Sustainable Development, Energy and Climate Change :Challenges and Opportunities for India

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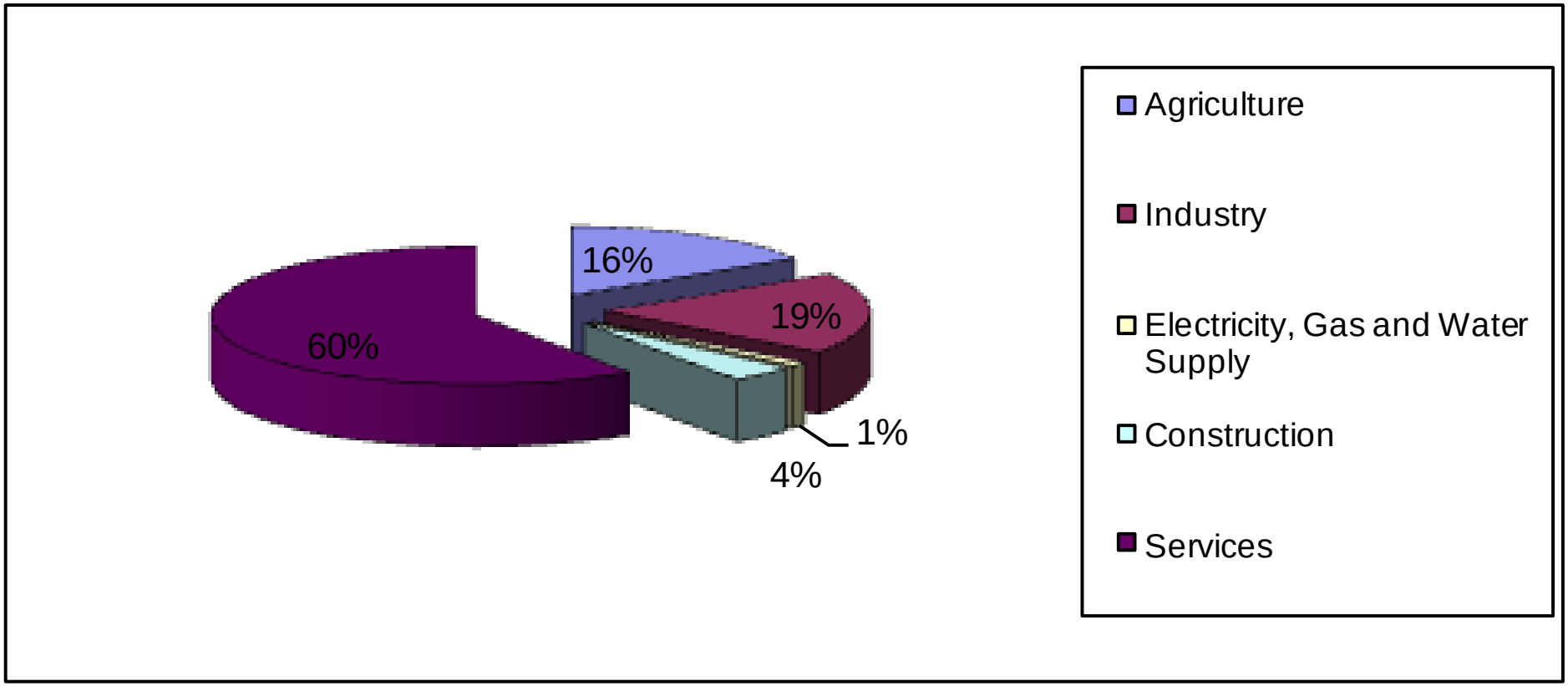
India's emission status *(World bank, 2015)*	
Total emission	2238.38 Million T CO2
Per capita emission	1.73 metric tonne CO2
Share in global emission	6.2%

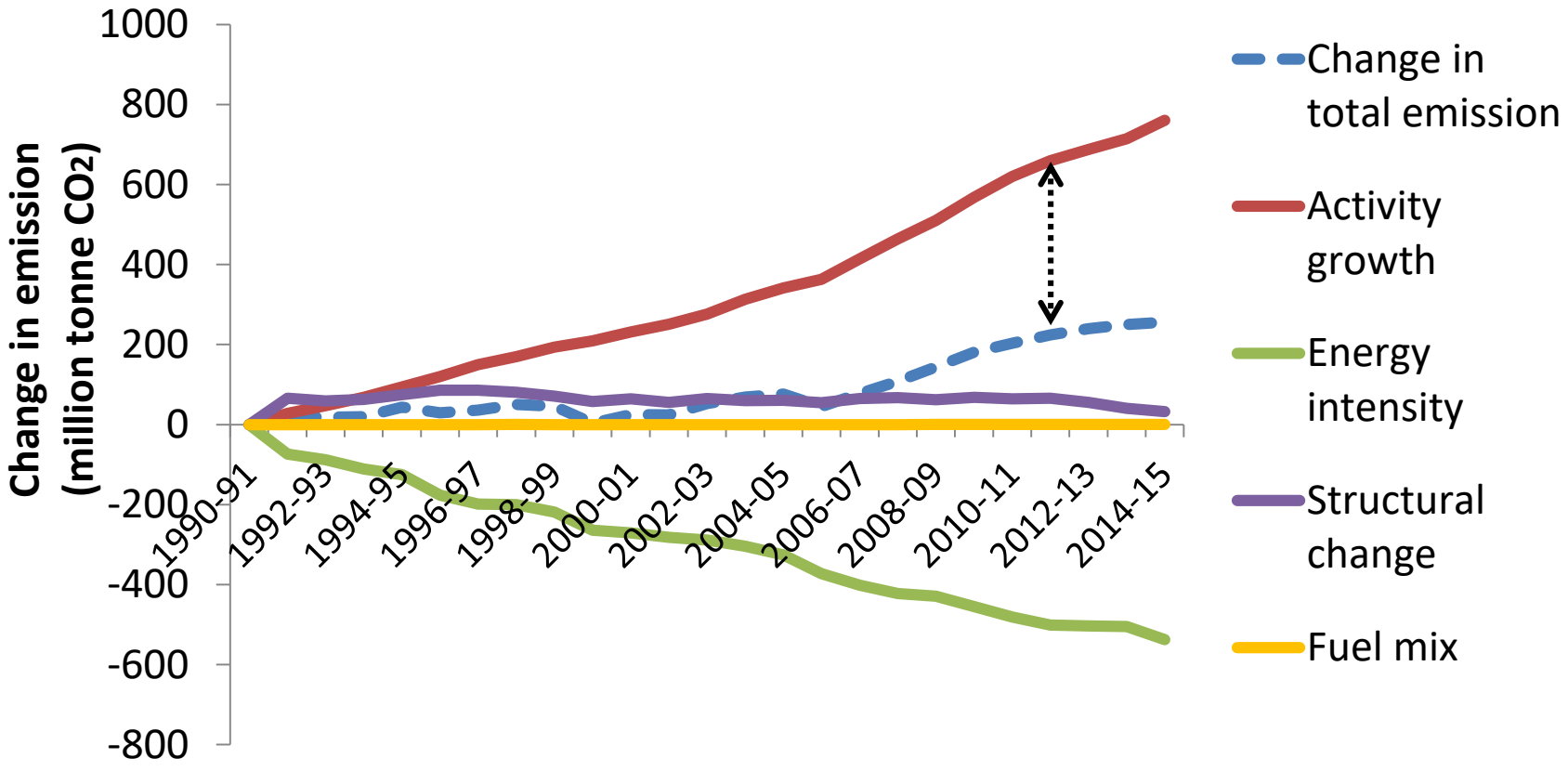
FACTORS EFFECTING THE TREND OF HISTORICAL GHG EMISSIONS IN INDIA

Structural advantage



Share in GDP

Primary energy emission decomposition- All India



History of Energy Efficiency in India: manufacturing sector

Energy Efficiency

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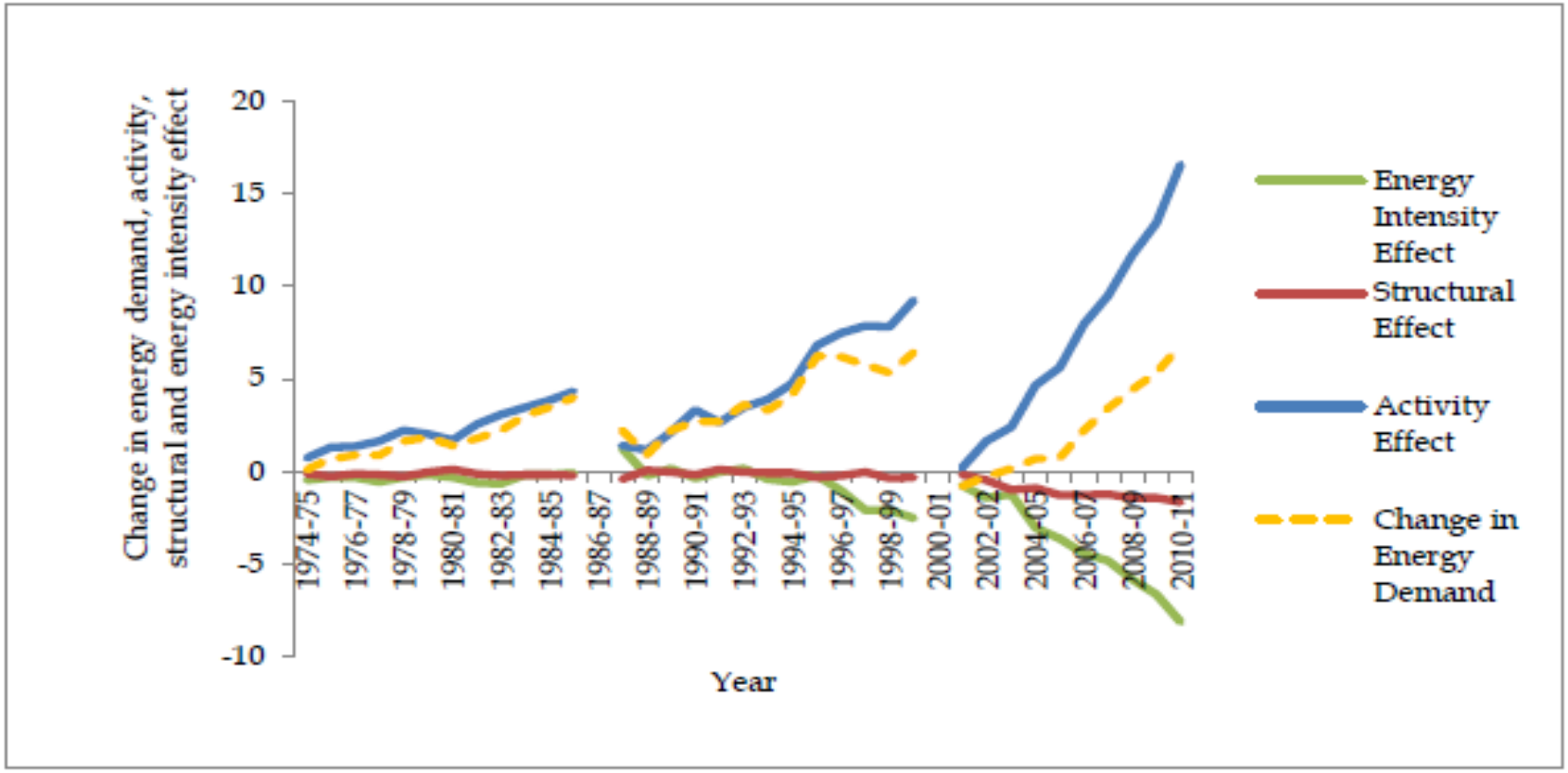
Decomposition of energy demand -Indian manufacturing industries



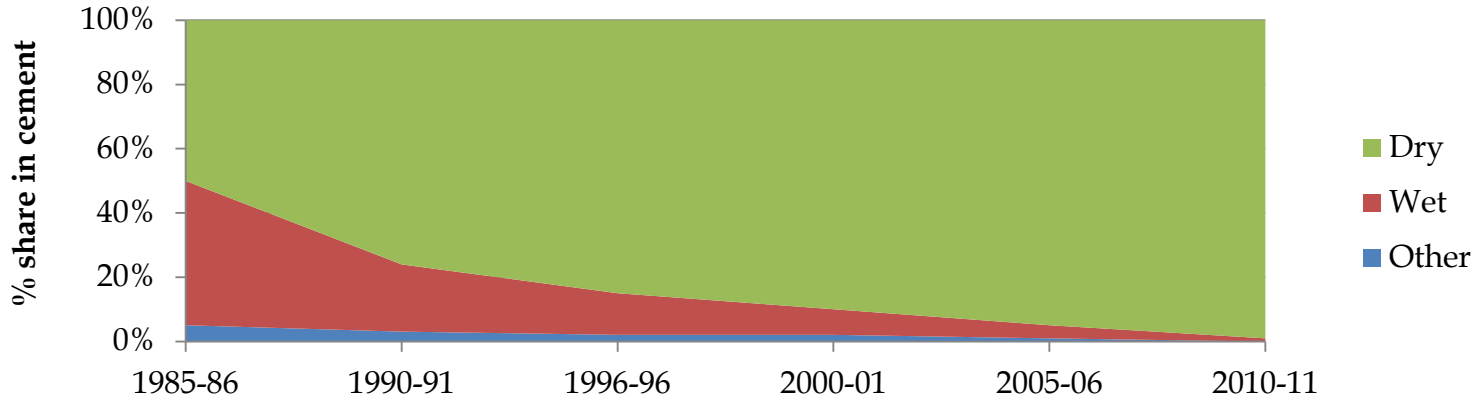
Based on Annual Survey of Industries, India 1973-74 – 2010-11
Dasgupta and Roy (2017)

Asian Institute of Technology

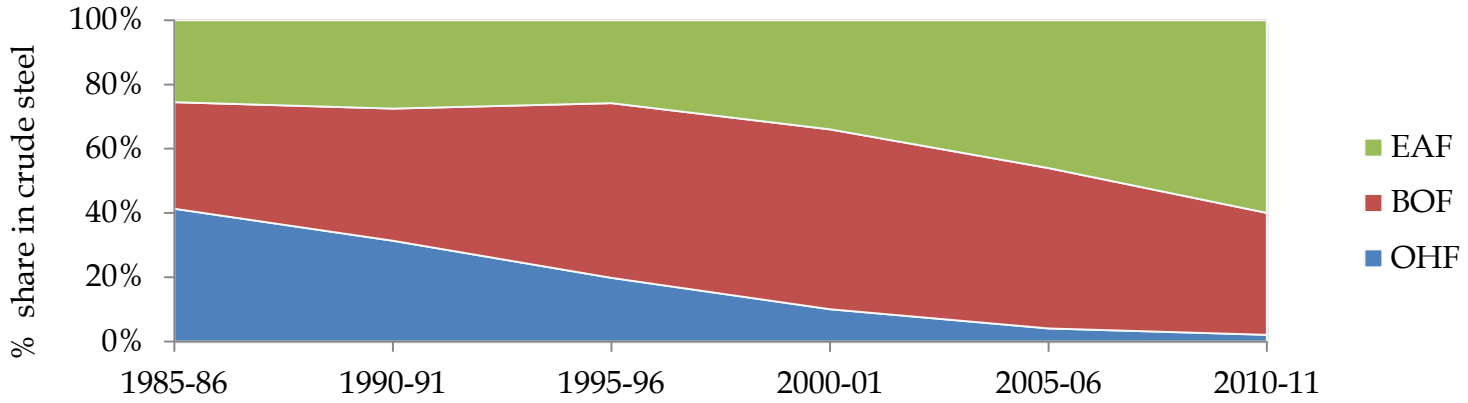
Transformational changes in process technology

Pace of process change – not similar for all industries

Cement



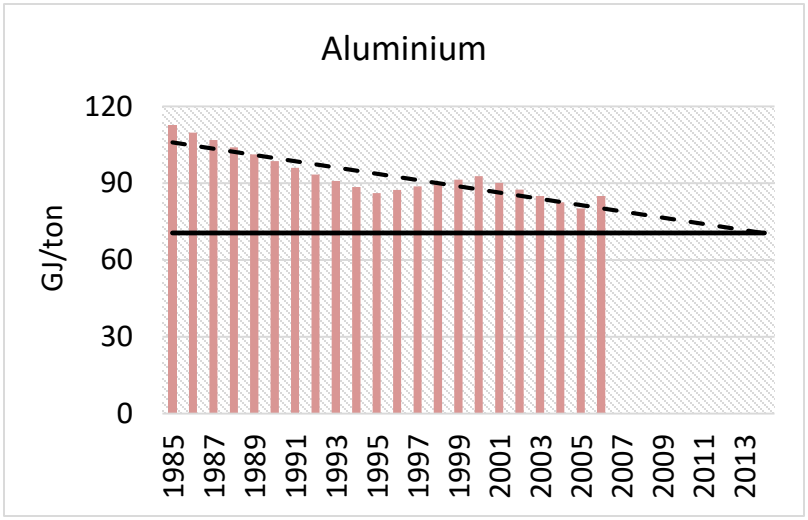
Steel

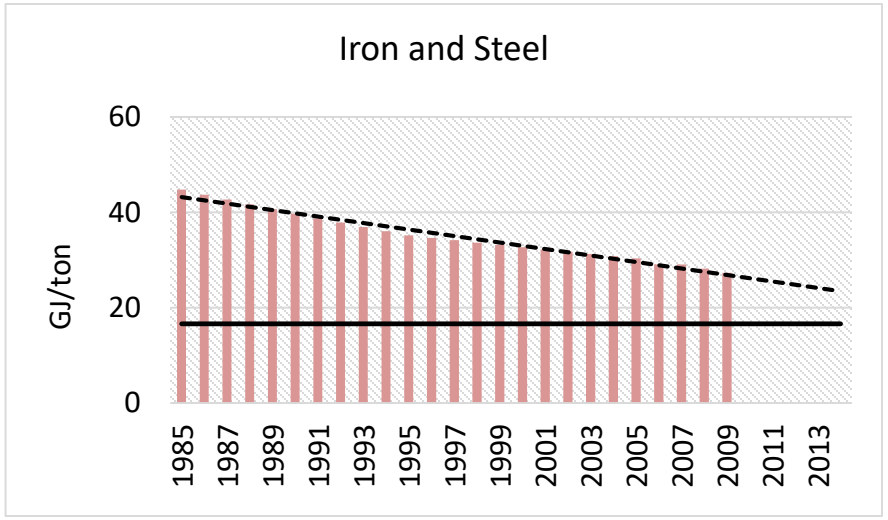


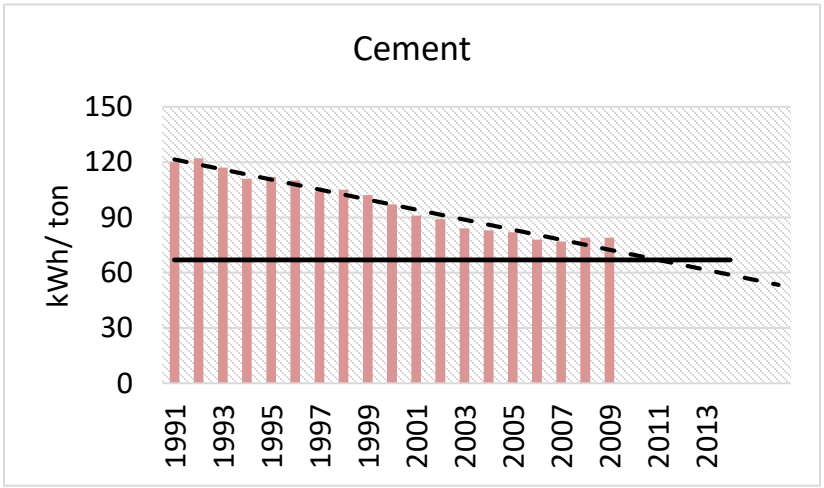
Source: Dasgupta and Roy 2017

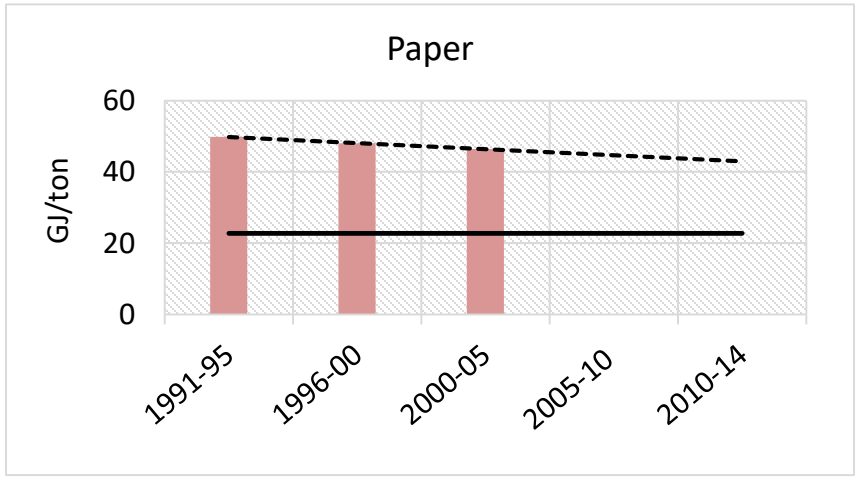
Catching up with BAT

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



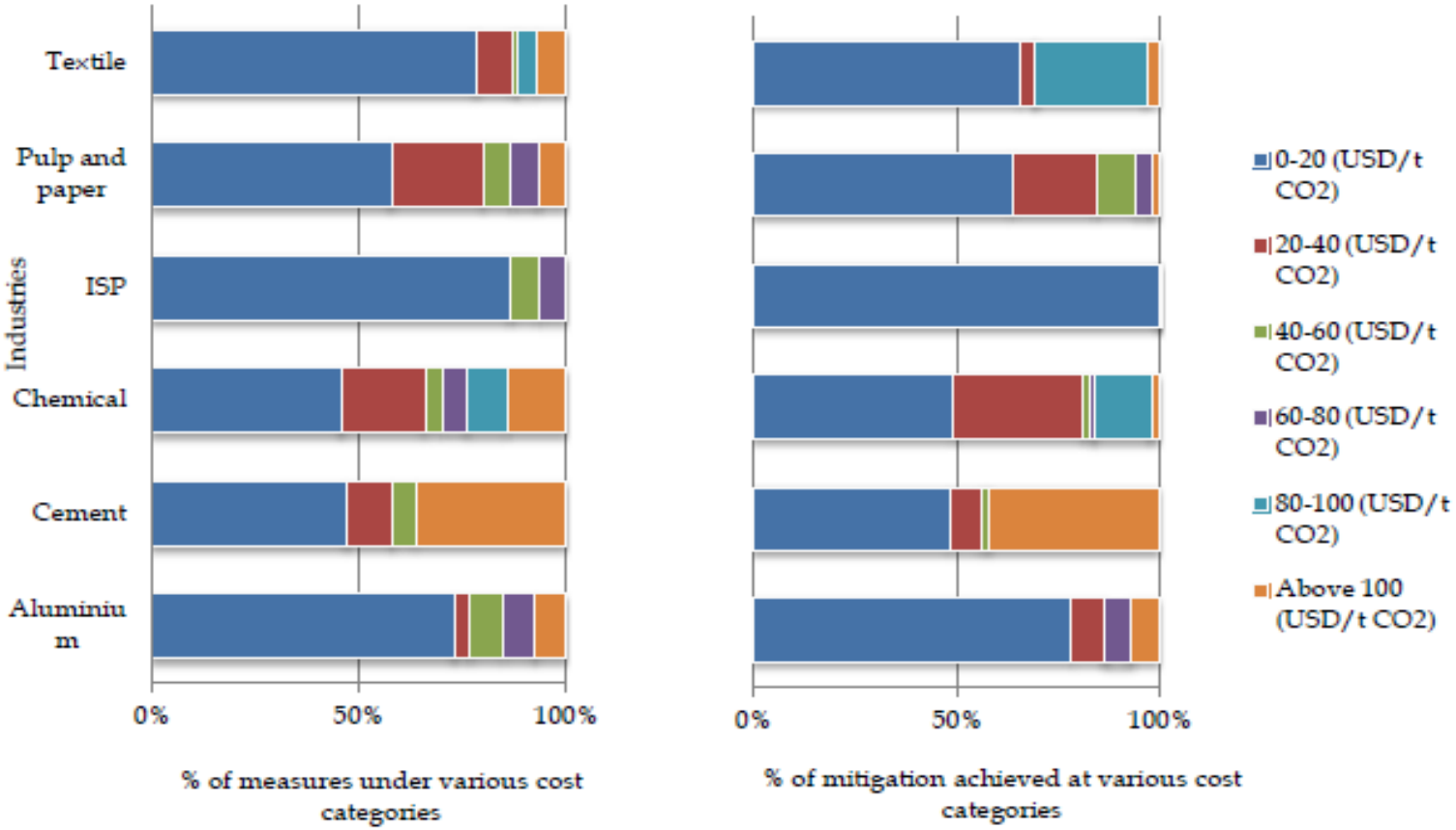






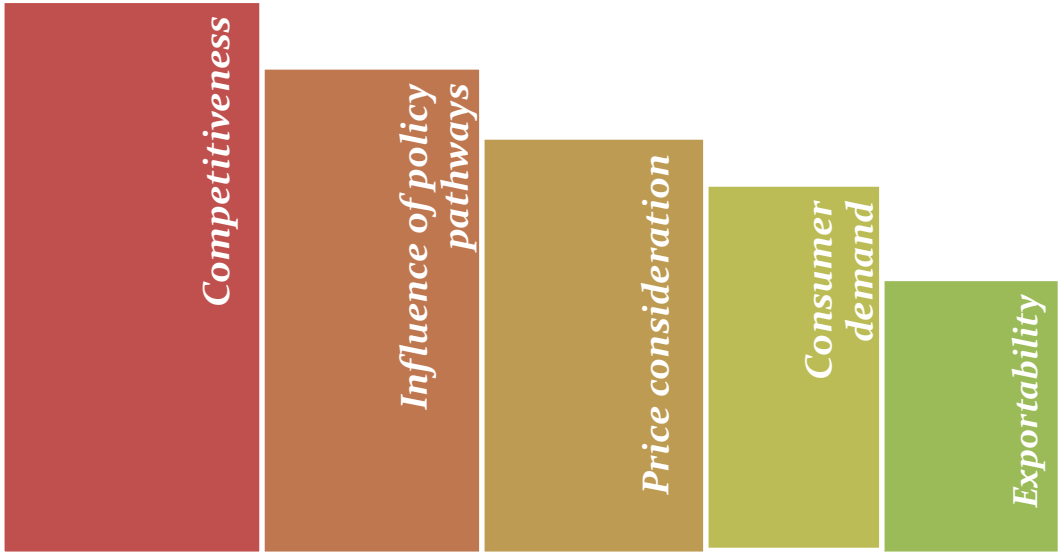
Source: Dasgupta and Roy 2017

Initiatives ranged from low to high cost



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

1. Driving force behind undertaking actions

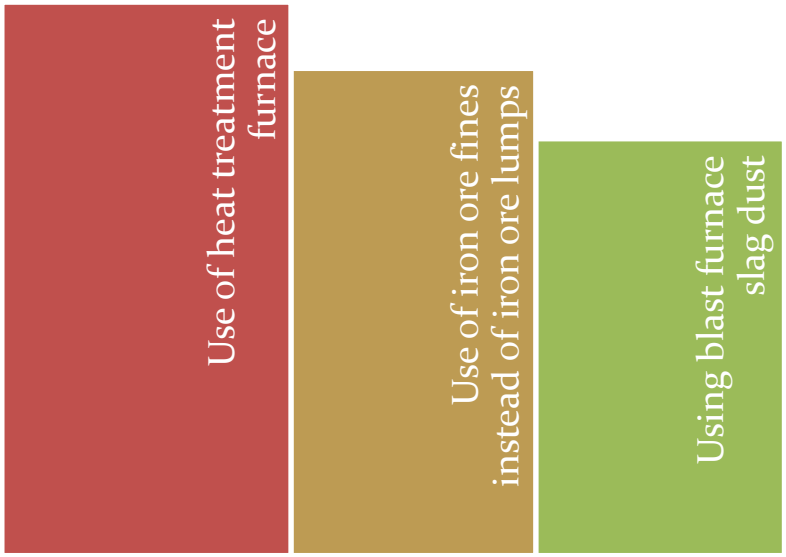


2. Emission reduction steps

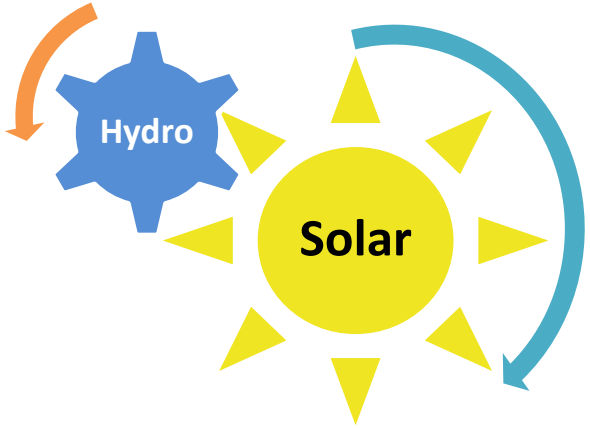
Recycling (water, metal, dust, blending of inferior raw materials, putting back scrap materials to the furnace, using of rejected pipes and slags in the plants again)

Source: Chakraborty & Roy 2012

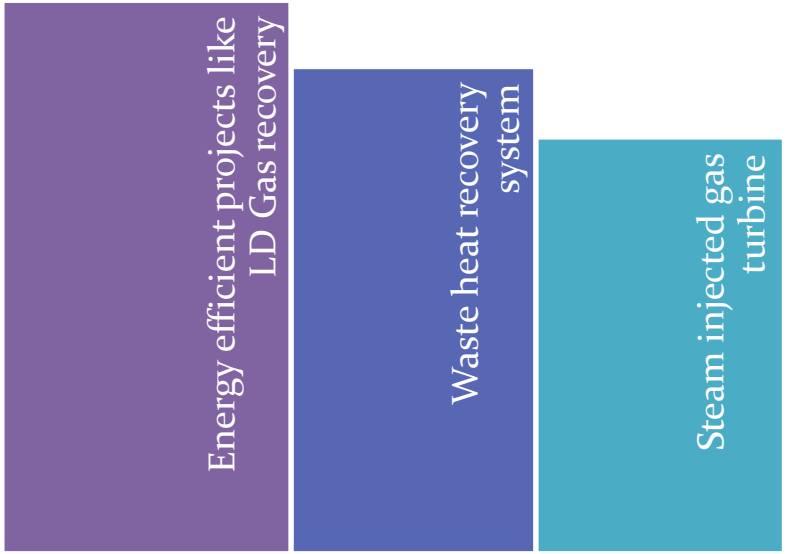
3. Energy conservation measures



5. Renewable Energy Technology



4. Energy savings measures



6. *Changes in Company's Input/ Fuel policy*

Coal gas and blast furnace gas instead of coal

Potential beyond energy efficiency: Role of carbon price

Behavioural Response

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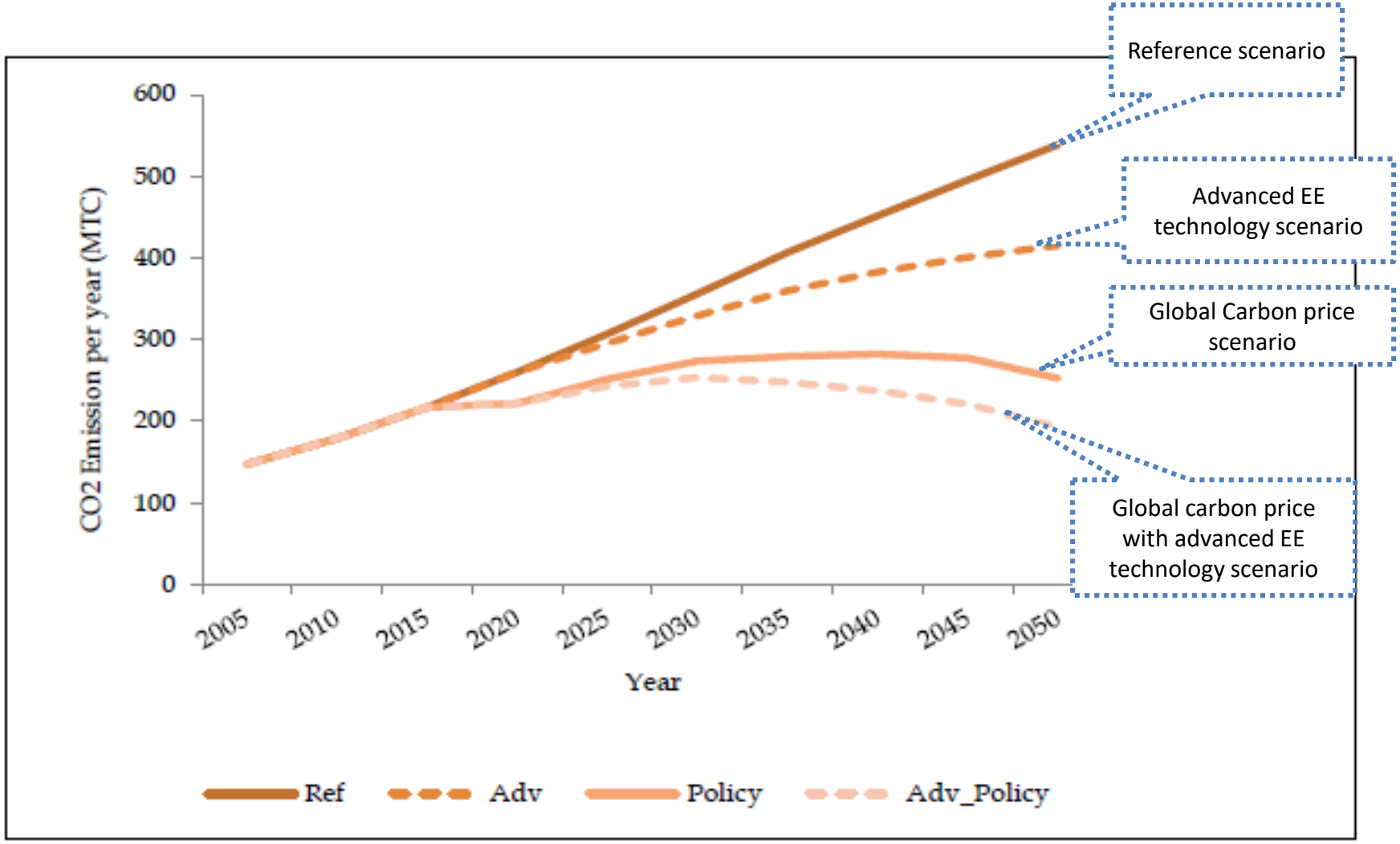
Inter-factor substitutability of inputs and own price elasticity of energy input

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.

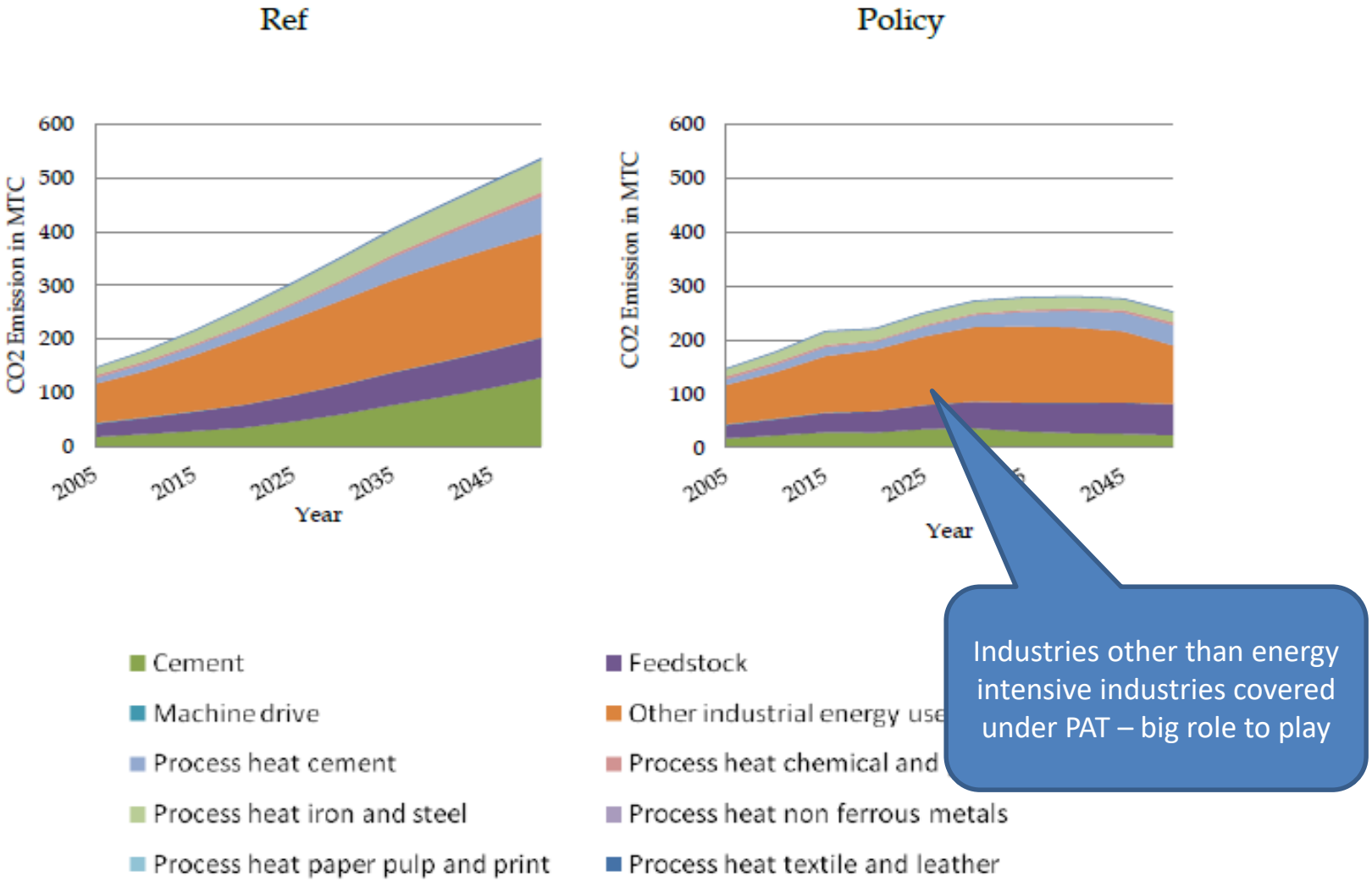
Dasgupta and Roy 2015, Energy Policy , 83, 1-13

Results from GCAM



Source: Dasgupta, Roy et.al (2017)

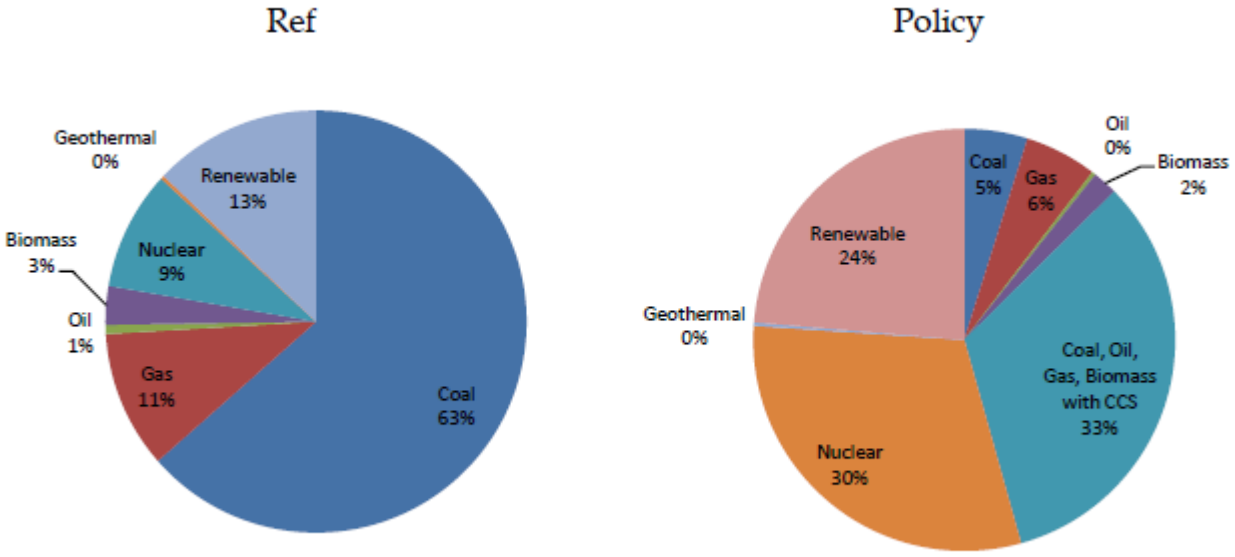
Potential beyond energy intensive industries



Source: Dasgupta, Roy et.al (2017)

Implications for power generation

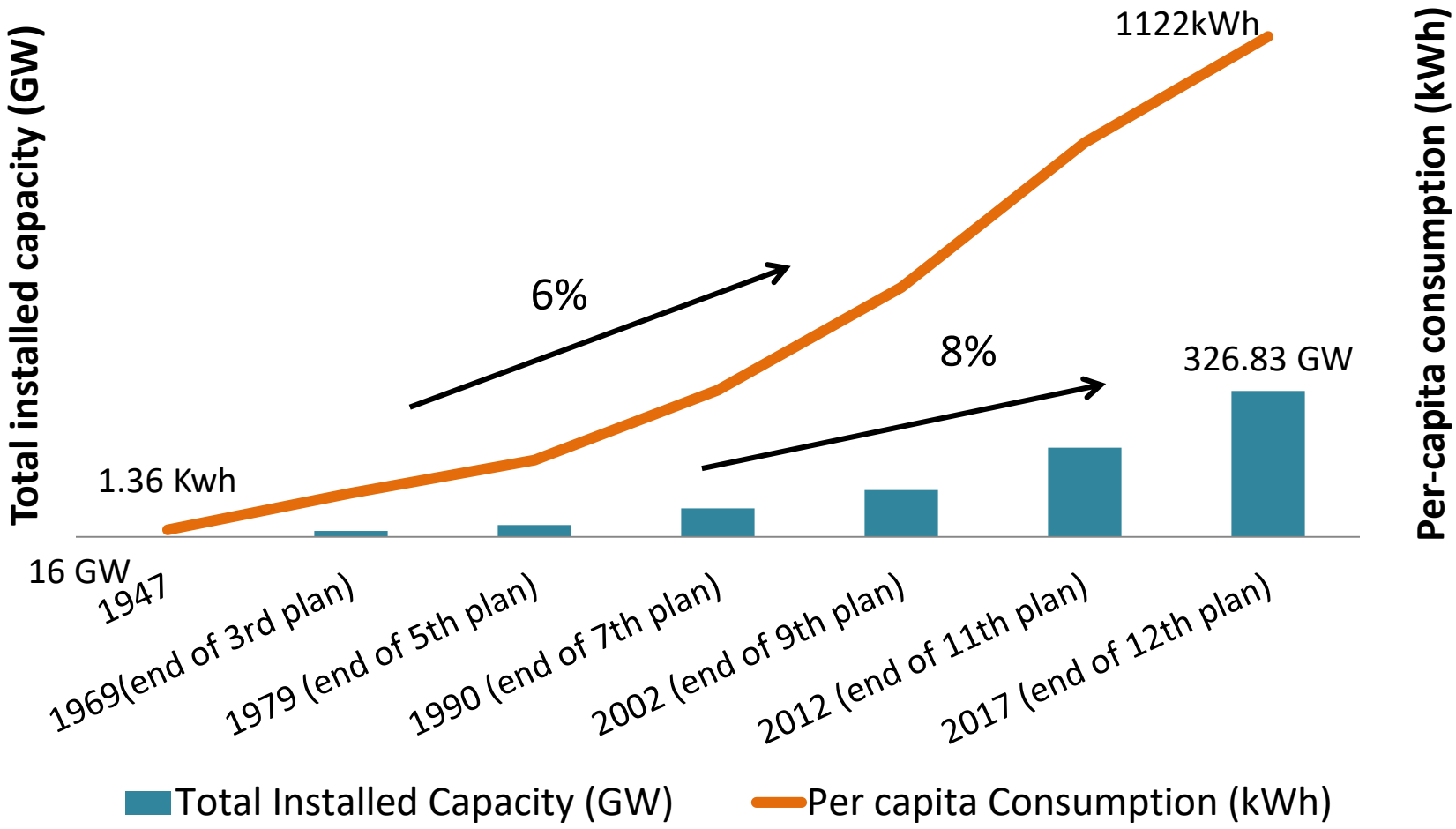
Long run green growth in industry requires large scale electrification



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

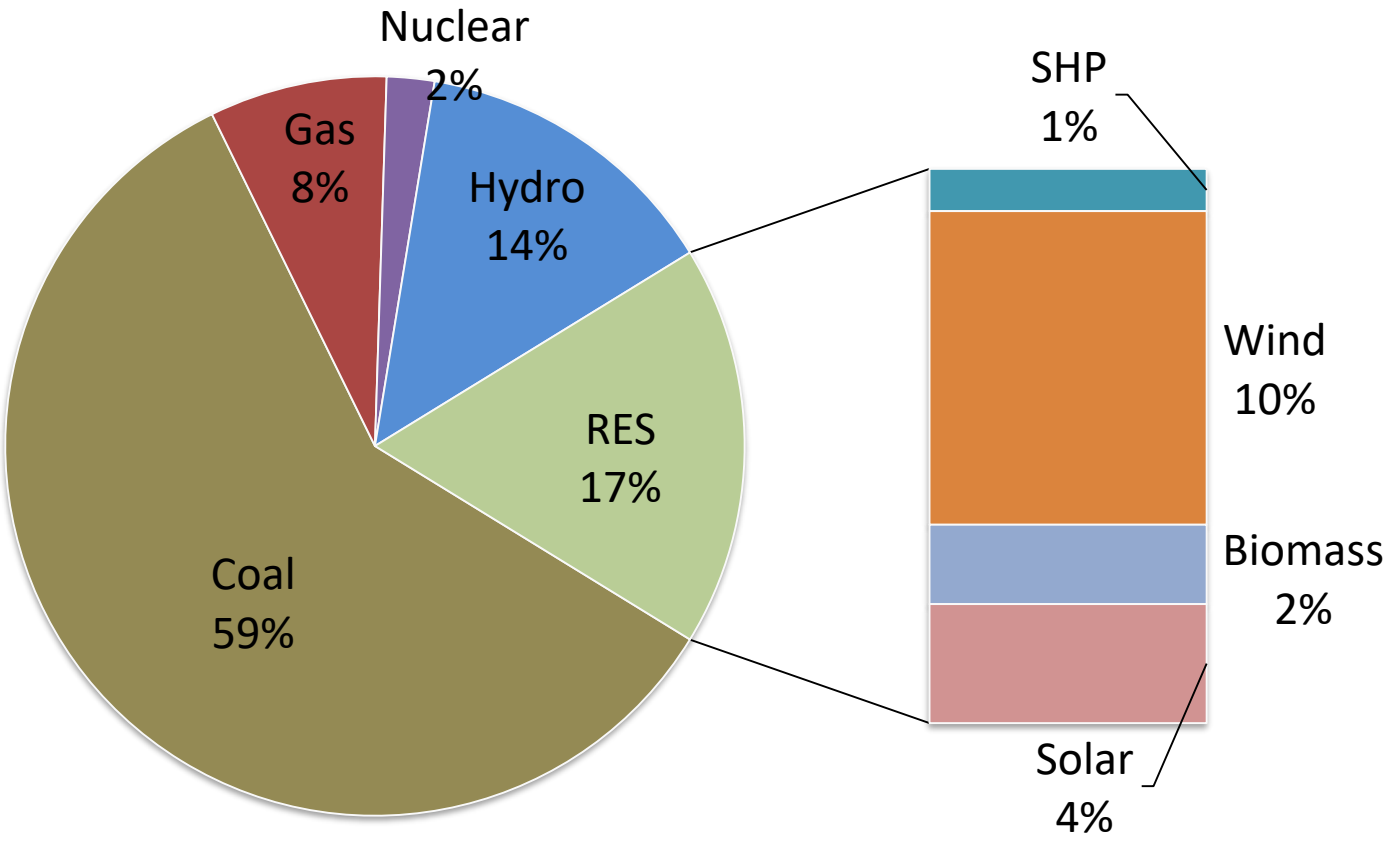
Source: Dasgupta, Roy et.al (2017)

Growth of Indian power sector



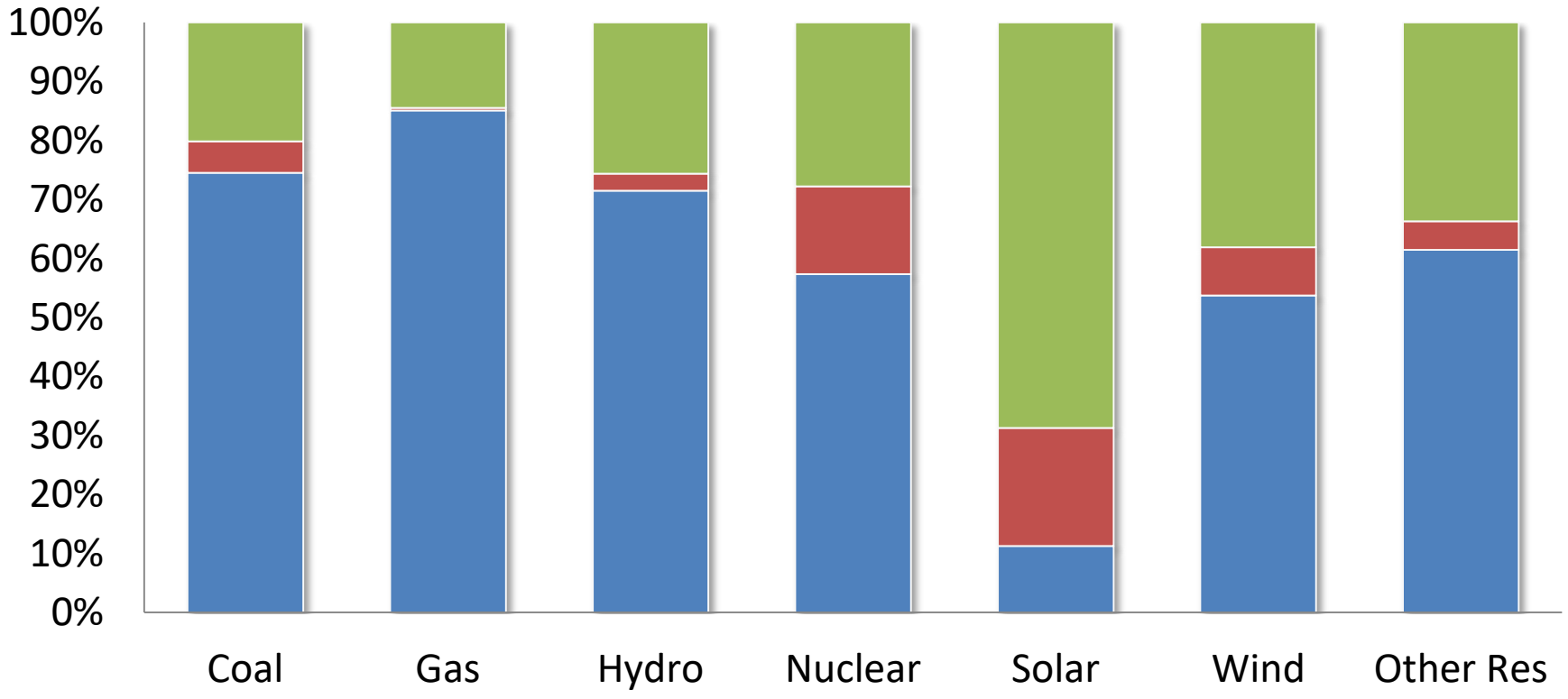
Source: Various issues of Annual Report of Central Electricity Authority

Fuel mix in installed capacity, as on March 2017



Source: CEA, 2017

Capacity expansion



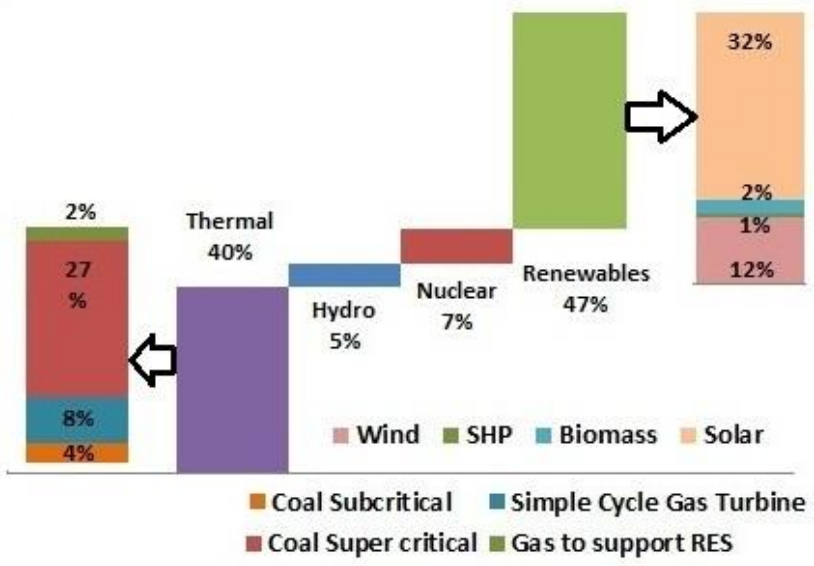
Source: CEA, 2016

4. Future emission scenarios: Alternative pathways
Potential of Clean Energy

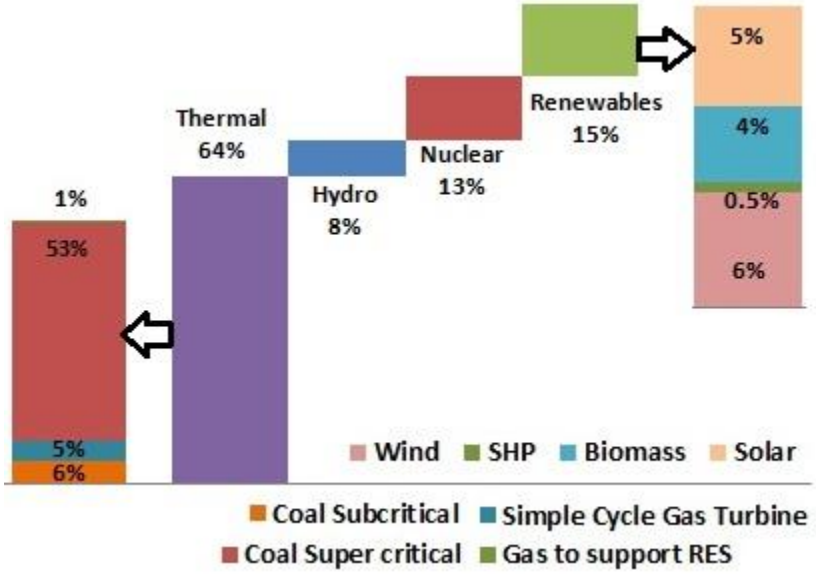
Non-fossil energy sources	Potential (MNRE, 2017)	Status (CEA, 2016)	Target (INDC, 2015)
Wind	302 GW	23.76 GW installed capacity	60 GW installed capacity by 2022
Solar	750 GW	4.06GW installed capacity	100 GW by 2022
Biomass	25 GW	4.4 GW current capacity	10 GW by 2022
Hydro	Large hydro 149 GW Small hydro 21 GW	46.1 GW current installed capacity out of 4.1 GW small hydro and 41.99 GW large hydro	
Nuclear		5.78GW current installed capacity	63 GW by 2032

4. Future emission scenarios: Alternative pathways
Future low carbon scenarios: NDC Scenario

Installed capacity 2050



Generation 2050



Uptake of systemic policies and contribution of renewable energy in selected Indian states

Policies to support Renewable Energy	**Maharashtra**	**Gujarat**	**Karnataka**	**Rajasthan**
Rebate on Municipal Taxes for promoting renewable energy	√			
Renewable Energy Re-purchase Obligation	√	√	√	√
Facilitating land acquisition for projects leading to generation of renewable energy	√	√	√	√
Special Tariff for Renewable Energy, Feed-in Tariff, Feed in Premium		√	√	
Single Window System for Projects for Renewable Energy Generation			√	√
Share of renewable in total power generation (in %)	15.54	10.85	22.25	10.19

India: success and failure stories

- National Biodiesel Mission of 2003
- **New technology with Missing new routines and new regulators**
  - Mobility sector: Intermediate transport
  - National Mission of Biodiesel

- Enhanced Energy Efficiency National Mission 2008
- **Pre conceived new technology with new routines and new regulators**
  - Policy, price, global partnership, trained manpower
  - PAT: new market system, institutional innovation

Roy et. al . 2017

Biodiesel in India: wrong pricing

- National Biodiesel Mission declared in 2003
  - Time bound targets for blending: 5% (2012), 10% (2017), 20% (beyond 2017)
  - Transforming fully fossil fuel based transport system
  - generate employment opportunities at grass root and the crop portfolio of agricultural community

- Progress so far:
  - Installed capacity is <2% of the requirement (assuming 5% blending)

Roy et. al . 2017

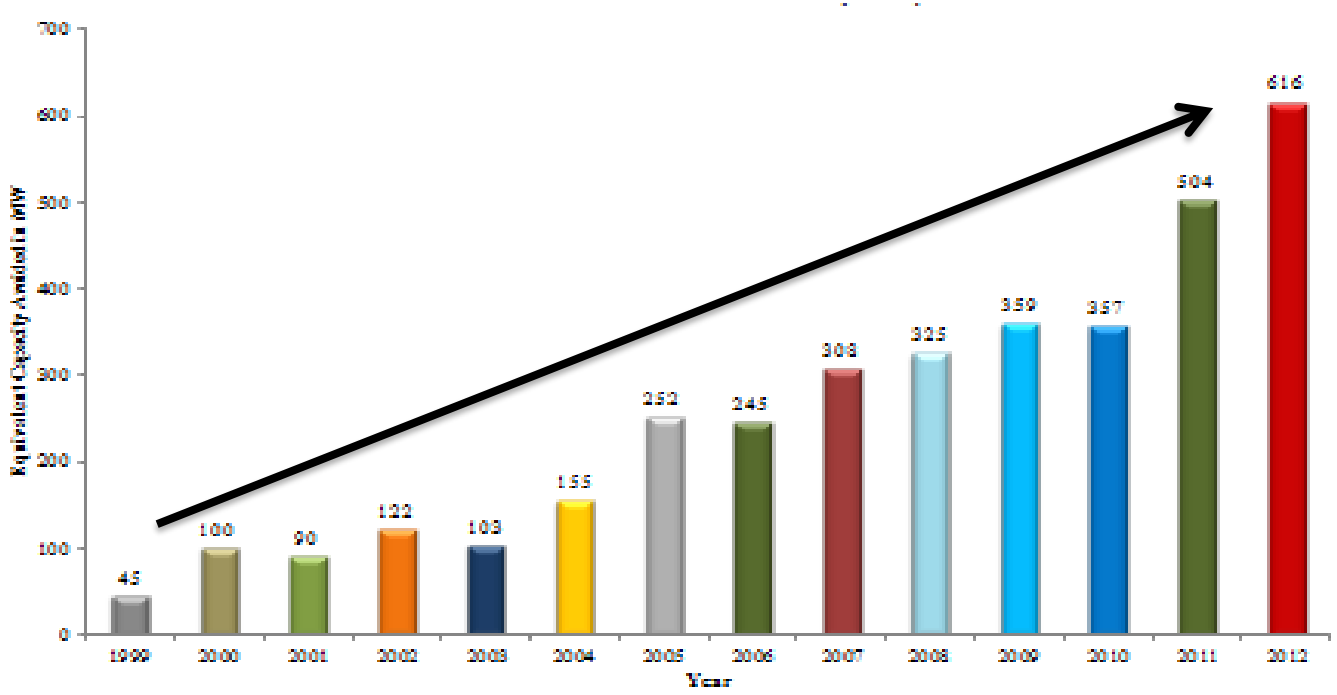
Downstream Link: Missing?

- Minimum Procurement Price (a Central Government Decision)
  - Linked to the price of Diesel?
  - Does not consider the volatility of price of feedstock and low capacity utilization?
  - MPP is uneconomic (Biodiesel Association of India, 2010)?
- National policy fails to iron out price uncertainties
  - Disparity between National Policy and Sub-national strategies.

Roy et. al . 2017

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

Bureau of Energy Efficiency, Government of India, 2014

Thank you

Acknowledgement

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http://juglobalchangeprogram.org/