New research can help electric utilities account for climate change

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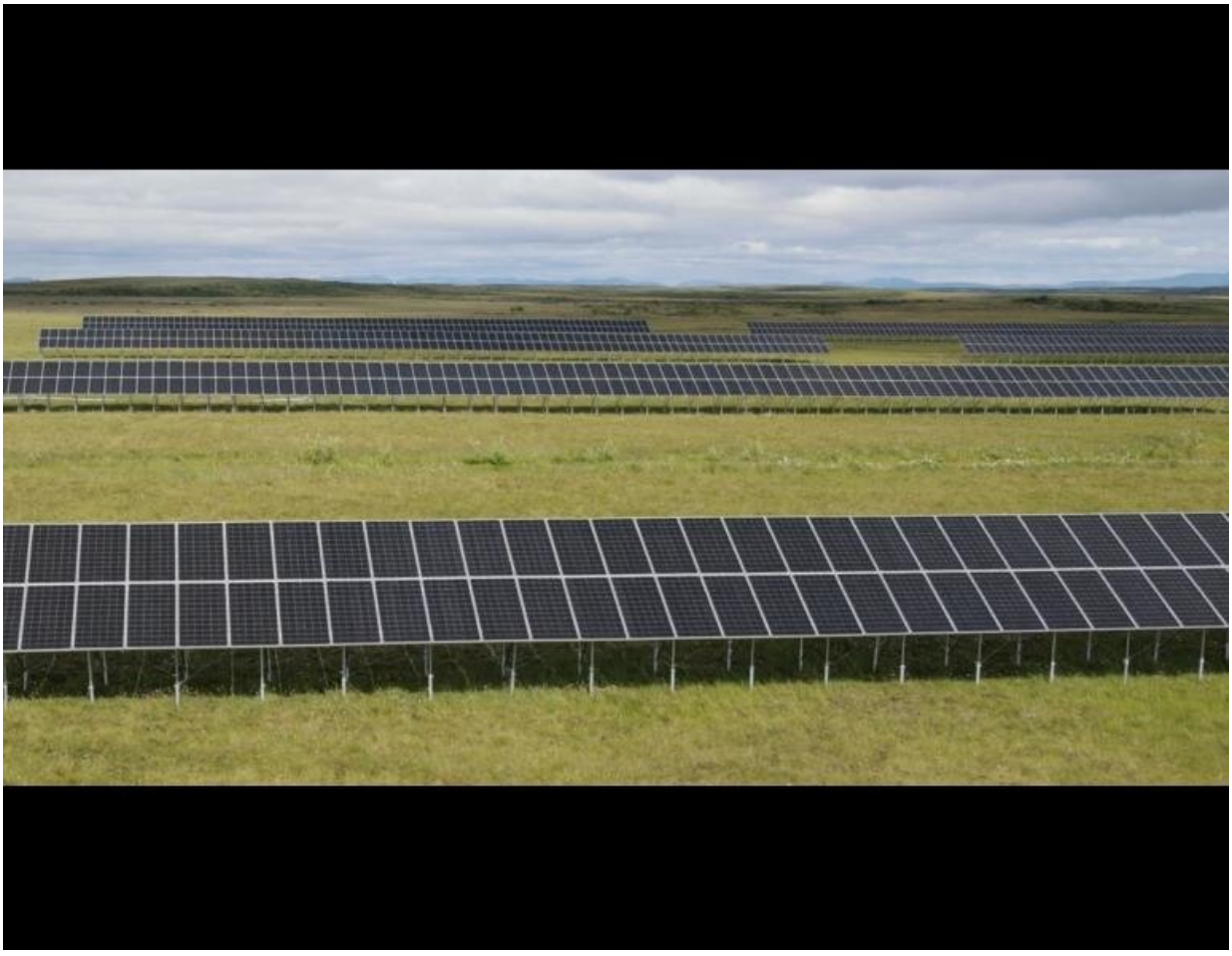

Kotzebue Electric Association's 576-kilowatt solar farm is the largest remote solar farm in Alaska. Credit: Amanda Byrd

Researchers have devised a method to determine the impact of climate change on the supply and variability of local renewable energy.

An increase in unusual weather patterns related to climate change means the demand for power and the availability of solar, hydro and wind energy can all become more variable.

The method by researchers at the University of Alaska Fairbanks Geophysical Institute and in Spain will help local energy planners determine the optimal mix of renewable energy sources and energy storage needs.

The research was published in August in the journal *Land*. Geophysical Institute atmospheric sciences professor Uma Bhatt is the lead author.

"It is important for society to understand the impact of climate change and variability on renewable energy resources in order to design a resilient power system and prepare for the future," Bhatt said.

The researchers studied intermittency, power production and energy storage in the context of historical climate data at two locations: the Alaska city of Cordova in Prince William Sound, which has a subpolar oceanic climate, and Palma de Mallorca, a city on a subtropical Spanish island. The researchers obtained 60 years of climate data for each location.

Wind, solar and hydropower are all susceptible to a climate that is becoming less predictable and producing more extreme weather events. Increased cloud cover could decrease the availability of solar power. Decreased precipitation could reduce the availability of hydropower. Increased winds could increase the availability of wind power.

Without proper planning, power grids risk becoming less reliable as

renewables make up an increasingly larger portion of the supply.

"If you have too high a percentage of high-variability renewable power without appropriate backup power in your system, it actually degrades the system's reliability a lot," said David Newman, a study co-author and physics professor at the UAF Geophysical Institute.

Further complicating the situation, the demand for power changes in unpredictable ways as the weather becomes increasingly variable. Even when demand is normal, a sudden drop in the availability of a renewable source—wind ceasing to turn the turbines, for example—can cause blackouts if a backup source is not in place for immediate use.

"How do you fix it? You have to find a way to remove the variability or to have a way to quickly compensate for it," Newman said.

The easiest and most obvious way is to have fossil fuel-based generators on standby. Of those, generators powered by natural gas can be started fairly quickly when needed. But it's still a fossil fuel product, though cleaner than other fossil fuel sources.

Another, cleaner method is to store excess energy produced by renewable sources during times of normal demand.

Advances in technology have improved grid-scale batteries, which can store excess power that can be distributed for short-term use during a widespread blackout.

Other storage methods include pumped storage hydropower, gravity energy storage, flywheel energy storage and compressed air energy storage. All are fundamentally simple methods and explained by the National Renewable Energy Laboratory.

"This is one of the really exciting areas [of study] right now," Newman said.

Pumped storage hydropower accounts for 95% of all utility-scale energy storage capacity in the United States. Water is pumped from one hydropower reservoir to another at a higher elevation during times of excess power, raising the level of the higher reservoir. That water is released to the generators of the lower reservoir when needed.

Gravity energy storage involves using excess energy to raise massive weights consisting of sand, gravel or rock and leaving the weights suspended. When power is needed, the weights are allowed to fall, with their attached cables turning a generator.

Flywheel energy storage is typically used in small applications and for much shorter energy needs than other storage methods. A motor powers a flywheel, a heavy wheel that spins freely when the motor loses power. The freely spinning wheel turns a generator, which produces electricity for several minutes.

Compressed air energy storage can provide power on a grid-scale for several days. Electricity is used to compress and store air underground, often in salt caverns. When needed, the air is released and heated to expansion to power a generator.

The research papers' authors offer a notable caveat to their work: Climate change is complicated and varies by location, as do the available sources of renewable energy.

"Both climate and energy are interconnected complex systems, and it is important that we educate the next generation to think across disciplines so they are prepared to address the complex problems that are looming," Bhatt said.

More information: Uma S. Bhatt et al, The Potential Impact of Climate Change on the Efficiency and Reliability of Solar, Hydro, and Wind Energy Sources, *Land* (2022). DOI: 10.3390/land11081275