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Energizing Tomorrow: Analyzing the Transformative Potential of Electric Vehicle Adoption

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Abstract

INTRODUCTION: A developing economy lacks the infrastructure required to produce renewable energy sources on a large scale that can be coupled with conventional resources. This prevents the economy from taking advantage of these types of resources. The emergence of the electric vehicles (EVs) industry has been a primary catalyst for both the expansion of the economy and the production of new employment opportunities. The manufacturing and distribution of electronic automobiles have cleared the way for the construction of new manufacturing locations as well as a supply chain. This has been made possible as a result of the increased demand for EVs.
OBJECTIVES: The objectives of this article are to know the overall impact of EVs on the environment through a review of the literature and to study if ongoing changes affect the economy of India.
METHODS: The systematic review of literature is used to fulfil the objectives of the study.
RESULTS: EVs offer a solution to reducing air pollution and greenhouse gas emissions due to their zero tailpipe emissions. They eliminate pollutants like nitrogen oxide and particulate matter, improving air quality and public health. EVs, powered by renewable energy sources like solar, wind, or hydroelectric power, reduce reliance on fossil fuels. Their higher energy efficiency and technological advancements in batteries also create employment and innovative economic opportunities. Additionally, EVs contribute to quieter and more serene environments, especially in densely populated areas, due to their silent operation.
CONCLUSION: It can be concluded that the adoption of EVs has both positive and negative impacts on economy countries. But as compared to negative impacts, positive impacts are very high on the economic condition of any country.

Keywords: Environment, Electric Vehicles, Renewable Energy, Sustainable Development, Review

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1. Introduction

Despite the fact that renewable resources provide a substantial potential to halt or stop the degradation of the environment, the expense of developing the necessary infrastructure has been a factor that has limited the use of these resources. This has been a limiting factor for the use of renewable resources. A developing economy lacks the infrastructure required to produce renewable energy sources on a large scale that can be coupled with conventional resources. This prevents the economy from taking advantage of these types of resources. When it comes to finding solutions to the problems that develop with investments and finances, the word “distributed” is the most important clue. The most effective solution to this problem is to carry out a scattered investing strategy. It is not possible to build a new infrastructure, but it is conceivable for end users to benefit from investments that have already been made in the system.

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It is projected that within a not-too-distant future, automobiles and other types of transportation will evolve into a vital component of the life of all homes.
The EVs need to have adequate mobility for day-to-day use, and they also need to be able to be utilised to assist the power grid in some capacity. Figure 1 provides information on battery EVs in use worldwide from 2016-2022 (in millions).

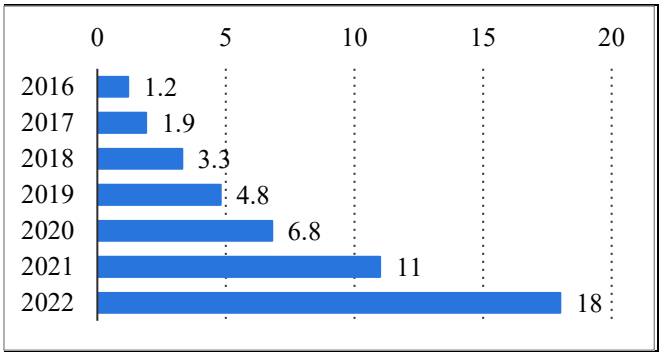

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Fig 1: Battery EVs in use worldwide 2016-2022 (in millions)

Source(s): IEA; ID 270603

EVs draw power from the grid in order to charge themselves during the system's off-peak hours. However, when the system enters a deficient power operation, the vehicles send power back to the grid by discharging themselves. One of the major advantages of EVs is their potential to reduce our reliance on fossil fuels. Figure 2 presents the average annual growth of carbon dioxide (CO2) emissions from new cars in European Union (EU) countries in 2021.

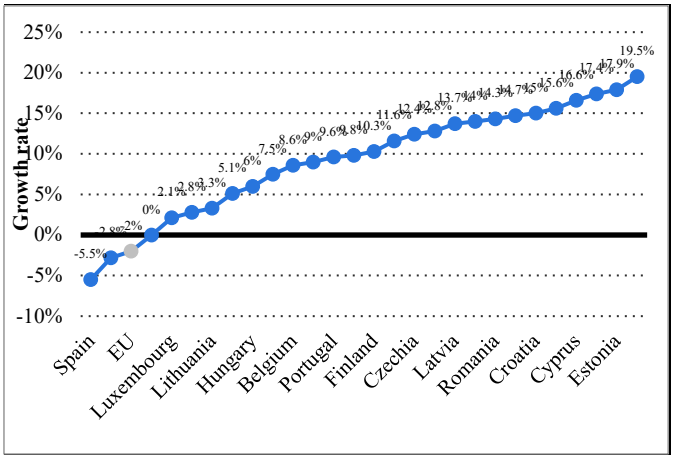

Fig 2: Average annual growth of carbon dioxide emissions from new cars in EU countries 2021

Source(s): ACEA; EEA; ID 1234438

The emergence of the electric car industry has been a primary catalyst for both the expansion of the economy and the production of new employment opportunities. The manufacturing and distribution of electronic automobiles have cleared the way for the construction of new manufacturing locations as well as a supply chain. This has been made possible as a result of the increased demand for EVs. A number of vehicle manufacturers have already emerged. Figure 3 shows the plug-in EVs' market share by manufacturer in 2022.

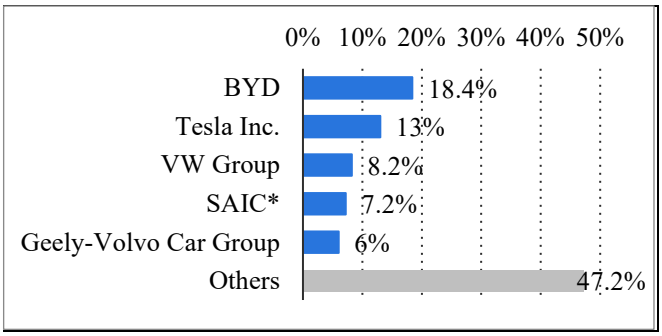

Fig 3: Plug-in EVs market share by manufacturer in 2022

Source(s): EV-Volumes.com; Inside EVs

Additionally, the widespread adoption of EVs has raised concerns regarding the revenue to the Government from fuel taxes, which are a significant source of Government revenue for many countries as their support to infrastructure and public services; this will cause policymakers to investigate alternative revenue sources or adjust taxation framework; it will cause both challenges and opportunities in terms of economic planning and governance.

Figure 4 gives an impression of the Global renewable energy consumption in 2022, by select countries.

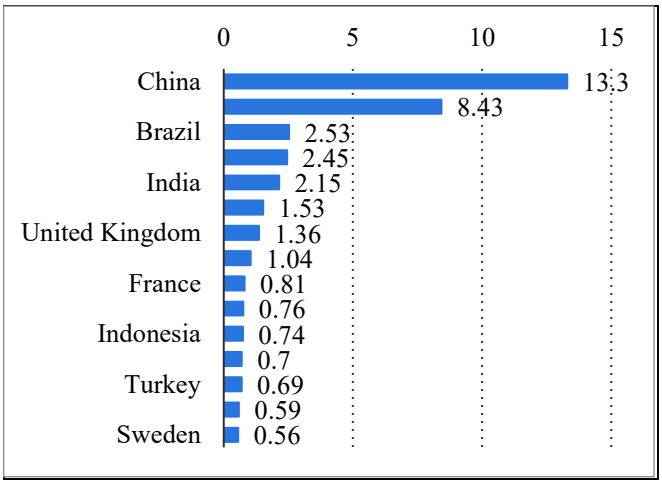

Fig 4: Global renewable energy consumption 2022, by select country

Source(s): Energy Institute; Kearney; KPMG

2. Review of Literature

A number of articles and papers have been published for the review of the environmental impact of EVs and how far it has impacted the world. This research work includes a number of papers published in past from the year 2009 to 2023. These papers clearly discussed how can reduce global warming, air pollution, and complaints of the ozone layer.

These are various articles and papers from different countries which show the different impacts of EVs on the environment of different regions and countries. 55 research papers and articles are included in this paper for analysis. We tried to cover as many papers as possible with the time constraint and given resources.

Most of the authors have studied EVs' environmental impact in India like as battery charging stations, technology development and the effect of global emissions of CO2 in different countries.

So, this research paper covers the research gap of various published papers in the context that it considers various variables related to electric vehicles' environmental impact in the world. The research paper includes new variables of EVs' environmental impact that have evolved over the years.

3. Research Methodology

The main objectives of this study are:

1. To know the overall impact of EVs on the environment through a review of Literature.
2. To study if ongoing changes affected the economy of India through a review of Literature.

The research papers and articles collected for this research are from secondary data. The range is from 2009-2023. Most of the research papers are the reviews of environmental impact of EVs and battery charging station adoption and are secondary study in nature.

The research papers and articles used for the review in this research are both nature that is an empirical study and a conceptual framework. This research work is also descriptive in nature. The fact-finding is done review of past papers so the whole project is descriptive in nature. The tools used to analyse and review past papers and articles are presented in the format of tables and graphs. Since the research work is descriptive in nature graphs and tables helped in presenting the information for the readers to understand in a better manner.

4. Analysis and Interpretation

This section will discuss about the analysis of the data and interpretation based on this analysis.

Table 1. Number of research papers from the year

Sr. No	Year	No. of Research Papers
1	2009	1
2	2010	2
3	2011	0
4	2012	3
5	2013	1
6	2014	3
7	2015	7
8	2016	4
9	2017	4
10	2018	3
11	2019	16
12	2020	4
13	2021	4
14	2022	3
15	2023	1
TOTAL	**2009-23**	**55**

It shows different research papers referred to from the year 2009-2023 the timeline is taken to represent research from different periods there is no research paper in the year 2011. In 2009, there was only one research paper; in 2010 there were two research papers; in 2012 there were three research papers; in 2013 there was only one research paper; in 2014 there were three research papers; in 2015 there were seven research papers, in 2016 there were four research papers, in 2017 there were four research papers, in 2018 there were three research papers, in 2019 there were 16 research papers, in 2020 there were four research papers, in 2021 there were four research papers, in 2022 there were three research papers, and in 2023 there was only one research paper till the time of data collection. It is therefore observed that 2019 has a maximum number of papers published on research work related to EVs.

Table 2. Research papers used from different countries

Sr. No	Country	Research Papers
1	USA	9
2	GERMANY	4
3	NETHERLANDS	2
4	HOLLAND	1
5	SINGAPORE	1
6	SWITZERLAND	2
7	CHINA	9
8	GREEK	1
9	NORWAY	3
10	GREECE	2

11	EUROPE	4
12	PORTUGAL	1
13	BANGALDESH	1
14	SPAIN	1
15	MALAYSIA	1
16	INDIA	2
17	INDONESIA	1
18	ITALY	1
19	BELGIUM	2
20	CALIFORNIA	1
21	POLLAND	1
22	HUNGARY	1
23	JAPAN	1
24	FINLAND	1
25	BRAZIL	1
26	NORTH AMERICA	1
27	AUSTRALIA	1
28	FRANCE	1
29	AUSTRIA	3
30	BRUSSEL	1
31	CANADA	1

Table 2 represents research papers taken from different countries in this study. Most number of the research papers included are on EVs' environmental impact constituting 55 papers. Two research papers were taken from India, and three papers were taken from Norway and the Netherlands.
Four papers are taken from Europe. Eight papers are taken from China. Nine papers are taken from the USA. Almost 20 papers have been taken from countries like France, Holland, Singapore, Brussels, Portugal, Bangladesh, Spain, Italy, California, Canada, Poland, Hungary, and Japan.

Table 3. Source of paper taken

Sr. No	Sources	No. of Papers
1	Management Science	1
2	American Economic Review	1
3	Transportation Research Part D-Transport and Environment	1
4	Transport Review	1
5	Journal sustainable development of energy water and environment systems	1
6	American economic association	1
7	Lee- transportation on intelligent transpiration system	1
8	American chemical society	1
9	Environment Science Technology	4
10	Journal Clear Production	3
11	Journal Industrial Ecology	1
12	World Electric Vehicles Journal	1
13	LCA In Transportation	1
14	Science Of Total Environment	1
15	Environment Research Letters	1
16	World Electric Journal	1
17	The Journal Of Science Direct	2
18	The International Journal of Lifecycle Assessment	4
19	Energy policy	1
20	Energy Conversion and Management	1
21	Environment Claims Journal	1
22	Journal Of Smart Cities	1
23	International Journal of Advance Research and Innovative Idea in Education	2
24	Clean Technology and Environment Policy	1
25	Sustainability Report	1
26	Renewable Energy	1
27	Applied Economic Letters	1
28	Waste Management	1
29	Resource Conversion Recycling	1
30	Energies	1
31	Sustainability	4
30	Transport Research Part-D	2
31	The Environment Economics and Management	1
32	SSRN Electronic Journal	1
33	Tribology International	1
34	Energy Policy	1
35	Applied Energy	1
36	Missouri S&T's Peer-to-Peer	1
37	Materials Today-Proceedings	1
38	Electric Vehicles International Conference Show	1
Total		**55**

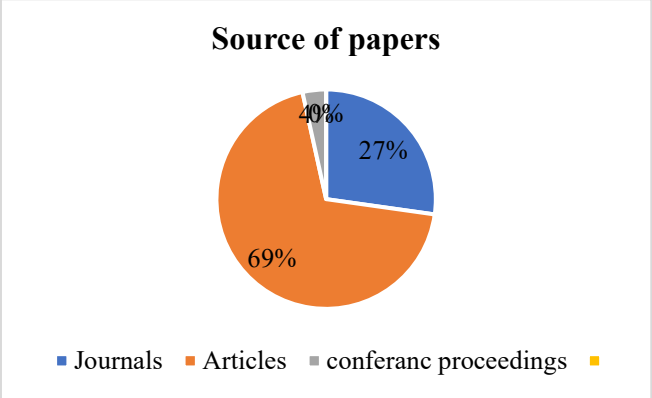

Fig 5. Sources of Sources Taken

Table 3 and Figure 5 show the different sources of papers taken for this article, different research papers from journals, articles and conference proceedings are included in this study. Almost 69 per cent of research papers have been taken from articles like sustainability, environment science technology environment claims journal, energy policy etc. Around 27 per cent of papers have been taken from journals and 4 per cent from conference proceedings. The trend shown in the above chart indicates that most papers that are published in journals about EVs and their impact on the environment are included in this study, followed by articles published in magazines, newspapers etc. and further followed by conference proceedings publications.

Table 4. Types of papers

Sr. No	Type of Study	No. of Papers
1	Empirical study	21
2	Conceptual framework	34
TOTAL		**55**

Table 4 shows the different types of papers such as conceptual framework and empirical studies different sources of papers taken for this research paper, different research papers from journals, articles and conference proceedings are included in this research paper. Almost 62 per cent of the conceptual framework has been taken from the article's likely sustainability, Missouri S&T's peer-to-peer etc. and the remaining 38 per cent is empirical study. The trend shown in the above chart indicates that most of the papers that are published in the journals are related to EVs' environmental impact on the conceptual framework. Almost 34 papers are published in conceptual framework and around 21 papers are published in empirical study.

Table 5. Impact of EVs on Various Variables

Sr. No	Particulars	Impact
1	Environmental benefits	Electronic vehicles produce zero emissions from their tailpipes, which helps to minimize air pollution and greenhouse gas emissions, and this is the key reason for the growing number of people opting to purchase EVs.
2	Air quality movement	Pollutants like nitrogen oxide, particulate matter, and volatile organic components all contribute to poor air quality and other ailments; however, EVs do not produce these types of emissions. The adoption of EVs will pave the way towards cleaner and healthier air in urban areas, and it will also help to minimize the unhealthy situation.
3	Reduced dependence on fossil fuels	EVs are propelled by electricity, which can come from a variety of sources of renewable energy such as the sun, the wind, or the water. Hydroelectric power is another option. It is possible for us to become less reliant on fossil fuels for transportation if we make the conversion to electric automobiles.
4	Energy efficiency	When compared to conventional automobiles powered by normal vehicles, EVs have a lower overall energy footprint. EVs convert a far larger percentage of the energy they take into powering the wheels, in contrast to petrol and diesel-powered vehicles, which squander a very high percentage of the energy they take in as heat.
5	Economic opportunities	It led to employment generation in such as manufacturing, research and development, charging infrastructure development, battery and technology and other related contributors.

		Furthermore, the increasing demand for EVs has created better advances in battery technology, resulting in improved energy storage solutions that can be applied to other sectors as well. The new industry of EVs has created an innovative economic opportunity.
6	Noise pollution reduction	It will contribute to a more serene environment, particularly in areas that are already densely inhabited, as EVs function considerably more quietly than traditional vehicles (because they don't have an engine with moving components).

5. Summary and Conclusion

This research paper reviews the impact of environmental EVs on various factors related to the emission of global warming in our economy. There are a number of research papers discussing the environmental impact of EVs and every paper deals with certain variables. The overall impact of EVs on economies needs to be studied more.

So, for this purpose, we choose to include all the major variables related to the economy of a nation that are affected by EVs in this paper. This will help other researchers and readers to study the impact of the environmental effect of EVs on the global conditions of countries.

We have taken various past published papers to bring them together. To start, we have introduced the basic concept of EVs, and their impact on the economy, and environment, then in the next phase we have mentioned the past papers that we have taken for review for our paper.

We have done analyses and interpretations of the review that is from the past published research papers to come to a conclusion.

From the analysis, it can be concluded that the adoption of EVs has both positive and negative impacts on the economy of countries. But as compared to negative impacts there are more positive impacts of the environment of EVs on the economic condition of any country.

The environmental impact of EVs in India is an important topic for discussion at the moment, particularly in light of the concerns that India has over pollution and climate change. Upon conducting a review of previous research and data, it has become abundantly clear that EVs have the ability to deliver enormous benefits to the environment of India. To begin, India is in a position to lessen its emissions of greenhouse gases like carbon dioxide and lessen the impact of the most significant aspect of climate change on the country if it transitions away from the usage of traditional internal combustion engine vehicles and towards EVs. In addition, EVs have the potential to lessen the hazardous pollutants that are released from tailpipes by petrol and diesel-powered vehicles. As a result of this, EVs have the potential to improve air quality, particularly in the most polluted cities.

In addition, the use of EVs in India may result in a sizeable reduction in the country's consumption of fossil fuels. Making the switch to electric mobility can assist a nation in diversifying its energy supply through the establishment of renewable energy sources that can be used to charge electric automobiles. This shift has the possibility to hasten the evolution to a more sustainable energy ecosystem by encouraging the exercising of renewable power sources like solar power. It furthermore helps the country become less reliant on fossil fuels, which is good for the environment and the economy.

However, it is important to acknowledge the difficulties and obstacles associated with the widespread use of EVs. This includes financial incentives and investments, a government support programme, the ability to purchase EVs, charging infrastructures, and the management of batteries at the usage end. By efficiently tackling these difficulties, India will be able to take advantage of chances to embrace EVs as a key solution for decreasing its carbon footprint, improving air quality, and enhancing sustainable development in the transportation industry.

6. Implications of the Study

Researchers from a variety of fields can make use of this study to further their investigation into the effects that EVs have on the Indian economy. This study contributes to the process of learning the overall impact of electronic vehicles and how it affects economies all around the world. The organisation has access to the data, which it can use to perform an accurate analysis of the influence that EVs have on a number of different variables. The government can also use the data in the process of developing policies for the future. By using this knowledge to understand the impact of EVs, the government can also encourage people to acquire EVs. The government provides exemptions from the individuals' required tax payments. This research can assist in making decisions regarding a variety of topics, such as the purchase of EVs and the mitigation of global warming.

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