

Electric Vehicles An Opportunity for India



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Rational for going Electric

- India does not have much oil
 - Our oil imports are rising continuously and hurting Indian economy very badly
 - No solution in site in short, medium or long-term
- Our cities and towns are highly congested
 - As middle class spreads, vehicle population continuously grow
 - Highly polluting urban India

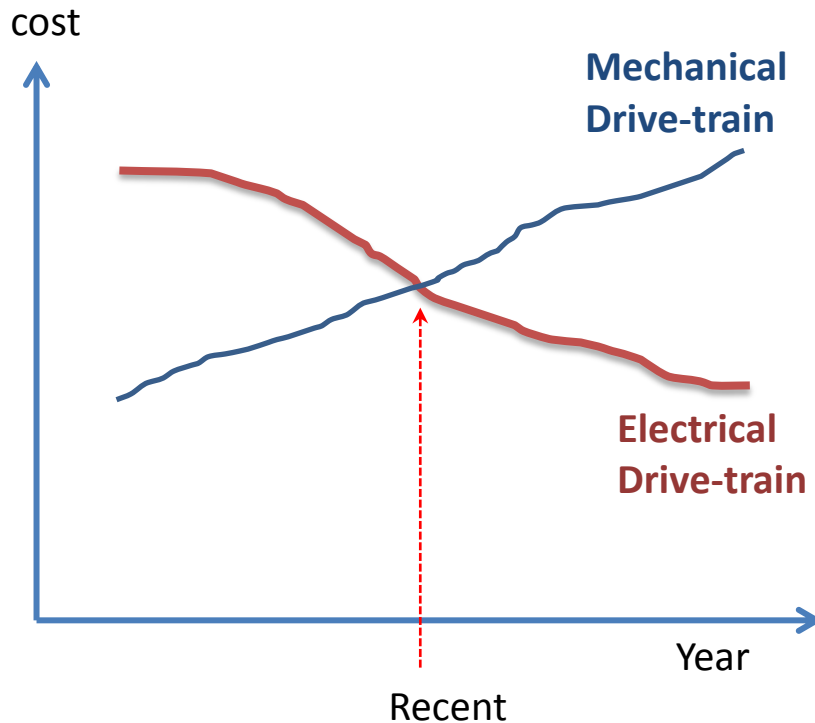


The nay-sayers

- But do we not have shortage of electricity?
 - No significant off-peak hour shortage of electricity
 - Electricity generation continuously increasing
 - Need to discourage EV charging during peak hours
 - India has huge solar potential to charge EV in day time
- Do electric-generation plants not pollute?
 - Power generator pollutes much less than a vehicle for every Km even today
 - Much easier to manage reduced pollution in large electric plants as compared to in every vehicle
 - Technology can be further improved to reduce emissions
 - Power pollution is not in most congested areas
- Disposal of battery
 - Technologies fast evolving for battery-reuse and end of life safe disposal



Is Technology Ready?

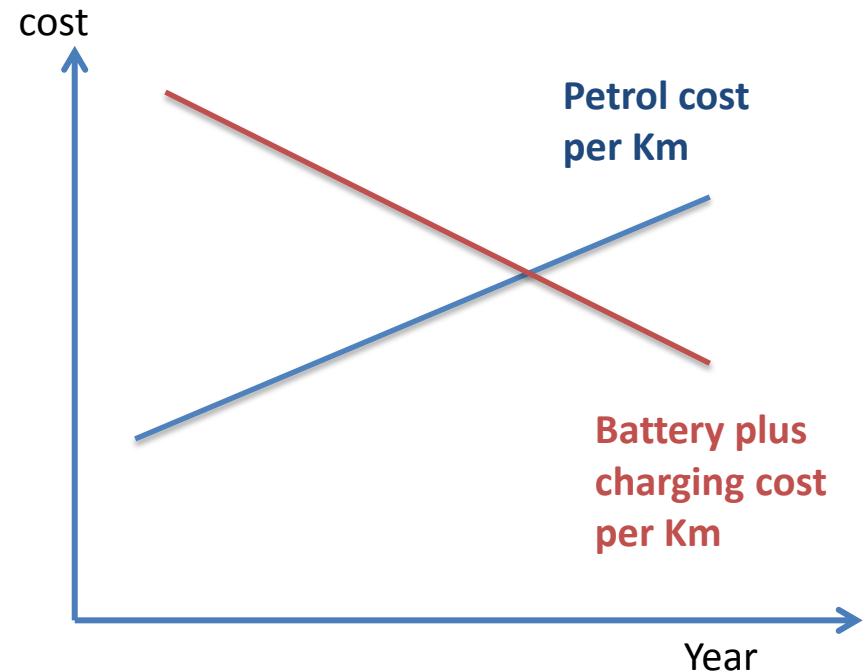


- For a vehicle **at volumes**, compare cost of mechanical (IC Engine) drive-train and electrical drive-train without batteries
- MDT cost goes up year after year (inflation)
- EDT cost goes down year after year (R&D, Moore's law and SW)
 - In recent times it crossed each other
 - Gap is to only increase year after year

Battery should be treated as fuel

Cost of Fuel

- Petrol cost per Km increases year after year
 - Though enhanced fuel-efficiency through R&D helps slow this
- Total cost of battery per Km (lifetime depreciation, interest, maintenance and charging of battery) keeps coming down
 - Battery R&D enhancing charge-discharge cycles and reducing costs continuously
 - Likely to only accelerate
- Crossover took place sometimes back



Li-Ion Battery costs are falling 8% per annum

Current Indian situation

- Sedan-size EVs capital costs ₹4 lakhs higher than petrol vehicles at low Volume (with 100 kms battery)
 - Incentives and subsidies (ED, VAT, Road-tax) off-set ₹2 lakhs
 - Capital Costs on road: ₹2 lakhs more
 - Operation costs work out to be about ₹1.50 per km Vs ₹7
- In three years the ₹4 lakhs capital costs can be shaven off
 - With high volume manufacturing and costs reduction
 - With Technology Innovation and R&D
 - Even 150 kms battery would costs only marginally more
 - 200 kms battery may costs higher
- Other electric-vehicles will follow similar trends
 - Large Buses would need focused intervention



Tasks that need to be taken up

- While expanding short-term incentives
 - Work on getting **volumes**: create market PULL
 - **Aggressively work on R&D and Innovation**
- Charging Infrastructure
- Public Transport on EV

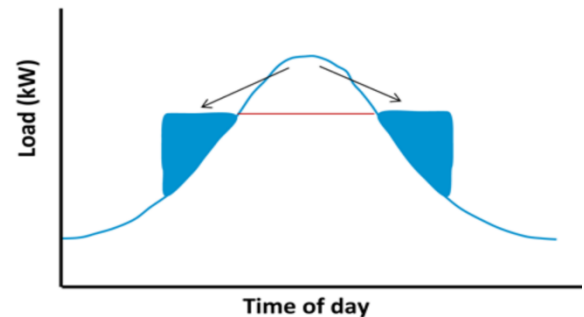


Incentives and Market Pull

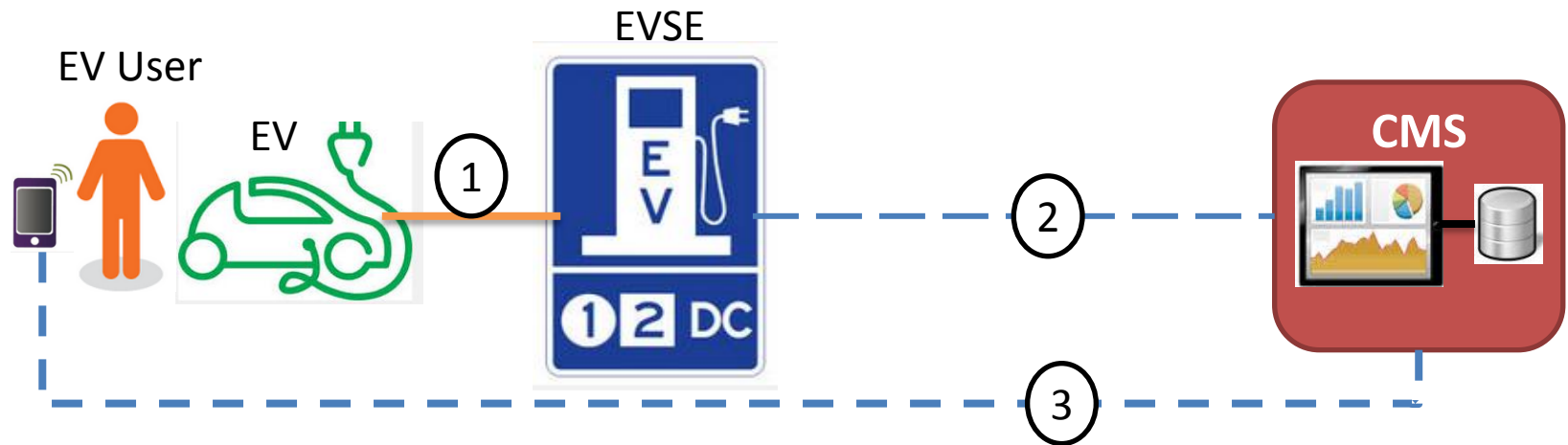
- Two-wheelers
- Four-wheelers
 - Small vehicles and Sedan
- 8-seater to 20-seater Public Transport Vehicle
- Goods Carrier
- Buses
- Use of Li-Ion Advanced batteries
 - 3000 cycles charge
- Incentives for five years
 - FAME need to be strengthened for EV
 - Create offset for ED + VAT + Road Tax
- Government Vehicles: Convert to EVs
- Give tax benefit to those who buy EVs
- License only EV taxis and Goods Carrier

EV Charging benefits Power Industry

- Slow-chargers at home
 - AC chargers: typically from 15A single phase: Charge in 7 hours
 - Define Specs for public charges
- **Fast DC Chargers** at Public Places
 - Need High Voltage DC Chargers: Charge in 45 minutes
 - Each charger costs about ₹1.25 lakhs (specs for <100V, defined by TAG)
 - Specs for upto 400V chargers need definition
- Set up in public places
 - Work on making business model work
- Introduce Time of day Metering for Vehicle-charging
 - Can enable significant off-take of power during night time and off-peak hours
 - **Helps in Load Balancing and reduce peaking**
 - Tariff for day time charging at commercial rates
 - Tariff for night-charging at **concessional rates**
 - When utilities costs are lower
- Also set-up **Solar Chargers for day time charging**



DC Fast Chargers at Public Places



- Power Electronics to provide right voltage and current (changing with time) from EVSE to EV
- Communication between EVSE and Central Management System
 - monitoring power used, ToD metering, Availability and reservation of Chargers: **CMS may decide ToD Charging dynamically**
- Communication between CMS and User Mobile: Reservation of charging slots

Aggressive R&D and Innovation

- Batteries
 - While price of battery-cells continue to decline worldwide, promote Innovation to reduce costs of battery packs in vehicles
 - Short term gains through Battery Physics rather than Chemistry
 - Aim for **factor of two** reduction in three years
- Motors and Controllers
 - Aim to increase **distance travelled (kms) per kW of battery power by a factor of 1.5 to 2**
- Air-conditioner and cooling (including battery cooling)
 - Significant enhancement of efficiency
- Body Materials and others to reduce weight
- Need a **new Approach to make a mark** in three years

Batteries

- Li Ion and its variants to be the dominant battery in coming years
 - Battery Cell: India **needs to set-up** manufacturing plant
 - **Small variation** in chemistry and packing can give us **gains**
 - Long term R&D should continue in different chemistry
 - **Cell to Module or Pack Design**
 - Indian capabilities maturing fast
 - Need to be broad-based: BMS, Electrical and Mechanical
 - Potential area of start-ups
 - Can scale up quickly
 - Need **better understanding** of battery usage at varying charge/discharge rates, DOD, temperature
 - And battery reuse and recycling

Buses and Trucks

- Large Batteries required
 - Would be high costs and weight
 - 150 km range: 150 kWh battery
- Need **Market Pull**
 - State corporation buying Electric Buses
 - **DC Fast Chargers**: 30 minutes to 45 minutes
 - **Battery Swapping**



Benefits and what we can achieve

- India can become **a leader** in small electric cars
 - **Make in India** can become a reality with large export potential
- Diesel / petrol Cars in India gradually replaced by EVs
 - **By 2030 most vehicles** in India could be electric
 - Help in India becoming **pollution free**
 - And most green nation (helps us assert ourselves in climate talk)
 - Our dependence on imported oil **considerably reduces**
 - Our Power Industry gets **load balancing** and reduced peaking



We should Avoid



- Short term measures like
 - Import of Electric Vehicles
- Inverted Duty structures for manufacturing in India
 - will hurt Make in India of EVs, when Indian manufacturers are ready to take off
 - They just need some help with volumes and return of taxes for first few years
 - And Power Ministry building **fast-charging** Infrastructure
- Duty-free Imports will hurt India going towards EV in long-run

