

2016: Year in Review

Three Trends Highlighting the Accelerating Global Energy Market Transformation



Institute for Energy Economics
and Financial Analysis
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Tim Buckley, Director of Energy Finance Studies, Australasia
(tbuckley@ieefa.org) and

Simon Nicholas, Energy Finance Analyst, (snicholas@ieefa.org)

Executive Summary

This paper summarises the key events across worldwide energy markets in 2016 and highlights three notable trends driving a rapid transformation of the global energy economy. Policy-makers, corporations and investors who disregard this historic, technology-led movement do so at their peril and with the likelihood that they will carry growing stranded-asset risk as this widening market shift picks up speed.

1. The Global Transition to Renewables Is Accelerating

- With the entry into force of the Paris agreement, countries lagging on action to reduce emissions are coming under increased international pressure. The phasing out of fossil fuel subsidies, including Export Credit Agency-subsidised financing of coal-fired power, is a key priority.
- Directors who fail fiduciary duties relating to climate-related risks are facing potential litigation.
- Carbon pricing is gaining momentum, as 2017 is set to see the largest increase in the proportion of GHG emissions covered by such pricing, with initiatives by China, South Africa, Chile and the Canadian province of Alberta in the works.
- Countries and regions with economies tied deeply and traditionally to fossil fuel production (e.g. the U.K., the U.S.) are accelerating their renewable energy deployment.
- Total reliance on renewables is growing: In 2016, a record number of regions reported periods in which electricity consumption was covered 100% by renewables, an occurrence that will become increasingly commonplace from 2017 on.
- Uptake of renewables globally will very likely outpace the IEA's recent, significantly increased 2016 medium-term forecast.
- Solar PV and onshore wind expansion will be complemented increasingly by offshore wind, first, and then by concentrated solar development.
- Africa is set to become the first continent whose development is driven primarily by renewable energy. Morocco continues to lead North African renewables growth.

2. Change Is Happening Faster Than Expected

- Record low tariffs were awarded in solar PV in 2016 across countries as diverse as India, the UAE, Chile, Argentina, Mexico and South Africa. The UAE saw the lowest solar tariff yet at US\$24 per Megawatt hour in September (a 60% reduction in just 18 months).
- Offshore wind price reductions will accelerate global uptake of wind-powered electricity in the decade ahead, providing greater system diversity in Europe, China, Japan and the U.S.

- Declining battery costs will see Electric Vehicles (EVs) approach price parity with combustion-engine cars this decade.
- The faster than expected rise of EVs, energy efficiency and renewable energy could result in oil consumption peaking as soon as 2030.
- Energy efficiency is accelerating the global transformation by decoupling energy consumption and hence emissions from GDP growth. China is a leader, delivering a 5.2% energy productivity gain in 2016 on top of a 5.6% gain in 2015.
- Clean energy is now a demonstrably sustainable business model that can deliver superior shareholder returns. Energy sector champions include Tesla and BYD in the EV sector, and ENEL, NextEra Energy, Brookfield Renewables, China Longyuan and Softbank in the utilities sector.
- The rapidly growing green bond market is indicative of the private capital moving out of fossil fuels and into renewable energy. New renewable infrastructure funds are also leveraging global pension funds, the largest reservoirs of capital.
- Renewable energy investment is being accompanied by an increase in technological efficiency and reduced costs, and is therefore yielding more capacity per dollar.

3. Those Being Left Behind Are Facing Increasing Financial Risks

- Rapid development of electric vehicles and the global policy action on climate change puts oil majors like ExxonMobil at clear stranded-asset risk.
- The implementation of accelerated policies to enact COP21 could see global seaborne thermal coal volumes decline 40% by 2035, resulting in stranded-asset risks across the coal-mining sector and in associated rail and port infrastructure.
- Renewable energy will continue to erode the viability of coal-fired generation by contributing to reduced coal-generation utilisation rates. A defining feature of 2016 was the record low utilisation rate (47%) of the Chinese coal-fired power fleet.
- Coal-fired electricity generation development has slowed: 2016 has seen a reduction in the development pipeline almost equal to the entire coal-fired capacity of the EU.
- World coal consumption is in decline, having peaked in 2013 and has declined in 2016 for the third consecutive year.
- The seaborne thermal coal market is facing structural headwinds despite traded coal prices doubling over 2016.
- The breakdown of the LNG pricing regime continues with weak oil prices compounded by the emergence of cheap U.S. gas exports. Lower-than-expected demand growth in conjunction with increased LNG supply is likely to lead to stranded LNG assets.

1. The Global Transition to Renewables Is Accelerating

Paris Agreement Enters Into Force

- Countries lagging on action to reduce emissions are likely to come under increased international pressure.
- Directors who fail fiduciary duties relating to climate-related risks could face litigation.

In October, the political process of the COP21 Paris agreement was concluded. The agreement enters into force 30 days after at least 55 parties, representing at least 55% of global emissions, have ratified it. With EU ratification the threshold has been crossed, triggering the agreement to become binding under international law from November 4, 2016. Entry into force of the agreement means that there will now be regular meetings of the world's nations at the UN to discuss how to strengthen individual climate pledges over time. Governments will have to report their progress to the UN on a regular basis.

The Paris agreement has dramatic implications for the global energy sector.

There is evidence already that developed nations considered to be lagging in emissions reductions are coming under pressure from the international community. Australia, for instance, is being asked to explain its lack of progress on climate change abatement given that its carbon emissions have consistently risen since the national price on carbon was removed in July 2014 and in the telling absence of a detailed, post-2020 plan¹. Similarly, Japan has attracted criticism for falling behind on the transition to cleaner sources of energy as well as continuing to be a major provider of subsidised finance for coal-fired projects².

In addition to greater scrutiny of national targets, countries can expect renewed focus on financing for sustainable development.

India was the 62nd country to ratify the Paris agreement, doing so on October 2, and with the agreement entering into force is likely to bring more scrutiny of India's ability to reach its ambitious renewable energy targets (350GW by 2030) as well as the delivery of significant financing commitments from international agencies including the **World Bank and the IFC, AIIB, NDB, JBIC, ADB, OPIC** and the **U.S. EXIM Bank**³. Meanwhile the pressure on carbon-intensive industries will only increase. A deputy governor of the **Reserve Bank of India** acknowledged in September that the international community is moving toward penalising industries that add to carbon emissions⁴.

The World Bank president, Jim Yong Kim, has stated that a slowdown in the construction of coal-fired power stations, particularly those planned in Asia, is vital if the Paris climate targets are to be met⁵. He added that there is no prospect of keeping global warming at

¹ <http://www.smh.com.au/federal-politics/political-news/australia-facing-questions-at-un-over-post2020-climate-change-stance-20161011-gs0avq.html>

² <http://www.bloomberg.com/news/articles/2016-06-13/japan-unswayed-by-increasing-pressure-to-disavow-coal-support>

³ <http://www.bridgetoindia.com/blog/ratification-of-climate-accord-to-bring-more-focus-on-indias-renewable-sector/>

⁴ https://www.rbi.org.in/Scripts/BS_SpeechesView.aspx?Id=1027

⁵ https://www.theguardian.com/environment/2016/oct/09/world-bank-jim-yong-kim-paris-climate-coal-power-emissions?CMP=Share_AndroidApp_Gmail

or below 2 degrees if such power projects are built. The World Bank also sees a global price on carbon as a key tool for achieving the Paris targets, which present countries with a transformative economic opportunity⁶.

The agreement also has substantial consequences for corporations. Company directors have a fiduciary duty to consider all risks, including those arising directly from climate change and from regulations that address it. Post-Paris, it is now possible that directors who fail to take account of risks related to climate change could be found to be in breach of their fiduciary duty⁷.

The ideology surrounding emissions and climate is now irrelevant; the increasing regulations implemented by governments moving to fulfil their Paris obligations will create additional risks for businesses regardless of personal beliefs⁸ on climate change. Some companies are significantly more prepared than others for this new reality. It is probably only a matter of time before legal action is taken against company directors over a failure to properly consider and respond to climate-related risks. The successful conclusion of the legal case won by the New York Attorney General against **Peabody Energy Corp** (U.S.) in November 2015 sets a clear precedent.⁹

Carbon Pricing Update

- 100 countries accounting for 58% of global emissions are planning a carbon price or equivalent; new movers in 2016 include India (doubling its coal tax) and Canada.
- 2017 is set to see the largest increase in the proportion of GHG emissions covered by a carbon price.

Individual country's Intended Nationally Determined Contributions (INDCs) to reducing carbon emissions encompass a range of policies and programs, but to IEEFA, carbon-pricing schemes will play a critical role in accelerating finance and realising the Paris targets. About 100 parties to the convention are planning or considering some form of carbon price or ETS, representing 58% of global greenhouse gas emissions¹⁰. However, tangible progress on the increased uptake of a carbon price worldwide has been limited in 2016. A carbon price that fully reflects the social cost of carbon emissions is a significant game changer for energy markets and makes renewable energy still more cost effective versus fossil fuels.

This year BlackRock, the world's largest investor, called on governments to make businesses pay a higher price for the pollution they generate to make it easier to understand climate risks when making investment decisions¹¹. In August, 130 investors collectively managing over US\$13tn in assets called on the G20 to implement a stable and

⁶ <http://blogs.worldbank.org/climatechange/paris-agreement-becomes-reality-how-transform-economies-through-carbon-pricing>

⁷ The Centre for Policy Development and The Future Business Council, Memorandum of Opinion: Climate Change and Directors Duties, 7th October 2016.

⁸ <http://www.bloomberg.com/news/articles/2016-10-24/climate-change-may-trigger-next-financial-crisis-fisher-says>

⁹ <http://www.ag.ny.gov/press-release/ag-schneiderman-secures-unprecedented-agreement-peabody-energy-end-misleading>

¹⁰ World Bank, State and Trends of Carbon Pricing, October 2016, p. 11.

¹¹ <https://www.ft.com/content/bde6859a-9ac2-11e6-8f9b-70e3cabccfae>

economically meaningful carbon price to aid investment decision-making. Further progress in this area is required going forward.

Forty national jurisdictions and more than 20 sub-national governments have implemented a carbon price, and the share of global emissions covered by carbon pricing initiatives has tripled over the past decade. Demonstrated impacts of carbon pricing are already apparent; the doubling of the U.K.'s carbon price floor to £18/tonne of CO₂ in 2015 was reported to have caused a 64% year-on-year drop in thermal coal imports for the first seven months of 2016¹². The price floor is set to double again in 2020 and reach £70/tonne in 2030.

British Columbia put a price on LNG gas plant emissions in 2016 alongside its existing carbon tax of C\$23/tonne. In October 2016 the Canadian federal government committed to bring in a minimum price of C\$10/tonne on carbon emissions by 2018 with each province to implement its own carbon price or have one set centrally¹³.

In February 2016, Finance Minister Arun Jaitley doubled India's coal tax to Rs400/tonne (US\$6/tonne), the third time the tax has been doubled since being introduced in 2010.¹⁴ The stated logic for the tax (officially called the Clean Energy Cess) is to price in some of the externalities of coal use.

Next year could see the largest annual increase ever in the proportion of global emissions covered by carbon pricing schemes. South Africa, Chile and Alberta are all due to implement a carbon tax whilst Ontario will commence an emissions trading scheme (ETS). However, by far the biggest impact will come from China. If the Chinese national ETS is implemented as planned over 2017, then the proportion of global emissions covered by carbon price schemes will reach 20% to 25% from the current 13%¹⁵. Mexico is due to launch a national scheme in 2018.¹⁶

In addition to national and sub-national schemes, the number of companies that are implementing internal carbon prices in 2016 has tripled since 2014. This year also saw the development of numerous international platforms that are helping build carbon pricing momentum. These include the **Ministerial Declaration on Carbon Pricing and the Carbon Pricing Leadership Coalition**. In addition, the **G7 Carbon Market Platform** was opened up to countries outside the G7 and the **High Level Panel on Carbon Pricing** set a target to ensure the emissions covered by carbon pricing schemes reaches 25% by 2020 and then doubles again within the following decade.

Such platforms for cooperation raise the prospect of an international carbon market that the **World Bank** models could reduce global mitigation costs by 50% by the middle of the century¹⁷.

¹² https://www.bimco.org/Reports/Market_Analysis/2016/1010_UK_coal_story.aspx

¹³ <http://www.reuters.com/article/us-canada-carbon-idUSKCN123200>

¹⁴ <https://cleantechnica.com/2016/03/04/india-doubles-tax-coal/>

¹⁵ World Bank, State and Trends of Carbon Pricing, October 2016, p. 11.

¹⁶ <https://cleantechnica.com/2016/09/07/mexico-will-launch-carbon-pricing-november/>

¹⁷ World Bank, State and Trends of Carbon Pricing, October 2016, p. 16.

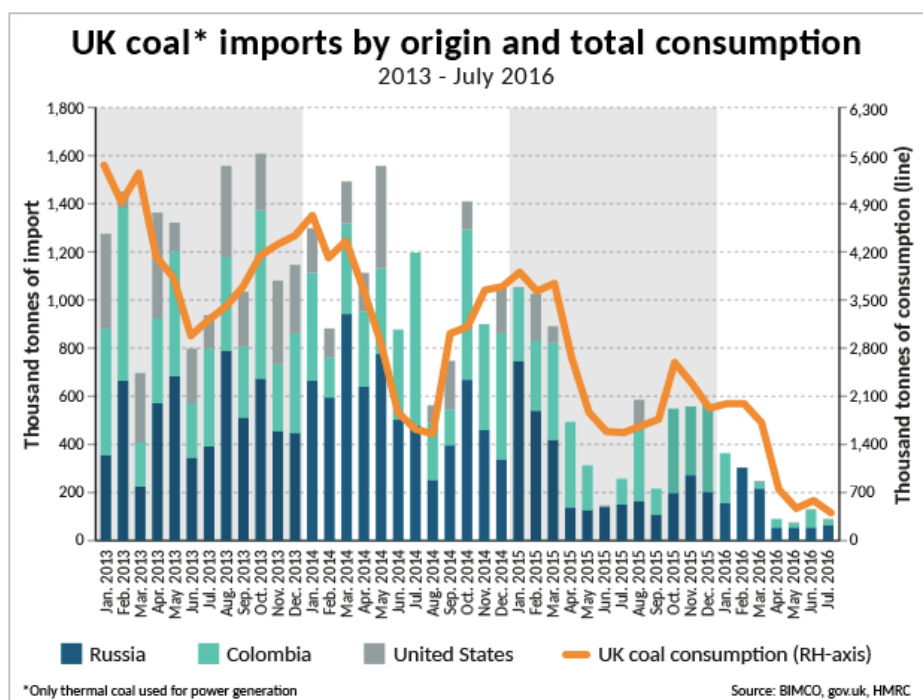
Turning Away From Coal: A Geographic Snapshot

- Countries and regions with economies tied deeply and traditionally to fossil fuels are turning to renewable energy.
- 2016 saw more nations experience periods of electricity consumption covered 100% by renewables, which will become increasingly commonplace from 2017.

The U.K., birthplace of the coal-fired Industrial Revolution, saw more electricity generated by solar panels than from coal in the six months from April to September 2016¹⁸. The turnaround, considered “unthinkable five years ago” by the **Renewable Energy Association**¹⁹, happened quickly—the first day that solar produced more electricity than coal was April 9, 2016. The following month of May marked the first time solar beat coal over an entire month. In that same month, the U.K. went without any coal-fired generation for a full day for the first time since electricity generation began. The U.K. government announced in 2015 that it planned to phase out all unabated coal-fired power stations by 2025.

Scotland has gone even further than the U.K. as a whole. On Aug. 7, Scotland's wind turbines produced enough electricity to power the whole nation²⁰. This comes after **Portugal**'s electricity consumption was entirely covered by solar, wind and hydro generation for four days in May²¹, which was closely followed by a similar event in **Germany** when electricity prices turned negative on May 15 as clean energy provided all its electricity needs. In addition, Uruguay ran entirely on renewables for six straight days in September²².

More generally, greater than 50% of Scotland's electricity comes from wind, hydro and solar sources and its target of becoming 100% reliant on renewables by



Source: BIMCO, gov.uk, HMRC

¹⁸ <http://www.energytrendtracker.org/2016/10/solar-outshines-coal-in-uk-for-6-months/>

¹⁹ <http://www.independent.co.uk/environment/solar-panels-electricity-coal-power-stations-uk-sun-a7344326.html>

²⁰ https://www.washingtonpost.com/world/europe/in-scotland-gusts-of-wind-usher-in-a-quiet-energy-revolution/2016/10/15/e5da2f5a-8a57-11e6-8cdc-4fbb1973b506_story.html?tid=ss_tw

²¹ <https://www.theguardian.com/environment/2016/may/18/portugal-runs-for-four-days-straight-on-renewable-energy-alone>

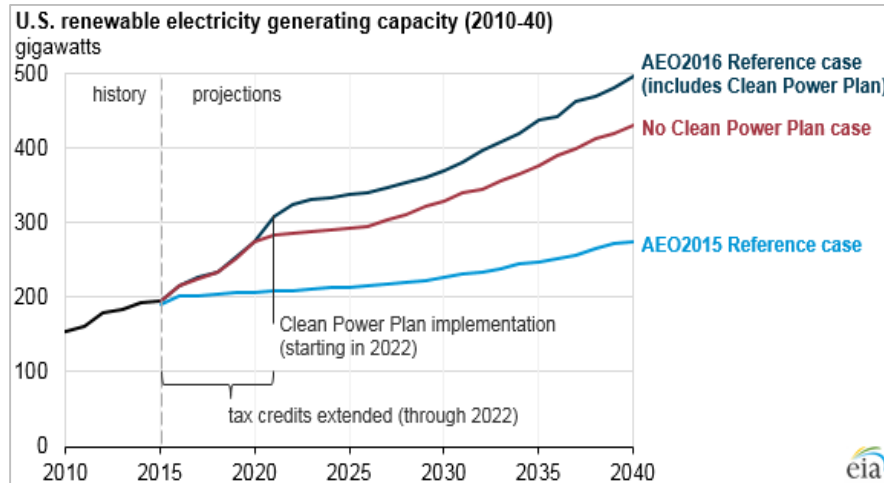
²² Global Wind Energy Council, Global Wind Energy Outlook, October 2016, p. 35.

2020 may well be realised. This from a nation that tapped its plentiful offshore oil and gas reserves for decades. With the last of its coal-fired power stations closing in 2016²³, Scotland is proof that renewables can be the mainstay of a nation's energy supply, not just a complement to fossil fuels.

U.S. coal production in 2016 is projected to decline 19% from 2015 with power generation coal consumption down 9% as coal stock levels are run down. Consumption in the U.S. is expected to be at its lowest level since 1984. Coal-fired power will make up 30% of electricity generation in the U.S. in 2016, down from 51% in 2005. U.S. Coal exports are also expected to drop significantly in 2016, totalling 54.5m short tons, 26.3% lower than 2015²⁴.

Meanwhile, in the first six months of 2016, renewable energy consumption in the U.S. increased 9% compared to the same period in 2015²⁵. New rooftop solar installs are forecast by **Bloomberg New Energy Finance (BNEF)** to reach around 2.8GW in 2016²⁶, up 40% year on year and three times the install rate achieved by Australia at its peak expansion. Including utility scale, solar power capacity in the U.S. will have almost tripled in less than three years by 2017. Wind generation capacity is expected to increase 15.5% in 2016²⁷.

The state of Texas demonstrates how the U.S. energy mix is moving from increasingly costly-to-maintain coal-fired power plants to progressively cheaper wind and solar—in addition to natural gas. Texas burns more coal than any other state and is the nation's biggest carbon emitter but it has also seen wind generation grow ten-fold since 2005²⁸. It is already the largest wind energy producer in the U.S.²⁹ The state is soon to lose 6GW of coal-fired generation, yet electricity prices may be about to fall as 11GW of wind power is set to come online during the 2015-2018 period, more than making up for the coal shutdowns³⁰. In addition to wind generation, solar PV is increasingly a factor in the state with power purchase agreements (PPAs) approaching US\$30/MWh³¹. The rise of



Source: EIA

renewables combined with low natural gas prices has led to sharp declines in coal-fired generation capacity factors and subsequent undermining of profitability³². By comparison, Iowa delivered 35.8% of its electricity from wind in 2015/16.³³

²³ <http://www.bbc.com/news/uk-scotland-edinburgh-east-fife-35882883>

²⁴ <http://www.platts.com/latest-news/coal/houston/us-power-sector-coal-consumption-to-near-1984-21781465>

²⁵ <http://www.eia.gov/todayinenergy/detail.php?id=28312&src=email>

²⁶ <http://www.bloomberg.com/news/articles/2016-10-20/get-ready-for-the-rooftop-solar-stall>

²⁷ https://www.theguardian.com/environment/2016/oct/21/us-energy-shakeup-continues-as-solar-capacity-set-to-triple?CMP=Share_AndroidApp_Gmail

²⁸ <http://www.bloomberg.com/news/articles/2015-11-13/coal-s-cruel-fortune-its-biggest-market-is-also-the-windiest>

²⁹ <http://www.dallasnews.com/news/politics/2016/10/18/obamas-climate-change-plan-upheld-court-mean-texas>

³⁰ <http://www.bloomberg.com/news/articles/2016-09-28/don-t-worry-about-coal-plant-shutdowns-texas-wind-s-got-this>

³¹ <http://www.pv-tech.org/news/8minutenergy-targeting-over-2gw-of-pv-projects-in-texas>

³² <http://ieefa.org/ieefa-report-beginning-end-texas-coal-fired-electricity-industry-rising-competition-wind-solar/>

³³ <http://reneweconomy.com.au/us-state-of-iowa-follows-south-australia-to-40-per-cent-wind-energy-52575/>

The Canadian province of Alberta, another example of a region identified with fossil fuels, is also now looking toward renewable energy. The provincial government has stated that its coal-fired power stations, making up 40% of generation capacity, will all be closed by 2030 and this year ramped up efforts to replace capacity with renewables. There are plans to establish the first solar power plants in western Canada³⁴ and to develop a further 5GW of renewable capacity as Alberta seeks to secure 30% of its electricity generation zero-emissions sources by 2030³⁵.

The continuing move away from coal by nations such as the U.S., China and the U.K. is leading to a drop in the carbon intensity of the global economy. PwC's 2016 Low Carbon Economy Index report found that carbon emissions per unit of GDP fell 2.8% last year, more than double the average fall between 2000 and 2014³⁶. Importantly, this drop occurred within the context of global economic growth which would normally lead to increased emissions. However, the figure of 2.8% is still well below the 6.5% reduction needed to hit the two degree target set at Paris.

Corporations are also turning away from coal. **Engie**, the world's largest independent power producer, has committed to focus on renewable energy and natural gas across Asia-Pacific as it begins its exit from coal-fired power generation across the region³⁷. Noting that the recent boom in renewables has had a huge impact on energy markets, Engie executives say they now doubt the sustainability of coal-fired power generation going forward. Meanwhile **AES Corp.**'s CEO has stated the company will most likely not build any more coal-fired power plants after completion of two current projects in India and the Philippines³⁸.

Renewable Energy: Targets, Growth and Worldwide Spread

- The IEA's significantly increased 2016 medium-term forecast mirrors the continued global uptake of renewables but still underestimates future growth.
- Solar PV and onshore wind expansion are likely to be increasingly complemented by offshore wind and then concentrated solar thermal.

In October the IEA significantly increased its five-year growth forecast for renewable energy, noting that renewable capacity has overtaken that of coal-fired generation for the first time³⁹. The agency remarked that renewables were leading a transformation in global energy, especially in emerging markets. The IEA's 2016 Medium-Term Renewable Market Report sees renewables growing by 13% more between 2015 and 2021 than it did in last year's forecast. According to the report, renewables will remain the fastest growing source of electricity generation over the next five years, moving from a 23% share of global electricity generation in 2015 to 28% by 2021. The IEA's re-assessment was influenced to a large degree by strong renewables policies in China, India, the U.S. and

³⁴ <http://www.pv-tech.org/news/alberta-government-investigates-50-solar-power-proposal>

³⁵ <http://www.cbc.ca/news/canada/calgary/alberta-target-2030-renewable-energy-electricity-1.3761787>

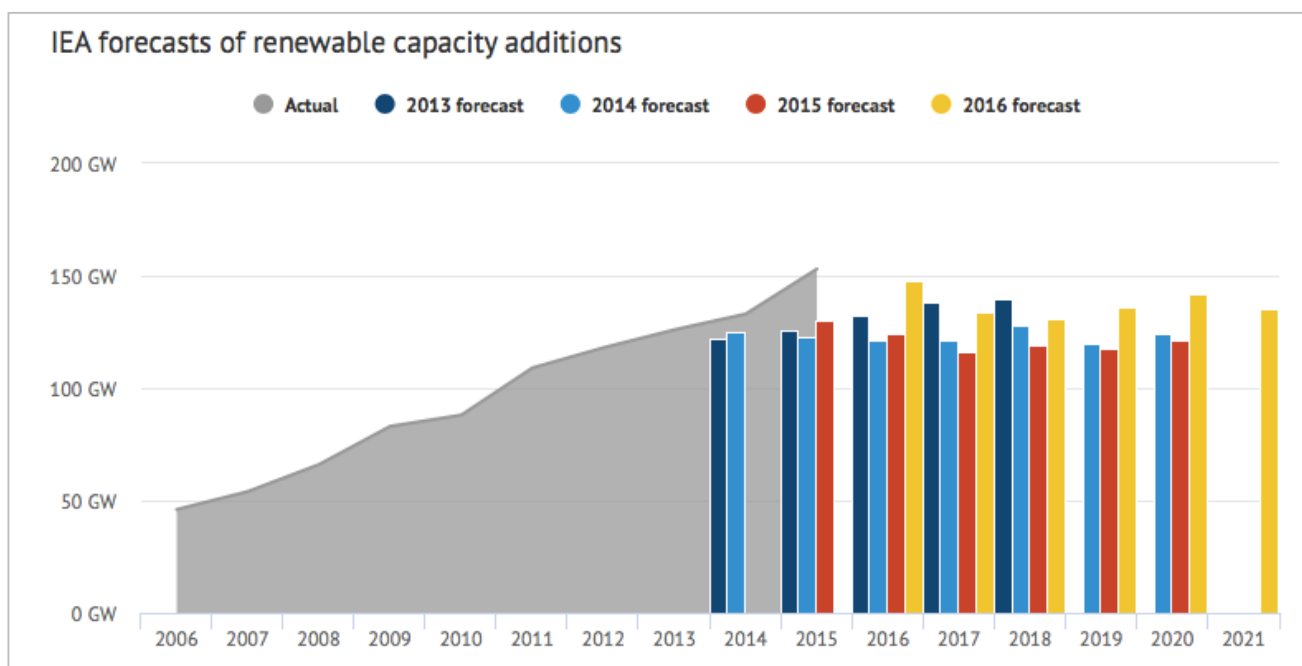
³⁶ <http://www.pwc.co.uk/lowcarboneyconomy>

³⁷ <http://www.reuters.com/article/us-asia-utilities-engie-idUSKCN12R0E7>

³⁸ <http://www.platts.com/latest-news/electric-power/louisville-kentucky/aes-winding-down-building-new-coal-projects-worldwide-21457945>

³⁹ http://www.iea.org/newsroom/news/2016/october/iea-raises-its-five-year-renewable-growth-forecast-as-2015-marks-record-year.html?utm_content=buffer84622&utm_medium=social&utm_source=twitter-ieabirol&utm_campaign=buffer

Mexico combined with the recognition that 2015 represented a turning point in global energy markets in terms of cost competitiveness of renewables.



Source: Carbon Brief, IEA

Despite its higher forecasts, however, the IEA continues to predict a slowdown in future renewables installation. The agency's latest forecast has 2015 as the peak year for renewable capacity additions with the amount added decreasing each following year through 2018. This is despite the fact that solar and wind are already the lowest-cost options in many regions. Analysis by BNEF does suggest a reduction in the value of global renewables investment in 2016 after a record year in 2015, but this is offset by the plunging cost of clean energy, which will see more capacity added for less cost going forward (refer "Financing" section).

A **Global Wind Energy Council (GWEC)** report released in October incorporated the most recent revised IEA wind generation projections. Under their New Policies Scenario, the IEA now sees wind power generation increasing from 4% of the world's electricity generation in 2015 to 14% by 2040⁴⁰. This is 50% higher than what the IEA was forecasting last year. However, the GWEC themselves see the share of wind generation increasing by as much as 29% by 2040, more than double the IEA's new figure. Global wind generation installations in 2016 are set to be 60GW, a 14% increase on the 2015 installed base of 433GW⁴¹.

In IEEFA's view, the IEA remains far too conservative and will have to revise its outlook again next year.

⁴⁰ Global Wind Energy Council, Global Wind Energy Outlook, October 2016, p. 40.

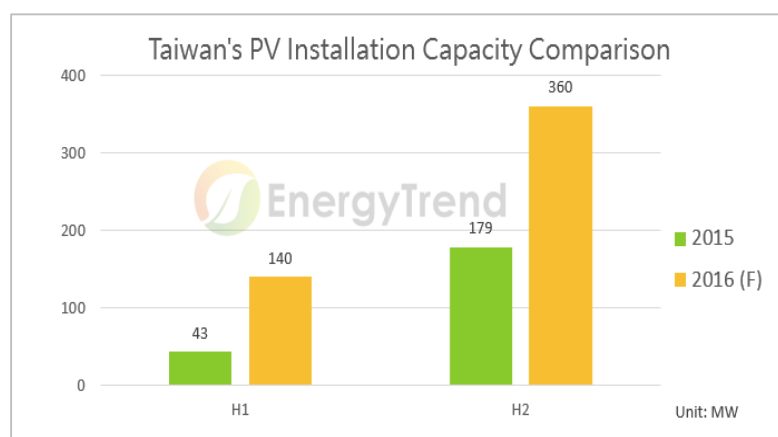
⁴¹ <http://mobile.reuters.com/article/idUSKBN12I09K>

Asia

China has been joined by **India** in leading global expansion of renewable energy. India made significant new progress toward its ambitious target of 350GW of renewable capacity by 2030. In September, Adani commissioned the world's largest solar power plant (648MW) as the country passed the milestone of 8GW of solar capacity. Growth in rooftop solar for the 12 months to October 2016 was at 113% with a similar level expected in 2017⁴². Rooftop solar received a further, major boost with the **Asian Development Bank** contributing US\$500m to a US\$1bn fund for Indian rooftop solar investment⁴³, strong international support for India reaching its 40GW-by-2022 rooftop target. India also saw a record low solar tariff at Rs4.34/kWh (US\$65/MWh) by Fortum in January 2016.⁴⁴

Meanwhile, China announced a project set to smash the record for the largest solar generation plant. That project, now under construction in Ningxia, will have a capacity of 2GW once complete and comprise six million solar panels. China's solar installations tripled in the two years through June 2016 (including over 20GW in just the first six months of 2016) and BNEF expects this to double again by the end of 2018⁴⁵. China also progressed solar thermal technology in 2016. The country's **National Energy Administration** unveiled a list of 20 solar thermal projects in September, with a combined capacity of 1.35GW that it aims to have commissioned by the end of 2018⁴⁶.

Elsewhere in Asia, the new **Taiwan** government announced significantly increased renewable energy targets this year. The goal for solar PV installations has been raised to 20GW by 2025 with 1.2GW of onshore wind and 3GW of offshore wind by the same date⁴⁷. The 2020 target will represent 20% of electricity generation from renewable energy sources. Currently Taiwan produces 4% of electricity from renewables⁴⁸ but solar uptake is increasing. The increased focus on renewable energy comes as the government has committed to cease using nuclear energy (representing a major policy turnaround from a



Source: EnergyTrend

few years ago) and boost energy self-sufficiency. Taiwan's green energy plan will take advantage of its solar PV manufacturing capacity and allow it to become an important player in the renewables industry across the region⁴⁹. **South Korea** also announced a plan in July to invest US\$36.6bn to develop renewable energy industries and produce clean energy equivalent to 26 coal-fired power stations each year⁵⁰.

⁴² <http://www.pv-tech.org/news/india-surpasses-1-gw-rooftop-solar-with-grid-parity-for-most-ci-consumers>

⁴³ <http://renewables.seenews.com/news/adb-to-fund-half-of-usd-1bn-rooftop-solar-programme-in-india-541936>

⁴⁴ <https://cleantechnica.com/2016/04/22/finlands-fortum-invest-e400-million-indian-solar-market/>

⁴⁵ <http://www.bloomberg.com/news/articles/2016-09-20/out-of-china-s-dusty-northwest-corner-a-solar-behemoth-arises>

⁴⁶ <http://renewables.seenews.com/news/china-says-1-35-gw-of-csp-projects-to-be-ready-by-2018-539749>

⁴⁷ http://pv.energytrend.com/news/Taiwan_Officially_Sets_Renewable_Energy_Target.html

⁴⁸ <http://www.taiwantoday.tw/ct.asp?xItem=248640&ctNode=2194&mp=9>

⁴⁹ <http://www.globalresearch.ca/taiwans-green-shift-green-energy-prospects-and-challenges/5549651>

⁵⁰ <http://www.ibtimes.com/south-korea-invest-36-billion-renewable-energy-2020-2389326>

Latin America

Renewables have gained meaningful traction across Latin America, with **Mexico** holding its first renewable energy auctions this year, awarding contracts of 1GW and 500MW, to **Enel Green Power** and **SunPower**, respectively⁵¹. In September, purchase contracts for 8.9m MWh of electricity per year were awarded⁵². At an average price of US\$33.47/MWh, such auctions are rapidly bringing down the cost of electricity at the same time as increasing renewables penetration. Mexico is targeting 35% of generation from clean energy sources by 2024, up from around 20% at present.

In August, **Chile** awarded 12.4m MWh of new contracts at a record low average price of US\$48/MWh (63% below Chile's last auction), mostly to wind and solar. Chile's Energy Minister Máximo Pacheco said this auction will lower electricity prices by 20%,⁵³ an increasingly common outcome of reverse tender auctions of renewable energy in 2016. In this Chilean auction, Ireland's **Mainstream Renewable Power** won a record 1GW of wind tenders worth US\$1.65bn.⁵⁴ Chile is planning auctions for an additional 19.9m MWh over the next few years.

In October, **Argentina** awarded 1.1GW of renewable energy projects in the first reverse auction round of its **RenovAR** program, launched in May 2016. Solar projects averaged just US\$60/MWh. Further rounds are set to take place in November and May 2017. A total of 123 projects bids with around 6GW of capacity were submitted. Argentina has set a goal to achieve 8% of generation from renewable energy by 2017 and 20% by 2025⁵⁵, a tenfold increase on current levels.

Recent projections show **Brazil** has the potential for 880GW of wind generation. The country benefits from wind assets along its long coastline, which rank it fourth in the world—behind the U.S., China and Germany—in terms of potential to expand wind generation⁵⁶. The country's huge and underdeveloped solar assets also have the potential to provide a large boost to renewables in Brazil, which is set for a solar auction in December 2016. Interest in the auction has been very high: by August, 419 projects totalling 13.4GW of solar capacity had registered for this auction⁵⁷.

North Africa and Middle East

Morocco's status as a renewables leader on the African continent was affirmed when the country extended its renewable energy target in late 2015 to 52% by 2030⁵⁸. To meet this goal, the **Moroccan Agency for Sustainable Energy** (Masen) is to develop 6GW of renewable energy projects by 2030. Until 2016, Masen had taken on solar projects only but its scope has now been extended to wind and hydro. Of this, 3GW of new capacity is to be commissioned in the next four years⁵⁹. Meanwhile, the first phase of the ground-breaking Noor concentrated solar power (CSP) came online in January, with progress on

⁵¹ <https://cleantechnica.com/2016/04/06/mexicos-awards-enel-green-power-nearly-1-gw-sunpower-approximately-500-mw-solar/>

⁵² <http://www.wsj.com/articles/mexico-awards-contracts-to-secure-renewable-energy-1475086767>

⁵³ <http://www.wsj.com/articles/chile-awards-contracts-in-its-largest-power-auction-1471463611>

⁵⁴ <http://www.businessgreen.com/bg/news/2468225/mainstream-renewable-power-wins-big-in-chilean-energy-auction>

⁵⁵ <http://planetsave.com/2016/10/17/renewable-electricity-auctions-argentina-awards-400-mw-solar-renovar-program/>

⁵⁶ <http://plus55.com/business/2016/10/brazil-wind-power-potential>

⁵⁷ http://www.pv-magazine.com/news/details/beitrag/134-gw-of-solar-submitted-brazils-december-auction_100025715/-axzz4MokaqrHL

⁵⁸ <https://www.ft.com/content/6eb0902c-cb3f-11e5-a8ef-ea66e967dd44>

⁵⁹ <http://renewables.seenews.com/news/moroccos-masen-to-lead-renewables-build-up-of-6-000-mw-by-2030-541390>

following phases throughout the year. Phases Two and Three are expected to be completed in late 2017 and, once the solar PV Phase Four is commissioned, the entire complex will have a capacity of 580MW⁶⁰.

Saudi Arabia announced its “**Vision 2030**” in April, which aims to transform the economy to one that is no longer dependent on oil. Included in this is an aim to build 9.5GW of renewable energy capacity by 2023 from almost nothing today⁶¹. In the biggest programme of this type in the region, 3.4GW of tenders are to be rolled out over the next three years. The lead Saudi Arabia is taking in Middle Eastern renewables development is confirmation of the promising future the sector has in the region.

Europe

In Europe, renewable energy expansion maintained momentum across much of the European Union. The first half of 2016 alone saw a significant increase in offshore wind development with US\$15.5bn invested in the sector. Offshore installations are set to double this year compared to 2015 with 3.7GW of new capacity additions⁶².

Sweden remains on track to produce all of its power from renewable sources by 2040⁶³. The declining cost of wind power means that no new nuclear power stations are likely to be built, and Sweden sees no need to build additional hydropower plants. In October, France confirmed a target to nearly double renewable energy installations to 70-76GW by 2023⁶⁴.

Renewables build-up has also shown acceleration outside the EU. Turkey’s Energy and Natural Resources Minister announced a tender for a 1GW solar PV project in October⁶⁵. The tender is to be held in December and is expected to attract US\$1.3bn of new investment. This is expected to be the first of many such developments in Turkey, where a tender for wind energy is due for the first quarter of 2017.

Going Forward

In 2016, solar PV made major strides as its cost dropped dramatically. From 2017 onward, solar PV is likely to see more cost reduction than onshore wind and to continue to find favour worldwide as was seen this year. On the wind front, many markets have yet to exploit the cost reductions of onshore wind made in Europe, the U.S., and other regions (refer section below), so onshore wind uptake will continue to expand globally. Increasingly, solar PV and onshore wind look set to be joined by increased installation of offshore wind after impressive cost reductions of this technology in Europe (refer to the “Dramatic Deflation” section). Led by countries like China, concentrated solar power will also attract investment in the near future as its energy storage capacity complements intermittent renewables uptake and will likely result in cost reductions and efficiency gains similar to those that have been achieved lately in offshore wind.

⁶⁰ <http://meconstructionnews.com/18002/energy-morocco-emerging-as-a-solar-superpower>

⁶¹ Ernst and Young, Renewable Energy Country Attractiveness Index, October 2016, p. 14.

⁶² https://www.theguardian.com/environment/2016/oct/20/europes-offshore-wind-industry-booming-as-costs-fall?CMP=Share_AndroidApp_Gmail

⁶³ <http://uk.reuters.com/article/uk-sweden-renewables-idUKKCN12P0E8>

⁶⁴ <http://renewables.seenews.com/news/france-locks-renewables-target-for-70-76-gw-by-2023-545098>

⁶⁵ <http://www.dailysabah.com/energy/2016/10/20/worlds-largest-photovoltaic-solar-plant-to-be-established-in-konya-by-2018>

Important strides by developed countries in pushing renewables forward have helped encourage the ambition of developing nations. However, some of the world's most affluent countries have lagged behind. Japan has seen its promising solar boom decline in the face of reduced solar tariffs, and major Japanese banks are looking mostly overseas for opportunities to finance renewables projects (refer "Financing" section). Australia has also been slow on the uptake of solar PV projects despite its huge solar radiation assets. From 2017, the developed nations that are lagging will be pushed to step up in order to help maintain the global momentum that renewables have won over the past few years.

Leapfrogging to Renewables: Africa

- The potential for Sub-Saharan solar installations is exponential.
- Africa is now set to become the first continent whose development is driven primarily by renewable energy.

The world has passed a turning point: more clean energy capacity is being added globally than coal, natural gas and oil combined. In addition, more than half the world's investment in clean energy is coming in emerging markets instead of in richer nations according to BNEF⁶⁶. If this trend is to continue, additional support for developing economies will be vital.

Operating and proposed utility-scale solar PV project installed costs in Africa, 2011-2018.



Source: IRENA

⁶⁶ <http://www.bloomberg.com/news/articles/2015-11-23/leapfrogging-to-solar-emerging-markets-outspend-rich-countries-for-the-first-time>

Countries such as China and India are embracing solar energy, and new solar capacity additions have increased by six times to around 47GW by 2015⁶⁷. However, this growth has largely bypassed Africa, which contains the majority of the least developed nations of the world. More than half of the 1.3 billion people without access to electricity live in Sub-Saharan Africa⁶⁸. This despite African countries having 52% to 117% more solar radiation than a developed solar leader like Germany⁶⁹.

This is set to change — technology improvements and cost reductions have sparked the development of the solar home system (SHS) market and growing interest in mini-grids. 2016 saw a significant increase in utility-scale solar capacity additions and the **International Renewable Energy Agency (IRENA)** predicts that Africa could have 70GW of solar generation in place by 2030. Technical improvements and dramatic cost reductions, combined with the continent's excellent solar radiation assets, have given rise to the prospect of Africa's energy markets leapfrogging the fossil fuel era and become the first continent whose development is driven largely by renewable energy⁷⁰.

Finance is becoming increasingly available; the **Green Climate Fund** is to contribute over US\$78m as an anchor investment in a fund managed by **Deutsche Asset Management** for renewable energy access in Africa. This anchor investment will be used to raise hundreds of millions of dollars, which in turn will help support US\$3.5bn of local investment in African renewables⁷¹. In July 2016, the **Rockefeller Brothers Fund** joined a consortium of investors supporting Mainstream Renewables in a program to install 1.3GW in Africa by 2018⁷².

Despite regulatory risks and financing issues, Sub-Saharan solar deployment potential is exponential, with the rooftop sector set to undergo dramatic growth⁷³ along the lines of that seen over the past five years in Bangladesh, where a world record of over 4 million solar home systems (SHS) have been installed. Solar home-lighting systems—small “plug-and-play” SHS with integrated lighting that are more like an electrical appliance than a residential solar PV system—have seen costs reduced by as much as 80% to as low as US\$120 per unit since 2010.

SHS can now provide electricity to households for as little as US\$56 a year, cheaper than getting energy from kerosene or diesel⁷⁴. Across Africa, millions of people are already taking advantage of the falling cost of off-grid SHS to get cheaper, clean and more reliable energy. IRENA estimates 10% of Africa's 600 million people living off-grid are using solar technology to light their homes. Innovation is apparent in the way many Africans pay for their solar services. Monthly payments can be made via another technology that famously leapfrogged an established system across the continent: mobile phones.

In order to achieve universal access to electricity by 2030, the current pace of extension will need to at least double, and off-grid solutions are expected to provide 60% of the required additions⁷⁵. Renewables are already the cost-competitive choice for off-grid installations across most rural and peri-urban areas, and as many as 350,000 mini-grids may be needed to achieve universal access in Africa. The alternative of extending electricity grids to those without access to electricity would be prohibitively expensive: grid

⁶⁷ Solar PV in Africa: Costs and Markets, IRENA, September 2016, p. 7.

⁶⁸ <http://www.pv-tech.org/editors-blog/how-market-entrants-can-exploit-africas-significant-solar-opportunity>

⁶⁹ Solar PV in Africa: Costs and Markets, IRENA, September 2016, p. 7.

⁷⁰ Solar PV in Africa: Costs and Markets, IRENA, September 2016, p. 16.

⁷¹ <http://renewables.seenews.com/news/deutsche-bank-secures-anchor-investor-for-african-renewables-fund-543864>

⁷² <https://www.ft.com/content/74b82046-5449-11e6-9664-e0bdc13c3bef>

⁷³ <http://www.pv-tech.org/news/rooftop-solar-market-to-explode-in-africa-if-chronic-issues-addressed1>

⁷⁴ <http://www.reuters.com/article/us-africa-solar-energy-idUSKCN12B254>

⁷⁵ <https://irenanewsroom.org/2016/10/05/solving-the-energy-access-problem-with-renewable-mini-grids/>

investment would need to increase to US\$55bn a year from the current US\$8bn⁷⁶. If the current trend is maintained it would take until 2080 to connect everyone. Off-grid solutions are cheaper and available now. IRENA predicts a 60 percent decrease in the cost of producing electricity from renewable mini-grids over the next 20 years⁷⁷.

Utility-scale solar also made a move in Africa in 2016. **Nigeria** signed its first ever PPA with 10 developers for a total of 975MW of solar PV generation⁷⁸. Meanwhile **Zambia** set a new African low-price record (excluding South Africa) of just US\$60/MWh fixed for 25 years under the IFC's "Scaling Solar" programme⁷⁹, helping change the perception that low renewable energy costs are unattainable in poor countries with under-developed institutions. Senegal and Madagascar are also benefitting from the programme, which aims to install 1GW of solar in the next three years⁸⁰. **Senegal**, which aims to have 20% renewable electricity generation by 2017, began construction on one of Sub-Saharan Africa's largest solar projects in October 2016. Being developed by **Greenwish Partners**, a French renewable energy provider dedicated to Sub-Saharan Africa, it is supported by **Green Africa Power**, a joint investment vehicle of the U.K. and Norwegian governments⁸¹.

Progress in Africa is not limited to solar energy. The continent's largest wind farm, the 310MW Lake Turkana project, is approaching completion in Kenya. It includes **Google** amongst its investors and is expected to provide 15% of Kenya's electricity needs⁸². Tanzania and Ethiopia are also planning to tap into the Great Rift Valley's wind assets. Such countries will be able to take advantage onshore wind energy costs dropping 23-36% globally by 2030 (as estimated by BNEF).

Renewables development in Africa still faces a number of challenges: regulatory risk, a lack of skills, poor financing options and inadequate data. However, as the global trend of renewable energy cost reduction starts to spread, Africa will very quickly reach the point where financing and regulatory barriers won't be able to hold renewables back.

⁷⁶ <http://www.economist.com/news/middle-east-and-africa/21709297-small-scale-solar-power-surg-ing-ahead-africa-unplugged?fsrc=scn/tw/te/bl/ed/offgridsolarpowerafricaunplugged>

⁷⁷ <http://www.reuters.com/article/us-africa-solar-energy-idUSKCN12B254>

⁷⁸ <http://www.pv-tech.org/news/nigeria-signs-first-ever-solar-ppa>

⁷⁹ http://blogs.worldbank.org/energy/why-zambia-s-6-cents-more-significant-dubai-s-3-cents?CID=EAE_TT_Energy_EN_EXT

⁸⁰ <http://www.pv-tech.org/news/ifc-zambia-solar-auction-sees-record-low-6-price-benchmark>

⁸¹ <http://www.pv-tech.org/news/senegal-launches-sub-saharan-africas-largest-solar-park>

⁸² <http://www.eenews.net/stories/1060044075>

2. The Pace of Change is Happening Faster Than Analysts Predicted

Dramatic Deflation: Annual Double-Digit Declines

- Record low tariffs were awarded in solar in 2016, with new lows set in countries as diverse as India, the UAE, Chile, Argentina, Mexico and South Africa.
- Offshore wind price reductions will accelerate global uptake this coming decade.

The deflationary nature of renewables globally is clear, and it is surprising all forecasters.

A succession of new records for solar PV tenders were set in 2016. In May, the first tender below US\$30/MWh set a new global record low price after an auction for 800MW of capacity in **Dubai**. The unsubsidised bid of US\$29.90/MWh was almost half the cost of the winning bid at a similar auction in Dubai in 2015. August saw this record beaten in Chile, where the winning bid was awarded a contract at US\$29.10/MWh for a 120MW solar PV plant in the Atacama Desert. This record did not stand long; the following month saw yet another new low with a US\$24.20/MWh tender for a solar installation in **Abu Dhabi**⁸³. This bid was won jointly by **JinkoSolar Holding Co.** of China and Japan's **Marubeni Corp.**

Elsewhere, national records and new landmarks continue to be set around the world as countries increasingly move away from feed-in tariffs and toward reverse auctions that help drive prices lower. Chile's August auction for wind and solar energy achieved an average price of US\$47.59/MWh, 63% lower than its previous auction⁸⁴. Cost reductions have also seen renewables begin to leave conventional generation far behind. An October 2016 report from **South Africa's Council for Scientific and Industrial Research** (CSIR) showed that solar PV and wind energy is 40% cheaper than coal-fired generation⁸⁵.

In October, **Deutsche Bank's** U.S. solar market report predicted solar module prices would drop to US\$0.35/W in the last quarter of 2016. Given that prices had already dropped by one third in the third quarter (from US\$0.6/W to US\$0.4/W), this would mean a price drop of 40% over 2016⁸⁶. This could result in payback periods of five years or less in the U.S. residential solar market. Given that the speedy decline in module prices is being accompanied by declines in inverter prices in Commercial & Industrial and utility-scale markets, Deutsche expects a significant improvement in solar economics across several U.S. markets in the next 12 to 18 months. Other markets are also benefitting from reduced module costs driven by increased supply from China. The reductions have come at the right time for India as it supports reduced bids and continues its progress toward its ambitious target of 100GW of solar capacity by 2022⁸⁷.

Offshore wind has been slow to take off in many parts of the world due to its cost. However, 2016 saw dramatic cost reductions in the more developed European market—a

⁸³ <http://reneweconomy.com.au/solar-price-hits-record-low-of-2-42ckwh-and-may-fall-further-32358/>

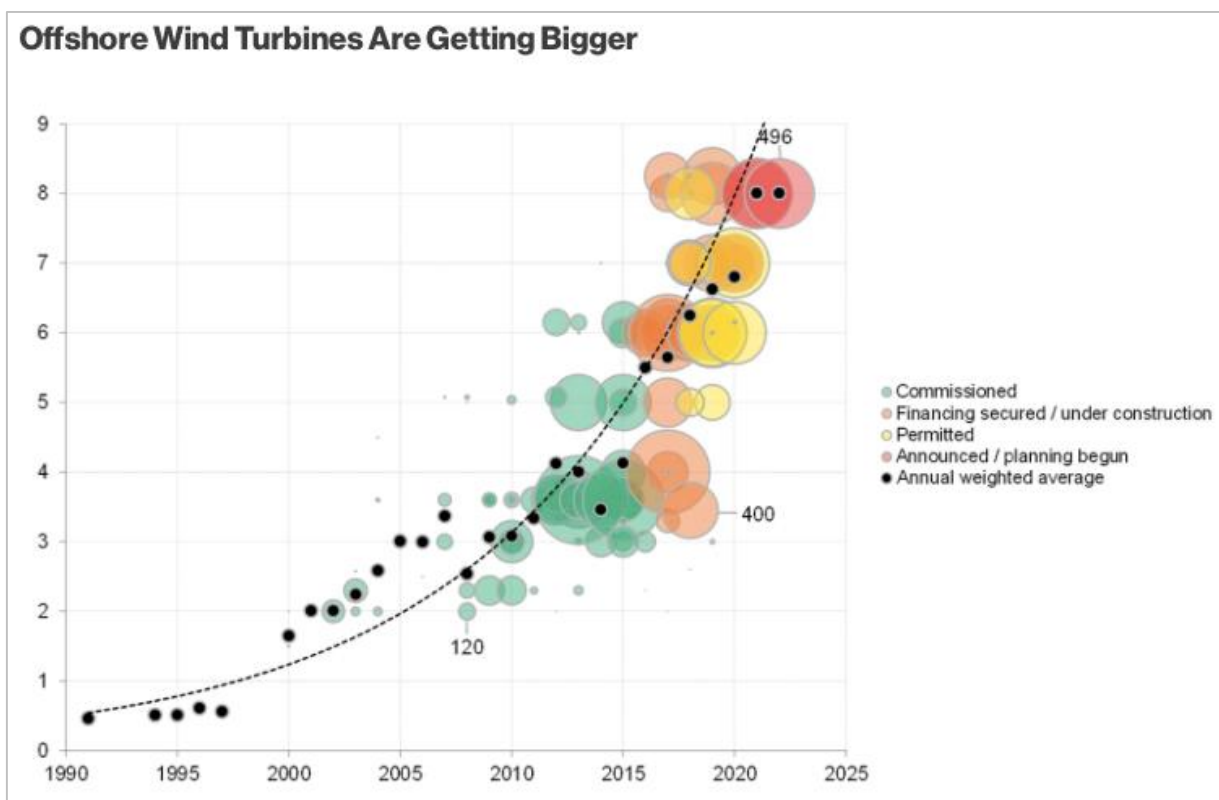
⁸⁴ <http://www.wsj.com/articles/mexico-awards-contracts-to-secure-renewable-energy-1475086767>

⁸⁵ <http://www.businesslive.co.za/bd/companies/energy/2016-10-19-renewables-cheaper-than-coal-says-csir/>

⁸⁶ <http://reneweconomy.com.au/2016/stunning-price-falls-could-spark-another-gold-rush-for-us-solar-pv-market-63495>

⁸⁷ <http://www.bridgetoindia.com/blog/sharp-fall-in-pv-module-prices-to-help-the-indian-solar-sector/>

development that is likely to see significantly faster offshore wind take-up globally. In July 2016, **Dong Energy** secured an offshore deal in the Netherlands at EUR72.5/MWh, half the prices seen five years previously. This record was beaten in a matter of weeks as **Vattenfall** won a Danish tender at EUR60/MWh⁸⁸. Cost reductions have been achieved via improved technology with aerodynamic turbine blades and sensors. In addition, the size of wind turbines has increased with the latest large turbines featuring a capacity of 8GW each. A single rotation of such a turbine is enough to provide the daily consumption of an average U.K. household⁸⁹. Fewer, larger turbines per array means fewer foundations and less cabling. Increased scale in Europe has also been a major factor in cost reduction. China, Japan and the U.S. are set to follow Europe's lead now the cost and technology issues have been largely overcome.



Source: Bloomberg New Energy Finance

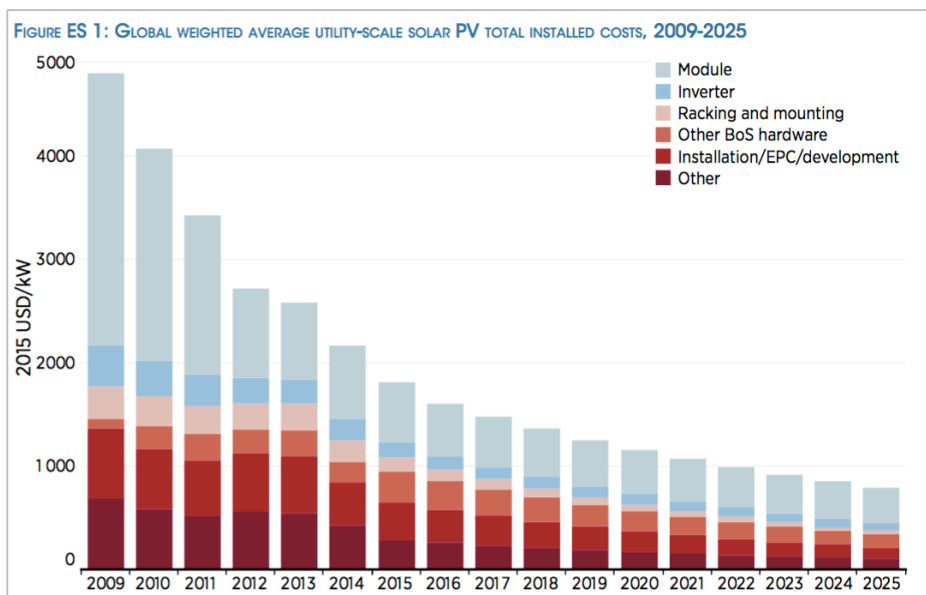
⁸⁸ <http://www.telegraph.co.uk/business/2016/10/02/cut-throat-competition-is-slashing-offshore-wind-costs-to-unthin/>

⁸⁹ https://www.theguardian.com/environment/2016/oct/20/europes-offshore-wind-industry-booming-as-costs-fall?CMP=Share_AndroidApp_Gmail

The latest IEA forecasts, from October, see renewable energy costs continuing to fall. The agency predicts a cost drop of 15% for wind and 25% for utility-scale solar by 2021⁹⁰. Given some of the cost reductions in 2016 and the IEA's tendency to err on the side of caution, these estimate will

probably turn out to be too conservative. By comparison, IRENA sees the possibility of cost reductions of 25% for onshore wind, 37% for concentrating solar power, 59% for solar PV and 35% for offshore wind by 2025. Offshore wind development has largely been confined to Europe but with recent cost reductions the take-up of this technology is likely to spread

globally from 2017 onward. Offshore capacity, already being planned in the U.S. and China, is set to join solar PV and onshore wind as a major energy growth area.



Source: IRENA

Electric Vehicles, Batteries, and Oil

- Declining battery costs will see EVs approach price parity this decade.
- The rise of EVs and renewable energy could see oil consumption peak as soon as 2030.

The number of plug-in electric vehicles (EVs) worldwide is set to pass 2 million in 2016⁹¹. China is the largest market, with Chinese-made models now amongst the bestsellers, followed by Europe and the U.S. China is on track for over 80% year-on-year growth in its domestic EV sales in 2016. Norway is the current world leader in EV diffusion; one in three cars sold in Norway is now an EV, a trend encouraged by major investments in charging infrastructure and by tax breaks. Norway and the Netherlands both intend to phase out the sale of fossil-fuel-based cars by 2025. In October, a proposal in Germany to cease the sales of new combustion-engine cars by 2030 won the support of the national parliament's upper house⁹². In the same month, a new EU directive aimed to ensure that every new and refurbished house have its own EV charging point⁹³. There are now more than 35,000 public and private EV charging points in the U.S., and in the U.K. charging

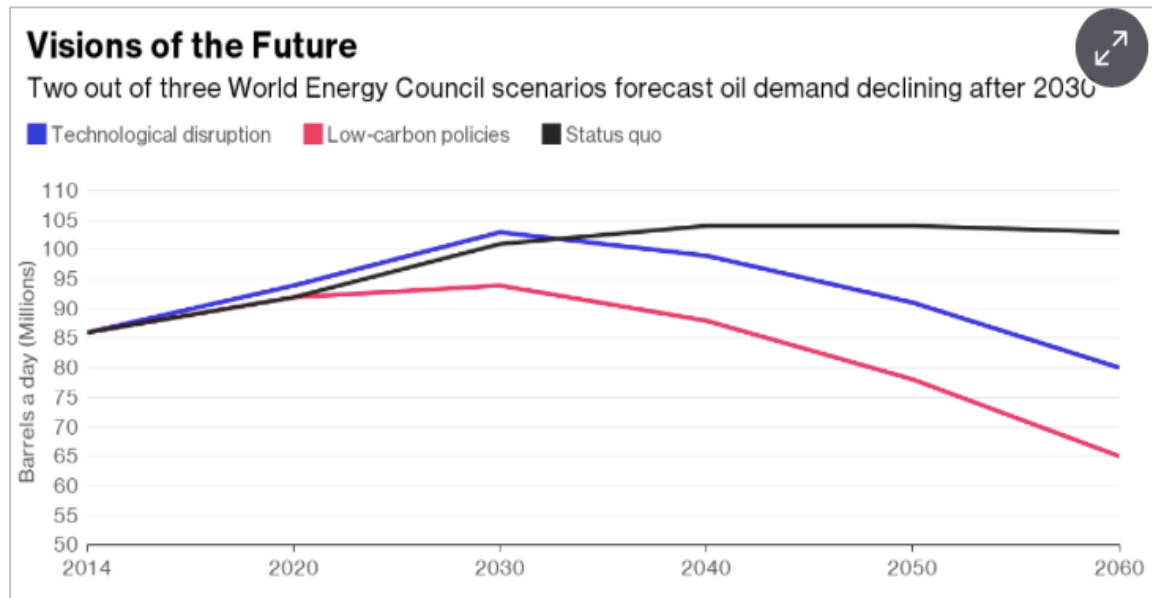
⁹⁰ <https://www.theguardian.com/environment/2016/oct/25/renewables-made-up-half-of-net-electricity-capacity-added-last-year>

⁹¹ https://www.theguardian.com/environment/2016/oct/13/electric-car-sales-set-to-pass-2m-landmark-globally-by-end-of-2016?CMP=tw_t_a-environment_b-gdneco

⁹² <http://www.reuters.com/article/us-autos-emissions-germany-idUSKCN1280G7>

⁹³ https://www.theguardian.com/environment/2016/oct/13/electric-car-sales-set-to-pass-2m-landmark-globally-by-end-of-2016?CMP=tw_t_a-environment_b-gdneco

points will outnumber petrol stations by 2020, according to **Nissan**⁹⁴. In 2016, **Renault** unveiled the first mainstream EV to have a range in excess of 200 miles. **Tesla** and **Chevrolet** will soon follow with their own mainstream models featuring a similar range. BNEF sees a 65% fall in battery costs between 2010 and 2015 making EVs as affordable as combustion-engine cars. There could be 11.4 million EVs on the road in the U.S. alone by 2025⁹⁵.



Source: World Energy Council, Bloomberg, Paul Scherrer Institute, Accenture Strategy

A key driver in the growth of EVs is the reduction in the cost of batteries, which have a technology learning rate of about 14% according to BNEF⁹⁶. This means prices should fall by this amount each time production doubles. Tesla's Gigafactory will be producing 35GWh of lithium-ion batteries each year when it reaches full capacity on 2020. This is more than the entire global production of 2013 and has been cited as a key driver of battery cost reduction. However, this is only part of the battery production ramp-up story that will unfold over the next few years. BYD, the Chinese EV maker, plans to ramp up battery production to 34GWh by 2019, CATL of China intends to reach 26GWh by 2020,⁹⁷ and Tianjin Battery, also of China, plans to expand battery production to 20GWh by 2020⁹⁸. When other battery manufacturers are taken into account, Tesla seems likely to end up with around 25% of the rapidly scaled-up market.

Tesla Motors Inc. stands as one of the key energy transformation champions of 2016, throwing out an open leadership and energy-efficiency challenge to the global automotive industry. In October 2016, Tesla reported record production rates in excess of 25,000 vehicles for the third quarter, a growth rate of 92% year on year. With revenues up 145% to US\$2.3bn for the quarter, this pushed the company into a marginal net profit position⁹⁹. Tesla targets a production run rate of 500,000 vehicles annually by 2018, with the

⁹⁴ <https://www.theguardian.com/environment/climate-consensus-97-per-cent/2016/oct/03/doe-charts-show-why-climate-doom-and-gloom-isnt-needed>

⁹⁵ http://www.greentechmedia.com/articles/read/11.4-million-evs-expected-to-be-on-the-road-by-2025?utm_source=Daily&utm_medium=Newsletter&utm_campaign=GTMDaily

⁹⁶ <https://www.bloomberg.com/gadfly/articles/2016-09-04/battery-assault>

⁹⁷ <https://www.bloomberg.com/gadfly/articles/2016-09-04/battery-assault>

⁹⁸ <http://reneweconomy.com.au/2016/car-companies-firm-electric-dreams-tesla-sales-top-expectations-97003>

⁹⁹ http://files.shareholder.com/downloads/ABEA-4CW8X0/3102679439x0x913801/F9E5C36A-AFDD-4FF2-A375-ED9B0F912622/Q3_16_Update_Letter_-_final.pdf

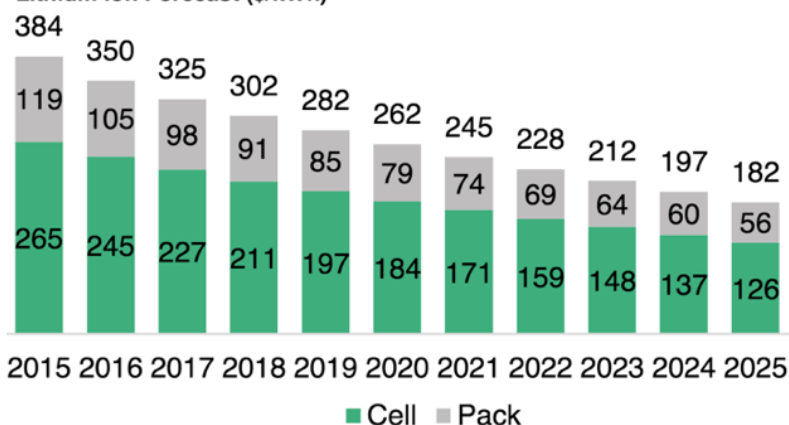
Tesla Model 3 pre-launch of March 2016 taking a record 325,000 reservations despite an 18-month delivery wait.

Another EV champion of 2016 is **BYD Company** of China. With its shares up 200% over the last five years, BYD has made significant progress and will be a key challenger to Tesla in the EV and battery manufacturing sectors globally. BYD reported revenues growing 44% year on year to Rmb44bn (US\$6.4bn) in the first half of 2016. BYD reported a 131% year on year increase to 49,000 new automotive sales for the half, representing a 27% share of the Chinese EV market, and a leading 65% market share in the plug-in hybrid sector.¹⁰⁰ With China on track to potentially reach 1 million EV sales in 2017, BYD is well positioned. As mentioned above, BYD is also looking to equal Tesla in terms of lithium ion battery manufacturing capacity, and this is a very credible target given BYD has a long history of rechargeable battery production, being one of the world's leading mobile phone assembly companies. A US\$2bn equity raising in July 2016 significantly enhanced BYD's financials to drive investment in lithium battery and EV production capacity.

Battery development has the potential to move the oil market from growth to contraction earlier than has been previously anticipated as the growth trajectory of EVs may be hugely underestimated, according to Fitch Ratings¹⁰¹. An October World Energy Council report suggests petroleum consumption may peak in 2030 at a level 10% below consensus estimates and decline thereafter due to the impact of EVs, renewable energy and other disruptive technologies. This has clear and significant implications for the oil industry (refer to "Stranded Assets" section). With battery costs falling rapidly and with action around the world to provide the required recharging infrastructure, EV growth looks set to become one of the fastest moving and most exciting trends in global energy. Bloomberg research has estimated that EVs will displace 13 million barrels of oil a day by 2040¹⁰².

Battery Prices Keep Tumbling

Lithium Ion Forecast (\$/kWh)



Source: Bloomberg New Energy Finance

The Tesla Powerwall 2.0 launch in October 2016 has been another defining event of 2016. Powerwall 2.0 offers a technology, size and scale enhancement that transforms the capacity and all-in cost of distributed rooftop solar with storage. Doubling the storage capacity to 14kWh and with output of 5-7kW, plus a 10-year warranty and inbuilt inverter¹⁰³, this second iteration is sufficient to cover almost all of a domestic residential customer's evening electricity demand on

a normal day. With shipping of this product commencing in December, the impact on high penetration rooftop solar markets like Australia is likely to be swift and broad. This will further hollow out centralised power generation and dramatically reduce end customer's reliance on a gold-plated grid structure that has failed to transition to accommodate unstoppable technologies of the future.

¹⁰⁰ <http://www.hkexnews.hk/listedco/listconews/SEHK/2016/0828/LTN20160828041.pdf>

¹⁰¹ <http://www.bloomberg.com/news/articles/2016-10-18/batteries-may-trip-death-spiral-in-3-4-trillion-credit-market>

¹⁰² <http://www.bloomberg.com/news/articles/2016-10-18/batteries-may-trip-death-spiral-in-3-4-trillion-credit-market>

¹⁰³ <https://electrek.co/2016/10/28/tesla-powerwall-2-game-changer-in-home-energy-storage-14-kwh-inverter-5500/>

Clean Energy Generation Champions of 2016

- Being a clean energy leader is demonstrably a viable and sustainable business model.
- IEEFA views **ENEL** of Italy, **NextEra Energy** of the U.S., **China Longyuan**, **Brookfield** of Canada and **Softbank** of Japan as five of the leading clean energy champions of 2016.

We detail here five of the largest utilities globally undertaking multi-billion dollar annual investments in renewable energy to profitably transform both their own business models and the markets they serve. Strong investor returns have been delivered while the collective investment has been key to driving economies of scale, technology deployment and learning by doing, thereby driving down delivered electricity costs to customers. This list should not be read in any way as comprehensive; the roster of globally relevant corporates moving toward a more sustainable, low emissions profile is expanding rapidly.

With 87GW of total installed electricity generation capacity globally, **ENEL S.p.A.** (ENEL) of Italy is undertaking an accelerated transformation toward a lower emissions generation profile and facilitating a smart grid by rolling out 2-3 million smart meters annually. With 38GW of renewable energy capacity, ENEL is one of the largest renewable energy investors globally. Over 2015-2019 ENEL plans capex of EUR34bn (60% in emerging markets) to commission another 9GW of renewable energy globally as a step toward its 2050 target of being entirely carbon neutral. It is clearly a corporate leader in the global energy transition.¹⁰⁴

NextEra Energy of the U.S. (equity capitalisation of US\$57bn) is another utility that has systematically transformed its business model over the last decade. With a target to exit 2016 with 16GW of installed renewable energy, NextEra is on track to build close to 2GW of renewable energy each year this decade. A total shareholder return of 250% in the last decade was delivered as a 15% lower overall electricity cost to customers was achieved, highlighting the concurrence of both exceptional investor returns and consumer deflation.

Brookfield Renewable Partners (BEP) of Canada operates 10.7GW of renewable energy globally, with a predominance of hydro-electricity but a growing presence in pumped hydro storage, wind and solar generation. Brookfield is very focused on sustainable, risk-adjusted returns with an exceptionally long duration, inflation-linked PPAs absent any reliance on subsidies. BEP has delivered a total return of 16% annualized over its 17 years as a listed entity and invests over US\$500m annually in new generation capacity with a 6.8GW pipeline.¹⁰⁵ BEP operates as a listed subsidiary of the Brookfield Group, which operates and manages a global asset base of US\$250bn.

China Longyuan Power Group (Longyuan) has become possibly the world's largest renewable energy capacity owner (excluding hydro electricity). Longyuan added 2GW of new wind capacity in the year to June 2016, having doubled its investment in the last five years to reach a total installed wind energy capacity of 16.5GW. Longyuan has a development pipeline of an additional 9GW planned, including 1.8GW of Chinese

¹⁰⁴ http://strategy2015.enel.com/files/Piano_industriale_2015-2019_ENG.pdf

¹⁰⁵ <https://bep.brookfield.com/~media/Files/B/Brookfield-BEP-IR/events-and-presentations/presentation-29-09-2016.pdf>

offshore wind farms. Longyuan is a listed subsidiary of the Chinese State Owned Enterprise, Guodian Group.

SoftBank of Japan is a relative newcomer to the global energy markets, but having delivered a 25-fold return on its accumulated Asian technology portfolio—transforming its original US\$3.7bn investment into US\$92bn—this powerhouse is one of the market leaders in the greater Asian region. Founded and run by Masayoshi Son, the richest man in Japan, Softbank is a telecommunications and technology giant (equity capitalised at US\$75bn). Having built almost 500MW of solar in Japan since the Fukushima disaster,¹⁰⁶ in mid 2015 SoftBank announced it would establish a joint venture with **Foxconn Technology** (Taiwan) and **Bharti Enterprises** (India) to potentially invest US\$20bn in Indian solar developments this coming decade. In December 2015, **SB Energy** won 100% of a US\$350m, 350MW Indian solar tender at a near record low Rs4.63/kWh (US\$64/MWh), fixed in nominal terms for 25 years – delivering competitively priced electricity to India with a baked in ~5% annual real price deflation.

Financing

- The rapidly growing green bond market is indicative of the private capital moving out of fossil fuels and into renewable energy.
- Renewable energy investment is being accompanied by an increase in technological efficiency, reduced cost and therefore more capacity per dollar.

Mark Carney, the Governor of the Bank of England stated in September that the growing green finance market is an opportunity to boost global financial stability in addition to funding renewable energy and emissions abatement¹⁰⁷. In order to realise this, more of the US\$100 trillion held by the major global investment firms needs to be channelled into green bonds to finance such initiatives. Activity in 2016 has gone some way toward achieving this with a significant increase in the issuance of such bonds.

The three months ended on Sept. 30 were the strongest quarter ever for green bond issuance (US\$26.1bn)¹⁰⁸. The total issuance for the first nine months of the year was US\$61.8bn, well over double the issuance for the same period in the prior year. Issuance in 2016 is already way ahead of the total for the whole of 2015 (US\$42.4bn) which was itself a record year. Renewable energy and energy efficiency remain the most popular projects linked to green bond issuance, which is being driven by sustained and increasing interest from institutional investors. **Rabobank**, which has EUR22bn in outstanding loans to “sustainable leaders” including EUR3.2bn for wind and solar, issued a EUR500m green bond in October¹⁰⁹. Catering to increasing demand for sustainable investments from pension funds and other investors, the bank expects strong growth in the green finance sector to continue.

¹⁰⁶ http://www.softbank.jp/en/corp/csr/future/instance_04/contents_05/

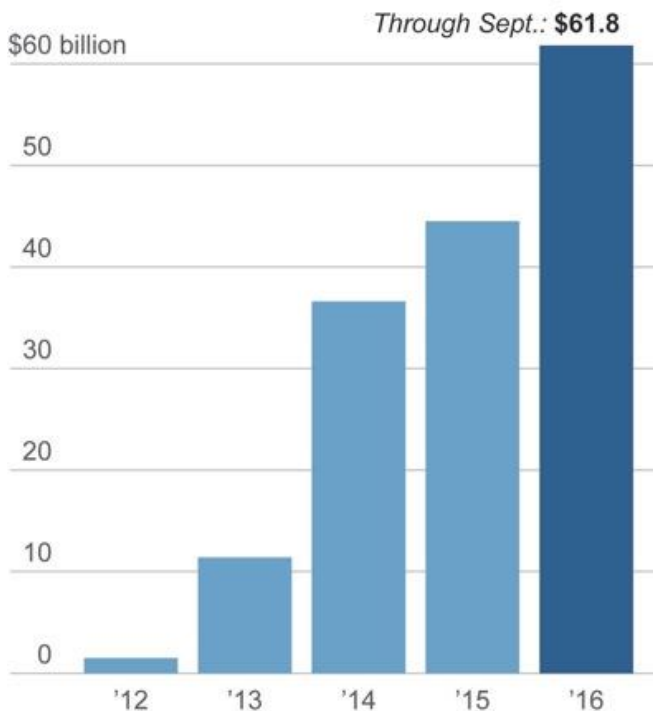
¹⁰⁷ <https://www.theguardian.com/business/2016/sep/22/carney-backs-green-finance-to-cut-emissions-and-boost-growth>

¹⁰⁸ <http://www.businessgreen.com/bg/news/2475232/moodys-green-bond-issuances-could-hit-usd100bn-by-year-end>

¹⁰⁹ <http://renewables.seenews.com/news/rabobank-sells-eur-500m-green-bond-542221>

Growth in Green Bond Issuance

The renewable-energy debt market continues to grow rapidly. Through September, global issuance of green bonds had reached \$61.8 billion.



Source: Environmental Finance

Green bonds have also made an impact in emerging markets in 2016.

Greenko is the largest clean energy independent power producer in India and raised US\$500m through a green bond issuance to overseas investors in August¹¹⁰. The renewable energy debt market, once dominated by development banks, can be an important source of capital on attractive terms for the continued expansion of the Indian renewables sector. With international bond rates of 2-4 percent, significantly lower than the usual 8-12 percent corporate borrowing costs in India, growing utilization of the green bond market will see the capital cost of these projects drop (even allowing for Indian rupee hedging costs of 3-4 percent).

In addition, Indian corporates now have the option of tapping into the masala bond market (masala bonds are linked to the rupee but issued offshore and settled in dollars). In September 2015, the **Reserve Bank of India** began to

allow Indian corporates to issue Indian rupee-denominated bonds in overseas markets. This allows Indian companies access to alternative, overseas funding without taking on currency risk. **NTPC** and **Adani Transmission** are among the companies that have issued masala bonds. With low global interest rates and the prospect of sustained growth across the Indian economy, ratings agencies **Fitch** and **Moody's** expect strong development of the masala bond market¹¹¹.

Such bond issuances are significant in light of the fact that government funding alone won't be enough to achieve the scale needed to achieve emission-reduction goals, especially in developing countries. What is required is the major mobilisation of private capital¹¹². The booming green bonds market is one of the successful new developments on this front, but innovative financing solutions can increasingly be found around the world.

Many examples of private capital fulfilling the requirement to drive energy transformation have emerged in 2016. **BlackRock**, the world's largest private investor (US\$4.9 trillion in assets) announced this year that it will include climate change as a major consideration when assigning risk to its portfolio. Given its size, BlackRock's words and actions tend to be highly influential. In a landmark September report, BlackRock stated its intention to consider how companies are exposed to climate risk and whether they may gain from emissions reduction action and policy, a change of stance likely to have ramifications for

¹¹⁰ <http://economictimes.indiatimes.com/markets/stocks/news/greenko-raises-500-million-via-indias-first-high-yield-green-bond-issuance/articleshow/53648517.cms>

¹¹¹ <http://profit.ndtv.com/news/corporates/article-after-hdfc-adani-more-indian-companies-could-join-masala-drive-1441639>

¹¹² http://mobile.nytimes.com/2016/09/20/opinion/how-to-raise-trillions-for-green-investments.html?_r=0&referrer=https://www.google.co.uk/

investment in the energy sector. BlackRock concluded that “all investors should incorporate climate change awareness in their investment processes”¹¹³.

Government and development bank anchor investments can help secure the private investment required. Whilst the **Green Climate Fund** has provided the anchor role for renewable investments in Africa, institutions like the **European Investment Bank** (EIB) have continued to play that role in the developed world in 2016. The **SUSI Renewable Energy Fund II**, set up to invest in European solar and wind, attracted EUR380m this year from pension funds and insurance firms on the back of a EUR62m investment from the EIB¹¹⁴.

Pension funds have been an important source of private capital in 2016. Canadian pension investment managers **PSP Investments** and **Ontario Teachers’ Pension Plan** announced plans to acquire indirect interests in **Cubico Sustainable Investments Ltd** in July¹¹⁵. Cubico won contracts for 540MW of solar parks in Mexico in the country’s latest energy auction with construction due to begin in early 2017.

In Australia, the **Queensland Investment Corporation (QIC)** and the **Future Fund** (the nation’s sovereign wealth fund) became backers of AGL’s renewables fund aiming to help develop projects to fulfil Australia’s renewable energy target. QIC (one of the country’s largest wholesale funds managers) and the Future Fund are to contribute A\$800m to the fund that plans to build 1GW of wind and solar along the east coast of the country¹¹⁶. In October, Australian infrastructure manager **Palisade Investments** launched a A\$600m renewables fund in partnership with the **Clean Energy Finance Corporation**¹¹⁷.

More of the world’s major global companies are investing in renewable energy as the sector has ceased to be considered a niche market and has hit the mainstream. In October, **GE** announced plans to buy wind turbine blade manufacturer **LM Wind Power** for US\$1.65bn, the latest of a number of acquisitions as GE accelerates the growth of its wind energy business¹¹⁸. **Goldman Sachs** has plans to reach US\$150bn of investment in clean energy projects and technology over the next decade¹¹⁹. The bank already has US\$41bn invested in clean energy globally including in major wind farms in Texas and Mexico, solar firms in Japan and the Danish utility **Dong Energy**—the largest offshore wind developer in the world (it held an IPO this past summer). Meanwhile, Australia’s **Macquarie Group** is considered to be in line to win the auction for the U.K. government’s GBP2bn privatisation of the **Green Investment Bank**, whose function is to bring public and private investment into environmental projects including renewable energy¹²⁰.

As well as increasing their backing for renewable energy, banks have continued to withdraw support for the coal industry this year. **JP Morgan Chase** announced in March that it will no longer finance new coal-fired power plants in developed nations following earlier announcements of a similar nature from **Citigroup**, **Bank of America** and **Morgan Stanley**¹²¹. In October, France’s **Credit Agricole** announced it was ending coal-fired power plant financing, a move quickly followed by **Societe Generale**, which at the same time announced an intention to double project finance in the renewable energy sector¹²².

¹¹³ BlackRock, *Adapting Portfolios to Climate Change: Implications and strategies for all investors*, p. 2.

¹¹⁴ <http://renewables.seenews.com/news/susi-wind-solar-fund-closes-at-eur-380m-542266>

¹¹⁵ <http://renewables.seenews.com/news/cubico-to-build-540-mw-of-wind-solar-ppa-projects-in-mexico-542407>

¹¹⁶ <http://www.theaustralian.com.au/business/mining-energy/qic-future-fund-back-agl-renewable-energy-fund/news-story/eaea194fd929734960efddd760c6deb7>

¹¹⁷ <http://reneweconomy.com.au/cefc-backed-renewables-fund-launched-palisade-45621/>

¹¹⁸ <http://www.bloomberg.com/news/articles/2016-10-11/ge-agrees-to-buy-blade-maker-lm-wind-power-for-1-65-billion>

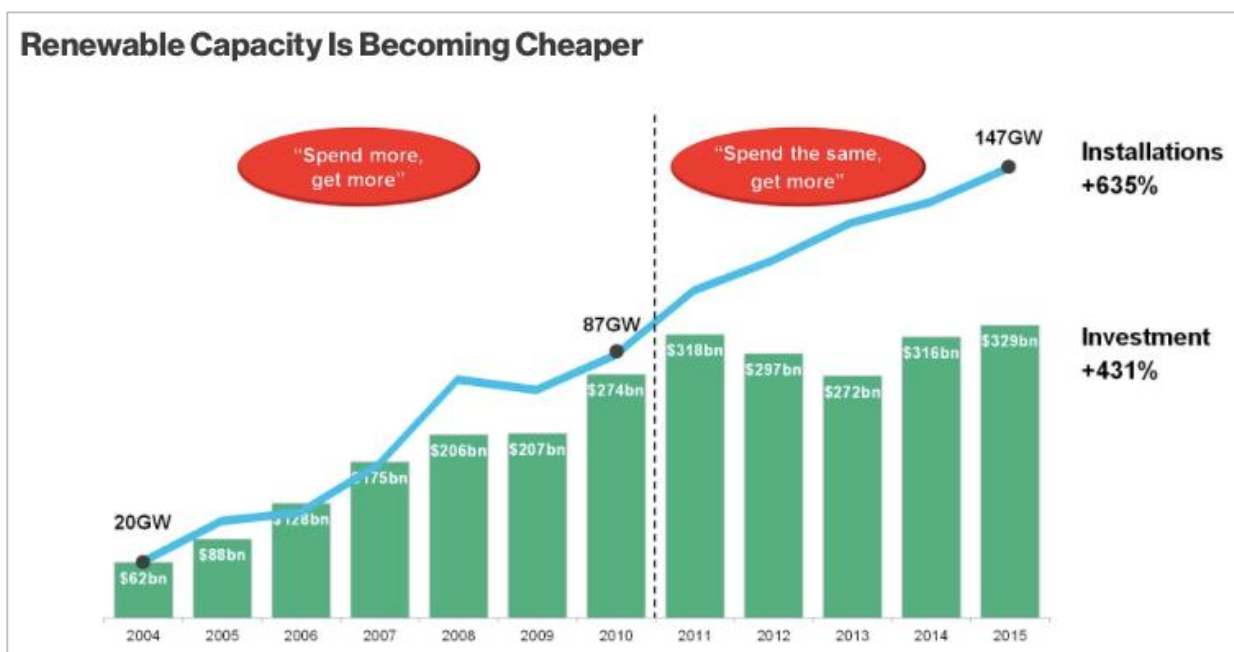
¹¹⁹ <http://ieefa.org/goldman-sachs-aiming-150-billion-clean-energy-portfolio-takes-stake-89-countries/>

¹²⁰ <http://www.telegraph.co.uk/business/2016/10/08/macquarie-in-line-to-win-2bn-race-for-the-green-investment-bank/>

¹²¹ <http://www.nytimes.com/2016/03/21/business/dealbook/as-coals-future-grows-murkier-banks-pull-financing.html>

¹²² <http://www.reuters.com/article/ste-generale-coal-idUSL8N1CX4K5>

Japanese banks have increased project finance loans to clean energy developers in the face of negative interest rates in Japan. Two of the country's biggest banks, **Mitsubishi UFJ** and **Sumitomo Mitsui**, have moved past European banks in lending to North Sea offshore wind projects, which offer steady yields to lenders¹²³. This trend is also enhanced by a lack of renewables lending in Japan, where tariffs for solar projects have been cut, effectively slowing down the nation's solar boom.



Source: Bloomberg New Energy Finance

Despite all these developments BNEF research shows a drop in global clean energy investment in the third quarter of 2016. The US\$42.4bn invested globally in Q3 was 43% lower than the same period of the prior year¹²⁴. This can in part be explained by the fact that in many countries, energy efficiency gains mean that actual energy demand growth is proving to be lower than government forecasts. It is also due to the continuing deflation of solar and wind energy costs as well as the increasing efficiency of such technologies. This means that more capacity and performance can be obtained from renewable energy from a lower investment than ever before. BNEF has concluded that such technology improvements have allowed renewable energy installations to increase 70% over the last five years whilst investment has remained relatively flat¹²⁵. In addition to technological gains, this trend has been driven by the growing number of countries using auctions to discover low prices rather than offering fixed subsidies.

¹²³ <http://www.bloomberg.com/news/articles/2016-10-31/japan-s-negative-rates-prod-megabanks-into-offshore-wind-loans>

¹²⁴ <http://reneweconomy.com.au/global-clean-energy-investment-slumps-43-q3-year-year-53125/>

¹²⁵ <http://www.bloomberg.com/news/articles/2016-10-12/green-energy-boom-picks-up-speed-even-as-investment-stagnates>

Incumbents Transforming

- Some of the world's most influential fossil fuel companies are increasingly turning their attention to clean energy.

- Fossil fuel company asset write-downs show stranded asset risks rising.

Some clean energy sector champions are progressively transforming their entire business model, and at the other end of the spectrum there are some key incumbent fossil fuel firms who can appear set to never change their thinking and/or entire business asset base. Be it **BP**, **ExxonMobil**,¹²⁶ **Shell**, **Santos** or **Peabody Energy**, these firms continue to run climate-science obfuscation and delay strategies, and in our view will consign themselves to history along the lines of Kodak and Nokia.

In between are the bulk of energy firms that will adapt, transforming over time. However, given the failure to incorporate adequate carbon pricing risk analysis, legacy assets will lead to write-downs tied to stranded assets as policies and markets move. Stranded asset losses have already eroded significant shareholder value, be it by **BHP Billiton** (US\$7.2bn in September 2016 on US oil and gas), **Rio Tinto** (US\$3.7bn on Mozambique Coal¹²⁷), **Volkswagen** (in October 2016 announcing a US\$20bn US legal settlement¹²⁸), **RWE** and **E.ON** (March 2016 saw a record €7bn loss). The more nimble are moving to reposition ahead of growing financial risks relating to “the tragedy of the horizon,” the term so well-coined last year by Mark Carney, governor of the Bank of England,¹²⁹ to describe climate change.

The German utility **E.ON** in March 2016 reported a record €7bn net loss, more than double the prior year net loss of €3.2bn¹³⁰. In the five years to October 2016 shareholders have seen E.ON's equity capitalisation halve, compounding on the halving in the prior five years. But following on from the destruction of 75% of shareholder wealth in the last decade, E.ON has dramatically slimmed down, reconfigured and has now restructured. E.ON has refocused on renewables and networks by spinning off its legacy convention power generation assets into the newly listed and ring-fenced **Uniper Group** in September.¹³¹ RWE has followed with the float of **Innogy** as the new owner of its renewables and networks business in October 2016, “ideally positioned to benefit from the megatrends of decarbonisation and digitalization in helping to shape the energy transition.”¹³²

In November 2016, **Engie** of France and **Mitsui** of Japan jointly announced the closure of the 1.6GW subcritical coal power plant at Hazelwood, Australia. A plant built over 50 years ago, Hazelwood has the highest emissions intensity in Australia and is amongst the highest globally. With this decision, Engie has taken a leadership position on energy transformation.

NTPC Ltd is a majority SOE and is the largest coal-fired power plant owner/operator in India. While NTPC continues to invest in coal power (witness its proposed equity support of

¹²⁶ http://ieefa.org/wp-content/uploads/2016/10/Red-Flags-on-ExxonMobil-XOM-A-Note-to-Institutional-Investors_October-2016.pdf

¹²⁷ <http://www.bloomberg.com/news/articles/2014-07-30/rio-tinto-closes-book-on-mozambique-coal-with-50-million-sale>

¹²⁸ <http://www.news.com.au/technology/innovation/motoring/landmark-volkswagen-settlement-reached--but-it-wont-have-any-effect-here/news-story/c4ced2be590a8209680eeb06daad1824>

¹²⁹ <http://www.bankofengland.co.uk/publications/Pages/speeches/2015/844.aspx>

¹³⁰ <http://www.eon.com/en/investors/key-figures.html>

¹³¹ <http://www.eon.com/en/investors/spin-off-of-uniper-group.html>

¹³² <https://www.innogy.com/web/cms/en/3113124/about-innogy/introducing-innogy/>

the US\$2bn Rampal power plant in Bangladesh), the influence of Energy Minister Piyush Goyal has seen NTPC also become a key facilitator of India's 175GW of renewables by 2022 plan. NTPC has committed to building 10GW of solar energy capacity and 1GW of wind farms by 2022, and is also standing as counterparty for electricity offtake agreements for another 15GW of solar investment by independent power producers¹³³. This role is critical in making solar projects bankable at the lowest practical finance cost, helping to drive down solar tariffs 40% over the last 18 months to record lows of US\$65-70/MWh (fixed in nominal terms for 25 years). UNESCO's adverse finding relating to Rampal in October 2016¹³⁴ builds on the decision by the **Norwegian Sovereign Wealth Fund** to divest in 2015¹³⁵ and might yet drive NTPC's strategic shift away from subsidised new coal power towards solar, potentially a radical realignment.

Tata Power is a listed subsidiary of the **Tata Group**, the largest conglomerate in India. A shift of strategic focus has clearly emerged over the last year to better align Tata with the strategic priorities in renewable energy by the Modi Government. Tata Power aims to increase renewables to 8GW or 30-40% of total installed capacity by 2025, with the company announcing in October 2016 it would cease building any new thermal power generation in India.¹³⁶ Tata Power has accelerated its investment in solar to become the largest project developer in India over 2016. A step-change in scale was achieved with the US\$1.4bn acquisition of **Welspun Renewable Energy** in June 2016¹³⁷, the largest transaction endorsing the Indian renewables sector to-date. In a similar strategic pivot, **Adani Green Power** is set to commission 1GW of new solar and wind projects over 2016/17 as a part of a US\$10bn six-year solar investment program.

In contrast to the retreat from solar undertaken by BP, **Total SA** of France has reaffirmed its move to invest in the energy market transition. Following the creation of a new organizational structure in May 2016, Total announced a US\$1.1bn acquisition of **SAFT SA**, a leading French battery manufacturer as a "spearhead into electricity storage"¹³⁸. This builds on Total's 2011 acquisition of a controlling stake in **SunPower** (U.S.), one of the world's leading solar manufacturers and solar project developers.

¹³³ <http://www.bloomberg.com/news/articles/2016-10-04/india-s-ntpc-to-expand-solar-goal-slow-thermal-power-bnef-says>

¹³⁴ <http://whc.unesco.org/en/news/1573>

¹³⁵ <http://etikkradet.no/files/2015/01/Council-on-Ethics-2014-Annual-Report.pdf>

¹³⁶ <http://energy.economictimes.indiatimes.com/news/renewable/tata-power-to-invest-in-renewable-energy-sector-in-india/55051857>

¹³⁷ <http://forbesindia.com/article/special/tata-powerwelspun-deal-may-become-benchmark-for-clean-energy-deals/43509/1>

¹³⁸ <http://www.bloomberg.com/news/articles/2016-05-09/total-to-buy-french-battery-maker-saft-in-1-1-billion-deal>

3. Those Being Left Behind Are Facing Increasing Financial Risks

Stranded Assets

- The rapid development of electric vehicles and global policy action on climate change puts oil majors like ExxonMobil at clear stranded-asset risk.
- The implementation of policies to enact COP21 could see global seaborne thermal coal volumes decline 40% by 2035, resulting in further stranded asset risks.

ExxonMobil is belatedly starting to address climate change in 2016, following on from the Paris agreement that clearly questions the extent existing fossil fuel reserves are likely to be able to be accessed. Exxon's reputational risk is growing with investigations by the SEC and New York attorney general in terms of allegations of misleading conduct.¹³⁹ Pressure is also the result of six shareholder proxy items presented at the annual general meeting. Financial pressure is also clear: with third quarter net profit down 38 percent year over year, Exxon is forecast to deliver net profits of less than US\$10bn in 2016, less than a quarter of the annual profits generated five years ago.¹⁴⁰ Exxon also reported its oil and gas reserves are likely to be substantially downgraded. Exxon lost its AAA credit rating in 2016, and net debt has risen to over US\$40bn. Exxon shares have underperformed the S&P500 in the last five years by a third.¹⁴¹

As discussed in Section 2, the rapid technology improvement and cost reductions being delivered in battery design and ever-greater scale of manufacturing is making the electric vehicle an increasingly cost competitive or arguably superior alternative to the internal-combustion engine. In doing so, it threatens the viability and longevity of the incumbent automotive and oil sectors, both in terms of the equity invested but also the debt market exposures. The Fitch rating agency in October raised warnings of stranded-asset risk due to technology disruption and low carbon policy measures which could over time result in declining oil demand.¹⁴²

This transition in oil markets and stranded asset risks is probably best illustrated by the moves by Saudi Arabia over 2015-16 to diversify its economy away from excessive reliance on oil, breaking ranks with OPEC in the process. Stranded asset risks are rising.¹⁴³

Another key area of potential stranded asset risk relates to the dedicated rail and port infrastructure associated with thermal coal exports. Being sole-use assets with an exceptionally long life, coal ports in particular are at significant stranded asset risk. Wood

¹³⁹ <http://ieefa.org/ieefa-issues-red-flag-report-exxonmobil-%E2%80%A8core-financials-show-oil-giant-decline-institutional-investors-owe-shareholders-fiduciary-review/>

¹⁴⁰ <http://www.bloomberg.com/news/articles/2016-10-28/exxon-enters-no-man-s-land>

¹⁴¹ <https://www.ft.com/content/1d719e1e-9f41-11e6-86d5-4e36b35c3550>

¹⁴² <http://www.bloomberg.com/news/articles/2016-10-18/batteries-may-trip-death-spiral-in-3-4-trillion-credit-market>

¹⁴³ <http://www.bloomberg.com/news/articles/2016-10-16/what-opec-s-oil-u-turn-missed-peak-demand-keeps-getting-closer-iud8k6o5>

Mackenzie forecast that global seaborne thermal coal export volumes would decline 40% to 527Mt by 2035 if policies in line with the Paris agreement are implemented.¹⁴⁴

Over the last 24 months most of the six Pacific Northwest coal port developments in the U.S. have been stalled, cancelled or blocked by the regulatory process.¹⁴⁵ With North American coal export volumes declining rapidly over the last three years, even existing coal export facilities have become financially challenged.

Ports built for coal exports in Australia have similarly been financially challenged, with proponents abandoning multiple new terminal proposals at Abbot Point in Queensland. In August 2016 **Rio Tinto** took a US\$709m write-down on onerous take-or-pay contracts relating to Abbot Point.¹⁴⁶ The latest greenfield project—Wiggins Island Coal Export Terminal (WICET)—with capacity of 27 million tonne per annum built at a cost of US\$3bn, was commissioned in 2015 but has operated well below capacity and remains in financial distress.¹⁴⁷ IEEFA expects total write-downs of US\$1-2bn relating to the port and the associated rail take-or-pay contracts signed by the eight coal mining companies at the height of the coal market boom.

The world's largest coal port, Hong Kong listed **Qinhuangdao Port** warned of an 80-90% drop in first half 2016 profits, which it attributed to an 18% yoy decline in coal volumes.¹⁴⁸ Similarly, the decoupling of China's electricity demand from economic growth has combined with a rapid diversification away from coal fired power generation, resulting in coal fired power plant utilisation rates in 2016 falling below 47%, with clear and rising stranded asset risks.

Coal-Fired Power Utilisation Rates

- 2016 has seen a reduction in the coal-fired electricity generation development pipeline almost equal to the entire coal-fired capacity of the European Union.
- Renewable energy will continue to erode the viability of coal-fired generation by contributing to reduced utilisation rates.

Although coal-fired power capacity still accounts for a large proportion of electricity generation in most countries, the growth of renewable energy is already having a major impact on the thermal power incumbents by reducing utilisation rates and eroding peak power demand. Lower than expected electricity demand growth is also a major factor.

With reduced utilisation of coal-fired generation, IEEFA estimates India does not need any new thermal power plants over the next three years. Coal-fired plants across **India** are operating at 56% utilisation rate¹⁴⁹. This raises severe doubts as to the viability of the 50GW of coal-fired generation plants currently under construction with as much as 10% of current capacity already considered stranded due to a lack of PPAs.

¹⁴⁴ <https://www.woodmac.com/media-centre/12533316>

¹⁴⁵ <http://www.martenlaw.com/newsletter/20160609-pnw-coal-terminals-tribal-fishing-rights>

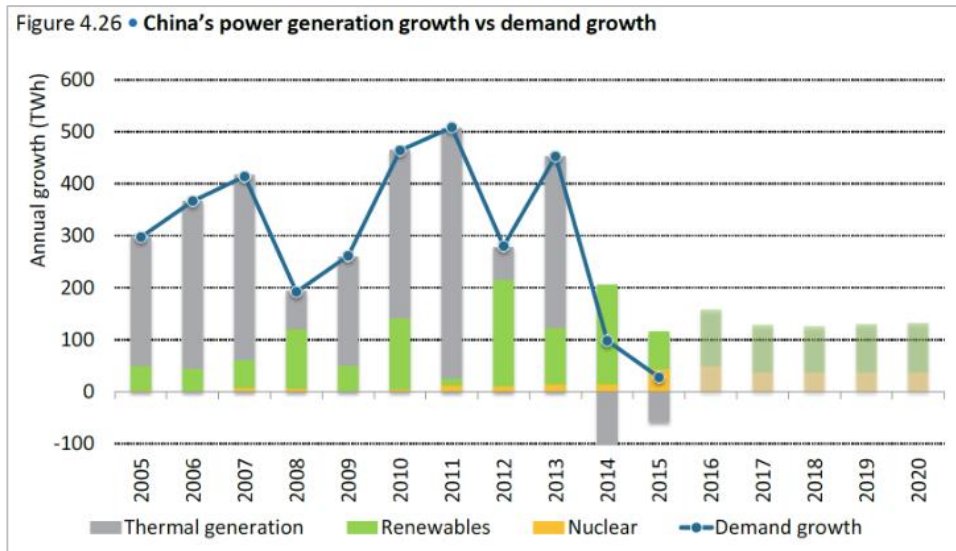
¹⁴⁶ <http://www.asx.com.au/asxpdf/20160803/pdf/4392c13nrzhw7g.pdf>

¹⁴⁷ <http://www.afr.com/business/mining/coal/wicet-appoints-fort-street-in-coal-restructure-20160602-gpa3xc#ixzz4AT4gomt9>

¹⁴⁸ http://www.simic.net.cn/news_list.php?lan=en&id=368&flag=cnports&pname=qinhuangdao

¹⁴⁹ <http://economictimes.indiatimes.com/industry/energy/power/india-wont-need-extra-power-plants-for-next-three-years-says-government-report/articleshow/52545715.cms>

The situation in **China** is even more stark as coal-fired generation utilisations rates are now below 47%¹⁵⁰. Even as 200GW of coal-fired generation capacity remains on the planning books as at April 2016, it has become apparent that China has already built over

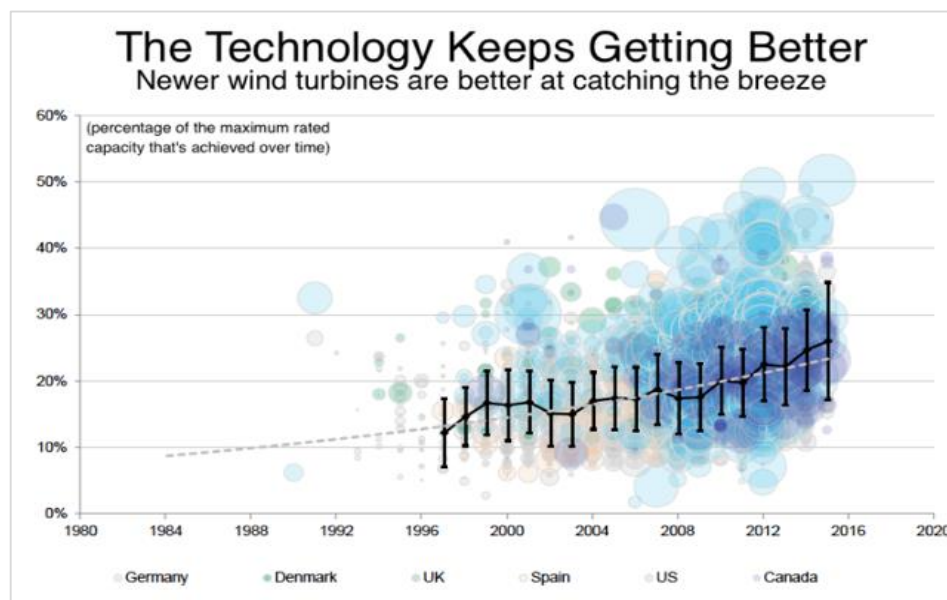


Source: IEA

200GW of stranded coal-fired capacity at the same time the period of high electricity demand growth (2000-2013) has come to an end. In October it was announced that construction on 30 coal-fired power plants would be halted¹⁵¹. This comes on top of the cancellation or postponement of plans for 114GW of coal power stations earlier this year.

Developed countries are face similar issues. As **Japan** pushes ahead with new coal-fired power plants despite over capacity, it risks creating US\$57bn of stranded assets that will need to be absorbed by taxpayers¹⁵². In **the U.S.**, the rise of renewables combined with the collapse of natural gas prices has pushed coal-fired generator utilisation rates down below 50% in some instances, as has been the case in Texas¹⁵³.

An unsurprising but highly significant result of excess coal-fired capacity and declining utilisation is the reduction in the pipeline of new thermal coal power stations. Worldwide, the amount coal-fired generation under development declined 14% in the first six months



Source: Bloomberg New Energy Finance

¹⁵⁰ <http://www.bloomberg.com/news/articles/2016-09-13/china-seen-investing-too-much-in-power-plants-that-burn-coal>

¹⁵¹ https://www.ft.com/content/78db1ca6-96ab-11e6-a80e-bcd69f323a8b?accessToken=zWAAAVf0RIlok942xymIqsR5tOoDrzWnzl6iw.MEUCIQDAyITfLp4ltr8sqeFYc3k0v04dAi2u-XdwrSUGDuj2BAIgeV1ROQ4zi4f_0sgOUWHPutpjtUMGGILqHeOp_K7G9UM&sharetype=gift

¹⁵² <http://www.smithschool.ox.ac.uk/research-programmes/stranded-assets/publications.php>

¹⁵³ <http://ieefa.org/ieefa-report-beginning-end-texas-coal-fired-electricity-industry-rising-competition-wind-solar/>

of 2016 alone¹⁵⁴. The reduction of 158GW was almost equal to the entire coal-fired generation capacity of the European Union. The trend was led by China and India but **Indonesia** and the **Philippines** are amongst others that have also moved to curb coal. Meanwhile, capacity factors for renewable technology are improving all the time.

From 2017 further cancellations of planned coal-fired generation will be of great importance, particularly in the Asia-pacific region that has a significant amount of such projects. As the president of the World Bank has noted, the continued development of such plans is a key threat to achieving the two-degree target agreed in Paris.

2016: Well Past Peak Global Coal Consumption

- World coal consumption peaked in 2013 and 2016 has seen the third consecutive annual decline.
- The seaborne thermal coal market faces structural headwinds despite traded coal prices doubling over 2016.

Total world consumption of thermal coal peaked in 2013. Contrary to most global forecasts, the total volume of thermal coal consumed in 2014 declined by -1% to 6,007Mt, with a further -3% decline to 5,828Mt reported by the IEA for 2015¹⁵⁵. IEEFA estimates 2016 will see a further 2% decline.

IEEFA's estimate for a 2% or greater decline in coal consumption globally in 2016 is predicated on consumption by China (50.2% of 2015 coal consumption) declining by more than 2%, combining with U.S. coal consumption (10.3%) down 9% year on year and the EU likely to be down over 12% year on year. Even with strong growth in Southeast Asian markets (4% of global demand up 7.5% year on year) and India on track for 5% growth (10.6% of global demand), the world consumption of coal is set for its third year of decline.

The trends in the seaborne thermal coal markets are similar. Having peaked at 1,063Mt in 2013, the IEA estimates that thermal coal exports declined -1.4% yoy to 1,048Mt in 2014 and a further -4.3% decline to 1,003Mt in 2015. IEEFA expects 2016 coal export volumes to be flat in line with 2015, with India (the largest thermal coal importer in 2015) down 5-10% yoy and China up 10-15% yoy (after a 30% decline in 2015).

The Indian Energy Minister, Piyush Goyal, continues to target a near cessation of thermal coal imports by the end of this decade, and this plan is likely to be accelerated with the near doubling of internationally traded coal prices over 2016. While Goyal targets this primarily in terms of the economic benefits of improving India's current account trade balance (with the associated benefits of a stronger currency and reducing imported inflation) plus boosting domestic investment and employment, the other financial driver is also clear—new solar electricity tariffs of Rs4.50-5.00/kWh (US\$65-75/MWh)¹⁵⁶ are

¹⁵⁴ <http://energy.economictimes.indiatimes.com/news/coal/global-coal-power-plans-shrink-14-in-2016-led-by-china-india/54161586>

¹⁵⁵ International Energy Agency (IEA) Coal Information Statistics 2016, page 11.15.

BP World Statistics 2016 report similar trends when recorded in millions of tonnes, but with a somewhat arbitrary adjustment, the Millions of tonnes of oil equivalent for coal consumption shows a slight +0.5% yoy growth in 2014, followed by a 1.8% yoy decline in 2015 in terms of all coal consumed.

¹⁵⁶ <http://www.livemint.com/Industry/WnUIDB3p8Ilex9VIJ8cQwI/Solar-power-tariffs-expected-to-fall-to-as-low-as-Rs350-a-u.html>

immediately lower than that of new imported coal fired power generation (estimated at Rs6.00-6.50/kWh or US\$90-95/MWh).

A key feature of 2016 was the reversal in coal pricing trends. After peaking in 2011, internationally traded coal prices (for both thermal and coking coal) declined by more than 60% through to 2015. After hitting five-year lows at the start of 2016, coal prices rallied by over 100% to hit two-year highs by October. IEEFA would attribute this dramatic reversal to a clear policy change evident in China. Having cut coal production by 10.5% in the first ten months of 2016, China found itself in a situation where coal consumption had only fallen by 2.4% year on year in the same period. With demand reduction falling well short of the decline in production, the result was a policy-induced recovery in Chinese coal imports, which rose +31% yoy for the month of August 2016 and +37% yoy in September 2016 to be up +15% yoy for the year to September 2016. Given China's domestic coal industry was facing financial distress of the same magnitude experienced by the U.S. coal industry over 2015/16, a policy-induced price recovery served to bolster financial stability in the Chinese coal industry at a time when the central government was already partway through a planned coal retrenchment of 1.2 million coal miners.

China is trying to orchestrate an orderly downsizing of the Chinese coal industry as part of its energy market transition.

Stranded Assets in the LNG Markets

- The breakdown of the LNG pricing regime continued in 2016 with weak oil prices compounded by the emergence of cheap U.S. gas exports.
- Lower-than-expected demand growth in conjunction with increased LNG supply is likely to lead to stranded assets.

The internationally traded LNG price in North Asia is down 60% over the last 2 years to US\$6.60/MMBtu¹⁵⁷, reflecting the oil-linked nature of the international LNG pricing regime. With the move for North America to dramatically expand LNG export capacity over 2016-2020, the LNG market pricing is likely to remain in this new trading range given US Henry Hub pricing of US\$2-3/MMBtu over 2016 is so far below international LNG rates (on a net back basis taking liquefaction and shipping into account) that a key outcome of 2016 is the likely permanent breakdown of the historic oil linkage regime.

In addition to the collapse in the LNG price, LNG demand from Asian markets has been well below expectations, with demand in the three key markets of Japan, Korea and China actually declining or slowing contrary to expectations in 2015, with demand weakness extending into 2016. LNG import demand has declined as energy efficiency combined with weak GDP growth to reduce overall Japanese electricity demand by an unprecedented, cumulative 12% in the last five years. At the same time, the construction of 10GW of new solar installs annually over 2013-2016 has combined with several nuclear restarts to permanently reduce Japanese thermal fuel import demand.

Emerging LNG markets have also failed to deliver the expected strong demand lift. For example, Bangladesh has to-date failed to start construction of even one of the ten LNG

¹⁵⁷ Singapore LNG import price accessed 28 October 2016 at:
https://ycharts.com/indicators/japan_liquefied_natural_gas_import_price

import terminals planned by the **Bangladesh Power Development Board** a decade ago, notwithstanding the acute supply disruptions of subsidised domestic gas supply now clearly evident. Many Southeast Asian markets have failed to deliver on excessively optimistic electricity demand growth forecasts made by the IEA and other fossil fuel proponents.

The implications for global gas majors in the LNG market are profound. Australia is set to become the largest exporter of LNG globally by the end of this decade, yet a clear result of this US\$200bn decade-long investment program is the emergence of LNG terminal stranded assets. Even prior to the full commissioning of the six LNG trains built over 2010-2016 at Gladstone Island in Queensland, multi-billion dollar write-downs have resulted. With an investment at Gladstone of US\$80bn, the impact on global LNG infrastructure owners has been severe. Shareholders in **Santos** have seen the destruction of almost 70% of their wealth over the last two years, while **Origin Energy** has delivered wealth destruction of 55%¹⁵⁸. Both Origin and Santos have been forced into expensive multi-billion-dollar debt for equity recapitalisations over 2016.

In contrast, the third Australian utility (Santos and Origin Energy are the other two), **AGL Energy** (AGL), has outperformed both Santos and Origin three-fold in the last two years, culminating in AGL's exit from upstream gas in 2016. We see this as a symbolic move, given AGL stands for **Australian Gas Light Company**. AGL's contrasting shareholder fortunes is evidence again of the shareholder merits of transitioning in the face of inevitable technology change (although we note AGL is singularly also the largest carbon polluter in Australia, showing it start from a very low base).

Shipping and Aviation

- Failure to act means the global shipping sector faces unnecessary risks and costs in the future.

Agreement on global action on climate change has generally been enhanced over 2016, with the aviation and hydrofluorocarbons (HFC) industries having reached global accords to accelerate the pace of change.

In contrast, the global shipping sector under the **International Maritime Organisation (IMO)** has failed to reach a plan of immediate action, instead voting for an effective seven-year delay. Given the long life nature of shipping assets, the risk for the shipping industry is action by individual countries or trading blocks to take action instead, and a delay could well increase stranded assets risk in the medium term as governments unilaterally implement sanctions in the face of the shipping industry's failure to act.

In a key example of industries putting short-term self-interest ahead of the clear pressing need for action, in IEEFA's view the **United Nation's IMO agreement** of October 2016 failed to commit to a reasonable roadmap of action, instead offering a seven-year delay, until 2023.¹⁵⁹ It will be interesting to see if the European Union can address this in part by expanding its cap-and-trade system in 2017 to include all ships that dock in EU ports. While

¹⁵⁸ Calculated using Origin Energy's share price is A\$5.38 on 28 October 2016, and Santos at A\$3.56 vs AGL Energy at A\$18.76.

¹⁵⁹ <http://www.climatecentral.org/news/shipping-industry-postpones-climate-plan-until-2023-20831>

inefficient relative to a global accord, it may force the hand of the shipping industry and the IMO to accelerate the transition required.

The failure of the IMO to undertake a serious and timely response to greenhouse gas emissions is contrasted by the milestone achieved in October 2016 by the International **Civil Aviation Organization** (ICAO).¹⁶⁰ The accord reached at the 39th ICAO Assembly in Montreal, Canada provides a global agreement to implement a market-based measure using a **Carbon Offset and Reduction Scheme for International Aviation** (CORSIA). Global aviation emissions in 2020 will be used as a benchmark, with around 80% of emissions above 2020 levels offset until 2035. The new system is weakened by being voluntary until 2027, but dozens of countries, including the world's two largest emitters, China and the U.S., have promised to join at its outset in 2020¹⁶¹.

A similarly potentially excellent milestone was achieved with the October 2016 accord reached in Rwanda in relation to phasing down the use of hydrofluorocarbons (HFC) globally.¹⁶² This represents a formal amendment to the landmark 1989 **Montreal Protocol** that required countries to phase out chlorofluorocarbon (CFC) use. Most manufacturers replaced CFC with HFCs, leading to a different, if related problem.

¹⁶⁰ <http://www.iata.org/pressroom/pr/Pages/2016-10-06-02.aspx>

¹⁶¹ <https://www.theguardian.com/environment/2016/oct/06/aviation-emissions-agreement-united-nations>

¹⁶² <http://fortune.com/2016/10/16/global-warming-hfcs-deal/>

Institute for Energy Economics and Financial Analysis

The Institute for Energy Economics and Financial Analysis (IEEFA) conducts research and analyses on financial and economic issues related to energy and the environment. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy and to reduce dependence on coal and other non-renewable energy resources.

More can be found at www.ieefa.org.

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About the Authors

Tim Buckley

Tim Buckley has 25 years of financial market experience covering the Australian, Asian and global equity markets from both a buy and sell side perspective. Tim was a top rated Equity Research Analyst and has covered most sectors of the Australian economy. Tim was a Managing Director, Head of Equity Research at Citigroup for many years, as well as co-Managing Director of Arkx Investment Management P/L, a global listed clean energy investment company that was jointly owned by management and Westpac Banking Group.

Simon Nicholas

Simon Nicholas is a Research Associate with IEEFA in Australia. Simon is a Fellow of the Institute of Chartered Accountants of England and Wales and has 16 years' experience working within the finance sector in both London and Sydney at ABN Amro, Macquarie Bank and Commonwealth Bank of Australia.

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