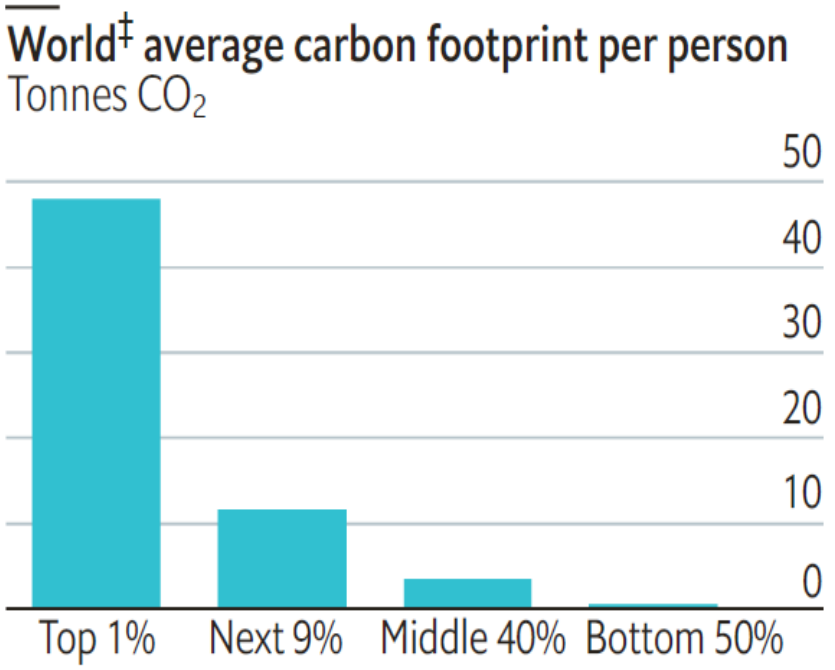
How soon can India get to Net-Zero?

Ashok Jhunjhunwala, ashok@tenet.res.in

IIT Madras and IITM Research Park

Global warming: who contributes? Who is impacted?

- GHG emissions dominated by well to do in every country and the world
  - Today, India is 103rd in per capita GHG emissions
- Who gets most affected?
  - The ones with lowest incomes
  - 85% families in India earn less than ₹25000 per month household income
  - Heavy Chennai rains last year: many got out of homes only in boats for 7 days

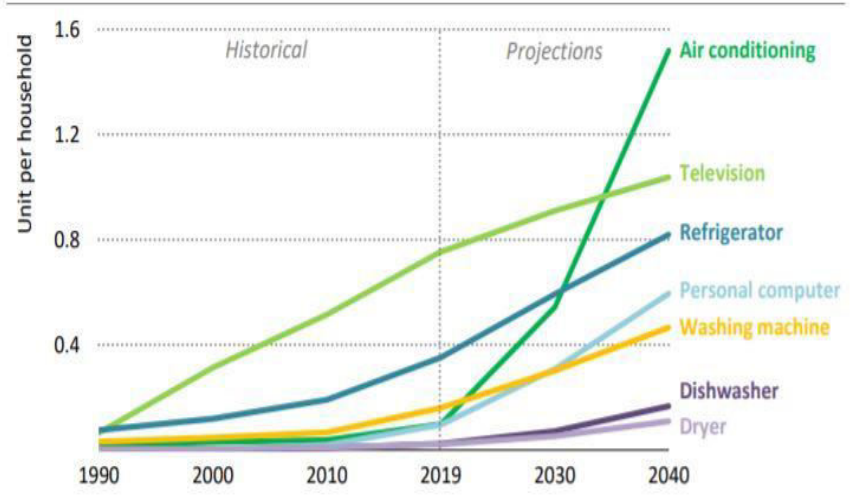


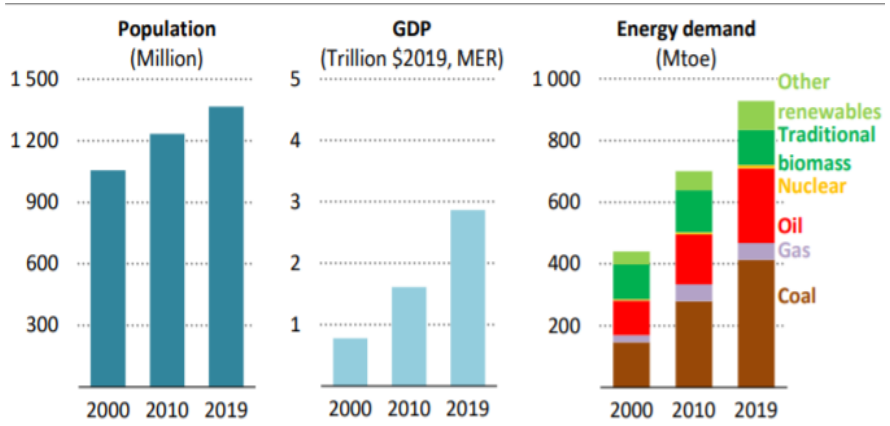
India needs to act Now

- India is 3rd in total GHG emissions
  - GHG emissions increased 335% since 1990
  - As India's GDP grows
    - GHG emissions increasing: **MUST Act Now**

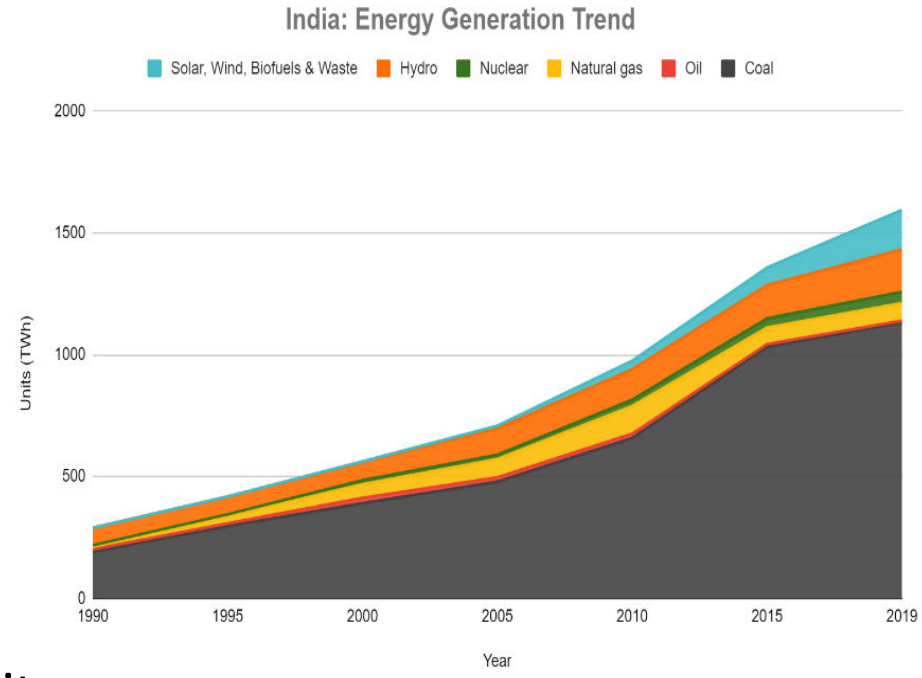
- India must get to net-zero while growing its GDP
  - R&D, Innovation and Governance can get us there by 2047
    - Will cause disruption
  - Strategy: Well to do can invest if commercially viable
    - Policy intervention and incentives
    - Government's focus should be to manage change: Preserve and grow employment and GDP

Appliance Ownership Projections





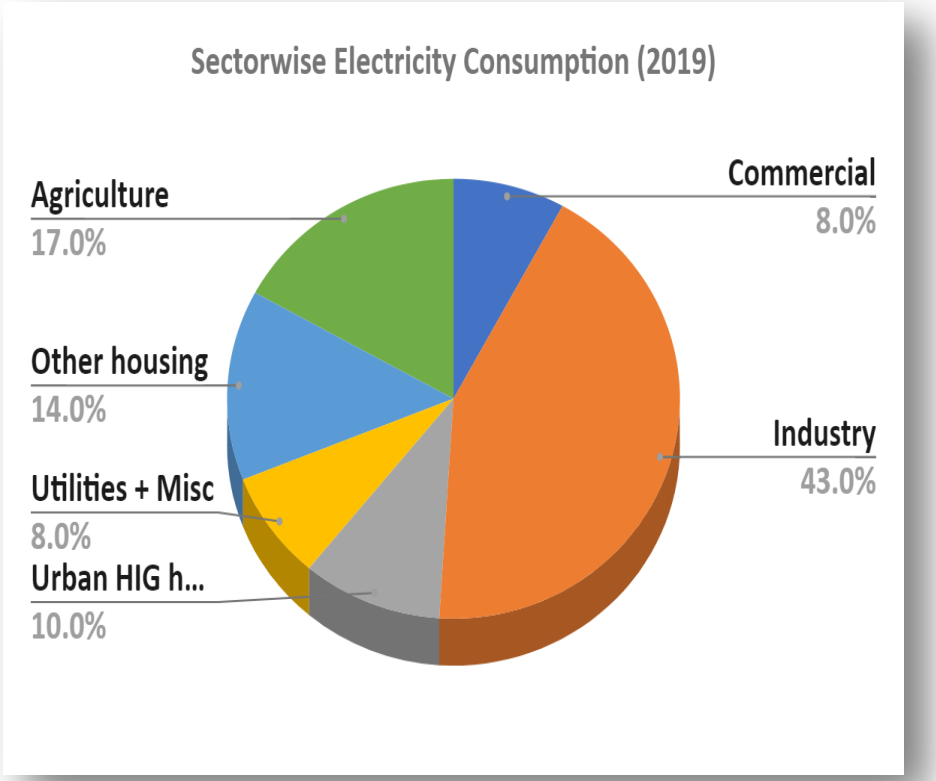
Today in India



- Installed Capacity of RE is 25% of total
  - total electricity generated from solar and wind only around 8%
- Solar and wind-based electricity costs ₹2 to ₹2.50 per kWh
  - Coal-based electricity costs ₹2.50 to ₹4 per kWh
  - Oil / gas-based plants produce at ₹24 / ₹20 per unit
- What stops India from converting fully to renewables?
  - India has plenty of Solar and Wind + Coastal / Ocean Wind for today and tomorrow
- However, Solar and wind-based electricity is not available 24x7
  - need flexibility in the form of Energy Storage

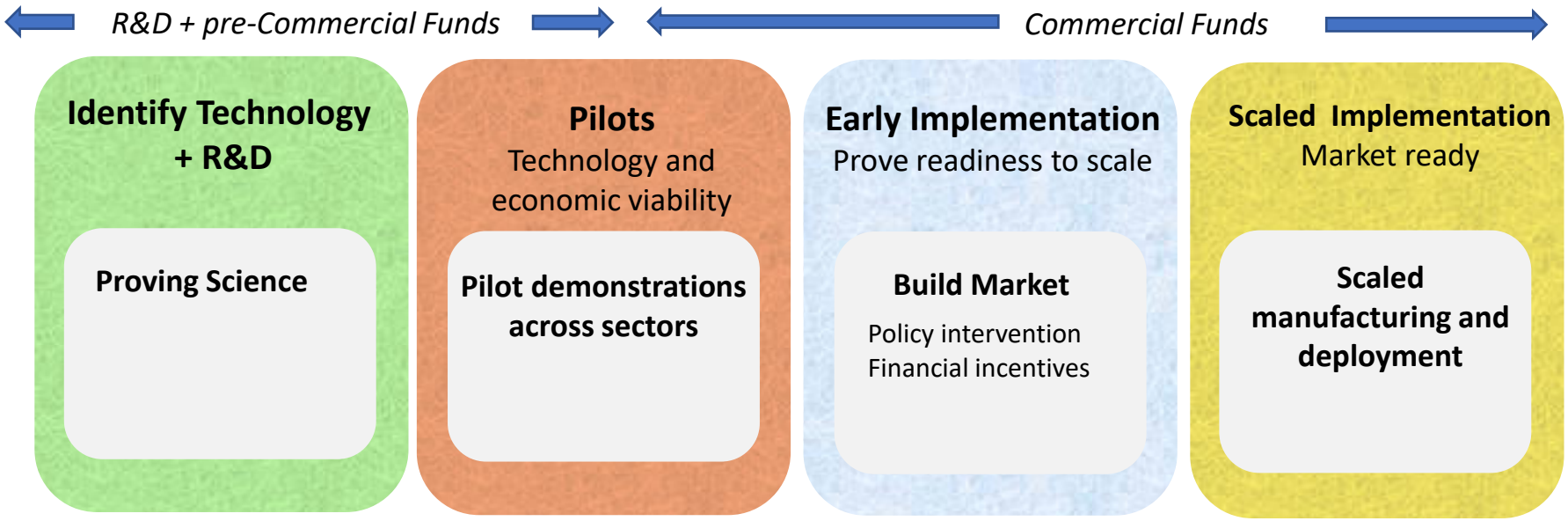
IITM Research Park Pilot for early gains

- Strategy: Starting with those who would invest if there is RoI → ready to scale
  - 65% electricity in India is consumed by Commercial sector + Industries + HIG Residence
  - Currently pays ₹7 to ₹11 per kWh (including DG diesel)
- IITMRP is 1.2 million sq ft commercial / industrial Complex
  - Consumes 40 MWh power per day at ₹9.15 per kWh
  - Open access Solar/Wind generation + Wheeling in through existing T&D lines + Local storage (chilled water + battery) can bring it below ₹8 per kWh
- Can we get Commercial + Industrial + HIG residence to 70% RE in 5 to 7 years?
  - Costs of solar and storage will fall
  - Can we get GREEN power at ₹7 per kWh?



Approach (R&D ➡ Innovation ➡ Commercialisation)

- Four stages to scaled commercialisation
  - R&D and pre-commercial funds for R&D and early pilot
  - Commercial funds for commercial pilots, early and scaled implementation



Technologies Towards 100% RE

Commercialisation in **0-5 Years**	**5-10 years**	**10-15 years**
Solar, Wind and wheeling of RE	Long term Storage: Zn-Air, Al-air	Small modular nuclear reactors
Grid storage: Chilled water + Battery	Ocean, Wave and Tidal energy	Compressed air storage
Energy efficiency in AC & Heat Pumps	Larger EVs and freight transportation	
Strengthening T&D grid for renewables	Green Hydrogen for Ammonia Production	
Hydro-electric storage	Usage of Green H2 in Cement production ++	
Electric Vehicles: 2W /3W	Usage of Green H2 in Iron & Steel production	
Energy Management System	Carbon Capture, Utilization and Sequestration	
Next Generation Solar (*Perovskites PV Cells),* Wind Turbines (Larger Capacity)		
Electrification of construction equipment		
Electrification of agriculture equipment		

Likely Bottlenecks

- From sectors with recent investments in coal and oil: large investments including investments from banks + Large employment
  - Power DISCOMS (loss making)
  - Coal mining Sector
  - Coal-based Power plants: 65% of India's total capacity installed in last ten years
  - Auto industry (+ ancillary industry)
  - Oil sector (refining and distribution)

- Transition requires careful Change Management
  - Help existing industries to transition to GREEN
  - Without impacting GDP and employment
  - Without impact on state powers and revenues

To Sum Up

- India and the world needs to move towards Net-ZERO very rapidly
  - R&D → Technology & Economic viability → Commercialisation
  - Focus on those who have / can raise capital if there is ROI
- Change Management preserving GDP and employment