Technology & Innovation: helping in making it possible

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

Many reasons why it is not possible, but is there one reason one can do it!

- Making India highly educated and talented
- Will power-cuts be ever a thing of past?
- Can 50% of our vehicles be EV by 2030?
- Will water be responsible for future wars?
- Can our agriculture attain fast growth?
- Can we fix our Public Health Centers in villages?
- Can Governments be accountable?

  - Can we leverage technology and innovation to fix large problems?

Education

Start with what we have attained

- What percentage of children in India at age of six enter school today?

- In 1981, India had 100 engineering colleges, graduating 20000 engineers a year
  - How about now?
  - Who goes to these colleges?
    - 25% of engineering students below poverty line
    - 25% are from villages

- What are the number of MBA graduates each year in India?
  - What about number of pharmaceutical graduates?
  - What about other professional courses?

So we have achieved Quantity and Equity

- What about Quality?
  - Lost it in rapid growth and equity-drive
  - Who has to fix it?
  - How?

Karen Cator: This is education's Internet moment. Are we ready?"

- *6 million watch Khan Academy's 4,400 videos on math, science and history every month?*
- *MIT's Open-Course-Ware initiative has produced thousands of college courses*
- *iTunes U surpassed one billion downloads*

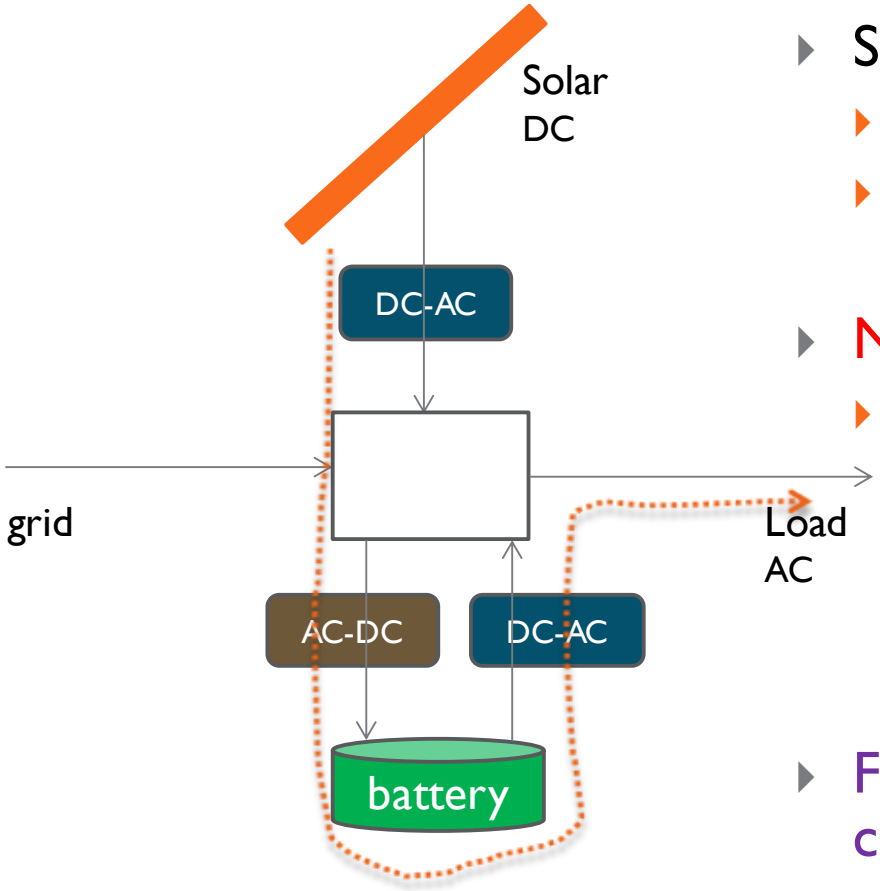
Leveraging ICT

- QEEE Recognises the role that ICT-based education can play
  - But also recognises the role that teachers and educational institutes would continue to play
  - Figures out how ICT can help enhance quality in education
    - Especially in countries like India where rapid expansion has implied poorly trained teachers

- ICT can certainly
  - Enable Direct to Students Program which delivers
    - Gets the pedagogy right for specific situation
  - Enable teachers to enhance their teaching
    - Get best UG students to be recruited as trainee teacher and remote PhDs at IITs while continuing to teach
  - Enable rating / enhance transparency

India's Power Cuts

Decentralised Solar Power at Homes



- Solar PV gives DC Power
  - But load is AC
  - Needs a DC-AC convertor
- Now if we add a battery
  - Battery stores only DC
    - Require a AC-DC convertor for charging
    - Require a DC-AC convertor during discharging
- For low power, each convertor* can have 10 to 15% loss
  - Solar with battery may have 25 to 45% loss

And it gets worse

- As one realises that home-load is moving towards DC

AC fan	72W	BLDC fan	30W
at speed I	60W		9W
CFL tube	**36W**	**LED tube**	**15W**
low intensity	na		4W

volume prices similar for fans

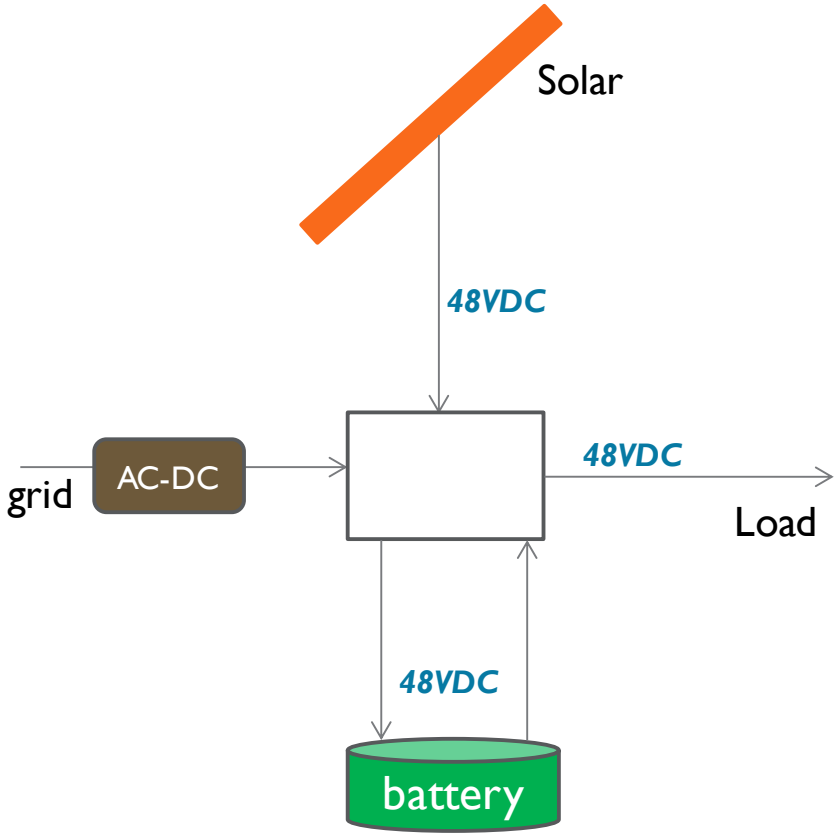
LED tube life much longer (DC powering enhances reliability)

- All Electronics devices work on low-voltage DC
  - TV (LED/LCD), laptops. Cell-phones, speaker-phones, tablets, speakers
    - AC to DC conversion has losses from 20% to 50% in each device

- Even the refrigerators, air-conditioners, washing machine in future will be BLDC motors

- Use of DC-powered and energy-efficient devices
  - Consumption **down by 50%**

Move to Solar-DC at Home Premises



- 48V DC line as an additional power line at home
  - Highly power-efficient usage of Solar
  - Low-power from grid alone converted from AC-DC
    - Designed to have minimal loss
  - Battery can be added with higher efficiency (no convertors), if required

But all this requires a PUSH

Can India's black-outs disappear?
Brown-out DC Power Solar-DC Innovation

- UDC (Brown-out) Innovation from IITM enables
  - Uninterrupted (24x7) but limited (to say 100W) DC power to each home from grid even during power-cuts
    - 100W DC enough for three tube-lights, two fans and a cell charger
      - Or one 24 inch TV instead of one fan
  - Adding Solar DC enables connecting more appliances

- Decentralised Solar can make huge difference: no T&D losses
  - Average of 500W solar (50 sqft) solar deployed at each Indian home (240M) produce power equal to total Domestic consumption in a year
  - On the other hand, 100 million homes using 1 kW on rooftop is equivalent to 40% of total peak power produced today

The Power Distribution Innovation achieves

- Reduce domestic demand: energy-efficient appliances
- Increase Supply as decentralized solar PV gets added
  - Reducing supply-demand gap

- And at the same time have 24x7 DC power at each home
  - Adequate for Lowest income homes
  - Mid and high Income homes will install solar
- Could help Manage Subsidy
  - Power Distribution Companies unconstrained: would become financially viable
    - uninterrupted DC power supply at low tariff
    - AC power can be charged at market rates
- Can help India get towards 50% power from solar by 2030

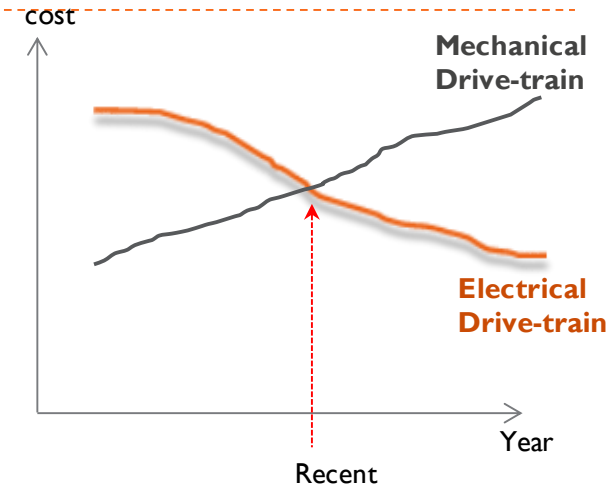
Can India get 50% of its vehicles as EV by 2030?

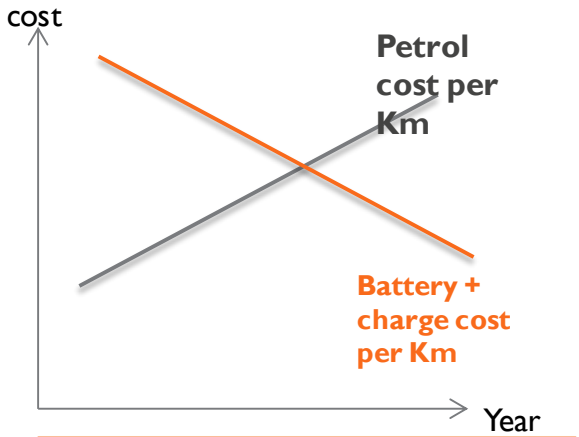
Can India's 50% vehicles be Electric by 2030?

- Rationale
  - India does not have much oil
    - Our oil imports rising continuously: hurts Indian economy
    - No solution in site in short, medium or long-term
  - Our cities and towns are highly congested
    - Highly polluting urban India

- Cost of mechanical (IC Engine) drive-train (MDT) goes up year after year
- Electrical drive-train without batteries (EDT) cost goes down year after year (R&D, Moore's law and SW)
  - Crosses each other and Gap increase year after year

- Cost of Fuel (Petrol) per Km increases every year
- Total cost of battery per Km (life-time depreciation, interest, maintenance and charging of battery) keeps coming down
  - Crossed over recently and gap likely to only accelerate





Li-Ion Battery costs fall 8% per annum

Can we prevent future Water-wars?

Situation more serious in India: ICT could enable tracking, usage and conservation of this precious resource

Agricultural Growth: small plots struggling to make ends meet

Using widely used sophisticated call-center technology

Can Governments be transparent?

ICT as prime interface to Government and inside Governments

Can PHC's be fixed

To Sum Up

- Technology combined with Innovation can go a long way
- Need to think of big problem
  - Immerse yourself into it
    - Understand what has been achieved and what needs to be
  - Do not get too attached to your solution
  - Do not call quits when difficulty arises
  - Remember that one can always improve on the solution