Status of the Power Electronics Industry 2020
Market and Technology Report 2020
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**Mergers and acquisitions**
- Wafer, device, module and system levels
- Other power electronics components, passives, materials, batteries, etc.
- EV/HEV partnerships and joint ventures
- Danfoss - enlarging business competencies and ensuring supply chain
- Mergers and acquisitions in railway
- ADI to acquire Maxim Integrated to strength its business
- Diodes Incorporated to acquire Lite-On Semiconductor Corporation
- Infineon - enlarging product portfolio

**COVID-19 crisis’s impact on the power electronics industry**
- A concomitance with potentially worsening factors
- Impact of COVID-19 on our forecasts
- COVID-19’s impact on customers’ thinking
- COVID-19’s impact on power electronics supply chain
- COVID-19’s impact on companies’ revenues
- Geographic supply chain re-organization

**Focus on China**
- What does the future hold for China?
- Different market segments, varying governmental influence
- Focus on China: application level
- China’s “gap” is tied to power semiconductor devices
- Focus on BYD
- IGBT players in China
- MOSFET player status in China

**Technology trends**
- Challenges, main requirements, and innovation axes
- Towards more integration
- Choice of semiconductor materials and new device designs
- Power device packaging
  - Discrete, module, packaging trends, integration
- Wide Bandgap
  - Highlights, commercial devices, SiC inverters, passive needs for WBG, SiC and GaN packaging solutions
- EV charging solutions
  - Different EV charging solutions, fast charging challenges, trends toward high power charging, bidirectional charging solutions for V2G and V2H
- Batteries and power electronics
  - Batteries for EVs, other driving applications
  - 800V vehicles and their impact on power electronics
  - Toward 1,500V DC in stationary battery packs
  - Where are the opportunities for power electronics players?
  - Different approaches to increase driving range in electric vehicles

**Take-away and outlook**
- Conclusions/take-aways
- Things to watch closely in the future

**Related reports**
- Yole corporate presentation

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Ana Villamor, PhD, Technology & Market Analyst, Power Electronics
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).

Contact: ana.villamor@yole.fr

Milan Rosina, PhD, Principal Analyst, Power Electronics & Batteries
Milan Rosina, PhD, is Principal Analyst, Power Electronics and Batteries, at Yole Développement (Yole), within the Power & Wireless division. He is engaged in the development of the market, technology and strategic analyses dedicated to innovative materials, devices and systems. His main areas of interest are EV/HEV, renewable energy, power electronic packaging and batteries. Milan has 20 years of scientific, industrial and managerial experience involving equipment and process development, due diligence, technology, and market surveys in the fields of renewable energies, EV/HEV, energy storage, batteries, power electronics, thermal management, and innovative materials and devices. He received his PhD degree from Grenoble Institute of Technology (Grenoble INP) in France. Milan Rosina previously worked for the Institute of Electrical Engineering in Slovakia, Centrotherm in Germany, Fraunhofer IWS in Germany, CEA LETI in France, and utility company ENGIE in France.

Contact: milan.rosina@yole.fr

Abdoulaye Ly, Technology & Market Analyst
Abdoulaye Ly is a Technology & Market Analyst specializing in Electronic Power Systems at Yole Développement (Yole). As part of the Power Electronics & Wireless division at Yole, Abdoulaye’s expertise is focused on power electronics system design. Prior to Yole, Abdoulaye served as an electrical engineer and power electronics system engineer at Centum Adetel Transportation Solution for 3 years, where he was in charge of converter design. He also performed simulations for catenary free tramways, tested qualifying Auxiliary Power Supplies (APS) for railway applications and managed a team developing a new battery cooling system. Abdoulaye graduated with a technical degree in 2014 from Bethune University Institute of Technology and in 2017 received an electrical engineering degree from Grenoble Institute of Technology.

Contact: abdoulaye.ly@yole.fr
This report focuses on silicon wafers and devices. However, our power market figures:
- include SiC and GaN forecasts.
- do not include power management ICs. These are available in a dedicated report published in Nov 2019.

Note that our MOSFET figures only include silicon substrate MOSFETs, since Yole offers a dedicated report with comprehensive coverage of the SiC substrate, including MOSFETs.

On the pages of this report that contain forecasts, a corresponding legend indicates the specific information included.
MEGATRENDS IN POWER ELECTRONICS

Power electronics devices, systems and applications are getting stronger, greener, smarter and more connected and integrated.

Green - clean, renewable and high power conversion efficiency

Smart and interconnected

Battery-powered cordless end-system 'batteryfication'

Increasing system power and power semiconductor content per system

Efficiency

Power generation → Energy solutions for smart buildings and cities

Product → Service
Today, the automotive segment, especially EVs/HEVs, drives both technological development and market demand. We should not forget about other applications which represent significant demand and have some specific requirements.

**Industrial applications**
- Photovoltaic inverters, wind converters

**Renewables**
- Strong synergies with other segments
- Renewable energy, stationary battery energy storage, charging infrastructure etc.

**Automotive incl. EVs/HEVs**
- EV/HEV inverter, boost converter, DC-DC converter, 48V converter, on-board charger, etc.
### MARKET TRENDS BY APPLICATION

#### SYSTEM-LEVEL TRENDS

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<thead>
<tr>
<th>Application</th>
<th>Market trends</th>
<th>Technology impacts/trends</th>
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<td>E&amp;HEVs</td>
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#### APPLICATION TRENDS

**Renewable energy sources: PV**

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**Renewable energy sources: Wind**

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**Motor drives**

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**UPS, computing and storage**

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#### SYSTEM-LEVEL TRENDS

**Networking & telecom**

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**Consumer audio, white goods and energy storage systems**

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MARKET TRENDS BY PRODUCT

MOSFET MARKET EVOLUTION, PER APPLICATION
Market segment size and evolution - comparison (1/2)

SUMMARY OF POWER DEVICES, BY APPLICATION
Voltage summary, by device and application

IGBT MARKET DEVELOPMENT, PER APPLICATION
Market segment size and development comparison - 1/2

IGBT MARKET - METRICS AND FORECASTS
Module IGBT vs. discrete IGBT market share

Yole expects IGBT modules to increase in share during the forecast period, driven by EVs.
FAB INCREASE - DEVELOPMENT TIMELINE

200 and 300mm fab expansion

Investment announcement

Envisaged readiness of the fab for volume production

Production started

Early 2000s

2017

300mm fab in Dresden, first for DRAM, later slated for power

0.36B

2018

300mm fab x2

BOSCH

Invented for life

2019

300mm fab

Power MOSFET in 300mm

2020

Dec 2018

200mm fab, Scotland

Power MOSFET, BCD, IGBT

300mm fab from Global Foundries, NY

$1B

$3.6B

$1.6B

$430M

300mm fab in Wuxi

2021

CanSemi

2022

300mm fab, Chongqing

2023

200mm fab expansion 1.5x; considering 300mm fab

*non-exhaustive list

Envisaged readiness of the fab for volume production

TOSHIBA

Yole Développement, September 2020

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MARKET SHARES AND SUPPLY CHAIN

KEY PLAYERS AND THE POWER ELECTRONICS LANDSCAPE
Geographic location of the main power semiconductor players and foundries

SUPPLY CHAIN
Varied offers exist in the supply chain for larger market capture

SUPPLY CHAIN IN CHINA

PACKAGING PLAYERS - OVERVIEW
Discrete power devices vs. power modules

- These trends favor the power module market, but also offer opportunities to companies with discrete packaging technology solutions and services.
MERGER AND ACQUISITIONS

Power Electronics Landscape - Developments

Device and module level

- There have been many M&As at the device level from different IDMs. The last five years have made the company portfolios with new products and/or new target applications the main reason for these deals.

System level

- Other power electronics components, passives, materials, batteries, etc.

EV/HEV partnerships and joint ventures: batteries, converters, modules, chip

- Cree and ABB for SiC modules
- ZF and Danfoss for SiC modules
- ZF and Cree for SiC components
- Volvo and Dana for a 48V system
- Bosch and CATL for 48V batteries
- Ford and Volkswagen for autonomous and EVs
- Toyota and Subaru for BEVs
- Denso and Aisin created BlueNext to develop modules for EVs
- Jaguar Land Rover and BMW group collaborate for EVs
- Toyota and BYD for EVs
- BYD and CATL for batteries in BEVs

2018
2019

For more information, please refer to Yole Development report: Power Electronics for Electric & Hybrid Electric Vehicles 2020

BYD to supply DAIMLER with its LPF batteries
- Mercedes-Benz and CATL partnership in the field of battery technology
- BorgWarner acquires Delphi Technology
- Daimler acquires stake in Tezla
- A long-standing collaboration
- ON Semiconductor and Danfoss for high-power devices for inverters
- Honda and General Motors for battery development
- ON Semiconductor and Audi for electronics in autonomous and EV

And more to come!
COVID-19 IMPACT
FOCUS ON CHINA

What does the future hold for China?

Different market segments, varying governmental influence

The Chinese market

Government control

Government support

Relatively free market

FOCUS ON CHINA

Application level

Development of Incentive Mechanisms for E-Mobility in China

China's 'gap' is tied to power semiconductor devices

FOCUS ON CHINA

IGBT players in China

There are more IGBT-type companies fabricating IGBTs.

SIGNIFICANT POWER INDUSTRY EVENTS, SINCE 2017

CHINESE COMPANIES GOING IPO

In 2020 there have been few Chinese companies going IPO. BYD Technology and CSR Micron.
TECHNOLOGY TRENDS

TOWARDS MORE INTEGRATION

POWER ELECTRONICS DEVICE TRENDS
Choice of semiconductor materials and new device designs

THE TREND TOWARDS HIGHER POWER DOES NOT MEAN THE END OF DISCRETE DEVICES

WHY IS PACKAGING SO IMPORTANT?

GLOBAL TRENDS FOR POWER MODULE PACKAGING

DISCRETE DEVICE PACKAGING TRENDS
How will discrete device packages evolve?
Development in discrete component packaging shares the same motivations as power modules:
- Miniaturization
- Increase power density
- Increase efficiency
- Increase yield

For discrete power devices, the key objective is to increase efficiency and power density.

Growing challenges related to heat dissipation necessitate development of excellent heat dissipation products.
FOCUS ON SIC AND GAN
FOCUS ON BATTERIES, POWER ELECTRONICS AND CHARGING INFRASTRUCTURE

WHAT INTEREST DO POWER ELECTRONICS PLAYERS HAVE IN THE EV/HEV SEGMENT?

Focus on battery electric vehicles

PHEV/BEV CHARGING SOLUTIONS

WHY IS DEMAND FOR FAST CHARGING SOLUTIONS INCREASING?

HIGH EFFICIENCY SOUGHT FOR EV CHARGING

Lower electricity cost for charging, better environmental impact

BATTERIES AS THE KEY ELEMENT OF SUSTAINABLE MOBILITY AND ENERGY GENERATION

WHERE ARE THE OPPORTUNITIES FOR POWER ELECTRONICS PLAYERS?
YOLE GROUP OF COMPANIES RELATED REPORTS

Yole Développement

Power Electronics for Electric & Hybrid Electric Vehicles 2020

Status of the Power Module Packaging Industry 2019

Power SiC 2019: Materials, Devices, and Applications

Compound Semiconductor Quarterly Market Monitor

Contact our Sales Team for more information

Power GaN 2019: Epitaxy, Devices, Applications & Technology Trends
GaN-on-Silicon Transistor Comparison 2018
Yole Group of Companies, including Yole Développement, System Plus Consulting and PISEO, are pleased to provide you a glimpse of our accumulated knowledge.

We invite you to share our data with your own network, within your presentations, press releases, dedicated articles and more, but you first need approval from Yole Public Relations department.

If you are interested, feel free to contact us right now!

We will also be more than happy to give you updated data and appropriate formats.

Your contact: Sandrine Leroy, Dir. Public Relations
Email: leroy@yole.fr