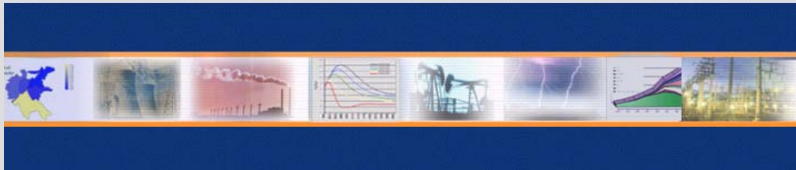


CSD-15 Learning Centre Course
30 April 2007, UN Headquarters, New York

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**

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

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

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

Understanding development

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

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

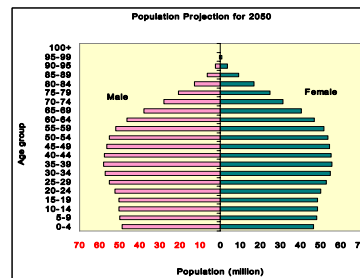
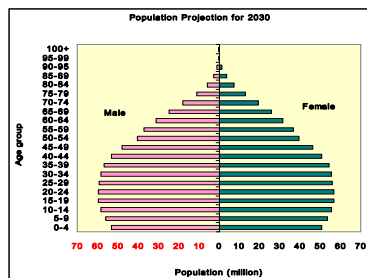
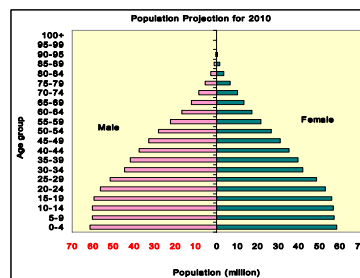
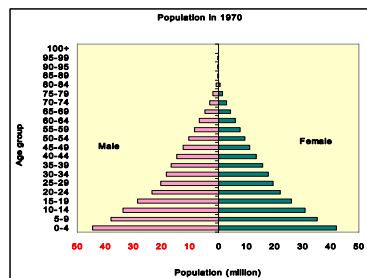
Transitions

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

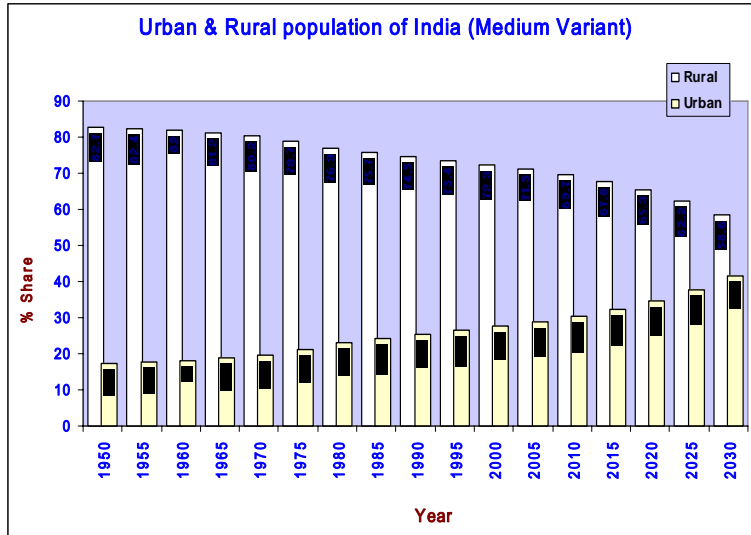
How to align climate change actions with national sustainable development goals?

Demographic Transitions in India: Age/Gender Profile



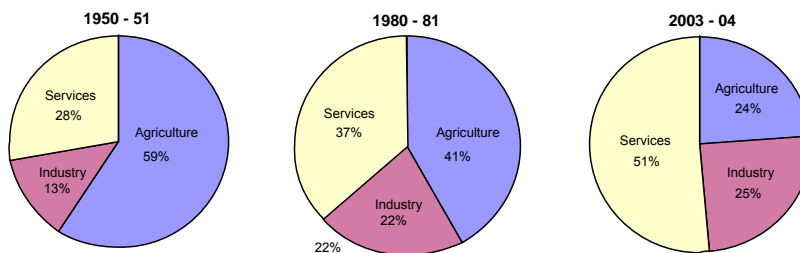
How to align climate change actions with national sustainable development goals?

Demographic Transitions in India: Urban/Rural



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

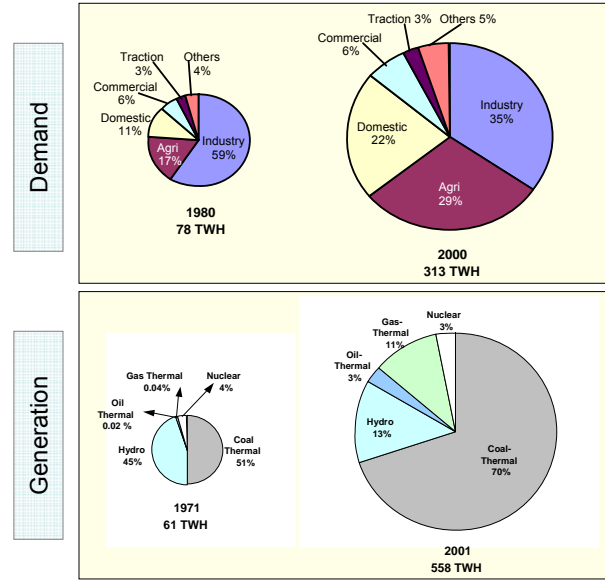
Composition of India's GDP by Sector



Data Source: CMIE and Economic Surveys of India

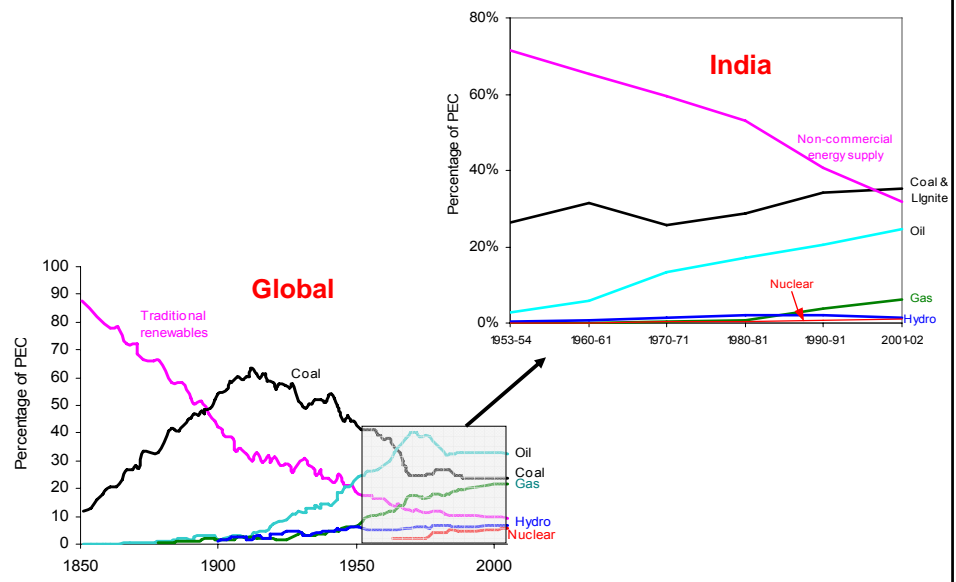
How to align climate change actions with national sustainable development goals?

Shift in electricity demand and generation



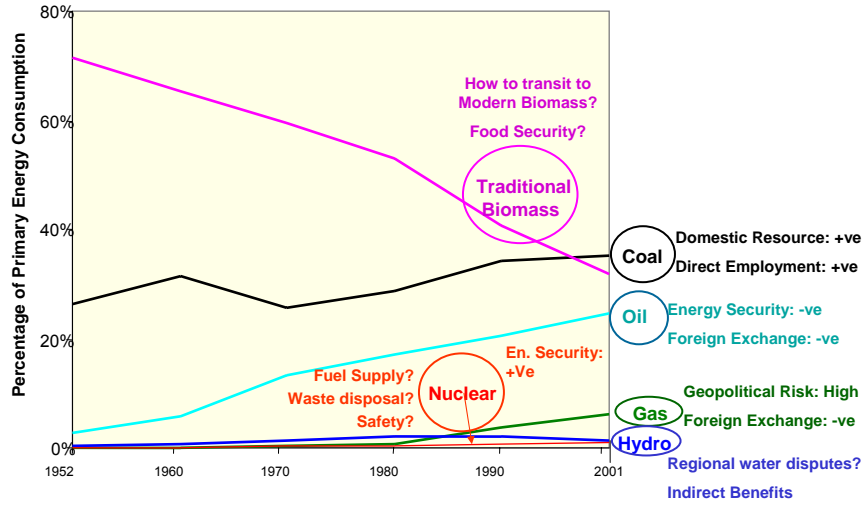
How to align climate change actions with national sustainable development goals?

Past Energy transitions: Global & India



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

Changing Structure of Energy Use



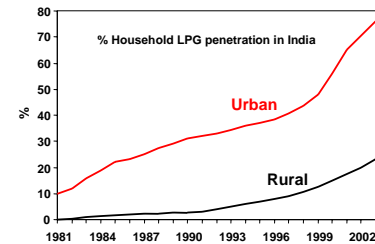
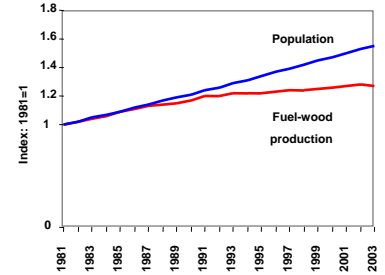
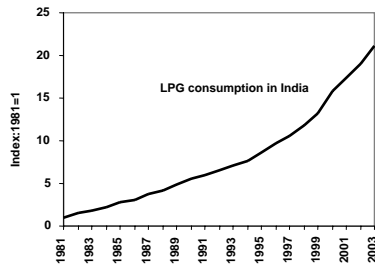
How to align climate change actions with national sustainable development goals?

Transitions Demand-side Opportunities

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

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

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



Data Sources - Census 2001, NSS 1994, 2000

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

Environmental Transitions

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

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

Consumption/Life-style Transitions

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

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

Backbone Technology Transitions

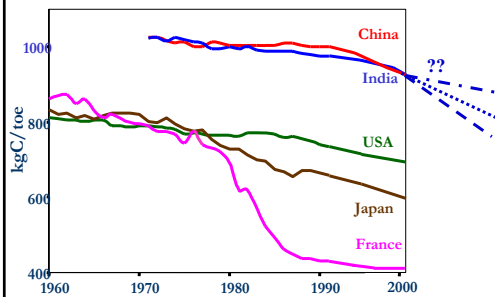
- Logistics
 - Pipelines
- Electricity T&D
 - Decentralized utilities
- Information
 - Wireless
- Nanotechnology
- New and Renewable Energy
 - Hydrogen

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

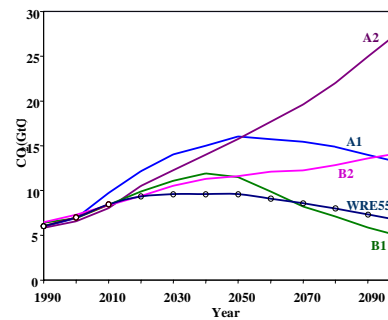
Path Dependence: Lock-ins vs. Innovations

- 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

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

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

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

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

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

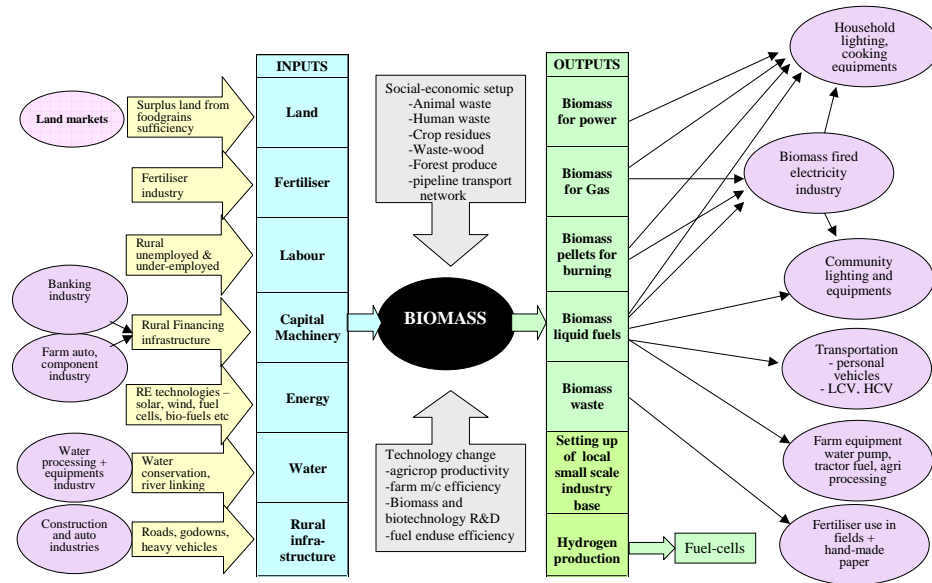


Rural Employment



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

Network for Biomass Technology/Fuel Deployment



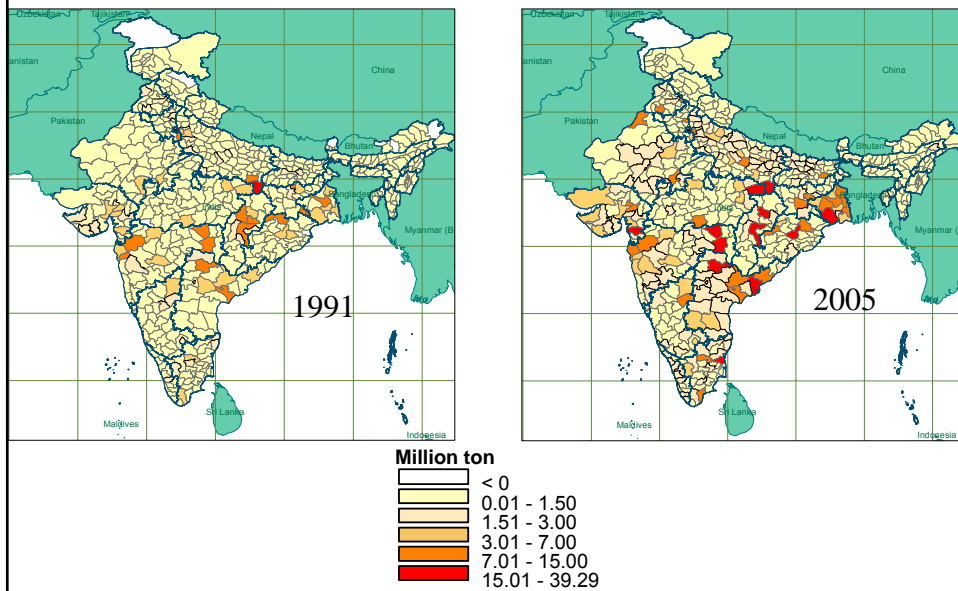
How to align climate change actions with national sustainable development goals?

Conjoint Market for CO₂ and SO₂ Emissions

MDG 7: Environmental Sustainability

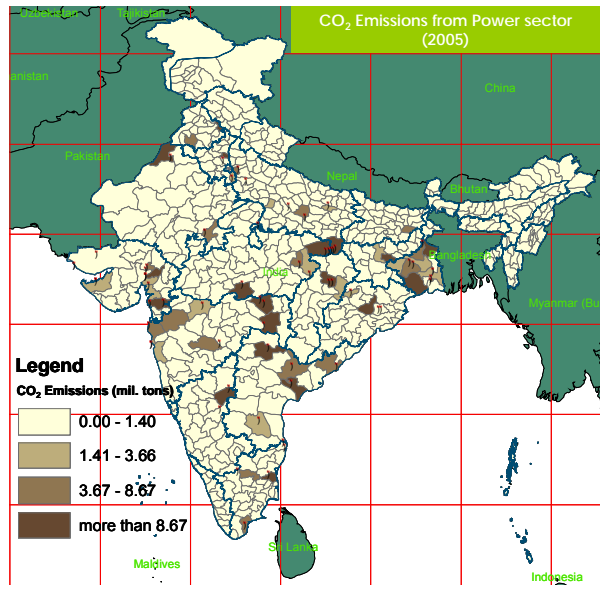
How to align climate change actions with national sustainable development goals?

District-wise CO₂ Emissions



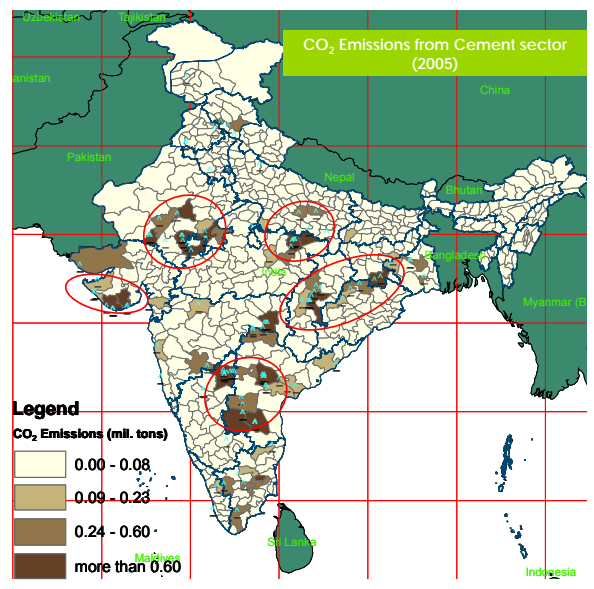
How to align climate change actions with national sustainable development goals?

CO2 emission from Power Sector (2005)



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

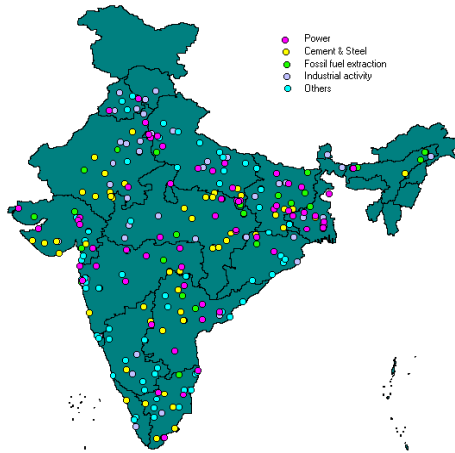
CO2 emission from Cement Sector (2005)



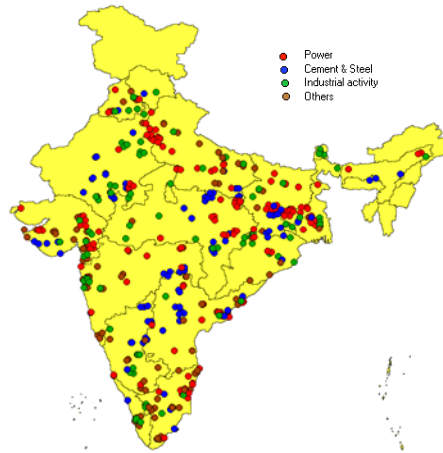
How to align climate change actions with national sustainable development goals?

LPS Locations

Year: 2000

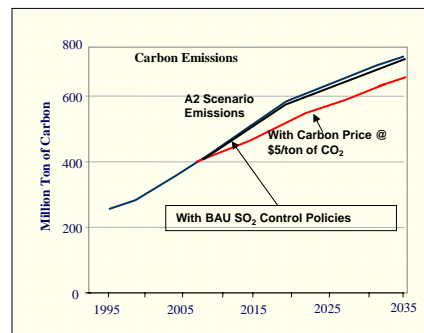
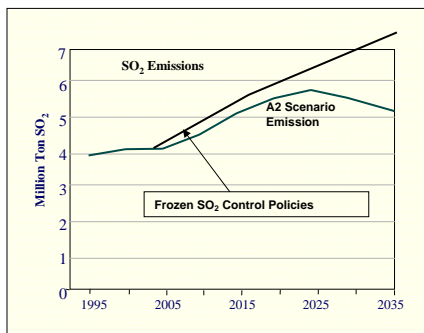


Year: 2030



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

Co-Benefits: Joint SO₂ and CO₂ Mitigation



Joint Mitigation (Period 2005-2030)

Mitigation Regime	Co-benefits
<i>SO₂ mitigation alone</i>	Little carbon mitigation
<i>Joint Mitigation: CO₂ mitigation @ \$5/ton & same SO₂ target</i>	Joint mitigation costs \$400 Million less

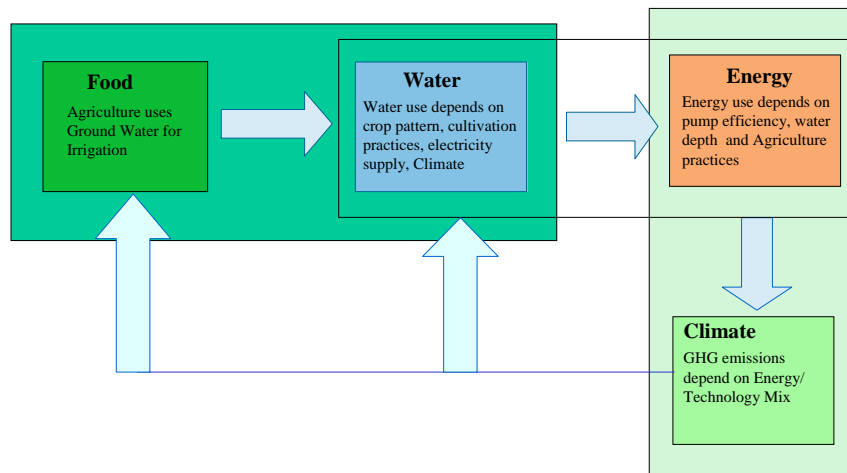
How to align climate change actions with national sustainable development goals?

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?

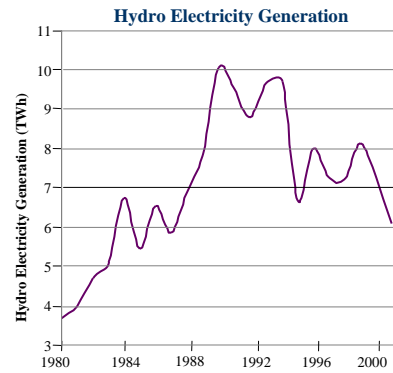
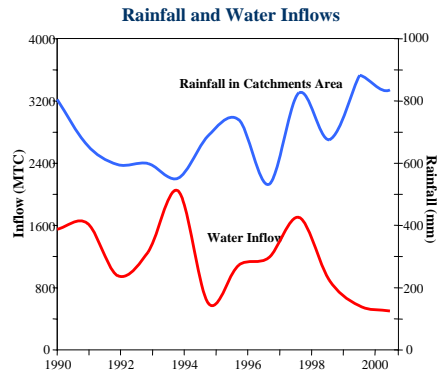
Adaptation Challenge: Food/Water/Energy/Climate



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

Rainfall, Inflows and Hydro Electricity Generation

State of Andhra Pradesh



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

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)

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

Modeling Climate Stabilization Induced Development Paths

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

Stabilization induced technological change

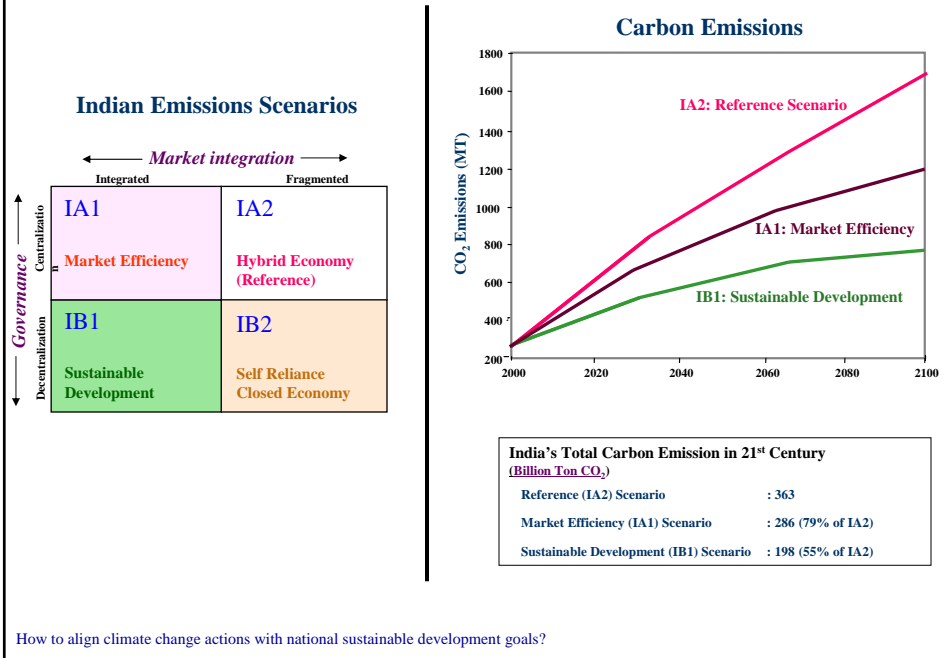
- Depends on the underlying endogenous development path
- Stabilization would induce significant technological change
- How to represent future technologies in models?
- Architecture of climate regime is the key driver

Addressing Questions from Negotiators

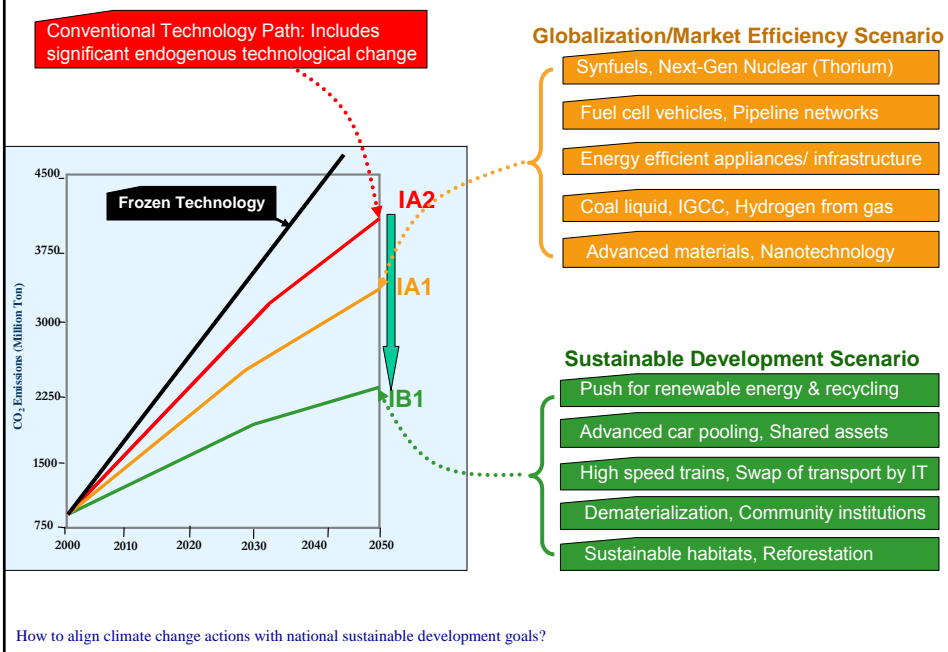
- Allocations of Emissions Rights
- Taxes and Revenue Recycling
- Who pays?
- Technology protocols

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

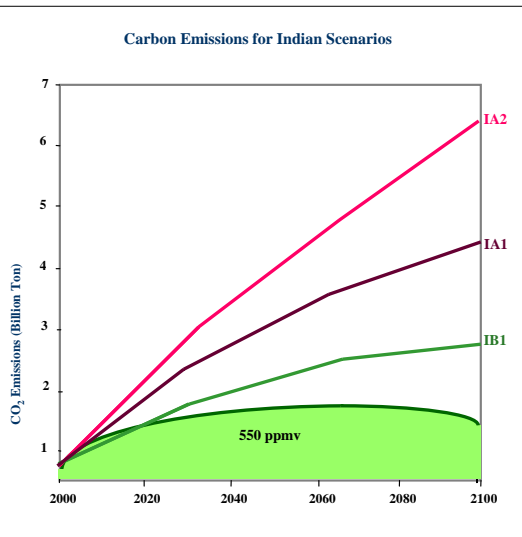
Indian Carbon Emissions Scenarios



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



Indian Emission Scenarios and Stabilization



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)
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?

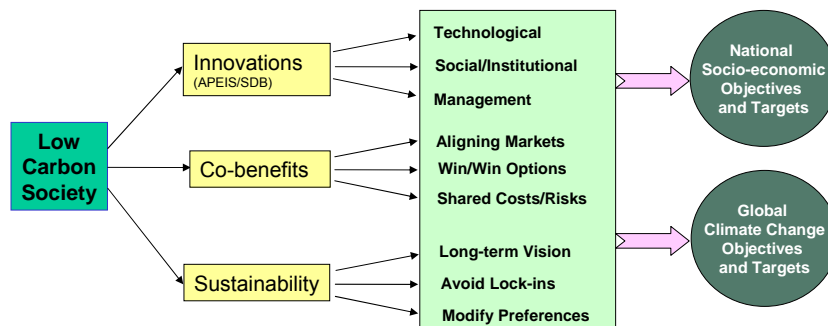
Low Carbon Society (LCS) in Developing Country context?

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.

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

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)

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

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 to align climate change actions with national sustainable development goals?

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)

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

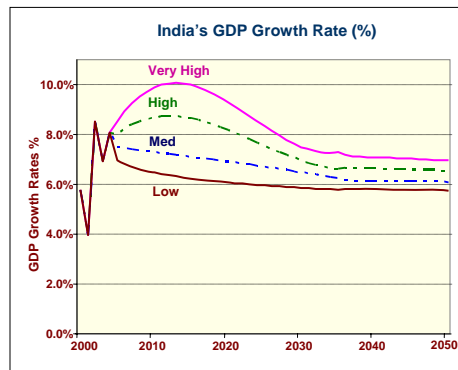
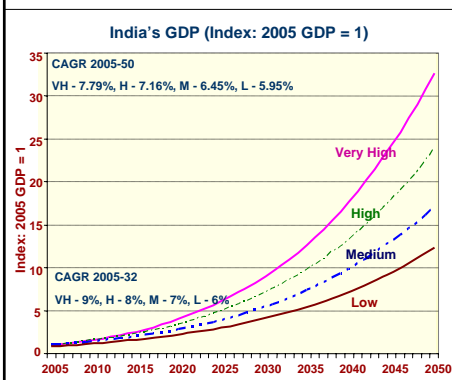
Scenario Drivers

- **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

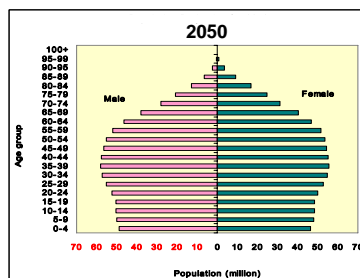
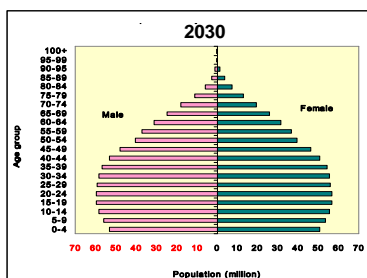
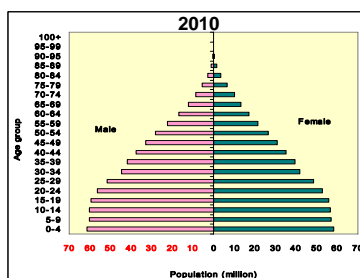
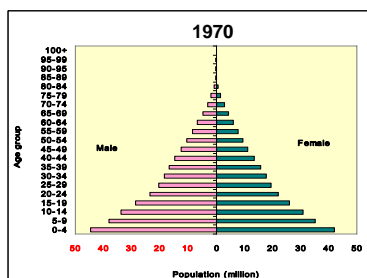
How to align climate change actions with national sustainable development goals?

India's Economic Growth: Future GDP Projections



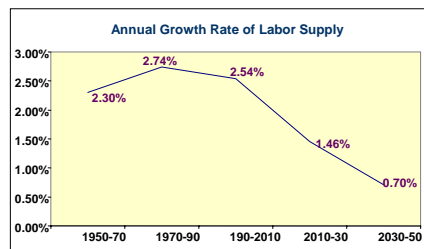
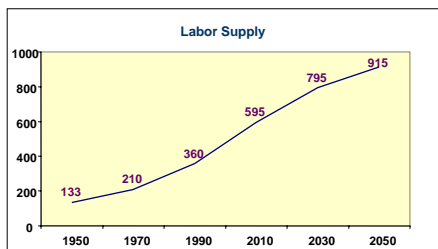
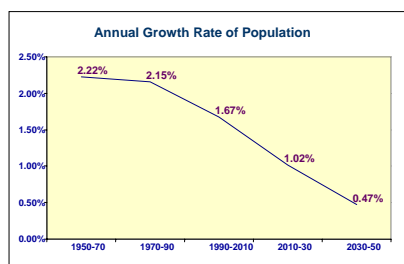
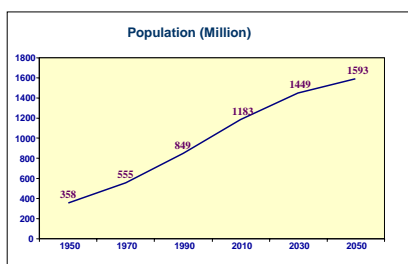
How to align climate change actions with national sustainable development goals?

Demographic Transitions in India: Age/Gender Profile



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

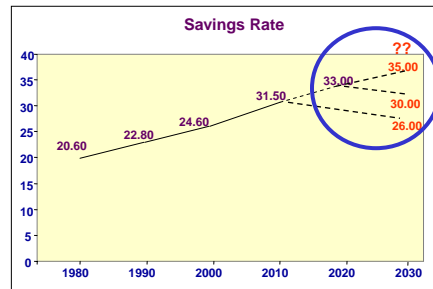
Population and Working Age Population



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

Growth Scenarios

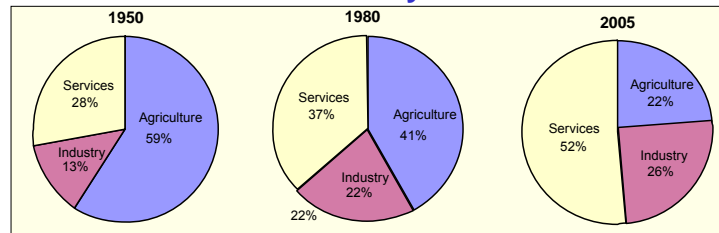
- **Human Capital**
 - Government Expenditure in Education
 - Private Expenditure in Education
 - Urban / Rural & Gender-wise Education Expenditure
 - (Net) Migration by Labor Classes (intra & inter county)
- **R&D**
 - Government/ Private Expenditure
 - Knowledge Flows
- **Technology**
 - Backbones (infrastructures)
 - Learning, transfers, deployment
- **Saving/ Investments**
 - Social Security
 - Lifestyles, Behaviors
- **Governance**
 - Institutions
 - Laws
 - Policies



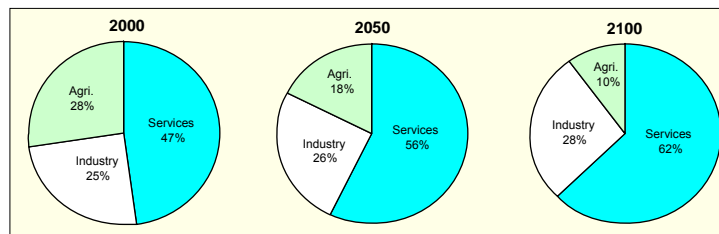
How to align climate change actions with national sustainable development goals?

Changing Structure of the Economy

History



Future



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

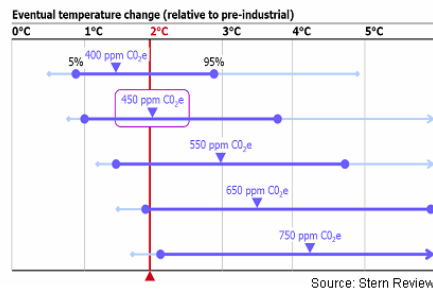
Modeling & Analysis of Low Carbon Development Path

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

Low Carbon Society (LCS) Scenario

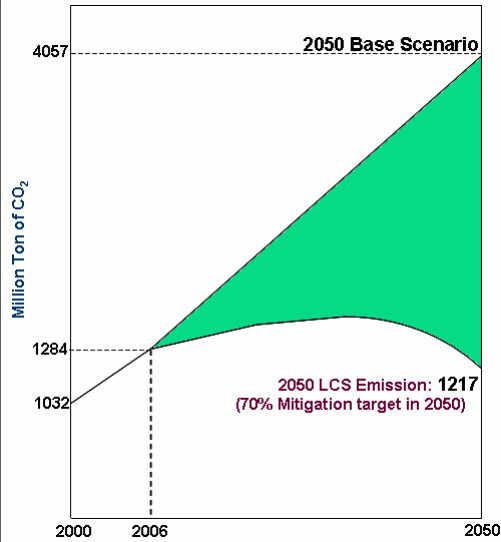
Drivers of India's LCS Scenario

- 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



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

Carbon Emissions: Base vs. LCS Scenario for India

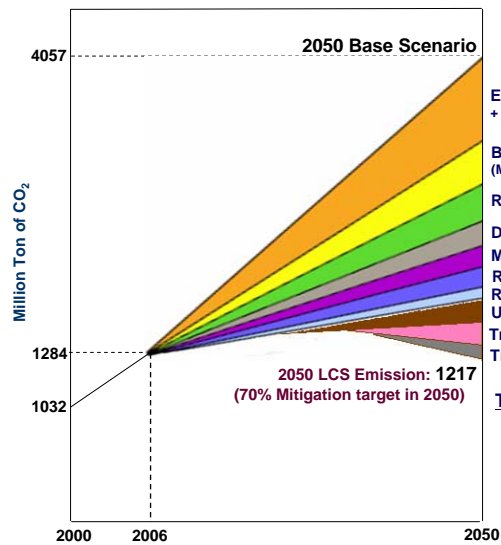


India's Cumulative Carbon Emission from 2000-2050

	<u>Billion Ton of CO₂</u>
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%

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

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 CO₂ Mitigation	2840

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

Mitigation through “dematerialization” in LCS Scenario

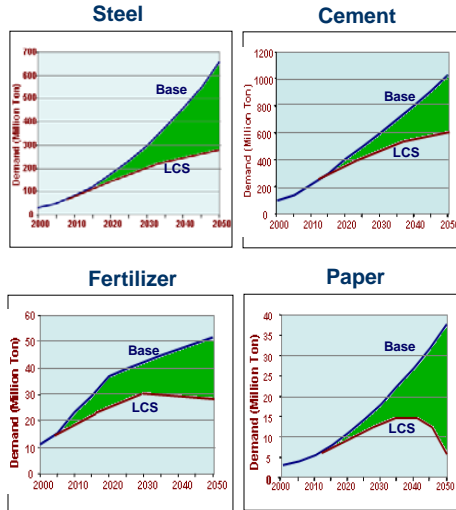
- Dematerialization in LCS vis-à-vis Base Scenario is contributed by multiple direct and indirect policies, most of which belong to the policy packages relating to “sustainable development”.
- Change in building materials and design contribute significantly to dematerialization and energy efficiency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

Mitigation (MT CO₂) in 2050

Material Substitutions	207
Reduced Consumption	173
Recycling	90

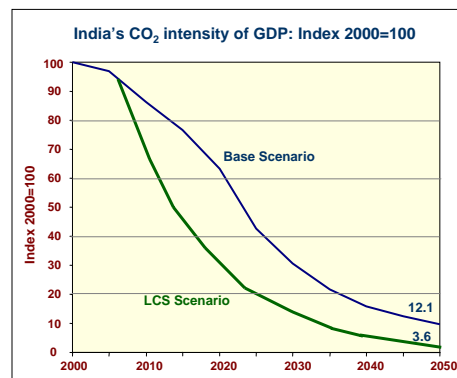
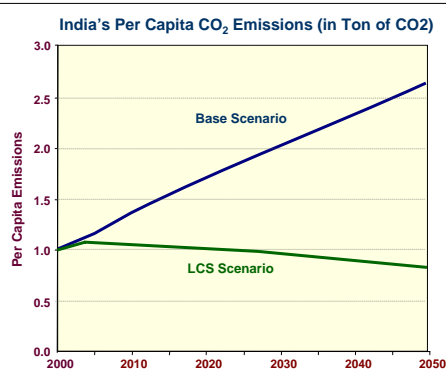
- Energy and carbon intensive materials - of which the substitutions and reduced consumption contribute most to mitigation in the LCS scenario - are steel, aluminum, cement, fertilizer and paper.
- Recycling reduces the energy and carbon intensity of the materials, besides delivering environmental co-benefits.

Materials Demand in Base vs. LCS



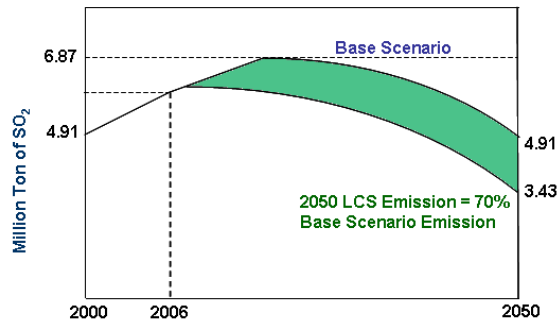
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CO₂ Intensities: Base vs. LCS Scenario



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SO2 Mitigation Co-benefits of LCS Scenario



Joint Mitigation (Period 2007-2050)

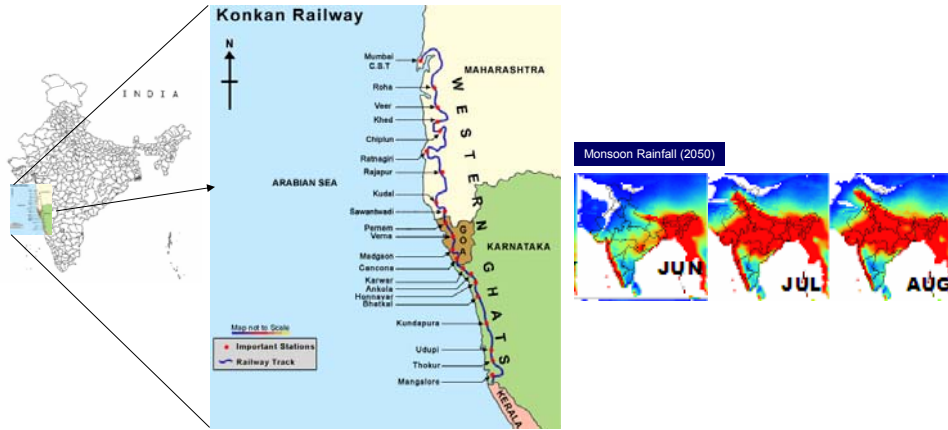
Mitigation Regime	Co-benefits
<i>SO₂ mitigation alone in Reference Scenario</i>	Little carbon mitigation
<i>SO₂ Co-benefit in LCS Scenario</i>	LCS policies generate benefits equivalent to 30% lower SO₂ in 2050 and cumulative saving in SO ₂ Emissions Reduction equivalent to \$11.2 billion over period 2006-2050

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Adapting to Climate Change: Vulnerability and Adaptation of Long-life Assets from Climate Change

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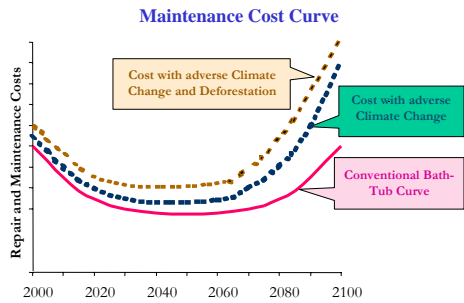
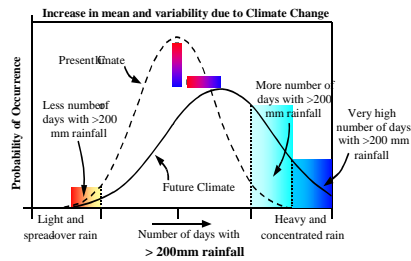
Sustainable Development & Climate: Impacts on Infrastructure



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Sustainable Development & Climate: Impacts on Infrastructure

Increase in Climate Intensity and Variability



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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

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

Thank you

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