

# **Test and Measurement Equipment Market – Global Industry Size, Share, Trends, Opportunity, and Forecast.Segmented By Type (Product, Services), By Product Type (General-purpose Test Equipment, Mechanical Test Equipment), By Service Type (Calibration Services, Repair/After Sales Services), By Application (Automotive, Aerospace and Defense, IT and Telecommunication, Industrial, Healthcare, Semiconductor and Electronics, Education and Government, Manufacturing, Others), By Region, By Company and By Geography, Forecast & Opportunities, 2018-2028**

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## **Abstracts**

Global Synchronous Generator Market was valued at USD 8.71 billion in 2022 and is anticipated to project robust growth in the forecast period with a CAGR of 5.01% through 2028

A synchronous generator, often referred to as a synchronous alternator or simply a synchro generator, is an electromechanical device designed to convert mechanical energy into electrical energy. It operates on the principle of electromagnetic induction and is a crucial component in various power generation systems. In a synchronous generator, a rotor, typically equipped with electromagnets or field windings, rotates within a stationary component known as the stator. The rotor is turned by a prime mover, such as a steam turbine, gas turbine, or diesel engine. As the rotor spins, it

generates a rotating magnetic field. This magnetic field induces voltage in the stator windings through electromagnetic induction, resulting in the production of alternating current (AC) electricity. One of the defining characteristics of a synchronous generator is that its output frequency is precisely synchronized with the rotational speed of the rotor. This synchronization makes synchronous generators particularly valuable for applications where grid stability and consistent frequency are essential, such as conventional power plants and industrial settings.

## Key Market Drivers

### Increasing Power Generation Capacity:

One of the primary drivers of the global synchronous generator market is the continuous need for expanding power generation capacity to meet the growing global demand for electricity. As economies develop and urbanize, the demand for electricity rises, driven by increased industrialization, urbanization, and electrification of rural areas.

Synchronous generators are a fundamental component of power plants, both conventional and renewable, and play a crucial role in generating electrical energy. Conventional power plants, such as coal, natural gas, and nuclear power plants, heavily rely on synchronous generators to produce electricity. In addition, the integration of renewable energy sources like wind and hydropower into the energy mix requires synchronous generators for grid stability and synchronization. As countries worldwide invest in new power generation facilities and upgrade existing ones to meet their energy needs, the demand for synchronous generators continues to grow.

### Expansion of Renewable Energy Sources:

The global shift toward cleaner and more sustainable energy sources is another significant driver of the synchronous generator market. Renewable energy technologies, such as wind turbines and hydroelectric power plants, employ synchronous generators to convert mechanical energy into electrical power. These generators play a crucial role in ensuring the reliability and stability of renewable energy systems. Wind turbines, in particular, have seen substantial growth in deployment, with larger and more powerful turbines requiring high-capacity synchronous generators. The expansion of wind farms and hydropower projects, often in remote or challenging environments, drives the demand for synchronous generators capable of operating under various conditions. Government incentives, environmental regulations, and international agreements to reduce greenhouse gas emissions further promote the adoption of renewable energy sources. As the renewable energy sector continues to expand, the synchronous

generator market benefits from increased installations and upgrades to support sustainable power generation.

#### Grid Stability and Reliability:

Grid stability and reliability are essential for ensuring the continuous supply of electricity to consumers. Synchronous generators contribute significantly to grid stability by providing essential services such as voltage and frequency regulation. These generators are inherently synchronous with the grid, allowing them to synchronize quickly and maintain grid stability during fluctuations in supply and demand. In regions with intermittent renewable energy sources like wind and solar, synchronous generators play a crucial role in grid integration. They provide grid inertia and support grid frequency control, helping to mitigate the challenges posed by variable energy generation. As grid operators prioritize reliability and stability, the synchronous generator market sees increased demand for units that can provide these essential grid services.

#### Industrial and Commercial Growth:

The industrial and commercial sectors are significant consumers of electrical power. As industries expand and commercial facilities proliferate, the demand for reliable power generation solutions, including synchronous generators, continues to rise. Industrial processes, manufacturing operations, data centers, and commercial facilities require uninterrupted power to maintain operations. Synchronous generators are often employed as backup or emergency power sources to ensure continuity during grid outages or disruptions. This is especially critical for industries that operate 24/7, such as healthcare facilities, telecommunications, and manufacturing plants. The need for reliable standby power solutions drives the growth of the synchronous generator market.

#### Infrastructure Development in Emerging Economies:

Emerging economies are undergoing rapid infrastructure development, including the construction of power plants, factories, and commercial complexes. This development necessitates the installation of synchronous generators to meet the electrical needs of these burgeoning industries and urban areas. As emerging economies industrialize and urbanize, the demand for synchronous generators for both primary and backup power generation grows significantly.

### Technological Advancements:

Advancements in synchronous generator technology contribute to the market's growth. Manufacturers are continuously developing generators with improved efficiency, reduced maintenance requirements, and enhanced performance characteristics. These technological innovations make synchronous generators more attractive to end-users seeking cost-effective and reliable power generation solutions. Additionally, innovations in materials and manufacturing processes enable the production of generators that are more compact and lightweight, offering greater flexibility in installation and use.

Various Government Policies are likely to Enhance the Market in the Upcoming years.

### Renewable Energy Incentives and Mandates:

Governments around the world are implementing policies to promote renewable energy sources, such as wind and hydropower, which heavily rely on synchronous generators. These policies include incentives like feed-in tariffs, tax credits, and subsidies to encourage investment in renewable energy projects. Additionally, some governments set renewable energy mandates that require a certain percentage of electricity generation to come from renewable sources. Such policies drive the demand for synchronous generators as they are essential components in these renewable energy systems.

For example, Germany's Renewable Energy Sources Act (EEG) introduced feed-in tariffs for renewable energy producers, which boosted the installation of wind turbines equipped with synchronous generators. Similarly, the United States offers the Production Tax Credit (PTC) and the Investment Tax Credit (ITC) to incentivize renewable energy projects, contributing to the growth of the synchronous generator market.

### Grid Interconnection Standards and Regulations:

Governments establish grid interconnection standards and regulations to ensure the seamless integration of synchronous generators, including those associated with renewable energy sources, into the electricity grid. These standards outline the technical requirements for connecting generators to the grid, including voltage and frequency synchronization, fault ride-through capabilities, and safety protocols.

For example, in the United States, the Federal Energy Regulatory Commission (FERC)

sets rules and standards for the interconnection of generators, including synchronous generators, to the electric grid. Compliance with these regulations is necessary for grid stability and the reliable operation of power systems.

#### Environmental Regulations and Emissions Standards:

Environmental regulations and emissions standards set by governments influence the design and operation of synchronous generators, especially those used in conventional power plants. These policies aim to reduce greenhouse gas emissions, air pollutants, and the environmental impact of power generation.

For instance, the European Union's Industrial Emissions Directive (IED) sets emissions limits for power plants and industrial facilities, pushing operators to adopt cleaner and more efficient technologies, including combined heat and power (CHP) systems using synchronous generators. Compliance with emissions standards drives investments in cleaner power generation technologies, benefiting the synchronous generator market.

#### Energy Efficiency Initiatives:

Government initiatives focused on energy efficiency play a role in the synchronous generator market by encouraging the adoption of high-efficiency generators. Policies like energy efficiency standards for appliances and industrial equipment influence the design and performance characteristics of synchronous generators, driving manufacturers to develop more efficient models.

Countries like Japan and South Korea have implemented energy efficiency labeling programs that encourage the use of efficient appliances and equipment, including synchronous generators used in industrial applications.

#### Incentives for Distributed Generation:

Some governments offer incentives and policies to promote distributed generation, where small-scale power generation sources, often equipped with synchronous generators, are located closer to the end-users. These policies encourage the deployment of combined heat and power (CHP) systems, microgrids, and distributed energy resources, contributing to the growth of the synchronous generator market.

For instance, the United States has programs like the Combined Heat and Power Partnership, which provides technical assistance and incentives for the installation of

CHP systems equipped with synchronous generators in industrial and commercial facilities.

#### Trade and Export Policies:

Government trade and export policies can also impact the global synchronous generator market. Export promotion policies and trade agreements facilitate the international trade of synchronous generators and related equipment. Governments may provide export financing, trade missions, and other incentives to support manufacturers' efforts to expand into foreign markets.

For example, the Export-Import Bank of the United States offers financing and insurance services to support the export of American-made synchronous generators and related equipment, helping manufacturers reach a global customer base. Trade policies, including tariff agreements and trade facilitation initiatives, further influence the dynamics of the synchronous generator market by reducing trade barriers and promoting international cooperation in the energy sector.

#### Key Market Challenges

##### Integration of Variable Renewable Energy Sources:

One of the significant challenges facing the global synchronous generator market is the integration of variable renewable energy sources, such as wind and solar power, into the electricity grid. While synchronous generators have been the backbone of the power generation industry for decades, their synchronous nature presents challenges in accommodating the intermittent and unpredictable nature of renewable energy generation.

Variable renewable energy sources, like wind turbines and solar panels, do not inherently produce electricity at a consistent frequency and voltage, unlike synchronous generators. This creates synchronization challenges when integrating renewable energy into the grid, as it must match the grid's frequency and phase.

##### Challenges:

**Grid Stability and Frequency Control:** Synchronous generators provide inherent grid stability by maintaining the grid's frequency and voltage. However, as more variable renewable energy sources are integrated, the grid's stability can be compromised due

to fluctuations in power supply. When wind or solar power output suddenly drops or surges, it can disrupt the grid's frequency, potentially leading to power outages or equipment damage.

**Synchronous Inertia:** Synchronous generators contribute to grid inertia, which is essential for maintaining system stability during disturbances. In contrast, many renewable energy sources lack this synchronous inertia, making it challenging to address sudden changes in power supply and demand. Additional technologies, such as energy storage systems or advanced grid control strategies, are needed to compensate for this deficiency.

#### Advancements in Power Electronics and Non-Synchronous Alternatives:

The emergence of advanced power electronics and non-synchronous alternatives poses a challenge to the traditional synchronous generator market. Power electronic devices, such as inverters, offer the capability to convert and control the output of variable renewable energy sources more effectively. Additionally, non-synchronous generators, such as induction generators or permanent magnet generators, have gained popularity in specific applications due to their advantages in efficiency and simplicity.

#### Challenges:

**Competition from Non-Synchronous Alternatives:** Non-synchronous generators, particularly permanent magnet generators used in some wind turbines, have become more competitive in terms of cost and efficiency. Their simpler designs and ability to generate power without the need for synchronization with the grid can pose a challenge to traditional synchronous generators in specific applications.

**Transition to Power Electronics:** Power electronic devices, such as inverters used in photovoltaic solar systems, are increasingly prevalent in renewable energy systems. These devices enable the direct conversion of DC power from solar panels or wind turbines into AC power for the grid without the need for synchronous generators. The transition to power electronics-based solutions can reduce the demand for synchronous generators in certain segments of the energy market.

In conclusion, the integration of variable renewable energy sources and the competition from non-synchronous alternatives and advanced power electronics are two significant challenges facing the global synchronous generator market. Addressing these

challenges requires innovative grid management strategies, investments in grid infrastructure, and continued advancements in generator technology to ensure the reliable and efficient integration of renewable energy while maintaining grid stability..

## Segmental Insights

### 2-5 MVA Insights

Based on the category of Form, the 2-5 MVA segment emerged as the dominant player in the global market for synchronous generator in 2022. The 2-5 MVA synchronous generator segment is characterized by its suitability for medium-sized power generation applications. This power rating range is often employed in various sectors, including manufacturing, commercial facilities, and smaller utility-scale power plants. The growing demand for reliable power sources in these applications drives the market for 2-5 MVA synchronous generators. Industries such as manufacturing, petrochemicals, and mining require consistent and stable power sources to support their operations. The 2-5 MVA synchronous generators are well-suited for providing backup or prime power to industrial facilities. They offer the necessary capacity to run critical machinery and systems, ensuring uninterrupted production processes. Commercial buildings, data centers, hospitals, and institutional facilities demand reliable power sources to maintain essential services and operations. Synchronous generators in the 2-5 MVA range serve as backup power solutions to ensure business continuity during grid outages. With the increasing reliance on digital technologies, data centers, in particular, require robust backup power systems, driving the demand for these generators. Synchronous generators in the 2-5 MVA range play a role in grid stability and distributed generation. They can be integrated into microgrid systems, providing localized power generation and enhancing grid resilience. As grid operators and utilities seek to improve grid stability and incorporate distributed energy resources, these generators become essential components. Synchronous generators within the 2-5 MVA range are commonly used in both diesel and natural gas generator sets. These generator sets are deployed in various applications, including emergency backup power, remote power generation, and prime power for off-grid locations. The choice between diesel and natural gas generators depends on factors such as fuel availability, emissions regulations, and operational requirements.

### Gas Turbine Insights



The Gas Turbine segment is projected to experience rapid growth during the forecast period. Gas turbines are widely used in power generation applications, both for base-load and peaking power plants. They operate on the Brayton cycle, using compressed air and fuel combustion to drive a turbine and generate mechanical power. Synchronous generators are an integral part of gas turbine power plants, as they convert the mechanical power produced by the gas turbine into electrical power. This combination of gas turbines and synchronous generators is commonly found in natural gas power plants and provides a reliable and efficient method of electricity generation. One of the notable developments in the power generation industry is the use of combined cycle power plants, which incorporate both gas turbines and steam turbines. In such plants, the gas turbine generates electricity directly, and the waste heat is captured to produce steam, which drives a steam turbine connected to another synchronous generator. This combined cycle configuration significantly improves overall plant efficiency.

Synchronous generators play a vital role in these systems by converting the mechanical energy from both the gas and steam turbines into electrical power. Gas turbines, particularly aeroderivative gas turbines, are used in industrial and commercial facilities to provide onsite power generation. These facilities, such as manufacturing plants, hospitals, data centers, and universities, rely on gas turbines to meet their electricity and thermal energy needs. Synchronous generators are paired with gas turbines to ensure a stable and reliable power supply. This combination is essential for maintaining critical operations and reducing dependence on the grid. Gas turbines are the primary propulsion systems in aviation (jet engines) and marine applications (gas turbine engines). In aviation, they power commercial and military aircraft, providing thrust for propulsion. In marine environments, gas turbines are used in naval ships, cruise liners, and fast ferries. While not directly connected to synchronous generators for power generation, these applications highlight the versatility and efficiency of gas turbines in transportation and marine industries. Gas turbines, often in the form of microturbines, are deployed in distributed energy resource systems. These systems provide localized power generation and can be integrated into microgrids or used for combined heat and power (CHP) applications. Synchronous generators are used in these setups to convert the mechanical energy produced by the gas turbines into electrical power for onsite consumption or export to the grid.

## Regional Insights

Asia Pacific was the largest market for synchronous generators, accounting for over 40% of the market share in 2022. The growth of the market in Asia Pacific is attributed to the increasing demand for electricity from renewable energy sources, such as solar and wind power. China is the largest market for synchronous generators in Asia Pacific,

followed by India and Japan.

North America was the second largest market for synchronous generators, accounting for over 25% of the market share in 2022. The growth of the market in North America is attributed to the increasing demand for power in the United States and Canada. The United States is the largest market for synchronous generators in North America, followed by Canada.

Europe was the third largest market for synchronous generators, accounting for over 20% of the market share in 2022. The growth of the market in Europe is attributed to the increasing demand for electricity from renewable energy sources, such as solar and wind power. Germany is the largest market for synchronous generators in Europe, followed by France and the United Kingdom.

### Key Market Players

ABB Ltd

Siemens Gamesa Renewable Energy S.A.,

GE Renewable Energy

Mitsubishi Heavy Industries, Ltd.

Andritz AG

Bharat Heavy Electricals Limited

Hitachi Energy Ltd.

Suzlon Energy Limited

Wood Group PLC

GE Power Conversion

Report Scope:

In this report, the Global Synchronous Generator Market has been segmented into the

*Test and Measurement Equipment Market – Global Industry Size, Share, Trends, Opportunity, and Forecast.Segment...*

following categories, in addition to the industry trends which have also been detailed below:

Synchronous Generator Market, By Prime Mover:

Steam Turbine

Gas Turbine

Synchronous Generator Market, By Speed:

1,500 RPM

3,000 RPM

Synchronous Generator Market, By Power Rating:

2-5 MVA

10-20 MVA

20-30 MVA

30-50 MVA

Synchronous Generator Market, By End User:

Hospitals,

Data Centers

Telecommunications Networks,

Residential

Others

Synchronous Generator Market, By Region:

North America

United States

Canada

Mexico

Europe

France

United Kingdom

Italy

Germany

Spain

Asia-Pacific

China

India

Japan

Australia

South Korea

South America

Brazil

Argentina

Colombia

Middle East & Africa

South Africa

Saudi Arabia

UAE

Kuwait

Turkey

Egypt

## Competitive Landscape

**Company Profiles:** Detailed analysis of the major companies present in the Global Synchronous Generator Market.

## Available Customizations:

Global Synchronous Generator market report with the given market data, Tech Sci Research offers customizations according to a company's specific needs. The following customization options are available for the report:

## Company Information

Detailed analysis and profiling of additional market players (up to five).

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15.9.1. Business Overview

15.9.2. Key Revenue and Financials

15.9.3. Recent Developments

15.9.4. Key Personnel

15.9.5. Key Product/Services Offered

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15.10.3. Recent Developments

15.10.4. Key Personnel

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