IRENA
International Renewable Energy Agency

RENEWABLE POWER: CLIMATE-SAFE ENERGY COMPETES ON COST ALONE


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As climate talks focus increasingly on practical solutions to cut carbon emissions, countries around the world are more firmly committed than ever to accelerating renewable energy deployment. They do so, moreover, with a view to economically replacing fossil fuels over the decades to come. Technological innovation, enabling policies and the drive to address climate change have placed renewables at the centre of this global energy transformation.

Yet alongside these developments, the chief driver of renewable energy deployment is a strong and steadily improving business case, which offers increasingly exciting economic opportunities.

Indeed, the cost of electricity from renewable energy technologies has fallen steadily, and in some cases dramatically, in recent years. This is particularly true over the decade since 2008, when solar and wind power first broke through as viable commercial options. Today, power generation from renewable sources and technologies has become increasingly competitive with, or in many situations less costly than, fossil-based or nuclear power.

Where untapped and economical resources exist, new installations of bioenergy, hydropower and onshore wind technologies all offer low-cost power generation. Recent and often rapid cost declines for electricity from solar photovoltaics (PV) have allowed this technology to compete head-to-head against conventional power sources, without financial support. Although offshore wind and concentrating solar power (CSP) are still in early stages of deployment, both saw cost declines between 2010 and 2017, continuing into 2018.

STEADILY CHEAPER POWER FROM SOLAR, WIND AND OTHER RENEWABLES

Global weighted average costs for electricity from all renewable technologies except CSP now fall within the range of fossil fuels, which in 2017 was between USD 0.047 and USD 0.167 per kilowatt-hour (kWh), although this can be much higher on islands and in remote locations.

After nearly a decade of steady cost decline for solar and wind technologies, renewable power is an increasingly competitive way to meet new generation needs. Between 2010 and 2017, for example, the global weighted average cost of electricity from newly commissioned utility-scale solar PV plants fell 73%, to USD 0.10/kWh in 2017 (see Figure 1).[1] While price declines of more than 80% on solar PV modules have been a major factor, balance-of-system costs have also fallen.

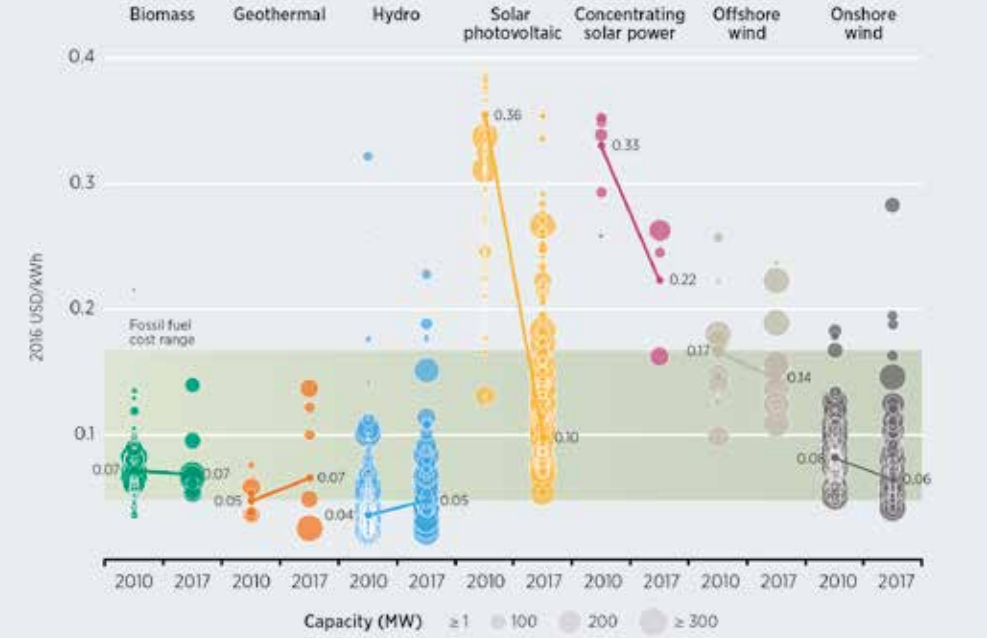
Onshore wind, where good resources exist, now represents one of the lowest-cost sources of new power generation capacity. The global weighted average cost of electricity from onshore wind fell by 23% between 2010 and 2017, to around USD 0.06/kWh, with some projects regularly delivering electricity for just USD 0.04/kWh.

Recent auctions in Brazil, Canada, Germany, India, Mexico and Morocco have resulted in onshore wind power levelised electricity costs (LCOEs) as low as USD 0.03/kWh. Similar results appear possible in other areas with excellent wind sites.

This onshore wind cost decline has been driven by falling turbine costs since 2009, as well as by increasing hub heights and larger swept areas that allow today's turbines to harvest much more electricity from the same site than turbines five or ten years ago. Such performance improvements drove the global weighted average capacity factor for onshore wind to increase from around 20% in 1983 to around 30% by 2018.

1 All data provided here are adjusted for inflation and presented in real 2017 USD. The data exclude all financial support for a project. Similarly, the cost of electricity quoted excludes the benefits or costs associated with local and global pollutant emissions. Figures for costs of electricity refer to levelised cost of electricity (LCOE) calculations using a weighted average cost of capital of 7.5% in OECD countries and China, and 10% elsewhere. Data are from the IRENA Renewable Cost Database, which encompasses 15 000 utility-scale projects.

Figure 1: Levelised cost of electricity by project and weighted average by technology, 2010 and 2017



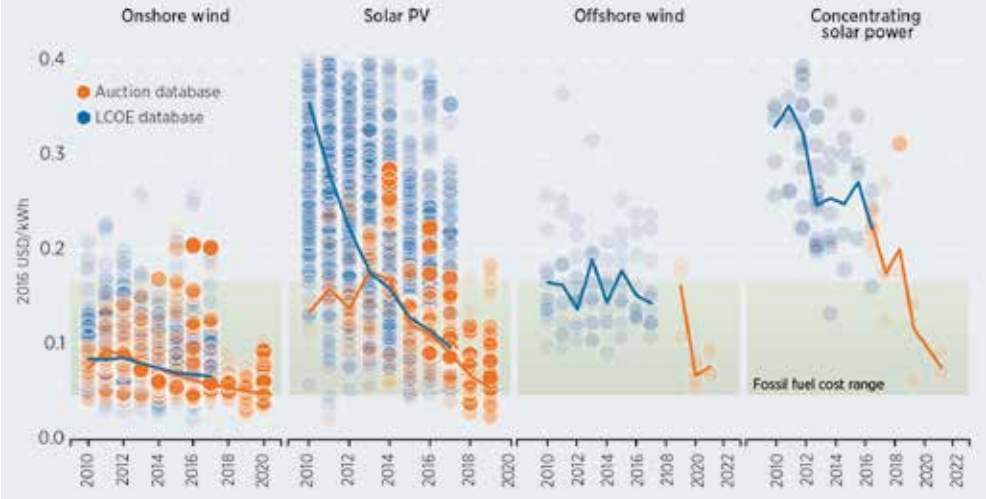
At the same time, the more mature renewable power generation technologies – meaning biomass, geothermal and hydropower – should not be forgotten.

For plants commissioned in 2017, the global weighted average cost of electricity from bioenergy was USD 0.07/kWh, from hydropower USD 0.05/kWh and from geothermal USD 0.07/kWh. Their importance to the electricity system will only increase over time as the share of variable renewables grows given their firm capacity availability.

The results of recent renewable power auctions – for projects to be commissioned in the coming years – confirm that cost reductions are set to continue through 2020 and beyond. The outlook for solar and wind electricity costs to 2020 presages the lowest costs yet seen for these modular technologies, which can be deployed around the world. Based on the latest auction and project-level cost data, global average costs could decline to about USD 0.05/kWh for onshore wind and USD 0.06/kWh for solar PV. Record low auction prices for solar PV in Dubai, Mexico, Peru, Chile, Abu Dhabi and Saudi Arabia in 2016 and 2017 confirm that the LCOE can be reduced to USD 0.03/kWh from 2018 onward, given the right conditions.

The global weighted average LCOE of offshore wind projects commissioned in 2017 was USD 0.14/kWh, while for CSP, it was USD 0.22/kWh. However, auction results in 2016 and 2017, for CSP and offshore wind projects that will be commissioned in 2020 and beyond, signal a step-change, with costs falling to between USD 0.06 and USD 0.10/kWh for CSP and offshore wind. Both recent and anticipated cost reductions point to remarkable deflation rates for solar and wind technologies and even though they are commercially mature, they still have significant potential for cost reduction. Learning rates[2] for the 2010-2020 period, based on project and auction data, are estimated at 14% for offshore wind, 21% for onshore wind, 30% for CSP and 35% for solar PV.

Figure 2: The levelised cost of electricity for projects and global weighted average values for CSP, solar PV, onshore and offshore wind, 2010-2022



Source: *IRENA Renewable Cost Database and Auctions Database.*

Note: *Each circle represents an individual project or an auction result where there was a single clearing price at auction. The centre of the circle is the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE, or auction values, by year. For the LCOE data, the real WACC is 7.5% for OECD countries and China, and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.*

2 The learning rate is the percentage cost reduction experienced for every doubling of cumulative installed capacity.

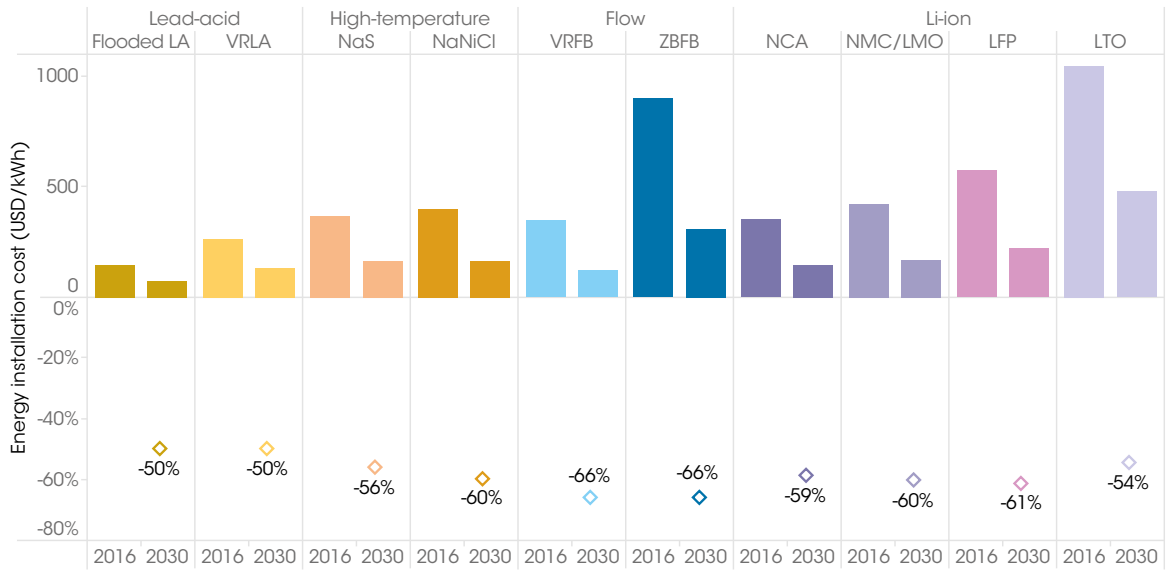
FACILITATING THE NEXT PHASE OF GLOBAL ENERGY TRANSFORMATION

With the growth of the variable renewable electricity technologies, meaning solar and wind power, significant progress is being made in decarbonising the global electricity sector. Experience in leading markets has demonstrated the viability of integrating high shares of these sources smoothly into existing power grids, with smart technologies helping to manage daily and seasonal variations in power supply.

However, the focus must now shift to how to integrate renewables in the end-use sectors (heating, cooling, transport, etc.). Efforts to integrate renewables into the end-use sectors, meanwhile, have brought into sharp relief the potential importance of electricity storage.

Rapidly improving batteries and other storage technologies will also permit greater system flexibility, a key asset as the share of variable renewables increases. More directly, storage makes possible a transport sector dominated by electric vehicles, enables effective, 24-hour off-grid solar home systems, and supports 100% renewable mini-grids.

Figure 3 Battery electricity storage systems: Installed energy cost reduction potential, 2016-2030



Cost reduction potential in the crucial years until 2030

Total electricity storage capacity could triple in energy terms by 2030. This, in tandem with rapid uptake of renewable power technologies, would suffice to double the share of renewables in the global energy mix in less than a decade and a half. With growing demand for electricity storage from stationary and mobile applications, the total stock of electricity storage capacity could grow from an estimated 4.67 terawatt-hours (TWh) in 2017 to 12-15 TWh by 2030.

The cost reduction potential for new and emerging electricity storage technologies is significant. The total installed cost of a lithium-ion battery could fall a further 54% or more by 2030 in stationary applications (Figure 3). This would open up new economic markets for electricity storage, as well as increase their role in providing flexibility services to the grid.

Other battery storage technologies also offer large cost reduction potential. The total installed cost of "flow batteries" could drop two-thirds by 2030. High-temperature sodium sulphur (NaS) and sodium nickel chloride batteries also will become much more affordable. Their installed cost could fall 56-60% by 2030, at the same time as their performance improves. The installed cost of flywheels could fall 35% by 2030. Compressed air energy storage (CAES), although based on a combination of mature technologies, could see a 17% cost decline by 2030.

DATA AND SOURCES

The above analysis for power generation is based on the latest available data from the IRENA Renewable Cost Database, which encompasses 15 000 utility-scale projects.

For a comprehensive look of electricity costs based on different technologies, see:

IRENA (2018), ***Renewable power generation costs in 2017***, International Renewable Energy Agency, Abu Dhabi.
www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017

IRENA (2017), ***Electricity storage and renewables: Costs and markets to 2030***, International Renewable Energy Agency, Abu Dhabi.
www.irena.org/publications/2017/Oct/Electricity-storage-and-renewables-costs-and-markets

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