ISGF White Paper

ELECTRIC VEHICLES: A SUSTAINABLE SOLUTION TO AIR POLLUTION IN DELHI

ABSTRACT

The objective of this paper is to highlight the relevance of electric vehicles (EVs) in reducing air pollution in cities and their significant environmental benefits. The paper recommends phased approach for rollout of EVs in Delhi on fast track. The same approach could be adopted in other cities in India and overseas as well. .

AUTHORS

Reji Kumar Pillai- President
Akshay Ahuja – Sr. Smart Grid Specialist

India Smart Grid Forum (ISGF)
CBIP Building, Malcha Marg, Chanakyapuri
New Delhi - 110021, India
www.indiasmartgrid.org

ABOUT INDIA SMART GRID FORUM

India Smart Grid Forum (ISGF) is a public private initiative of the Ministry of Power (MoP), Government of India for accelerated development of smart grid technologies in the Indian power sector. ISGF was set up in 2010 to provide a mechanism through which academia, industry; utilities and other stakeholders could participate in the development of Indian smart grid systems and provide relevant inputs to the government's decision making.

TABLE OF CONTENTS

ELECTRIC VEHICLES: A SUSTAINABLE SOLUTION TO AIR POLLUTION IN DELHI

Emissions from automobiles may not be the single most source of air pollution in Delhi, but it is a significant contributor to the deteriorating air quality there. Transport sector accounts for about 20% of global energy use but different reports indicate that automobiles alone contribute 25-30% of the emissions globally. World over the key philosophy gaining momentum towards transition to low carbon economy is to electrify all human activities including transportation and agriculture (to the best extent possible) and take electricity sector to decarbonise it through measures such as dramatic increase in the share of renewable energy, nuclear power and carbon capture and sequestration from thermal power plants. Delhi has one of the most rapidly growing automobile market in India with number of vehicles having zoomed from 3 million in 2007 to 88 million in 2015! Electric Vehicles (EVs) represent one of the most promising pathways to increase energy security, reduce carbon emissions, and improve air quality.

ELECTRIFICATION OF TRANSPORTATION ESSENTIAL FOR CLEAN AIR IN CITIES

Electrification of transport sector is gaining popularity and congested cities are taking bold steps in this direction - hence the mushrooming of metros, electric trams, BRT corridors with EVs and promotion of EV adoption in general in several countries. Emphasis on low carbon development and clean air is becoming the central theme in infrastructure planning. Successful and widespread deployment of EVs and its supporting infrastructure is key to reducing greenhouse gas emissions, and mitigating the effects of climate change. Realising the importance of EVs in reducing the intensity of emission, Ministry of Heavy Industries (MoHI), Government of India (GoI) launched National Electric Mobility Mission Plan (NEMMP) in 2013 with a target of 6 to 7 million EVs on Indian roads by 2022. However, the EV rollout has not taken off as envisaged mainly due to non-allocation of funds in the last two years for this mission. MoHI has conducted several brainstorming sessions with stakeholders in order to promote EVs in India. It is assumed that in the first phase public transport – buses, three wheelers, taxi fleet - will be given priority. NEMMP is expected to start in a big way provided Government of India allocates the approved amount of Rs 795 crores (US$ 120 million) for the NEMMP in next year's budget. Considering that the customer-adoption of EVs follow the availability of adequate charging infrastructure, NEMMP funds can be used to setting up charging infrastructure, technology developments, incentives and pilot projects.

CARBON EMISSION COMPARISON

Fuel Type	CO_2 Emission (kg per km)
Petrol	0.2325[1]
Diesel	0.273[1]
Electric Vehicle	0.103[2]

[1] http://paryavaranmitra.in/Carpooling%20project%20report%20for%20CEE.pdf
[2] http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver10.pdf

[3]Generation of 1 kWh of energy by coal power plant emits 1 kg of CO_2. In the table above it is assumed that in one litre of petrol/diesel an average car runs ten kilometres in cities; and an electric car can run 10 km with 1kWh of electricity. Even if electricity used for charging the EV is generated through fossil fuel, still CO_2 emission is less than half the emissions from petrol and diesel cars. In the case of EVs the electricity used for charging is produced in power plants located hundreds of kilometres away from the cities that are struggling with air pollution. If electric vehicles are charged through renewable sources of energy then emissions from EVs will be nil.

GLOBAL EV OUTLOOK

The number of EVs sold each year is growing rapidly, rising from 45,000 EVs sold in 2011 to more than 300,000 sold in 2014. In 2014, EVs represented more than 1% of new car sales in four countries: the Netherlands, Norway, Sweden, and the United States. Figures[4] below show the global sale of EVs and EVSE:

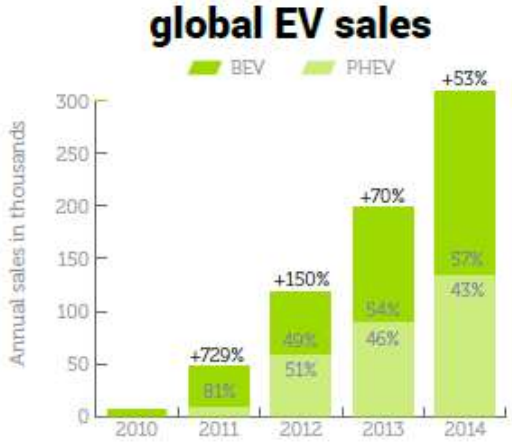

Figure 1: Global EV Sales

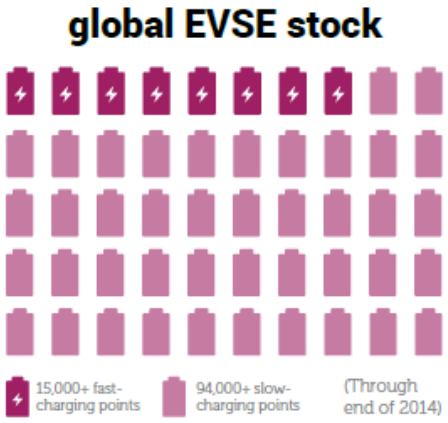

Figure2: Global EVSE Stock

China has done very impressive work on electric two wheelers and electric buses in the recent past. They have developed local capabilities for production of vehicles and charging equipment. As of 2014, China had over 230 million electric two wheelers.

Know EVSE

Electric Vehicle Supply Equipment (EVSE) is used to supply electric energy to recharge electric vehicles which includes: ***Physical components****, such as internal electronics, controllers, cord, EV compatible plug and telecommunications devices to share data and enable network connections,* ***Software applications*** *to manage the charging, billing, driver access, and administration of an EVSE program.*

[3] http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver10.pdf

[4] *http://www.cleanenergyministerial.org/Portals/2/pdfs/EVI-GlobalEVOutlook2015-v14-landscape.pdf*

California State has set the target of 1 million electric passenger cars by 2020 and 1.5 million by 2025. Many other states in USA and several cities around the world are seriously considering aggressive targets for EVs.

Today there are over 50 EV models to choose from. Popular makes and models are given in the table below:

S.No	Model	PHEV/EV	Battery Cell Maker	Battery Size (kWh)	Range (miles)
1	BMW i3	EV	Samsung SDI	22	80-100
2	Chevrolet Spark EV	EV	LG Chem	20	80-85
3	Fiat 500e	EV	Samsung SDI	24	80-90
4	Ford Focus Electric	EV	LG Chem	24	70-75
5	Kia Soul EV	EV	SK Innovations	27	80-100
6	Mercedes B	EV	Panasonic	36	80-90
7	Mitsubishi i-MiEV	EV	GS Yuasa/ Mitsubishi	17	60-80
8	Nissan Leaf	EV	AESC	24 30	80-90 100-110
9	Smart Electric Drive	EV	LG Chem	17.6	60-80
10	Tesla Model S 70/70D	EV	Panasonic	70	200-250
11	Tesla Model S 85/85D	EV	Panasonic	85	270-280
12	Tesla Model S 90/90D	EV	Panasonic	90	270-280
13	Tesla Model S P85D	EV	Panasonic	85	250-260
14	Tesla Model S P90D	EV	Panasonic	90	250-260
15	Tesla Model X 70D	EV	Panasonic	70	200-220
16	Tesla Model X 90D	EV	Panasonic	90	250-260
17	Tesla Model X P90D	EV	Panasonic	90	240-250
18	Volkswagen E-Golf	EV	LG Chem	24	80-100
19	BYD e6	EV	BYD	60	120-130
20	Chevrolet Bolt	EV	LG Chem	60	150-200
21	Tesla Model 3	EV	Panasonic	40 60 85	100-150 150-200 250-300
22	TATA Megapixel (only in Europe)	EV	-	22	50-65
23	Audi A3 e-tron	PHEV	LG Chem	8.8	80-100
24	Audi Q7 e-tron	PHEV	LG Chem	17.3	-
25	BMW 225xe Active Tourer	PHEV	Samsung SDI	7.7	-

26	BMW 330e	PHEV	Samsung SDI	7.6	-
27	BMW i8	PHEV	Samsung SDI	7.1	10-20
28	BMW X5 xDrive40e	PHEV	Samsung SDI	9	10-20
29	Cadillac CT6 Plug-In Hybrid	PHEV	LG Chem	18.4	30-40
30	Cadillac ELR Sport	PHEV	LG Chem	17.1	40-50
31	Cadillac ELR	PHEV	LG Chem	17.1	30-40
32	Chevy Volt (2016)	PHEV	LG Chem	18.4	40-50
33	Ford C-Max Energi	PHEV	Panasonic	7.6	20-30
34	Ford Fusion Energi	PHEV	Panasonic	7.6	20-30
35	Honda Accord Plug-In Hybrid	PHEV	GS Yuasa	6.7	10-20
36	Hyundai Sonata Plug-in Hybrid	PHEV	LG Chem	9.8	20-30
37	Mercedes C350e	PHEV	Samsung SDI	6.2	10-20
38	Mercedes GLE500e	PHEV	Samsung SDI	8.7	-
39	Mercedes S550e	PHEV	Samsung SDI	8.7	-
40	Mitsubishi Outlander Plug-In	PHEV	GS Yuasa/ Mitsubishi	12	-
41	Porsche Cayenne S E-Hybrid	PHEV	Samsung SDI	10.8	10-20
42	Porsche Panamera S E-Hybrid	PHEV	Samsung SDI	9.4	10-20
43	Toyota Prius Plug-In	PHEV	Panasonic	4.4	10-20
44	Volkswagen Golf GTE	PHEV	LG Chem	8.8	-
45	Volkswagen Passat GTE	PHEV	LG Chem	9.9	-
46	Volvo S90 Plug-In	PHEV	LG Chem	9.2	-
47	Volvo V60 Plug-In	PHEV	LG Chem	11.2	-
48	Volvo XC90 T8	PHEV	LG Chem	9.2	-
Cars Available in India					
49	Mahindra Reva	EV	-	10	60-80
50	Toyota Camry Hybrid	HEV	Panasonic	4	-
51	Toyota Prius Plug-In	PHEV	Panasonic	4.4	10-20
52	BMW i8	PHEV	Samsung SDI	7.1	10-20

PHEV: Plug-in Hybrid Electric Vehicle; HEV: Hybrid Electric Vehicle

(Source: https://docs.google.com/spreadsheets/d/1B5zqIQoI4aGD6faBthYvjEpYhiUzsFt4j2bDjuVPAXw/edit?pref=2&pli=1#gid=0 ;)

(This is not an exhaustive list - there may be many more players in EV market which are not mentioned in this list)

EV SCENARIO IN INDIA

EVs in India is still in its infancy and require policy intervention by government to kick-start the rollout to meet the NEMMP goals. There are few manufacturers for electric two wheelers and three wheelers. But when it comes to four wheelers it is only Mahindra Reva who manufacture EVs in India. There are no established electric bus manufacturers yet. List of some of the existing manufacturers of Electric Vehicles in India is given below:

S.No.	Organisation	Products
1	Hero Electric	EV-2Wheelers
2	Mahindra Reva	EV-4Wheelers
3	Electrotherm	EV-2Wheelers
4	Avon Cycles	EV-2Wheelers
5	Ampere Vehicles Private Ltd	EV-2Wheelers/3Wheelers
6	Lohia Auto Industries	EV-2Wheelers/3Wheelers
7	Ajanta Manufacturing Ltd	EV -2Wheelers
8	Sehgal Elmoto Ltd	EV-2Wheelers
9	Fusion Power System	EV-Components
10	Tunwal Electronics	EV-2Wheelers/Components
11	Ather Energy	EV-2Wheelers

(This is not an exhaustive list - there may be many more players in EV market in India which are not mentioned in this list)

Several business houses and entrepreneurs are planning to start manufacturing facilities for electric vehicles and associated infrastructure and components in the country, but they are not sure of the market potential. When the government will take bold decisions to make EVs mandatory in cities in a phased manner, the industry will have the confidence to invest in production facilities. For example Tata Motors make EVs in Europe but not launched those models in India. Several international car makers presently operating in India such as Mercedes Benz, BMW, Toyota, Honda, Nissan, Ford, GM, Audi, Volkswagen, Mitsubishi etc., have EVs and they can quickly launch EVs in India provided a market is created through policy interventions.

ISGF has conducted several brain storming sessions with various stakeholders to formulate the recommendations on appropriate EV charging infrastructure and policies for India. This was submitted to MoHI in August 2015 which is under active consideration of MoHI. Standardization of charging equipment will help interoperability and facilitate faster adoption by industry and EV users.

ISGF RECOMMENDATIONS FOR PROMOTION OF EVS IN DELHI

Considering the severe situation in Delhi, it is recommended that electric vehicles may be promoted in Delhi on fast track as recommended below:

1. All public transportation buses shall be converted to Electric Buses starting with those plying on most congested routes where traffic is moving slowest resulting in most emissions and high fuel use
2. From April 2016 only electric three wheelers shall be registered in Delhi. All existing non-electric three wheelers shall be phased out by 2020
3. From 2017 only electric motor cycles, electric scooters and electric mopeds shall be sold and registered in Delhi/NCR. All existing non-electric scooters, mopeds and motor cycles shall be phased out by 2025
4. All new taxis and buses (all categories) shall be electric and existing buses and taxes shall be phased out by 2020
5. 10% of the new cars registered (4-wheelers) in Delhi shall be electric vehicles from 2016 and to be increased to 100% by 2020; and all existing non-electric vehicles to be phased out by 2025
6. Direct current fast charging (DCFC) and Level-2 charging stations may be installed in locations such as: bus stands, railway and metro stations, BRT stops, malls, IT parks, commercial centres, colleges/school campuses, hospitals, courts, petrol pumps, government buildings, parking lots, residential colonies, etc.
7. All electric vehicles (2 wheelers, 3 wheelers, cars and buses) shall have lithium ion batteries which can be charged with fast chargers (DCFCs) or Level-2 charging stations. Lead acid batteries will lead to severe environmental degradation owing to its recycling by small scale industries locally
8. Three wheelers and four wheelers may be allowed to charge only from standard EV charging units equipped with EVSEs
9. Separate electricity tariff shall be introduced for EVs. Two wheelers may be allowed to charge from ordinary plug points and no special tariffs to be introduced. For EV charging stations, time of use pricing should be introduced which could help balance the load on the electric grid and also help optimal use of the electricity distribution network. Concessional EV charging tariff at night hours could promote EV rollout as well as help improve the plant load factor of power stations
10. For next 5 years all large organizations (both public and private) should allot half of their CSR funds for creation of EV charging facilities near their facilities and strategic locations within the city
11. All fuel pumps shall be mandated to install fast charging stations (DCFCs)
12. Battery swapping model may be introduced for 3 wheelers and such charging and battery swapping stations may be setup near metro stations
13. All new commercial buildings and muti-storied residential buildings may be mandated to install EV charging units in their parking spaces
14. Concessional taxes may be offered to EVs and its parts. Several states have already offered lower registration charges and road taxes. This may be relooked and appropriate tax concessions may be offered to promote EVs on fast track

15. Other incentives such as free (or concessional) parking, reserved parking lots, free (or concessional) toll fee etc., may be considered
16. Certain exclusive localities (for example Connaught Place, Karol Bagh, Chandni Chowk, Pragati Maidan, Sports Stadiums etc.) should allow only EVs from 2017
17. Registration number of all EVs should have a clearly recognizable numbering series – for example: DL-EV-1234567. This will make recognition of EVs easier for differential treatment for several incentives
18. In other busy districts of the city a congestion fee may be levied on non-electric vehicles (could have implementation challenges) during peak hours
19. Duty free import of EVs may be allowed for a limited time (or limited numbers) for the buses, taxis and government vehicles
20. To enable different ownership and operation models and interoperability of the charging infrastructure with different EV manufacturers and electric grid infrastructure, they should be supported by open standards such as Open Charge Point Protocol (OCPP), IEC/ISO 15118 etc.
21. All cars owned (or leased) by central government, state governments and PSUs in Delhi shall be replaced with EVs in 2016

In the interim, hybrid vehicles may also be promoted as emissions from hybrid cars like Toyota Prius are 10% of that of petrol cars. With hybrids rollouts can be faster as they do not require charging stations.

CONCLUSION

EVs will be the only lasting and sustainable solution for controlling the vehicular pollution in cities. Government need to take policy level interventions to make this happen immediately. In the budget for 2016-17 funds may be allotted for the NEMMP to setup charging infrastructure in Delhi. Accelerated action on development and deployment of EVs will not only improve energy security, lower GHG emissions, and improve air-quality, but also enable new economic development opportunities and technology innovation in the transportation and electricity sectors.