



New Energy Outlook 2017

Bloomberg New Energy Finance's annual long-term economic forecast of the world's power sector.

Bloomberg
New Energy Finance

Executive summary
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#NEO2017

Preamble

Welcome to the 2017 New Energy Outlook (NEO), Bloomberg New Energy Finance's annual long-term analysis of the future of energy. Focussed on the electricity system, NEO combines the expertise of over 65 in-house country and technology-level specialists in 12 countries to provide a unique assessment of the economic drivers and tipping points that will shape the sector to 2040.

What sets NEO apart is that our assessment is focussed on the parts of the system that are driving rapid change in markets, grid systems and business models. These include the cost of wind and solar technology, battery storage, electricity demand, electric vehicles and consumer dynamics. To say something meaningful about the evolution of the system as a whole, we also analyse coal, gas and oil markets and their fundamentals.

In the near term, our market projections are based on an assessment of policy drivers and Bloomberg New Energy Finance's proprietary project database, which provides a detailed understanding of planned new build, retrofits and retirements, by country and sector. In the medium to long term, the forecast is driven by the cost of building different power generation technologies to meet projected peak and average demand, country by country. The modelling then preferentially deploys least-cost technology options that change over time in line with shifting capital, operating and financing costs.

We explicitly model small-scale and large-scale battery systems, as well as taking a view on growth of demand response and charging electric vehicles. These new sources of flexibility allow for more dynamic balancing of supply and demand and become particularly important in markets where large amounts of variable wind and solar are deployed and conventional assets retire.

It is important to note that NEO explicitly removes renewable energy subsidies once they have run their course, and does not assume national climate targets are met, unless a mechanism to ensure compliance has been legislated. For example, we not include the US Clean Power Plan or assume the Paris Agreement is achieved.

The objective of the study, therefore, is not to provide a political document or a BNEF house view, but to highlight the changing fundamentals of renewable and conventional energy, how these may shape the future energy landscape and what opportunities and risks may arise for market participants as a result. Since NEO is a least-cost optimization exercise, for it to come true would require significant market reform and new price signals to maximise value from new technologies – a topic of ongoing focus for the analyst team at BNEF

This year we have incorporated a number of interesting changes. On the demand side we have included dynamic electric vehicle charging and lithium-ion peaker batteries, and changed India's load profile to better take into account uptake of air-conditioning. On the supply side we have updated our PV, onshore wind and lithium-ion battery cost curves, and for the first time, explicitly modelled offshore wind. In addition, we have updated a number of the proprietary models central to this forecast, including: our EV and small-scale solar PV and storage consumer uptake models, our electricity demand fundamentals model, and our capacity-build and dispatch.

Clients value this unique view of the changing market, and we look forward to helping you make the most of this flagship Bloomberg New Energy Finance report.

The New Energy Outlook is published in seven volumes – Global Synthesis, Americas, EMEA, Asia Pacific, Wind, Solar and Fossil Fuels.

Executive Summary

- **Global power demand grows by 58% between now and 2040, or 2% per year.** Growth in power demand increasingly decouples from GDP, however – we expect the intensity of electricity consumption per unit of GDP to fall by 27% over 2016-40.
- **We expect \$10.2 trillion to be invested in new power generation capacity worldwide to 2040.** Of this, 72% goes to renewables, or \$7.4 trillion. Solar takes \$2.8 trillion and wind \$3.3 trillion. Investment in renewable energy increases to around \$400 billion per year by 2040, a 2-3% average annual increase. Investment in wind grows faster than solar – wind increasing 3.4% and solar 2.3% per year on average.
- **Wind and solar account for 48% of installed capacity and 34% of electricity generation world-wide by 2040.** This is compared with just 12% and 5% today. Installed solar capacity increases 14-fold and wind capacity fourfold by 2040. We anticipate renewable energy reaching 74% penetration in Germany, 38% in the U.S., 55% in China and 49% in India by 2040 as batteries and new sources of flexibility bolster the reach of renewables.
- **The levelized cost of new electricity from solar PV drops by 66% by 2040.** By then, a dollar will buy 2.3 times as much solar energy than it does today. The levelized cost of new electricity from onshore wind drops 47% by 2040, thanks to more efficient turbines and streamlined operating and maintenance procedures.
- **Onshore wind costs fall fast, but offshore falls faster.** We expect the levelized cost of offshore wind to decline 71% by 2040, helped by development experience, competition and reduced risk, and economies of scale resulting from larger projects and bigger turbines.
- **Consumer-driven PV becomes a significant part of the power sector.** By 2040, rooftop PV will account for as much as 24% of electricity generation in Australia, 20% in Brazil, 15% in Germany, 12% in Japan, and 5% in the U.S. and India.
- **Electric vehicles bolster electricity use and help balance the grid.** In Europe and the U.S., EVs account for 13% and 12% respectively of electricity generation by 2040. Charging EVs flexibly, when renewables are generating and wholesale prices are low, will help the system adapt to intermittent solar and wind. The growth of EVs pushes the cost of lithium-ion batteries down 73% by 2030.
- **We expect lithium-ion batteries for energy storage to become a \$20 billion per year market by 2040,** a tenfold increase from today. Small-scale batteries installed by households and businesses alongside PV systems accounts for 57% of installed storage capacity worldwide by 2040.
- **By 2030, wind and PV start to undercut existing coal plants on an operational basis** in some countries, prompting an acceleration in the deployment of renewables and the decline of coal generation. Only 35% of new coal power plants that are in planning ever get built. That means 369GW of projects stand to be cancelled and global demand for thermal coal in 2040 ends up 15% lower than in 2016.
- **Global coal-fired power generation peaks in 2026.** Growth in coal demand is centred on Asia, but is offset by sharp declines in Europe and the U.S. Coal-fired generation in China is set to peak within the next 10 years.
- **Gas is a transition fuel, but not in the way most people think.** Gas-fired capacity increases 16% by 2040 but gas plants will increasingly act more as a source of flexible generation needed to meet peaks and provide system stability rather than as a replacement

for 'baseload' coal. In North America, however, where gas is plentiful and cheap, it plays a more central role, especially in the near term.

- **Asia Pacific sees almost as much investment in generation as the rest of the world combined.** China and India alone are a \$4 trillion opportunity for the energy sector. China accounts for 28% and India 11% of total regional investment over 2017-40. Wind and solar both account for around a third of total investment.
- **Powering China and India presents a \$4 trillion opportunity.** These countries account for 28% and 15% of all investment in power generation to 2040. Asia Pacific sees almost as much investment as the rest of the world combined, at \$4.8 trillion. Of this, just under a third goes to wind, a third to solar, 18% to nuclear and 10% to coal and gas.
- **Peak coal is in sight in Asia.** Peak coal capacity occurs in 2024, and peak generation in 2028, as retirements begin to outpace new additions. By the mid-2020s, cheap wind and PV begin to undercut new coal on a levelized basis throughout the region, trimming average installations to just 9GW a year. Coal, however, remains the bedrock of the region's power supply, providing 34% of electricity in 2040 – a larger share than any other fuel.
- **China will go big on renewables, with wind and solar capacity increasing eight-fold to 2040.** Coal consumption in China peaks in 2026, but at a level 20% higher than today. Nevertheless, China remains the world's largest coal consumer and emitter, with that fuel still accounting for 30% of the generation mix in 2040.
- **India significantly expands its coal fleet over the next five years, adding over 40GW of new coal plants.** Following that, we expect coal new build to slow but existing plant utilization to increase, pushing up coal consumption by around 3% per year through the 2020s. From 2030, solar begins to sideline coal in India, with the pace of PV additions more than doubling from the 2020s to the 2030s.
- **Japan and South Korea shift from gas to coal, and then to solar.** Gas generation declines in both countries as over 30GW of coal capacity is commissioned over the next decade – Japan and Korea are the only two members of the OECD to build significant volumes of new coal in our forecast. Power sector gas demand in Japan and South Korea declines by over 50% in the next ten years with possible ramifications for the global LNG market as the two countries account for half of current demand for seaborne gas.
- **Australia's electricity system becomes one of the most decentralized in the world.** By 2040, around 45% of Australia's power generating capacity is located behind-the-meter. Its fossil-fuel dominated grid also transforms into a predominantly renewable system, as wind, PV and batteries replace retiring coal.
- **European investment in renewables grows by 2.6% per year on average out to 2040,** averaging \$40 billion per year. Total investment in renewables across Europe reaches almost \$1 trillion over 2017-40. Europe's firm generating capacity shrinks by 29%, replaced by variable and flexible capacity.
- **Half of European electricity supply in 2040 comes from variable renewables, posing challenges for grid and generators.** With 97% of fossil fuel capacity in 2040 required for peak demand, under-utilized thermal plants are the norm. The changing grid creates opportunities for 103GW of new flexible capacity, including 56GW of batteries. These help with peak load, ancillary services, shifting demand or renewable supply and regulating frequency.
- **Gas in Europe benefits from a wave of coal and nuclear retirements over the next decade,** but power sector gas consumption never returns to the record level set in 2008 as

the role of gas shifts from providing firm capacity to providing flexible generation. Nuclear generation drops 50% and the combination of sluggish demand, cheap renewables and coal-to-gas fuel switching slashes coal use by 87% by 2040. This drives down power sector emissions by 73% over 2017-40.

- **Installed capacity in the MENA region moves from 93% fossil fuels to 53% zero-carbon over 2017-40.** The region becomes less reliant on oil and more reliant on gas. Gas provides over half of generation by 2040. In Turkey, coal and nuclear push out gas, which declines from 36% to 2% of the generation mix over 2017-40.
- **Investment in renewables across the Americas averages \$50 billion per year to 2040,** to reach almost \$1.5 trillion over 2017-40. Investment in solar grows faster than wind – solar increasing 1.5% and wind 0.8% per year on average. In the U.S., power sector coal consumption drops 45% as coal plants are retired and replaced by cheaper natural gas and renewables.
- **By 2023, onshore wind and PV are competitive with new-build gas plants in the U.S.** Five years later, PV undercuts existing gas generation. PV averages 15GW of additions and \$10 billion invested per year, such that more PV is added in the U.S. than any other technology. Small-scale PV grows to 140GW by 2040, yet only a minority of systems are paired with batteries as the economics remain difficult for much of the forecast period.
- **Renewables produce 80% of Mexico's electricity by 2040, a fourfold increase from today.** Solar overtakes gas and hydro to dominate Mexico's capacity mix, which more than triples in size to 2040. Electricity demand is expected to grow 60% from 2016 to 2040 thanks to strong economic growth, but the country also becomes 29% more efficient in how it uses electricity over that time.
- **U.S. natural gas influences the power generation mix all across the Americas, as exports accelerate.** Cross-border exports to Mexico and liquid natural gas exports further south keep gas prices in check across both continents, particularly through 2030. This allows new gas plants to displace retiring coal and nuclear in North America while offering a relatively low-cost option in parts of Latin America for new build.
- **We expect U.S. power sector emissions in 2030 to be 30% below 2005 levels, coming very close to fulfilling the Clean Power Plan's headline goal even in the absence of federal policy.** The federal Clean Power Plan was anticipated to reduce power sector emissions by 32% below 2005 levels by 2030 and the U.S. pledge in the UNFCCC Paris Accord set an economy-wide goal of 26-28% below 2005 levels by 2025.
- **Global power sector emissions peak in 2026 at 14.1Gt, then decline by 1% per year out to 2040.** This is a steeper decline than in our previous forecast, mainly due to a faster rate of Chinese coal retirements compared with NEO 2016. We also expect India's emissions to be 44% lower by 2040 than in our NEO 2016 analysis, as that country embraces solar and invests \$405 billion to construct 660GW of new PV.
- **Although the world's power sector emissions reach a peak within a decade, the rate of decline in emissions is not nearly enough for the climate.** A further \$5.3 trillion investment in 3.9TW of zero-carbon capacity will be needed place the power sector on a 2°C trajectory.

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