Study shows renewable energy could partially replace diesel fuel to power instruments, provide heat at South Pole

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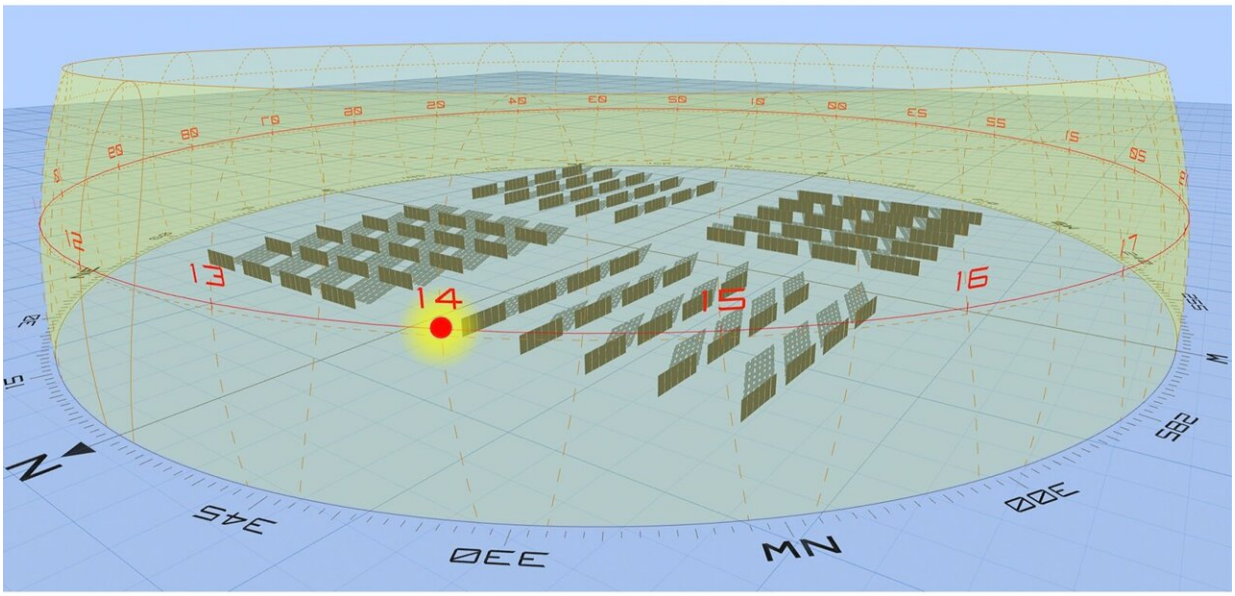

The arrangement of solar panel arrays sketched out in the study. The panels are aligned to catch sunlight along the horizon at virtually any time of day during austral summer. Credit: Argonne National Laboratory and National Renewable Energy Laboratory.)

A recent analysis shows that renewable energy could be a viable

alternative to diesel fuel for science at the South Pole. The analysis deeply explores the feasibility of replacing part of the energy production at the South Pole with renewable sources.

For almost as long as humans have spent time in Antarctica, the continent has been a home for science. One of the research outposts located there is the Amundsen-Scott South Pole Station. The science done there includes studies of climate change and cosmology.

Currently, this site exclusively uses nonrenewable energy sources, specifically diesel fuel, to power the instruments and provide warmth for staff. A recent analysis by scientists at U.S. Department of Energy's (DOE) Argonne National Laboratory and National Renewable Energy Laboratory (NREL) shows that renewable energy could be a viable alternative. Their analysis, published in Renewable and Sustainable Energy Reviews, explores the feasibility of replacing part of the energy production at the South Pole with renewable sources.

"All of the energy at the South Pole currently is generated by diesel fuel and a generator," said Amy Bender, a physicist in Argonne's High Energy Physics division. "We were asking if it is possible to transition to renewables. This study is the beginning of trying to make that case."

Bender, who has spent time working at the South Pole, is the paper's corresponding author. The analysis illustrates the first steps for how renewable energy sources could be implemented at the South Pole, as well as details of what energy could be generated by these sources and the potential carbon savings that this program could enable.

To begin with, according to Ralph Muehleisen, chief building scientist and group manager for Buildings & Industrial Technologies at Argonne, the team wanted to know if using solar energy sources during the austral summer (November-February) would be feasible as a means of

substantially reducing diesel fuel usage at the South Pole.

"Just having diesel as a backup during the summer, you could reduce the carbon footprint," says Muehleisen. "Even if we aren't eliminating the use of diesel completely, being able to avoid having to buy that diesel fuel for the summer cuts back on its use significantly."

Amundsen-Scott South Pole Station. Credit: Amy Bender/Argonne National Laboratory

Sue Babinec, the program lead for stationary storage at Argonne, described the team's focus on the type of energy storage required to make the project possible. She pointed out that renewable energy needs different energy storage than everyday battery applications such as transportation or consumer electronics. Demands specific to the South Pole make the differences even more stark.

"The types of batteries that you need for power with renewable energy don't just have to last for years, they have to provide energy for a very long period of time," she said. "We did a detailed analysis of what type of battery works best depending on whether you're using either solar or wind or both for power."

"When I got into renewables, no one talked about deploying solar in Alaska or in Canada because it was very expensive and it's not very sunny up there," says Nate Blair, a group manager in the Integrated Applications Center at NREL. "A renewable component, paired with existing diesel generators, provides greater reliability and resilience. If one piece breaks, the other components in the system can help get you through until that can get repaired. We see continuing cost declines for solar and wind and batteries into the future."

To complete their study, the team had to compile a substantial amount of data and then crunch the numbers to see the possibilities. Using NREL's Renewable Energy Integration and Optimization software, they concluded that replacing 95% of the diesel fuel needed to supply 170 kW of power at the South Pole station would save approximately $57 million over 15 years, after an initial investment of $9.7 million.

What's more, the time before the investment would pay itself back through fuel cost savings would be just over two years. These results alone make it clear that the concept of replacing nonrenewable energy sources at the South Pole with renewable ones presents a worthy topic for further discussion.

Implementing any such plan will take considerable effort. That includes getting the equipment across the Southern Ocean, then across hundreds of kilometers of icy tundra to the South Pole. Also, the infrastructure would need to be built to make renewable energy use a reality.

As Muehleisen puts it, "The DOE and universities all over the world have been trying to decarbonize our six continents. They're only starting to reach Antarctica, so we are now truly, for the first time, talking about decarbonizing the world." As he sees it, if we can begin to roll back use of nonrenewable energy sources at the last frontier on Earth, where only a few thousand people live and work at any one time, then there is no

reason we can't do it everywhere else.

In addition to Bender, Babinec, Blair and Muehleisen, the paper's authors include Ian Baring-Gould, Xiangkun Li, Dan Olis and Silvana Ovaitt.

More information: Susan Babinec et al, Techno-economic analysis of renewable energy generation at the South Pole, *Renewable and Sustainable Energy Reviews* (2024). DOI: 10.1016/j.rser.2023.114274

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