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"Enabling Energy Transition towards Low-Carbon Pathways: TERI's Activities"

27th July, 2018 | Lawrence Berkeley National Laboratory (Berkeley Lab)

Creating Innovative Solutions for a Sustainable Future

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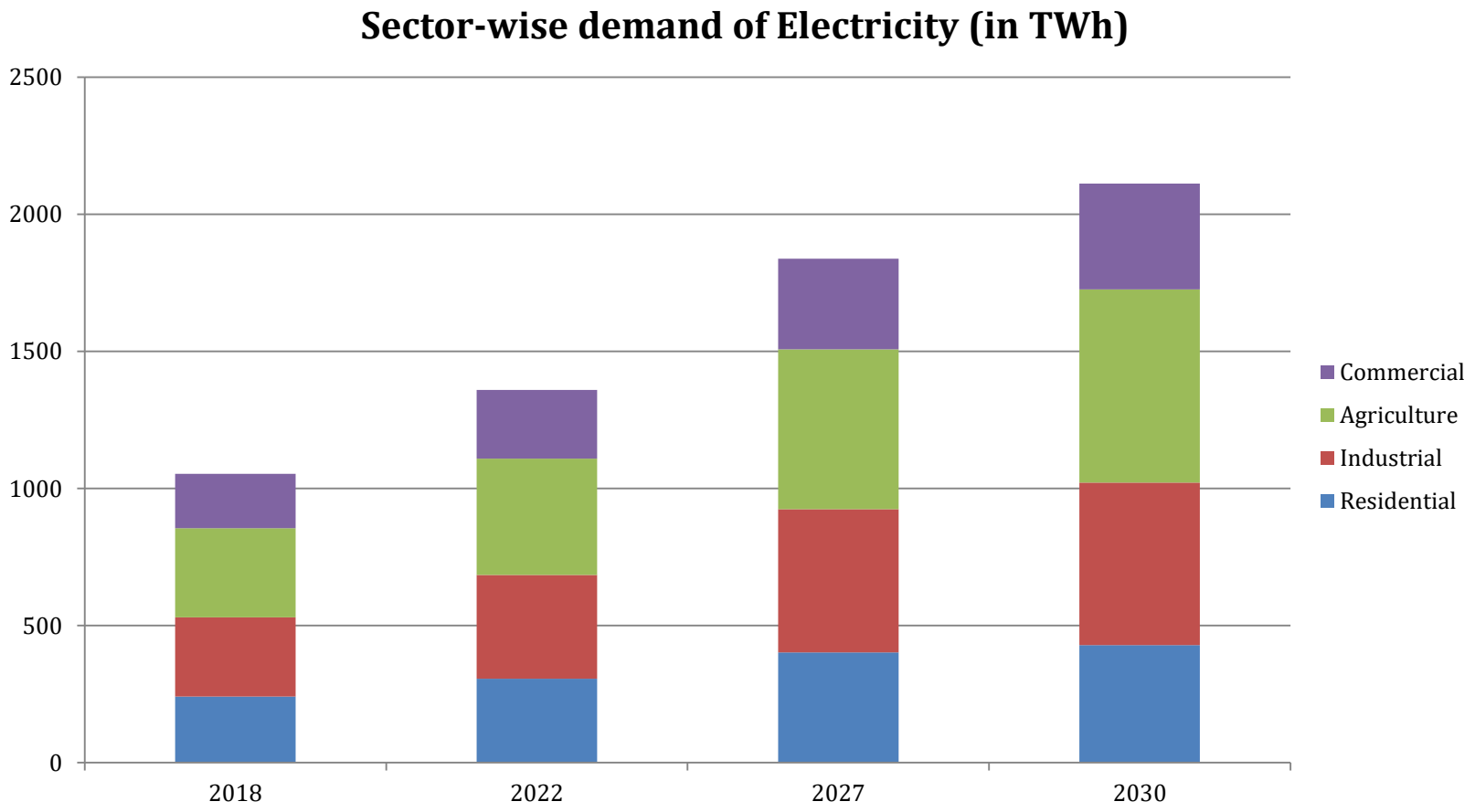
Dr. Shashank Vyas, Associate Fellow
&
Er. Alekhya Datta, Fellow
Electricity & Fuels Division (EFD), TERI

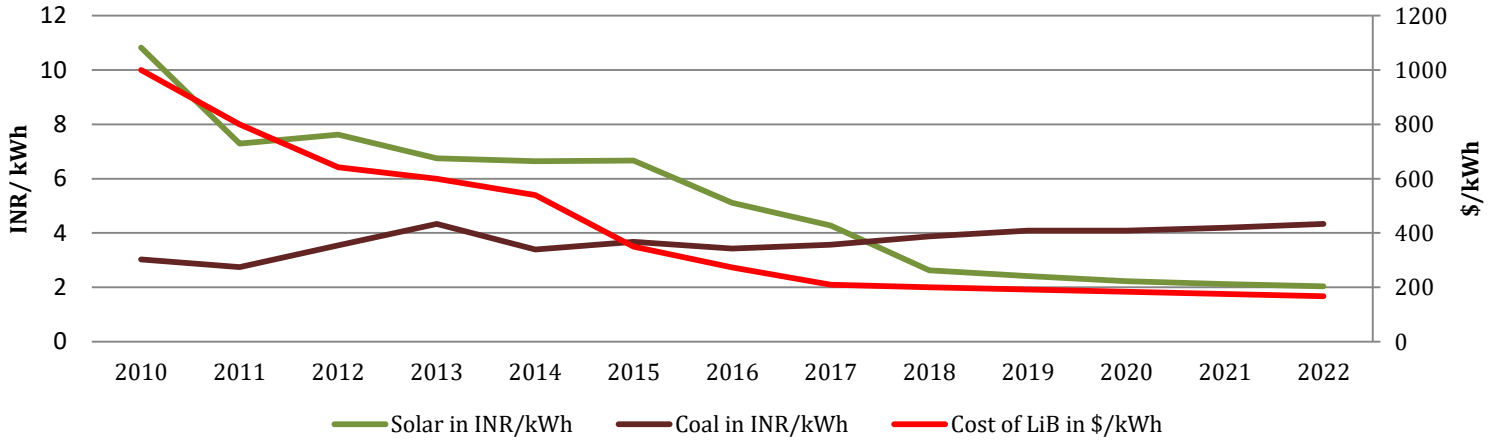
ELECTRICITY DEMAND IN INDIA BY 2030



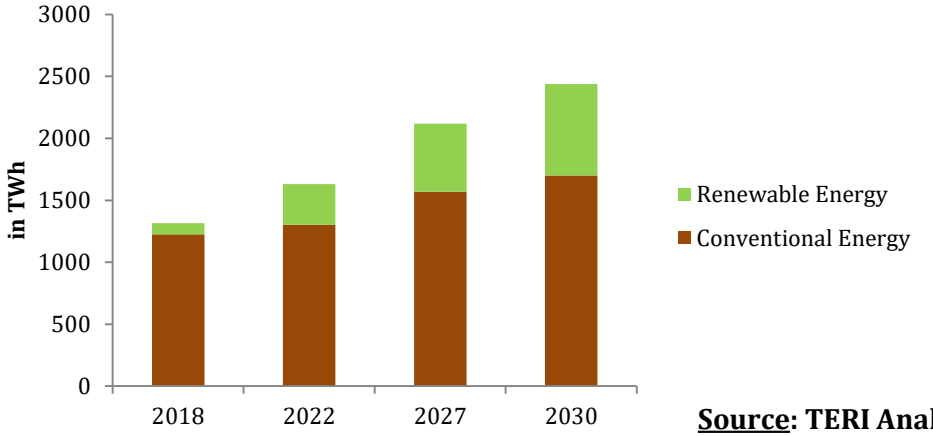
Source: TERI Analysis

India's Solar Transition/ Electricity Transition

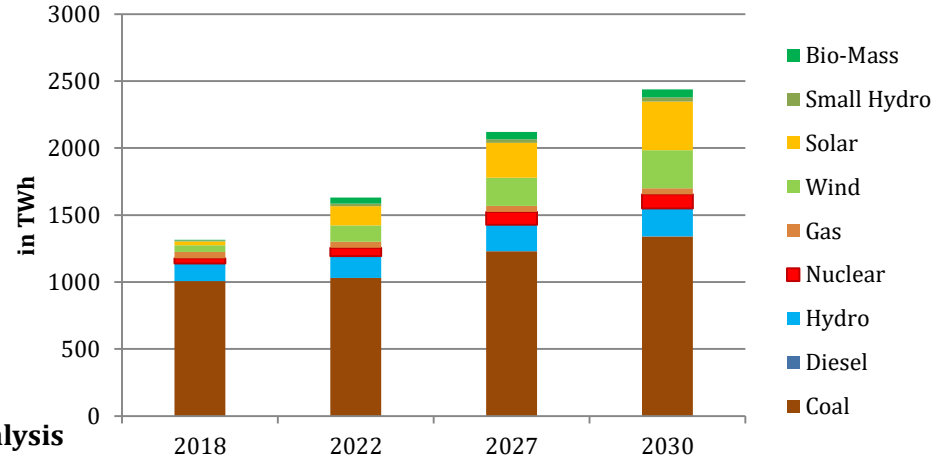
Price/ Tariff Trends



Power Generation in India (By 2030)



Source-wise Power Generation in India (By 2030)



Source: TERI Analysis

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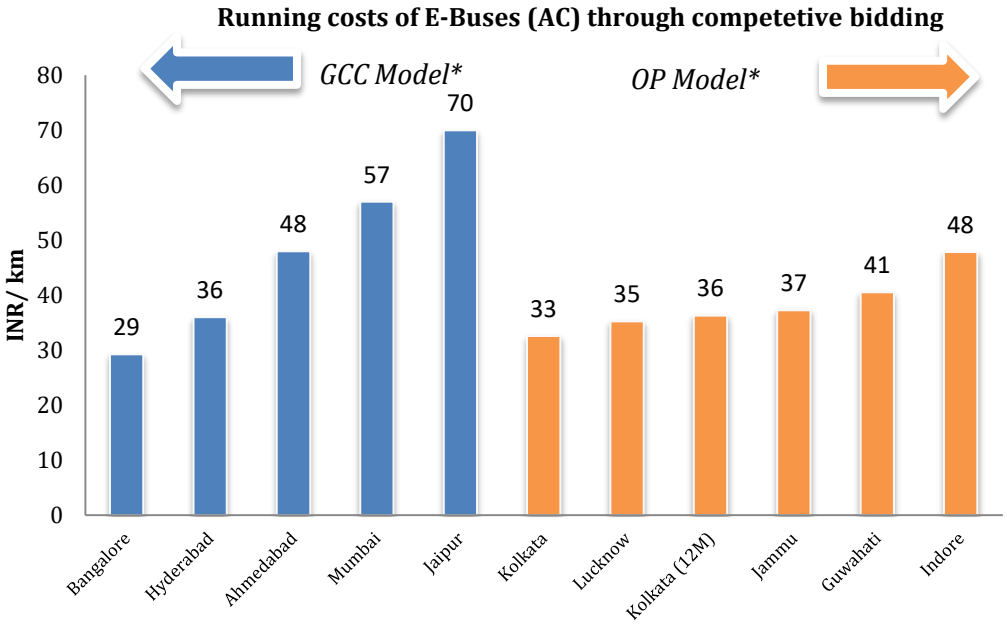
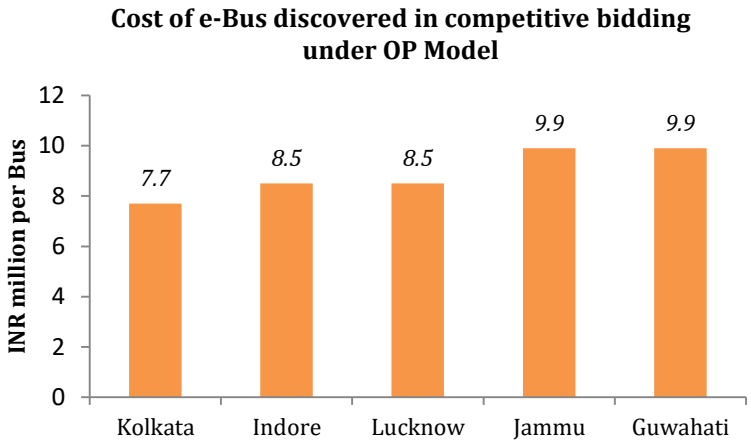
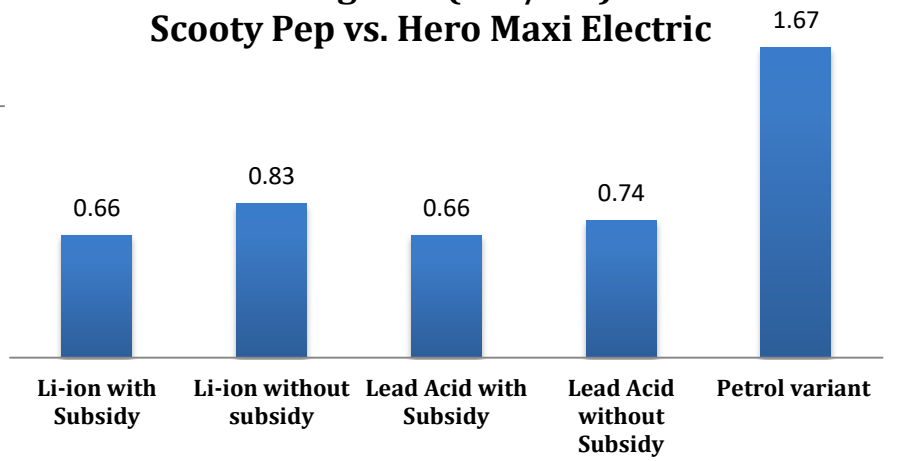
CASE FOR TRANSPORT ELECTRIFICATION

AC Electric Bus total cost bid without Subsidy INR/ km lower than of Diesel Bus today:







Diesel Bus = INR 60-80/ km; Electric Bus (AC) = INR 30-55/ km (without Subsidy)

Note: Daily distance travelled = 170-200 kms.
Cost includes capita repayment at 10% interest, electricity, O&M costs & battery replacement for purchased buses in year 8. FAME subsidy is excluded in these estimates.
***Gross Cost Contract (GCC) & Outright Purchase (OP)**

Note: Daily distance travelled = 40 kms; Battery replacement costs are included.

Source: TERI Analysis

Electrification of the Industry Applications

Switch from thermal heating to electricity in industrial processes:

- **Fuel switching can be explored in a number of other sectors e.g. foundries, forging, secondary steel, chemicals, textiles, food processing, etc.**
- **Switch over would depend upon availability of suitable technologies (including detailed design & engineering solutions), comparative prices of fuels, finance etc.**

Source: TERI Analysis

Case study of a typical forging furnace:

Switch over from furnace oil (FO) firing to Induction billet heater,

Capacity of FO furnace	400 kg. per shift
Capacity of induction billet heater	45 kW
Investment	INR 22 lacs.
Avoided FO consumption	93 kl/ Year
Electricity consumption with induction heater	1,78,000 kWh per Year
GHG reduction potential	270 t CO_2/ Year

NEED FOR TRANSITIONING TO LOW CARBON INDUSTRIES

- **Many large industry sub-sectors undertaking steps to reduce their energy intensity:**
  - **Few are already equivalent to global standards e.g., cement, fertilizer**
- **Opportunities to further reduce Specific Energy Consumption (SEC) levels exist in several units in both large industries and MSMEs;**
- **A major challenge is to transit from fossil fuels to low carbon energy sources for thermal (process) energy requirements in 'Hard-to-abate' sectors such as iron & steel, cement, etc.**
  - **No commercially available zero carbon technologies globally; few are under development**
  - **Need for long-term collaborative R&D with global players**
  - **Huge capital investment and long gestation periods**

POSSIBLE STEPS TOWARDS LOW/ ZERO CARBON EMISSIONS – CEMENT INDUSTRY

1. **Improve efficiency through modernisation and adoption of EE measures – Reaching global best levels**
   - ❑ **Reduce SEC-Thermal : From 725 kcal/ kg clinker to 660 kcal/ kg clinker**
   - ❑ **Reduce SEC-Electrical : From 80 kWh/ t cement to 65 kWh/ t cement**
2. **Meet all electrical energy needs through RE sources**
3. **Meet thermal energy requirements for combustion through electric route (fully/ partially) – *to be explored***
4. **Remaining CO_2 emissions only from calcination**

***Alternate routes*:**

1. **Carbon Capture, Utilization, and Storage (CCUS)**
2. **Explore/ Research and switch over to alternate materials that avoid CO_2 generation (e.g., Timber for housing, new chemistry, other options ??)**

POSSIBLE STEPS TOWARDS LOW/ ZERO CARBON EMISSIONS – IRON & STEEL INDUSTRY

1. **Improve efficiency through modernisation and adoption of EE measures – reaching global best levels**
   - ❑ **Blast Furnace (BF)/ Basic Oxygen Furnace (BOF) Route - Reaching to SEC level of 5.5 Gcal/ tcs (giga calories per tonne of crude steel)**
   - ❑ **Electric Arc Furnace (EAF)/ Induction Furnace (IF) route through RE sources – Increase production to the extent possible; increase circularity**
2. **Use of hydrogen for iron ore reduction as a substitute for coke/coal**
   - **Hydrogen through biomass route or electrolysis of water**
3. **Meet thermal energy requirement through RE based electricity and/or, off-gases generated in the process**

FREIGHT TRANSPORT

Technological choices are not yet clear:

- LNG Trucks?
- Long Distance Electric Trucks?
- Aviation (adoption of Bio-Fuels)

  - Technology development
  - Economically viable

PROMOTING ENERGY EFFICIENCY

Innovative business models need to promote:

- **Energy efficient appliances at Household-level, mainly Air Conditioners;**
- **Industrial energy efficiency;**
- **Energy efficient Electric Vehicles (including Charging Infrastructure)**
- **Energy efficient Pump-sets (including Solar pumps) for Agricultural applications, and**
- **Building energy efficiency (promoting ECBC & GRIHA)**

Conclusion & Way Forward

- Decarbonization of Indian electricity sector is now inevitable;
- Promoting energy efficiency through innovative Business Models for large scale adoption of energy efficient technologies & practices;
- Electrification of Buses & Two-Wheelers: Challenges – Charging Infrastructure;
- The techno-economic viability of electric heating vis-à-vis fossil fuel based heating should be explored in selected energy intensive industry processes, and
- Decarbonizing 'hard-to-abate' sectors such as Steel / Iron & Cement – Research on technologies is needed.