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Will the Wide Bandgap Power Electronics Market hit \$10 billion and Beyond?

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Semiconductors: Power, Automotive, Industrial, MEMS & Sensors

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The logo for VICM, consisting of the letters 'VICM' in a bold, black, sans-serif font. The 'V' is stylized with a dot at its top left corner. The logo is positioned in the bottom right corner of the slide.

VICM

Your Presenter



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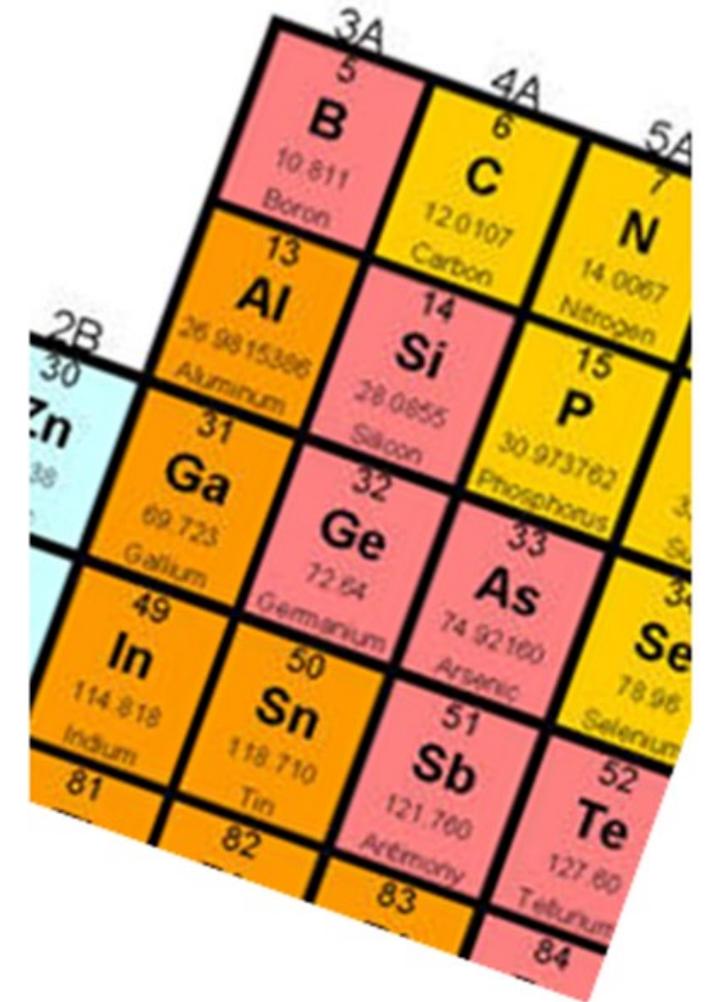
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Since 2010, Richard Eden has been the market analyst for power semiconductor discretes and modules in what is now the Semiconductor group of Omdia (a division of Informa Tech). Richard is one of the team that writes Omdia's reports on the Si, SiC and GaN power semiconductor markets, which are highly regarded within the industry.

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Silicon carbide (SiC) device manufacturers and foundry providers



Silicon carbide (SiC) substrate wafer suppliers



Recent changes to the SiC power semiconductor market

- | | |
|----------------|---|
| In 2020 | <ul style="list-style-type: none">• II-VI Incorporated acquired Ascatron AB of Sweden; II-VI Inc., it then changed its name to “Coherent” in 2022.• Hitachi partnered up with ABB Group, including ABB Semiconductors. In 2021, the JV was renamed Hitachi Energy. |
| In 2021 | <ul style="list-style-type: none">• LX Semicon acquired LG Innotek's silicon carbide (SiC) semiconductor business.• onsemi acquired GT Advanced Technologies to become a vertically-integrated SiC supplier: boule > wafer > semiconductor. |
| In 2022 | <ul style="list-style-type: none">• SK Group bought a majority stake in Yes Power Technix (Korea), to complement its ownership of SK Siltron• ROHM Semiconductor increased SiC power semiconductor capacity with the opening of a new building at its Apollo site• Wolfspeed opened its 8-inch SiC device fab in NY state and is expanding its SiC material operations in NC.• STMicroelectronics announced plans to grow SiC wafers at its Catania fab, bringing all SiC processing steps into one site.• Navitas bought GeneSiC Semiconductor to become “the first pure-play, next-generation power semiconductor company”• onsemi added SiC wafer polishing and epitaxy (EPI) growth capacity to its Si wafer site in Roznov, Czechia |
| In 2023 | <ul style="list-style-type: none">• Showa Denko K.K. merged with the former Hitachi Chemical Co., Ltd. and transformed into “Resonac Corporation”• Wolfspeed will build a 200mm SiC wafer fabrication facility in Saarland, Germany, in partnership with ZF Friedrichshafen.• Combined with the construction of a new fab in NC, USA, Wolfspeed will expand its materials capacity by more than 10x.• SK Siltron Inc. will invest \$640 million in Korea to expand its silicon carbide (SiC) wafer output by 17x by 2025• Mitsubishi Electric announced plans to build a new 8-inch SiC wafer plant in Kumamoto prefecture, Japan. |

Gallium nitride (GaN) device manufacturers and foundry providers



Selected GaN foundry service providers:



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Recent changes to the GaN power semiconductor market

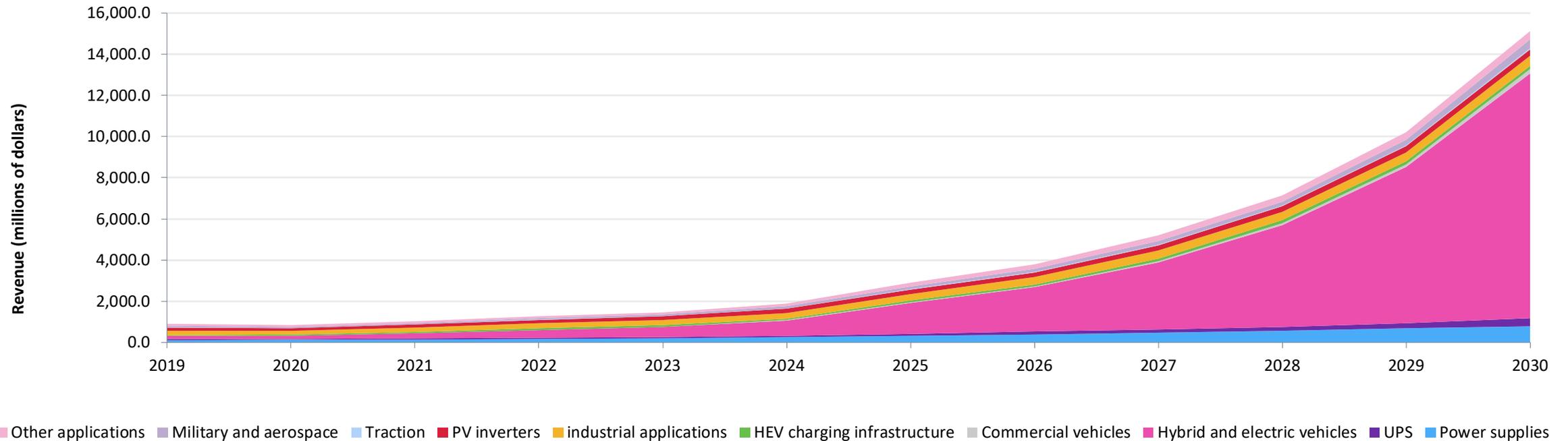
| | |
|---------|---|
| In 2015 | <ul style="list-style-type: none">Innoscience of Suzhou, China, was founded with the aim of becoming the world's largest GaN semiconductor manufacturer. It opened a 2nd fab in 2020 and has established offices in the US and Europe recently. |
| In 2016 | <ul style="list-style-type: none">Cambridge GaN Devices (CGD) was founded. It designs, develops, and commercialises GaN transistors and ICs. |
| In 2020 | <ul style="list-style-type: none">Transphorm Inc., went public and has been traded on the NASDAQ stock exchange since 2022.Wise Integration was spun out of CEA-Leti in France to develop GaN power transistors and GaN ICs. |
| In 2021 | <ul style="list-style-type: none">Infineon and Panasonic announced that they are jointly developing second generation normally-off GaN transistors.Following the acquisition of GaN developer Exagan, STMicroelectronics launched its first MasterGaN® products.Former GaN IC developer Dialog Semiconductor was acquired by Renesas Electronics.GaNPower demonstrates the industry's first 1200V single-die E-mode GaN power transistor.Navitas Semiconductor debuted on the NASDAQ stock exchange.Nexperia launched its first 6 GaN transistors. |
| In 2022 | <ul style="list-style-type: none">The Oudenaarde GaN foundry operation of onsemi in Belgium was sold-off and acquired by BelGaN.ROHM Semiconductor launched its first 120V GaN power transistor products, developed together with GaN Systems.Transphorm demonstrated its first 1200V GaN power device to enable greater cost effectiveness than SiC solutions.Odyssey Semi became the first company to achieve 1200V operation of a vertical GaN power FET device. |
| In 2023 | <ul style="list-style-type: none">Infineon Technologies announced an agreement under which Infineon will acquire GaN Systems for US\$830 million. |

Wide band-gap (SiC & GaN) power semiconductor market forecasts

- SiC market by applications and products
- GaN market by applications and products

The SiC power semiconductor market by application sector

Overall SiC power semiconductors by application



Source: Omdia

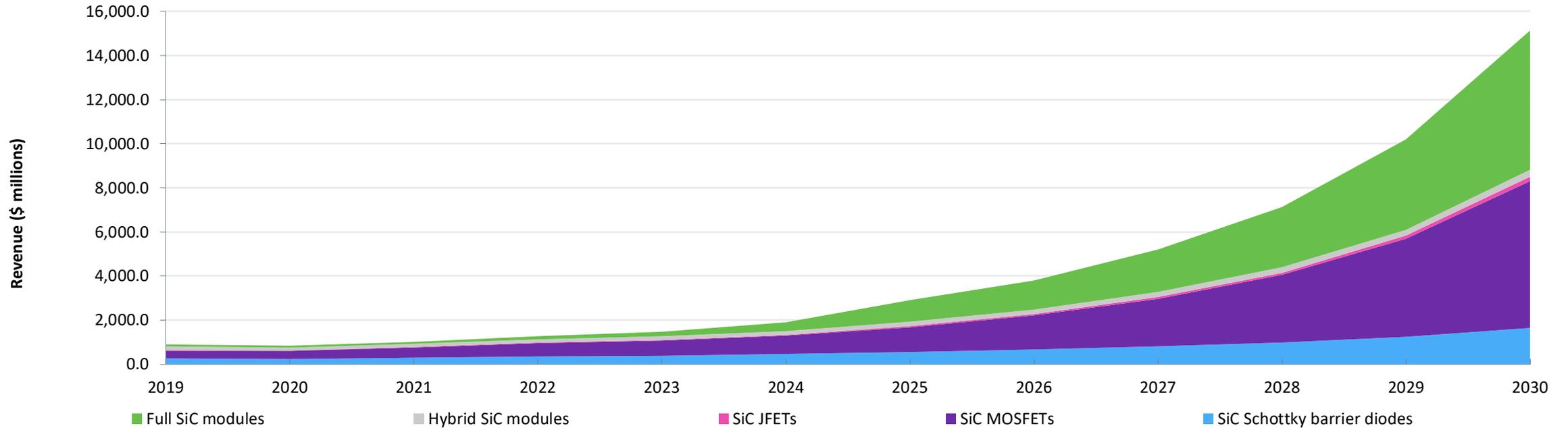
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Data: The SiC & GaN Power
Semiconductors Report – 2021

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The SiC power semiconductor market by product type

Overall SiC power semiconductors by product type



Source: Omdia

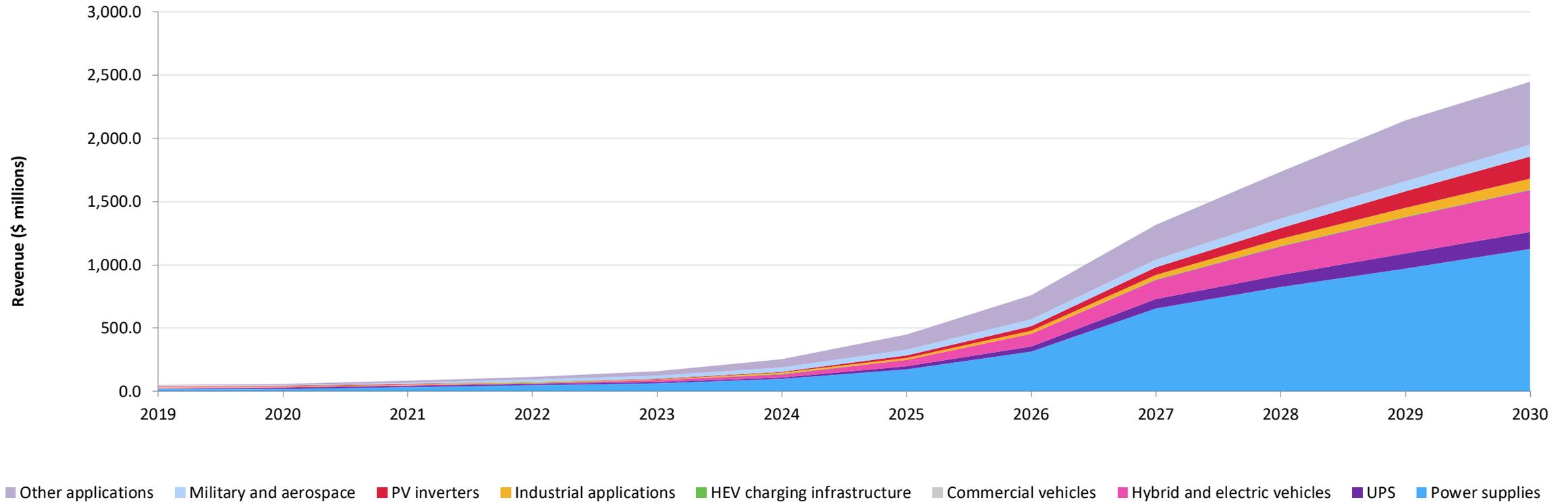
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Data: The SiC & GaN Power Semiconductors Report – 2021



The GaN power semiconductor market by application sector

Overall GaN power semiconductors by application



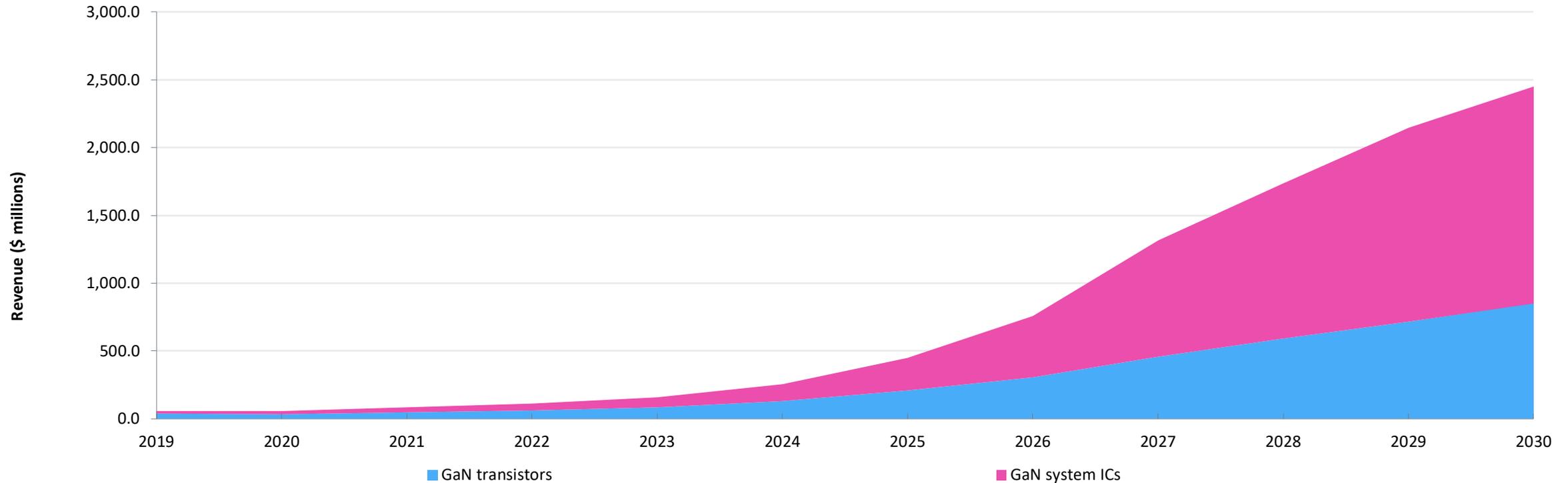
Data: The SiC & GaN Power Semiconductors Report – 2021
Source: Omdia

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The GaN power semiconductor market by product type

Overall GaN power semiconductors by product type



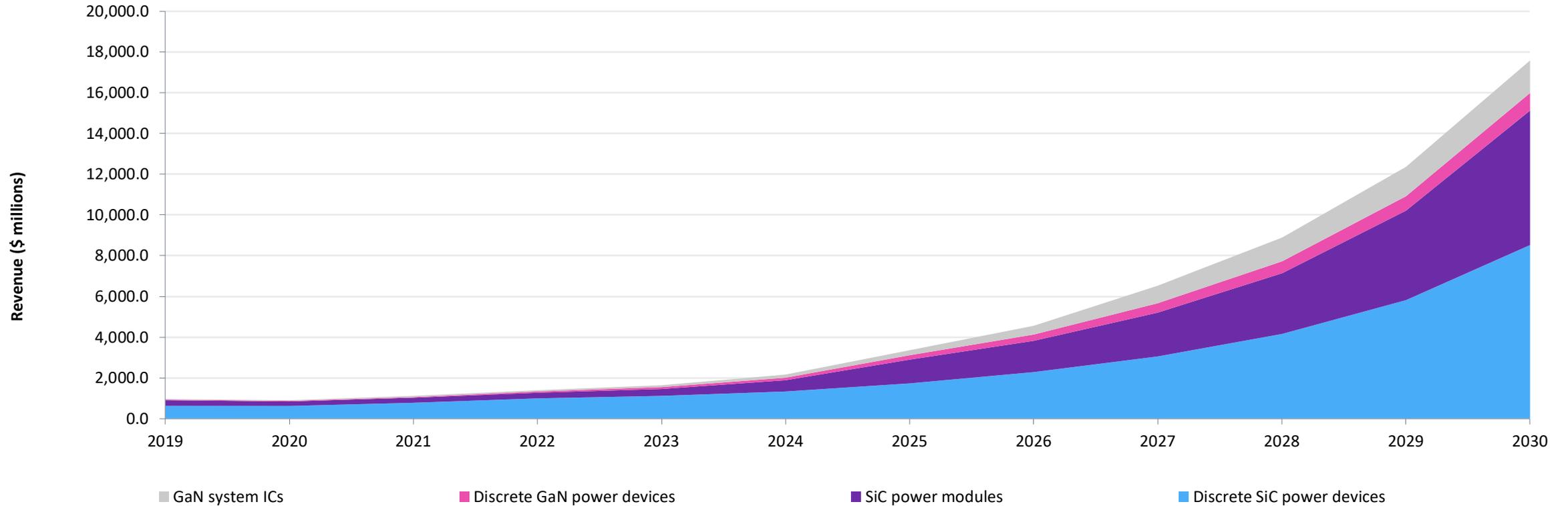
Source: Omdia

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Data: The SiC & GaN Power Semiconductors Report – 2021

The combined SiC and GaN power semiconductor market by product

Combined SiC and GaN power semiconductors by technology



Source: Omdia

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Data: The SiC & GaN Power Semiconductors Report – 2021



Conclusions

Conclusions

- When compared with Silicon, SiC offers most benefit **above** 1,000V and GaN offers most benefit **below** 1,000V.
- **Decreasing device prices are triggering adoption NOW.**
- SiC is being used in HEVs already and has started to appear in industrial niches (e.g., PSUs, PV, UPS, HEV charging stations, etc.).
- **The SiC supply chain infrastructure is improving to allow the rapid ramp up of production. Most SiC wafer suppliers are preparing 8-inch SiC wafer production. Production capacity is expanding, especially for SiC wafers – see SiC page 7.**
- At 650V, SiC MOSFETs, JFETs and GaN transistors can now match Si Superjunction MOSFETs for price and performance.
- GaN system ICs are now available from several suppliers in high volumes (Power Integrations, TI, Navitas, etc.).
- GaN is now established in high-end computing and telecom/server PSU applications.
- GaN ICs are now established in adaptors and fast chargers for cell phones and Notebook PCs.
- GaN is being evaluated to replace Si and SiC in HEV OBC and dc-dc converter applications.
- **GaN still has work to do to demonstrate reliability before industrial sectors will adopt, but it is coming.**

Yes, wide band-gap (SiC & GaN) power semiconductor sales should surpass the \$10 million level in 2028, if not sooner. Wafer capacity should exceed semiconductor demand for the foreseeable future.”

Get in touch!

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