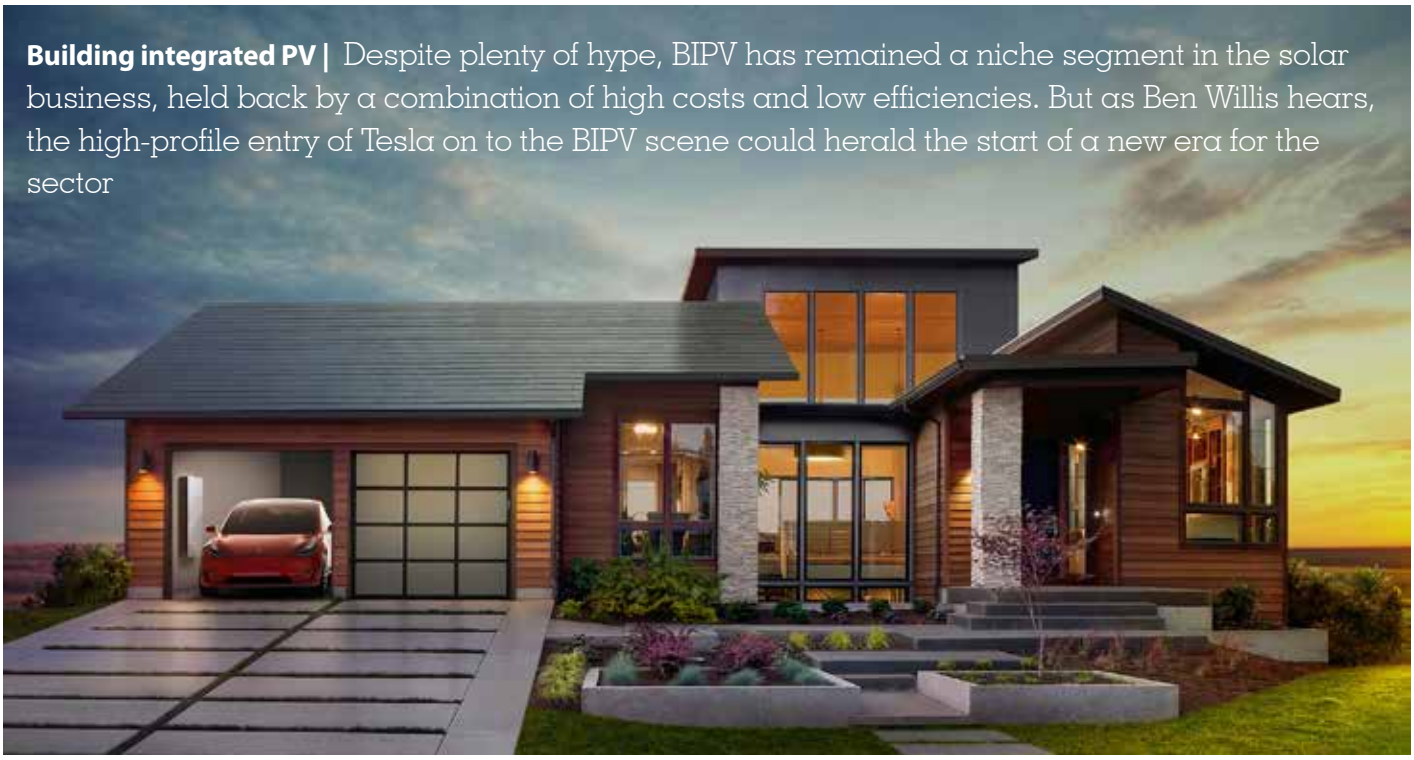
Living up to expectations

Building integrated PV | Despite plenty of hype, BIPV has remained a niche segment in the solar business, held back by a combination of high costs and low efficiencies. But as Ben Willis hears, the high-profile entry of Tesla on to the BIPV scene could herald the start of a new era for the sector



Credit: Tesla

In late October, with all the usual fanfare that accompanies an Elon Musk announcement, the CEO of EV and battery storage manufacturer, Tesla, took to the stage to lift the lid on a heavily trailed new product. Most of Musk's recent utterances on energy have been about storage, particularly Tesla's high-profile foray into the world of stationary storage through its Powerwall battery system. But this was something a bit different – a building-integrated PV (BIPV) product designed to emulate various kinds of roofing tile and eliminate the need for clunky conventional roof-mounted modules once and for all.

Critics were quick to pick holes in Musk's BIPV play. They pointed to a landscape littered with the carcases of companies that had been lured to the sleek looks and theoretical logic of BIPV only to come unstuck when they found the market – for many reasons including cost, technical challenges and the general complications of integrating two different industries (solar and construction) – just wasn't there yet. Why, the pundits asked, should Musk and his Tesla/SolarCity machine presume to be able to crack a market that so far has evaded all attempts at mainstreaming?

That may well prove to be a pertinent and prescient question. For sure, BIPV so far has remained very much a niche segment of the solar business, beautiful but confined to signature projects where the client most likely sees the designerly incorporation of PV into a building as an effective way of expressing green credentials. All of the negatives cited by Musk's detractors are perfectly valid as they have so far been the main reasons why BIPV has yet to hit the big time. And of course, details of the Tesla/SolarCity BIPV offering are still sketchy to say the least, and fall well short of a full-blooded product launch.

Yet for some seasoned BIPV observers, Musk's announcement is symptomatic of a general shift in the market that could see BIPV take a step up to a new level of deployment. A convergence of technical, cost and regulatory factors point to potentially fertile conditions for the solar industry's great underachiever to finally flourish.

Adel El Gammal is director of the Becquerel Institute, the Brussels-based solar market research and consultancy. He has been involved in BIPV in some shape or form since 2008, when he founded architectural BIPV company, Ecotemis. From what he has seen of this segment over the years, El Gammal believes BIPV's time is coming. "We know what has happened with BIPV but based on the experiences I have had we are certainly approaching the moment where we can expect to see BIPV really ramping up maybe for the first time as a mainstream market segment," he says.

Tesla CEO Elon Musk has unveiled a new solar roofing product to combine with is Powerwall battery

Policy

El Gammal's assertion is based on the fact that, particularly in Europe, the drivers behind solar are changing. Broadly speaking, the solar boom that began in Germany in the previous decade and subsequently spread to other countries was driven by subsidies that deliberately encouraged volume production as a means of driving down costs rapidly. In that aim it was successful, but at the expense of BIPV, which although a good idea on paper, was by definition a more specialist product unable to compete with standard rooftop or ground-mount deployments.

But that environment is now changing. "We can see clearly in Europe that the market will be stagnating or even decreasing in coming years, as a result of basically mostly all subsidies being cut or significantly decreased," says El Gammal. "This means there will be little case for continuing to build big ground-mount systems in Europe. There are markets that are much more attractive outside Europe for ground-mount systems."

As that change happens, some, including El Gammal, are hoping that so-called 'prosumer' policies – that encourage self-

consumption of own-generated, primarily solar power – will fill the gap left by subsidies. He concedes this is by no means a given, but says it could favour BIPV if it does.

"BIPV could become very interesting if we see prosumer-friendly policies gaining ground. It's very uncertain at the moment; if you look at the landscape in the EU, almost every European country has a different approach to self-consumption, and there are as many regulations on self-consumption as there are PV markets in Europe. But we can see clearly that the commission is very interested in pushing that concept forward.

"And I believe we will see the market in Europe growing again based on the pure competitiveness of PV under prosumer-friendly policies. This of course doesn't mean that rooftop installation will be competitive at any price. But we can see with the tremendous decrease in the cost of production of cells it becomes realistic to build more customised products at costs which are still compatible with profitability on rooftops in general conditions in Europe."

Another promising driver on the policy side is the growing interest, not just in Europe but around the world, in buildings designed to minimise energy consumption. This takes different forms in different areas – dubbed variously zero net energy, net-zero energy, nearly-zero energy or energy-plus buildings. Whatever the name, BIPV is seen as potentially having a great deal to offer in helping realise the general aim of reducing the emissions from buildings, a significant contributor to global greenhouse emissions. The European Commission's 'Energy performance of buildings directive', for example, stipulates that all new public buildings must be 'nearly zero energy' by 2018 and all other new buildings from 2020.

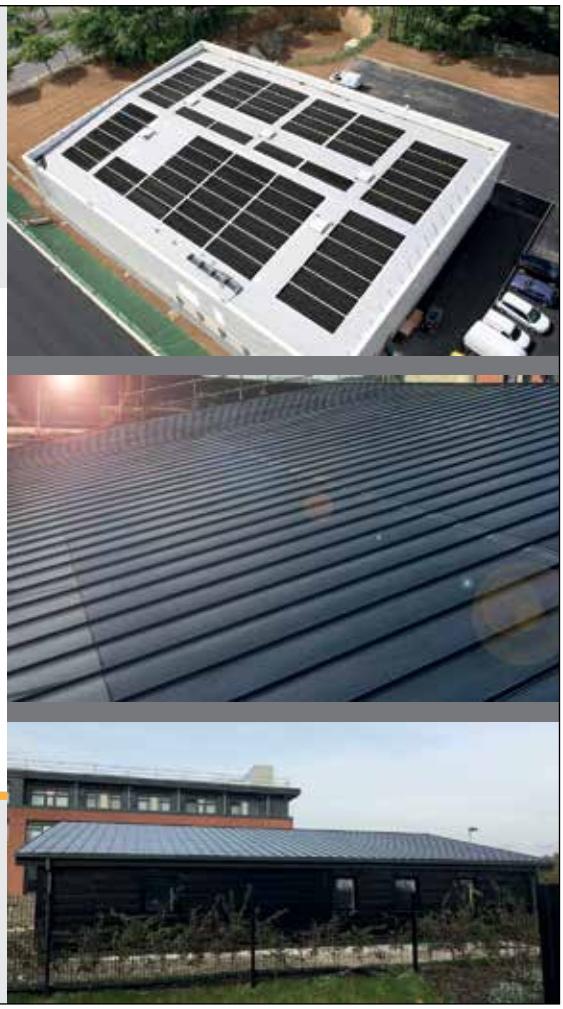
"In Europe and the US there's a big push towards net-zero energy buildings, so you need to have solar that will offset your energy usage," says Anil Vijayendran, vice president of sales and marketing at MiaSolé, the California-based CIGS thin-film specialist acquired by China's Hanergy in 2012. MiaSolé recently launched what it described as a "next-generation" range of flexible CIGS products aimed at BIPV applications. "It's mostly on homes, so those homes need to be aesthetically beautiful; the traditional panels may not cut it, so you'll start to see more and more use of BIPV in order to meet some of these net-zero challenges. In France they're talking about a net-zero policy, in the US there are certain areas with net-zero compliance. I think those things are going to push adoption."

Lower cost, higher efficiency

Exactly how those policies play out in the current climate, with an incoming US president who has already made clear his hostility towards clean energy, the unknown consequences of Brexit and a European Union that looks politically ever shakier, remains to be seen. But other countries such as Canada and Japan have policies in place, and there is discussion of heavy hitters such as China and India taking steps towards net-zero energy buildings.

And aside from the vagaries of policy, one immutable fact is that on cost and performance BIPV has made some significant advances in recent years. These two areas have traditionally been BIPV's biggest Achilles heels, the generally lower efficiencies achievable with most BIPV products and the relatively greater costs compared to regular crystalline silicon products together acting as a significant barrier to adoption.

Vijayendran says that in the past, leaders in the BIPV field were only able to muster



performance efficiencies of around 8%. "There were some nice products, but if you needed to use two to three times as many solar panels to get the same amount of power the economics don't work out, and frankly there's just not enough space on the roof," he says. Now, MiaSolé's CIGS product is able to achieve efficiencies of more like 16-17%. "Once you get to that level of efficiency you can start to play from an economic standpoint," Vijayendran says.

Alongside the greater efficiencies, Vijayendran says MiaSolé has been able to significantly reduce its costs. This is in a large part thanks to a new proprietary tool the company has developed that allows it to deposit all the layers of the PV film in one hit. "It allows us to deposit thousands of different cells per hour," he explains. "So we can go through many different recipe types to fine tune the efficiency in an hour – having 10 different tools for each process step, it would take you 100 times longer to do the optimisation and testing."

New products

Of course, BIPV products are still not at the point of being able to compete directly with regular crystalline modules. MiaSolé is driving its costs down, but expects the best cost of a system using its products still to be 10 to 30% higher than one using standard modules. But where BIPV comes into its own, and will increasingly do so if the regulatory environment tightens, is in buildings where standard PV is not applicable.

One of MiaSolé's collaborators is the UK-based company, BIPVco, a spin-out from Swansea University in Wales that produces metal roofing products incorporating its US partner's CIGS cells. Its CEO Daniel Pillai agrees that the significant advances in efficiency achieved by MiaSolé have enabled his company to develop products that although still more costly than regular crystalline silicon modules offer the sort of return on investment that makes them competitive. And crucially, given the lightweightness of MiaSolé CIGS cells, they can be applied to buildings where regular panels would be too heavy.

For Pillai, with the likelihood that BIPV products will be unable to compete with their mainstream c-Si counterparts for the foreseeable future, this is where the real opportunities in BIPV now lie. "There's a clear need [for BIPV products] in the sense that traditional PV cannot address huge chunks of buildings," he says. "The existing technologies can't meet the need, so BIPV offers a solution."

Another exciting development on the horizon is the possible emergence of new BIPV products manufactured by construction material companies as opposed to PV manufacturers. There have been some attempts at this, but they generally haven't worked for the reasons already highlighted. Clearly, however, the successful manufacture of BIPV products by companies with both knowledge of and clout in the construction materials business could be a significant boost to the adoption of BIPV.

El Gammal reveals that he has been consulting with two such companies, which he says are close to launching BIPV products. "These are both actors who have traditionally been outside of the PV sector and are very, very significant players," he says. "They are at the very point of commercialising pure BIPV products, which have been designed starting from a building construction material perspective on which, by different technologies, you apply a PV functionality. And this is a totally different approach which I believe is very effective, because it means you don't need to change much in the manufacture, in the distribution and implementation process – because it's basically fitting the material you are used to fitting with a PV component. All you need is an electrical connection. It's a very different approach."

Working together

This represents a potentially important step forward for BIPV. One factor that has hitherto been a hindrance for the sector has been the lack of success by the PV and construction industries to collaborate on developing solutions that work optimally for both the energy-production and construction functions that BIPV must necessarily perform.

Earlier this year, a new association, Allianz BIPV, was launched in Germany with the specific intention of uniting the disparate spheres of expertise that fall under the BIPV umbrella. Among its members so far are research bodies representing the solar and construction industries, architecture firms, solar technology companies and building material companies. Its chairman, Sebastian Lange, a Potsdam-based lawyer specialising in climate change and renewable energy, explains the thinking behind the venture.

"We had a very long, intense discussion about whether or not to found a new organisation," he says. "There are so many organisations with some connection to BIPV; we wondered if it really makes sense to set up another. But the view actually was that there is a gap between all these organisations; BIPV really is in the middle of so many different aspects – you have the building aspect, you have the energy industry… you have the architects and the ones who are ordering and paying for the buildings. That led us to the conclusion that there's actually a missing link between all these organisations. So we have the intention not to be in a way another organisation but build up these missing links and work together."

The aim of the organisation, which Lange says will not be limited solely to BIPV in Germany, will be to undertake research, collect and disseminate information on best practice and help develop the right regulatory frameworks for BIPV, as well as generally helping raise its profile in the public's eye. Lange says the alliance has just completed its first piece of work, an exercise to document the knowledge available on how to install BIPV in a new building, from the perspective of an architect or planner. "We are working on documents which will be helping tools for the ones who are thinking about BIPV and investing in it – what does it cost, what are the benefits – but also for the ones who then have to plan and build it – what do they have to know about the new technologies?"

From initiatives such as these, it would seem that the will is certainly there to coax BIPV out of the niche it has occupied so far. The conditions look better than they ever have for BIPV to take off, and coupled with recent developments on the technology front, there are reasons to feel optimistic this could happen. On top of that, Elon Musk's announcement in October will have helped further the cause: BIPV is now firmly in the public's mind, and who knows, it may even turn out in time that Musk has chosen the right time to back a winning horse.

"The fact you see a highly respected businessman, considered as a visionary, linking together e-mobility, electricity and storage and PV, this is absolutely essential in terms of the credibility of the story and the credibility of BIPV as a solution for the future," says El Gammal. "The fact that he's looking at it as well means there will be an economic case for BIPV otherwise he wouldn't announce it. It was exactly the same with storage - he has made his very bold announcement on the price of storage, and now we see it happening. This announcement is fundamental in terms of awareness in the general public and in industry, but it proves the economics of BIPV will soon be there to make it a truly attractive case." ■

Next generation - BIPV technologies to watch

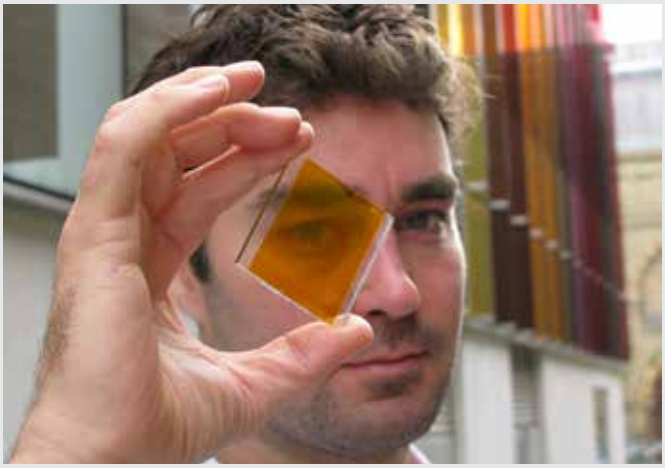
CIGS thin film

By virtue of its light weight and flexibility CIGS thin-film technology is particularly well suited to BIPV applications. Following the launch in September of its next-generation CIGS products, MiaSolé announced a partnership with American roofing manufacturer McElroy Metal to produce a range of solar roofing materials. As well as BIPVco in the UK, MiaSolé is also partnering with General Membrane, an Italian firm specialising in bitumen roofs to develop BIPV roofing products.

Another attribute of CIGS is its transparency, which makes it suited for use in solar glass. In September the German thin-film specialist Avancis announced a partnership with French PV glazing manufacturer SunPartner to produce semi-transparent solar glass incorporating Avancis' CIGS cells.

"We are quite sure the BIPV market will grow quickly," says Avancis' head of business development and sales, Jochen Weick. "There is more and more manufacturing work going on in this field, and there are a lot of requests from architects and planners [for BIPV]. And there is demand due to zero-emissions buildings."

Credit: MiaSolé



Credit Oxford PV

Perovskite

Perovskite, the new solar 'wonder material' being developed by the likes of UK-based Oxford PV, has frequently been touted for its potential in building-integrated applications. Oxford PV itself recently took the first steps towards commercialisation by acquiring a former Bosch PV production line in Germany to begin pilot-scale production of its technology.

Speaking to PV Tech Power, Oxford PV's chief technology officer Chris Case says that for the time being the company is focusing on producing its perovskite technology for use in tandem with regular silicon solar cells – the latter having the greatest market presence at the moment and thus offering the greatest opportunities for scaling up perovskite. However, he says that in the fullness of time, applying perovskite to BIPV is still a big strategic objective for Oxford PV, as it had been when the company first came into being.

Perovskite is also making progress in combination with CIGS technology. In October a team from Belgium's imec and Germany's ZSW and KIT research institutes achieved a 17.8% conversion efficiency with a tandem perovskite/CIGS module. A combination of perovskite and CIGS would be particularly suited for BIPV applications, given the latter's proven attributes in this area.

Other companies working on perovskite solutions include Australia's Dyesol.

Organic PV

Organic PV (OPV) uses carbon-based semiconducters to produce power. OPV cells are printed, meaning, like CIGS technology, they have the flexibility to be applied to almost anything – glass, building materials and even clothing and other small-scale products.

Germany's Belectric, under its 'Solarte' brand, is one of the leading names working on OPV technology and claims to have put into operation the world's first grid-connected OPV project – a 0.2kW installation at the Frankfurt base of German energy supplier, Mainova.

In October, in a press release published to mark four years of operation of this installation, Belectric declared it a success, claiming it had exceeded the simulated energy yield by 7%. In conjunction with its partner, Merck, Belectric declared OPV a next-generation PV technology to watch.

"Four years trouble-free operation, with no apparent degradation, a higher energy yield than expected and Mainova a satisfied partner, are confirmation of our good work. Finally, the system was built to the 2012 level of technology. Since then we have made great progress in terms of performance and integration. With our current possibilities, such a project would look different, even better, and achieve higher yields. With the knowledge that OPV technology development is continuing to advance, we are in a good position to meet the future," said Hermann Issa, director of business development at Belectric OPV.

Other companies working on OPV technologies include Germany's Heliatek, which recently received an €80 million investment boost to expand production capacity for its 'HeliaFilm' OPV technology, which is used in the building and automotive industries.

Credit Belectric