Solar Roadways: The Future We've Been Looking For

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Abstract

Electrical engineer Scott Brusaw and his wife Julie have a dream to pave our freeways with solar panels to meet our increasing energy needs and reduce our carbon footprint. By substituting solar cells for the asphalt of our highways, playgrounds and parking lots, our world could be powered entirely by the sun. The concept of solar roadways provides plenty of technical challenges that will need to be hurdled, but the promise of unlimited clean energy, along with safer, smarter roads is already driving the cells into production.

Introduction

Envision a network of city streets, plazas and pathways that begin to glow as the sky grows dark. With an array of LED bulbs integrated into each solar road panel – as seen in Figure 1 – sidewalks and parks paved with the cells would generate electricity by day and illuminate your way at night. The same LED's could be used to display messages that warn drivers of weather conditions, road obstructions and accidents. These solar panels promise an entire infrastructure that can think and communicate with drivers in real time, providing live traffic intelligence that was never before attainable. The road could send signals to cars that inform drivers of traffic conditions and suggest alternate routes; commutes would be faster and safer than ever before.

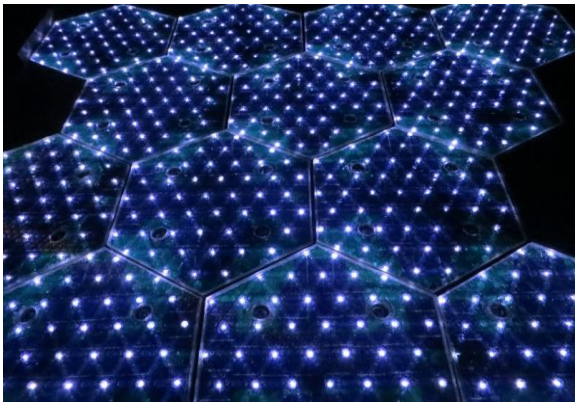

Figure 1: LED's illuminate solar road panels at night

Solar road panels would allow for smart highways and a grid of city streets that looks pulled straight from Joseph Kosinski's *Tron*.

But the reach of these panels transcends brighter, smarter streets. In short, our modern cities could be entirely powered by the sun. Parking lots become solar farms and our country's vast network of 28,000 square miles of road would serve as our new and improved electric grid [2]. Electric vehicles would boast an infinite range, charging as they drive in a process known as electromagnetic induction [5]. And, energy intensive industries and buildings would all become emission free, leaving the air as clean as the Alaskan bush – even in the heart of downtown. All of this is our future if Scott and Julie Brusaw have their way.

Over the course of ten years, the Brusaws have developed special solar road cells, as seen in Figure 2, that collect the sun's energy while being strong and rugged enough to survive constant overhead car traffic, changing weather conditions, and even the occasional flipped semi-truck. These panels have the potential to power our cities cutting our carbon footprint significantly while upgrading our antiquated infrastructure.

Figure 2: The Brusaw's installing solar road panels in a driveway

The Innovation

Solar panels are by no means a new technology, with the earliest designs hitting the markets back in 1955 [6]. But there are many reasons why we do not presently drive on solar panels to work. For one, solar panels by themselves are made of delicate, brittle silicon wafers – a material not exactly designed to survive high impact use or car traffic. To make solar roadways feasible, the Brusaws had to meet up with structural engineers from the University of Idaho to create a transparent durable case for the solar cells from recycled bottles and glass. The result was a clear hexagonal box constructed of bullet proof glass strong enough to support up to 250,000 lbs. [2]. As Figure 3 shows, the surface has raised bumps that provide traction for the car's tires even when wet, yet do not add vibration when a car is in motion. The panels are installed in succession and lock into place to form a honeycomb-like array, as shown in Figure 1. According to the Brusaws, potholes should be a thing of the past with these cells in place, since they are far more impact resistant than asphalt and will hold up better in rain and snow. If a cell ever does get damaged, other cells around it will immediately inform the closest municipality and it can be quickly removed and replaced, weighing in at just 110 lbs. per panel [2]. Their proprietary strong box gives delicate solar panels a serious armor upgrade making these panels the obvious choice over asphalt from a structural point of view.

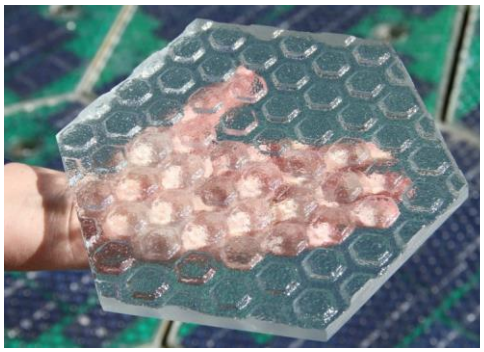

Figure 3: Bullet proof glass used in panels

Other Features

The case itself though can house far more than just a solar cell, making it a blank template for a list of other devices that could end up under our streets and highways creating a

new generation of smart infrastructure. In cold regions where snow and ice can accumulate on the roads, heating elements could be placed in the panels. People would no longer need to shovel their driveways to get their cars, nor would snowplows be required to keep roads clear. LEDs in the cells could be used to light up sidewalks, park pathways and plazas, making these safe communal spaces even at night. These same LEDs paired with a microprocessor, also in the cell, could alert drivers of road traffic conditions in live time. As shown in *Figure 4* by the yellow writing on the pavement, the road will tell a driver to slow down if conditions are wet, or if as much as a deer steps onto the panels. The roads could even speak directly with a car's on board processors informing a driver to take an alternate route if the there is an accident up ahead or if traffic is simply congested. At any given moment, the streets should be safer and traffic should flow faster because of the intricate network of communication that can take place between the road and its vehicles.

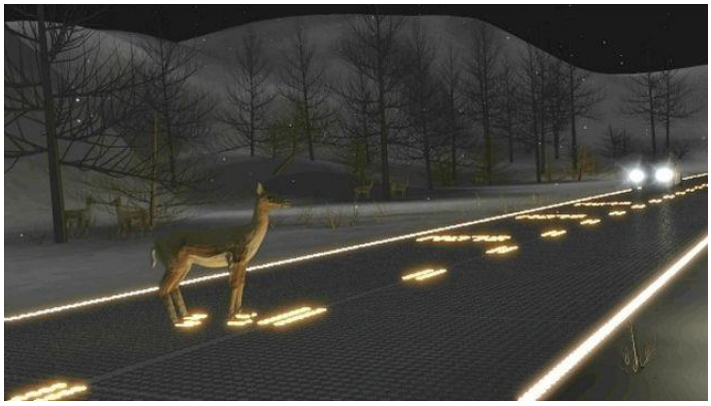

Figure 4: Warning appears on road to alert driver

The Promising Future of the Technology

The prospects are even more promising when looking at the long term. By turning the freeways into solar generators, the power grid itself can be redefined. Widespread blackouts would be almost impossible since electricity would be provided by a network of cells rather than by centralized and damage prone power plants [2]. Telephone poles and overhead electrical wires, which mar landscape vistas and become dangerous during wind and rainstorms, could be taken out of the sky and routed through an easily accessible underground housing found at the

shoulder of all solar roadways – called a cable corridor; see Figure 5. With electricity so plentiful and accessible, electric vehicles would become as practical as ever and through the rise of local energy production, America would feel an unprecedented freedom from foreign oil.

Figure 5: Mr. Brusaw working on a cable corridor

With energy being produced at every square inch of pavement, charging stations for electric vehicles could be placed at any street corner, parking lot or gas station, extending the range of electric vehicles to surpass any gas powered counterpart. Plans are already under way to enable the road cells to charge vehicles through induction as they drive overhead [5]. If implemented, our kids will one day laugh at the idea that we once had to sit at a gas station for minutes waiting for our cars to fuel before carrying on our way. With exhaust producing cars out of the equation, the air would breathe deep and clean and our carbon footprint would start to disappear. If solar roadways were integrated throughout the nation, the United States' power appetite would be satisfied entirely by clean energy.

Where the Project is Now

With the stakes as high as endless clean energy, the project has already gained momentum on crowd funding sites. In 2009, the US Federal Highway Administration awarded the Brusaws several contracts to further their concept [1]. They developed a prototype of their solar road cells and started what has now become the most successful Idiegogo campaign of all time, raising over $2 million in just a month and a half, with money still flowing in at a rate of $10,000 an hour [1]. Scott and Julie Brusaw have already paved a parking lot outside their engineering shop in Sagle, Idaho with the cells, which measures 12' x 12' and generates 3600

Watts of power [2]. As a reference, in 2012 the average American home used energy at a mere rate of 1250 Watts [4]. The Brusaws already have several pre-orders by people who want their driveways paved with the solar road cells. With the money they receive from the campaign, the Brusaws hope to expand their work into production mode and implement the panels in a public parking lot that will serve to test the technology against real world conditions. The Brusaws have shown that they are not just dreamers; they are taking steps every day to bring their vision to our streets. Their product is already powering their lab in Idaho.

Foreseeable Problems

Among all of the praise and hope the Brusaw couple garners for their vision, there are some foreseeable technical hurdles that will have to be overcome to make these solar bricks ready for highway use. The main problems with solar roadways are cost, energy storage and traction [7]. To pave every road in the US is estimated to cost around $56 trillion – 20 times the United States' annual budget [2]. This is a massive initial cost, but it must not be overlooked that these are also a monetary investment. It should take about 22 years for the panels to pay for themselves – something regular asphalt would never do [3]. As production costs come down even further with better manufacturing techniques, the break-even time could come down significantly further. As for energy storage, there currently are not any efficient methods for transporting electricity over long distances, so electricity generated far from where it will eventually be used is not very practical [2]. And batteries have too small of a storage capacity to be practical for use in solar applications. New energy storage techniques and technologies will likely be needed before widespread use of solar roadways becomes economical. Lastly, the traction of the tiles is not yet proven in high speed situations when conditions are wet. Since

providing the cars' tires with grip is one of the most important criteria a road must meet, it must be thoroughly tested before people risk their lives driving on it. .

Solutions and Conclusions

There are, however, a couple of other options that would dismiss the traction and energy storage problems entirely. The technology might first be best fit in parking lots, playgrounds, driveways and plazas. In these locations, high speed traction is not a problem and they would be excellent beds for testing the longevity of the panels' surfaces and other internal hardware. Also, by putting the cells in populated areas, where one would find plazas, parking lots, driveways and playgrounds, the electricity generated by the photovoltaic cells could flow immediately into the power grid, avoiding heavy power losses. These public places would furthermore put the technology on widespread display, in locations where people could stop to look and be curious about them. Focusing on these public places would garner the interest of the public and media, which is integral to continue funding and further research on the tiles to make them ready for real high speed motor vehicles.

Although there are some technical challenges that still lay in the way of mass production of these solar road panels, it is still a promising technology that can be pushed forward today. Putting the panels in outdoor city plazas, such as LA Live, would provide a perfect template to promote the technology in a place where it will get plenty of attention. The panels would bring good publicity to any city, school or home that installs them, for solar is a clean energy. The break-even time is no worse then what standard roof-mounted solar panels already offer, so the technology has plenty of space in the commercial and residential markets. It will be fascinating to see where the Brusaws take this technology next; the future is truly bright if solar roads light the way.

Works Cited

[1] McFarland, Matt. "The campaign to pave American roads with solar panels just passed a whopping $2 million in donations." *Washington Post*. The Washington Post, 9 June 2014. Web. 12 June 2014. <http://www.washingtonpost.com/blogs/innovations/wp/2014/06/09/the-campaign-to-pave-american-roads-with-solar-panels-just-passed-a-whopping-2-million-in-donations/>.

[2] Nguyen, Tuan. "Forget roofs, are solar roads the next big thing?." *Washington Post*. The Washington Post, 20 May 2014. Web. 12 June 2014. <http://www.washingtonpost.com/blogs/innovations/wp/2014/05/20/forget-roofs-are-solar-roads-the-next-big-thing/>.

[3] "Introduction." *Solar Roadways - A Real Solution*. N.p., n.d. Web. 12 June 2014. <http://www.solarroadways.com/intro.shtml>.

[4] "How much electricity does an American home use?" *U.S. Energy Information Administration*. N.p., n.d. Web. 11 June 2014. <http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3>.

[5] Belfiore, Michael. "We Could Build a Solar-Powered Roadway—But Will We?."*Popular Mechanics*. N.p., 11 June 2014. Web. 11 June 2014. <http://www.popularmechanics.com/technology/engineering/infrastructure/we-could-build-a-solar-powered-roadway-but-will-we-16879565>.

[6] "Timeline of solar cells." *Wikipedia*. Wikimedia Foundation, 6 Sept. 2014. Web. 13 June 2014. <http://en.wikipedia.org/wiki/Timeline_of_

[7] Thunderf00t. (2014 May 31). “Solar FREAKIN Roadways, are they real?” [Video File] <https://m.youtube.com/watch?v=H901KdXgHs4>