

Mahindra – CBEEV meeting

Collaboration for R&D to Commercialisation in EV domain

Outline

- Battery: factors driving declining costs
- Auto-rickshaw Battery
 - Auto motor and Controller
- Passenger Car
 - Battery
 - Fixed plus Range Extension Battery

Cost driver for Batteries

- Energy density of battery is measured in Wh/kg
 - Higher the Wh/kg, less amount (kg) of materials (Li, Co, Ni, Mn and Graphite) required for 1 kWh of battery
 - Less the material required, lesser is cost
 - Battery using cells of 300 Wh/kg would roughly cost half vis-à-vis that with cells of 150 Wh/kg
 - LFP energy density theoretically less than 160 Wh/kg
 - NMC (or NCA) cells just starting to become available today at 300 Wh/kg
 - Will see 400 Wh/kg in two to three years, bringing cell costs to be less than \$100 per kWh
- Yes, higher the energy-density of a cell, more risky will it be
 - Will require battery pack and BMS design to make it safe

Battery pack-design

- Possible to design a NMC-graphite battery pack of greater than 5 kWh at cost just above \$200 per kWh with about 1500 usable cycles (with only natural air-cooling)
 - Ideal for e-auto (fixed or swappable battery)
- Liquid cooling will add \$50 to \$100 per kWh costs (including chiller) for larger size battery

CBEEV can offer e-Auto NMC Battery

- 7 kWh fixed battery or
- 3.5 kWh fixed + 3.5 kWh Range-extension or
- 3.5 kWh swappable battery

- Smaller than 3.5 kWh battery not desirable as peak–power requirement for auto may be 7 kW and not desirable to have greater than 2C discharge

- Cost target (note that subsidy of ₹10,000 per kWh will help)
 - 7 kWh at ₹105,000
 - 3.5 kWh at ₹56,000

To scale small and medium electric cars

- Personal Cars: ₹6 lakhs to ₹9 lakhs
- Fleet (taxi): ₹6 lakhs to ₹9 lakhs
- Large battery will increase costs substantially
 - Personal cars travel 25 km to 80 km per day for 95% of days
 - Greater than 80 km only for 5% of days
 - Fleet would travel 200 kms to 250 kms per day
- Fixed battery for 110 kms of size 15 kWh battery: costs ₹3 lakhs
- Range extension battery for 110 kms of size 15 kWh: costs ₹3.25 lakhs
 - Used only 5% of days by personal car-owners: swapped in 5 minutes at a petrol pump
 - Possible to persuade BPCL or HPCL
 - Used every day by fleet: can make both battery swappable – lease one or two batteries

Market is hot today

- EODB willing to commit 1000 taxis to be delivered from March 2020
- Several others are willing to commit 200 to 300 cars for next one year
- Important to seed concept today and launch early for fleets
 - Subsequently work with two or three manufacturers to standardise battery
 - Connector, protocols, maximum size
 - Seed it with some personal vehicles
- Launch new electric car brand with RE battery in 15 months with standardised battery

Mahindra - CBEEV

- Could speed up and build quickly
- Carry out tests and certifications as modifications of e-veritto
- Battery with chiller may be manufactured by third-party or by Mahindra
- CBEEV has also developed motor and controller for e-auto
 - 5 kW continuous and 8 kW peak

Monitoring and Data Analytics

- CBEEV has 250 million data points on battery
 - Remote Data collection and use of Analytics
 - To improve vehicle performance and economics