# BP Technology Outlook:
Focus on Solar Podcast
May 2019


This is BP Technology Outlook: Focus on Solar Podcast.

Angela Lamont: I'm going to give you a lovely Caribbean island, all of your own and you're in charge of the energy mix on that island. What's your energy mix going to be?

Jenny Chase (BNEF): Probably I'm gonna go for about 50% solar and a wind turbine and some batteries… and I might have a backup diesel generator with a tank of diesel for real emergency situations.

Angela Lamont: To get you through October, would be the problematic period.

Jenny Chase: You obviously know more about the Caribbean than I do. (laughter)

Angela Lamont: I'm Angela Lamont, a technology broadcaster. I have been for decades so when BP asked me to do a podcast on solar I thought "Well, is there anything new to say? Solar's been around so long."

I've got this app on my phone called 'Electricity Map' and it gives you a breakdown of the whole electricity production and consumption for the UK. If you have a look at today, solar is less than three gigawatts at the moment which is nothing when you compare it to the amount of electricity coming from gas or even nuclear today. When will solar really be a viable chunk of our electricity production? It's been around that long... What is new?

Dan Walker (BP): Solar PV is the fastest growing power generation technology out there.

Angela Lamont: Dan Walker heads up BP's Technology Futures unit.

Angela Lamont: Now, BP and solar aren't really two things that most people would link together so where did this all come from?

Dan Walker: We believe that solar technology integrated with other technology such as energy storage, batteries and indeed

integrated with gas have a major role to play in the energy sector into the future, so we're really trying to understand the leading technologies in the solar space and where BP wants to play, through what business models.

Dan Walker: These are often areas where we don't have core competence or capabilities so we are happy and keen to work with anyone out there who can help us understand these new areas.

Angela Lamont: Over the past few weeks I've had the pleasure of talking to experts from all over the solar industry. One thing they did agree on: solar's on the rise.

Jenny Chase: Jenny Chase, I'm head of Solar Analysis at Bloomberg NEF. In 2008 the global market for solar was under seven gigawatts. Last year, in 2018, there was about 107 gigawatts sold worldwide with solar now generating nearly 2% of the world's electricity supply and there's no real signs of it slowing down.

Chris Buckland (Lightsource BP): Chris Buckland, I'm Technical Director at Lightsource BP.

There are still a lot of markets which haven't seen solar yet and haven't been able to see solar, possibly because of the longevity of the pricing. Sub-Saharan Africa, 650 million people with Smart phones, with mobile money and no electricity. That has to be an opportunity which will come sooner rather than later. We're operating and trying to optimize these technology solutions across a total of 12 countries.

Bogdan Gagea (BP): We have a forecast, long-term forecast for solar PV…

Bogdan Gagea, I work for BP Technology Futures and I lead the research in low carbon power and storage.

…we do our best and we try and take feedback from across the market but still we get it wrong almost every year. And, in our latest update on the BP energy outlook I think the adjustment from 2018 to 2019, it's something


like, 40, 50% more installed capacity in 2014, so significant adjustment in one year.

Angela Lamont: So, everyone's agreed that solar's on the rise and the technology is mature, it's proliferating but you know what happens next. You take the technology. You refine it. You improve it. So, which technology has the best potential and what's the most exciting?

Bogdan Gagea: I'll tell you what my favourite technology is and those are the bifacial solar panels. A new technology that's being introduced in the market where the back of the solar panel can pick up some of the reflected light and generate a little bit of extra energy. And I've seen the panels with white gravel or maybe white rooftops to help that light reflection and increase the yield.

Jenny Chase: Just a couple of years ago the main technology for making solar wafers from crystalline silicon switched from using a wire saw to a *diamond* wire saw. The wafers can be much thinner so the switch to a diamond wire saw actually cut a couple of cents per watt off the price of a module.

David Eyton (BP): In solar there's different ways of capturing sunlight…

David Eyton, I'm BP's Head of Technology.

…one of them is solar photovoltaics but another one is concentrated solar thermal and to be honest, I mean, that's what plants do as well. So, you have photosynthesis today but in the long-term you could have artificial photosynthesis, things like artificial leaves, building a human made tree which captures sunlight and makes store-able energy out of it, rather than the ones that nature grows today, so we look at all of those sorts of ideas.

Angela Lamont: So we've heard about quite a few, new technologies but which one is the real contender? Well, I'm on my way now to Oxford to meet Chris Case at Oxford PV and see if he can shed a little light on the matter. Pun intended.

Chris Case (Oxford PV): This is a solar panel from about 1980. These are silicon solar cells.

Angela Lamont: It looks ancient. It kind of looks like the kind of stuff I thought that they would probably take to the moon with them.

Chris Case: A lot of people don't realize how far back you can trace solar. I mean, the first demonstration, sort of the conversion of sunlight into electricity was 1839 and Charles Fritts, a US inventor, put solar panels up on the top of a building in New York City around 1890.

Angela Lamont: And we're basically still using that same solar PV technology today.

Chris Case: Now, the PV panel is made from silicon. It's not a bad material and it's a relatively inexpensive material but it has limitations on efficiency. Now, the technology that Oxford PV is developing actually is a different kind of solar cell material. It's based on a material that's named or known as 'perovskite'. It was discovered in the Ural Mountains in 1839. It was named after a Russian mineralogist, Lev Perovski.

David Eyton: We do look at perovskite which is very interesting, thin filmed technology that could be used either in combination with or singly by itself as silicon technologies.

Chris Case: This looks like a conventional silicon solar cell but it has a perovskite solar cell built as a very thin coating on top of the silicon. The magic is when you put the two solar cells together the theoretical efficiency jumps from 29% of silicon by itself to 43%.

Bogdan Gagea: Perovskite certainly could be a major disrupter, perhaps in 5 to 10 years it will be able to play more of a role.

Chris Case: The perovskite that we use is not mined. It's not the mineral. It's a synthetic form of perovskite. This material is several hundred times more efficient absorbing sunlight than silicon. That means it can be used as a very thin layer

and that, of course, is good for the world because it only takes 35 kilograms of perovskite to make a megawatt of solar PV. It takes seven tons of silicon.

Bogdan Gagea: We see with perovskite tandem cells, something like 28, 30% is currently the target for the perovskite developers, so that is a 50% gain on efficiency - which is absolutely massive.

Angela Lamont: Although the numbers sound exciting not everyone's convinced…

Jenny Chase: I've seen a lot of thin film solar technologies go into early stage commercial production and pretty much all of them are by companies which are now bankrupt.

It's actually much harder than you would think to take a technology from the lab to commercial production because laying down a layer of semi-conductor is technologically incredibly difficult.

Bogdan Gagea: One of the key challenges for perovskite cells is their limited lifetime which is currently only a couple of months, maybe a few years.

Jenny Chase: And the lifetime issues of perovskite's basically making it a non-starter at the moment for anyone who's financing projects.

Chris Buckland: During our research we have identified over 50 technology innovations but we believe silicon will continue to dominate the solar PV sector for around the next 10 years.

Angela Lamont: The sense was that with or without exciting new tech like perovskite, solar's growth is inevitable.

Bogdan Gagea: We have all agreed with fast growth in the solar market. The question is whether that is fast enough for the global community to be put on path to hit the milestones agreed in the Paris Agreement back in 2015.

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| Chris Case: | Solar installations have doubled seven times since the year 2000. They would only have to double six more times to actually have 100% solar in another 15 years. |
| Angela Lamont: | But, what's the goal here? What's the end game? Are we going for 100% solar? Because looking at my app, if I scroll over the energy production - because I can take it back and forwards 24 hours - yes, yesterday was sunny. Everything was looking good for solar at that point but then overnight the amount of solar, well, disappears. That doesn't take a genius but also the wind drops too, the wind energy production. So, what can you do about this massive problem? We can't pretend intermittency doesn't exist. |
| Bogdan Gagea: | I would say challenge, maybe not problem. There could be an opportunity in this intermittency as well if you are a power trader and you're with a forecast algorithm is one hour better or more accurate than your competitors, when you mix your consumer behaviour with solar forecast, wind forecast and all of the other things it can get quite interesting and I think solution is maybe to take a step-by-step caution approach and allow more and more of these renewables to come on the grid to learn, adapt. |
| Dr. Shawn Qu (Canadian Solar): | This is Doctor Qu, Chairman, CEO and President of Canadian Solar Inc.<br><br>I think there are two kinds of intermittency. One is the natural weather intermittency. Another is a political weather intermittency and sometimes the unexpected change of policies create 'stop and gos' for the industry, so we have to deal with both intermittencies. |
| Jenny Chase: | Solar has always outperformed our forecasts, largely because there's always some other country that implements some kind of policy and these days, it's not so much that it implements a policy to subsidize solar... It's that a country will realize how cheap solar is and then say, "Oh. That'll look nice on our power grid." |


Angela Lamont: So, in your opinions which do you think are the countries that are displaying the most joined-up thinking with regards to their energy policies, and how are they slotting solar into their energy mix and dealing with the intermittency?

Jenny Chase: California's done an interesting thing. Electricity prices for nearly everybody change depending on what time of the day it is and now, for most people, there's a time in the middle of the day when power is very cheap - and that encourages people to shift their demand for when there's loads of solar.

Chris Buckland: In Ireland where the Grid Code has been worked on with some very smart people and a lot of input from across the globe as to how to connect renewables without disturbing too much of the grid and solar with batteries enables a much cheaper connection in Ireland because they're thinking ahead of the challenges that's going to come with 60% renewable on their grid.

David Eyton: The solution for one part of the world is not necessarily the same as the solution for another part of the world. Less developed countries, in terms of their power system in particular, have an advantage because they can then invest in and design this system consistent with where the world's going. The overall cost of the transition for those countries need not be as great as those countries that have got to basically start again with large components of their energy system and the capital stock that they've already built up.

Angela Lamont: I can't help wondering if this app in my pocket isn't actually the solution to this. Uber wasn't formed by a load of taxi drivers and Airbnb wasn't formed by a hotel owner. Sometimes a problem can't be solved from within an industry. You need to look outside it.

Hariram Subramanian (Huawei): My name is Hariram Subramanian. I'm based in Germany, Nuremberg, working with Huawei Technologies in the PV Fusion Solar Solutions.


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| | We are into the electronics side. We are not into the panels. Our perspective was trying to bridge energy power systems and telecommunication data analytics from different interdisciplinary fields into one stream to bring in the next generation internet of energy. |
| Angela Lamont: | The internet of energy is a new concept to many people. Could you just explain that? |
| Hariram Subramanian: | Let's say we are working in intermittent sources, like PV, solar, et cetera, where we need energy to be provided when there is a big demand. Looking into smart grids, looking from generation to transmission and also to distribution in a most energy efficient way. |
| Pierre Verlinden: | My name is Pierre Verlinden and I'm a consultant in photovoltaic technology. The innovation process is accelerating mostly because the industry's growing so big and there's so much collaboration between the different companies that we see a faster implementation of innovation. |
| Pierre Verlinden: | I've been in this for 40 years and I remember when I started my work on PV research I thought it would boom within five years. It surprised me that it took so long but it's so great to see the industry's moving so fast, sometimes it makes our head spin. And we haven't seen the limit yet. |
| Angela Lamont: | I suppose when I started this podcast I was wondering why we were doing a podcast on solar because hasn't solar been around for decades? But as is so often in this industry, I've spent decades watching technologies come of age, waiting for them to come of age, getting quite frustrated about them not coming of age and solar is just coming of age. |
| Angela Lamont: | You can watch things go up the Gartner Hype Curve forever until they mature at the top and then they either disappear without trace, or they come mainstream, change our lives and then five years later we take them completely for granted. |

Angela Lamont: So, I hope you tune into our next podcast about batteries. Meanwhile, I'm off to sort out my Caribbean Island, lots of solar I think, maybe PV roof tiles. That could be good.

This was a BP Technology Outlook Production

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