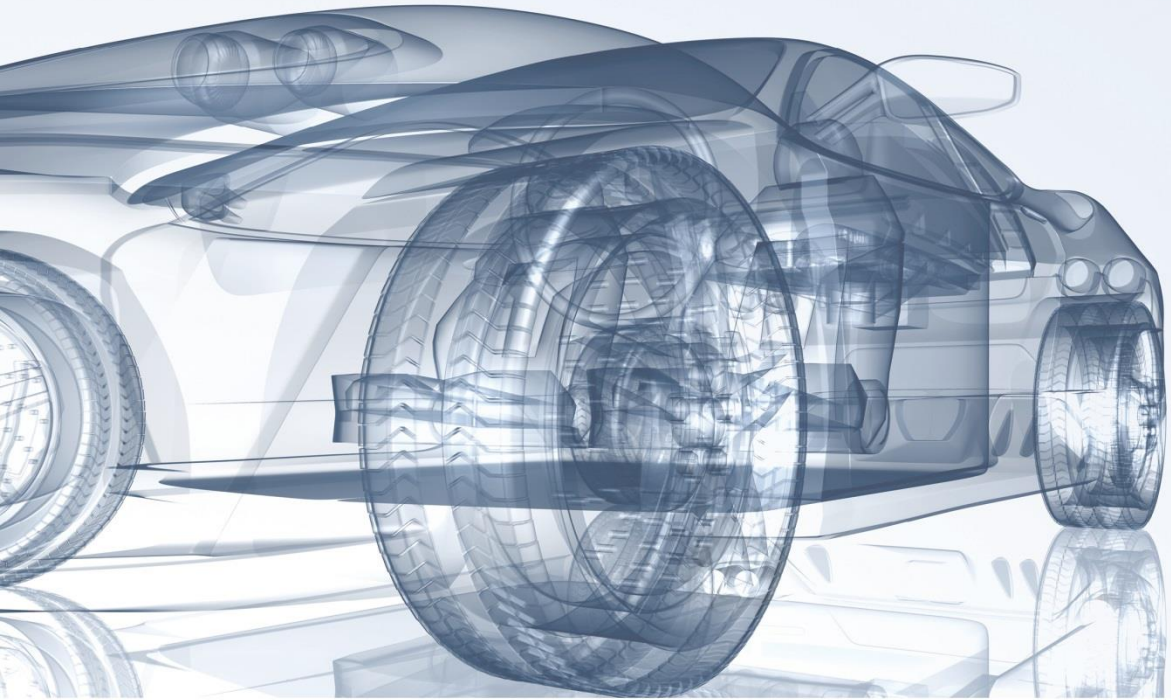
evs 30



The 30th International
Electric Vehicle
Symposium & Exhibition

October 9–11, 2017

Messe Stuttgart, Germany

www.evs30.org

Sponsored by

DAIMLER BOSCH Invented for life GROUPE RENAULT MAHLE EnBW PORSCHE swarco

Impact of charging infrastructure growth on EV market in India

Sreejakumar Nair, Narendar Rao
Charging Solutions Group , Mahindra Electric Mobility Limited , India

Agenda

Automobile market in India

Factors affecting the EV growth in India

Existing charging infrastructure scenario

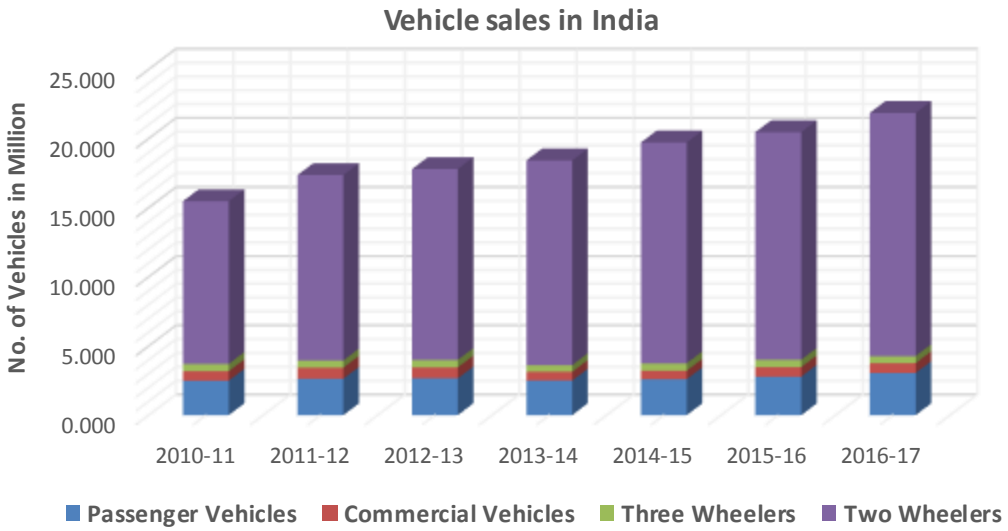
Challenges in charging infrastructure growth

Overview of charging standards & regulations

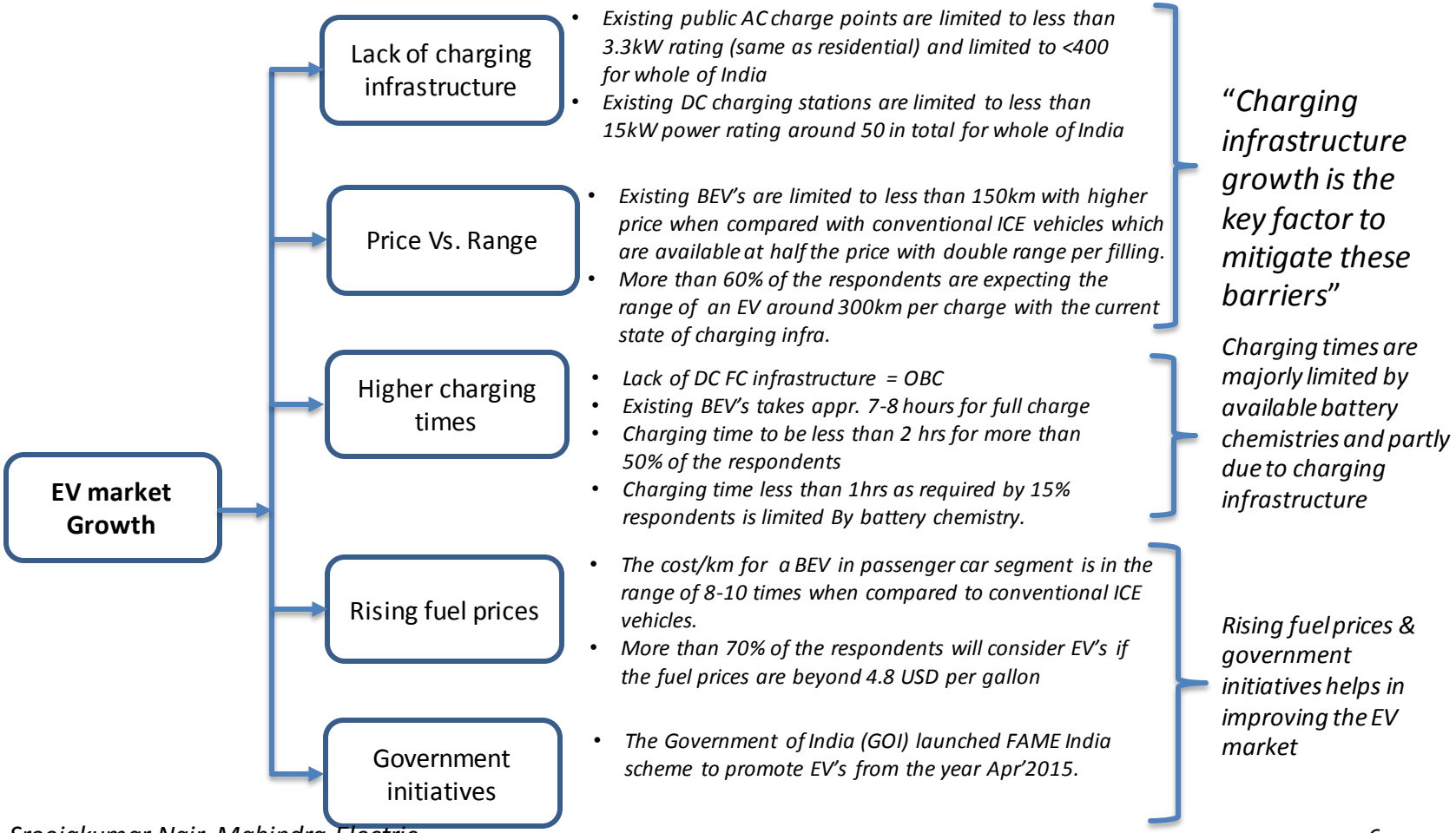
India's Mission plan

Conclusion

Automobile market in India



Factors affecting the EV growth in India

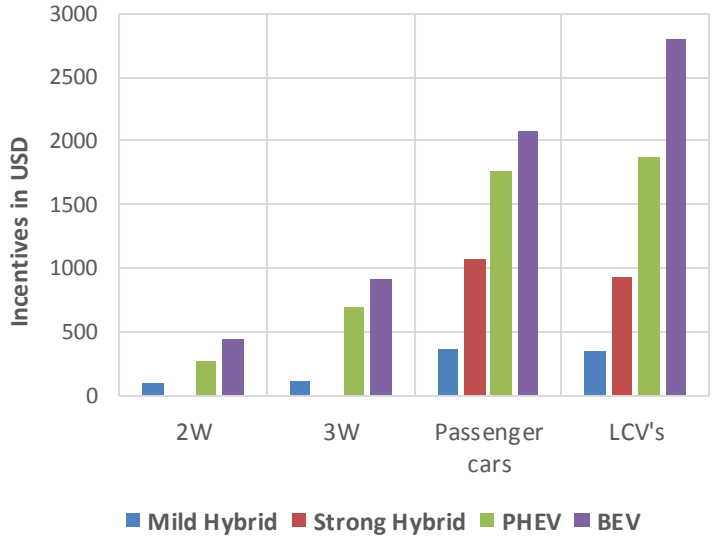

EV market Growth
Lack of charging infrastructure
Existing public AC charge points are limited to less than 3.3kW rating (same as residential) and limited to <400 for whole of India
Existing DC charging stations are limited to less than 15kW power rating around 50 in total for whole of India
Price Vs. Range
Existing BEV's are limited to less than 150km with higher price when compared with conventional ICE vehicles which are available at half the price with double range per filling.
More than 60% of the respondents are expecting the range of an EV around 300km per charge with the current state of charging infra.
Higher charging times
Lack of DC FC infrastructure = OBC
Existing BEV's takes appr. 7-8 hours for full charge
Charging time to be less than 2 hrs for more than 50% of the respondents
Charging time less than 1hrs as required by 15% respondents is limited By battery chemistry.
Rising fuel prices
The cost/km for a BEV in passenger car segment is in the range of 8-10 times when compared to conventional ICE vehicles.
More than 70% of the respondents will consider EV's if the fuel prices are beyond 4.8 USD per gallon
Government initiatives
The Government of India (GOI) launched FAME India scheme to promote EV's from the year Apr'2015.
"Charging infrastructure growth is the key factor to mitigate these barriers"
Charging times are majorly limited by available battery chemistries and partly due to charging infrastructure
Rising fuel prices & government initiatives helps in improving the EV market

Government Initiatives:

a) FAME India Scheme:

- The government of India (DHI - Department of Heavy Industry) has formulated a scheme FAME-India (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India) in 2015
- The Phase-1 of the scheme has been implemented over a 2 year period i.e. FY 2015-16 and FY 2016-17 commencing from 1st April 2015
- The Phase-1 of the FAME scheme is extended further up to six months i.e. 30th September 2017 or till the approval of Phase-2

Component of the scheme	2015-16 (In million USD)	2016-17 (In million USD)
Technology platform (Including testing infrastructure)	10.5	18
Demand Incentives	23	50.7
Charging Infrastructure	1.5	3
Pilot projects	3	7.4
IEC/Operations	0.8	0.8
Total	**38.8**	**79.9**
Grand Total	**118.8**	



Existing charging infrastructure scenario

- RED stations are AC charging points set up provided by Mahindra Electric with less than 3.3kW rating compatible to it's electric vehicles
- GREEN stations are AC charging points which have been set-up with the help of the EV community with less than 3.3kW rating compatible for multiple EV's
- Currently the number of AC charging points in India are close to 400 with less than 3.3kW rating
- Apart from this, around 50 DC quick charging stations are existing in India installed by Mahindra Electric with 15kW rating which are compatible to it's own electric vehicles

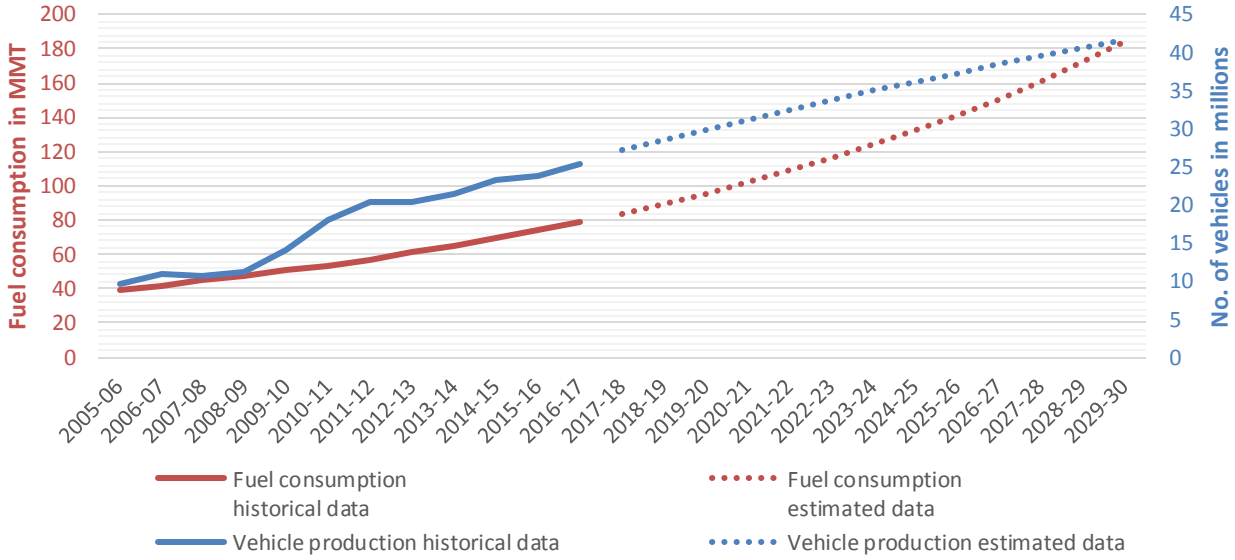
http://rechargeindia.me/

Challenges in charging infrastructure growth

1) Increase in Electricity Demand

- As the charging infrastructure is installed on a large scale, the energy required from the utility grid increases.
- The demand in electrical energy from the utility grid is projected up to 2030 if all the conventional vehicles were converted to BEV's based on the available data of fuel consumption in transportation sector in India.

a) Fuel consumption & vehicle production in India:

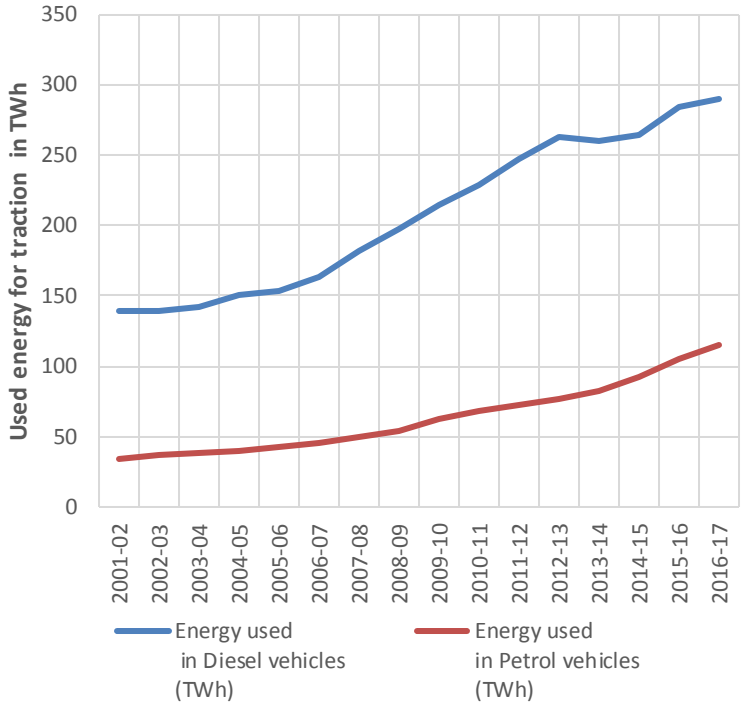


1) Increase in Electricity Demand

b) Traction energy calculation in conventional (Petrol & Diesel) vehicles:

Sl.No.	Parameter	Petrol	Diesel
1	Energy density in MJ/kg (ρ)	44 MJ/kg	49MJ/kg
2	Fuel consumptions during the year 2016-17 in MMT (w)	23.5 MMT	53.2 MMT
3	Equivalent energy in TWh , $E_{equ} = \frac{\rho * w}{3.6}$	287.2 TWh	724.1 TWh
4	Efficiency of conventional vehicle (η_{ICE})	40%	40%
5	Used energy for traction in TWh, $E_{used} = (\eta_{ICE} * E_{equ})/100$	115 TWh	289.6 TWh

MMT – Million Metric Tonnes
TWh – Tera Watthour



Total energy used by conventional vehicles for traction is sum of both petrol & diesel vehicles

1) Increase in Electricity Demand

c) Conversion of existing (Petrol & Diesel) vehicles to BEV's:

The following table shows the calculation for required electricity generation in TWh for 100% BEV's during the year 2016-17

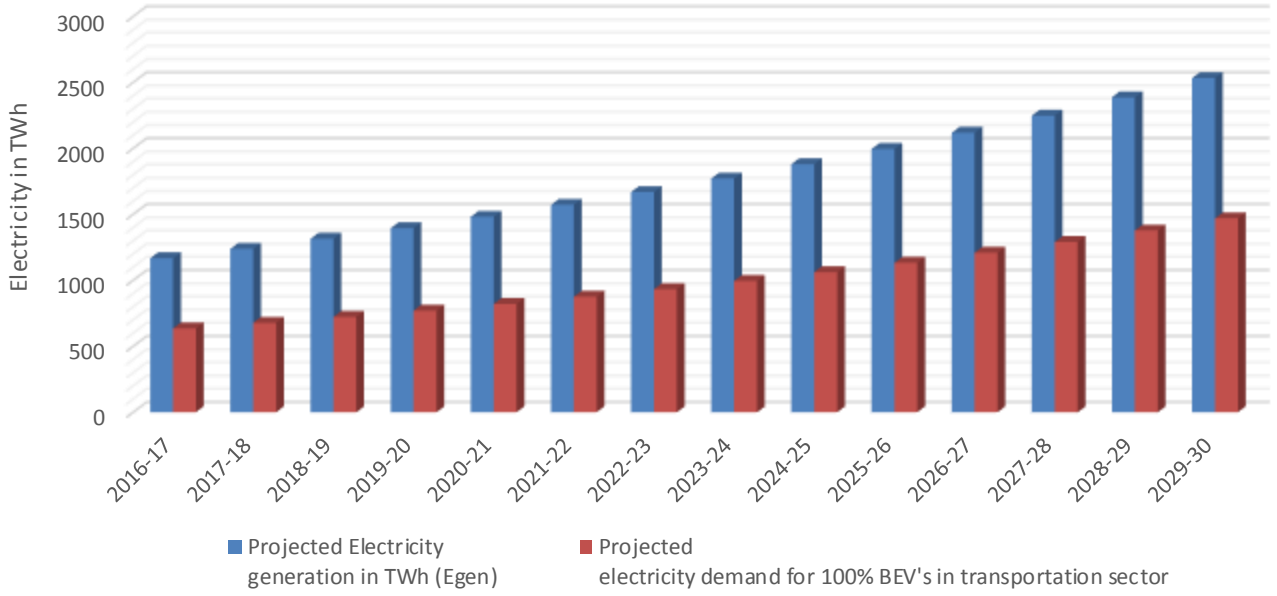
Sl.No	Parameter	Value
1	Total energy required for traction in TWh $E_{traction} = E_{used\_diesel} + E_{used\_petrol}$	404.6 TWh (115 TWh for petrol & 289.6 TWh for diesel)
2	Typical Efficiency of a BEV (η_{BEV})	85%
3	Total Energy required at the BEV charging inlets in TWh $E_{inlet} = (E_{traction} * 100)/ \eta_{BEV}$	476 TWh
4	Avg. Transmission & Distribution losses in India (T&D loss)	23%
5	Required electricity generation in TWh for 100% BEV's $E_{gen\_tr} = (E_{inlet} * 100)/$ T&D loss %	618 TWh
6	Total electricity generated in TWh during the year 2016-17 (E_{gen_total})	1160 TWh
7	Additional demand (%) required in transportation sector for 100% BEV's during the year 2016-17 ($E_{gen\_tr} / E_{gen\_total}$)* 100	53.27%

1) Increase in Electricity Demand

c) Conversion of existing (Petrol & Diesel) vehicles to BEV's:

By 2030, the electricity generation (E_{gen}) in India will grow along with the demand in the domestic, commercial, industrial & agriculture sectors which is shown in figure (Blue).

Similarly, the projected electricity demand for 100% BEV's by 2030 is projected in the below figure (red).

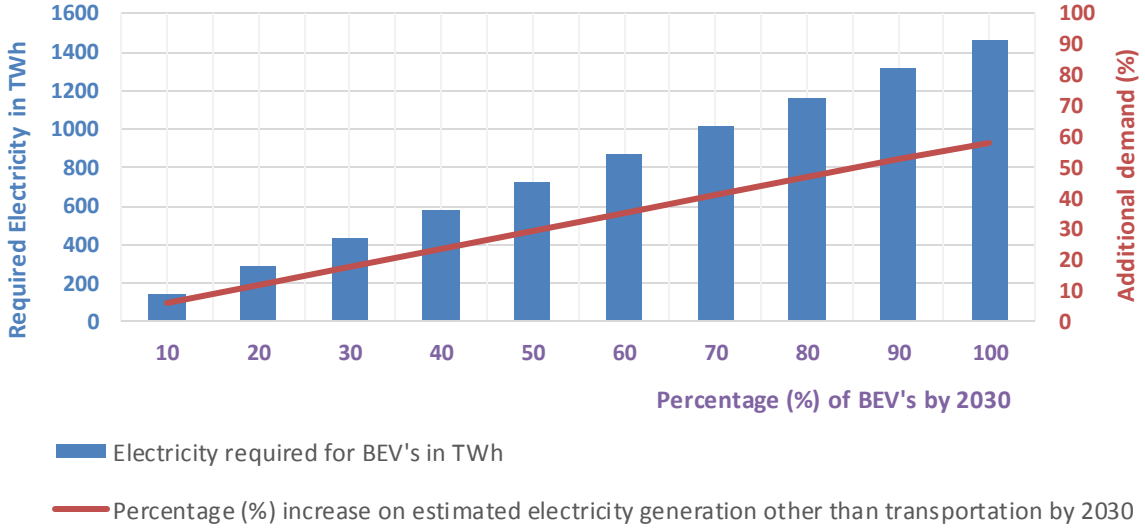


1) Increase in Electricity Demand

d) Charging Infrastructure energy demand by 2030:

The estimated electricity generation in 2030 by considering the growth rate in domestic, commercial, industrial and agriculture sectors is around 2500TWh

By 2030, the cumulative vehicle sales are estimated as 0.5 billion and the following figure shows the percentage of BEV's w.r.t percentage of electricity demand in 2030.



By 2030, 20% of BEV's would require an energy of 291 TWh. If all the required energy is produced by clean energy sources, which helps to meet the minimum criteria mentioned as per ***Paris declaration***

2) Non-availability of Indian Charging standards:

- The government of India is planning to release the charging standards for all types of EV's (2W, 3W & 4W Passenger & Commercial etc.)
- BEVC-AC001 for AC charging with less than 3.3kW power rating & BEVC-DC001 with less than 15kW power rating are going to be notified for both 48V & 72V systems
- Automotive Research Authority of India (ARAI) also published AIS 138 Part 1 (Electric Vehicle conductive charging system) AC charging standard in May 2017 and the AIS 138 Part2 DC charging standard is still in a draft stage which are derived from IEC 61851.
- The Bureau of Indian Standards formed three sub-committee's for publishing the charging standards in three categories namely LEV (less than 120V), MEV (between 200V to 500V) & HEV (above 500V)

3) Lack of incentives for charging infrastructure:

- The government of India is providing incentives for purchasing the electric vehicles and it is expected to provide incentives for installing the public charging infrastructure also.
- As per the FAME scheme, the government allocated 300 million INR (5 million USD) for the charging infrastructure during the year 2015-17 but the major contribution of this budget is allocated for the standardization and for running few pilot projects regarding the charging infrastructure.

4) Non-adaptability of global DC charging infrastructure :

- All the existing EV's in India are operating with 48V & 72V (nominal) battery systems whereas globally most of the EV's are operating with 400V battery systems.
- Globally there are multiple charging connectors and protocols are defined for 400V systems like Type 1 CCS, Type 2 CCS, Chademo, GB/T , Tesla supercharger etc.
- The Type 2 CCS & Type 1 CCS fast chargers mostly operating from 200V to 600V or 1000V which are not suitable for charging low voltage vehicles (< 100V).
- The Chademo & GB/T DC connectors are operating from lower voltages and can be adapted easily to charge the low voltage vehicles but because of the maximum current limits of these connectors, the output power is limited.

S.No.	DC Charging connector	Voltage range	Current	Power	Communication protocol
1	Chademo	50V-500V	Up to 125A	50kW	CAN
2	GB/T	Up to 750V	Up to 250A	50kW	CAN
3	Type 2 CCS	Up to 1000V	Up to 200A	150kW	PLC
4	Type 1 CCS	Up to 600V	Up to 200A	100kW	PLC
5	Tesla supercharger	Up to 500V*	Up to 300A*	120kW	-

** estimated*

Overview of charging standards & regulations

- The BEVC-AC001 & AIS 138 part1 standards describes EV conductive AC charging which are derived from the IEC 61851 sub-parts.
- The BEVC-DC001 describes the EV conductive DC charging for 48V & 72V systems which is derived from GB/T 20234 standard whereas AIS 138 part2 standard describes the EV conductive DC charging which is also derived from IEC 61851

Similarities between BEVC, AIS & Global charging standards:

a) AC Slow Charging mode:

Connection of EV to the single phase EVSE with < 15A current rating including basic RCD protections

Recommended Interface: CEE 16 (IEC 60309)

Types of connection between EV & EVSE:

•*AC Slow Cable A:* EVSE to Power Converter and Power Converter to EV
•*AC Slow Cable B:* EVSE to EV
•AC Slow Cable C: Attached to EVSE

This mode is described in both BEVC-AC001 & AIS Part1 standards. This mode of charging is prohibited in many countries because it doesn't have any communication between EV and EVSE which is similar to Mode1 of IEC 61851-1.

b) AC fast Charging mode:

Connection of EV to the EVSE with <63A, 415V three phase including control pilot communication & RCD protections
Recommended Interface: TYPE 2

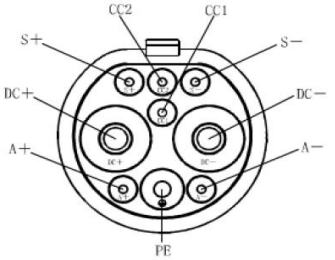
Types of connection between EV & EVSE:
- *AC Fast Cable D*: EVSE to EV
- *AC Fast Cable E*: Attached to EVSE
- *AC Fast Cable F*: Extension Cable for D to connect to EV

This mode is described only in AIS Part1 standard and it is similar to Mode2 & Mode3 of IEC 61851-1

c) DC Charging for low voltage vehicles (48V or 72V):

- **Type 1**: Single vehicle charging at 48V or 72V with a maximum of 10kW power, or a 2W vehicle charging at 48V with maximum power of 3.3 kW.
- **Type 2**: Single vehicle charging at 48V with a maximum of 10kW power or 72V with a maximum of 15 kW power or a 2W vehicle charging at 48V with maximum power of 3.3 kW.

Recommended Connector used for 10kW or 15kW:



This DC charging mode is described only in BEVC-DC001 standard for low voltage vehicles. The connector for 3.3kW DC charging for 2W vehicles is not yet finalized. The communication between DC charging station & EV is as per IEC 61851-24 and the connector is as per GB/T 20234.3 standard.

India’s Mission plan

- To achieve India's mission plan on deployment of 6 to 7 million electric vehicles by 2020 and to ban petrol and diesel vehicle sales from 2030, the charging infrastructure should be improved at faster rate.

- The large scale charging infrastructure requires a sufficient energy from the utility grid and generating this using renewable energy sources will help to achieve the mission.

- As a part of national solar mission, the Government of India is targeting to install the renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power.

Parameter	Existing (As on Apr'2017)	Future FY 2022-23
Installed capacity of solar (P_{inst_solar})	12.5GW	100GW (Target)
Average annual DNI (Direct Normal Irradiance) in India	5.0-5.5 kWh/m^2/day	
The peak power of typical solar panel per sq. meter (J_p)	150-200 W/m^2	
Area required for installed capacity in m^2, $A = \frac{P_{inst\_solar}}{J_{p\_min}}$	0.083 x 10^9 m^2	0.667 x 10^9 m^2
Solar energy generated in a year in TWh $E_{gen\_solar} = \frac{DNI_{min} * A * 365}{10^{12}}$	151.4 TWh	1217 TWh
Typical efficiency of solar cell to convert radiation into DC current (η_{pv})	20%	
DC output of installed solar capacity (E_{dc}) = $E_{gen\_solar} * \eta_{pv}$ (15% is considered for calculations)	30.28 TWh	243.4 TWh
Conversion losses from DC to AC ($\eta_{conv\ loss}$)	20%	
AC output of installed solar capacity (E_{ac}) = [E_{dc} * (100- η_{conv_loss})]/100 (25% losses are considered for calculations)	24.22 TWh	194.7 TWh
Required electricity generation in TWh for 100% BEV's in transportation sector (E_{gen_tr})	618 TWh (Up to Apr'2017)	934 TWh (Estimated during 2022-23)
% of electricity generated from solar systems w.r.t required electricity in transportation = (E_{ac} / E_{gen_tr})*100	3.9%	20.8%

The electricity generation calculations from the installed solar system capacities (existing & future) is given in the below table and also it shows the energy requirement for 100% BEV's (assuming all the solar energy is used for BEV's)

- As on Apr'2017, if India was having 100% BEV's in transportation sector, only 3.9% of energy would have been accommodated from existing solar plants and remaining energy would have been accommodated from other sources

- If India achieves national solar mission by 2022, 20.8% of the required energy (934 TWh*) for the existence of 100% BEV's during the year 2022-23 can be accommodated from solar power plants.

- The achievement of national solar mission (100GW solar power) in 2022 will help in reducing the emissions and thereby it helps in achieving the NDC (Nationally Determined Contribution) targets given in Paris Climate Agreement.

- The government of India has also announced the taxes on conventional & electric vehicle sales as per the new GST rules which is applicable from July 2017. The taxes on conventional passenger cars is 12.5% and for electric vehicles it is 6% which helps in encouraging the growth of EV market.

** estimated*

Conclusion

- The government of India is planning to notify the charging standards for the large scale charging infrastructure growth. The government of India has also announced lesser taxes on electric vehicles compared to a conventional ICE vehicles and planning to release the Phase-2 of FAME-India scheme by 31-st March 2018.

- The Ministry of New and Renewable Energy sources (MNRE) has planned to work on a National Solar Mission to install 100GW of solar power by 2022 and the achievement of solar mission would generate 137TWh of electricity which covers the 20.8% of electricity required for 100% BEV's for transportation during the year 2022-23.

- With the charging infrastructure growth, the government of India can achieve the deployment of 6 to 7 million hybrid & electric vehicles by 2020 as per National Electric Mobility Mission Plan and also government can easily achieve the ban of petrol and diesel vehicle sales by 2030.

- With this, and adequate charging stations, India will easily achieve the NDC targets (Nationally Determined Contributions) for Paris Climate Agreement