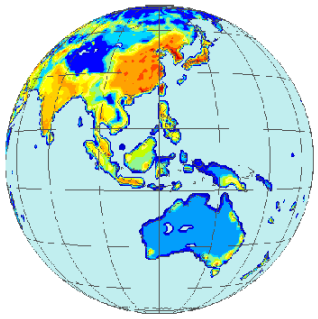
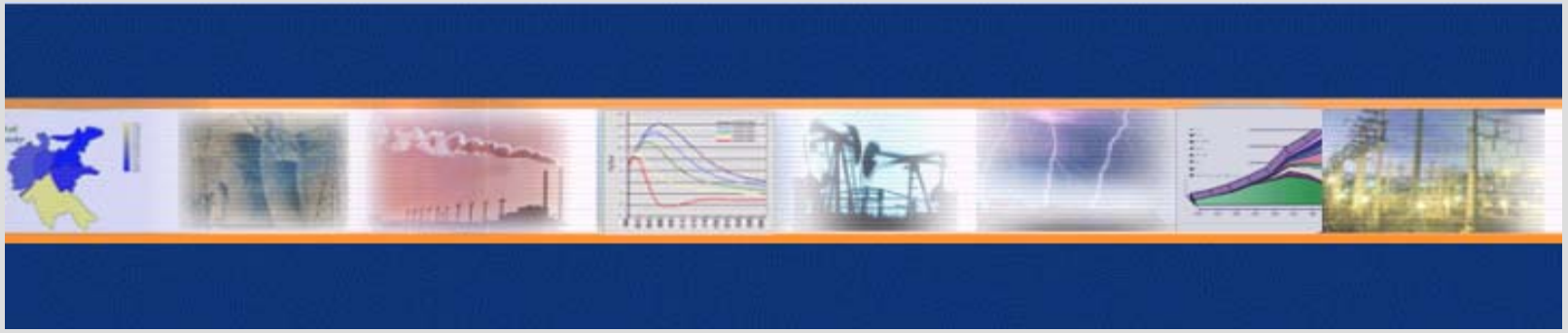


CSD-15 Learning Centre Course
30 April 2007, UN Headquarters, New York

How to align actions to address climate change with national sustainable development goals?



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

Agenda

- **Developing Country Dynamics**
  - Scenarios: Transitions of Goals, Institutions, Demographics, Incomes, Preferences
  - Modeling: Co-benefits, Lock-ins, Endogenous and exogenous environment
  - Policy analysis: Balancing Equity, Efficiency and Sustainability
- **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**
- **Modeling Transition to Low Carbon Future through Sustainable Development**
- **Conclusions**

Developing Country Dynamics

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

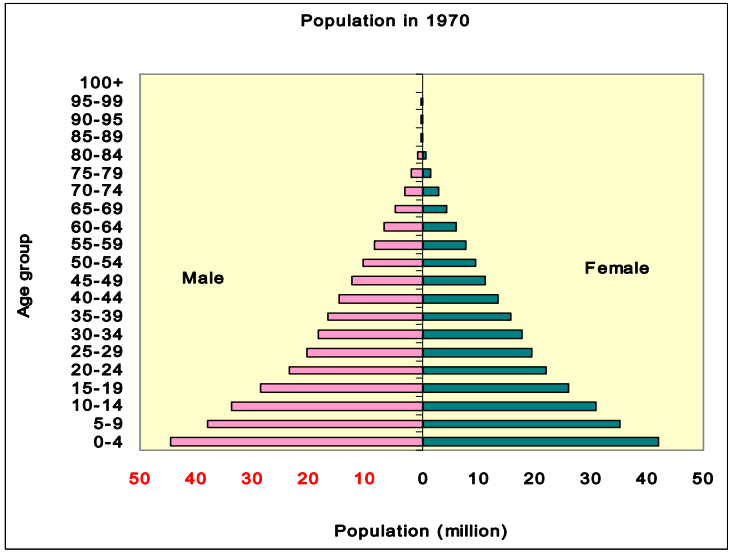
Understanding development

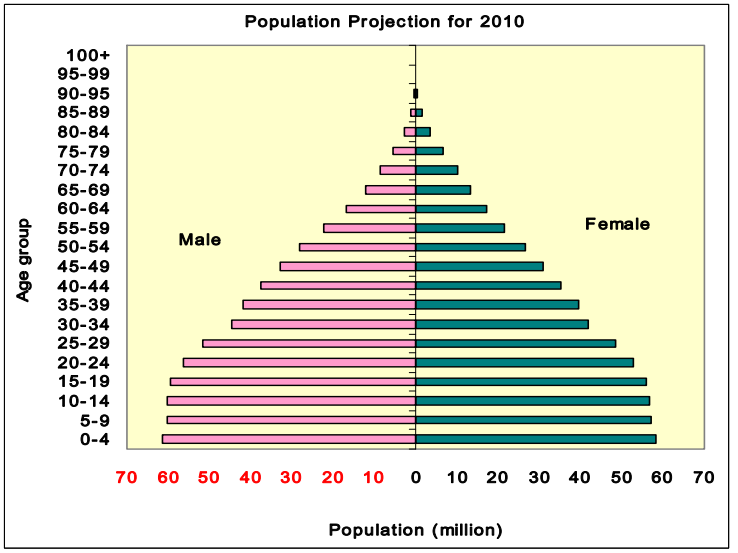
- Dual Economy
- Multiple Transitions
- Informal Activities
- Subsistence Production
- Market Performance and Disequilibria
- Non-commercial Fuels
- Non-economic Concerns
- Policy Distortions

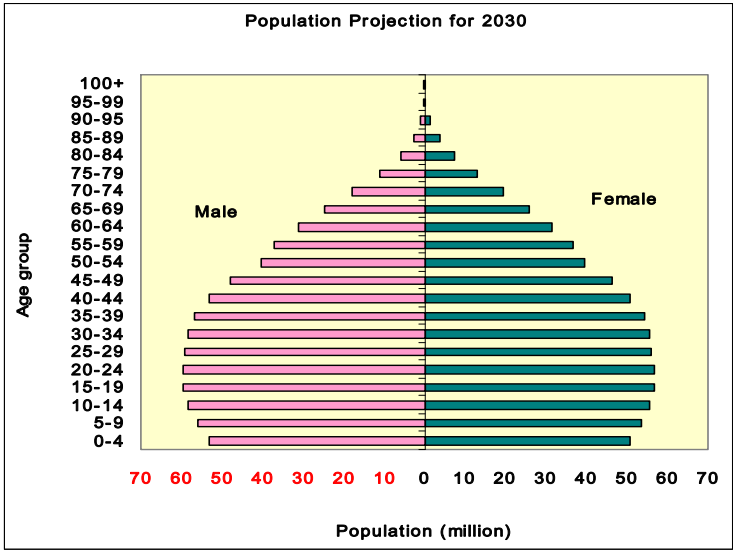
Transitions
Socio-Economic

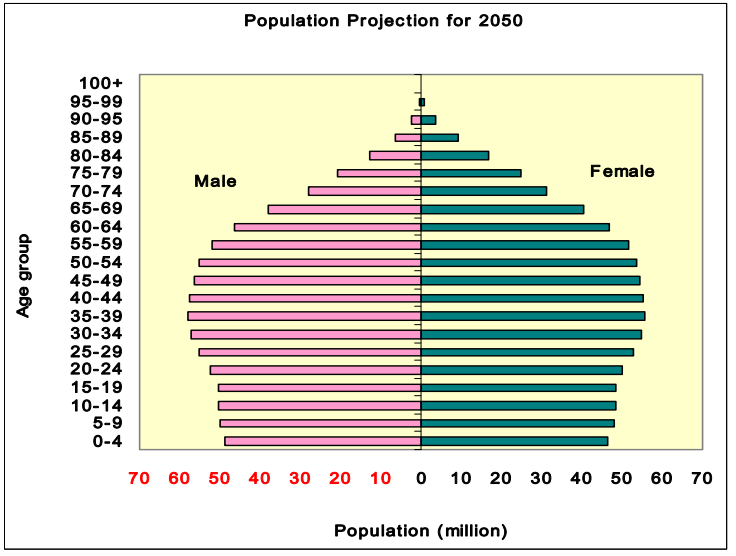
- Demographic
  - Population
  - Urban / Rural
  - Gender ratio
  - Migration
- Development
  - Soft indicators: Income, Equity, Literacy, Health
  - Hard indicators: Infrastructure, Housing, Vehicles, Appliances
- Political
  - Institutions
  - Laws
  - Policies

Demographic Transitions in India: Age/Gender Profile

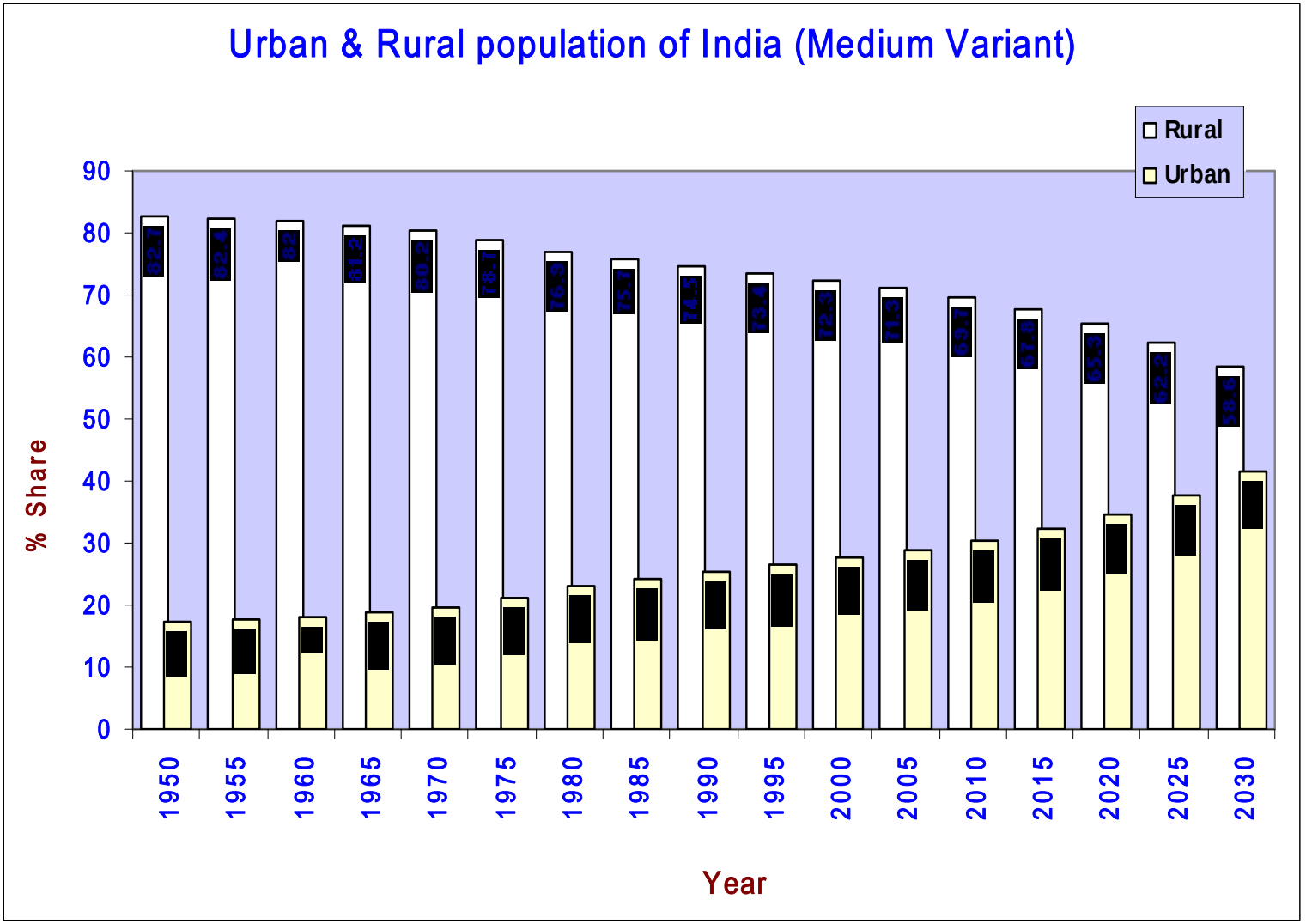




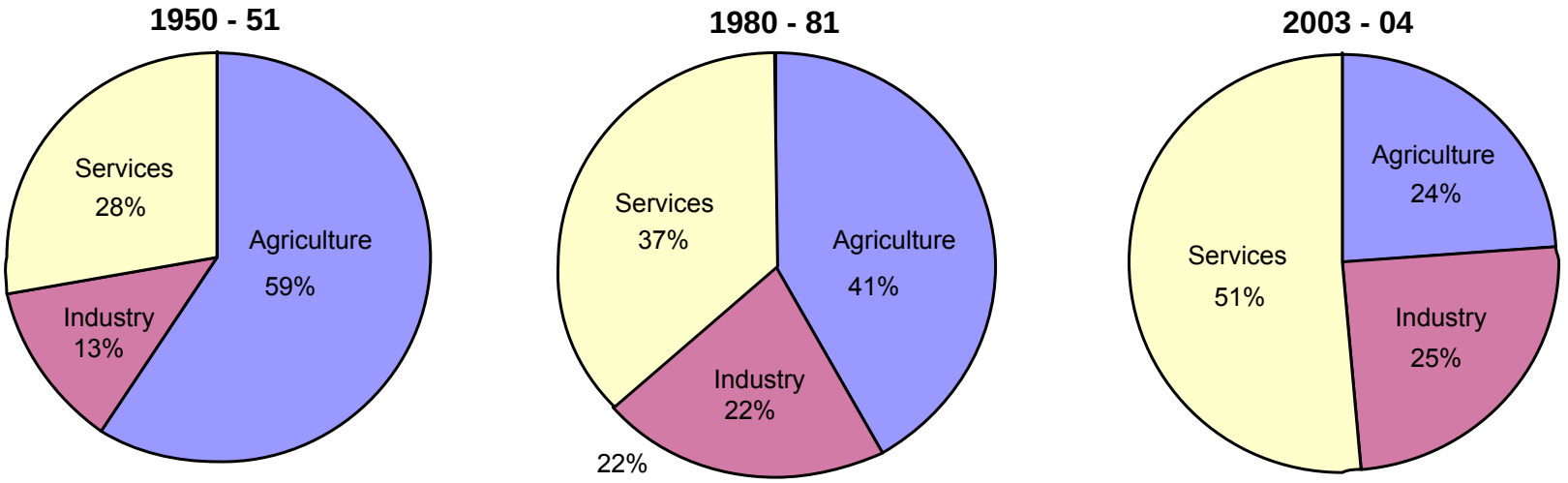




Demographic Transitions in India: Urban/Rural



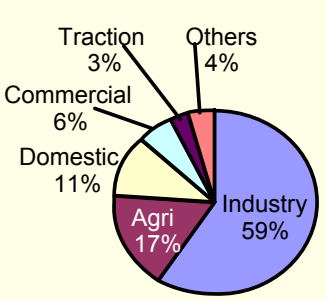
Composition of India's GDP by Sector



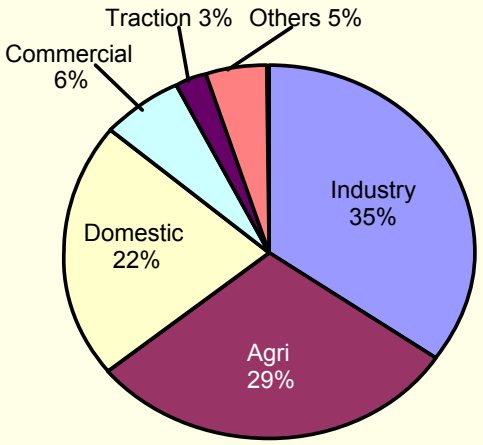
Data Source: CMIE and Economic Surveys of India

Shift in electricity demand and generation

Demand

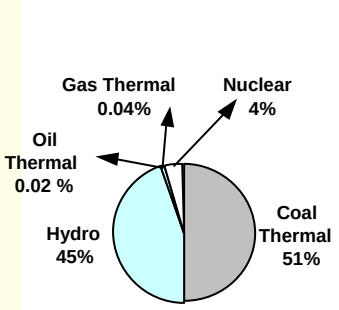


1980
78 TWH

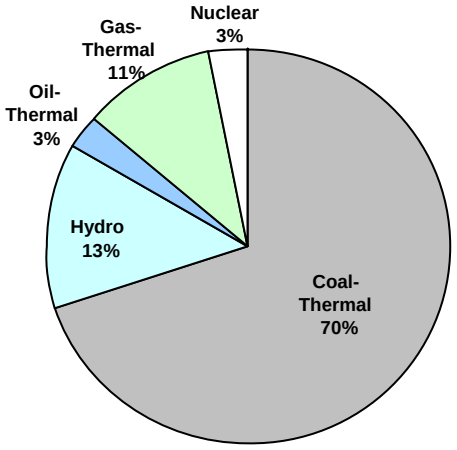


2000
313 TWH

Generation

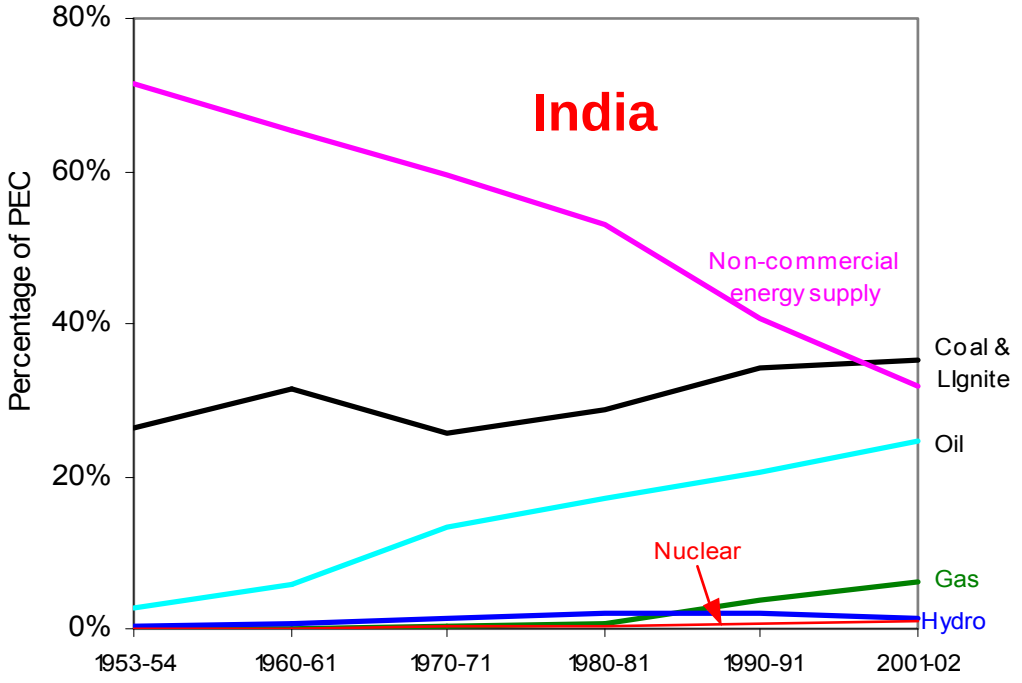


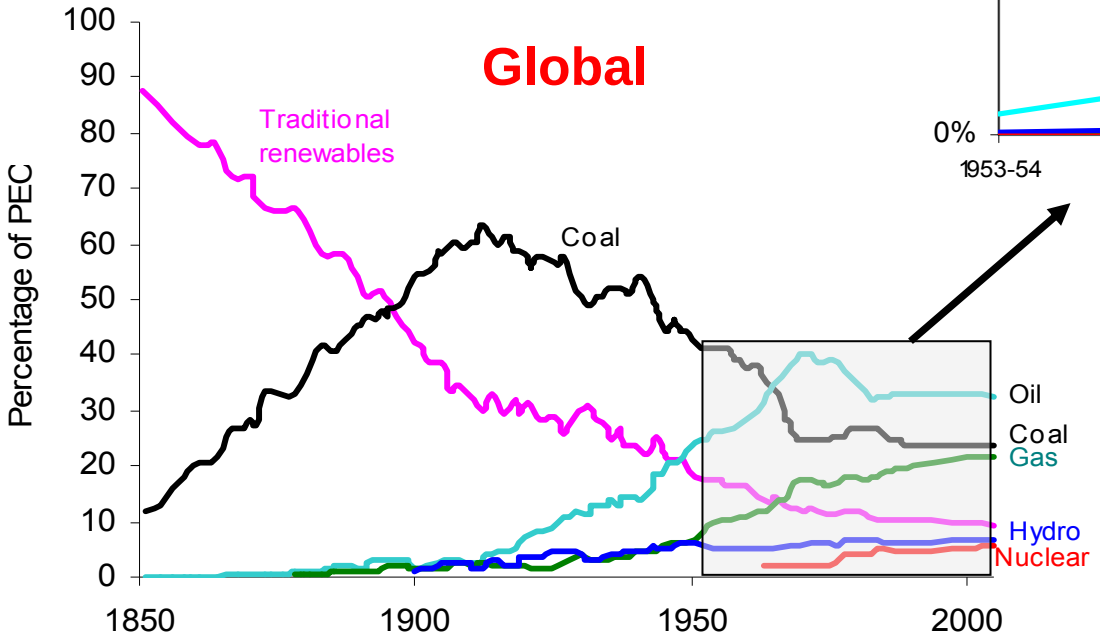
1971
61 TWH



2001
558 TWH

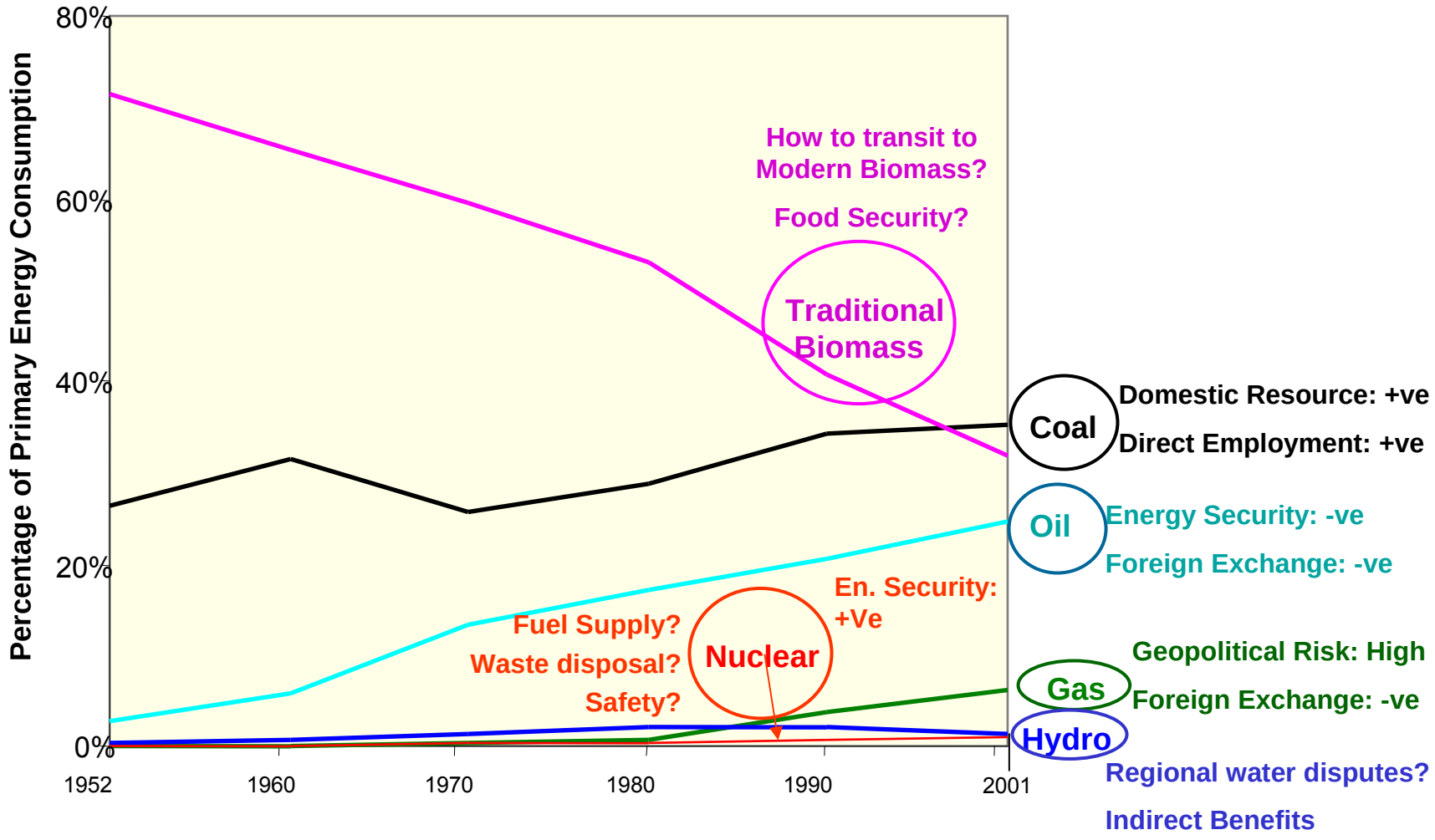
Past Energy transitions: Global & India





How to align climate change actions with national sustainable development goals?

Changing Structure of Energy Use

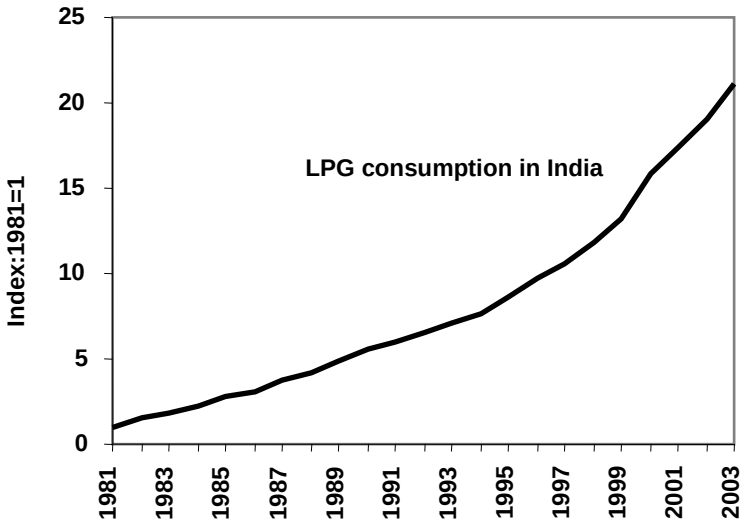


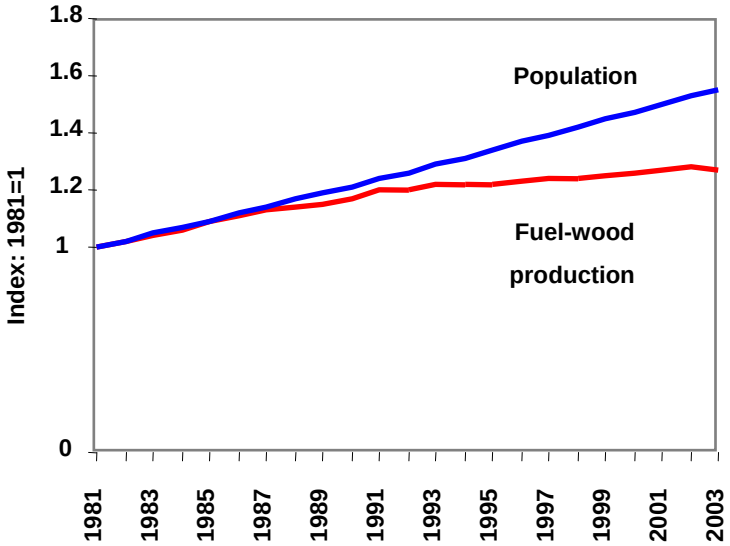
How to align climate change actions with national sustainable development goals?

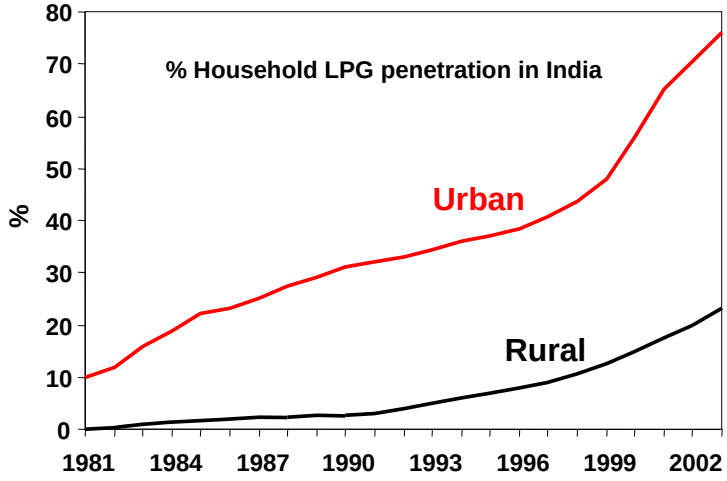
Transitions
Demand-side Opportunities

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

Transition in Household Energy Use 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

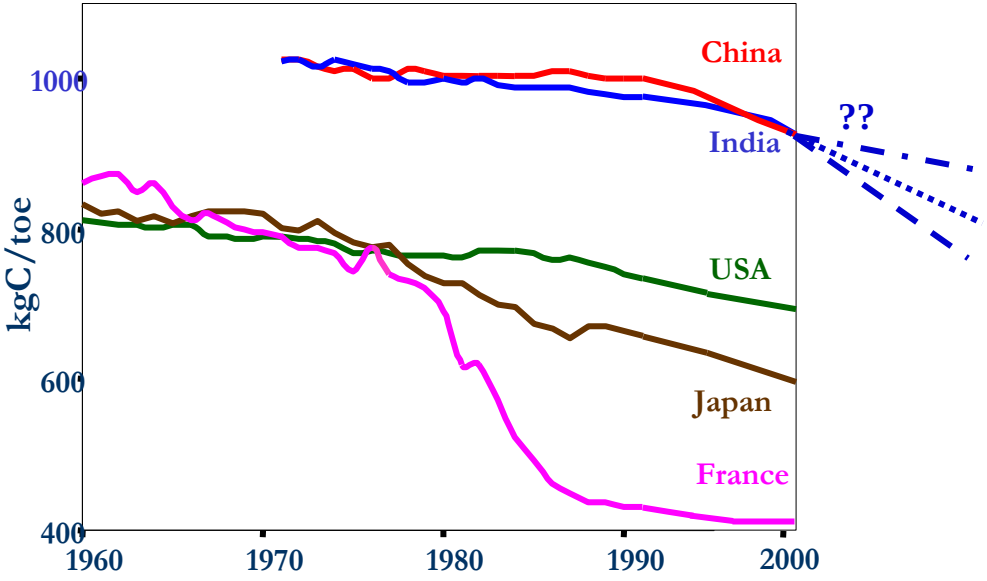
Backbone Technology Transitions

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

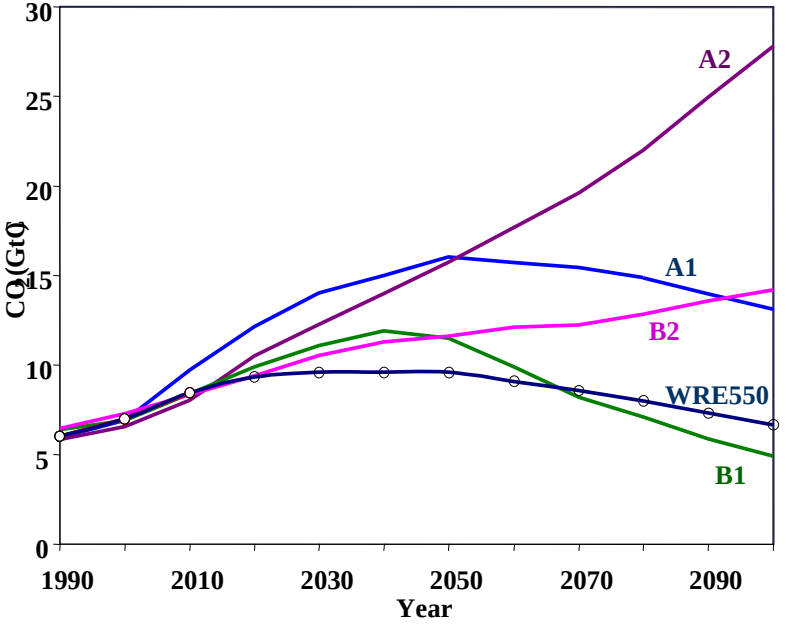
Path Dependence: Lock-ins vs. Innovations

- 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



How to align climate change actions with national sustainable development goals?

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

Modeling Developing Country Dynamics (Some illustrations from India)

- Aligning Technology Transitions with Climate Goals
- Conjoint Market for CO_2 and SO_2 Emissions
- Co-benefits from Aligning Energy-Water Markets in South-Asia

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
Goal 1: Eradicate extreme poverty and hunger Targets: Halve, between 1990 and 2015, the proportion of people with income below $1 a day and those who suffer from hunger	• Double the per capita income by 2012 • Reduce poverty ratio by 15% by 2012 • Contain population growth to 16.2% between 2001-2011	• Higher income enhances access to services, food, fuel, information, an enhances mitigative and adaptive capacity • Higher climate variability would enhance risks to meet the goal
Goal 7: Ensure environmental sustainability Targets: Integrate SD principles in country policies/ programs to reverse loss of environmental resources Target: Halve by 2015 the proportion of people without sustainable access to safe drinking water	• 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	• 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

How to align climate change actions with national sustainable development goals?

Bio-energy: Climate and Development Goals

Jatropha Plantation in India

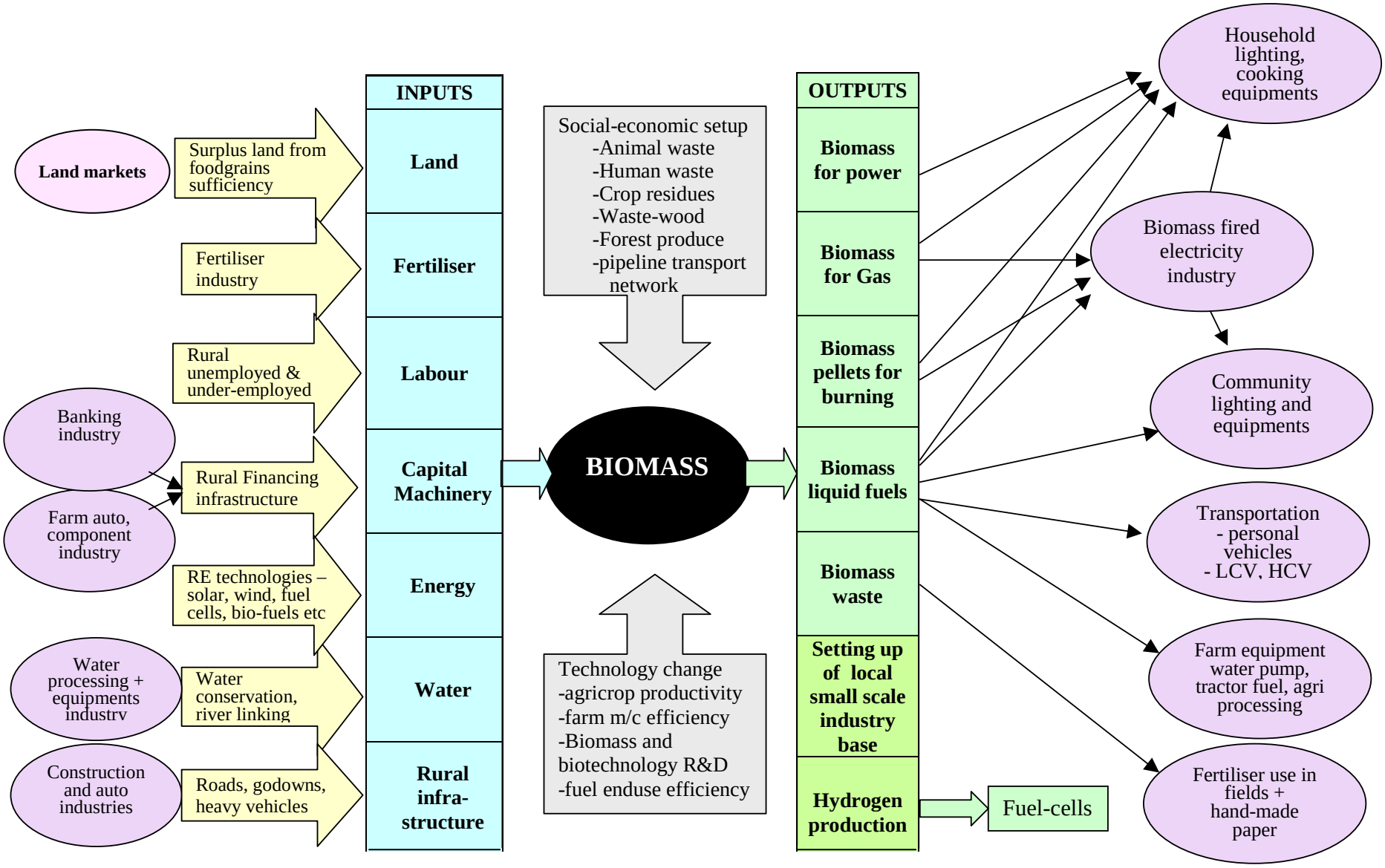
- **Rural Employment: (MDG1)**
  Large scale employment potential in Jatropha plantation, seed collection and extraction
- **Farm Income (from waste lands): (MDG1)**
  Net income Rs. 12000/Ha/year
- **Energy Security (MDG1&7)**
  Imported fossil oil is replaced
- **Environment (MDG7)**
  Carbon neutral, Rehabilitates waste land

Oil Extraction Plant

Rural Employment

How to align climate change actions with national sustainable development goals?

Network for Biomass Technology/Fuel Deployment



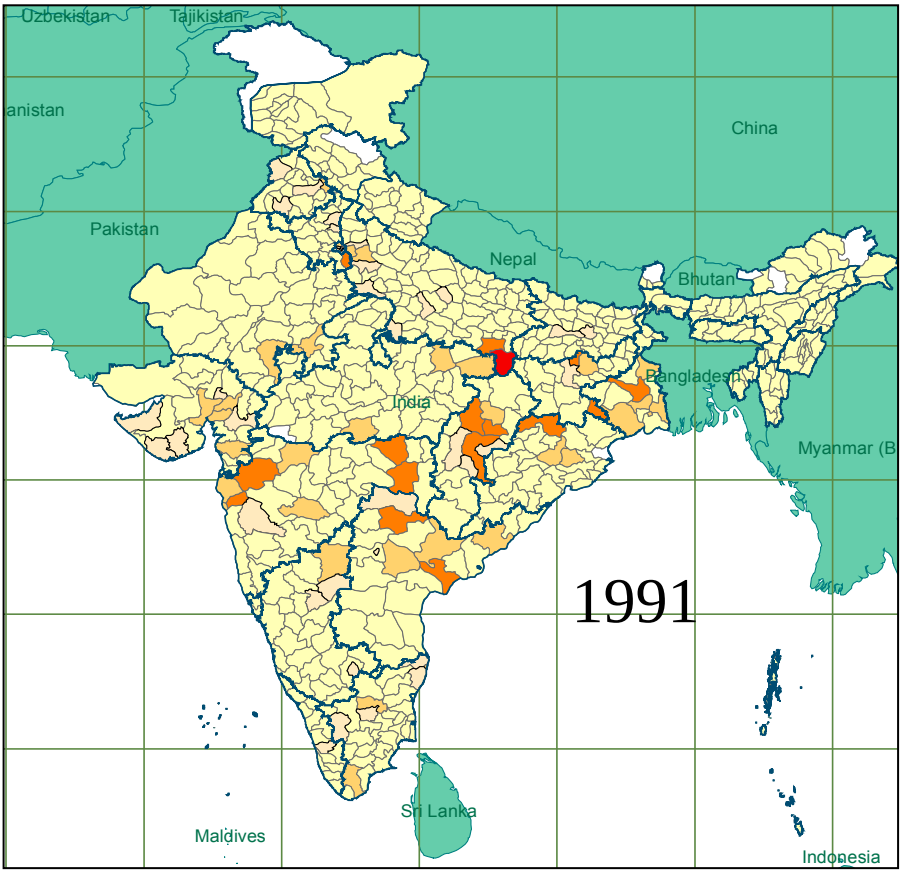
How to align climate change actions with national sustainable development goals?

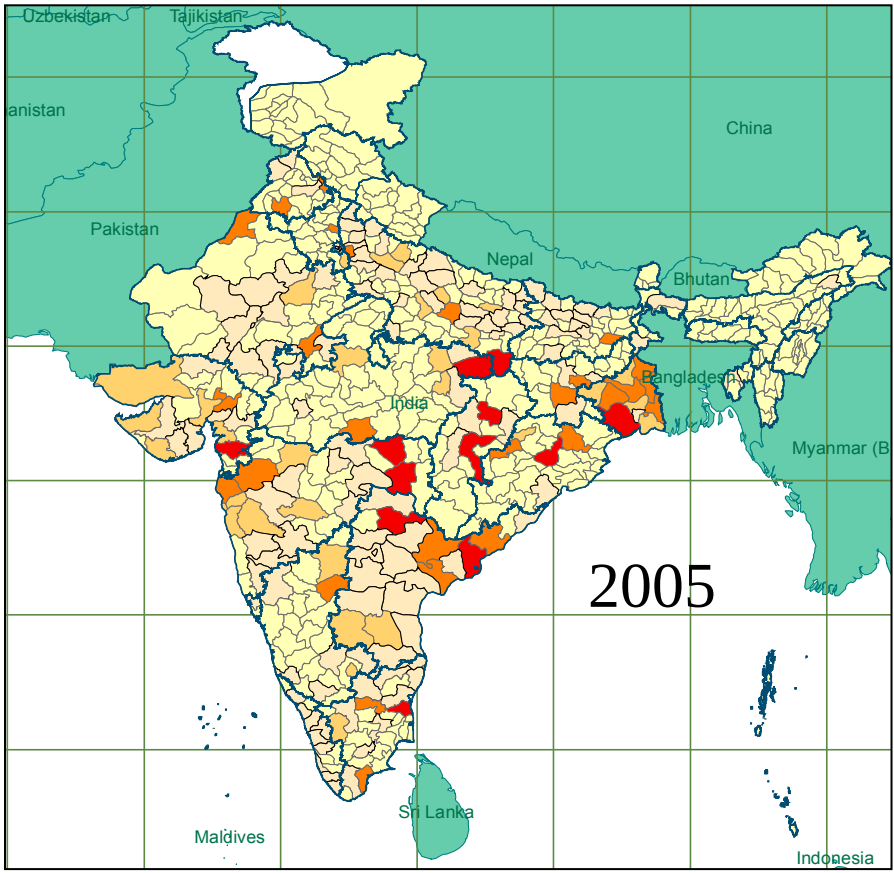
Conjoint Market for CO_2 and SO_2 Emissions

MDG 7: Environmental Sustainability

How to align climate change actions with national sustainable development goals?

District-wise CO2 Emissions



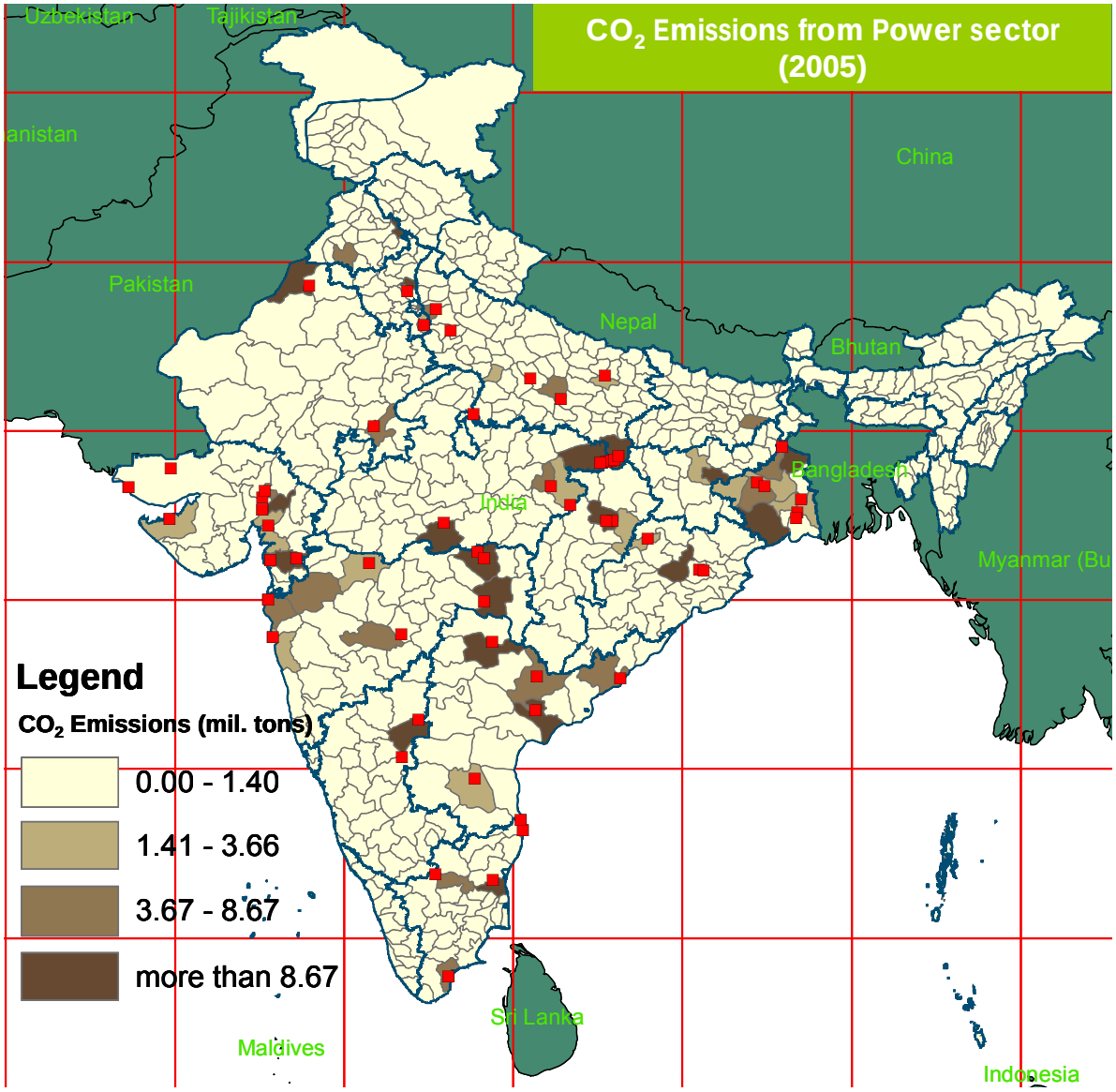


Million ton

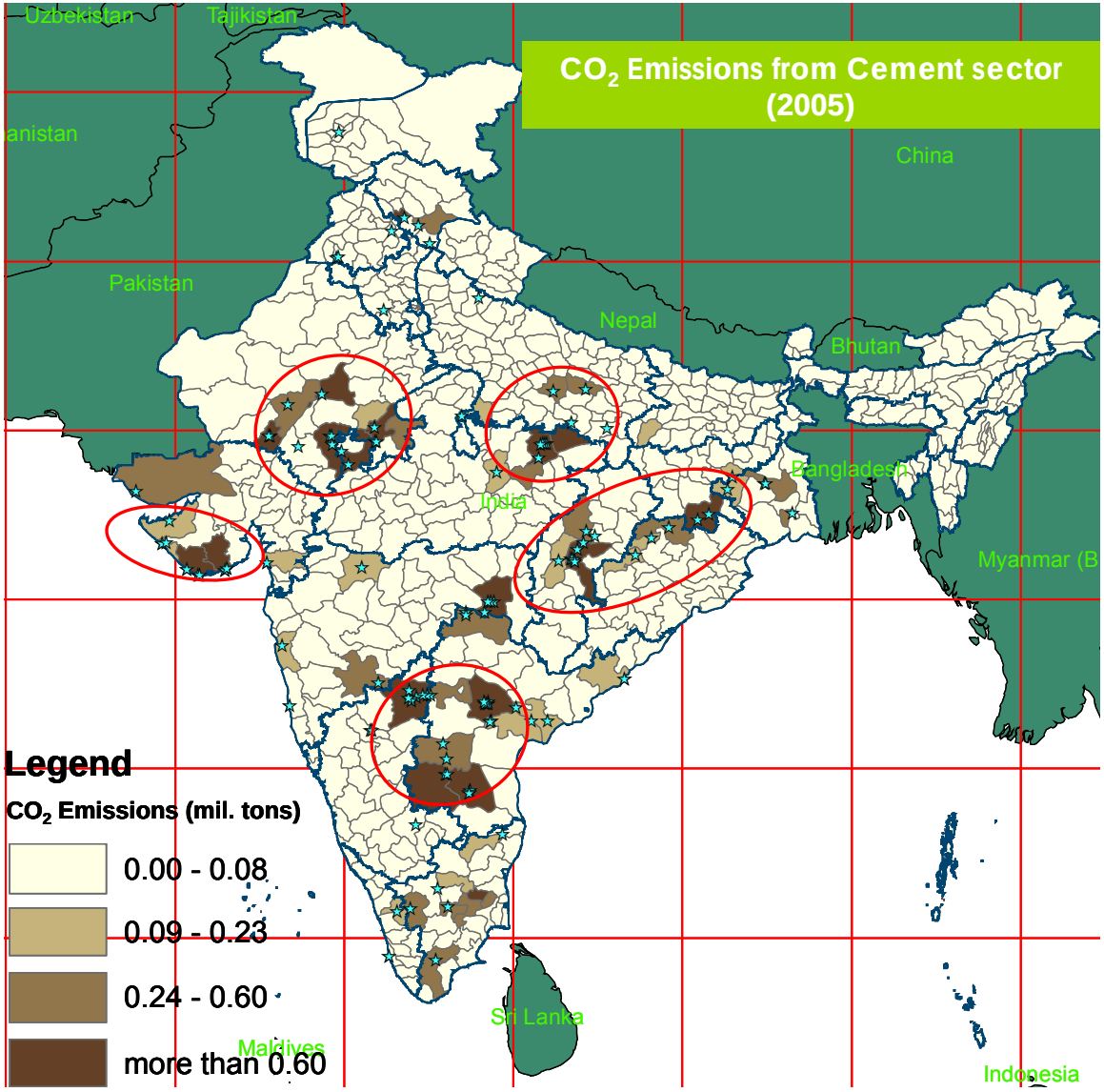
	< 0
	0.01 - 1.50
	1.51 - 3.00
	3.01 - 7.00
	7.01 - 15.00
	15.01 - 39.29

How to align climate change actions with national sustainable development goals?

CO2 emission from Power Sector (2005)

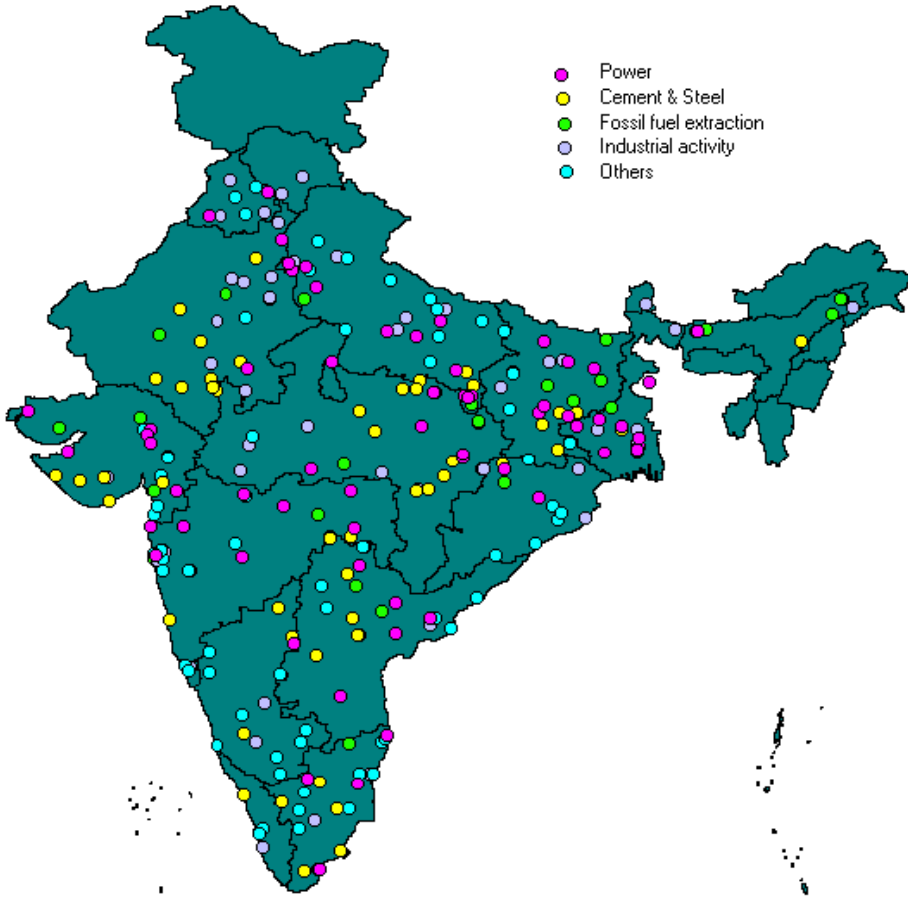


CO2 emission from Cement Sector (2005)

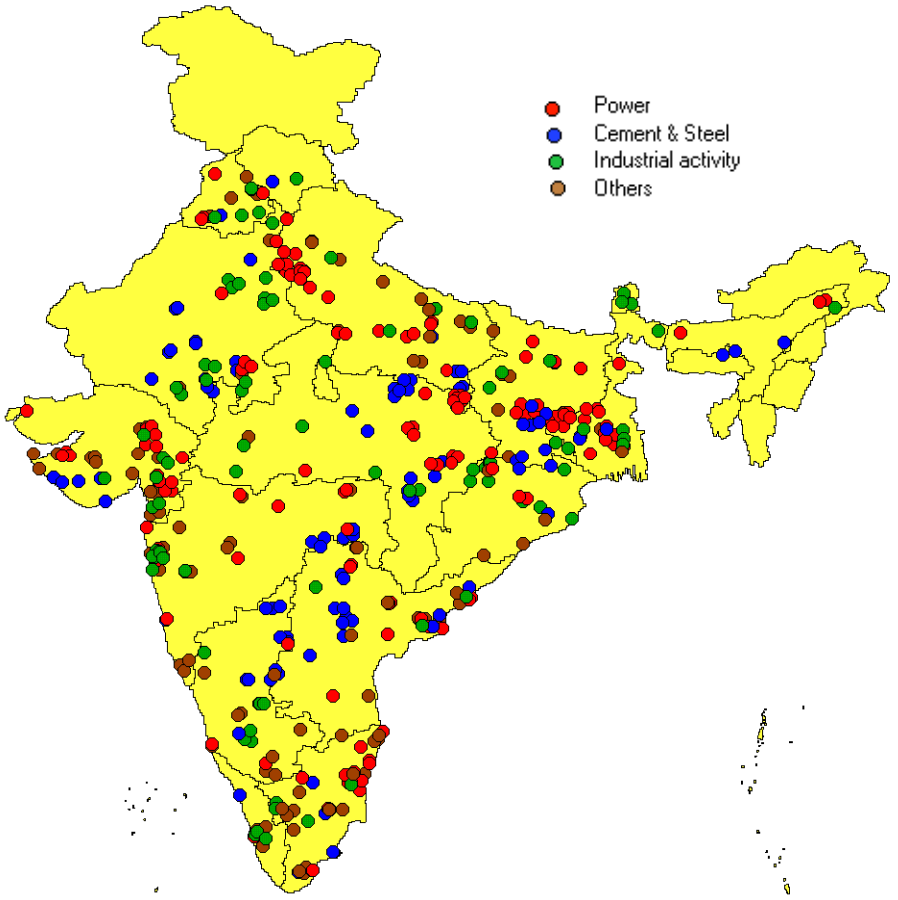


LPS Locations

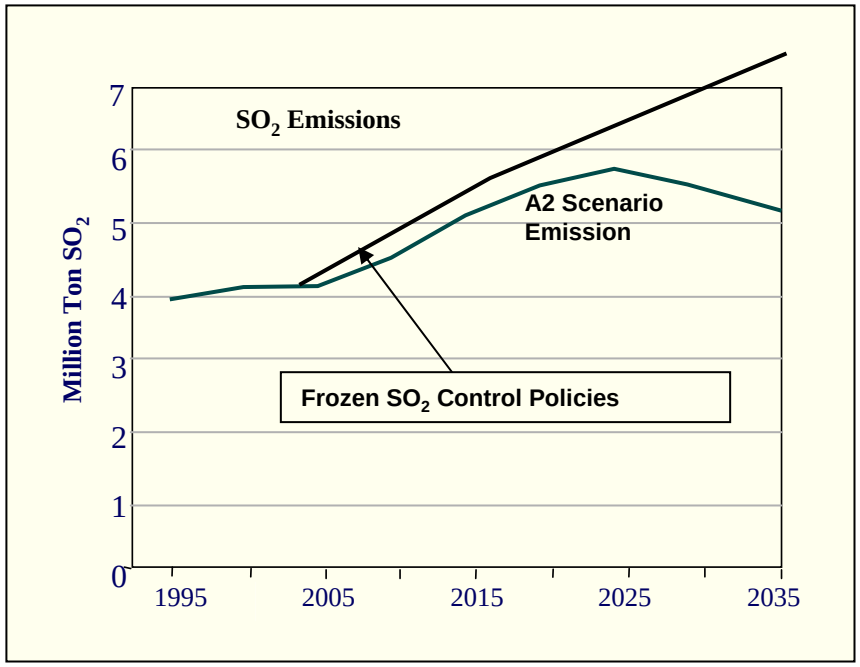
Year: 2000

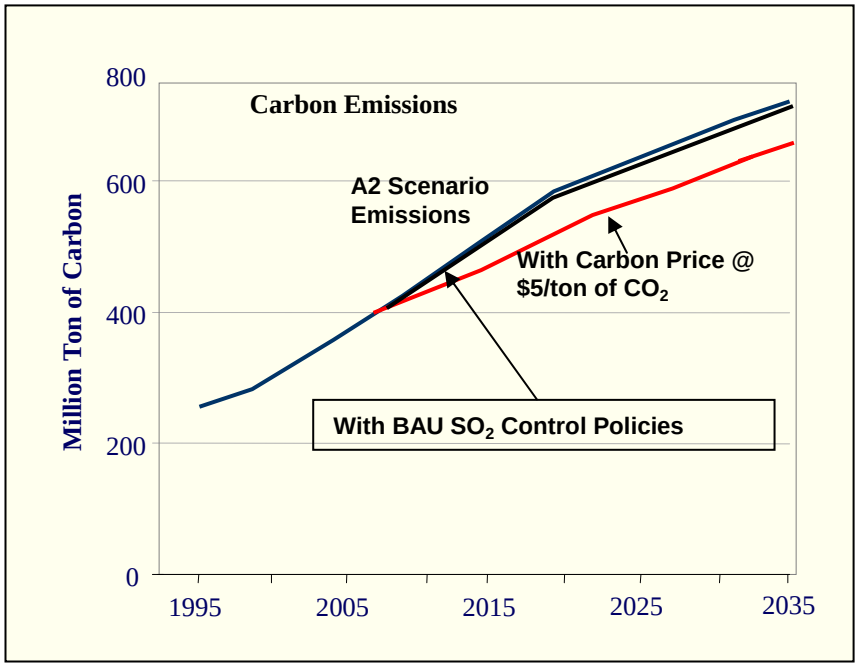


Year: 2030



Co-Benefits: Joint SO2 and CO2 Mitigation





Joint Mitigation (Period 2005-2030)

Mitigation Regime	Co-benefits
SO_2 mitigation alone	Little carbon mitigation
Joint Mitigation: CO_2 mitigation @ $5/ton & same SO_2 target	Joint mitigation costs $400 Million less

How to align climate change actions with national sustainable development goals?

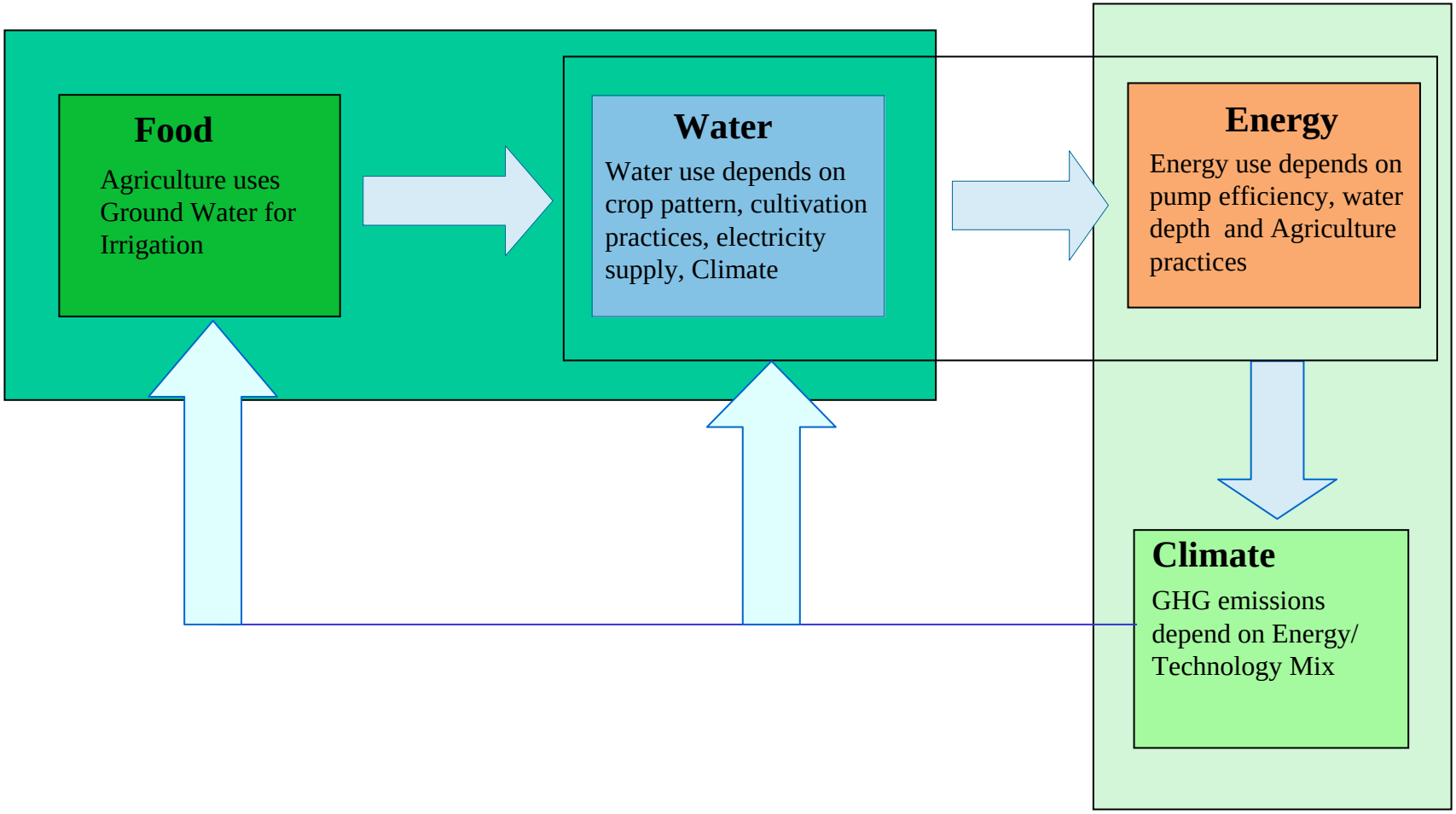
Co-benefits from Aligning Energy-Water Markets in South-Asia

MDG 1: Eradicate extreme poverty and hunger

MDG 7: Environmental Sustainability

How to align climate change actions with national sustainable development goals?

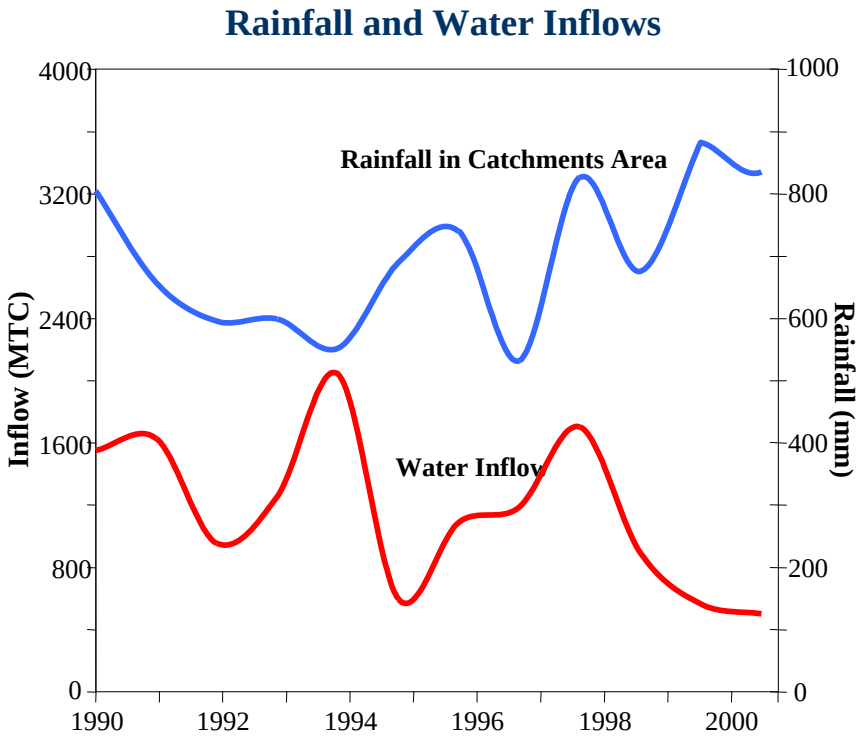
Adaptation Challenge: Food/Water/Energy/Climate

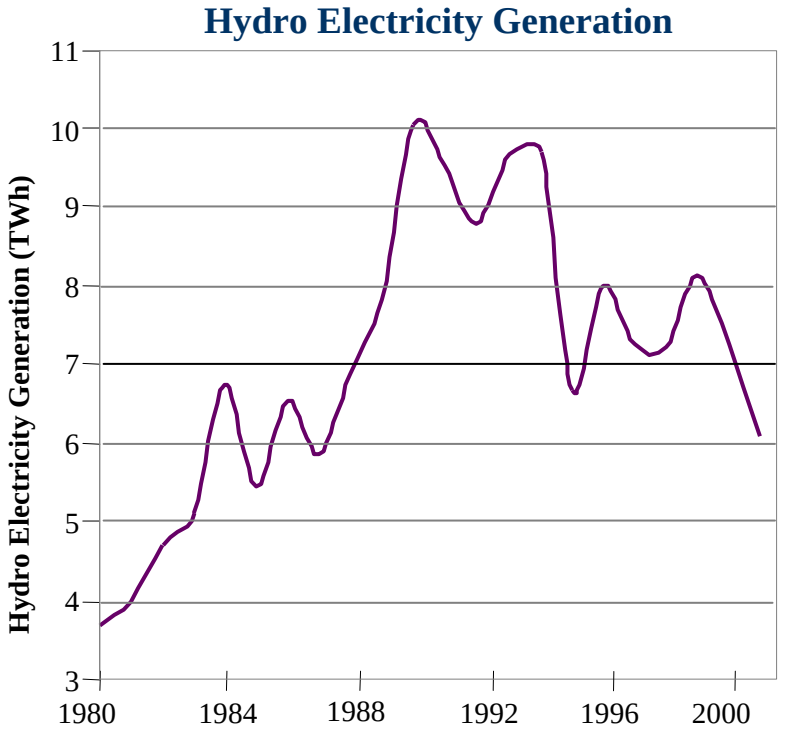


How to align climate change actions with national sustainable development goals?

Rainfall, Inflows and Hydro Electricity Generation

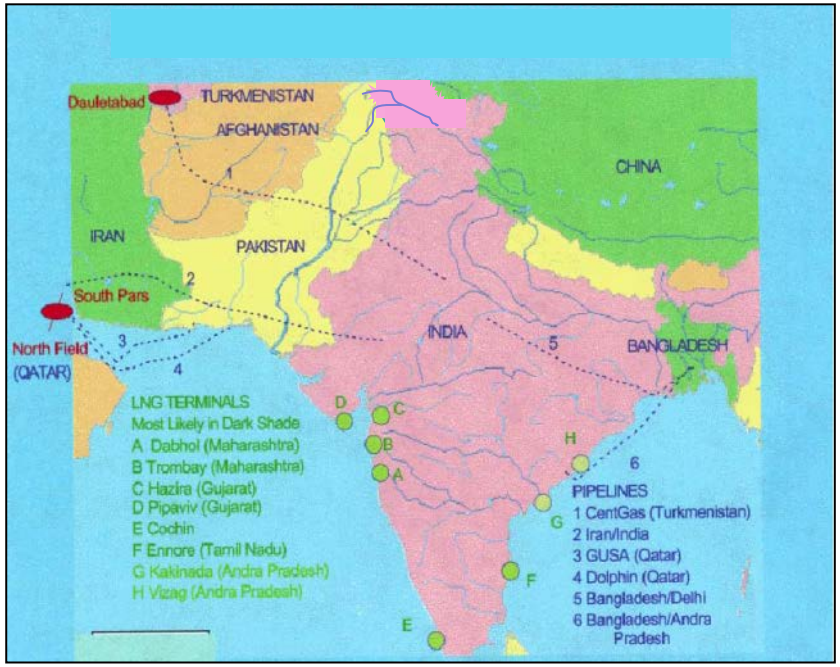
State of Andhra Pradesh





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

How to align climate change actions with national sustainable development goals?

Stabilization induced technological change

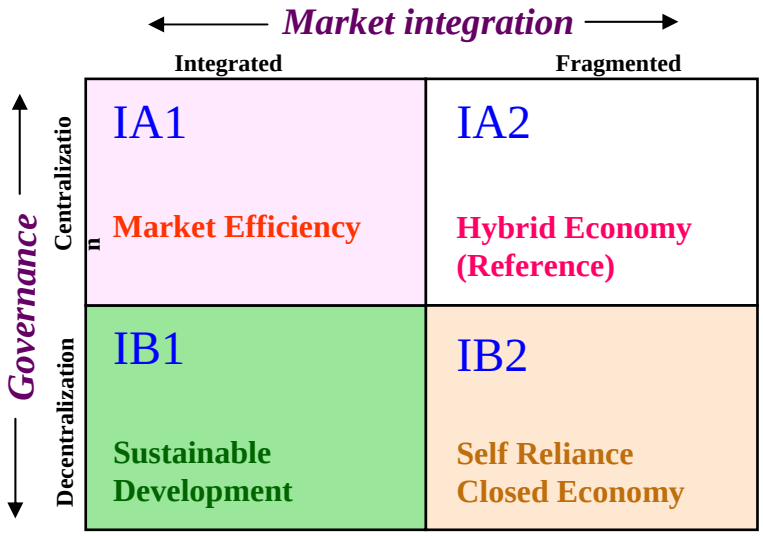
- Depends on the underlying endogenous development path
- Stabilization would induce significant technological change
- How to represent future technologies in models?
- Architecture of climate regime is the key driver

Addressing Questions from Negotiators

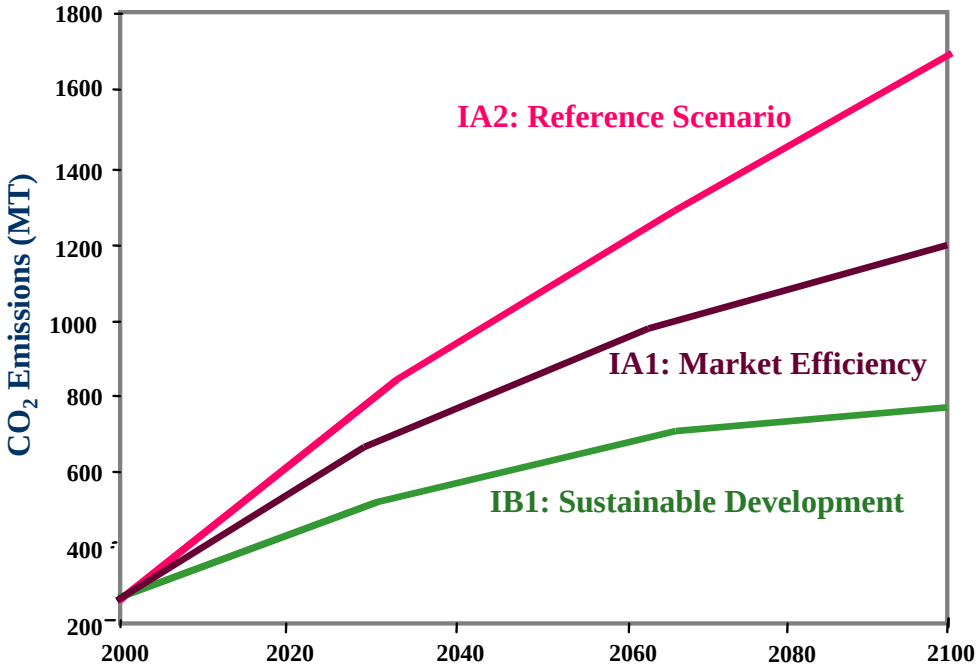
- Allocations of Emissions Rights
- Taxes and Revenue Recycling
- Who pays?
- Technology protocols

Indian Carbon Emissions Scenarios

Indian Emissions Scenarios



Carbon Emissions



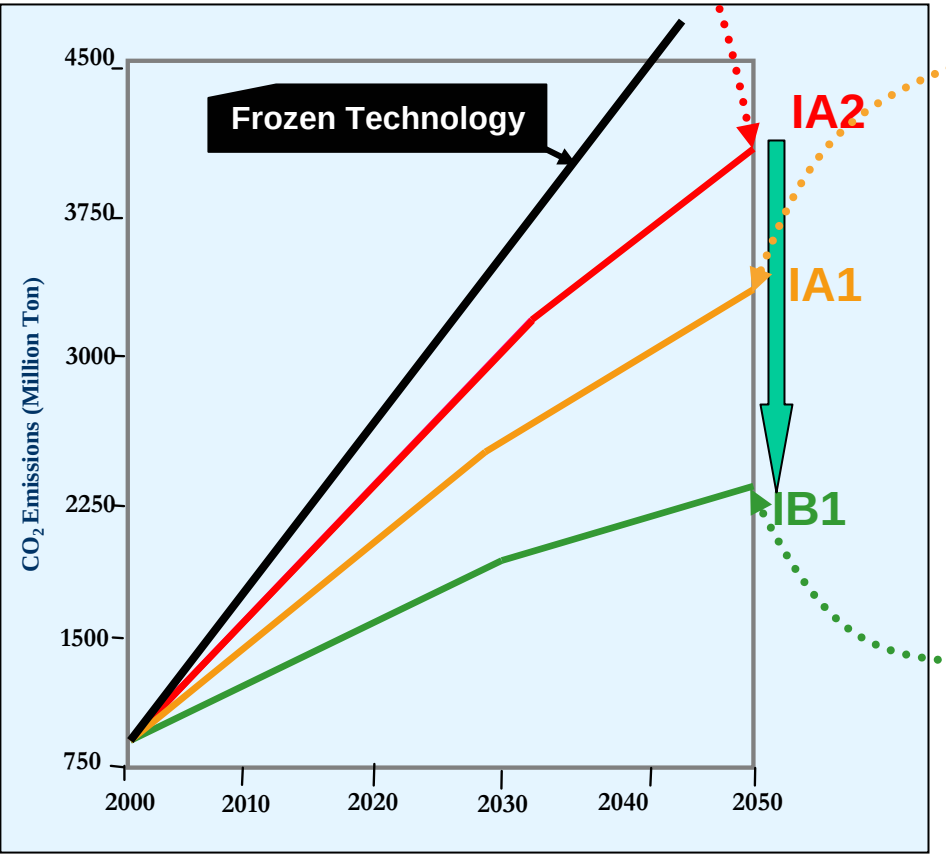
India's Total Carbon Emission in 21st Century
(Billion Ton CO_2)

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

How to align climate change actions with national sustainable development goals?

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

Conventional Technology Path: Includes significant endogenous technological change



Globalization/Market Efficiency Scenario

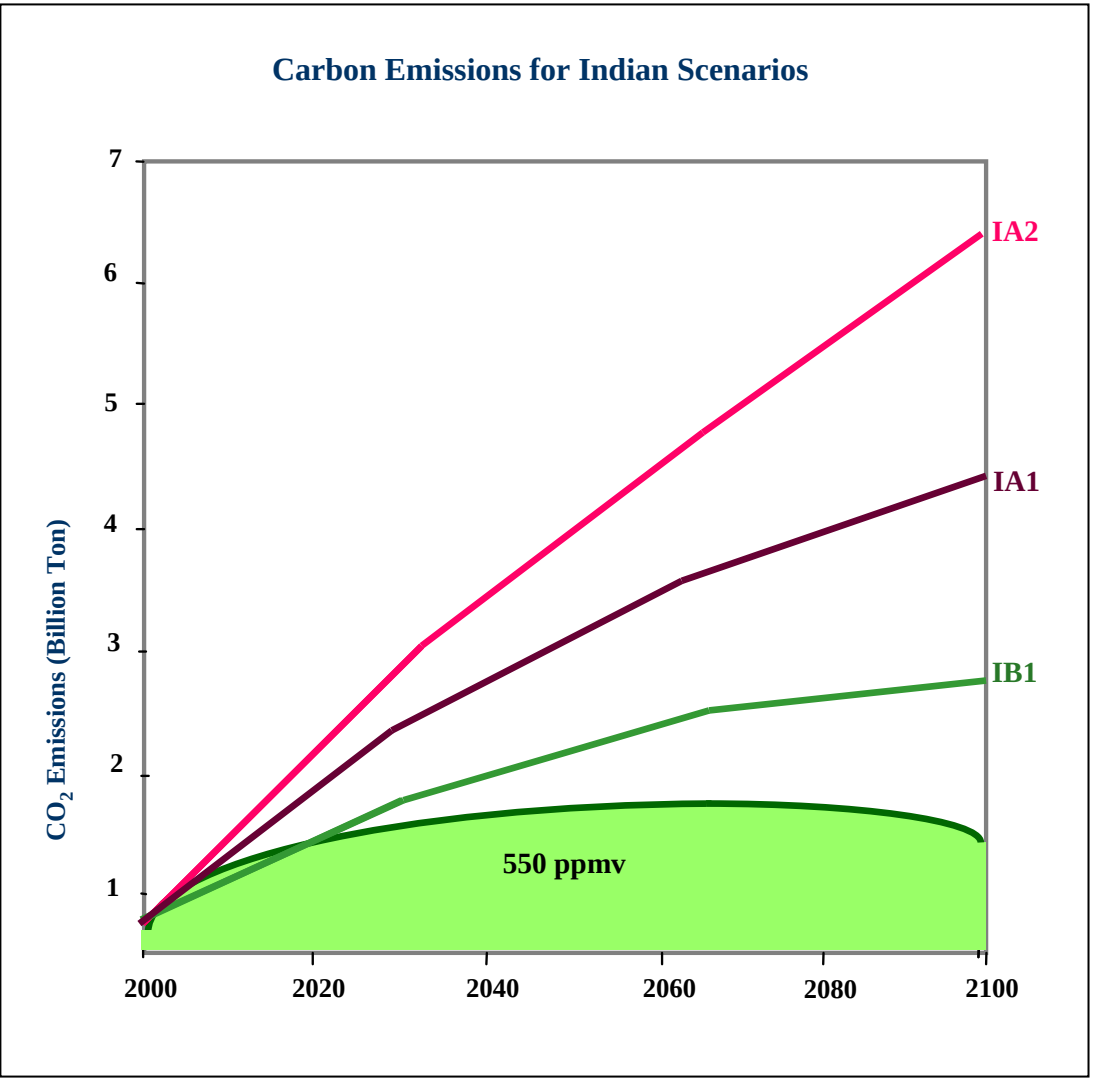
- Synfuels, Next-Gen Nuclear (Thorium)
- Fuel cell vehicles, Pipeline networks
- Energy efficient appliances/ infrastructure
- Coal liquid, IGCC, Hydrogen from gas
- Advanced materials, Nanotechnology

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

How to align climate change actions with national sustainable development goals?

Indian Emission Scenarios and Stabilization



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Sustainable Development (IB1) Scenario	: 198 (55% of IA2)
550 PPMV Cost-effective Regime	: 140 (39% IA2)

How to align climate change actions with national sustainable development goals?

Modeling Transition to Low Carbon Future through Sustainable Development:

An Analysis for India

How to align climate change actions with national sustainable development goals?

Low Carbon Society (LCS) in Developing Country context?

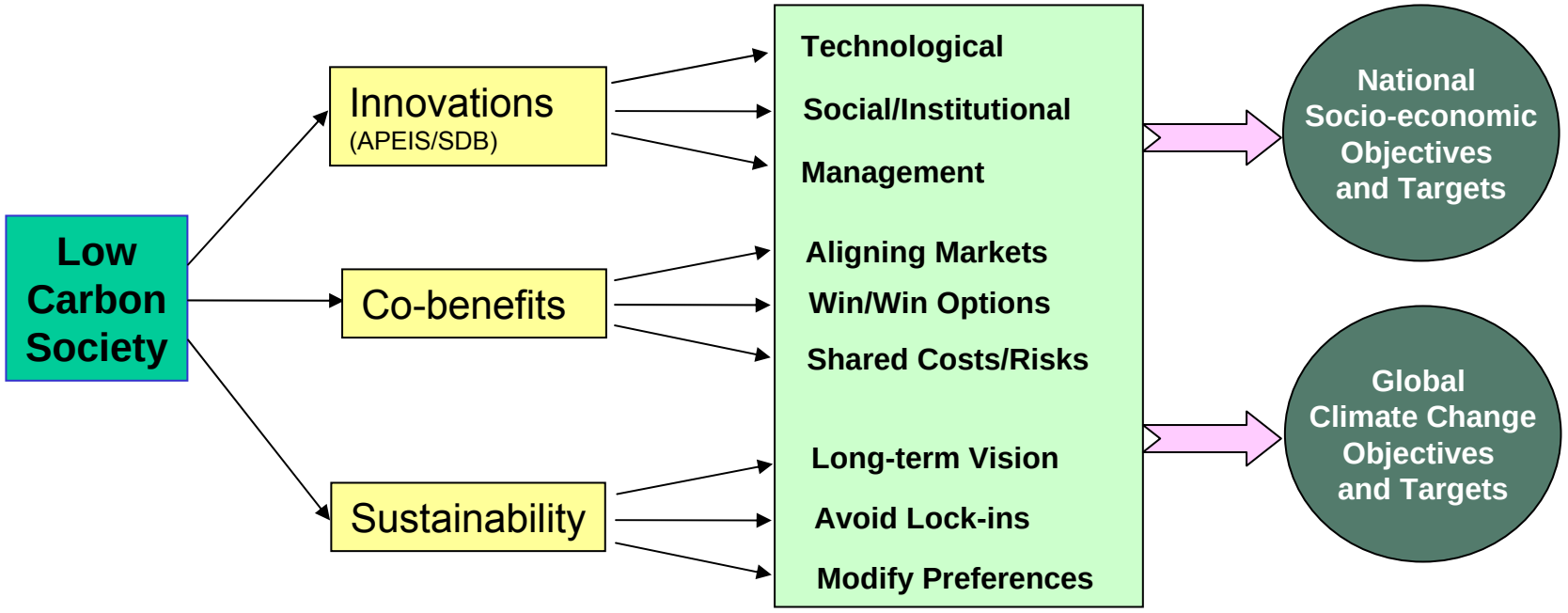
LCS is a "**Development Pathway**" which:

a. facilitates achievement of the **national socio-economic objectives and targets,**

b. while contributing to the achievement of **global objectives and targets** for stabilization of greenhouse gas concentrations in the atmosphere,

c. in a **cost-effective and sustainable** manner.

Low Carbon Society Roadmap



Specifics of the roadmap would differ across countries. What is important is to communicate transparently the qualitative story and its quantification (i.e. modeling)

Low Carbon Society: Scenario Development for India

Key areas for interventions:

- Demographics
  - Lower Population Growth (e.g. investment in women's education)
  - Higher investment in social infrastructures (e.g. health, education)
- Conservation
  - Efficient technology, Substitutions, Recycling, Pricing, Dematerialization
- City Planning
  - Architecture/ Building Codes; Land use policies; Public Transport
- Infrastructure choices
- R&D, technology transfer and selective technology push
- Incentives for environmental industry
- Influencing consumer preferences/ behavior

How sustainable development policies influence LCS?

E.g. Education, Employment and Productivity nexus

- Policies for public private partnership → higher (public and private) investments in education → Increases supply of education services
- Incentives for education for women and socially and economically backward sections enhances demand for education
- Women's education reduces fertility rates & this together with family planning campaigns lead to lower population (than in reference & some others cases)
- The increases in labor participation rates and enhanced skill profiles maintains labor supply and higher productivity in next few decades
- Rural development policies (including education, employment, infrastructure push and reduced risk for investments) break through the rural/ urban dualism

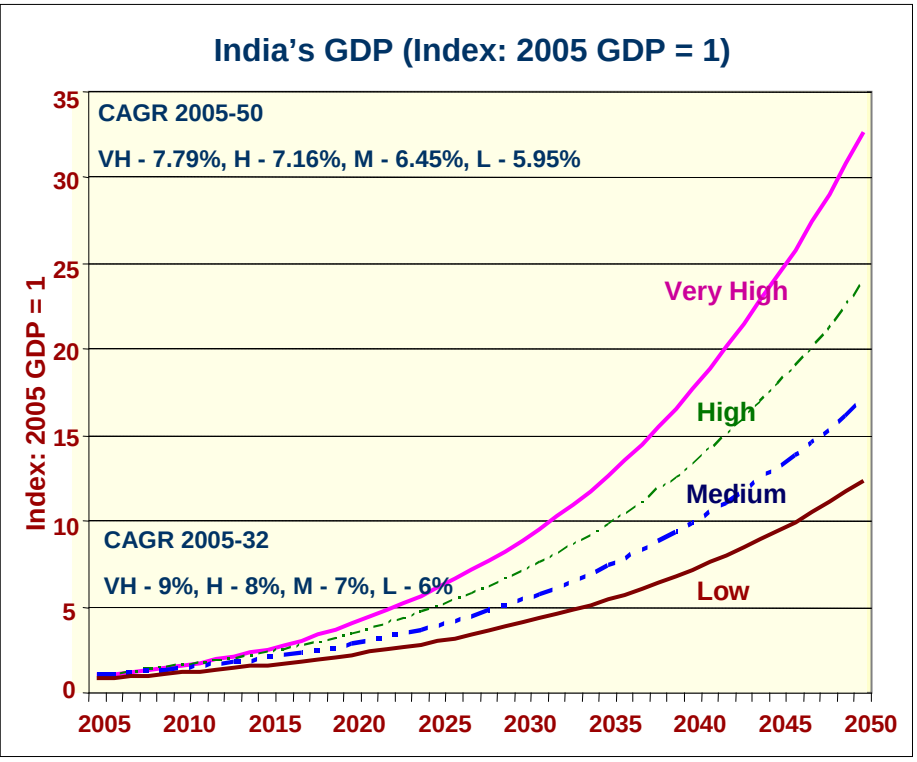
(Likewise for other drivers, the sustainability scenario story differ)

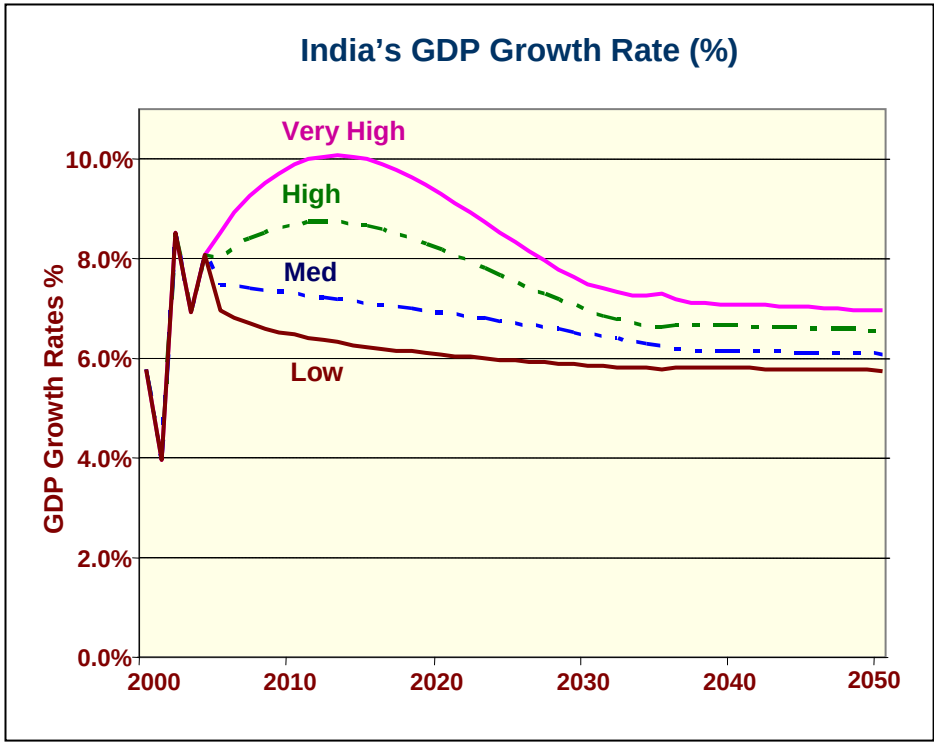
Scenario Drivers

- **Factors of Production**
  - Labor Supply, Land-Use, Capital (Savings/ Investments)
- **Inputs: Resources supply/ Technologies**
  - Energy
- **Intermediate goods & investments**
  - Infrastructures
  - Energy (& Carbon) Intensive Sectors
- **Final Demand/ Behavior**
  - Private Consumption (Income effects/ preferences)
  - Government expenditure
- **Governance**
  - Rents
  - Taxes
  - Geopolitical Risks
- **Global/ External**
  - Trade
  - Geopolitical Risks

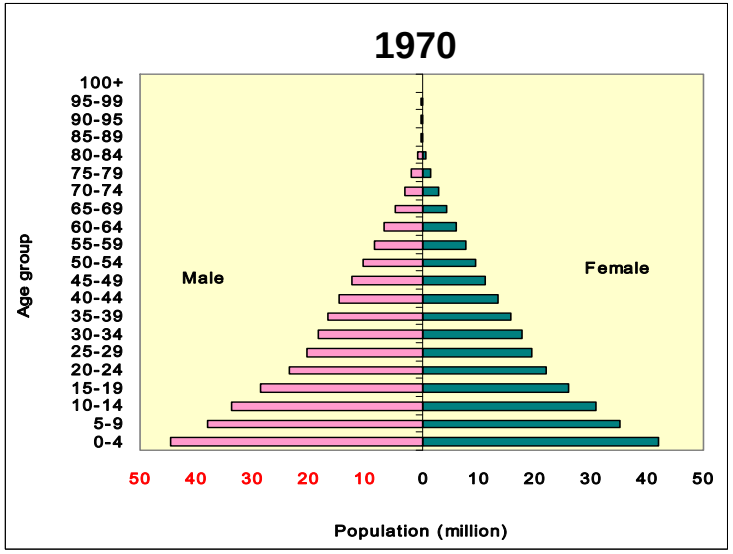
Demographic Transitions, Human Capital, Productivity, Growth and Sustainability

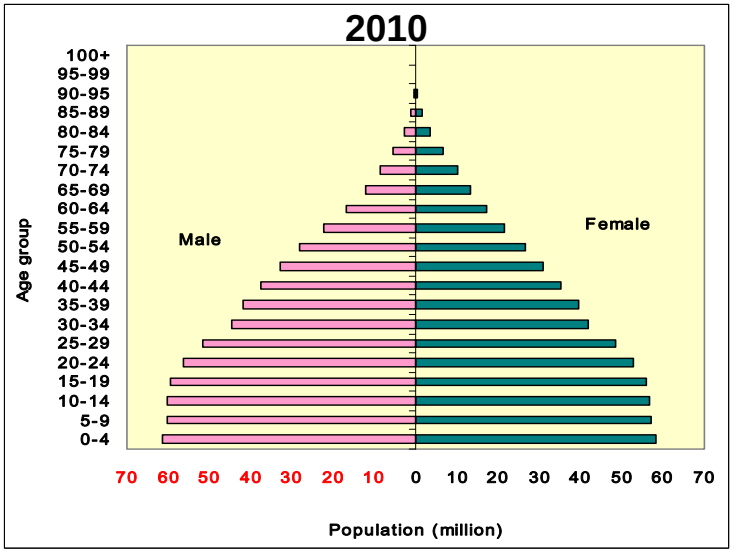
India's Economic Growth: Future GDP Projections

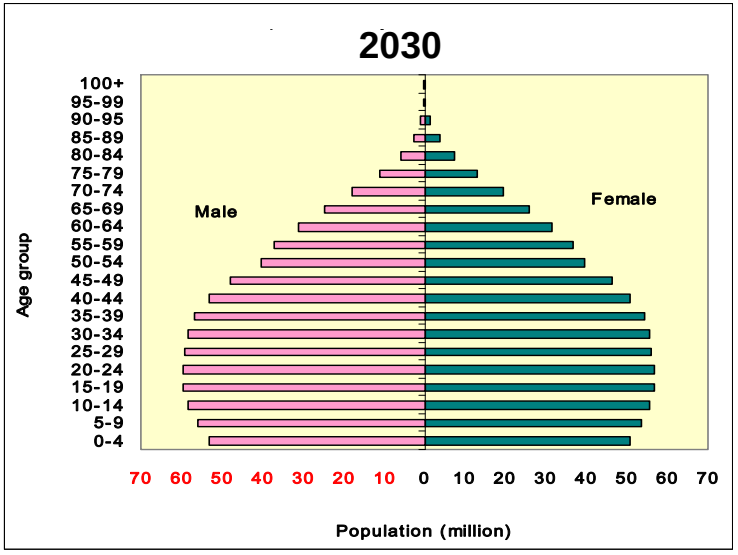


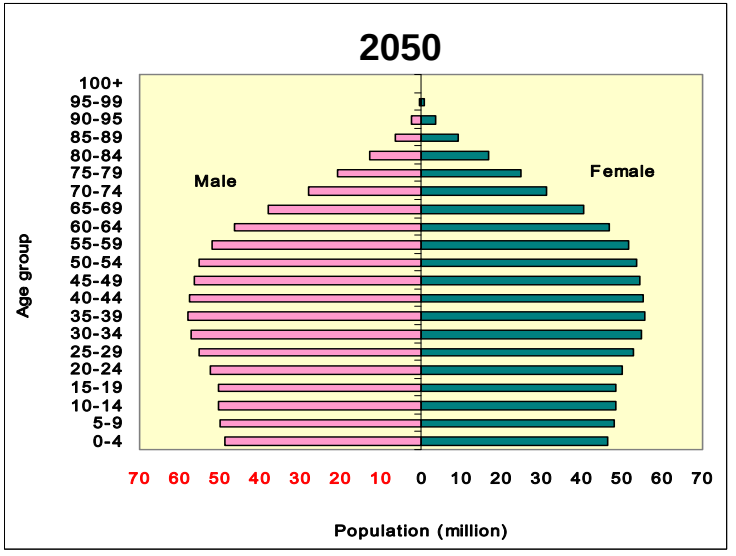


Demographic Transitions in India: Age/Gender Profile

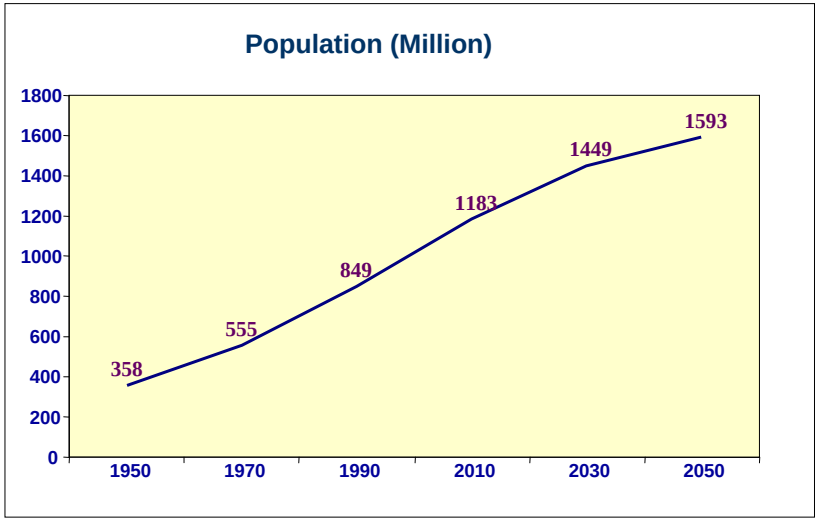


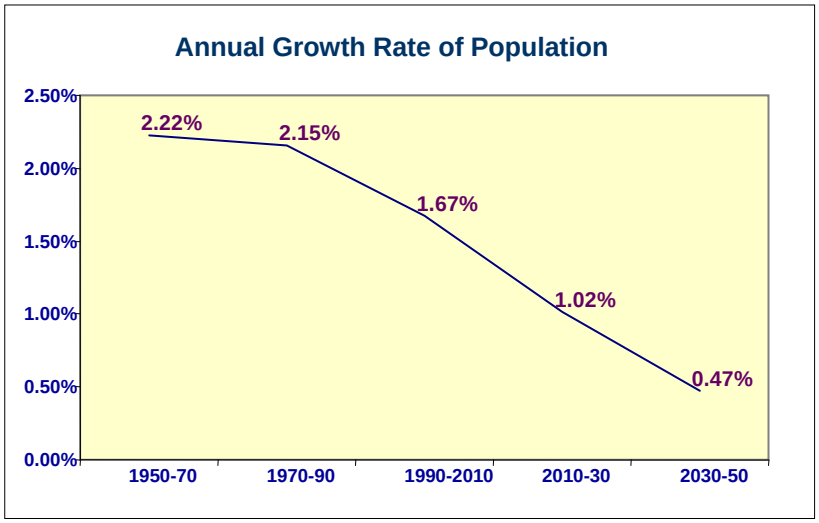


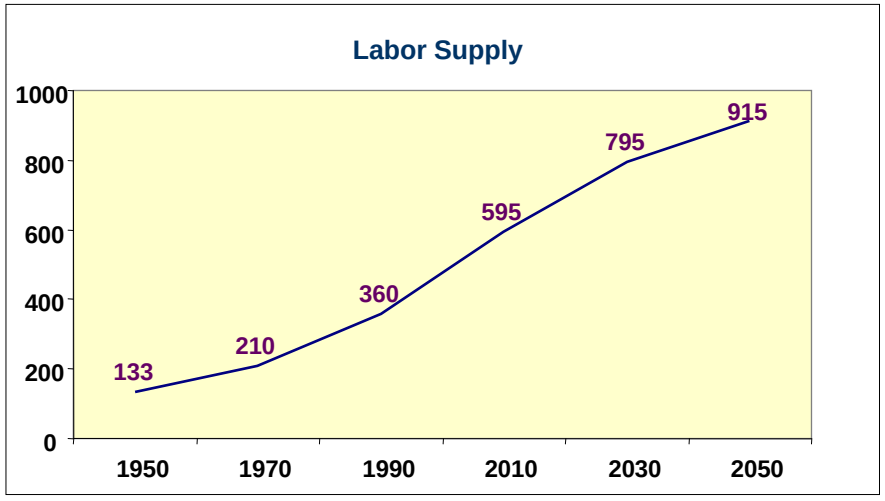


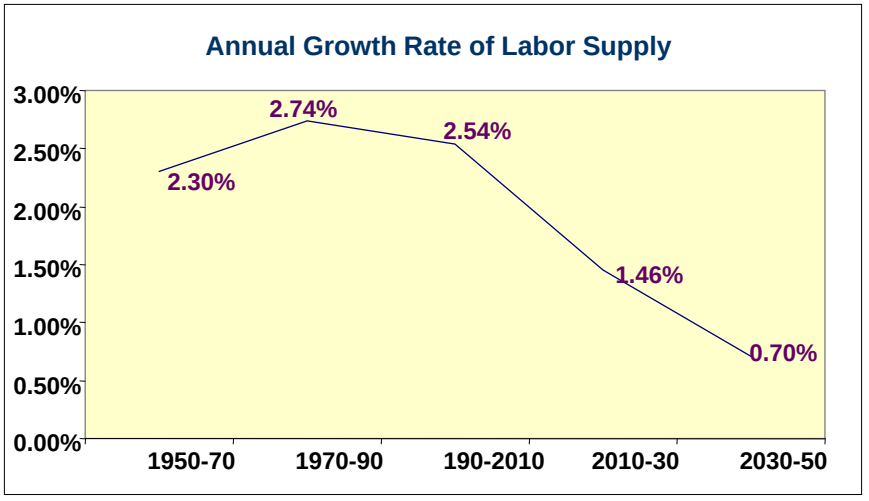


Population and Working Age Population



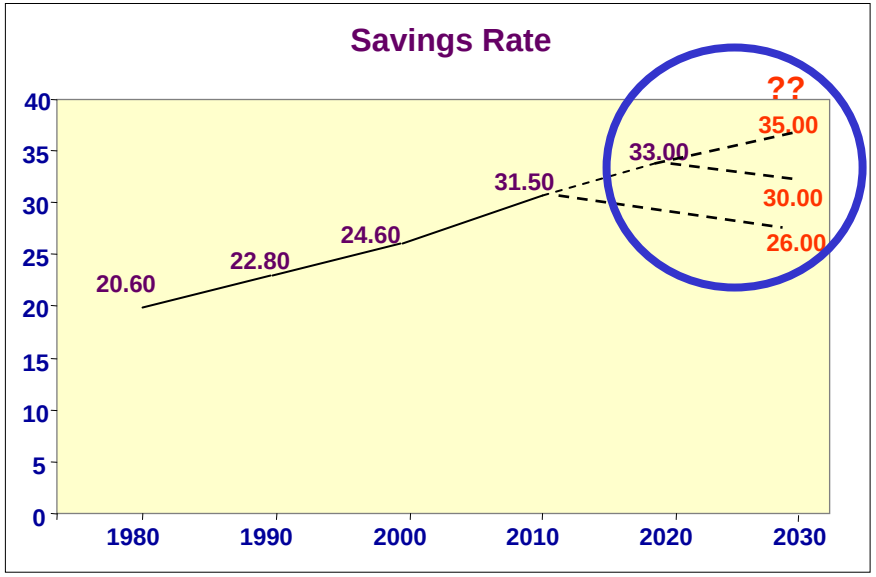






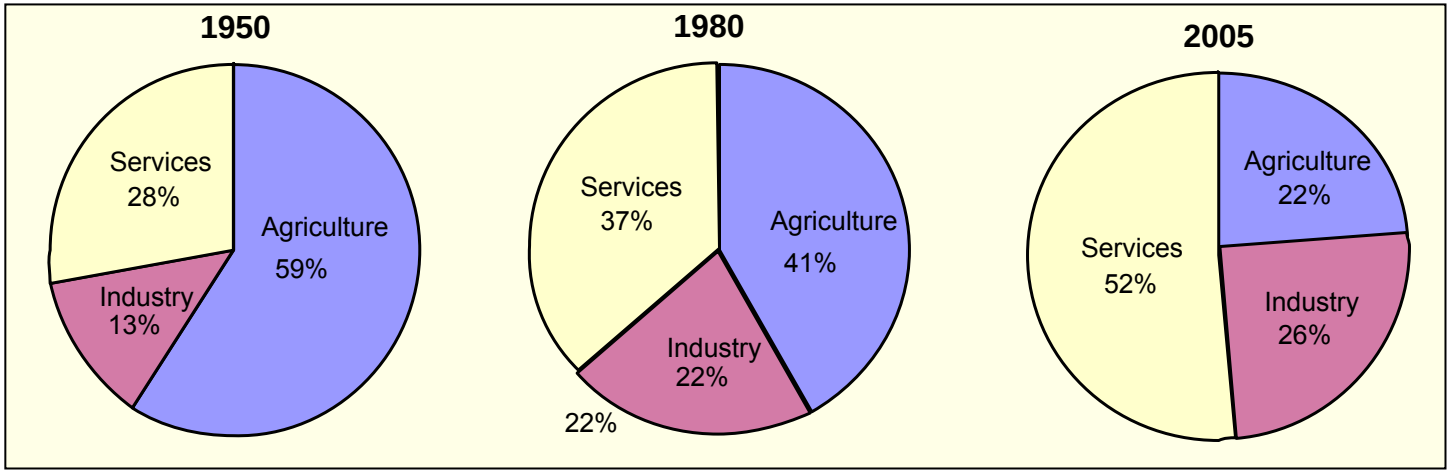
Growth Scenarios

- 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

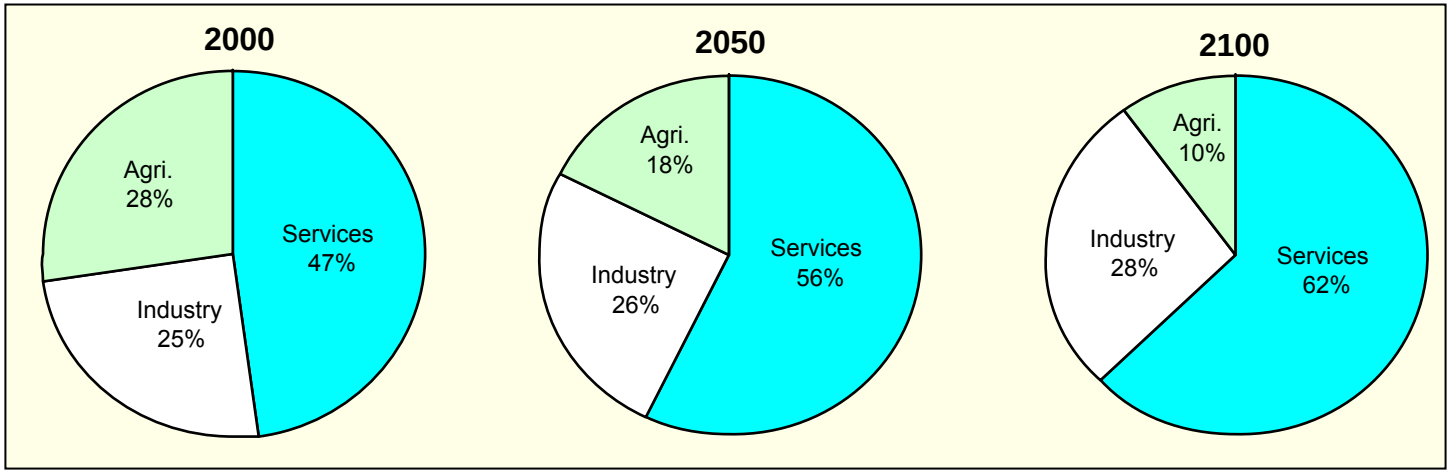


Changing Structure of the Economy

History



Future



How to align climate change actions with national sustainable development goals?

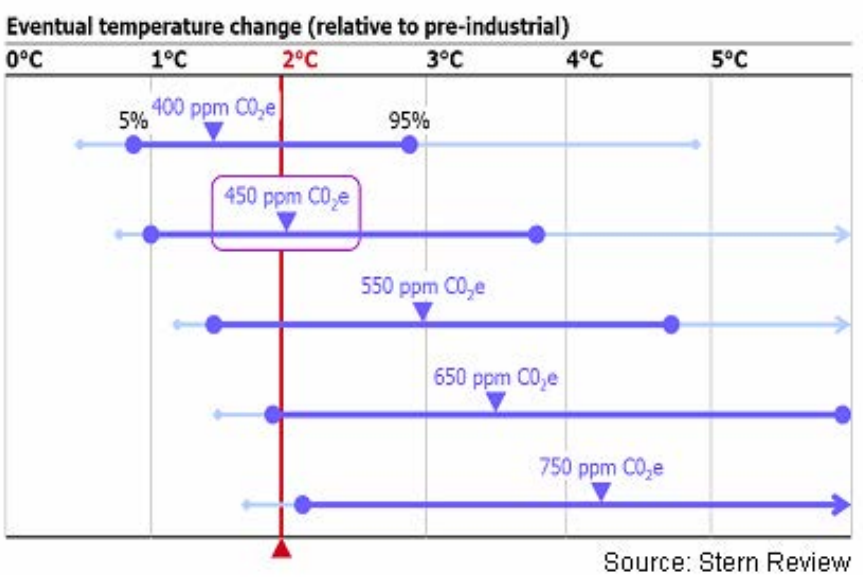
Modeling & Analysis of Low Carbon Development Path

How to align climate change actions with national sustainable development goals?

Low Carbon Society (LCS) Scenario

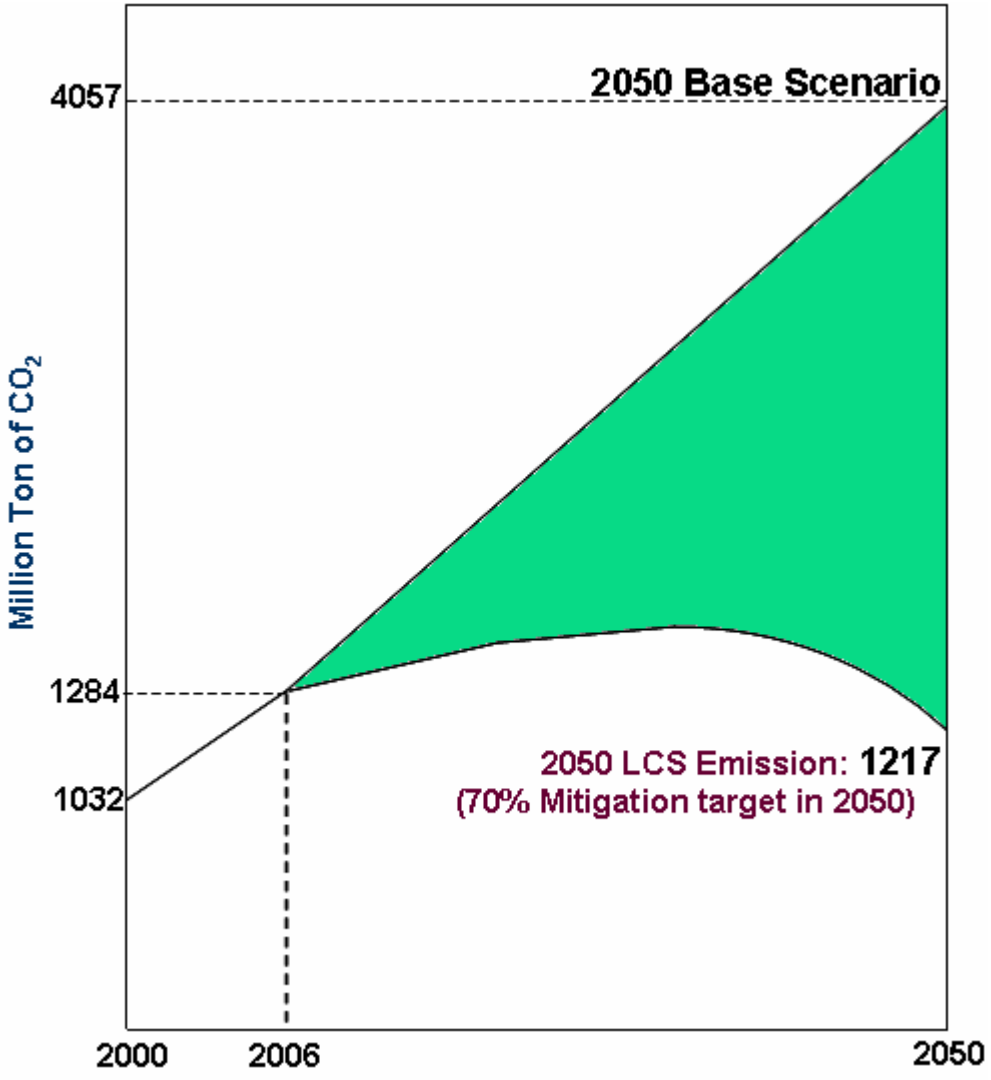
Drivers of India's LCS Scenario

- Carbon Market Signal (e.g. from 2°Centigrade Global Target)
- Energy Device Efficiency (Demand and Supply-side)
- Dematerialization
  - Building Materials and Design
  - Reduce (demand), Recycle & Reuse (3R) Materials
- Infrastructure investments
  - Avoid lock-ins
  - Shift demand (e.g. transport modal split)
- R&D and Technology Transfer
  - Leapfrog (to the efficiency frontier)
  - Innovations (to shift the efficiency frontier)
- Planning & Governance
  - Facilitate change in Lifestyles & Behaviors
  - Institutions, Laws, Policies



Source: Stern Review

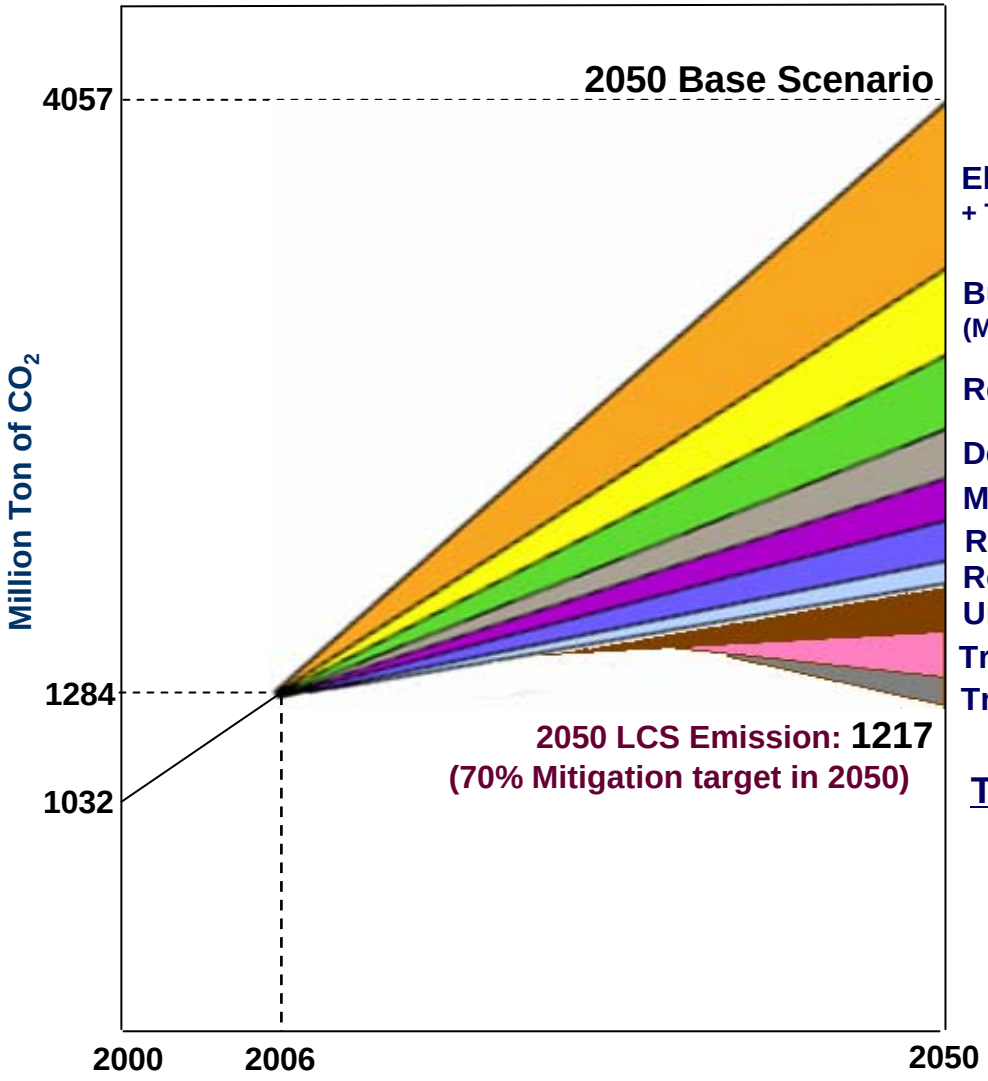
Carbon Emissions: Base vs. LCS Scenario for India



India's Cumulative Carbon Emission from 2000-2050

	Billion Ton of CO_2
Reference Scenario:	127.2
LCS Scenario:	64.3
Cumulative Mitigation in LCS:	62.9
% Cumulative Mitigation in LCS:	49.5%
% Mitigation in LCS in 2050:	70.0%

Mitigation in LCS Scenario for India



	Mitigation in LCS (in 2050)
Electricity (Supply + T&D Efficiency)	745
Buildings (Materials/Design)	384
Renewable Energy	328
Device Efficiency	274
Material substitutions	207
Recycling	173
Reduced Consumption	90
Urban Planning	265
Transport (Modal shift)	272
Transport Infrastructure	102
Total CO_2 Mitigation	**2840**

Mitigation through “dematerialization” in LCS Scenario

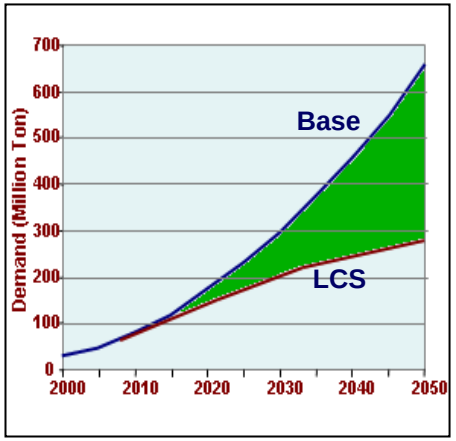
- **Dematerialization in LCS vis-à-vis Base Scenario is contributed by multiple direct and indirect policies, most of which belong to the policy packages relating to “sustainable development”.**
- **Change in building materials and design contribute significantly to dematerialization and energy efficiency in construction**
- **In addition, three other key contributors to mitigation through dematerialization are:**

	Mitigation (MT CO_2) in 2050
Material Substitutions	207
Reduced Consumption	173
Recycling	90

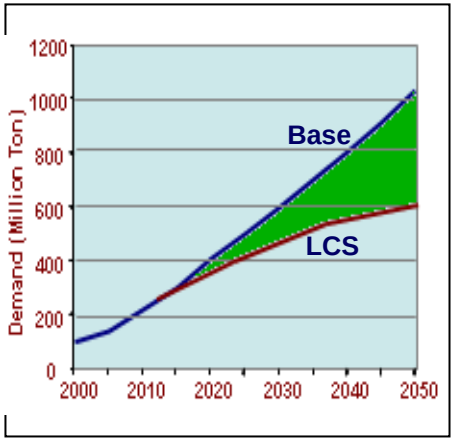
- **Energy and carbon intensive materials - of which the substitutions and reduced consumption contribute most to mitigation in the LCS scenario - are steel, aluminum, cement, fertilizer and paper.**
- **Recycling reduces the energy and carbon intensity of the materials, besides delivering environmental co-benefits.**

Materials Demand in Base vs. LCS

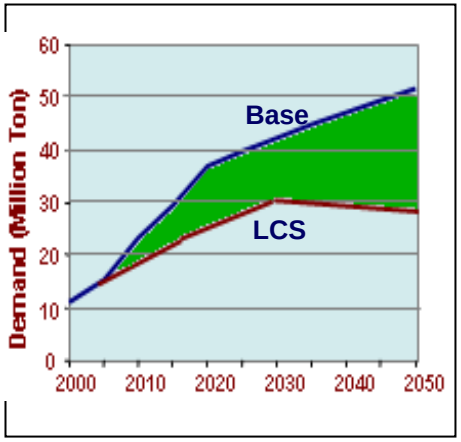
Steel



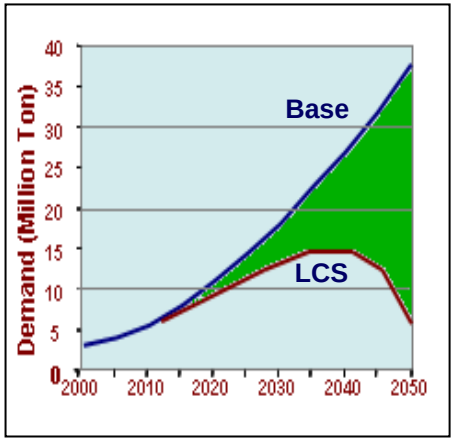
Cement



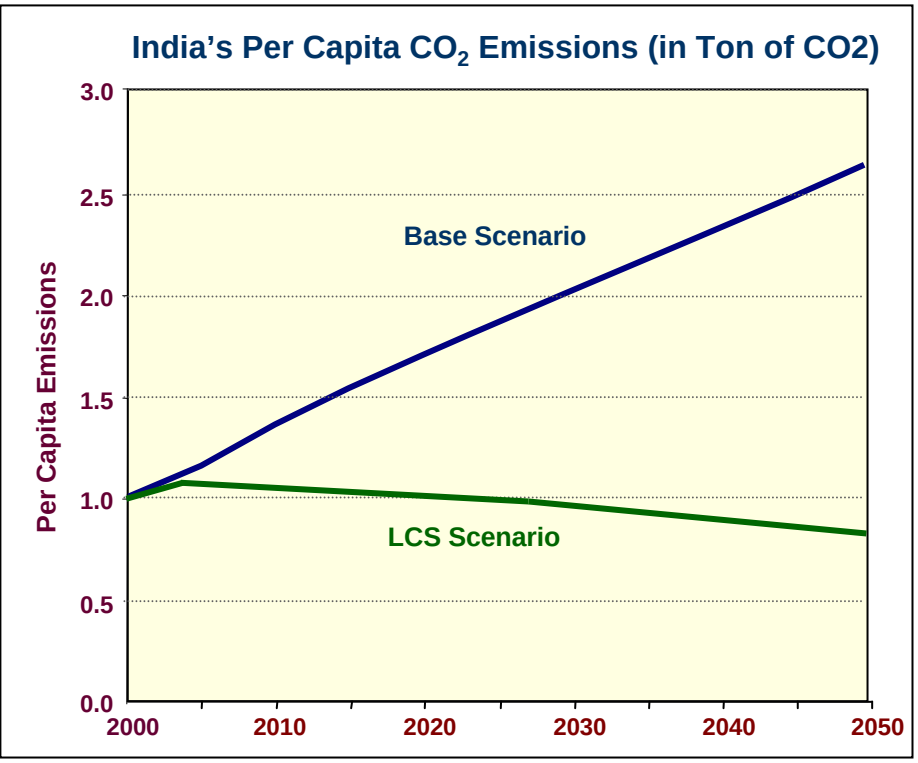
Fertilizer

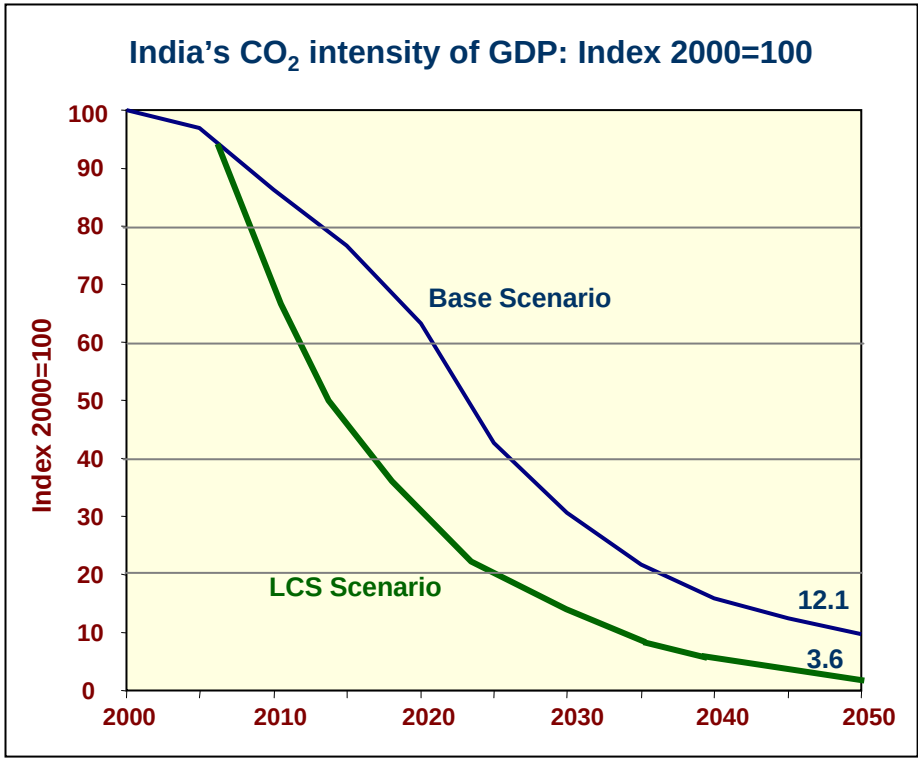


Paper



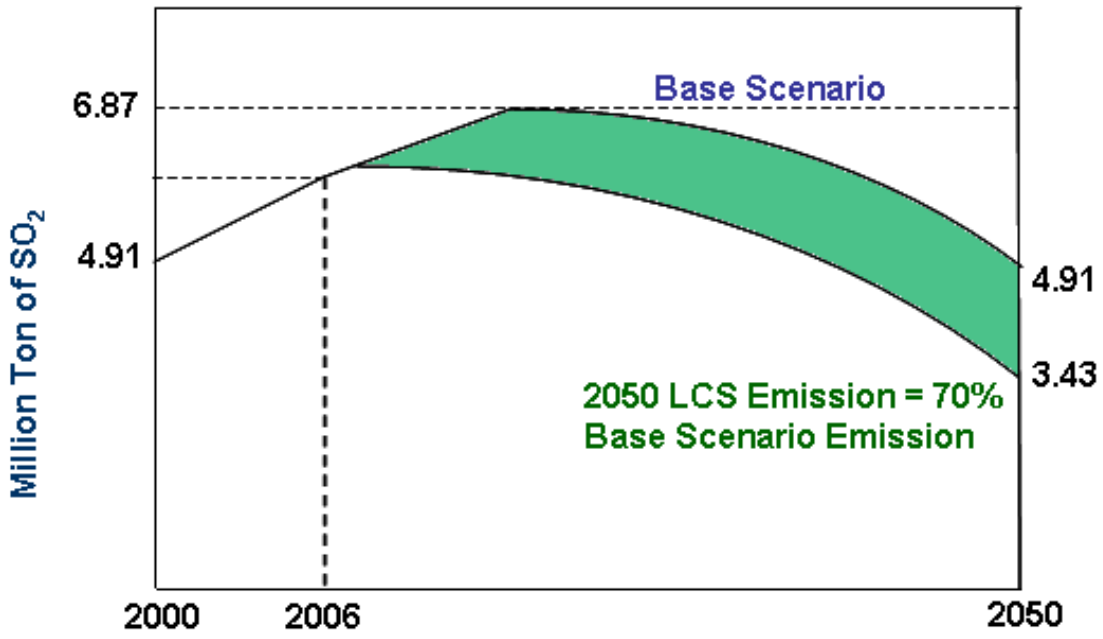
CO2 Intensities: Base vs. LCS Scenario





How to align climate change actions with national sustainable development goals?

SO2 Mitigation Co-benefits of LCS Scenario



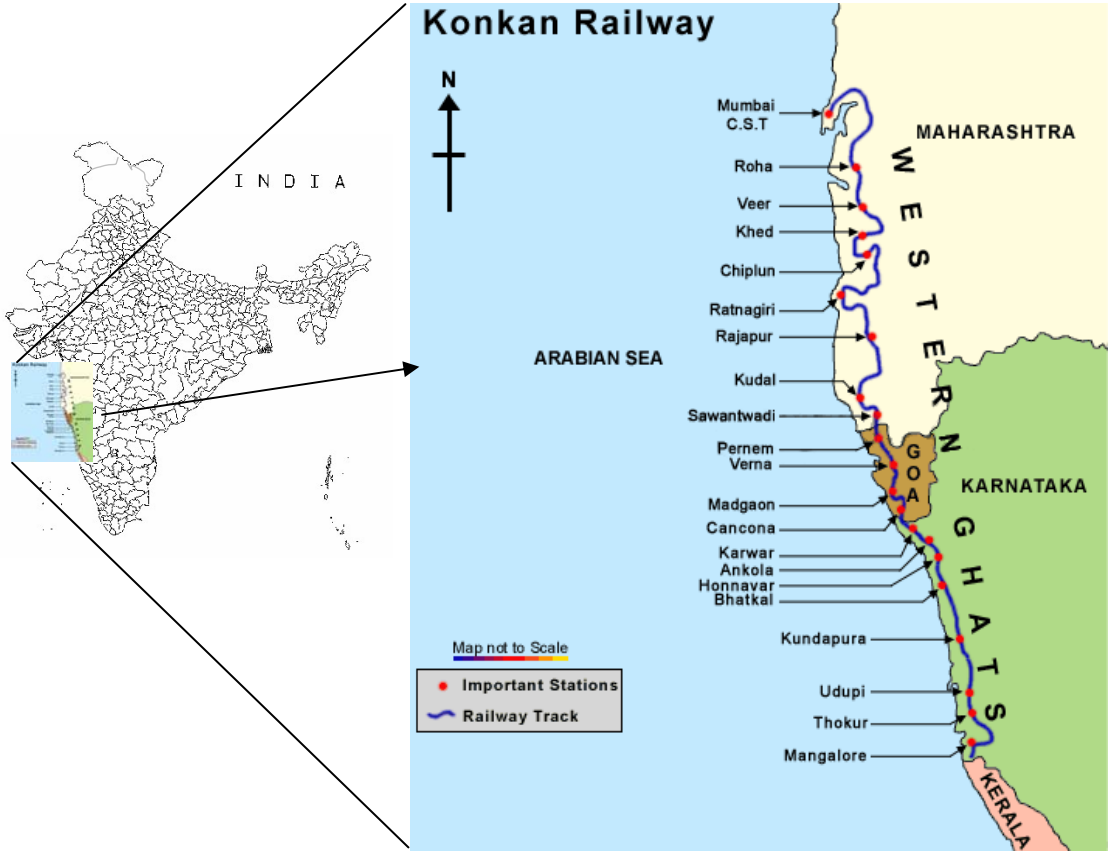
Joint Mitigation (Period 2007-2050)

Mitigation Regime	Co-benefits
SO_2 mitigation alone in Reference Scenario	**Little carbon mitigation**
SO_2 Co-benefit in LCS Scenario	**LCS policies generate benefits equivalent to 30% lower SO_2 in 2050 and cumulative saving in SO_2 Emissions Reduction equivalent to $11.2 billion over period 2006-2050**

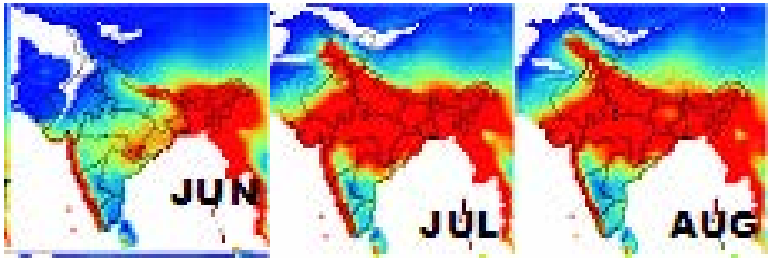
Adapting to Climate Change:

Vulnerability and Adaptation of Long-life Assets from Climate Change

Sustainable Development & Climate: Impacts on Infrastructure



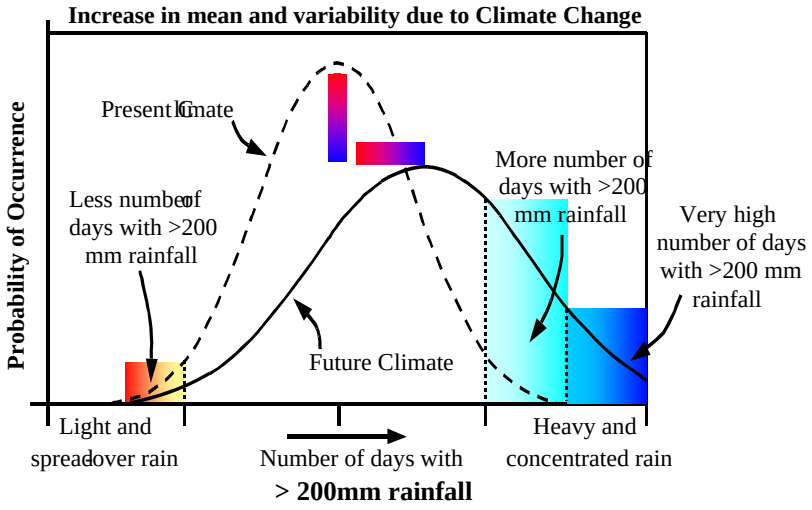
Monsoon Rainfall (2050)



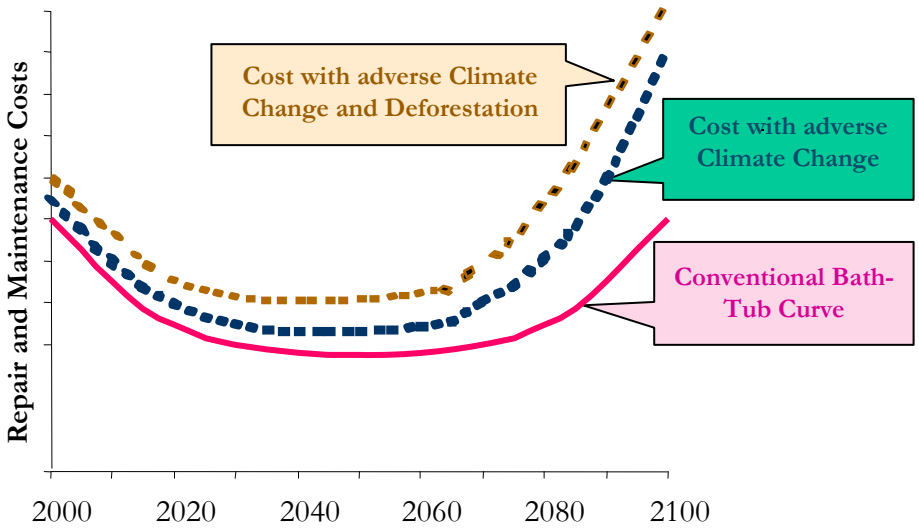
How to align climate change actions with national sustainable development goals?

Sustainable Development & Climate: Impacts on Infrastructure

Increase in Climate Intensity and Variability



Maintenance Cost Curve



How to align climate change actions with national sustainable development goals?

Conclusions: Aligning Climate & Sustainable Development Actions

Transiting to a Sustainable and Low Carbon Society

- The LCS actions in developing countries should be development centric and facilitate achieving **national sustainable development** and **global environmental** objectives **simultaneously** and **cost-effectively**

Developing Scenarios for Sustainable and Low Carbon Society

- Developing scenario storyline to gain 'development and climate' **co-benefits** in the near-term and avoid **lock-ins** in the **long-run** to transit to a **sustainable development pathway**
- Mainstreaming climate actions, including mitigation and adaptation, with development actions that include **innovations, co-benefits** and **sustainability**

Modeling and Analysis for Sustainable and Low Carbon Society

- **Multi-purpose soft-linked** modeling tools linked to strategic **global & national databases**
- **Mainstream** assessment of climate change and development actions through national sustainable development objectives and targets

Thank you