The Future of Solar Panels

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Solar panels are becoming increasingly common on rooftops, in fields and even in your calculators. But what are we doing to try and make these solar panels even better?

If the entirety of the state of New Mexico in the USA were covered in solar panels, then they would generate enough electricity to power the whole world. Whilst this is not a practical idea, it does show the potential that solar panels have to help us cleanly meet our electricity demands.

Solar panels convert sunlight directly into electricity. They are made up of numerous electronically connected smaller devices, small enough to fit into the palm of your hand, called solar cells. These solar cells convert light energy from the Sun into electrical energy and can convert a maximum of 34% of the light energy that reaches them into electrical energy. The amount of light a solar cell converts into electrical power is known as its solar cell efficiency.

Most solar panels that you will see today use silicon. Silicon solar cells have proven to be very successful and are one of the cheapest ways to generate electricity, even cheaper than the fossil fuel alternatives. The energy required to make these panels is offset within two years of the panels being made and, as they last for at least twenty-five years, they are a very environmentally friendly option to produce electricity. While these solar panels convert around 25% of the light that strikes them into electricity, close to the theoretical limit, large amounts of research is ongoing, investigating methods to push the efficiencies of these solar cells even higher.

As silicon has been so successful commercially, and because the need for solar power is so important, another key area of research is trying to find alternative materials that can compete with silicon. One large area of research is into thin film solar cells which use materials that absorb light more efficiently than silicon and so a thinner layer of material is needed. This has the benefit of bringing down costs and making the method of producing them less energy-intensive which in turn leads to them being more environmentally friendly than silicon. The most commercially successful thin film technology is the CdTe (cadmium telluride) solar cell. CdTe solar panels are already made in the USA on a large scale and have been shown to produce electricity cheaper than their silicon alternatives. Other thin-film materials are also being investigated such as copper zinc tin sulphide and antimony selenide. These are examples of new solar cell technologies, which although still in development, are showing such rapidly improving efficiencies that they could become commercially available in the near future.

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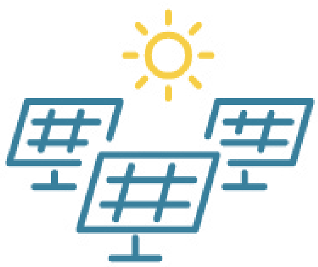
Another long-studied area is organic solar cells. Like the thin films mentioned previously, organic solar cells use ultra-thin layers of materials to absorb the light but are based around organic compounds which are predominantly made from carbon and hydrogen. They have the potential to be cheaper than silicon solar cells, and even cheaper than the previously mentioned inorganic thin film materials. However, efficiencies only recently passed 15%, despite decades of development, and there are issues that the cells are very sensitive to air and water, which has limited the commercial interest in the technology. They do offer a range of possibilities though, and companies using the research based on organic solar cells, has had great success with organic LED (oLED) TVs.

Arguably the cell attracting the most interest is the perovskite solar cell, named after the crystal structure that the material uses. These are known as hybrid materials, meaning they combine both inorganic and organic aspects. The materials have gone from an efficiency of around 4% in 2010 to over 25% in 2020, which in terms of solar cell development is extremely rapid. These materials can absorb light very effectively and be made in a method that has low costs and minimal environmental impact.

Whilst their performance is extremely exciting, they still have issues as they are notoriously unstable, meaning that the high efficiencies fall within hours and days, rather than the 25-year lifetime you can achieve with silicon solar cells. Researchers are confident they can overcome this hurdle though. A company formed based on the perovskite research at Oxford University, Oxford PV, has plans to start selling perovskite solar panels in the next couple of years.

Current research goes far beyond just new materials though and some researchers are trying to figure out ways to break the maximum theoretical 34% efficiency limit to try and convert even more sunlight into electricity. The two ideas that have attracted the most interest are concentrated solar cells and tandem or multijunction solar cells. A concentrated solar cell, as the name suggests, uses mirrors or lenses to capture light from a large area and concentrate that light onto a small solar cell. More light energy hitting the solar cell means more electrical energy generated and because the cell need only be small costs are reduced. A tandem solar cell combines different individual solar cells which use different portions of the solar spectrum in a stack on top of each other. On the top layer is a material that can absorb the higher energy wavelengths with minimal heat loss. Any sunlight with insufficient energy to be absorbed by this cell will pass through and can be absorbed by a solar cell below meaning a larger portion of the solar spectrum is used. By combining the two approaches concentrated tandem solar cells in the laboratory have nearly reached 50% efficiency. There are also plans to begin selling a silicon-perovskite tandem solar panel in 2021.



Organic solar cells use ultra-thin layers of materials to absorb the light but are based around organic compounds which are predominantly made from carbon and hydrogen.

This article aimed to show you that solar cells are continuing to be developed and that research is aiming to improve the efficiency and cost of solar panels. There is research is aimed at improving silicon cells, finding alternatives to silicon or to break the limit of what a single material can do. This research will make solar panels cheaper, more environmentally friendly and more efficient in the long run. Maybe at some point in the future we will only need half of New Mexico covered in solar panels to power the world.

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Glossary

Solar cell – The small devices within a solar panel that are connected electronically to form the solar panel

Solar cell efficiency – The amount of light a solar cell converts into electricity

Organic compounds – Materials mainly made with carbon and hydrogen

Find out more

A great resource explaining how a solar panel works and some of the history behind the technology, can be found here: solarmuseum.org

About the author

My name is Matthew Smiles. I am currently doing a PhD at the University of Liverpool which involves me researching new materials that could be used in solar panels. Before this, I did a bachelors and master's degree at the University of Warwick. Alongside my PhD I have been doing an internship with Crowberry Consulting as a sustainability intern.