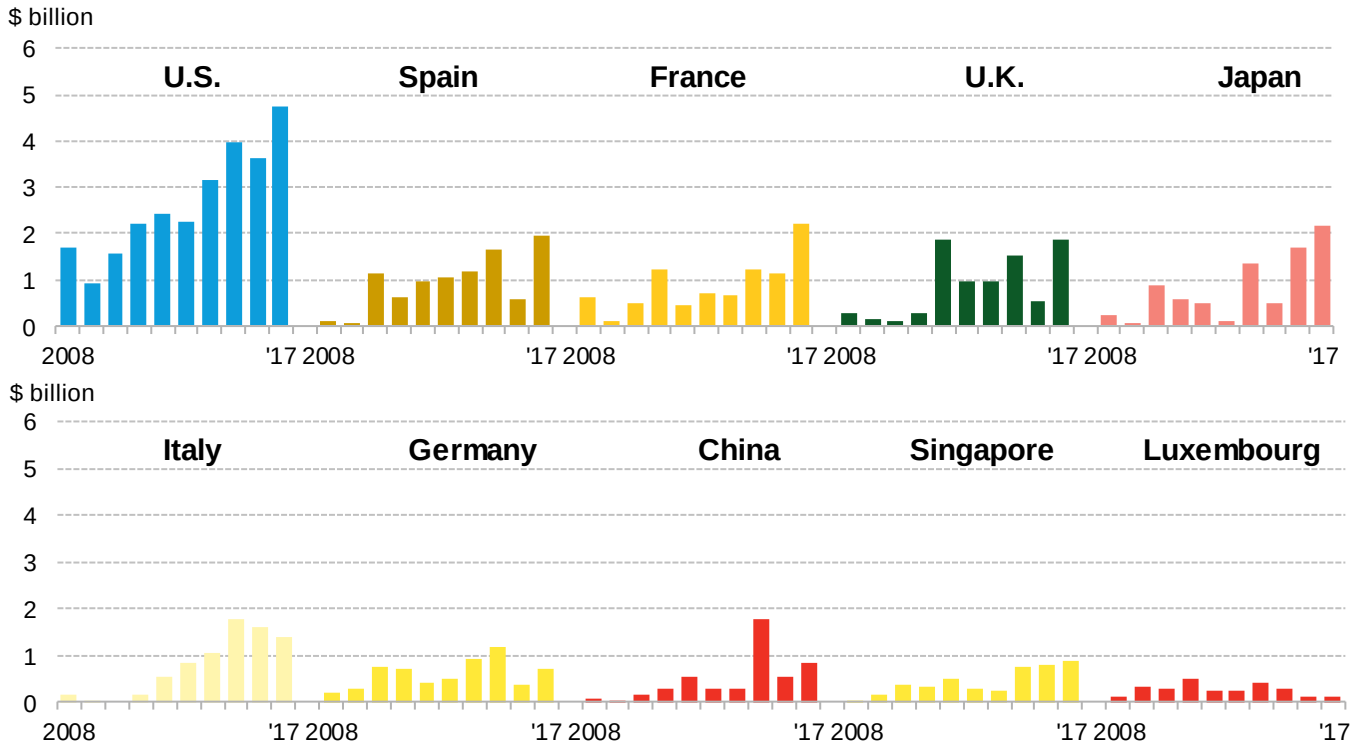


Source: BloombergNEF

North America's contribution to clean energy investment in emerging markets is entirely due to the U.S., the world's largest economy (Figure 47), which deployed just over $22 billion into developing countries in support of clean energy (or $30 billion if international development institutions based in the U.S. like the World Bank are taken into account). The country's utility

holding companies are notably absent from the picture, accounting for less than 2% of outflows over the last decade. Rather, it is U.S. development and export agencies that are among the most active in the world, accounting for just under half of all outflows. The rest of the tally is split among project developers and private investors.

Figure 47: Ten largest providers of clean energy investment to developing nations over the past decade



Source: BloombergNEF

The sources of investment from Asia are somewhat more surprising. For all the talk of China's ambition in delivering infrastructure investment around the globe, it is Japan that has ramped efforts considerably in clean energy (excluding large hydro) over the last two years. Over the last 10 years, Japanese institutions deployed around 60% more capital to clean energy asset finance in emerging markets than their Chinese peers. Japanese investment was almost entirely delivered by the government directly or through its development and export credit agencies. This is a reflection of the Japanese government's long history of encouraging the use of Japanese equipment and supporting domestic companies through the provision of long-term financing. This record of providing export finance and the strong reputation of Japanese firms globally helps explain why the footprint of the country's outflows is more developed than China's, with investment split relatively evenly between Asia, Latin America and the Middle East.

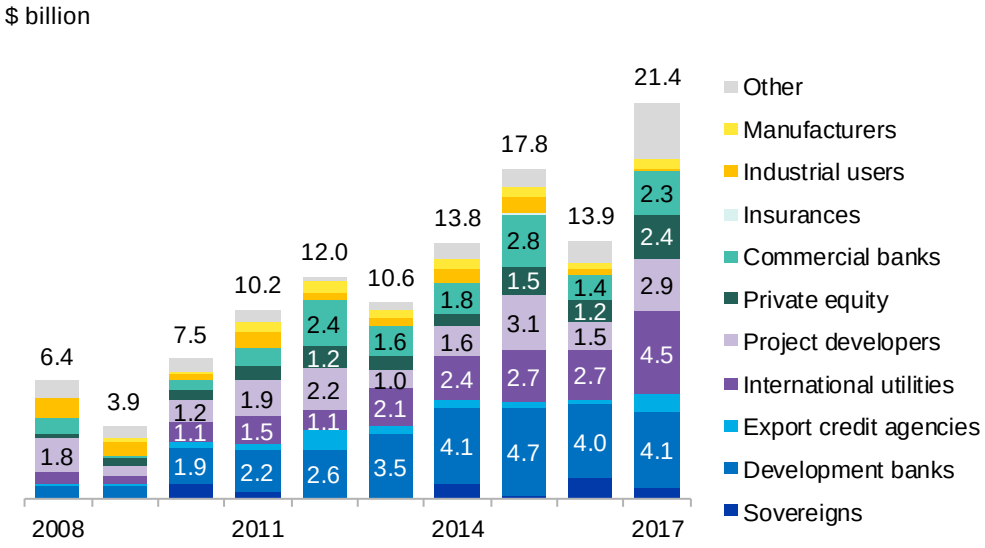
Chinese investors, and its commercial banks in particular, have so far been more comfortable with investing in countries in their home region, which accounts for just under half of the outflows over the last 10 years. The fact that Chinese investment has not accelerated significantly since the launch of President Xi Jinping's One Belt One Road program highlights the fact that the policy has more often involved the country's gigantic state-owned enterprises than its myriad of renewables project developers. This has meant that Chinese investment has often taken the form of large infrastructure projects such as roads or railways and, in the energy space, large coal or hydro projects. Less often has the BRI supported smaller wind or solar projects. This trend could,

however, change over the coming years as opportunities for renewables investors in China are shrinking now that the government has decided to reduce incentives.

Sector of origin

Public funds, particularly those deployed through development banks, continue to be the main source of cross-border investment into renewable assets in emerging markets. Development banks are now clearly comfortable with the risks associated with renewables (Figure 48 and Figure 49) and in recent years have developed new frameworks to enable clean energy investment to happen in new markets. The World Bank's Scaling Solar auction program in particular has delivered significant investment, even in complicated markets such as Madagascar.

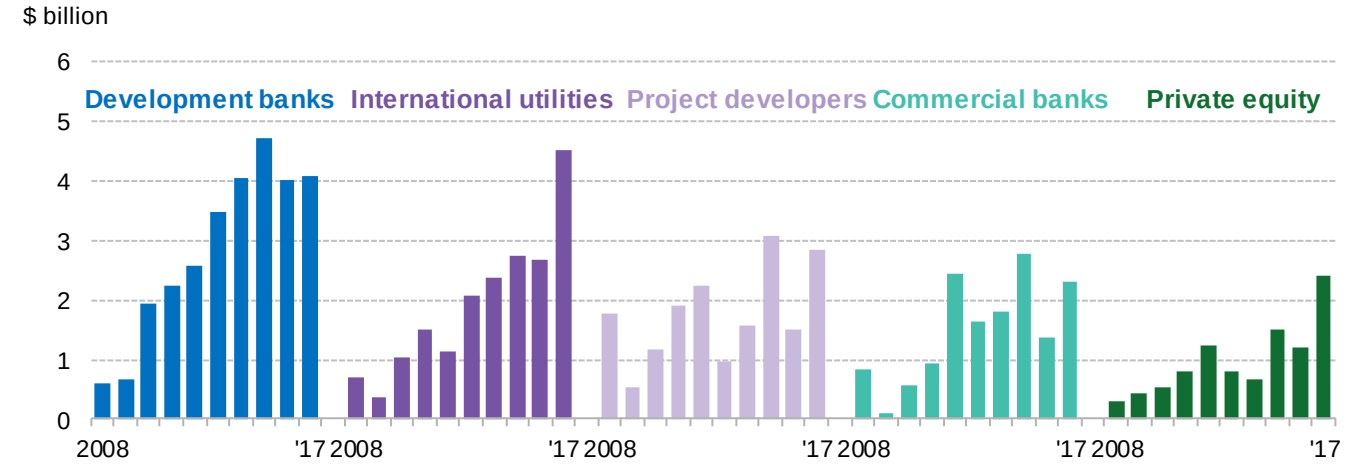
Figure 48: Emerging market foreign direct investment by investor group



Source: BloombergNEF

The international utility segment is, however, the one that has grown the most significantly between 2016 and 2017 (Figure 48 and Figure 49). This performance is entirely due to European utilities that delivered $4.3 billion of the $4.5 deployed in this category in 2017, overtaking development banks as the largest source of clean energy asset finance for the first time. And once again, it is Latin America and the region's auction programs that have been the center of their attention. Almost 90% of the investment made by EU utilities abroad over the last decade has gone to the region, with Brazil, Chile and more recently Mexico all key destinations.

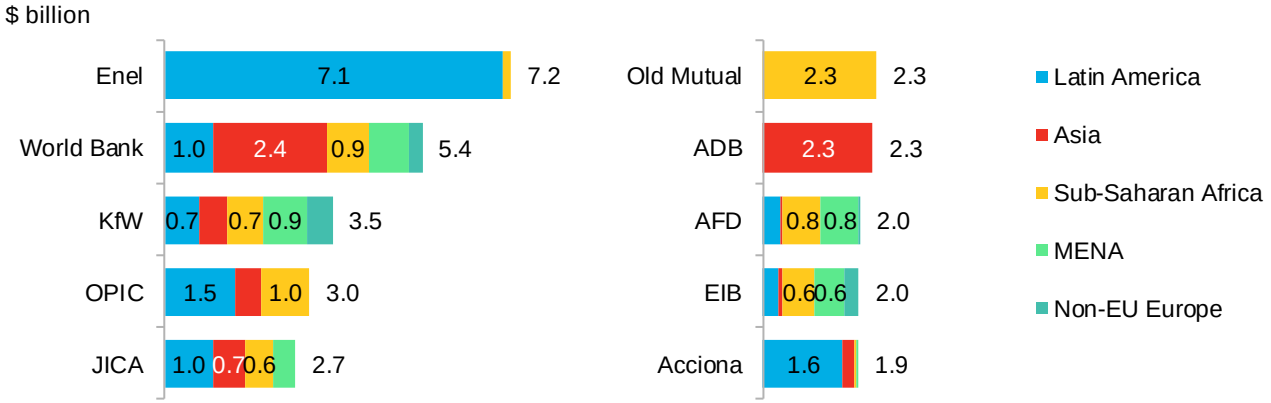
Figure 49: Top five international investor groups in emerging markets



Source: BloombergNEF

The focus of utilities on Latin America is also reflected in the geographical distribution of investment of the two organizations from the sector that feature in the top 10 of largest emerging market clean energy foreign investors (Figure 50). Enel and Acciona have mostly focused their investments on the Latin American market. This trend has shifted slightly in recent years as a growing number of countries introduced clean energy auctions, opening up new markets for competition. However, several European utilities have also slowed their activity in markets such as India where competition against local actors has become more challenging.

Figure 50: Top 10 emerging market clean energy foreign investors over the last ten years



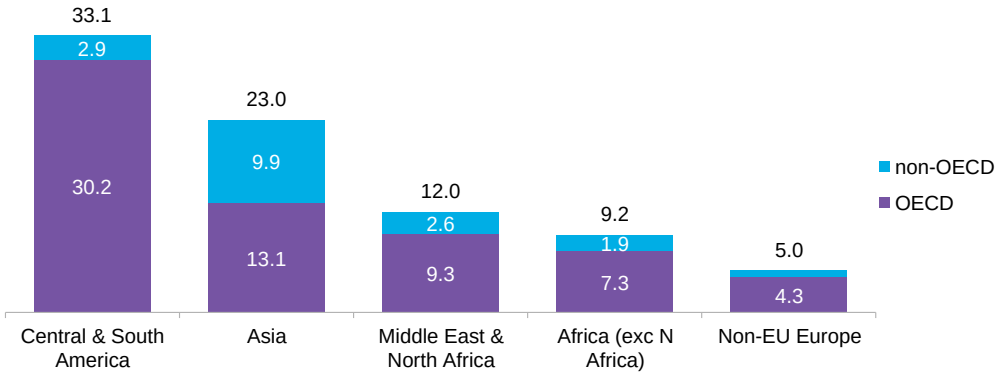
Source: BloombergNEF. Note: KfW = Kreditanstalt für Wiederaufbau, OPIC = Overseas Private Investment Corporation, JICA = Japan International Cooperation Agency, ADB = Asia Development Bank, AFD = African Development Bank, EIB = European Investment Bank.

The rest of the top 10 is dominated by development agencies who, with the exception of the Asian Development Bank, all have relatively diversified geographic footprints. Old Mutual, the U.K.-based insurer, stands out as the only private sector financial institution in the top 10. However, this investment is quasi-domestic due to the organization's historical presence in South Africa, where it has been one of the largest backers of the renewables auction program.

6.4. Inflows

Latin America is the region that has attracted by far the most foreign capital, in particular from organizations based in OECD countries (Figure 51). Once again, this can be credited to the region's power market structure and early adoption of clean energy auctions that have since been used across the globe. Strikingly, markets in which clean energy auctions are in use can claim three quarters of all foreign investment into clean energy assets in the emerging world over the last decade (Figure 52).

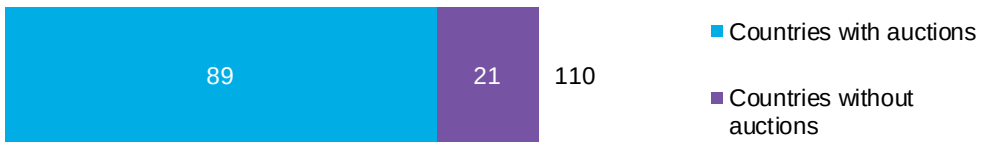
Figure 51: 10-year foreign renewables asset finance by region, $ billion



Source: BloombergNEF

Asia is the region that shows the most balanced split in attracting investment from the OECD and from outside the OECD. This can be explained by the high levels of growth posted in the region over the last two decades and relatively high integration of regional financial markets. The three other regions reviewed have relied heavily on investments from OECD countries, in particular from the EU, which has established several energy sector cooperation programs with the countries that surround it to the east and south through the European Energy Community.

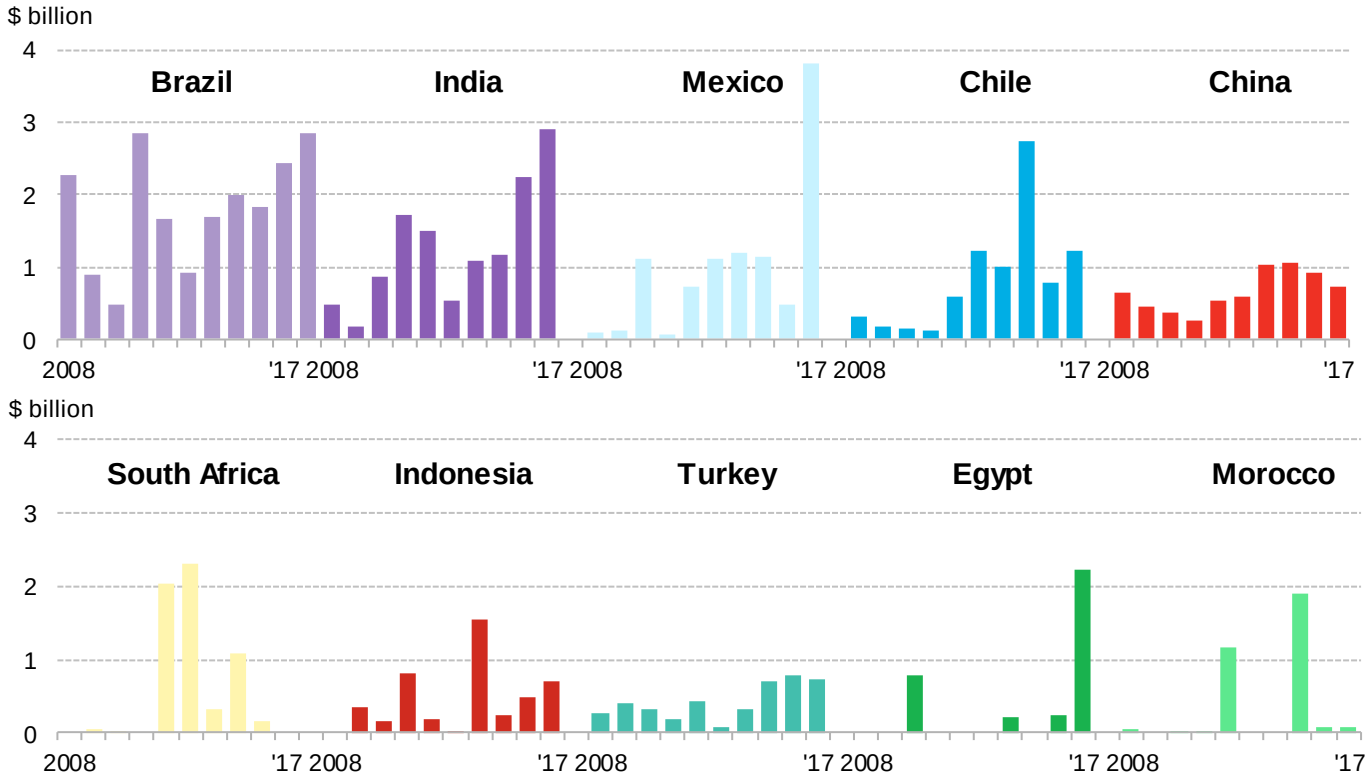
Figure 52: 10-year foreign investment in emerging markets, $ billion



Source: BloombergNEF

The 10 largest markets for foreign clean energy asset finance over the last decade are dominated by the largest and most rapidly growing emerging economies (Figure 53). Brazil, India and Mexico are the top three while China, South Africa, Turkey, Egypt and Indonesia all also feature. Chile and Morocco are the slightly smaller emerging economies that complete the ranking thanks to a liberal, market-based approach in Chile, and heavy government involvement in Morocco.

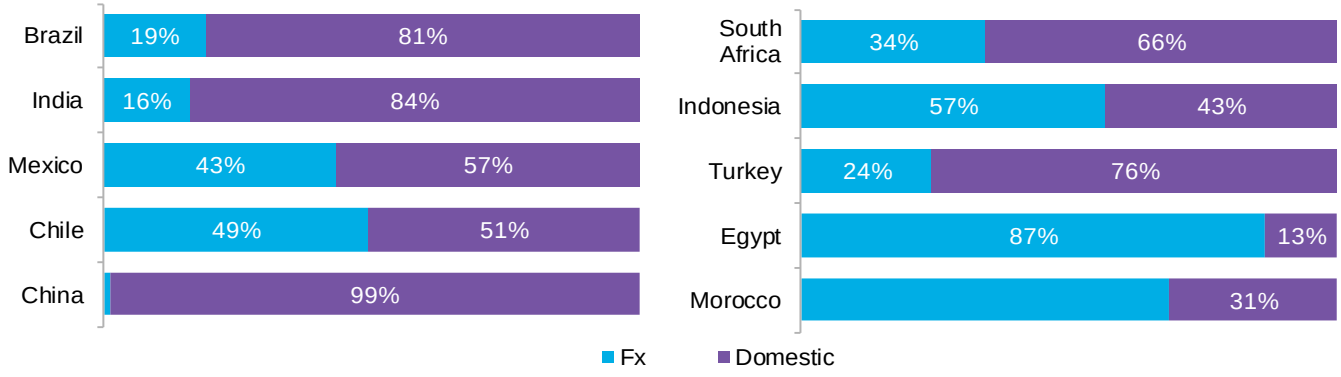
Figure 53: Top 10 emerging markets for international clean energy investment over the last 10 years



Source: BloombergNEF

Once again, it is striking that the international investment volume recorded in Brazil, India, Mexico, Chile, South Africa, Egypt and Morocco directly correlates with the countries' auctions programs. These have often given international investors a clear, transparent framework in which to compete for long-term price agreements, and allowed governments to attract large volumes of competitively-priced foreign capital. In the same respect, the presence of China in the top 10 should be considered with care. The country's size has allowed some international investors to get involved despite difficult foreign ownership rules. However, the role of foreign players in the Chinese market is trivial when compared to other countries (Figure 54).

Figure 54: Share of disclosed foreign asset finance in select emerging markets over the last 10 years



Source: BloombergNEF

Section 7. Power systems

7.1. Technologies

Total power-generating capacity in developing nations has jumped 61% since 2010, from 2.2TW to 3.6TW as of year-end 2017. Coal still accounts for the lion's share with 1.4TW installed, and its share of total capacity has only marginally slipped, from 42% in 2010, to 39% in 2017 (Figure 55). Generation (actual power produced) is also growing in developing nations, but at lower speed. It jumped 40%, from 9,864TWh in 2010 to 13,817TW in 2017 (Figure 56). China alone accounts for almost half of emerging markets' total capacity, followed by India with 9% and Russia with 4%. Meanwhile, the proportion of total power produced from coal has remained essentially level at 46%.

Figure 55: Cumulative capacity by technology in emerging markets

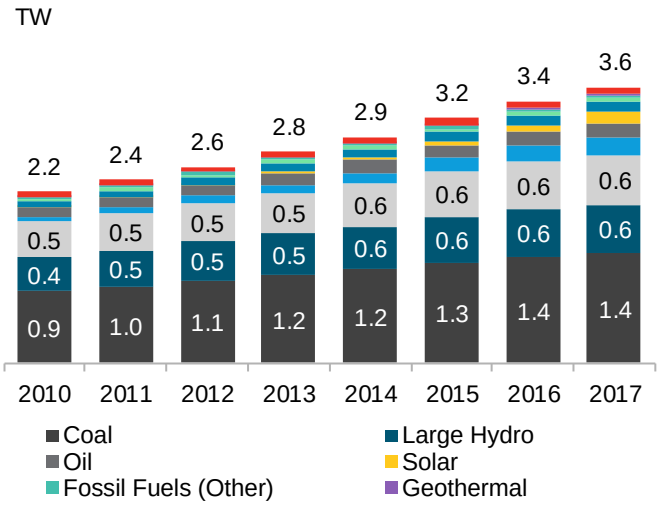
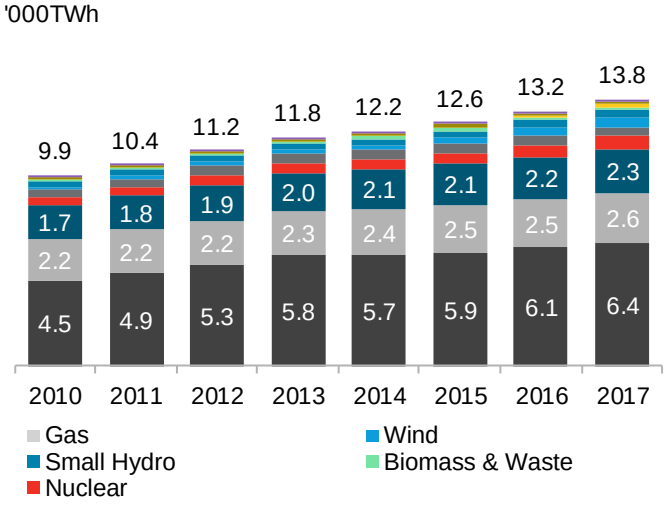


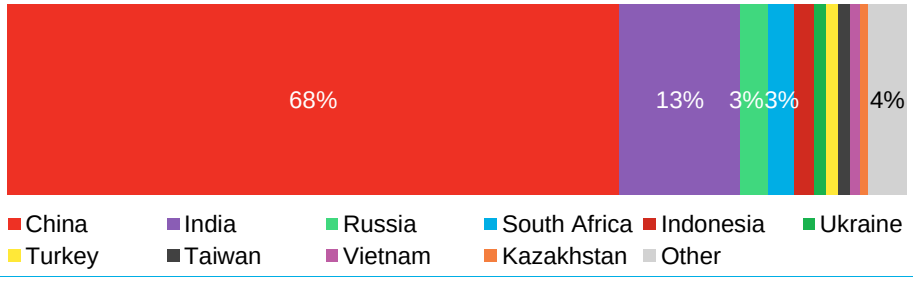
Figure 56: Annual generation by technology in emerging markets



Source: BloombergNEF, Climatescope

Although coal remains the main provider of baseload, the technology is mainly concentrated in a relatively few countries. Ten nations account for 96% of all coal capacity installed in emerging markets, with China, India, Russia and South Africa alone accounting for 88% (Figure 57).

Figure 57: Coal cumulative installed capacity in emerging markets by country



Source: BloombergNEF, Climatescope

While total annual power-generating capacity additions have slumped since 2015 (Figure 58), clean energy installations have grown for the most part steadily since 2011 and reached record levels in 2017, with over 100GW added (Figure 59).

Among clean energy technologies, the shift from wind to solar became even more evident in 2017. Wind was the dominant renewable energy technology in emerging markets until 2015, when it reached a peak of 42GW installed. However, with a steep drop in technology prices, solar capacity additions have jumped over 2016-2017, leaving wind far behind. For policy-makers, the fall in wind investment could potentially be worrying; successful energy transitions inevitably will require a diversified clean energy mix.

Figure 58: Total annual capacity additions by technology in emerging markets

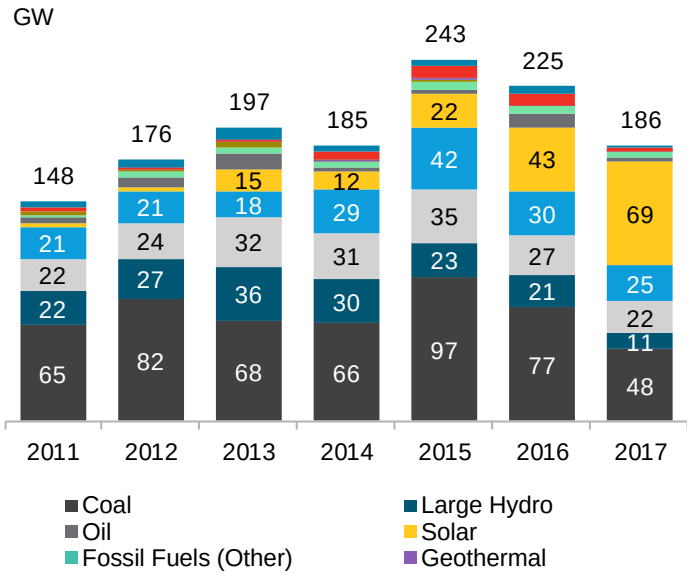
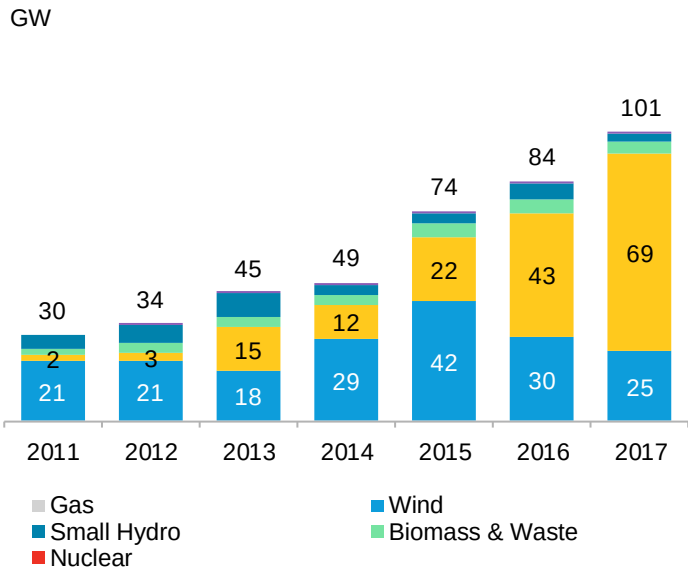


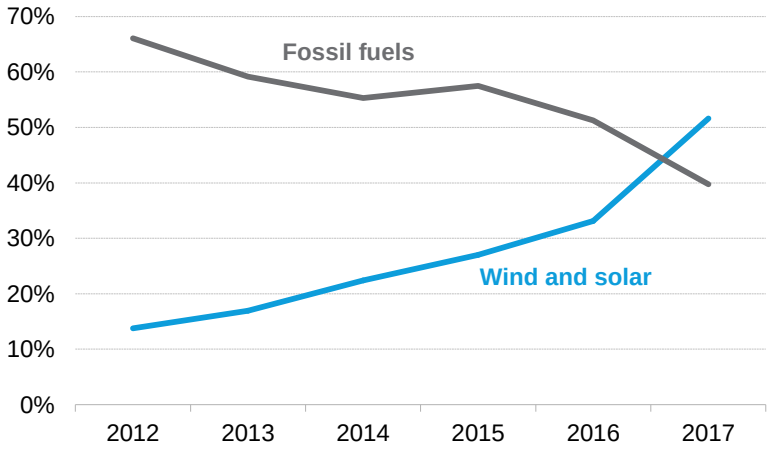
Figure 59: Clean energy annual capacity additions by technology in emerging markets



Source: BloombergNEF, Climatescope

With record levels of clean energy capacity additions, emerging markets reached a key milestone in 2017, and perhaps a major tipping point, as more wind and solar got added to grids than fossil fuel capacity. Wind and solar together accounted for 52% of all capacity installed in 2017, up from 14% just five years earlier. Fossil sources, on the other hand, fell from 66% of total capacity added in 2012 to 40% in 2017, with 72GW commissioned in 2017 (Figure 60).

Figure 60: Share of annual capacity additions by technology in emerging markets

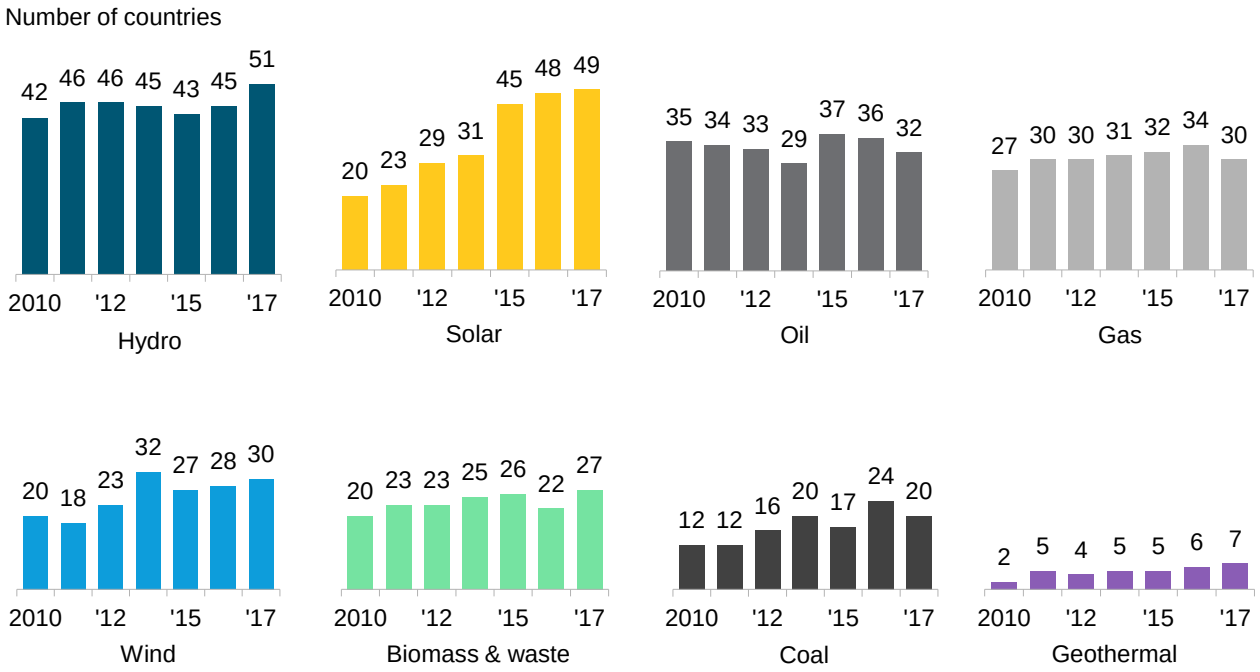


Source: BloombergNEF, Climatescope

China and India account for most of the reduction in fossil fuel capacity additions and for a large share of the clean energy capacity commissioned. However, clean energy sources, especially solar, are spreading to more countries while fossil fuel-fired technologies appear mainly to be confined to those countries where they have already been built.

Thanks to relatively straightforward installation and flexibility on project size, 49 emerging markets installed solar capacity in 2017, up from only 20 in 2010. Meanwhile, 20 countries installed coal-fired power plants in 2017, down from 24 in 2016. Hydro remains a key technology, especially in Africa and Latin America, and was installed in 51 countries in 2017.

Figure 61: Number of developing countries that recorded net capacity additions for each technology



Source: BloombergNEF, Climatescope. Note: net capacity additions as reported in official figures for total installed capacity.

As a result, while emerging markets still rely primarily on four technologies for generation (coal, gas, oil and hydro in Figure 62), capacity additions are becoming more diversified. No less than 81 of the 103 markets surveyed in Climatescope had additions of some sort in 2017. Among these, 45 (56%) installed more carbon-free than fossil capacity, including China and India. Solar made up 43% of the 123GW installed in China and 45% of the total installed in India in 2017.

Figure 62: Climatescope markets by main sector by 2017 installed capacity

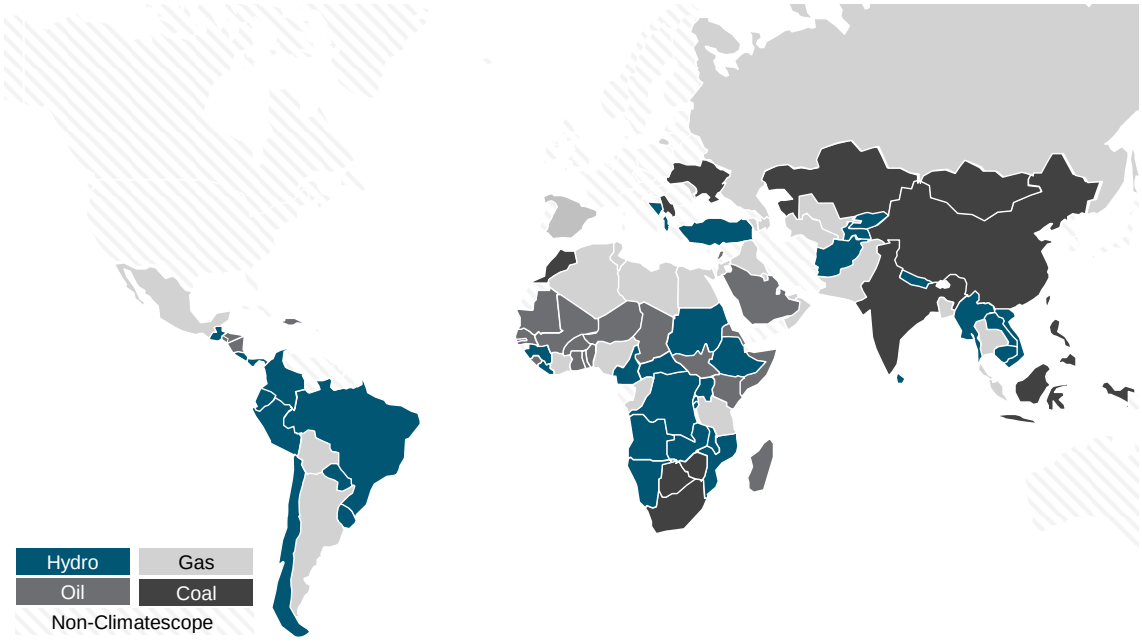
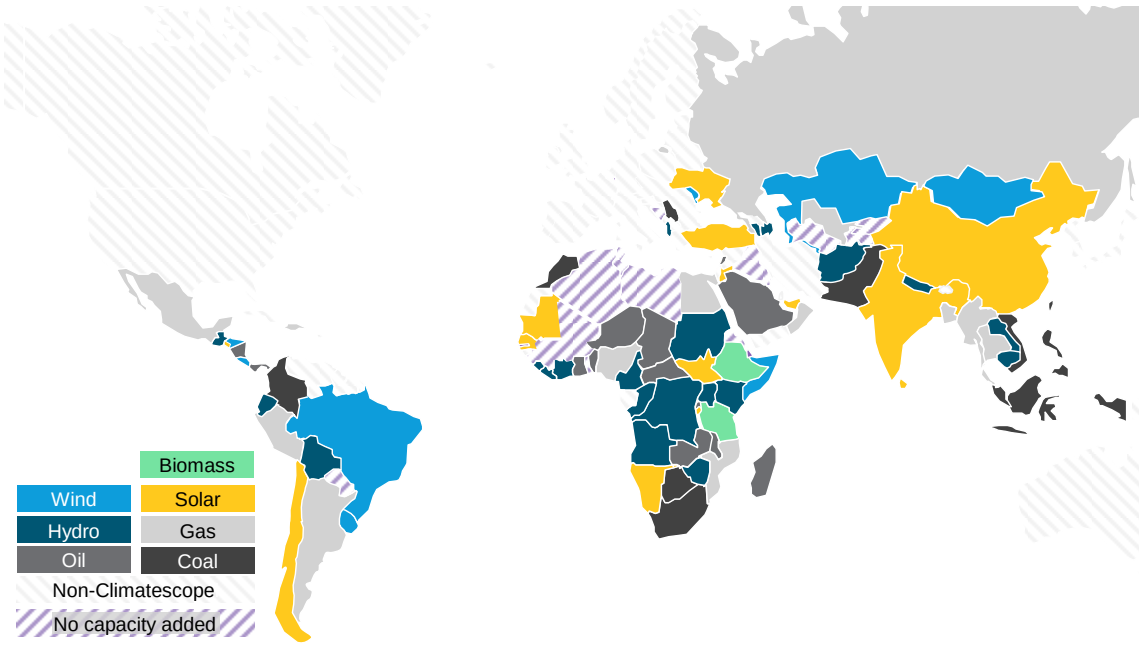


Figure 63: Climatescope markets by main sector by 2017 net installed capacity additions

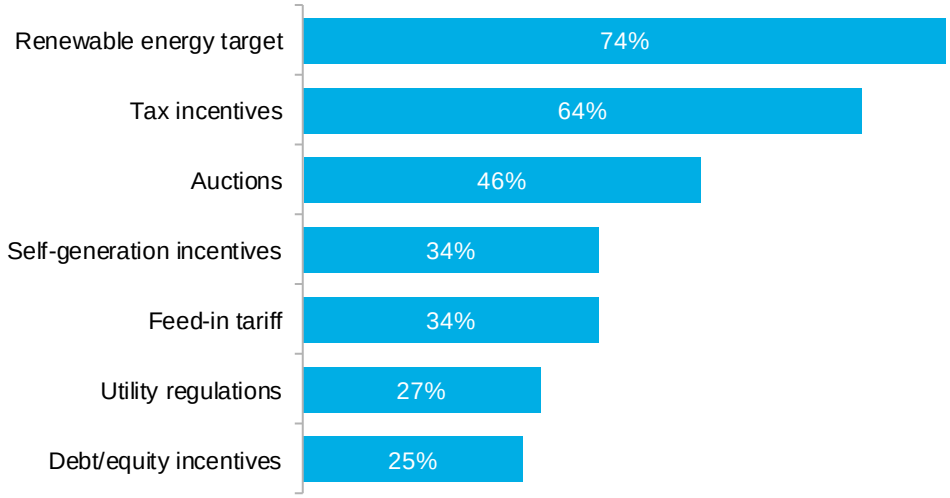


Source: BloombergNEF, Climatescope

7.2. Policies

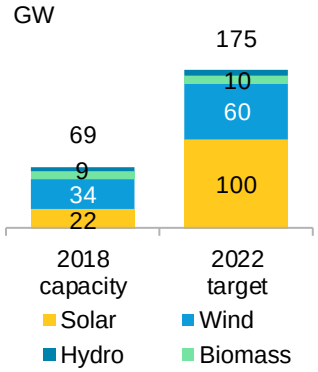
The energy transition worldwide is being facilitated by clean power policies that are increasingly commonplace in developing nations. Among the 103 emerging markets surveyed for Climatescope, just 11 today have no clean energy policies of any sort in place. Of the policies that are on the books, renewable energy targets represent the most popular policy type. These are in place in 74% of the markets analyzed. This is followed by tax incentives, which are present in 64% of the countries (Figure 64).

Figure 64: Share of emerging markets using each policy



Source: BloombergNEF, Climatescope

Figure 65: India's 2022 renewable energy target



Source: BloombergNEF, Ministry of New and Renewable Energy.

Renewable energy targets

Setting targets represents the starting point for most renewable energy policy frameworks. The number of countries that have introduced them has grown year after year as governments have become better aware of the opportunities lower-cost renewables offer for expanding energy access and controlling CO2 emissions. Three out of every four emerging markets reviewed by BNEF for Climatescope now have targets on their books.

India has one of the most ambitious in the world. It aims to reach 175GW of clean energy capacity by March 2022. This includes solar, wind, small hydro and biomass and waste (Figure 65). To reach the target, the country will need to add 106GW of clean power, with solar accounting for almost a third. To this end, the government is ramping up auctions and updating some existing clean energy policies.

Tax incentives

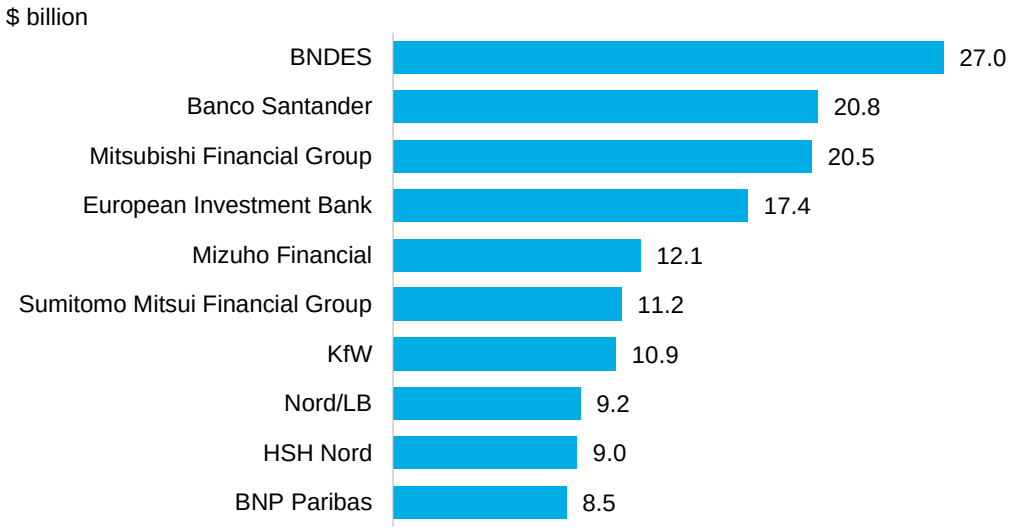
Tax incentives are the second most popular renewables support mechanism in emerging markets and their popularity predates the recent wave of renewables targets. This can partly be explained by the formerly high cost of renewables and the relatively low levels of deployment. Indeed, from a government's perspective, tax incentives are not terribly costly so long as build/investment levels and the associated tax revenues foregone are low. Tax incentives are a relatively blunt mechanism that, when not combined with other incentives, can see their costs rise as deployment levels grow. It is also worth noting that such incentives can typically be removed relatively easily

as tax policies are often reviewed annually, or their effectiveness reduced through new levies and duties.

Debt incentives

Debt incentives have proven to be extremely effective when well designed as they address the major challenge of access and cost of finance in emerging markets. Brazil's national development bank BNDES, for example, dominates clean energy lending thanks to below-market rates and generous terms. Providing concessional loans in local currency, BNDES financed 70% of all projects contracted in the 2012-2015 Brazil auctions. Between 2008 and 2017, BNDES alone provided almost $27 billion to clean power plants and was not only the largest clean energy lead arranger in Brazil, but worldwide (Figure 66).

Figure 66: Top 10 clean energy asset finance lead arrangers, 2008-2017

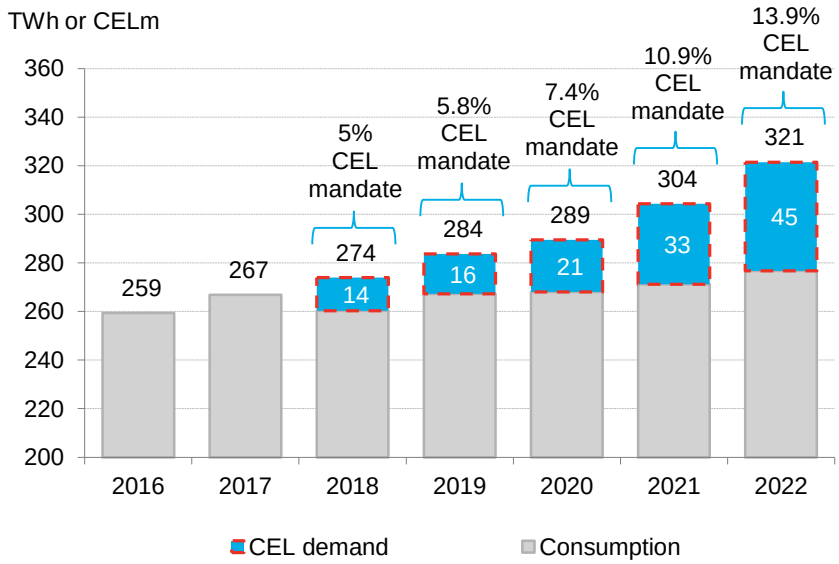


Source: BloombergNEF

Utility regulations

Utility regulations can include a wide range of policies. Those known to drive clean energy deployment most are ambitious renewables portfolio standards that apply specifically to regulated utilities or large consumers, and green certificate markets. While these policies can play an important role in helping renewables developers, they typically cannot support sector growth on their own. In Chile, for example, a 2013 law mandates that electric utilities with more than 200MW operational capacity should generate 20% of electricity from renewable sources by 2025. Mexico is the only Latin American country with a mandatory clean energy certificates market (CEL) in force. The policy was introduced as part of the country's energy reform in 2013 and officially kicked off in 2018. It is Mexico's primary policy mechanism for ensuring its goal of reaching 35% of clean energy generation is met, and mandates all major power buyers to buy a certain number of certificates relative to energy consumption. Obligations start at 5% of power consumption in 2018 and jump to 13.9% in 2022 (Figure 67).

Figure 67: Mexico clean energy certificate demand and Sener's power consumption



Source: BloombergNEF, Prodesen, Sener

Feed-in tariffs (FiTs)

Combined with clean energy auctions, feed-in tariff mechanisms have supported the vast majority of renewables procurement globally to date. While auctions are very much in vogue at the moment, however, FiTs have rapidly fallen out of favor in the wake of the European experience. In some EU countries, generously priced FiTs prompted unexpectedly large and sudden booms in renewable build. This, in turn, resulted in ballooning public subsidy liabilities and put considerable pressure on electricity bills or government budgets.

Nonetheless, FiTs can still play an important role in supporting small-scale projects for which the costs of organizing auctions can be prohibitive. Feed-in tariffs are on the books in one third of the nations surveyed in Climatescope, but countries are moving away from expensive FiTs as they face similar challenges to their OECD peers. Transitioning to auctions allows such countries to exploit the steep drop in clean energy technology prices.

Kazakhstan, for example, set feed-in tariffs for PV, wind, hydro and biofuels plants in 2013 to kick-start the country's clean energy sector. But in January 2018 the government unveiled Central Asia's first renewable energy tender, to contract 1GW capacity from wind, PV, biofuels and hydro. In June 2018, the FiT scheme ceased to be available for new-build projects that had not previously qualified, as a way to push developers to compete in the new auction mechanism to secure further PPAs.

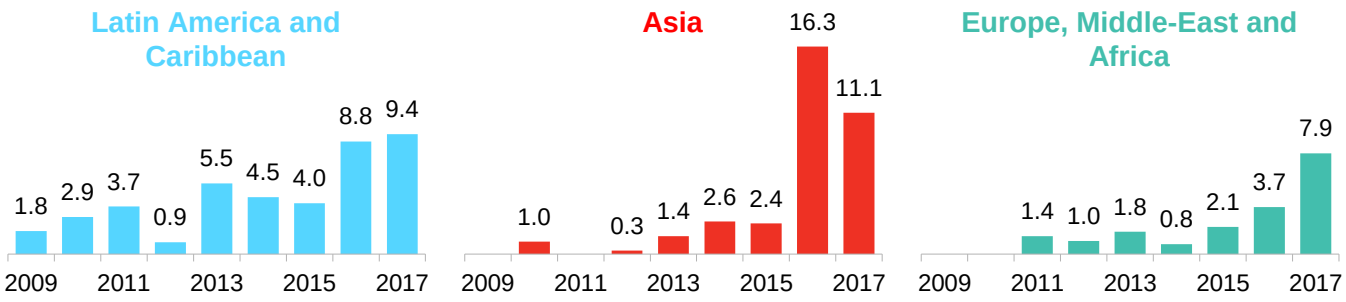
In 1H 2018, China's National Energy Administration (NEA) announced a major revamp of policies supporting wind and solar. The FiT for new wind projects was cut in May 2018 and all new projects are to be subjected to an auction mechanism. In June 2018, the Chinese authorities announced that they would control the volume of new solar installations by switching away from tariffs set by regulators, after the government accumulated a $19 billion deficit related to payments owed to renewables project owners.

Auctions and tenders

Auctions and tenders have repeatedly proven effective at driving down clean energy tariffs awarded to projects, while giving regulators better control over volumes of renewables added to the grid. As a result, they are often policy-makers' mechanism of choice and the primary way contracts get awarded globally today. Brazil and other Latin American nations, in particular, have pioneered the use of auctions that invite developers to bid to sell their power at least cost. Tenders for power contracts are by no means new in the context of emerging markets, however. What has been novel is the extension of these to renewables specifically.

Countries new to crafting auctions have been able to look to across Latin America to learn about tenders, but particularly at Brazil, Chile and Mexico. There, regulators have been using auctions in parallel with wholesale power markets to drive investment in power-generating capacity from both renewables and fossil-fueled generators. From 2009 through 2017, emerging markets have contracted over 95GW of clean energy capacity via auctions (Figure 68).

Figure 68: Clean energy contracts signed annually under organized auctions in emerging markets, by region (GW)



Source: BloombergNEF. Note: includes contracts signed with wind, solar, geothermal, biomass, and small hydro projects to deliver power. Contracts signed are typically for a target capacity (MW). When the target is for generation, BNEF aggregates, totals, and converts these to capacity figures using expected capacity factors by technology.

Latin America leads the way with 41.7GW contracted over the period, mainly in Brazil and Mexico. Capacity contracted via competitive auctions in Asia was moderate until 2016, when it spiked, driven by India and China. India alone contracted 15.3GW through auctions in 2016-2017, while China contracted almost 11GW in 2016.

In addition, India's Minister for New and Renewable Energy announced that the government aims to hold auctions for 80GW of solar and 28GW of wind projects during FY2018–FY2020 (Figure 69) to achieve its stated target of 175GW of renewable energy capacity by March 2022.

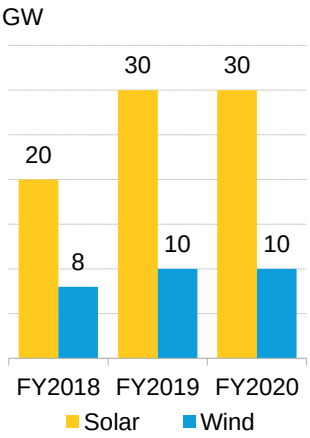
The Indian market is home to the most competitive auctions in the world. Rounds are always oversubscribed and the difference between winners and losers is decided in fractions of rupees. This has allowed India to become a booming renewables market, and low prices have encouraged the government to reduce its coal capacity target for 2027 by 11GW against a renewables target of 215GW of new build over 2017-2027.

However, there are signs that developers are allowing too little margin for error when assembling bids to edge out the competition. Independent power producers (IPPs) are forced to squeeze engineering, procurement and construction players, negotiate aggressive equipment supply contracts that are exposed to duty or tax changes, and make favorable assumptions on financing costs (for more, see Section 4.2). The coming years will be critical in determining whether the

Indian market can enjoy explosive growth, will go through a period of controlled consolidation –or suffer a bust that will take its toll on developers and financial institutions.

7.3. Power markets

Figure 69: India clean energy auctions planned



Source: Press Information Bureau, BloombergNEF. Note: FY2018 stands for financial year 2018 –April 1, 2017 to March 31, 2018.

In addition to clean energy policies, Climatescope tracks several other power sector indicators that can be critical in either incentivizing clean energy build in emerging markets or restricting it. These include key indicators such as whether or not electricity is traded on a wholesale market, whether the market for generation is concentrated, how favorable the terms of power purchasing agreements are to investment, and measures of the demand for new renewables investment.

Power sector structure

This year's Climatescope suggests that countries with power sectors fully open to private players attract far more investment than those whose markets are monopolized by a single actor (China not included in the analysis due to its size). Climatescope tracked 13 countries where the generation, transmission and retail segments of the power market are all open for private participation. Investment in these countries over 2013-2017 was seven times as high on average as in the 78 countries where the generation segment alone is open to private participation, but other segments are not, and 49 times the size of the 11 markets monopolized by a single player (Table 3).

Table 3: Clean energy investment in developing countries by level of power sector privatization

Power sector structure	Number of countries	Average 5-year investment (excluding China, $ billion)	Total investment (excluding China, $ billion)
Vertically-integrated monopoly	11	0.2	2.2
Generation only liberalized	78	1.3	104.6
All market segments liberalized	13	9.7	126.2

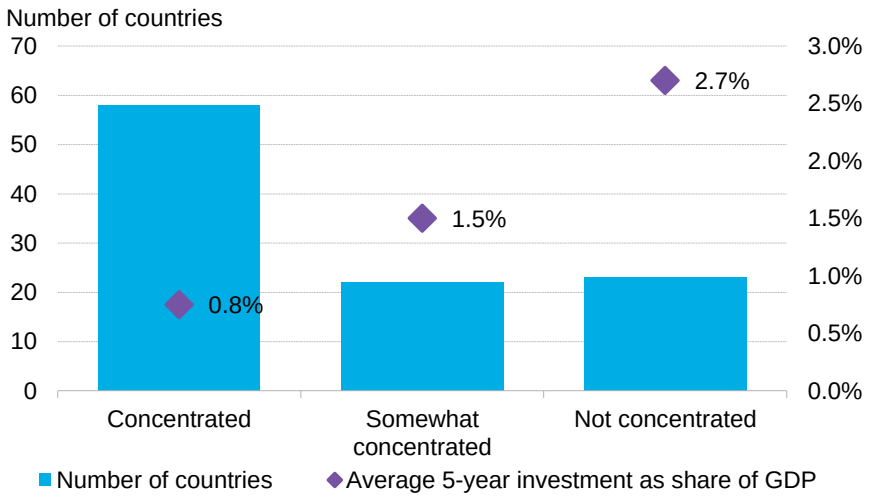
Source: BloombergNEF

Mexico offers a useful example of how a well-designed reform program linked to strong policy frameworks can help a country boost its clean energy investment. As a consequence of the 2013 energy reform effort, Mexico's electricity market has transitioned from a single, state-owned, vertically integrated utility (CFE) to a liberalized generation market, while establishing a new independent grid operator (Cenace), introducing clean energy auctions, laying out an aggressive mandate to generate 35% of its power from clean sources by 2024, and establishing a clean energy certificates (CELs) market to achieve this. The reform has unleashed a boom in new-build clean energy investment, which spiked from $1 billion in 2013 to $6.2 billion in 2017.

Liberalizing the generation segment need not mean excluding state-owned companies from participating in renewable energy development. State-owned Eletrobras in Brazil, for example, is the largest utility in Latin America and controls nearly a third of the nation's 158GW installed capacity and 57% of its transmission lines. However, Climatescope analysis suggests correlation between the level of concentration in a country's power market and the level of clean energy

investment it attracts. The 58 markets with a highly concentrated power generation sector recorded renewables investment volume worth around 0.8% of their 2017 GDP (Figure 70). Countries with a somewhat or not-concentrated generation market on the other hand recorded almost twice and three times as much investment as a measure of GDP.

Figure 70: Concentration of generation market and average 5-year investment as share of GDP



Source: BloombergNEF, Climatescope

Power purchase agreements (PPAs)

Standardized and long-term PPAs are other essential factors to help boost clean energy investment in emerging markets. Standardized PPAs facilitate the entrance of new players into the market and reduce risk perception among new developers. Just over a quarter of the countries surveyed in Climatescope have made standardized PPAs available to developers. Between them, these countries averaged $4.6 billion in investment over 2013-2017. This represents three times the average for the 75 countries that do not have fully standardized PPAs (Table 4).

Table 4: Standardized power purchase agreements

Fully standardized PPAs?	Number of countries	Total 5-year investment (excluding China, $ million)	Average 5-year investment (excluding China, $ million)	Average 5-year investment as share of GDP
Yes	27	123,015	4,556	1.8%
No	75	109,940	1,465	1.2%

Source: BloombergNEF, Climatescope

Moreover, long-term PPAs are crucial to helping project developers secure investment with commercial banks, as they underpin longer term project revenues. The 62 Climatescope markets that have 15-year or longer PPAs in force have secured an average 5-year investment total almost 7 times higher than the 40 nations that only offer shorter-term PPAs (Table 5).

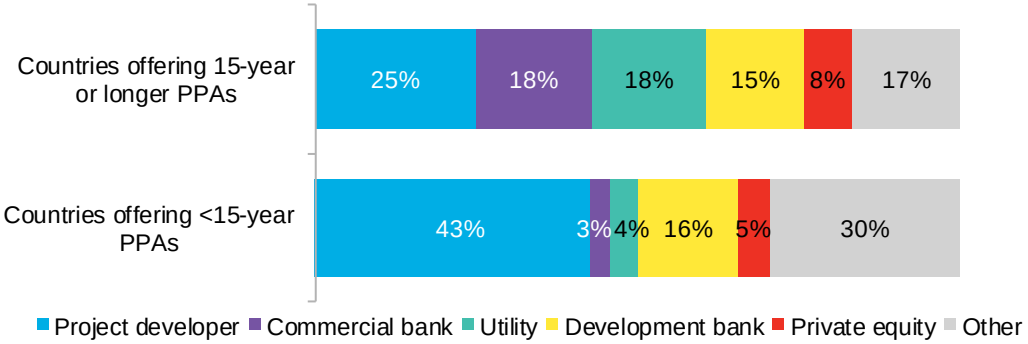
Table 5: Duration of power-purchase agreements offered (excluding China)

PPA duration	Number of countries	Total 5-yr investment ($ million)	Average 5-yr investment ($ million)	Average 5-yr investment as share of GDP
15 years or longer	62	213,006	3,435	1.5%
<15 years	40	19,949	498	1.1%

Source: BloombergNEF, Climatescope

This is clear when looking at clean energy investment by type of investor. While the markets with 15-year or longer PPAs in force secured 18% of their investment from commercial banks, the other countries together secured only 3% of total investment from this source. (Figure 71).

Figure 71: Clean energy investment by type of investor

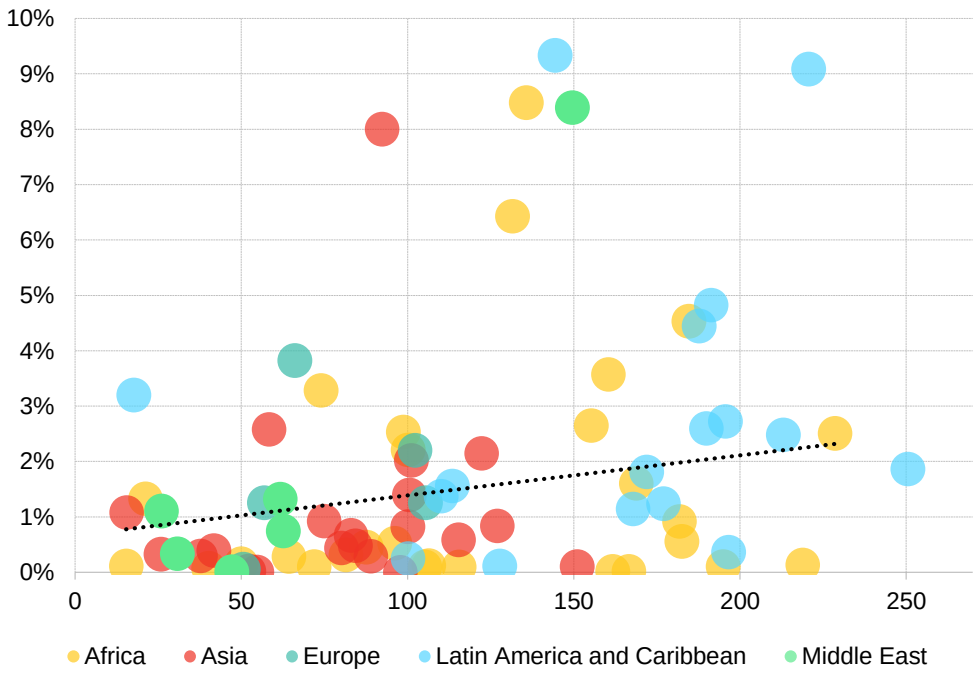


Source: BloombergNEF, Climatescope

Electricity prices

Power prices are also key to incentivizing clean energy deployment in emerging markets. Countries with higher prices tend to attract more capital. On average, Climatescope countries with average retail power prices above $200/MWh have attracted 5-year clean energy investment levels equivalent to 2% of their GDP, while nations with tariffs below $200/MWh recorded investments equivalent to less than 1% of their GDP (Figure 72).

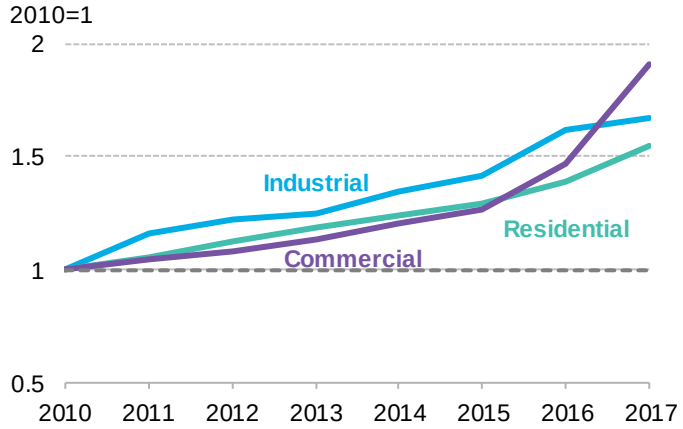
Figure 72: 5-year clean energy investment of countries as a share of their GDP vs. average electricity prices ($/MWh)



Source: BloombergNEF

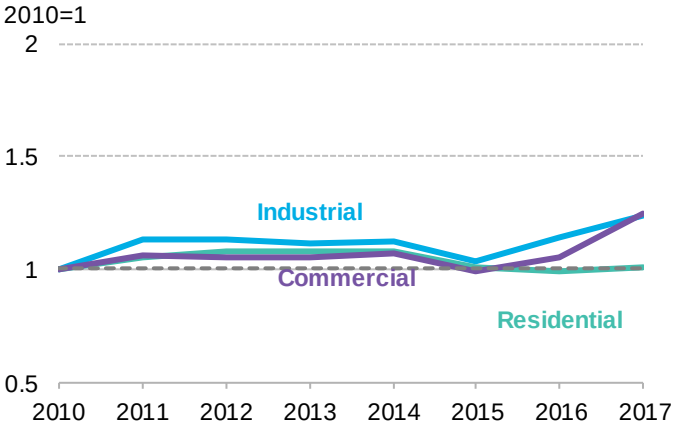
As retail prices are carefully regulated, they can at times be set below utilities' own operating costs with the help of government subsidies. This is particularly true in emerging markets. Still, retail electricity prices have risen significantly across developing nations in recent years (Figure 73 and Figure 74). In fact, in two thirds of the 103 markets surveyed by BNEF retail rates rose when measured in domestic currency. This suggests that governments and regulators are hiking rates in response to inflation, higher power system investments or currency depreciation, despite the risk of public backlash. However, retail power prices as measured in U.S. dollars have not risen much, highlighting that unpopular rate hikes in local currency may not always be sufficient to keep up with the rising costs of power system that are exposed to an appreciation of the dollar through the signing of PPAs in hard currencies, or fuel imports.

Figure 73: Progression of retail electricity prices across emerging markets in domestic currencies



Source: BloombergNEF. Note: sample of 103 markets.

Figure 74: Progression of retail electricity prices across emerging markets in U.S. dollars

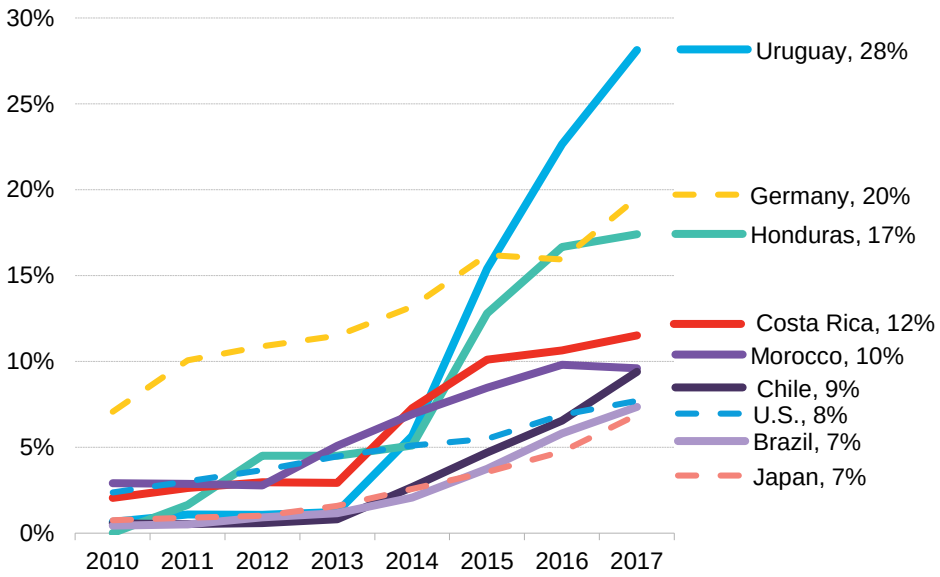


Source: BloombergNEF. Note: sample of 103 markets.

7.4. Advanced energy transition

As technology prices decline, wind and solar build are rising and producing higher levels of variable generation. Uruguay was the leader in 2017 in terms of wind and solar penetration, with 28% of its power coming from those two technologies, putting it well ahead of the U.S. and Japan, and even Germany, which was in second place. Honduras has the third highest level of penetration worldwide with 17%, followed by Costa Rica with 12% and Morocco with 10%.

Figure 75: Share of wind and solar generation in select markets

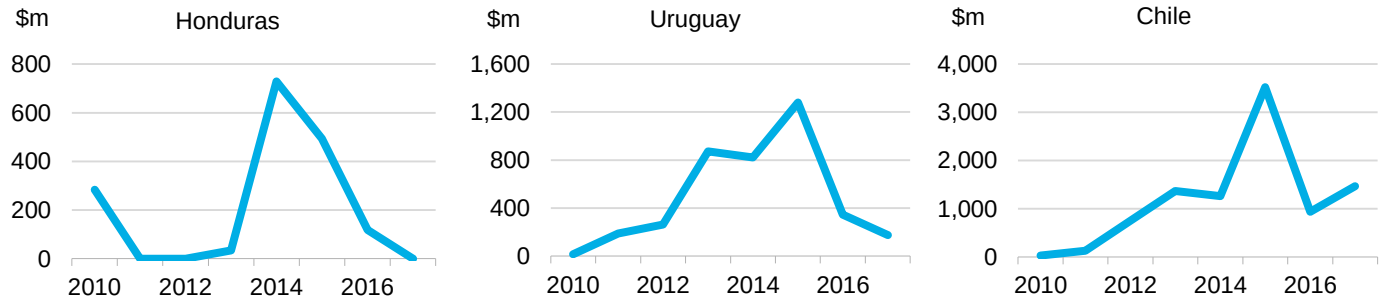


Source: BloombergNEF, Climatescope

Such high penetration levels are, of course, due in no small part to the fact that a number of these countries are quite small. Such countries may, however, be approaching the limit of variable sources that their grids can absorb. In Honduras, Chile and Uruguay, peaks of clean energy investment have been followed by steep declines.

Uruguay's clean energy investment and build booms were fueled by strong clean energy targets and a series of technology-specific auctions. Between 2013 and 2015, the country attracted almost $3 billion for wind and solar. As of year-end 2017, these technologies together accounted for over 38% of Uruguay's 4.5GW capacity. However, slow overall electricity demand growth and a relatively limited share of installed fossil fuel capacity could limit further additions of variable generation.

Figure 76: Wind and solar new-build asset finance investment



Source: BloombergNEF

Driven by generous feed-in tariffs for PV plants, Honduras attracted almost $600 million in new-build clean energy investment in 2014 for solar alone, equivalent to a whopping 3% of the country's entire GDP that year. This translated into almost 400MW of PV capacity commissioned in 2015, or 17% of the country's capacity installed in that year. However, as the market started to saturate, investment in large-scale projects fell to zero in 2017.

Honduras and other Central American markets are increasingly taking advantage of the Regional Power Market (MER) to balance generation from intermittent sources. Interconnection between these tiny countries has existed for years, but cross-border flows ramped up in 2013 once the MER was implemented alongside rules that enabled generators and distribution companies to benefit from access to a larger power pool. Since 2013, activity on the MER has grown almost continuously and allowed energy trade across the region to spike from 120MWh in Q1 2013 to 710MWh in Q2 2018.

Figure 77: Central America power market exports

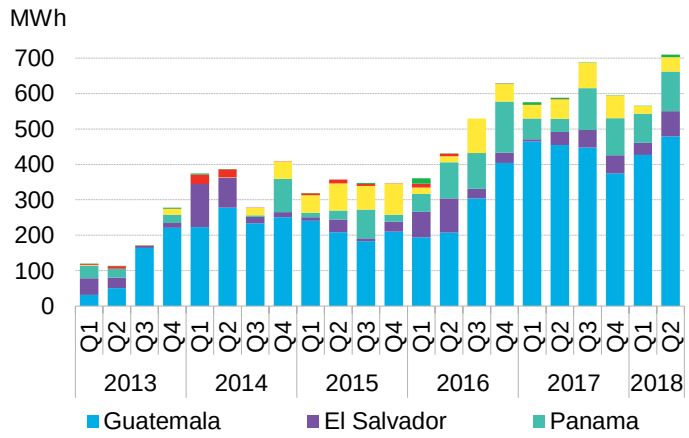
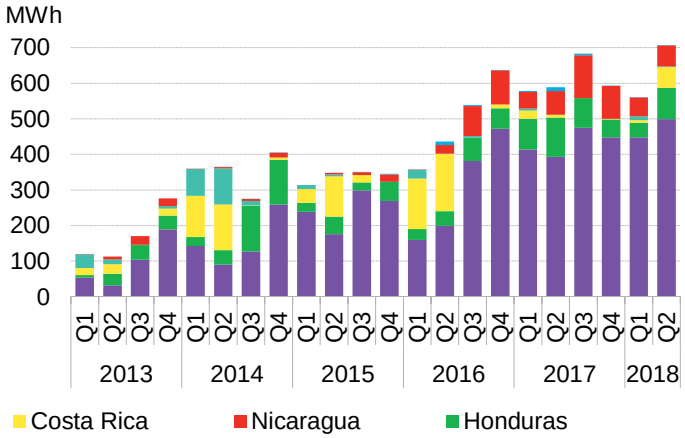


Figure 78: Central America power market imports



Source: BloombergNEF, Ente Operador Regional

Thanks to a series of ambitious regulations to support renewables, Chile saw wind and solar investment spike from approximately $100 million in 2011 to over $3.5 billion in 2015. Lack of interconnection between Chile's two main power systems had the effect of curtailing further project development and new investment then sank in 2016. With the government determined to continue de-carbonizing its power system and fight climate change, the clean energy sector started to rebound in 2017. Chile serves as an example not only on how to deal with the complexities generated by high penetration of wind and solar, but also how to design a comprehensive approach to further de-carbonize a power matrix and integrate even higher levels of wind and solar.

Chile's challenges to integrate renewables, and its response

Chile's power grid is divided into four main systems, with little or no interconnection between them. In the north, the Sistema Interconectado Central (SIC) and Sistema Interconectado del Norte Grande (SING) subsystems have to meet most of the country's energy demand (Figure 25). The SIC serves 90% of the population, while SING has a high concentration of industrial activity, in particular mining.

Lack of transmission capacity led to curtailment, which reached 16% of renewables generation in 2017. A first major step toward improving the situation was made in November 2017, when the 600km transmission line that connects the SING and SIC was commissioned. The $880 million investment has helped reduce curtailment, but Chile is investing considerably more in the expansion of its grid. A second interconnection between the two largest systems is due to be commissioned in December 2018, and the government launched a grid expansion tender program in 2017 that will require around $2 billion for the development of more lines.

Chile has one of the most coal-dependent electricity mixes in Latin American. However, the Chilean government sees the importance of developing renewables to mitigate the increasing emissions intensity of the country's generation. In 2016, Chile released its long-term energy plan, which sets a target for renewables to account for 70% of electricity by 2050. In January 2018, the four companies that own all of Chile's coal-fired plants pledged publicly to build no further coal projects unless they employ carbon capture and storage technology.

Figure 79: Chile's power grids

Source: CNE

Assuming no new coal gets build and existing coal plants get retired as scheduled, Chile will require 5GW of alternative capacity by 2040, according to a study from the electric system operator Coordinador Electrico Nacional. The mix of technologies would lean towards gas over the coming decade, before a mix of solar, wind, pumped hydro and batteries takes over. This transformation would require more investment into new generation and grid assets.

Integration with the energy systems of other countries in the region will also play an important role in delivering Chile's de-carbonization strategy. Neighboring Argentina recently increased production of unconventional natural gas and started to export to Chile for the first time in 11 years. Chile Energy Minister Susana Jimenez also plans to expand cross-border transmission interconnections, particularly with Argentina and Peru, to increase the flexibility of the grid. Currently, Chile has only one international transmission line with Argentina, inaugurated in 2015.

Section 8. The path to de-carbonization

The clean energy sector today finds itself at an important juncture. Costs associated with wind and solar, in particular, have fallen sufficiently so that both technologies are now regularly cost-competitive (on an *un*-subsidized basis) when competing against their fossil-fueled rivals. Meanwhile, thanks to millions of logged operating hours and the associated data, investors and lenders are far more comfortable with the technological risks than they were five years ago.

Middle-income developing countries represent some of the very hottest markets for clean energy deployment today. Mexican clean energy investment, for instance, has been ignited by a combination of market reforms, growing demand for electricity, and exceptional natural resources. There is no shortage of other examples of developing nations where clean energy development has either taken root or is in the process of doing so. As noted above, 2017 was the first year in which emerging nations installed more wind and solar than fossil fuel generation. Yet most of the de-carbonization of emerging market power grids still lies ahead, as zero-carbon sources need to displace existing and planned fossil fuel based generation capacity.

BNEF anticipates two tipping points in the competitive economics between different energy technologies. These will determine the pace at which individual markets de-carbonize their electricity mixes. The first tipping point occurs when the cost of new-build wind and solar becomes cheaper than the cost of building a new gas or coal plant for bulk generation. From this point on, wind and solar would be built preferentially for bulk generation.

The second tipping point occurs when it gets cheaper to build and operate new onshore wind or solar PV than to run an existing, amortized coal or gas plant providing bulk electricity. Once the levelized cost of electricity (LCOE) for solar or wind falls below the short-run marginal cost of an existing fossil fuel plant, it makes economic sense to replace that fossil plant with a new unit of clean energy.

India, for example, is home to some of the lowest levelized costs globally for utility-scale PV and onshore wind today. This reflects mainly extremely competitive auctions held there that have prompted developers to squeeze their project development costs as low as possible. Still, in 2017 coal-fired plants represented 58% of India's capacity and 75% of generation.

Our latest analysis suggests that onshore wind and utility-scale PV are today already more competitive, on an LCOE basis, than new coal- and gas-fired power plants in India. Therefore in Figure 80, we explore how and when new solar and wind capacity is likely to outcompete *existing* coal and gas-fired power plants (second tipping point).

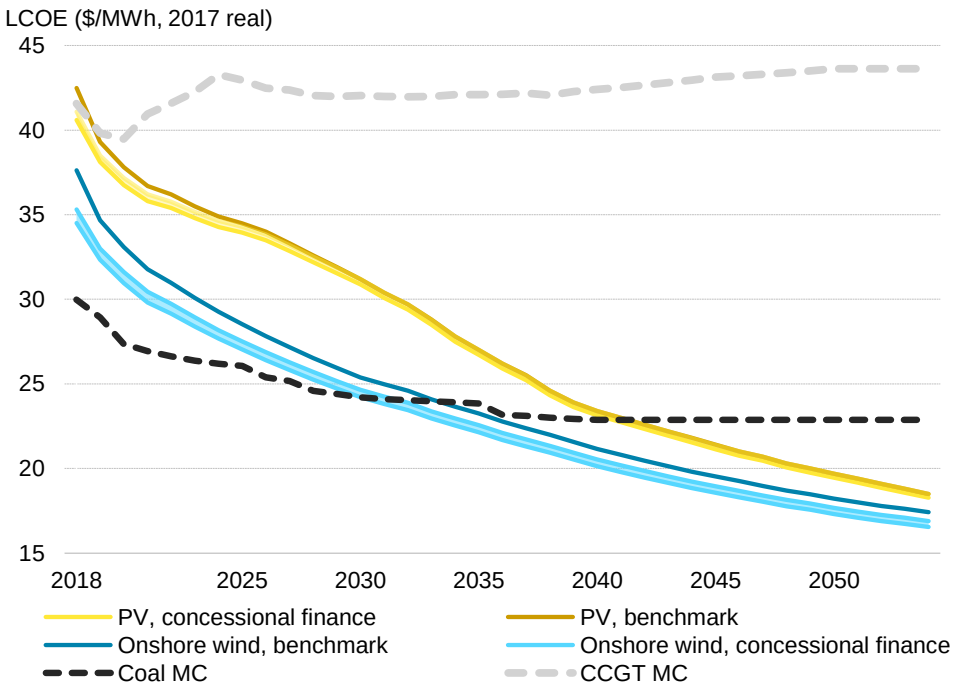
In our benchmark scenario we expect new wind capacity in India to start competing with the marginal cost of coal plants only by the mid-2030s. However, onshore wind is already competitive versus existing combined-cycle gas turbine plants in India. For new solar power plants, the competitive tensions against existing coal are likely to occur only by the beginning of the 2040s.

As part of its work for the Clean Technology Fund, BNEF also explored how concessional financing, which has been so critical in kick-starting renewables investment in emerging markets, has the potential to shift tipping points. For new onshore wind with existing coal, concessional finance has the potential to pull forward tipping point two by two to four years. This shift is fundamental when considering that India installed 94.3GW of new coal over 2012-2017. Given

that such assets have the potential to emit CO2 at high volume for a generation or two, the sooner they can be rendered obsolete the sooner India can cut its power-sector emissions.

For solar, we expect the gap between commercial financing and the CTF scenarios to be much narrower as both financing conditions seem already to be very close. This is likely to be a consequence of two elements: (1) a very competitive environment for both renewable developers and financing institutions, which has pushed down commercial financing costs in India recently; and (2) the high premium required to hedge against the fluctuations of the Indian rupee compared to the U.S. dollar. (CTF and MDB loans are often denominated in U.S. dollars).

Figure 80: Levelized costs of power-generating technologies, India



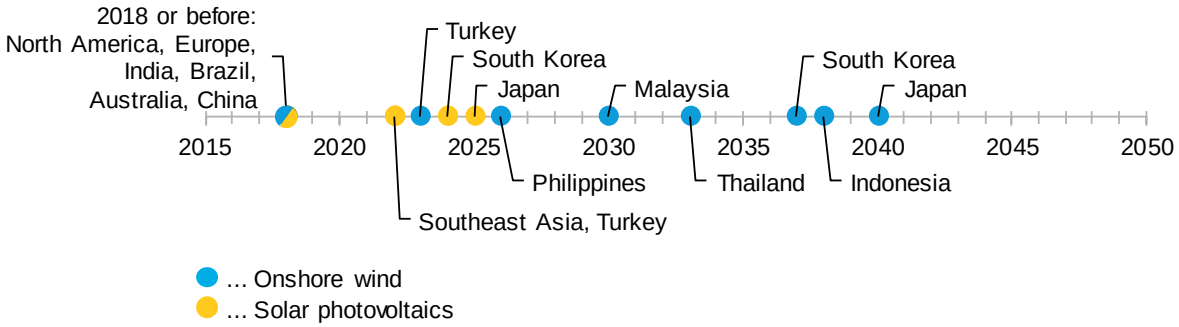
Source: BloombergNEF. Note: MC = marginal cost. Concessional finance scenario assumes a 350bps margin to Libor (USD), and a 491bps INR to USD currency swap.

The relative economics of renewables and coal, and the capacity of governments to recognize these tipping points when planning their energy systems, will be fundamental in shaping the de-carbonization path of the world, and emerging markets in particular. Coal remains the most prominent fuel used in electricity generation today, accounting for 38% of global power production. Its use, however, is set to peak in 2027 and slide thereafter under BNEF's New Energy Outlook[1] 2018 view. NEO shows that the contribution of coal globally might drop to just 11% by 2050, as low-cost renewables, more flexible gas and cheap batteries push in and reshape the electricity system. A fall in coal generation in almost all countries, including in large economies that rely heavily on coal today, will drive the global decline of this fossil fuel.

[1] *Updated annually, BNEF's NEO updates and forecasts data on costs, energy prices, capacity, generation and emissions. Get the executive summary here: http://www.bloomberg.com/company/new-energy-outlook/*

Quickly falling costs of solar and onshore wind, and the limited capability of coal-fired power plants to operate flexibly in partnership with variable renewables, should hasten coal's decline. In North America, Europe, India, Brazil and Australia, electricity from new, unsubsidized wind and PV plants is already cheaper than new coal (Figure 76). In China, where coal represented 40% of 2015-17 capacity additions, the costs of recent PV projects are now on par with those of new-build coal and will start to undercut them from 2019. In most of Southeast Asia, this happens by 2022.

Figure 81: Projected tipping points when new solar/wind projects out-compete new coal on a levelized cost basis



Source: BloombergNEF New Energy Outlook 2018

Furthermore, prospects are dim for coal to keep pace with the technology cost declines achieved by wind and solar through better manufacturing, economies of scale and improved efficiency. In many countries, capital costs associated with new coal power plants have actually risen with the introduction of more complex technologies to limit air pollution. At the same time, improvements in minimizing energy losses in coal-based electricity generation are slowing. This is because gains in the efficiency of steam turbines – the machines that convert thermal energy from coal into mechanical energy – are ever harder to achieve as the technology matures.

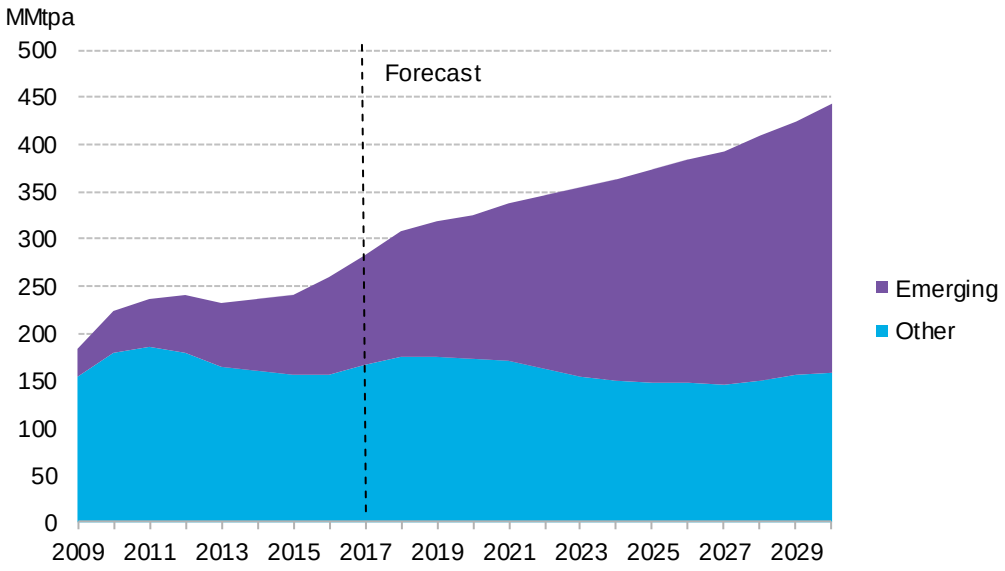
Because of coal's worsening cost-competitiveness against PV and wind, new coal build is set to drop in all markets. BNEF modelling shows that around 355GW of new coal plants, equivalent to $190 billion of investment, could still get commissioned out to 2025. Many of these are legacy projects that were planned and financed many years ago, predominantly in China and India. Yet by the middle of the next decade, BNEF projects annual additions of new coal-fired power to start to plunge. On average, the world adds less than 5GW of new coal per year between 2025 and 2050, compared with an average 78GW between 2015 and 2018, under the NEO view. China, Europe, North America, Brazil, Australia and South Korea are among the regions that add zero coal after 2025. India continues to invest in the fuel until the early 2040s, mostly for system security reasons, adding about half of the global coal capacity, worth $45 billion, between 2026 and 2050.Crucially, the world closes over 1 600GW of coal plants in the period to 2050, more than three times the volumes of coal capacity additions.

As the share of variable renewables increases, the limited flexibility of coal power plants to quickly adjust their load to wind and solar output aggravates the fossil fuel's challenging position in a transformed power system. Batteries and so-called peaker gas generators help with the integration of renewables by providing flexibility to the power grid. For coal, its primary role in the power sector shifts from providing bulk electricity around-the-clock to energy provisioning during nighttime hours and extreme periods of low generation and high demand not met by renewables.

Adding to the pain for coal, a growing number of emerging market governments, including those of China and India, are establishing measures to reduce the impact of coal plant emissions on public health. China's policy over the last two years has been to boost gas use and shutter its oldest, dirtiest coal plants located close to urban centers. Ongoing work on power sector reform could also put an end to "must-run" guaranteed operating hours awarded to the coal sector every year. In its place could come a fully marginal-cost based dispatch system that maximizes consumption of clean power.

In India, new emission mandates from the government aimed at reducing sulphur dioxide, nitrogen oxides and particulate emissions from power plants will require the installation of emissions control technology at power plants. We estimate that these installations increase the levelized cost of electricity from coal by as much as 9%, depending on which technology is employed. BNEF anticipates China and other emerging markets will continue to shift their focus from coal to gas, and that those that have yet done so will soon. As a result, we anticipate that emerging markets will account for all of the growth in global LNG demand in the period to 2030 (Figure 82).

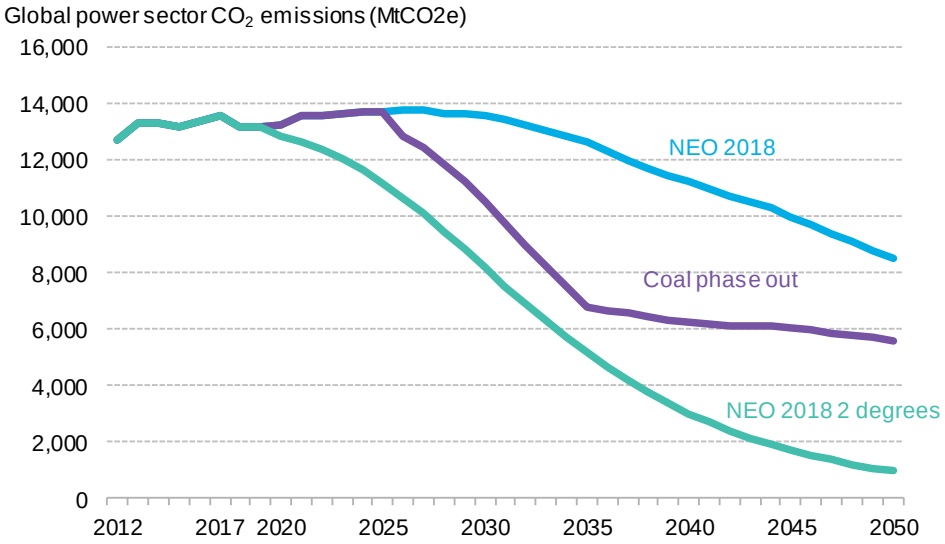
Figure 82: Global LNG demand forecast



Source: BloombergNEF, Poten & Partners, Customs. Note: BNEF base case scenario

In NEO, BNEF contemplated a scenario under which governments effectively shuttered all coal-fired plants worldwide from 2025 through 2035. In such a world, both gas and renewables would of course see faster growth. Gas generation would account for 73% of the deficit created, which in turn would require adding 51% more generation by 2050 than in in NEO's core least-cost scenario. An extra 1,196GW of new gas plants would provide this electricity. And an additional 715GW of solar and wind, aided by 531GW of additional utility-scale batteries, could make up the rest of the gap left by coal.

Figure 83: Global power sector emissions under three possible scenarios



Source: BloombergNEF. MC: marginal cost. Note: "NEO 2018" is BNEF's core scenario under its long-term outlook. It essentially assumes policy status quo and progress achieved through improving economics for renewables. The "coal phase-out" simply assumes that governments establish and enforce policies from 2025-2035 to take all existing coal-fired power plants off line. The "NEO 2018 2-degree" scenario plots a path that would be required to ensure the power sector makes its share of contributions toward keeping emissions sufficiently in check to avoid a 2-degree C rise in the earth's temperature longer term.

Yet, in the larger context of addressing climate change, phasing out coal entirely should be regarded only as a first step. Replacing coal with a least-cost combination of renewables, batteries and gas pushes emissions down to 5.2 gigatons of carbon dioxide, or 54% below the least-cost system trajectory in 2035 (Figure 83). This is certainly good news from a climate perspective, as this emissions level would bring the world closer to a 2-degrees Celsius trajectory in the medium term. However, simply getting rid of coal will not be enough to keep the earth on track for 2 degrees in the longer-term. For this, new zero-carbon technologies that can de-carbonize gas at scale or supplant its role in the system would be required.

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