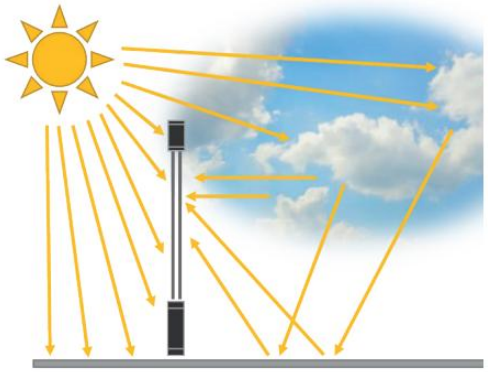
How do bifacial solar modules work?

The vertical bifacial panels are different from conventional fixed-tilted arrays in that they are installed vertically to use light from both sides of the panel to generate power. Each panel is 4 inches wide and occupies only 1-2% of the area within the field, leaving most of the land for crops. Rows are positioned in a North/South direction, with the two sides of the modules facing East and West. This leads to a peak in energy generation during the mid-morning and in evening rather than mid-day. Depending on the bifacial module used, 5-15% higher electricity yields (kWh/kWp) than from fixed-tilt arrays can be achieved.



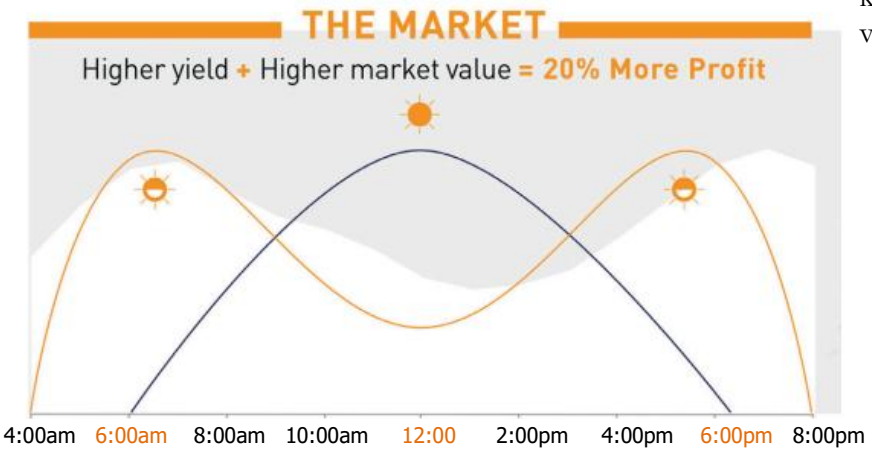
Solar radiation distribution and reflection patterns relative to vertical bifacial panels.

Economics of this Bifacial System

In addition to generating more total energy, vertical bifacial arrays provide higher energy yields in the morning and afternoon. These are the times when energy consumption is particularly high, and the cost of power from the grid is greatest. This results in greater revenues from the array and adds to the income generated from continued ag production.

Bifacial Solar Arrays: Why are they A Win-Win Opportunity?

- Contribute to Vermont's goal to cut greenhouse gas emissions 40% from 1990 levels by 2030.
- Suitable for incorporation into diverse agricultural production systems.
- May generate more energy than conventional fixed arrays.
- A source of extra revenue for farmers.
- Increase renewable energy generation to meet Vermont's goal to obtain 90% of its energy from renewable sources by 2050.



Daily cycle of solar power:
orange = bifacial vertical panel; blue = conventional fixed-tilted array.

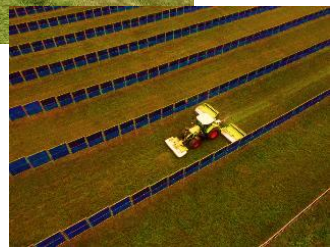
UVM's Proposed Research

Permitting is underway and once approved, three rows of vertical solar modules will be installed and are projected to be in operation by March 2026. Over subsequent years, vegetable crops will be grown outside the panels and at various distances from the panels within the array. Data on agronomic suitability for growing within the array will be collected, including microenvironmental conditions, as will power generation potential and the economic costs and benefits of this new agrivoltaic system. Results from this work will provide farmers, energy specialists, policy makers and researchers with key information about the potential of this vertical agrivoltaic innovation.

Bifacial solar modules on vertical racking designed by Norwich Technologies with engineering students from Norwich University that will be trialed at the UVM site.

Potential Uses of Vertical Solar Arrays

The vertical bifacial system we will use was designed by Norwich Technologies and is similar to ones used in Europe. In Europe they have been used for multiple applications, including as fencing to enclose livestock, including cows and chickens. They are also installed in areas of hay and forage production.



Because the panels are raised 3 ft above the ground, and all wiring associated with the system are held above the panel, land close to the array is available for crop production. At UVM, we will test the suitability of growing high-value vegetables and herbs within the array. This has not been studied extensively but is applicable to Vermont agroecosystems.

What about winter?

Vertical solar panels may be ideal for Vermont, where heavy snow falls over the winter are common.

Unlike for conventional fixed-tilted arrays, snow will not build up to obstruct solar generation. In addition, power generation may be enhanced when snow covers the ground. Sunlight reflects off the snow and back to the vertical panels (snow albedo), increasing energy generation.

Want to learn more about our agrivoltaics research?

Contact:

Bruce L. Parker, bparker@uvm.edu
Margaret Skinner, mskinner@uvm.edu
Laura Eckman, leckman@uvm.edu

https://site.uvm.edu/agrivoltaics/

The Entomology Research Laboratory
661 Spear Street, Burlington, VT 05405
Tel: 802-656-5440

The University of Vermont

NORWICH TECHNOLOGIES

Troy McBride
15 Railroad Row
White River Jct., VT 05001
Tel: 802-738-8059

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Vertical Bifacial Solar Initiative at the University of Vermont (UVM)

An Innovative System for the Future

Vertical solar array in a European agrivoltaics system.

Over 90% of US farmers are ranked as "small" by the USDA, generating less than $350,000 gross income annually. They are the backbone of local fresh food production in our country. To remain in business, they must devise innovative ways to generate revenue and support their agrarian way of life. **Agrivoltaics**—the combination of solar power production and agriculture—offers opportunities for farmers to efficiently use their crop land and bring in additional income from solar. A vertical solar panel occupies ≈4 inches of land, leaving 30 ft between the rows to grow crops while allowing access with large farm equipment. They are suitable for both field production and high-value specialty horticultural crops. Vertical systems are used widely in Europe but not in the US.

UVM is partnering with Norwich Technologies, a local solar company, to establish a demonstration vertical bifacial array (50kW capacity) at the UVM Horticultural Research Center to assess vegetable cultivation around the array. This project will show how a vertical agrivoltaic system can maximize on sustainable agricultural production of high-value crops and electricity from a renewable source.