


# Electric Vehicles in India: Can we Scale?

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# India Recognises

- India imports most of its oil impacting its economy badly
  - It has 14 out of 20 most polluted cities in the world
  - EV is the future: four times higher **energy efficiency** and 95% less moving parts
- Worldwide EVs driven by 30 to 40% subsidy
  - India has **low affordability** and can afford **minimal subsidy**
    - Battery contributes to **50% of costs**
      - falling rapidly over last five years but still expensive
  - EV must make **business sense: How?**
- India needs innovative approach to get its EV to scale today: Not follow the West
  - Failure to do so will imply it gets **flooded by imports in four to five years**
  - 7.1% (auto-sector) + 5% GDP (fuel-processing) and almost 30 million jobs impacted

Year	Li battery costs per kWh
2012	USD 600
2015	USD 450
2017	USD 250
2020	USD 150
2024	< USD 100



# India's focus: different from that in the West

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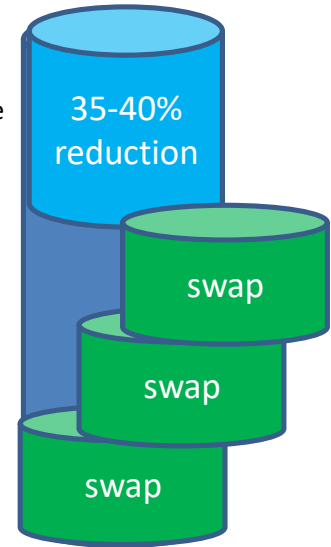
- India's vehicles different from that in most of the world: low-cost
  - 79% two-wheelers, 5% Autos and e-rickshaw
  - 3% Buses and large goods vehicle
  - 12% Economy Cars (< ₹10 lakhs) and 2% Premium Cars (> ₹10 lakhs)
  - 98% of public and affordable vehicles: not the focus of the rest of the world; India could attempt to get leadership here
    - For premium cars, it may use the same approach as in the West

**Business needs to depend upon itself**  
Some help from governments (local manufacturing + promotion)

# Strategy for EVs for Public Transport

- Higher efficiency **Wh/km** (kms/litre of petrol) reduces **battery size, weight and costs**
  - For e-autos in last one year: 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
- 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** aided by Public procurement

Battery size without range anxiety



# EV Strategy for **Private Transport** (2/4-wheelers)

- Batteries **dominate** the cost of an EV: Tesla uses battery with 540 kms range
  - Increasing the **vehicle weight** (reducing the **energy efficiency or kms/kWh**)
  - On the other hand, Smaller battery creates **range anxiety**
    - Use Public Fast Charger: **waiting time** + **public charging infrastructure**: takes an hour to charge battery
    - Fast Charge in **15 to 20 minutes**: needs expensive batteries (life impacted as temperature crosses 40°C)
- **Suppose EVs have a small** low-cost battery with limited range built-in: **Affordable**
  - Example: 100/ 50 km range for e-car / e-scooter: **Enough** 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)
  - use a **RANGE EXTENDER battery** to completely overcome range anxiety
    - **Swap-in** a second (swappable) battery **doubling the range** at a petrol pump (**3 to 5 minutes**)
    - **Swap** the swappable battery again for **still longer range (300 kms or 400 kms)**

# Strategy for EV 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 [30-35% 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, Ni and Mn

# Materials for Batteries (40% costs)

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- Li-Ion batteries today use **Lithium, Cobalt, Manganese, Nickel and Graphite**
  - India does not have much of the mines for any these
    - **Import bill could sky-rocket** if we import all the materials
  - India may need up to **25 GWh per year** by 2025
- Focus on recycling of used batteries (**urban mining**)
  - A start-up is recovering **95% of Li and Co**, and 93% of Ni and Mn and 90% Graphite: being scaled today
  - Need R&D to set-up large number of recycling plants with **ZERO EFFLUENT**
- India could import used batteries and become the **urban-mining capital of the world** for Li-Ion battery-materials

# Summing up: India's Tasks

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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** (30-35%), **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**



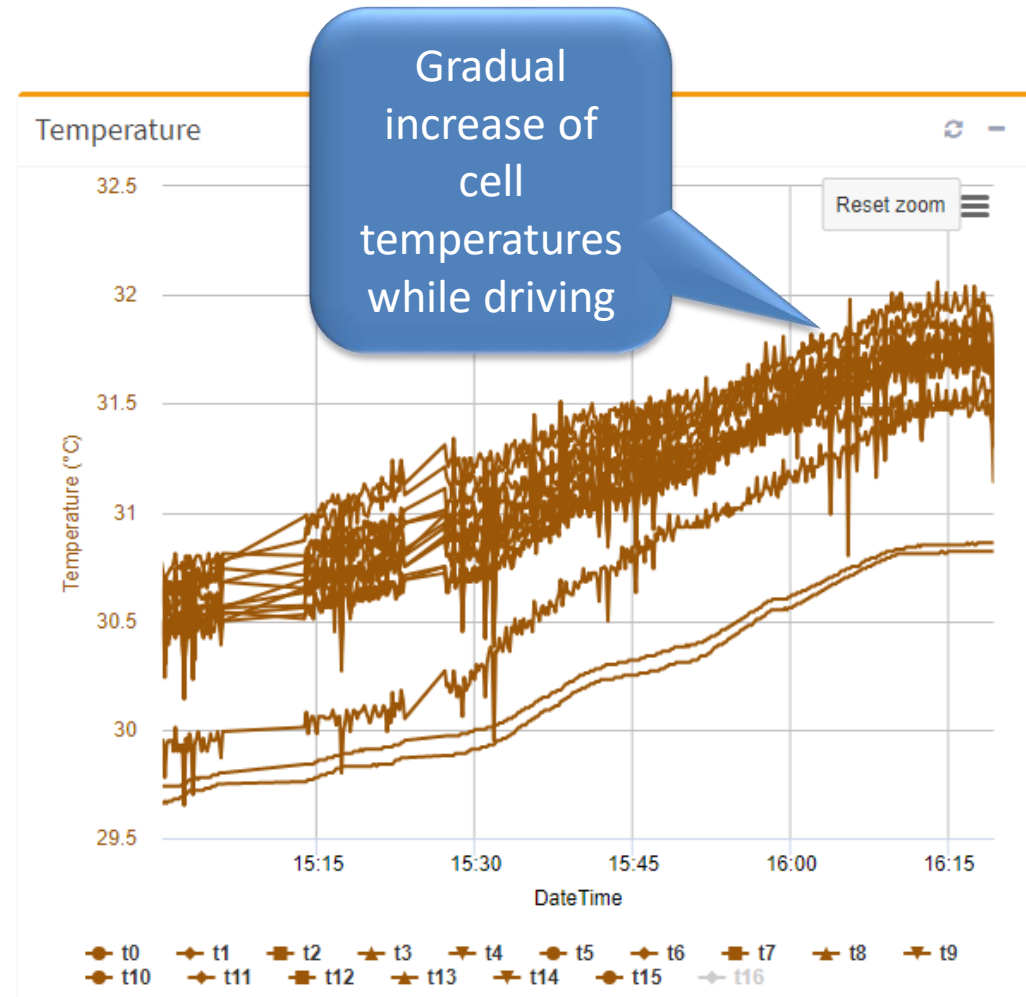
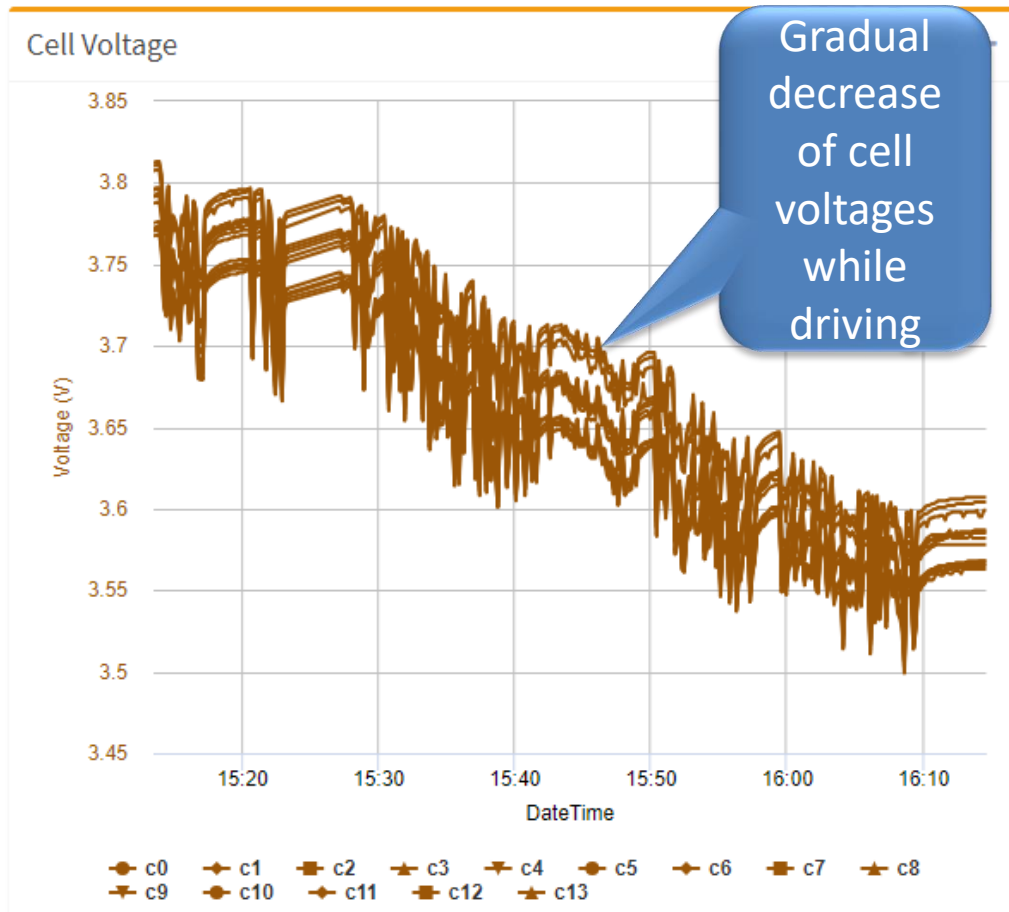
# Vehicles on Drive

## Pilot with Battery swapping at CBEEV, IITM Campus



Test vehicle with school kids, residents and staff in IITM campus

# IOT: Cell voltage and temperature monitoring to maximise battery-life



# Current State and Scaling by better battery utilisation

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- Electric three-wheelers with battery swapping will scale soon
- Electric two-wheelers (78% of vehicles) would make maximum impact in short run and would require **some innovation to scale**
- Buses would **still take time to scale**: battery-swapping will emerge in 2019 and would compete with fixed-battery buses
- End of 2019: first signs of scaling of 4-wheelers
  - Battery pack manufacturing will start-scaling
  - Battery recycling would bring-up urban mining
- Industry and local governments would push EV forward

# To

- India needs innovative approach to
  - As battery dominates costs of EV, o
  - Less energy consumption and small

- **Time is of essence**

- Several industries and start-ups 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 and R&D institutions
  - With attempts to preserve India's GDP and grow jobs

- Can we do it by 2030: **Certainly**

- EV article in latest IEEE Electrification Magazine: <https://ieeexplore.ieee.org/document/8546812>

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

- **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, Goldstone
- **Chargers, Motors and Monitoring**: Delta, ACME, Exicom, TVS Motors, Esmite
- Most State Governments, STUs