Limited subsidy and Low-affordability imperatives for EVs in India

Can we still scale quickly?

Ashok Jhunjhunwala, IIT Madras (on sabbatical), Principal Advisor (Minister of Railways), ashok@tenet.res.in
with Prabhjot Kaur, IITM
The talk around a year back

• EV will not happen in India soon; will take the hybrid route; requires 30 to 40% subsidy (as in rest of the world); Charging infrastructure not ready
  – Industry was largely disinterested

• Today: some **50 Indian companies** going hammer and tongs on EV, believing that India will charter its own path
  – **Vehicles**: Ashok Leyland, Tata Motors, Mahindra, Eicher, Bajaj, Kinetic, Lohia, Electrotherm, Goenka, Hero-Eco, Okinawa, Ather, Avon Cycles, TVS Motors
  – **Li Ion Battery and recycling**: Exide, Amar Raja, Exicom, ACME, Grintech, Greenfuel, Ion Batteries, Attero, Sun-mobility
  – **Energy Operators**: Essel Infra, Sun-mobility, BPCL, NTPC, PGCIL, Kerala DISCOM
  – **Chargers & Motors**: Delta, ACME, Exicom, TVS Motors, Consulneowatt, Valeo Compageautomation
  – Most State Governments, STUs
How did this happen?

- Recognition that EV is the future
  - Four times higher energy efficiency and far higher reliability (50 times less moving parts)
  - will threaten India’s GDP (auto-sector 7.1% + 5% transport fuel processing and distribution) and large number of jobs

- Recognition: India has low affordability
  - 30 to 40% subsidy on Electric Vehicles in USA, Europe and China: but subsidies in India will be limited (or none at all)
  - EV must make business sense even with this!

- How do we make business sense? Battery contributes to 50% of costs
  - Falling rapidly over last five years
    - Battery-pack with low-cost NMC-Graphite cells under $200 per kWh today
    - but still expensive for the desired range

<table>
<thead>
<tr>
<th>Year</th>
<th>Li battery costs per kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>USD 600</td>
</tr>
<tr>
<td>2015</td>
<td>USD 450</td>
</tr>
<tr>
<td>2017</td>
<td>USD 250</td>
</tr>
<tr>
<td>2020</td>
<td>USD 150</td>
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<tr>
<td>2024</td>
<td>&lt; USD 100</td>
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</tbody>
</table>
Can India Drive its EV program Innovatively and Differently?

Copying the EV program of USA, China, Europe will take us nowhere
India’s Vehicles dominated by two-wheelers

No of Vehicles sold in India in Millions

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Passenger Vehicles</td>
<td>2.63</td>
<td>2.67</td>
<td>2.5</td>
<td>2.6</td>
<td>2.79</td>
<td>3.05</td>
</tr>
<tr>
<td>Commercial Vehicles</td>
<td>0.81</td>
<td>0.79</td>
<td>0.63</td>
<td>0.61</td>
<td>0.69</td>
<td>0.71</td>
</tr>
<tr>
<td>Three Wheelers</td>
<td>0.51</td>
<td>0.54</td>
<td>0.48</td>
<td>0.53</td>
<td>0.54</td>
<td>0.51</td>
</tr>
<tr>
<td>Two Wheelers</td>
<td>13.4</td>
<td>13.9</td>
<td>14.8</td>
<td>15.9</td>
<td>16.5</td>
<td>17.6</td>
</tr>
<tr>
<td>Grand Total</td>
<td>17.4</td>
<td>17.8</td>
<td>18.4</td>
<td>19.7</td>
<td>20.4</td>
<td>21.9</td>
</tr>
</tbody>
</table>

- Cars no more than 13% of total vehicles
  - About 15% of this (less than 2% of total) costs more than ₹10M ($15,000)
  - World-efforts focused only on this

- Three wheelers have become the main last-mile public transport for 75% Indians
  - Urban as well as Rural (village to town)
  - Rickshaws not included in above table

Percentage of Cars sold in India

<table>
<thead>
<tr>
<th>Price Range</th>
<th>2015-16</th>
<th>2016-17</th>
<th>2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below ₹500,000</td>
<td>2.82</td>
<td>28.85</td>
<td>27.43</td>
</tr>
<tr>
<td>₹500K to 1 million</td>
<td>55.49</td>
<td>54.96</td>
<td>56.48</td>
</tr>
<tr>
<td>₹1 to 1.5 million</td>
<td>15.29</td>
<td>15.23</td>
<td>14.65</td>
</tr>
<tr>
<td>Above ₹1.5 million</td>
<td>1.20</td>
<td>0.96</td>
<td>1.43</td>
</tr>
</tbody>
</table>

$1 = ₹65

June 2018
InfraConclave 2018
An Alternate Approach for Public Transport

• 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
  – Swapped battery can be charged in conditioned environment and in two hours to maximise its life
Approach towards Business Viability

• 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
Private Vehicles: EV Batteries, costs and range-anxiety

• Batteries dominate the cost of an EV
  – Larger battery increase costs (Tesla uses battery for 540 kms)
    • and also vehicle weight (reducing the energy efficiency or kms/kWh)
  – Smaller battery creates range anxiety
    • Use Public Fast Charger: waiting time + public charging infrastructure
    • Fast Charger with 1C charge: takes about an hour to charge the battery
    • 4C Fast Charger -- 15 to 20 minutes: but reduces battery life for low-cost Graphite-NMC batteries (gets worse as temperature crosses 40°C)
    • Alternatively LTO batteries: Charge Fast even at high temp: but three times costlier
Range-extender Batteries for 4W and 2W

• Suppose EVs have a small low-cost battery with limited range built-in (example 100 km range for e-car or 50 km for e-scooter)
  – Enough to drive within cities for 90% of days
  – Use only night-time Slow Charging: maximising battery life
  – Affordable

• When one needs to drive longer distances (10% of days)
  – use a RANGE EXTENDER battery to overcome range anxiety
    • Swap-in a second (swappable) battery doubling the range at a petrol pump (3 to 5 minutes), enabling another 100 kms range for a e-car
    • Swap the swappable battery again for still longer range (300 kms or 400 kms)
  – Swapping by Energy Operators
Summing up: India’s Tasks

1. Most **Energy Efficient** Vehicles: low Wh/km will reduce the size of the **battery**
   – 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 and battery swapping

4. **Demand Generation and Policies**
Task I: Vehicles and Demand generation

- E-rickshaw & e-auto: just started to deployed with **battery swapping** – will scale
- E-cargo auto: to be developed over next six months **with battery swapping**
- 2-wheelers with **RE battery swap**: will launch next month

- 4-wheelers: 100 km range being deployed with fast chargers – **volume buying by EESL**
  - 4-wheeler with **RE battery swap**: to be ready in six months

- 9m / 12 m city buses
  - being deployed with **fast charger** (requires 1 hour charging every 100 kms)
  - With battery swapping at end of each trip: **to be deployed in four months**
Task II: Charging & swapping Infrastructure

• Develop Low-cost Swapping infrastructure -- Ready to launch and scale

• Chargers at affordable costs
  – Overnight AC chargers: standards defined; product ready and affordable
  – DC Fast chargers under 15 kW (DC-001): standards defined; product ready and affordable -- costs about ₹1.25 lakhs in volumes
  – Fast Chargers with higher powers for larger cars and buses: standards being defined; product to be developed and made affordable over next one year

• Creating charger service industry: to be done this year

• Creating charging and swapping industry (energy operators): done

• Develop communication protocols to get highest performance: good progress
Tasks III: 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 [30% value add]

- Battery Cell Development
  - JV with external tie-ups [30% value add]

- Battery Material Development: **great progress** with battery recycling (urban mining) [40% value add]
  - scaling on way

Cell to Pack Manufacturing 2017 – some 15 companies

Cell Manufacturing: 2019 -20

India has little Li, Mn, Co

Battery Recycling to recover 95% of Li, Mn and Co, and 93% of Ni and Mn and 90% Graphite
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: more needed in developing high-efficiency motors and controllers -- to be done over next two years
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**
  – like fuel-cells, distributed motors, batteries withstanding higher temperatures, motors without permanent magnets, heavy trucks

*Biggest Threat: Policy paralysis allowing massive Chinese Imports*
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
    • With attempts to preserve India’s GDP and grow jobs

• Can we do it by 2030: Certainly

For deeper understanding, look at the blog “understanding the EV Elephant”: https://electric-vehicles-in-india.blogspot.in/2017/12/