**Even in the context of a rapidly developing global renewable energy market, I think we can fairly safely say that the reduction in the cost of solar photovoltaics over the last decade or so has been nothing short of astonishing. Solar panels are now more than eighty percent less expensive than they were in twenty ten. That’s largely due to the mind-boggling volume of panels being produced in China, but the solar PV panel industry is growing quickly in several other countries around the world as well.**

**So, we know how to make them, and we know how to make them in massive quantities and with remarkable reliability and longevity.**

**The only slight wrinkle in an otherwise flawless resume is the fact that the pesky laws of physics are making it devilishly difficult to achieve a real world, commercially available panel with a sunlight to electricity conversion efficiency rate greater than about twenty-two or twenty-three percent. And in theory those laws of physics will only ever allow an absolute maximum conversion efficiency of about thirty percent.**

**Which is a shame. It’s all to do with the different wavelengths of light and which wavelengths can actually be used by the photon absorption layer to make electrons move out into an external circuit. And of course, being a sciency thing, the phenomenon has a sciency name – it’s called the Shockley-Queisser limit, named after the two clever chaps who first worked it out back in nineteen sixty-one.**

**Of course, lots of research teams are working on possible solutions to overcome this irritating limitation. You’ve probably heard of Perovskite for example, which we looked at in this video, and you may also know about a technology called multi-junction cells. And doubtless in the fullness of time one or both of these ideas may get worked up into a genuine, commercially viable, product.**

**But now there’s another bunch of kids on the block to challenge the existing research work going on around the world. They’re a UK firm called Cambridge Photon Technology and they reckon they’ve found a way to take full advantage of the whole spectrum of light that our sun provides.**

**So, how do they do that then?**

**Hello, and welcome to Just Have a Think,**

**A typical solar panel is made up of a transparent conductive oxide or TCO layer on top of a semi-conductor, typically silicon. The top section of silicon is infused, or ‘doped’, with another element like phosphorous which gives it a negative charge, which is why phosphorous doping is also called n-type doping. The bottom section of silicon is doped with something like boron which gives it a positive charge, which is why boron doping is referred to as p-type doping. When a photon hits the silicon layer, it creates something called an exciton, which is essentially a negatively charged electron and a positively charged electron hole which are released from the silicon but connected to each other by an electrostatic charge. In very basic terms, the negatively charged electron is attracted to the p-type layer and the positively charged hole moves up to the n-type layer. The two doped layers act like electrodes to facilitate the movement of electrons out of the photovoltaic sandwich and into an electrical circuit.**

**Now that limitation I highlighted a moment ago comes from the fact that silicon works best with photons in the red and near-infrared portion of the spectrum. The wavelengths further out in the spectrum like far infrared, microwaves and radio waves, don’t carry enough energy to kick the electrons out of their position and get a current flowing.**

**At the other end of the spectrum, you’ve got the shorter wavelength photons which carry far more energy. In fact, far more energy than the silicon absorber can deal with, so any energy that doesn’t kick an electron out of place is simply wasted as excess heat. Which, as I mentioned earlier, is a shame!**

**William Shockley and Hans Joachim Queisser tried just about every combination of wavelengths you could think of and once they’d crunched the numbers from their experiments, they did indeed find that the maximum efficiency from a PV cell, set up with these n-p layers, was limited to a maximum of thirty percent.**

**The insight that Cambridge Photon Technology say they’ve come up with is a way to convert those wasted high-energy photons into lower-energy photons that the silicon absorber layer can handle.**

**In this article published in the online journal, Nature, the company’s head of business development, David Wilson explains how it works.**

**The technique uses a phenomenon called singlet exciton fission.**

**It was originally developed by a physicist called Akshay Rao and his team at the University of Cambridge in the UK and although it’s an extremely smart piece of lateral thinking, it’s actually a remarkably simple idea in principle.**

**What Rao and his team have created is a film made from an organic polymer called pentacene, which is studded with lead selenide quantum dots. These things are tiny, light-emitting clumps of inorganic material. The longer wavelength light at the red end of the spectrum is able to pass straight through the pentacene film and gets absorbed by the silicon semi-conductor in the normal way.**

**But the shorter wavelength blue and green photons get absorbed by the film which converts them into pairs of excitons, and for reasons that would probably melt my brain if I tried to understand them, the quantum dots absorb the pairs of high energy excitons and then emit lower-energy red or infrared photons back out again.**

**Which is quite handy because when the film is placed on top of a silicon solar cell, the longer wavelength light from the quantum dots shines onto the silicon where it can then be absorbed in the normal way. So, you’re effectively getting more useable photons out of the available sunlight which results in an increase in electrical current.**

**Akshay Rao has calculated that his method could increase the potential conversion efficiency of solar cells up to about thirty five percent. He hasn’t actually achieved that yet, so we’re still in that ubiquitous territory of “Promising new breakthrough technology”, and yes I know quite a few of you good folks get a bit frustrated when I talk about new concepts that haven’t yet been built at commercial scale, but you hopefully know my view by now – I think these ideas should be given air time so that interested parties can get involved and, who knows, maybe even accelerate their development to market.**

**An in fact, David Wilson is hopeful that, by the end of twenty-twenty-two, Cambridge Photon Technology will have a prototype that converts about thirty one percent of sunlight into electricity.**

**The company’s Chief Executive, Claudio Marinelli, explains that the plan from the outset was to look to commercialize this work, so the researchers approached real world solar-panel manufacturers to understand what they needed and how this new technology could make a difference within existing production parameters.**

**I mentioned other technologies like perovskite and tandem cells or multi junction cells, earlier on. Those techniques can also capture shorter wavelength photons and they can then be combined together with silicon cells to make a kind of hybrid combo that can produce more electricity. But that means making two devices that need to work seamlessly together while producing different currents, which can be quite complicated. Plus, it adds new equipment and an extra step into the manufacturing process, which drives up the cost.**

**Cambridge Photon Technology reckon they can avoid all of that using this simple non-toxic film material that requires no electrical connections at all and that that adds very little complication to an existing solar PV design. The finished film could be sold to solar-panel manufacturers to apply directly onto their PV modules during production.**

**Or… the film could be supplied straight the companies that make either the vinyl acetate layer that encapsulates the silicon or the glass panels that cover the solar cells. The PV panel manufacturers could then just assemble the already-treated components into the final device.**

**The company currently employs about a dozen people and has raised one point four million dollars in working capital. They also have a number of research grants, and access to researchers and facilities at the University of Cambridge. With that level of investment and expertise in place, they aim to have a market ready product available by twenty-twenty five.**

**As David Wilson puts it.**

 **“It’s really clear that there’s a fairly urgent need. And this technology, if it works as promised, will go a long way to meeting that need.”**

**I know there are lots of you out there with a great deal of knowledge and experience in this field, so if that‘s you and you can share some insights, or if you just want to voice an opinion on solar PV technology in general then why not dive down to the comments section below and leave your thoughts there.**

**That’s it for this week though.**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.
See you next week**