

India's Electric Vehicle Efforts Report Card: Progress over last Nine months

Ashok Jhunjhunwala, IIT Madras (on sabbatical)
Principal Advisor, Minister of Railways

ashok@tenet.res.in



BACKGROUND

EV is Future Transport

- Today GDP of auto-sector is **7.1% of GDP + 5% of GDP** for transport fuel processing and distribution
 - Large number of jobs
- **EV is the future**: will make **economic sense** by itself in **5 years**
 - Will displace ICE vehicles in about a decade and half
 - Can potentially impact GDP and jobs, unless we are **proactive and innovate** so that EV and its accessories contribute equally, if not more, to GDP and jobs
 - A difficult but doable task if we act **TODAY**

What India needs?

- EV happens today in USA, Europe, China with 30 to 40% subsidy
 - India can not afford to provide **subsidy at scale**
- If EV in India crawls, **imported** EV and accessories will **dominate the market in a few years**
 - Catching up with technology would become almost impossible
 - Will **impact our GDP and jobs**
- India needs to act to acquire **technology leadership** in some EV segments and build upon it

Some Unique aspects impacting EVs in India

- Limited / no **subsidy**
- Low **affordability**
- Our **driving patterns** are different (average vehicle speed in city is **25 kmph** as compared to 40 to 60 kmph elsewhere)
 - Will require different **motors and controllers**
- Our temperature **crosses 40 deg C** and even 45 deg C quite often
 - FAST Charging **full** low-cost battery (**in 10 minutes to 30 minutes**) would severely **impact battery life-time**
- Need to evolve **new approaches** in partnership with industry, R&D community and Government

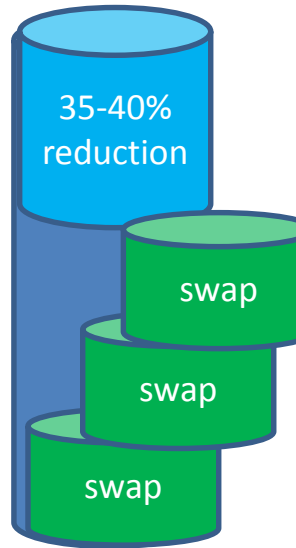


APPROACHES

Approach 1

- Focus on higher efficiency: **Wh/km** (equivalent to kms/litre of petrol)
 - Lower Wh/km brings down **battery size, weight and cost**
 - For e-autos in last six months: from **70 to 80 Wh/km** to 45/50 Wh/km
 - E-buses: from **1600 Wh/km** to 900 Wh/km
- **Split battery** into smaller size (one third) and **swap**
 - No waiting time to charge battery; **no public infrastructure** required
- Battery-life severely affected by Fast Charging at 45 deg C: **one-third** as compared to charging in two hours below 25 deg C
 - Low temperature and slower charging **Possible** with swapping

Battery size
without range
anxiety



Approach I (contd)

- Separate **vehicle business** (without battery) & **energy business** (battery)
 - Capital cost similar to that for petrol / diesel vehicle
 - Operation cost today same as petrol / diesel vehicle
 - WITH **no SUBSIDY**; but **lower GST** for strictly **three years**
 - Drive Volumes using public vehicles
 - Get companies to buy vehicles in bulk (100,000 plus) and lease
 - Get companies to buy batteries in bulk and set up energy business
 - Private vehicles to leverage the eco-system
- No subsidy needed as with these 5 steps, capital cost of vehicle similar to that for petrol vehicles, and ₹/km operation costs same as petrol / diesel / CNG
 - Manufacture motors and drives, chargers, batteries, cells and battery-chemicals in India

Approach II

- Focus on vehicles with **larger drive-distance per day**
 - Taxis with 200 kms
 - Buses with 200 plus kms
- Possible to work towards solution where **total cost of ownership per km** comparable to that of petrol vehicles with
 - Some **slow** (overnight) charging
 - Some **fast** charging / or **top-up** charging (**top-up with small batteries possible**)
 - need to **overcome high temperature barrier**: may be higher-cost LTO batteries
 - Some **combination** of slow-charging and swapping

India's Strategy

1. Most **Energy Efficient** Vehicles: low Wh/km will reduce the size of the **battery, the most expensive component**
 - Better motor and drive (**power-train**), better tyres, lower weight and better aerodynamics
2. Battery ecosystem: **Pack manufacturing (30%), cell-making (30%), materials and chemicals (40%)**
3. Charging and **swapping** Infrastructure for range-extension
 - Slow-charging, fast charging, battery swapping and petrol-based extender
4. **Demand Generation and Policies**



TASKS

Tasks I: Technology- Power train and Infra

- Build vehicles with higher efficiency (low Wh/km)
 - Some excellent progress by industry; more needed; competition helps
 - much more needed in developing high-efficiency motors and controllers
- Develop Low-cost Swapping infrastructure
 - Ready to launch and scale
- Develop Chargers at affordable costs
 - Overnight chargers: standards defined; product ready and affordable
 - Fast chargers under 100V / 15 kW (DC-001): standards defined; product ready and affordable
 - Test set up at ARAI and IITM -- costs about ₹1.25 lakhs in volume
 - Fast Chargers from 100V to 400V: standards to be defined; product to be developed and made affordable over next one year
 - Fast Chargers for buses: standards to be defined; product to be developed and made affordable over next one year
- Develop communication protocols to get highest performance: good progress

Tasks I: Technology - batteries

- Battery pack development: **thermal** design, **mechanical** design and **Battery Management System** to get the best out of low-cost cell: **largely ready**
 - established and start-ups moving [30% value add]
- Battery Cell Development: strategy needs to be worked out
 - **Will need outside help** -- evolve as cell demand grows in country
 - Will work out strategy over next one year [30% value add]
- Battery Material Development: **great progress** with battery recycling (**urban mining**); scaling on way [40% value add]

Task II: Industry

- Creating charger service industry: to be done over next year
- Creating charging and swapping industry: to be done over next year
- Demand generation
 - Volume Buying and leasing 4-wheelers: started with EESL tender
 - Volume Buying and leasing 3-wheelers (e-rick and e-auto): ready to be started over next three months
 - Volume buying and leasing buses: ready to be started over next six months
 - Volume buying and leasing of small cargo vehicles: can be started over next nine months
 - 4-wheeler personal vehicle strategy: a proposal to use Range-Extension Batteries
 - 2-wheeler personal vehicle strategy: a proposal to use Range-Extension Batteries

Task II: Industry

- Waking up auto industry: **done**
- Waking up large auto-companies: **done**
- Waking up large battery industries: **done**
- Transforming small and medium sub-system and auto-component industries: **not begun**
- Developing new Electrical (power-electronics) industries: **to be done over next two years**

Task III: Immediate Policy & Regulatory support

- Have **zero** import duty and **5% IGST** on lithium cells for EVs. Have 5% GST on Locked Smart Batteries, EVs, Charging Equipment **for three years**
- Have **5% GST** on Integrated Service provided by the Locked Smart Battery Charge and Swap stations
- Allow Aggregators and Businesses to **own and operate** fleet of electric 3-Wheelers and exempt e-Autos from permit requirement **for three years**
- Allow Charging and Energy-business (Charge & Swap Stations) **to procure power** at competitive rates through Open Access (without cross-subsidy)

Future technology tasks

- Examine Hydrogen-fuelled vehicles
- Distributed Motor architecture for vehicles
- New Motors without or with minimum permanent magnet
 - China has about 90% of rare-earth magnets
- Development of low-cost cell chemistry tolerating higher temperatures
- Develop second use of batteries
- Better understand battery behaviour in different use conditions
- Develop heavy duty EV trucks
- Develop Agricultural Machinery using electric power

Other tasks

- Develop Comprehensive **long-term and stable policy for EVs**
 - Including policy to incentivise setting up new technology industry in order to attract investment
- Develop **strong R&D** to commercialisation in EV subsystems
- Encourage electricity production from **Renewables**
 - Encourage solar-PV modules being **manufactured locally**
- Watch out for new approaches and technologies

A new approach: EV Batteries, costs and range-anxiety

- Batteries **dominate** the cost of an EV
 - Larger battery will increase costs
 - And also **vehicle weight** (reducing the **energy efficiency or kms/kWh** of energy)
 - Smaller battery will create **range anxiety** (what happens when battery runs-out?)
 - Conventional solution uses Public Fast Charger: **waiting time** + **public charging infrastructure**
 - Fast Charger with 1C charge will take a little more than an hour to charge the battery
 - Fast Charger with 4C can charge in **15 to 20 minutes**
 - But fast charge at this rate **reduces battery life**, specifically the **low-cost** Graphite-NMC batteries
 - Problems get worse as temperature crosses 40 degree C, as is common in India
 - Alternatively use **LTO batteries** which can withstand fast charging as well as higher temperatures
 - But about **three to four times as expensive** as low-cost Graphite-NMC batteries

Can Indian EVs do something else?

- Suppose EVs have a **small** low-cost battery with limited range built-in (example 100 km range for car)
 - **Enough to drive** within cities for **90% of days**
 - Use only night-time **Slow** Charging: **maximising** battery life
- When one needs to drive longer distances (10% of days)
 - Option 1: Stop and use a fast charger (**1 hour waiting time**) giving another 100 kms
 - Another hour wait for a fast charge if one drives longer than 200 kms
 - Option 2: use a **RANGE EXTENDER to** overcomes complete range anxiety
 - **Swap-in a second (swappable) battery doubling the range** at a petrol pump (**3 to 5 minutes**), enabling another 100 kms range
 - **Swap the swappable battery again for still longer range (300 kms or 400 kms)**

To Conclude

- More needs to be worked out
- Time is of essence
 - Several industries have worked hard over the last few years
 - They need to be encouraged and see a continuous forward movement
 - More focus on Make in India and start-ups

For deeper understanding, look at the blog: <https://electric-vehicles-in-india.blogspot.in/2017/12/>