STATUS OF THE POWER ELECTRONICS INDUSTRY 2019

Market & Technology Report - August 2019

Long term growth of the power electronics market is driving 300mm wafer-based production.

KEY FEATURES

- The power device market expanded by 13.9% in 2018 compared to 2017, leading to a second consecutive high growth year in the power electronics market after a couple of flat years
- The power electronics semiconductor market reached $17.5B in 2018, not including power ICs
- In 2018 there was a shortage of 200mm wafers arising from high demand for power electronics devices
- 2019 started positively, but customer demand is falling because major customers still have device inventory from last year
- Main players are investing in enlarging their manufacturing capabilities, investing in 300mm fabs for power devices
- The IGBT and MOSFET markets will continue to increase but part of the market will go to SiC, especially when talking about modules for EV/HEV. However, SiC remains small compared to the Silicon market, still accounting for less than a 10% share by 2024
- The power module market is expected to increase its share in coming years compared to discrete devices

POWER ELECTRONICS MANUFACTURERS ARE EXPANDING THEIR FAB CAPABILITIES TO 300MM

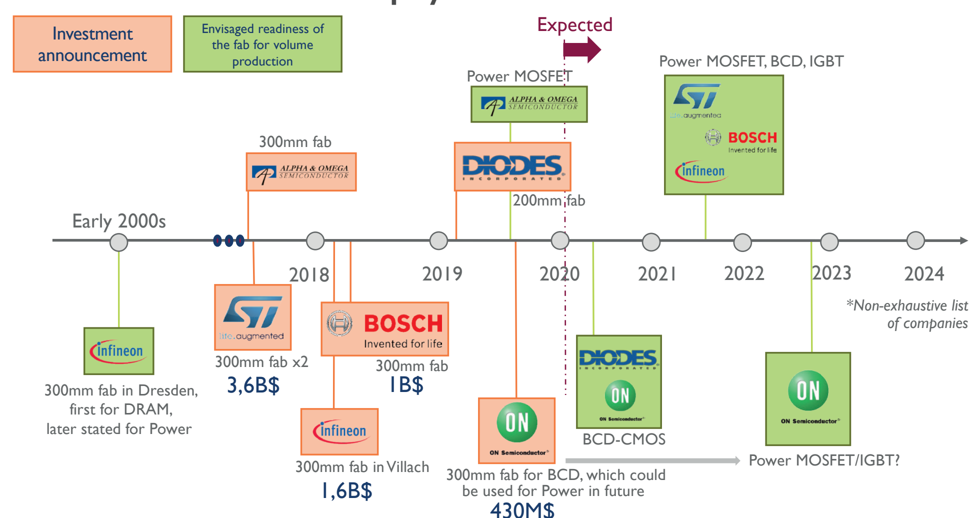
The power electronics industry is experiencing a shift in its dynamics. The shift comes from the increase of demand predicted for coming years, which translates into a move for 300mm wafer-based production. In 2018 there was saturation of 200mm wafer demand, leading to wafer price rise instead of wafer supply. As of today, more than seven power electronics players have announced investments in new fabrication capabilities, to be in production from 2021.

Infineon has invested $1.9B in Villach to build a second fab for power devices on 300mm wafers. STMicroelectronics has also started the expansion of its Agrate site for 300mm production, for Bipolar CMOS-DMOS, power MOSFETs and IGBTs. Another example is Bosch, which has also started building its 300mm fab in Dresden, preparing for the imminent increase in volumes for both automotive and Internet of Things (IoT) applications. Chinese players have also started the expansion to 300mm, like Silan Microelectronics or GTA Semiconductors, the latter having confirmed that it is working on its automotive-grade IGBT production line.

A concern with these moves might be the equipment delivery time. This is one of the reasons why players such as ON Semiconductor and Diodes Inc have acquired an existing fab. Such acquisitions also require lower investments. The ramp up for production for ON Semiconductor will therefore be in 2020 with advanced CMOS technology. Once that transfer is complete in 2022, the equipment can be used for a possible ramp up in power devices, depending on demand, as the equipment will already be established. A choice must be made.

We will have to keep a close eye on the next steps of the power electronics players as they shape the power semiconductor industry in coming years. An overview of the full power supply chain and a focus on the 300mm transition is included in this report.

Development timeline of power electronics fabs: investments of the main players* in 300mm/200mm



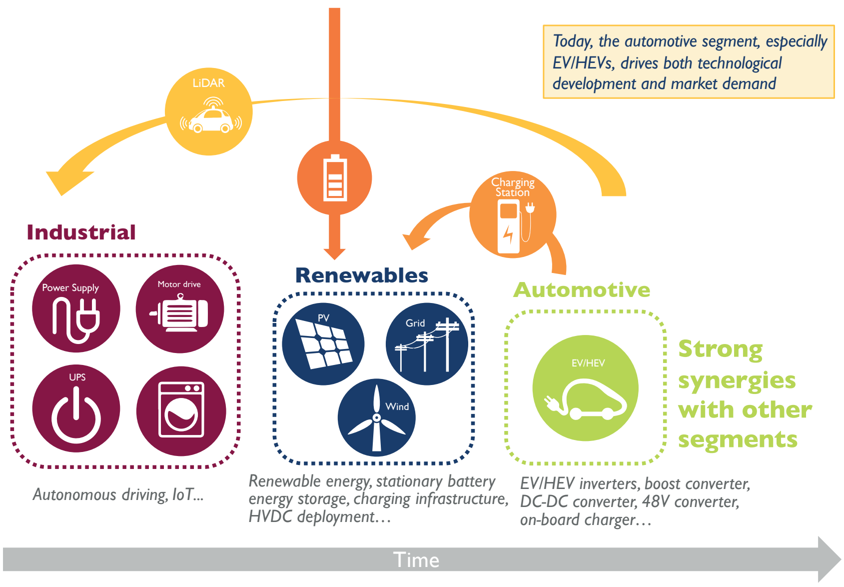
(Yole Développement, August 2019)

ELECTRIFICATION IS STILL THE KEY MARKET DRIVER OF THE POWER ELECTRONICS INDUSTRY

The power electronics market comprised $53.4B for power inverters in 2018, and $17.5B for power semiconductor devices. Key driving factors include electrical power conversion optimization and expansion, driven by electrification trends in transportation, CO_2 emission reduction goals, the development of clean electricity sources, and industrialization. We can say that the main driving application with a huge market potential and technological innovation is electric and hybrid electric vehicles (EV/HEVs). But let's not forget that there are other applications that are boosted by electrification needs and by EV/HEVs. This is the case in renewable energy, which is boosted by clean driving trends and growing electricity consumption. More grid lines also need to be deployed to sustain greater amounts of required energy. Similarly, more energy storage systems need to be deployed for better distribution of the energy to the grid. The grid must also reach newly installed EV charging stations outside cities, enabling many cars to be plugged in at the same time with an acceptable charging time. Moreover, if we take into account automated driving and long term vehicle-to-everything (V2X) communication, more data centers could be required, more LiDAR systems, along with other supporting technology. Hence, we are living an era where established applications are boosted by electrification and also by the EV/HEV transition, making the power electronics market very interesting to follow.

How are these applications evolving? Which are the main drivers? How is this translating to power semiconductors? And to Silicon substrates? All of these topics are discussed in this report.

Power electronics industry: driving applications' perspectives



(Yole Développement, August 2019)

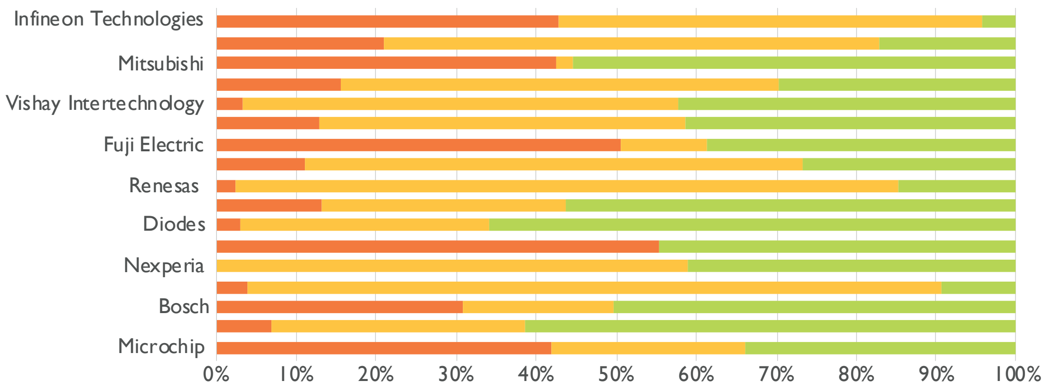
SEMICONDUCTOR MARKET EVOLUTION TOWARDS HIGHER POWER OFFERS MODULES A BOOST

The module market is today motivated by high power efficiency and density requirements from the main power applications. Still today, modules represent 23% of the total market. But we now see the push from end-user demand for new applications such as energy storage, charging infrastructure or EVs. These applications, and conventional ones like renewable energy and motor drives, will use modules with different power levels and reliability requirements. This will lead to a vast choice of power modules in the coming years. Power modules are being developed with new substrates, die attach materials or new semiconductor materials. Different players are focusing on innovation for modules and pushing production to enter this market. On the other hand, established players are fighting for their position in the market through innovation and delivering good product offerings.

The power electronics semiconductor market is in a growth period, which started in 2017 and continued in 2018. It is now saturated for some segments, specifically MOSFETs in 2019, but high demand is expected to continue. Yole Développement (Yole) expects a 4.5% Compound Annual Growth Rate (CAGR) from 2018-2024 for IGBT modules, while discrete IGBT parts' CAGR will be 2.7%. These forecasts are directly linked with investments in manufacturing lines from different players mentioned previously. Note also that the IGBT module market will be directly affected by the penetration of SiC during coming years, with a big push in the EV segment. This is indeed a worthy market to follow!

In this report, Yole summarizes the different markets in the power semiconductor area, from the silicon wafer to the discrete device, module and inverter.

Power electronics landscape: key players* and repartition of their activities



*Non-exhaustive list of companies

**Modules and discrete are added together in IGBT and MOSFET

(Yole Développement, August 2019)

REPORT OBJECTIVES

- Assess the market for wafers, devices, modules and inverters
- Understand the market dynamics for the whole power electronics industry
- Identify the key drivers that will shape the market in the future
- Have an overview on the different components used in power electronics and its integration
- Understand the main technological challenges to overcome and the solutions developed so far
- Provide a clear overview of the different applications driving the power electronics business
- Present data ranking the power electronics industry leaders, describing supply chain consolidation, the latest M&A activity and future trends in the power player landscape

WHAT'S NEW

- Update on power electronics wafer level market from 2018 to 2024
- Update on power electronics' major discrete and module segments, specifically IGBT and MOSFET, from 2018 to 2024
- Updated global SiC and GaN markets
- Forecast comparison for discretes and modules by type of device and material
- Update of power electronics inverter market from 2018 to 2024
- Market and technology trends for each power electronics application
- Company revenues in 2018
- Power electronics player ranking and landscape analysis for 2018
- Analysis of the latest M&A activity
- Overview of technology status for power electronics
- Focus on packaging trends
- Wide band gap update

COMPANIES MONITORED IN THE PRODUCT

ABB, Alpha and Omega Semiconductor (AOS), Alstom, Amkor, Analog Devices, ASE Group, Bosch, BYD, Continental, Cree, CRRC, Danfoss, Denso, Dialog Semiconductor, Diodes Incorporated, Diotec semiconductor, Episil, EXAGAN, Fuji Electric, GaN Systems, General Electric, Global Wafers, GTA semiconductor, HHGrace, Hitachi, Honda, Huawei, Infineon, Ingeteam, LEM, Littelfuse, MACMIC, Magnachip, Maxim Integrated, Microchip, Mitsubishi Electric, Monolithic Power Systems, Navitas, Nexperia, NXP, Okmetic, ON Semiconductor, Panasonic, Powerex, Power Integrations, Qualcomm, Renesas, Rohm, Sanken, Semikron, Semtech, Shindengen, ShinEtsu, Siemens, Silan Microelectronics, Silego Technology, Silterra, Siltronic, Sino-Microelectronics, Soitec, ST Microelectronics, StarPower, Sumco, Sungrow, Tamura, TDK, Tesla Motors, Texas Instruments, Toshiba, Toyota, Transphorm, UnitedSiC, UTAC, Valeo, Vishay, Volkswagen, and more...

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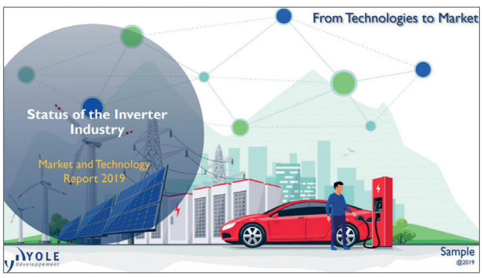

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AUTHOR

Ana Villamor, PhD serves as a Technology & Market Analyst, Power Electronics & Compound Semiconductors within the Power & Wireless division at Yole Développement (Yole). She is involved in many custom studies and reports focused on emerging power electronics technologies at Yole Développement, including device technology and reliability analysis (MOSFET, IGBT, HEMT, etc). In addition, Ana is leading the quarterly power management market updates released in 2017.

Previously Ana was involved in a high-added value collaboration related to SJ Power MOSFETs, within the CNM research center for the leading power electronic company ON Semiconductor. During this partnership and after two years as Silicon Development Engineer, she acquired a relevant technical expertise and a deep knowledge of the power electronic industry.

Ana is author and co-author of several papers as well as a patent. She holds an Electronics Engineering degree completed by a Master and PhD. in micro and nano electronics from Universitat Autonoma de Barcelona (SP).

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The present document is valid 24 months after its publishing date: August 6, 2019

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