

# Understanding the EV Elephant

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# Why is Electric Vehicle (EV) the future transport?


*Better efficiency with less number of moving parts*

Area	Petrol / Diesel	EV
Energy efficiency	17 – 21%	90 – 95%
Moving parts (reliability)	2000+	20+

- In **four years**, EV capital costs will be less than that of petrol vehicles
  - with acceptable range and **operational costs at a fraction** of that of petrol vehicles
- But if we wait, India will **import most EV sub-systems** and batteries instead of oil

*Falling battery costs*

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



# Electric Vehicles today

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- World-over EVs happen today with **30% to 40% subsidy**
- China is driving its EV program hard: have started driving their vehicles **into India**
- 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**
- Today GDP of auto-sector is **7.1% of GDP + 5% of GDP** for transport fuel processing and distribution
  - Large number of jobs

# India's Specifics

EVs: *Hamare yahan hota to hai, dikhta nahee hai, dikhna chahiye*

World-over EV is scaling driven by subsidies – some 30 to 40%

Subsidies is possible, but not at scale

- So India has to do its EV with
  - Limited / no **subsidy**
  - Low **affordability**
  - **So how do we do it without subsidy?**
    - must make economic sense
- 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 scale rapidly and evolve **new approaches** in partnership with industry, **Start-ups**, R&D community and Government

Copying the EV program of USA, China, Europe will take us nowhere

# **CAN INDIA DRIVE ITS EV PROGRAM DIFFERENTLY?**

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

- Batteries **dominate** the cost of an EV
  - Larger battery increase costs (Tesla uses battery for 600 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 (worse as temperature crosses 40°C)
    - Alternatively **LTO batteries**: Charge Fast even at high temp: but **three times costlier**

# Can Indian EVs do something else?

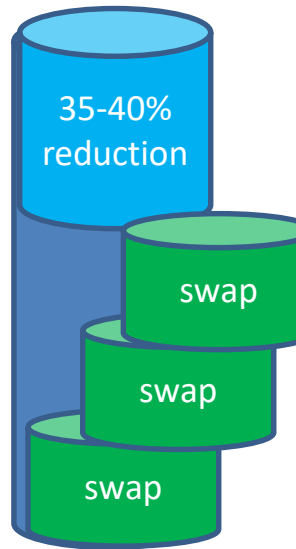
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- Suppose EVs have a **small** low-cost battery with limited range built-in (example 100 km range for car)
  - **Enough to drive** within cities for **90% of days**
  - Use only night-time **Slow** Charging: **maximising** battery life
  - **Affordable**
- 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
    - **Swap the swappable battery again for still longer range (300 kms or 400 kms)**

# India's alternate strategy for affordable vehicles

- 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





# Strategy (contd)

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- 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

# Summing up: India's Tasks

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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 and battery swapping
4. **Demand Generation and Policies**

# 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
  - DC Fast chargers under 15 kW (DC-001): standards defined; product ready and affordable
    - costs about ₹1.25 lakhs in volume
  - Fast Chargers with higher powers for larger cars and buses: standards being defined; product to be developed and made affordable over next one year
- Develop communication protocols to get highest performance: good progress



*from 80Wh/km to 52 Wh/km*

Driven by Industry and Start-ups

# 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 to be worked out
  - **external tie-ups** -- evolve as demand grows over one year **[30% value add]**
- Battery Material Development: **great progress** with battery recycling (**urban mining**); scaling on way **[40% value add]**

Cell to Pack Manufacturing  
2017 – some 15 companies



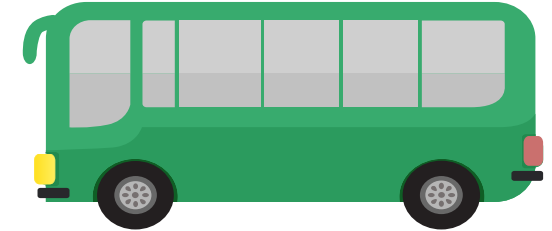
Cell Manufacturing: 2019 -20



India has little Li, Mn, Co  
Battery Recycling to recover 95% of  
Li, Mn and Co

# Task II: Industry

- Most City buses travel 30 km /trip
- Typical 8 trips per day
  - Swap at each trip



- Creating charger service industry: to be done over next year
- Creating charging and swapping industry: 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): within two months
  - Volume buying and leasing buses: by June- July 2018
  - Volume buying and leasing of small cargo vehicles: to be started over nine months
  - 4-wheeler personal vehicle strategy: propose to use Range-Extension Batteries
  - 2-wheeler personal vehicle strategy: a propose to use Range-Extension Batteries

# Task II: Industry

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- 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**

# Other tasks

Biggest Threat: Policy paralysis  
allowing massive Chinese Imports

- 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

# To Conclude

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- 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/>