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Hybrid Energy Portable Power System

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Final year Bachelor of Technology Presentation

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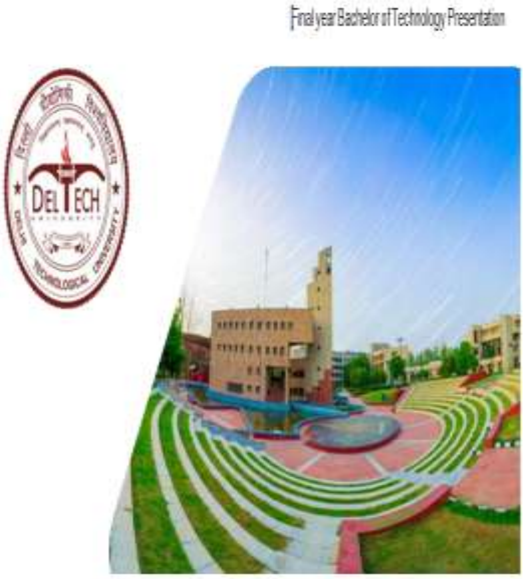


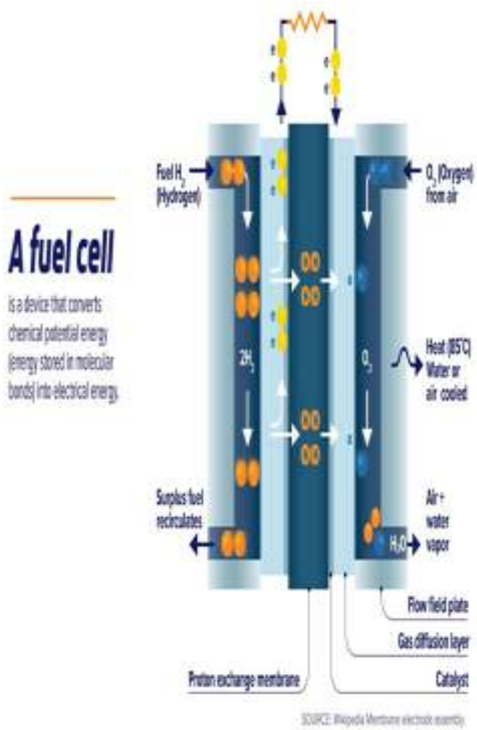
ABSTRACT
Portable Power Systems based on fuel cells have emerged as a promising solution to address the increasing demand for clean, efficient, and portable energy sources. This abstract presents an overview of the implications of such systems.
Fuel cell technology offers significant advantages, including high energy efficiency, low emissions, and quiet operation. By integrating fuel cells with other energy sources such as solar panels, wind turbines, or energy storage systems which are battery, Hybrid Energy Portable Power Systems can harness multiple energy inputs and optimize power generation and utilization.
The implications of Hybrid Energy Portable Power Systems based on fuel cells are far-reaching. These systems enable the provision of clean and reliable power in remote areas, emergency situations, outdoor events, and off-grid applications. They contribute to reduced carbon footprint, improved air quality, andenhanced energy security.
However, challenges still remain but their performance, compatibility, and scalability of fuel cell-based hybrid systems offer a promising solution. Continued innovation, collaboration, and investment in this field are crucial to realizing the full potential of these systems and accelerating their adoption in a wide range of applications.

WHAT IS FUEL CELL?

- Fuel cells are battery tending device, they do not run down or need recharging. They produce electricity and heat as long as fuel is supplied. A fuel cell consists of two electrodes—a negative electrode (or anode) and a positive electrode (or cathode)—sandwiched around an electrolyte.
- A fuel cell uses fuels to cleanly and efficiently produce electricity. Fuel cells are unique in terms of the variety of their potential applications; they can use a wide range of fuels and feedstocks and can provide power for systems as large as a utility power station and as small as a laptop computer.
- A fuel cell is preferred over conventional methods of energy generation because, in a fuel cell, zero combustion takes place. Thus, carbon dioxide is not produced. Increasing environmental problems, limited fossil resources and the geopolitical dependence on

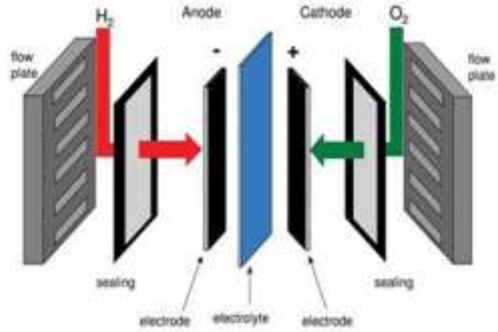
crude oil are enormous challenges for our societies.

- According to energy experts from all over the world, fuel cell and hydrogen energy technologies will play an important role in the portfolio for a future energy economy.

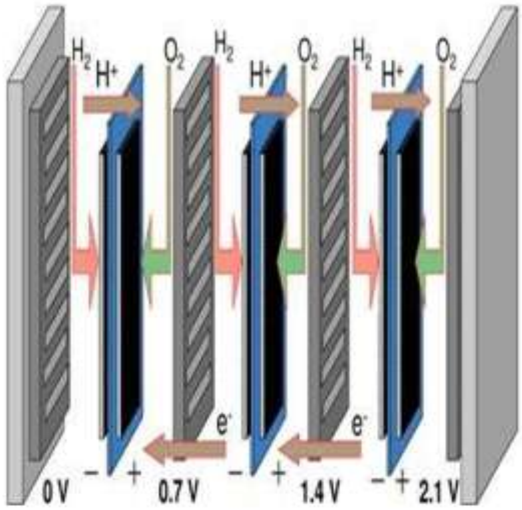


Fuel cell setup: from single cell to systems

Single cell. Besides conducting ions from one electrode to the other, the electrolyte serves as gas separator and electronic insulator. The electrodes are the sites at which the electrochemical reactions take place. Besides containing the suitable catalysts, the electrode architecture should be such that transport of reactants to and products from the catalyst–electrolyte interface is taking place at the maximum possible rate. A single fuel cell, as displayed in Fig. , produces the power, which results from the area × the current density of the cell × the cell voltage. The typical cell voltage under load conditions amounts to 0.7 V, which is too low for practical applications.



Schematic, simplified overview of a fuel cell stack



Stacks - It is therefore common practice to put a number of cells in series, resulting in a so-called fuel cell stack. Flow plates connect two adjacent cells. These flow plates, also called separator plates or bipolar plates when a single plate is used for the anode side of one cell and for the cathode side of the other cell, should have a high electronic conductance, and should act as a gas separator between the two adjacent cells. The flow plates contain flow patterns on the cellside to generate an even distribution of reactants across the cell area. On the backside, cooling liquid flow patterns transport the heat to a heat exchanger in the system. The stack power and voltage is obtained by the number of cells × the individual cell power and voltage. A three-cell stack is schematically drawn in Fig..Besides the repeating units displayed in Fig. , a stack contains two endplates and two current collector plates from which the current is collected.

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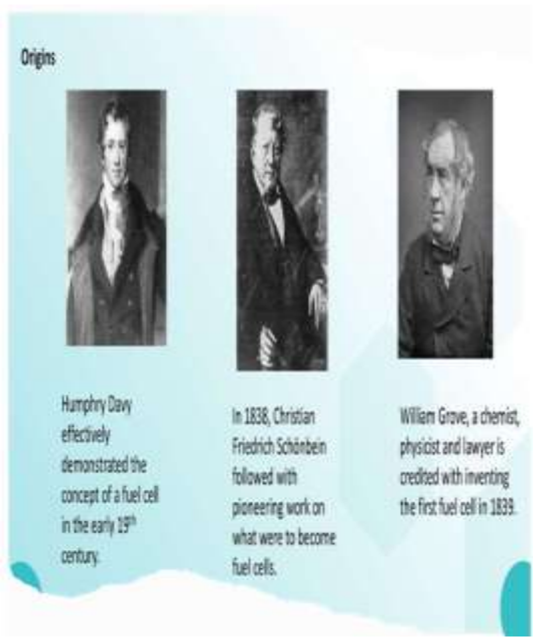
History / Origin of Fuel Cell System

Fuel cells have been known in the scientific community for about 150 years. They began to be explored in the 1800s, and have been extensively researched during the second half of the twentieth and early twenty-first century.

First ever fuel cell was from **In 1800, William Nicholson and Anthony Carlisle** described the process of using electricity to break water into hydrogen and oxygen. **William Grove** is credited with the first known demonstration of the fuel cell in 1839. Grove saw notes from Nicholson and Carlisle and thought he might “recompose water” by combining electrodes in a series circuit, and soon accomplished this with a device called a “gas battery.” It operated with separate **platinum electrodes** in oxygen and hydrogen submerged in a dilute sulfuric acid electrolyte solution. The sealed containers contained water and gasses, and it he observed that the water level rose in both tubes as the current flowed. The device was nicknamed the “Grove cell,” and it consisted of a platinum electrode immersed in nitric acid, and a zinc electrode immersed in zinc sulfate. It generated about 12 amps of current at approximately volts.



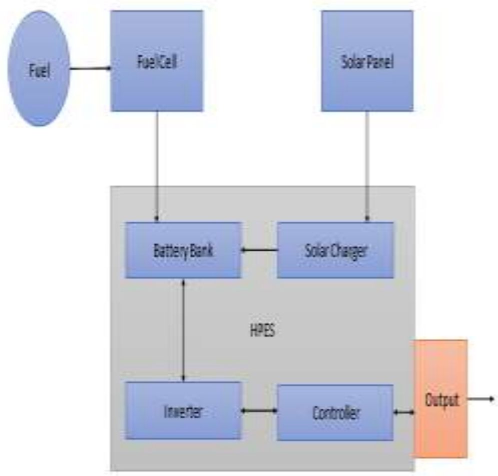
OBJECTIVES

- The primary objective is to maximize portability and mobility with Environmental Sustainability due to the fact this system is based on the green renewables.
- Hybrid Energy Portable Power System based on fuel cell technology can be developed to meet the growing demand for clean, efficient, and portable energy solutions. These objectives align with the goals of energy sustainability, environmental stewardship, and improved energy access in various sectors where there are no grid or in the harshest conditions and various applications.

IntroductiontoHPES

- A hybrid portable energy system is a type of energy system that combines multiple sources of energy to provide power for a variety of applications. These systems typically consist of a combination of renewable energy sources such as solar, wind, or conventional grid, along with a new green technologycalled fuel cell.
- Hybrid portable energy systems can be used for a wide range of applications, including powering remote homes or cabins, providing electricity for outdoor events, and powering construction sites or other temporary work locations, as well as using these hybrid power source we can power up the mission critical for our defense and homeland security forces of India as it eliminate the heavy weight and use of diesel as fuel. They can also be used as backup power systems for homes or businesses in the event of a power outage.

Principal Behind Hybrid Portable Energy System



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Different Fuel Cells in the Market

- POLYMER ELECTROLYTE MEMBRANE FUEL CELLS
- DIRECT METHANOL FUEL CELLS
- ALKALINE FUEL CELLS
- PHOSPHORIC ACID FUEL CELLS
- MOLTEN CARBONATE FUEL CELLS
- SOLID OXIDE FUEL CELLS
- REVERSIBLE FUEL CELLS

CLASSIFICATION OF FUEL CELL

Description	AFC	DMFC	MCFC	PAFC	PEMFC	SOFC
Full Form	Alkaline Fuel Cell	Direct Methanol Fuel Cell	Molten Carbonates Fuel Cell	Phosphoric Acid Fuel Cell	Polymer Electrolyte Membrane Fuel Cell	Solid Oxide Fuel Cell
Electrolyte	Potassium Hydroxide	Polymer Member	Molten Carbonates	Phosphoric Acid	Ion Exchange Membrane	Ceramic
Operating Temp	60–90°C	60–130°C	600–650°C	200°C	60–80°C	600–800°C
Charge Carrier Electrodes	OH- Metal/Carbon	H+ Pt on carbon	CO_3^{2-} Ni+Cr	H+ Pt on carbon	H+ Pt on carbon	O_2^- LSM/Ni-YSZ (Yttria stabilized Zirconia)
Area Specific Resistance (ASR) Values of the Electrolyte						
Efficiency	40–60%	40%	45–60%	35–40%	40–60%	50–65%
Typical Electric Power Range	Up to 20KW	<10KW	>1MW	>50KW	Up to 250KW	W–MW
Possible Application	Submarines/ Spacecraft	Portable Application	Power Station	Power Station	Vehicle/ Power Station/ Stationary	Portable/ Power Station

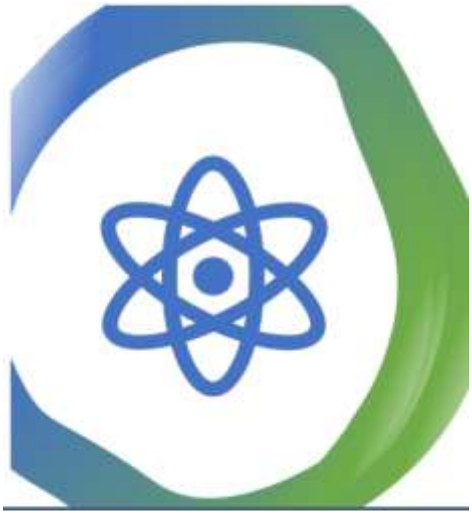
SOLID OXIDE FUEL CELLS

A solid oxide fuel cell (SOFC) is an electrochemical device that converts chemical energy directly into electrical energyby utilizing an ion-conducting ceramic material as the electrolyte.

One of the key advantages of SOFCs is their high efficiency. They can achieve electrical efficiencies above 50%, and whencombined with heat recovery systems, total efficiencies can exceed 80%. Additionally, SOFCs have a wide range of fuel flexibility. They can directly use a variety of fuels including hydrogen, natural gas, biogas, and even carbon monoxide.

This versatility makes them suitable for a range of applications, from stationary power generation to transportation and portable power systems.

Overall, solid oxide fuel cells offer a promising technology for efficient and clean energy conversion. Ongoing advancements in materials, manufacturing processes, and system integration continue to improve their performance, reliability, and commercial viability, paving the way for their widespread adoption in various energy applications.



Application for Hybrid PortableEnergySystem

- Portable Power Supply
- Military and Defense
- Telecommunications
- Transportation
- Disaster Relief
- Remote Monitoring and Sensing
- Marine and Boating
- Aviation
- RV

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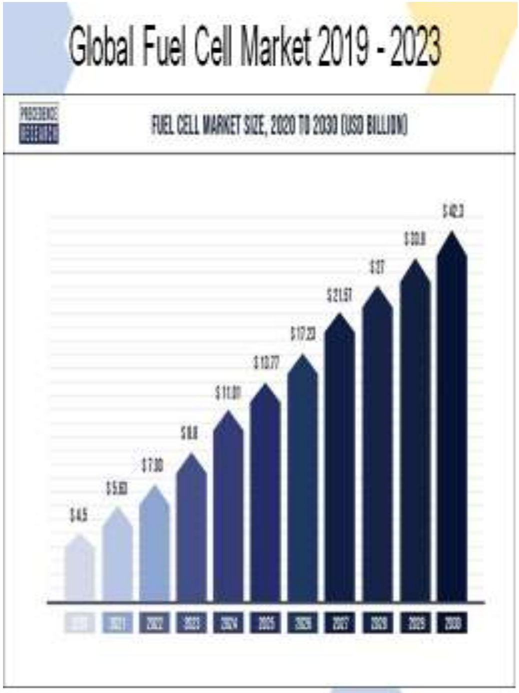

CONCLUSION

In conclusion, fuel cell-based hybrid energy systems offer a promising and transformative approach to meet our energy needs in a sustainable and efficient manner. The key findingsfrom research and analysis demonstrate the significant advantages and implications of these systems.

The environmental advantages of fuel cell-based hybrid energy systems are substantial. Moreover, fuel cell-based hybrid energy systems provide enhanced energy security and resilience. Their ability to operate independently of centralized power grids ensures a reliable energy supply, particularly in remote or off-grid areas. The findings suggest that fuel cell hybrids can serve as backup power sources during grid outages or emergencies, contributing to overall energy resilience and stability.

In summary, fuel cell-based hybrid energy systems have the potential to revolutionize our energy landscape by offering higher efficiency, reduced emissions, enhanced energy security, and increased reliance on renewable energy sources. The key findings highlight their environmental benefits, economic viability, and implications for policy, research, and public engagement. By harnessing the power of fuel cells and integrating renewable energy, these systems pave the way towards a sustainable, resilient, and cleaner energy future.