

Approach and Analysis of Low Carbon Society Scenarios for India

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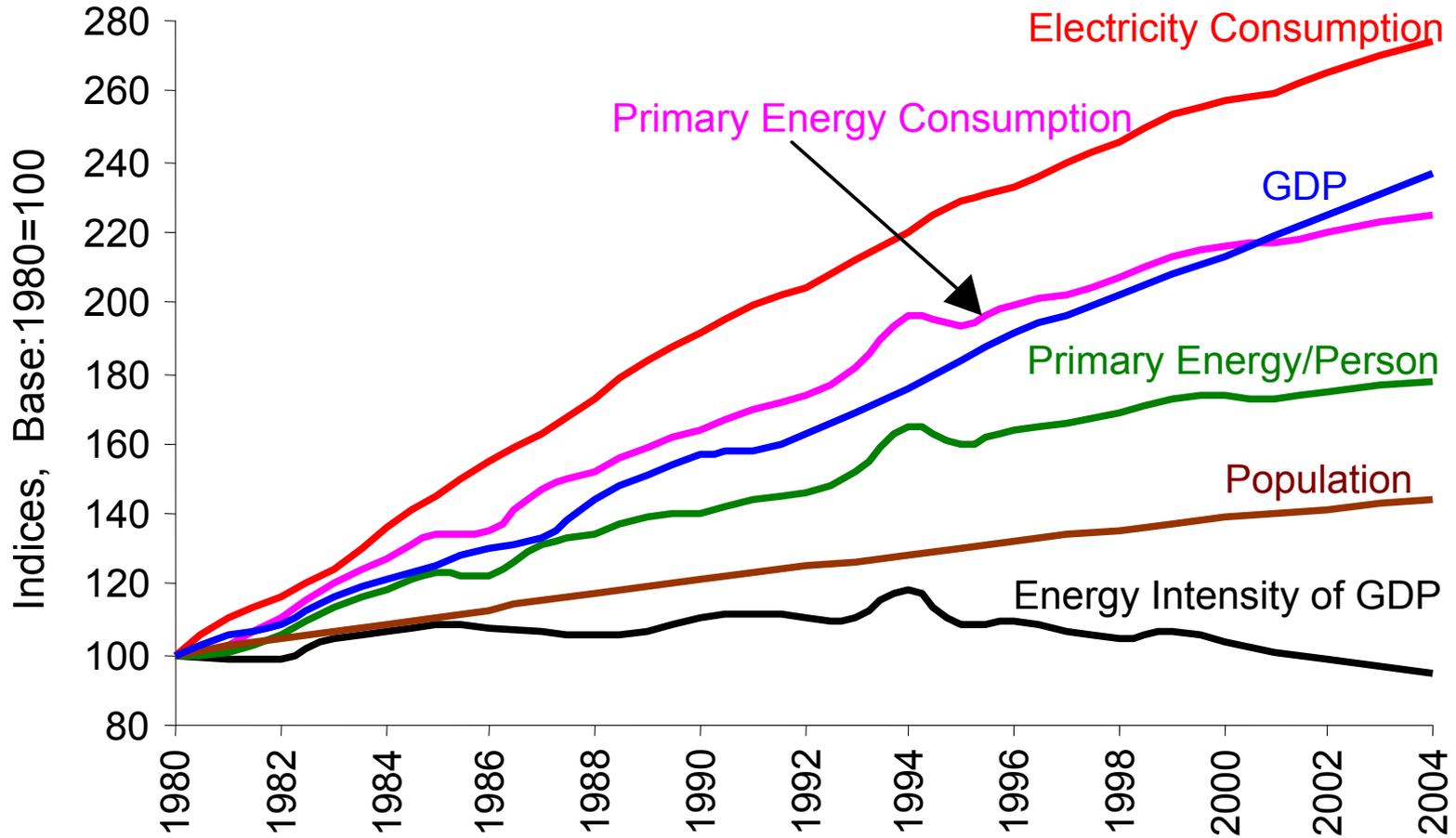


Indian Institute of Management, Ahmedabad, India

Agenda

- **Base Case Scenario**
- **LCS Scenarios: Paradigms**
- **Base Case Scenario Analysis**
- **Low Carbon Society Scenario Analysis**
- **Comparative Scenario Analysis**
- **Choice of ‘LCS Pathway’**
- **Conclusions**

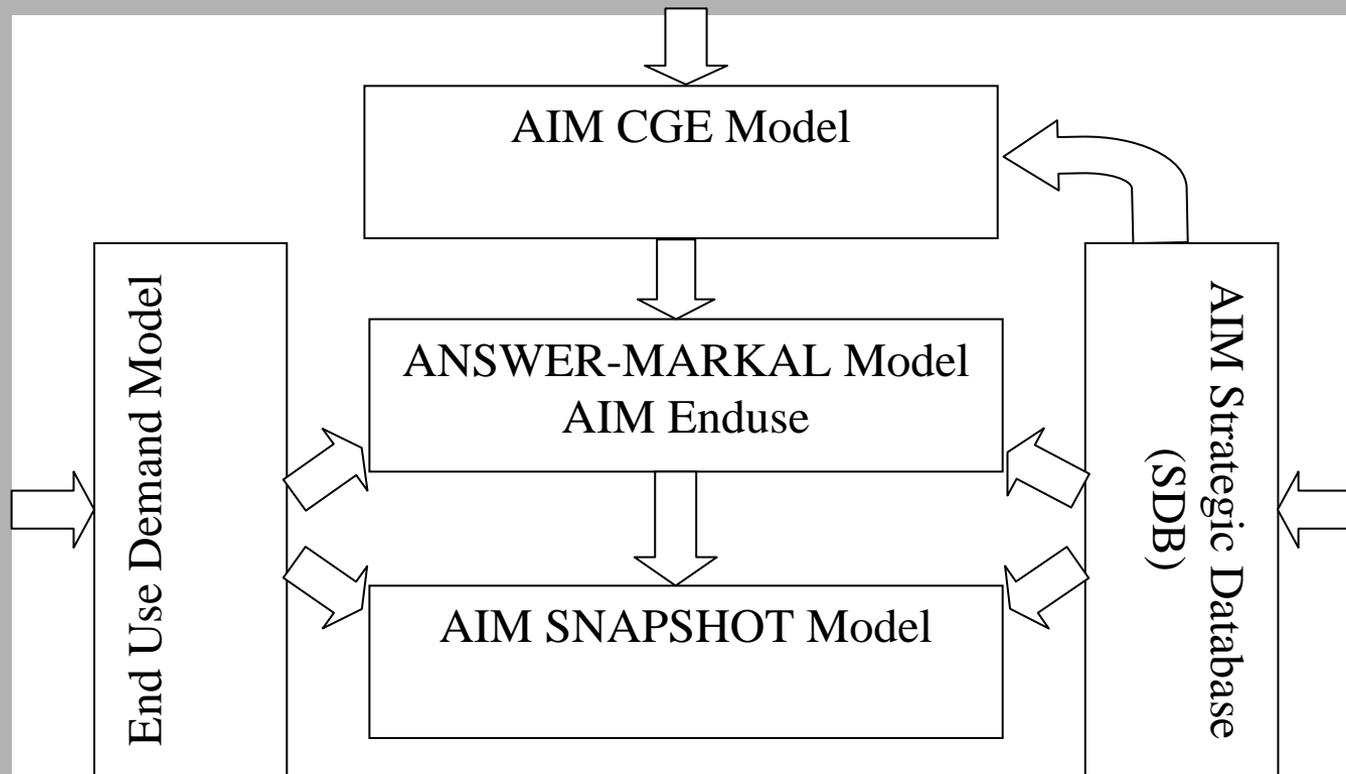
India: Population, GDP and Energy Trends



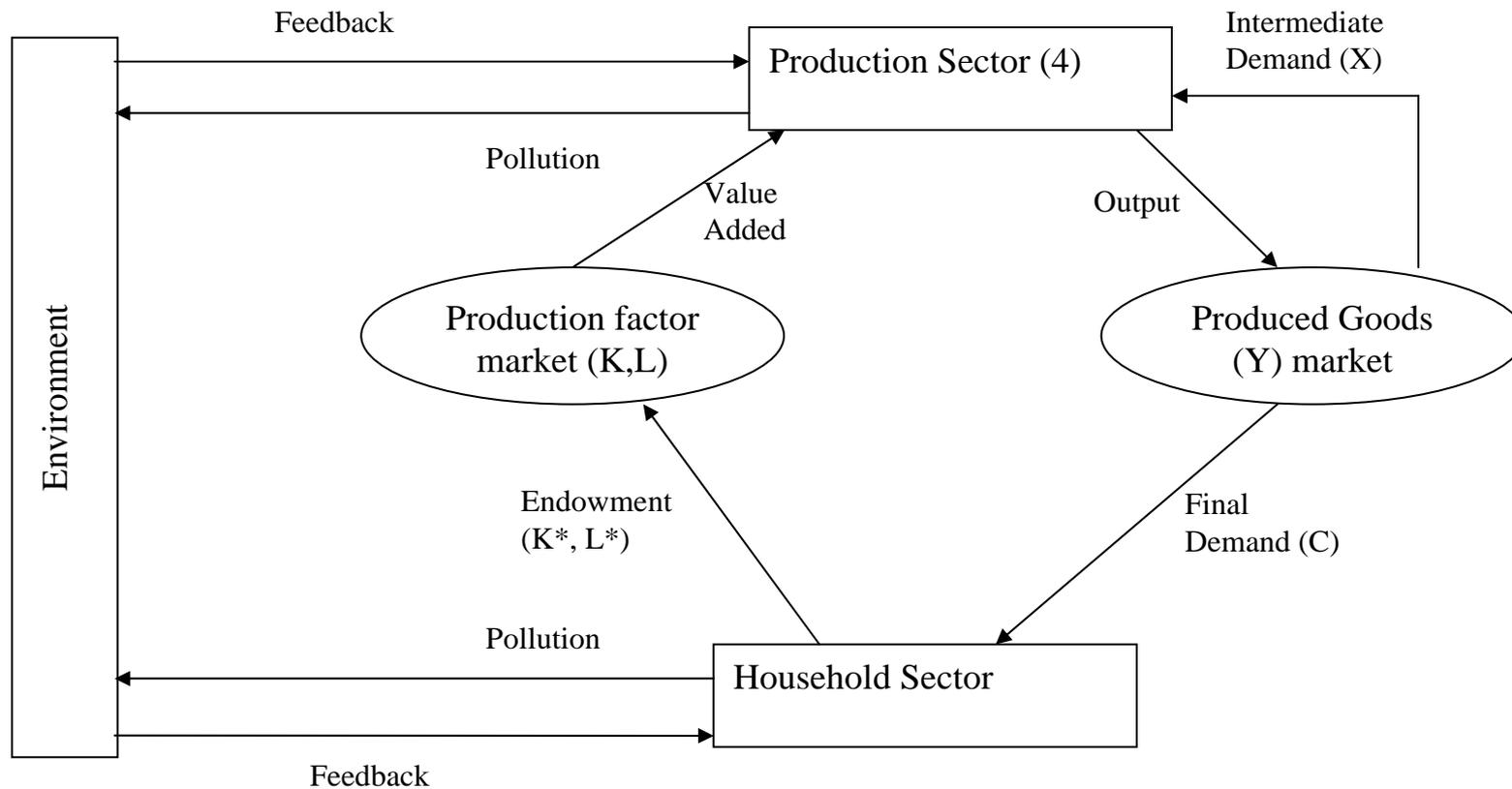
Integrated Model Framework

DATABASES:

Socio-Economic, Technologies, Energy Resources, Environmental Constraints



AIM CGE

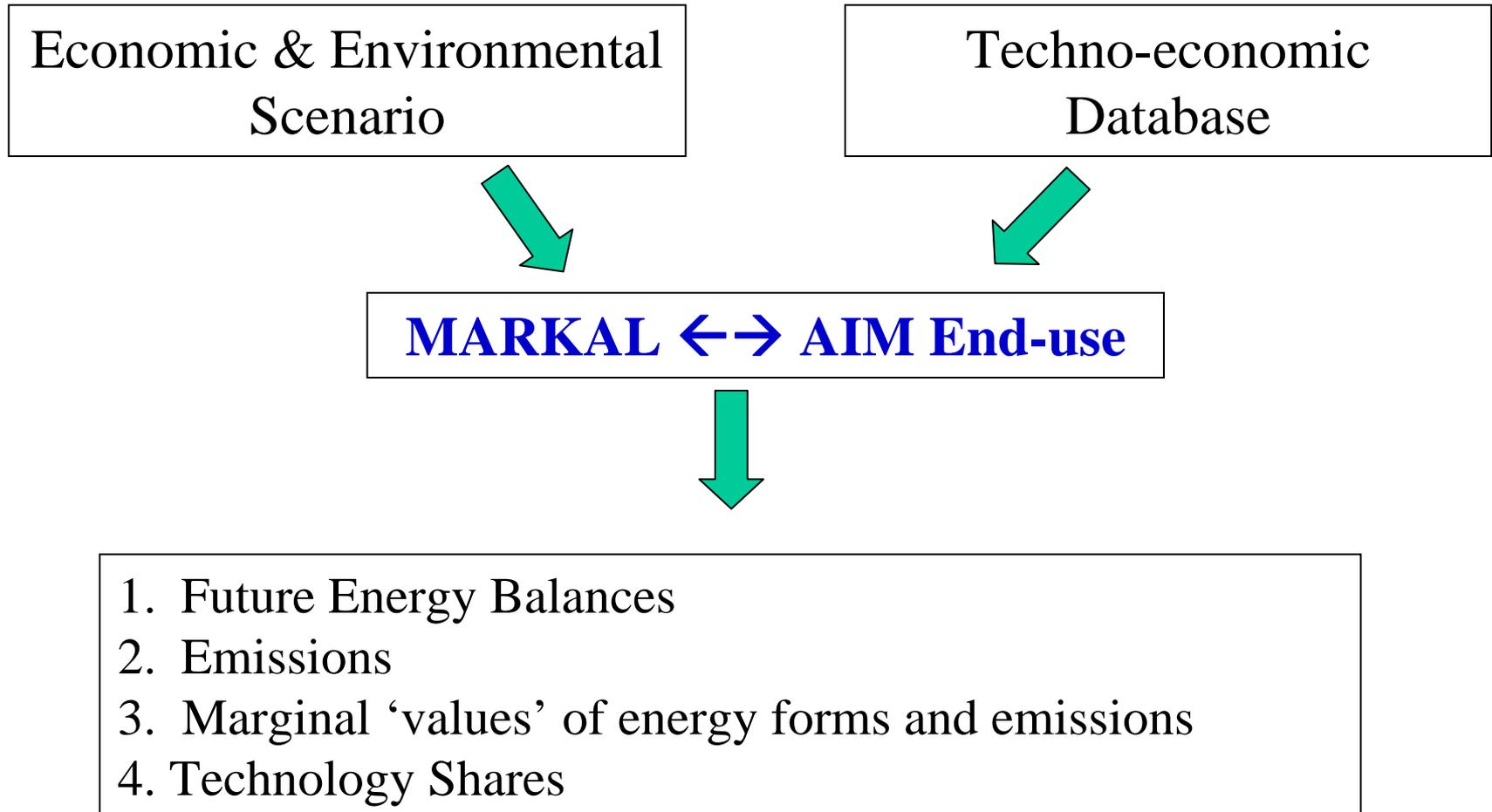


Source : Masui, T, 2005

India AIM CGE Data Structure

- Indian I/O Table (1998-99)
 - 115 X 115 Commodity
- Aggregated to
 - 4 Sector X 4 Sector
 - 2 Energy Sectors
 - Fossil Fuels & Other Energy
 - 2 Production Sectors
 - Manufacturing & Non Manufacturing
- Carbon Tax trajectory

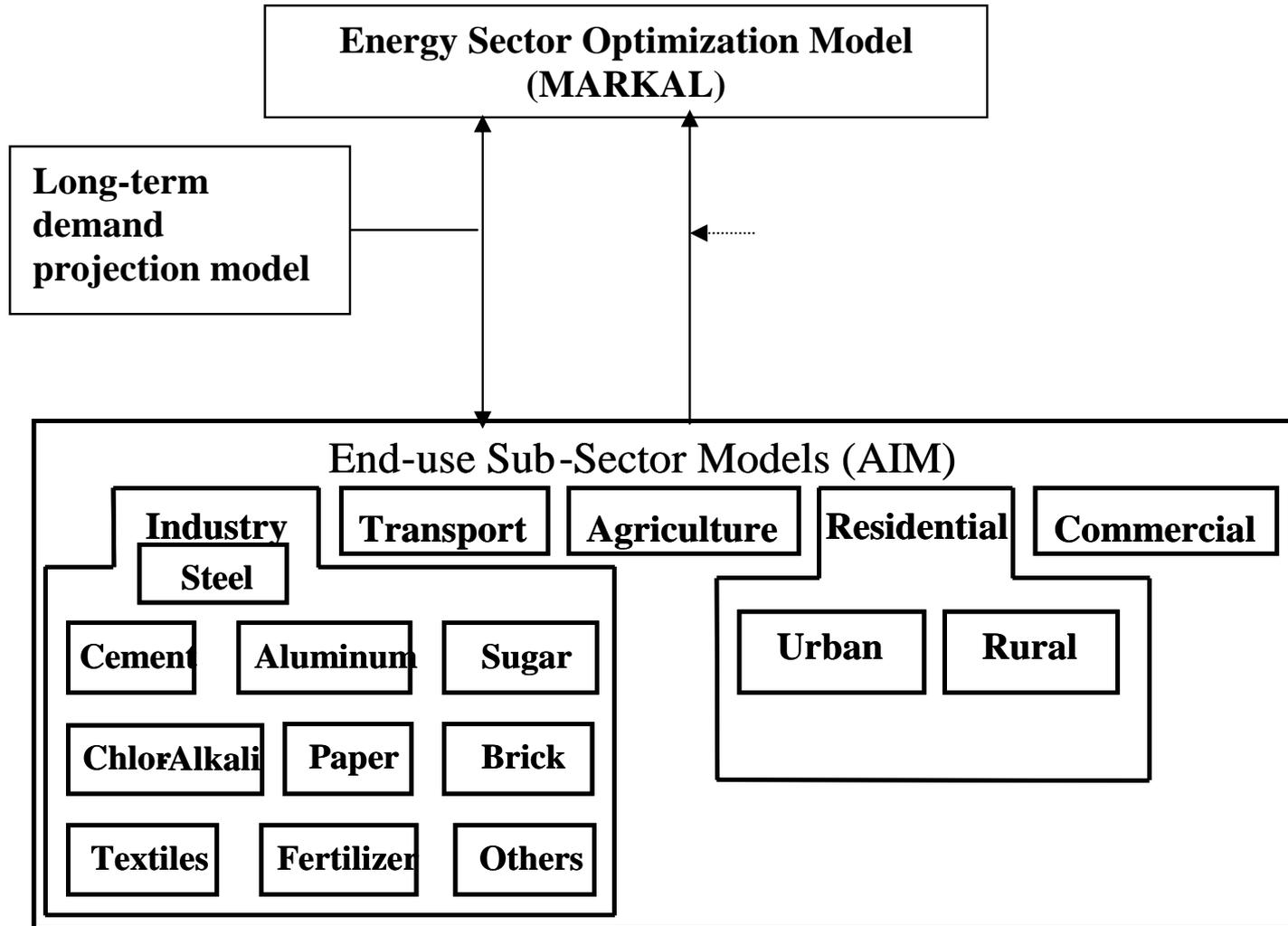
ANSWER MARKAL/ AIM End-use



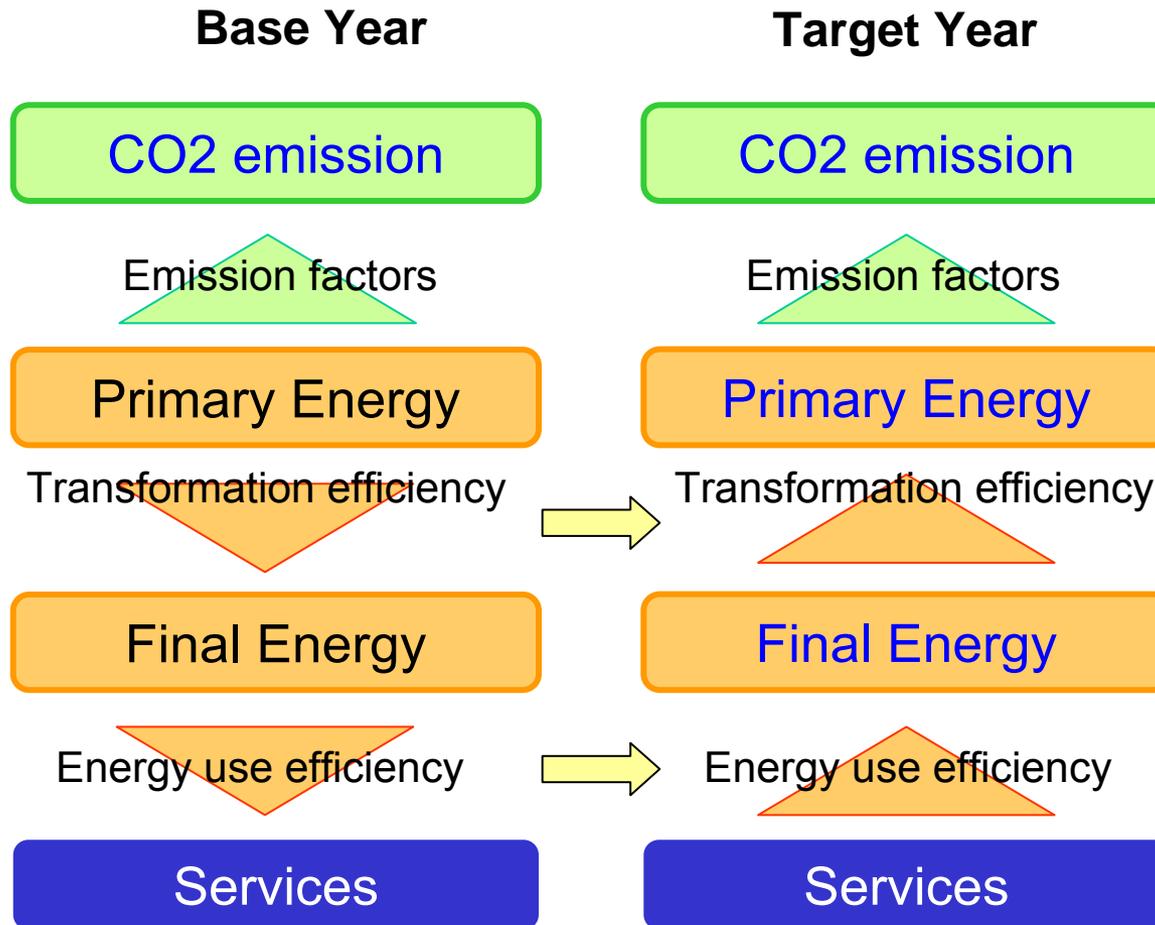
MARKAL Data Structure

- Specification of Technologies for
 - Electricity Sector (Generation/ Transmission)
 - End Use Demand Sectors
 - Fuel Supply
- Technology Parameters (SDB)
 - Cost – Capital & Operating (TD)
 - Life
 - Fuel choices
 - Efficiencies (TD)
 - Emissions (TD)

AIM End-use Model

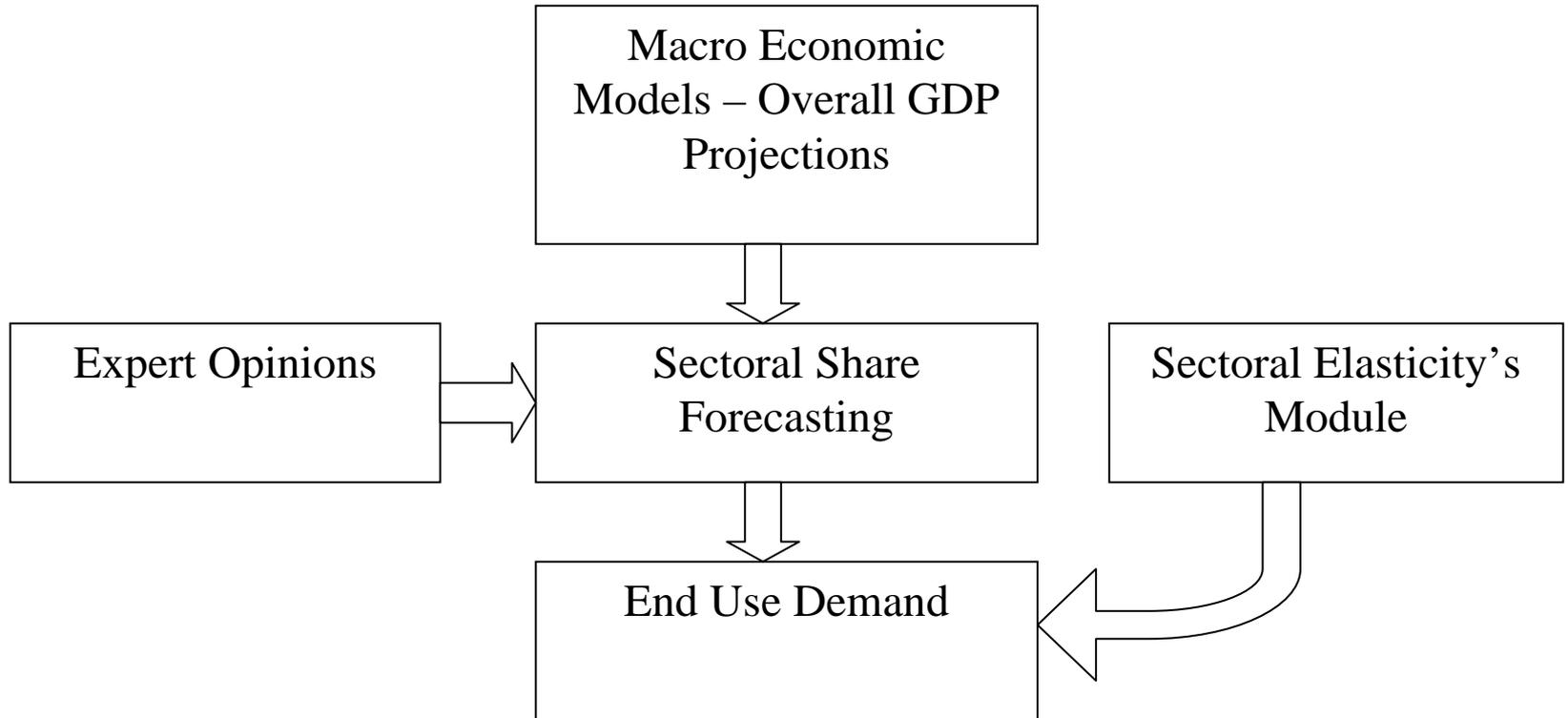


AIM SNAPSHOT



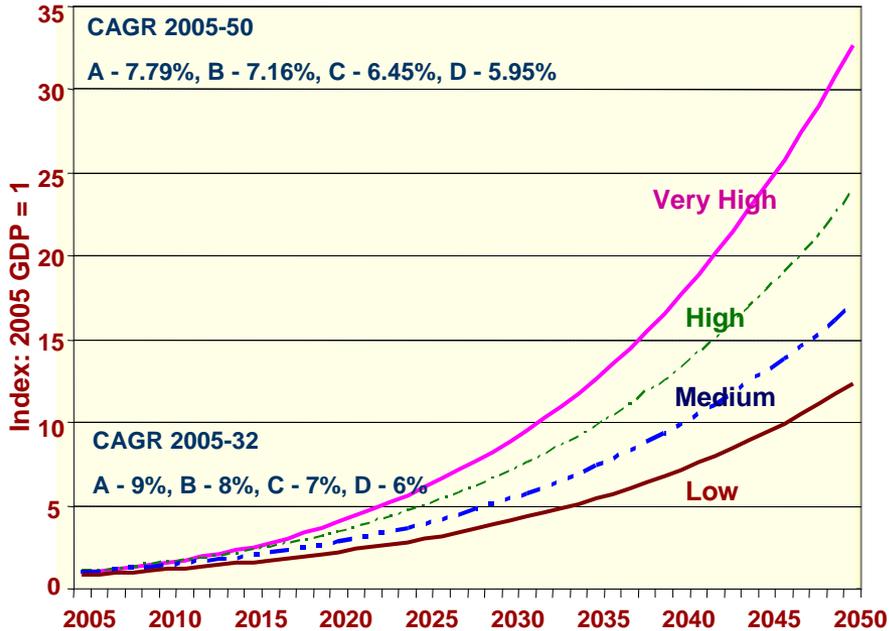
Source : Mizuho, 2006

End-Use Demand



Economic Growth: GDP Projections

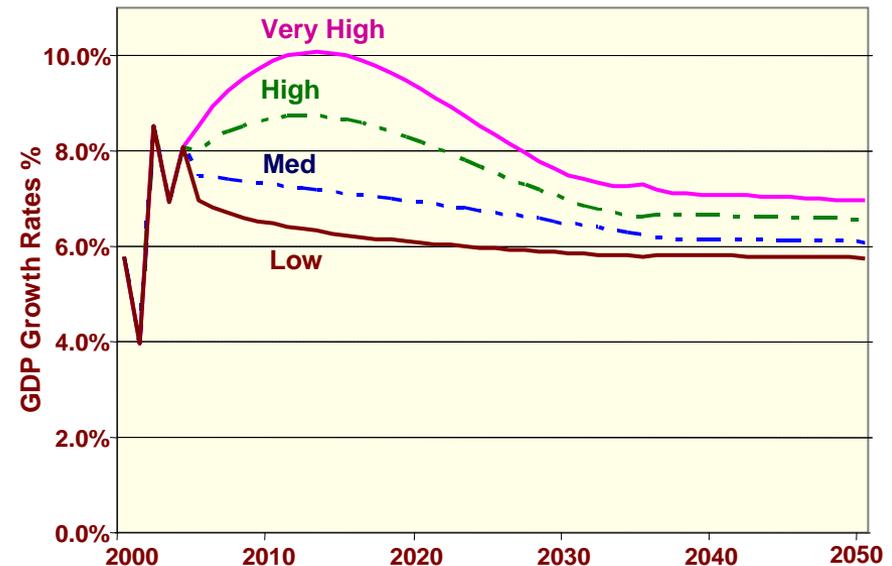
India's GDP (Index: 2005 GDP = 1)



Sustainable Economic Growth

- Energy Security
- Trade
- Human Capital
- Innovations
- Institutions

India's GDP Growth Rate (%)

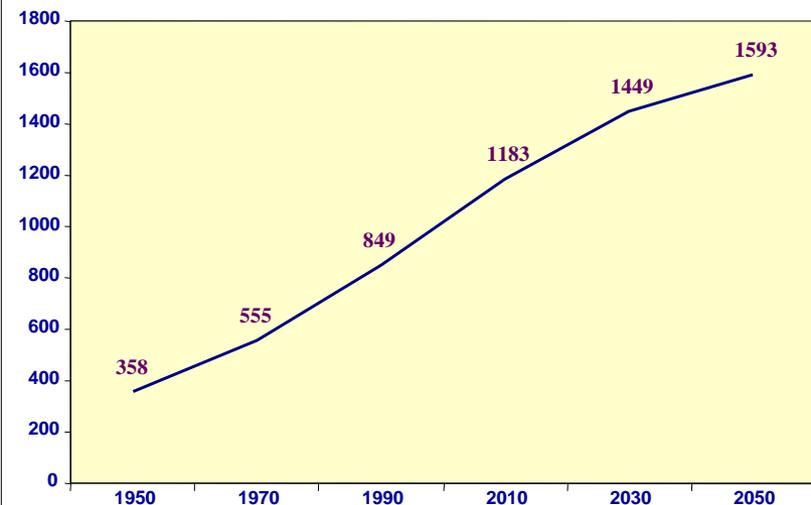


Population

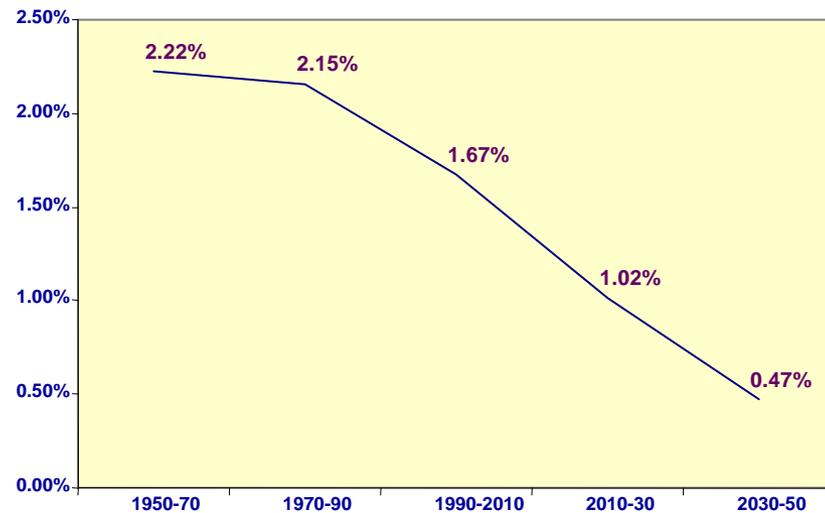
Population and Sustainability

- Growth
- Quality
- Mobility
- Opportunity
- Empowerment

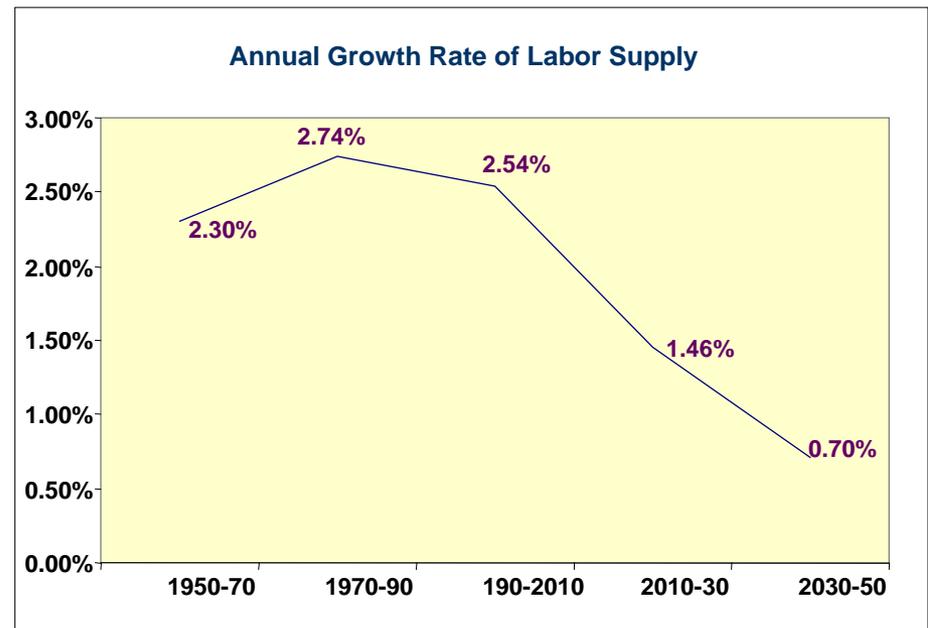
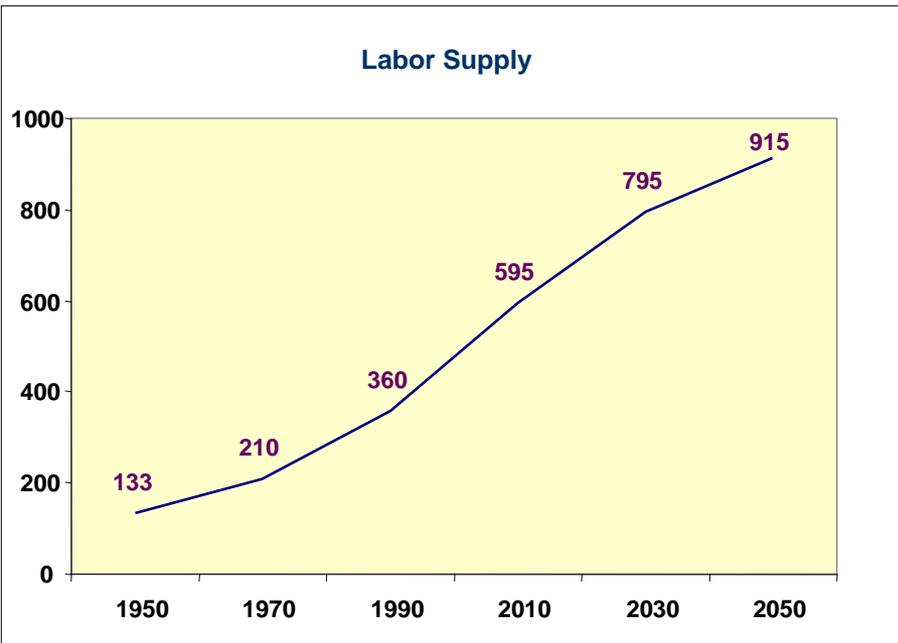
Population (Million)



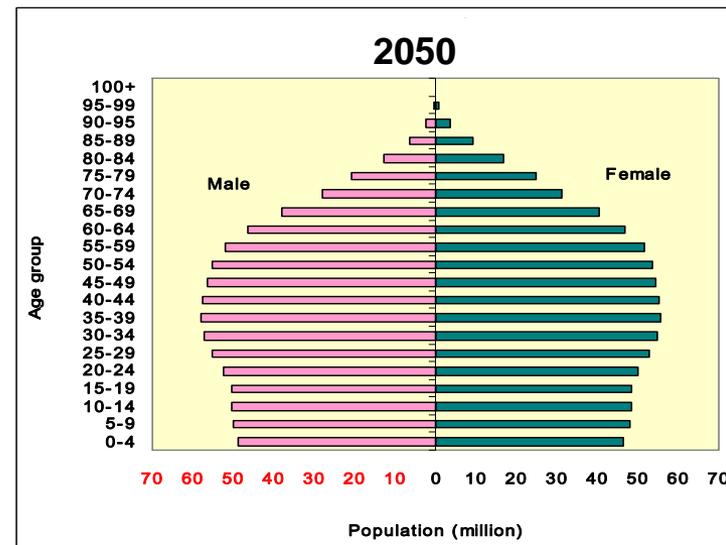
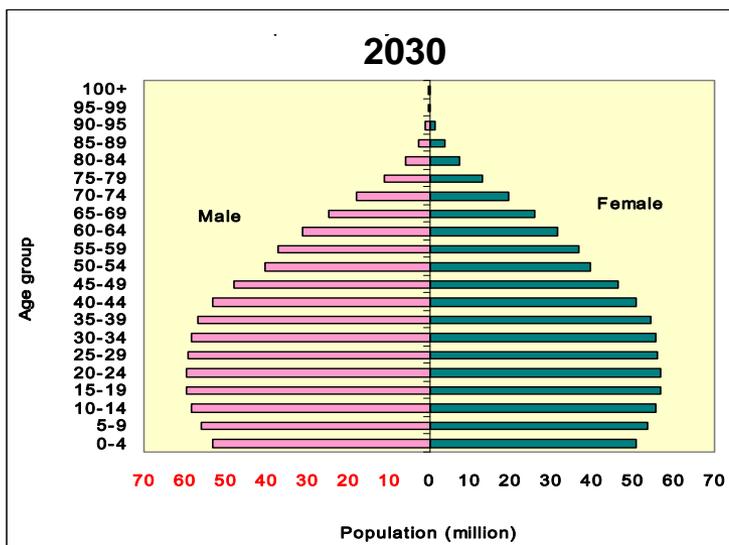
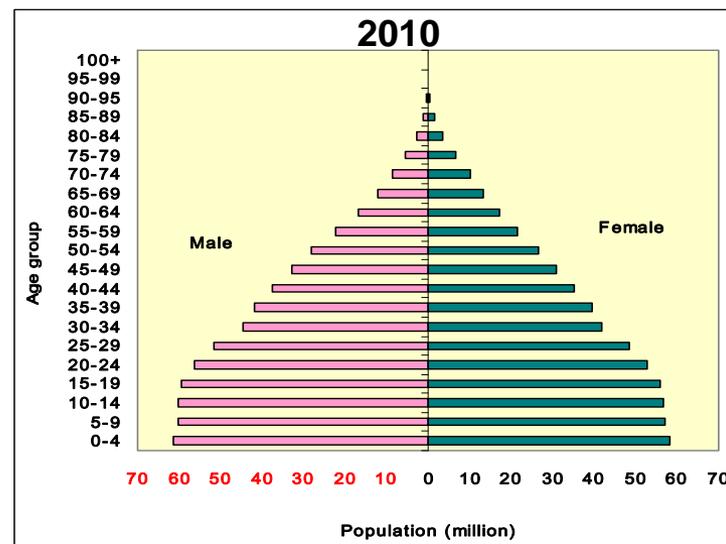
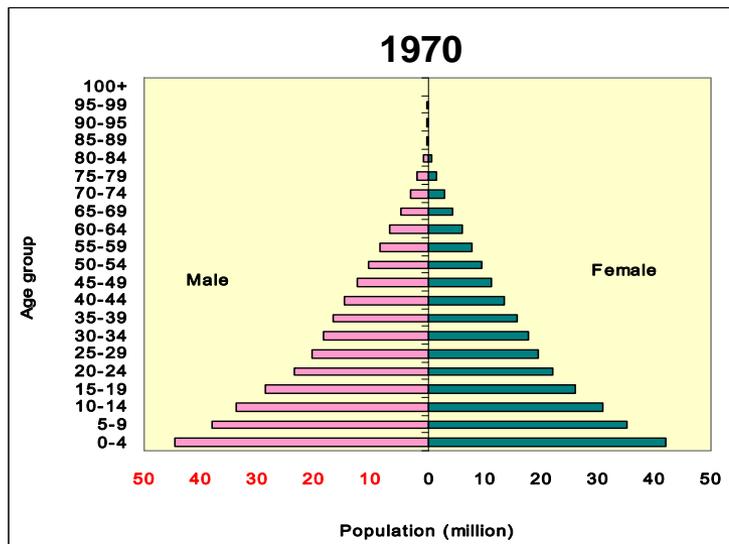
Annual Growth Rate of Population



Demographic Transitions



Age/Gender Profile



Growth Scenarios

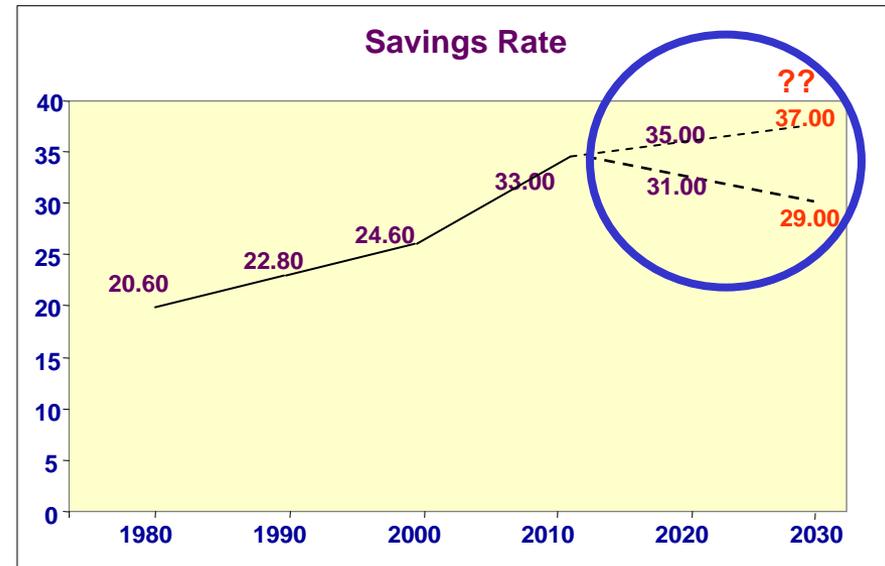
- Human Capital
 - Government Expenditure in Education
 - Private Expenditure in Education
 - Urban / Rural & Gender-wise Education Expenditure
 - (Net) Migration by Labor Classes (intra & inter county)

- R&D
 - Government/ Private Expenditure
 - Knowledge Flows

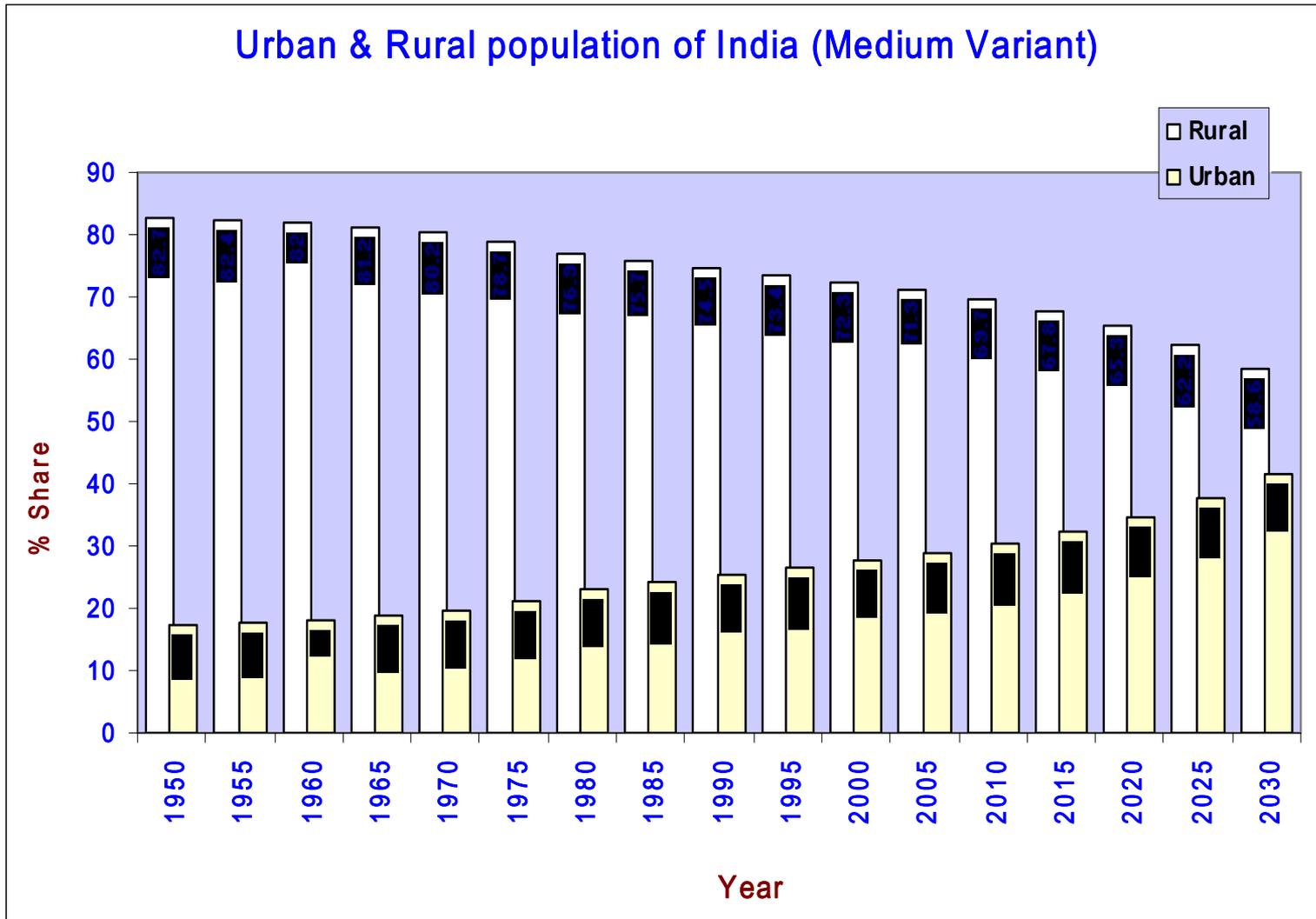
- Technology
 - Backbones (infrastructures)
 - Learning, transfers, deployment

- Saving/ Investments
 - Social Security
 - Lifestyles, Behaviors

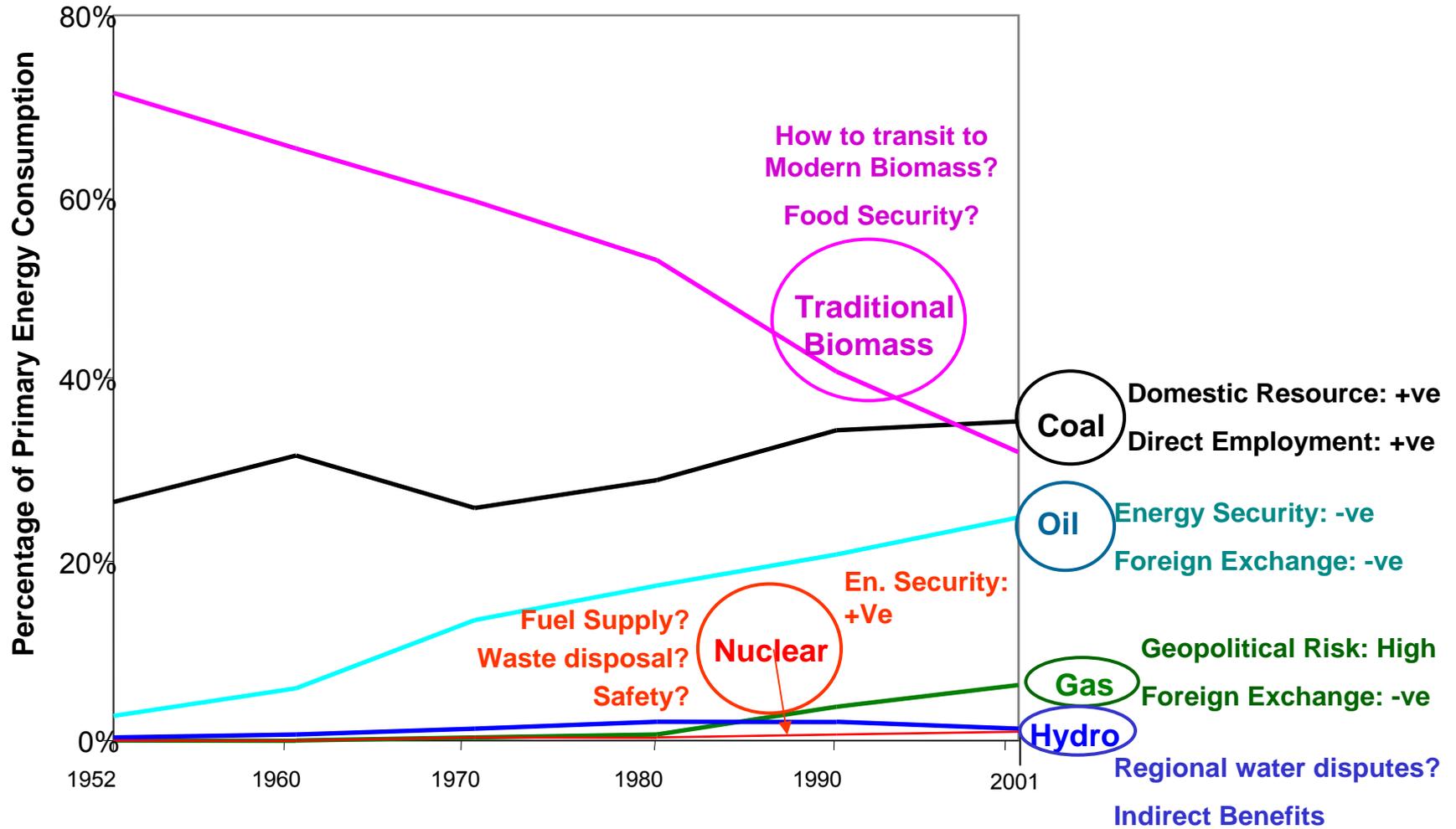
- Governance
 - Institutions
 - Laws
 - Policies



Demographic Transitions in India: Urban/Rural



Energy Transitions to Low Carbon Future?



Base Case Energy & CO2 Emissions

From 2000-2050:

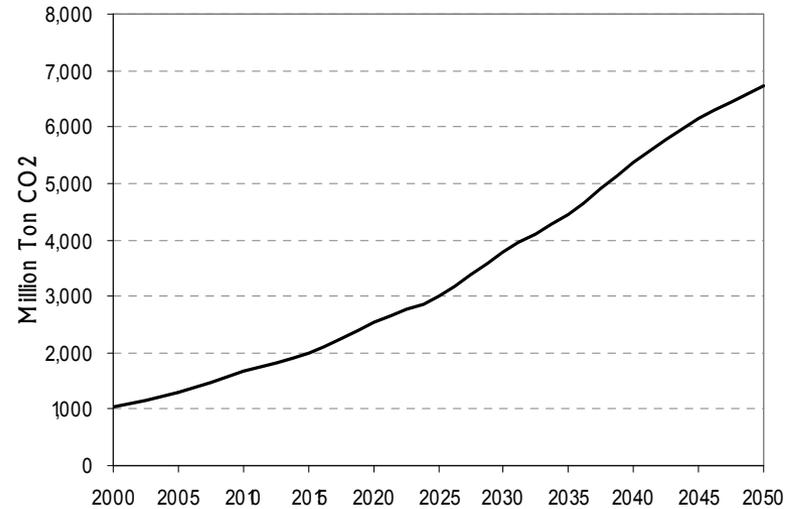
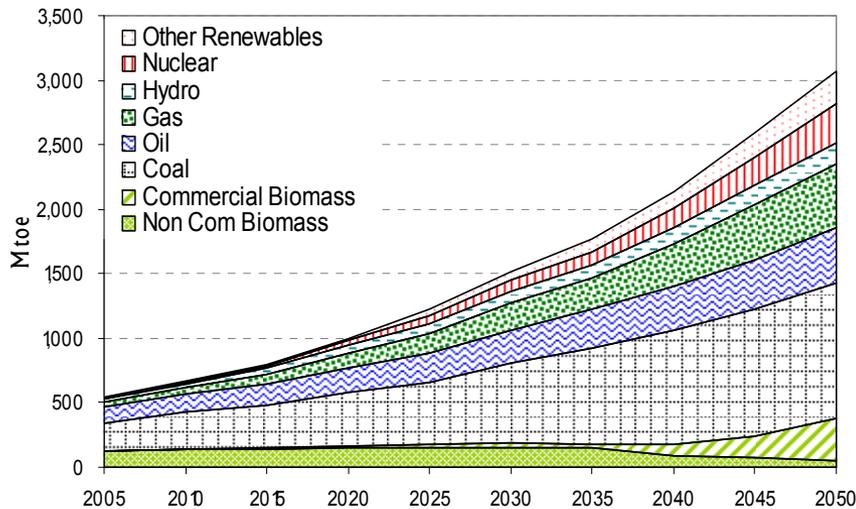
Annual Economic Growth: 7.2%

Annual Population Growth: 0.9%

Absolute Growth in 2050 over 2000

Economy 33 times

Population 1.6 times



Annual Improvement From 2000-2050:

Energy Intensity (%): 2.65

Decarbonization of Energy (%): 1.48

Carbon Intensity (%): 4.13

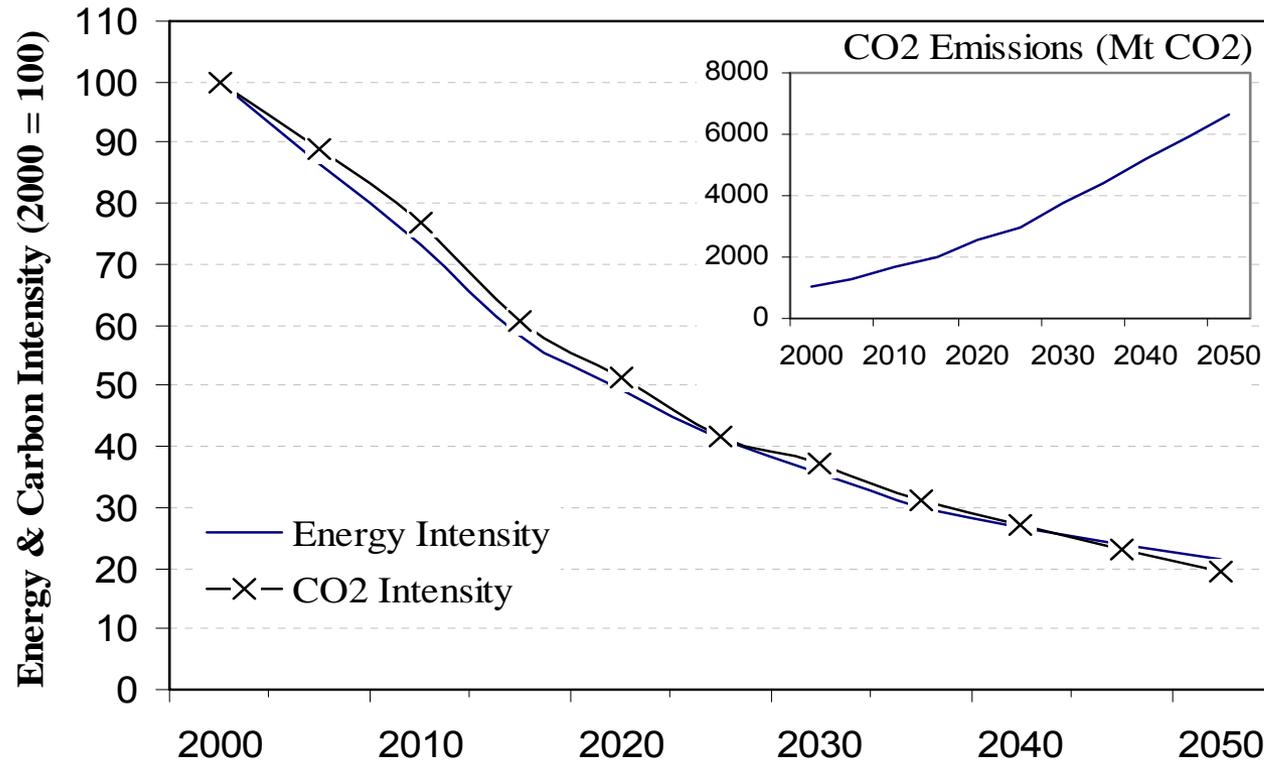
Ratios: 2050 over 2000

Energy Intensity: 0.29

Decarbonization of Energy: 0.49

Carbon Intensity: 0.14

Base Case: Energy & Carbon Intensities



Energy Efficiency Improvement but no
more decarbonization of Energy

LCS as a Development Pathway

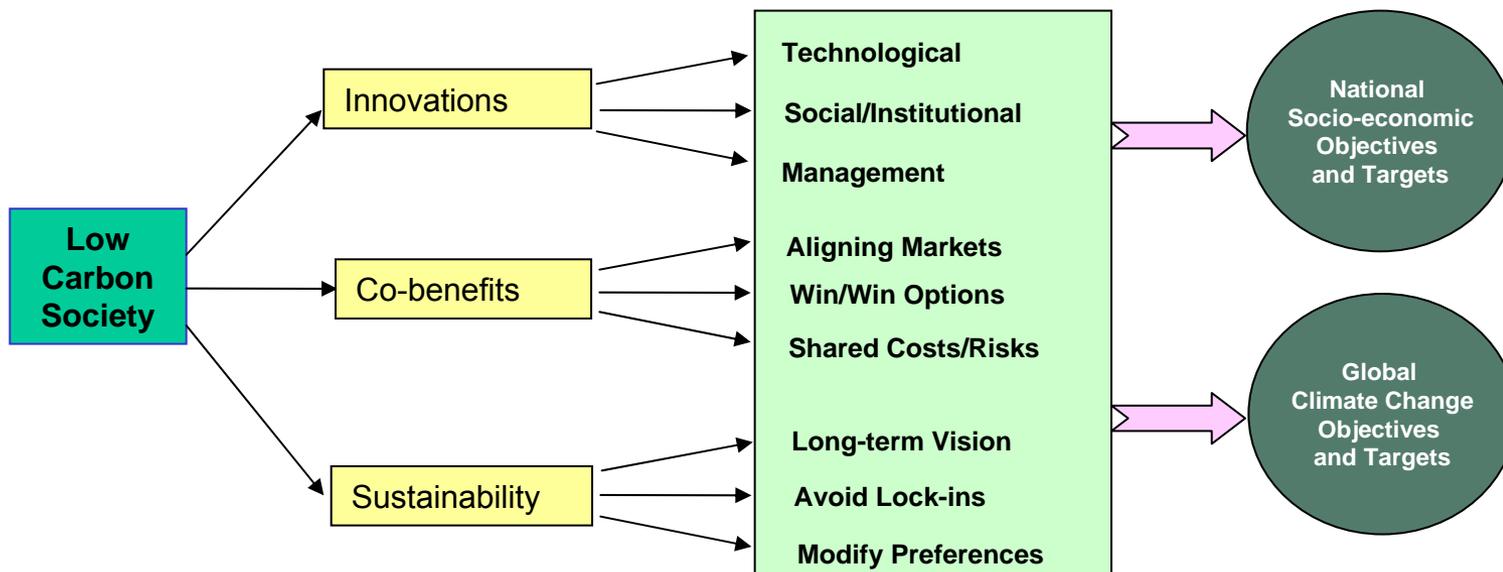
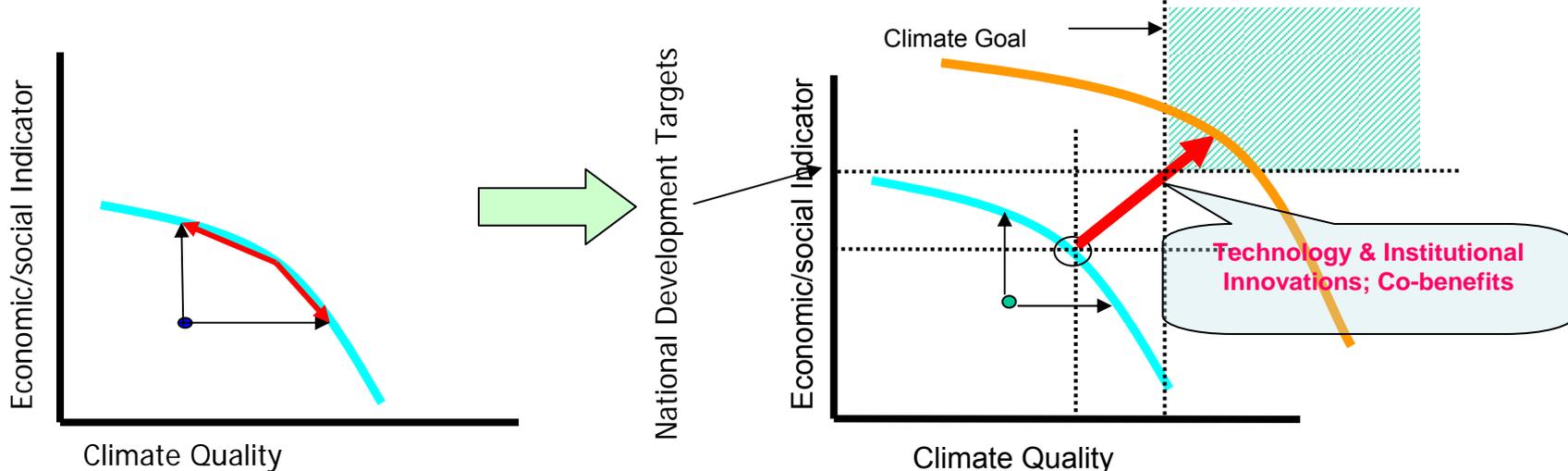
- Stabilization Target 550 ppmv CO₂e
- Two “Alternate Scenarios” or “Development Pathways”
 1. **Conventional Development + High Carbon Tax**

The global stabilization studies show that to altering conventional emissions path to stabilization would need high carbon tax:
E.g. according to US-CCSP report the tax would be:

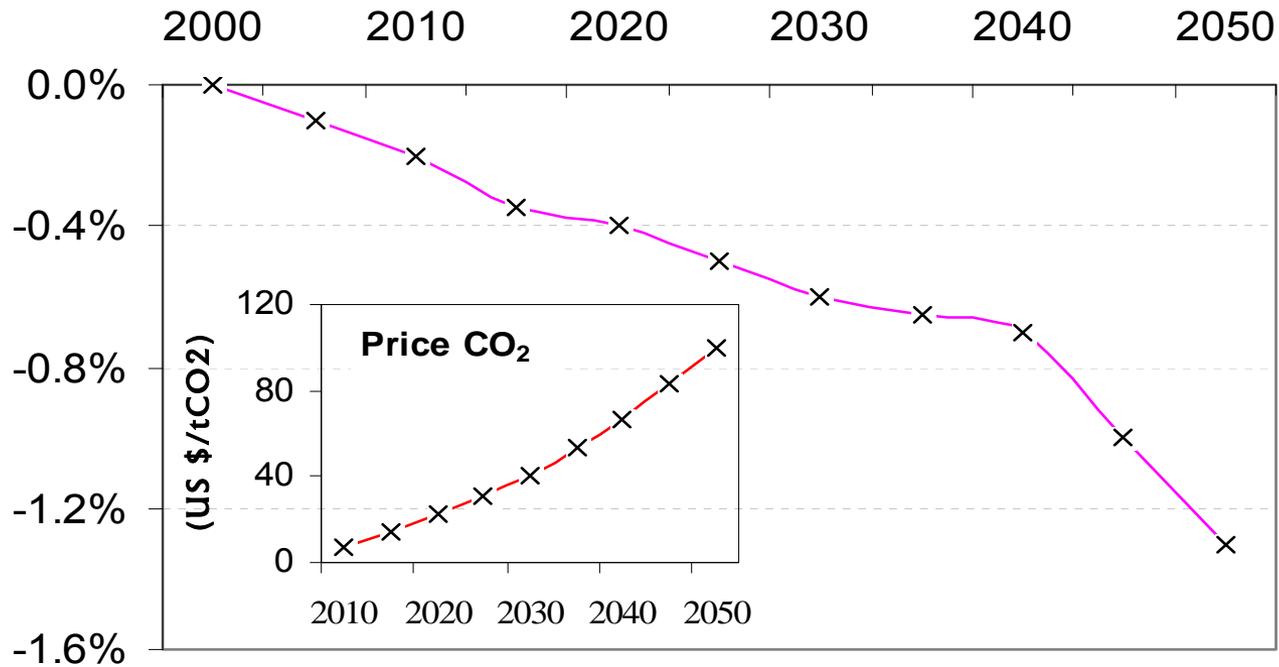
 - 2010: US\$10
 - 2050: US\$100
 - 2100: US\$167
 2. **Sustainable Development Pathways + Low Carbon Tax**

Also called the “Low Carbon Society” Scenario

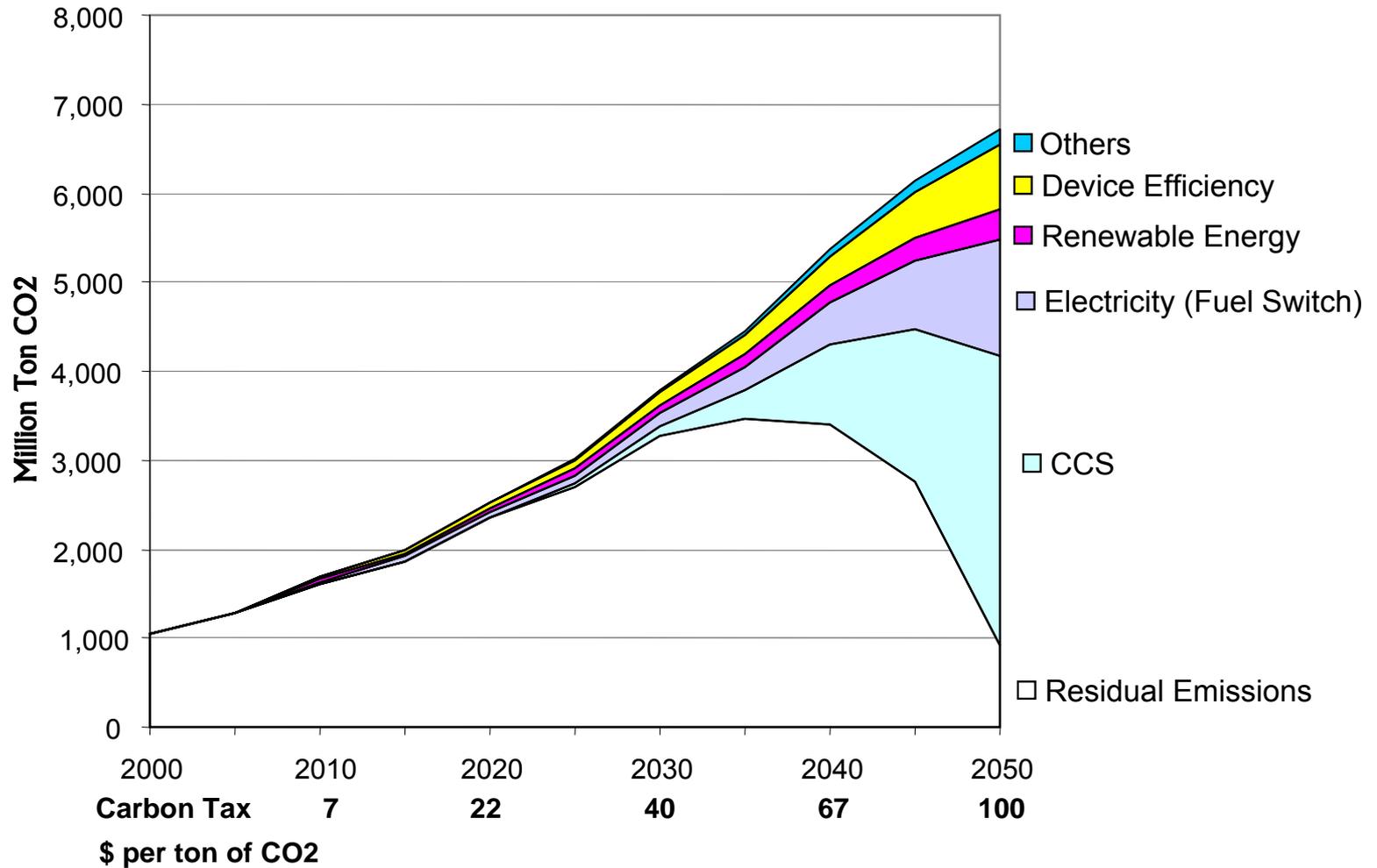
Concept of Low Carbon Development through Sustainability



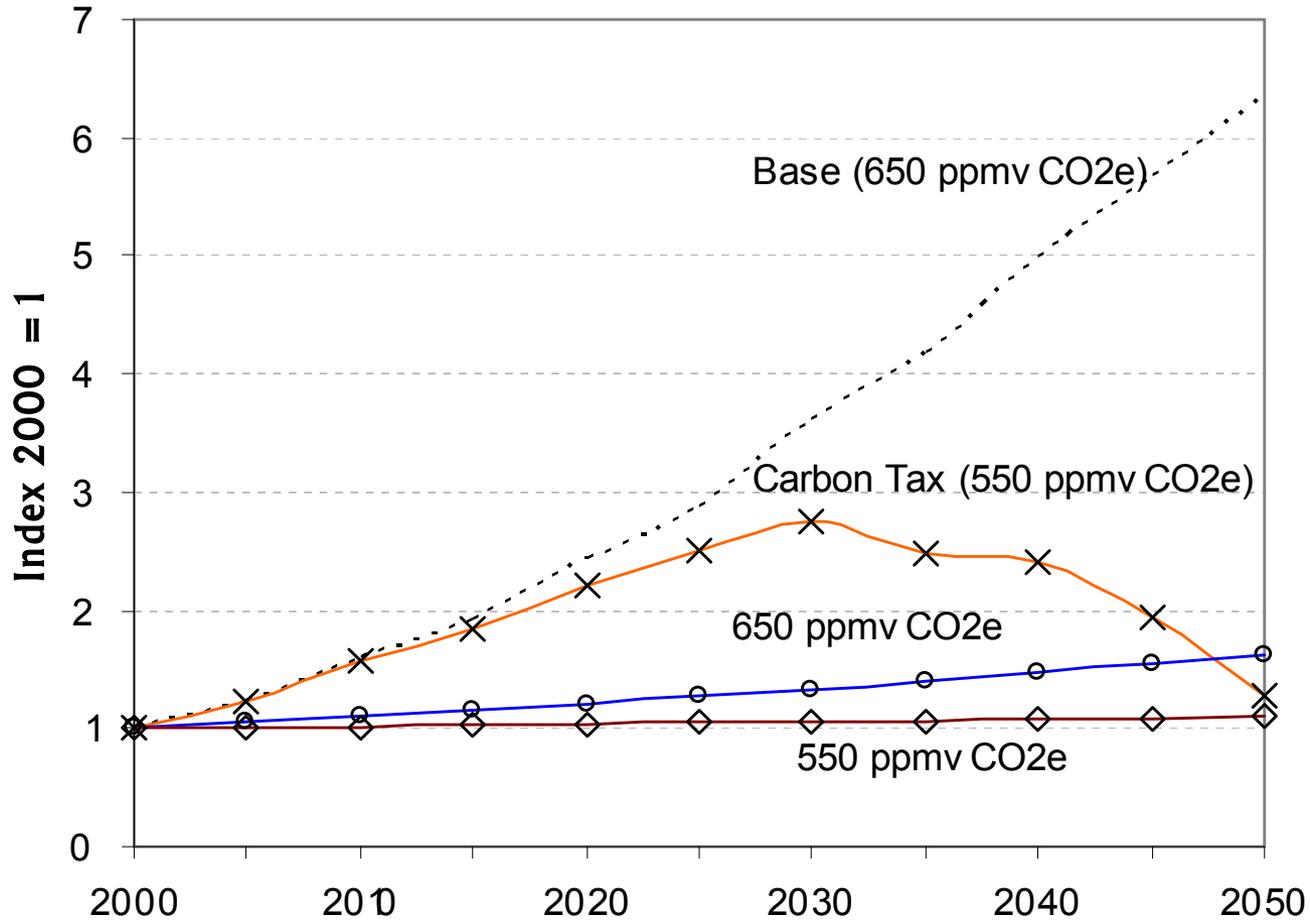
GDP Loss due to Carbon Tax



CO2 Mitigations in Carbon Tax Scenario

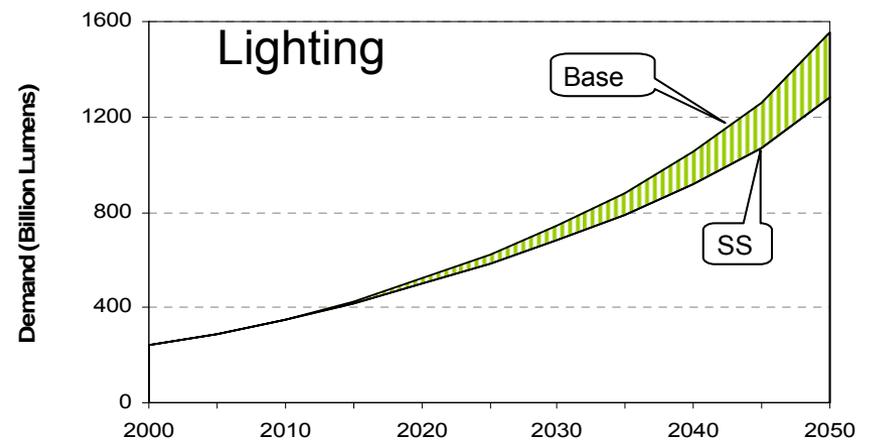
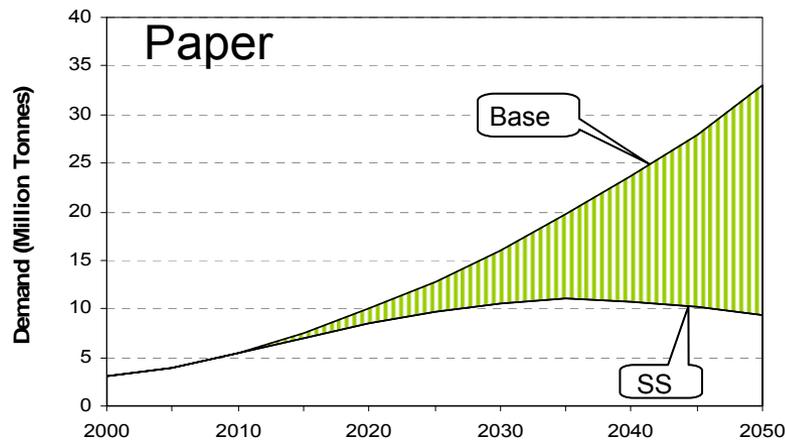
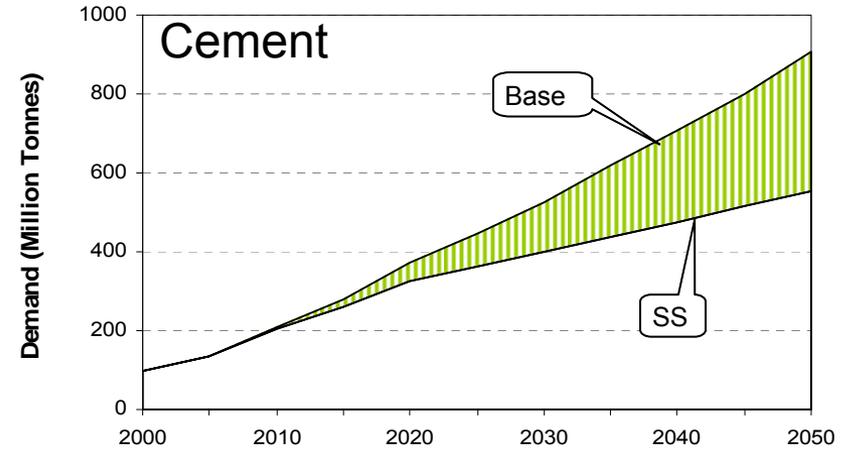
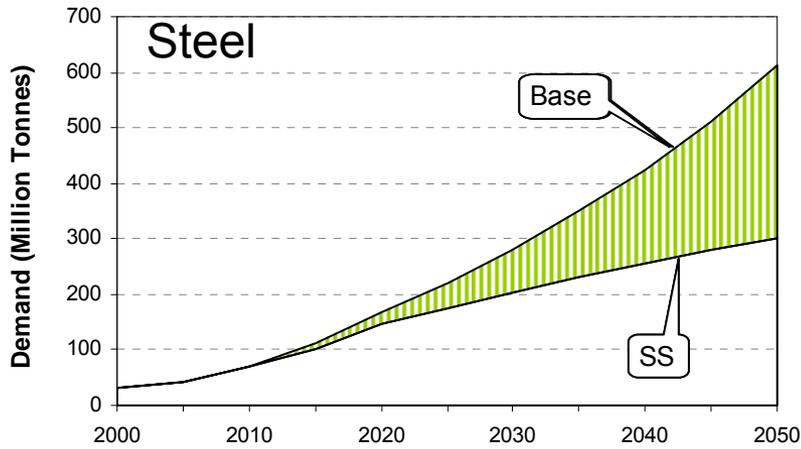


CO₂ Emission trajectories India & Global

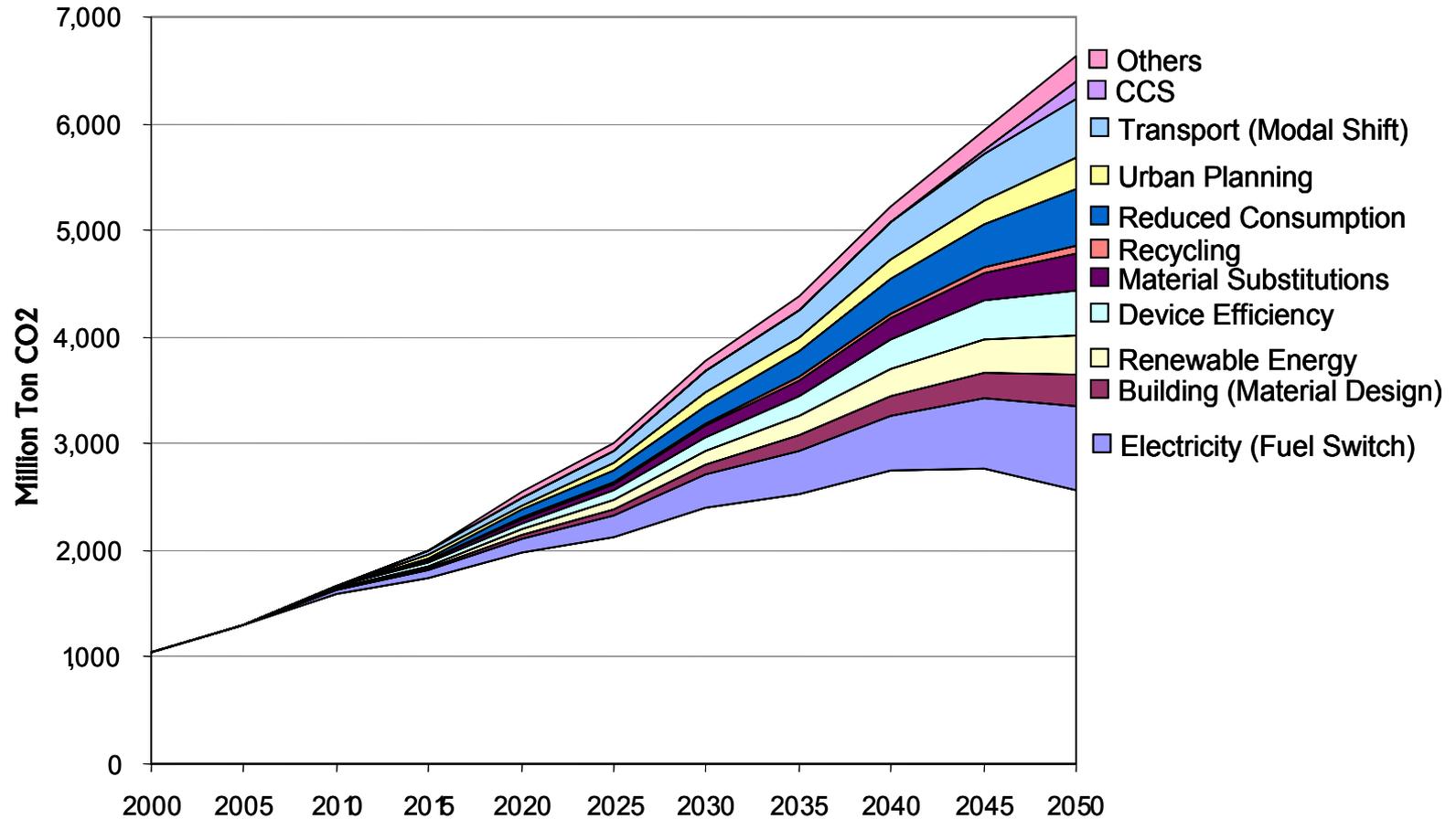


Some Intermediate & Final Demands

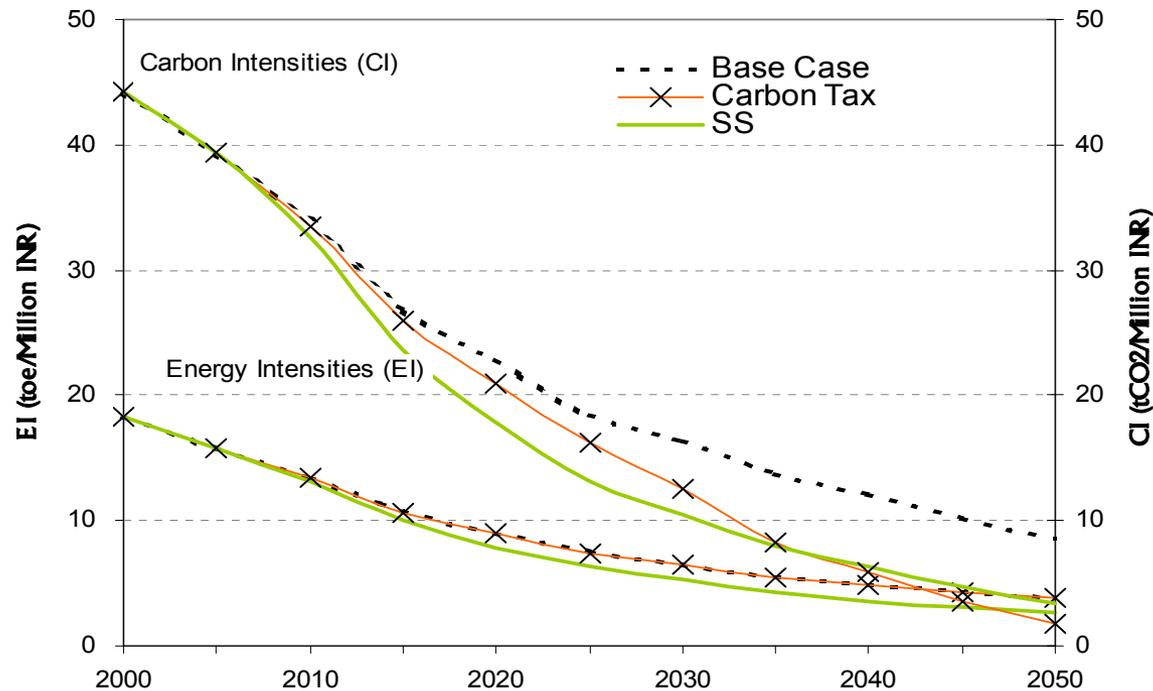
Base & Sustainability Scenario



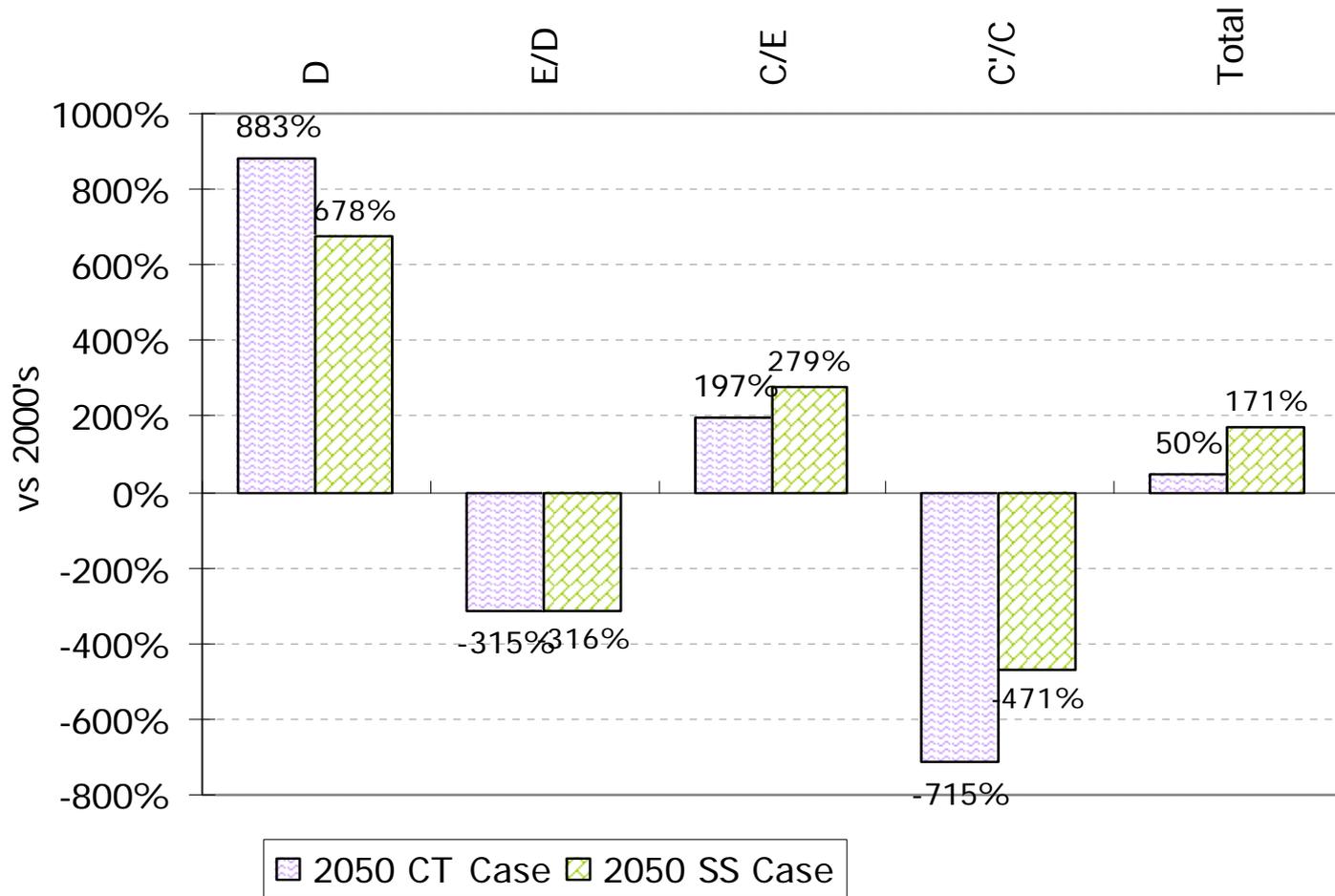
Mitigation Options in SS Scenario



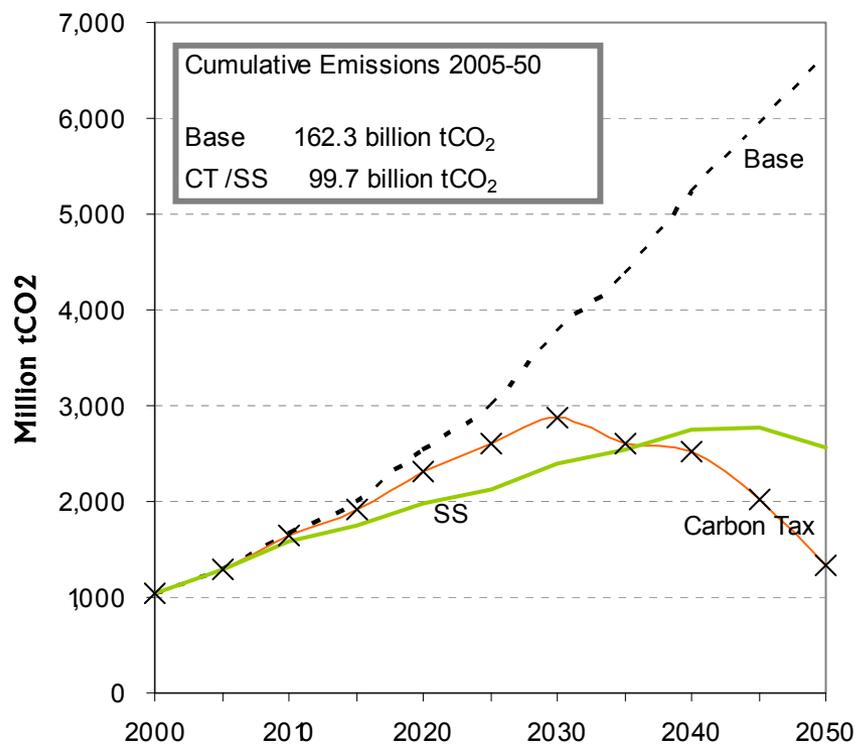
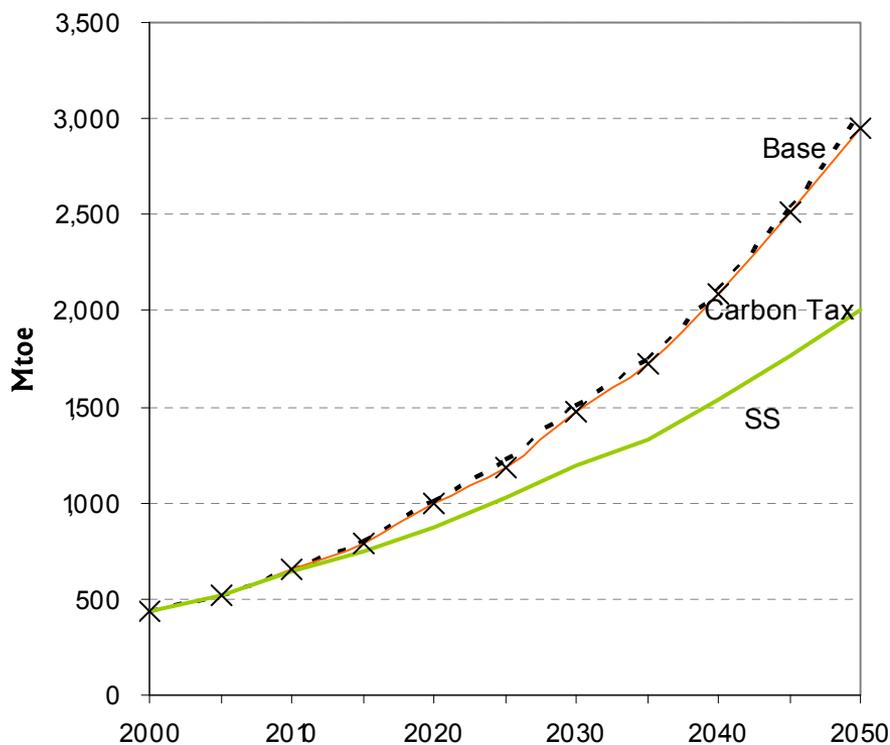
Energy and Carbon Intensities: Base & LCS Scenarios



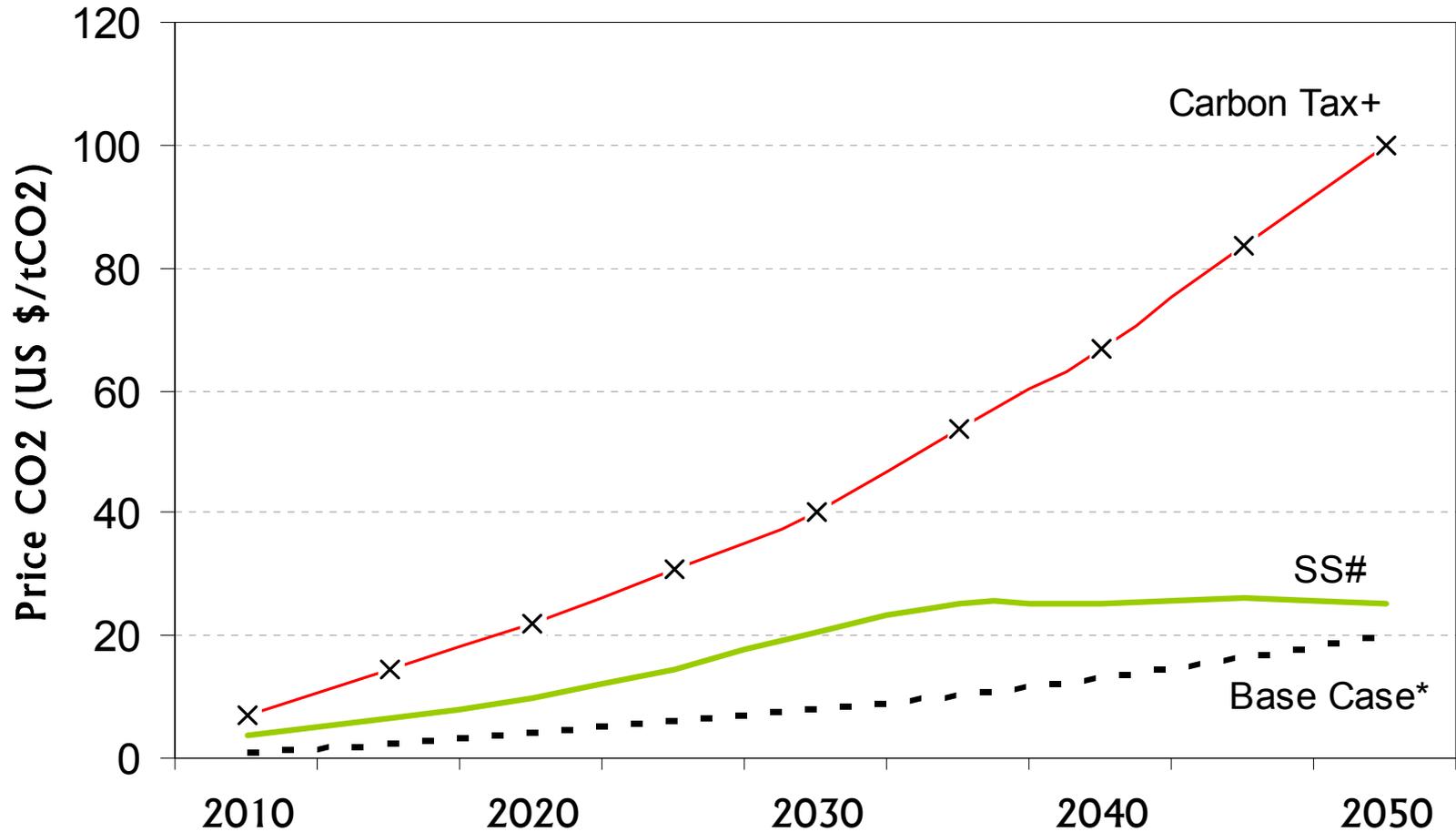
Kaya Analysis of LCS Scenarios



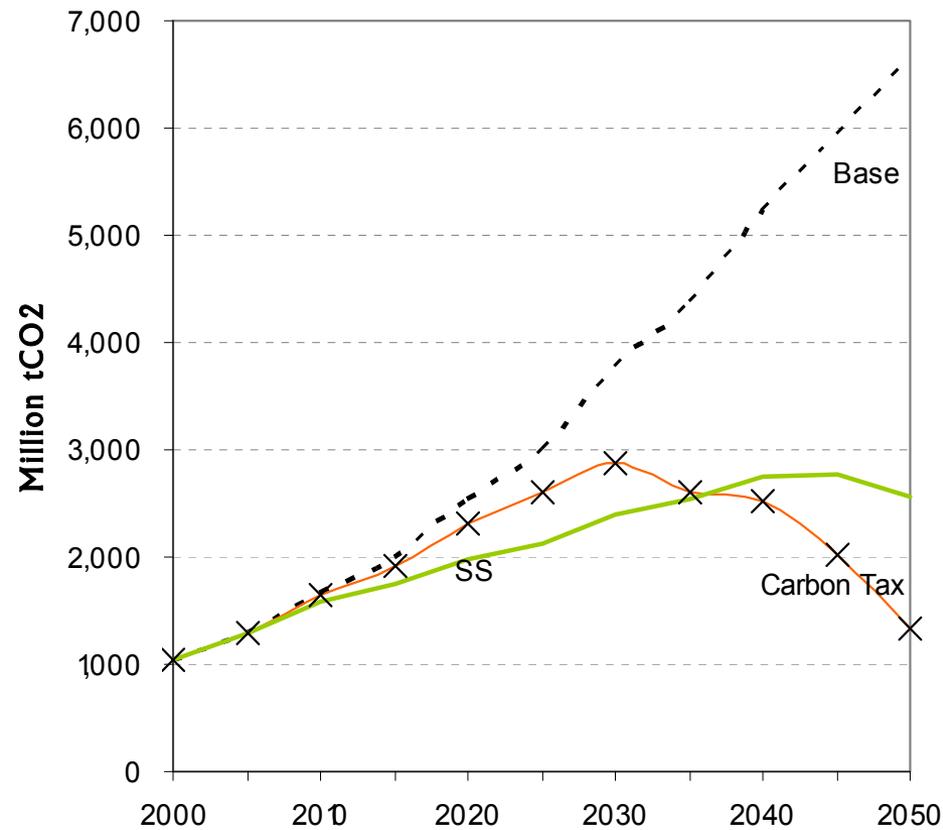
Energy & CO₂ Emission Trajectories across LCS scenarios



Carbon Price: LCS vs. Base Scenarios



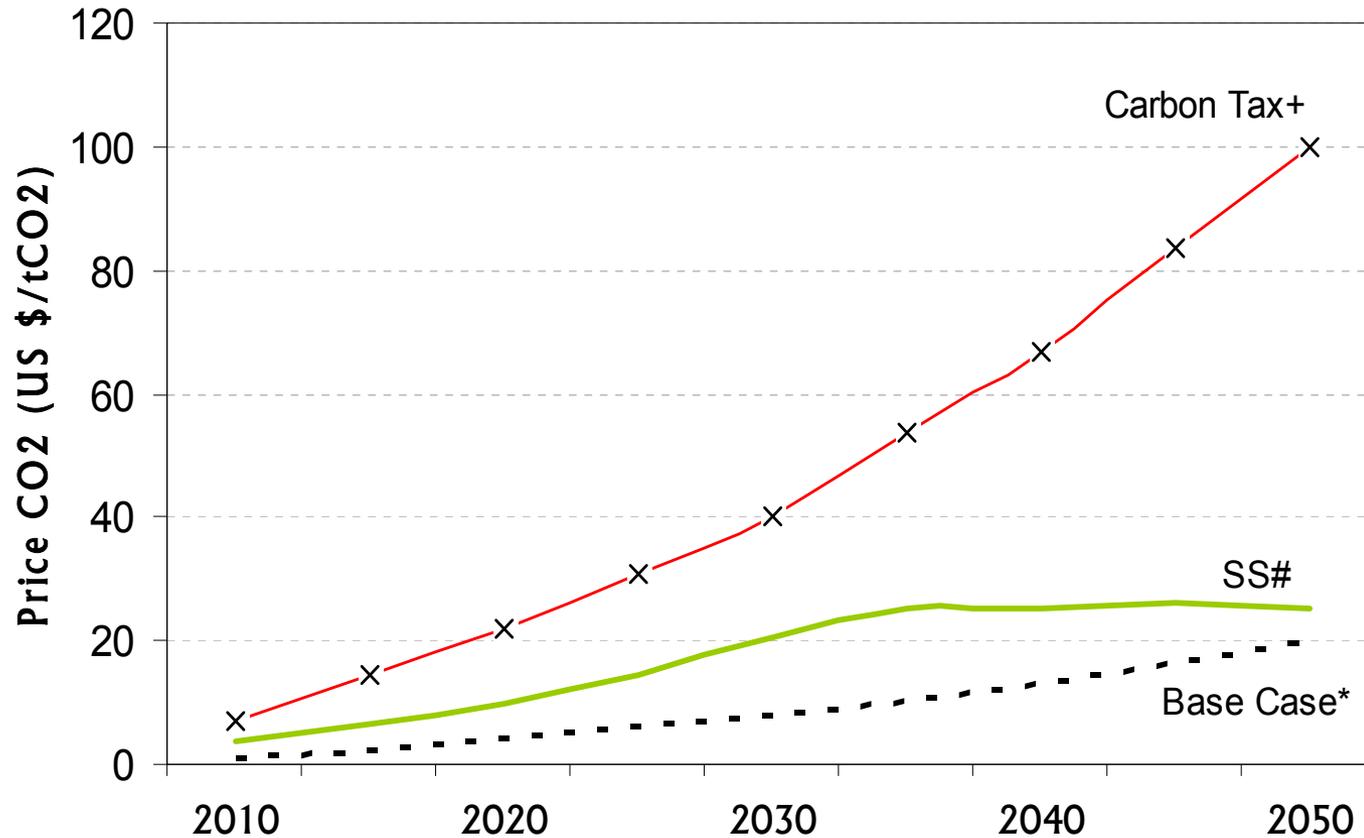
CO2 Mitigation Pathways – SS Vs Carbon Tax Case



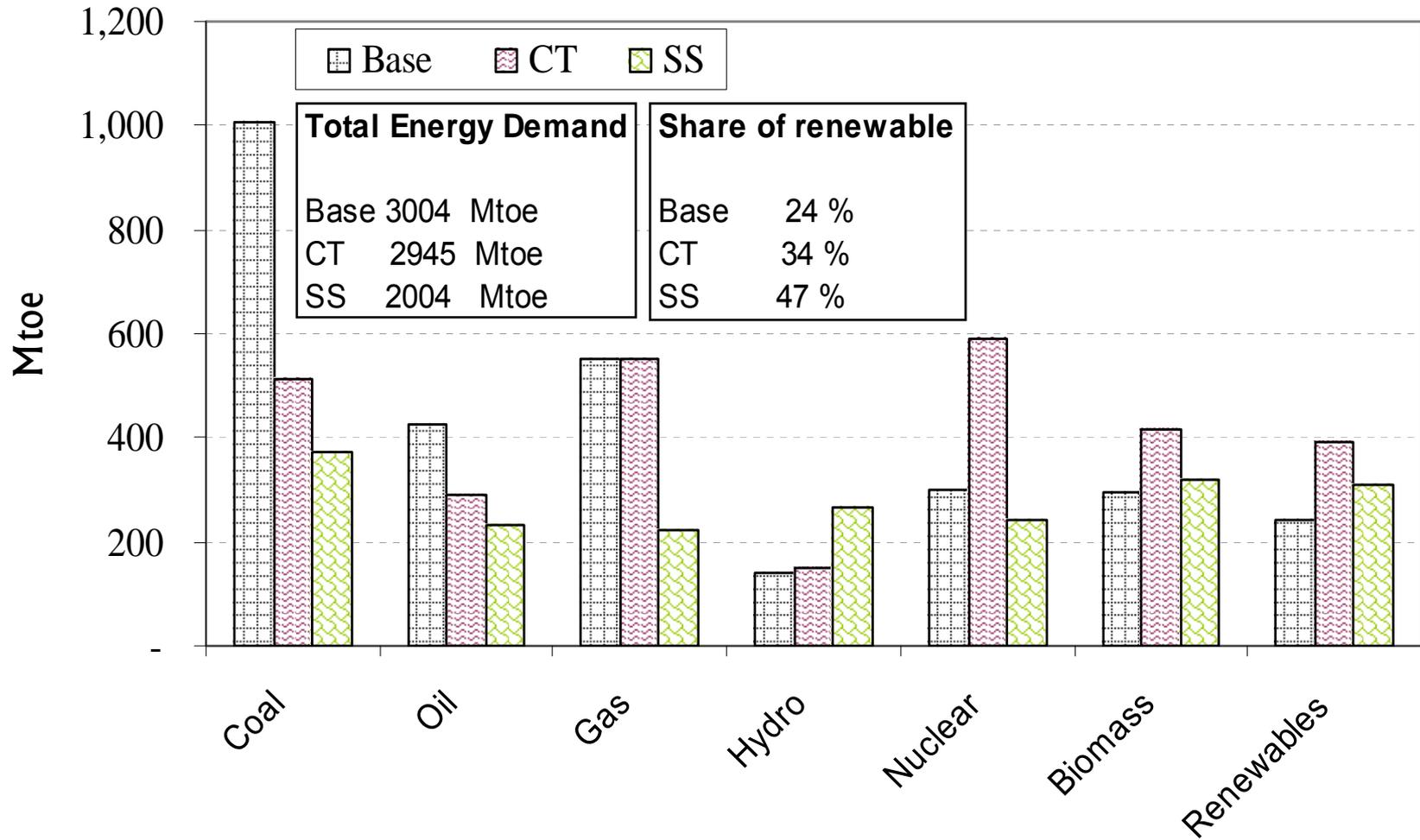
Billion Tonnes of CO₂

Mitigation Choice	SS	CT
Electricity (Fuel Switch)	13.4	30.5
Building (Material Design)	4.6	-
Renewable Energy	6.2	2.8
Device Efficiency	6.7	5.9
Material Substitutions	4.9	-
Recycling	1.0	-
Reduced Consumption	8.0	-
Urban Planning	4.7	-
Transport (Modal Shift)	8.6	-
Others	3.8	4.3
CCS	0.5	19.1
Total Mitigation	62.6	62.6

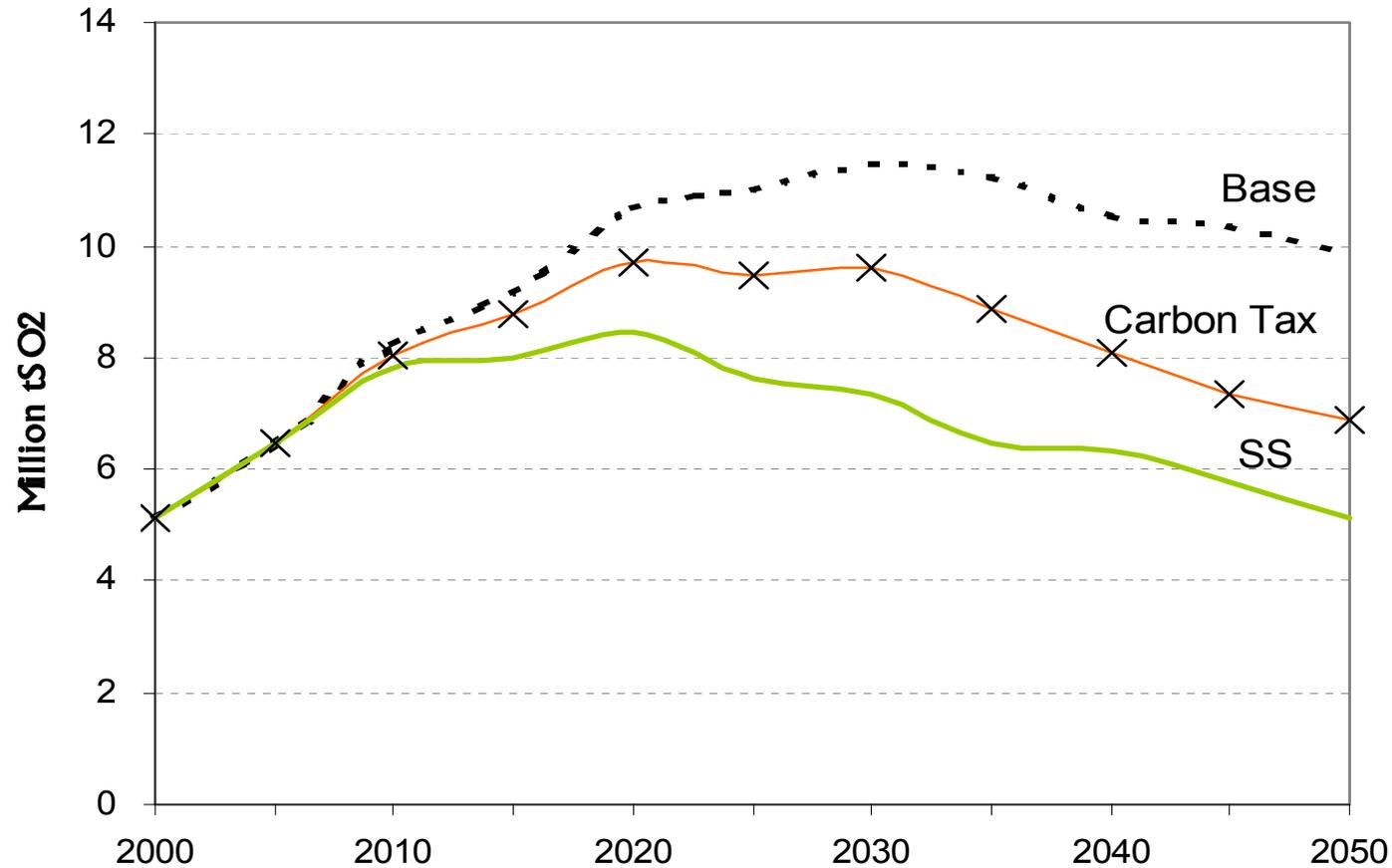
Carbon Price Trajectories



Fuel mix: LCS & Base Scenarios



SO₂ Emissions: LCS & Base Scenarios



Conclusions: LCS with Sustainability

Stabilization via Sustainability: The Post-Kyoto Regime



- LCS requires 'Paradigm Shift' to treating climate change at the 'mainstream' and not at the 'margin'
- In developing countries, where economies are not on the efficient frontier, 'mainstreaming' would permit gaining 'multiple dividends'
- Even under sustainable development, stabilization would require direct climate focused policies, both for mitigation and adaptation
- Sustainability roadmap provides a practical way-out from managing climate change as a zero-sum game for nations to a win-win proposition
- LCS through sustainability therefore will promote cooperation and deliver climate goals at lower costs and risks
- No single country can decide pathway that is very different than the global trend.
- LCS roadmap for countries has to be mainstreamed in agreements among governments, financial institutions, corporations and NGOs and implements through wider stakeholder initiatives.

Thank you

**Please look at following websites
for some recent work:**

www-iam.nies.go.jp/aim

www.developmentfirst.org

www.electricityindia.org

www.e2models.com