

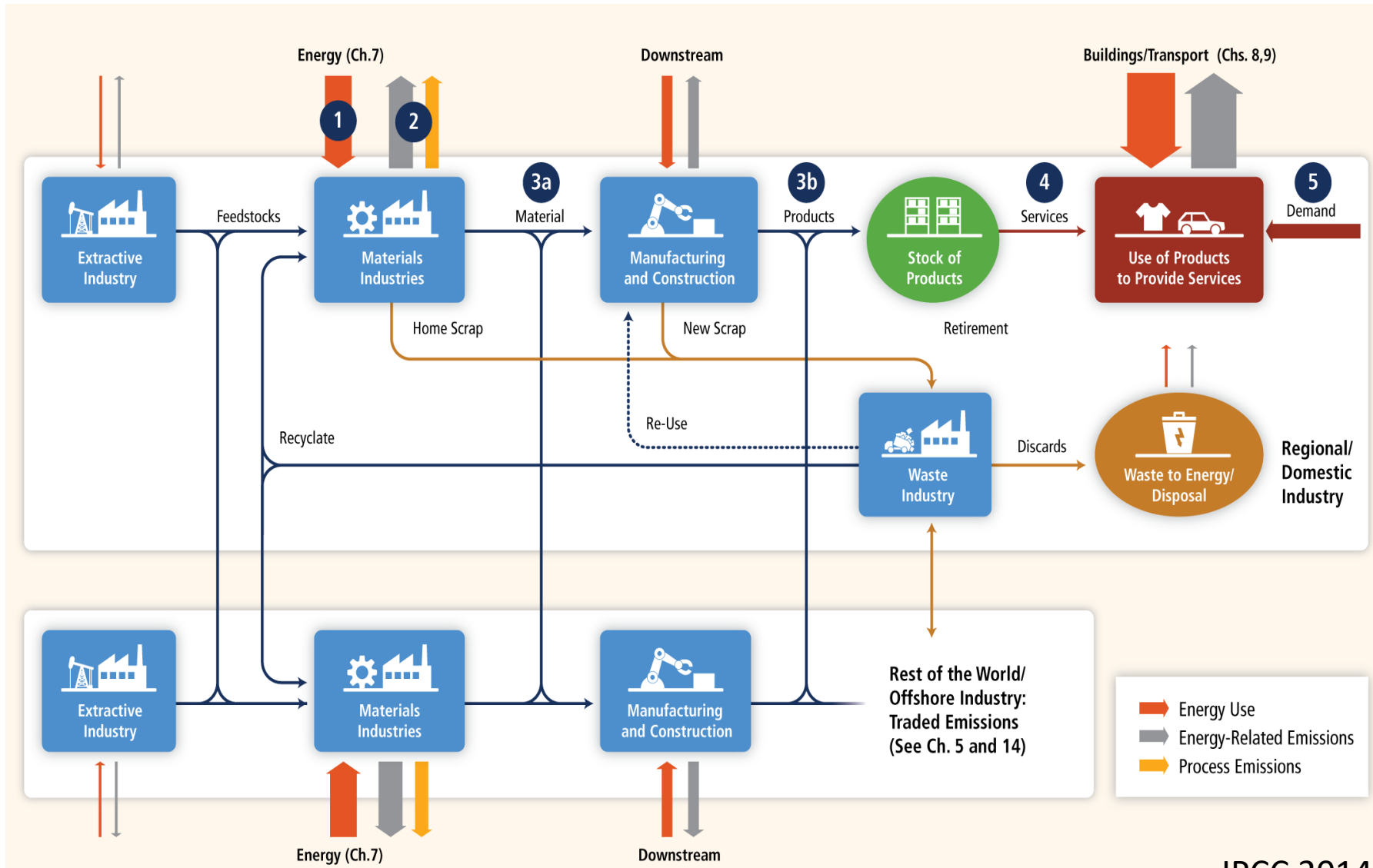
How are Indian industries doing: historical perspective and future outlook

Joyashree Roy

Bangabandhu Chair Professor

Asian Institute of Technology, Thailand

Figure 10.1. A schematic illustration of industrial activity over the whole supply chain. Options indicated by the circled numbers: (1) Reducing energy requirements of processes; (2) Reducing emissions from energy use and processes; (3) Reducing material requirements for products and in processes; (4-5) Reducing demand for final manufactured products and for their use.

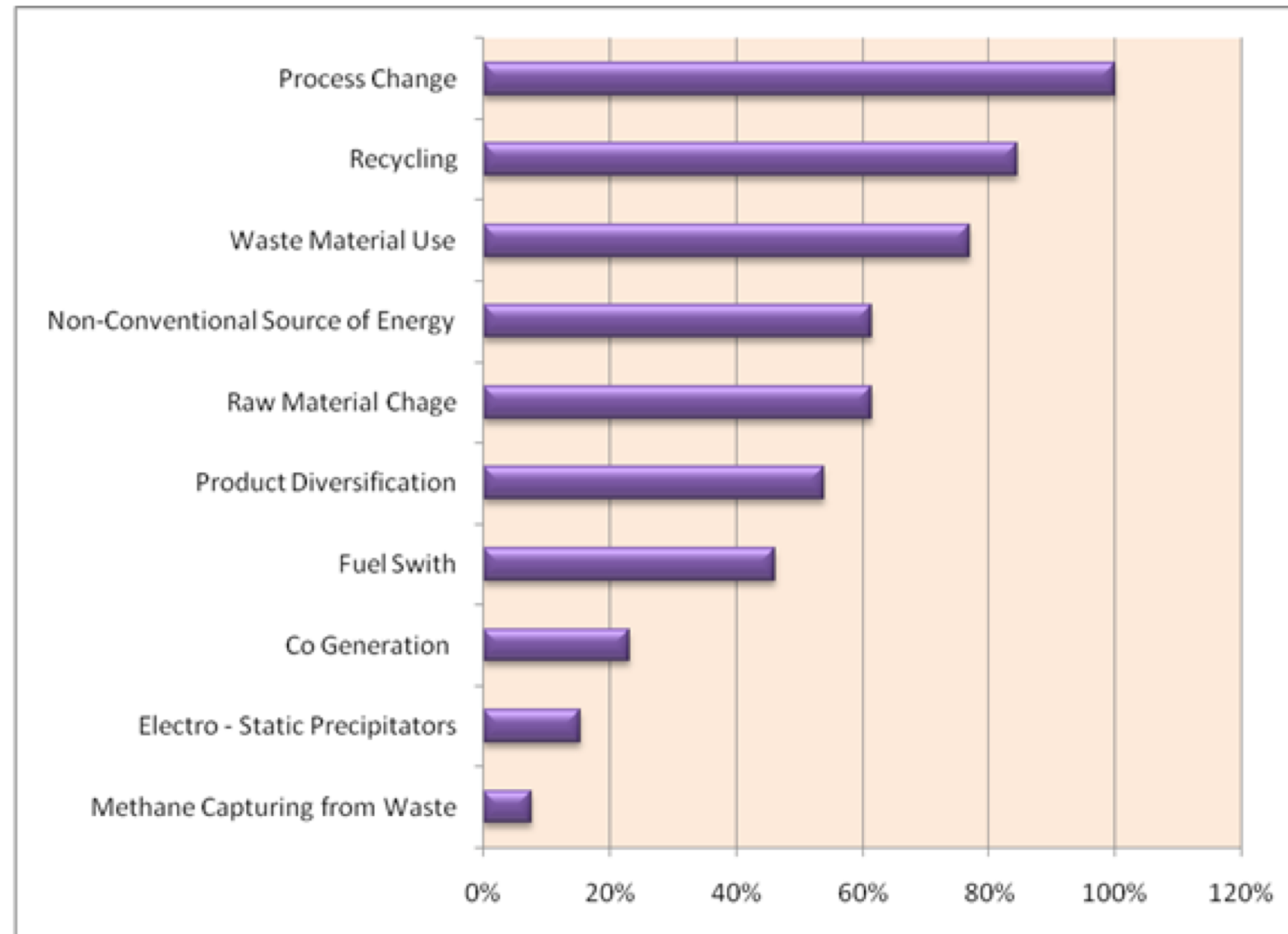


$$\text{Industrial emissions} = (\text{energy/material} \times \text{emissions/energy} + \text{process_emissions/material}) \times \text{material/product} \times \text{product/service} \times (\text{New_demand_for_service} + \text{Replacement_demand_for_service})$$

AR6 WGIII: Chapter 5, Demand, Services and Social aspects of mitigation

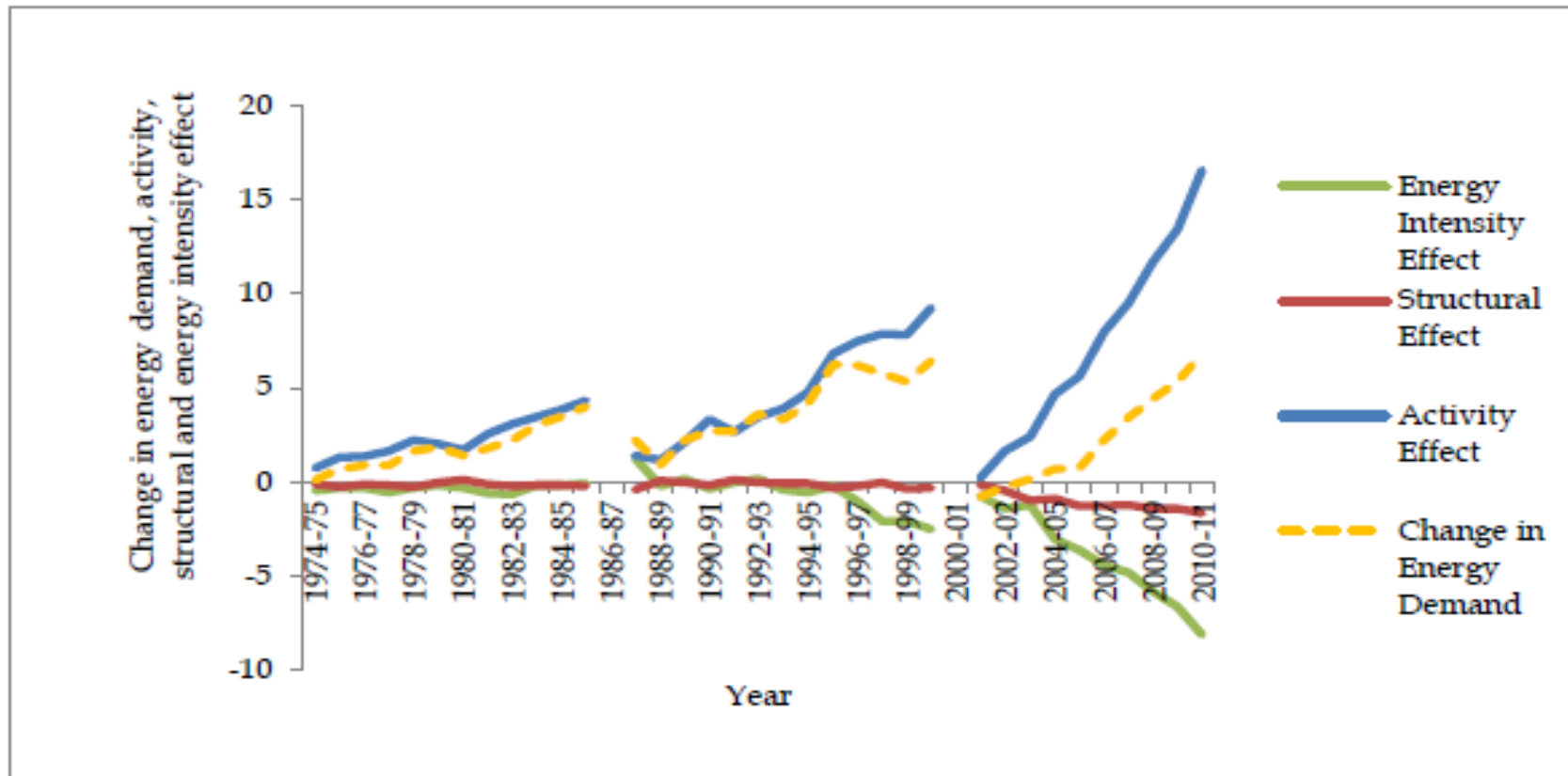
	Service	Avoid	Shift	Improve
Transport	<ul style="list-style-type: none"> ➤ Accessibility ➤ Mobility 	<ul style="list-style-type: none"> ➤ Integrate transport & land use planning ➤ Smart logistics ➤ Tele-working ➤ Compact cities 	<ul style="list-style-type: none"> ➤ Mode shift from car to cycling, walking, or public transit 	<ul style="list-style-type: none"> ➤ Electric two, three, and four wheelers ➤ Eco-driving ➤ Electric vehicles (various kinds) ➤ Smaller, light-weight vehicles
Buildings	<ul style="list-style-type: none"> ➤ Shelter 	<ul style="list-style-type: none"> ➤ Passive house or retrofit (avoiding demand for heating/cooling) ➤ Change temperature setpoints 	<ul style="list-style-type: none"> ➤ Heat pumps, district heating, combined heat and power 	<ul style="list-style-type: none"> ➤ Condensing boilers ➤ incremental insulation options ➤ Energy efficient appliances
Industry	<ul style="list-style-type: none"> ➤ Clothing ➤ Appliances 	<ul style="list-style-type: none"> ➤ Long lasting fabric, appliances, sharing economy, ➤ eco-industrial parks, circular economy 	<ul style="list-style-type: none"> ➤ Virgin material to recycled materials, new materials for buildings and infrastructure 	<ul style="list-style-type: none"> ➤ Use of low carbon fabrics ➤ New manufacturing processes and equipment use

What Indian industries are doing?



Changing Energy Intensity

Decomposition of energy demand-Indian manufacturing industries

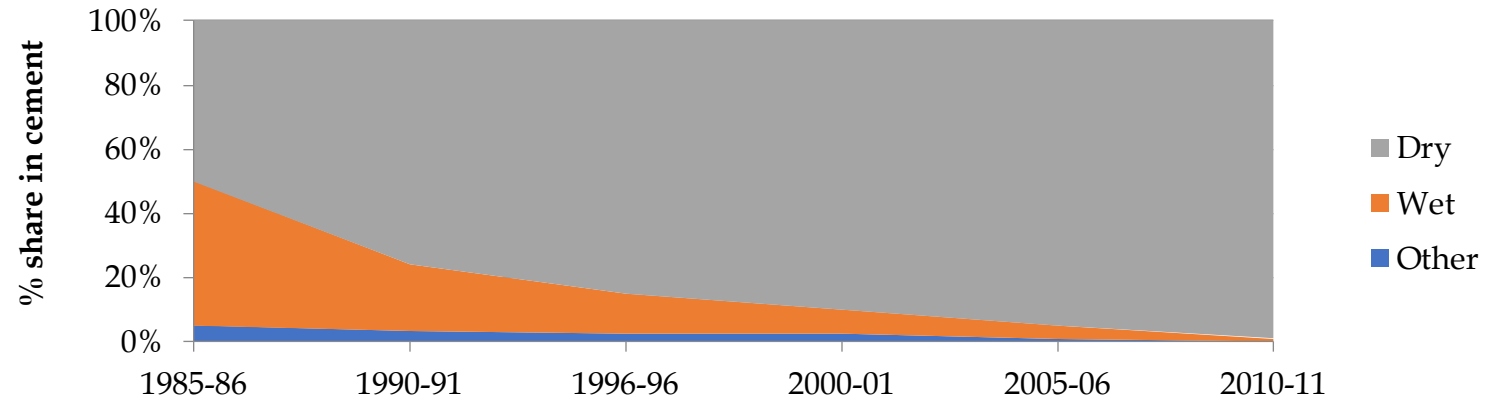


Based on Annual Survey of Industries, India 1973-74 – 2010-11
Dasgupta and Roy (2017)

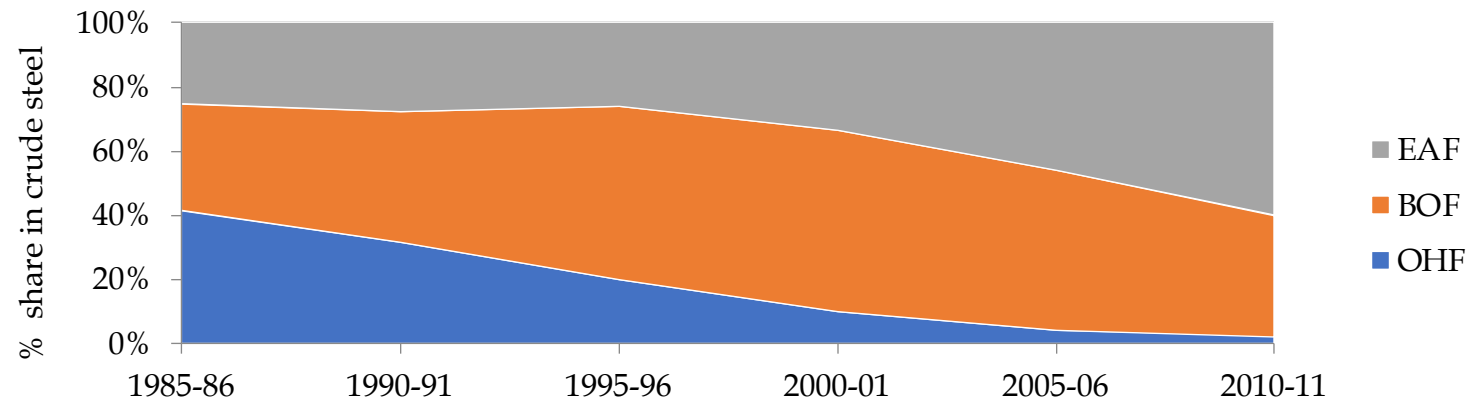
Transformational changes in process technology

Pace of process change – not similar for all industries

Cement



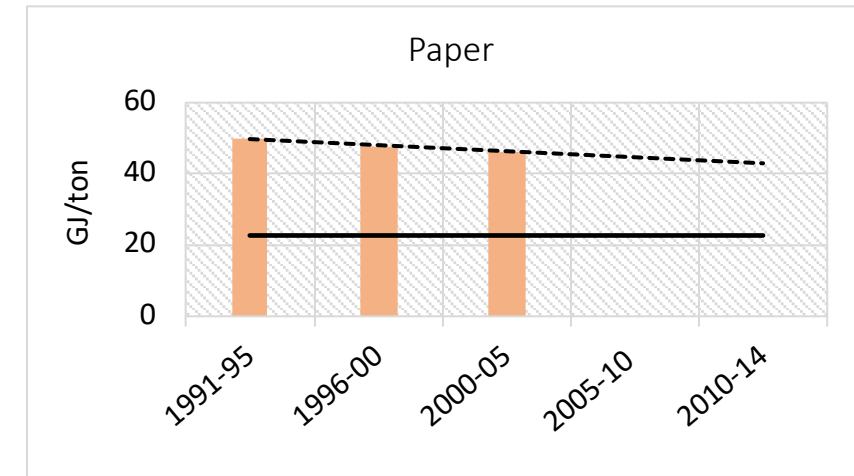
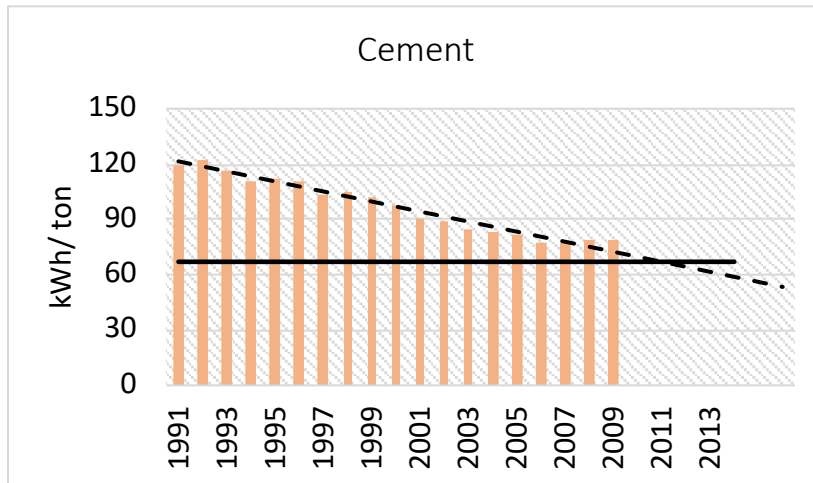
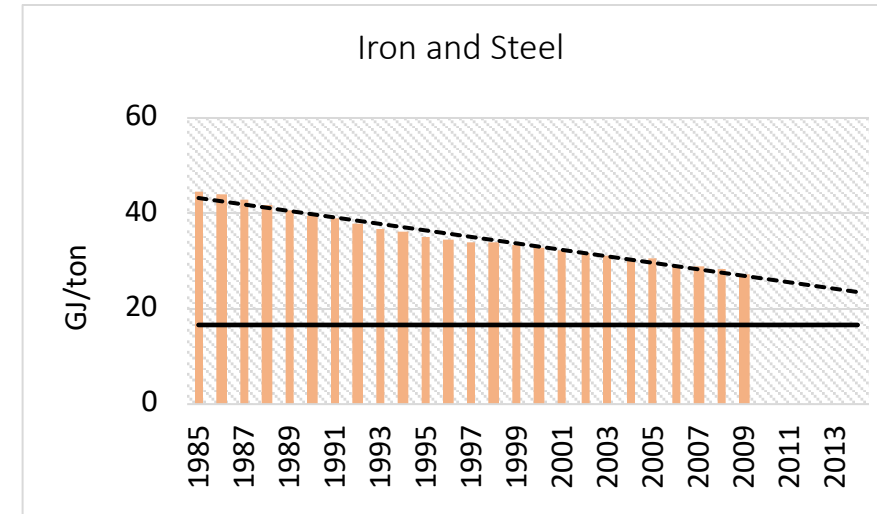
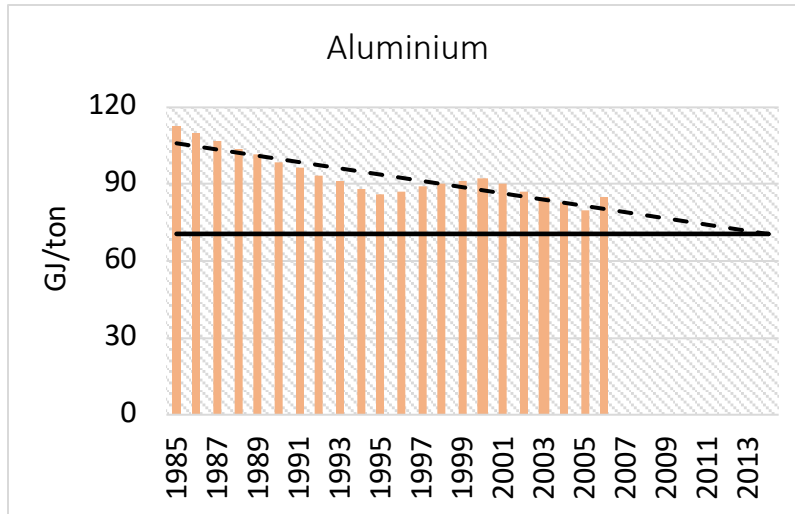
Steel



Source: Dasgupta and Roy 2017

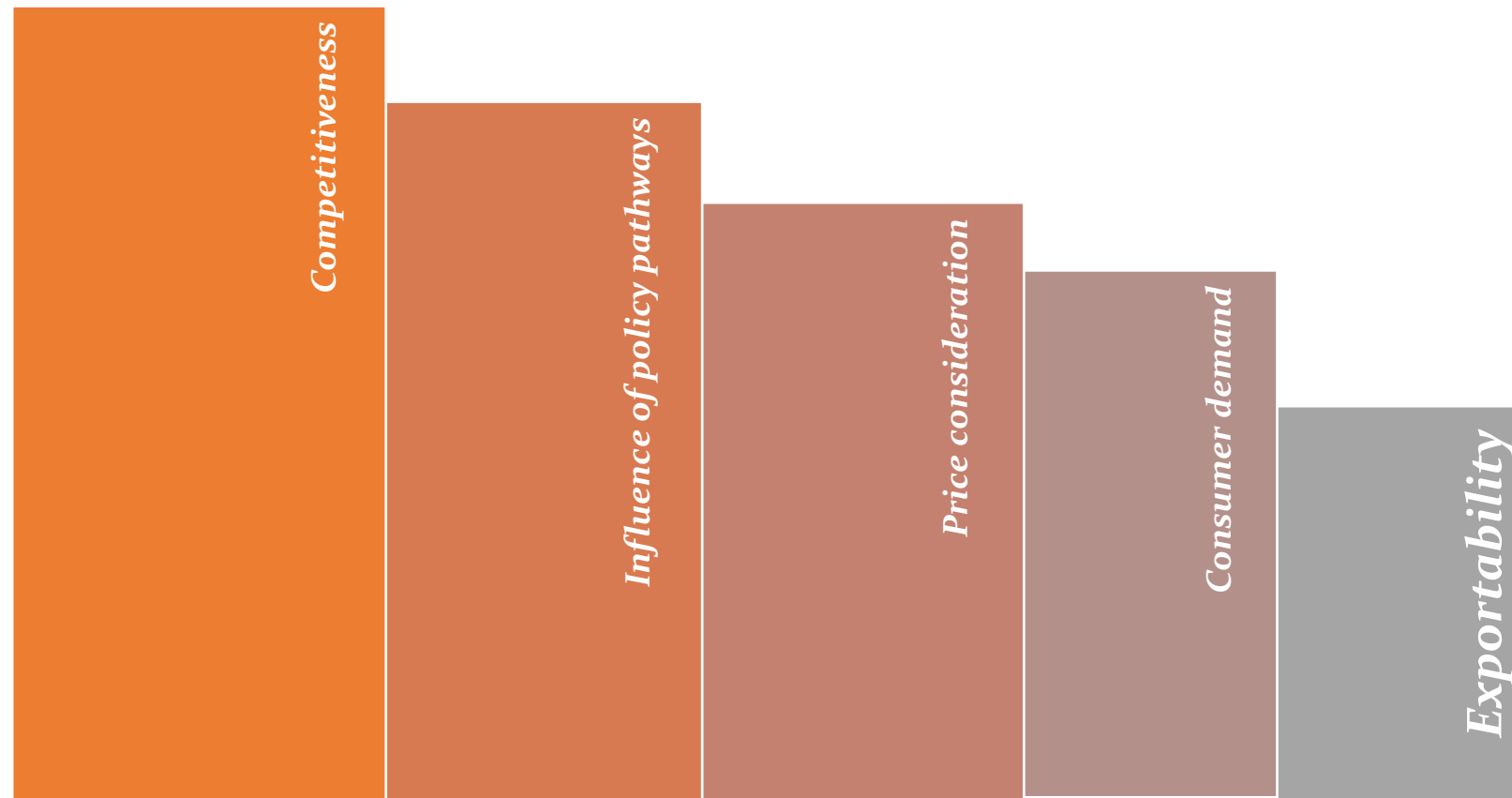
Catching up with BAT

Energy efficiency performance of Indian industries vis-à-vis world



Source: Dasgupta and Roy 2017

1. Driving force behind undertaking actions

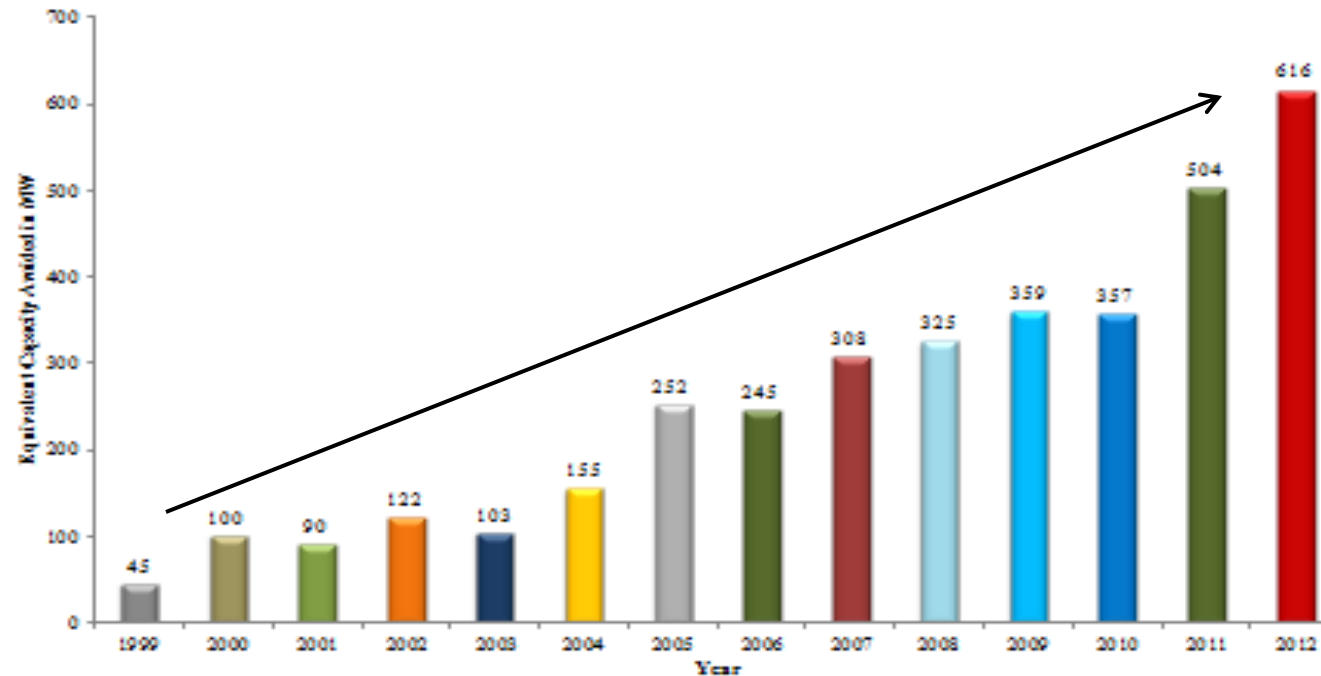


Source: Chakraborty & Roy 2012

Energy Conservation Awards (since 1991)

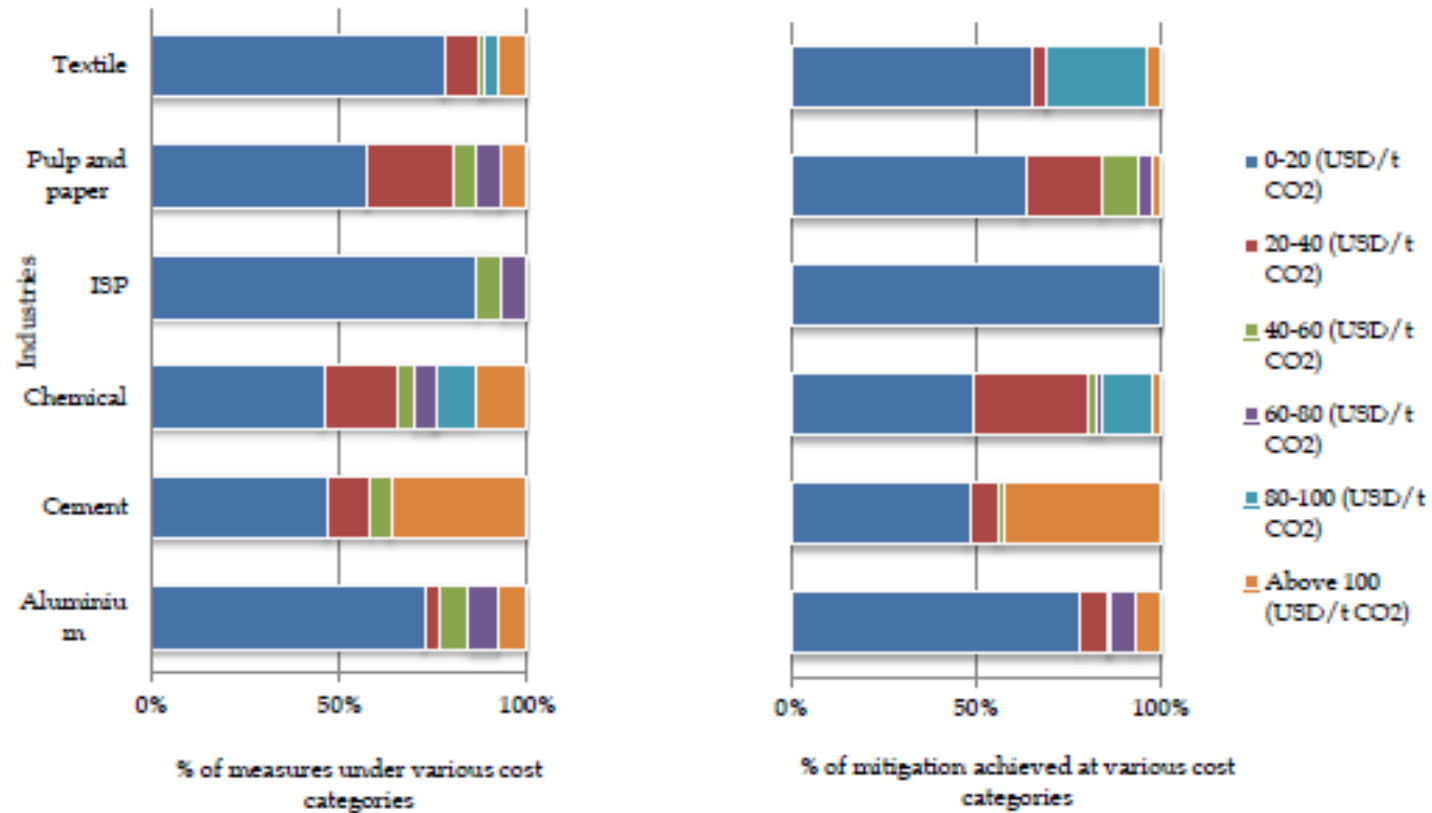


- Participation (voluntary) increased from 123 units in 1999 to 773 in 2012
- Investment energy conservation in 2012 = INR. 1948 Crores
- Monetary saving achieved in 2013 = INR. 2886 Crores in 2013
- A payback period of 8 months



Electrical energy saving in terms of equivalent avoided Capacity in MW

Costs associated with the energy efficiency measures (USD₂₀₁₀/tCO₂)



- achieving near-zero emission intensity levels in the industry sector would require additional realization of long-term step-change options and these options are associated with higher cost

Source: IPCC 2014. Roy, Dasgupta, Chakraborti (2017)

Behavioural Response

Inter-factor substitutability of inputs and own price elasticity of energy input

Factors	1973-74 to 2010-11	1973-74 to 1985-86	1986-87 to 1999-00	2000-01 to 2010-11
Capital- Labour	Complement	Substitute	Complement	Substitute
Capital - Material	Substitute	Substitute	Substitute	Complement
Capital-Energy	Substitute	Substitute	Complement	Substitute
Labour- Material	Substitute	Substitute	Substitute	Substitute
Labour- Energy	Substitute	Substitute	Substitute	Substitute
Material- Energy	Substitute	Substitute	Substitute	Substitute
Own price elasticity of energy	-0.22	-0.60	-0.74	-1.22

- ✓ Technological progress evolved to substitute energy input, especially by material inputs
- ✓ But, this along with a technological bias towards material input seeks attention
- ✓ Own price elasticity of energy input is negative with an increasing magnitude
- ✓ Price based intervention is expected to be effective to pull down the energy use further with far reaching implications towards reduction of emission as well.

Dasgupta and Roy 2015, Energy Policy , 83, 1-13

Emergence of Policy framework

- National Enhanced Energy Efficiency Mission (for large energy intensive industries)
- Energy Certificates Market under PAT (like EU-ETS)
- Coal Cess (INR 400/ton of coal~ \$6/ton)

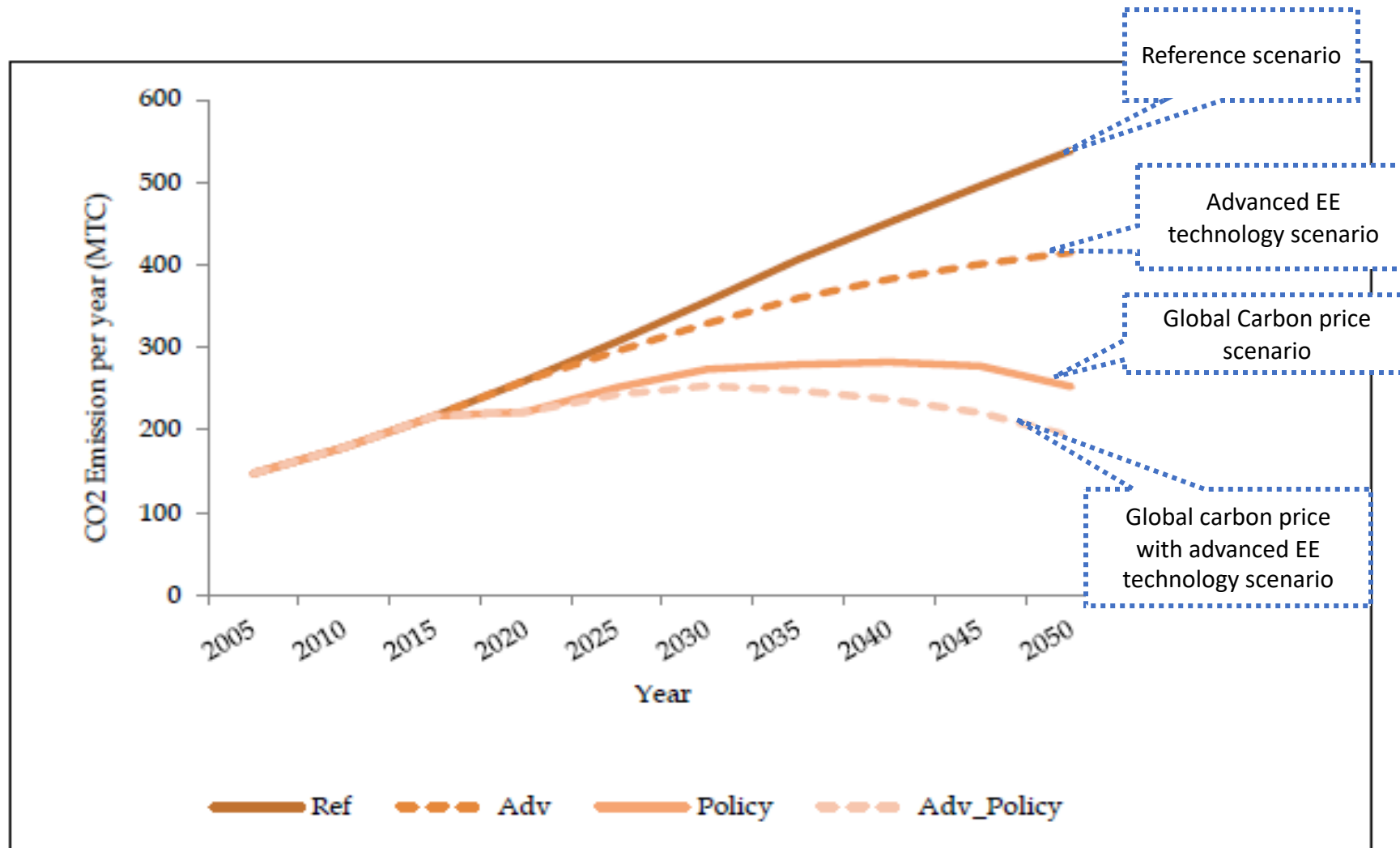


What more?
New Potential

Response of Indian industries to global climate goals:

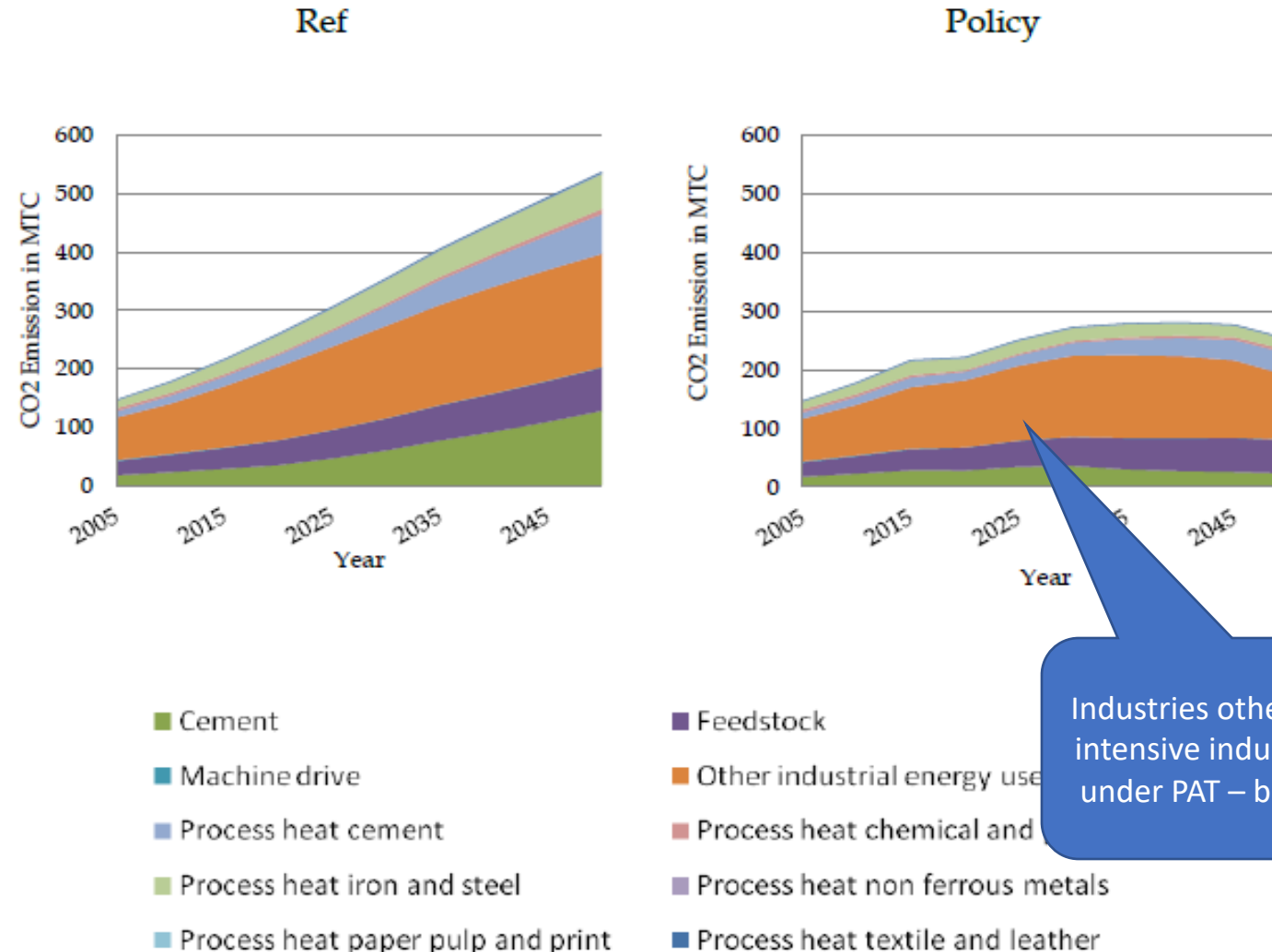
- Results from GCAM with detailed industry sector for India
- How Indian industries are expected to respond if a uniform global CO₂ price is implemented to meet a cumulative emission mitigation target to achieve the 2 degree goal?
- The policy consider – a global carbon price uniformly prevailing across nations and across sectors.

Results from GCAM



Source: Dasgupta, Roy et.al (2017)

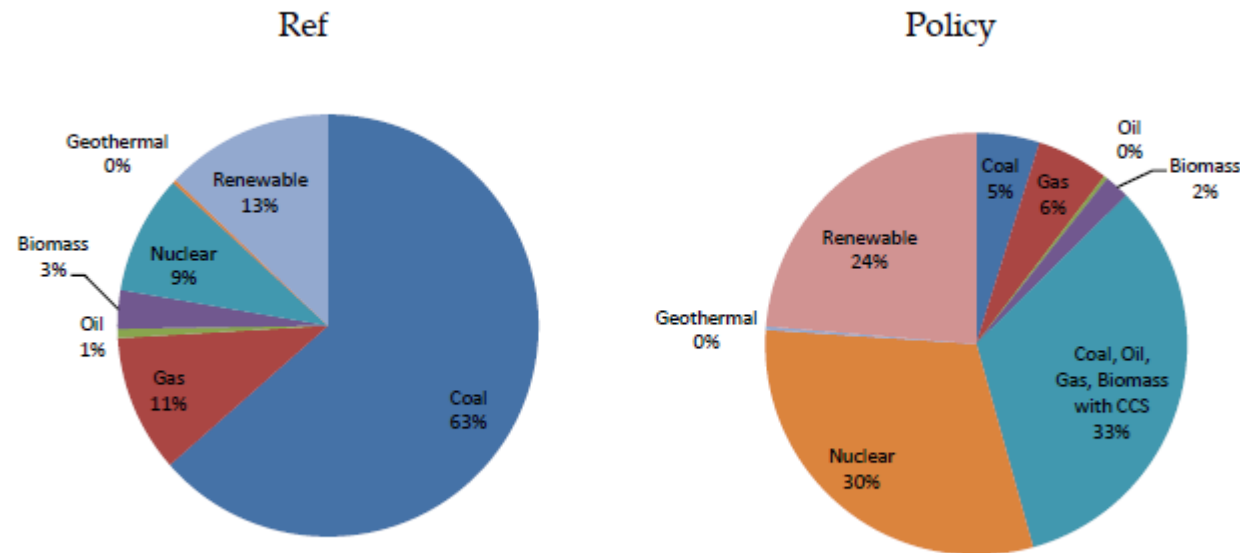
Potential beyond energy intensive industries



Source: Dasgupta, Roy et.al (2017)

Implications for power generation

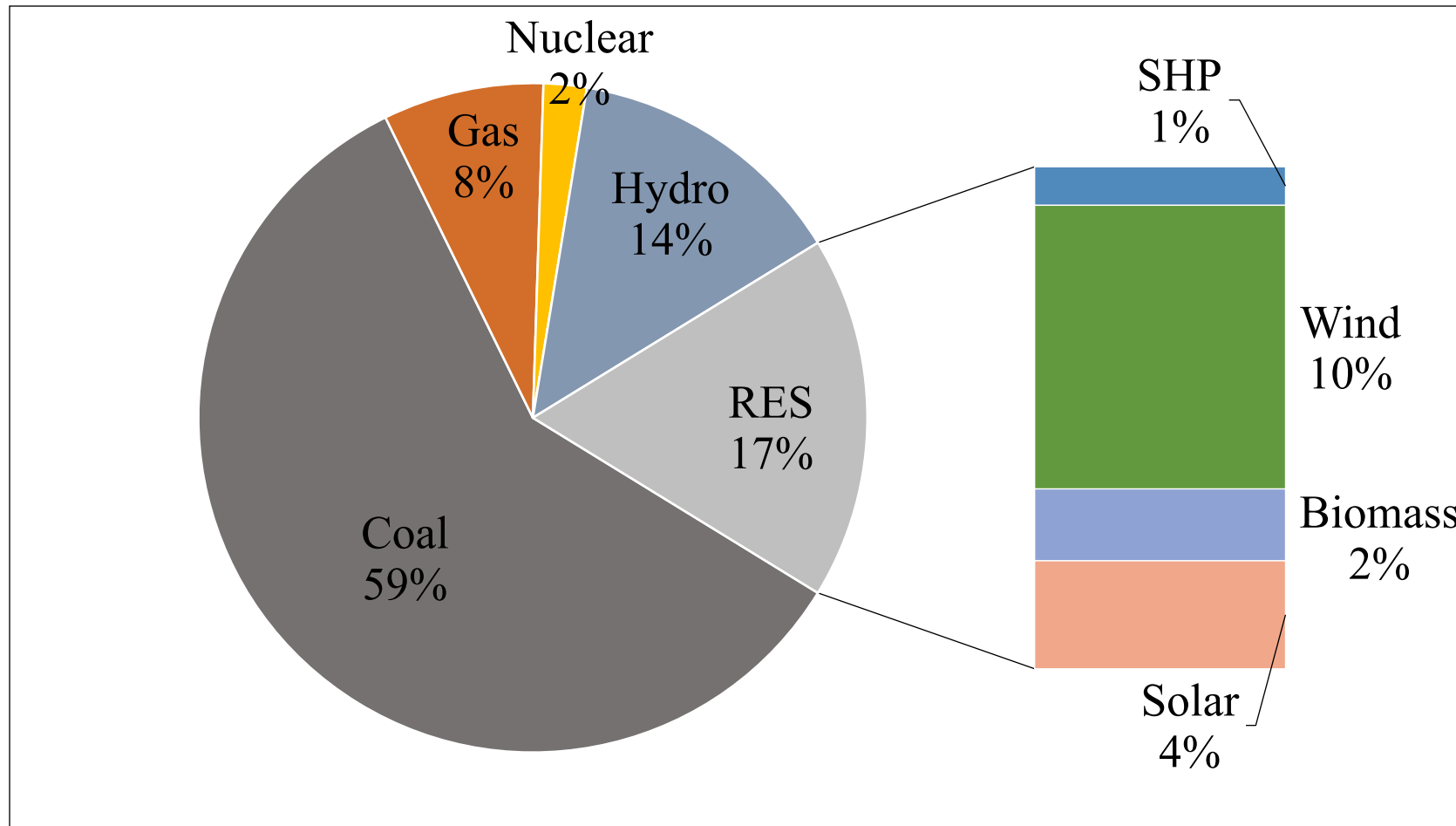
Long run green growth in industry requires large scale electrification



Projected consumption of fuel use for electricity generation in Indian in 2050: comparison of Reference scenario and green growth policy scenario

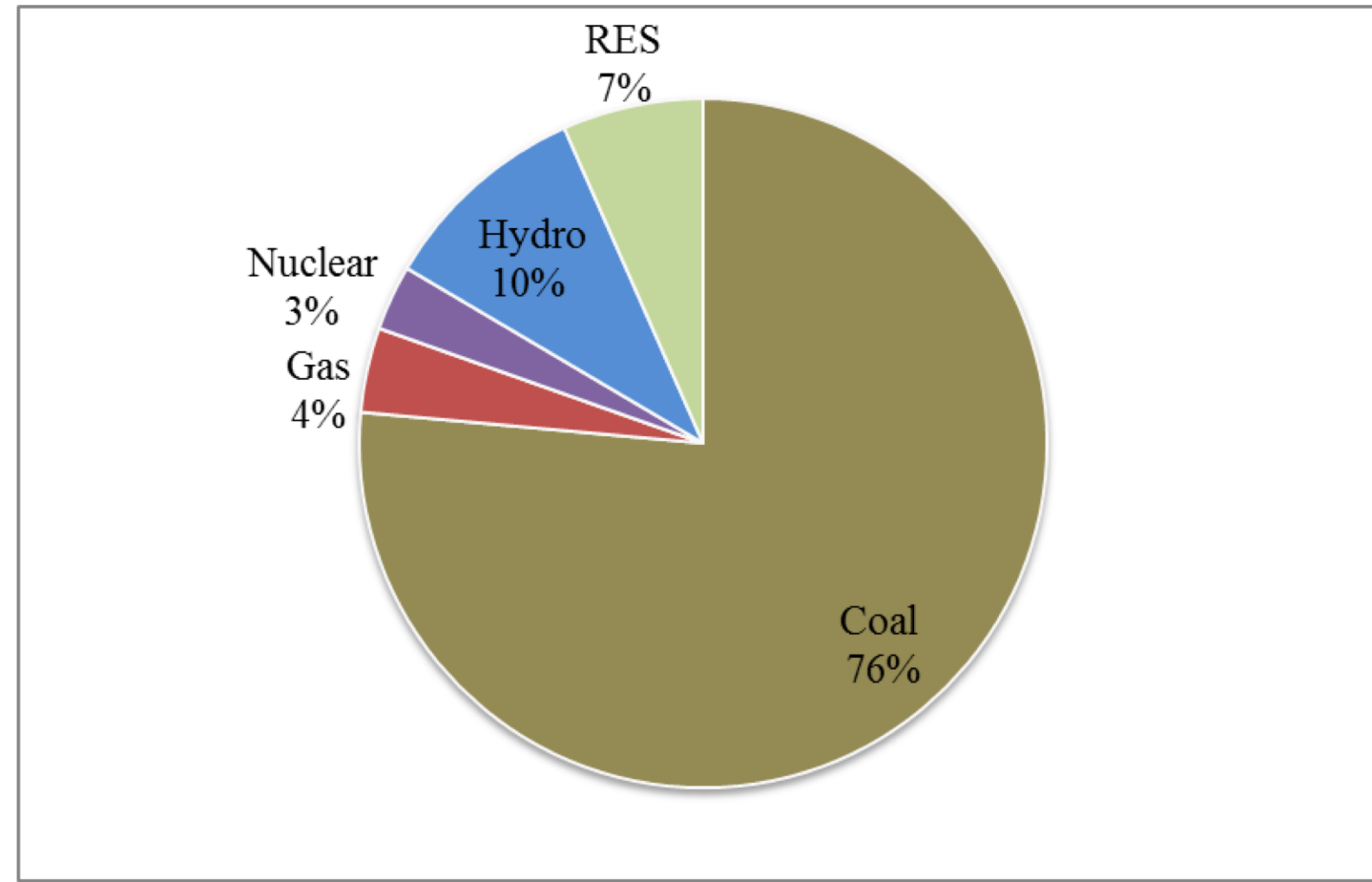
Source: Dasgupta, Roy et.al (2017)

Installed capacity: share of different fuels in March, 2017

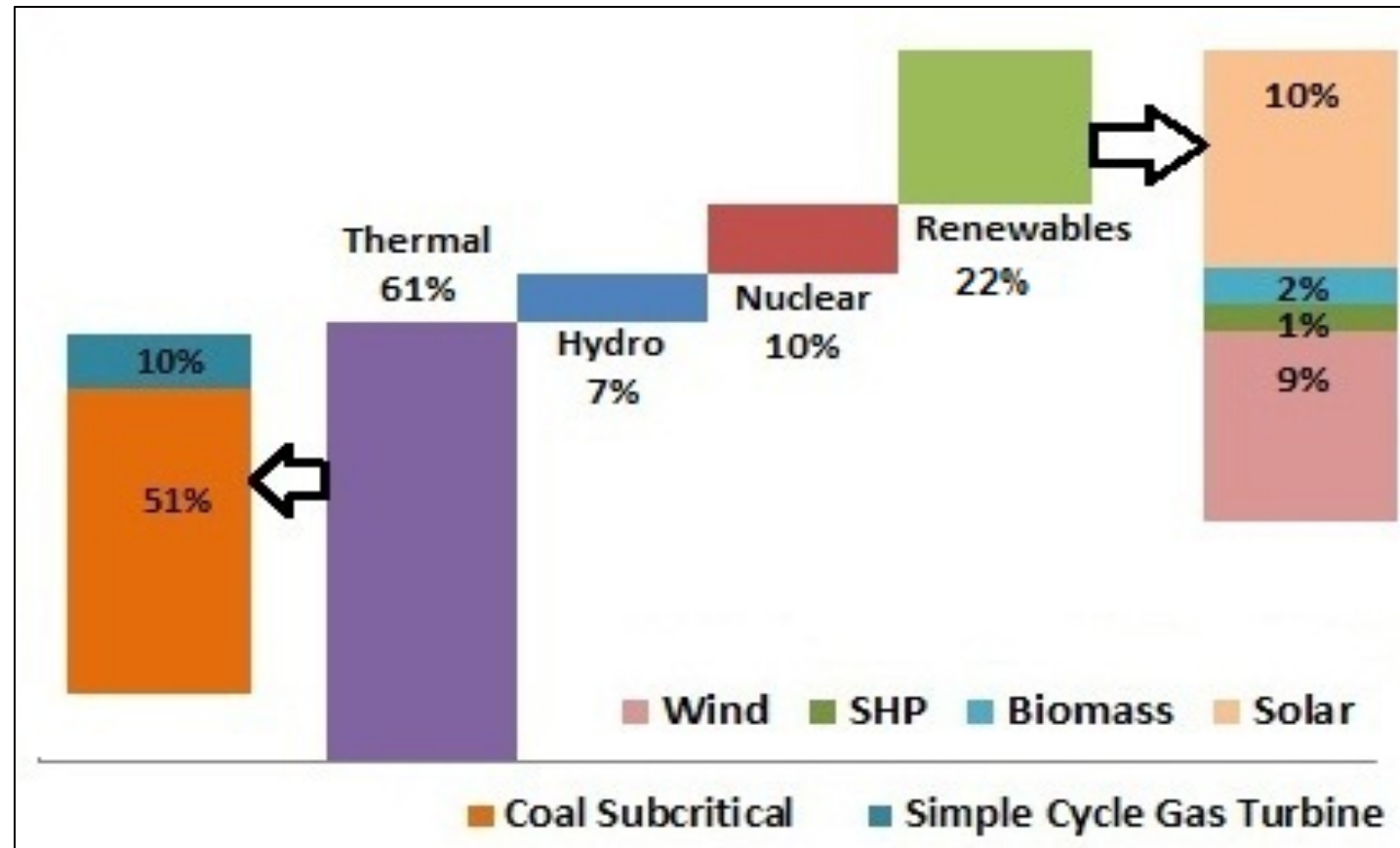


Source: Central Electricity Authority of India, 2017

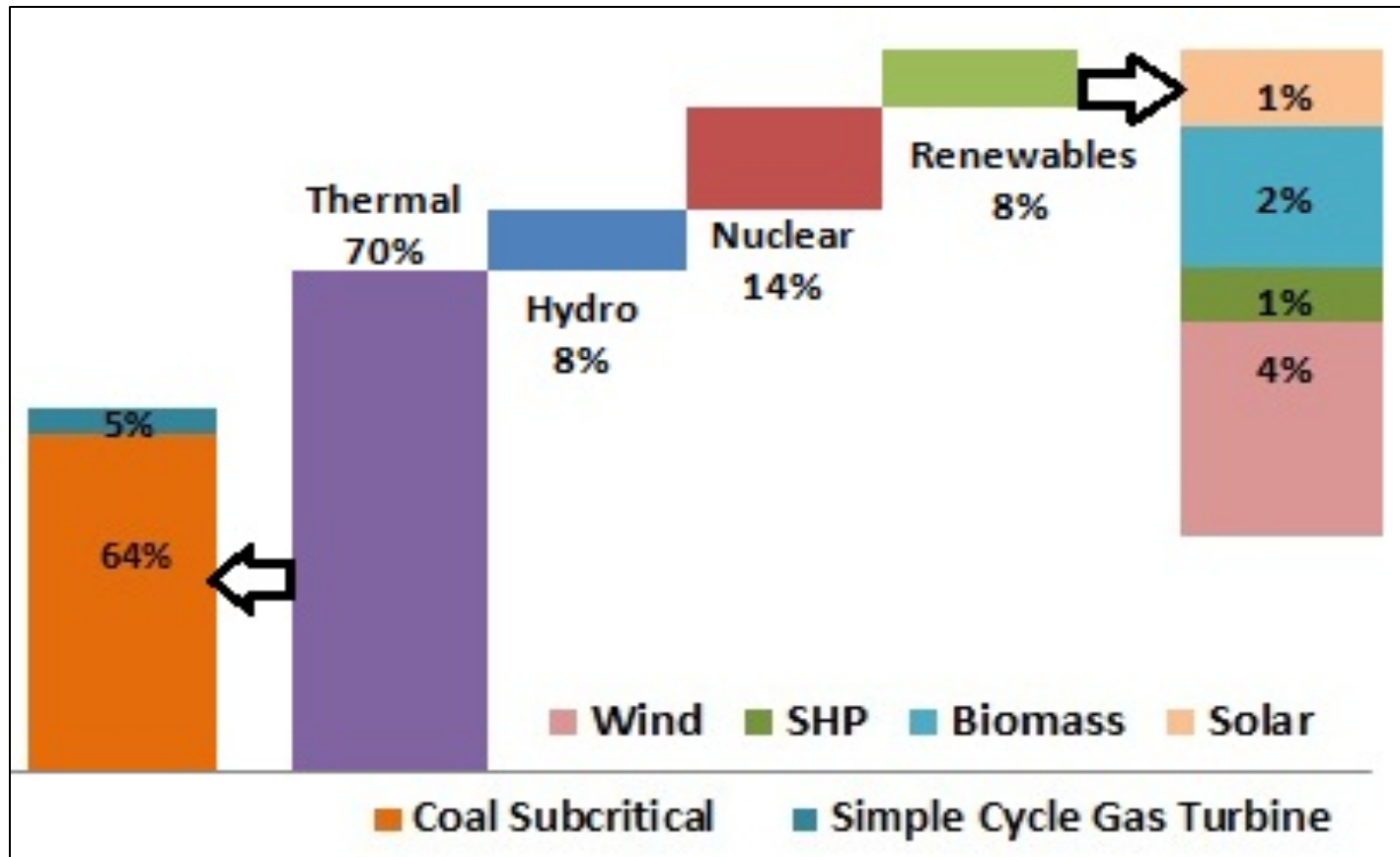
Share of different fuel and technology in generation in 2017



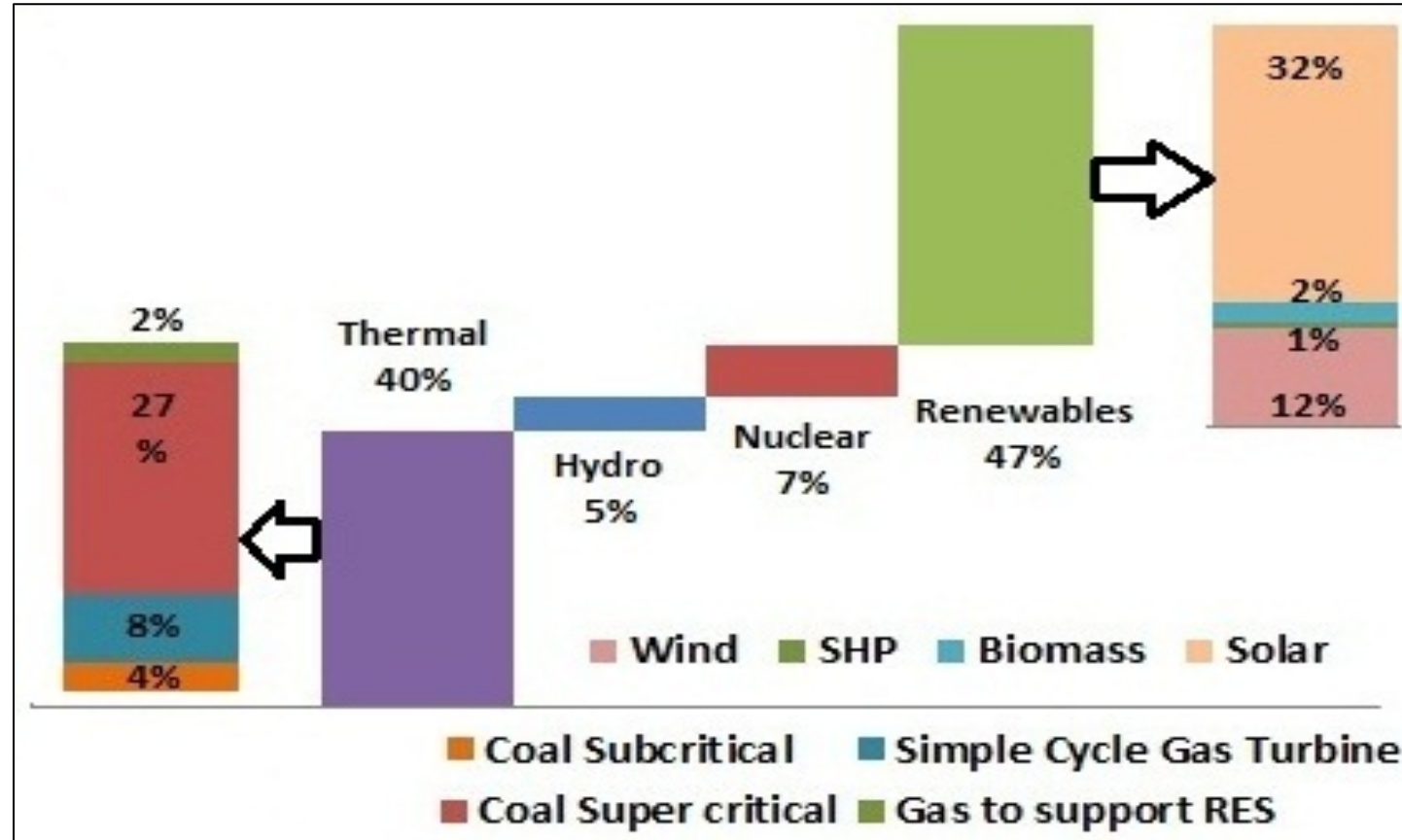
Installed capacity share of different fuel and technology Reference Scenario in 2050



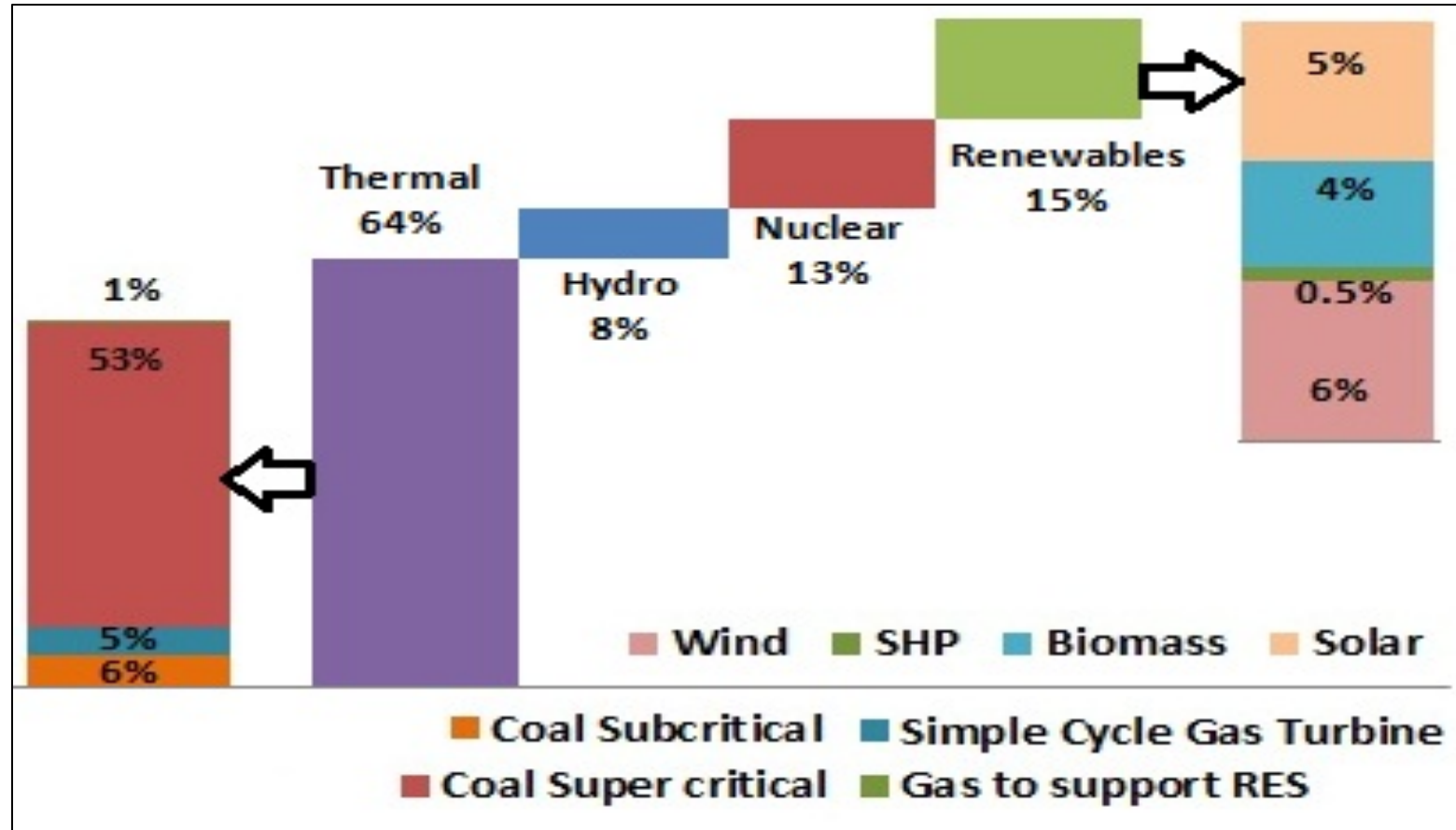
Share of different fuel and technology in generation Reference Scenario in 2050



Installed capacity share of different fuel and technology NDC Scenario in 2050



Share of different fuel and technology in generation NDC Scenario in 2050



Natural Gas as transition fuel



- As the average quality of Indian coal is low, the import of high-quality coal has become indispensable
- Increasing the share of natural gas in power production diversifies the import dependency of India
- Together with the increase in sources and decrease in market concentration energy security may in fact increase

Natural Gas Supply in India

- After 2012 the production of natural gas in India has declined consistently due to geological uncertainties (Ministry of Petroleum & Natural Gas, GoI, 2017)
- LNG import in future is expected to be approximately 78 BCM annually by 2030 (Petroleum & Natural Gas Regulatory Board, 2013)
- Three LNG terminals in the west coast and two in the east coast of India have been commissioned
- Government has taken initiatives in development of nationwide grid for the transportation of natural gas (Petroleum & Natural Gas Regulatory Board, 2013)

Thank you

Acknowledgement

Global Change Programme Research Team

Jadavpur University, India

<http://juglobalchangeprogram.org/>