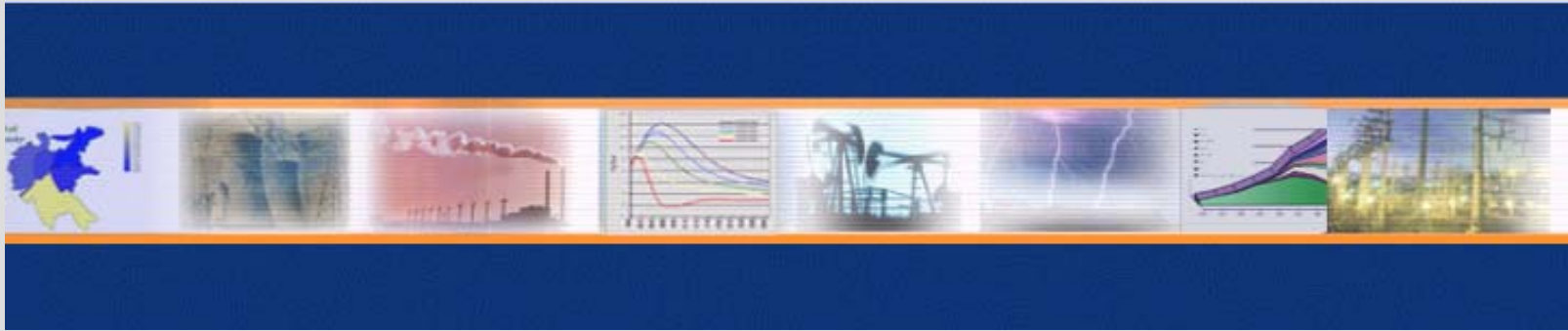


Aligning climate change & development policies: ***Scenarios, modeling and policy analysis from developing country perspective***



P.R. Shukla
Indian Institute of Management, Ahmedabad, India

Presentation for the
AIM Training Workshop
October 16-20, 2006, National Institute for Environment Studies, Tsukuba, Japan

Agenda

- **Developing Country Dynamics**
 - **Scenarios:** Transitions of Goals, Institutions, Demographics, Incomes, Preferences
 - **Modeling:** Co-benefits, Lock-ins, Endogenous and exogenous environment
 - **Policy analysis:** Equity vs. Efficiency,
- **Some Illustrations (from India)**
 - Aligning Energy Security and Technology Transitions with Climate Goals
 - Co-benefits from Aligning Energy-Water Markets in South-Asia
 - Sustainable Development and Adapting Long-life Assets to Climate Risks
- **Modeling Climate Stabilization Induced Development Paths**
- **Conclusions**

Developing Country Dynamics

1. What make developing countries different?

- Different stage of development: priorities and capabilities
- Different economic dynamics than assumed in scenario assessments
- Need and opportunities to align climate and development agenda

2. Modeling vs. Model Developments

Understanding development

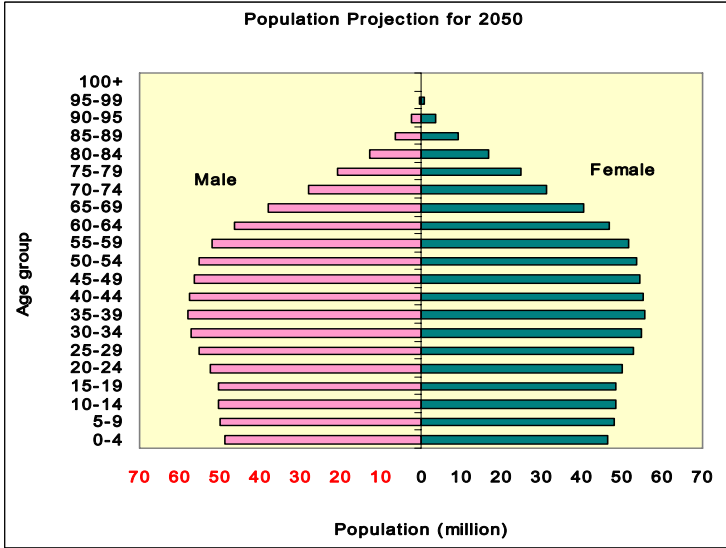
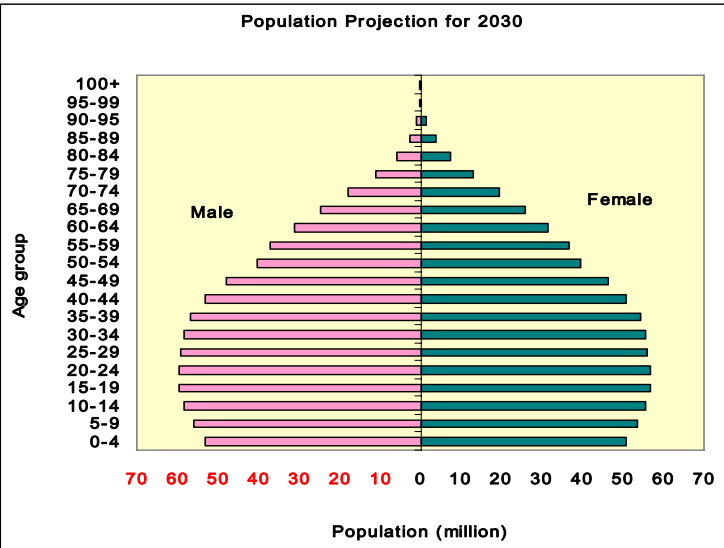
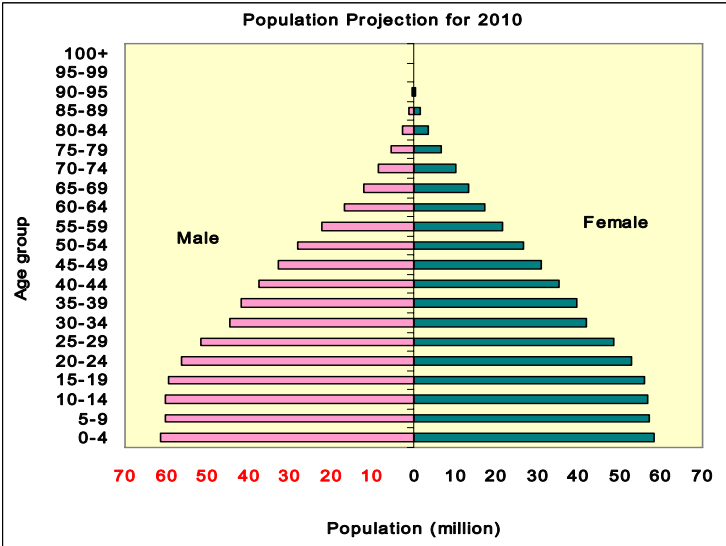
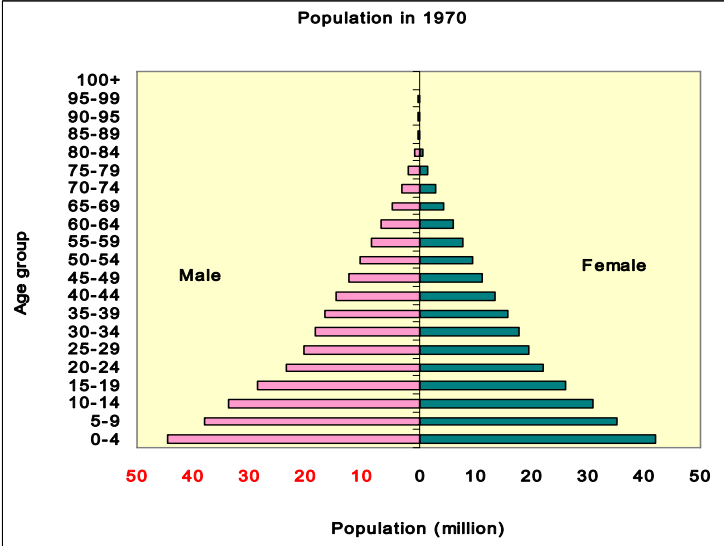
- Dual Economy
- Multiple Transitions
- Informal Activities
- Subsistence Production
- Market Performance and Disequilibria
- Non-commercial Fuels
- Non-economic Concerns
- Policy Distortions

Transitions

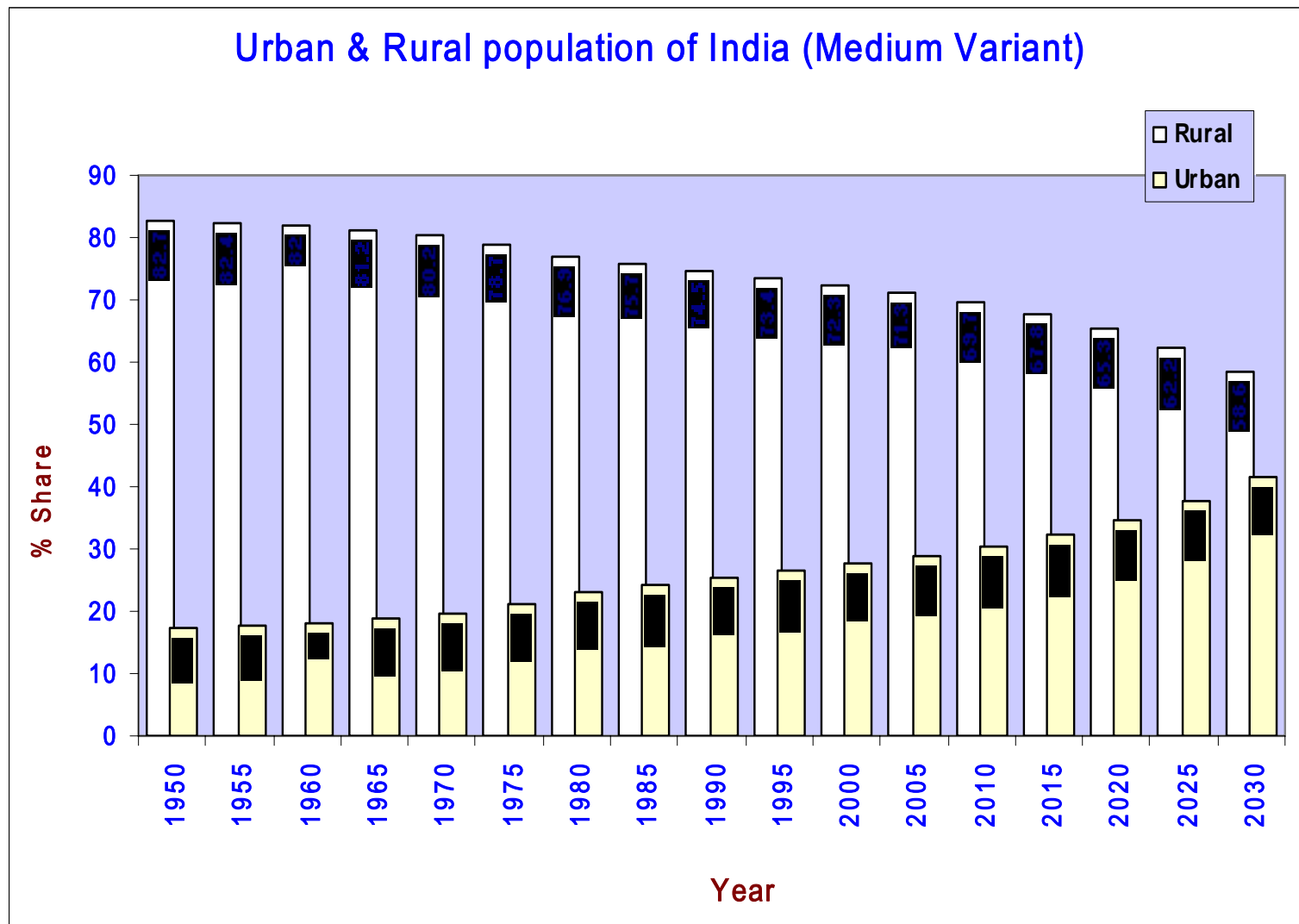
Socio-Economic

- Demographic
 - Population
 - Urban / Rural
 - Gender ratio
 - Migration
- Development
 - Soft indicators: Income, Equity, Literacy, Health
 - Hard indicators: Infrastructure, Housing, Vehicles, Appliances
- Political
 - Institutions
 - Laws
 - Policies

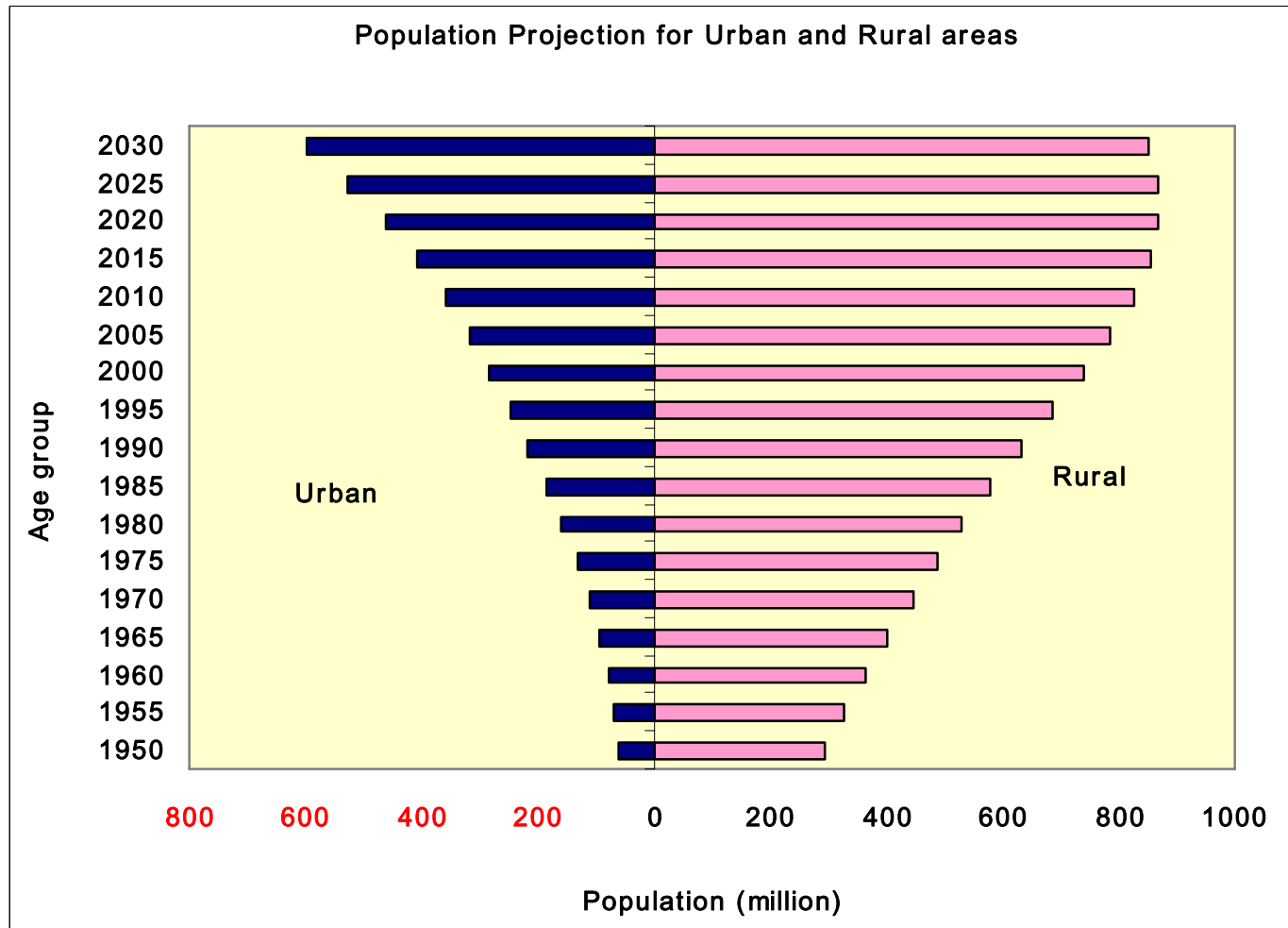
Demographic Transitions in India: Age/Gender Profile



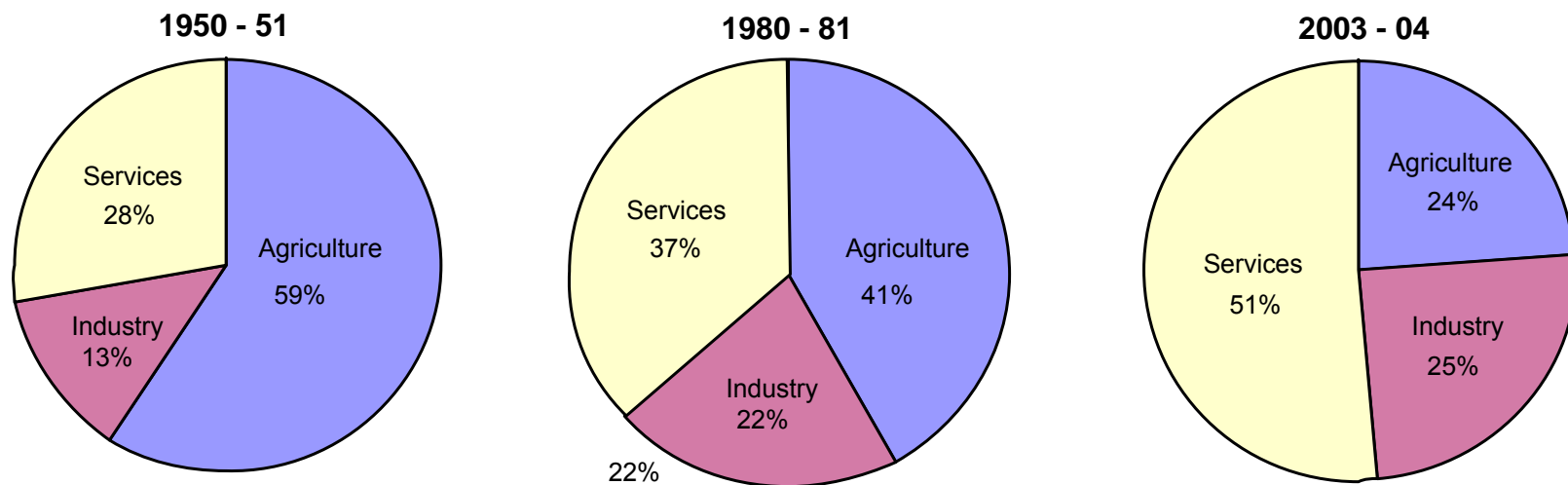
Demographic Transitions in India: Urban/Rural



Demographic Transitions in India: Urban/Rural

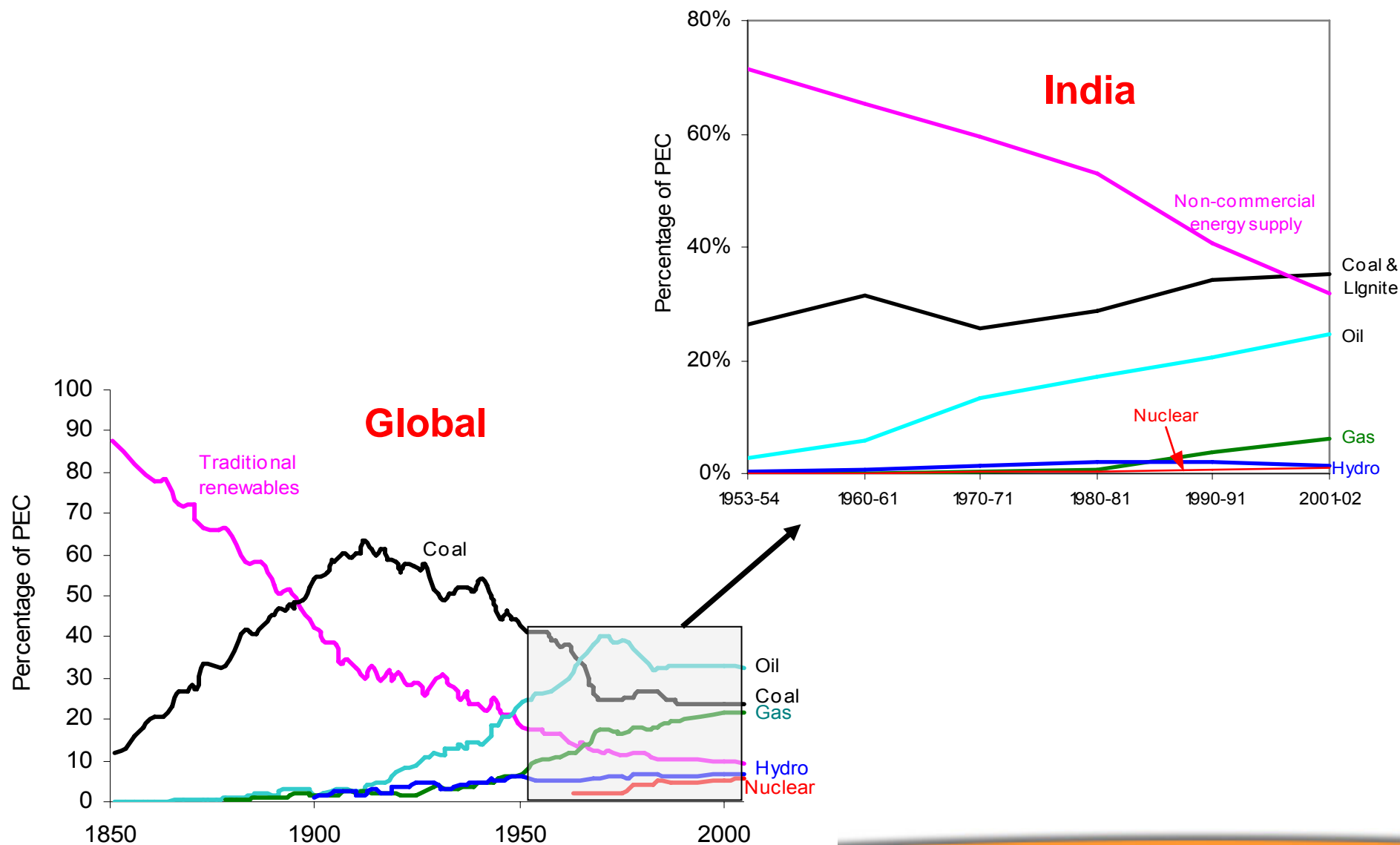


Composition of India's GDP by Sector

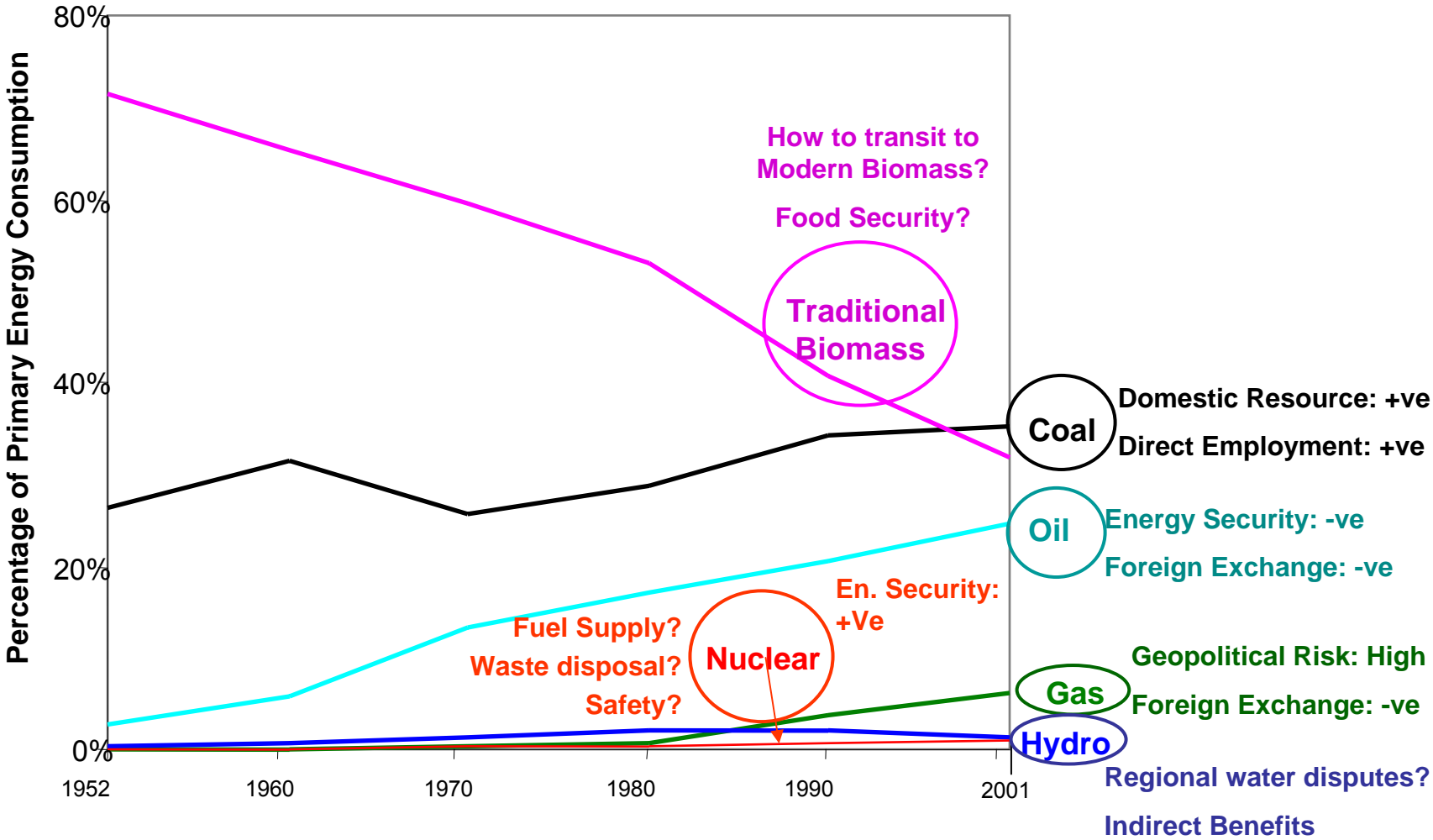


Data Source: CMIE and Economic Surveys of India

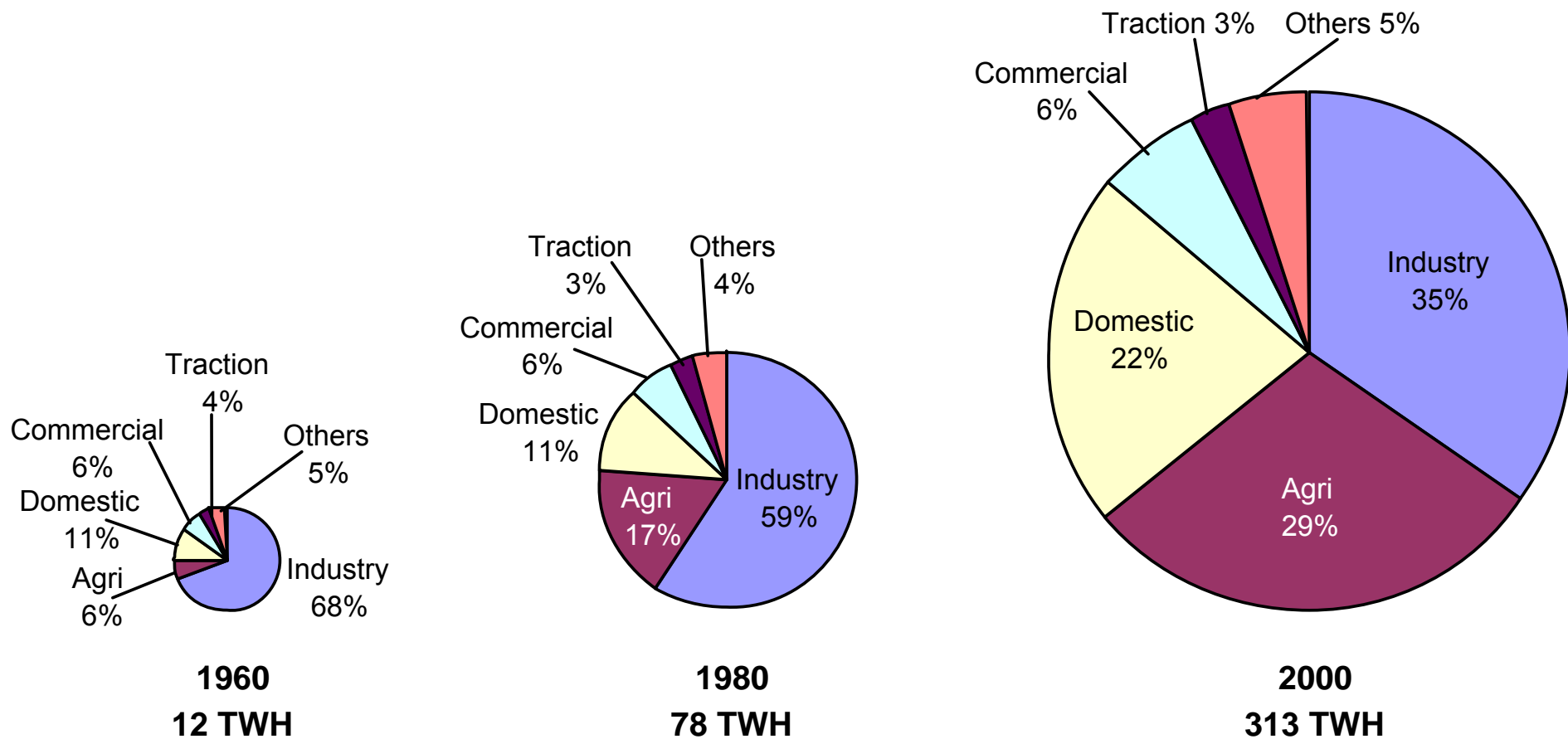
Past Energy transitions: Global & India



Energy Transitions: How they matte to Low Carbon Future?

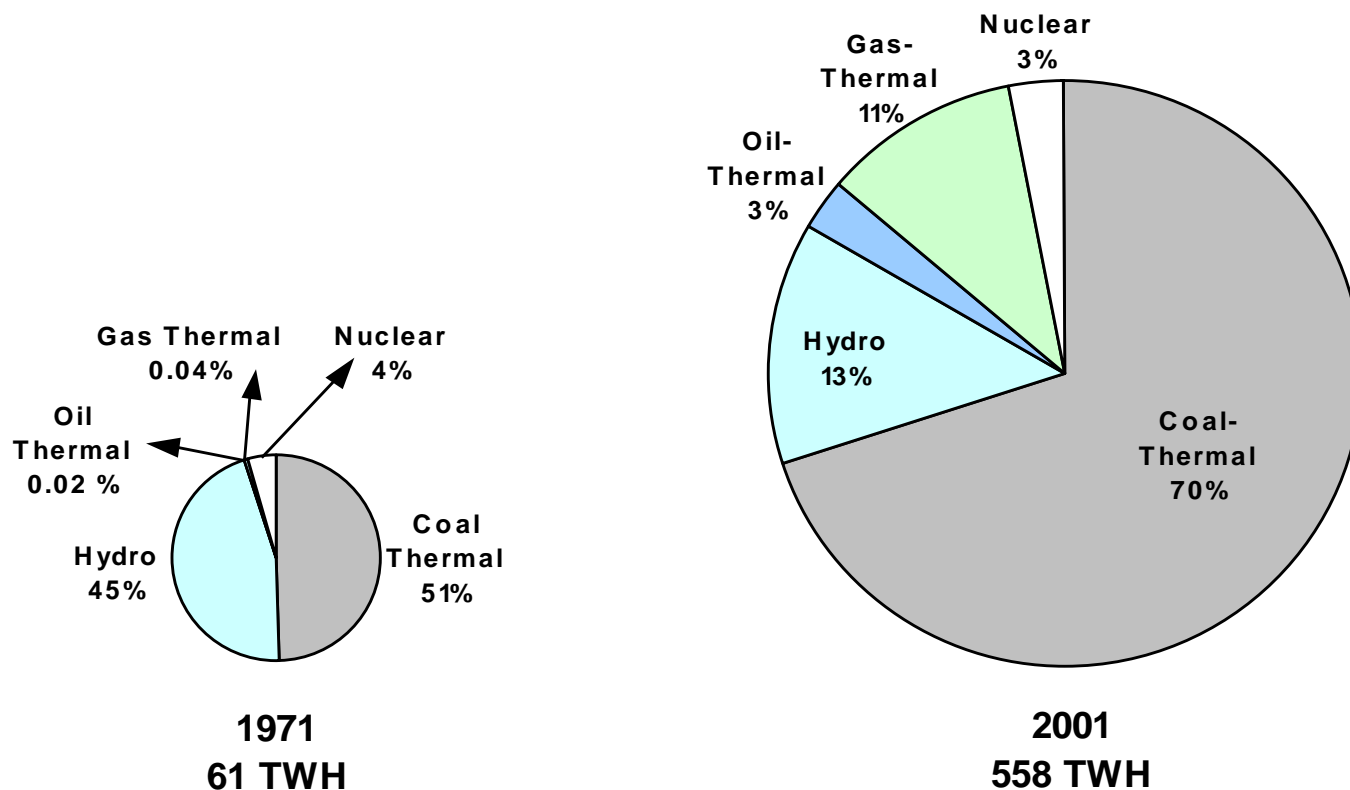


Energy transition evidences: Electricity consumption by sectors



Data Source: CMIE

Energy transition evidences- Changing mix of Electricity Generation



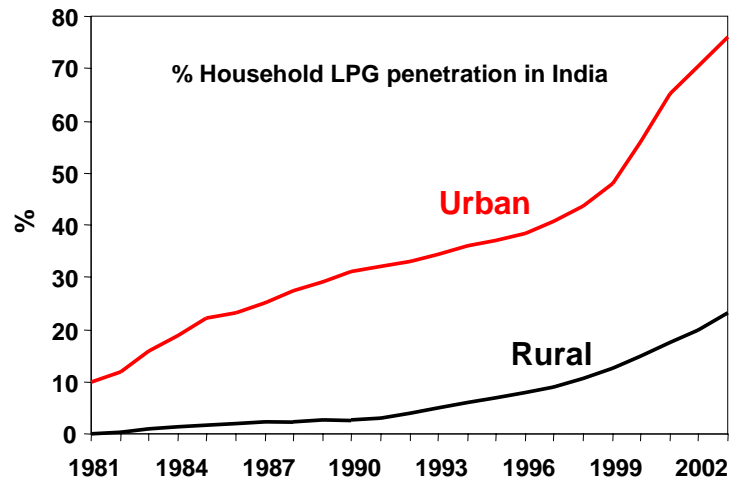
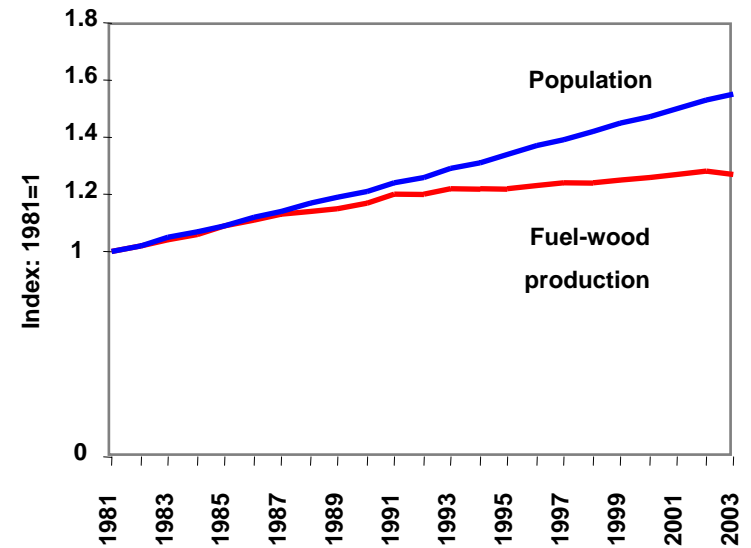
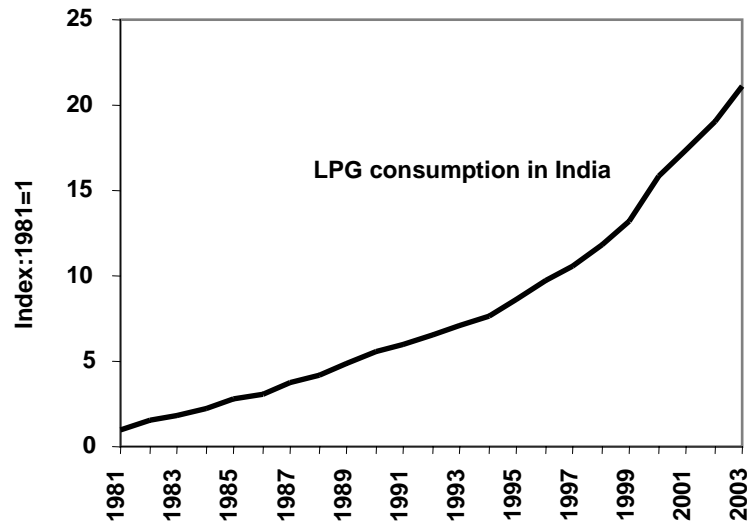
Data Source: CMIE

Transitions

Demand-side Energy

- Efficient Appliances
- Substitutions (e.g. Information for transport)
- Advance Technologies
 - Fuel-cell
 - Hydrogen economy
 - Bio-engineering

Transition in Household Energy in India: Fuel-wood to LPG



Data Sources - Census 2001, NSS 1994, 2000

Environmental Transitions

- Awareness
 - Pressure groups
- Income-effects
 - E.g. Kuznets phenomenon
- Laws and Regulations
 - Global agreements
 - National policies
- Technology
 - Zero-effluent Processes
 - Recycling

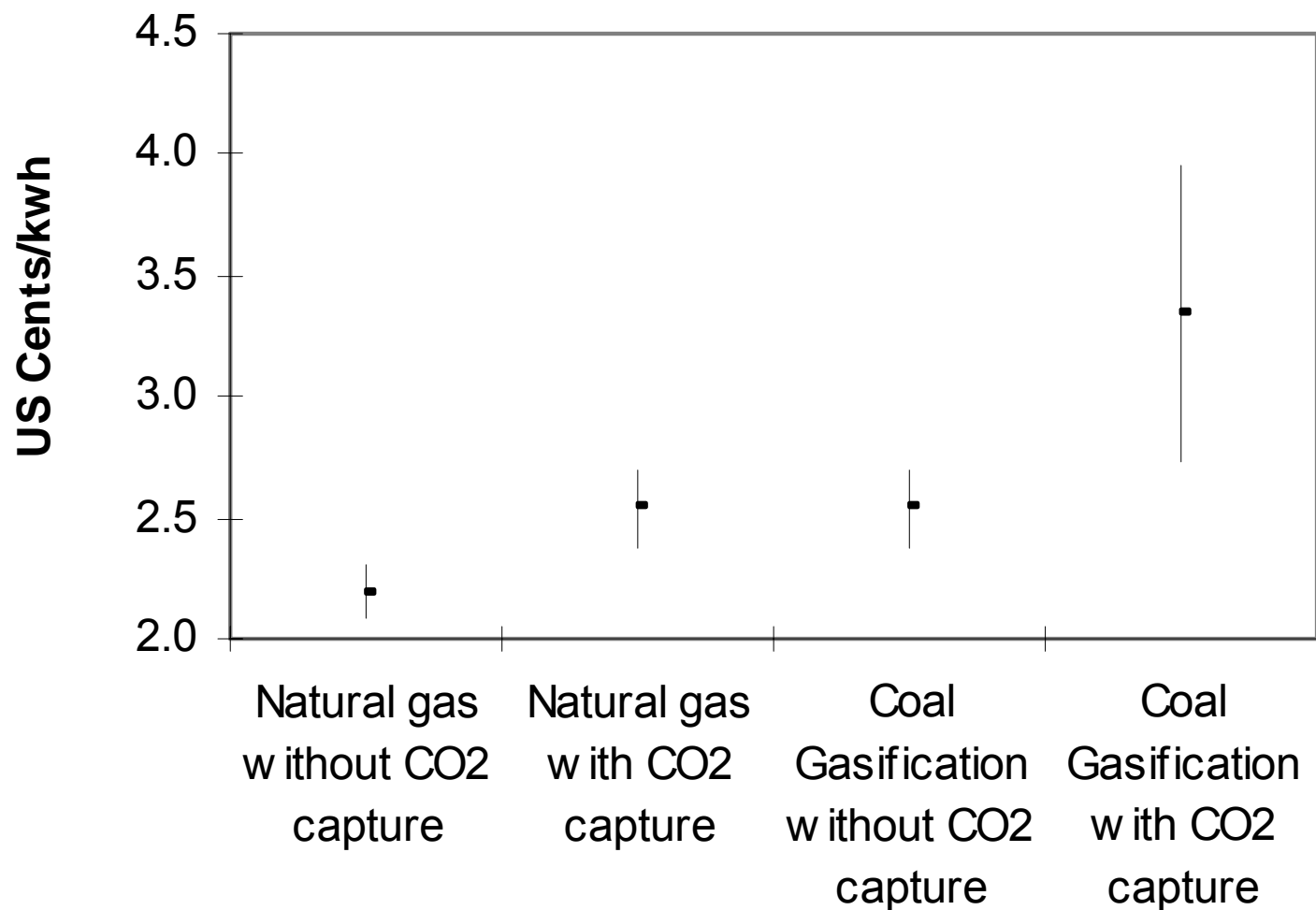
Consumption/Life-style Transitions

- Conservation
 - Substitutions
 - Recycling
- City Planning
- Architecture/ Building Codes
- Changing Preferences
- Income Effects

Backbone Technology Transitions

- Logistics
 - Pipelines
- Electricity T&D
 - Decentralized utilities
- Information
 - Wireless
- Nanotechnology
- New and Renewable Energy
 - Hydrogen

Hydrogen fuel production costs



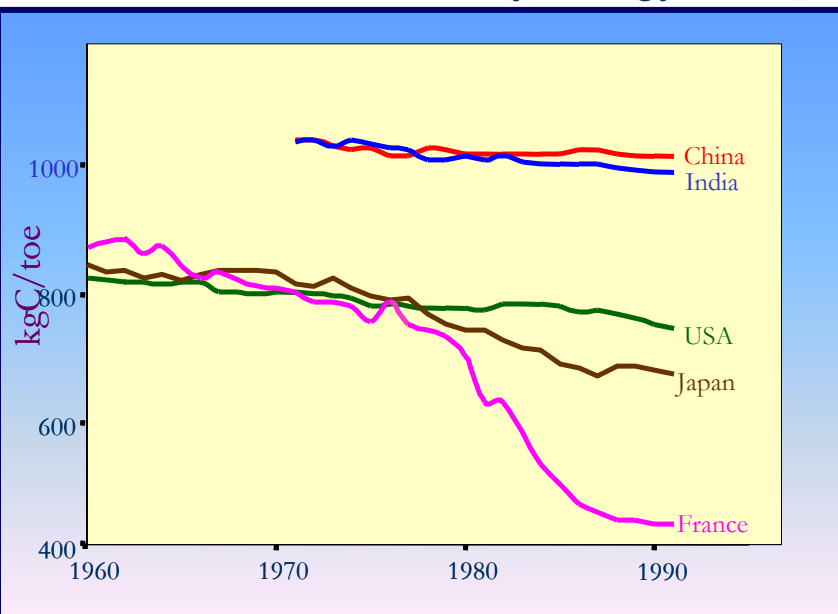
Path Dependence

- Elasticity of long-term paths to short-term influences
- Lock-ins from current technology supply
- SRES Scenarios and Technology paths
- Development policies and path dependence

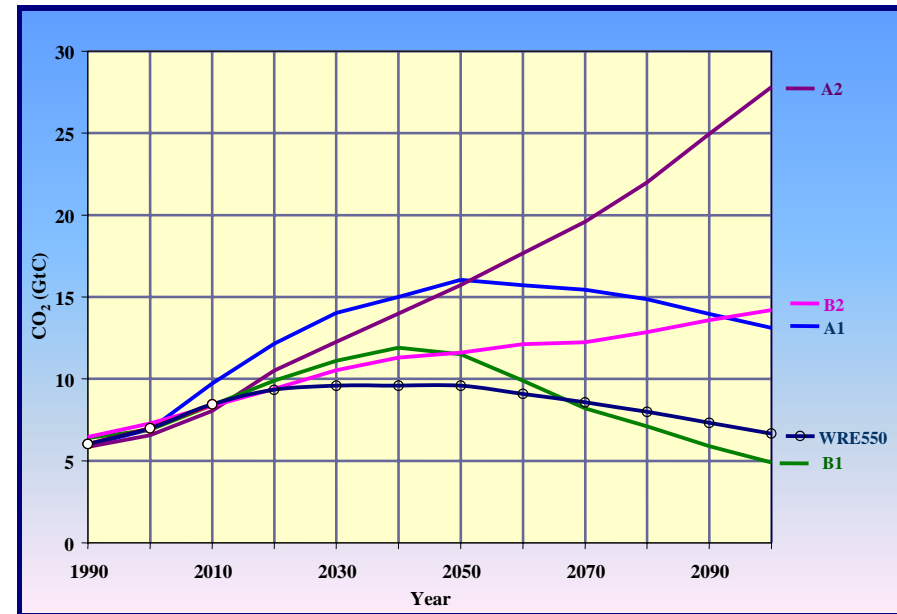
Path Dependence: Lock-ins vs. Innovations

- Elasticity of long-term paths to short-term influences
- Lock-ins from current technology supply
- SRES Scenarios and Technology paths
- Development policies and path dependence

Decarbonization of Primary Energy: History



IPCC SRES Emission Scenarios



Emerging drivers of technological change

International Labor market

- Wage differential
- Income gaps
- Migration

Human Capital

Knowledge flows

- Diasporas and social networks
- Shifting comparative advantage in knowledge services
- Role of local and contextual knowledge

Governance, risks and investment flows

Hazards of Disaggregated Scenarios

- Shifting comparative advantage
- Path dependence
- Hazards of disaggregated scenarios
 - High error
 - Poor benchmark for negotiations

Modeling Developing Country Dynamics (Some illustrations from India)

- Aligning Technology Transitions with Climate Goals
- Conjoint Market for CO₂ and SO₂ Emissions
- Co-benefits from Aligning Energy-Water Markets in South-Asia

Aligning Development and Climate Policies

- Aligning endogenous and induced change
- Co-benefits
- Spillovers

Mainstreaming Climate Change in National Development

Aligning climate policies and actions with:

- *MDGs / National development targets*
- *Agreed goals under extant international agreements*
- *Developing resilience to Vulnerabilities and Adapting to changing Climate Parameters*

MDG, India's National Targets and Climate Change

MDG and global targets	India's National plan targets	Interface with Climate Change
<p>Goal 1: Eradicate extreme poverty and hunger</p> <p>Targets: Halve, between 1990 and 2015, the proportion of people with income below \$1 a day and those who suffer from hunger</p>	<ul style="list-style-type: none"> • Double the per capita income by 2012 • Reduce poverty ratio by 15% by 2012 • Contain population growth to 16.2% between 2001-2011 	<ul style="list-style-type: none"> • Higher income enhances access to services, food, fuel, information, and enhances mitigative and adaptive capacity • Higher climate variability would enhance risks to meet the goal
<p>Goal 7: Ensure environmental sustainability</p> <p>Targets: Integrate SD principles in country policies/ programs to reverse loss of environmental resources</p> <p>Target: Halve by 2015 the proportion of people without sustainable access to safe drinking water</p>	<ul style="list-style-type: none"> • Increase in forest cover to 25% by 2007 and 33% by 2012 (from 23% in 2001) • Sustained access to potable drinking water to all villages by 2007 • Electrify 80,000 additional villages by 2012 via decentralized sources • Cleaning of all major polluted rivers by 2007 and other notified stretches by 2012 	<ul style="list-style-type: none"> • Enhanced sink capacity, reduced GHG and local emissions; lower fossil imports; reduced pressure on land, resources and ecosystems • Higher adaptive capacity to from enhanced supply of water, health & education in rural areas

Bio-energy: Climate and Development Goals

Jatropha Plantation in India



- **Rural Employment: (MDG1)**

Large scale employment potential in Jatropha plantation, seed collection and extraction

- **Farm Income (from waste lands): (MDG1)**

Net income Rs. 12000/Ha/year

- **Energy Security (MDG1&7)**

Imported fossil oil is replaced

- **Environment (MDG7)**

Carbon neutral, Rehabilitates waste land

Oil Extraction Plant

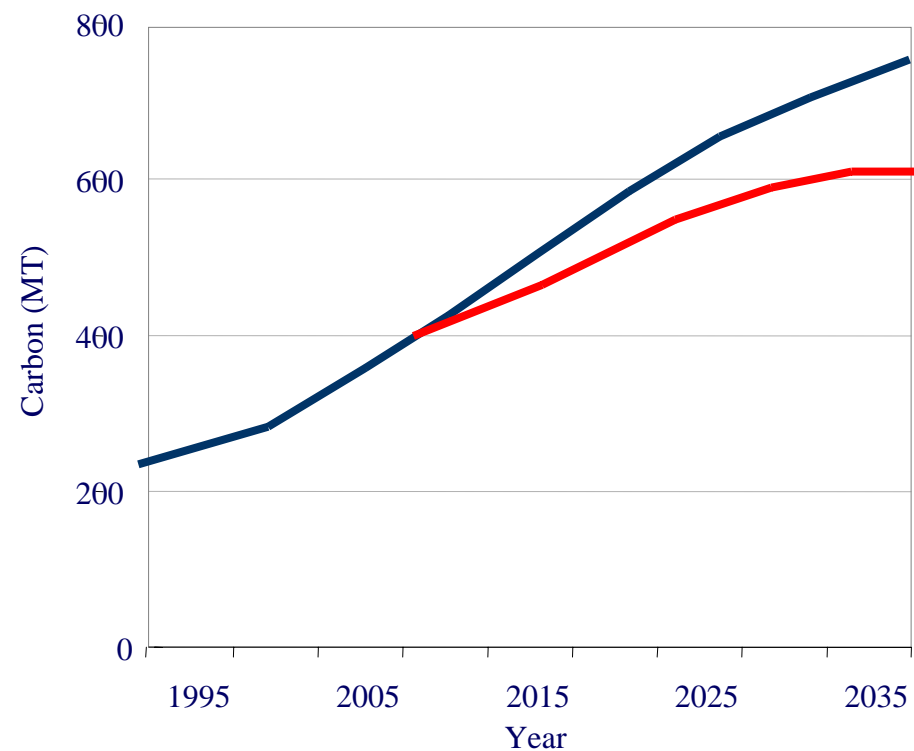


Rural Employment

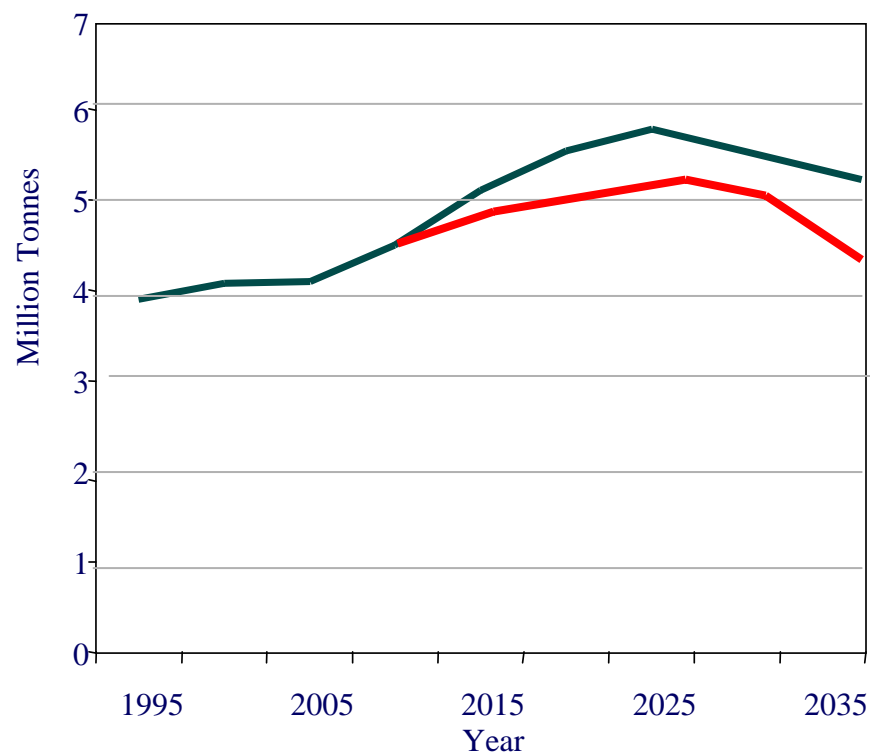


Co-benefits of CO₂ & SO₂ Mitigation: India B2 Scenario

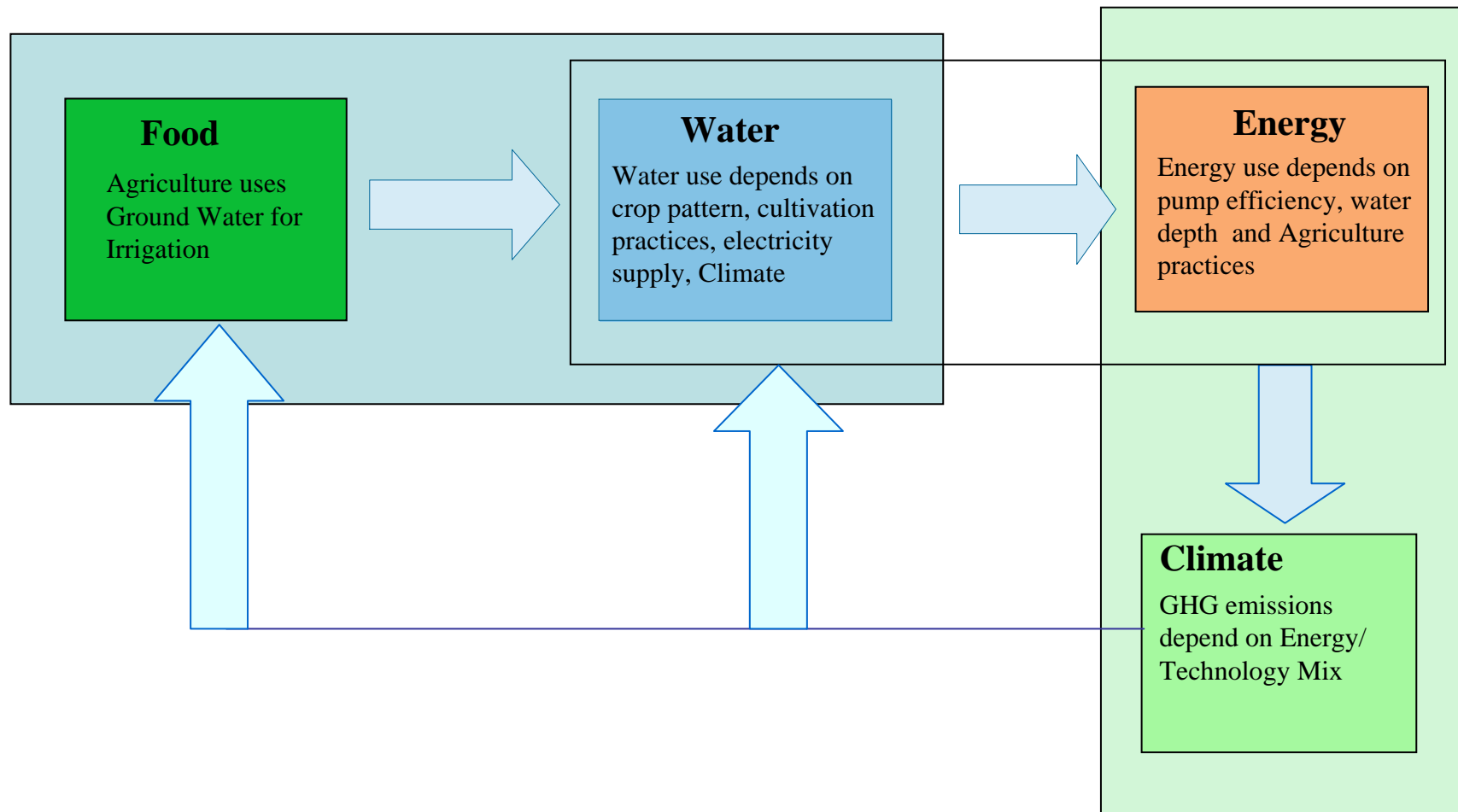
Carbon Emissions



SO₂ Emissions



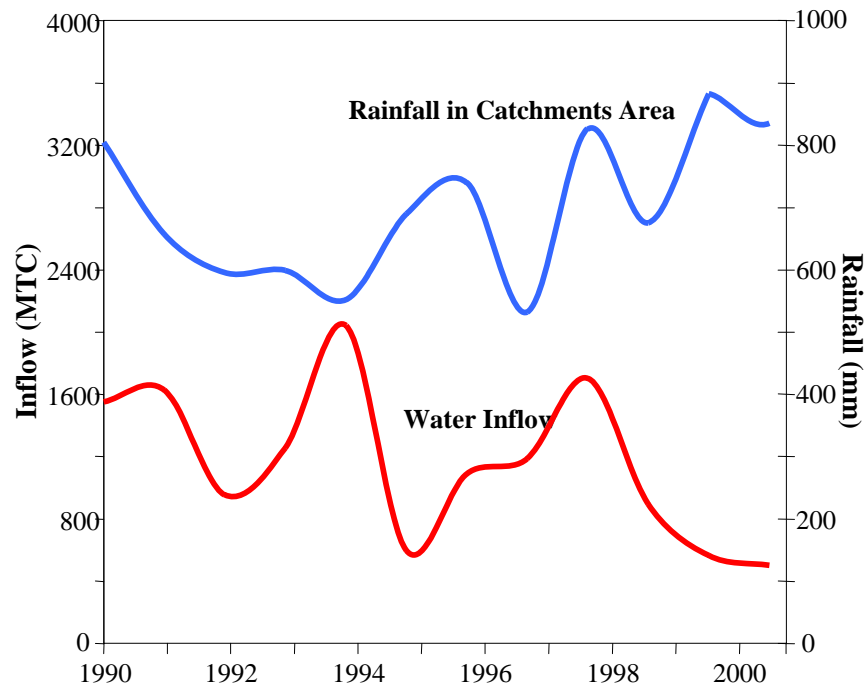
Adaptation Challenge: Food/Water/Energy/Climate



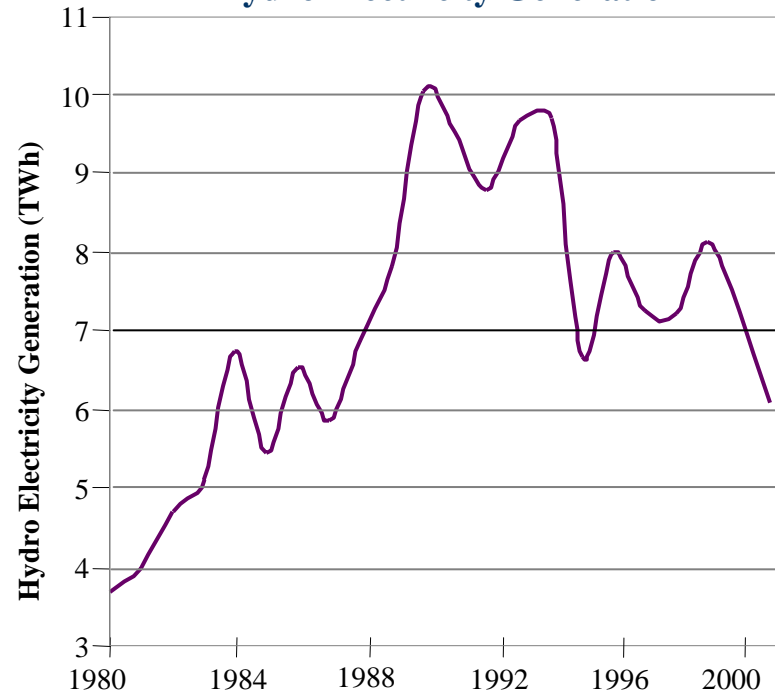
Rainfall, Inflows and Hydro Electricity Generation

State of Andhra Pradesh

Rainfall and Water Inflows



Hydro Electricity Generation



South-Asia Energy-Water Cooperation: Co-benefits

Integrated South-Asia Energy-Water Market



Benefit (Saving) Cumulative from 2010 to 2030		\$ Billion	% GDP
Energy	60 Exa Joule	321	0.87
CO ₂ Equiv.	5.1 Billion Ton	28	0.08
SO ₂	50 Million Ton	10	0.03
Total		359	0.98

Spill-over Benefits / Co-Benefits

- More Water for Food Production (MDG1)
- 16 GW additional Hydropower (MDG1&7)
- Flood control (MDG1&7)
- Lower energy prices would enhance competitiveness of regional industries (MDG1)

Modeling Climate Stabilization Induced Development Paths

Stabilization induced technological change

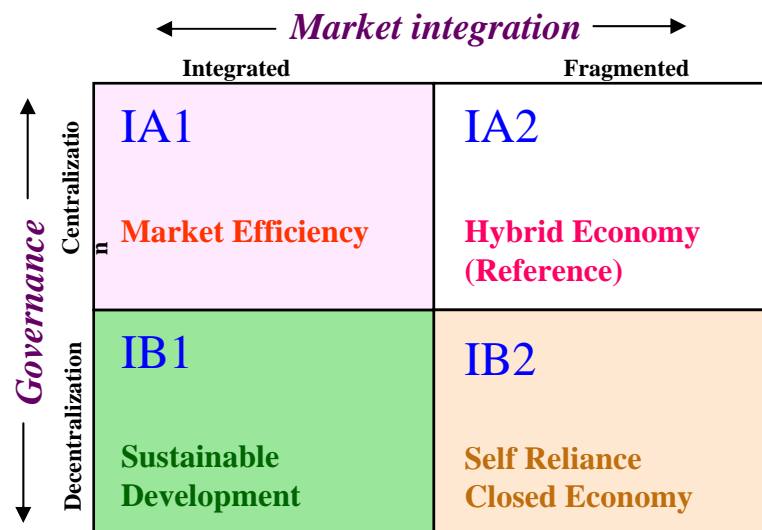
- Depends on the underlying endogenous development path
- Stabilization would induce significant technological change
- How to represent future technologies in models?
- Architecture of climate regime is the key driver

Addressing Questions from Negotiators

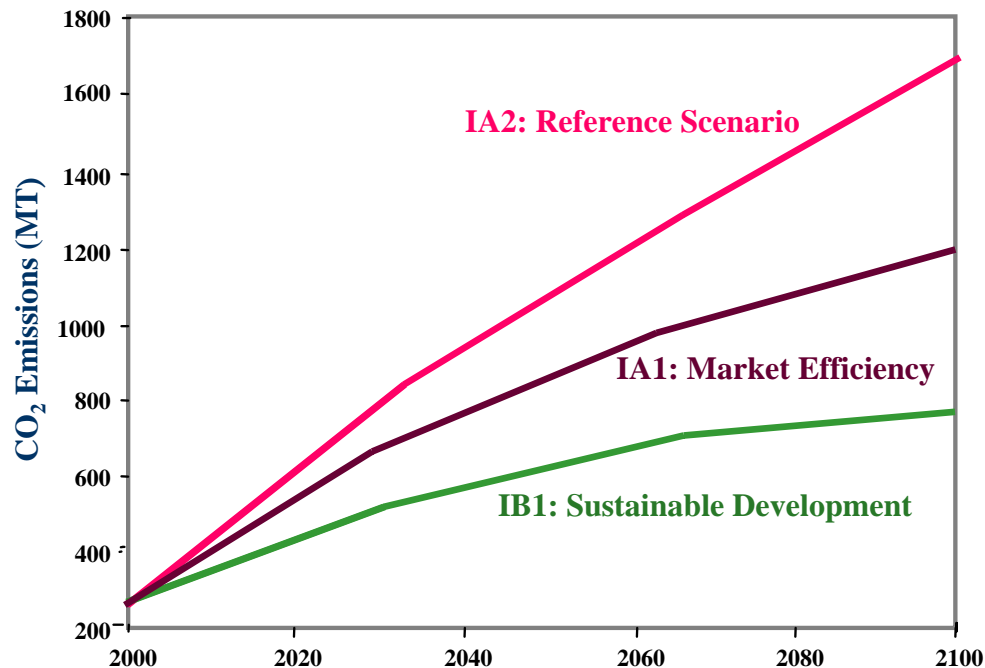
- Allocations of Emissions Rights
- Taxes and Revenue Recycling
- Who pays?
- Technology protocols

Indian Carbon Emissions Scenarios

Indian Emissions Scenarios



Carbon Emissions

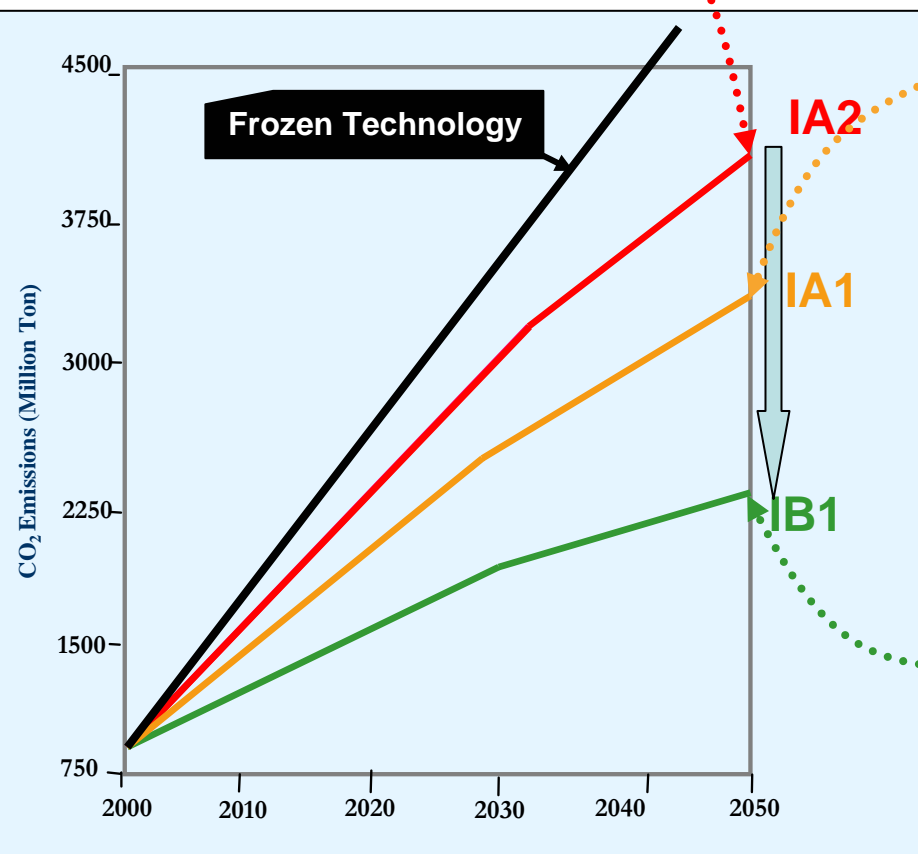


India's Total Carbon Emission in 21st Century (Billion Ton CO₂)

Reference (IA2) Scenario	: 363
Market Efficiency (IA1) Scenario	: 286 (79% of IA2)
Sustainable Development (IB1) Scenario	: 198 (55% of IA2)

Technologies in Low Carbon Scenarios: Medium-Term (2050)

Conventional Technology Path: Includes significant endogenous technological change



Globalization/Market Efficiency Scenario

Synfuels, Next-Gen Nuclear (Thorium)

Fuel cell vehicles, Pipeline networks

Energy efficient appliances/ infrastructure

Coal liquid, IGCC, Hydrogen from gas

Advanced materials, Nanotechnology

Sustainable Development Scenario

Push for renewable energy & recycling

Advanced car pooling, Shared assets

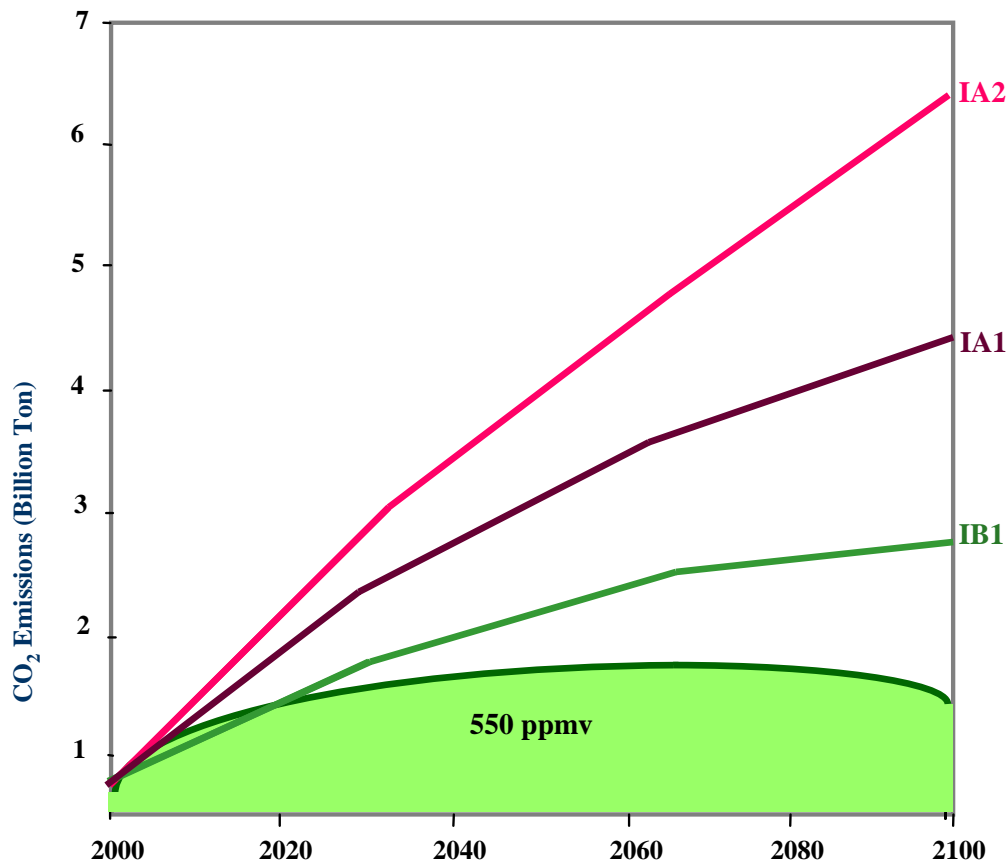
High speed trains, Swap of transport by IT

Dematerialization, Community institutions

Sustainable habitats, Reforestation

Indian Emission Scenarios and Stabilization

Carbon Emissions for Indian Scenarios



India's Total Carbon Emission in 21st Century

(Billion Ton CO₂)

Reference (IA2) Scenario	: 363
Market Efficiency (IA1) Scenario	: 286 (79% of IA2)
Sustainable Development (IB1) Scenario	: 198 (55% of IA2)
<u>550 PPMV Cost-effective Regime</u>	<u>: 140 (39% IA2)</u>

Scenarios

- Developing **realistic and consistent scenarios** for developing countries within each global storyline (e.g. transitions, lock-ins, PPP)
- Linking level of **geographic disaggregation** with **objectives of analysis**
- Mainstreaming climate actions with development actions through **endogenous representations/drivers**

Modeling

- **Multi-purpose soft-linked** modeling tools versus **hard-linked single model**
- Consistent and purposive linking of **global and national databases**
- Extending modeling capacities to incorporate **emerging drivers and policy questions**

Policy Analysis

- Aligning **short-term actions with long-term** vision and objectives
- Linking **global and national policy** analysis
- Using market and non-market policies to gain **co-benefits**

Thank you