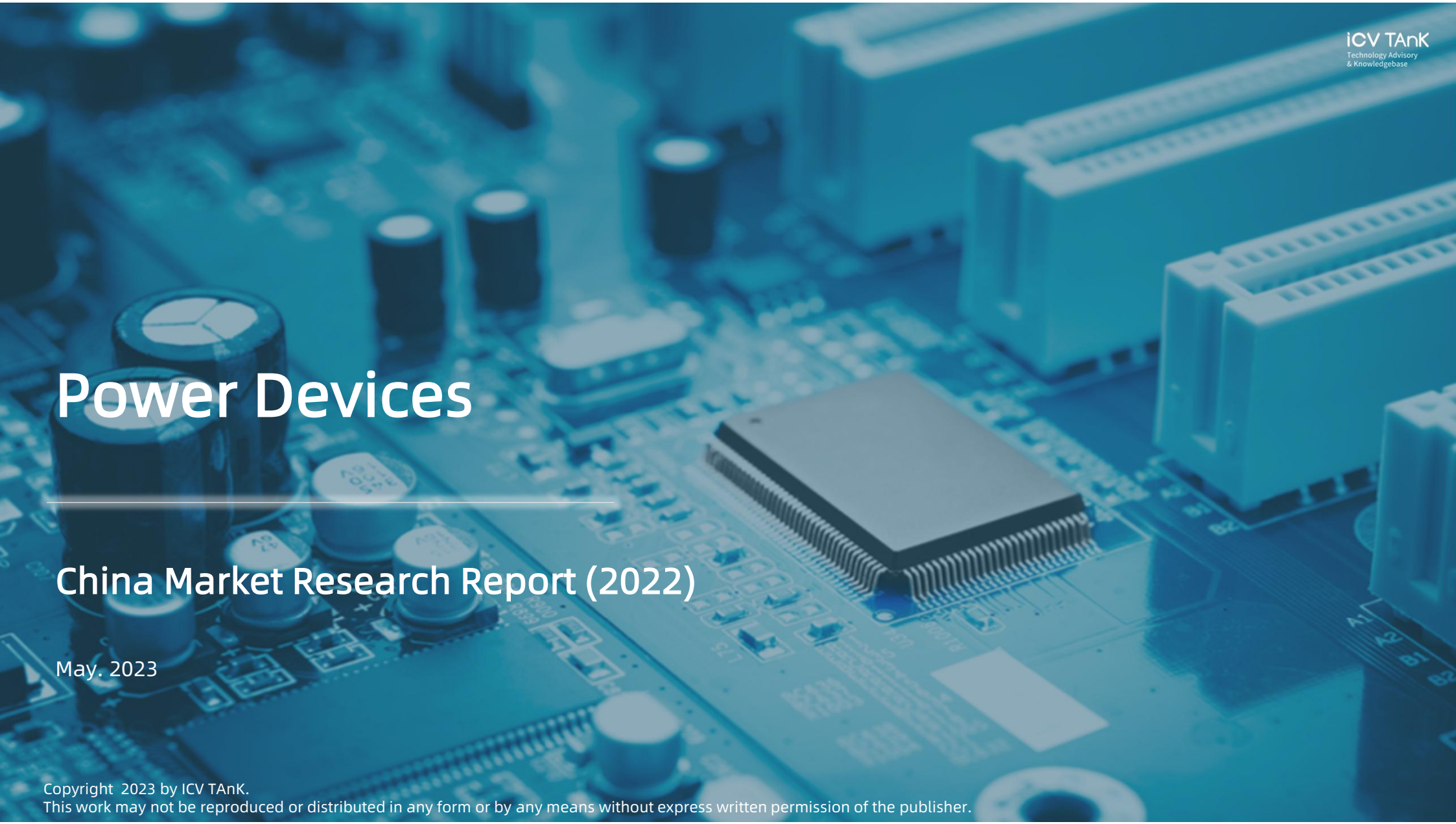


Power Devices

China Market Research Report (2022)

May. 2023

Methodology

Industry research: By conducting interviews with relevant companies, consumers, and industry experts, we aim to understand the demand, trends, and scale of the market.

Data analysis: By collecting, organizing, and analyzing market data, including market size, growth rate, pricing trends, consumer preferences, and more, we aim to understand the current status and development trends of the market.

Competitive analysis: By analyzing information such as competitor's products, prices, and market share, we aim to understand the competitive landscape in the market and our own strengths and weaknesses.

Technical analysis: By evaluating the technical requirements and development trends of the market, including the advantages and disadvantages of single photon detector technology characteristics, we aim to gain insights into the market's direction.

Regional analysis: By understanding factors such as local consumer demands and policy environments, we aim to identify regional differences in markets and potential for development.

Introduction (1)

Power electronic devices, also known as power semiconductor devices, are electronic components used in circuits for power conversion and control, specifically for high-power applications (typically referring to current in the range of tens to thousands of amperes and voltages of several hundred volts or higher). Power devices are capable of handling and controlling large currents and voltages, and they offer advantages such as high efficiency, high reliability, and high-speed operation. They play a critical role in various application scenarios. The main types of power semiconductor devices include diodes, thyristors, and transistors. Among them, diodes and thyristors have relatively mature and simple manufacturing processes, while transistors, particularly insulated-gate bipolar transistors (IGBTs), metal-oxide-semiconductor field-effect transistors (MOSFETs), and bipolar junction transistors (BJTs), have the largest market share.

MOSFETs and IGBTs are important components of the power semiconductor device market. As core components in the field of industrial control and automation, they can adjust voltage, current, frequency, phase, and other parameters in circuits based on signal instructions from industrial devices, enabling precise control. They find extensive applications in various fields such as motor energy saving, rail transportation, smart grids, household appliances, automotive electronics, renewable energy generation, and electric vehicles. The market prospects are very promising, and power semiconductor devices are expected to have the highest growth potential in the coming years.

Introduction (2)

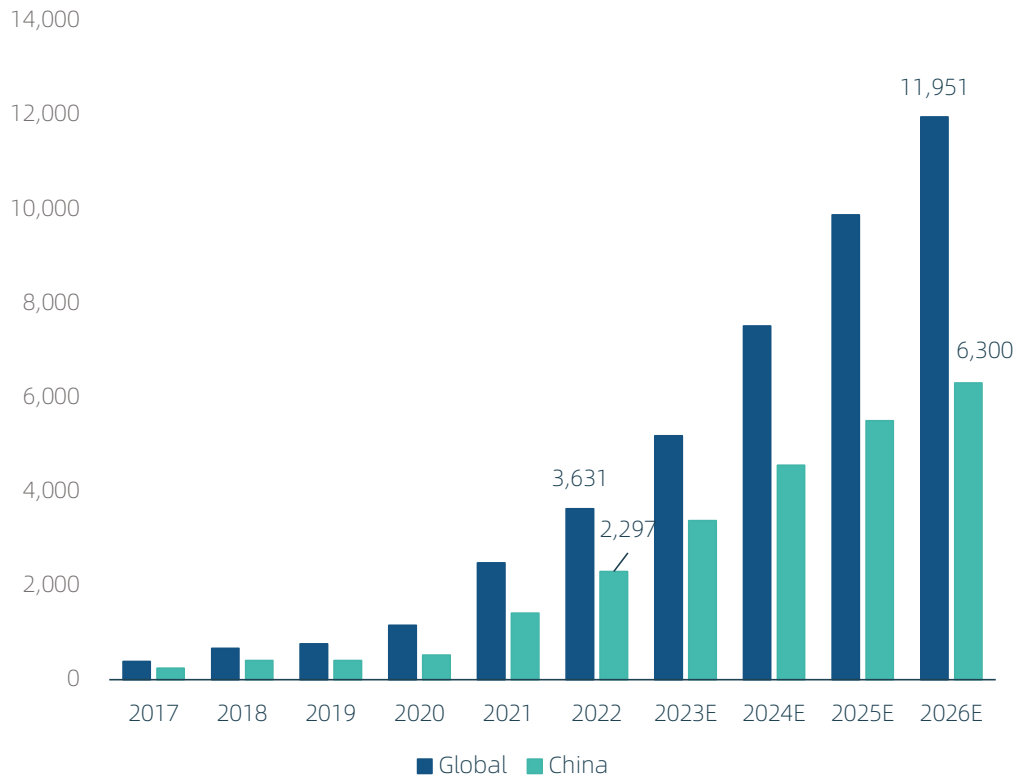
As a technology-intensive industry, the field of new power semiconductor devices is dominated by international manufacturers such as Infineon, Onsemi, ROHM, STM, and Nexperia, who enjoy significant advantages in terms of product recognition and industry awareness, placing them in a leading position. Domestic power device manufacturers in China are currently in a catch-up phase, with relatively low levels of self-sufficiency in product supply. China has a vast market for automobiles, power, industrial applications, household appliances, and consumer electronics. In recent years, China has made continuous efforts in energy conservation and environmental protection, driving the increasing demand for new power semiconductor devices in areas such as new energy vehicles, photovoltaics, energy storage, industrial control, variable frequency household appliances, and consumer electronics. Consequently, the Chinese region has become an important market for new power semiconductor devices.

Classifications

	Operating Power Environment	Characteristics	Main Applications
IGBT	High frequency, high voltage, and high current	High input impedance, low conduction voltage drop, fast switching speed, low driving power requirements, and excellent thermal stability	Industrial control, new energy generation, new energy vehicles, motor energy-saving systems, railway transportation, and smart grids
MOSFET		High input impedance, high-speed switching capabilities, strong controllability, compact size, and lightweight	Consumer electronics, industrial control, telecommunications, automotive electronics, computer and peripheral devices, and power management
SiC MOSFET		High input impedance, low conduction voltage drop, high-speed switching characteristics, high-temperature tolerance, and low power loss	New energy vehicles, photovoltaics, energy storage, and charging stations

New Energy Vehicle Sector: Power Devices

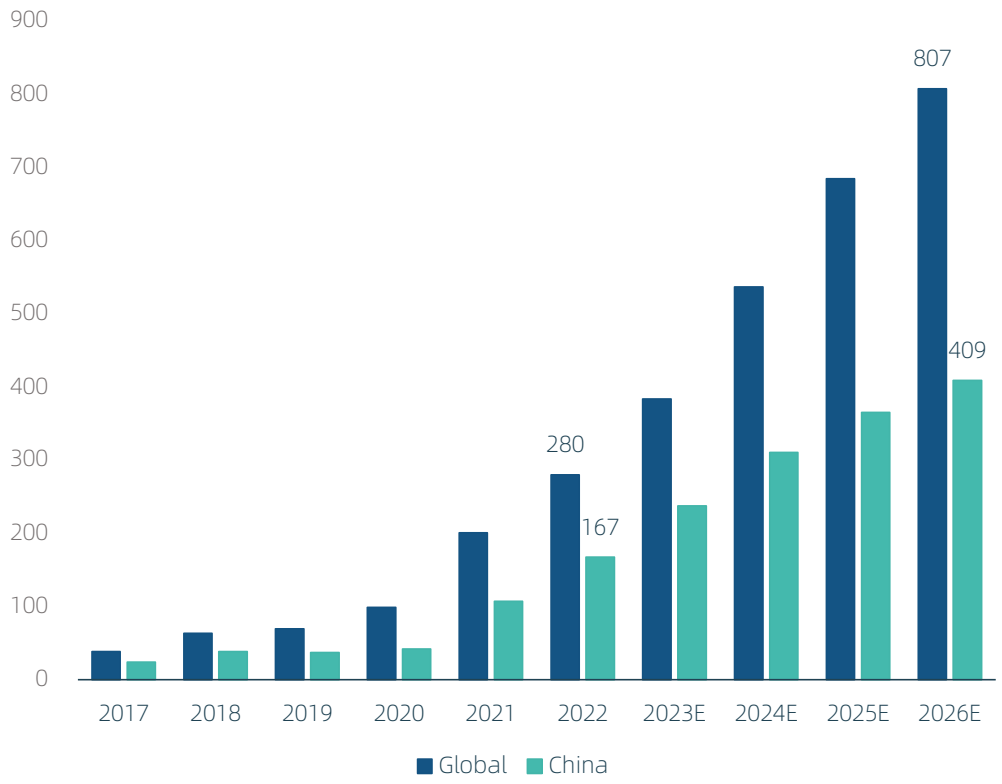
Market Size of Power Devices in the Global and Chinese New Energy Vehicle Sector (in Million USD)



In comparison to traditional fuel-powered vehicles, new energy vehicles introduce power conversion systems such as motor drives, DC/DC modules, on-board chargers (OBC), and high-voltage auxiliary drives. This significantly increases the demand for power semiconductors. IGBT, MOSFET, and SiC are the core components of power semiconductors in vehicle applications. IGBTs are utilized in high-voltage power conversion scenarios, MOSFETs are employed in low-voltage system voltage regulation, and SiC, with its advantages of lower energy losses, high-temperature resistance, and high-voltage tolerance, gradually penetrates the main drive inverters. In comparison to traditional fuel-powered vehicles, various systems in new energy vehicles experience a significant increase in power, necessitating corresponding improvements in the specifications of power devices, including working current and voltage.

New Energy Vehicle Sector: MOSFET

Market Size of MOSFET in the Global and Chinese New Energy Vehicle Sector (in Million USD)

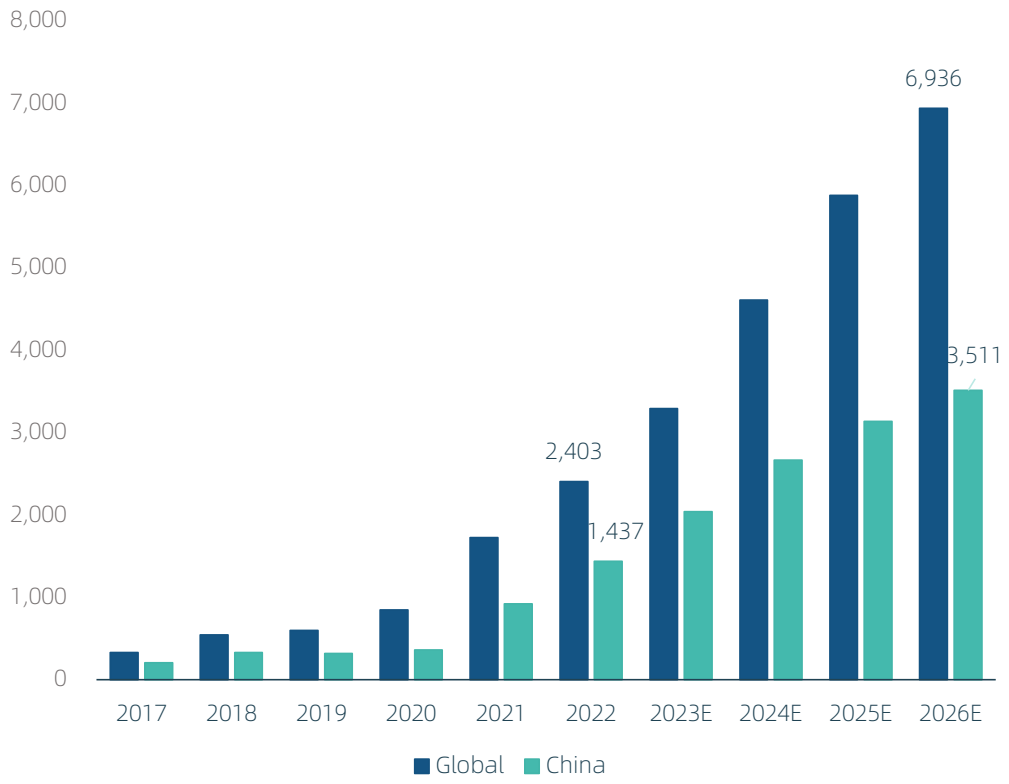


According to the structural characteristics of MOSFETs, they find widespread application in automotive scenarios. For instance, in the electric functionality of fuel-powered vehicles, low-to-medium-voltage MOSFETs are extensively utilized, with an average of approximately 100 units per vehicle. In new energy vehicles, medium-to-high-voltage MOSFETs are widely employed in DC-DC converters, on-board chargers (OBC), and other components, with the average usage per vehicle increasing to over 200 units.

With the development of intelligent automotive technologies, MOSFETs are also required for functions such as ADAS, safety systems, and infotainment. It is anticipated that the number of MOSFETs in mid-to-high-end vehicle models could increase to 400 units.

New Energy Vehicle Sector: IGBT

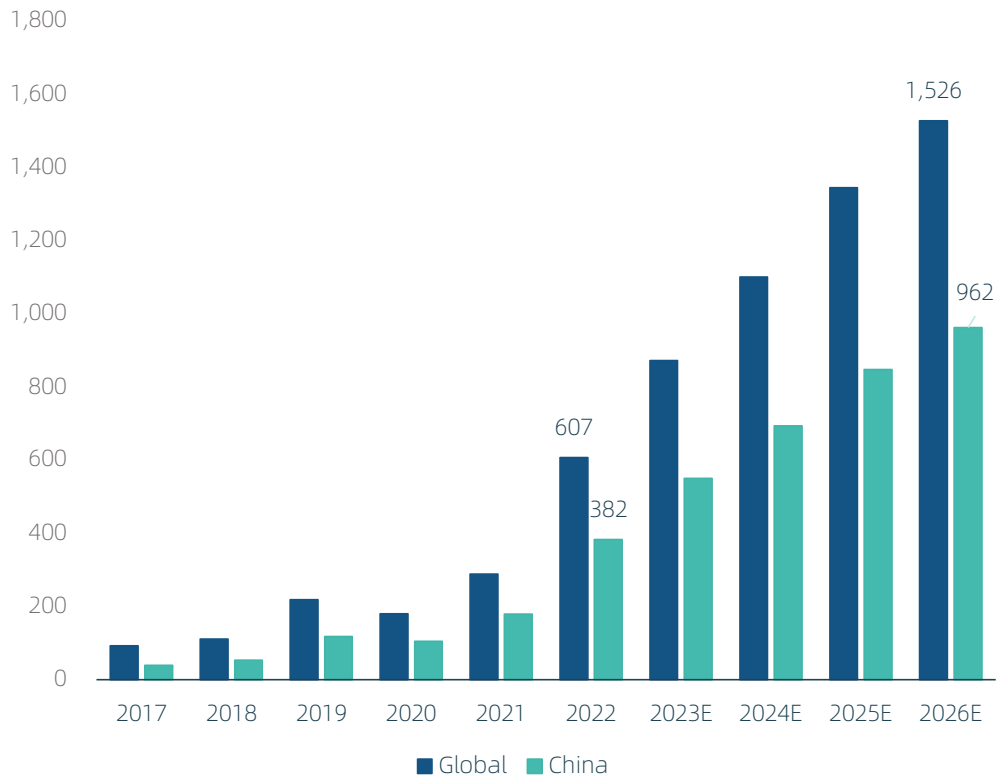
Market Size of IGBT in the Global and Chinese New Energy Vehicle Sector (in Million USD)



IGBT power devices are primarily employed in various systems of new energy vehicles, including motor drive control systems, thermal management systems, and power supply systems. In the main inverter, IGBTs play a crucial role in converting the direct current (DC) from high-voltage batteries into alternating current (AC) to drive the three-phase motor. In on-board chargers, IGBTs are responsible for converting AC power into DC power to charge the high-voltage battery. In DC-DC converters, IGBTs can convert the high voltage output from the battery into low voltage for the low-voltage power network in the vehicle. Additionally, IGBTs are extensively used in auxiliary inverters such as PTC heaters, water pumps, oil pumps, and air conditioning compressors, where they perform low-power DC-AC conversion tasks.

Charging Station Sector: IGBT

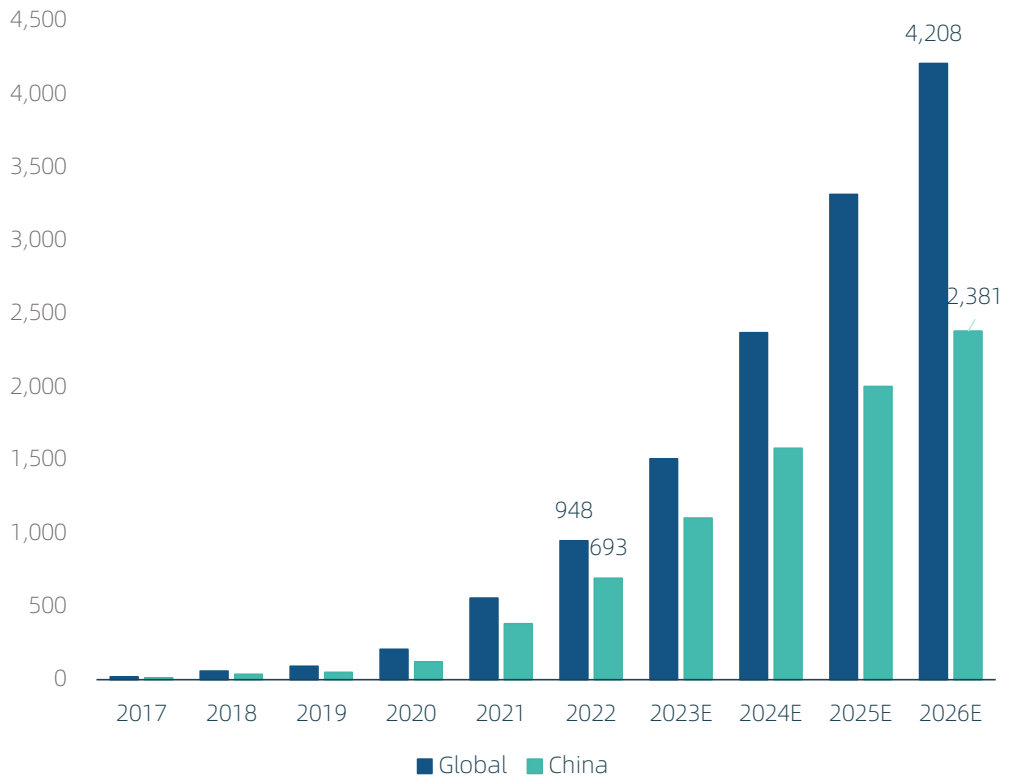
Market Size of IGBT in the Global and Chinese Charging Station Sector (in Million USD)



In addition to its direct application in electric vehicles, IGBT is also a crucial power device in DC charging stations. Similar to its function in On-Board Chargers (OBCs), IGBT plays a role in DC-DC voltage conversion in DC charging stations. The charging process involves converting AC power to DC power through power modules, followed by voltage stabilization and filtering using capacitors. The DC power is then transformed into high-frequency AC power through an inverter power module. Finally, the transformed power is converted into different levels of DC voltage by coupling transformers and rectification units to facilitate the charging of electric vehicles. As the scale of the electric vehicle market expands, the demand for charging stations is also growing.

New Energy Vehicle Sector: SiC

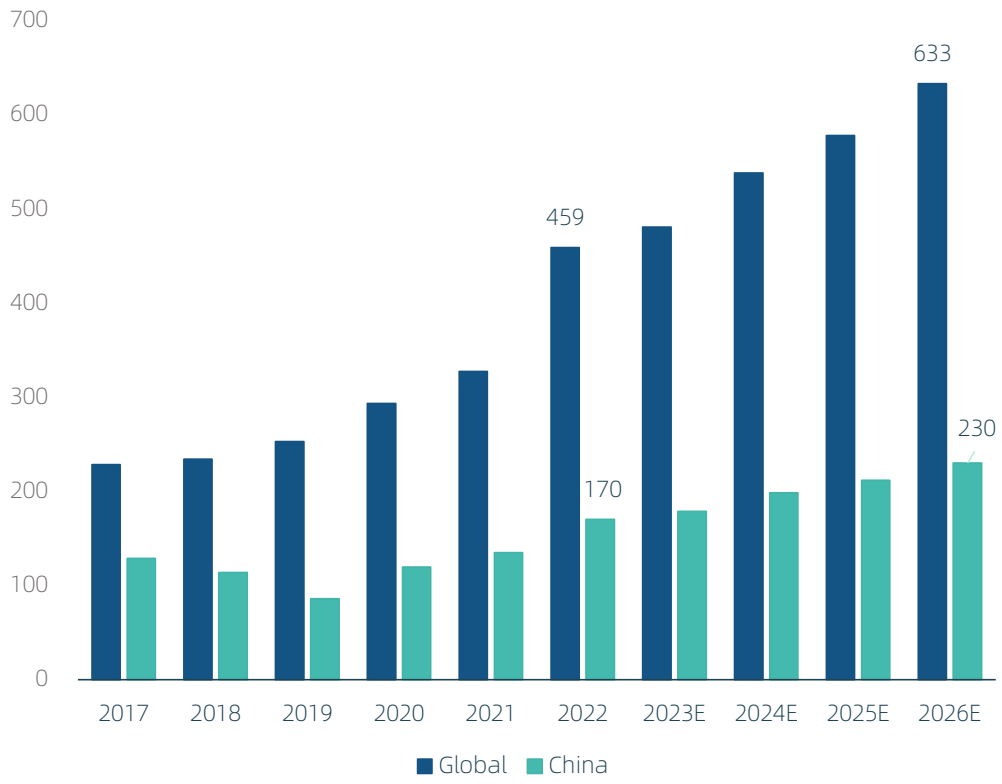
Market Size of SiC in the Global and Chinese New Energy Vehicle Sector (in Million USD)



In the future, as the electrification of vehicles continues to advance, new requirements and challenges are being posed to power devices in terms of switching frequency, heat dissipation, and withstand voltage performance. The third-generation semiconductor material, Silicon Carbide (SiC), possesses a wider bandgap, higher thermal conductivity, stronger breakdown electric field strength, and higher electron mobility. Power devices fabricated using SiC exhibit excellent performance and are more suitable for high-voltage, high-frequency, and high-temperature applications. They complement Insulated Gate Bipolar Transistors (IGBTs) in the field of new energy vehicles. However, SiC devices have a higher cost, approximately 3-5 times that of IGBTs, and are mainly used in vehicles with motor power of 180 kW and above. As a result, SiC technology is still in its early stages and holds significant development potential in the future.

Photovoltaic (PV) Sector: IGBT

Market Size of IGBT in the Global and Chinese PV Sector (in Million USD)

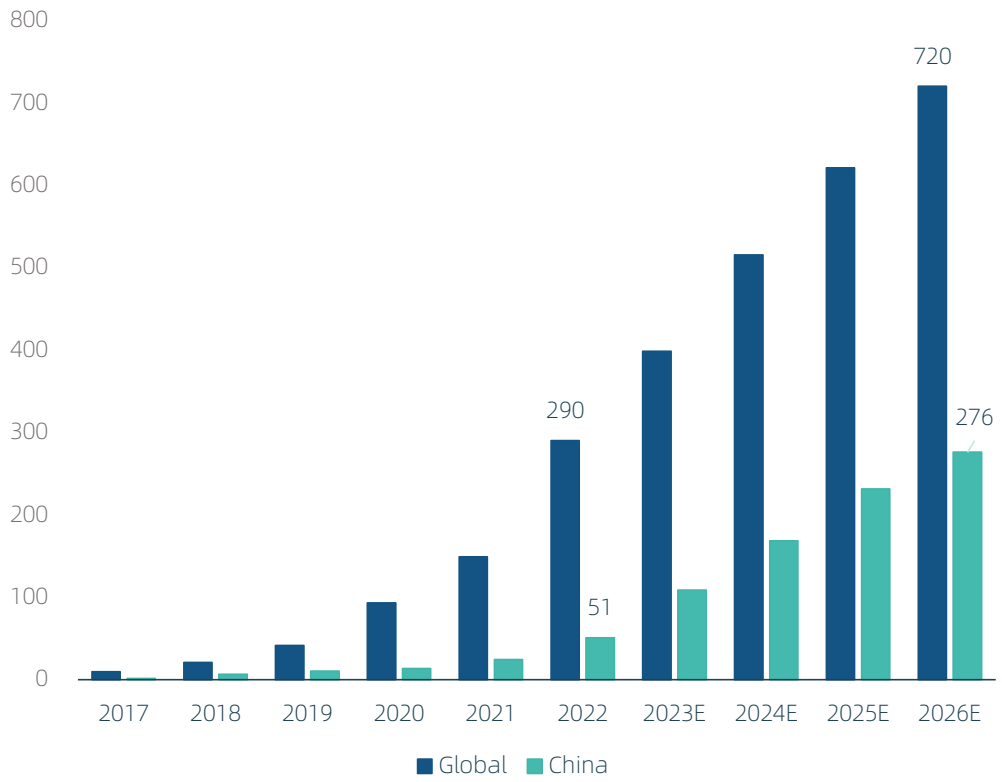


In photovoltaic inverters, IGBT and other power devices play a crucial role in achieving the inversion function. Photovoltaic inverters are primarily composed of structural components, passive components, PCB circuit boards, integrated circuits, power devices, and other parts. IGBT typically accounts for approximately 10%-15% of the raw material cost and contributes to approximately 7% of the total value of the inverter.

Given the dual pressures of energy crisis and environmental pollution, there is an urgent demand for new energy sources such as solar photovoltaic and wind power. Photovoltaic technology, with its unlimited resource availability, noise-free operation, high flexibility, and reliability, has emerged as one of the most promising and rapidly developing renewable energy technologies. With the global push for carbon neutrality, both global and Chinese photovoltaic installations have witnessed a significant increase in capacity.

Energy Storage Sector: IGBT

Market Size of IGBT in the Global and Chinese Energy Storage Sector (in Million USD)

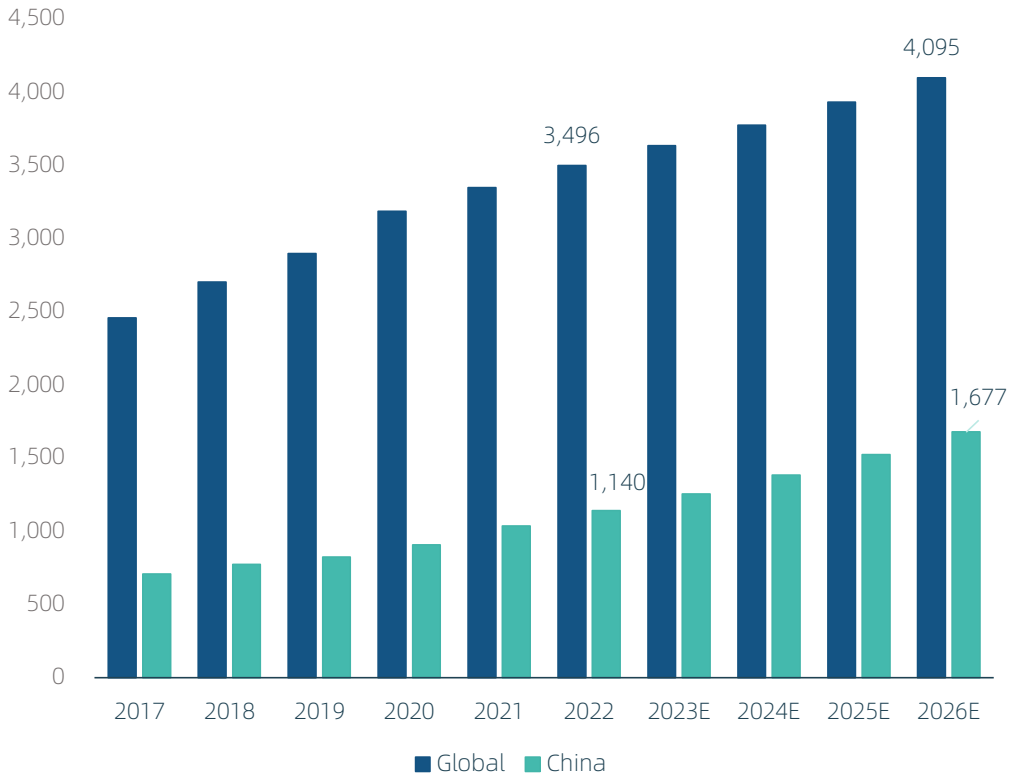


In the field of energy storage, power devices are primarily used in inverters. In energy storage inverters, IGBT is employed to perform voltage transformation and current inversion, ensuring the output of desired sinusoidal AC power. IGBT typically accounts for around 11%-12% of the raw material procurement cost and contributes to approximately 7% of the overall value of the inverter market.

With the significant growth in energy storage installations, driven by the increasing demand for energy storage solutions, the market size of energy storage inverters is also expanding.

Industrial Control Sector: IGBT

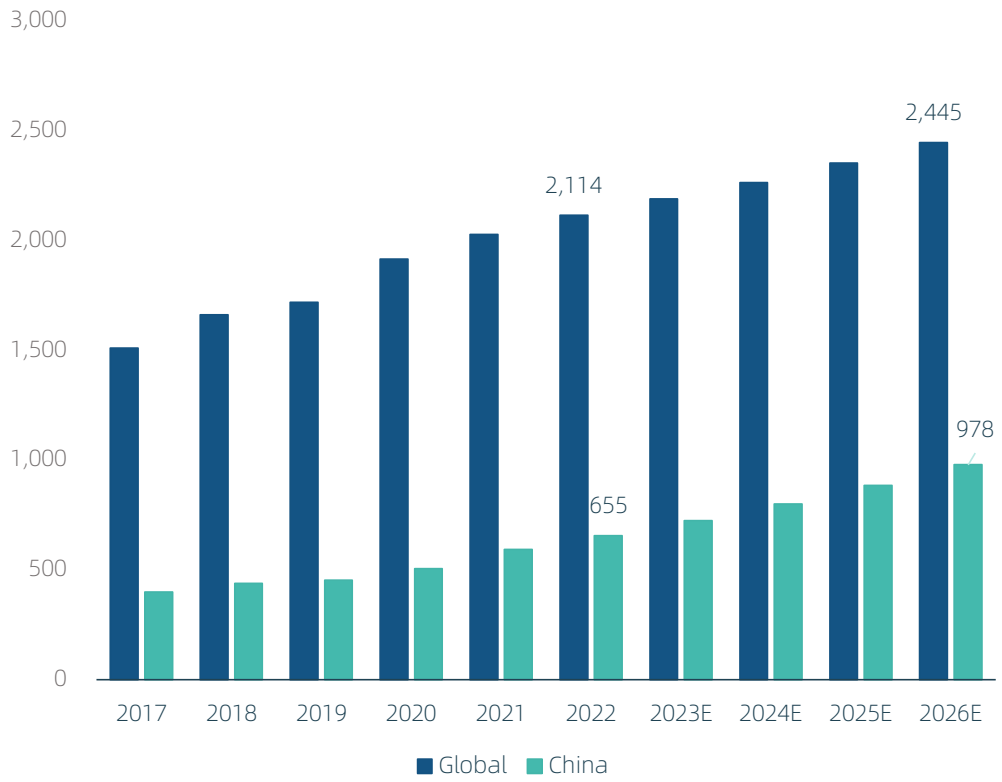
Market Size of IGBT in the Global and Chinese Industrial Control Sector (in Million USD)



In the field of industrial control, with the continuous upgrading of the manufacturing industry, there is a growing demand for high-performance motors in industrial production, logistics, and other processes. IGBT power devices serve as core components in industrial applications such as variable frequency drives, arc welding machines, and UPS power supplies. Their role is crucial in motor control and power management. As a result, IGBTs are becoming increasingly common in the field of industrial control.

Industrial Control -Industrial Variable Frequency Drives

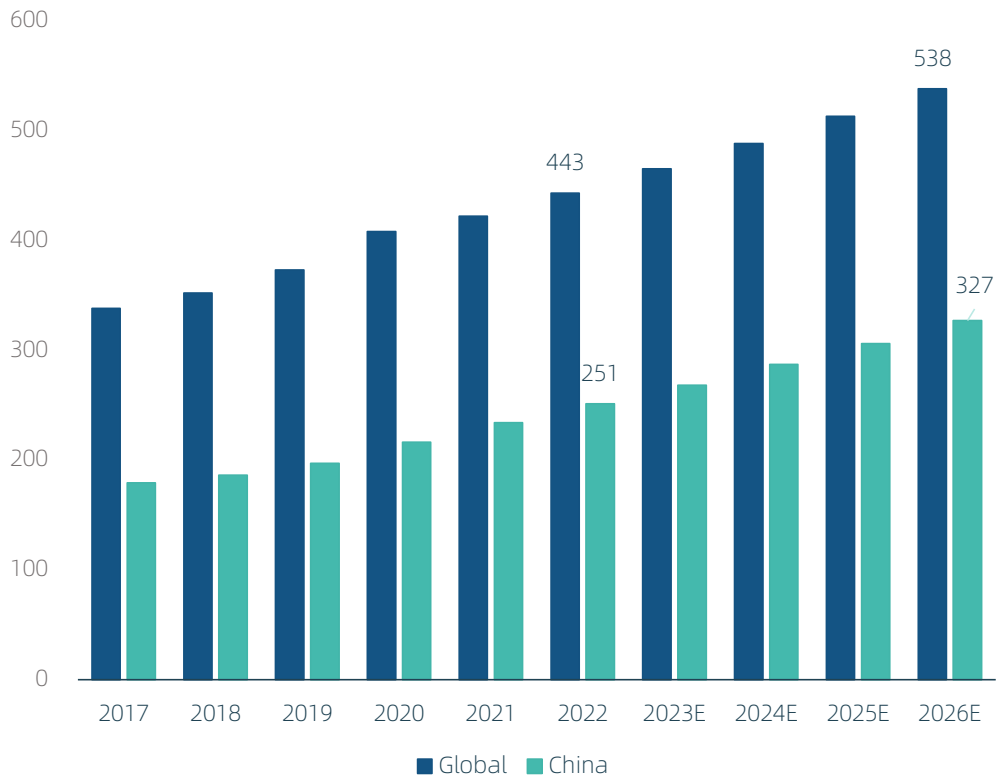
Market Size of IGBT in the Global and Chinese Industrial Variable Frequency Drives (in Million USD)



Industrial variable frequency drives are power control devices that regulate the operation of AC motors by changing the frequency of the motor's power supply. They consist of rectification (AC to DC), filtering, inversion (DC to AC), braking units, drive units, control units, and sensing units. IGBTs play a crucial role in industrial variable frequency drives, enabling functions such as rectification, braking, and inversion. By adjusting the voltage and frequency of the output power supply, IGBTs account for approximately 11% of the raw material cost of industrial variable frequency drives. Utilizing IGBTs for variable frequency speed control in industrial drives offers several advantages. Firstly, it meets the requirements for improving labor productivity, enhancing product quality, increasing automation levels, and improving quality of life. Secondly, it contributes to energy savings and reduced production costs.

Industrial Control -Inverter Welding Machines

Market Size of IGBT in the Global and Chinese Inverter Welding Machines (in Million USD)

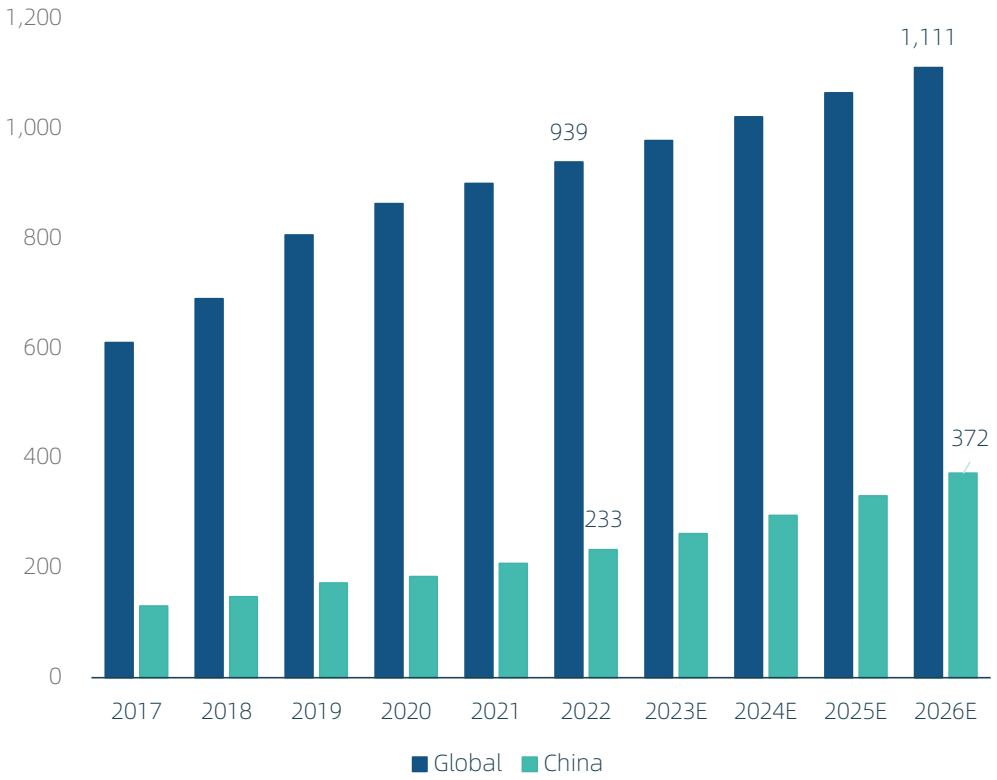


The introduction of power electronic devices has addressed the limitations of traditional arc welding power sources, such as the inability to precisely control welding parameters, high material and energy consumption, and excessive noise. These devices enable the use of low-power electronic circuits to control high-power output in power circuits, reducing the equipment's size and enhancing the versatility of output characteristics and precise parameter control in arc welding power sources.

With the maturation of inverter technology, the development of inverter-based arc welding power sources has progressed. The core component of these power sources is the inverter, with IGBT playing a crucial role within the inverter. Currently, arc welding machines powered by IGBT-based inverter arc welding power sources have become significant players in the welding industry.

Industrial Control -UPS Power

Market Size of IGBT in the Global and Chinese UPS Power (in Million USD)

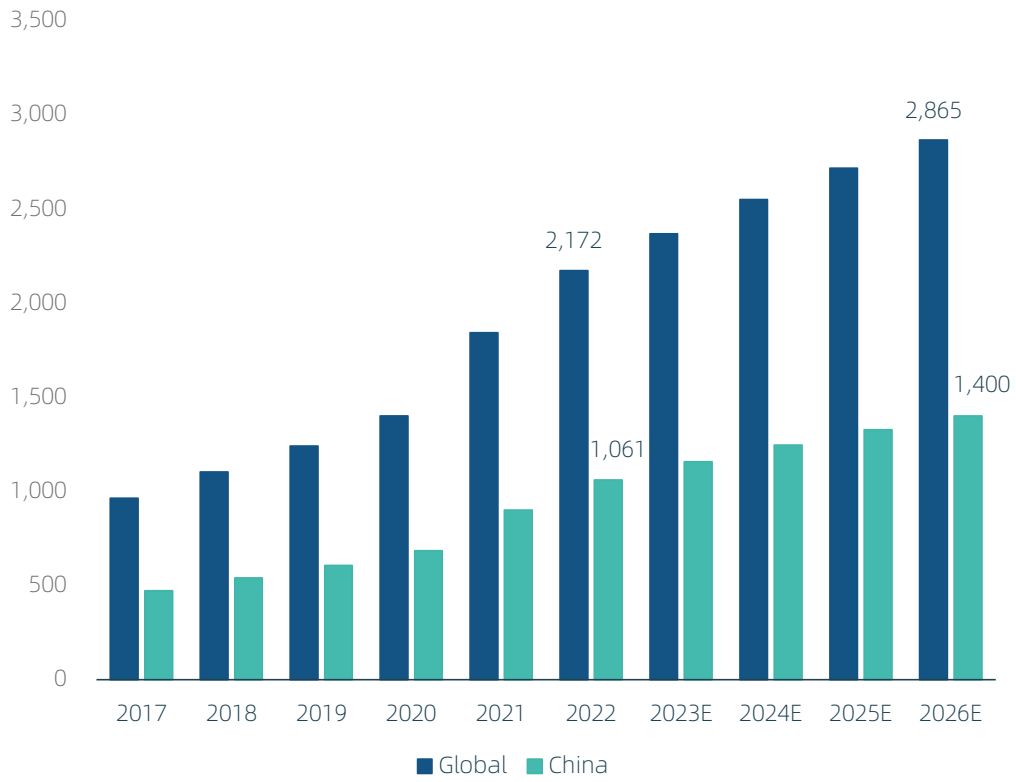


As an essential energy backup device, Uninterruptible Power Supply (UPS) addresses issues such as power outages, low voltage, high voltage, surges, and noise in existing power systems. It finds wide applications in computer information systems, communication systems, data centers, banking systems, industrial power supply, and other fields.

A UPS power system comprises rectifiers, inverters, batteries, bypass switches, and other components. Among them, IGBT serves as an ideal device for power conversion in the charging process, bypass switching, inverter operation, and rectification process within the UPS system. Its usage typically accounts for approximately 12% of the UPS power system's raw material costs.

Household Appliances Sector: IPM

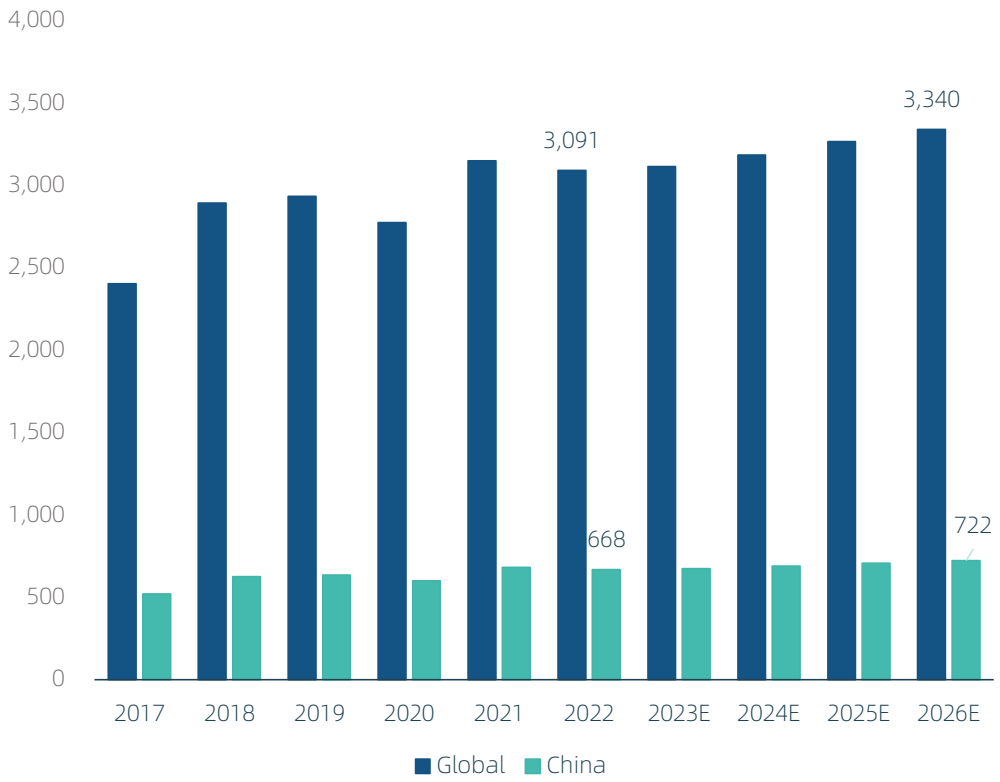
Market Size of IPM in the Global and Chinese Household Appliances Sector (in Million USD)



The hardware of mainstream variable-frequency home appliances primarily consists of motors, motor controllers, and power conversion modules. Among them, the power conversion module represents the highest component cost in the electronic control system. In most cases, intelligent power modules (IPMs) are used. Leveraging their switching characteristics, IPMs convert the rectified and boosted DC voltage into controllable three-phase AC power, which is then supplied to the electric motor to achieve speed regulation. Each variable-frequency air conditioner, variable-frequency refrigerator, and variable-frequency washing machine typically require 2, 1, and 1 IPM module(s) respectively.

Consumer Electronics Sector: MOSFET

Market Size of MOSFET in the Global and Chinese Consumer Electronics Sector (in Million USD)



Consumer electronics encompass a wide range of products, and power devices such as MOSFETs play a prominent role in various consumer electronics, including smartphones, PCs, wearable devices, and LED lighting. With the increasing demand for laptops, smartphones, smart home devices, and other consumer electronics, the global MOSFET market in the consumer electronics sector is experiencing overall growth.

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Ordering Information

Power Devices

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