

*Converting India's Vehicles to Electric by 2030*  
*Role of Energy Storage Devices*

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# India Recognises

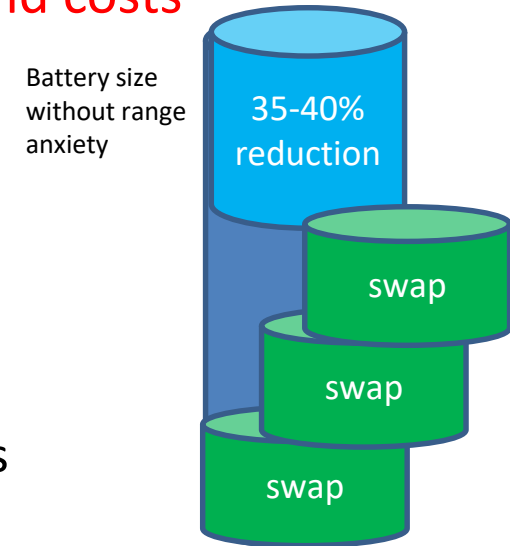
- India imports most of its oil impacting its economy badly
  - It has 14 of 20 most polluted cities in the world
  - EV is the future: four times higher **energy efficiency** and 50% less moving parts
- India's vehicles different from that in most of the world
  - 79% two-wheelers, 5% Autos and e-rickshaw, 3% Buses and large goods vehicle
  - 12% Economy Cars (< \$13000) and 2% Premium Cars (> \$13000)
  - 98% of **public and affordable vehicles**: not the focus of the rest of the world; India could attempt to get leadership here
- India has **low affordability** and can afford minimal subsidy
  - EV must make **business sense: How?**
  - Battery contributes to **50% of costs**
    - falling rapidly over last five years but still expensive

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



# 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



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

- Batteries **dominate** the cost of an EV (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**: 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 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  
Battery Recycling to recover 95% of  
Li, Mn and Co, and 93% of Ni and  
Mn and 90% Graphite

# 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

# To

- India needs innovative approach
  - Or will be flooded by imports in f
  - Kerala can show the way
- **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 Kerala/ 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**

- **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, Esmito
- Most State Governments, STUs

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