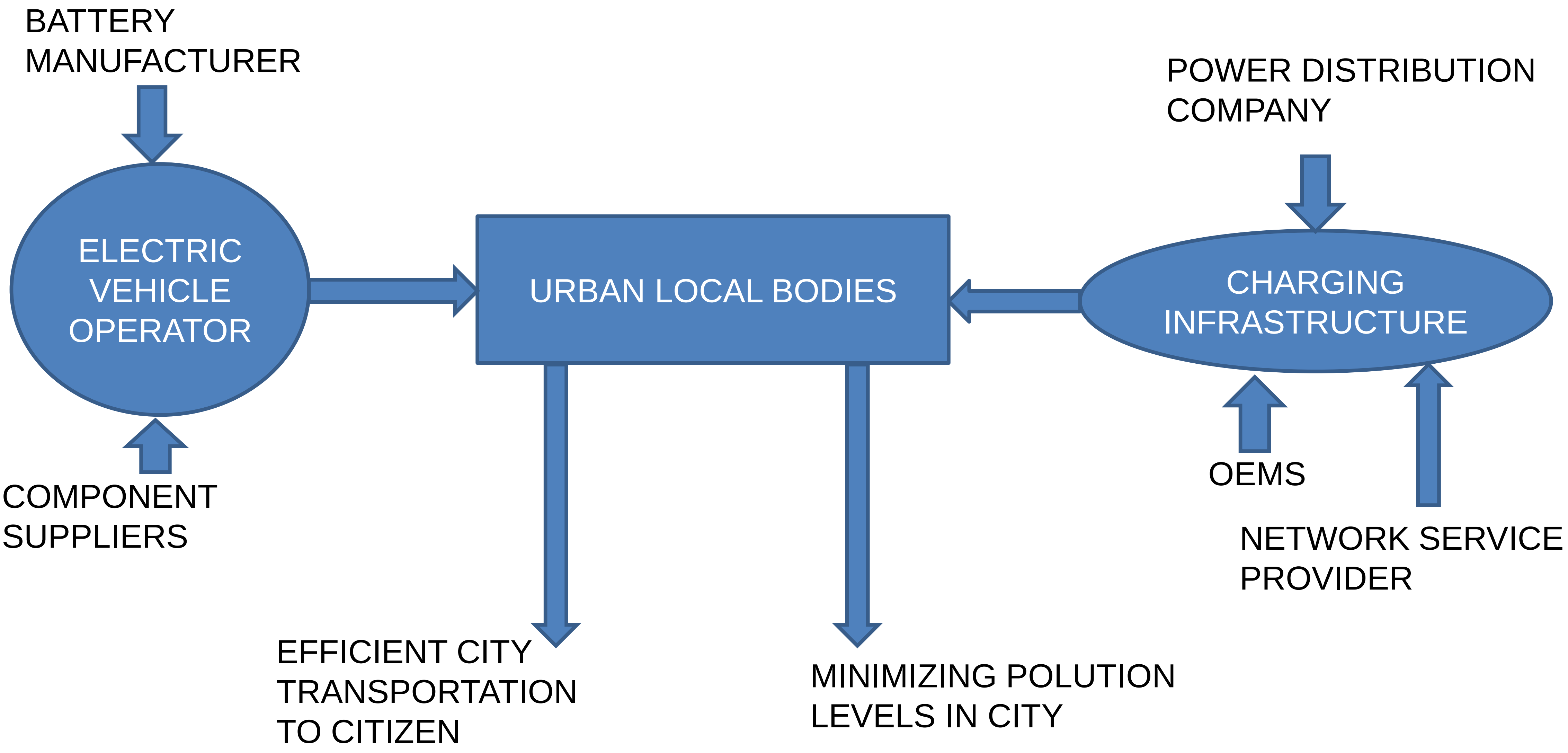
E-bus Technology & charging infrastructure

ELECTRIC MOBILITY – STAKE HOLDERS



STAGES OF ELECTRIC MOBILITY PLANNING

Traffic Analysis and Estimating the present and future requirement

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Finalization of Route plan

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Planning City wide Charging points, Evaluating Bus Technology, Retrofitting Existing Depots to accommodate Charging station, planning reliable power source

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Tendering Strategy

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WET LEASE | DRY LEASE | EPC + O & M

E – BUS TECHNOLOGY

Classification of Electric Vehicles		
Battery Operated Electric Vehicles (BEV)	Plug in Hybrid Electric Vehicles (PHEV)	Hybrid Electric Vehicles (HEV)

Focus of this presentation is on Battery Operated Electric Buses

- Buses with On board Charger- A.C Charging
- Buses with Off board Charger- D.C Charging
- Buses with Battery Swapping

BATTERY DESIGN PARMETERS

Battery Technology - Lithium Ion batteries

Battery range - Distance Covered per Charge

- More distance per charge would require more battery size than lower distance per charge.

Vehicle Mode – Two-Three – Four Wheeler

- Depending upon the type of vehicle the battery size can be decided
- Two/ Three Wheeler – 1-10kWh; Light Vehicles – 60-100 kWh; Heavy Vehicles – 90-150 kWh.

Charging Frequency –

- With less frequent charging (say once a day) the energy storage required is more and hence the size would be more and vice versa.
- However, higher Charging power will be required for short charging facilities. High charging power significantly reduce the life of the batteries.

Battery Life

- Depends upon the cycle between charging and discharging
- Frequent charging might reduce the size, however, higher Charging power will be required for short charging facilities. High charging power significantly reduce the life of the batteries.

E V BUS CHARGERS – Based on Charging Method

AC Chargers –

- Takes AC power input, the in-vehicle inverter converts AC to DC which then charges the Battery.
- Has limitation of charging rate @ 4-5 hrs per charge

DC Chargers –

- DC supply is used for charging and AC to DC conversion is done external to the vehicle.
- Have much lower charging rates @ 1-2 hrs per charge

Battery Swapping –

- The Charging stations will have facility to charge and Store Batteries.
- The Discharged Batteries inside the Vehicle will be replaced by Charged Batteries

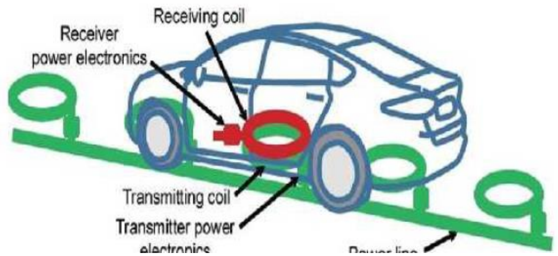
E V BUS CHARGERS – Type of Mounting

Ground Mounted Chargers –

- This system is a conventional charging system with charger mounted on ground and connected to the EV by cable for charging.

Wireless Chargers –

- This system uses electromagnetic Induction to charge batteries. There will be a Induction at Charging station and second Coil will be located in EV and through induced Electromagnetic Field charge the battery.
- Currently used for smaller capacity vehicles.



Pantograph Charger –

- These are Ultra fast charging or Flash charging solutions for E-buses where in the buses can be charged on the go at every or selective stops within the schedule stop period

E V BUS CHARGERS - Standards

CHAdeMO –

- Oldest standard co-developed by Tokyo Power Electric Company (TEPCO) and the Japanese automakers
- Charging up to 1000 V DC, 400kW and 400 A with liquid cooled cables

Combined Charging System (CCS) Combo -

- CCS was founded by an association of German Car Manufacturers
- CCS connectors are applicable for both AC as well as DC charging.
- AC charging - the maximum power output that can be derived from the Combo Connectors is 43kW with three phase connections
- DC charging - a maximum power of 400 kW can be derived at 1000 V and 400 A for fast charging of EVs.

GB/T –

- GB stands for GuoBiao is an independent standard developed by China in collaboration with its Car manufacturers.
- The DC charger can deliver a maximum output of 237.5 kW, 900 V DC.

KEY REQUIREMENTS FOR CHARGING INFRASTRUCTURE

- **Land -** Adequate space is required for Parking, Charging, Maintenance and Maneuvering of the buses
- **Location –** The Charging Stations shall be preferably centrally located in order to effectively utilize the Distance travelled per charge
- **Power Source –** Availability of Quality and Reliable power from nearby source
- **Number of Chargers –** Adequate no. of chargers shall be provisioned so that optimum no. of busses can be charged overnight/ through out the day
- **Communication Access** – connectivity with OFC/ Wireless network
- **Illumination** – Proper Illumination required for safety
- **Electricity Cost** – Optimizing annual Electricity cost by going for Roof Top Solar and Net metering
- **Local Bye Laws and Safety**

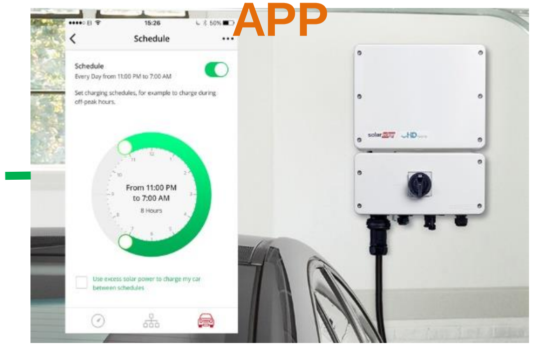
IOT AND COMMUNICATION IN EV

ELECTRIC VEHICLE

EVSE

CMS

EV - MOBILE APP



EV – EVSE Communicatio

To guarantee safe and secure supply of energy for battery Charging

EVSE - CMS Communicatio

To handle grid related parameters, User Authorisation, billing & other Information related to charging

CMS – Mobile App. Communication

For locating nearest charging station, reservation, billing details, etc.

CHARGING INFRASTRUCTURE CHALLENGES

Costs involved in setting up and operating an EV Charging infrastructure

- Cost of Installation of equipment, including power supply and investment in utility upgrade
- Demand charge, electricity sale, peak and off-peak hour energy charges
- Security of EV Charging Infrastructure Network against vandalism and accidental damage
- Maintenance of the equipment and ensuring adherence to safety procedures
- Covering the cost of insurance of equipment, staff and third party
- Working capital Costs and other finance charges
- Administrative, training and supervision expenses

Financial Factors – Service Provider

- Rate of increase in cost of Electricity v/s that of fuels for IC engines
- Basic rate of energy costs as compared to that of fuels used for IC Engines
- Fuel Efficiency of IC Engines and Energy Efficiency of EV vehicles
- Energy losses during charging
- Sunk cost of infrastructure and it obsolescence

Financial Factors - Users

- Opportunity cost of EV waiting in a queue to start the charging cycle
- Opportunity cost of the manpower during the queue waiting period
- Opportunity cost of both EV and manpower during the charging duration
- Number of charging stations at the Charging station per kWh or per hour cost of charging

Key Outcome

- There are a lot of challengers, both technical & behavioural which affect breakeven of charging infrastructure

CLIENT OWNERSHIP + OEM AMC + OPERATOR MODEL

Key Decision Issue – Charging Time v/s EV Range

- Client procures the EV from OEM with 2 - 5 yrs AMC & Operator does vehicle charging & operates the EV
- A public transport vehicle is expected to operate from 5:00 am to 11:00 pm viz. 18 hrs
- Considering a range of 180 km with one hour opportunity charging and an average city driving speed of 30 km/hr the vehicle is fit to operate for 6 hrs (excluding 1 hr required for opportunity charge for AC Charging)

Scenario 1 - AC Charging

- AC Charging for a Battery of similar capacity with a smaller capacity AC Charger of around 40 kW capacity would take 4-5 hours
- An EV can operate for two charge-discharge cycles of (6 + 1 hr) + one AC charging cycle of 4 hrs during the working time. Effectively the vehicle can be utilized for only 12 hrs and would need 8 - 10 hrs of charging per day
- AC Charging system having inbuilt AC to DC conversion requires more investment in chargers and external charging infrastructure

Scenario 2 - DC Charging

- DC Charging of 200 kW suitable for a Battery of 150 kW capacity is capable of achieving a charging time of 2 – 3 hours
- An EV can operate for two charge-discharge cycles of 6 hr each + one DC charging cycle of 2 hrs during the working time. Effectively the vehicle can be utilized for only 15 hrs and would need 6 – 9 hrs of charging per day.
- DC Charging system having external AC to DC conversion requires investment in charging infrastructure mainly at the depot

Key Outcome

- DC Charging is suitable for point to point operations while AC charging is more suitable for continuous duty

THANK YOU