

LUCINTEL INSIGHT
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FIVE TRENDS SHAPING THE FUTURE OF THE POWER MODULE MARKET

The power module market is growing significantly due to increasing utilization of intelligent power modules in personal computing applications owing to their compact design and increased energy efficiency, and also due to rising adoption of electric vehicles, and growing renewable energy resources. Some of the key trends in the power module market are the emergence of IGBT high-power modules, development of high-temperature SiC power modules, increasing focus of

consumers on minimizing power losses, and power module solutions in renewable energy. The major growth drivers for this market are high growth of electric vehicles, increasing focus of consumers for minimizing power losses, and maximizing power savings. .

The power module market is divided into insulated gate bipolar transistors (IGBTs), field effect transistors (FETs), silicon carbide (SiC), and others. Key players in the power module market include Infineon, Fuji Electronics, Semikron, STMicroelectronics, and Mitsubishi Electric Corporation. These have been working on different strategies to drive sales using highly influential marketing approaches; however, as we examine the challenges and opportunities ahead in this market, companies can benefit from the strategy of developing capabilities in high-power IGBT modules and high-temperature SiC power modules, as well as considering the key target market trends we have identified. Lucintel predicts that the global power module market will be valued at \$12.4 billion by 2025, with an expected CAGR of approximately 16.6% between 2020 and 2025.

Lucintel identifies five trends set to influence the global power module market. Most of the industry players and experts agree that these five trends will accelerate developments in the power module industry in the near future. In terms of the widespread knowledge about the power module market already on the horizon, there is still a lack of unified perspective on the direction the industry is moving to proactively address developments. To help bring more clarity to this gap, our study aims to provide insights concerning the direction that changes are taking and how these changes will impact the power module market.

1. Emergence of IGBT High-Power Modules

In accordance with the continuous development of power electronics in the coming years, IGBT modules have become the key power modules used in a wide range of fields, such as automotive, industrial, and others. The development of high-power IGBT modules is designed to cover the full voltage range of IGBT chips from 1.2 to 6.5kV. These are used in industrial drive,



traction, renewable energy, and power transmission applications. One key innovation is the scalability, which greatly simplifies system design and manufacturing. Moreover, the robust architecture and the new high-power platform provides long-term reliability in applications with demanding environmental conditions. The main reason for the development of this new technology is to meet the need for flexibility and reliability while assuring optimal integration into customer systems.



2. Development of High-Temperature SiC Power Modules

When the power module operates at a high temperature, its reliability, specifically in areas such as the occurrence of lowering main bonding strength of the power module, is considerably reduced due to thermal deformation. In this power module, the main components of the module are combined using eutectic solder with a solidus line above 350°C. Copper-tungsten (CCW) is selected as the base plate material.



Since the coefficient of thermal expansion values of CuW and silicon nitride (SiN), it is possible to reduce the stress applied to these joints when the temperature changes. Additionally, CCW has excellent thermal conductivity and heat capacity, and suppresses the heat generation of Si-power modules. The high-temperature capability of SiC gate driver ICs allows for them to be packaged into the power module and be located physically close to the power devices. This provides separate benefits by decreasing the gate driver loop inductance, which promotes the high-frequency operation, while also reducing the overall volume of the system through higher levels of integration.



3. Growth of Electric Vehicles

Power modules are used in electric vehicles to meet typical application requirements, such as the capability to withstand more than three million active thermal cycles. By consistently avoiding solder connections, solder fatigue, a key failure mechanism in power modules, can be completely eradicated, which further reduces material fatigue in solder joints. The main traction inverter, a critical component in the electrified drivetrain, has a direct influence on the driving experience, the battery range, and the overall safety of an electric vehicle. The function of the traction inverter is to convert the DC current from the electric vehicle's battery to AC current to be used in the electric motor to drive the vehicle's propulsion system. This plays a key role in capturing energy from regenerative braking and feeding it back to the battery. These inverters combine ease of assembly with a modular design approach and comprise frame based, silicone-gel-filled power modules in a six-pack or customized configurations, sometimes even including charger or booster topologies. Most electrified powertrain traction inverters contain a multichip-semiconductor power module. It can comprise IGBTs, diodes, or MOSFET dies, and the typical circuit topologies are half-bridge or six-pack. The design of these power modules becomes a core element in achieving higher levels of power density and fulfilling increasingly stringent requirements in electric vehicles.



4. Power Module Solutions in Renewable Energy

Power modules play a key role in producing energy from renewable sources. In wind turbines, they are used to convert power and to couple the generator with the grid. They are also built into various auxiliary drives such as yaw drives, pitch drives, and pumps, and into protection circuits like crowbars. Wind power converters control a number of vital functions and applications, and therefore require power semiconductors of the highest quality standards. These are applied in particular to offshore wind converters which operate in exceptionally harsh environments, being exposed to salt, humidity, etc. The fastest growth has been seen in the offshore segment.



The solar module with integrated micro inverter is a Plug & Play solution that delivers power as soon as it is connected to the grid. It is also suitable for larger on-roof applications as a Plug & Play solution. Unpack, assemble, and plug in: there is no need for additional wiring efforts. Power modules are reliable and optimized for use for harsh environments.

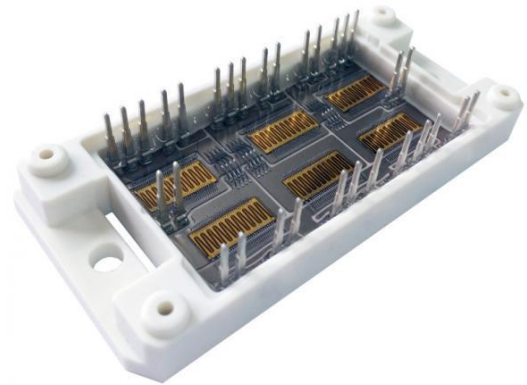
5. Focus of Consumers on Minimizing Power Losses and Increasing Power Density

In an increasingly energy-driven world, there is more and more dependence on and proliferation of electric vehicles, renewable energy, powerful industrial motors, and smart consumer electronics. Nowadays the latest FPGAs, processors, ASICs, and associated memories in various industrial equipment have raised performance requirements significantly for point-of-load (POL) power converter solutions. To ease the system design challenges associated with these advanced systems, high-current and high-power density power modules are being



employed. Integrated power module solutions can achieve superior performance over conventional discrete solutions in terms of efficiency, thermal management, and power density, which lends the advantage of better margins to power design specifications and a faster time to market for new product development.

Power modules such as GaN transistors will enable the next generation of EVs by reducing size, weight, power loss, and system cost. Higher-power density and lighter-weight systems can change the dynamics of battery sizing and management. Energy storage systems help manage peak demand, provide backup power, and function as part of an off-grid system when combined with renewable sources of energy. A number

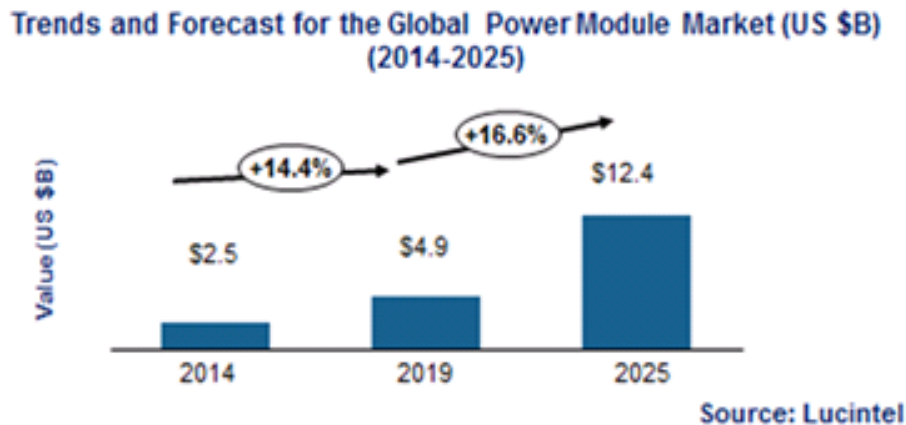


of home energy storage projects are now trending in several cities across the world. GaN Systems expects that energy storage systems will improve in efficiency and pricing, which will happen only through new power technologies and techniques. Industrial electric motors and drives are the key components that help commercial and industrial plants operate. The pressure is mounting for increasing efficiency through technology and government policy approaches, which include incentives and introducing more rigorous energy efficiency standards and motor efficiency regulations. GaN Systems focuses on improving high-efficiency motor drive technology and integration. Thus, GaN Systems makes possible the design of smaller, lower-cost, more efficient power systems.



Strategic Considerations for Key Players in the Power Module Market

The power module industry is dynamic and ever-changing. Successful industry players are masters of innovation, change, and adaptation. To retain this status, they need to be attentive to current trends. We believe there will be promising opportunities for power modules in the transportation, industrial, wind energy, and solar PV industries. As per Lucintel's latest market research report (Source: <https://www.lucintel.com/power-modules-market.aspx>), the [power module market](#) is expected to grow with a CAGR of approximately 16.6% between 2020 and 2025, and reach \$12.4 billion by 2025. This market is primarily driven by the high growth of electric vehicles, increasing focus of consumers for minimizing power losses, and maximizing power savings.



Whether you are new to the power module market or an experienced player, it is important to understand the trends that impact the development process, as these trends as listed above will lead players to create long-term strategy formulation that will allow them to remain competitive and successful in the long run. For example, to capture growth, some of the strategic considerations for players in the power module market are as follows:



- Power module market players can increase their capabilities to develop high-power IGBT modules for industrial drives, renewable energy, and power transmission applications.
- Players can focus on high-temperature SiC power modules, which are expected to lead future trends.
- Investment to increase competencies in power modules used in electric vehicle to meet typical application requirements, such as capability to withstand more than three million active thermal cycles
- Research and development activities to develop low-cost high-power modules.

Note: In order to gain better understanding, and learn more about the scope, benefits, and companies researched, as well as other details in the power module market report from Lucintel, click on <https://www.lucintel.com/power-modules-market.aspx>. This comprehensive report provides you with in-depth analysis on market trends and forecast, segment analysis, regional analysis, competitive benchmarking and company profiling of key players. In addition, we also offer **strategic growth consulting** to meet your customized needs. We have worked with many PE firms and corporate customers in the process of their market entry and M & A initiatives.



Lucintel - At a Glance

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