



# BUILDERS

## ENGINEERING COLLEGE

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai | ISO 9001:2015 Certified Institution | Recognized 2(f) Status by UGC  
EBET Knowledge Park, Nathakadaiyur, Kangeyam, Tirupur - 638 108, Tamil Nadu, India.



### Department of Electrical & Electronics Engineering

### JUNE 2023



VOLUME 04

## About the Institution

Builders Engineering College (Formerly known as Erode Builder Educational Trust's Group of Institutions) was established by Erode Builder Educational Trust (EBET) in the year 2009 as an integrated campus and presently functioning as a technical campus. It offers six UG Programmes (BE – Civil, CSE, ECE, EEE, Mechanical) and four PG Programmes (ME – CEM, STR, CSE and MBA) with an intake of 114 students. Stepping into the fourteenth year of service, the Management, CEO, Principal and faculty members are committed to elevating the lives of budding rural aspirants through academics and research. The Chief Patrons are the pioneers in the field of infrastructure and construction all over India.

### Vision

To be the most preferred knowledge provider.

### Mission

Builders Engineering College endeavours to prepare rural students for successful career through academic and applied research.

## About the Department

The Department of Electrical and Electronics Engineering was started in the year 2010 and offers BE EEE programme in tune with the syllabi of Anna University. The department aims to develop electrical engineers who are innovative, entrepreneurial, and equipped to become global leaders in research and technology. The department has well qualified faculty members who are specialists in the fields of Power Electronics and Drives, VLSI Design, Applied Electronics and Power Engineering and Management. The faculty team includes a doctorate serving for the betterment of the students. The department has well equipped laboratories. The department provides an environment to students in such a way that they will be able to understand the core concepts including Electrical machines, Circuits and Networks, Power systems, Power Electronics, Electromagnetic theory, Instrumentation, Microprocessors and Microcontrollers and Electron Devices & Circuits.

### Vision

To be the renowned department in creating highly talented, skilled and well-disciplined professionals in Electrical and Electronics Engineering.

### Mission

- Having state of the art facilities for enabling students' to learn, understand, apply and disseminate knowledge.
- Improve employability through Industrial Interaction and Entrepreneurship.
- Develop the Professional Ethics and Human Values for the benefit of society.

## Programme Educational Objectives (PEOs)

- Shall flourish in their professional careers, further education, research, or as entrepreneurs
- Must always learn new things and hone existing abilities to create solutions that have a big impact and are cutting-edge in terms of energy use.
- To create and build practical, multidisciplinary solutions that are technically sound, commercially viable and socially acceptable, graduates must have strong communication skills, a professional demeanour and ethical behaviour.

# Contents

- ⚡— **About the Institution**
- ⚡— **About the Department**
- ⚡— **Navigating the Evolving Landscape of Electric Vehicle Infrastructure: Embracing**
- ⚡— **Unveiling Electric Vehicle Adoption: A Global Journey through Market Trends**
- ⚡— **The Role of Renewable Energy in Powering Electric Vehicles: A Sustainable Road Ahead**
- ⚡— **Power Electronics in Electric Vehicles: Technical Insights into Motor Control and Energy Conversion**

June 2023

Electrical & Electronics Engineering

Electrical & Electronics Engineering Magazine

CREA is published for the Alumni, Friends, and Peers of the Department.

©2023 Builders Engineering College  
Department of Electrical & Electronics Engineering  
EBET Knowledge Park, Nathakadaiyur, Kangeyam,  
Tamilnadu - 638 108.

## Design & Concept

**A. Sakthi Murugan, II Year**

**K. Karthi Keyan, III Year**

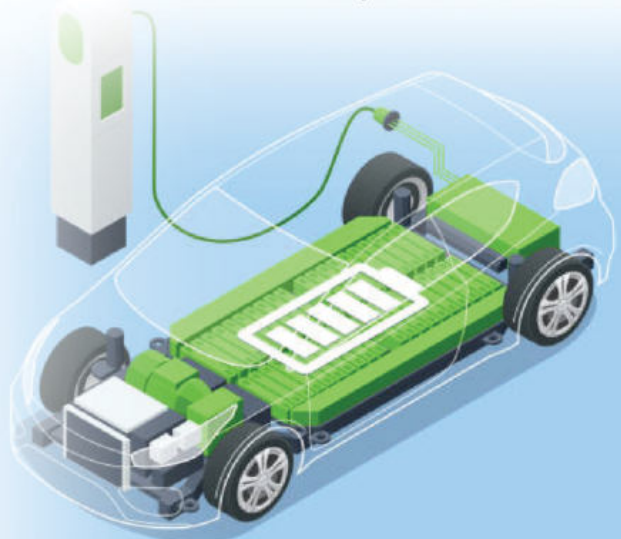
## Editor

**Mr. M. Balasubramanian**  
**Assistant Professor**

**M. Loopika, II Year**

**B. Yogesh, IV Year**

**S. Barath, III Year**



# Navigating the Evolving Landscape of Electric Vehicle Infrastructure: Embracing

by Mr. M. Balasubramanian, Assistant Professor

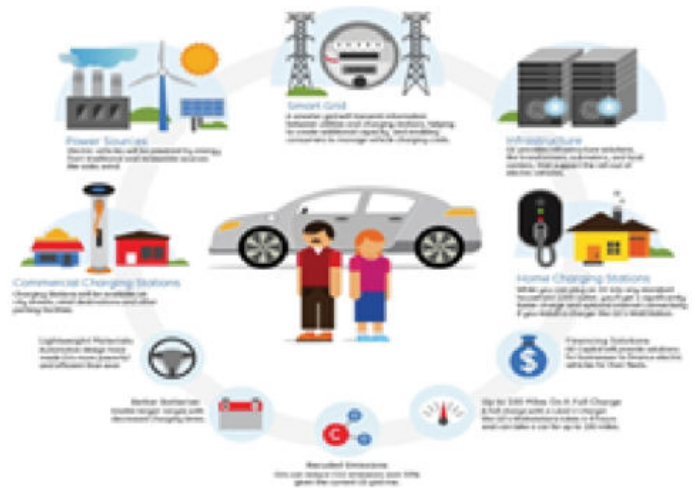
**Introduction:** The global transition towards electric vehicles (EVs) has sparked a parallel evolution in infrastructure development. This article delves into the burgeoning landscape of electric vehicle infrastructure, exploring the myriad opportunities it presents alongside the challenges that demand innovative solutions.

**Opportunities in Expansion:** One of the most promising opportunities lies in the rapid expansion of charging networks. As governments and private enterprises invest in charging infrastructure, the accessibility and convenience of EVs are vastly improving. Initiatives such as public-private partnerships and government incentives are driving this expansion, fostering a competitive market that benefits both consumers and businesses.

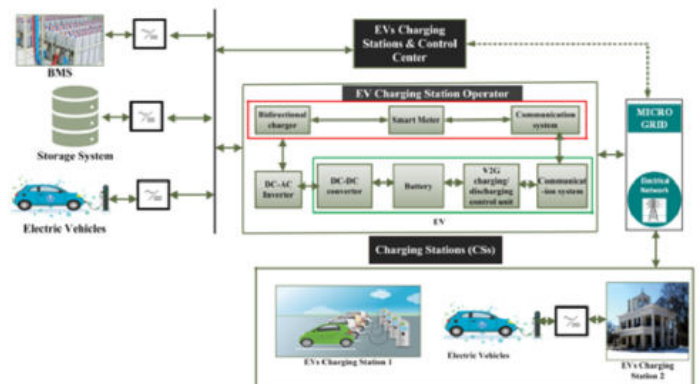


**Challenges of Scalability:** However, scalability remains a significant challenge. The exponential growth in EV adoption strains existing infrastructure, leading to congestion at charging stations and grid overload. Addressing this challenge requires proactive planning and investment in robust, scalable infrastructure capable of meeting the escalating demand for charging services.

Technological Innovations



**Driving Efficiency:** Technological advancements play a pivotal role in overcoming infrastructure challenges. Smart charging solutions, leveraging IoT and data analytics, optimize charging patterns, alleviating strain on the grid and enhancing user experience. Moreover, rapid charging technologies and bidirectional charging capabilities are revolutionizing EV infrastructure, offering faster charging speeds and enabling vehicle-to-grid (V2G) integration for grid stabilization.



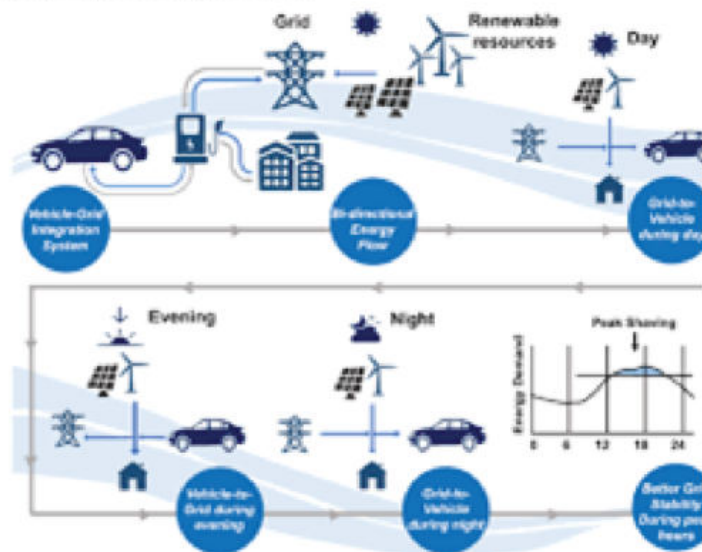
**Integration with Renewable Energy:** The synergy between EV infrastructure and renewable energy sources presents another opportunity for sustainable development. By coupling EV charging stations with solar arrays and wind turbines, communities can reduce reliance on fossil fuels and promote clean, renewable energy generation. This integrated approach fosters energy independence and resilience while mitigating environmental impact.

**Solar-powered EV charging station:** A sleek charging station with solar panels mounted on the roof, generating clean electricity to power EVs.

**Wind-powered EV charging station:** A charging station with wind turbines nearby, harnessing wind energy to charge EVs.

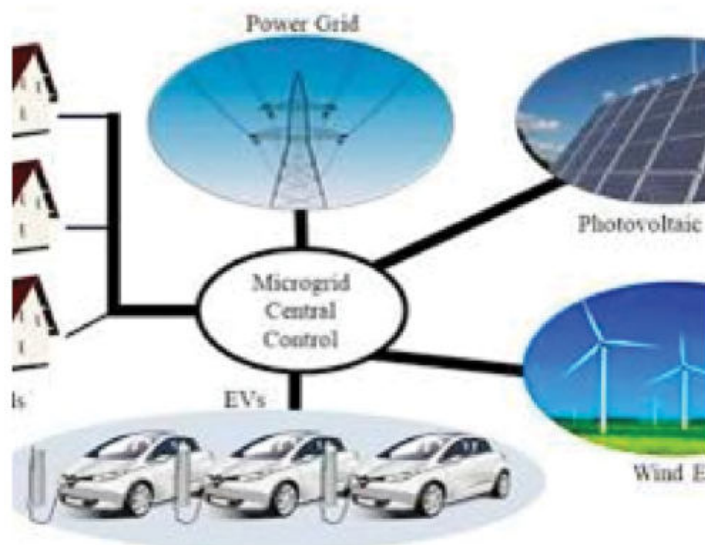


**Vehicle-to-grid (V2G) integration:** An EV connected to a smart grid, with electricity flowing from the vehicle's battery back to the grid during peak demand periods.



**Microgrid with EVs and renewable energy sources:** A self-contained microgrid powered by solar panels, wind turbines, and battery storage, with EVs seamlessly integrated for transportation and energy storage.

By integrating renewable energy sources into EV charging infrastructure, we can create a more sustainable and resilient transportation system. These images can help visualize the potential of this integration and its benefits for the environment and energy security.



**Policy and Regulatory Frameworks:** Policy and regulatory frameworks play a crucial role in shaping the future of EV infrastructure. Governments must incentivize investment in charging infrastructure while implementing standards to ensure interoperability and safety. Additionally, regulations mandating EV-ready building codes and parking requirements further accelerate infrastructure development, facilitating seamless EV integration into society.

**Conclusion:** In conclusion, the rise of electric vehicle infrastructure heralds a transformative era in transportation. While challenges such as scalability and grid integration persist, innovative solutions driven by technological advancements and supportive policies offer unprecedented opportunities for growth. By embracing these opportunities and addressing challenges collaboratively, stakeholders can catalyze the widespread adoption of electric vehicles, paving the way towards a sustainable and electrified future.

## Unveiling Electric Vehicle Adoption: A Global Journey through Market Trends

by M. Loopika, II Year

### Introduction:

Electric vehicles (EVs) have emerged as a disruptive force in the automotive industry, with their adoption reshaping the global transportation

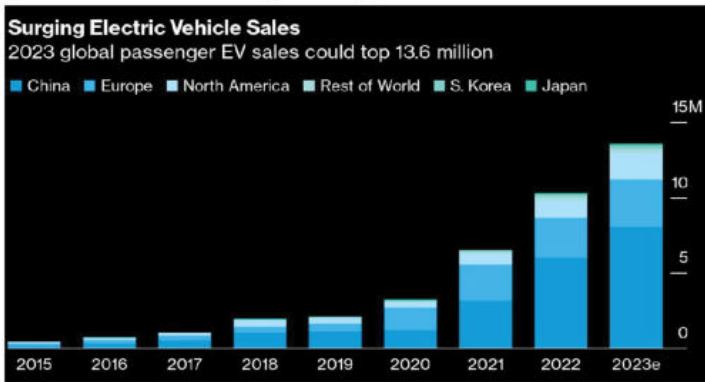
landscape. This article embarks on a journey to explore the dynamic market trends driving the proliferation of electric vehicles worldwide.

Rapid Growth in EV Sales:



Rapid Growth in EV Sales:

The global electric vehicle market has witnessed exponential growth in recent years, fueled by a combination of technological advancements, environmental concerns, and government incentives. According to industry reports, EV sales have surged, with major automakers ramping up production and expanding their electric vehicle portfolios to meet growing consumer demand.



Regional Variances in Adoption:

While electric vehicle adoption is gaining momentum globally, regional disparities exist in market penetration and growth rates. Countries like Norway and China lead the charge in EV adoption, buoyed by generous subsidies, favorable regulations, and robust charging infrastructure. In contrast, some regions lag behind due to infrastructure limitations, affordability concerns, and entrenched reliance on traditional combustion engine vehicles.

Shift in Consumer Preferences:

A notable trend driving electric vehicle adoption is the evolving preferences of consumers. Increasing

environmental consciousness, coupled with rising fuel costs and concerns about air quality, are prompting consumers to consider electric vehicles as viable alternatives to conventional cars. Additionally, the growing availability of affordable EV models with longer ranges is broadening the appeal of electric mobility across diverse demographics.



Technological Advancements:

Advancements in battery technology and electric drive trains are instrumental in accelerating electric vehicle adoption. Ongoing research and development efforts focus on enhancing battery performance, reducing charging times, and lowering production costs, making electric vehicles more accessible and practical for mainstream consumers. Furthermore, innovations in autonomous driving, connectivity, and electrification synergize to redefine the driving experience and expand the market potential for EVs.

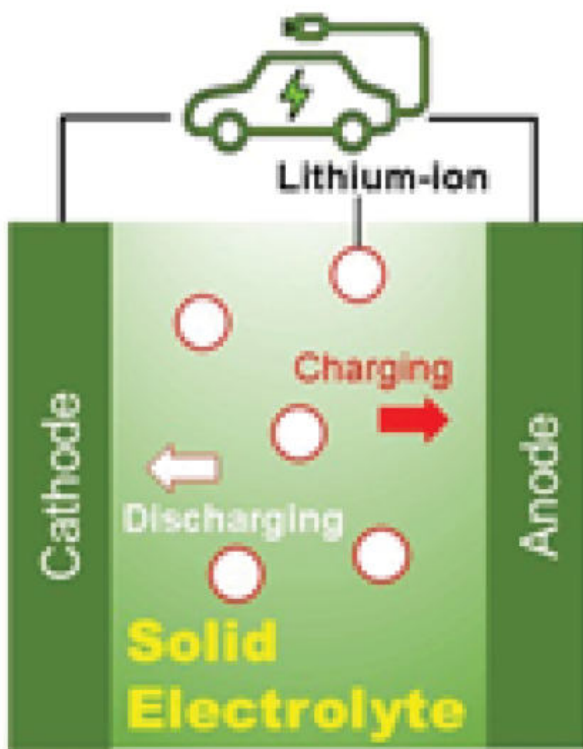
Technological Advancements in EV Batteries: Powering the Future

The future of electric vehicles hinges on advancements in battery technology. Here's a glimpse into some exciting breakthroughs:

Solid-State Batteries:

- A sleek, futuristic EV battery with a solid electrolyte, emphasizing its durability and safety.
- **Description:** Replacing liquid electrolytes with solid ones offers enhanced safety, higher energy density (increased range), and faster charging times. Companies like Toyota and Quantum Scape are leading the charge in this field.

## Solid-State Battery



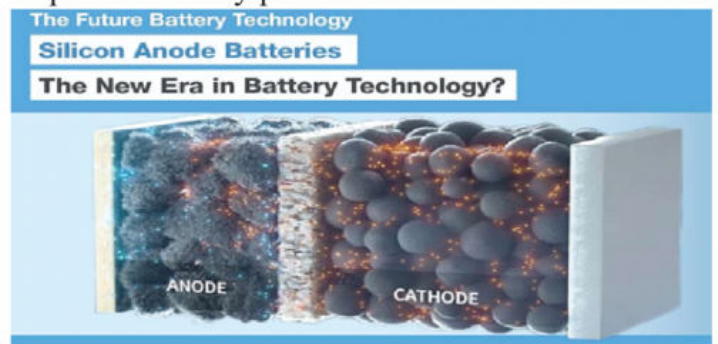
### Lithium-Sulfur Batteries:

- A bright yellow lithium-sulfur battery cell, highlighting its potential for high energy density.
- **Description:** These batteries boast the potential for significantly higher energy density than lithium-ion batteries, leading to much longer ranges. However, challenges in lifespan and stability still need to be addressed.



### Silicon Anode Batteries:

- **Image:** A close-up of a silicon anode, emphasizing its ability to store more lithium ions.
- **Description:** Replacing graphite anodes with silicon allows for more lithium storage, potentially doubling energy density compared to current lithium-ion batteries. However, challenges in cycling stability and cost remain.
- Silicon anodes absorb more lithium than graphite anodes, resulting in significant improvements in battery performance.
- Silicon has a comparatively high theoretical-specific capacity, which means it can pack more energy into the same amount of space as graphite and other metal alloys, resulting in improved battery performance.



- Silicon-based batteries have a greater energy density than graphite-based batteries, which means they can store more energy in the same amount of space.
- Silicon anodes can enhance EV battery density and range without increasing costs.
- Silicon anodes can enhance battery capacity by up to 30%, resulting in greater range and faster charging times. Silicon anodes can cut the cost of EV batteries by up to 30%, making them more cost-effective than graphite anodes.

### Sodium-Ion Batteries:

- A blue sodium-ion battery cell, highlighting its abundance and affordability compared to lithium.
- **Description:** Offering a more sustainable and cheaper alternative to lithium-ion batteries, sodium-ion batteries are being explored for grid

## storage and potentially lower-performance EVs.

### Difference Between Sodium-ion and Lithium-ion Batteries

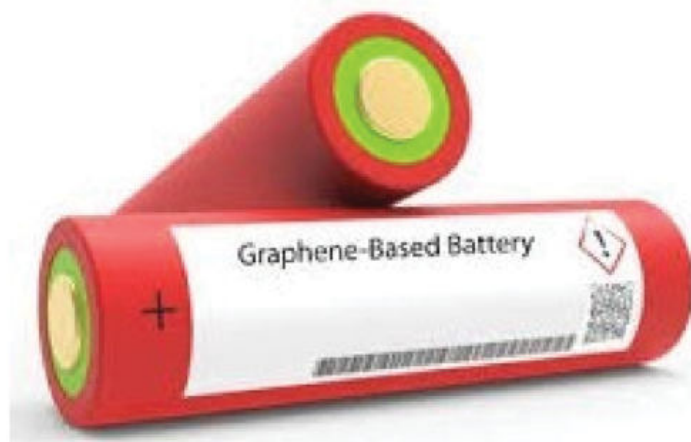
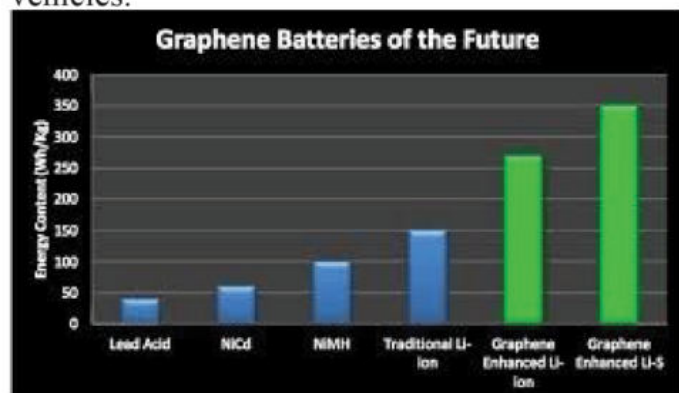
Sodium-ion	Lithium-ion
 Availability: Sodium is more than 500x more abundant than lithium.	 Availability: Lithium availability is limited to a few countries in the world.
 Recyclability: simple recovery and recycling process.	 Recyclability: complex separation of metals may be required.
 Environmental Friendly: can be transported at zero volt.	 Environmental Friendly: must be always stored with a minimum charge.
 Raw Material Cost: sodium hydroxide is \$USD 300 to 800 per metric ton.	 Raw Material Cost: lithium hydroxide is \$USD 78,000 per metric ton.
 Manufacturing Cost: fully compatible, cheaper, uses aluminum.	 Manufacturing Cost: relatively high due to the usage of copper.
 Rechargeability: 1,500 cycles.	 Rechargeability: 2,000 to 3,000 cycles.

### Graphene-Based Batteries:

- **Image:** A honeycomb-like structure representing graphene, emphasizing its potential for faster charging and higher capacity.
- **Description:** Graphene's unique properties could lead to batteries that charge much faster and store more energy, but research is still in its early stages.

### Beyond Batteries:

- **Wireless Charging:** Imagine parking your car and it automatically charges without cables. Wireless charging technologies are being developed to improve convenience and accessibility.
- **Battery Swapping Stations:** Quickly swapping depleted batteries for charged ones could address range anxiety and charging time concerns. These advancements show the incredible potential of EV batteries to revolutionize transportation. While challenges remain, continued research and development promise a future of cleaner, longer-range, and more convenient electric vehicles.



### Government Support and Policy Initiatives:

Government support and policy interventions play a pivotal role in shaping the trajectory of electric vehicle adoption. Incentives such as tax credits, rebates, and subsidies incentivize consumers to purchase electric vehicles while stimulating investment in charging infrastructure and R&D. Additionally, regulatory mandates for emissions reductions and vehicle electrification drive automakers to accelerate their electric vehicle initiatives, fostering a conducive environment for market growth.

### Conclusion:

In conclusion, the global market for electric vehicles is experiencing a transformative shift driven by evolving consumer preferences, technological innovations, and supportive government policies. While challenges persist, such as infrastructure limitations and cost considerations, the momentum towards electric mobility is undeniable. By navigating market trends and capitalizing on opportunities for collaboration and innovation, stakeholders can propel the widespread adoption of electric vehicles, ushering in a sustainable and electrified future for transportation worldwide.

## The Role of Renewable Energy in Powering Electric Vehicles: A Sustainable Road Ahead

by B. Yogesh, IV Year

### Introduction:

In the ever-evolving landscape of transportation,

the integration of renewable energy sources holds the promise of revolutionizing the way we power our vehicles. With the pressing need to mitigate climate change and reduce dependence on finite fossil fuels, electric vehicles (EVs) have emerged as a pivotal solution. However, the environmental benefits of EVs can only be fully realized when coupled with renewable energy generation. This article explores the symbiotic relationship between renewable energy and electric vehicles, highlighting the crucial role of renewables in shaping a sustainable future for transportation.

### **Transitioning to Electric Mobility:**

The transportation sector is a significant contributor to greenhouse gas emissions, primarily through the combustion of fossil fuels in vehicles. Recognizing the urgent need to curb emissions, many countries and industries are accelerating the transition to electric mobility. EVs offer a cleaner alternative to internal combustion engine vehicles, emitting zero tailpipe emissions and reducing air pollution in urban areas. However, the environmental benefits of EVs extend beyond their zero-emission operation; they also pave the way for integrating renewable energy into the transportation ecosystem.



### **Harnessing Renewable Energy:**

Renewable energy sources, such as solar, wind, hydroelectric, and geothermal power, offer a sustainable alternative to fossil fuels for generating electricity. Unlike coal, oil, and natural gas, renewable energy is abundant, inexhaustible, and emits minimal greenhouse gases during electricity generation. The synergy between renewable energy and electric vehicles lies in their

complementary nature. By leveraging renewable energy to charge EV batteries, we can significantly reduce carbon emissions associated with transportation.



### **Solar Power:**

Solar energy holds immense potential for powering electric vehicles, especially in regions with abundant sunlight. Solar panels installed on residential rooftops, commercial buildings, and parking structures can generate clean electricity that directly charges EV batteries. Moreover, advancements in solar technology, such as solar canopies and integrated photovoltaic systems, enable seamless integration with EV charging infrastructure, making solar-powered charging stations a viable option for sustainable transportation.



### **Wind Power:**

Wind energy is another renewable resource that can contribute to the electrification of transportation. Wind farms harness the kinetic energy of the wind to generate electricity, which can be used to charge EVs. Offshore wind projects, in particular, offer vast expanses for large-scale energy generation, providing a reliable source of power for electric vehicles. Integrating wind power into the grid not only reduces carbon emissions but also enhances energy security and resilience.



### **Hydroelectric Power:**

Hydropower has long been a cornerstone of renewable energy generation, accounting for a significant portion of global electricity production. Hydropower plants utilize the energy of flowing water to generate electricity, offering a reliable and flexible source of renewable energy. In addition to powering homes and industries, hydropower can support the widespread adoption of electric vehicles by supplying clean energy for charging infrastructure. Hydroelectric dams can also serve as energy storage facilities, providing grid stability



and balancing intermittent renewable sources like solar and wind.

### **Challenges and Opportunities:**

While the integration of renewable energy into the transportation sector presents immense opportunities, it also poses several challenges. One of the primary hurdles is the intermittency of renewable sources, which can impact the availability and reliability of charging infrastructure. Addressing this challenge requires investment in energy storage technologies, smart grid solutions, and demand-response strategies to optimize renewable energy utilization. Moreover, policy support, financial incentives, and public-private partnerships are essential for accelerating the deployment of renewable energy and electric vehicles.

### **Conclusion:**

The transition to electric mobility powered by renewable energy is imperative for achieving long-term sustainability and combating climate change. By synergizing renewable energy generation with electric vehicle adoption, we can reduce carbon emissions, improve air quality, and enhance energy independence. Governments, industries, and communities must collaborate to overcome barriers and foster innovation in renewable energy and transportation. Together, we can pave the way for a cleaner, greener future where electric vehicles roam the streets powered by the limitless energy of the sun, wind, and water.

---

## **Power Electronics in Electric Vehicles: Technical Insights into Motor Control and Energy Conversion**

*by S. Barath, III Year*

### **Introduction:**

As the automotive industry undergoes a profound transformation towards electrification, the role of

power electronics in electric vehicles (EVs) becomes increasingly critical. Power electronics technology is at the heart of EV propulsion systems, enabling efficient motor control and energy conversion. In this article, we delve into the intricate workings of power electronics in EVs, exploring key components, control strategies, and the impact on vehicle performance and efficiency.

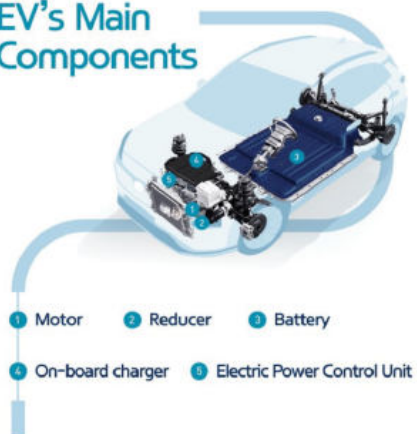
#### Power Electronics Components:

Power electronics components in EVs encompass a range of devices responsible for managing electrical energy flow within the vehicle. This includes inverters, converters, DC-DC converters, and onboard chargers. Inverters play a central role in converting DC power from the battery into AC power to drive the electric motor. Converters are used for voltage regulation and DC-DC conversion to power auxiliary systems and accessories. Additionally, onboard chargers facilitate the charging of the vehicle's battery from external power sources.

#### Motor Control Strategies:

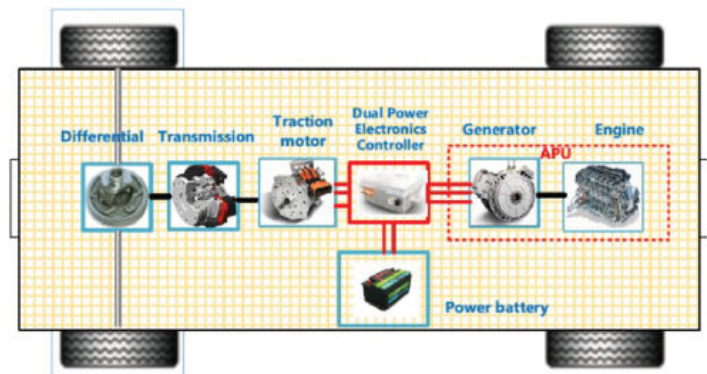
Precise motor control is essential for optimizing performance, efficiency, and drivability in electric vehicles. Power electronics systems employ sophisticated control algorithms to regulate motor speed, torque, and direction. Field-Oriented Control (FOC) is a commonly used technique that coordinates the stator and rotor currents of the electric motor, enabling smooth and efficient operation across a wide range of operating conditions. Additionally, predictive control algorithms and advanced sensor technologies are employed to enhance responsiveness and stability in dynamic driving scenarios.

#### EV's Main Components



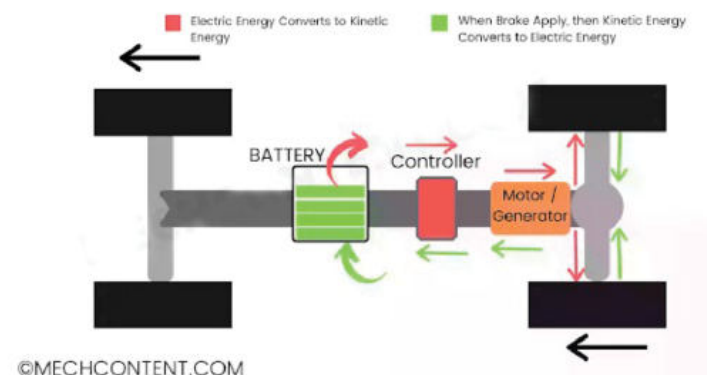
#### Energy Conversion Efficiency:

Efficiency is a paramount consideration in power electronics design for electric vehicles, as any losses in energy conversion directly impact vehicle range and performance. Power semiconductor devices such as insulated gate bipolar transistors (IGBTs) and silicon carbide (SiC) MOSFETs are utilized for their high switching speeds and low conduction losses. Moreover, advanced thermal management systems are employed to dissipate heat generated by power electronics components, ensuring optimal operating conditions and prolonging component lifespan.



#### Regenerative Braking Systems:

Regenerative braking systems play a crucial role in maximizing energy efficiency and extending the driving range of electric vehicles. During deceleration, kinetic energy is converted into electrical energy and fed back into the battery for storage. Power electronics components, including inverters and DC-DC converters, facilitate seamless energy conversion and management during regenerative braking events. By harnessing braking energy that would otherwise be dissipated as heat, regenerative braking systems contribute to overall vehicle efficiency and performance.



### Future Perspectives:

The field of power electronics in electric vehicles continues to evolve rapidly, driven by ongoing advancements in semiconductor technology, control algorithms, and system integration. Emerging trends such as wide-bandgap semiconductors (e.g., silicon carbide and gallium nitride) offer the potential for further improvements in efficiency and power density. Additionally, the integration of bidirectional power flow capabilities enables new functionalities such as vehicle-to-grid (V2G) and vehicle-to-home (V2H) energy transfer, enhancing the flexibility and resilience of electric vehicle systems.

### Energy Conversion Efficiency:

The efficiency of power electronics is crucial for maximizing the range and performance of EVs. Every conversion process incurs some energy losses, which can reduce the driving range and increase energy consumption. Therefore, it is essential to design and optimize power electronics for high efficiency.

Here are some factors that affect the efficiency of power electronics in EVs:

**Semiconductor technology:** The type of semiconductor devices used in power electronics converters significantly impacts efficiency. Traditionally, silicon (Si) has been the dominant material, but newer wide-bandgap (WBG) semiconductors like silicon carbide (SiC) and gallium nitride (GaN) offer higher efficiencies and lower losses.

**Converter topology:** The design and configuration of the power electronics converter can also affect efficiency. Different converter topologies have different inherent losses, and choosing the right topology for the specific application is crucial.

**Operating conditions:** The efficiency of power electronics can vary depending on the operating conditions, such as temperature, load current, and switching frequency. Optimizing the operating

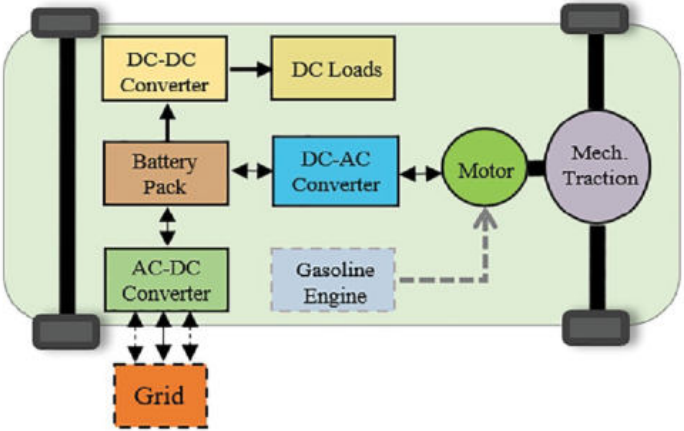
**Passive components:** The passive components used in power electronics converters, such as inductors and capacitors, can also contribute to energy losses. Choosing high-quality components with low losses can improve efficiency.

**Technical Insights into Motor Control and Energy Conversion:**

**Motor control algorithms:** Advanced motor control algorithms can help to optimize the efficiency of the electric motor by minimizing torque ripple and reducing switching losses.

**Multilevel converters:** Multilevel converters offer improved efficiency compared to traditional two-level converters by reducing switching losses and harmonics.

**Integrated circuits:** Integrated circuits (ICs) specifically designed for EV applications can help to improve efficiency by integrating multiple functions into a single chip, reducing complexity and losses.



### Conclusion:

Power electronics technology plays a fundamental role in shaping the performance, efficiency, and functionality of electric vehicles. By enabling precise motor control, efficient energy conversion, and seamless integration of regenerative braking systems, power electronics systems optimize vehicle operation and contribute to the broader transition towards sustainable transportation solutions. As the electric vehicle market continues to expand, advancements in power electronics will play a central role in driving further innovation and accelerating the adoption of electric mobility