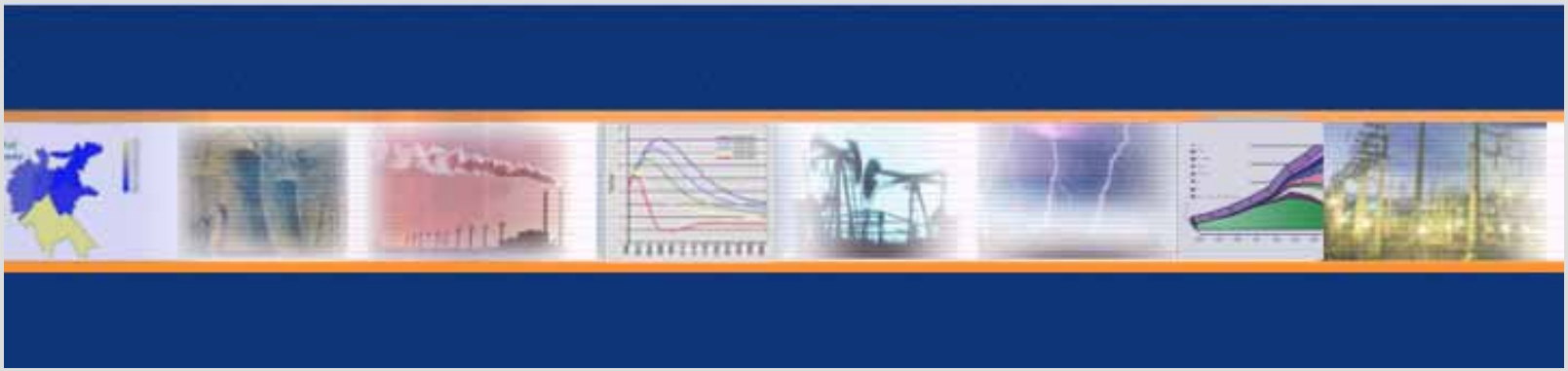
Indian Institute of Management, Ahmedabad

Stabilization Scenarios and Implications for India

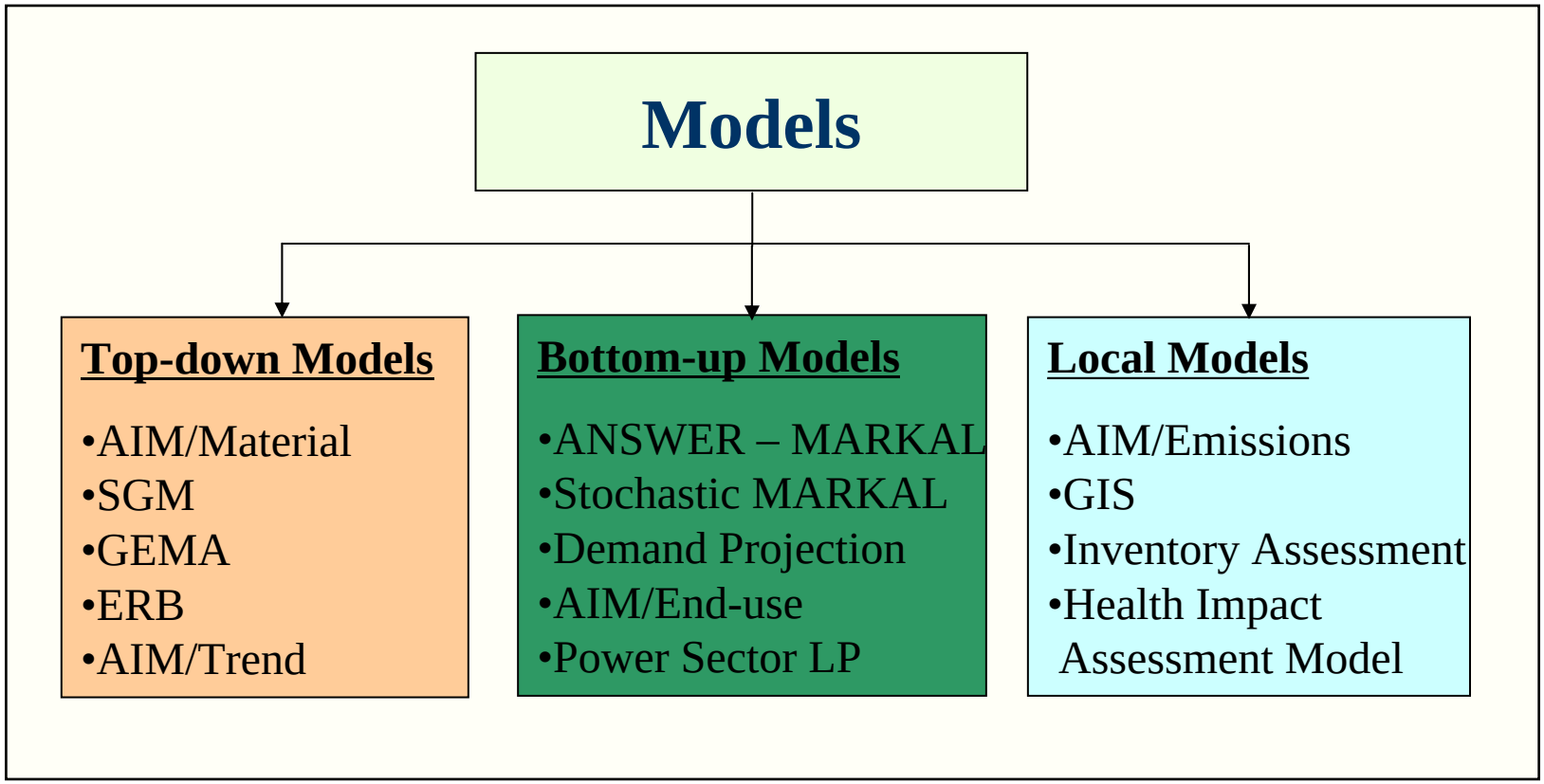
P.R. Shukla



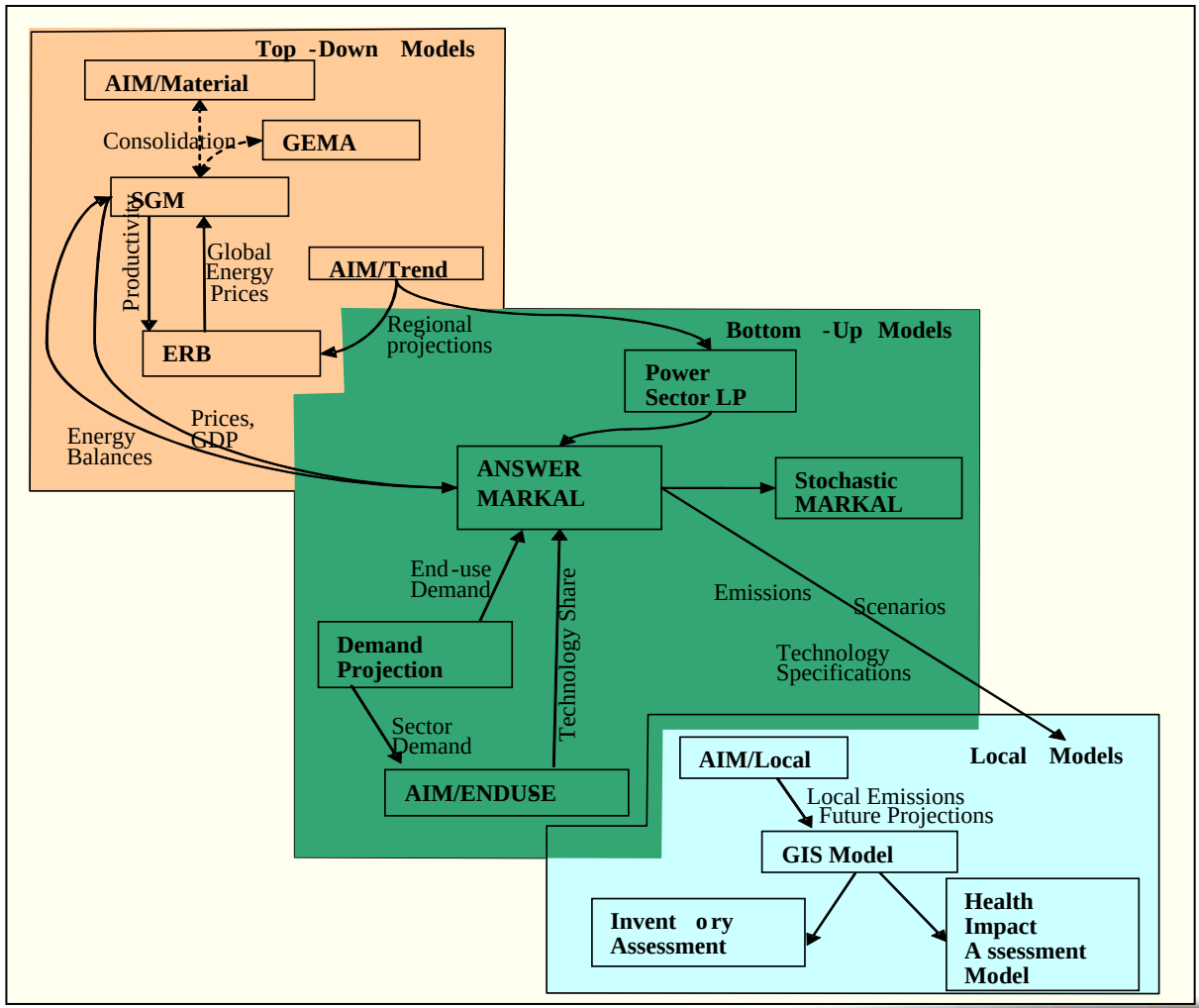
WORKSHOP on Greenhouse Gas Stabilization Scenarios
January 22-23, 2004, Tsukuba, Japan

Integrated Economy-Energy-Environment Modeling System for India

Model System for India's Emissions Policy Analysis

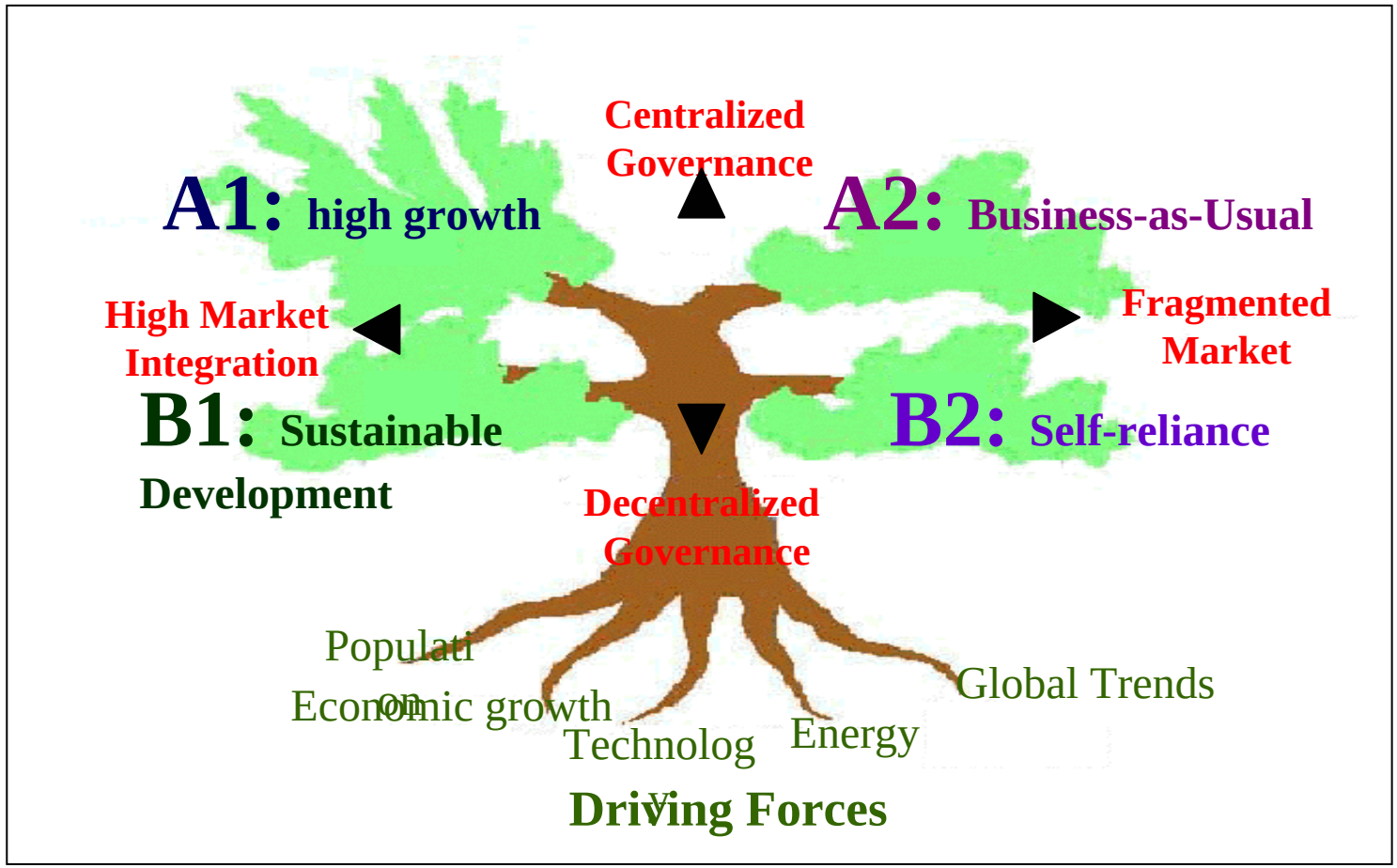


Soft-linked Models Framework

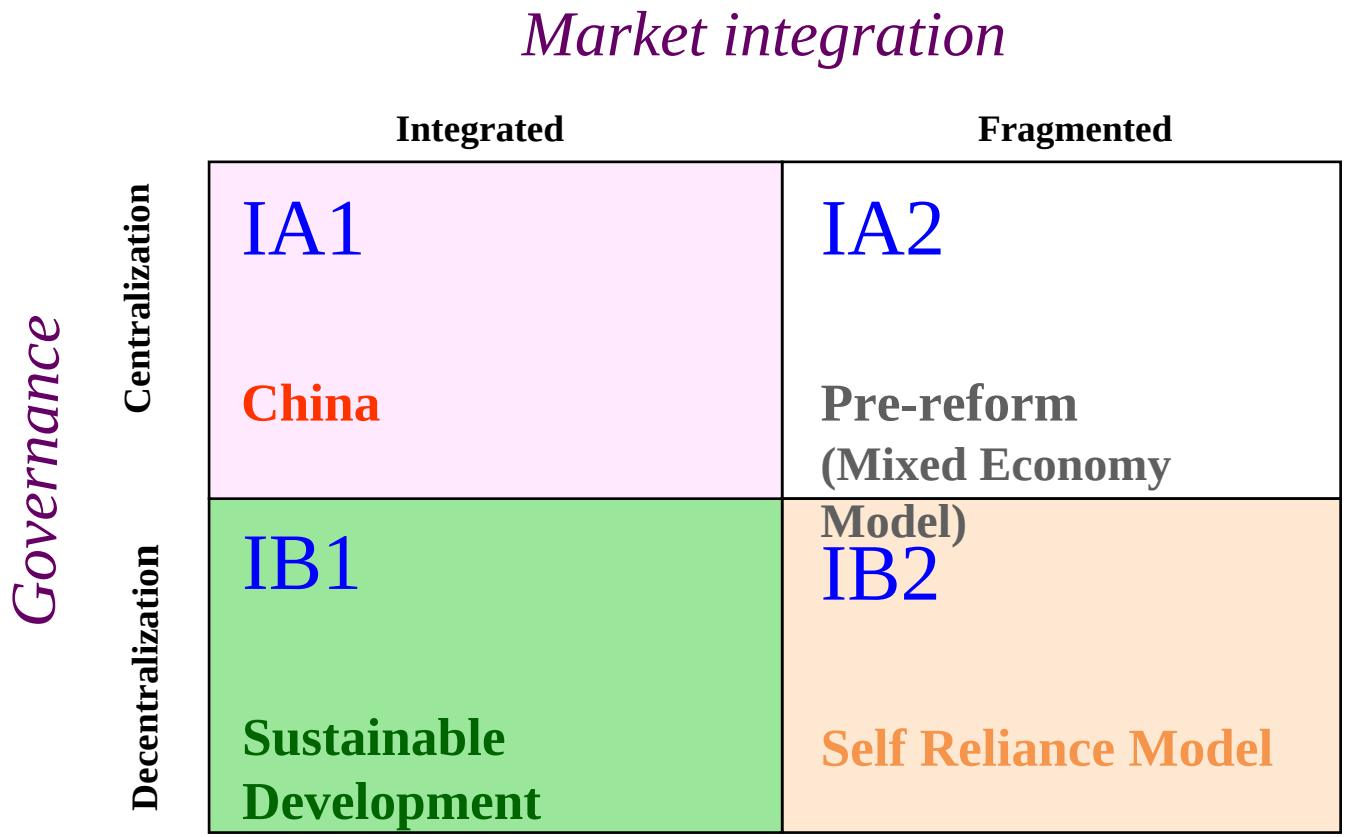


Medium-Term National Scenarios (for Emissions Projections)

Indian Scenario Tree



Indian Scenarios



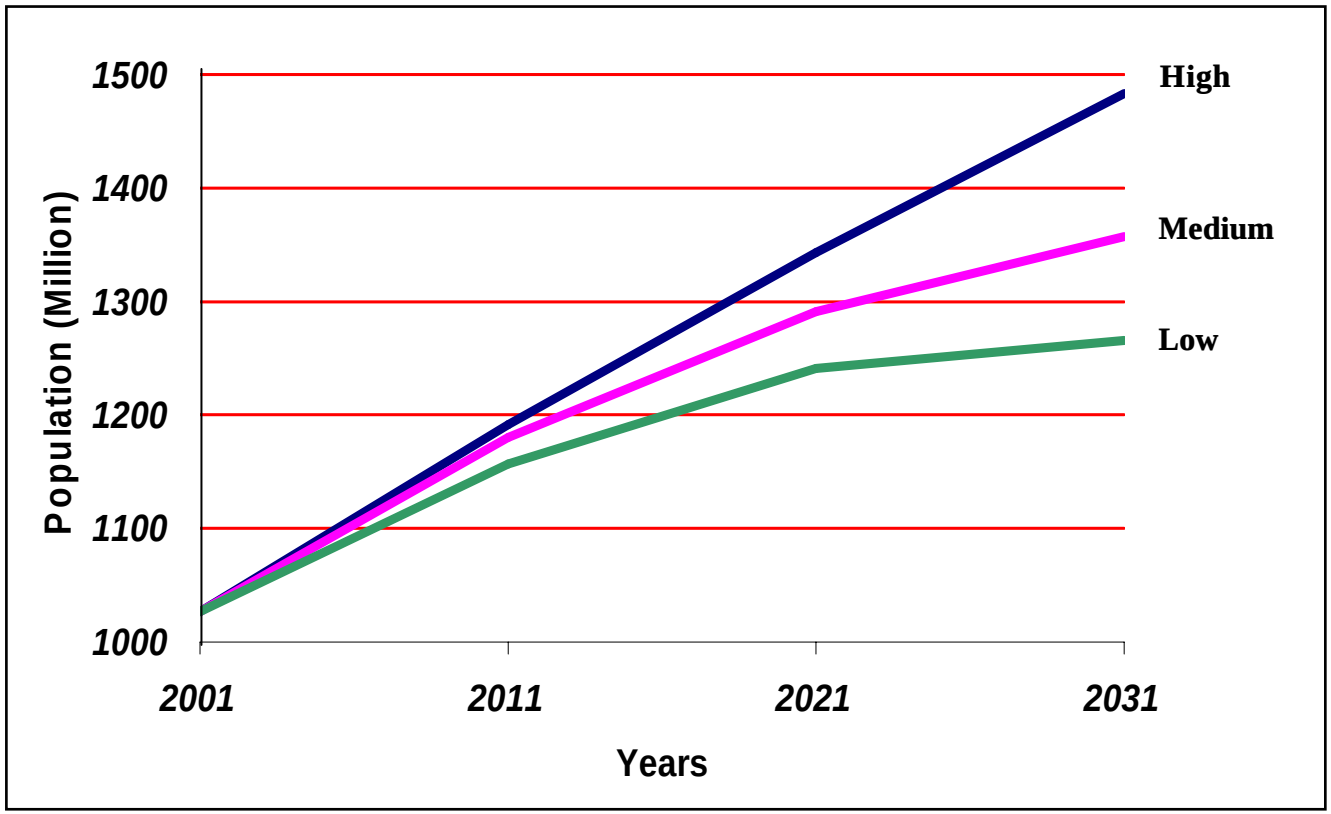
Governance

Centralization	Decentralization
Supply-side orientation	Demand-side orientation
State Monopoly	Competition
Top-down development	Regional development
Central planning/ policies	Rural focus
Focused Industries	Distributed utilities
Low/medium population	Medium/high population
Medium/high GDP Growth	Low/medium GDP growth

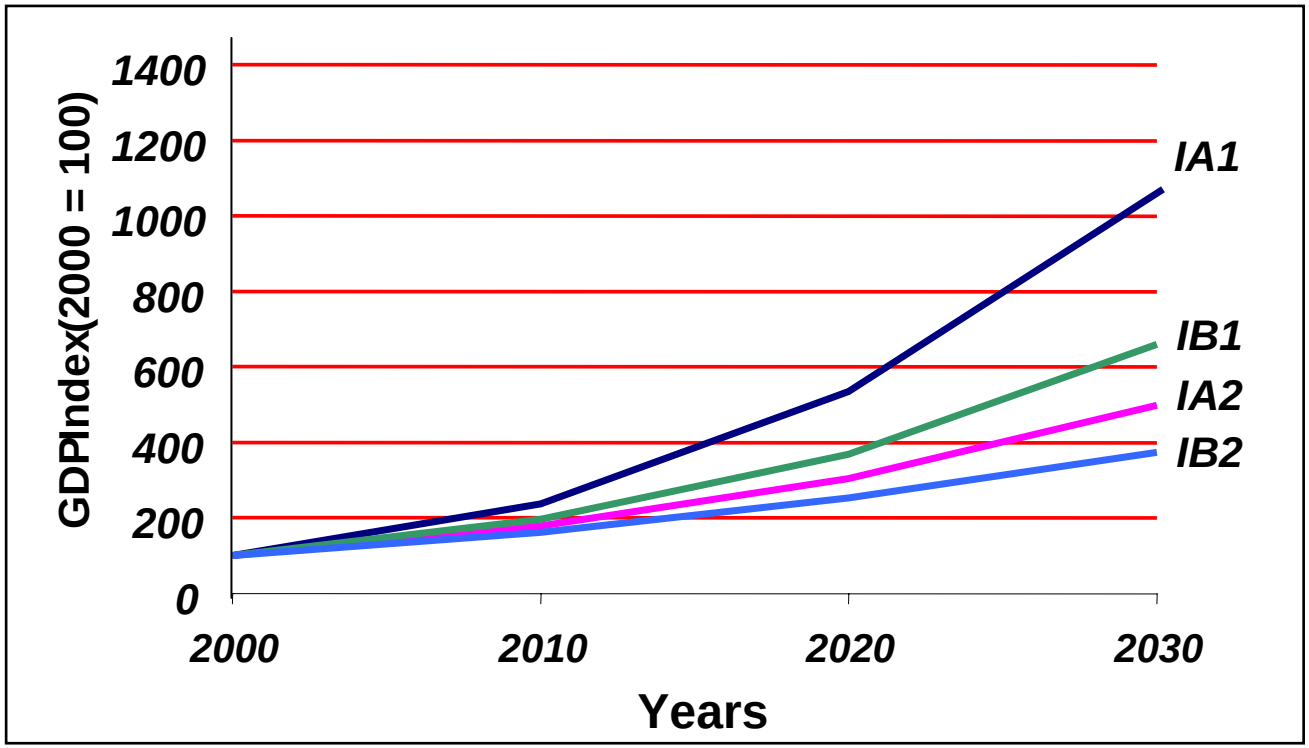
Market Integration

High integration	Low integration
High-medium growth	Low-medium growth
Low tariffs	High tariffs
Technology transfer	Indigenous technology
External investment	Self reliance model
Globalization / competition	Fragmanted market

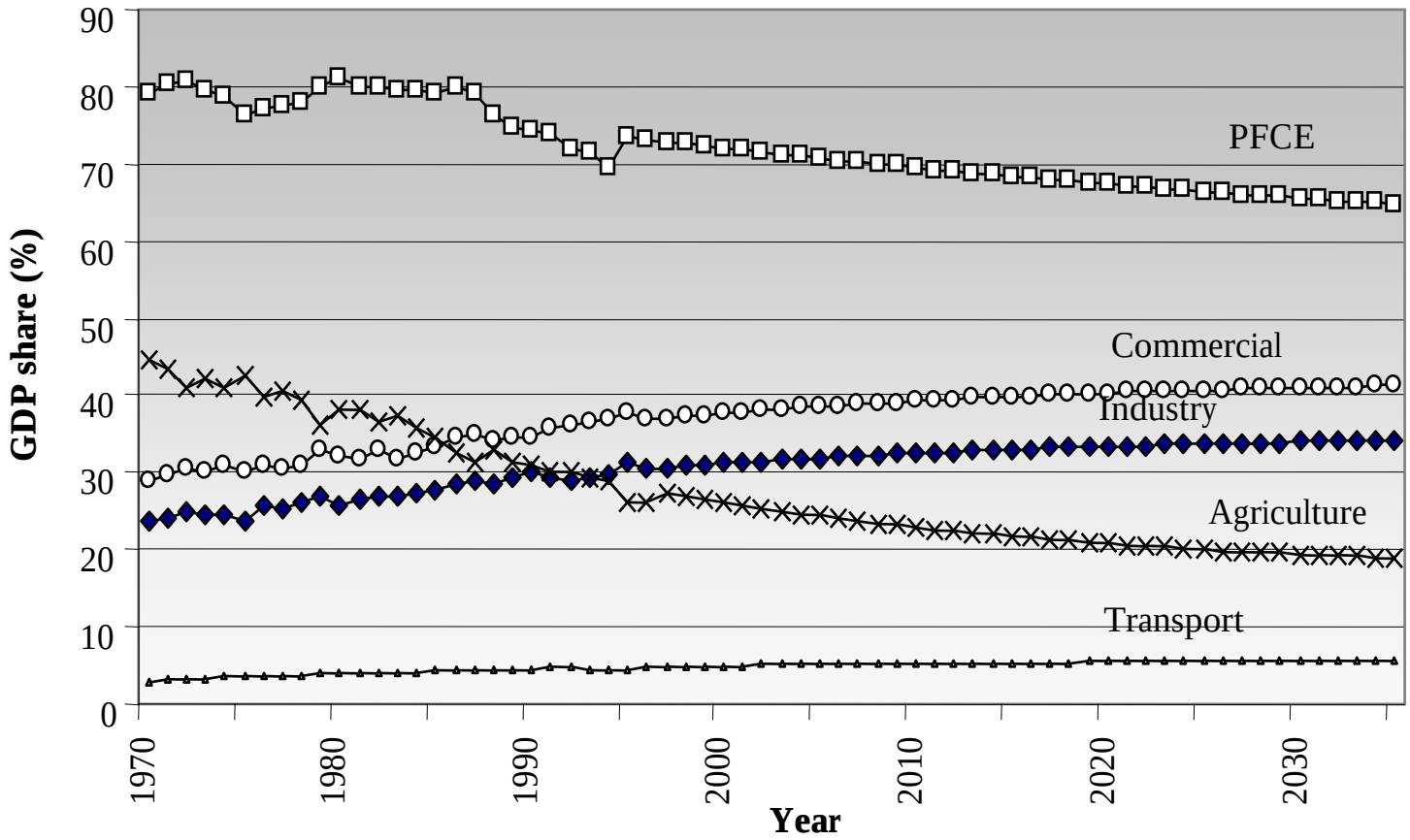
India: Population Projection



India: GDP Projection



Share of Major Sectors in GDP



Energy Resources

	Oil and Gas	Coal	Renewables
IA1	High	Moderate	Moderate
IA2	Moderate	High	Low
IB1	Moderate	Low	High
IB2	Low	Moderate	Low

National Development Goals

1) Economic Security

2) Energy Security

3) Environment Security

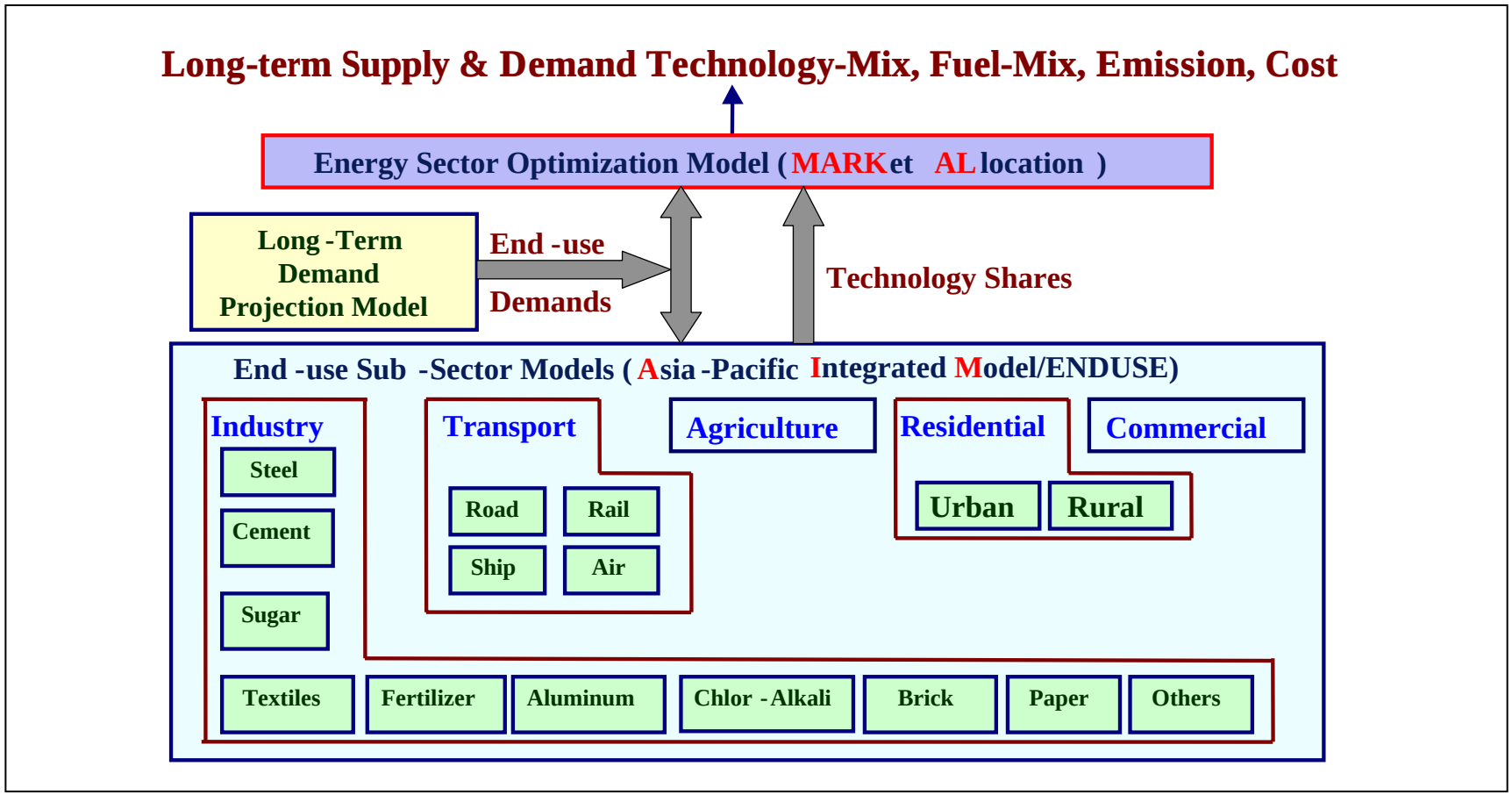
4) Water Security

5) Food Security

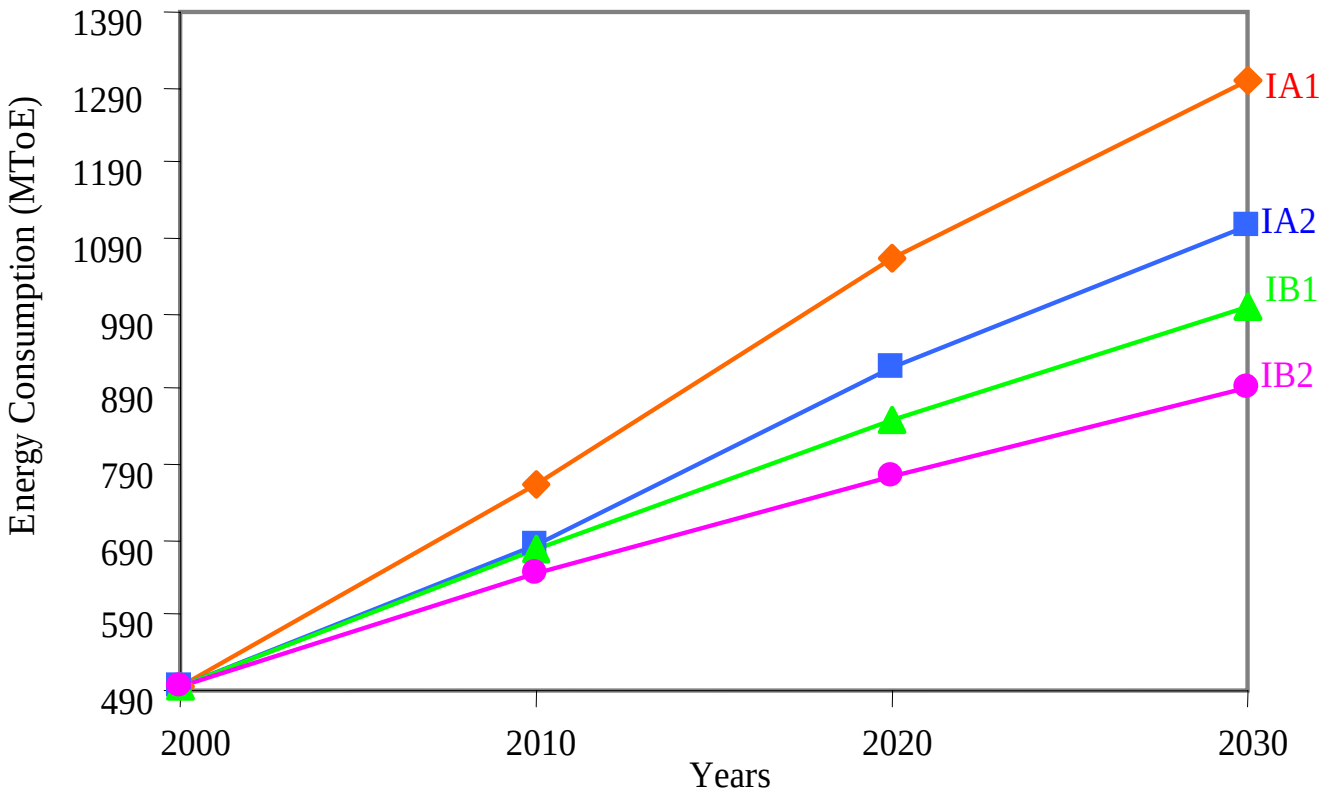
6) Health Security

Future Energy and Emissions Projections for Scenarios

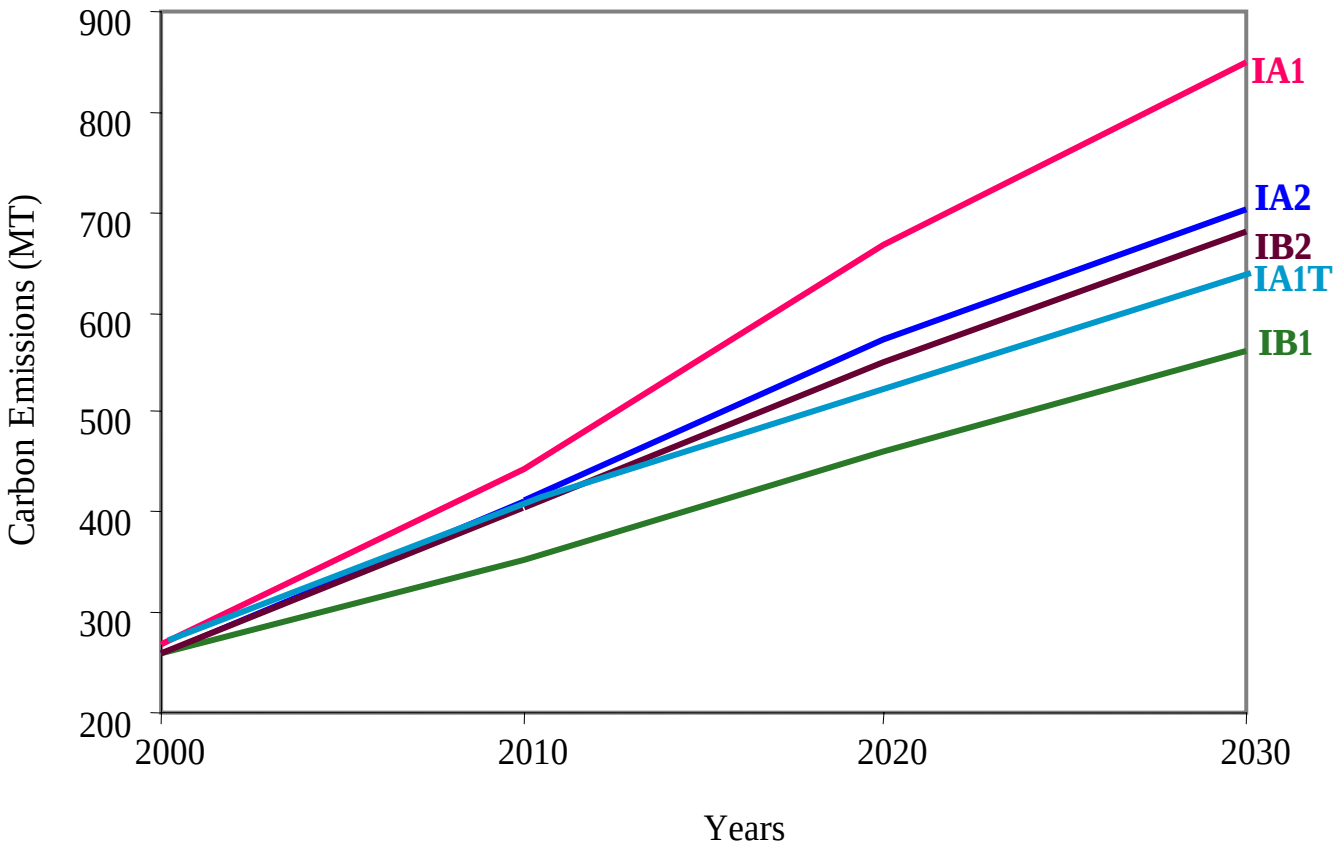
Integrated Bottom-Up Modeling System



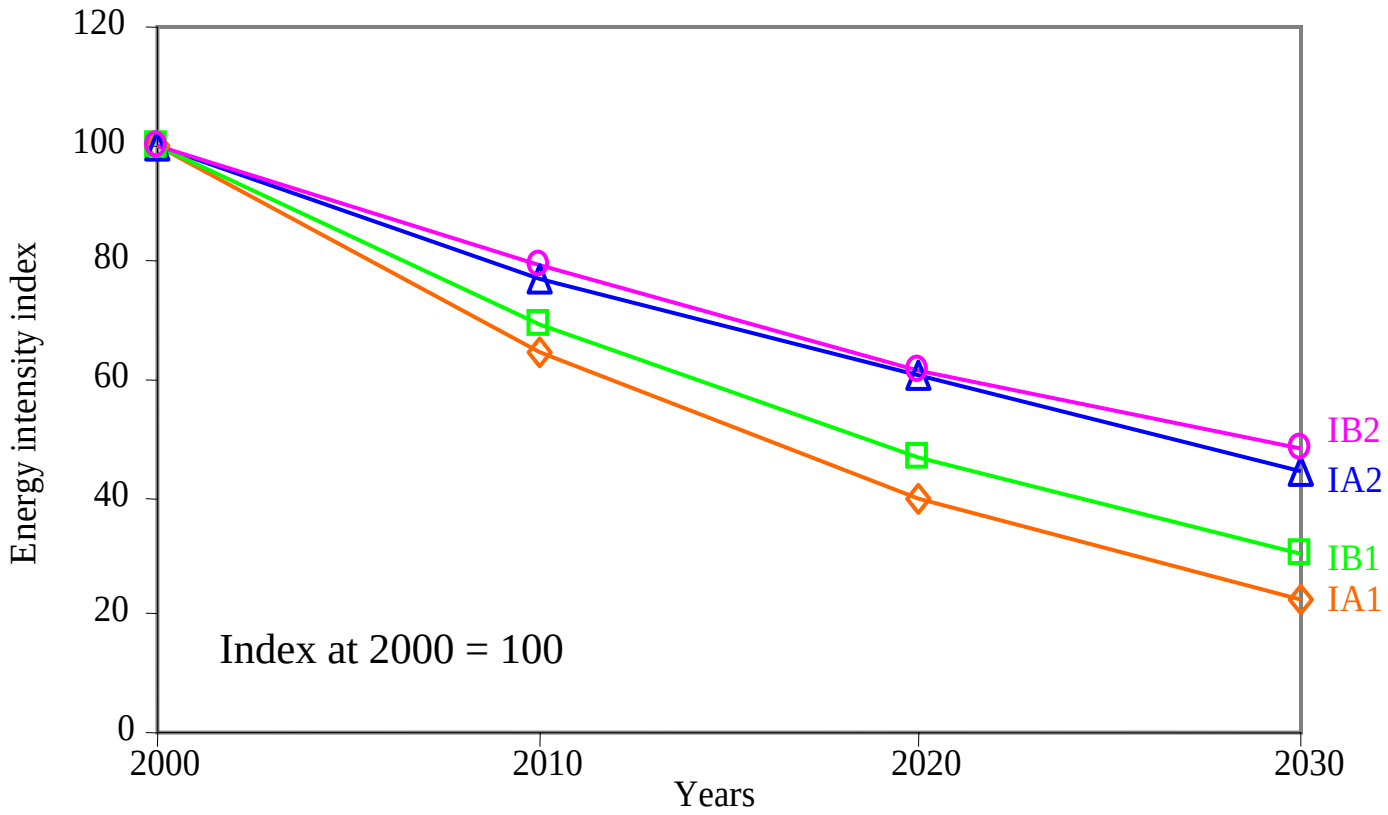
Energy Consumption



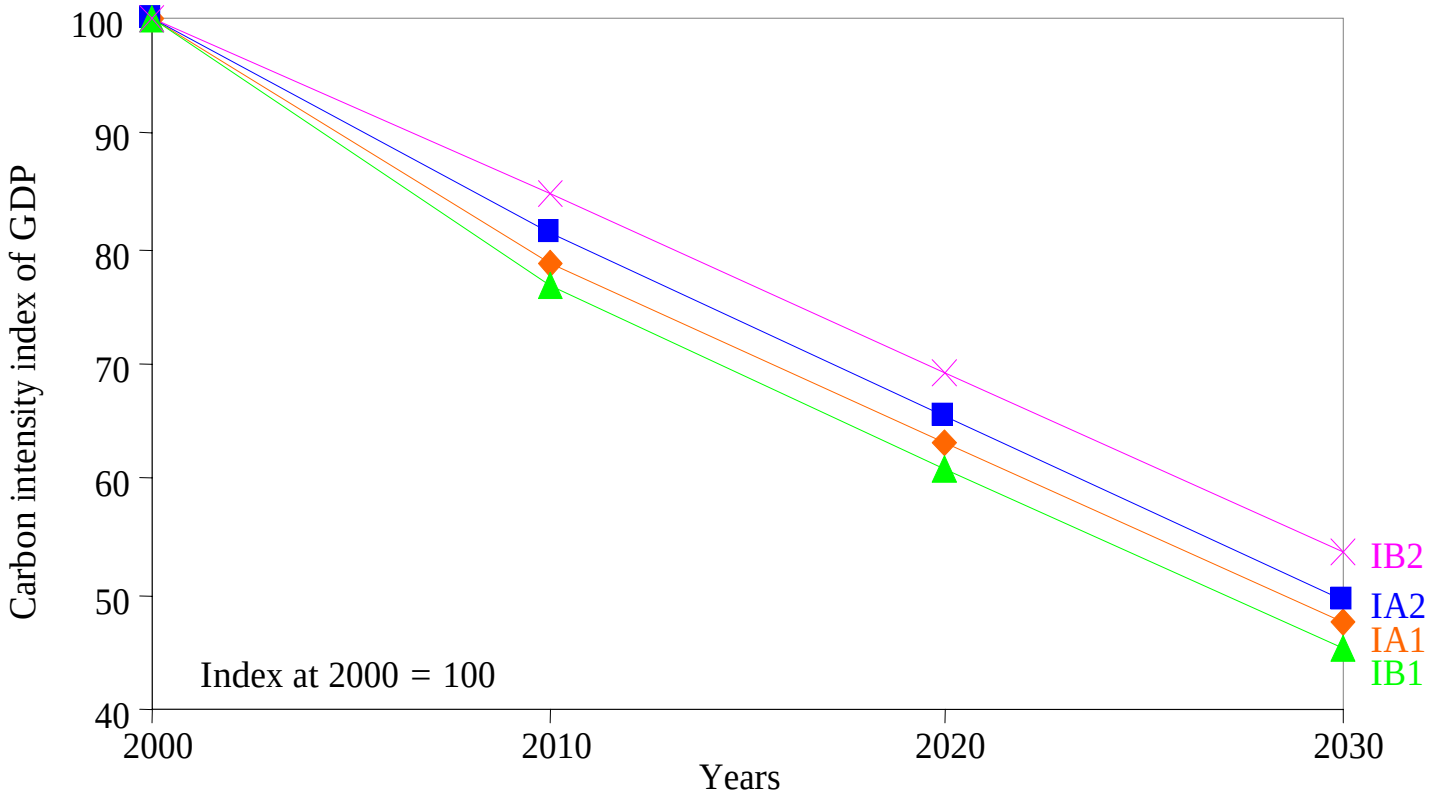
Carbon Emissions (MT)



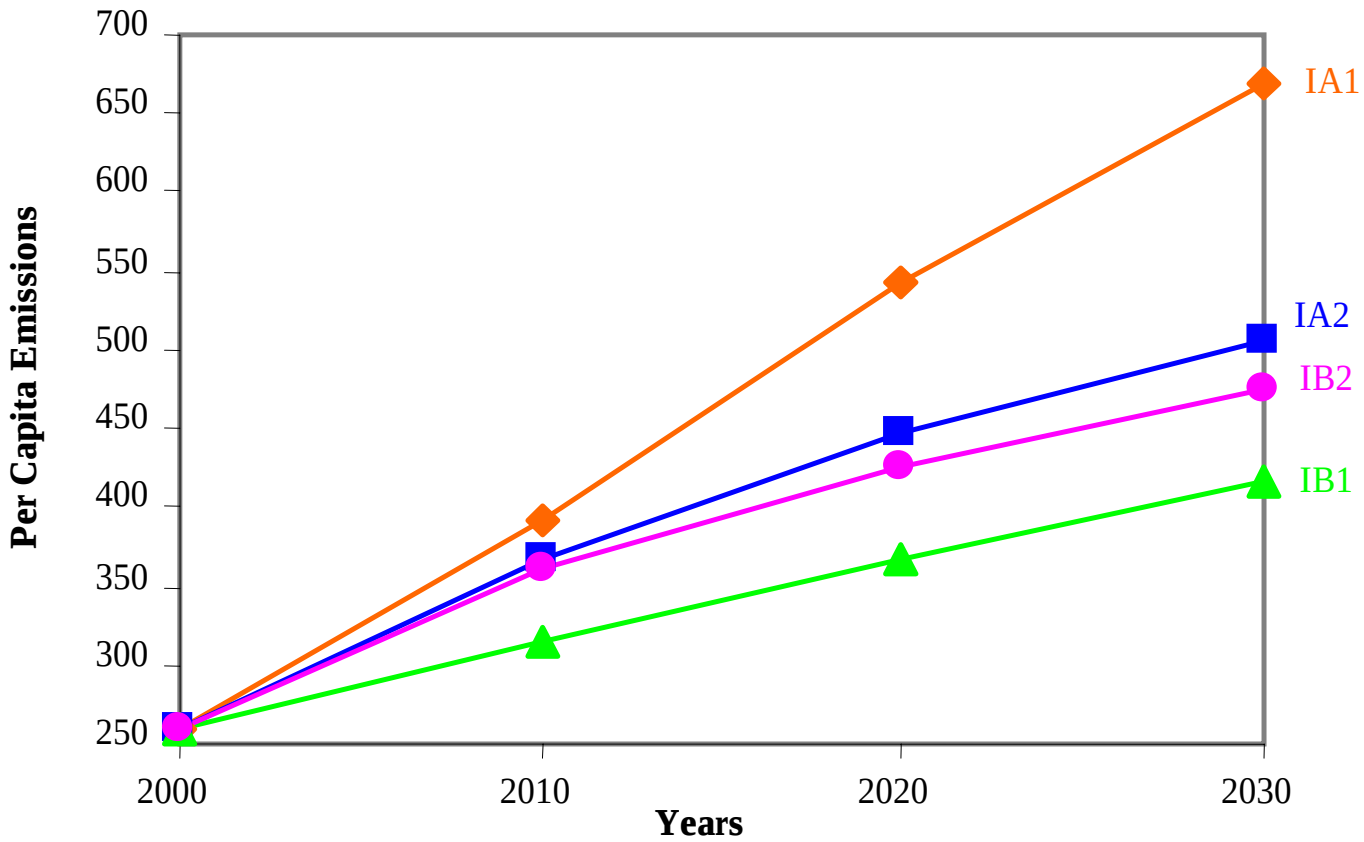
Energy Intensity (Index 2000=100)



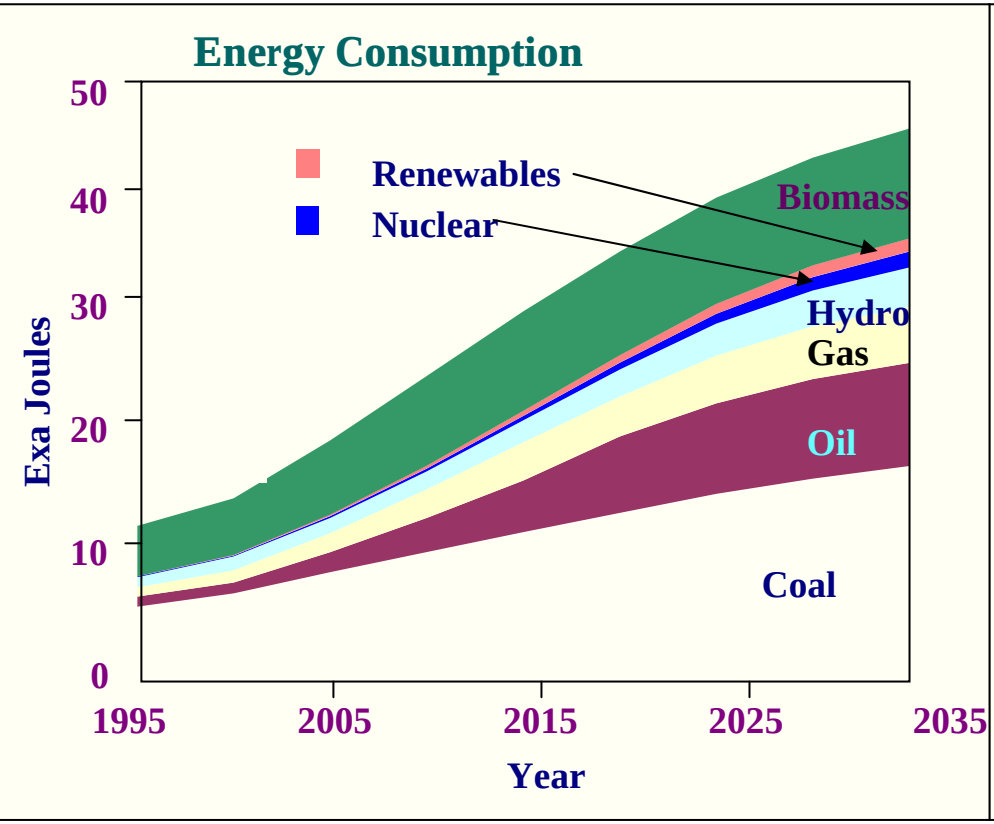
Carbon Intensity Index of GDP

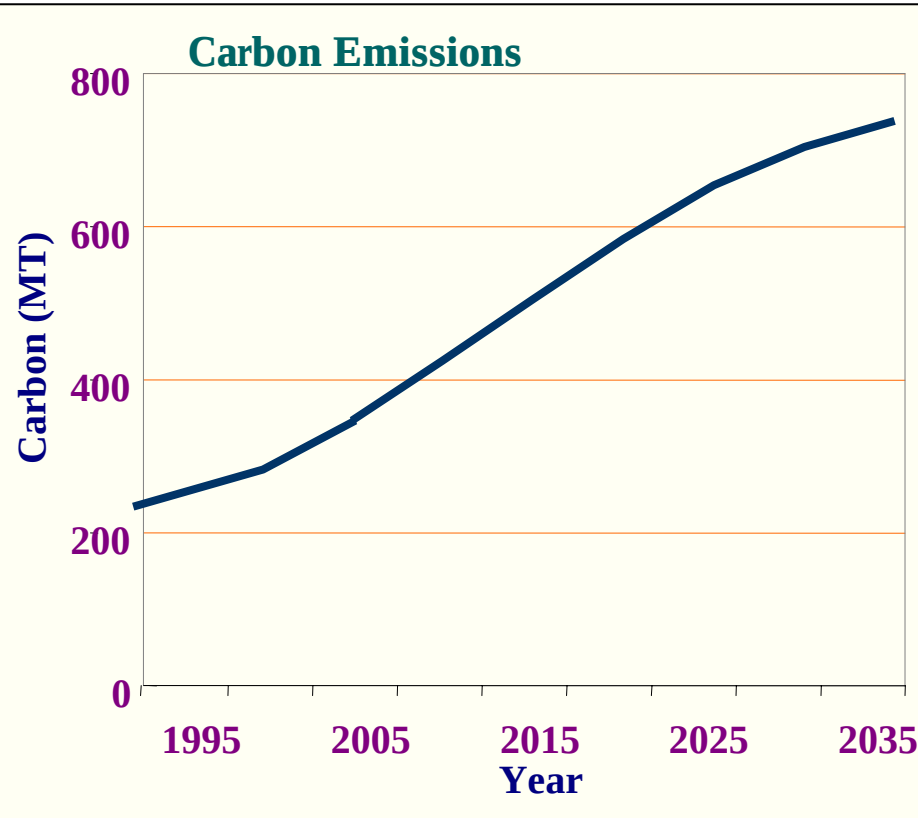


Per Capita Carbon Emissions (kgC / person)



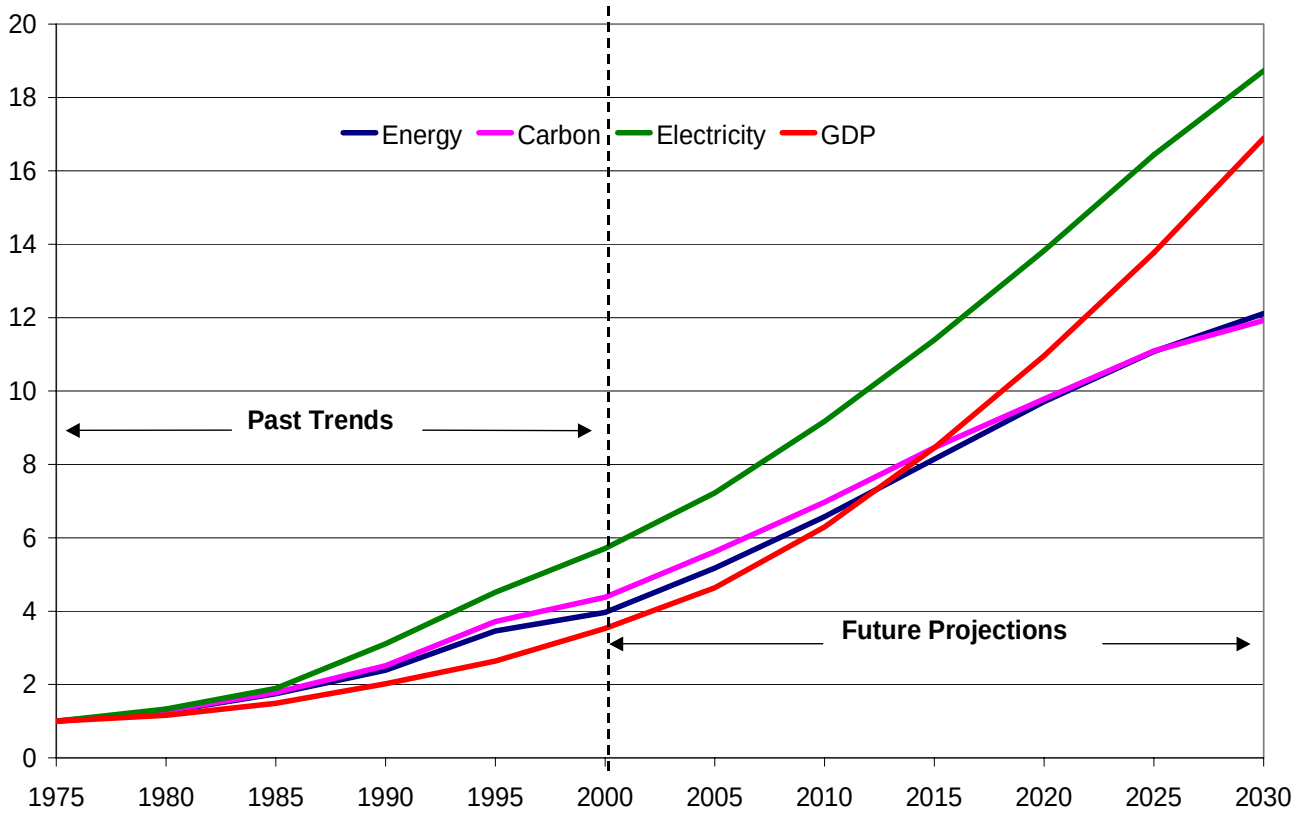
Energy and Carbon Emissions for India (IA2 Scenario):
Analysis with AIM/MARKAL Models



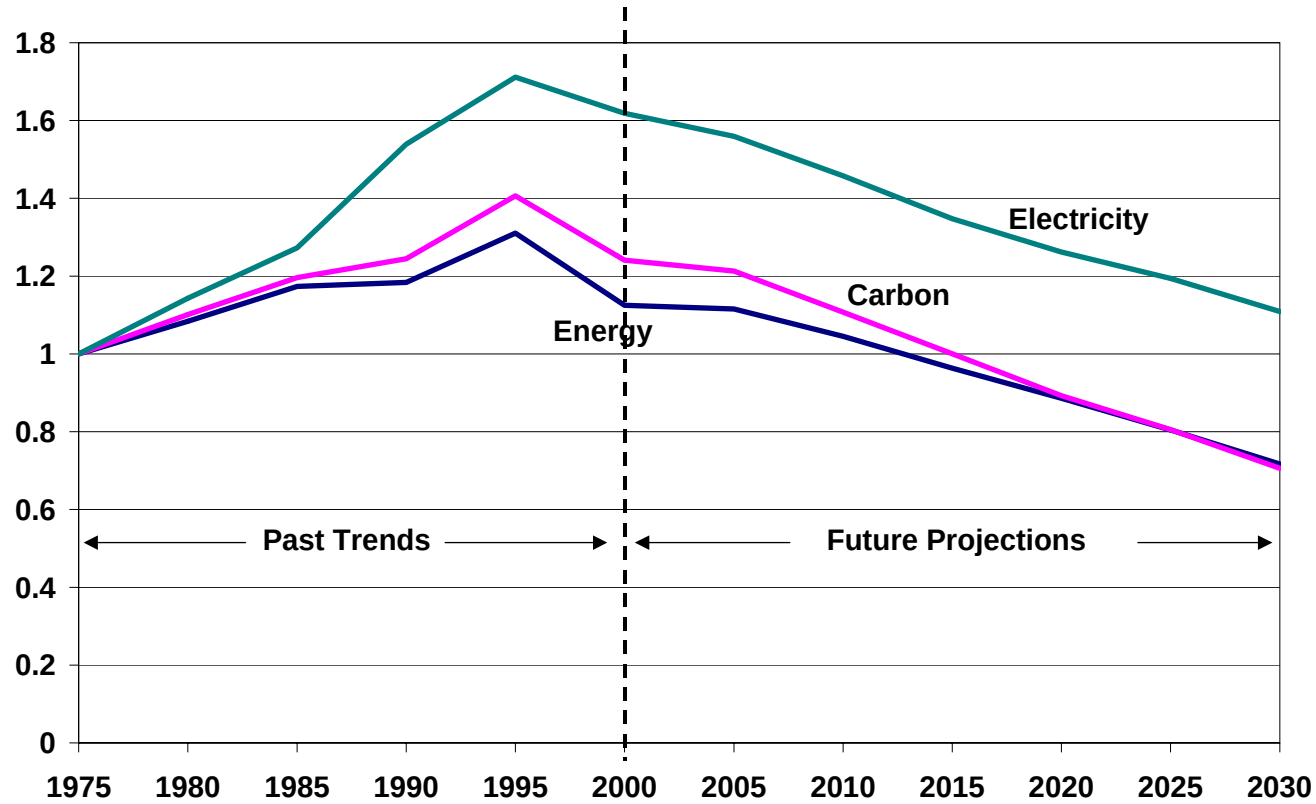


Energy, Carbon, Electricity and GDP

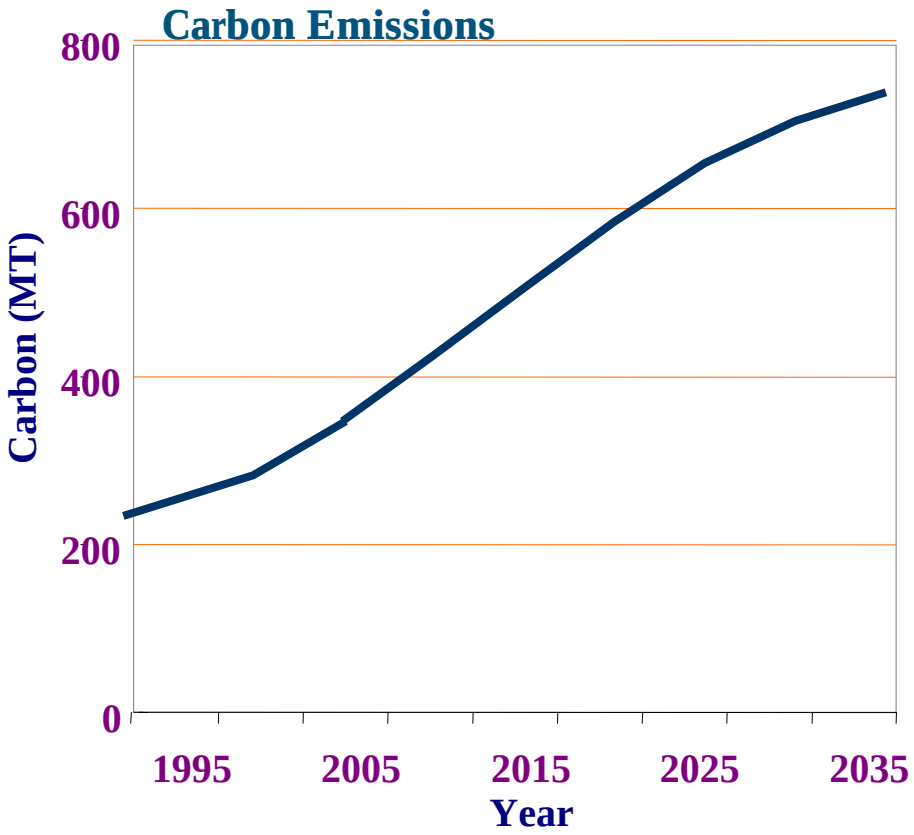
(IA2 Scenario)

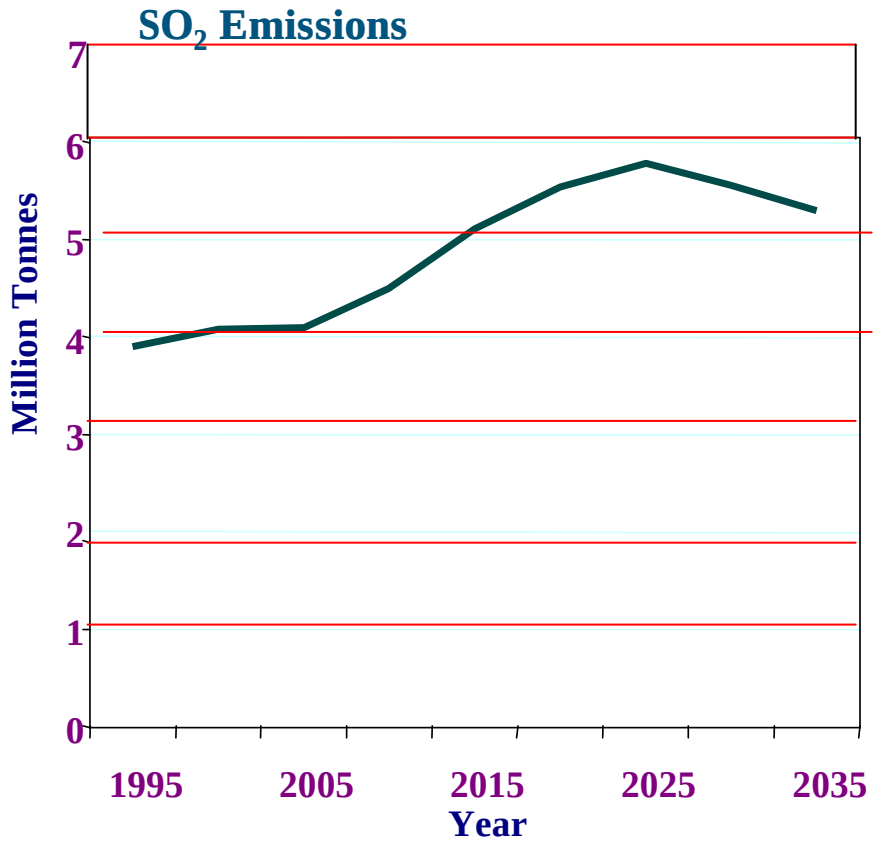


GDP intensities of Energy, Electricity and Carbon
(IA2 Scenario)



GHG versus Local Emissions in India

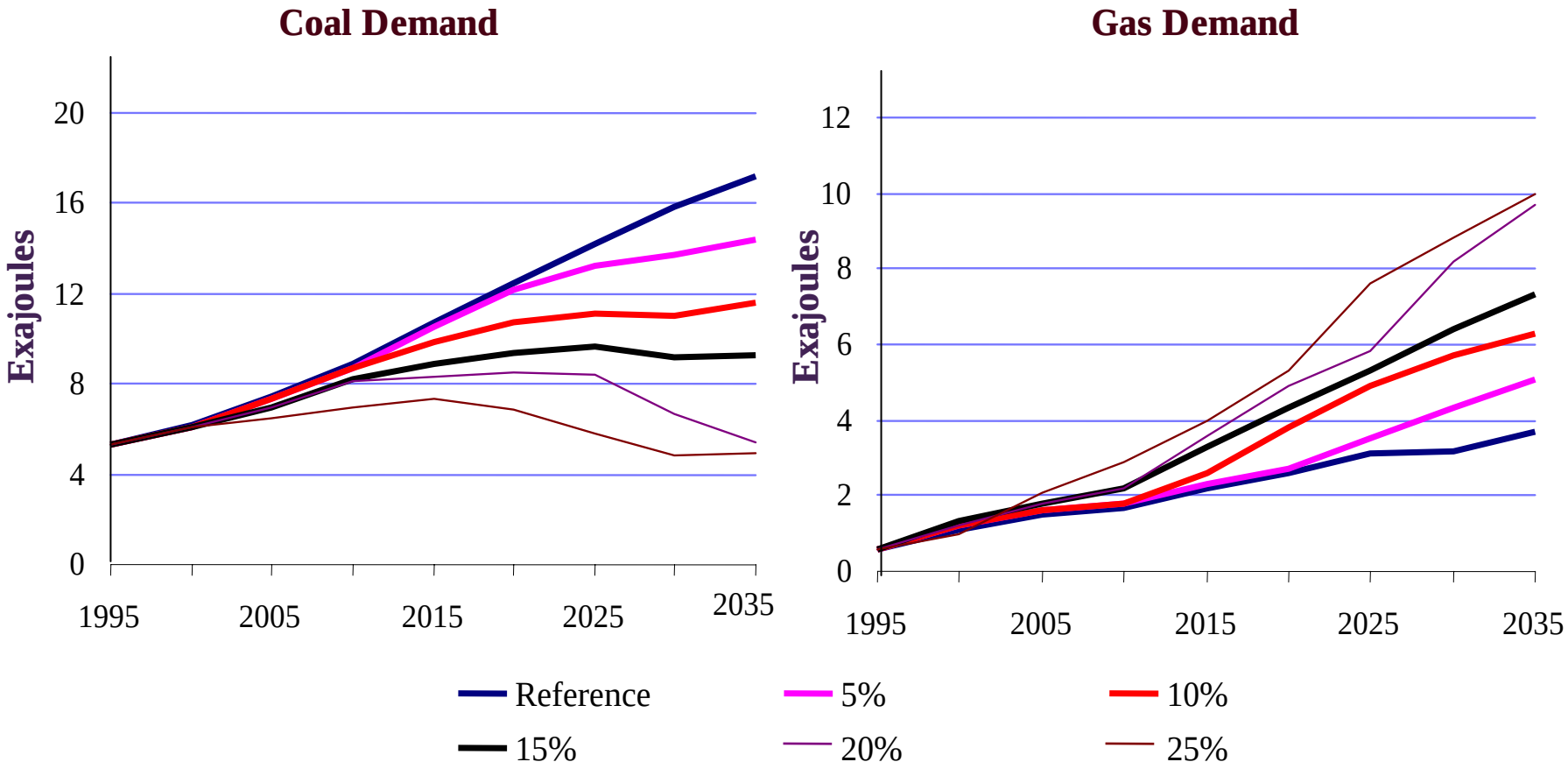




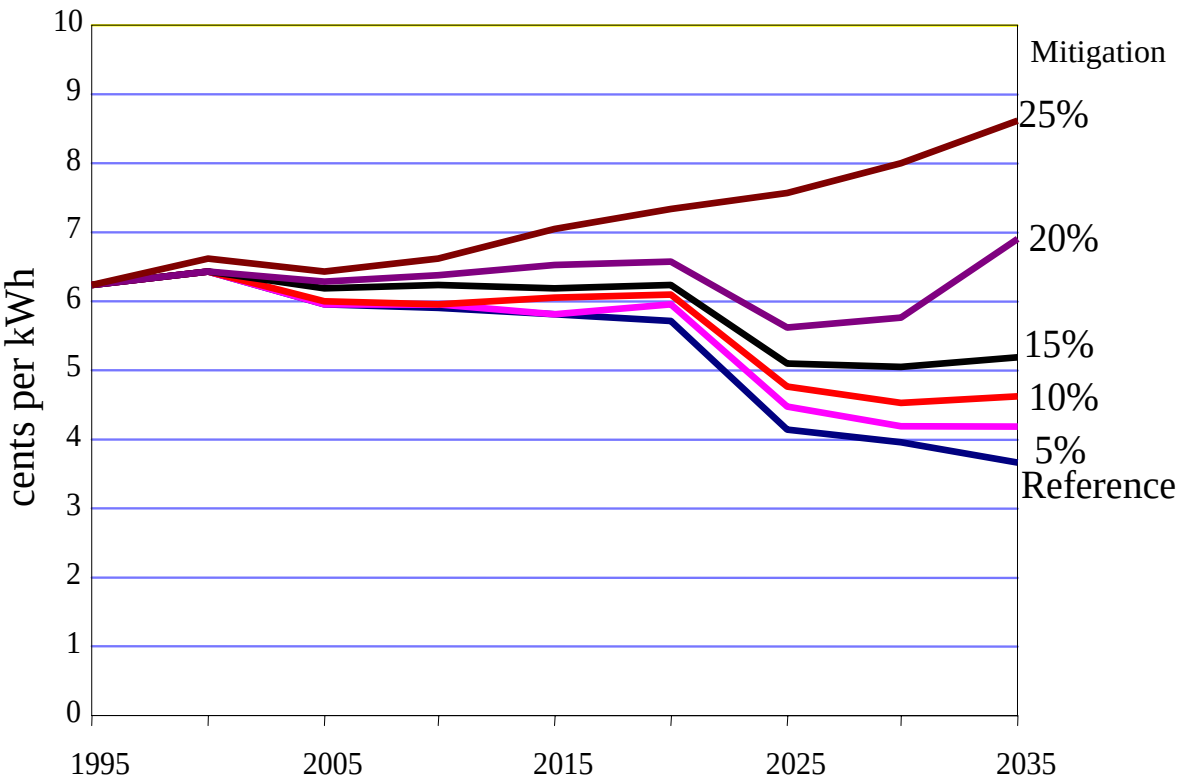
Implications of Medium Term Mitigation

Assessment for IA2 Scenario for 2000-2030 Period

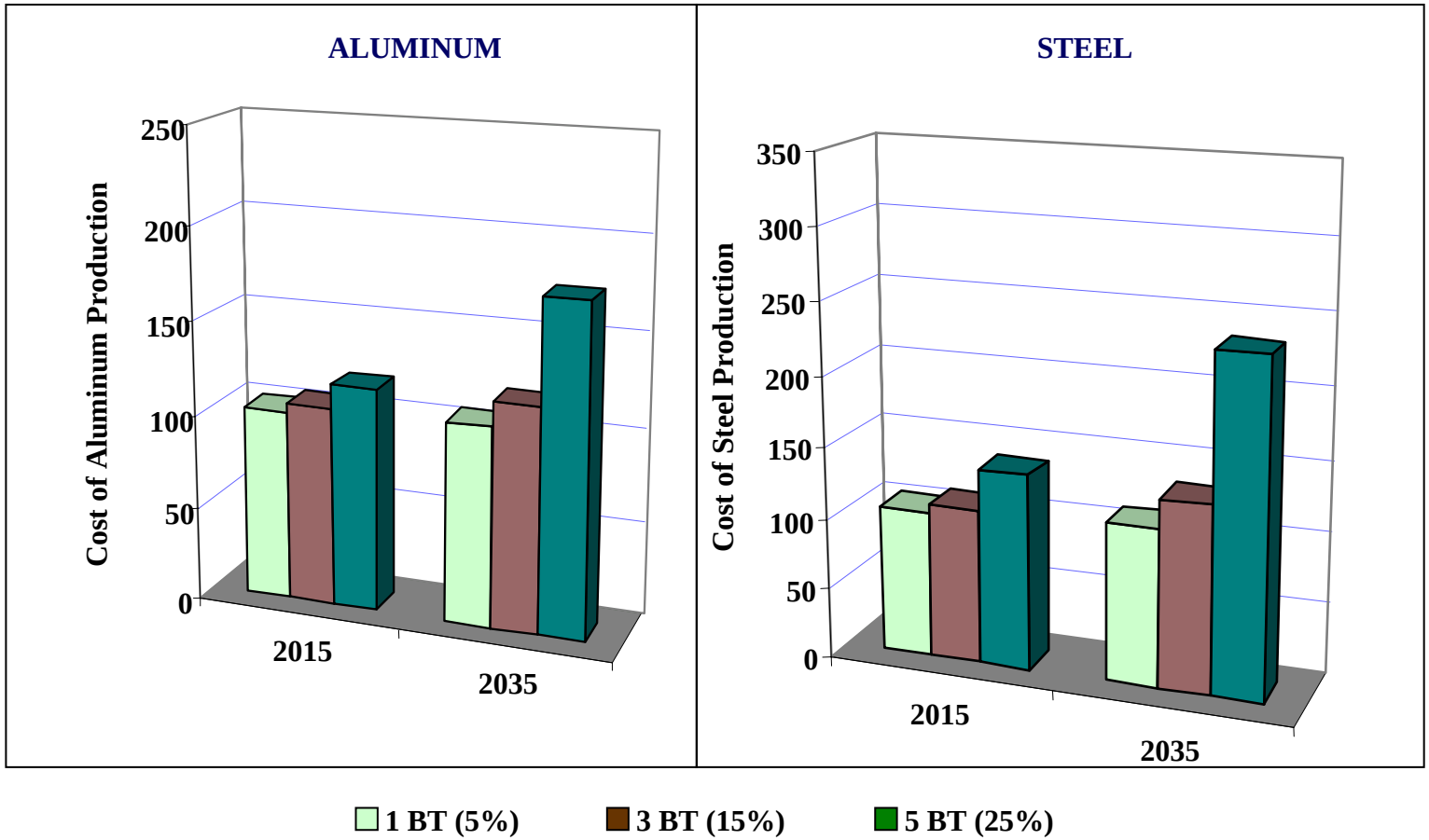
Implications of Mitigation: Coal and Gas in IA2 Scenario



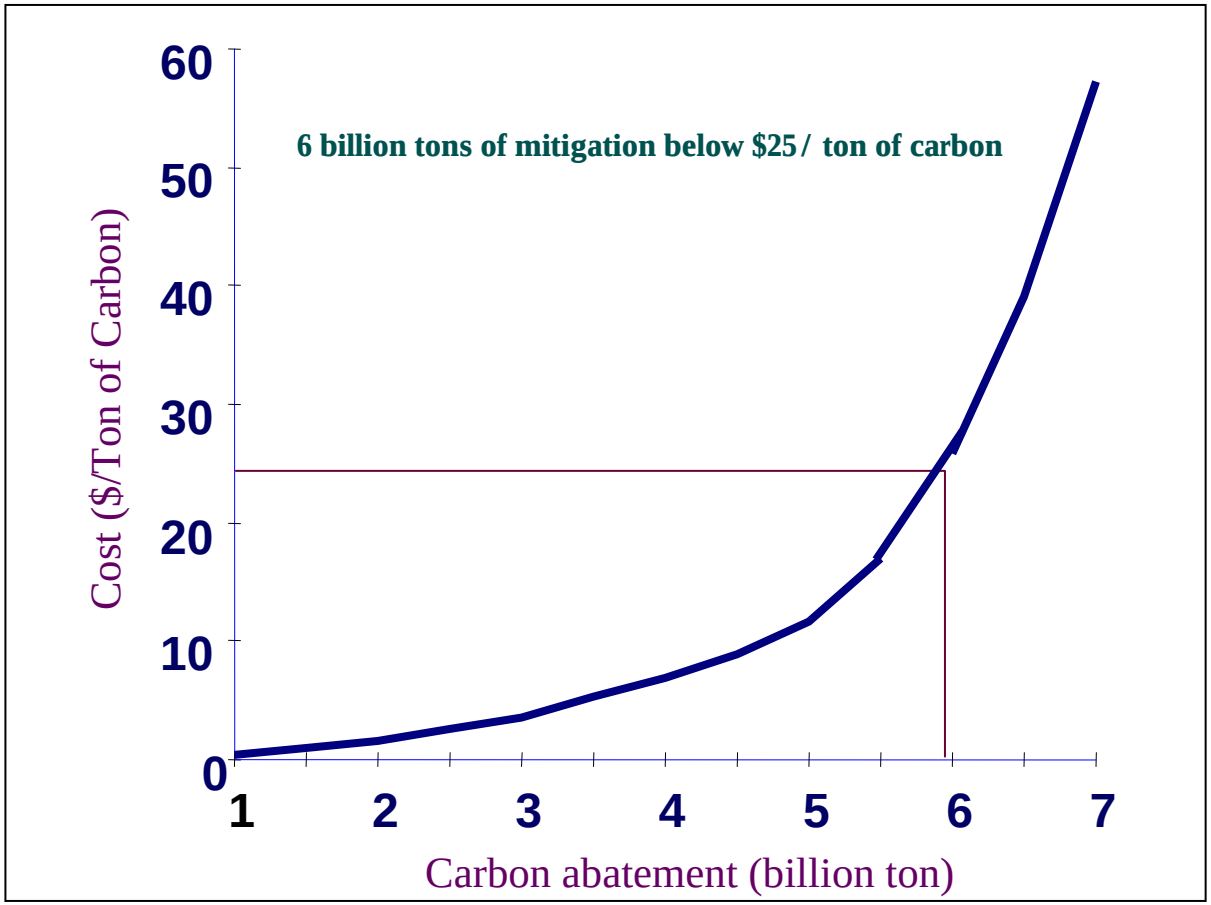
Implications of Mitigation: Electricity Price in IA2 Scenario



Implications of Mitigation on Production Cost



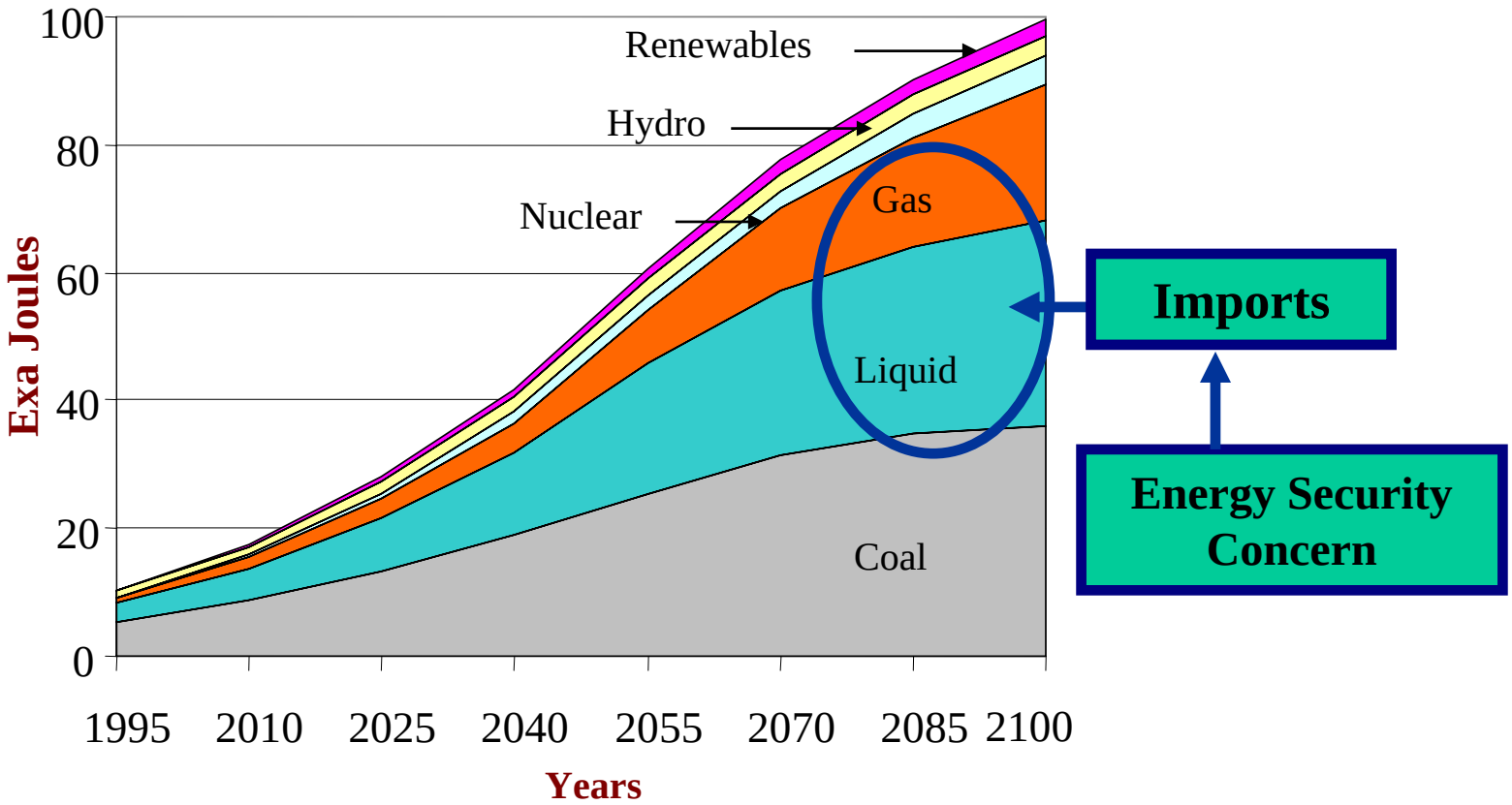
Carbon Mitigation Supply Curve: (2005-2035)



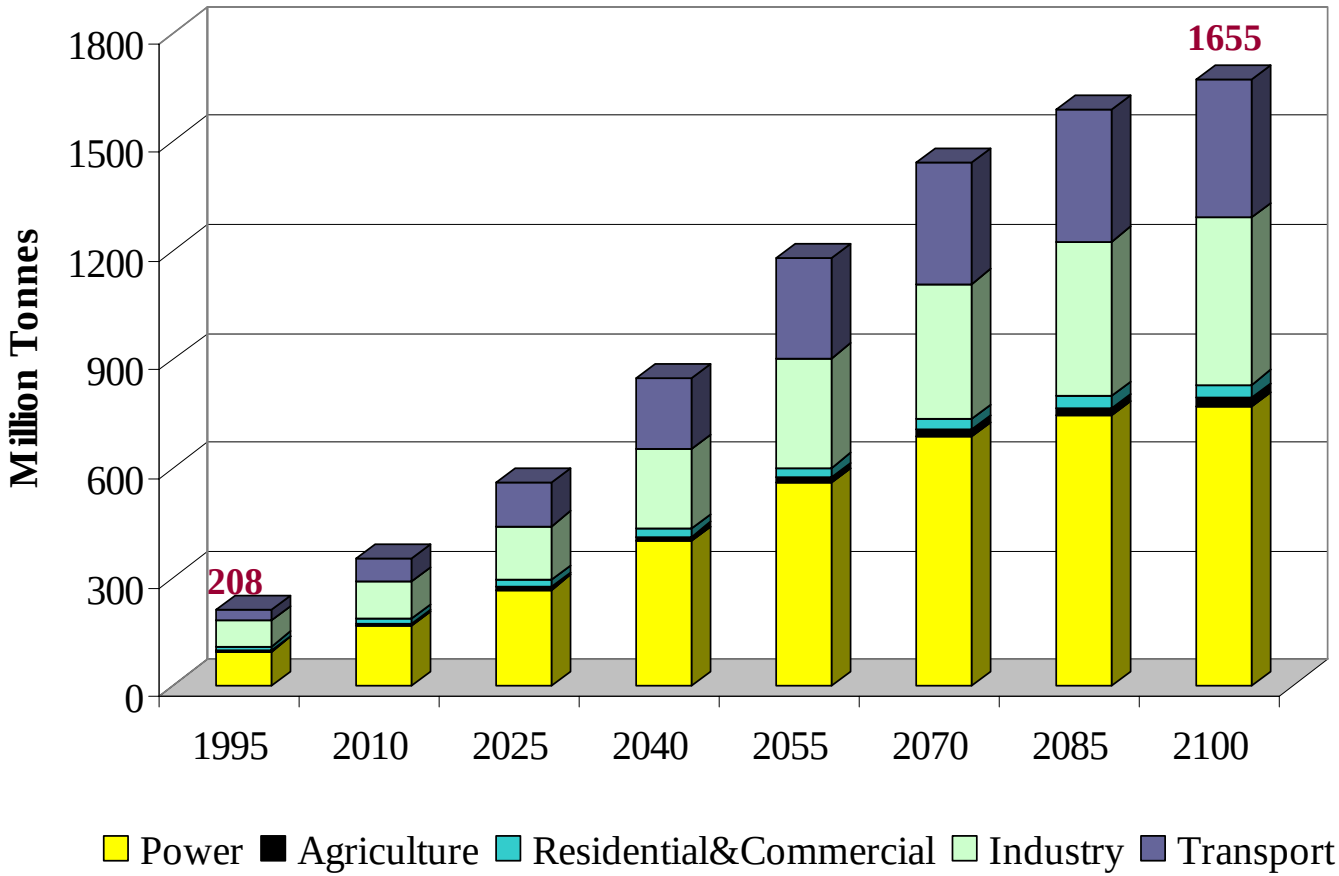
Implications of Stabilization Regimes

Assessment for IA2 Scenario for 2000-2100 Period

Primary Energy Projections (IA2 Scenario)

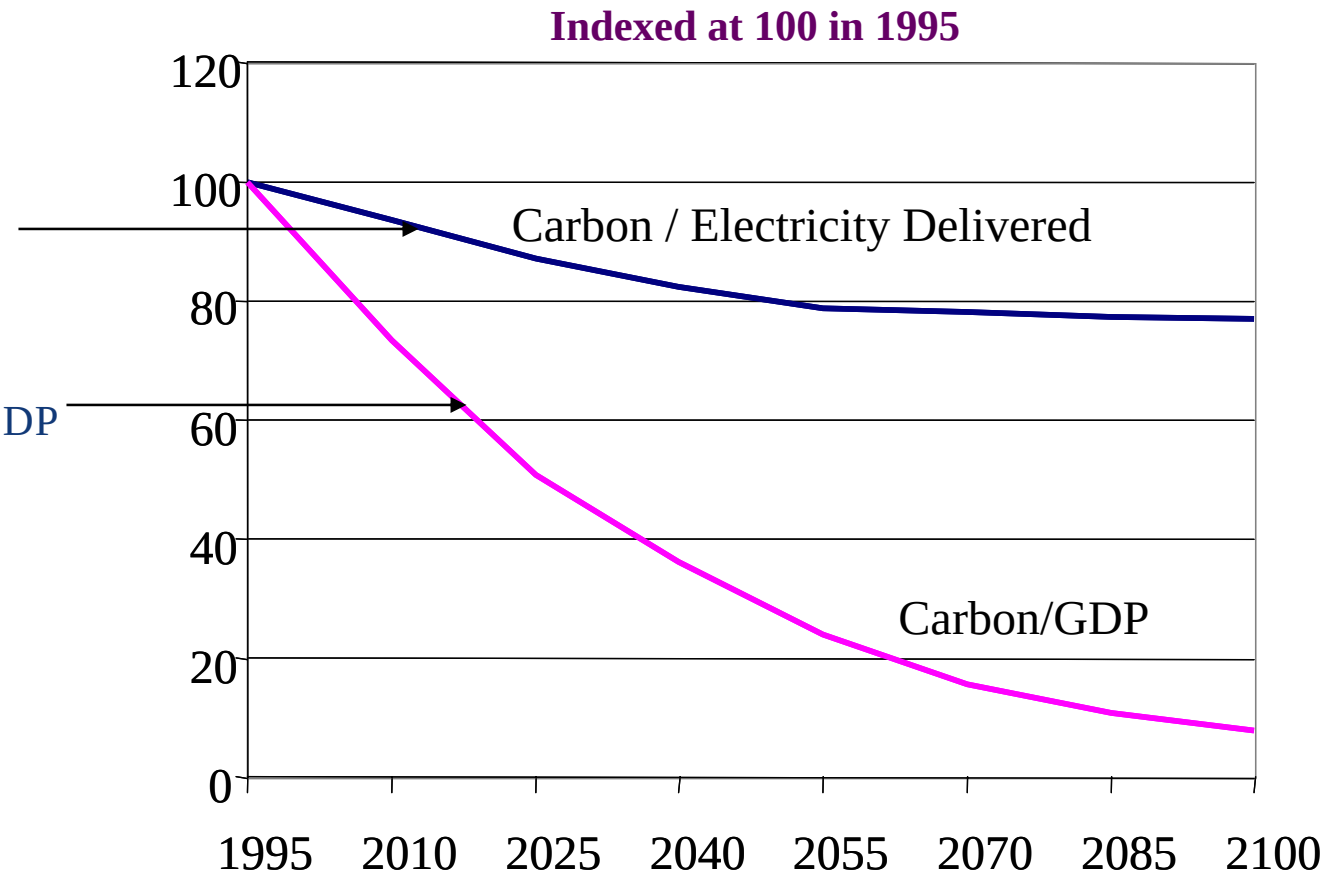


Carbon Emission Projections (IA2 Scenario)

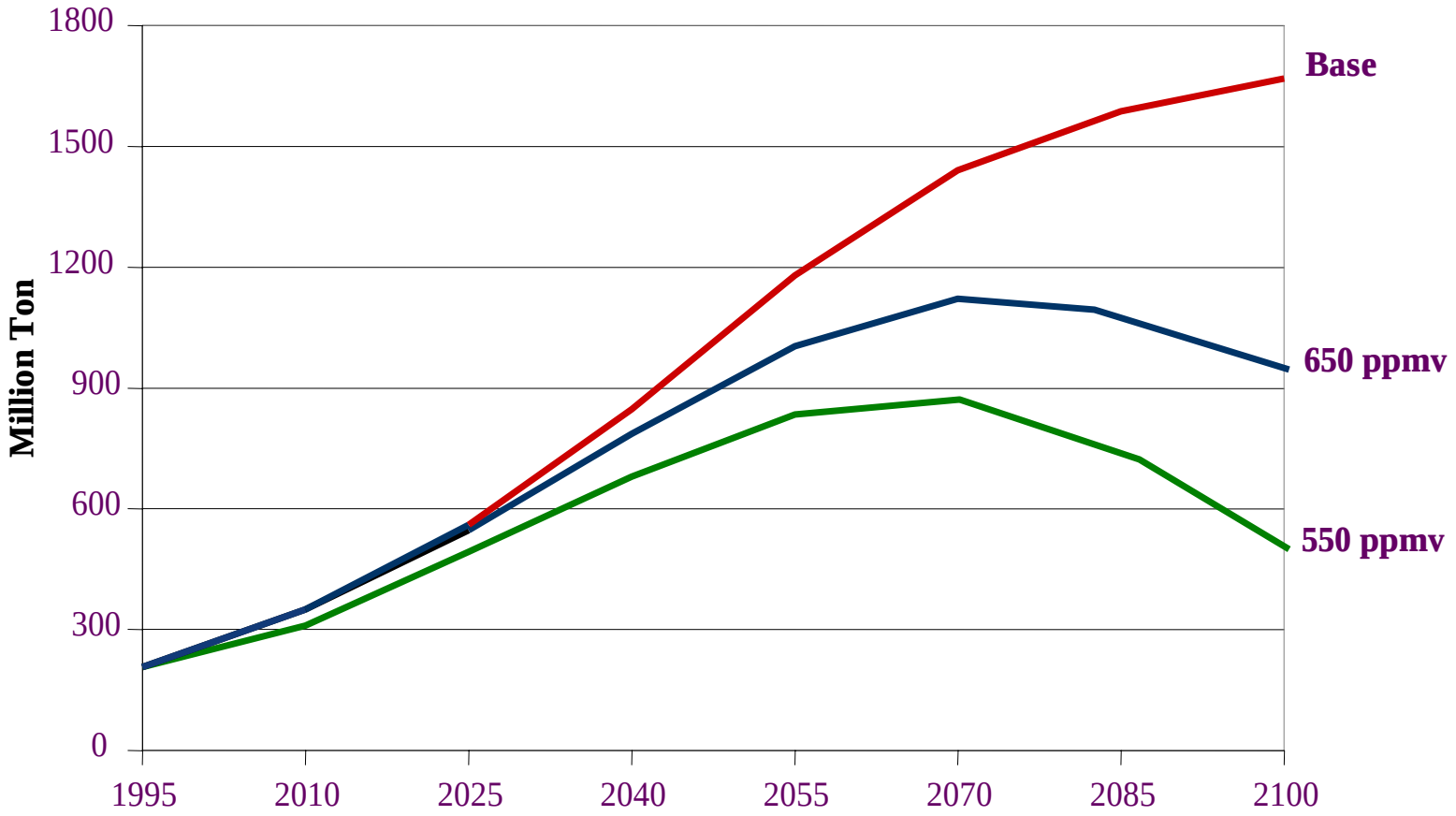


Future Intensities

- Carbon intensity of electricity reduces gradually
- Strong decoupling between GDP growth and carbon emissions

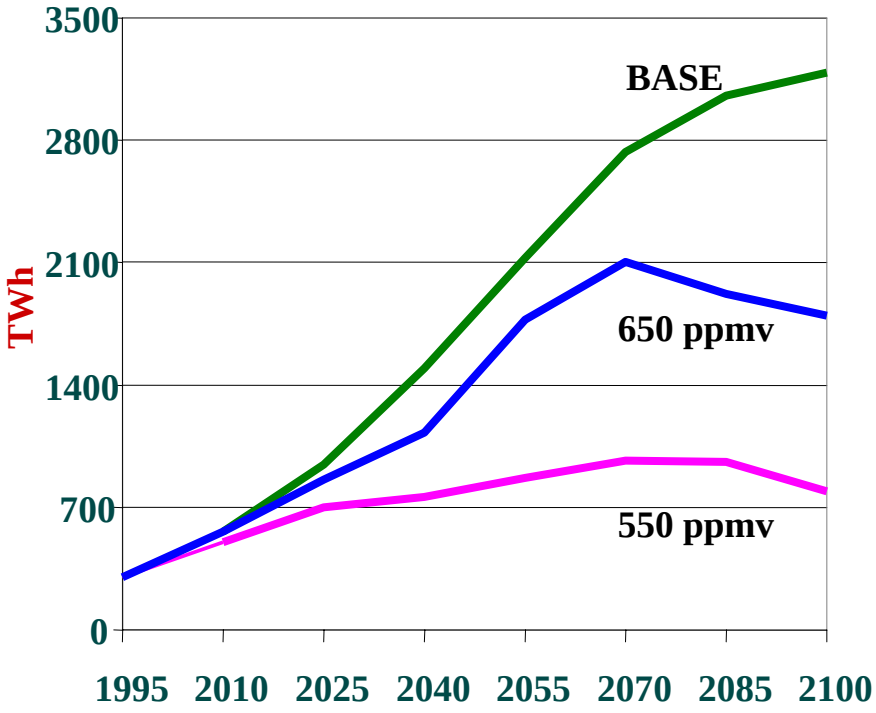


Carbon Emission Constraints

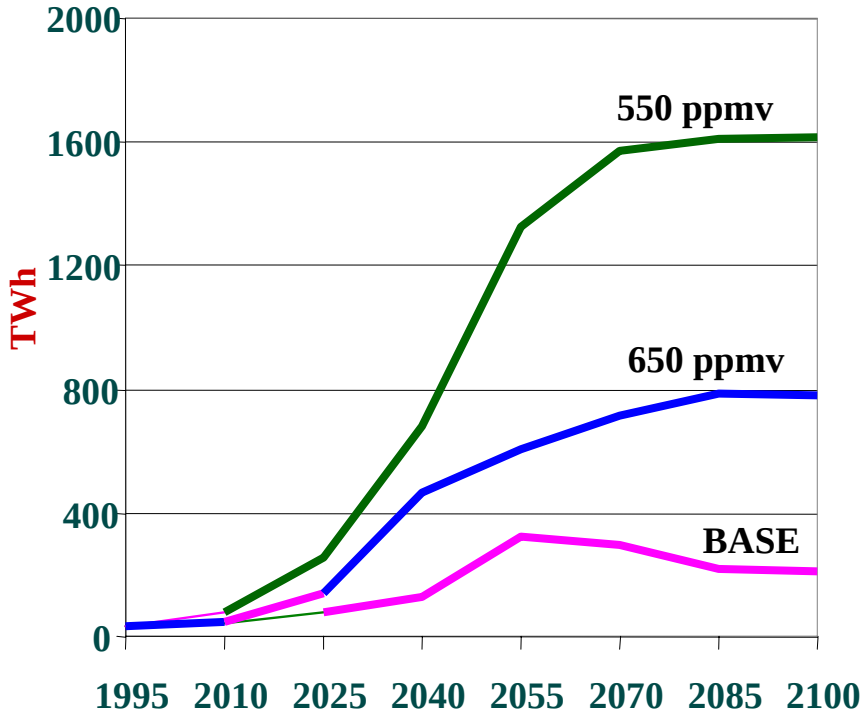


Impact on Fossil Technologies in Electricity

Coal Electricity

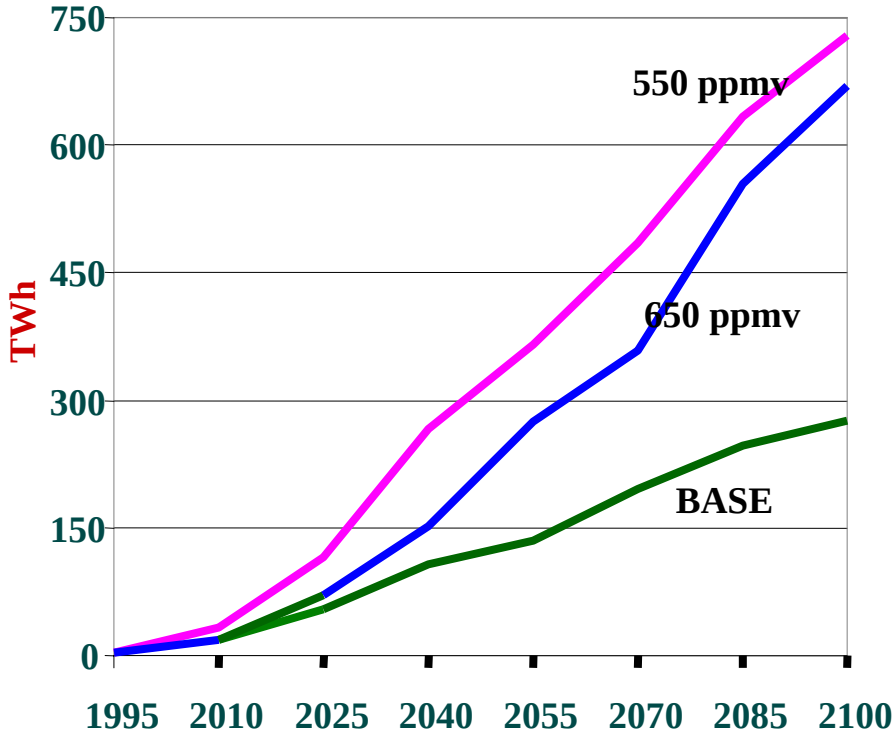


Gas Electricity

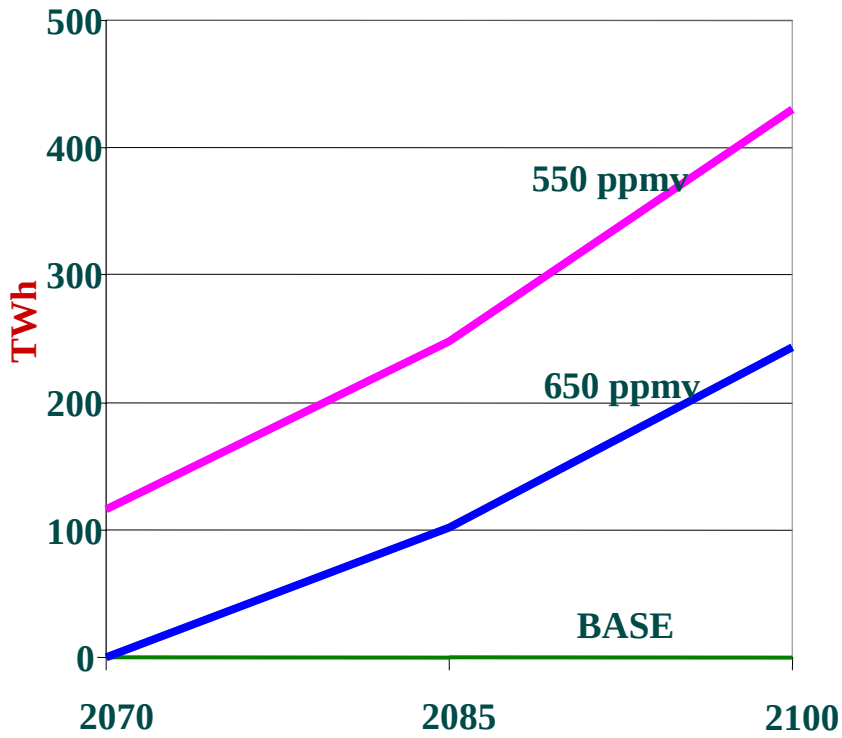


Impact on New and Renewable Technologies

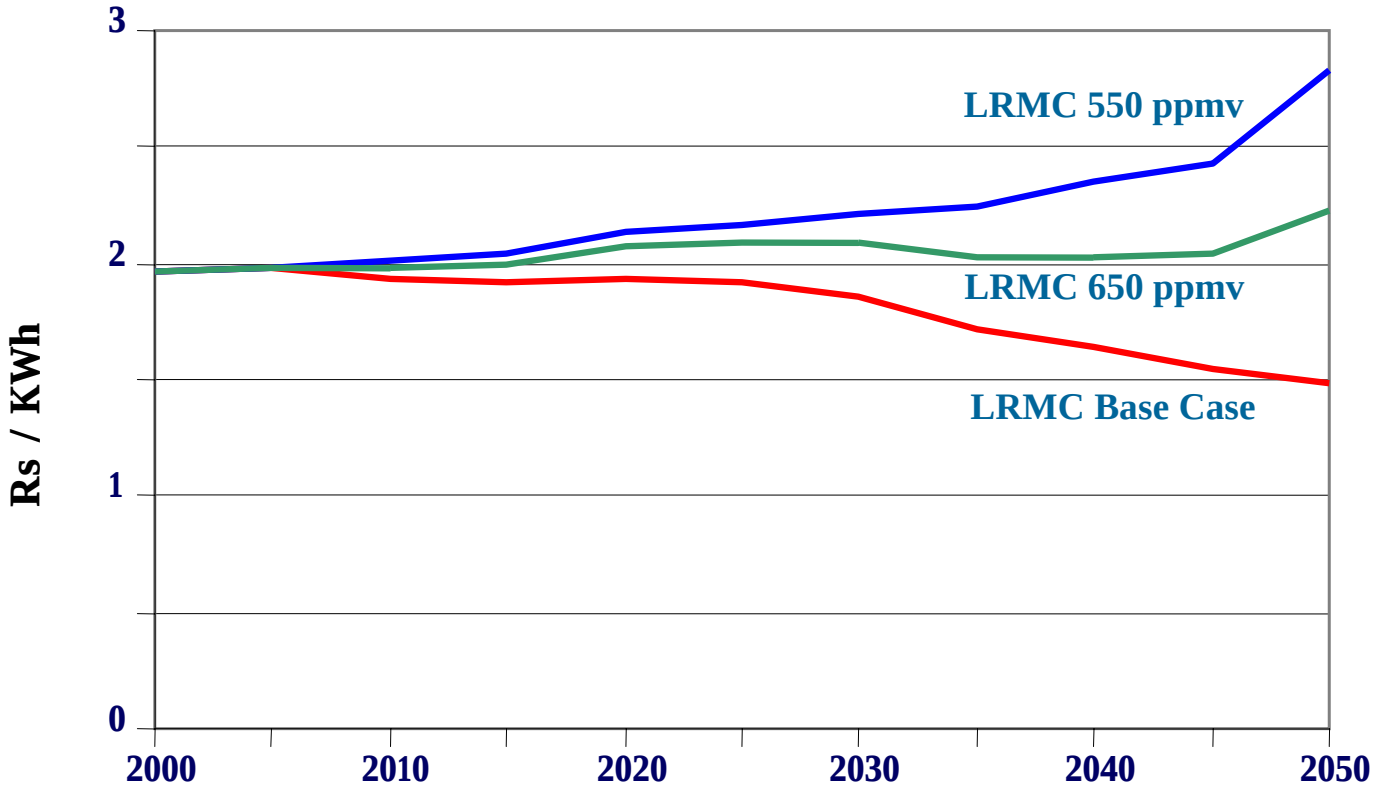
Renewable Technologies



Nuclear Fusion

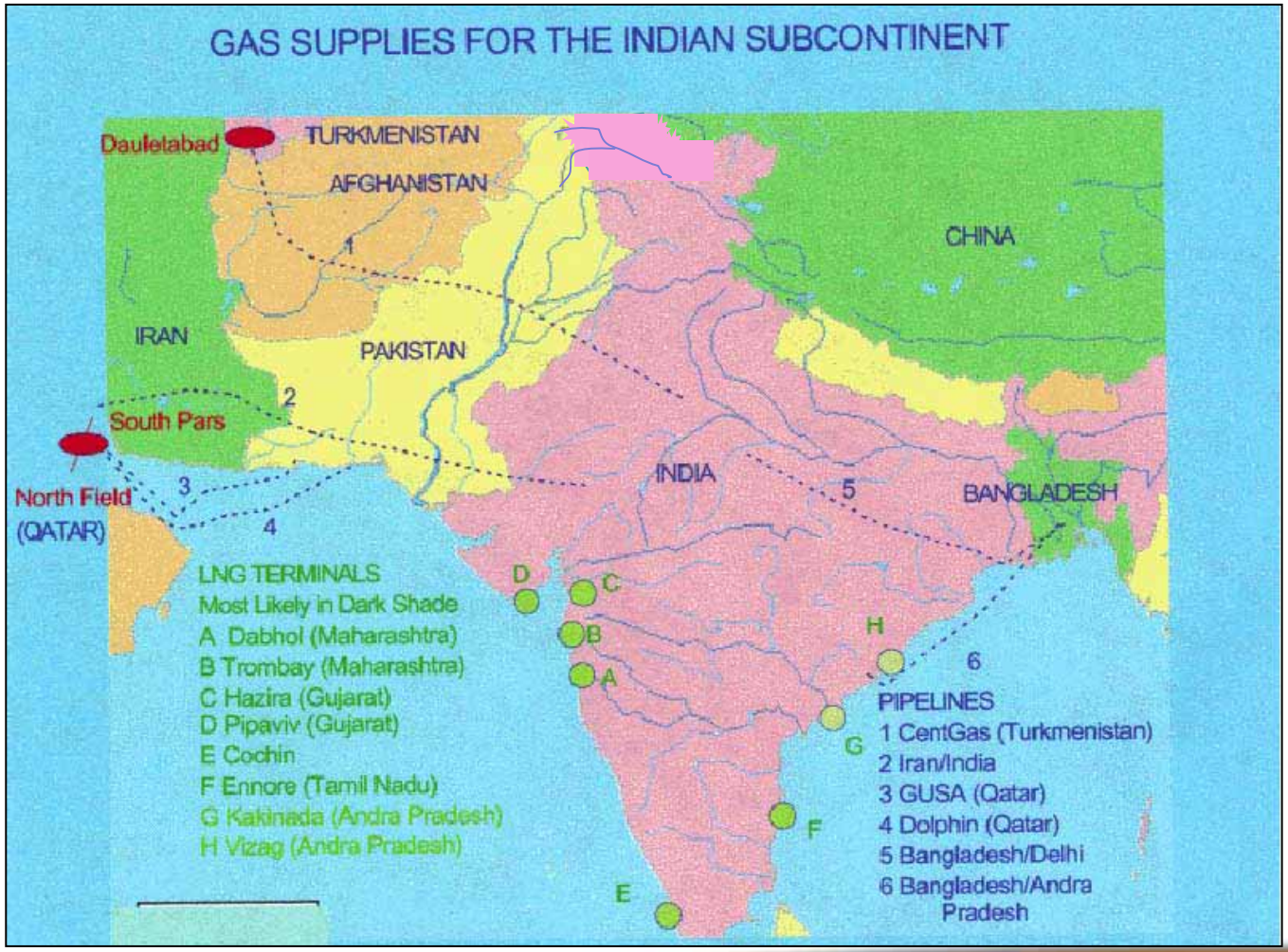


Effect of Carbon Constraints on Electricity Cost

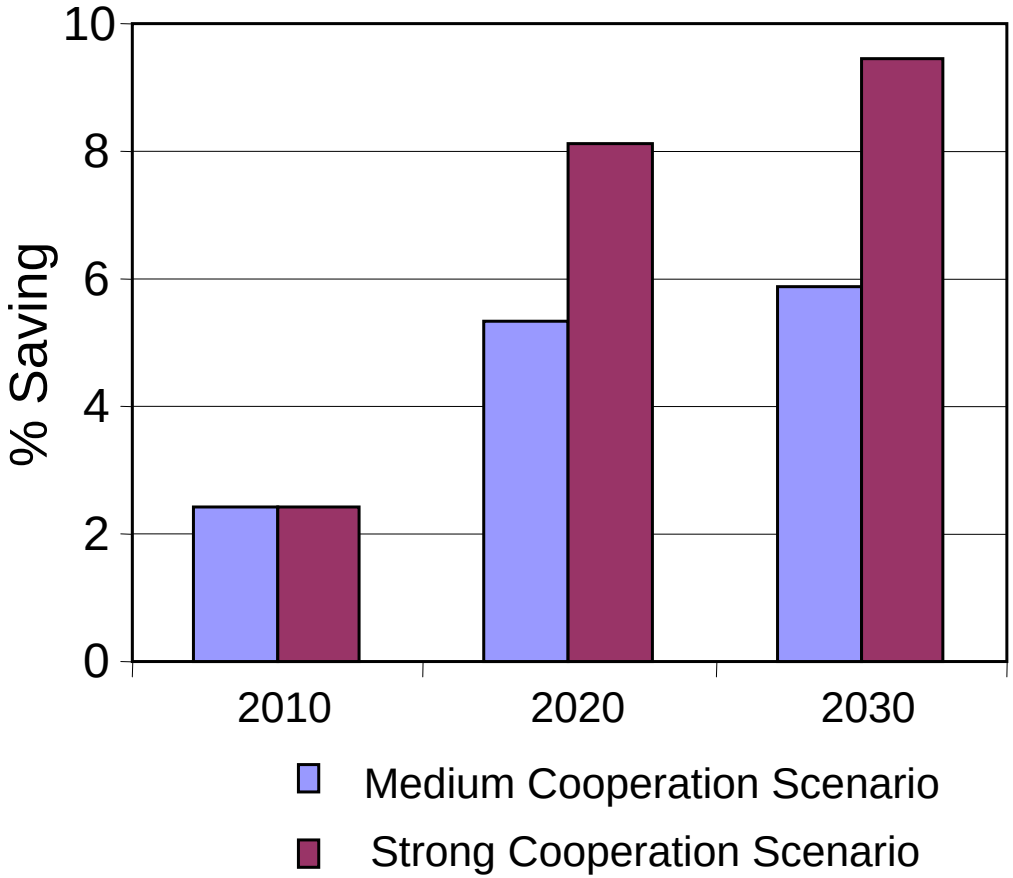


South-Asia Regional Cooperation: Implications for Stabilization

Regional Energy Market Development

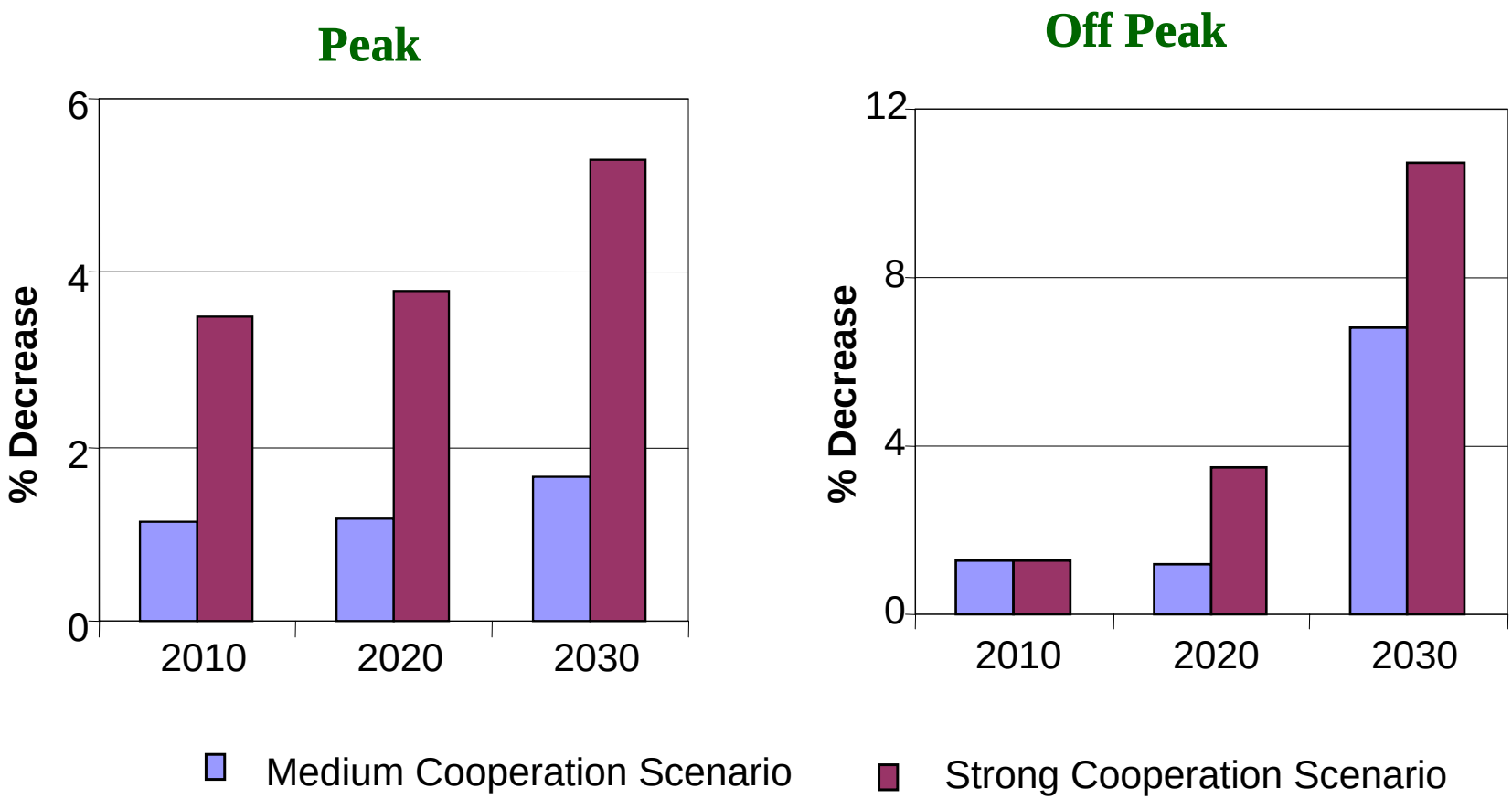


Total Primary Energy Supply Saving



- Cumulative Saving in Strong Cooperation: 60 EJ in 20 years (2010-2030)
- This is equivalent to $180 billion cumulative

Decrease In Electricity Costs

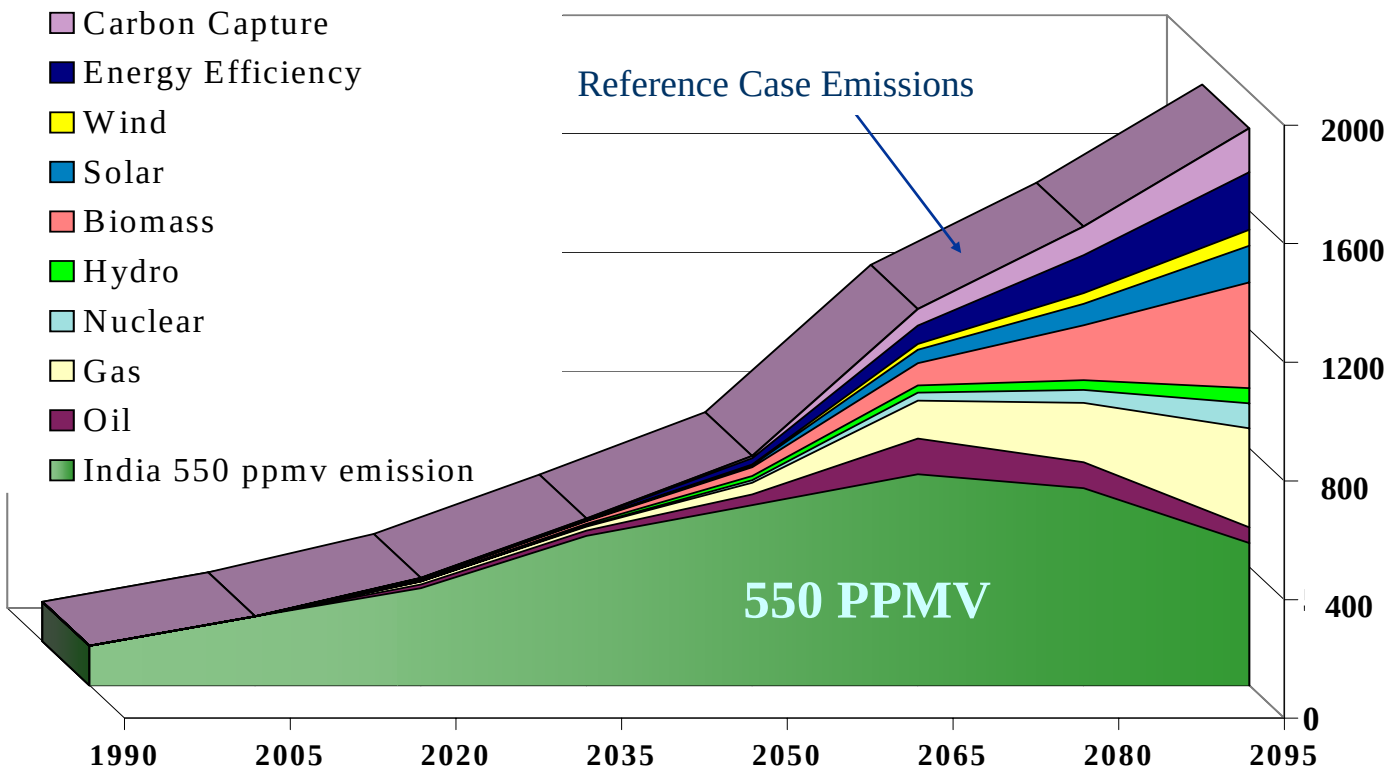


Benefits from South-Asia Energy Cooperation (2010-2030)

Benefit (Saving)		$ Billion	% of Region's GDP
Energy (Direct Benefits)			
Energy	60 Exa Joule	180	0.48
Investment in Energy Supply Technologies		72	0.19
Investment in Energy Demand Technologies		69	0.18
Environment (Indirect Benefits)			
Carbon	1.4 Billion Ton	28	0.08
Sulfur Dioxide (SO_2)	50 Million Ton	10	0.03
Total Direct and Indirect Benefits		359	0.98
Spillover Benefits			
Water	16 GW additional hydro capacity		
Flood Control	From additional dams		
Competitiveness	Reduced unit energy/electricity cost		

Stabilization and Technological Change

Technological Change in India to Stabilize CO_2 at 550 ppmv



Stabilization: Policy Issues and Concerns

- UNFCCC Article 2 definition (Balancing costs and benefits)
- Emissions Rights Regime
- Indigenous Coal
- Competitiveness
- Structural changes in the economy (autonomous and policy driven)
- Implications for Developmental Goals

Stabilization: Policy Actions

- Technology Portfolio
- “Fair” Allocation of Emissions Rights
- Linking Development and Climate Change
- Obtaining Multiple Dividends (Designing Pathways)