Response to the queries raised during the webinar on "EV charging infrastructure and its Grid integration in Indian EV ecosystem" held on 24 June 2021

1. India's fleet is dominated by 2/3 wheelers. what are the takeaways from China and other Asian countries in that respect?

The high demand for 2W in Asian countries can be in general attributed to easy manoeuvrability in congested spaces, overcrowded public transportation, relatively shorter distances of commute etc. Over the past several years, there is a high market demand/ competition in the e-2W and e-3W segment in Asian countries, particularly in China. In regard to charging infrastructure for 2W/3W segment in Asian countries, particularly in China, low cost slow chargers are available all throughout the cities along with a vibrant market for spare batteries. Different establishments such as street-side local shops, restaurants etc. provide charging facilities.

More detailed information on charging infrastructure in China will be provided in Report 2 *"International Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* of this study which will be made public soon.

2. What is the cost of a typical charging infrastructure for 100 bus, across countries?

A typical 50 kW DC charger costs around INR 10-15 lakh (11000-16000 €) and costs for a charger of around (120-150) kW is in the range of INR 18-20 lakh (20,000-22,500 €). For 100 buses multiple such chargers would be needed. In addition to EVSE capital cost, there would be costs of new electricity connection and adequate infrastructure (cabling, safety and protection), civil works, and charging management software as well as labour costs. Grid upgradation (separate transformer for HT/LT connection) is likely required in a charging station/hub for e-buses, therefore, cost for grid upgradation also needs to be taken into account, unless the grid upgradation cost is borne by other stakeholders (DISCOM/subsidy etc.). Deepening on the regulations and market rules/business model in place, cost of charging infrastructure to cater a given number of buses will vary from one location to another. Land availability, land procurement model (own land, on lease etc.) for charging infrastructure will significantly impact the cost/business model of charging hub for e-buses.

3. For private charging, what is the share of 1 phase vs. 3 phase?

Most of the private home chargers are single phase chargers. Although 3 phase chargers can be installed to cater charging needs of 4 wheelers at 11 kW (or higher) level, the residential establishment should have a 3-phase supply and the desired sanctioned load. For other private applications, such as commercial captive charging of 4 W fleet, predominantly three phase supply would cater to the DC or AC chargers in a given charging station/hub.

4. Sir role of DISCOMs also need to be explained ?

DISCOMs/ DNOs (Distribution network operators) are one of the key stakeholders in EV charging infrastructure. They play an active role for smooth integration of EV charging load into the system. The

[1] The report (s) are planned to be made public over next few months. The final title of the report may change at the time of release.

necessary planning regarding grid infrastructure development required to cater to increased EV load needs to be adequately carried out by the DISCOM. Further, the DISCOMs would also need to design an adequate charging management system to enable smart charging. Another key role would be to identify ways to efficiently implement renewable energy based charging. More details on role of DISCOMS in EV charging infrastructure integration including technical analysis of grid integration of EVs is provided in Report 3 *"Indian Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* and Report 4 *"Gap Analysis and Way Forward for Seamless adoption of EV Charging Infrastructure in Indian EV Ecosystem*[1] *"*

5. What are suggestion for India, where GOI is pushing for Shared Mobility?

Shared Mobility is considered as one of the key cornerstones for sustainable mobility. The different opportunities for shared mobility include, low per capita vehicle ownership leading to better economics, lower energy/fuel consumption etc. Shared mobility has already gained a reasonable popularity in India. The young population in India is more likely to adopt new innovations, and the following suggestions can help shared mobility to succeed,

- Promotion of high occupancy vehicles[2]
- Growing smartphone and internet connectivity is a key enabler for shared mobility
- Promotion of mass/public transit
- Enhancing the availability of data
- Development of infrastructure needed to support shared mobility
- Build services to cater to a wider geographic coverage.

6. Indian EV market somehow favours slow charging instead of fast charging despite empirical study showing better infra utilisation with fast charging setup! Could it be financing or some other factors impacting this decision?

Globally, fast (7kW – 50 kW), rapid (50-99 kW) and ultra-rapid (above 100 kW) charging solutions, particularly in public charging infrastructure is being rapidly adopted over the past several years. The share of fast charging in some of the countries (such as Germany and UK) is as high as 80%, with rapid and ultra-rapid charging solutions getting more popularity in recent years. In India, there is relatively more focus on 2/3 W segment compared to 4 W and Heavy-duty EVs primarily due to policy interventions. Therefore, one of the key factors to our opinion, that is driving the growth on slow chargers in India in public charging space is Indian EV policies and other state driven market enablers. Currently, developing a fast charging station in India would warrant grid infrastructure upgradation which is to be borne by the charging station developer, which is one of the discouraging factors for fast charging. On the other hand, slow chargers can generally be accommodated on LT side without the need of extra investment on the grid. Lower share of EV models currently available in the Indian market that can utilize fast charging is another limiting factor. Another argument is the higher share of 2W and 3W in the Indian market compared to 4W. Moreover, 2W and 3W EV models are not compatible with fast chargers for which slow chargers has been widely favoured in India so far. However, with the increase in share of 4W EVs in India and the rapid technology development in EV ecosystem, share of fast chargers is going to increase significantly which to our opinion will be primarily market driven irrespective of policy interventions. Slow chargers, on the other hand are likely to find it difficult to sustain in the public charging sector without any policy driven subsidy/incentive based enablers. Further, in 2W/3W EV segment, due to rapid battery technology development, it is expected that 2 W/3

[2] Under normal times where social distancing would not be required

W EVs (particularly 3W) will adopt high energy/power battery, which in turn will need fast charging. Therefore, it is expected that significant proportion of 2 W/3W segment will also switch to fast charging, thereby, boosting further the fast charging adoption.

A detailed statistics globally along with a critical analysis of EV charging infrastructure in Indian EV ecosystem is provided in Report 3 *"Indian Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* and Report 4 *"Gap Analysis and Way Forward for Seamless adoption of EV Charging Infrastructure in Indian EV Ecosystem*[1] *"*

7. Interesting contradiction of the low of no of charger infra in Norway per EVs as against very high level of adoption in the country. Does this mean that requirement of high quantum of chargers infra to promote EV adoption is over-rated? Also what is the typical levels of utilisation is being seen in slow/rapid/fast/ultra-fast infrastructure?

No. In Norway the growth of EVs has been faster than the growth of the charging infrastructure. So the number of public chargers per EV is much behind than the European Union target of 10 EVs per charger. However, it will not be right to conclude that EV demand can be increased without adequate charging infrastructure, which is one of the key enablers for faster adoption of EVs in any country. It has been demonstrated in most of the EV rich countries, particularly in China, developing an adequate charging infrastructure is a key intervention for seamless adoption of EVs.

In Europe and USA, the typical levels of utilization of public chargers is around 5-10%. However, in China, the utilization of its public chargers is much higher at around 15%. The utilisation factor of EV chargers is going to increase further as the EV penetration grows.

8. What are the standard chargers available in India?

In India the charger types recommended by the Ministry of Power are Bharat AC001, Bharat DC001, Type 2 AC, CCS2, CHAdeMO.

9. What is the expected main charging infrastructure for two wheelers? Predominant vehicles e.g. in countries like Vietnam

2W EVs are generally charged using proprietary connectors as generally there is no widely accepted/adopted standardized charging connector. So, the main charging infrastructure for 2W is a standard AC outlet with added metering and smart functionality such as remote start/stop of charging, and communication of energy consumption. A new low cost AC charging standard is also currently in development by BIS specifically for Indian needs.

More details on this topic including the gap analysis are provided in in Report 3 *"Indian Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* and Report 4 *"Gap Analysis and Way Forward for Seamless adoption of EV Charging Infrastructure in Indian EV Ecosystem*[1] *"*

10. What is the charging time with different capacity of chargers?

The time required for charging is dependent on the battery capacity of the vehicle, and the capacity and technology (AC/DC) of charger. The details of charging time for a few of the vehicles are given below,

Table: Charging time for different charger ratings

Vehicle details		**Charger rating**			
Model	Battery Capacity	3.7 kW (AC)	7 kW (AC)	22 kW (AC)	50 kW (DC)
Tesla Model S	75 kWh	21 hrs	11 hrs	5 hrs	2 hrs
BMW i3	33 kWh	11 hrs	4.5 hrs	3 hrs	35 mins
Nissan LEAF	40 kWh	11 hrs	6 hrs	6 hrs	1 hr

11. How DISCOMs will be benefited from all the policy please explain?

DISCOMS can benefit in various ways from the EVs and associated policies and regulations. For details, please refer to Report 3 *"Indian Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* and Report 4 *"Gap Analysis and Way Forward for Seamless adoption of EV Charging Infrastructure in Indian EV Ecosystem*[1] *"*

12. Any implementation experience / learnings on how the state EV policies are progressing? What's the industry feedback?

The experience of state EV policy implementations vary from state to state, with some states actively implementing the EV policy. Some of the related aspects are discussed in Report 3 *"Indian Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* and Report 4 *"Gap Analysis and Way Forward for Seamless adoption of EV Charging Infrastructure in Indian EV Ecosystem*[1] *"*

13. Are there any policies for battery disposal in the countries wherever EV policies has been adopted and the EV mobility is happening?

EV rich countries, such as China, Germany (EU as a whole), USA, Norway and Japan have battery waste management/recycling policies (final/draft/guidelines) in place which. The economics of battery recycling is largely dependent on the stringent implementation of the policy, collection efficiency of batteries as well as consumer dynamics. Some of the country examples are mentioned below.

- Germany promotes voluntary submission of batteries by the consumers, in lieu of battery replacement guarantee schemes/ payback schemes, which are then recycled through registered recyclers.
- In China, a complete circular economy has been implemented as per policy to enable reuse and recycle of EV batteries and enable flow of raw material for batteries in the value chain.
- In Japan, automotive manufacturers are required to collect batteries and develop their own battery recycling value chain.

14. Can we have some success story available in India about the e-mobility. What is felt is that either the e-vehicles are not too much or the EV Chargers are also not too much. Space in cities is a constraint. Then comes loading on Power Network- tariff issues and charges from

the EV owners by the EV Charger owner. Safety issues - how these are being addressed. Are the charging guns standards. Information about the time taken in Charging of the E-vehicle. Of course range of vehicle is still a question because everybody may not afford the high end version of the e-vehicles. Two wheelers and e-rickshaw charging on single phase causes unbalance problem. Is there emergence of Battery swapping station and whether these are permitted under the existing Regulations.

In Nagpur, Ola launched a project of electrification of a share of its fleet. Under the project, battery charging and battery swapping infrastructure was developed to cater to its electric 4W and 3W fleet. From 2017 to 2019, the electric fleet of Ola in Nagpur served successfully to over 3,50,000 customers and travelled a cumulative distance of around 7.5 million km. Details of the study can be found from this here.

Yes, space/land availability in cities is a critical constraint for installation of EV chargers. To address this, appropriate agreements may be made for installation of chargers in municipality parking areas, malls, markets etc. There are also some innovative charging solutions, such as retrofitting of existing streetlights to act as EV chargers, kerb side chargers etc. that can also be used to address the issue.

For load management, time based EV tariffs is a passive mechanism of shifting of charging loads. Control signal based smart charging is an active charging management where the charging power can be controlled based on the status of the distribution grid. Different demonstration, pilot, and commercial projects have been implemented across the countries in this direction, and many of such case studies have been reported in our Report 2 *"International Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"*, in Report 3 *"Indian Review of Integration of Electric Vehicles charging infrastructure with distribution grid*[1]*"* and Report 4 *"Gap Analysis and Way Forward for Seamless adoption of EV Charging Infrastructure in Indian EV Ecosystem*[1] *"*

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Several companies/startups are working on providing battery swapping facilities in India, such as, Sun Mobility, Lithion Power, VoltUp etc. Battery swapping stations have been deployed by such companies to primarily cater to the 2W and 3W EV market. The Ministry of Power has allowed the operation of battery swapping stations in India. Government of India has recently allowed sale of EVs without battery.

15. **Question - 1. What is more important for EV adoption in India - Battery Swapping or Public Charging Stations? And Why? 2- Which segment of vehicle - 2W, 3W or 4W - are important for EV uptake? 3 - How can we change the mindset of normal vehicle owner with regard to Switching cost to EV and status quo of easiness of owning an ICE vehicle?**

In India both public charging stations and battery swapping stations are expected to cater the EV charging needs. For 2W/3W fleets, and ride-hailing companies for whom the reduction of charging time is of more importance, battery swapping might be favourable, however that may not be the case for private users due to ownership issues. Swapping of batteries of 4W EVs is logistically challenging currently. Further, the OEMs may be unwilling to relinquish control over the batteries, so 4W segment would be probably use charging stations as the main charging source.

Some of the current issues with battery swapping in India include

1. The FAME II subsidies are based on battery size, so claiming subsidies for EVs without batteries would warrant clarification.

2. In order to increase compatibility, the batteries would be needed to be standardized which would slow down innovation.
3. Ownership issues would also need to be regulated, who owns the EV battery after being swapped at a swapping station.
4. Warranty claims would be difficult.

Although transition of all the vehicle segments to EVs is important, 4W EV segment growth will have more influence on public charging business due to the higher energy batteries and higher economy involved in 4W segment.

In addition to technology and other challenges, social acceptability and public awareness are among the key factors for faster and seamless adoption of EVs. Visibility of chargers would also play an important role in providing the confidence in consumer to get their vehicle charged whenever they need. Therefore, besides various other factors there is a need for mass awareness focusing on the overall benefits of EVs over ICE vehicles. With the advancement of EV technology and falling prices, due to cost competitiveness of EVs compared to ICE vehicles down the line, the transportation sector is expected to experience rapid electrification. For cost comparison of ownership of EVs over ICE vehicles, Bureau of Energy Efficiency India has provided tool which can be accessed **here**[3].

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[3] Accessed on 01 July 2021