ACCELERATING ELECTRIC VEHICLE PENETRATION IN ASIA: TRENDS, CHALLENGES AND FUTURE PROSPECTS

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ABSTRACT

Purpose: The purpose of present study is to analyze the patterns, difficulties and future possibilities of speeding up electric vehicle entrance in Asia.

Design and Methodology: Asia, being home to probably the biggest car markets, holds huge potential for the far and wide reception of EVs. It investigates the current status of the EV market in key Asian nations, examines the elements affecting EV reception, distinguishes difficulties impeding its development and discusses the expected procedures to defeat these difficulties.

Findings: The paper reveals insight into the job of government arrangements, mechanical headways, framework advancement and customer inclinations in forming what's in store the possibility for electric vehicles in Asia.

Practical Implications: In order to meet the goal of sustainability, it is imperative to shift towards the use of electric vehicles which is being meticulously explained in the paper.

Originality/Value: The paper deeply analyzes the state of EV adoption in Asian countries and focus on government efforts to increase the EV penetration.

Key words: Automobiles, Electronic Vehicles, Energy Demand and Supply, Sustainable Development

JEL Classification: L62, L94, Q41, Q01

INTRODUCTION

The worldwide transportation area is going through a critical shift towards supportability and decreasing ozone harming substance discharges. Electric vehicles (EVs) have arisen as a promising answer to accomplish these ecological objectives, offering a cleaner and more productive option in contrast to traditional petroleum based or gas-powered motor vehicles. Asia is home to probably the most contaminated urban communities worldwide, with vehicle outflows being a huge supporter of air contamination.

The World Health Association (WHO) assesses that roughly 4.2 million passing's every year are ascribed to outside air contamination. Progressing to electric vehicles could fundamentally diminish the emanations of contaminations like nitrogen oxides (NOx) and particulate matter (PM), subsequently further improving air quality and the general wellbeing. Asia, with its huge car markets and different economies, holds colossal potential for the far-reaching reception of electric vehicles.

Transportation is a significant wellspring of ozone depleting substance outflows, especially carbon dioxide (CO2), which adds to worldwide environmental change. As indicated by the Worldwide Energy Organization (IEA), the vehicle area is answerable for around one-fourth of worldwide CO2 emanations. Changing to

electric vehicles, which can be controlled by sustainable power sources, can assist with bringing down the carbon impression of the transportation area.

Numerous Asian nations have perceived the need to advance EV reception and have carried out strategies and impetuses to energize it. These arrangements might incorporate monetary impetuses, tax cuts and appropriations for EV buys, as well as the advancement of charging framework. China, for example, has been a worldwide innovator in EV reception and assembling, with significant government support. The choice to choose EVs over gas powered motor (ICE – Internal Combustion Engine) vehicles is impacted by many elements, for example, strategy support, innovation costs, cost equality between ICE vehicles and EVs, and by and large nation level decarbonisation endeavours. Strategy measures can incorporate both draw and push factors, for example, appropriations or other financial impetuses for EVs or out and out ICE vehicle boycotts.

According to S&P Worldwide, the car business' progress to EVs is speeding up. The year 2026 will be a tipping point for an increase in EV reception that will drive car zap patterns ahead. By 2030 more than one of every four new vehicles sold will be an electric vehicle. Many significant vehicle makers overall have flagged the conclusion of an important time period of gas-powered motors (ICE) as the progress to zero discharge vehicles (ZEV) is sloped up. Also, as per the Global Outlook 2023, as opposed to ICE models, EV model accessibility has been developing rapidly, at a build yearly development pace of 30% over the 2016-2022

periods. Such development is not out of the ordinary in an early market with countless new participants carrying imaginative items to the market, and as occupants expands their portfolios. Development has been somewhat lower as of late: the yearly development rate remained at around 25% in 2021 and 15% in 2022. Later on, the quantity of models can be anticipated to keep on expanding rapidly, as significant carmakers grow their EV portfolios and new participants reinforce their positions, especially in developing business sectors and creating economies (EMDEs). For a better future, the transition from fossil fuels to renewable energy is the need of the hour.

RESEARCH OBJECTIVES

This research aims to investigate the trends, challenges, and future prospects of accelerating electric vehicle penetration in Asia. The specific research objectives are as follows:

1. Analyze the Current State of the EV Market in Asia:

Give an outline of the electric vehicle market in key Asian nations, look at the market size and development rates.

2. Identify Factors Influencing Electric Vehicle Adoption:

Examining the effect of government strategies and guidelines including motivating forces, sponsorships and emanations principles aimed at advancing EV reception. Further, we are looking at the job of mechanical headways, advancements in battery innovation, range enhancements and charging framework impacting the EV reception.

3. Discuss Challenges Hindering Electric Vehicle Penetration:

Address the difficulties connected with the higher starting expenses and moderateness of electric vehicles contrasted with traditional

vehicles.

4. Propose Strategies for Accelerating Electric Vehicle Penetration:

Suggest government drives and strategy systems that can uphold and speed up EV reception in Asia by investigating joint efforts among public and private areas to put resources into EV foundation and innovative work.

By accomplishing these research objectives, this study aims to provide insights and recommendations for policymakers, industry stakeholders, and researchers involved in promoting electric vehicle adoption in Asia. The findings of this research can contribute to the development of effective strategies and policies that will enable a faster and smoother transition towards sustainable and environmentally friendly transportation in the region.

LITERATURE REVIEW

The world has been witnessing a remarkable surge in the adoption of electric vehicles (EVs). This indicates a shift towards a more sustainable and low-carbon future. This growing trend, paved the way for the researchers, to do extensive research about the opportunities, challenges, and strategies surrounding EV development and deployment. These researchers explored various regional perspectives with respect to the adoption of EVs.

Liu et al (2023) published a research paper on Opportunities, Challenges and Strategies for Developing Electric Vehicle Energy Storage Systems under the Carbon Neutrality Goal

wherein he proposed to create a favorable market environment, advancing battery technology and focusing on V2G management and also emphasized the need for a collaborative ecosystem, strategic planning and the implementation of technical standards, to conclude that the EV energy storage has potential for technology advancement, market expansion, and economic benefits.

Raj, Roy and Ray (2021) analyze the market dynamics, vehicle segments, and policy environment in India with respect to EV adoption. They identify that although the Indian EV market is growing, the adoption rate remains relatively low due to various challenges. Singh, Tyagi and Thakur (2020) also provide an overview of EV adoption trends in India and emphasize the importance of government initiatives and policies in promoting EVs.

A preliminary case study for Delhi, India (2017) - "Battery Electric Vehicle Global Adoption Practices and Distribution Grid Impacts", further discusses the opportunities and challenges of electric vehicle (EV) adoption in various countries with a focus on India. It highlights the importance of incentives, charging infrastructure and grid integration in promoting EV adoption, this study aims to provide recommendations to accelerate and scale EV adoption in India, in line with the country's electric mobility goals.

"Electric Vehicles in Malaysia and Indonesia: Opportunities and Challenges", a review by Energies in 2022 discusses the adoption and challenges of electric vehicles (EVs) in Malaysia and Indonesia. It discusses the importance of addressing critical issues and

promoting the development of EVs in Malaysia and Indonesia. It further emphasizes the potential for EV deployment to improve air quality and reduce greenhouse gas emissions when combined with sustainable power plants.

Ranwala, S. (2019) discussed the opportunities and challenges of promoting electric vehicles (EVs) in Sri Lanka. It identifies global trends, rising fossil fuel prices, financing options, low maintenance requirements and passionate early adopters as opportunities for promoting EVs in Sri Lanka. However, it also acknowledges challenges such as managing electricity demand, limited driving range, higher vehicle prices, lack of technical expertise, charging infrastructure, regulatory frameworks, and environmental concerns related to battery disposal.

Gideon Ng (2023) discusses the challenges and solutions to the adoption of electric vehicles (EVs) in Asia, with a focus on China, Singapore, and Vietnam. It highlights the need for collaboration between the government, private sector, and consumers to make EVs the norm.

Numerous studies emphasize the role of government policies in driving EV adoption in India. Kumar, Kansal and Singh (2021) evaluate the impact of the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, highlighting its effectiveness in stimulating EV sales and charging infrastructure development. Kamboj and Dutta (2019) assess the influence of state-level policies and incentives on EV adoption, emphasizing the need for consistent policies

across regions.

Painuli et. al. (2018) have assessed that the reduced fuel consumption, capability of reducing CO2 emission make EV the promising devices in smart grid which are inclined to overtake the future of transportation.

The availability of charging infrastructure is crucial for EV adoption. Ghosh and Sarkar (2020) examine the challenges and opportunities in charging infrastructure development in India. They discuss the need for a comprehensive charging network, including home charging, workplace charging, and public charging stations, and stress the importance of standardization and interoperability.

Several studies delve into consumer perceptions and awareness of EVs in India. Vaitheeswaran and Jabbal (2021) investigate consumer preferences, concerns, and the role of social influence in EV adoption. They emphasize the importance of addressing range anxiety, affordability, and charging infrastructure concerns to boost consumer confidence. Mathur, Singh and Sivakumar (2019) analyze consumer attitudes towards EVs and identify factors influencing purchase decisions, including purchase price, operating costs, and environmental consciousness. Jana, Rangaraju and Ghosh (2020) examine the challenges in battery recycling and emphasize the importance of sustainable end-of-life management for EV batteries.

Hagh et. al. (2023) suggested in their study

that many incentives will be required to motivate the adaptation of the EV like mitigating the challenges of city tolls, easy finance accessibility, handling the traffic restrictions in well ordered manners, discounting the cost of EV charging.

As the world accelerates its transition towards sustainable transportation, understanding the global landscape of EV adoption is paramount. Through the insights gained from literature and research, we have explored the strategic importance of EV adoption, identified opportunities and challenges in Asia region to be specific, and discussed the solutions to foster EV adoption. By contributing to the existing literature, we are actively shaping the discourse on EV development and deployment, paving the way for a greener, more sustainable future powered by electric vehicles.

CONCEPTUAL FRAMEWORK

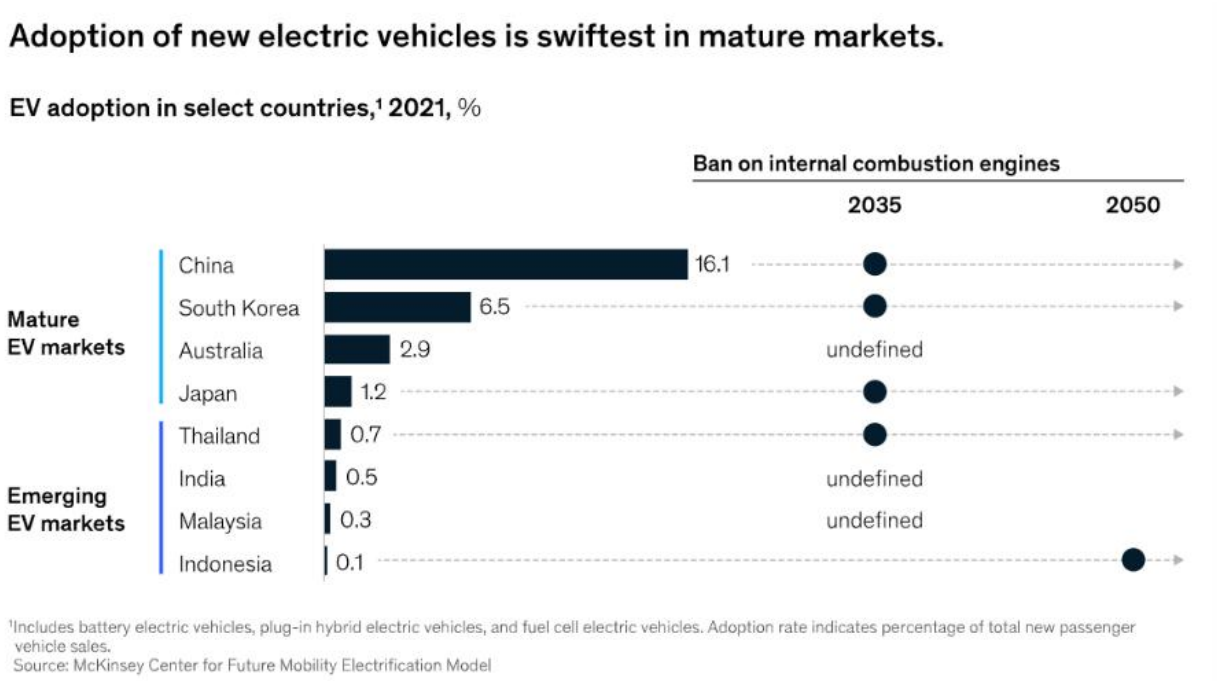
EV adoption differs between nations and locales in Asia and globally. Although Asia is currently leading in market share, other regions are also catching up and experiencing their own distinctive patterns of growth. The McKinsey & Company article (2022) "Capturing growth in Asia's emerging EV ecosystem", shows that the transportation division is responsible for around 17 percent of around the world nursery gas outflows. In order for Asian countries to realize their outflows targets, it is pivotal to drive both the supply and request for electric vehicle (EV) adoption within the mass showcase, because it is the requirement of the hour. The nations within the Asia locale incorporate China, Japan, South Korea, India, Indonesia, Malaysia, the Philippines, Singapore, Thailand, Vietnam, the more noteworthy

China locale, and Pakistan. Asian nations are in numerous ways confronting climate challenges. Asia is home to 93 of the 100 most contaminated cities and six of the best ten nations most influenced by climate risks. The locale moreover faces generally tall vitality demand, as numerous nations are still quickly developing and urbanizing. China alone expends more than three times the full vitality utilized in Europe.

As per the IEA, Global EV Outlook 2023 Executive Summary, Asia leads in worldwide electric vehicle (EV) deals. According to the Universal Vitality Organization (IEA), Asia accounted for over 60% of EV deals around the world in 2020. China, as the biggest EV advert all inclusive, played a critical part in Asia's dominance, contributing to over 40% of worldwide EV deals within the same year. China has been the world's biggest EV advert for a long time. In 2020, China sold around 1.3 million EVs, comprising over 40% of worldwide EV sales.

Japan and South Korea, among other Asian nations, moreover play a noteworthy portion within the region's advertised share and generally EV adoption. In 2020, Japan accounted for around 7% of worldwide EV deals, with over 140,000 EVs sold. Though, South Korea has too seen striking development in EV appropriation; it accounted for around 3% of worldwide EV deals, with over 70,000 EVs sold.

As per the citations in McKinsey Center for Future Mobility Electrification Model article (2022) by Farmer et. al., the above 2021



depiction is focused on the Asian markets, showcasing how emerging economies like India, Thailand, Malaysia, Indonesia lag behind the mature markets such as China, South Korea, Australia and Japan in their adoption of electric vehicles. For the emerging markets to reach the level of mature markets, it would require them to make

greater investment in partnerships, infrastructure and technology development, accelerated low-cost EV model distribution (with total cost of ownership at or ahead of parity with internal combustion engines), integrated finance, government incentives to encourage EV adoption and discourage ICE-Internal Combustion Engines, and a supporting green investment framework.

Focusing on the sales in South East Asian countries, Gupta, A. (2022) reported that the Electric vehicle (EV) sales in the Southeast Asia (SEA) region are gradually increasing but still constitute only 0.5% of global EV sales in 2022. Battery EVs (BEVs) make up the majority of sales, while plug-in hybrid EVs (PHEVs) account for the rest. SEA countries face challenges in achieving their EV targets while increasing the share of renewables in their electricity grids. However, EV sales are expected to double in 2023, leading to the establishment of more production plants in SEA. Thailand is currently the most advanced in EV sales, followed by Indonesia and Vietnam. Wuling's Air EV was the best-selling model in the region in 2022.

According to an article published by The Economist in April 2023, The Indian Government had already set targets, it has predicted for 30% of passenger car sales, 70% of commercial vehicle sales, and 80% of two and three-wheeler sales of electric vehicles by 2030. The scenario is not great currently. EVs represent a small percentage of new vehicle registrations, with only 1.3% of cars and 4% of two-wheelers being electric in recent years. While state governments provide subsidies for EV purchases, the high upfront cost remains a challenge. Battery technology needs to

improve and become more affordable, and charging infrastructure needs to be developed to address range anxiety. The incentives have fueled the growth of EV scooter startups, but there is still potential for new firms to emerge. The growth of EVs is driven by consumers in smaller cities with poor public transport, where two-wheelers are popular. India aims to reduce its import bills and energy dependence through the adoption of EVs, while also making strides in transitioning to renewable energy sources.

Despite so many challenges, India has shown major improvement in sales of EVs. An article by Felicity Bradstock dated May 13, 2023 - "The Electric Vehicle Market In Asia Is Booming" revealed that, India's electric vehicle (EV) sales in 2022 reached almost 50,000, marking a fourfold increase from the previous year. The government's $3.2 billion incentive program has attracted $8.2 billion investment to develop the country's EV market. Battery EVs accounted for 61% of sales, while hybrid EVs made up the rest. There is dominance of Two-wheelers and Three-Wheelers in EV segment. The availability of affordable electric scooters and e-rickshaws has played a significant role in driving EV adoption, particularly in urban and semi-urban areas of the country. However, India still lags behind major EV markets like China, the US, and Europe. Southeast Asia, particularly Thailand and Indonesia, also show potential for EV manufacturing and consumer markets. Major automakers such as Citroën, Volvo, and Audi have entered the Indian market, and battery EVs accounted for 6.2% of new car sales in the first two months of 2022. The growth of EV markets in India, Thailand, and Indonesia is expected to continue with increased foreign investment

and government support.

When it comes to EV penetration rates, China leads with 27.1 percent, while South Korea has reached 10.3 percent after a slow start. In countries like Indonesia, Vietnam, Malaysia, the Philippines, and Thailand, EV penetration ranges from 0.1 percent to 2.5 percent on average. Japan has a 2.2 percent EV penetration, but this is due to the government's support for various clean technologies, including hybrids, plug-in hybrids, and fuel cell vehicles, alongside lithium-ion battery-powered vehicles. This diversification limits the pure EV penetration in Japan. Globally, the overall EV penetration stands at 13.3 percent.

CHALLENGES INVOLVED IN EVOLUTION OF EV

With regards to progress from one state to various, it requires heaps of execution and structures through the legislatures of different economies to give you the best and productive plans. Reception of EVs accompanies their own requesting circumstances: the primary recognized adventure is achieving equality inside the general worth of possession (TCO) when contrasted with customary internal ignition motor (ICE) autos. TCO alludes to the general cost of purchasing and running a vehicle over its lifetime, comprehensive of purchase charge, fuel or strength expenses, safeguarding, and different related costs. Achieving TCO equality is fundamental since it guarantees that the worth of gladly possessing an EV is serious with ordinary ICE vehicles.

In many occasions, EVs presently have higher ahead of time charges because of the cost of batteries and other electric fueled drivetrain added substances. In any case, as

the innovation improves and economies of scale are done by means of large-scale manufacturing, the costs of EVs are expected to diminish. What's more, the administrative environmental factors play out an urgent situation in TCO equality. States can affect the reception of EVs by executing strong rules like assessment impetuses, sponsorships, and offers.

One more challenge is the accessibility of unique hardware producer (OEM) models and the availability of the inventory network to help EV creation and circulation. In developing business sectors, the store network for EV parts may not be completely settled or enhanced. Interest in neighborhood producing capacities and organizations with worldwide providers can assist with fostering a hearty and effective store network environment.

The third challenge lies in accomplishing a fundamental mass in charging foundation. A pleasantly evolved and close by charging network is basic for the enormous reception of EVs. Key arrangement of charging stations in neighborhoods, business offices, workplaces, and close by significant transportation courses is essential. Introducing a mix of charging speeds and laying out smooth-to-utilize value frameworks can improve the charging revel in. Coordinating accusing framework of environmentally friendly power assets advances maintainability and diminishes dependence on non-renewable energy sources.

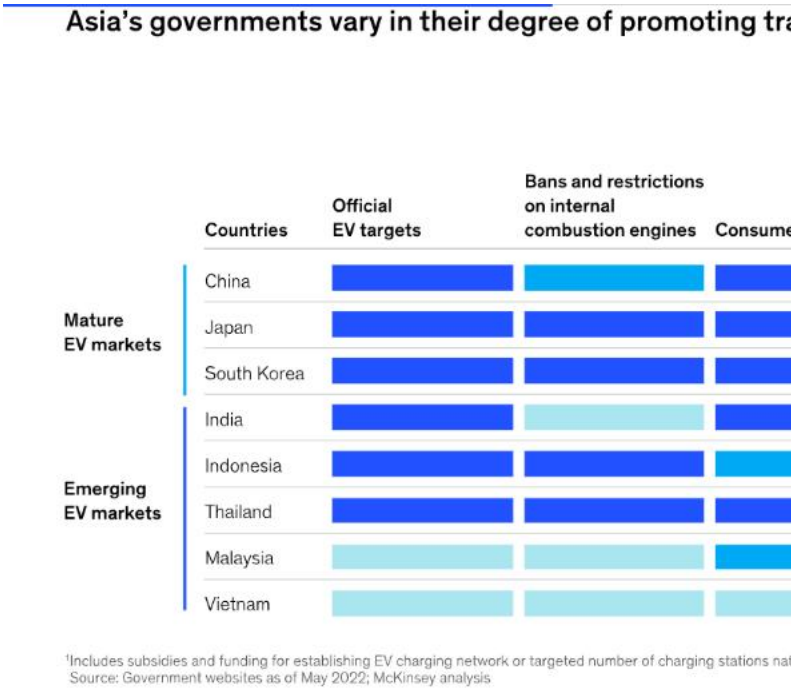
Notwithstanding the difficulties, the EV development is set to advance in Asia. The reception of Electric 4 wheelers is set to ascend, with China driving the charge by turning into the biggest EV market in outright

term. Asian business sectors, progressing from its ongoing low levels to a significant piece of the pie, are projected to develop by 45% in the E4W fragment.

Likewise, Asian business sectors address the biggest miniature portability markets with E2W taking these business sectors by a tempest. Such improvement will convert into a jolt pace of bikes at around 36% in India and ASEAN by 2030, contrasted and under 1% today, as per the Mckinsey & Co, article (2022).

STRATEGIES FOR ACCELERATING EV PENETRATION

Government in Asian markets is significantly making efforts in the electrification process of the transport system. The picture below shows how Asia's government is fuelling their net zero emission dream by taking various initiatives such as, banning ICE and combustion engines, providing subsidies to consumers and developing the charging infrastructure for the EV system. According to the depiction taken from the article published by McKinsey (2022): Japan, South Korea and Thailand have the highest degree of support from their respective governments, with Vietnam at the end of the ladder.



Asian countries have implemented strong

government policies and incentives to drive EV adoption. China, for example, offers generous subsidies, purchase rebates, and tax incentives to encourage EV purchases.

Japan and South Korea have also implemented similar incentive programs to stimulate consumer demand and accelerate EV adoption.

Asia is rapidly expanding its charging infrastructure network. China leads in this regard, with a vast and growing network of public and private charging stations. As of 2021, China had over 1.5 million public charging points, accounting for more than 80% of global public charging infrastructure. Other Asian countries are also investing in charging infrastructure development to support the increasing number of EVs on the roads.

CONCLUSION AND POLICY IMPLICATIONS

Asia is encountering a groundbreaking movement towards electric vehicles, with nations like China, Japan and South Korea driving the change. Next in line are the countries including India, Thailand, Singapore and Malaysia where focus of Electric vehicles is gaining momentum. Continued government support, technological advancements, infrastructure development, and consumer acceptance will play crucial roles in shaping the future of the EV segment across Asia. Defeating difficulties connected with charging framework, battery innovation, customer insights and augmenting the financial advantages will be urgent for supporting this energy. The ascent of EVs in Asia denotes a critical second in the worldwide progress towards manageable transportation

framework and commitment of India in this whole changing would be of significant value. It should effectively take part in the improvement of green organizations, particularly in the electric vehicle (EV) area, as the need is squeezing and conditions are quickly evolving. Asian organizations, whether laid out or new businesses, ought to gain by this second and influence worldwide encounters to build a vigorous EV environment for what's in store.

Policy Implications:

The findings of this research have several policy implications for promoting EV adoption in Asia:

1. **Financial Impetuses and Sponsorships:** Legislatures ought to offer appealing buy appropriations and duty exclusions to make EVs more reasonable for customers. Motivators for homegrown assembling and battery creation can likewise decrease costs.

2. **Charging Foundation Improvement:** Thorough plans are expected to construct a vigorous charging framework organization. Public-private associations ought to be urged to introduce charging stations in local locations, working environments, and public spaces, while guaranteeing interoperability and normalization.

3. **Regulatory System:** Legislatures ought to lay out clear and predictable guidelines and principles for EV charging framework, wellbeing, and valuing straightforwardness. Stricter emanations guidelines and eco-friendliness standards can additionally empower EV reception.

4. **Research and Advancement:** Proceeded with interest in battery innovation innovative work is pivotal to further develop energy

thickness, charging rate, and cost decrease. Coordinated efforts between the scholarly community, research establishments, and industry ought to be encouraged.

5. **Public Mindfulness and Buyer Training:** Designated mindfulness crusades are important to instruct shoppers about the advantages of EVs, disperse legends, and address concerns connected with charging framework and reach uneasiness.

6. **International Joint effort:** Cooperation with nations driving in EV innovation and foundation can work with information trade, skill sharing, and innovation move.

7. **Strengthening Framework Foundation:** Appraisal and overhauling of the power lattice is fundamental to oblige the expanded interest from EV charging. Savvy network innovations and incorporation of environmentally friendly power sources ought to be investigated.

8. **Research and Information Assortment:** States and foundations ought to put resources into information assortment and examination on EV reception patterns, charging examples, and customer conduct to illuminate strategy choices and framework arranging.

By carrying out these strategy suggestions, policymakers, industry partners, and scientists can establish an empowering climate for EV reception, address difficulties, and speed up the progress towards practical and clean transportation in Asia.

The tides positively appear to demonstrate a push toward electric vehicle. Before far reaching reception turns into a reality, nonetheless, a number of headwinds should be cleared. As the world is progressing towards adoption of better alternatives, green energy is the way ahead.

The EV adoption would accelerate the reduction of carbon emissions which would help achieve a Net Zero Emission World. Participation and collaboration of both private as well as public players would help transition from ICEs to EVs.

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