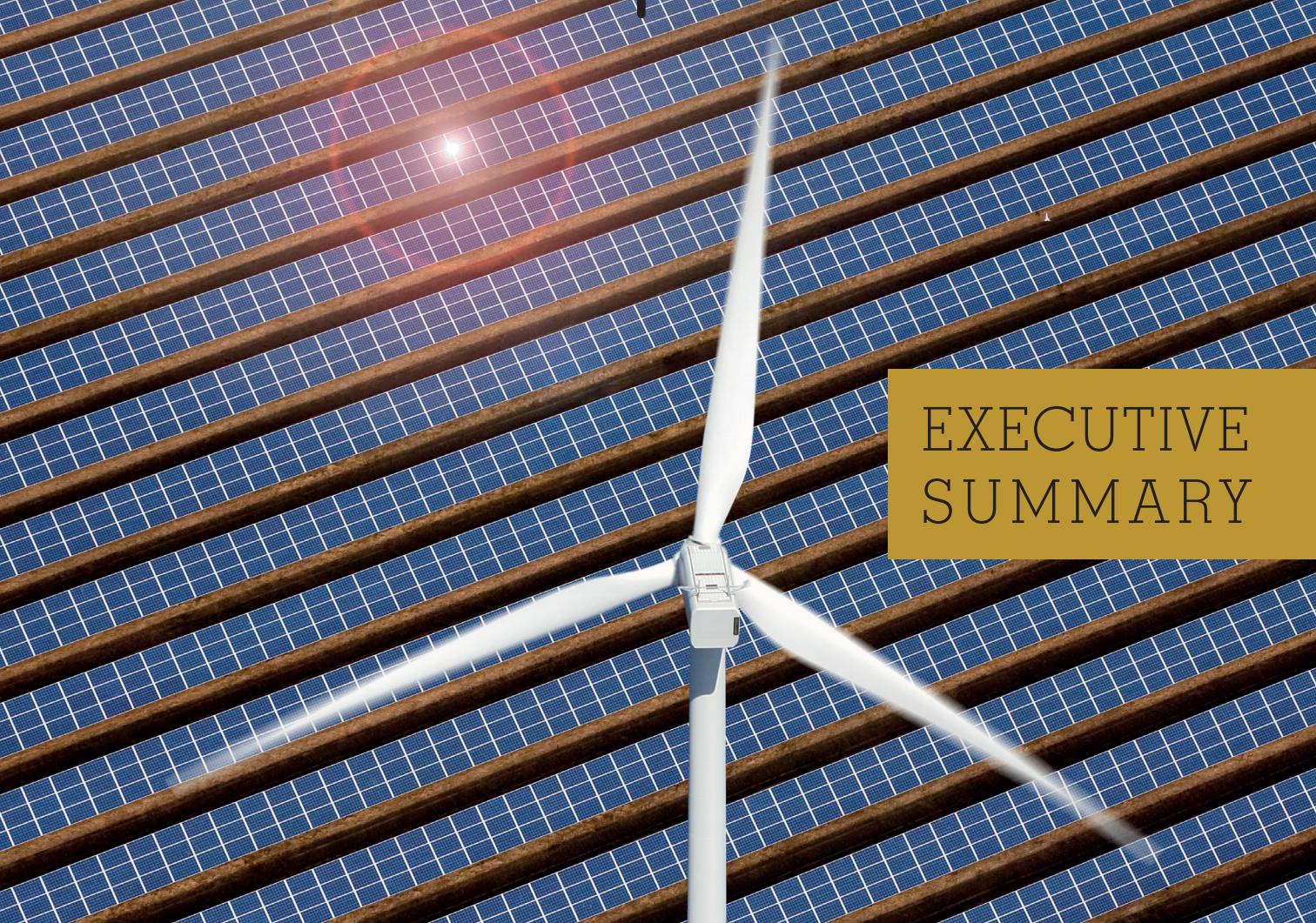


RENEWABLE ENERGY

Medium-Term Market Report

2016



EXECUTIVE
SUMMARY

Market Analysis and Forecasts to 2021



International
Energy Agency
Secure
Sustainable
Together

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- 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.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:



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The European Commission also participates in the work of the IEA.

EXECUTIVE SUMMARY

2015 – A year of records for renewable electricity

In 2015, annual renewable electricity capacity growth reached an all-time record at 153 gigawatts (GW), thanks to record additions in both onshore wind (63 GW) and solar photovoltaics (PV) (49 GW). This is equivalent to more than the total cumulative installed power capacity of a country like Canada. For the first time, renewables accounted for more than half of net annual additions to power capacity and overtook coal in terms of cumulative installed capacity in the world.

Record deployment was accompanied by continued sharp generation cost reductions, with announced record-low long-term remuneration prices ranging from USD 30/megawatt hours (MWh) to 50/MWh for both onshore wind and solar (PV) plants. These projects are expected to become operational over the medium term in markets as diverse as North America, Latin America, Middle East, and North Africa. In addition, recent tender results in Europe for large-scale offshore wind projects indicate possible 40% to 50% cost reductions for new plants by 2021. While these contract prices should not be compared directly to average generation costs, and final project delivery costs may ultimately differ at the time of commissioning, still they signal a clear acceleration in cost reductions, increasing the affordability and improving the attractiveness of renewables among policy-makers and investors.

The Medium-Term Renewables Market Report (MTRMR) expects onshore wind generation costs to decrease by a further 15% on average by 2021, while utility-scale solar PV costs are anticipated to decline by another quarter. These trends are underpinned by a combination of sustained policy support, technology progress and expansion into newer markets with better renewable resources. In addition, improved financing conditions play a particularly important role, driven by the expanding use of long-term power purchase agreements (PPAs) awarded through price competitive public or private tenders, including government-backed auction systems.

Policy improvements drive more optimistic outlook for renewable power

Global renewable electricity capacity is expected to grow by 42% (or 825 GW) by 2021. Overall, this forecast is much more (13%) optimistic than *MTRMR* 2015. Most of this revision is due to policy changes and improved market prospects in four key countries. The United States (US) alone represents close to half of the forecast revision thanks to the medium-term extension of federal tax credits, which are set to boost solar PV and onshore wind expansion. The People's Republic of China's (hereafter "China") renewable electricity outlook is also more optimistic with higher (indicative) targets under its 13th five-year economic plan, backed by supportive policies. In India an improved policy environment, competitive tenders and decreasing generation costs are major drivers for the more optimistic solar PV outlook. The recent power reform and auction system in Mexico has also increased expectations for medium-term growth.

Asia is the engine of renewable power capacity growth

China remains the undisputable global leader of renewable energy expansion, representing close to 40% of growth. China's air pollution concerns and a favorable policy environment are driving the growth. In 2021, more than one-third of global cumulative solar PV and onshore wind capacity will be located in China. Nonetheless, grid integration will remain an important challenge over the medium

term, despite policy improvements and anticipated power sector reforms. Moreover, a new challenge of electricity overcapacity may emerge over the medium term given that China still has a substantial number of coal, nuclear and renewable plants under development at the same time as a slow-down in electricity demand growth driven by several factors including energy efficiency improvements.

India's solar PV capacity is forecast to grow eight-fold supported by ambitious government targets and competitive auctions, where contract prices have already declined by a factor of two since 2014. In Southeast Asia, growing electricity demand, increasing fossil fuel imports and air pollution concerns remain important drivers for renewable targets and policies, which are expected to bring increased diversification in the energy mix.

Renewable capacity growth will be faster in the United States than in the European Union (EU). The medium-term extension of federal tax incentives supported by state-level Renewable Portfolio Standard (RPS) policies has improved the economic attractiveness of onshore wind and solar PV, even in the context of current low natural gas prices. With this policy improvement, the United States is set to become the second largest market globally in terms of renewable capacity additions over the forecast period. Weak electricity demand growth, pending legislation on renewables, market design and governance of 2030 targets, as well as persistent policy uncertainty in a number of major countries are the main reasons for a slower expansion of renewable electricity in the European Union compared to the past.

Solar PV and onshore wind lead capacity growth while hydropower additions slow

Solar PV and onshore wind together represent 75% of global renewable electricity capacity growth over the medium-term. Solar PV leads providing almost 40% of global additions while onshore wind is the largest source of new renewable electricity generation. Hydropower growth slows because fewer large-scale conventional projects are expected to be commissioned in China and in Brazil while some projects are delayed in various developing countries. Other renewable technologies are expected to grow at a slower rate but still scale up significantly. Among them, bioenergy is the most significant, with prominent applications including coal-to-biomass conversions particularly in Europe, and the deployment of waste to energy and biogas projects in emerging Asia, particularly in China. Offshore wind capacity is forecast to triple over the forecast period led by deployment in Europe but with China's capacity also scaling-up fast. These developments are complemented by modest growth in concentrated solar thermal (China and Morocco), geothermal (Indonesia and Turkey) and ocean (France and Korea) technologies.

Renewables to provide for the majority of new global electricity demand but strong regional differences are evident

The share of renewables in overall electricity generation will rise from over 23% in 2015 to almost 28% in 2021. Global electricity demand growth is likely to be slower compared to the last five-year period, due to energy efficiency improvements and less-energy intensive economic output. On average, world renewables output is expected to provide over 60% of total electricity generation growth during the forecast period, but strong regional differences are evident. In most developed economies, incremental renewable generation over the medium term is higher than electricity demand growth (e.g. European Union, United States), thus accelerating the de-carbonisation of the

power sector. In many emerging markets such as those in China, India and the Association of Southeast Asian Nations (ASEAN) where power demand is expected to continue to grow significantly, renewables are anticipated to meet only a portion of new generation growth.

Biofuels and low oil prices: A complex interplay

The share of biofuels in transport fuel demand is expected to increase only marginally from 3% in 2015 to 4% by 2021, with growth slowing compared to the 2009 to 2015 period. Blending mandates have partly shielded biofuels from the low oil price environment and the strengthening of these in key markets, supporting production growth of 19% over the medium term. However, lower oil prices have resulted in a more challenging investment climate for both conventional and advanced biofuels, heightening the importance of suitable governance measures to ensure compliance with mandated consumption and limiting opportunities for discretionary blending above mandated volumes given less favourable blending economics. Sound regulatory frameworks that can assure the sustainability of biofuels remain key components of appropriate policy support that will be necessary to ensure longer-term market growth.

Asia is poised to head biofuels market expansion over the medium term. While the United States and Brazil will comfortably remain the largest biofuel producers in 2021, Asian markets are forecast to account for over a third of the 2015-21 global biofuels production increase. Driven by security of supply considerations, enhanced policy support for domestically produced biofuels is boosting ethanol production in India and Thailand while biodiesel growth is concentrated in Indonesia and Malaysia. With regard to advanced biofuels, higher output from existing plants and a pipeline of new projects should see higher production. However, significant growth in the industry will require more widespread policy support and is more likely following the medium-term.

Scaling up renewables in the heat sector remains a challenge

Renewable heat deployment is expected to grow slowly over the medium term. Heat accounts for more than half of global final energy consumption and is still primarily supplied by fossil fuels. Modern renewable heat (excluding the traditional use of biomass) currently provides just under 9% of heat demand globally including renewable electricity for heat. The European Union is the biggest producer of renewable heat followed by North America. Of the emerging economies, Brazil stands out in meeting almost 40% of its heating needs (which are primarily in industry) from renewables. Renewable heat use is expected to grow by 21% over the forecast period. This expansion will be dominated by modern bioenergy followed by solar thermal and geothermal, as well as the increasing use of renewable electricity for heat. The growth is likely to come primarily from China, the European Union, North America and India. However, as total global heat demand is expected to grow, the contribution of renewables to heat consumption will rise to over 10% by 2021.

Renewable heat markets face multiple economic and non-economic barriers that need targeted policy support, particularly in a low fossil fuel price environment. Fewer countries have established renewable policies in the heat sector than in the electricity sector, although a variety of instruments are in place across diverse markets, often with a particular focus on the buildings sector and linked to energy efficiency policies. A combination of high investment costs and reduced operational cost savings owing to lower fossil heating fuel prices makes the economic case for investing in renewable

heating solutions more challenging especially in the market segment where renewable heat options compete directly with oil boilers such as in Germany and the United Kingdom.

More renewables deployment is required to reach long-term climate goals and reduce harmful air pollution

The MTRMR main case forecast results show that renewable power growth is currently in line with the INDC electricity targets to 2030. However, only onshore wind and solar PV deployment are on track with long term 2°C pathways. Meeting the objective of the COP21 global climate agreement to hold the increase in global average temperature to well below 2°C, will require stronger decarbonisation rates and accelerated penetration of renewables in all three sectors: power, transport and heat.

For the electricity sector, MTRMR identifies a set of additional policy initiatives in a number of key markets (including China, United States, India, the European Union and Brazil) which could be implemented in a short period of time with significant impacts over the forecast period. Under this *accelerated case* projection, global renewable capacity growth could be 29% higher than in *the main case forecast*. These initiatives would put the global power system on a firmer path towards ambitious climate targets while also improving air quality in key emerging markets (China, India and ASEAN). Achieving this *accelerated case* would require policy makers to address three important challenges to deployment:

- Addressing infrastructure challenges and market design issues to improve grid integration of renewables.
- Implementing stable and sustainable policy frameworks that give greater revenue certainty to capital-intensive renewables and reducing policy uncertainties
- Developing policy mechanisms that reduce cost of financing and lower off-taker risks especially in developing countries and emerging economies.

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The rapid spread of renewable energy is a bright spot in the global energy transition towards a low carbon economy. Despite lower fossil fuel prices, renewable power expanded at its fastest-ever rate in 2015, thanks to supportive government policies and sharp cost reductions. Renewables accounted for more than half of the world's additional electricity capacity last year. Yet, even with this remarkable progress, there are questions about whether renewables are on track to reach targets set by the Paris Agreement.

This report examines these questions in detail, looking closely at how renewable energy in the power, heat and transportation sectors will evolve over the next five years in the face of lower fossil fuel prices. It explores recent renewable deployment and policy trends across different regions and countries, particularly as costs for wind and solar PV continue to fall.

The *Medium-Term Renewable Energy Market Report 2016* also assesses the potential impact of enhanced policy action for the electricity sector under its "accelerated case", which would position the world firmly on a path to a more sustainable and secure energy system.

Market Analysis and Forecasts to 2021