

# *EV in India: Technology and Policy*

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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



# A year back

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- Will not happen in India soon; will take the hybrid route; requires 30 to 40% subsidy; Charging infrastructure not ready
  - Industry was largely disinterested
- Today: some **50 Indian companies** going hammer and tongs on EV. Believe 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?

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- Recognition that EVs are the future and will threaten India's GDP (auto-sector 7.1% + transport fuel processing & distribution is 5%) and large number of jobs
- Recognition: India has low affordability -- EV must make business sense
  - How do we make business sense? Battery contributes 50% of costs
- So India has to do its EV with
  - Limited / no subsidy
  - Low affordability
- Our driving patterns are different (average city-speed 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: evolve new approaches jointly 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 INNOVATIVELY AND 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**

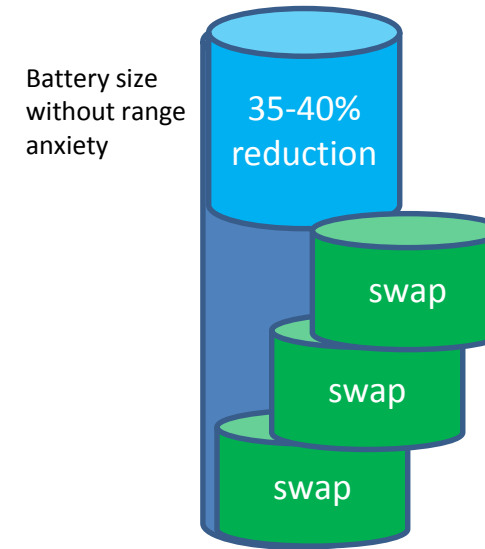
# India's Alternative: personal vehicle

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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)**
  - Swapping by Energy Operators

# India's Alternative: public vehicles (Autos and Buses)

- 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





# Auto and Bus (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

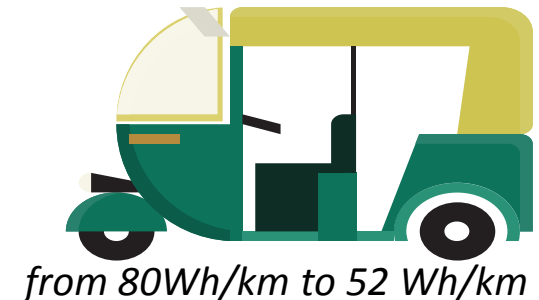
# Summing up: India's Strategy and Tasks

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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**

# Vehicles and Demand generation

- E-rickshaw & e-auto / cargo-auto: being deployed with Li-Ion battery swapping – **will scale**
- 2-wheelers with RE battery swap: **will launch next month**
- 4-wheelers: 100 km range with fast chargers – volume buying by EESL
  - 4-wheelers with RE battery swap: to be ready **in six months**
- 9m / 12 m city buses: being deployed with fast charger
  - With battery swapping at end of each trip: to be **deployed in four months**
- Develop Low-cost Swapping infrastructure -- **Ready to launch** and scale
- Develop communication protocols to get highest performance: **good progress**
- Chargers at affordable costs: slow AC chargers: standards defined; product ready and **affordable**
  - DC Fast chargers under 15 kW (DC-001): product ready and **affordable** -- costs ₹1.25 lakhs in volumes
  - Fast Chargers with higher powers for larger cars and buses: **standards being defined**
- Creating charging and swapping industry (energy operators): **done**



# 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

# Industry and Technology

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- Waking up auto industry and 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**
- **Develop strong R&D to commercialisation in EV subsystems**
- **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
  - SAARC needs to cooperate
- Time is of essence
  - More focus on Make locally and start-ups

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