

# POWER GAN 2018: EPITAXY, DEVICES, APPLICATIONS AND TECHNOLOGY TRENDS

Market & Technology report - November 2018

*GaN market growth is fed by LiDAR, wireless charging and fast charging solutions.*

## KEY FEATURES

- In-depth analysis of GaN's penetration in different applications, including power supplies, PV, EV/HEV, UPS, LiDAR, and wireless power
- State-of-the-art GaN power devices review, including product charts and device descriptions
- Description of the GaN power industrial landscape, from epitaxy and device design to device processing
- Discussion of GaN power market dynamics
- State-of-the-art developments for power GaN packaging and integration
- GaN reliability overview
- Market projection for GaN epitaxy through 2023, by value and volume

## WHAT'S NEW

- Updated market segmentation from Yole Développement
- Comprehensive analysis of the power supply segment, including GaN power supplies for data center applications
- LED-driver market segment
- Device segmentation, by discrete and power IC
- Discussion on GaN diode technology and its market potential
- Review of GaN-on-GaN for power electronics
- Technological analysis and impact on the value chain
- Integration roadmap
- Cost analysis

## THE GAN POWER DEVICE MARKET FACES TWO POSSIBLE SCENARIOS: WHICH APPLICATION WILL CAUSE THE MARKET TO EXPLODE?

Today, it is crystal-clear that, from theoretical point of view, GaN offers fantastic technical advantages over traditional Si MOSFETs. Even though the current GaN power market remains tiny compared to \$32.8B silicon power market, GaN devices are penetrating confidently into different applications: for example, LiDAR applications, which are high-end solutions that take full benefit of high-frequency switching in GaN power devices. The accumulation of the market growth in this application and other various applicative markets confirms a first scenario in which the GaN market is expected to grow steadily (base scenario).

However, this is not the only possibility. Is there any killer application that could cause the GaN power device market to explode?

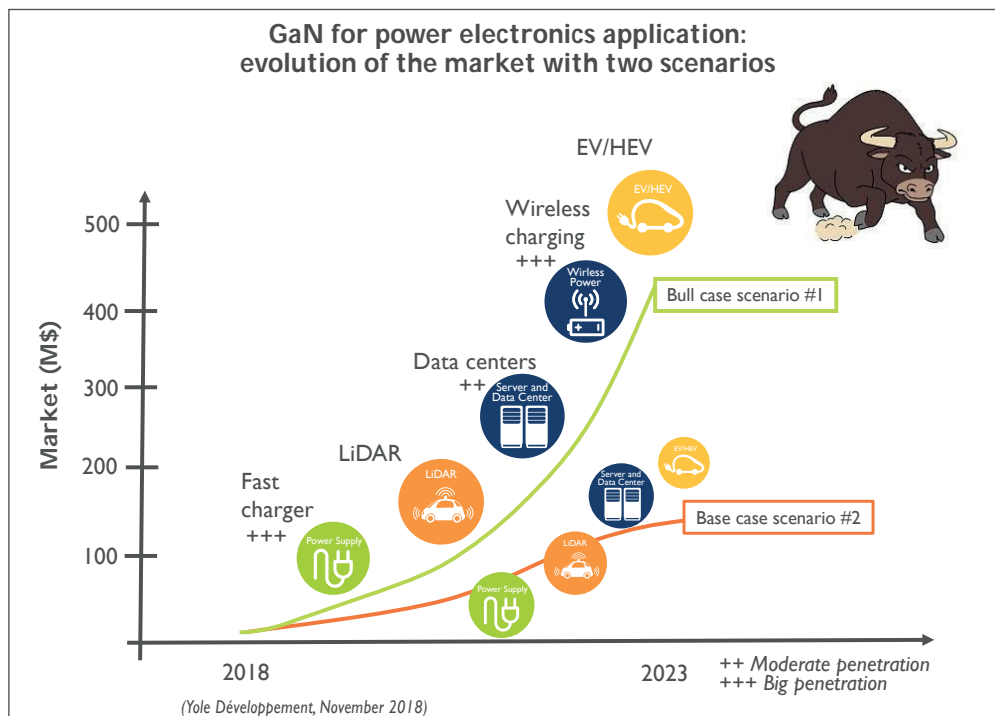
As matter of fact, several industrial players confirm that Apple is interested in GaN technology for its wireless charging solution. It goes without saying that the potential adoption of GaN by Apple or another smartphone giant would completely change the market's dynamics and finally provide a breath of life to the GaN power device industry. We imagine that after a company like Apple adopts GaN, numerous other companies would follow on the commercial electronics market.

Indeed, the biggest segment in the power GaN market is still power supply applications, i.e. fast charging for cellphones. In fact, this year Navitas and Exagan introduced 45W fast-charging power adaptors with an integrated GaN solution.

And what about the EV market, where SiC is replacing Si IGBTs in main inverters? What is GaN's role here? Various players, such as EPC and Transphorm, have already obtained automotive qualification in preparation for GaN's potential ramp-up. Moreover, BMW i Ventures's investment in GaN Systems clearly demonstrates the auto industry's interest in GaN solutions for EV/HEV technology.

Globally, Yole Développement's (Yole) second scenario (bull scenario), which is more aggressive, projects that the GaN power business will reach around \$423M by 2023, with a compound annual growth rate (CAGR) of 93%.

*This report conveys Yole's understanding of GaN implementation in different market segments, with two possible scenarios. Our report also delivers comprehensive market projections for GaN power discrete and the IC device market, and conveys our understanding of the market's current dynamics and future evolution.*



## WHAT IS POWER GAN'S SUPPLY CHAIN STATUS?

Eight years have passed since the first release of commercial power GaN devices. People in the power industry are becoming increasingly familiar with the names of start-ups that are actively promoting GaN technology. Not surprisingly, the list of pure GaN start-up players is getting longer: Efficient Power Supply (EPC), GaN System, Transphorm, Navitas, and more are coming, according to Yole's intelligence. Most of these start-up players choose the foundry model, mostly using TSMC, Epasil, or X-fab as their preferred partner. Meanwhile, other foundries might offer this service if the market takes off. The

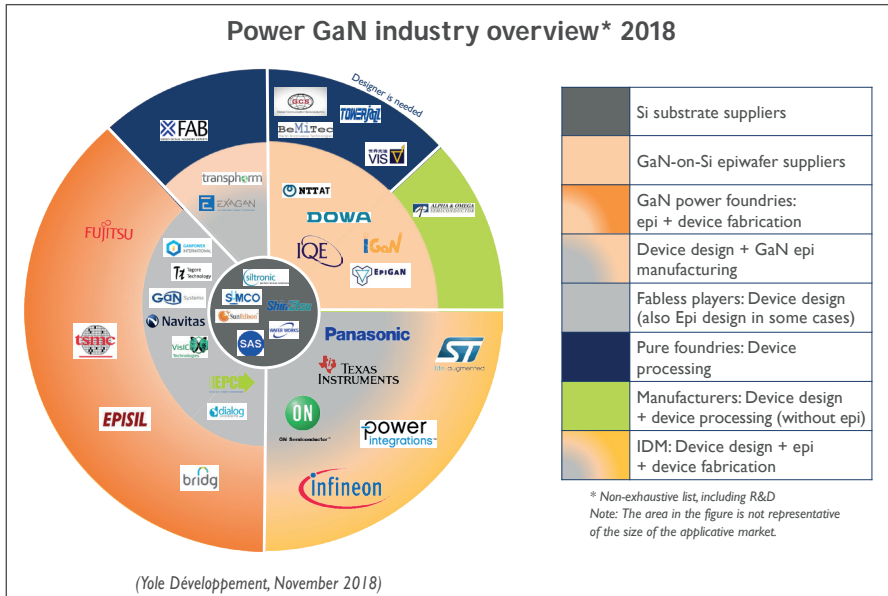
foundry model affords fabless or fab-lite start-ups the possibility of ramping up quickly if the market suddenly takes off, as discussed in the previous section.

It is fascinating to see that along with these start-up players, companies with very different profiles are competing in the same playground: industrial giants like Infineon, On Semi, STMicroelectronics, Panasonic, and Texas Instruments. Several news items caught our attention in 2018:

- Infineon announced it would start volume production for CoolGaN 400V and 600V e-mode HEMT products by the end of 2018
- STMicroelectronics and CEA Leti announced their cooperation in developing GaN -on-Si technologies for both diode and transistor on Leti's 200mm R&D line, and expect to have validated engineering samples in 2019. In parallel, STMicroelectronics will create a fully qualified manufacturing line, including GaN-on-Si hetero-epitaxy, for initial production running in the company's front-end wafer fab in Tours, France, by 2020.

These IDMs will leverage their vertically integrated structure and bring to market cost-competitive products.

*This report furnishes an overview of the GaN power industry playground, covering the value chain from epitaxy and device design, to device processing. Also outlined is Yole's understanding of the market's current dynamics and future evolution.*

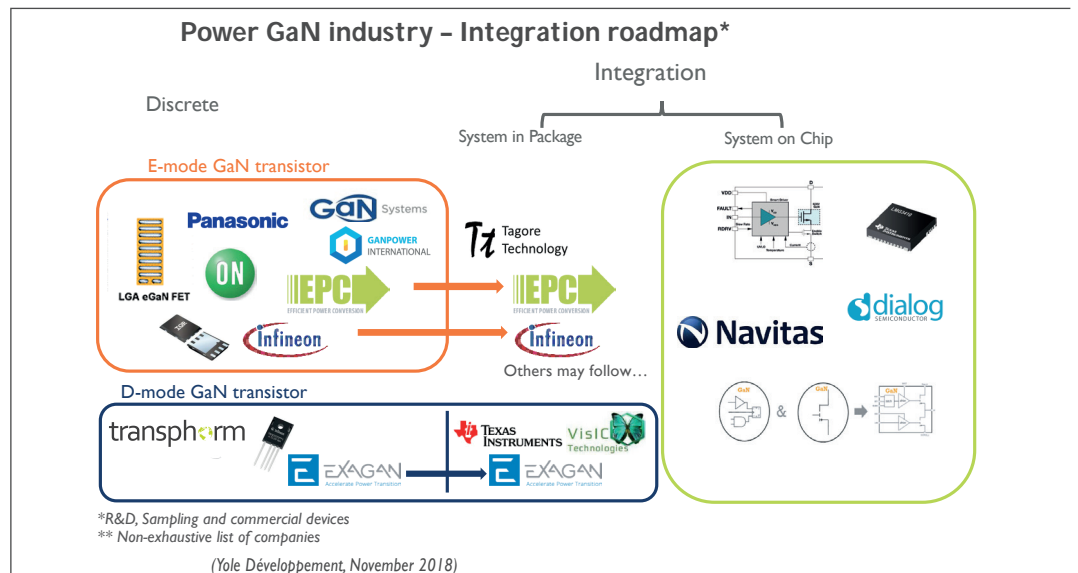


## IS GAN A COST-EFFECTIVE SOLUTION?

The integration of GaN solutions in a final electronics product is a very attractive idea: if properly designed, it will increase system efficiency, and passive components will be smaller because the system can work at higher frequencies. These are significant advantages for the final user...but is that true?

Cost is one of the key aspects to take into account when introducing a new technology to the market,

and it is currently not one of GaN's strong points. GaN's principal competitor is silicon MOSFET, which has been on the market for many years and offers very competitive cost with high average efficiencies, excellent quality, and superb reliability. Currently, only one company, EPC claims to be at the same price level as silicon with its low-voltage wafer-level package products. However, when standard





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The "More than Moore" market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

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