

# **Fuel Cell Market – Global Industry Size, Share, Trends, Opportunity, and Forecast Segmented By Type (PEMFC, SOFC, PAFC and Others), By Application (Portable, Stationary and Fuel Cell Vehicles), By Size (Small Scale and Large Scale), By Region, Competition 2018-2028**

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## **Abstracts**

The Global Fuel Cell Market was valued at USD 5.18 billion in 2022 and is growing at a CAGR of 19.75% during the forecast period. Favorable regulations and policies aimed at expediting the adoption of clean energy, coupled with increased funding for electrification in off-grid and remote areas, will drive revenue growth in the fuel cell market. Furthermore, the implementation of diverse investment programs to shift focus towards distributed power generation techniques will fuel market expansion. Additionally, rising consumer awareness to mitigate greenhouse gas emissions and a growing emphasis on clean energy will stimulate demand for the product.

### **Key Market Drivers**

#### **Environmental Concerns and Emissions Reduction**

One of the key drivers behind the growth of the Global Fuel Cell Market is the increasing global awareness and concern regarding environmental issues, coupled with the urgent need to reduce greenhouse gas emissions. The combustion of fossil fuels for power generation and transportation has significantly contributed to air pollution and the accumulation of greenhouse gases in the atmosphere, ultimately leading to climate change.

Fuel cells, which generate electricity through an electrochemical process with minimal emissions, are regarded as a promising solution to address these environmental challenges. Fuel cells, especially hydrogen fuel cells, produce only water vapor and heat as byproducts during electricity generation. This zero-emission characteristic makes fuel cells an appealing choice for reducing air pollutants and mitigating carbon dioxide emissions, aligning with international climate agreements such as the Paris Agreement. With governments worldwide implementing stricter emissions regulations and setting ambitious sustainability goals, the demand for fuel cells as a clean energy solution continues to grow.

In the transportation sector, fuel cell vehicles (FCVs) are gaining prominence as a means to reduce the carbon footprint of the automotive industry. FCVs offer long driving ranges, rapid refueling, and zero tailpipe emissions, addressing one of the major sources of urban air pollution. Governments and automakers are investing in FCV technology, providing incentives, and developing hydrogen refueling infrastructure to support the transition to cleaner transportation.

### Energy Efficiency and Energy Security

Fuel cells are widely recognized for their exceptional energy conversion efficiency, a key driver in the Global Fuel Cell Market. Unlike conventional combustion engines that dissipate a substantial amount of energy as heat, fuel cells can achieve energy efficiencies above 50% and even higher when utilized in combined heat and power (CHP) applications. This superior energy efficiency not only reduces energy consumption and greenhouse gas emissions but also optimizes the utilization of fuel resources.

The efficiency of fuel cells plays a crucial role in enhancing energy security by diminishing dependence on fossil fuels and promoting the utilization of renewable and low-carbon hydrogen. Hydrogen, a commonly used fuel for fuel cells, can be derived from diverse sources such as natural gas, biogas, electrolysis of water using renewable electricity, and industrial byproducts. This flexibility in feedstock enhances energy security by diversifying fuel sources and mitigating vulnerability to supply disruptions.

Furthermore, fuel cells hold the potential for decentralized energy generation, which can enhance grid resilience and minimize transmission losses. In regions prone to power outages or remote areas with limited access to traditional grid infrastructure, fuel cells act as reliable backup power sources, thereby contributing to energy security and reliability.

## Technological Advancements and Innovation

The continuous progress of fuel cell technologies plays a vital role in driving the Global Fuel Cell Market. Ongoing research and development efforts have resulted in enhancements in fuel cell efficiency, durability, and cost-effectiveness. These advancements have widened the scope of applications and increased the competitiveness of fuel cells compared to conventional energy technologies.

Advancements in materials science, catalyst development, and manufacturing techniques have effectively reduced the cost of fuel cell components, particularly proton exchange membrane fuel cells (PEMFCs) and solid oxide fuel cells (SOFCs). Cost reductions have made fuel cells economically viable, opening up new opportunities in stationary power generation, transportation, and other sectors.

Innovation in fuel cell technology has also led to the creation of more robust and durable systems, extending their operational lifetimes and reducing maintenance requirements. Improved durability makes fuel cells suitable for a wider range of applications, including heavy-duty transportation, distributed generation, and off-grid power solutions.

Furthermore, research into alternative and sustainable hydrogen production methods, such as green hydrogen produced from renewable sources, has contributed to the sustainability and competitiveness of fuel cell technology. These technological advancements and innovations continue to drive the growth of the Global Fuel Cell Market and its adoption across various industries.

## Key Market Challenges

### High Manufacturing and Infrastructure Costs

One of the major challenges confronting the Global Fuel Cell Market is the relatively high manufacturing and infrastructure costs associated with fuel cell technology. These costs present a hurdle to widespread adoption and impede the competitiveness of fuel cells compared to conventional energy technologies.

Fuel cells necessitate precise manufacturing processes and materials, including catalysts like platinum, which can be costly. Platinum is employed as a catalyst in proton exchange membrane fuel cells (PEMFCs) to facilitate the electrochemical reactions that produce electricity. Reducing dependence on precious metals such as

platinum is a crucial challenge in rendering fuel cells more cost-effective.

Furthermore, the establishment of a hydrogen infrastructure, encompassing production, storage, and distribution facilities, entails substantial capital investment. Constructing a comprehensive network of hydrogen refueling stations for fuel cell vehicles (FCVs) requires significant financial backing, and the limited availability of infrastructure can curtail the market penetration of FCVs.

Addressing this challenge involves research and development endeavors aimed at alternative materials and catalysts that can lower manufacturing costs. Innovations in manufacturing processes, scaling up production, and achieving economies of scale can also contribute to reducing the overall cost of fuel cell systems. Additionally, government incentives and subsidies can play a critical role in offsetting initial investment costs and promoting the deployment of fuel cell technologies.

### Hydrogen Supply and Distribution

The availability and distribution of hydrogen, a crucial fuel for various types of fuel cells, present a significant challenge to the Global Fuel Cell Market. The development of hydrogen production methods, storage, and distribution infrastructure is still in its early stages and often encounters logistical and economic obstacles.

One of the challenges lies in sourcing hydrogen feedstock. While hydrogen can be derived from different sources like natural gas, water electrolysis, and biomass, the production methods must be both environmentally sustainable and economically viable. For instance, the production of hydrogen from fossil fuels can lead to carbon emissions, which counteracts the environmental advantages of fuel cells.

The transportation and distribution of hydrogen also pose challenges. Due to its low density, hydrogen has lower energy density compared to fuels like gasoline or diesel. Hence, efficient and safe transportation and storage of hydrogen necessitate specialized infrastructure, which can be expensive to establish and maintain.

Moreover, the establishment of a hydrogen refueling network for FCVs faces challenges related to siting, safety regulations, and financing. Efforts to tackle this challenge involve the advancement of green hydrogen production methods, expansion of hydrogen storage solutions, and establishment of a comprehensive hydrogen distribution infrastructure. Collaboration among governments, industry stakeholders, and research institutions is vital in overcoming these obstacles and ensuring a reliable and

sustainable hydrogen supply chain.

## Key Market Trends

### Hydrogen Infrastructure Expansion

One of the prominent trends in the Global Fuel Cell Market is the significant expansion of hydrogen infrastructure. As fuel cells, particularly proton exchange membrane fuel cells (PEMFCs), rely on hydrogen as their primary fuel source, the availability and accessibility of hydrogen refueling stations and production facilities are crucial for the widespread adoption of fuel cell technology.

Governments and private-sector stakeholders are making substantial investments in the development of hydrogen infrastructure to support the growing demand for fuel cell vehicles (FCVs) and stationary fuel cell applications. The increasing popularity of FCVs, offering longer driving ranges, rapid refueling, and zero tailpipe emissions, is driving governments and energy companies to establish a network of hydrogen refueling stations. Regions such as Europe, Japan, South Korea, and California are witnessing significant expansion in hydrogen refueling infrastructure.

Innovations in hydrogen production methods, including green hydrogen produced using renewable energy sources and electrolysis, are contributing to a more sustainable and cost-effective hydrogen supply chain. Electrolyzers powered by renewable electricity play a vital role in producing clean hydrogen for fuel cells. The hydrogen ecosystem is evolving to support various industries. Besides transportation, hydrogen is being explored for applications in industrial processes, energy storage, and grid support, further emphasizing the need for infrastructure expansion.

### Decarbonization and Sustainability Initiatives

Another significant trend in the Global Fuel Cell Market is the increasing focus on decarbonization and sustainability initiatives. Governments, corporations, and individuals are becoming more aware of the environmental impact of energy production and consumption. Fuel cells, renowned for their minimal emissions and high efficiency, are well-aligned with these sustainability objectives.

Fuel cell vehicles (FCVs) are gaining traction as a means to mitigate greenhouse gas emissions from the transportation sector. Governments and automakers are investing in FCV technology to transition away from internal combustion engine vehicles.

There is a growing emphasis on producing hydrogen using renewable energy sources, commonly referred to as green hydrogen. This approach ensures that the hydrogen fuel utilized in fuel cells has a minimal carbon footprint, thus contributing to decarbonization efforts.

Fuel cells, particularly solid oxide fuel cells (SOFCs), are being integrated into decentralized energy generation systems. They enable on-site power generation using hydrogen derived from renewable sources or biogas, which reduces dependence on centralized fossil fuel power plants. Fuel cells' high energy conversion efficiency is highly valued in applications where energy conservation and sustainability are of paramount importance, such as combined heat and power (CHP) systems in residential and commercial buildings.

## Segmental Insights

### Type Insights

The Proton Exchange Membrane Fuel Cell (PEMFC) segment holds a significant market share in the Global Fuel Cell Market. PEMFCs are recognized for their exceptional energy efficiency, low emissions, and versatility for various applications. They play a crucial role in FCVs by offering benefits such as quick refuelling, extended driving ranges, and zero tailpipe emissions.

The increasing interest in hydrogen-powered vehicles presents significant opportunities for the adoption of PEMFCs. Moreover, PEMFCs provide reliable backup power for critical applications, including data centers, hospitals, and telecommunications infrastructure. Their rapid start-up and high energy density make them highly suitable for such purposes.

Additionally, PEMFCs are utilized in portable fuel cell chargers for smartphones, laptops, and other electronic devices. They offer longer operating times compared to traditional batteries, making them preferred by users who require extended device usage.

In warehouses and distribution centers, PEMFC-powered forklifts are gaining popularity due to their advantages such as rapid refuelling, longer operation on a single tank, and zero emissions. These benefits contribute to improved operational efficiency. Furthermore, PEMFCs are known for their high energy conversion efficiency, making



them an attractive option for various applications where energy efficiency is crucial.

Lastly, it is worth noting that PEMFCs produce minimal emissions, primarily water vapor. This characteristic makes them environmentally friendly and suitable for applications in urban areas with strict emissions regulations.

### Size Insights

Small Scale segment is expected to dominate the market during the forecast period. The small-scale segment of the Global Fuel Cell Market encompasses a wide range of applications and technologies designed for decentralized power generation, portable devices, and niche markets.

Fuel cells offer a higher energy density compared to traditional lithium-ion batteries, making them well-suited for portable electronics like smartphones, laptops, and tablets where longer battery life is a key selling point. Small-scale fuel cells also serve as backup power sources for critical applications in power outage-prone areas, including telecommunications equipment, remote weather stations, and emergency response systems where reliable and uninterrupted power supply is crucial.

Hydrogen fuel cells are increasingly employed to power forklifts and other material handling equipment in warehouses and logistics centers, offering benefits such as fast refueling and zero emissions, thereby improving operational efficiency.

Additionally, small-scale fuel cell CHP (combined heat and power) systems provide both electricity and heat to homes, achieving high energy efficiency by utilizing waste heat generated during electricity production for space heating and hot water, thus reducing overall energy consumption. Fuel cells are also being explored as power sources for marine vessels and recreational vehicles, offering advantages such as reduced noise, emissions, and extended operating ranges for boating and camping enthusiasts.

### Regional Insights

The Asia Pacific region is expected to dominate the market during the forecast period. The Asia-Pacific region is a significant player in the Global Fuel Cell Market, propelled by factors such as escalating energy demand, mounting environmental concerns, and government initiatives that promote clean energy technologies. Several countries in the Asia-Pacific region, including Japan, South Korea, and China, have implemented supportive policies and incentives to foster the adoption of fuel cell technology. These

policies encompass subsidies, feed-in tariffs, tax incentives, and research funding.

Extensive investments in fuel cell research and development within the Asia-Pacific nations have resulted in notable advancements in fuel cell efficiency, durability, and cost-effectiveness. The collaboration between governments, academia, and industry players has been instrumental in driving innovation within the sector. With its robust industrial base, encompassing automotive, electronics, and energy sectors, the Asia-Pacific region is strategically positioned to play a pivotal role in fuel cell manufacturing and deployment across diverse applications. Notably, nations like Japan and South Korea have made substantial investments in FCV development and infrastructure.

The growing interest in FCVs presents lucrative opportunities for fuel cell manufacturers and hydrogen infrastructure providers. Fuel cells, particularly in combined heat and power (CHP) applications, offer distributed energy generation solutions for residential, commercial, and industrial sectors, thereby aligning with efforts to enhance energy resilience and efficiency.

In conclusion, the Asia-Pacific region assumes a paramount role in the Global Fuel Cell Market, driven by supportive policies, robust R&D efforts, a strong industrial base, growing adoption in the transportation sector, and increasing environmental concerns. The region's steadfast commitment to fuel cell technology and hydrogen development positions it as a significant contributor to the global transition toward clean and sustainable energy solutions.

### Key Market Players

Ballard Power Systems Inc.

Horizon Fuel Cell Technologies Pte. Ltd.

Toshiba Energy Systems & Solutions Corporation

FuelCell Energy Inc.

Plug Power Inc.

Nuvera Fuel Cells LLC

Intelligent Energy Limited



SFC Energy AG

Mitsubishi Power Ltd.

Cummins Inc.

Report Scope:

In this report, the Global Fuel Cell Market has been segmented into the following categories, in addition to the industry trends which have also been detailed below:

Global Fuel Cell Market, By Type:

PEMFC

SOFC

PAFC

Others

Global Fuel Cell Market, By Application:

Portable

Stationary

Fuel Cell Vehicles

Global Fuel Cell Market, By Size:

Small Scale

Large Scale

Global Fuel Cell 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

### Competitive Landscape

Company Profiles: Detailed analysis of the major companies present in the Global Fuel Cell Market.

### Available Customizations:

Global Fuel Cell 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).

## Contents

### **1. PRODUCT OVERVIEW**

- 1.1. Market Definition
- 1.2. Scope of the Market
  - 1.2.1. Markets Covered
  - 1.2.2. Years Considered for Study
  - 1.2.3. Key Market Segmentations

### **2. RESEARCH METHODOLOGY**

- 2.1. Objective of the Study
- 2.2. Baseline Methodology
- 2.3. Key Industry Partners
- 2.4. Major Association and Secondary Sources
- 2.5. Forecasting Methodology
- 2.6. Data Triangulation & Validation
- 2.7. Assumptions and Limitations

### **3. EXECUTIVE SUMMARY**

### **4. VOICE OF CUSTOMERS**

### **5. GLOBAL FUEL CELL MARKET OUTLOOK**

- 5.1. Market Size & Forecast
  - 5.1.1. By Value
- 5.2. Market Share & Forecast
  - 5.2.1. By Type (PEMFC, SOFC, PAFC and Others)
  - 5.2.2. By Application (Portable, Stationary and Fuel Cell Vehicles)
  - 5.2.3. By Size (Small Scale and Large Scale)
  - 5.2.4. By Region
- 5.3. By Company (2022)
- 5.4. Market Map

### **6. NORTH AMERICA FUEL CELL MARKET OUTLOOK**

- 6.1. Market Size & Forecast

- 6.1.1. By Value
- 6.2. Market Share & Forecast
  - 6.2.1. By Type
  - 6.2.2. By Application
  - 6.2.3. By Size
  - 6.2.4. By Country
- 6.3. North America: Country Analysis
  - 6.3.1. United States Fuel Cell Market Outlook
    - 6.3.1.1. Market Size & Forecast
      - 6.3.1.1.1. By Value
    - 6.3.1.2. Market Share & Forecast
      - 6.3.1.2.1. By Type
      - 6.3.1.2.2. By Application
      - 6.3.1.2.3. By Size
  - 6.3.2. Canada Fuel Cell Market Outlook
    - 6.3.2.1. Market Size & Forecast
      - 6.3.2.1.1. By Value
    - 6.3.2.2. Market Share & Forecast
      - 6.3.2.2.1. By Type
      - 6.3.2.2.2. By Application
      - 6.3.2.2.3. By Size
  - 6.3.3. Mexico Fuel Cell Market Outlook
    - 6.3.3.1. Market Size & Forecast
      - 6.3.3.1.1. By Value
    - 6.3.3.2. Market Share & Forecast
      - 6.3.3.2.1. By Type
      - 6.3.3.2.2. By Application
      - 6.3.3.2.3. By Size

## **7. ASIA-PACIFIC FUEL CELL MARKET OUTLOOK**

- 7.1. Market Size & Forecast
  - 7.1.1. By Value
- 7.2. Market Share & Forecast
  - 7.2.1. By Fuel Type
  - 7.2.2. By Size
  - 7.2.3. By Country
- 7.3. Asia-Pacific: Country Analysis
  - 7.3.1. China Fuel Cell Market Outlook

- 7.3.1.1. Market Size & Forecast
  - 7.3.1.1.1. By Value
- 7.3.1.2. Market Share & Forecast
  - 7.3.1.2.1. By Type
  - 7.3.1.2.2. By Application
  - 7.3.1.2.3. By Size
- 7.3.2. India Fuel Cell Market Outlook
  - 7.3.2.1. Market Size & Forecast
    - 7.3.2.1.1. By Value
  - 7.3.2.2. Market Share & Forecast
    - 7.3.2.2.1. By Type
    - 7.3.2.2.2. By Application
    - 7.3.2.2.3. By Size
- 7.3.3. Japan Fuel Cell Market Outlook
  - 7.3.3.1. Market Size & Forecast
    - 7.3.3.1.1. By Value
  - 7.3.3.2. Market Share & Forecast
    - 7.3.3.2.1. By Type
    - 7.3.3.2.2. By Application
    - 7.3.3.2.3. By Size
- 7.3.4. South Korea Fuel Cell Market Outlook
  - 7.3.4.1. Market Size & Forecast
    - 7.3.4.1.1. By Value
  - 7.3.4.2. Market Share & Forecast
    - 7.3.4.2.1. By Type
    - 7.3.4.2.2. By Application
    - 7.3.4.2.3. By Size
- 7.3.5. Australia Fuel Cell Market Outlook
  - 7.3.5.1. Market Size & Forecast
    - 7.3.5.1.1. By Value
  - 7.3.5.2. Market Share & Forecast
    - 7.3.5.2.1. By Type
    - 7.3.5.2.2. By Application
    - 7.3.5.2.3. By Size

## **8. EUROPE FUEL CELL MARKET OUTLOOK**

- 8.1. Market Size & Forecast
  - 8.1.1. By Value



## 8.2. Market Share & Forecast

### 8.2.1. By Type

### 8.2.2. By Application

### 8.2.3. By Size

### 8.2.4. By Country

## 8.3. Europe: Country Analysis

### 8.3.1. Germany Fuel Cell Market Outlook

#### 8.3.1.1. Market Size & Forecast

##### 8.3.1.1.1. By Value

#### 8.3.1.2. Market Share & Forecast

##### 8.3.1.2.1. By Type

##### 8.3.1.2.2. By Application

##### 8.3.1.2.3. By Size

### 8.3.2. United Kingdom Fuel Cell Market Outlook

#### 8.3.2.1. Market Size & Forecast

##### 8.3.2.1.1. By Value

#### 8.3.2.2. Market Share & Forecast

##### 8.3.2.2.1. By Type

##### 8.3.2.2.2. By Application

##### 8.3.2.2.3. By Size

### 8.3.3. France Fuel Cell Market Outlook

#### 8.3.3.1. Market Size & Forecast

##### 8.3.3.1.1. By Value

#### 8.3.3.2. Market Share & Forecast

##### 8.3.3.2.1. By Type

##### 8.3.3.2.2. By Application

##### 8.3.3.2.3. By Size

### 8.3.4. Italy Fuel Cell Market Outlook

#### 8.3.4.1. Market Size & Forecast

##### 8.3.4.1.1. By Value

#### 8.3.4.2. Market Share & Forecast

##### 8.3.4.2.1. By Type

##### 8.3.4.2.2. By Application

##### 8.3.4.2.3. By Size

### 8.3.5. Spain Fuel Cell Market Outlook

#### 8.3.5.1. Market Size & Forecast

##### 8.3.5.1.1. By Value

#### 8.3.5.2. Market Share & Forecast

##### 8.3.5.2.1. By Type

- 8.3.5.2.2. By Application
- 8.3.5.2.3. By Size

## **9. SOUTH AMERICA FUEL CELL MARKET OUTLOOK**

- 9.1. Market Size & Forecast
  - 9.1.1. By Value
- 9.2. Market Share & Forecast
  - 9.2.1. By Type
  - 9.2.2. By Application
  - 9.2.3. By Size
  - 9.2.4. By Country
- 9.3. South America: Country Analysis
  - 9.3.1. Brazil Fuel Cell Market Outlook
    - 9.3.1.1. Market Size & Forecast
      - 9.3.1.1.1. By Value
    - 9.3.1.2. Market Share & Forecast
      - 9.3.1.2.1. By Type
      - 9.3.1.2.2. By Application
      - 9.3.1.2.3. By Size
  - 9.3.2. Argentina Fuel Cell Market Outlook
    - 9.3.2.1. Market Size & Forecast
      - 9.3.2.1.1. By Value
    - 9.3.2.2. Market Share & Forecast
      - 9.3.2.2.1. By Type
      - 9.3.2.2.2. By Application
      - 9.3.2.2.3. By Size
  - 9.3.3. Colombia Fuel Cell Market Outlook
    - 9.3.3.1. Market Size & Forecast
      - 9.3.3.1.1. By Value
    - 9.3.3.2. Market Share & Forecast
      - 9.3.3.2.1. By Type
      - 9.3.3.2.2. By Application
      - 9.3.3.2.3. By Size

## **10. MIDDLE EAST & AFRICA FUEL CELL MARKET OUTLOOK**

- 10.1. Market Size & Forecast
  - 10.1.1. By Value

## 10.2. Market Share & Forecast

10.2.1. By Type

10.2.2. By Application

10.2.3. By Size

10.2.4. By Country

## 10.3. Middle East & Africa: Country Analysis

10.3.1. Saudi Arabia Fuel Cell Market Outlook

10.3.1.1. Market Size & Forecast

10.3.1.1.1. By Value

10.3.1.2. Market Share & Forecast

10.3.1.2.1. By Type

10.3.1.2.2. By Application

10.3.1.2.3. By Size

10.3.2. South Africa Fuel Cell Market Outlook

10.3.2.1. Market Size & Forecast

10.3.2.1.1. By Value

10.3.2.2. Market Share & Forecast

10.3.2.2.1. By Type

10.3.2.2.2. By Application

10.3.2.2.3. By Size

10.3.3. UAE Fuel Cell Market Outlook

10.3.3.1. Market Size & Forecast

10.3.3.1.1. By Value

10.3.3.2. Market Share & Forecast

10.3.3.2.1. By Type

10.3.3.2.2. By Application

10.3.3.2.3. By Size

## 11. MARKET DYNAMICS

11.1. Drivers

11.2. Challenge

## 12. MARKET TRENDS & DEVELOPMENTS

## 13. COMPANY PROFILES

13.1. Ballard Power Systems Inc.

13.1.1. Business Overview

- 13.1.2. Key Revenue and Financials
- 13.1.3. Recent Developments
- 13.1.4. Key Personnel
- 13.1.5. Key Product/Services
- 13.2. Horizon Fuel Cell Technologies Pte. Ltd.
  - 13.2.1. Business Overview
  - 13.2.2. Key Revenue and Financials
  - 13.2.3. Recent Developments
  - 13.2.4. Key Personnel
  - 13.2.5. Key Product/Services
- 13.3. Toshiba Energy Systems & Solutions Corporation
  - 13.3.1. Business Overview
  - 13.3.2. Key Revenue and Financials
  - 13.3.3. Recent Developments
  - 13.3.4. Key Personnel
  - 13.3.5. Key Product/Services
- 13.4. FuelCell Energy Inc.
  - 13.4.1. Business Overview
  - 13.4.2. Key Revenue and Financials
  - 13.4.3. Recent Developments
  - 13.4.4. Key Personnel
  - 13.4.5. Key Product/Services
- 13.5. Plug Power Inc.
  - 13.5.1. Business Overview
  - 13.5.2. Key Revenue and Financials
  - 13.5.3. Recent Developments
  - 13.5.4. Key Personnel
  - 13.5.5. Key Product/Services
- 13.6. Nuvera Fuel Cells LLC
  - 13.6.1. Business Overview
  - 13.6.2. Key Revenue and Financials
  - 13.6.3. Recent Developments
  - 13.6.4. Key Personnel
  - 13.6.5. Key Product/Services
- 13.7. Intelligent Energy Limited
  - 13.7.1. Business Overview
  - 13.7.2. Key Revenue and Financials
  - 13.7.3. Recent Developments
  - 13.7.4. Key Personnel

13.7.5. Key Product/Services

13.8. SFC Energy AG

13.8.1. Business Overview

13.8.2. Key Revenue and Financials

13.8.3. Recent Developments

13.8.4. Key Personnel

13.8.5. Key Product/Services

13.9. Mitsubishi Power Ltd.

13.9.1. Business Overview

13.9.2. Key Revenue and Financials

13.9.3. Recent Developments

13.9.4. Key Personnel

13.9.5. Key Product/Services

13.10. Cummins Inc.

13.10.1. Business Overview

13.10.2. Key Revenue and Financials

13.10.3. Recent Developments

13.10.4. Key Personnel

13.10.5. Key Product/Services

## **14. STRATEGIC RECOMMENDATIONS**

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