

**Transformation through Technology,
Innovation & Disruption: 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?

Some Examples of what disruption through Digital and other Innovations can do in various fields

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:

Enhancing overall quality in ten years

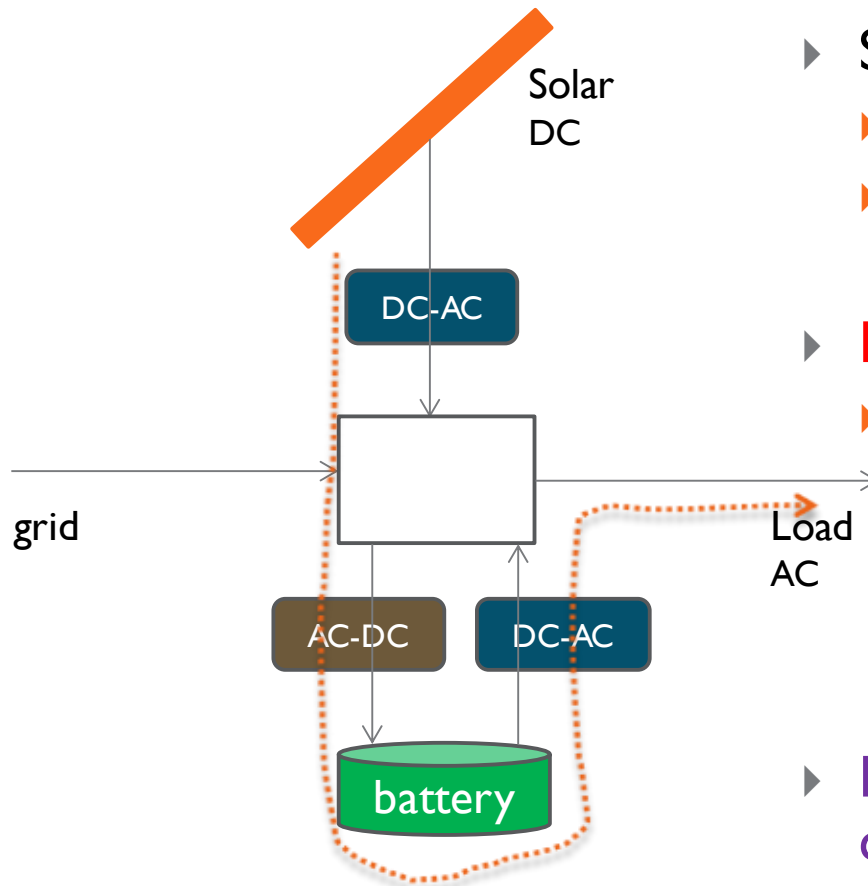
- ▶ Can ICT-based education play a disruptive role?
 - ▶ QEEE also recognises the role that teachers and educational institutes would continue to play
 - ▶ Figures out how ICT can help enhance quality in education
 - Especially in countries like India where rapid expansion has implied poorly trained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



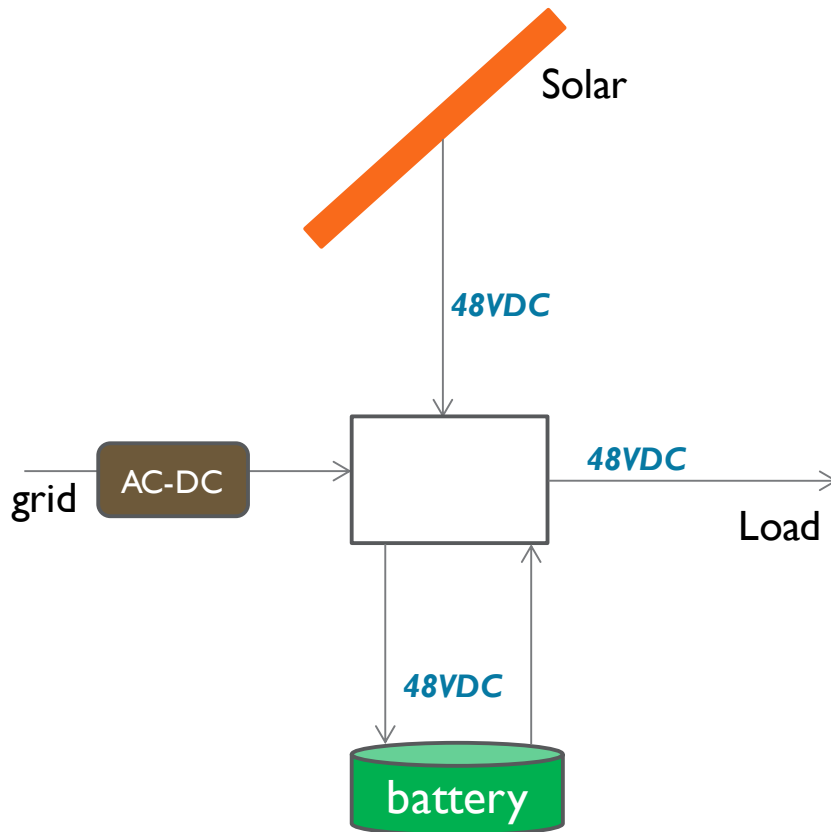
LED tube life much
longer (DC powering
enhances reliability)

- ▶ 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



But all this requires a PUSH

- ▶ 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

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

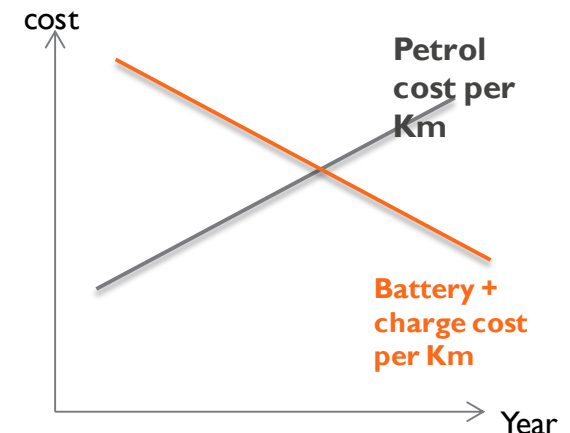
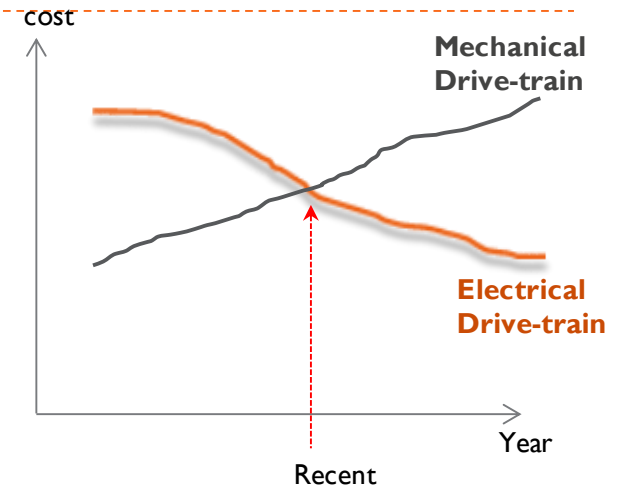
- ▶ Our oil imports rising continuously: hurts Indian economy
- ▶ No solution in site in short, medium or long-term

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?

Continuous mobile based citizen feedback on Performance of Doctors and Staff and incentivising and penalising

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