Bifacial Solar Photovoltaic Panel Performance at High Latitudes

Erin Whitney, Christopher Pike, Daisy Huang, and Dan Manley (Alaska Center for Energy and Power, University of Alaska Fairbanks)
Josh Stein, Olga Lavrova, Jeff Zirzow, Dan Riley, and Abraham Ellis (Sandia National Laboratories)

Background

Solar PV panels are becoming a viable, economic energy source in a number of locations around Alaska to offset high energy costs. The technology is especially attractive due to the lack of moving parts requiring little to no maintenance in extreme, remote conditions.

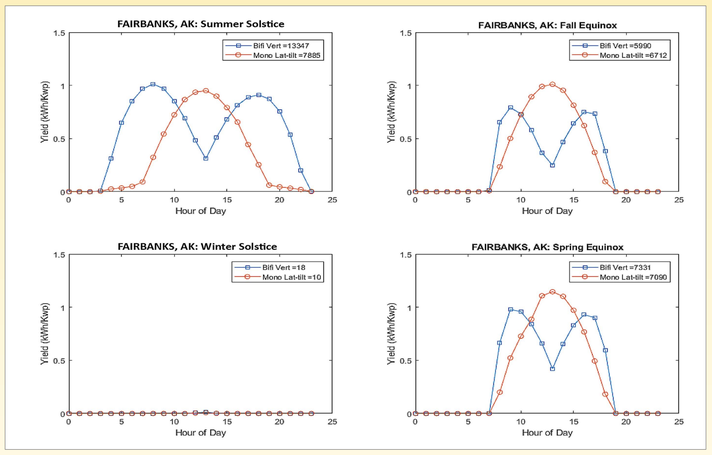
The University of Alaska Fairbanks (UAF) and Sandia National Laboratories recently broke ground on a solar photovoltaic (PV) test site on the UAF campus (~65º North). The goal of the inaugural installation is to characterize performance enhancements of bifacial solar PV panels at high latitudes. Previous studies show bifacial PV panels outperforming monofacial panels by 17-132% (***1***). These enhancements should be even more prominent in Alaska, due albedo effects from snow (***2***) and low temperatures in winter (***3***), as well as large solar azimuth range.

Modeled Performance Predictions *(4)*

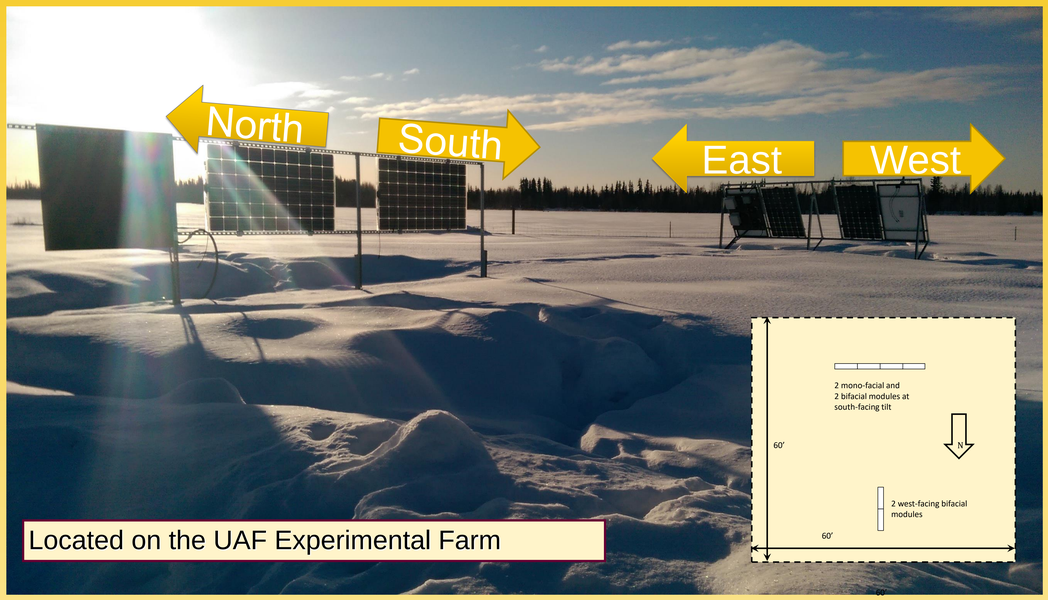
Field measurements on bifacial solar PV panels at Regional Test Centers in New Mexico and Vermont have already shown enhancement over monofacial modules (***1***).

A simple model of bifacial PV performance implemented in Matlab using PVLIB was validated using Sandia National Laboratories Regional Test Center measurements.

Under clear sky conditions in Fairbanks, the model shows that East-West vertical bifacial modules have the potential to produce power earlier and later in day, which may be promising for use in combination with latitude tilt systems and help with integration issues.



Test Site From the Northwest

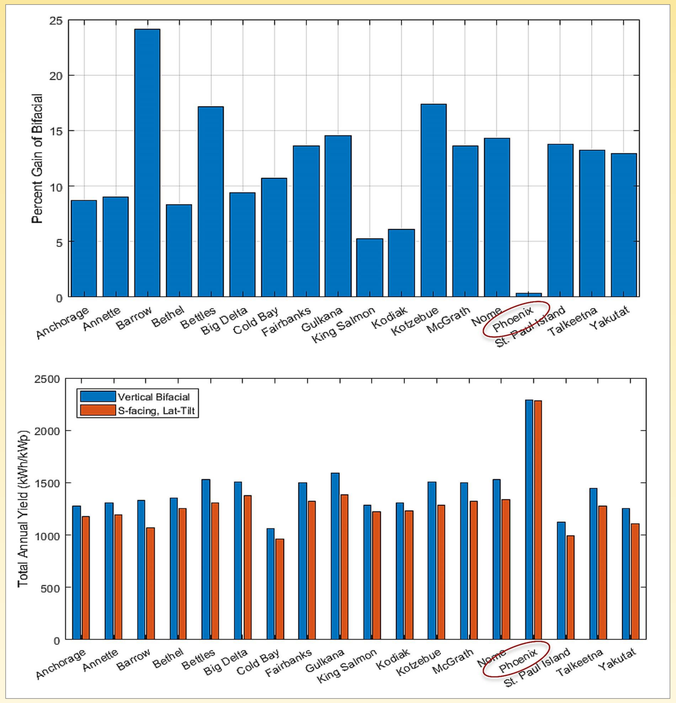


Located on the UAF Experimental Farm

The test site is equipped with Stratasense Gateway current-voltage tracers, Shark meters, and Campbell Scientific dataloggers.

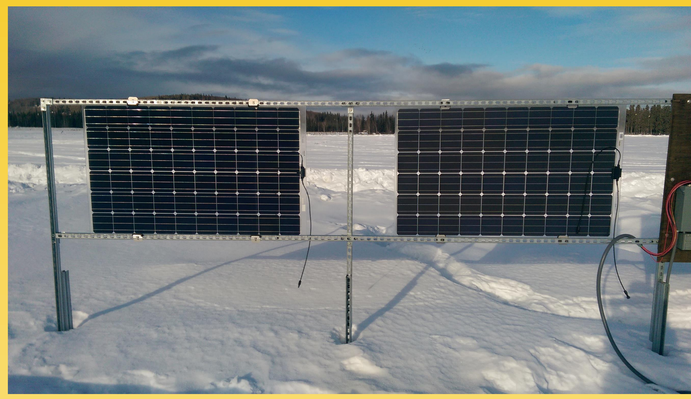
Modeled Annual Yields Across Alaska *(4)*

- East-facing vertical bifacial modules outperform South-facing latitude tilt systems in Alaska.
- Bifacial PV advantages increase with latitude and duration of snow on ground.
- Vertical bifacial PV modules take advantage of a large range in solar azimuths
- Vertical bifacial PV modules collect light from highly reflective snow-covered ground.



This material is based upon work supported by the U.S. Office of Naval Research and the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under Solar Energy Technologies Office (SETO) Agreement Number 30286.

East Side of East and West-Facing Bifacial Solar Panels



Next Steps and Opportunities

Short term:

- Daily recordings of wind, temperature, sky conditions, snow, ice, frost, active precipitation, as well as qualitative data
- Power production from panels
- Collection of current-voltage curves and global horizontal irradiance measurements

Long term (4):

- East-West vertical bifacial PV modules may have advantages over traditional designs, including wider power profiles that better match loads, and increased snow shedding from vertical modules.
- Commercial racking solutions for vertical bifacial modules are not developed, and field layouts to minimize shading needs to be designed.
- Testing standards for bifacial modules are still under development.

References

1. *Stein, Joshua S, et al. "One Year Performance Results for the Prism Solar Installation at the New Mexico Regional Test Center: Field Data from February 15, 2016 - February 14, 2017. 2017, pp. 1–41, One Year Performance Results for the Prism Solar Installation at the New Mexico Regional Test Center: Field Data from February 15, 2016 - February 14, 2017."*
2. *McIntosh, Keith, et al. "Altermatt Lecture: The Solar Spectrum." PV Lighthouse, 27 Mar. 2018, www2.pvlighthouse.com.au/resources/courses/altermatt/The Solar Spectrum/Albedo.aspx.*
3. *Honsberg, Christiana, and Stuart Bowden. "PVEducation." Effect of Temperature | PVEducation, 27 Mar. 2018, www.pveducation.org/pvcdrom/effect-of-temperature.*
4. *Stein, Joshua S. "Solar PV Performance and New Technologies in Northern Latitude Regions," presented at the Rural Energy Conference, April 2018, Fairbanks, Alaska.*