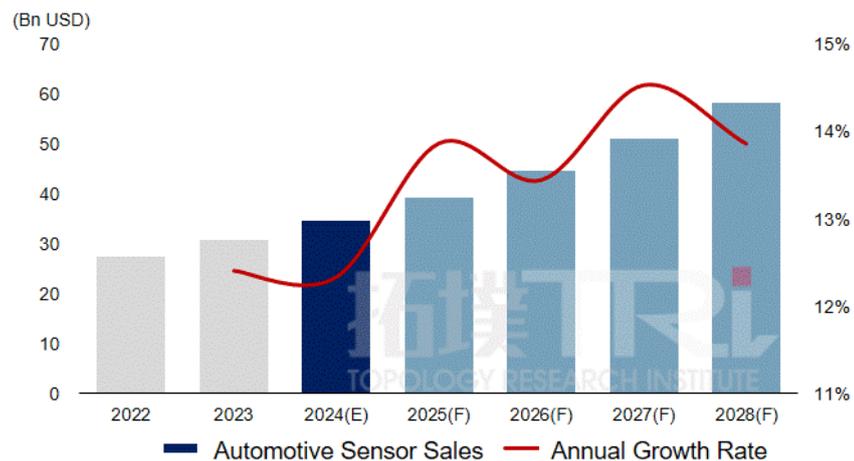


Electrification and Intelligence in the Automotive Industry Drive Strong Growth for Automotive Sensors

Topology Research Institute

The global automotive industry is accelerating innovation with a focus on EVs and autonomous driving technology, alongside software-defined vehicles. This vision of safety, efficiency, and sustainability is creating a new blue ocean for automotive sensors.

Global Automotive Sensor Market Size Forecast (2022–2028)



Source : TRI ; 2024/06

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I. Global Automotive Sensor Market: An Overview

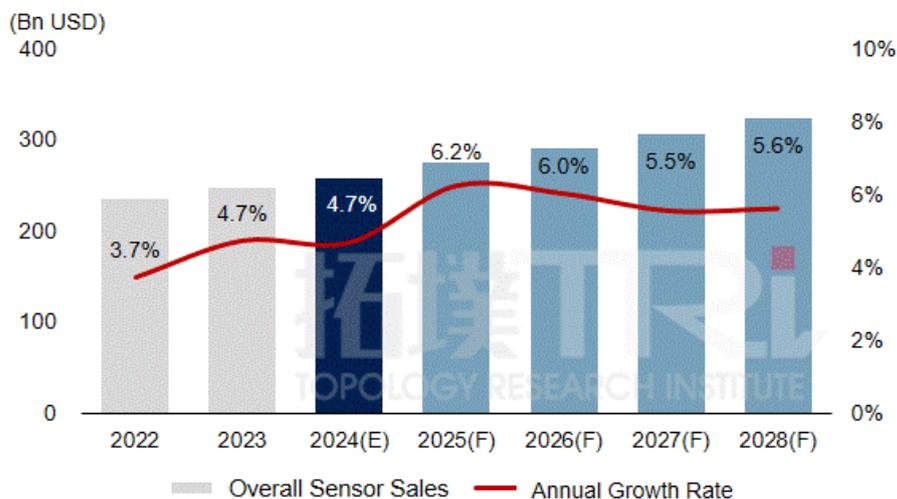
EVs, autonomous driving, ADAS, and smart cockpits have become trends in the automotive industry, owing to various measures from different countries. These advancements are key drivers of growth in the global sensor market. However, as vehicle electrification increases, power distribution and wiring complexity also rise. Therefore, IoT technology and sensors are being used to ensure driving safety, a stable transmission system, and smart in-car functions.

For example, unmanned vehicles are equipped with high-spec environmental monitoring sensors and frequency meters, supporting remote smart parking assist (RSPA), support vehicle application (SVM), and driving state monitoring (DSM) to ensure safety and positioning accuracy.

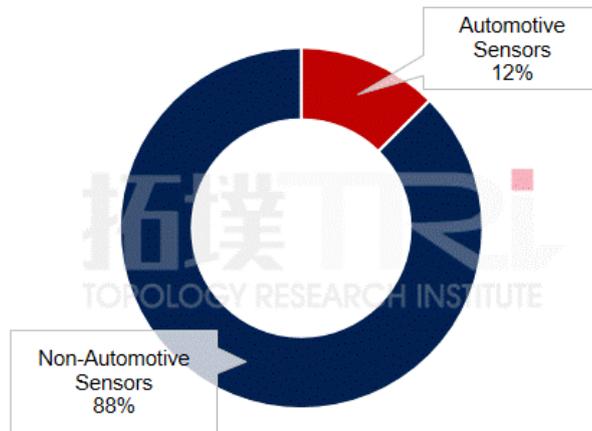
The rapid development of vehicle electrification, autonomous driving technology, and smart cockpits is integrating these advancements into daily life and promoting the creation of smart cities, smart transportation, and smart logistics. The fast growth of the automotive industry has been evident in the rising global sensor market size from 2020 to 2023, with a noticeable increase in the market share of automotive sensors each year.

Sensors and their corresponding components focus on quality improvements due to the frequent updates of automotive electrical components and onboard systems. This means higher-tier vehicles are equipped with more sensors that require greater accuracy. In 2023, the global sensor market reached \$246.2 billion, with automotive sensors accounting for approximately 12.5% of this total, reaching a market size of \$30.8 billion.

Figure 1: Global Sensor Market Size Forecast (2022–2028)



Source : ICV , TRI ; 2024/06

Figure 2: 2023 Global Automotive Sensor Market Share Breakdown

Source: TRI · 2024/06

Automotive sensors can be categorized into two types based on their application: vehicle perception and environmental perception. Vehicle perception sensors—often referred to as automotive neurons—are the core sensors for vehicle information. These include infrared, cameras, millimeter-wave radar, ultrasonic radar, and LiDAR, which are primarily installed in critical systems such as the body, chassis, and transmission to enhance vehicle informatization.

Environmental perception sensors cover a wider range of products, including pressure, temperature, airflow, linear/angular acceleration, and position sensors. These are used to improve the vehicle's ability to perceive and recognize its surroundings. These sensors collect environmental data around the vehicle and transmit it to the car's computer system, providing crucial information for automotive decision-making. This enables core systems, like the closed-loop system, to respond to road conditions in real-time.

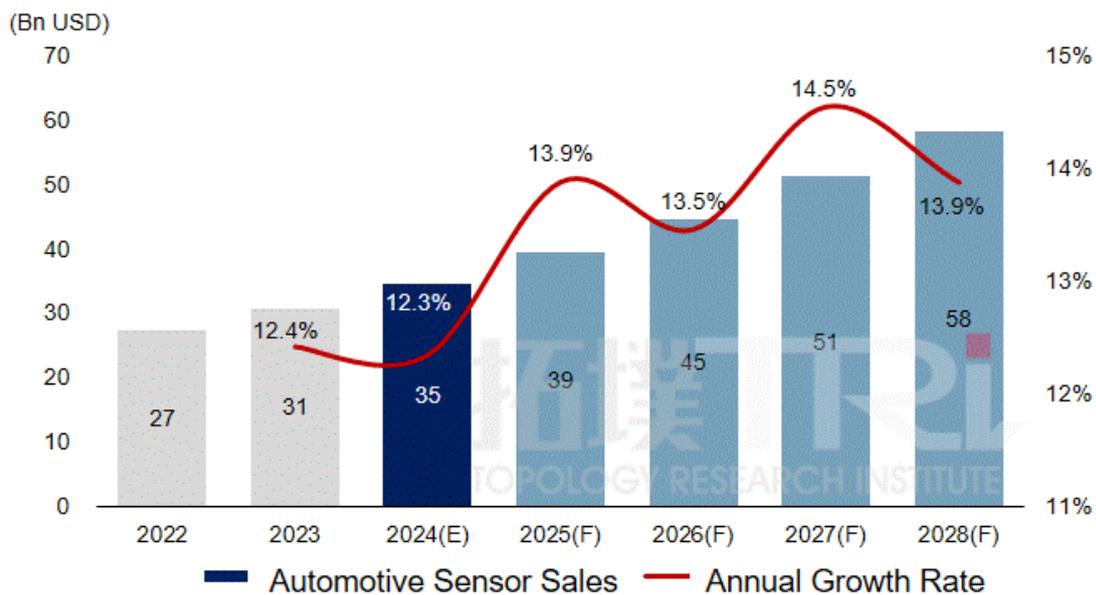
With changes in automotive production and consumption patterns, the application of sensors in the automotive field is becoming increasingly widespread. The US, China, Japan, South Korea, Singapore, and European nations are actively integrating AI into daily life to build advanced transportation systems that are safe, efficient, and sustainable.

Recently, government have been integrating technical resources from industry, government, and academia to build smart cities and smart transportation. This will inevitably lead to more diverse applications for sensors in the future. Currently, companies like Sekonix, Winstrong, OFILM, Trace Technology, Kantatsu, and Fujifilm are expanding their footprint in the EV and smart cockpit markets. They focus on developing related products, such as hidden cameras, to tap into the potential markets of driver monitoring systems (DMS) and open street map (OSM).

Furthermore, the number of sensors used in autonomous vehicles varies by level. Level 1–2 vehicles have around 12 sensors, level 3 about 30 sensors, and levels 4–5 more than 32 sensors. Currently, most autonomous vehicles are at level 2–3. There are over 95 sensors in total for a B-class level 3 car: approximately 45–60 in the power system, 25–28 in the body system, and 30–40 in the chassis system. Compared to traditional industrial sensors, automotive sensors have stricter requirements for performance stability, sensitivity, and durability—nearly matching the specifications of high-end industrial sensors.

The global automotive sensor market is expected to reach US\$34.6 billion by 2024. With advancements in autonomous vehicle technology and software-defined vehicles (SDV), and as more countries gradually relax regulations for level 4 autonomous driving, the global automotive sensor market is anticipated to see significant growth between 2025 and 2026.

Figure 3: Global Automotive Sensor Market Size Forecast (2022–2028)



Source : ICV , TRI ; 2024/06

II. ESG Trends Catalyze EV Development and Drive Sensor Demand Skyward

The IEA's "Global EV Outlook 2024" reveals that EVs are expected to account for 20% of global car sales. The EV markets in China, the US, and Europe will continue to grow, with emerging markets in ASEAN showing increasing interest in EVs. For example, Vietnamese EV manufacturer VinFast sold over 31,000 vehicles and is pursuing geographic expansion into new ASEAN markets like the Philippines. The pandemic,

supply chain disruptions, and geopolitical conflicts have heightened the focus on the stability of the automotive supply chain.

Currently, Indonesia and Thailand are key markets in ASEAN that are attracting attention from many automakers. Indonesia's automotive industry is experiencing significant growth, and although vehicle electrification is in its early stages, there are ample opportunities for investment and cooperation. The Indonesian government is actively working to transform the country into a hub for electric vehicle manufacturing by creating a roadmap focused on green and energy-efficient practices and establishing a comprehensive electric vehicle supply chain.

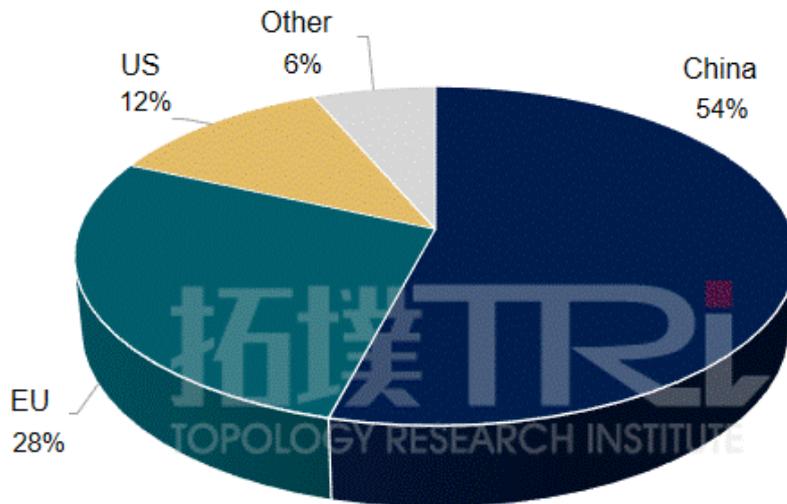
On the other hand, Thailand, often referred to as the "Detroit of the East," has been vigorously promoting Industry 4.0, the National Energy Plan, and its new power plan in recent years. These initiatives serve as the foundation for industrial transformation and vehicle electrification, leading to an annual increase in EV conversion rates from 2020 to 2023. Companies such as Toyota, Honda, BYD, Chery, NETA, Wuling Motors, and Great Wall Motors have entered the market and taken advantage of local import tariff incentives for EVs, relevant industry plans, and conditions for foreign investment in local manufacturing. They are collaborating with the local automotive ecosystem to help local businesses achieve vehicle electrification.

For example, Great Wall Motors acquired and renovated GM's factory in Thailand to start production lines for EVs and NEVs. BYD expanded its overseas operations with a second factory in Thailand, planning to make it a major production base in Asia with production starting in 3Q24, while also planning to establish production facilities in Indonesia. Hyundai and Wuling Motors are focusing on the Indonesian EV market and actively expanding the EV industry ecosystem.

OEM automakers have an urgent need for high-performance computing solutions due to the increasing number of vehicles equipped with OTA updates and in-car information systems on the market, along with the continuous development of V2X technology. These solutions are essential for improving operational efficiency and enhancing the human experience (HX), which includes infotainment, high-precision maps, and parking services.

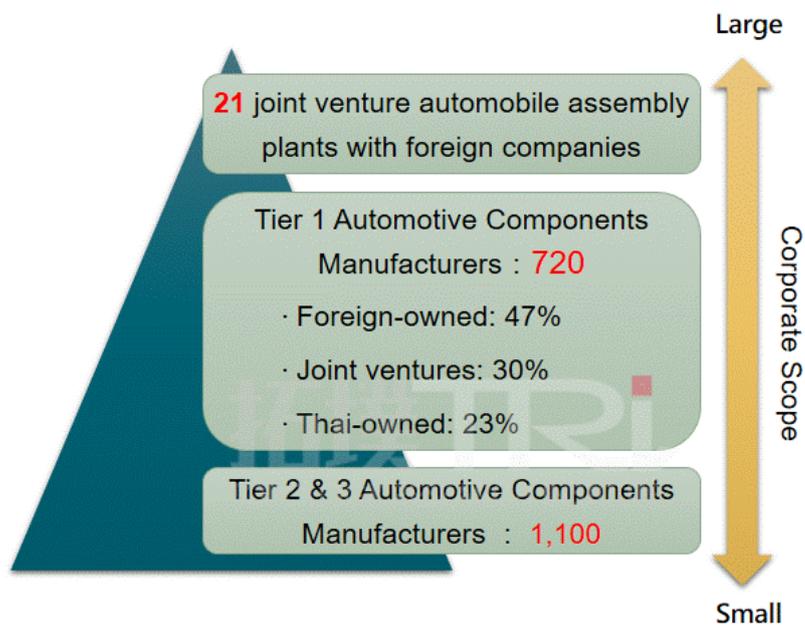
The primary focus is on maintaining "Always On" services to ensure safety and reliability at high speeds. Therefore, certain countries place significant emphasis on the development of key electronic components and communication technologies, including the core technologies of automotive sensors and the establishment of a comprehensive sensor industry chain.

Figure 4: 2023 Global EV Ownership Distribution



Source : IEA ; ICV , TRI ; 2024/06

Figure 5: Thailand’s Automotive Components (Inc. Parts and Assembly) Supply Structure



Source : Thailand Automotive Institute, TRI ; 2024/06

III. Future Trends and Outlook for Automotive Sensors

The advancement of autonomous driving technology, the steady growth of NEVs, and innovations in smart cabin technology are driving the evolution of the automotive industry. By 2024–2025, the integration of EVs and autonomous driving is expected to revolutionize traditional automobiles through the application of AI, big data, and high-

performance computing. This will further accelerate the industry's progress in intelligence and digitalization.

The global landscape of autonomous driving is entering a rapid development phase, spurred by supportive policies and corporate innovation. Countries such as the US, China, India, and Germany are building foundational infrastructure and industrial chains for measuring national data in the automotive autonomous driving sector. This effort is aimed at optimizing and upgrading autonomous driving technologies, including enhancing foundational roadside data and vehicle data through devices like cameras and sensors.

Simultaneously, initiatives promoting smart cities and intelligent transportation are encouraging close cooperation among industry players. These collaborations focus on advancing autonomous driving technologies, in-car entertainment systems, and corresponding network communication technologies (including 5G and V2X). The goal is to explore new profitable models and achieve mutually beneficial outcomes.

Moreover, countries like Norway, the Netherlands, India, and the UK have recently set targets to ban the sale of gasoline vehicles. The US and China have also announced related regulations to strengthen EV policies. The former has introduced corporate average fuel economy standards, while the latter has implemented a dual-credit system to incentivize the development and production of EVs. Given this clear trend, automakers are expected to seize this opportunity to deepen their supply chains and innovation networks. They will also likely focus on rapid advancements in cybersecurity and information protection or prepare for interconnected environments like smart cities and intelligent transportation.

In light of current trends, sensor technology is poised to experience significant growth in the EV market. As EVs rapidly advance toward autonomous driving, sensors that precisely measure pressure, temperature, and monitor battery currents are becoming essential for ensuring vehicle safety and stability. This technological shift highlights the automotive industry's commitment to sustainable development and drives ongoing innovation in sensor technology.

Key factors contributing to this growth include: (1) Increased requirements for accuracy as EVs demand precise measurement of current and gases to ensure efficient energy management and system safety; (2) Reliable supplies of power for sensors given that the development of sensors is closely linked to EV advancements and sensors need a stable power supply to operate effectively.

(I) Application of visual algorithms and LiDAR in the EV market

Tesla is shifting its focus toward the development and deployment of autonomous driving technology, with visual algorithms at its core. Currently, advanced visual solutions primarily rely on cameras, supplemented by millimeter-wave radar to capture environmental information. The advantages of this approach include lower costs and relatively mature hardware. Tesla has improved its autonomous driving capabilities by using sophisticated algorithms to compensate for the long-range detection limitations of millimeter-wave radar. For instance, Tesla has completely removed ultrasonic radar in favor of high-resolution visual solutions.

In contrast, traditional LiDAR systems typically combine millimeter-wave radar, ultrasonic sensors, and cameras to achieve long-distance, all-around detection with high-resolution feedback. Although the hardware cost for LiDAR solutions is higher, some companies continue to prioritize it as their main product route. Notable examples include Google, Waymo, and Baidu Apollo. In 2023, several Chinese automakers increased their application of LiDAR in sensor technology solutions. For example, the ZEEKR New 001 boasts 26 environmental sensors, including one LiDAR sensor mounted on the roof's M platform and is aimed at improving the safety and efficiency of smart driving.

The demand for advanced automotive sensors continues to grow and innovate as the global automotive industry gradually moves toward intelligent and connected vehicles. To guide and promote the development of the automotive sensor industry, countries like the US, Japan, India, and China have introduced a series of policies and plans. These initiatives aim to provide direction for sensor development, foster technological breakthroughs, and support commercial deployment, thereby advancing and upgrading the industry chain.

(II) The importance of SDVs to the automotive industry

As traditional automobiles evolve into extensions of computers and smartphones, the rise of EVs and autonomous driving technology is not only driving the demand for automotive sensors but also highlighting the significance of SDVs. Sensors in these vehicles must have robust network transmission capabilities—particularly for supporting digital cockpits, autonomous driving, and computer vision under secure virtualization technology.

Companies like Mercedes-Benz, Rolling Wireless, Continental, and Harman have already partnered with Qualcomm to integrate multiple automotive chip functions into a single chip. Qualcomm has developed over 26 digital cockpit solutions based on the Snapdragon Ride Flex SoC as of 2023. These solutions provide advanced in-car

electronic system experiences, optimize the management and control of in-vehicle electronic systems, and simplify the complexity of in-car wiring.

Qualcomm's approach to automotive SoC processors is centralized, with the core managing all resources. This includes handling data generated by various sensors and running ML models to meet the current market demands of SDVs. Additionally, Qualcomm has been continuously improving its automotive wireless communication chipsets to boost the performance of connection-oriented communication (CO-mode). The computational power of the Flex SoC, for example, can reach up to 2,000 TOPS.

This demonstrates that Qualcomm's automotive processors and chips not only focus on the fundamental applications of SDVs but also cover two major subfields: the cockpit and ADAS. This comprehensive approach underscores the critical role of SDVs in the future of the automotive industry, driving innovation and integration across various aspects of vehicle functionality.

IV. TRI's View

(I) Three major trends in the automotive industry signal new prospects for the sensor industry

EVs, autonomous driving technology, and SDVs have become key opportunities for the sensor industry. Traditional sensors play a crucial role in EVs by monitoring important parameters such as battery temperature, voltage, and current, promptly detecting component failures, and improving vehicle reliability. Additionally, environmental sensors like LiDAR and cameras significantly improve the performance of autonomous driving technology to ensure the safe operation of vehicles.

Moreover, as countries around the world expand their vision and layout in the smart domain, projects related to smart cities and smart transportation are being actively promoted. During this transition period of automotive technology toward intelligence and electrification, the industry is undergoing a smart connectivity revolution. SDVs are seen as the core of EV development, with sensors being a vital component. These sensors must seamlessly integrate with the vehicle's software systems and be adjusted and optimized according to software requirements to meet market demands.

(II) Automotive sensors to enter high-growth phase from 2024 to 2026

The application and scope of sensors in the automotive field will become increasingly extensive as automotive production and consumption patterns evolve. Major countries

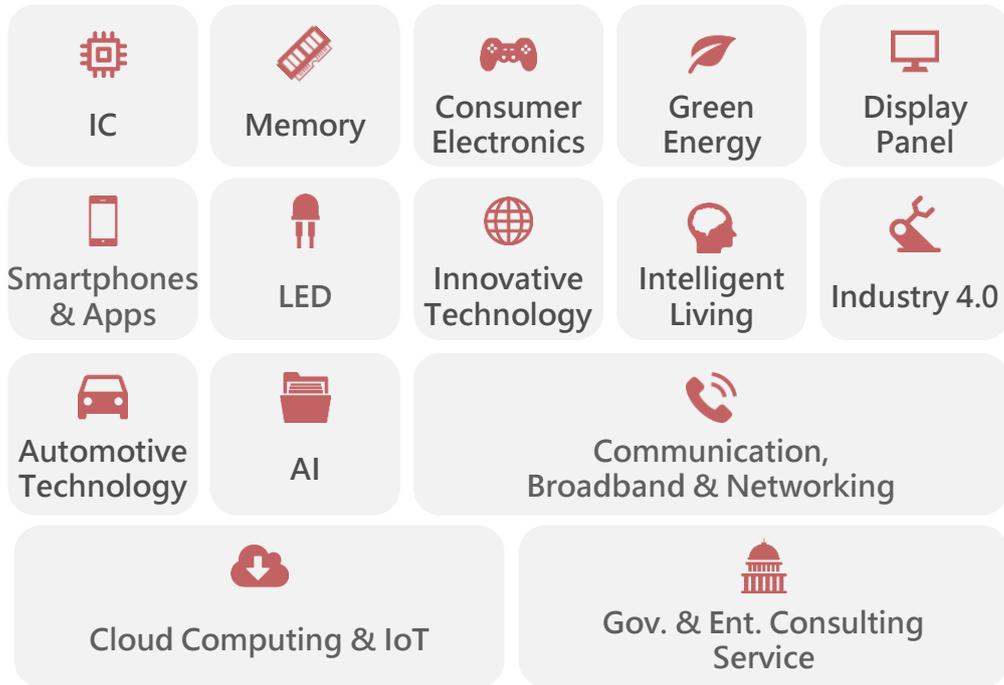
like the US, China, Japan, South Korea, and Singapore are working toward integrating AI into everyday life with advanced transportation systems that are safe, efficient, and sustainable.

China, the UK, India, and a number of European nations (including Norway and the Netherlands) have issued bans on the sale of gasoline vehicles and implemented subsidy programs to boost the adoption of EVs. These initiatives promote green, energy-saving, and carbon-reducing practices while strengthening integration with smart transportation. This accelerates the automotive industry's transition from gasoline vehicles to EVs and the development of their ecosystems. For instance, the US has adopted Corporate Average Fuel Economy (CAFE) standards, while China has implemented the dual credit system.

In this revolutionary innovation process within the automotive industry, automakers are expected to make significant strides in the wave of intelligence and digitalization. It is anticipated that by 2024, the global automotive sensor market will reach \$34.6 billion. With the ongoing development of autonomous vehicle technology, SDVs, and smart cars, and as countries gradually relax regulations and driving rights for level 4 autonomous vehicles, the global automotive sensor market is expected to grow substantially in 2025–2026.

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