SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35
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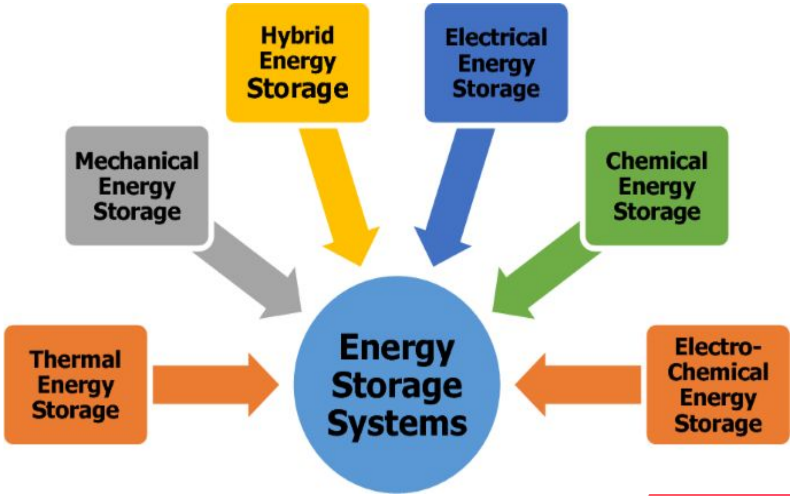
UNIT III: REQUIREMENTS IN HYBRID AND ELECTRIC VEHICLES

TOPIC: **Hybridization of different energy storage devices**

Introduction

- **Why Hybridization in EVs?**
  - Increasing demand for longer driving range, better efficiency, and reduced charging time.
  - Single energy storage devices often have limitations.
  - Hybridization leverages the strengths of different technologies.
- **Objective of the Presentation:**
  - To explore various hybrid energy storage systems (HESS) for electric vehicles (EVs).



Energy Storage Devices in EVs

- **Primary Energy Storage Technologies:**
  - **Batteries:** Lithium-Ion (Li-ion), Solid-state, Nickel-Metal Hydride (NiMH)
  - **Supercapacitors:** High power density but low energy density
  - **Fuel Cells:** Hydrogen-based, zero emissions, high energy density

Challenges with Single Energy Storage

- **Batteries:**
  - Long charging time
  - Limited lifespan and thermal issues
  - Moderate power density
- **Supercapacitors:**
  - Limited energy storage capacity
  - Not suitable for long distances
- **Fuel Cells:**
  - Hydrogen storage and infrastructure challenges
  - High costs

Hybrid Energy Storage System (HESS)

- **What is HESS?**
  - A combination of two or more energy storage devices working together to optimize performance.
- **Benefits:**
  - Improved energy and power density
  - Enhanced efficiency and lifespan
  - Better thermal management
  - Fast charging and discharging capabilities

Common Hybrid Configurations

1. **Battery + Supercapacitor**
    - Battery provides energy for long-range
    - Supercapacitor delivers power for acceleration and regenerative braking
    - Benefits: Improved lifespan, efficiency, and reduced thermal issues
2. **Battery + Fuel Cell**
    - Battery for immediate power needs
    - Fuel cell provides sustained energy
    - Benefits: Increased range, zero emissions, and lower battery size requirements
3. **Fuel Cell + Supercapacitor**
    - Supercapacitor handles power fluctuations
    - Fuel cell delivers continuous energy
    - Benefits: Smooth power delivery and improved efficiency

Working Principle of HESS

- **Energy Flow Management:**
  - Power distribution managed by a control unit or power electronic converters.
  - Intelligent Energy Management System (EMS) optimizes performance.

Diagram: (Insert a schematic showing energy flow between components in a hybrid system.)

Advantages of HESS for EVs

- Higher energy density and power density
- Enhanced range and acceleration
- Faster charging and discharging
- Better thermal stability and longevity
- Regenerative braking efficiency

Challenges in Implementing HESS

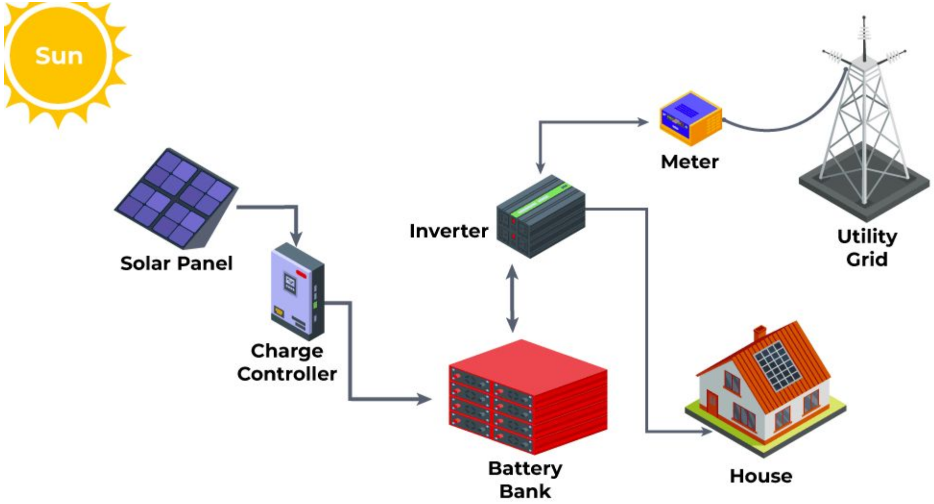
- **Cost:**
  - High initial cost due to multiple devices and control systems.
- **Complexity:**
  - Integration and management of hybrid systems are technically challenging.
- **Size and Weight:**
  - Increased system complexity may affect vehicle weight and size.
- **Infrastructure:**
  - Hydrogen fuel cells require significant infrastructure development.

Future Trends and Innovations

- Solid-state batteries and hybrid supercapacitors
- Hydrogen storage advancements for fuel cells
- AI and Machine Learning in Energy Management Systems
- Lightweight materials to reduce weight penalties

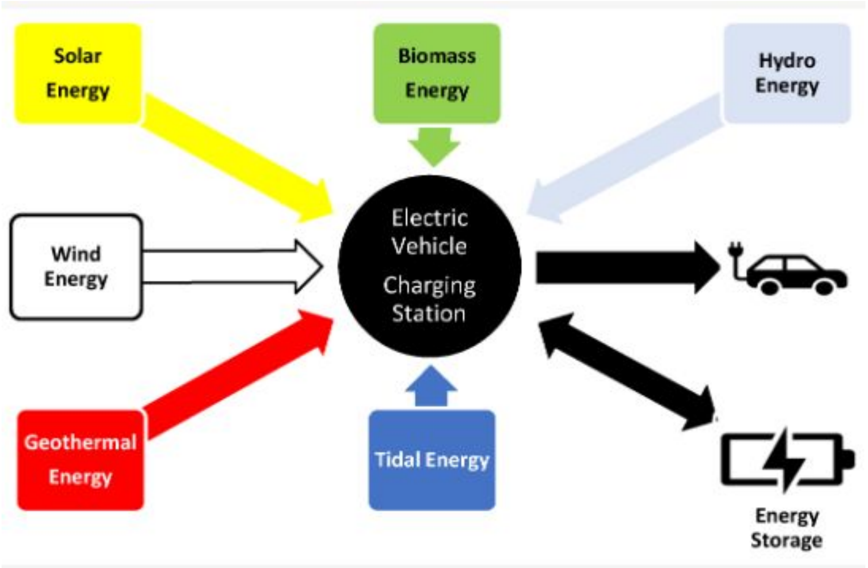
Case Studies

- **Tesla Model S Plaid:**
  - Battery-dominated hybrid energy management
- **Toyota Mirai:**
  - Fuel cell-powered EV with hybrid storage for better range
- **Formula E Cars:**
  - Use of supercapacitors for rapid energy release



Conclusion

- Hybridization of energy storage devices is key to addressing current EV limitations.
- It improves performance, range, and overall efficiency of EVs.
- Continued innovation is essential for widespread adoption and cost reduction.



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