



# Indian Industry Sector Decarbonization: Technology and Policy options

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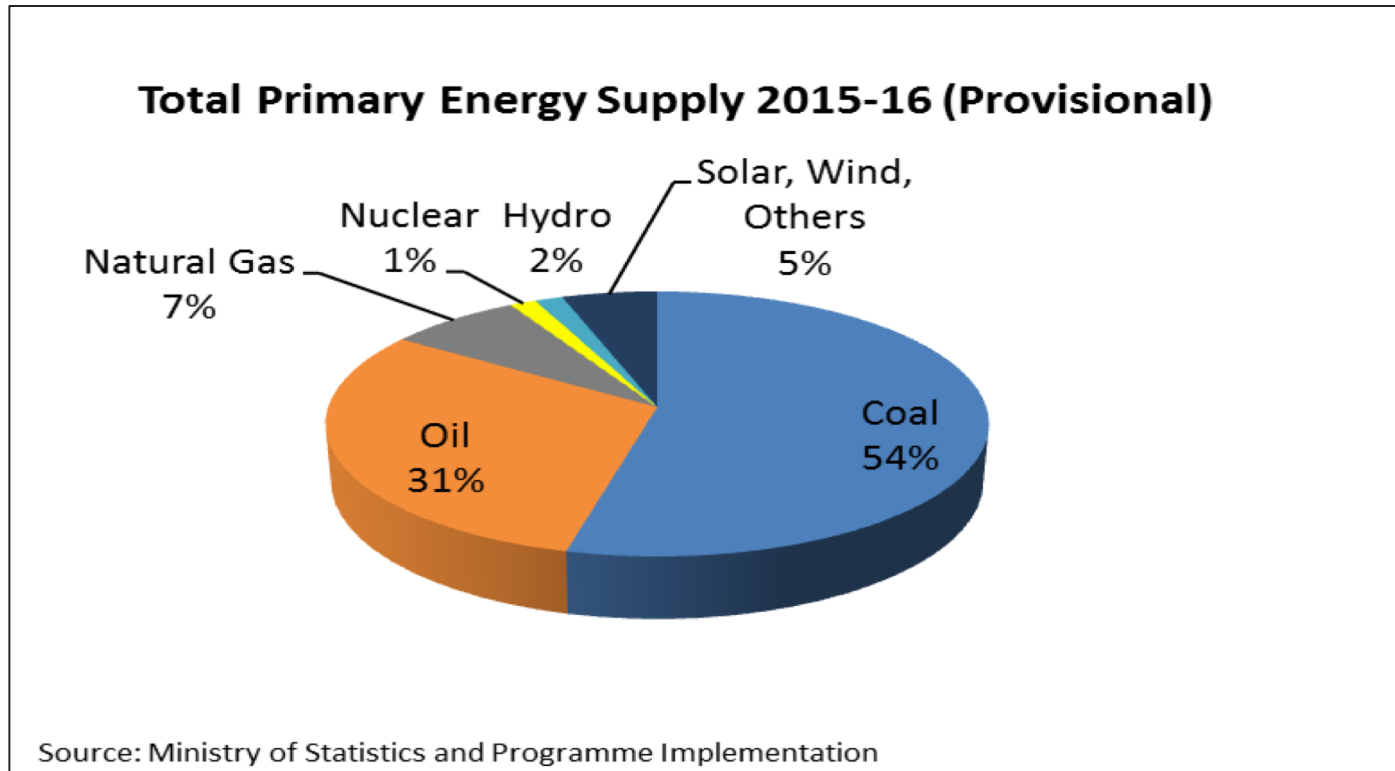
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# Snapshot: Energy Supply



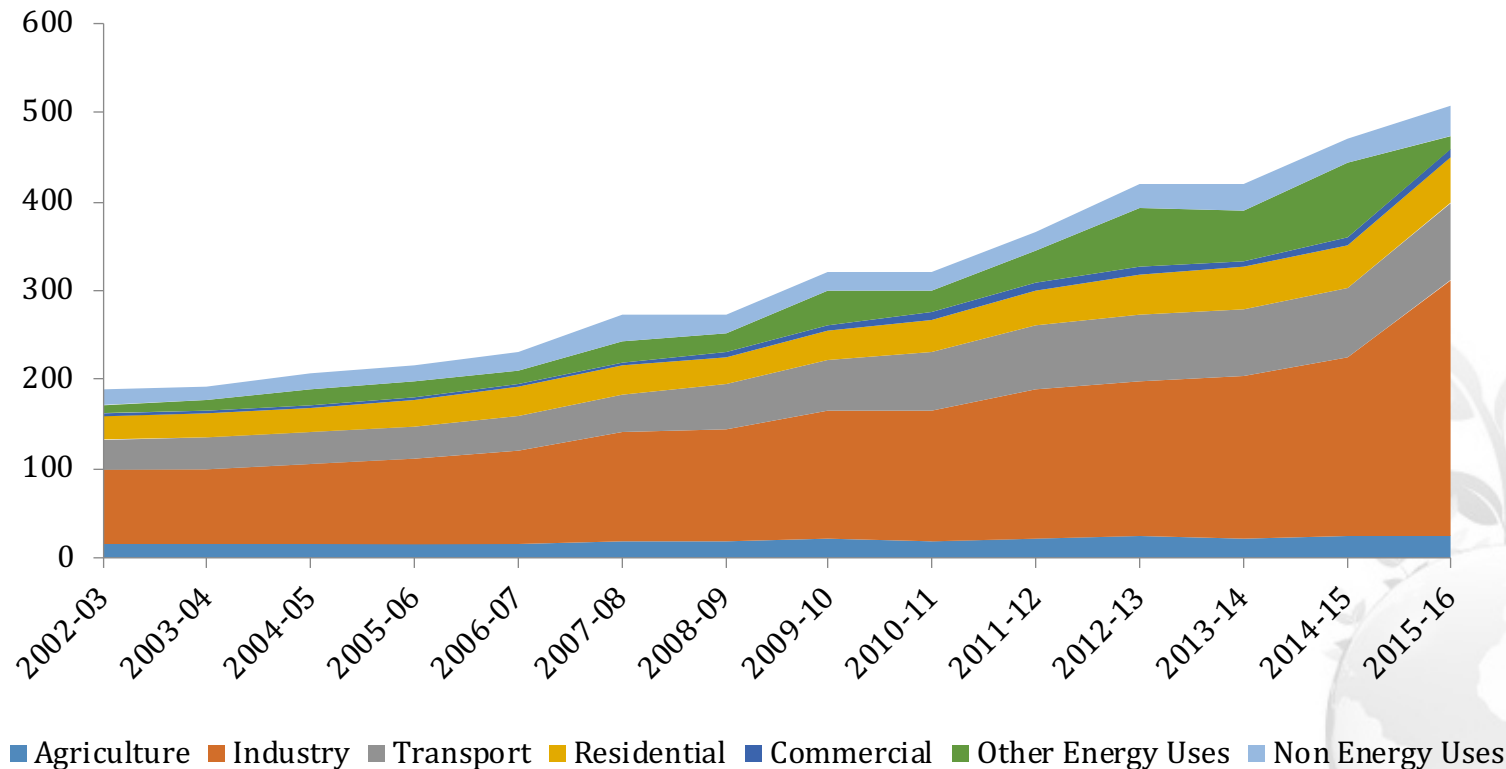
**Coal- largest share in energy supply- mainly power & industry sector**

**Oil- Second largest share- mainly transport sector**

**Renewable Energy – increasing at a rapid pace**

# Snapshot: Energy Demand- India

Energy Demand (Mtoe)



Source: TERI Analysis

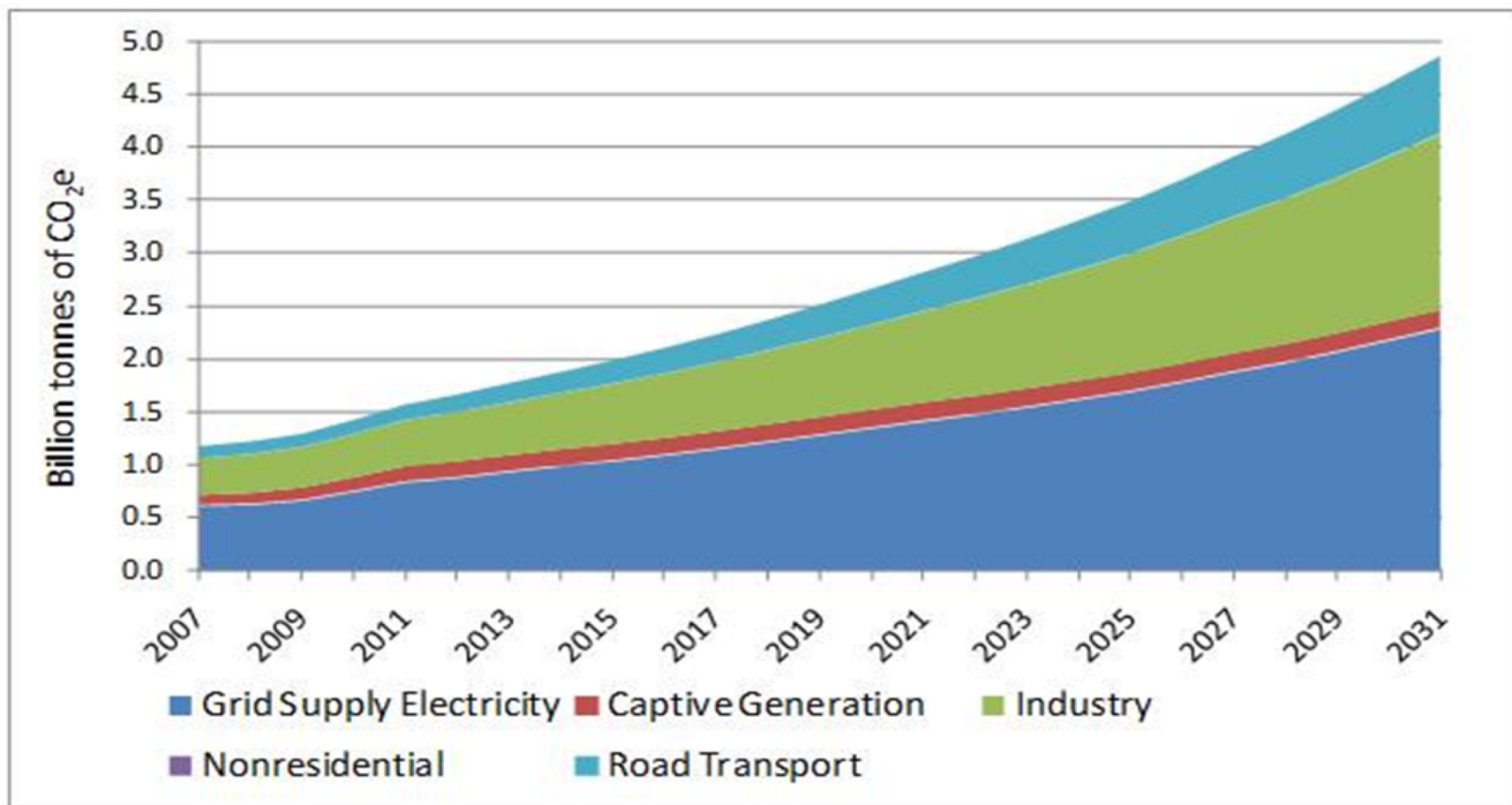
**Average Growth Rate of total final energy: 8%**

**Maximum Share: Industry(57%)**

**Rapid growth: Commercial (10%) & Transport sector (9.6%)**



# Enhancing energy consumption IMPLIES increased GHG emissions



# Drastic reductions in emissions by 2050 and beyond would require ...

- ☐ Continuing with the present pace of large scale deployment of renewable energy sources (both power & heat)
- ☐ De-carbonization of energy-intensive industries, especially cement, steel & “other” sectors
- ☐ Shift of city transport to electric vehicles and exploring low carbon options for long distance trucking, shipping and aviation

*Collaboration is essential for setting-up (joint) R&D goals, learning from pilots, and converge on technical options*

# Industry Sector



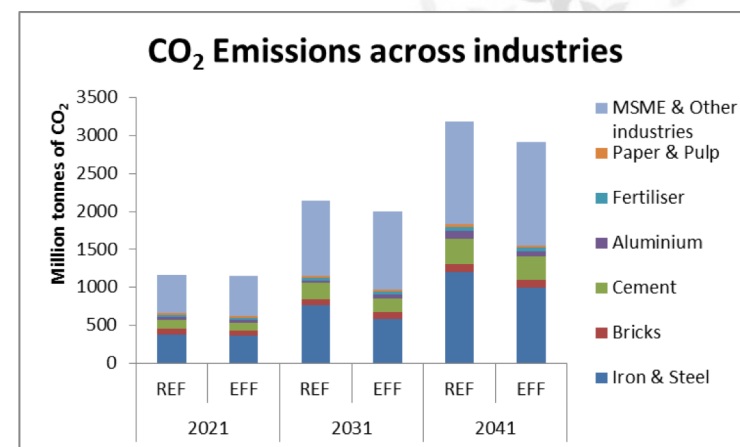
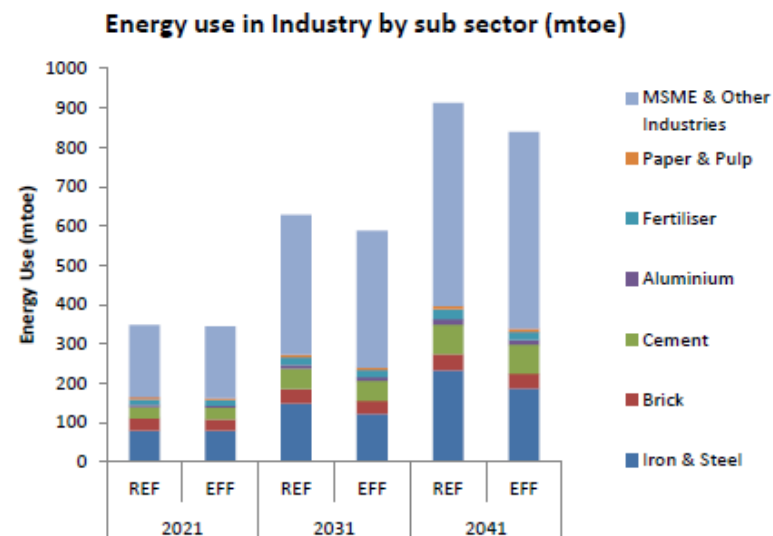
# Indian industrial sector

- ❑ The share of manufacturing sector in overall GDP of India ~ 16.5% (2016)
- ❑ Total commercial energy consumption of India : 360 Mtoe (2014-15)
  - ✓ Share of industry is 200 Mtoe (~ 56%)
- ❑ Industry sector including MSMEs offer significant potential for EE improvements
- ❑ Adoption of EE options in industries include:
  - ✓ Process specific technologies
  - ✓ Cross-cutting technologies
  - ✓ Fuel switch, including electrification wherever feasible
  - ✓ Recycling & use of secondary materials



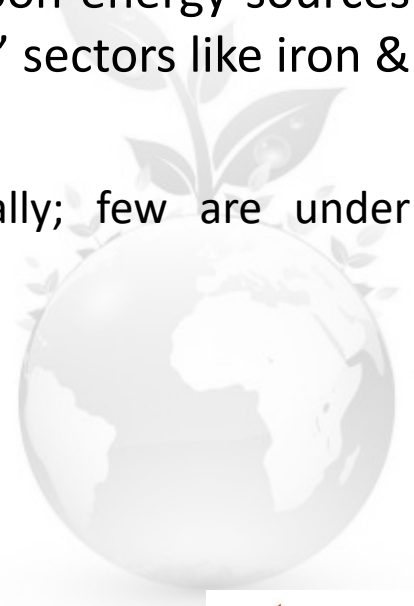
# Future trends - industrial energy consumption

- ❑ Policies of Government of India such as “Make in India” will provide an impetus to the manufacturing sector.
- ❑ Industry sector will continue to remain the major commercial energy consumer in India
- ❑ Industry sector has a significant potential for energy efficiency improvements distributed across various sub-sectors.
- ❑ GHG emission reduction potential of around 300 mt CO<sub>2</sub> in EFF scenario by 2041
  - ✓ Largest potential in Iron & Steel sector
  - ✓ Other sectors including MSMEs offer huge saving potential



# Hard To Abate sectors

- ❑ 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 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 like 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

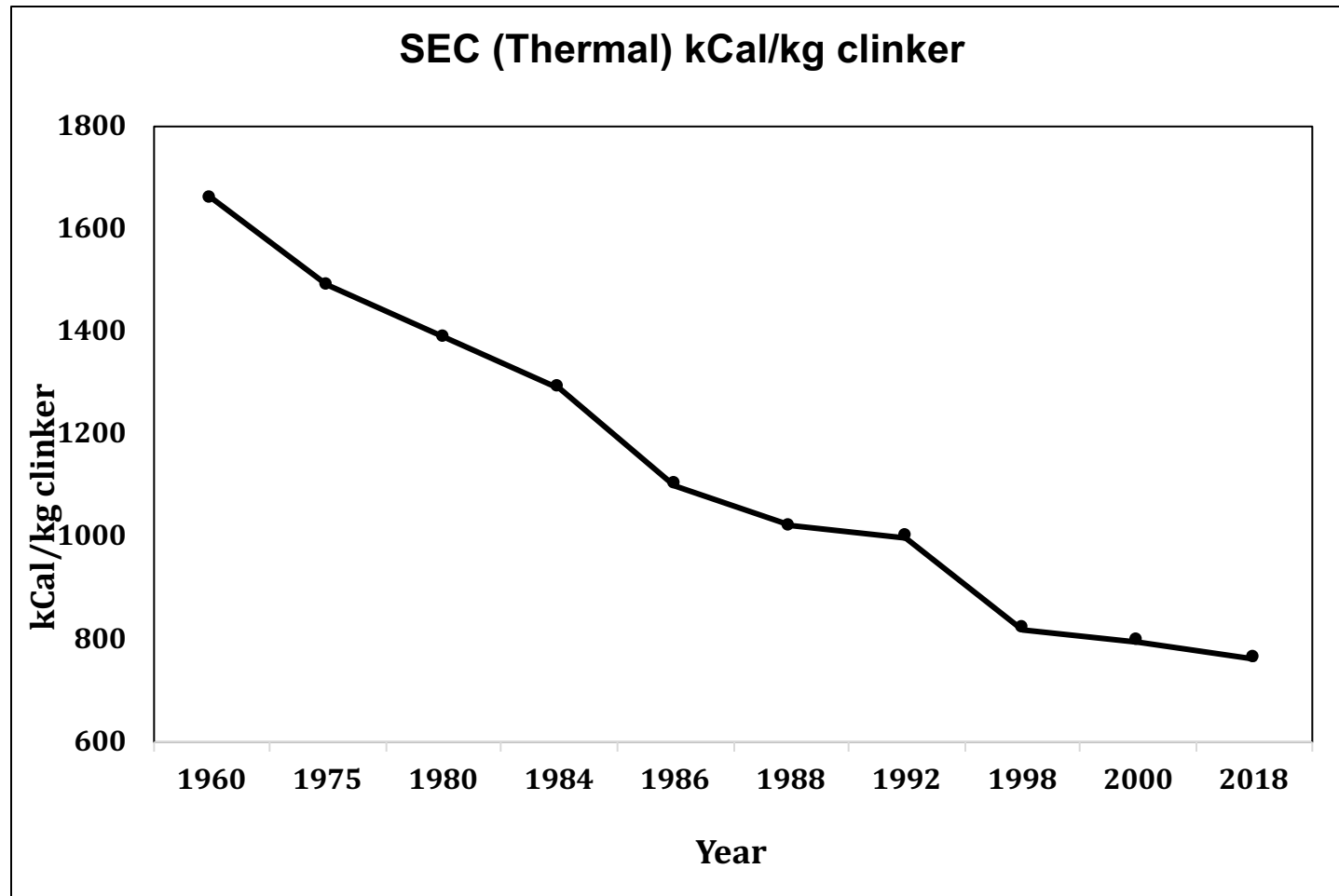


# Cement industry

- ❑ Total installed capacity of cement is 361 million tonne, producing a variety of cements; Ordinary Portland Cement, Portland Pozzolana Cement, Portland Slag Cement, etc.
- ❑ Expected production by 2050: 1350 million tonnes
- ❑ Large cement industries (210 no.) accounting for 97% of total capacity
- ❑ Cement sector is one of the most technological advanced industries in India
  - ✓ Modern efficient “dry process” technology accounts for about 99% production
- ❑ Energy performance of Indian cement industry vis-à-vis global level
  - ✓ Indian Average: Thermal – 762 kcal/kg clinker; 82 kWh/t cement
  - ✓ India Best : Thermal – 667 kcal/kg clinker; 67 kWh/t cement
  - ✓ Global Best (Japan): 660 kcal/kg clinker; 65 kWh/t cement

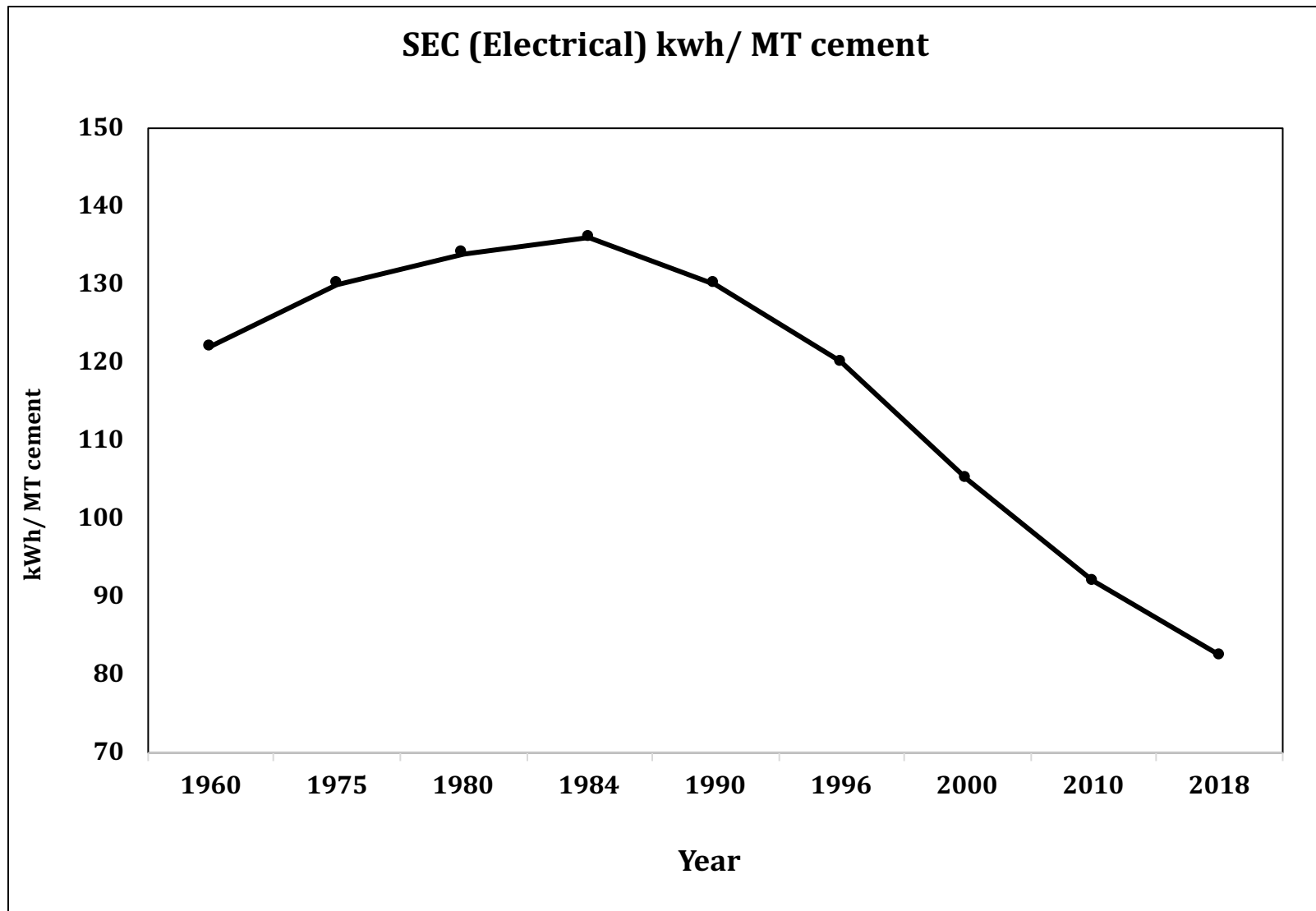


# Thermal energy consumption trends in cement plants





# Electrical energy consumption trends in cement plants



# 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 762 kcal/kg clinker to 660 kcal/kg clinker
  - ❑ Reduce SEC-Electrical : From 82 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<sub>2</sub> emissions only from calcination
5. Reduce demand of cement through improved structural practices

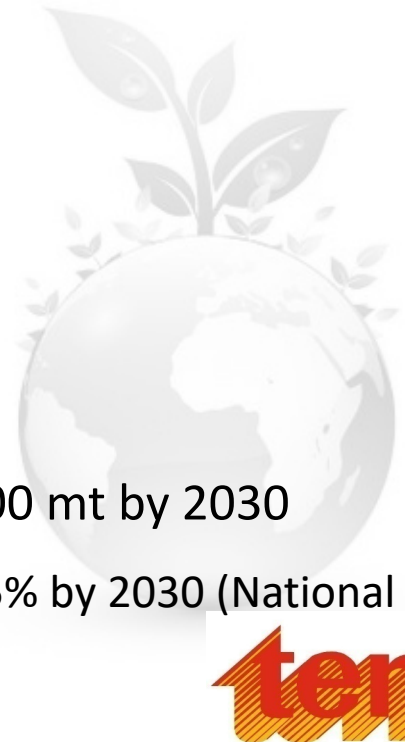
## Alternate routes:

1. CCUS - ?
2. Explore/ Research and switch over to alternate materials that avoid CO<sub>2</sub> generation (e.g. Timber for housing, new chemistry, other options ??)

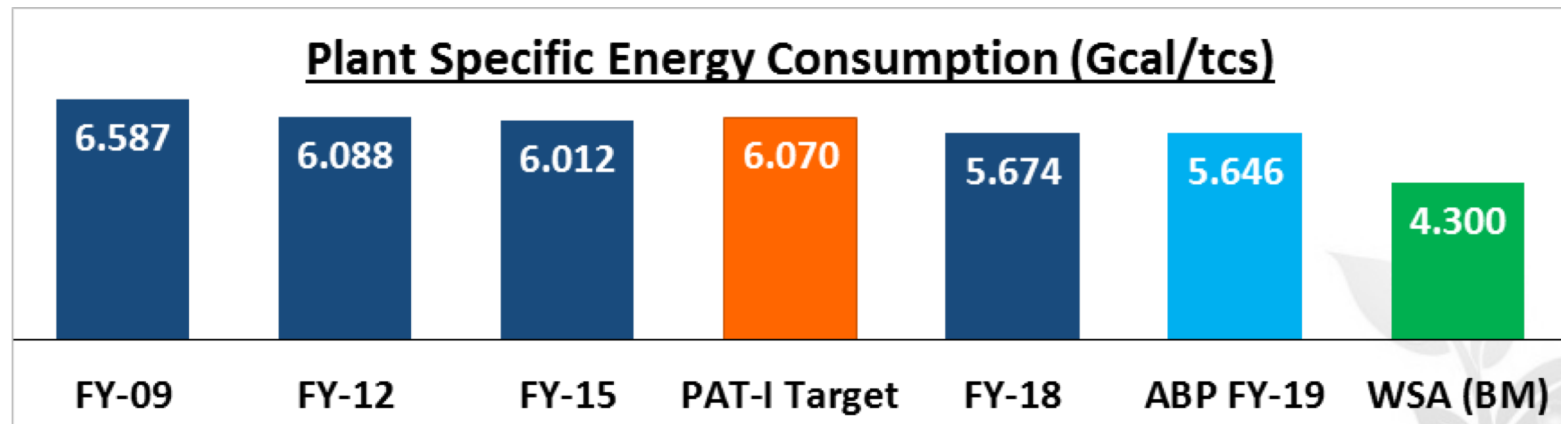


# Iron & steel industry

- ❑ Annual production is ~ 98 million tonne (2016-17)
- ❑ Technology use:
  - ✓ Primary producers - Blast furnace- Basic oxygen furnace (BF-BOF) route (42% of total production)
  - ✓ Secondary producers - Direct reduced Iron (DRI) with Electric Arc Furnace (EAF)/Induction furnace route (~58%)
- ❑ SEC of crude steel production:
  - ✓ BF-BOF route :
    - India : 5.92-7.52 Gcal/t crude steel
    - Japan : 5.47 Gcal/t (Best)
  - ✓ DRI route : 4.5-5.5 Gcal/t (India)
- ❑ With new capacity additions, steel production would touch 300 mt by 2030
  - ✓ Share of energy intensive BF-BOF route would increase to 60-65% by 2030 (National Steel Policy, 2017)



# Energy consumption trends in Integrated steel plant: Tata Steel



Source: Tata Steel

ABP- Annual Business Plan  
WSA- World Steel Association  
BM- Benchmark

# Possible steps towards low/zero carbon emissions – Iron and steel industry

1. Improve efficiency through modernisation and adoption of EE measures – reaching global best levels
  - ☐ BF/BOF Route - Reaching to SEC level of 5.5 Gcal/tcs
  - ☐ EAF/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

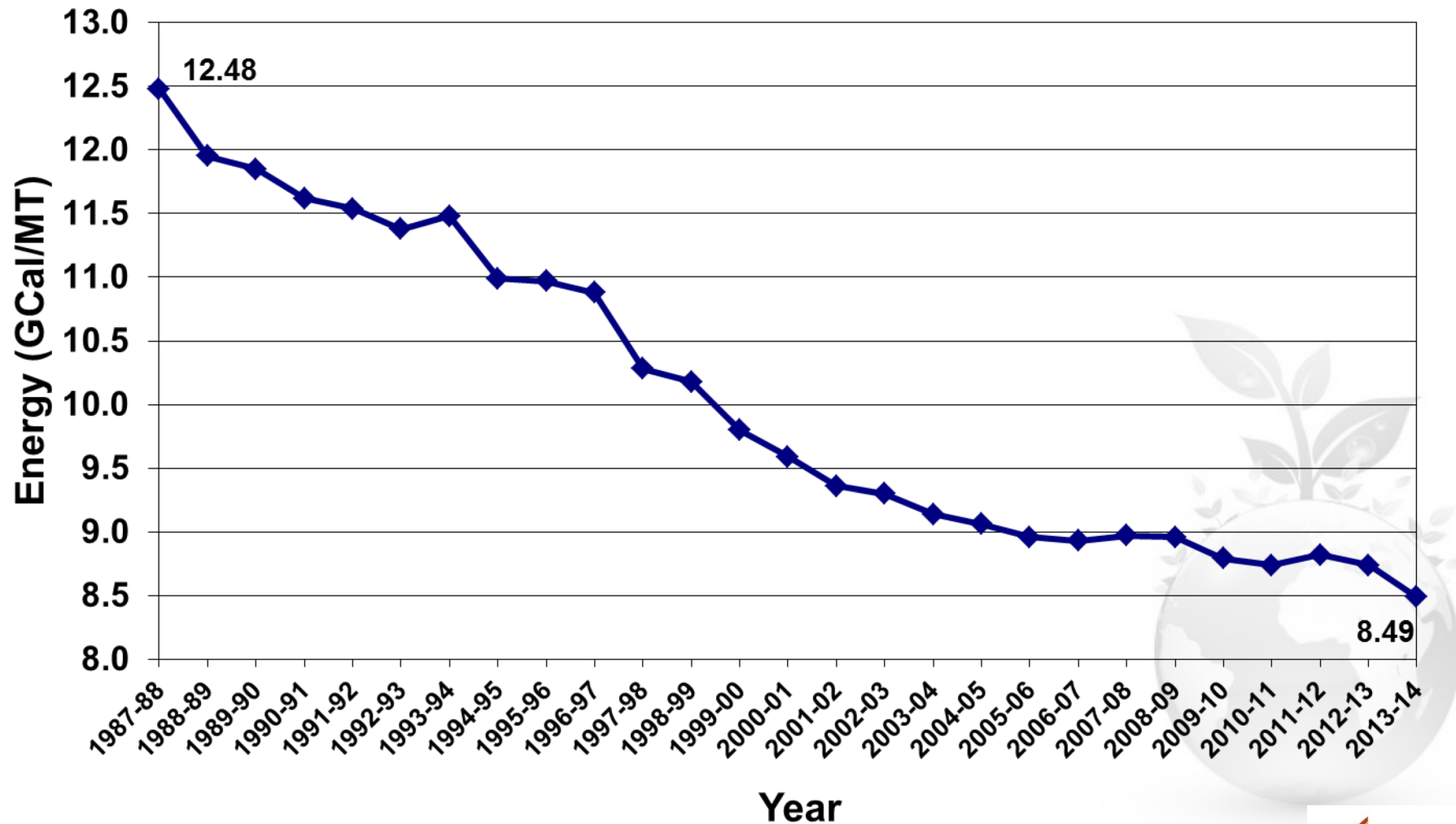


# Fertiliser industry

- ❑ Annual production is ~ 41 million tonne (2016-17)
- ❑ India's dependency on import is to the extent of 25% of our requirement of Urea, 90% in case of Phosphates and 100% in case of Potash
- ❑ Ammonia-urea manufacturing is most energy-intensive segment in the chemical fertilizer industry. It accounts for about 85% of the total energy consumption in the sector.
  - ❑ Fuel : Mainly Natural Gas
- ❑ Ammonia accounts for 80% of the energy required for the production of urea.
- ❑ SEC of gas based ammonia manufacturing plants (2010/11)
  - India ~ 8.29 Gcal/tonne of ammonia
  - Europe ~ 8.41 Gcal/tonne of ammonia and
  - USA ~ 8.51 Gcal/tonne of ammonia (FAI 2015)



# Energy consumption trends in Indian Ammonia plants



# Relevant Policies

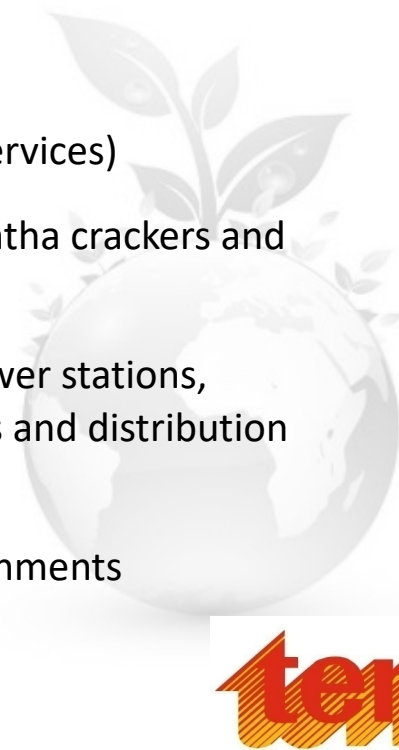




# EC Act 2001

- ❑ Energy Conservation Act 2001 provides for Efficient use of energy and its conservation
- ❑ Framework to establish Bureau of Energy Efficiency (BEE) with the objective to reduce energy intensity of Indian economy
- ❑ List of energy intensive industries and other establishments specified as Designated Consumers (DCs)

- |                   |   |
|-------------------|---|
| 1. Aluminium      | 10. Railways  |
| 2. Fertilizers    | 11. Port trust  |
| 3. Iron and steel | 12. Transport sector (industries and services)  |
| 4. Cement         | 13. Petrochemicals, gas crackers, naphtha crackers and petroleum refineries                                     |
| 5. Pulp and paper | 14. Thermal power stations, hydel power stations, electricity transmission companies and distribution companies |
| 6. Chlor alkali   | 15. Commercial buildings and establishments   |
| 7. Sugar          |   |
| 8. Textile        |   |
| 9. Chemicals      |   |



# Addressing climate change mitigation by India

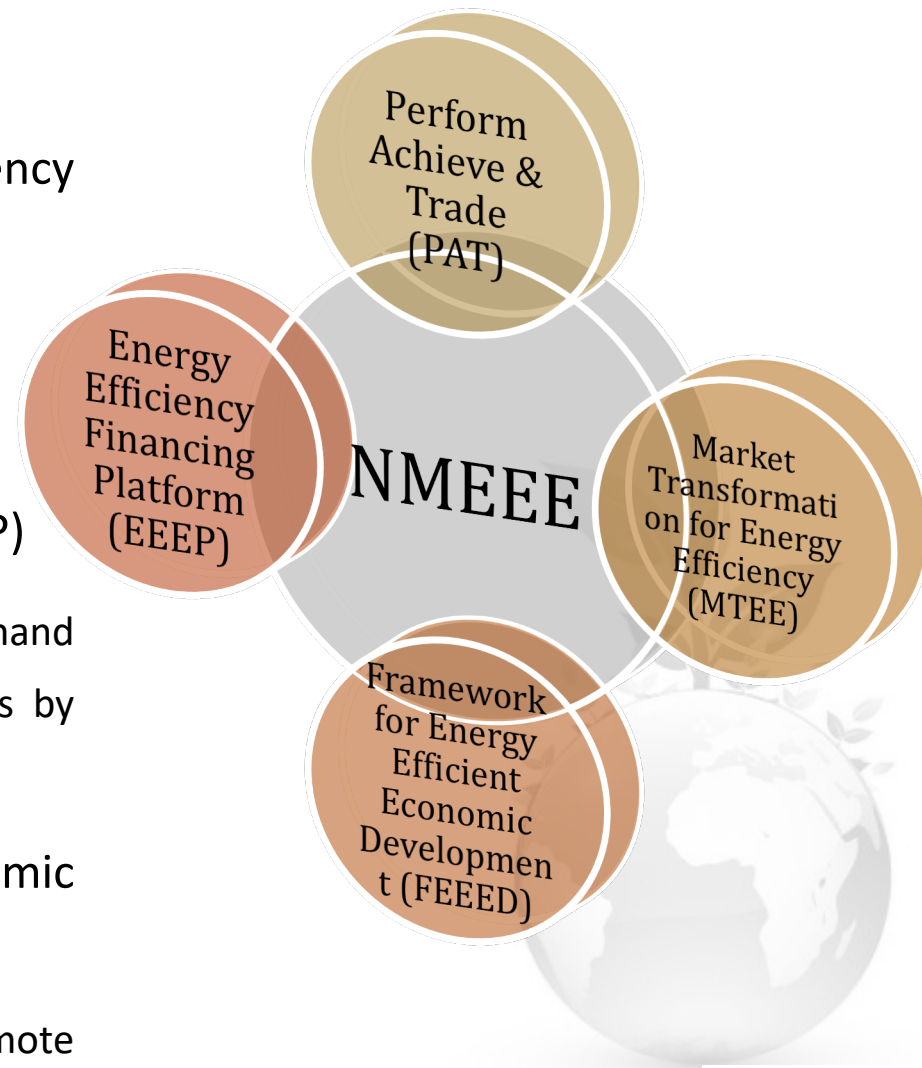
**1. National Action Plan on Climate Change** to achieve sustainable development path that simultaneously advances economical and environmental objectives (June 2008).

- Eight National Missions
  - National Solar Mission
  - **National Mission for Enhanced Energy Efficiency**
  - National Mission on Sustainable Habitat
  - National Water Mission
  - National Mission for Sustaining the Himalayan Ecosystem
  - National Mission for Sustainable Agriculture
  - National Mission on Strategic Knowledge for Climate Change

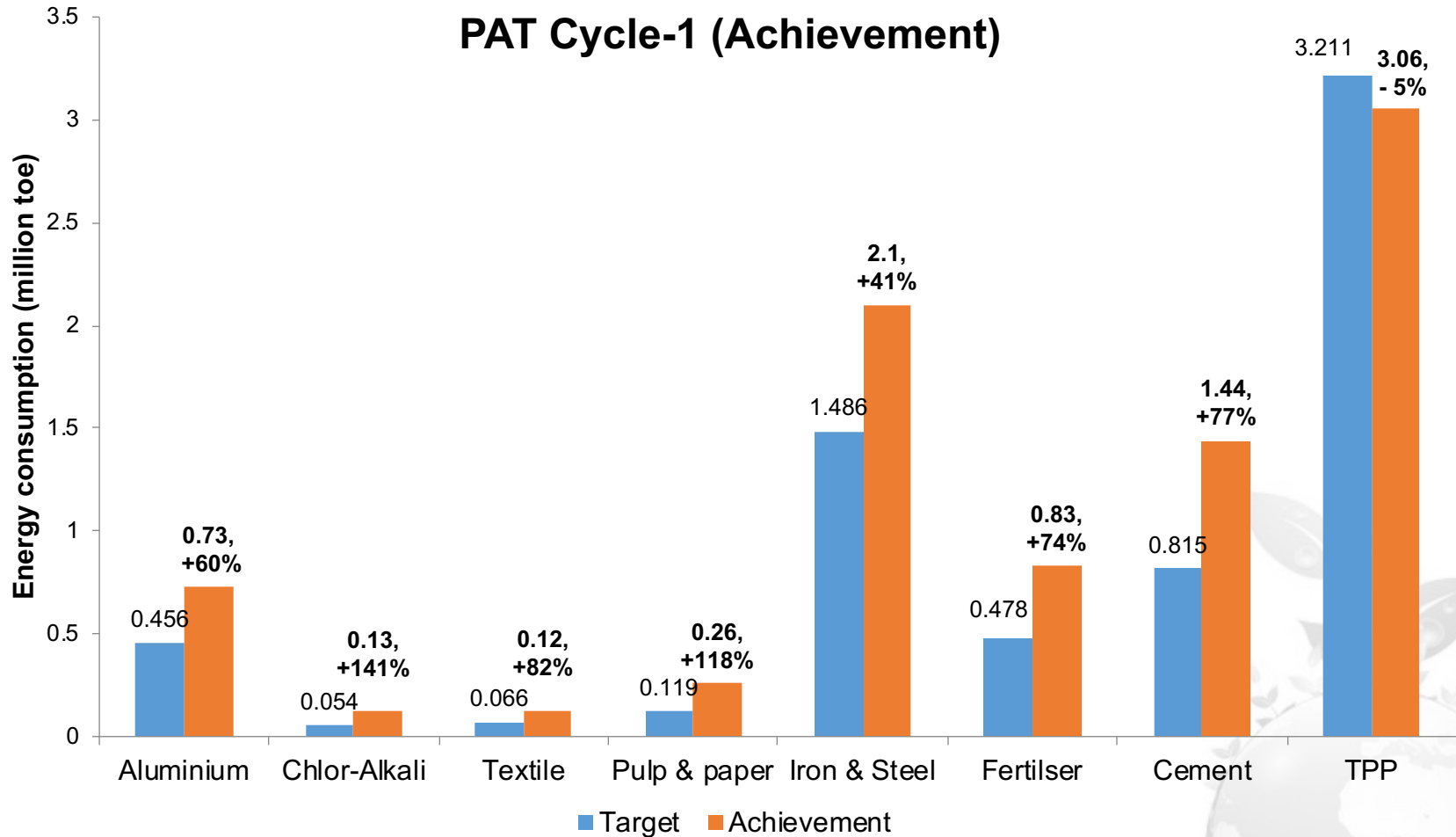


# Initiatives under NMEEE

- ❑ Perform Achieve & Trade (PAT)
- ❑ Market Transformation for Energy Efficiency (MTEE)
  - ✓ SEEP-Super efficient equipment program
  - ✓ BLY- Bachat Lamp Yojana
- ❑ Energy Efficient Financing Platform (EEFP)
  - ✓ creation of mechanisms to help finance demand side management programmes in all sectors by capturing future energy savings
- ❑ Framework for Energy efficient Economic Development (FEEED)
  - ✓ development of fiscal instruments to promote energy efficiency



## PAT Cycle-1 (Achievement)



- Target exceeded by almost 30%;
- Equivalent coal savings of 20 million tonnes
- Avoided emission of about 31 million tonnes of CO<sub>2</sub>

## 2. Nationally Determined Contributions (NDCs) - India

Reduce the emissions intensity of its GDP by 33-35% from 2005 levels by 2030.

Achieve about 40 percent cumulative electric power installed capacity from non fossil fuel based energy resources by 2030

Create an additional carbon sink of 2.5 to 3 billion tonnes of CO<sub>2</sub> equivalent through additional forest and tree cover by 2030.

# Way forward to low/zero carbon industry

- ❑ Energy performance compared to global level clearly shows significant scope for EE improvements in several industry sub-sectors in India
  - ✓ New capacity additions with only state of the art technologies will help in significant reduction in energy consumption
- ❑ A major reduction in energy intensity of industry sector is possible through:
  - ✓ Shift to NEW production processes requiring significant R&D efforts and cooperation at global level, including setting up pilot plants
  - ✓ Shift towards new materials that are low energy intensive
  - ✓ Increased use of recycled materials
- ❑ A paradigm shift towards low carbon emissions in industry sector would necessitate key players to come together on a common platform to discuss, deliberate and act.
- ❑ Need for developing specific plans for HTA sectors like cement, iron & steel and plastics (both short-term & long term) in collaboration with Indian industry



# Thank you !



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