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Study on Next Generation of Electric Vehicles

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ABSTRACT

The future of electric vehicles (EVs)promises a transformative shift towards sustainable and efficient transportation. With ongoing advancements in battery technology, charging infrastructure, and manufacturing processes, EVs are poised to become increasingly accessible and affordable. This evolution not only addresses environmental concerns by reducing carbon emissions but also stimulates innovation in the automotive industry. The integration of smart technologies, such as autonomous driving and interconnected systems, further amplifies the potential for a seamless and eco-friendly transportation future. As the global commitment to de-carbonization intensifies, the trajectory of electric vehicles signifies a cleaner, greener, and more intelligent future for mobility.

1. INTRODUCTION

Electric vehicles have been gaining popularity worldwide as people become increasingly aware of the adverse effects of fossil fuel-powered vehicles on the environment. In India, the rise of electric vehicles has been slower than in some other countries, but there are indications that this trend is changing. In this article, we will explore the rise of electric vehicles in India and consider whether they could be the future of transportation.

A. The Current State of Electric Vehicles in India

India needs a transportation revolution. The current trajectory of adding ever more cars running on expensive imported fuel and cluttering up already overcrowded cities suffering from infrastructure bottlenecks and intense air pollution is unfeasible.

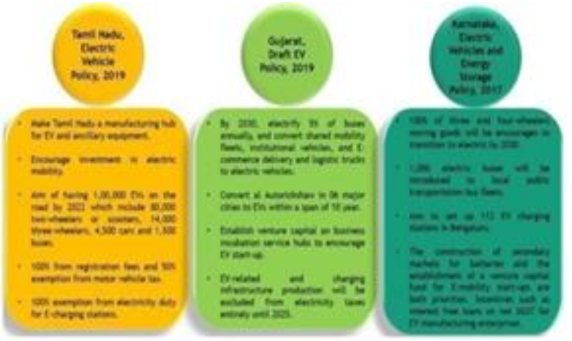

Figure 1: Solar panel on a car

B. Air Quality Index of India's Largest Cities

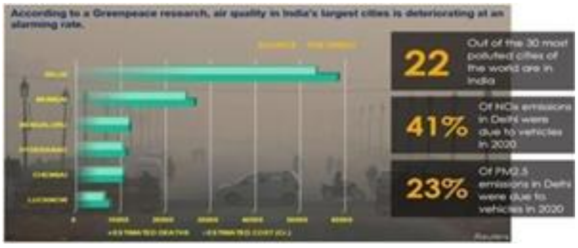

Figure 2: Pollution ratio

The transition to electric mobility is a promising global strategy for decarbonizing the transport sector. India is among a handful of countries that support the global EV30@30 campaign, which aims for at least 30% of new vehicle sales to be electric by 2030. India is aiming to reduce carbon emissionsby1 billiontonnesby2030andachieve net zero by 2070.

C. Types of Flexible Solar Cells

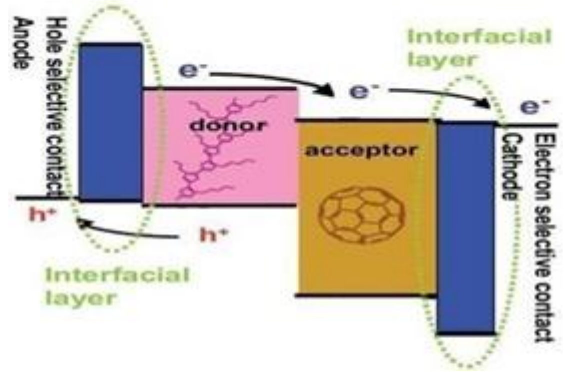

Figure 3: Organic solar cell

Organic solar cells, also known as organic photovoltaics (OPVs) or organic photovoltaic cells (OPCs), area type of solar cell that utilizes organic materials to convert sunlight into electricity. They are a promising alternative to traditional in organic solar cells, such as silicon-based photovoltaics. Organic solar cells are composed of thin films of organic molecules or polymers that have semiconducting properties. These organic materials are typically carbon-based and contain conjugated pi-electron systems, which enable them to absorb photons and generate electric charges.

The primary use of organic solar cells is in solar energy harvesting for various applications. They can be integrated into building materials, such as windows or facade elements, to generate electricity from sunlight. Additionally, they are suitable for portable electronics, wearable devices, and low-power applications. However, organic solar cells currently have lower energy conversion efficiencies compared to silicon-based solar cells, limiting their use in large- scale solar power installations. Ongoing research and development aim to improve their efficiency and stability to enhance their commercial viability.

D. Thin-Film Solar Cells

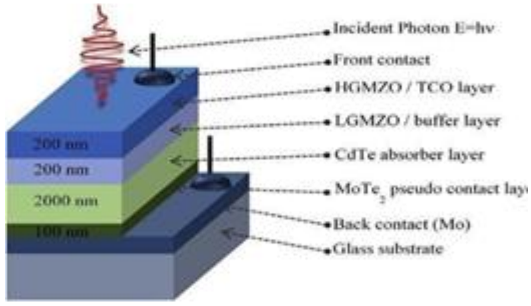

Figure 4: Thin film solar cell

It's important to note that the efficiency of thin film solar cells is generally lower compared to traditional silicon-based solar cells. However, ongoing research and development efforts aim to improve the efficiency and performance of thin film technologies to make them more competitive in the solar energy market

E. Electric Four-Wheelers

Figure 5: Solar cell on car

Similar to two-wheelers, flexible solar cells can be integrated into electric cars, vans, or buses to harness solar energy. They can be integrated into the roof, hood, or other exterior surfaces of the vehicle. The solar energy captured by these cells can be used to charge the vehicle's battery, power auxiliary systems, or even contribute to the overall propulsion of the vehicle. While the amount of energy generated by the solar cells may not be sufficient to fully power the vehicle, it can help in reducing the reliance on the electrical grid and increase the overall efficiency

F. Efficiency And Power Density

The efficiency and power density of flexible solar cells for electric vehicles depends on various factors, including the specific type of flexible solar cell technology used and the design considerations for integration. Efficiency refers to the ability of a solar cell to convert sunlight into electrical energy. Flexible solar cells typically have lower efficiency compared to rigid silicon-based solar panels. The efficiency of flexible solar cells can vary depending on the specific technology employed, such as amorphous silicon (a-Si), cadmium telluride (CdTe), copper indium gallium selenide (CIGS), or organic photovoltaics (OPVs). Currently, the efficiency of flexible solar cells typically ranges from around 7% to 15%. However, it's important to note that research and development efforts are ongoing to improve the efficiency of flexible solar cell technologies. Advanced materials and engineering techniques aim to enhance the efficiency and performance of these cells

Power density refers to the amount of power that can be generated per unit area. Flexible solar cells generally have lower power density compared to traditional rigid solar panels due to their lower efficiency and often limited surface area available for integration. The power density of flexible solar cells for electric vehicles depends on factors such as the size of the vehicle's surface area available for solar integration, the efficiency of the solar cells, and the intensity of sunlight. While the power density of flexible solar cells alone may not be sufficient to solely power an electric vehicle, they can contribute to the overall energy generation and help extend the vehicle's range or power auxiliary systems. To maximize power density, integration strategies aim to cover as much available surface area of the vehicle as possible with flexible solar cells, including the roof, hood, or other exterior panels. Advanced design techniques are being explored to optimize the solar cell arrangement, orientation, and tracking systems to capture the maximum amount of sunlight and increase power density. It's worth noting that while flexible solar cells may have lower efficiency and power density compared to rigid solar panels, their flexibility, and lightweight characteristics offer advantages in certain applications, such as their integration into curved surfaces or portable devices.

CHALLENGES TO THE ADOPTION OF ELECTRIC VEHICLES IN INDIA

Several challenges need to be addressed for electric vehicles to become more prevalent in India. One of the main challenges is the need for charging infrastructure. While the government has announced plans to set up charging stations across the country, the progress has been slow, and many potential buyers are deterred by the fear of running out of charge during a long journey. Another challenge is the high cost of electric vehicles. While the prices of electric vehicles have been coming down in recent years, they are still more expensive than their petrol or diesel counterparts. This makes them less accessible to the average consumer. Finally, the range of electric vehicles still needs to be improved, which makes them unsuitable for long- distance travel. While this is less of an issue for urban commuters, it remains a significant concern for those who need to travel long distances. Some challenges are listed below:

Battery Manufacturing: It is estimated that by 2023-30 India’s cumulative demand for batteries would be approximately 900- 1100 GWh. However, there is concern over the absence of a manufacturing base for batteries in India, leading to sole reliance on imports to meet rising demand. As per government data, India imported more than $1 billion worth of lithium-ion cells in 2021, even though there is negligible penetration of electric vehicles and battery storage in the power sector.

Policy Challenges: EV production is a capital-intensive sector requiring long-term planning to break even and profit realization, uncertainty in government policies related to EV production discourages investment in the industry.

Lack of Technology and Skilled Labour: India is technologically deficient in the production of electronics that form the backbone of the EV industry, such as batteries, semiconductors, controllers, etc. EVs have higher servicing costs which require higher levels of skills. India lacks dedicated training courses for such skill development.

Unavailability of Materials for Domestic Production: Battery is the single most important component of EVs. India does not have any known reserves of lithium and cobalt which are required for battery production. Dependence on other countries for the import of lithium-ion batteries is an obstacle to becoming completely self-reliant in the battery manufacturing sector.

Electric Cars & their Vital Parts

A single-battery 2-wheeler can reduce CO2 emission by 2.00 MT every 5 years. Apart from CO2 emission, owning a battery vehicle is cheaper compared to a petrol vehicle and other costs such as running costs, maintenance costs are also lower than petrol-powered vehicles

HSS – Home Storage Systems, LSS – Large Scale Storage Systems

An Electric Car is an automobile by itself and consists of many components and a large cluster of wires connecting them all. But there are few basic bare minimum materials for an Electric Car which is shown in the block diagram below

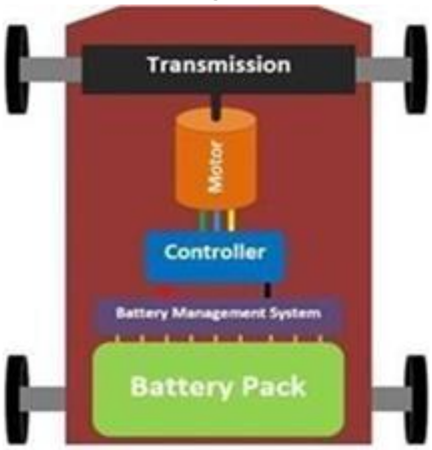

Figure 6: Electric Car

The Engine of a conventional IC Engine Car is replaced by an electrical Motor and the fuel tank is replaced by the Battery Pack. Of all the components only the Battery Pack and Motor alone contributes to about more than 50% of the total car's weight and price. As you can see the Battery Pack, Battery Management System (BMS) Controller, and Motor and Transmission unit form the major components of an EV.

EV Working

Electric vehicles (EVs) operate by storing electrical energy in high-capacity rechargeable batteries, typically lithium- ion. The charging process involves connecting the EV to an external power source, either through home outlets or public charging stations. The onboard charger converts alternating current (AC) to direct current (DC) for battery storage. When driving, the electric motor uses this stored energy, converting it into mechanical energy to propel the vehicle.

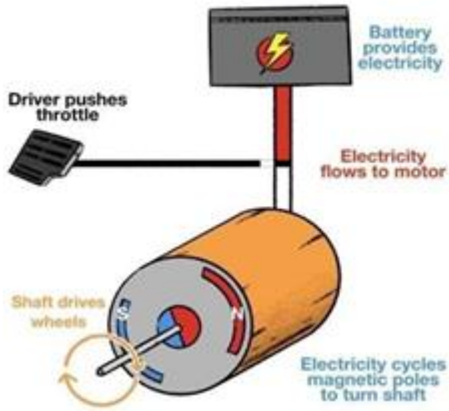

Figure 7: Drives of Car

A power inverter regulates the electric motor's speed and torque by converting DC back to AC. Regenerative braking, a key feature, reverses the motor during braking, converting kinetic energy into electrical energy for battery replenishment. Control systems, including the Battery Management System (BMS) and Vehicle Control Unit (VCU), manage battery health and overall vehicle operation. The user interface provides real-time information on battery status and driving range. This comprehensive integration of technologies ensures efficient and sustainable transportation with zero tailpipe emissions.

THE FUTURE OF ELECTRIC VEHICLES IN INDIA

Despite the challenges, there are indications that the future of transportation in India could be electric. The government has set a target of achieving 30% electric vehicle replacement by 2030, and several manufacturers have announced plans to launch electric vehicles in the coming years.

Another positive development is the increasing focus on renewable energy in India. The government has set a target of achieving 175 GW of renewable energy capacity by 2022 and plans to increase this to 450 GW by 2030. This will help reduce the carbon footprint of electric vehicles and make them a more sustainable mode of transportation.

Finance Minister Nirmala Sitharaman a budgetary allocation of INR 35,000 crore for significant capital expenditures targeted at attaining transition to renewable energy and net-zero objectives by 2070 in the 2023–24 Union Budget. She also said the government would provide scalability gap financing to assist Battery Energy Storage Systems with a capability of 4,000 MWH. The Faster Adoption of Manufacturing of Electric Vehicles Scheme-II (FAME-II) and the Production Linked Incentive Scheme are two government programs previously made available to electric car manufacturers (PLI).

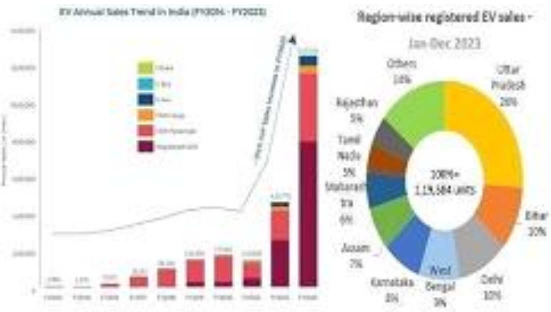

Figure 8: Annual Sale

Further, the discovery of 5.9 million tonnes of lithium reserves in the Indian region of Jammu and Kashmir is a significant development for the country's electric vehicle industry. Lithium is a critical component in the production of batteries used in electric vehicles, and currently, India relies heavily on imports for its lithium requirements. The discovery of these reserves is expected to significantly reduce India's dependence on imports and make electric vehicles more affordable and accessible to the masses.

Conclusion

Electric Vehicles (EVs) hold great promise to replace comparable Internal Combustion Engine (ICE) vehicles for various on-road applications. EVs offer several benefits, including reducing dependence on petroleum, improving local air quality, lowering greenhouse gas emissions, and enhancing the driving experience. Vehicle electrification aligns with broader trends in electrification and decarbonization and integrates synergistically with emerging mobility innovations such as urban micro-mobility, automation, and Mobility-as-a-Service (MaaS) solutions. The effective integration of EVs into power systems presents numerous opportunities to enhance the efficiency and economics of both electromobility and electric power systems, with EVs capable of supporting power system planning and operations in several ways.

Conflict Of Interest

The authors declare that they have no conflict of interest.

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