India's Energy Transitions: Challenges & Opportunities

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India's GHG emissions profile

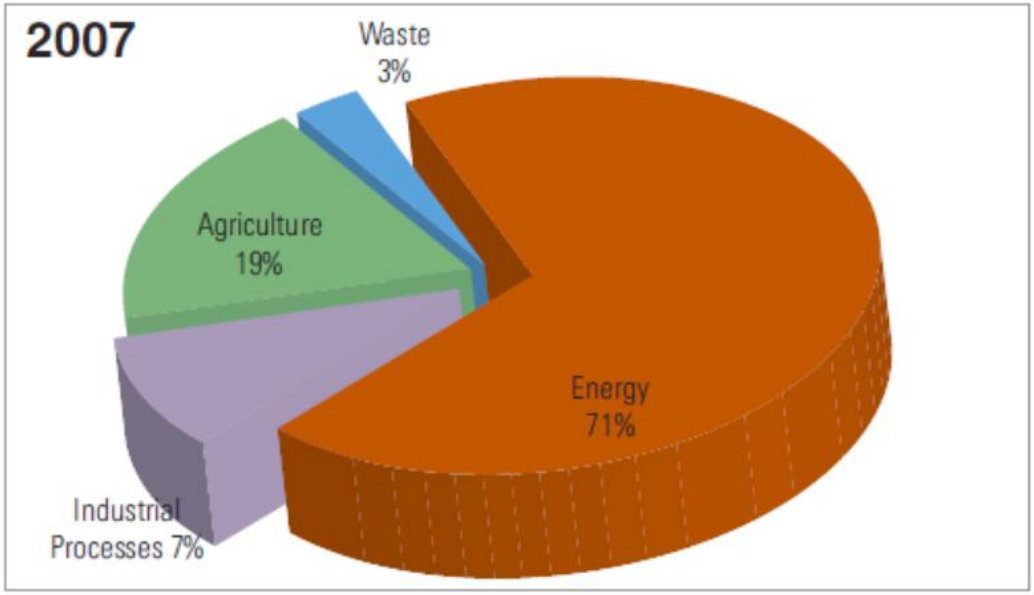


Figure 1: Sectoral distribution of GHG emissions in India (2007
Source: (MOEF, 2012)

- India's GHG emissions grew by 4.5% pa between 2000 and 2007
- Total emissions (inc. LULUCF) being 1771.66 mt CO_2e in 2007
- Energy sector accounts for 71% share in gross GHG emissions of India

India's development challenge

- With 2.4% of the world's area, India houses around 17.5% of the world population
- It houses:
  - largest proportion of global poor (30%)
  - around 24% of the global population without access to electricity (304 million)
  - about 30% of the global population relying on solid biomass for cooking
  - 92 million without access to safe drinking water
  - about 1.77 million people are houseless
  - 4.9% of the population (aged 15 years and above) are unemployed
- India's per capita energy consumption was only 0.6 toe in 2011 as compared to the global average of 1.88 toe [per capita electricity consumption: 917 kWh]
- India: HDI level of 0.609 in 2014 and a global rank of 130.
- No country in the world has been able to achieve a HDI > 0.9 without an annual energy availability of at least 4 toe per capita
- Per capita GDP (nominal): ~USD 1408/year; but wide disparities amongst people & regions

Key aspects of India's INDC

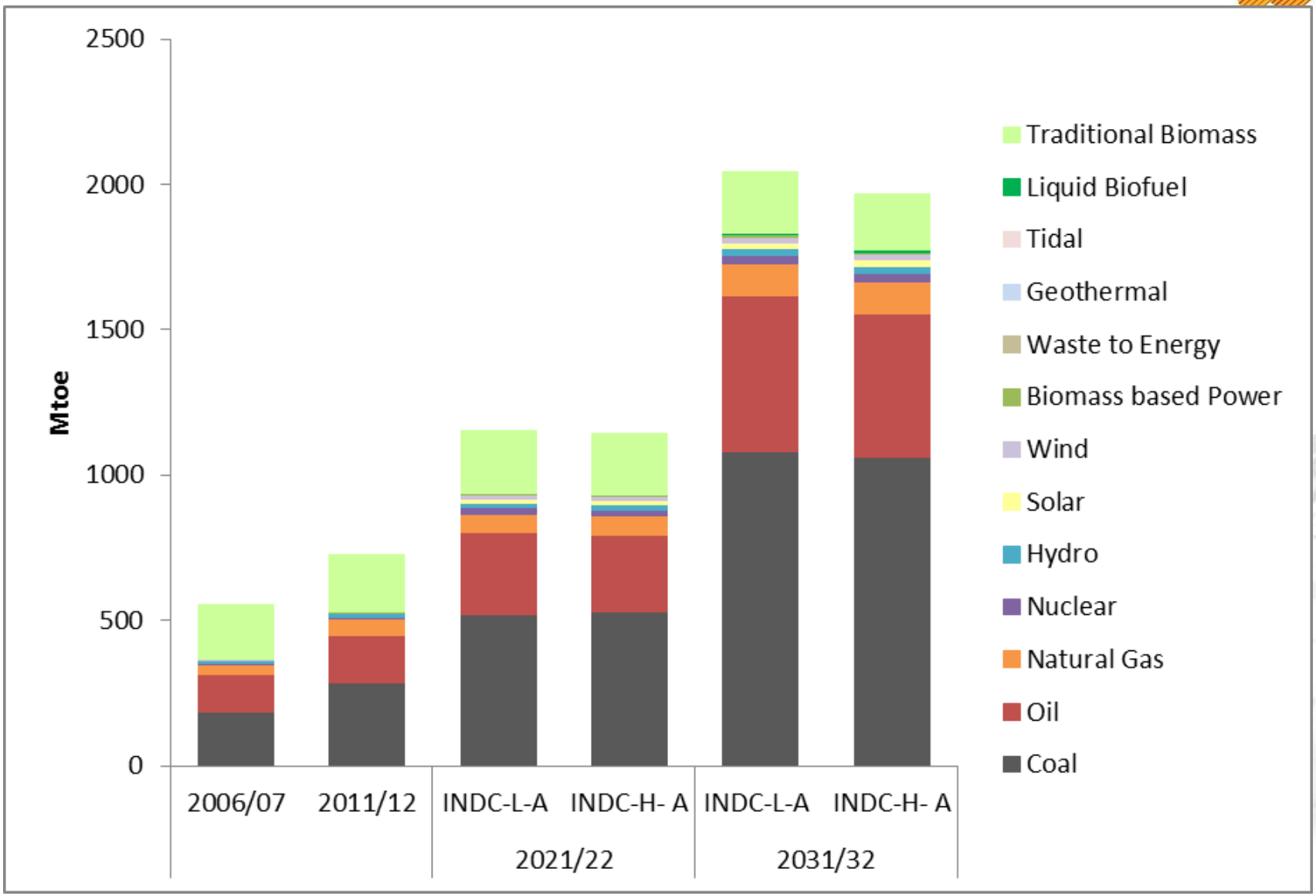
India's INDC – 3 main targets:

1) An unconditional target of 33-35% reduction in emissions intensity of GDP by 2030 from 2005 levels.

2) Achieving around 40% RE share by 2030 (conditional)

3) Creating a carbon sink of 2.5 to 3 bn CO2e through forests.

India's energy trajectory in line with INDC targets



Analysis based on TERI's MARKAL model

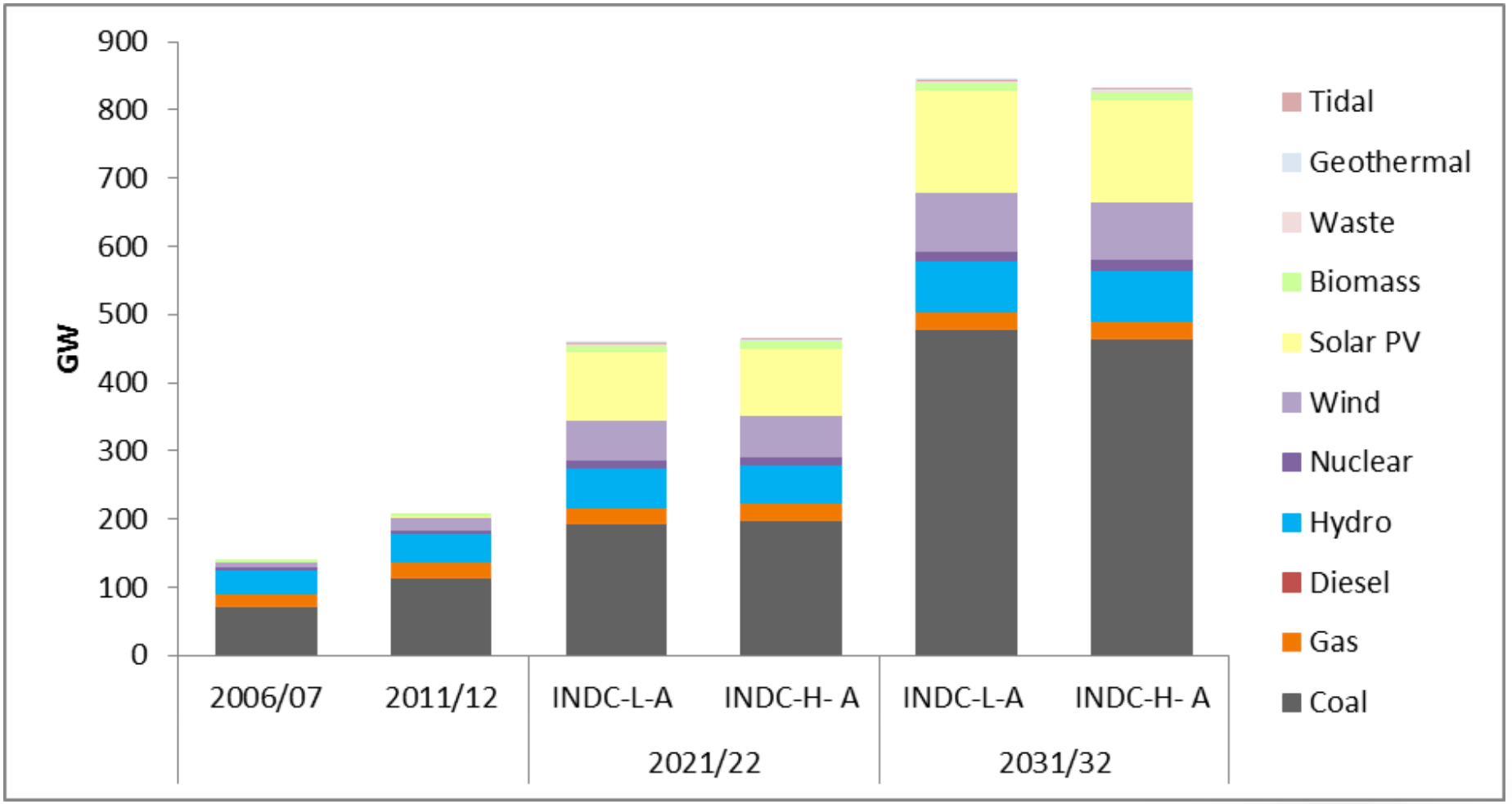
Key elements to achieve the INDC trajectory

- In the transport sector, petroleum products would need to be increasingly substituted by CNG, electricity and biofuels.
- Fuel efficiency of vehicles would need to improve at around 1% per annum over the time period till 2031
- Share of efficient appliances such as air conditioners, fans, coolers & refrigerators would need to increase rapidly; with entire stock of appliances being replaced by efficient appliances by 2051
- By 2031, more than 50% of the lighting demand in both the urban and rural areas would needs to be met by LEDs.
- Increased penetration of Green buildings, especially commercial buildings
- Improved efficiency of public lighting, public water works & sewage pumping
- Efficiency of irrigation equipment & farm practices would need to improve significantly

Power sector to play a major role

- Management and reduction of sectoral energy demands across end-use sectors crucial
- Additionally, success of India's INDC largely related to the power sector, which needs to move to higher efficiencies and greater decarbonization.
- Renewables like solar & wind would need to increase their capacities rapidly and achieve large scale-ups upto 2031
- Storage and solar thermal would need to play a key role
- Cleaner advanced fossil-fuel technologies like supercritical/ ultra-supercritical power generation important
- Need for a robust & balanced power supply grid

Power sector capacity addition



Implications

- Increase in total capacity addition (~800 GW by 2030, depending on the share of RE)
- RE based capacity addition during 2016-2030 has to be greater than capacity addition in fossil based energy
- Coal based generation still most economical – cost of supplying & balancing RE based power still much higher

Challenges

- Focus on the quality of economic growth
  - Bring in investments into the economy, direct investments the energy sector and power sector
  - Policy like 'Make in India' to build employment opportunities
- A strategy on fossils
  - Complementary to the policy on renewable energy to provide base load power
  - Strategy to manage investments, in tandem with other goals
- Capacity development
  - Technologies and investment, especially in management of the power sector
- Finance for infrastructure investment

Managing the power sector transition

- India's power sector transformation has to balance multiple objectives
  - Ensure development targets of poverty alleviation, inclusive development (24X7 Power-For-All)
  - Facilitating INDC achievement
- Enable access to desired technologies & services at prices that people are willing and able to pay.
- Need for financial resources for identification and customization of various technologies to suit local context, needs and scale.
- Adopt appropriate business models and build absorptive capacities

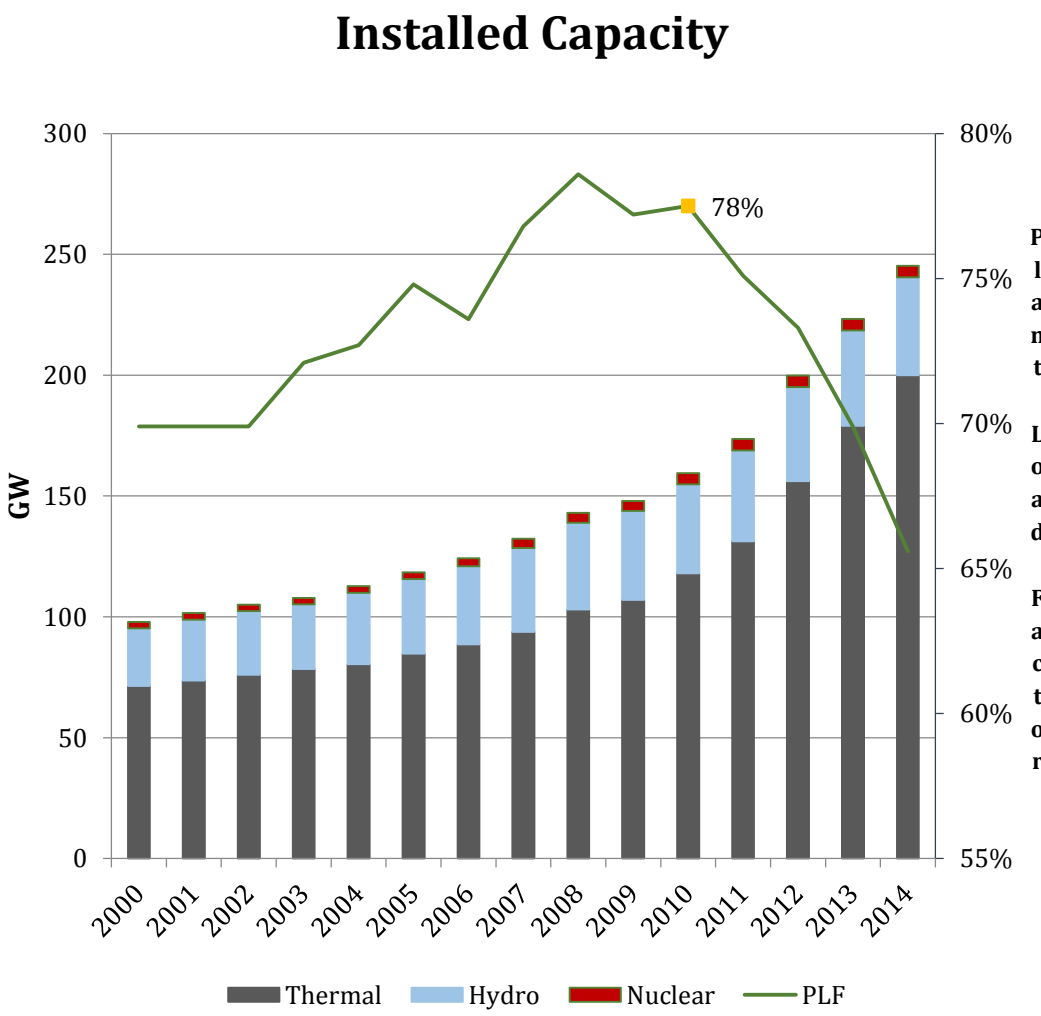
Current snapshot of India's power sector

- **303 GW installed capacity (31 May 2016); by 2022 > 500 GW** (Major addition from RE 175 GW)
  - Non-renewable 72%
  - Renewable 28%

- **Need to enhance access to basic energy & infrastructure in an affordable manner**
  - TERI estimates 2200 TWh by 2022 at GDP growth rate of 8.3%

- **Declining deficit**
  - Reduction in T&D losses from 37% in 2003 to 27% in 2013 (excluding latent demand)

- **Short term fall in PLF**
  - PLF has been falling since 2009, but likely a short term phenomenon



Implications

- Low PLF: Economic inefficiencies and cost to economy
  - Could this imply a lock-in in potentially infructuous fossil based generation?
  - Unavoidable requirement in the short term in the absence of competitive & reliable alternatives available at scale
  - Managing robustness of economic activity in economy equally relevant as enhancing shares of intermittent RE and ensuring a robust & balanced power supply system
- Investments are required in the capacity development within power sector stakeholders
  - Management solutions for distribution utilities to be able to forecast demand

Need for modelling & scenario building to understand India's energy transitions

- Understand changing demand patterns
  - What would be the magnitude and nature of power sector demand?
    - Influences planning for the correct mix of fuels & technologies
  - Wide variations in peaks across seasons and across regions
    - Relevant for DSM and optimal planning for base and peak loads
- Variability in power a growing concern with larger share of renewable capacity
  - Resource availability patterns across regions and seasons need to be understood to harness the appropriate resources
- Short term and long term transitions need to be integrated in a dynamic manner
  - Long term directions need to be maintained as a goal, but short term measures need to be continuously reassessed and managed as well
    - Minimise infructuous infrastructure & technology investments
  - Long term policies to guide R&D investments, nudges for behavioural change; planning for robust and well managed supply network & planning for structural changes /impetus to appropriate sectors

Need for application of various tools & frameworks

- Estimating the financial needs (Techno-economic analysis of options)
- Evaluating co-benefits and co-costs in an integrated manner
- Multi-criteria analysis and integrated planned approaches to minimise lock-ins.

Challenges can be viewed as opportunities

- India's growth story can be viewed as an opportunity as well
  - Should take advantage of technological leapfrogging and move to efficient options as quickly as possible
- Large gestation & lock-ins of energy infrastructure need to be carefully planned for
- Integrated and dynamic planning through appropriate modeling frameworks and tools necessary

Thank you for your attention....