Making difficult things doable by leveraging Communications: A case study of electric vehicles in India

Ashok Jhunjhunwala, IIT Madras, ashok@tenet.res.in

Communications have changed the World

- Hitherto unimaginable things are now doable
  - Internet, WhatsApp, Facebook, Twitter
  - What is Search Engine without communications?
  - Electronic Banking, mobile-payments, e-commerce
    - Flipkart, Amazon, Snapdeal
    - Ola, Uber
    - Swiggy, Zomato, Urban Clap
    - E-governance
  - Internet of Things will dominate our lives more and more
    - May be primary role of communications going forward

Electric Vehicle is another such area

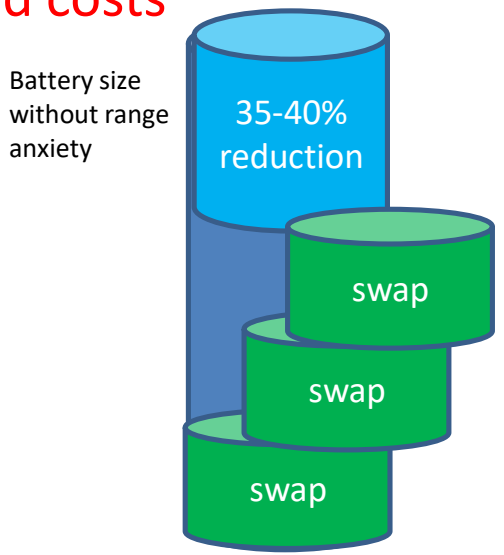
- India imports most of its oil
  - have fourteen out of the twenty most polluted cities in the world
  - Emergence of EVs a god-send opportunity
- However, EVs today are 1.6 to 2 times equivalent petrol vehicle
    - Costs dominated by battery -- prices falling rapidly
  - China, Europe, USA provides up to 40% subsidy for EVs
  - Unfortunately India cannot afford that
- If we wait, we will soon import EVs and its sub-systems
  - impacting 7.1% of India's GDP

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

- Can India make its EVs affordable today?
  - Possible by optimising the battery resource, the key driver of costs for Evs
  - not possible without telecom and IoT

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



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

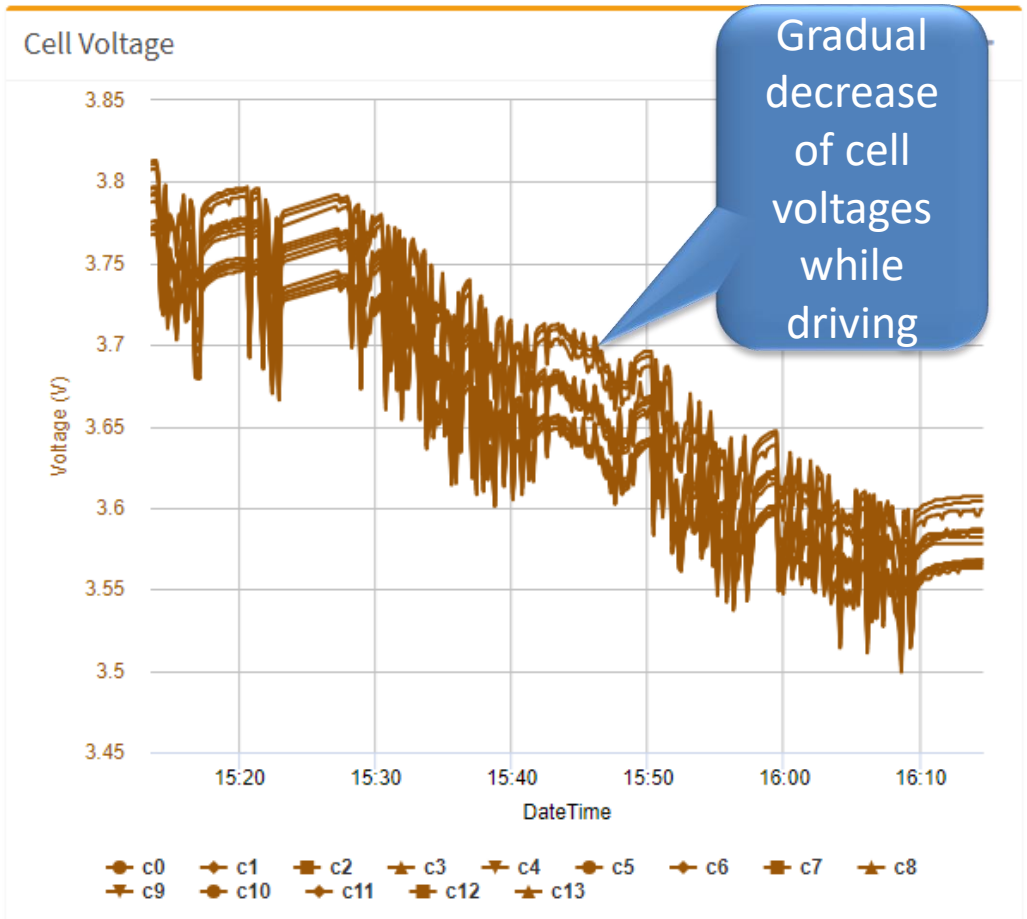
- Worldwide EV uses large batteries (Tesla uses battery with 540 kms range)
  - Smaller battery creates range anxiety
    - Use Public Fast Charger: waiting time + public charging infrastructure: takes an hour to charge battery
    - Fast Charge in 15 to 20 minutes: needs expensive batteries (life impacted as temperature crosses 40°C)
- Suppose Indian EVs use a small low-cost battery with limited range: 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
- The day 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)

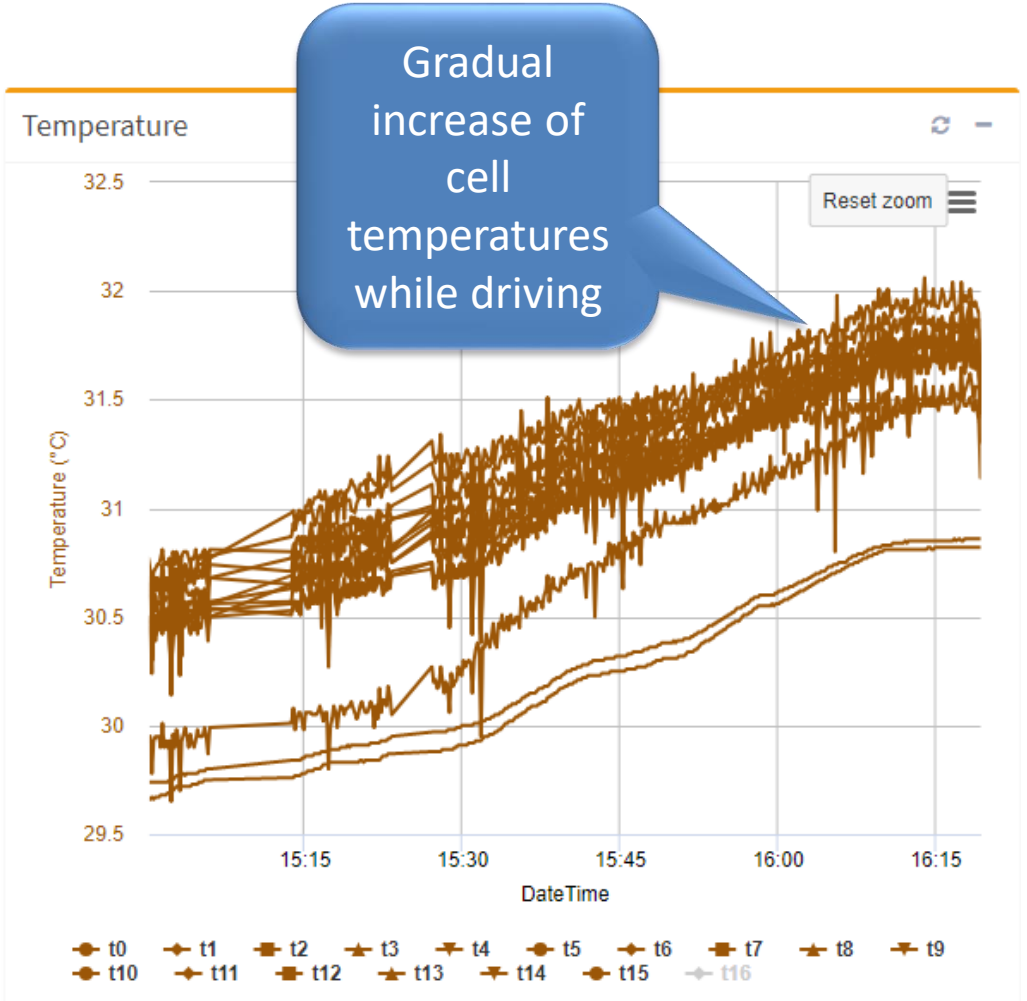
Vehicles on Drive

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 during driving





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- India needs innovative approach to
  - As battery dominates costs of EV, r
  - Less energy consumption and smal
- 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, Esmito
- Most State Governments, STUs