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How New Technology Makes Solar Power Greener and More Affordable

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Renewable energy development is critical to help mitigate the impacts of climate change. Wind, hydroelectric, tidal, geothermal, and solar energy are promising ways to meet growing energy demands without the carbon footprint associated with traditional fossil fuel sources. However, research shows that pluses and minuses must be balanced. Although the energy produced by the new sources is green, the process of manufacturing renewable energy technologies results in substantial greenhouse gas emissions. In order to move toward more fully green energy production, new production technologies and materials are needed — and funding for these projects must garner public support. I am part of a team researching one promising new approach.

The Costs of Producing Solar Power

Solar power in the United States has only recently transitioned from the fringe of energy production into serving as a core method in a well-established nation-wide market. Both policy changes and increasingly low-cost manufacturing methods have driven costs down almost one hundredfold, resulting in a massive increase in solar panel installations. Solar power currently supports about 11 million American homes and accounts for one-third of newly installed energy generation capabilities in the United States. Solar cell power has reached technological maturity, and the industry has a well-established understanding of how to make efficient solar cells.

The major hurdle now involves scaling up the industry. Yet, as such upscaling occurs, policymakers and industry leaders must think about the carbon emissions generated by this new industry and consider how they can be reduced. The solar energy industry must do more than turn out more panels and cells to move towards a more renewable future. It must make manufacturing advances and consider new material choices.

Silicon is currently the active material in most solar cells, but silicon for solar cells must be very high quality and, as a result, the production of the raw materials requires a manufacturing process that is energy-intensive, high-pressure, and high-temperature. Only so much can be done to reduce this footprint in the manufacturing requirements for silicon. Consequently, alternative or complementary materials need to be developed.

As this example suggests, innovators must look at the greenhouse gas emissions throughout the entirety of a product supply chain. Only such a holistic perspective can reveal the “real” impact of each energy source. Yes, the electricity produced from solar panels is 100% carbon emission free, but the processes to grow the silicon, ship the solar cell, and install that cell on a rooftop is not. Current silicon-based solar cells produce about 17-times less greenhouse gases than coal, but four-times more than nuclear power over the entire lifetime of the technologies. Other common solar materials, such as gallium arsenide or cadmium telluride, require

expensive and rare materials to manufacture and therefore are not well-suited to sustain industrial-scale energy production. Overall, solar power is a cleaner energy source than any fossil fuel, but it is not the cleanest energy production option currently available.

Support for Energy Research

Public support and funding for energy research are critical to achieving the technological breakthroughs necessary for a new national system of renewable energy production. This has been made painfully clear in the wake of the Trump administration's threats to defund agencies like the Department of Energy, National Science Foundation, or National Institutes of Health. The research urgently needed for creating more sustainable materials and systems, requires extensive resources, researchers, and time.

As university labs lose and cut funding due to unstable funding sources, the private sector must take on more of this research, diverting some resources from the direct output. Private sector research on sustainable materials is driven by return on investment, and this limits the private sector's ability to spend time and resources on more than incremental improvements. This constraint on private sector efforts is why publicly funded research is essential. The country must maintain a balance between the pragmatic approach of private industry and visionary goals of public research. Both sectors must work in concert to develop the next generation of sustainable materials.

Developing Truly Green New Materials

With public support for energy research, researchers using that funding must work along with those in the private sector to double down on developing and piloting sustainable materials. For the past five years, I have been researching a cheap and abundant material that can perform as well, if not better, than traditional solar cell materials. Such materials are called *perovskites* — and they have a few advantages over traditional solar cell materials that can make this green energy sector even greener. Perovskites require significantly less material to produce the same amount of solar power, making them light and easy to handle. And they can be produced on flexible foundations to be used in non-flat spaces. In other words, these materials can be installed not just on rooftops but can also be wrapped around a building or draped onto a restaurant awning, significantly increasing the number of their potential uses.

Perovskite solar cell production removes the most energy-intensive process in making silicon solar cells, specifically the growing and cutting of the silicon. The economic viability of perovskites will be realized in high throughput production approaches such as spray coating or inkjet printing. By removing energy-intensive processes, manufacturing lines for perovskites would, according to available estimates, cost roughly one-third of those used to manufacture commercial silicon solar cells. According to some estimates, the total cost for a perovskite solar cell may someday be around $40 per square meter, which is little more than half of what silicon solar cells cost. To be sure, this ideal will take some time to realize, but it provides a great motivation to invest in this technology.

Research on perovskites has only just begun, and there is quite a bit more to learn about the material before it can be deployed at scale. As researchers gain an understanding of the fundamental characteristics of this new type of solar material, solar cells can be developed that will help reduce carbon emissions. Making solar power as accessible, sustainable, and affordable as possible is the only viable way for countries, including the United States, to transition entirely away from fossil fuels and embrace an economy based on truly renewable

energy.

Read more in Eric Amerling, Sangita Baniya, Evan Lafalce, Chuang Zhang, Zeev Valy Vardeny, Luisa Whittaker-Brooks "Electroabsorption Spectroscopy Studies of (C4H9NH3)2PbI4 Organic–Inorganic Hybrid Perovskite Multiple Quantum Wells," *The Journal of Physical Chemistry Letters,* 8, no. 18, (2017): 4557-4564.