Passive component suppliers are challenging power electronic module producers’ dominance in IGBT power stacks. Gaining a share of this large and expanding sector could provide a significant boost to their fortunes. "The market is growing very fast," Yole Développement power electronics analyst Wenbin Ding commented. "In our opinion, it will reach more than $4 billion in 2016, with a compound annual growth rate of about 51%." And while the incumbent players’ position is strong, the invasion looks set to be reinforced by dedicated drivers for IGBT power stacks supplied by specialist manufacturers.

Power stacks typically assemble IGBT modules together with passive components like busbars, capacitors, cooling systems, resistors, and drivers in optimised formats, typically at ratings above 500 kW. "They can make inverter components modular, ‘plug and play,’" explained Ding’s colleague, Alexandre Avron. "For a three-phase inverter, you could have three stacks that each deal with one leg of the inverter. Then, if you’ve got an issue with one leg, it’s easier to replace the stack rather than repair the full cabinet. It’s more convenient, beneficial in terms of reliability and maintenance, and also cost effective."

The term ‘IGBT power stack’ typically refers to readymade solutions supplied to system producers. But increasingly system makers are devising their own modular solutions that package together components in a similar way. One recent example comes from AEG Power Solutions, which is headquartered in Zwanenburg in the Netherlands. In May, it released a 150 kW maximum power PV inverter, built up from 15 kW modules, into the US market. "It’s similar to what they have in data centres, where you can plug and unplug modules from racks of servers," Avron said. "AEG has done the same for PV inverters, making them completely modular so it’s easy to replace parts, and monitor them as well."

Unlike most of the dominant power stack suppliers, AEG does not produce its own IGBTs. And the fact it’s possible to make stacks and stack-like products without that capability opens opportunities for companies throughout the supply chain. "A lot of passive component manufacturers want to get..."
involved in this business because they are targeting vertical integration,” said Ding. “For example, the Chinese company, Eagtop, were originally busbar manufacturers then started to develop capacitors, and now they are doing power stack assembly.”

These companies feel that they can exploit their particular expertise to enhance performance. “Having know-how for several components allows them to adjust the solution, giving better performance for the whole power stack,” Ding said. “We’re seeing companies that were targeting higher levels of integration make their move,” Avron added. “There will be competition, and so each company has to find how they’re going to add value. The idea is not only to provide the components but also to create more margin in doing design or customization for their customers.”

**Difficult territory**

Another example is materials expert Mersen, based in Paris, France, which manufactures cooling systems for power modules. In 2012, it acquired Rochester, New York’s Eldre, which produces laminated busbars that are also used in modules. Now it has brought the knowledge of those areas together to help customise integrated products in ways that overlap with IGBT stack offerings. “It has a team of power electronics specialists able to combine components from different business units of the company, which is new,” Avron said. “If you have only one company or team designing the capacitors, busbar and cooling at the same time, they know what the possibilities are and can provide designs to better fit customer needs.”

Goldwind are doing power stack assembly for their high power wind turbines, and CSR, the train manufacturer is looking at complete vertical integration.” Goldwind has gained the ability to produce power stacks in-house thanks to a licensing deal with Neubiberg, Germany’s Infineon signed in 2010.

But companies offering new solutions into IGBT stack markets face some considerable obstacles. “There may be resistance to the new solutions, as we’re talking about high power applications, where companies are more conservative,” Avron said. “Rail traction particularly likes to stick with solutions if they still work. Also, the stack approach can make it more difficult to have a second source ready in case of supply issues. They are potentially giving the whole design to one company, and for real custom-made designs they will have only one supplier for all the components.”

“There may be resistance to the new solutions, as we’re talking about high power applications, where companies are more conservative,” Alexandre Avron said.

Meanwhile, power electronic system users are keen to get the cost effectiveness and improved reliability modular IGBT stacks can provide. That makes it beneficial for system makers like AEG Power Solutions to provide these capabilities, and inevitably they also develop their own stacks and stack-like solutions. “That’s been the general trend among Asian players, who are planning vertical integration,” Ding said. “It is a very hot topic in China. System players like Newcomers with power stack offerings are also unlikely to flourish if they threaten the business of IGBT module makers like Infineon, Nuremberg, Germany’s Semikron, or Nordborg, Denmark’s Danfoss. “The most important component in a power stack is the IGBT module,” Ding underlined. “The market is still led by IGBT module makers like Semikron, Infineon and Danfoss because it’s a huge part of the power stack cost.” Perhaps for this reason Barre, Vermont, capacitor manufacturer SBE is ascending the value chain by developing fully integrated IGBT modules with Danfoss, rather than making its own modular stacks. For established module makers to maintain the same level of dominance over the IGBT stack market, they must deal with changes happening on more than just one front. That’s because there is also an influx of new companies producing IGBT module drivers, namely Philadelphia, Pennsylvania’s AgileSwitch, Amantys in Cambridge, UK, and Pürgen, Germany’s InPower.

“The driver comes between the power module and the software control systems – the brain of an inverter – deciding when and how to switch the IGBT,” Avron said. “It directs current from a module’s capacitors to load and open or close the IGBT gate to make it switch efficiently. These start-ups are bringing innovation into the driver area, helping improve performance and bringing new possibilities in how power modules and power stacks work together.”

**Rapid switch**

All the start-ups exploit different approaches to IGBT switching, Avron added. “They can be applied through software or hardware,” he said. “They can help make two IGBT power modules switch at the same time, which is difficult, or help the IGBT switch more efficiently by reducing the switching losses. They can help switch different types of power modules in the same stack or system, which give more flexibility when choosing power modules for an IGBT stack. That opens possibilities for inverter design and supplier choice. You have less constraints on making it work well, and can use lower quality IGBTs to get the same result.”
With driver innovation most applicable to medium and high power applications, the new companies must also face this sector's inertia. "A very big part of the market is closed," Avron said. "Many inverter makers want to do their own IGBT drivers. They have their own techniques, for example French traction manufacturers Alstom do their own IGBT drivers because there are specific operations in starting a train. So these new companies have to be innovative to compete and get market share in IGBT drivers."

And AgileSwitch’s strategy to overcome this problem is a familiar one – to begin offering power stacks. In this case it’s as part of the SmartPower Stack Consortium, which includes Tokyo, Japan’s Fuji Electric as the main IGBT module supplier. And although IGBT stacks are today used at very high powers, the SmartPower Stack Consortium’s is rated at 100 kW. "AEG Power Solutions is also proposing modular systems down to 15 kW," Avron said. "The market is growing at these power levels, with renewable energies now part of the equation, which wasn’t the case five years ago. It’s a bigger market with new needs, which is why we’re seeing more power stacks."

IGBT suppliers could benefit from the added performance these innovations promise, reducing any advantages of upcoming wide bandgap SiC and GaN rivals. However they may ultimately help devices made using these materials, Avron noted. "These improvements make IGBTs moving targets for SiC and GaN," he said. "IGBTs are mature, with few device innovations left to make. They already have outstanding performance, so now manufacturers are improving what surrounds the IGBTs. That’s helping improve inverters’ overall operation which we think will give IGBTs a longer life cycle. But improving what surrounds the IGBT will also benefit SiC and GaN in the end. We really believe that power stack improvements for IGBTs will also transfer to SiC devices, when they are ready, though it will require some adaptation and variation. Keep in mind that they are still for high power and SiC hasn’t yet reached this range."

Regardless of who benefits most, Avron stressed that these events represent some of the fastest changes in the power electronics industry in recent years. "Power module producers are the decision makers, the heart of the business, but these new innovations and companies are bringing some fresh air," he said. "These events are not really changing the market now, but are big signs of evolution. I don’t think that we have seen so many new companies proposing IGBT solutions in such a short time in the past."

"Power module producers are the decision makers, the heart of the business, but these new innovations and companies are bringing some fresh air,” explains Alexandre Avron.

With driver innovation most applicable to medium and high power applications, the new companies must also face this sector's inertia. "A very big part of the market is closed," Avron said. "Many inverter makers want to do their own IGBT drivers. They have their own techniques, for example French traction manufacturers Alstom do their own IGBT drivers because there are specific operations in starting a train. So these new companies have to be innovative to compete and get market share in IGBT drivers."

And AgileSwitch’s strategy to overcome this problem is a familiar one – to begin offering power stacks. In this case it’s as part of the SmartPower Stack Consortium, which includes Tokyo, Japan’s Fuji Electric as the main IGBT module supplier. And although IGBT stacks are today used at very high powers, the SmartPower Stack Consortium’s is rated at 100 kW. "AEG Power Solutions is also proposing modular systems down to 15 kW," Avron said. "The market is growing at these power levels, with renewable energies now part of the equation, which wasn’t the case five years ago. It’s a bigger market with new needs, which is why we’re seeing more power stacks."

IGBT suppliers could benefit from the added performance these innovations promise, reducing any advantages of upcoming wide bandgap SiC and GaN rivals. However they may ultimately help devices made using these materials, Avron noted. "These improvements make IGBTs moving targets for SiC and GaN," he said. "IGBTs are mature, with few device innovations left to make. They already have outstanding performance, so now manufacturers are improving what surrounds the IGBTs. That’s helping improve inverters’ overall operation which we think will give IGBTs a longer life cycle. But improving what surrounds the IGBT will also benefit SiC and GaN in the end. We really believe that power stack improvements for IGBTs will also transfer to SiC devices, when they are ready, though it will require some adaptation and variation. Keep in mind that they are still for high power and SiC hasn’t yet reached this range."

Regardless of who benefits most, Avron stressed that these events represent some of the fastest changes in the power electronics industry in recent years. "Power module producers are the decision makers, the heart of the business, but these new innovations and companies are bringing some fresh air," he said. "These events are not really changing the market now, but are big signs of evolution. I don’t think that we have seen so many new companies proposing IGBT solutions in such a short time in the past."

"Power module producers are the decision makers, the heart of the business, but these new innovations and companies are bringing some fresh air,” explains Alexandre Avron.

With driver innovation most applicable to medium and high power applications, the new companies must also face this sector's inertia. "A very big part of the market is closed," Avron said. "Many inverter makers want to do their own IGBT drivers. They have their own techniques, for example French traction manufacturers Alstom do their own IGBT drivers because there are specific operations in starting a train. So these new companies have to be innovative to compete and get market share in IGBT drivers."

And AgileSwitch’s strategy to overcome this problem is a familiar one – to begin offering power stacks. In this case it’s as part of the SmartPower Stack Consortium, which includes Tokyo, Japan’s Fuji Electric as the main IGBT module supplier. And although IGBT stacks are today used at very high powers, the SmartPower Stack Consortium’s is rated at 100 kW. "AEG Power Solutions is also proposing modular systems down to 15 kW," Avron said. "The market is growing at these power levels, with renewable energies now part of the equation, which wasn’t the case five years ago. It’s a bigger market with new needs, which is why we’re seeing more power stacks."

IGBT suppliers could benefit from the added performance these innovations promise, reducing any advantages of upcoming wide bandgap SiC and GaN rivals. However they may ultimately help devices made using these materials, Avron noted. "These improvements make IGBTs moving targets for SiC and GaN," he said. "IGBTs are mature, with few device innovations left to make. They already have outstanding performance, so now manufacturers are improving what surrounds the IGBTs. That’s helping improve inverters’ overall operation which we think will give IGBTs a longer life cycle. But improving what surrounds the IGBT will also benefit SiC and GaN in the end. We really believe that power stack improvements for IGBTs will also transfer to SiC devices, when they are ready, though it will require some adaptation and variation. Keep in mind that they are still for high power and SiC hasn’t yet reached this range."

Regardless of who benefits most, Avron stressed that these events represent some of the fastest changes in the power electronics industry in recent years. "Power module producers are the decision makers, the heart of the business, but these new innovations and companies are bringing some fresh air," he said. "These events are not really changing the market now, but are big signs of evolution. I don’t think that we have seen so many new companies proposing IGBT solutions in such a short time in the past."