

Study: wind and solar can power most of the United States

Wind, solar, and storage could meet 90–100% of America's electricity needs



Wind turbines and solar panels. Photograph: Alamy

In order to combat climate change, we need to rapidly move from fossil fuel energy to clean, renewable energy. The two energy sources I am most interested in are wind and solar power; however, there are other sources that have great potential.

Some people doubt how much wind and solar can supply to a country's electricity grid. This is a particularly challenging question to answer in part because both solar power and wind power fluctuate in both space and time. We all know solar panels work well during the day, when the sun shines – they don't work so well at night. And wind turbines only send electrons when the wind is blowing.

Fortunately, these two sources of energy fluctuate in ways that complement each other. For instance, solar power generation is highest in the summer and lowest in the winter. Wind power is greatest in the spring and fall. Wind turbines work at night when solar panels are dormant. So, can these complementing variations help balance out the power that the two technologies can provide?

This question was addressed in a very recent paper published in the journal *Energy and Environmental Science*. The author list included Dr. Ken Caldeira, who is extremely well known for his years of work in environmental science and energy.

The authors analysed 36 years of hourly weather data (1980–2015) in the US. They calculated the available wind and solar power over this time period and also included the electrical demand in the US and its variation throughout the year.

With this information, the researchers considered two scenarios.

- ❑ In scenario 1, they imagined wind and solar installations that would be sufficient to supply 100% of the US electrical needs.
- ❑ In the second scenario, the installations would be over-designed; capable of providing 150% of the total U.S. electrical need.

But the authors recognise that just because a solar panel or a wind turbine can provide all our energy, it doesn't mean that will happen in reality. It goes back to the prior discussion that sometimes the wind just doesn't blow, and sometimes the sun isn't shining.

With these two scenarios, the authors then considered different mixes of power, from all solar to all wind. They also included the effect of aggregation area, that is, what sized regions are used to

generate power. Is your power coming from wind and solar in your neighbourhood, your city, your state or your region?

The authors found that with 100% power capacity and no mechanism to store energy, a wind-heavy portfolio is best (about 75% wind, 25% solar) and using large aggregate regions is optimal. It is possible to supply about 75-80% of US electrical needs. If the system were designed with excess capacity (the 150% case), the US could meet about 90% of its needs with wind and solar power.

The authors recognised that sometimes these systems generate too much power to be used. Under this situation, you could store the energy for later use. Imagine a solar panel generating excess energy during the day and able to store that power for night use. Power can be stored in several ways, for example in batteries or by pumping water into elevated tanks and then letting the water fall at night and turn a turbine.

The authors modified their study to allow up to 12 hours of US energy storage. They then found that the 100% capacity system fared even better (about 90% of the country's energy) and the optimal balance was now more solar (approximately 70% solar and 30% wind). For the over-capacity system, the authors found that virtually all the country's power needs could be met with wind, solar, and storage.

This study considered only wind and solar. If other sources, such as hydroelectricity, biofuels, or even nuclear power were added, it would be relatively straightforward to reach 100% clean energy.

Furthermore, people are learning to use energy more wisely, either by using more efficient products or purchasing electricity during off-peak hours. These behavioural changes can also help us reach a 100% clean energy target.

The point is, the use of clean energy to power an entire country (or a group of countries) is achievable. *It's no longer viable to say "we can't."*