Photo by Dennis Schroeder, NREL 48095

Dynamic Photovoltaic Cell Technology Transforms Windows Into Clean Energy Producers

NREL Creates Self-Tinting Solar Window with Perovskite Technologies

Market Challenge: Combining Good Windows and Good Solar Cells

Buildings are the largest consumers of energy and would benefit from an increase in on-site photovoltaic (PV) generation, offering economic benefits and grid capacity. Although buildings often have limited rooftop space for PV generation, they usually have ample surface area dedicated to windows.

Attempting to take advantage of all that surface area, solar windows have been around for decades, but their solar cells were only semi-transparent or fully opaque, making the windows less functional.

Solution: Transparent, Self-Tinting Solar Windows

NREL researchers have cracked the code with SwitchGlaze, a fully transparent photovoltaic window system with high solar efficiency. Relying on a thin coating of a perovskite material, SwitchGlaze transforms from transparent to tinted in response to heat, generating energy while also potentially lowering summertime indoor cooling costs.

SwitchGlaze solar cell layers could be added to existing high-performance windows at a small incremental cost. It is expected that windows using SwitchGlaze will deliver a 4- to 6-year return on investment from solar energy generation and energy efficiency savings.

Potential Growth: Commercial, Residential, and Automotive Applications

The technology can be commercialized in future applications, including:

- Vehicle windows and sunroofs that extend electric battery ranges
- Self-tinting, self-powered, electronically controlled skylights with greater surface area for generation
- Strategic glazing on commercial buildings with flat glass coatings.

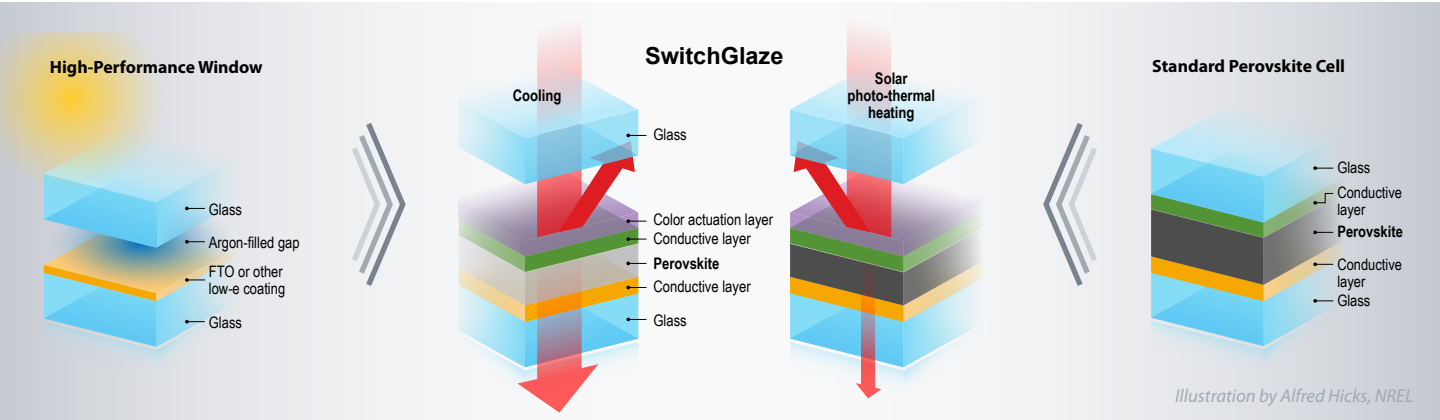
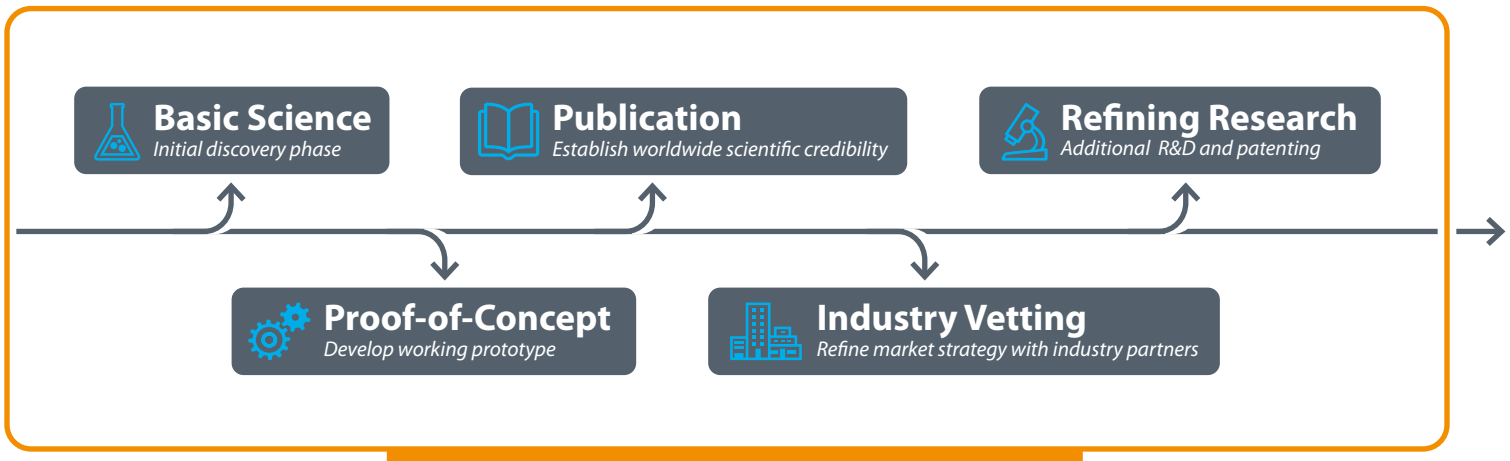


Illustration by Alfred Hicks, NREL

How It Works: SwitchGlaze features a perovskite solar cell while mirroring the traditional construction of a high-performance window for its overall construction. This hybrid design allows for manufacturing on conventional window production lines.



World-class R&D from concept to commercialization.
NREL brings technologies from basic science research to market.

Scientific Research to Market Strategy

SwitchGlaze technology was developed entirely at NREL from basic science research to a proof-of-concept device. Our laboratory leveraged resources, including:

Scientific innovation and expertise. A cross-disciplinary research team with Ph.D.s in solar photophysics, materials science, and chemistry conducted SwitchGlaze R&D at NREL.

Visibility and credibility. NREL researchers published a proof-of-concept paper in *Nature Communications,* showing a solar power conversion efficiency of 11.3% and establishing scientific credibility for the technology.

A path to commercialization success. NREL honed SwitchGlaze's path to commercialization through Energy I-Corps, a program that pairs researchers with industry to identify customer needs and develop viable routes to market.

Refining research. NREL is performing research to perfect the technology with 12 patents obtained or submitted.

Partner With Us:

Learn how NREL can collaborate with your team to jumpstart your concept. Contact **tech.partnerships@nrel.gov**.

Why NREL?

NREL's world-class researchers and facilities enable us to catalyze cutting-edge innovations while lowering industry risk for new technology investment. We enable industry, government, research, and nonprofit partners to conceive innovative ideas and develop concepts into prototypes. NREL can help you bring your idea to market. Here's why:

We are results-driven: Backed by 42 years of achievement, NREL leads the way in helping to meet the growing demand for energy innovation. NREL is a neutral, trusted technical resource.

We are relevant: With more than 750 active partnership agreements, including small and large businesses; nonprofits; educational institutions; and local, state, and federal government, NREL is helping partners solve their energy challenges.

We are focused: NREL is America's only federal laboratory entirely dedicated to research, development, commercialization, and deployment of renewable energy and energy efficiency technologies.

We have the resources: NREL's distinctive expertise, state-of-the-art laboratories, and testing and partnering facilities for developing commercially viable products can help you.

We have the track record: We have a stronger history of conducting industry partner-driven R&D and transitioning technology to market than any other national lab.

NREL Transforming ENERGY

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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