Inflatable Design Could Make Solar Energy More Affordable

Florida State University

In 1973, Ian Winger experienced a harsh reality that would stick with him for the next 40 years. He had just graduated from high school and was starting to enjoy the freedom of owning a car. But that year, a stumbling block wedged itself between Winger and the open road: the energy crisis of 1973.

An OPEC (Organization of the Petroleum Exporting Countries) embargo triggered a four-fold increase in world oil prices, and fuel became extremely scarce in U.S. communities. Some gas stations closed temporarily, and consumers had to wait in long lines just for the privilege of buying a few gallons.

At the time, Winger thought: "We've got to do something. This is really bad." By the '80s, the energy crisis had abated, and the national zeitgeist suggested that the energy worries were over. At least that's how it seemed to Winger, now a scientific research specialist at Florida State University (FSU): "And I thought, 'No, not everything is OK again.'"

To Winger, those gas lines signified more than a temporary annoyance. They reflected a larger problem — over-reliance on fossil fuels. Decades later, he's played an instrumental role in an energy alternative. Working with an FSU

colleague, Sean Barton, Ph.D., Winger has helped design a solar collection device called the Solar Sausage. Commercialized by Florida-based Sunnyland Solar, the product harnesses the sun's energy with an innovative, low-cost design that could spur notable advances in renewable energy efforts.

A Lightbulb Moment

Even though he wanted to make a dent in the energy problem, Winger didn't immediately believe he was the right guy to do it. "You think, 'Well, a lot of people know a lot more than I do,'" says Winger. "Well, over time, you learn there are a lot of things that just haven't been tried."

He always had a do-it-yourself ethos, coupled with an acute need to understand how stuff works. As a high school student, he built his own electric bass. While earning a bachelor's degree in electrical engineering, he worked his way through college by learning the machine shop trade. That experience made him a good fit for his current FSU job, which includes making equipment for the physics department.

Before Winger came up with the idea that would become the Solar Sausage, he worked on designing a helium-inflated kite that would harness wind energy. He made the kites out of a type of mylar, similar to the material used for special-occasion balloons or the inside of chip bags.

Winger came up with another use for mylar during one oppressive summer day in 2005, repairing the roof of a disadvantaged homeowner. His engineering brain kept remembering how much sunlight hits the surface of the Earth at noon on a cloudless day: about 1,000 watts per square meter. "It's a tremendous amount of energy," he says. "And when you're on that roof, you really get a good feeling of what that is."

During the hour-long ride home, he thought about the relentless heat that day. And he thought about mylar. Winger told himself, "There's got to be an easy configuration to concentrate sunlight so you can do stuff with it." He brainstormed different configurations in his head during that drive home, but didn't start actively working on the project until a year later, when he teamed up with Sean Barton, a grad student at the time. "He was one of those physics whiz kids," says Winger.

Like Winger, Barton knew a few things about mylar — he had used it to make inflatable vacuum chambers. They discovered that mylar could also provide an inexpensive way to create a solar concentrator.

Creative Problem Solving Slashes Costs

To understand why that's significant, it helps to know what a solar concentrator does. Solar concentrators are parabolic mirrors. Some are dish-shaped mirrors, and when the sunlight reflects off the curved shape, it focuses those rays to a single point. But most solar concentrators use trough-shaped mirrors, which focuses the sunlight along a line. That sunlight can be concentrated on photovoltaic cells. It can also be used for thermal energy collection, where a fluid-filled pipe becomes a heat source that powers an engine (such as a steam turbine).

Here's the problem with conventional solar concentrators: They're expensive. The reflective surface is made of glass, and that can cost about $30 per square meter. Plus, heavy structures are needed to support those mirrors, and they carry a hefty price tag.

Winger and Barton tackled those issues by designing a trough-style solar concentrator that doesn't use glass. The basic design features a transparent sausage-shaped inflatable with a sheet of mylar inside, cutting lengthwise through the middle. That creates two separate chambers, which allows changes in air pressure to adjust the curve of

the mylar sheet. And mylar costs about 50 cents per square meter — compared to the cost of the shaped glass used in conventional solar concentrators, that's a 98 percent savings per square meter.

> *Because the Solar Sausage is inflatable and creates its own rigid structure, it doesn't need expensive support structures. "All you have to do is secure it on both ends. If you keep it tightly inflated, it will handle very high winds," says Winger.*

Shining a Light on Commercial Viability

The initial design wasn't much bigger than a mylar party balloon — about a foot and a half long and 8 inches in diameter. Winger and Barton expanded on that, building a 12-foot long model and installing it on the roof of the FSU physics building. They soon realized it had potential. In 2009, Winger requested a $7,500 grant from the FSU Research Foundation Grant Assistance Program to develop a proof-of-concept version. But Winger didn't receive the amount he requested. Instead, the program gave him $15,000. "That's the only GAP application where we've gone back and said, 'You need more money,'" says Jack Sams, director of licensing at FSU's Office of IP Development and Commercialization. The grant helped ensure that Winger's idea could move beyond the confines of the physics building roof, and the university's technology transfer office (TTO) helped facilitate a patent application for the device (in August 2012, patent #8,235,035 was issued). In November 2009, a Florida-based company called Basic Concepts signed a licensing agreement for the innovation, hoping to win a government contract to develop a solar thermal facility.

That facility proposal didn't pan out. But Winger's invention had already caught the attention of another local entrepreneur — J.T. Burnette, founder of Sunnyland Solar. "We were very interested in having an economic impact on the local community, with commercialization of technology out of the university," says Burnette. He also saw a chance to achieve the unfulfilled promise of solar energy: grid parity. With the Solar Sausage, Burnette's ultimate goal is to produce renewable energy that doesn't cost any more than power already available on the grid.

To that end, Burnette bought Basic Concepts in November 2010, acquiring the license for the Solar Sausage. The TTO played a vital part along that path, says Burnette. "They were instrumental. With the help of Jack Sams, we were able to whip up a licensing agreement in less than 30 days," he says.

"They're very interested in progressively pursuing people who want to commercialize and invest in technology." Kim Rivers, principal of Florida-based Inkbridge, assisted with financial transactions that helped fund commercialization of the technology. In addition, FSU helped obtain a $50,000 grant from the Florida Energy Systems Consortium to provide research support for the design effort. To further the Solar Sausage design, Burnette contracted with Barton to aid his company's development team.

Burnette wanted the Solar Sausage to concentrate light on photovoltaic cells, which required some alterations — and Winger was impressed with the entrepreneur's fast-paced approach to problem solving. "To me, when things are developed, it's a very incremental process," says Winger. "But when J.T. saw it, he just went gangbusters."

That fits with Burnette's overarching business philosophy: Hurry up and mess up. "The sooner we make mistakes, the sooner we can correct those problems," says Burnette.

His company worked with DuPont to develop a special type of UV-resistant mylar for the Solar Sausage. DuPont also helped sort out one of the invention's greatest challenges — namely, how to attach the sheet of mylar. The current Solar Sausage design is a 6-foot diameter, 50-foot long inflatable, which puts significant pressure on the seams. "I think we went through 40 different bonding materials to finally come up with an adhesive that worked with mylar,"

says Burnette. "That took about six months."

To collect data for ongoing improvements in the technology, there are now three separate Solar Sausage farms set up in northern Florida. Collectively, they cover an area about the size of 35 U.S. football fields, and contain about 2,600 Solar Sausages. Each one is suspended about a foot off the ground. "There's more to this than just how they collect and concentrate sunlight," Burnette says. "It's how they interact with the environment."

Sunnyland Solar hasn't sold any Solar Sausages yet, and the Solar Sausage farms won't produce energy for a few more months. That's because there's an important component that needs to be tweaked a bit more: the photovoltaic cells (where the Solar Sausages will concentrate the reflected sunlight). Although grid parity is the long-term goal, Burnette does have an interim goal in mind. In the next 24 months, he'd like to reduce the cost of solar production by 20 percent. "We may also look at licensing the technology for consumer products, such as a solar hot-water heater for your pool," says Burnette.

Basking in the Glow of Solar's Potential

Burnette is a savvy entrepreneur — he's started more than 14 businesses ranging from an information technology company to a boutique hotel. But with the Solar Sausage, he sees something more than a market opportunity.

"This is a renewable source that can service very remote communities, so that's also very exciting to us," says Burnette. Locally, the company is already helping the economy. So far, 60 jobs have been created around the Solar Sausage (including Sunnyland Solar, as well as its suppliers). Burnette says that job number could increase to 500 during the next few years.

Another added benefit of the device: Most of the materials it uses can be recycled. And unlike solar concentrators made of shaped glass, the Solar Sausage transports easily. "You can fold them up and stack them on pallets, and inflate them onsite and install there," says Winger. That makes the devices ideal for water purification or providing electricity in isolated areas. "To me, this is really for developing nations, more than anything else," says Winger.

It's one more way the Solar Sausage could help feed the world's growing appetite for energy.

For more information about this technology, watch this video.

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