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Enabling Sustainable Road Transportation Through Electric Vehicles: Implications for Governments and Buyers

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Abstract

The study discusses the role of Governments and Buyers to enable sustainable road transportation by facilitating mass adoption of electric vehicles (EVs). EV sales have witnessed strong growth in the last few years to reach 753,000 units in new registrations in 2016 (compared to just 48,000 in 2011). Although EVs possess several social, operational and environment benefits, the study reviews existing literature to highlight certain attitudinal and socio-technical barriers including low range and less matured charging infrastructure along with others. To expedite EVs penetration, the study explores certain practical considerations for Governments as well as current and prospective Buyers. The considerations listed in the study holds implications for Buyers and Governments to limit certain attitudinal, economic and technical barriers thererby accelerating EVs adoption.

Keywords: Sustainable Transportation, Electric Vehicles, Strategy, Drivers, Barriers, Considerations

Introduction

With rising pollution and its detrimental impacts, depleting oil reserves, rising temperature across the globe and higher taxation on fuel & combustion engines resulting in lower economic viablility of conventional vehicles, sustainable transportation is the need of the hour. Sustainable transportation can be defined as a way of transportation that is sustainable in terms of environment, climate and social impacts. Sustainable transportation can be evaluated using several components such as vehicles used for road, water & air transport, pipelines for transporting liquid & gas substance along with source of energy and infrastructure to support this transportation. The study focuses on accelerating the adoption for clean vehicles leading to towards sustainable road transportation, electric vehicles (EVs).

It is without debate that EV is the biggest disruption that the automotive industry has witnessed in the last few decades. An EV is driven by one or more electric motors powered by the charge stored in its battery. Depending upon the degree of dependability on electric motor and combustion engine, EVs can be broadly classified into three categories viz. hybrid, plug-in hybrid and pure electric vehicle. A hybrid electric vehicle (HEV) is the entry level EV comprising a non-plug-in electric motor (of smaller power output) which works in pair with the combustion engine. A plug-in hybrid electric vehicle (PHEV) on the other hand features a larger electric motor (paired with a chargeable battery pack). Even though the combustion engine is still present in a PHEV, its role is highly reduced with the advent of a larger motor. Finally, a battery electric vehicle (BEV) is propelled solely by electric motors. Several markets have initiated EV adoption from HEVs and are slowly transitioning towards BEVs. EVs possess several advantages such as zero emissions, no noise pollution, lower operating costs than conventional vehicles, better built and performance to catch the attention of buyers, but certain barriers around low range, less matured charging infrastructure and high price continue to haunt their further development.

While the global vehicle market grew at a compounded annual growth rate (CAGR) of just over 1% from 2012 to 2016 to reach 94.5 million units, EVs grew at a staggering rate of 38% to reach 753,170 units in 2016 compared to 547,120 units sold in 2015. Although, EVs comprise a miniscule share (a little over 1% in 2016) in the overall vehicle fleet, several studies point towards their positive future outlook.

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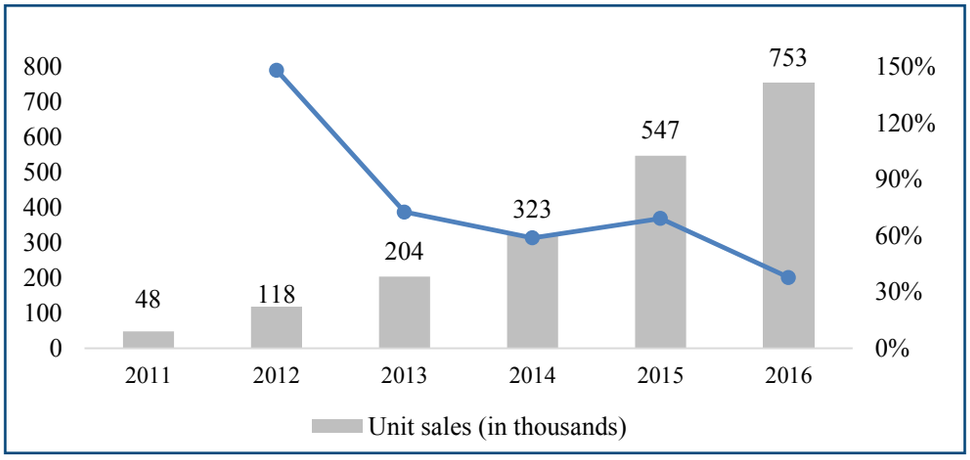

Source: International Energy Agency, 2017 (As cited by Global EV Outlook 2017)

Exhibit I: Global EV (BEV and PHEV) Sales and Growth Trend

In terms of size, China, US, Netherlands, Norway, Sweden, United Kingdom, Japan, Germany and France are among the significant EV markets. China and US cumulatively account for a share of more than 60% of global EV sales. Although China and US were incomparable in terms of quantum of sales a few years back, sales in China picked up strongly in 2014 to reach 336,000 units in 2016 compared to not so far sales of 159,620 units sold in the US. In terms of penetration, Norway leads with EVs commanding a share of 28.76% followed by Netherlands at a distant 6.39% in 2016.

International Energy Agency (IEA) expects EV stock to reach around 9-20 million and 40-70 million by 2020 and 2040 respectively. Bloomberg New Energy Finance (BNEF) also predicts strong EV sales in future reaching 41 million by 2040, commanding a healthy share of 35% in new light vehicle sales.

Evidences from Literature

Certain studies have attempted to define & classify sustainable transportation and Electric Vehicles. Jeon C.M. et. al. (2005) characterized the emergent thinking on what constitutes transportation sustainability and its measurement. The study argued while there is no standard definition for transportation sustainability, it is largely being defined through its impacton the economy, environment and general social well-being andis measured by system effectiveness and efficiency including its impact on the natural environment. It concluded that several frameworks can be developed collectively to enable agencies in planning procedures, measurement and monitoring systems for achieving sustainable transportation systems. Kohler J. et. al. (2009) studied and reported the development of a model for assessing transitions to sustainable mobility combining agent-based modelling techniques with system dynamics structure. Results based on data collected revealed that while hydrogen fuel cell based vehicles shall aide in sustainable transportation in long run, hybrid electric vehicles shall act as alternatives to conventional vehicles in next 10 to 30 years owing to their more developed infrastructure. Poullikkas A. (2015) focussed on achieving sustainable road transportation through not only adopting EVs but also with their charging using clean sources of energy. He defined and classified several types of EVs on the basis of dependency on conventional engines and electric motors as HEVs, PHEVs & EVs and argued that when EVs are recharged from electricity produced from conventional technology power plants such as oil or coal-fired, they may produce equal or sometimes even more greenhouse gas emissions than conventional gasoline vehicles. Thus he concluded that in order to achieve full-cycle sustainability, the electricity available to recharge the batteries must be generated from renewable energy sources.

With rising popularity of EVs, several papers have highlighted their social, operational and environment benefits in contrast this conventional gasoline vehicles. Tseng. H.K. et. al. (2013) compared the economic and environmental benefits of pure and hybrid electric vehicles with that of conventional vehicles and argued

that in absence of tax credits, only the hybrid vehicles (without plug-in) incur lifetime total costs equivalent to a conventional vehicles. The study demonstrated the importance of developing an energy policy that includes tax credits to address the inadequacy of cost differential and consumer affordability. It concluded that the environmental benefits provided by both EV and HEV should satisfy consumers interest in protecting the environment and promoting sustainable road transport. Hao, H. (2017) also examined and compared the life-cycle cost and greenhouse gas emissions of CVs, HEVs and BEVs. The results indicated that although BEVs contribute to reducing greenhouse gas emissions compared with other polluting conventional vehicles, their current cost-effectiveness is not comparable with HEVs. It recommended that the deployment of BEVs should be prioritized in intensively-used fleets such as taxis to realize high cost-effectiveness.

While EVs have been successful in causing a stir in the mobility industry, several barriers still pose a significant threat to their further adoption. Several studies have identified these barriers in terms of inferior attitude towards EVs, high procurement costs and lack of charging infrastructure. Lane B. et. al. (2007) identified attitudinal barriers inhibiting the development of sustainable road transportation in UK. The study reviewed the evidence of consumer attitude towards low carbon cars and showed that car buyers have a poor knowledge of cleaner car technologies, the environmental impacts of road transport and car ownership costs. It also identified key factors that influence consumers' adoption of low carbon products and concluded that identifying where and when these factors occur could enable the formation of initiatives to facilitate consumer adoption. Fengbo L. et. al. (2011) highlighted several problems existing in China transportation system such as lack of coordination between different transportation means, small scale of transportation facilities among others. Post discussing the necessity for building a low carbon sustainable transportation system owing to reasons including rising energy consumption and emissions, the study presented the 'Governance model' highlighting the role of government, transportation and public in achieving sustainable transportation system. Egbue O. et. al. (2012) identified potential socio-technical barriers to consumer adoption of EVs and examined whether issues regarding sustainability influence consumer purchase decision. The study argued that individuals highly connected to technological development are most likely to emerge as early adopters of EVs. It suggested that several measures such as increased awareness & investments in technology, infrastructure, battery swap programs, strong warranties on EV batteries and increased tax credits need to be explored to reach mass adoption. Furthermore, the findings revealed that sustainability and environmental benefits of EVs are ranked behind cost and performance for consumer purchase decision.

The existing literature thus highlighted several aspects regarding sustainable road transportation including its definition & measurement along with the classification of EVs, their operational& environment benefits coupled with several attitudinal & socio-technical barriers to EV adoption. While the majority of studies have given recommendations to automakers for eliminating attitudinal & technological roadblocks, very few studies have suggested considerations for other significant players in the EV value chain viz. governments and buyers. Thus, the current study focuses on giving certain practical considerations to government and buyers to realise sustainable road transportation.

Considerations for Governments

Governments can play an active role in promoting EVs by forming favourable policies at the macro level in expectance of a significant trickle-down effect extending to the micro level. They can award several exclusive provisions, incentives and subsidies along with others. Some of them are discussed in this section.

Building Charging Infrastructure

Charging stations for EVs are what petrol stations are for CVs. Development of charging stations is required to enable proper support infrastructure required for mass EV adoption. Higher density of these charging stations can help a great deal in eliminating the range anxiety syndrome (fear of low range of an EV) as users would have access to charging stations at near distances. Currently, the state of charging infrastructure remains to be immature globally.

To tackle this growing need for installing charging stations, the government needs to ensure that proper policy and framework are in place. The government also needs to increase public spending at building charging infrastructure in expectance that private investments

shall follow. This would also reduce the capital risk as well as boost investors' confidence. As building charging infrastructure requires extensive capital, governments can explore several operating models to limit their role in the charging infrastructure ecosystem going forward. Government can outsource activities such as operating and maintaining of these stations to third parties. Once private investments gain momentum, the government can also explore the options from transferring their ownership to private players.

Renewable Capacity Additions

Sustainable road transport cannot be achieved only through limiting emissions from vehicles, but these emissions also need to be curtailed for the source of electricity powering these vehicles. Thus in order to attain full-cycle sustainability, the adoption of zero-emission vehicles (EVs) need to be paired with a clean source of energy production achievable through renewable power generation which can be produced from solar, wind, hydro, biomass etc.

Governments need to ensure proper policy and regulatory framework for facilitating renewable power production. They can also provide several incentives and subsidies such as appreciated depreciation, tax rebate on raw materials, financial assistance, concession on import and export etc. to expedite the proportion of renewable power generation in the overall power generation mix. These efforts leading to cleaner source of energy coupled with mass adoption of EVs shall eliminate greenhouse gas emissions leading to sustainable road transport.

Inclusion of EVs in Public Transport Fleet

Cost structure of every vehicle mainly comprises of three parts viz. procurement, operation and maintenance. While the current procurement costs for EVs are high, they bank upon their lower operation and maintenance costs (with reference to CVs) to lure early adopters. Several studies have pointed that heavy usage of EVs shall be required to realise the economic benefits of EVs essential for offsetting these high procurement costs.

Initial EV adoption within public transport and vehicle fleet used by the Government can provide a major boost to the overall EV industry. Apart from reaping reduced overall costs benefits, the inclusion of EVs in public transport shall make it necessary to provide fast high-voltage charging points in bus depots, parking areas, metro stations and other public places. Another consideration to make this pilot project successful can be the introduction of battery-swapping stations (a battery-swapping station switches the vehicles' discharged battery for another fully charged battery pack) to eliminate the inconvenience caused due to longer charging times. Although public buses can have sufficient range for city commute, these battery swapping stations can be a great boon for the EV buses employed for longer durations. The Government can also involve private players for setting up these battery-swapping stations on a bidding basis or a public-private partnership (PPP) basis.

Subsidies and Incentives

The government can award several subsidies and incentives to promote EVs. These benefits can lower the high procurement costs and make them cost competitive with CVs. Apart from providing direct benefits, governments can also introduce several indirect benefits such as free parking spaces, access to lanes reserved for heavy vehicles and exemption from toll charges. Several countries have already started introducing host of benefits for EV users. Some of them are mentioned below:

Chinese government offers exemptions from acquisition and excise taxes ranging between USD 5,000 to USD 8,000 on purchase of EVs. Some of the larger cities also allows partial or total waiver from licence plate availability restrictions *(Notice on Adjusting the Policy of Financial Subsidy for Promoting and Applying New Energy Vehicles, Ministry of Finance of the People's Republic of China, 2016)*.

In United States, the government awards tax credits in the range of USD 2,500 to USD 7,500 on purchase of EVs depending upon the dependability of electric motor *(Global EV Outlook 2017 – International Energy Agency, 2017)*.

In Norway, the government has exempted EVs from acquisition taxes to make them cost competitive against CVs. EVs are also exempt from 25% value-added tax *(Global EV Outlook 2017 – International Energy Agency, 2017)*.

In United Kingdom, BEVs are eligible for purchase incentive up to GBP4, 500 and GBP8,000 for cars and light commercial vehicles respectively *(Low-emission vehicles eligible for a plug-in grant, Government of UK, 2017).*

In India, EVs attract lowest tax rates at 12% in the goods and services tax (GST) regime. In comparison, CVs are taxed at 28% (base rate) plus additional cess ranging from 1% to 25% depending upon the type of vehicle *(GST Rates on Goods and Services, Ministry of Finance, Government of India, 2017).*

In order to extend maximum provisions for EVs, governments of lesser matured EV markets including India (in reference to other relatively matured markets such as China, US, Norway etc.) should consider waiving of excise and procurement taxes completely or should keep these taxes at the minimum possible slab. Once EV fleet gets strong coupled with lower costs due to mass production, then governments in these immature EV markets can marginally increase tax rates on EVs.

Considerations for Buyers

Personal Charging Infrastructure

EV charging infrastructure remains a major barrier and establishing an appropriate public charging infrastructure is bound to take time. However there are several solutions already available to help users in sailing through this transition. For instance, as most of the EV charging takes place during the night at home or during the day at office, installing a personal charge point at these two locations can offer great assistance in dealing with the current immature state of charging infrastructure.

With increasing participation from leading technological companies, installing a personal charge point is now a practical option for consumers. Several manufactures are partnering with automakers to offer this personal charge device in combination with an EV on a lease or financing contract. A typical EV charge point with a life span of 15 years can be purchased for less than USD 2,500. Recently, charge point providers such as ABB and Schneider entered into a strategic partnership with EV makers to offer easy-to-use charging devices.

Charging in Non-Peak Hours

Sustainable road transportation is going to shift the energy focus from oil towards cleaner electricity. When the industry achieves higher EV penetration, then electricity usage and its associated charges are going to play a wider role than they do today. Several power utilities have started exploiting this opportunity by moving from static (constant prices irrespective of demand) towards dynamic prices (varying prices, electricity prices move in the direction of electricity demand).

As electricity charges form a major chunk of operating costs for EVs, users would need to keep track of these dynamic prices in order to avoid charging their vehicles in the peak demand scenario (a scenario when the demand is highest and so are the charges). Charging EVs in non-peak has advantages for both the users as well as power utilities. While the customers can reduce operating costs by charging their vehicles when electricity prices are low, charging in non-peak hours can help power utilities in balancing as well as reducing the strain on the grid.

Long Term Benefits

Several governments have announced their plans to facilitate EVs adoption by offering incentives and subsidies while introducing several restrictions to curb CVs sales by imposing higher taxes. Several countries are even planning to phase out CVs within the next 10-20 years.

This might be a strong signal to choose an EV over CV as the valuation of the latter is expected to drop steeply with increasing government intervention to reduce reliance on fossil fuelbased vehicles. The buyers need to understand the higher resale value of their EV going forward as the value of CV would depreciate at a much higher rate than EV.

Conclusion

The study discussed how increased adoption of EVs can enable sustainable road transportation in the future. EVs possess several social as well as environmental benefits, certain barriers in terms of low driving range, high procurement costs, and immature charging infrastructure continue to limit their mass adoption. The

paper presented several considerations for Governments as well as Buyers to enable mass adoption of EVs leading towards sustainable transportation. These considerations hold strong implications to foster further development of EVs by catering to certain technical, economical, and attitudinal barriers in the short and long term. The study also suggested that apart from relying on Government for building charging infrastructure and providing incentives & subsidies, Buyers can also do their part towards sustainable transportation by focusing on purchasing their own charging equipments till the public or company-based charging stations get denser as well as recommended them to charge their EVs in non-peak hours to reduce the burden on the transmission grid as well to facilitate operational savings thereby compensating for high procurement costs. These recommendation would in turn help in the elimination of part of the technical, economic and attitudinal barriers to advance the further adoption of EVs to realise sustainable road transportation.

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