



## AN OUTCOME ANALYSIS OF SUSTAINABLE ENERGY AND ITS ROLE IN ELECTRICAL VEHICLE

**Anurag Bansal**

Managing Director, 13D Research & Strategy.

**Shashank**

Research Lead, Adept InResearch LLP.

### ABSTRACT

The future of sustainable energy is bright, with continued advancements in technology and growing global awareness of the need to transition to renewable energy sources to combat future challenges. The electrical vehicle is new hope for the automobile industry where the deduction of carbon emission is the priority. The increasing level of carbon emission may be harmful to the environment and society. A qualitative exploration of sustainable energy and its role in electrical vehicles are other aspects of the study where green energy is another variable. The research design used in the study is exploratory in nature and covers the different dimensions of sustainable energy. Production of the batteries is also following certain protocols of natural sustainability and emission. This study will enunciate the role of sustainable energy sources under the aspects of green energy. Economic benefits are also associated with the defined issue. Resultants are qualitative in nature where the crux of the previous study had been discussed. This study has concluded

**KEYWORDS :** Sustainable energy, outcome analysis, electrical vehicle and, green energy

### INTRODUCTION

Sustainable energy sources such as solar, wind, hydro, and geothermal power do not produce harmful greenhouse gas emissions that contribute to climate change. By replacing fossil fuels with sustainable energy sources, we can significantly reduce our carbon footprint and mitigate the negative impacts of climate change. Green energy, also known as renewable energy, is derived from sources that are naturally replenished and do not deplete the Earth's resources or contribute to environmental pollution. Examples of green energy sources include solar power, wind power, hydropower, geothermal energy, and biomass. Green energy, also known as renewable energy or clean energy plays a critical role in the 21st century as the world faces unprecedented environmental challenges, including climate change, air pollution, and resource depletion (Kadher-Mohien, T. S. Eds.2010).

Green energy can help address social and environmental justice issues by providing access to clean and affordable energy for marginalized communities, reducing energy poverty, and promoting equitable distribution of energy resources. This can help bridge the energy gap and create a more inclusive and just society. Green energy provides an opportunity for sustainable development by promoting economic growth, creating jobs, and improving energy access in remote and underserved areas. Green energy technologies can be harnessed locally, reducing dependence on imported fossil fuels and enhancing energy security (Thompson, L. T. 2016).

The future of green energy looks promising due to several factors:

**Climate Change Concerns:** The increasing awareness of the negative impacts of fossil fuels on the environment, including climate change, has led to a growing demand for clean and sustainable energy sources. Green energy is seen as a viable solution to reduce greenhouse gas emissions and mitigate climate change.

**Technological Advancements:** Advances in technology have made green energy more efficient, affordable, and accessible. Solar panels and wind turbines have become more affordable and efficient, making them increasingly popular as sources of green energy. Additionally, advancements in energy storage technologies have improved the reliability and stability of green energy sources, overcoming one of their major limitations (J. W. 2017).

**Government Support and Policies:** Many governments around the world are implementing policies and incentives to

promote the use of green energy. This includes subsidies, tax incentives, and renewable energy targets, which are driving the growth of green energy installations and fostering a supportive environment for the development of green energy technologies.

**Economic Benefits:** Green energy can stimulate economic growth by creating new jobs, fostering innovation, and reducing dependence on fossil fuel imports. As the green energy sector expands, it has the potential to create millions of jobs in areas such as manufacturing, installation, operation, and maintenance of renewable energy systems.

**Public Demand and Social Responsibility:** Consumers are increasingly demanding cleaner and more sustainable energy options. Many individuals and organizations are recognizing the social responsibility of adopting green energy practices to reduce their carbon footprint and contribute to a more sustainable future for generations to come.

However, there are also challenges and barriers to the future of green energy. These include the intermittency and variability of some renewable energy sources, the need for robust energy storage solutions, infrastructure challenges, and the entrenched interests of the fossil fuel industry. Overcoming these challenges will require continued investment in research and development, policy support, and public awareness and engagement. In conclusion, the future of green energy is promising, with increasing awareness of climate change, advancements in technology, supportive government policies, economic benefits, and public demand driving its growth (Meibom, P2012). With continued efforts and investments, green energy has the potential to become a dominant and sustainable source of energy, contributing to a cleaner, healthier, and more sustainable future for our planet (M. A. 2009).

### Sustainability and Green Energy

Sustainability plays a crucial role in the development and use of electric vehicles (EVs). Here are some ways in which sustainability is integrated into various aspects of EVs. EVs are often charged using electricity from renewable energy sources such as solar, wind, or hydroelectric power. This helps reduce greenhouse gas emissions associated with electricity generation and reduces the carbon footprint of EVs. Battery production is a key component of EVs, and sustainability efforts are focused on reducing the environmental impact of battery manufacturing processes. This includes reducing the use of hazardous materials, optimizing production techniques, and improving recycling and disposal methods

for battery waste. EVs are designed to be more resource-efficient compared to internal combustion engine vehicles (A. J. 2018).

This includes using lightweight materials for the vehicle body and optimizing vehicle design to reduce energy consumption, extending battery life, and maximizing the use of regenerative braking to recover energy. Recycling and proper disposal of EV batteries are important to prevent environmental pollution. Many EV manufacturers have implemented programs to recycle used batteries and recover valuable materials such as lithium, cobalt, and nickel for reuse in new batteries. This helps reduce the demand for raw materials and minimizes environmental impact. Evaluating the overall environmental impact of EVs throughout their lifecycle, from production to use to disposal, is an important sustainability consideration. This includes assessing emissions, energy consumption, and resource use at each stage and identifying areas for improvement. Sustainable charging infrastructure is crucial for EV adoption. This includes utilizing renewable energy sources for charging stations, optimizing charging station locations to minimize energy waste, and using smart grid technologies to manage energy demand effectively. V2G technology allows EVs to not only draw energy from the grid but also feed excess energy back to the grid. This enables EVs to serve as mobile energy storage units, helping to stabilize the grid and support renewable energy integration. Adopting circular economy principles, such as repair, refurbishment, and reuse of EV components, helps extend the lifespan of EVs and reduce waste, thereby promoting sustainability. EV manufacturers are increasingly using eco-friendly materials for vehicle interiors, such as recycled plastics, bio-based materials, and natural fibres, to reduce the environmental impact of the production process and make EVs more sustainable. Many EVs are certified by organizations such as the Green Car Council or the LEED (Leadership in Energy and Environmental Design) program, which provide standards for sustainable vehicle design, production, and operation (Martinez, J. 2009).

Green energy, also known as renewable energy or clean energy, refers to energy generated from sources that are naturally replenished and do not produce harmful greenhouse gas emissions or other pollutants. Some common forms of green energy include solar power, wind power, hydropower, geothermal power, and biomass. The use of green energy has numerous benefits for environmental concerns (Cumo, M. 1998).

Green energy sources do not produce greenhouse gases, which are the primary drivers of climate change. By using green energy, we can significantly reduce our carbon footprint and mitigate the negative impacts of climate change, such as rising temperatures, extreme weather events, and sea level rise. Unlike traditional energy sources such as fossil fuels, green energy sources do not produce harmful pollutants that contribute to air and water pollution. This helps in improving air quality, reducing smog, and protecting water bodies from contamination, which in turn benefits human health, wildlife, and ecosystems. Green energy sources are often based on abundant and renewable resources such as sunlight, wind, and water, which are naturally replenished. This reduces the dependence on finite and depleting resources such as coal, oil, and natural gas, conserving valuable natural resources for future generations. Green energy projects, such as wind and solar farms, can be designed and implemented in a way that minimizes impacts on wildlife habitats and preserves biodiversity. For example, well-planned wind farms can avoid sensitive areas for bird nesting and migration, and solar farms can be established on degraded lands to avoid encroaching on natural habitats. Green energy can contribute to economic growth and job creation. Investments in renewable energy technologies can stimulate local

economies, create new job opportunities, and diversify energy sources, reducing dependence on fossil fuel imports and associated price volatility. Green energy sources do not produce harmful air pollutants, which can have negative impacts on human health, such as respiratory diseases, cardiovascular diseases, and cancers. By reducing air pollution, green energy can help improve public health, particularly in areas with high levels of pollution from traditional energy sources (Scholtens, B. 2015).

Climate change adaptation: Green energy can also help in climate change adaptation by reducing vulnerabilities to climate impacts. For example, distributed renewable energy systems, such as solar panels on rooftops, can provide local sources of electricity, increasing resilience during extreme weather events or power outages (D. B. 2013).

The future of electric vehicles (EVs) in India looks promising, with significant growth expected in the coming years. Here are some key trends and factors that are likely to shape the future of EVs in India. The Indian government has been actively promoting the adoption of EVs through various policies and incentives. This includes offering subsidies on EV purchases, tax exemptions, and promoting research and development in EV technology. Additionally, the government has set a target to achieve 30% of total vehicle sales to be electric by 2030, which is expected to drive the growth of EVs in India. As concerns about air pollution and climate change grow, there is an increasing awareness about the benefits of EVs in reducing carbon emissions and improving air quality. This is expected to drive consumer demand for EVs, especially in urban areas with high pollution levels. The availability of a robust charging infrastructure is critical for the widespread adoption of EVs. In India, there has been significant progress in expanding the charging network, including public charging stations, private chargers, and battery-swapping solutions. This is expected to further boost consumer confidence in EVs and drive their adoption. The EV technology is evolving rapidly, with advancements in battery technology, power electronics, and electric motor technology. This is resulting in improved performance, longer range, and reduced costs of EVs, making them more attractive to consumers. As technology continues to evolve, it is expected to accelerate the adoption of EVs in India. Both domestic and international companies are investing heavily in the development of EVs in India. This includes investments in manufacturing facilities, R&D, and charging infrastructure. These investments are expected to drive innovation, create jobs, and accelerate the growth of the EV market in India. The way people commute is changing, with a growing preference for shared mobility options such as ride-hailing and car-sharing services. This presents an opportunity for EVs to be adopted in fleet operations, where they can offer cost savings and environmental benefits. Many ride-hailing companies in India have already started adding EVs to their fleet, and this trend is expected to continue in the future (Pode, R. (2015).

#### **A Model framework of Sustainability management**

There are various frameworks and models used to analyze and implement sustainable energy systems. One commonly used framework is the "Three Pillars of Sustainability" model, which consists of three interconnected dimensions: environmental, economic, and social. These pillars help guide decision-making and policy development for sustainable energy.

#### **Environmental Dimension**

This includes solar, wind, hydroelectric, geothermal, and biomass energy. These sources are sustainable and have lower environmental impacts compared to fossil fuels. Focuses on reducing energy consumption through efficient technologies and practices. This involves improving energy

efficiency in buildings, transportation, industrial processes, and appliances. Aims to minimize greenhouse gas emissions through the adoption of clean energy sources and the use of carbon capture and storage technologies.

#### Cost-Benefit Analysis:

Evaluates the economic viability of sustainable energy projects by considering the costs and benefits over their lifetime. This includes factors like initial investment, operational costs, energy savings, job creation, and economic growth. Considers various financing options, such as government subsidies, tax incentives, grants, and loans, to promote the development and deployment of sustainable energy technologies. Encourages the integration of sustainable energy into existing energy markets, ensuring fair competition and adequate pricing mechanisms.

#### Social Dimension

The main aim of the social dimension is to provide affordable and reliable energy access to all individuals, including those in remote or underserved areas. Focuses on ensuring that the benefits and burdens of sustainable energy systems are distributed equitably across different social groups, addressing issues of energy poverty and social inequality. Involves active participation and collaboration of various stakeholders, including local communities, policymakers, industry, and NGOs, in the decision-making processes related to sustainable energy.

These dimensions interact and influence each other, and a holistic approach is essential for developing effective sustainable energy frameworks. Policy frameworks, such as feed-in tariffs, carbon pricing mechanisms, renewable energy standards, and energy efficiency targets, are often used to support the implementation of sustainable energy models at regional, national, and international levels.

#### CONCLUSION:

The outcomes of sustainable energy, also known as renewable energy or clean energy can have positive impacts on various aspects of society, the environment, and the economy. Sustainability is a crucial aspect of the development and use of electric vehicles, encompassing various elements such as renewable energy, battery manufacturing, resource efficiency, recycling, charging infrastructure, vehicle-to-grid technology, circular economy, eco-friendly materials, and adherence to environmental standards. These efforts aim to reduce the environmental impact of EVs and promote a more sustainable transportation system. Green energy plays a critical role in the 21st century by mitigating climate change, promoting sustainable development, protecting the environment and human health, diversifying the energy mix, driving technological innovation, and addressing social and environmental justice issues. It is an essential part of the transition towards a more sustainable, resilient, and equitable energy future.

The future of EVs in India looks promising, with strong government support, increasing environmental awareness, improving charging infrastructure, technological advancements, growing investments, and changing mobility patterns. These factors are expected to drive the adoption of EVs in India and help in building a sustainable and greener transportation ecosystem.

Green energy offers numerous benefits to environmental concerns, including the reduction of greenhouse gas emissions, air, and water pollution, conservation of natural resources, preservation of biodiversity, economic benefits, improved public health, and climate change adaptation. Transitioning to a greener energy mix is crucial for addressing environmental challenges and building a sustainable future for generations to come.

#### REFERENCES

1. Aswathanarayana, U., Hari Krishnan, T., & Kadher-Mohien, T. S. (Eds.). (2010). *Green energy: technology, economics, and policy*. Crc Press.
2. Arbabzadeh, M., Johnson, J. X., Keoleian, G. A., Rasmussen, P. G., & Thompson, L. T. (2016). Twelve principles for green energy storage in grid applications. *Environmental Science & Technology*, 50(2), 1046-1055.
3. Jacobson, M. Z., & Bellocchi, M. A. (2009). A path to sustainable energy by 2030. *Scientific American*, 301(5), 58-65.
4. Serrano, E., Rus, G., & Garcia-Martinez, J. (2009). Nanotechnology for sustainable energy. *Renewable and Sustainable Energy Reviews*, 13(9), 2373-2384.
5. Afgan, N. H., Al Gobaisi, D., Carvalho, M. G., & Cumo, M. (1998). Sustainable energy development. *Renewable and sustainable energy reviews*, 2(3), 235-286.
6. Van Der Schoor, T., & Scholtens, B. (2015). Power to the people: Local community initiatives and the transition to sustainable energy. *Renewable and sustainable energy reviews*, 43, 666-675.
7. Diouf, B., & Pode, R. (2015). The potential of lithium-ion batteries in renewable energy. *Renewable Energy*, 76, 375-380.
8. Tong, S., Fung, T., Klein, M. P., Welsbach, D. A., & Park, J. W. (2017). Demonstration of reusing electric vehicle batteries for solar energy storage and demand side management. *Journal of Energy Storage*, 11, 200-210.
9. Richardson, D. B. (2013). Electric vehicles and the electric grid: A review of modeling approaches, impacts, and renewable energy integration. *Renewable and Sustainable Energy Reviews*, 19, 247-254.
10. Hedegaard, K., Ravn, H., Juul, N., & Meibom, P. (2012). Effects of electric vehicles on power systems in Northern Europe. *Energy*, 48(1), 356-368.
11. Robledo, C. B., Oldenbroek, V., Abbruzzese, F., & van Wijk, A. J. (2018). Integrating a hydrogen fuel cell electric vehicle with vehicle-to-grid technology, photovoltaic power, and a residential building. *Applied Energy*, 215, 615-629.