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RENEWABLES 2017

Analysis and forecasts to 2022

EXECUTIVE
SUMMARY

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- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
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EXECUTIVE SUMMARY

Photovoltaics grew faster than any other fuel in 2016, opening a new era for solar power

Renewables broke new records in 2016, largely as a result of booming solar photovoltaics (PV) deployment in the People's Republic of China (hereafter, "China") and around the world, driven by sharp cost reductions and policy support. This performance forms the bedrock of our 2017-22 electricity forecast. Renewables represented almost two-thirds of new net electricity capacity additions in 2016, with almost 165 gigawatts (GW) coming online.

Last year, new solar PV capacity around the world grew by 50%, reaching over 74 GW, with China accounting for almost half of this expansion. For the first time, solar PV additions rose faster than any other fuel, surpassing the net growth in coal. This deployment was accompanied by the announcement of record-low auction prices as low as USD 30/megawatts per hour (MWh). Annual capacity growth of wind declined by almost one-fifth in 2016, following the 2015 boom caused by a developer rush in China. Hydropower capacity expansion was lower than in 2015 as the Chinese market declined for a third year in a row, while Brazil saw strong growth. The growth of other renewable technologies such as bioenergy, concentrating solar power (CSP), and geothermal was relatively slow, and it represented only 4% of 2016 global renewable capacity additions.

China is the undisputed renewable growth leader, holding the key to the future of solar PV

Between 2017 and 2022, we expect global renewable electricity capacity to expand by over 920 GW, an increase of 43%. This forecast is more optimistic than last year, mainly because of upward revisions for solar PV in China and India. China alone is responsible for 40% of global renewable capacity growth, which is largely driven by concerns about air pollution and capacity targets that were outlined in the country's 13th five-year plan to 2020. In fact, China already surpassed its 2020 solar PV target, and we expect it to exceed its wind target in 2019. China is also the world market leader in hydropower and, bioenergy for electricity and heat, as well as electric vehicles.

Solar PV is entering a new era. For the next five years, solar PV represents the largest annual capacity additions for renewables, well above wind and hydro. This marks a turning point and underpins our more optimistic solar PV forecast which is revised up by over one-third compared to last year's report. This revision is driven by continuous technology cost reductions and unprecedented market dynamics in China as a consequence of policy changes. As a result, by 2022, total solar PV capacity around the world reaches 740 GW in our main case forecast, which is more than the combined total power capacities of India and Japan today.

China is a critical actor in the market development and prices for solar PV worldwide. Today, the country represents half of global solar PV demand, while Chinese companies account for around 60% of total annual solar cell manufacturing capacity globally. As such, market and policy developments in China will have global implications for solar PV demand, supply, and prices.

If uncertainties and barriers are addressed, solar PV growth could accelerate even more. Two important challenges in China – the growing cost of renewable subsidies and grid integration – limit growth in the main case forecast. China's renewable energy policies are being modified quite substantially in order to address these challenges. China is moving away from its feed-in-tariff (FIT)

programme to a quota system with green certificates. Together with ambitious power market reform, new transmission lines, and the expansion of distributed generation, these new policies are expected to speed up deployment of solar (and wind). However, the timing and implementation of this policy transition remains uncertain.

Our accelerated case forecast assumes that governments address policy challenges and lift barriers to deployment, leading to more rapid growth. Accordingly, solar PV in China could reach a total of 320 GW by 2022, equivalent to the total capacity of Japan. This also has global implications: combined with possible policy and regulatory improvements in other key countries such as India, Japan and the United States, world solar PV cumulative capacity could almost triple to 880 GW by 2022.

The United States remains the second-fastest growing market, while renewable electricity growth in India surpasses the European Union

Despite policy uncertainty, the United States remains the second-largest growth market for renewables. The main drivers remain strong for new onshore wind and solar capacities, such as multi-year federal tax incentives combined with renewable portfolio standards as well as state-level policies for distributed solar PV. Still, the current uncertainty over proposed federal tax reforms, international trade, and energy policies could have implications for the relative economics of renewables and alter their expansion over our forecast period.

India's forecast is more optimistic as it moves to address the financial health of its utilities and to tackle grid-integration issues. By 2022, India is expected to more than double its current renewable electricity capacity. For the first time, this growth over the forecast period is higher than the European Union. Solar PV and wind together represent 90% of India's capacity growth as auctions yielded some of the world's lowest prices for both technologies. In some Indian states, these recent contract prices are comparable to coal tariffs. India's accelerated case indicates that renewable capacity expansion could be boosted by almost a third, providing that existing grid integration and infrastructure challenges are addressed, policy and regulatory uncertainties are reduced, and costs continue to fall. This deployment path could put India's growth on par with the United States, thus becoming the joint second-largest growth market after China.

In the European Union, renewable growth over the forecast period is 40% lower compared with the previous five-year period. Overall, weaker electricity demand and overcapacity remain challenges to growth while limited visibility on forthcoming auction capacity volumes in some markets presents a forecast uncertainty. Beyond 2020, policy uncertainty remains. However, if adopted, the new EU Renewable Energy Directive covering the post-2020 period would address this challenge by requiring a three-year visibility over support policies, thereby improving market predictability for investors.

The growth in solar PV helps bridge the electrification gap in developing Asia and sub-Saharan Africa. For the first time, our report tracks off-grid solar PV applications more closely in developing Asia and sub-Saharan Africa. Over the forecast period, off-grid capacity in these regions will almost triple – reaching over 3 000 MW in 2022 – from industrial applications, solar home systems (SHSs), and mini-grids driven by government electrification programmes, and private sector investments. Although this growth represents a small share of total PV capacity installed in both regions, its socio-economic impact is nonetheless significant. We estimate that over the next five years, SHSs – the most dynamic sector in the off-grid segment – will bring basic electricity services to almost 70 million more people in Asia and sub-Saharan Africa. It will also lead to new business players bringing innovative payment solutions that allow low-income populations initial access to electricity services.

Renewable generation becomes more competitive, closing the gap with coal

By 2022, global renewables electricity generation is expected to grow by more than one-third to over 8 000 terawatts per hour, equal to the total consumption of China, India and Germany combined. The share of renewables in power generation will reach 30% in 2022, up from 24% in 2016. Despite slower capacity growth, hydropower will remain the largest source of renewable electricity generation in our forecast, followed by wind, solar PV and bioenergy. In the next five years, growth in renewable generation will be twice as large as that of gas and coal combined. While coal remains the largest source of electricity generation in 2022, renewables close in on its lead. In 2016, renewable generation was 34% less than coal but by 2022 this gap will be halved to just 17%.

Renewable policies in many countries are moving from government-set tariffs to competitive auctions with long-term power purchase agreements (PPAs) for utility-scale projects. Increased competition has reduced remuneration levels for solar PV and wind projects by 30-40% in just two years in some key countries such as India, Germany and Turkey. This competitive price discovery mechanism has squeezed costs along the entire value chain making tenders a cost-effective policy option for governments. Auctions can also enable a better control of deployment, total incentives, and system integration aspects. Almost half of the renewable electricity capacity expansion over 2017-22 is expected to be driven by competitive auctions with PPAs, in contrast to just over 20% in 2016.

Announced auction prices for wind and solar have continued to fall although average generation costs of new-built projects remain higher. Over the period 2017-22 global average generation costs are estimated to further decline by a quarter for utility-scale solar PV; by almost 15% for onshore wind; and by a third for offshore wind. Still, these average costs for solar PV remain relatively high because of high FITs in China and Japan as well as relatively elevated investment costs in the United States. Meanwhile, announced auction prices indicate much steeper possible cost reductions, ranging from USD 30-45/MWh for solar PV (India, Mexico, United Arab Emirates, Argentina) to USD 35-50/MWh for onshore wind (India, Morocco, Egypt, Turkey, Chile). Auctions are also proving effective in rapidly reducing costs of offshore wind and CSP. While auction announcements (in terms of both volumes and prices) need to be verified over time, they suggest that expanding competitive pricing could result in even lower average costs in coming years.

As growth of wind and solar accelerates, system integration becomes increasingly important

Wind and solar together will represent more than 80% of global renewable capacity growth in the next five years. By 2022, Denmark is expected to be the world leader, with almost 70% of its electricity generation coming from variable renewables. In some European countries (Ireland, Germany and the United Kingdom), the share of wind and solar in total generation will exceed 25%. In China, India and Brazil, the share of variable generation is expected to double to over 10% in just five years. These trends have important implications going forward. Without a simultaneous increase in system flexibility (grid reinforcement and interconnections, storage, demand-side response and other flexible supply), variable renewables are more exposed to the risk of losing system value at increasing shares of market penetration since wholesale prices are depressed precisely when wind and solar production is abundant and demand is low. Market and policy frameworks need to evolve in order to cope simultaneously with multiple objectives, including providing long-term price signals to attract investment, ensuring efficient short-term electricity dispatching, pricing negative externalities, and unlocking sufficient levels of flexibility as well as fostering a portfolio of dispatchable renewable technologies, including hydropower, bioenergy, geothermal and CSP.

Biofuels remain the champion of renewables in transport while the share of electric vehicles grows

The share of renewables in road transport is expected to increase only marginally, from over 4% in 2016 to almost 5% in 2022. Biofuels and electric vehicles (EVs) are complementary options to achieve transport sector decarbonisation with renewables. Despite strongly rising sales, the share of EVs remains limited, and biofuels are still expected to represent over 90% of total renewable energy consumption in road transport by 2022. Biofuels production is expected to grow by over 16% over the forecast period. Asia leads this growth due to the rising demand for transport fuel, the availability of feedstocks, and supportive government policies. Brazil makes a key contribution as a result of its efforts to increase sustainable biofuels consumption in line with its national target for 2030. In the United States, ethanol and biodiesel production also expands as a result of supportive policy frameworks. Modest growth is expected in the European Union given that the policy landscape after 2020 is not expected to encourage industry investment. Advanced biofuels (such as cellulosic ethanol) have made important progress in recent years but are not yet competitive with petroleum products. Production is expected to increase sevenfold from a low base, which is still just over 1% of total biofuels production.

With a more favourable market and policy landscape, biofuel production could be 13% higher. For the first time, we provide accelerated case forecast for biofuels that assumes additional investment in new production capacity in Brazil; scaling up fuel distribution infrastructure in the United States; and roll-out of a blending programme in India. Still, in this accelerated case, the share of renewables in road transport fuel demand would only reach just over 5% by 2022.

Renewables account for 30% of electricity consumption of EVs by 2022, up from 26% today. Globally, electricity consumed by EVs – including cars, two- and three wheelers, and buses – is expected to double by 2022 but will still account for less than 1% of total electricity generation. China is the largest consumer of renewable electricity in EVs, thanks to the expansion of two- and three-wheelers and the increasing share of renewables in its power mix. The second-largest consumer is Europe due to the deployment of electric cars in markets with high shares of renewables such as Norway and Germany. Despite the United States being the third-largest electric car market, renewable consumption is relatively lower than China and Europe because of the less prominent role of renewables in its electricity supply.

Renewable heat grows by a quarter, but its share increases only marginally

The share of renewables in heat consumption increases slowly, from 9% in 2015 to almost 11% in 2022. Almost 40% of global energy-related CO₂ emissions comes from heat used for water and space heating in buildings and for industrial processes; therefore, decarbonising heat remains an important challenge. The building sector is expected to lead the growth in renewable heat consumption, with the fastest growth in this sector seen in China, the European Union and North America. In industry, China and India see a significant growth in renewable heat consumption. In terms of sources, bioenergy will lead renewable heat consumption growth over the outlook period, followed by renewable electricity for heat. Global solar thermal energy consumption is also expected to increase by over a third, although growth is projected to be slower than in previous years. China alone provides over a third of overall renewable heat growth over the outlook period, driven by strengthened targets for solar thermal, bioenergy and geothermal as well as by increasing concerns over air pollution in cities. The European Union is the second-largest growth market as a result of the binding targets of the Renewable Energy Directive, and it remains the global leader in terms of absolute renewable heat consumption.

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The renewable electricity market has witnessed an unprecedented acceleration in recent years, and it broke another annual deployment record in 2016. The market's main driver last year was solar photovoltaics, which is boosting the growth of renewables in power capacity around the world. As costs decline, wind and solar are becoming increasingly comparable to new-build fossil fuel alternatives in a growing number of countries. China remains the dominant player, but India is increasingly moving to the centre stage. Government policies are introducing more competition through renewable auctions, further reducing costs.

The IEA's newly renamed *Renewables 2017* (formerly titled *Medium-Term Renewables Market Report*) provides a detailed market analysis and overview of renewable electricity capacity and generation, biofuels production, and heat consumption, as well as a forecast for the period between 2017 and 2022. This year's report also provides additional analysis on the contribution of electric vehicles to renewable road transport and on the off-grid solar market in Africa and developing Asia.

Finally, the report identifies a set of policy improvements in key markets that could accelerate the growth of renewables in the electricity sector as well as the growth of transport biofuels for the first time. These are needed to accelerate decarbonisation in all sectors in order to be on track to meet long-term climate goals.