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editorial

Adjusting China's sails

A third of the world's installed wind energy capacity is in China, but technological and policy challenges need to be addressed to make the most of the country's wind resources.

In 2015, a record 63 additional gigawatts of wind power were installed worldwide, representing a 22% annual market growth and increasing the global wind power capacity to 433 GW. 145 GW of that is installed in China alone[1], which has huge wind resources particularly in its northern regions (Inner Mongolia, Jilin, Heilongjiang, Gansu, Ningxia and Xinjiang). Still, wind energy plays only a minor role in meeting China's energy demand, and about 70% of China's electricity is generated by coal-fired plants, which consume 4.2 billion tonnes of carbon annually[2]. This coal-dependence makes China the world's largest CO_2 emitter and contributes to degraded air quality in many Chinese cities, resulting in a toll on public health and the environment. Cutting CO_2 emissions by shifting to a greener energy system, with wind energy at the forefront, would address both climate change concerns and local pollution issues. Regardless of which of these is the real drive for China's recent investments in renewable energy, the country pledged at the Paris Climate Conference (COP21) to curb emission from its coal power plants by 60% by 2020, and to peak its overall CO_2 emissions by 2030[2], at which point China hopes to generate 20% of its energy from renewable sources.

In line with these targets, installed capacity for wind power has been steadily increasing in China in the past five years, with 31 GW added last year alone — nearly half the total new global capacity. Chinese wind capacity now dwarfs that of any other country: USA, the runner-up, now has only half of the wind capacity boasted by China, while Germany follows in third position with 45 GW. In the face of these numbers, it is perhaps surprising to find that the USA is still ahead of China in terms of actual electricity generated by wind farms. One might think that this is due to differences in wind resources in the two countries. However, a recent study in *Nature Energy* by Lu, McElroy and colleagues has quantified the relative weight of this and other factors, and found that the wind resource difference is only a minor contribution to China's reduced power production (article no. 16061). Instead, the main culprits are curtailment of wind power, poorer turbine quality and delayed connection to the grid, which all contribute more or less equally to sub-standard wind energy performance in China (article no. 16061).

The trouble is that while China has invested massively in installing more and more turbines, they have not put as much effort into addressing the challenges of connecting these turbines to the electricity distribution grid and using the wind-generated electricity. In 2015, wind power generation in China reached 186 TWh, accounting for 3.3% of total electricity generation[3], but an additional 34 TWh was wasted because it didn't make it onto the grid in the first place. Such wastage makes up the 15% of wind energy that ends up gone with the wind[1]. Other sources suggest curtailment could be up to 20%[4]. These figures are significant, and a growing concern: in 2014, curtailment was at 8%[5].

Wind power is wasted because either there are no facilities to connect the generated electricity to the distribution grid or — where such facilities do exist — grid operators favour coal as it's a cheaper option. Additionally, growth of electricity demand in the country has slowed down due to reduced economic growth. The increasing problem of wind power curtailment led the Chinese government to issue a regulation in November 2015 ordering grid operators to give priority to clean energy over coal, setting a minimum limit of 5% of electricity on the transmission grid that must come from wind, solar or biomass. Then, in March this year the government went a step further to halt investments on new wind farms in its wind-rich northern provinces[5]. This has likely contributed to a 50% drop in clean energy investment in China in the first quarter of 2016 compared with the previous quarter[6].

Moving forward, China necessarily will shift its attention from increasing installed capacity to improving the transmission grid and managing it so that renewables can compete with coal and curtailment is reduced. In this month's issue of *Nature Energy*, a study by Karplus, Zhang and colleagues predicts that by 2030 China could generate up to 2.6 PWh per year from wind (article no. 16086). Because wind resources are intermittent, the electricity generated by wind farms is variable over time, with both short-term changes on an hourly basis, and also longer-term ones over seasons and years. When this electricity is integrated in the power distribution grid, the grid is faced with varying levels of supply that it has to somehow compensate to keep matching its load. This requires flexibility in power generation, which is not particularly suitable for coal-burning plants, but if addressed it could boost power generation to 3.1 PWh, thereby contributing 14% of the country's primary energy (article no. 16086).

In China as elsewhere, the large majority of global installed wind capacity is onshore. While large offshore farms promise to generate more electricity by exploiting greater wind speeds than on land, the high costs for building and maintenance have limited their current presence to a few gigawatts. The design of offshore wind turbines and farms is still a matter of investigation, as issues such as the wake effect are not yet satisfactorily modelled. Increased accuracy in predicting how much power can be generated by offshore farms — and the same is true for those onshore — is greatly needed to foster investor confidence in supporting these expensive projects.

The Global Wind Energy Council forecasts that by 2020, 792 GW of wind power will be installed globally, and almost half of that will be in Asia[1]. Wind energy is a key path for China and other big CO_2 emitters to achieve their pledges of significantly reducing their emissions and to reverse the negative effects on public health. Technological advances in both turbine and farm design as well as smart management of the grid should go hand in hand with political will to keep pushing for a transition to a greener, more sustainable energy system. The challenges ahead are significant, but the pace at which China's renewable energy market is growing brings hope for the future. ❐

References

1. *Global Wind Report* (Global Wind Energy Council, 2015); http://go.nature.com/28LQNUP
2. China has promised to cut emissions from its coal power plants by 60% by 2020. *COP21* (2015); http://go.nature.com/28Q9FWi
3. China's new wind power capacity rises 60%, hits record high. *China Daily* (3 February 2016); http://go.nature.com/28SCDTh
4. China wasted 20 percent of wind power generated in 2015. *Reuters* (17 March 2016); http://go.nature.com/28OlNI3
5. Liu, C. Facing grid constraints, China puts a chill on new wind energy projects. *Inside Climate News* (28 March 2016); http://go.nature.com/28NT5IH
6. China lull behind quiet quarter for global clean energy investment. *Bloomberg* (19 April 2016); http://go.nature.com/28N3C1W