Low Carbon Society Project:

Data Availability and Feasibility in India

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Modeling and Data Availability Issues & How to overcome these?

Model Structure and Modeling Issues

Model Structure and Assumptions

- Perfect markets (Foresight, Completeness)
- Perfect property rights and enforceable contracts
- No distortions (perfect equilibrium)
- Path independence (learning effects)

Modeling Issues

- Inadequate (model relevant) database
- Rapidly changing parameters (e.g. saving rates, trade, technologies)
- Changing global interface (PPP vs. Market Exchange Rate)
- Large informal sectors
- Dual economy and transition processes
- Market disequilibria
- Subsistence behavior (not profit maximization)
- Structural changes (e.g. export oriented IT industry in India)

Data Issues related to Traditional Sectors

- Unavailability
- Disparity
- Inconsistency
- Incompatibility
- Unsuitability
- Diversity

Example: Biomass Data Problems

- No database for supply or demand
- No formal data on resources/ technologies
- No price data as most biomass is collected and not traded
- No data for cost estimation, e.g. time spent for collection
- Consistent time series data is rarely available
- Shifting context and local events create wide data fluctuations

How this translates in modeling problems?

- In absence of data, accounting has to be estimation based
- Bottom-up estimations too cumbersome
- Top-down estimates too error prone
- Aggregation is error prone due to diversity of resources and local conditions

Technology Data

- Diverse Technologies and Vintages
- Local Learning
- Existence of Barriers
  - Technical Potential
  - Economic Potential
  - Market Potential
  - Market Penetration
- Data for Future Technologies has to come from Global Databases

Why and how these translate in modeling problems?

- Models assume no market barriers
- Models presume learning effects to be universal
- Technology representation in models is very aggregate and global
- Weak representation of future technologies add to significant uncertainties in long-term projections from models

How to overcome shortcomings to get robust results?

- Aligning “Model” as scientific framework with Art of “Modeling”
  - Structure of the model versus Assumptions
  - From Model Results (Numbers) to Interpretations & Insights
- Modeler as the mediator - translating complex reality
  - Non-market Factors (e.g. multiple criteria assessment)
  - National Priorities and Policies
  - Multiple baselines
  - Secondary benefits
- Modify model inputs to account for deviation from assumptions (E.G.)
  - Introducing “fudge” factors like transaction costs
  - Adding constraints such as on the transforming share of technologies
  - Representing technology and resource diversity through multiple grades
  - Introducing back-stop technologies
- Data for New and Future Technologies from Global Databases
  - Shared Databases
  - Global Modeling and Assessment Co-operations (e.g. AIM, EMF, PNNL)
- Consistency and Validation of National Scenarios
  - Internal consistency of global scenario storylines across regions and countries
  - Consistent and common assumptions
  - Consistency of Macro - Micro (i.e. Top-Down/Bottom-up) Assessments

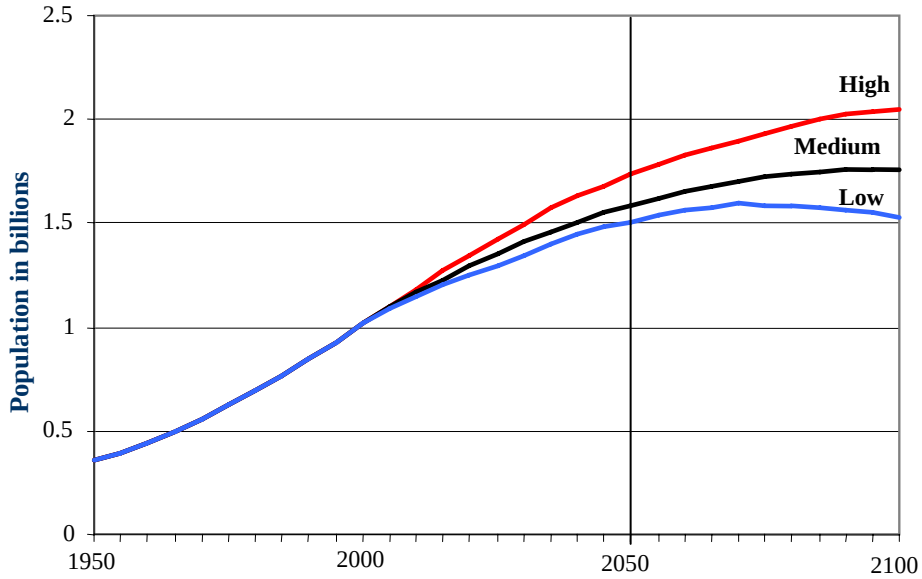
Feasibility of Low Carbon Society in India in 2050: Aligning Development and Climate

Drivers of Future Emissions

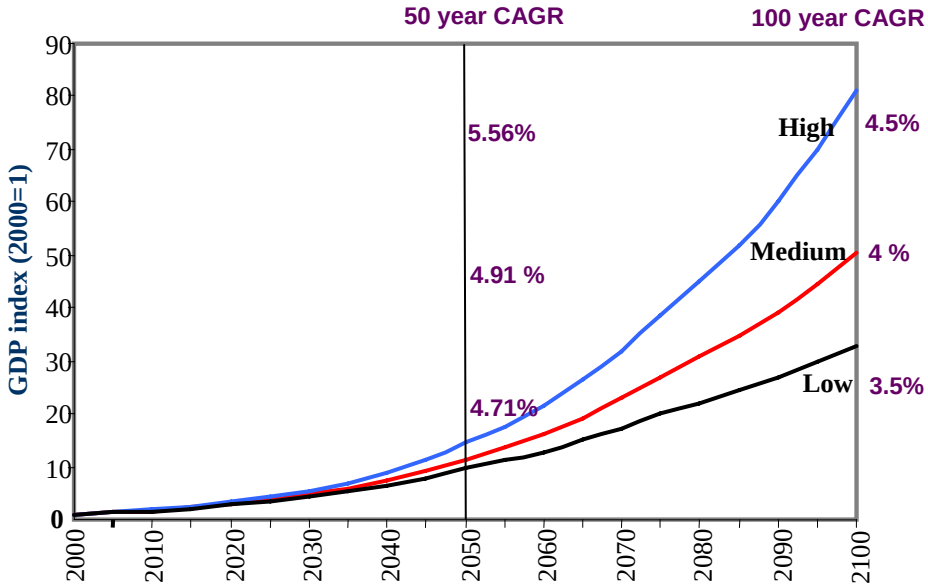
Conventional Drivers

- Population
- Economic Growth
- Energy Resources
- Technologies

Population



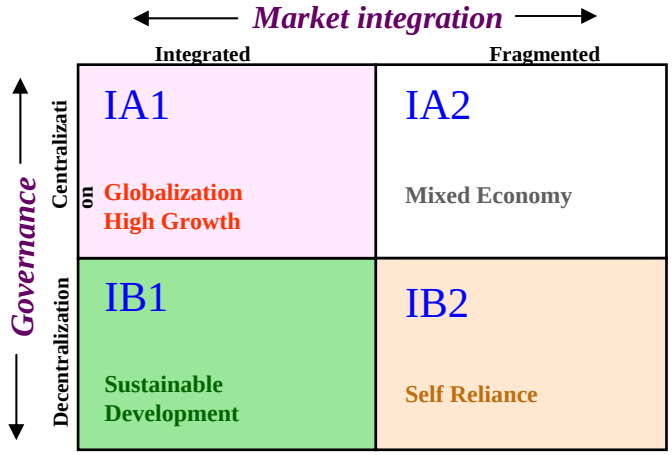
Economic Growth

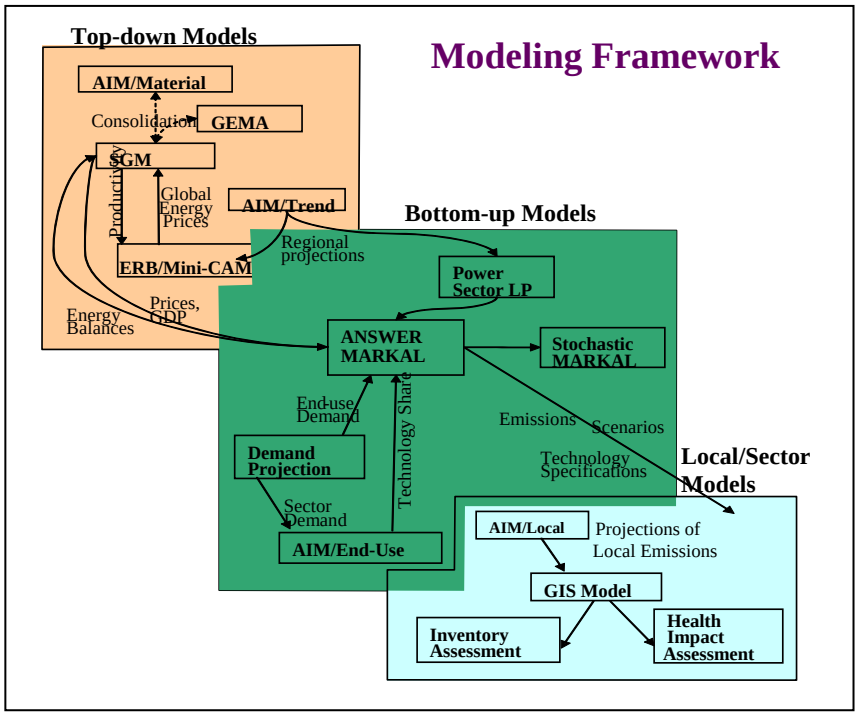


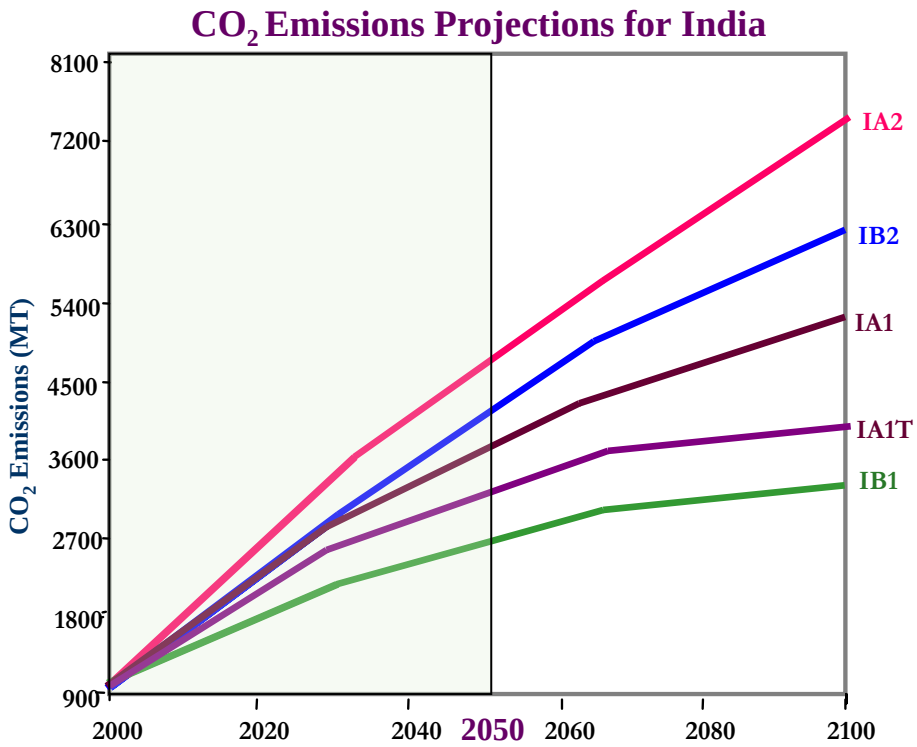
Emerging Drivers for Developing Countries

- Transition Processes (Lock-ins)
- International Labor Markets
- Human Capital
- Knowledge Flows
- Governance (Risks, Investments)

Indian Emissions Scenarios

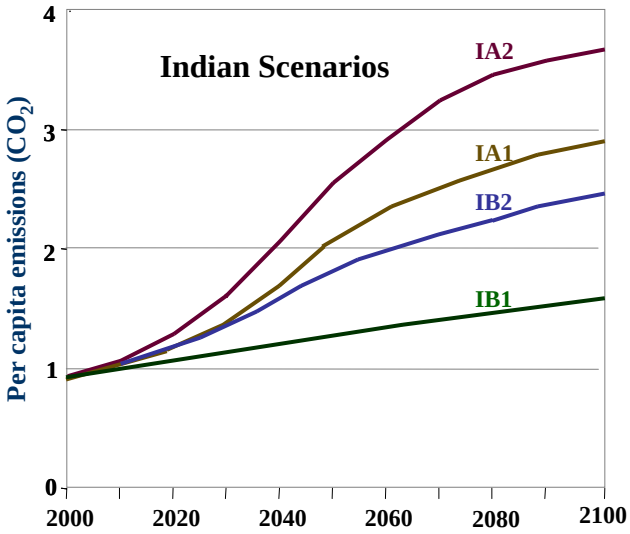


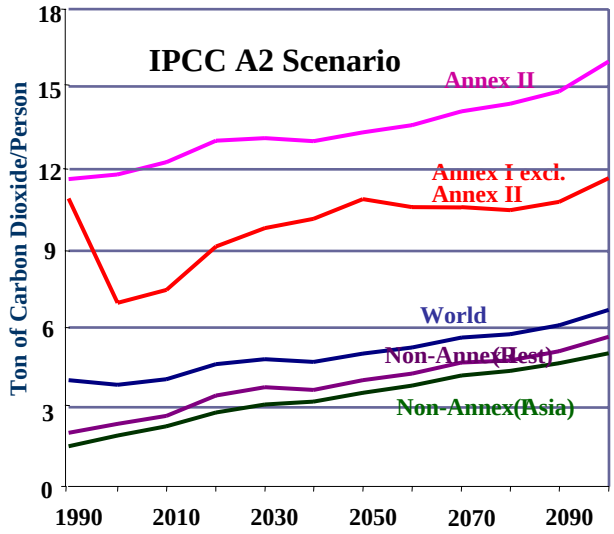




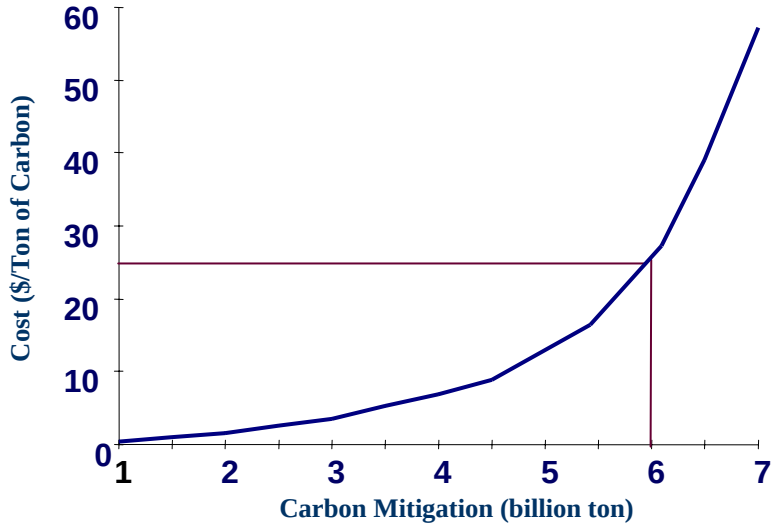
Indian Emissions: Equity and Cost-effectiveness

Per Capita CO_2 Emissions



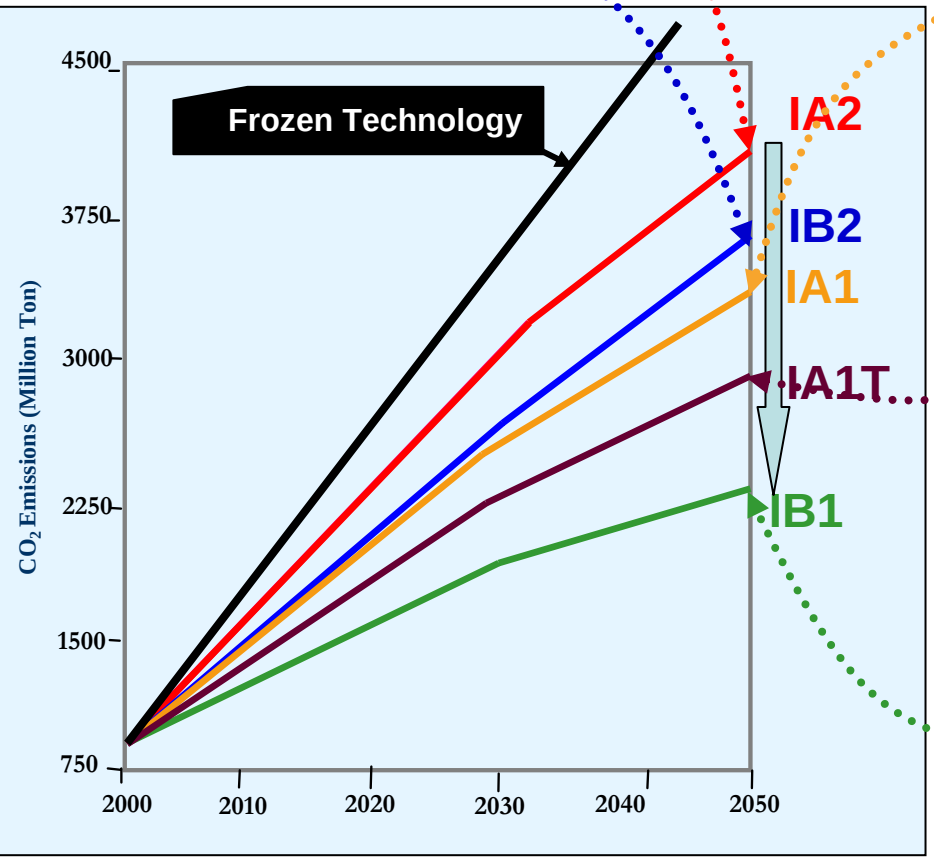


Mitigation Supply-curve from India 2005-2035)



Technologies in Scenarios

Conventional Technology Paths: Include significant endogenous technological change

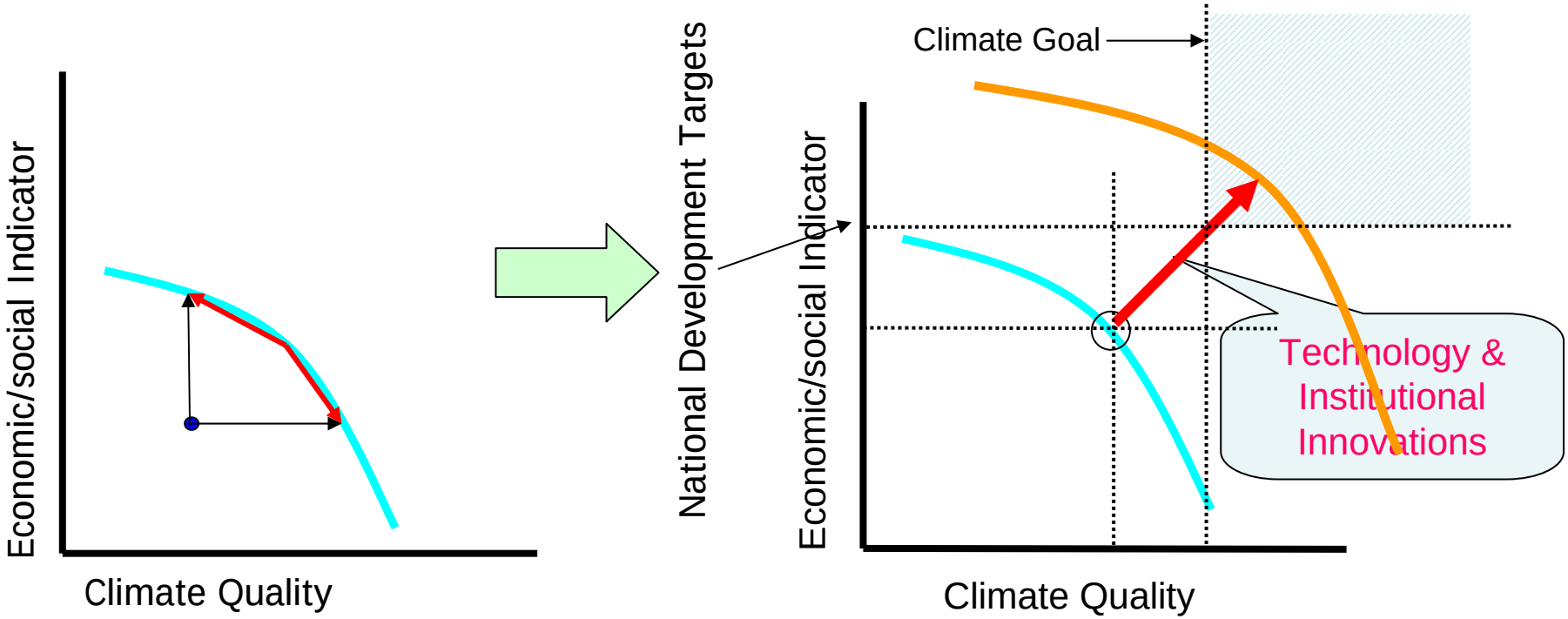


- Synfuels, Next-Gen Nuclear Fission
- Fuel cell vehicles, Pipeline networks
- Energy efficient appliances/ infrastructure
- Coal liquid, IGCC, Hydrogen from gas

- Nuclear (Thorium), Carbon-free hydrogen
- Information highways, High speed trains
- Advanced materials, Nanotechnology

- Push for renewable energy & recycling
- Bikeway, Advanced car sharing system
- Substitution of transport by IT
- Dematerialization, Material substitutions
- Sustainable habitats & land-use practices

Aligning Development and Climate

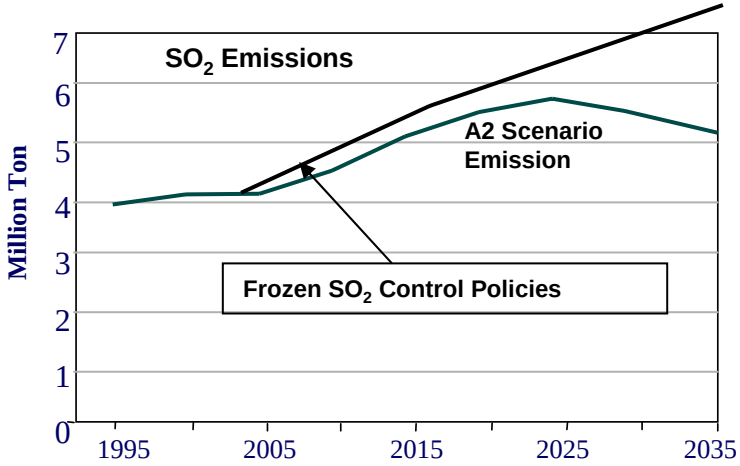


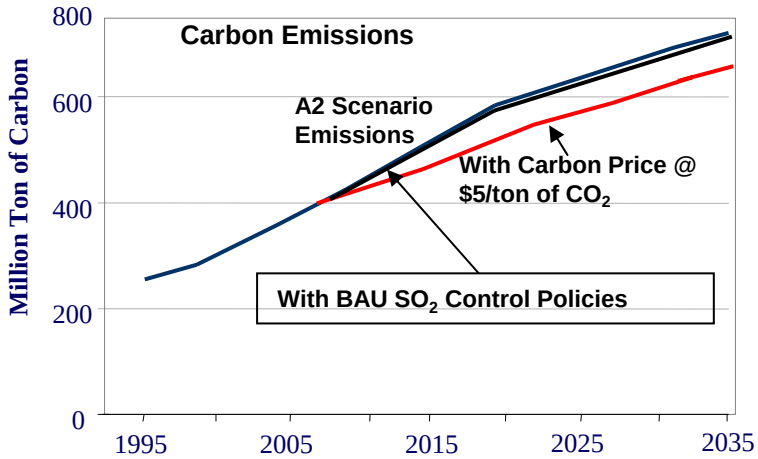
Aligning Development & Climate Actions to Gain Multiple Dividends

Indian Examples

- **Air Quality and GHG Mitigation**
- **Energy Security and GHG Mitigation**
- **South-Asia Regional Energy and Economic Cooperation and Climate**
- **Infrastructure Investment and Climate Risks**

Joint SO2 and CO2 Mitigation

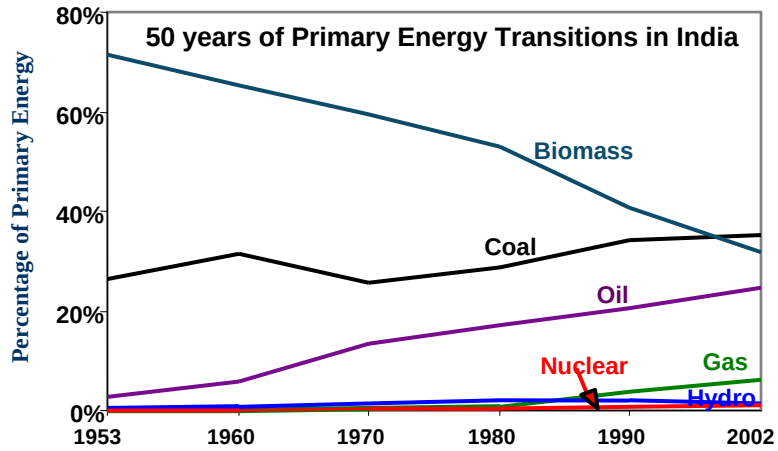




Joint Mitigation (Period 2005-2030)

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

Energy Security and GHG Mitigation



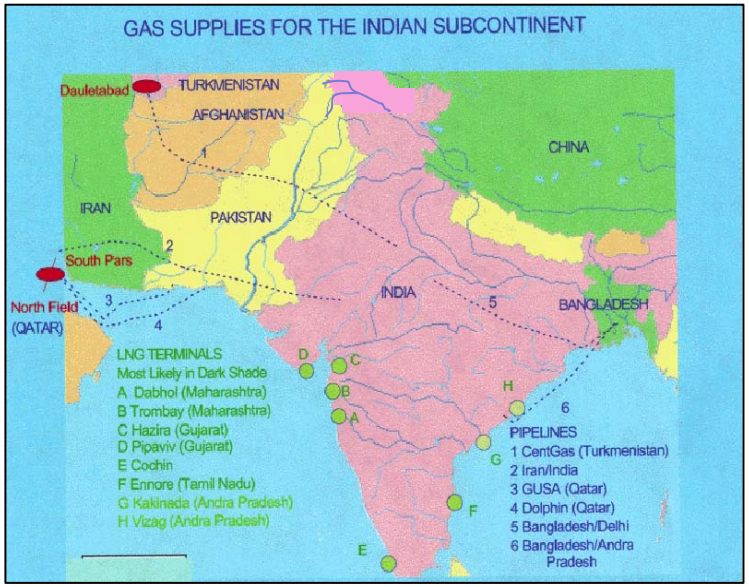
Energy Security: How choices matter to climate?

- **Domestic Coal – High Emissions**
- **Nuclear Fission – Carbon Free, Safety Issues**
- **Wind – Limited Potential, Supply stability**
- **Solar – High upfront cost, Supply stability, Storage**
- **Bio-fuels**
  - *Ethanol – Food Security, Water Stress*
  - *Bio-Diesel – Land Restoration, Employment*

Indian Bio-diesel Mission

- **Phase I (2003-07):Demonstration Projects**
  - *Crop: Jatropha Curcas*
  - *400,000 hectares of land*
  - *Participation by Oil Companies*
- **Phase II (2007-2012)**
  - *Self Sustaining Expansion of Biodiesel*
  - *Production target 1.2 MT of oil/ hectare*

South-Asia Energy Cooperation

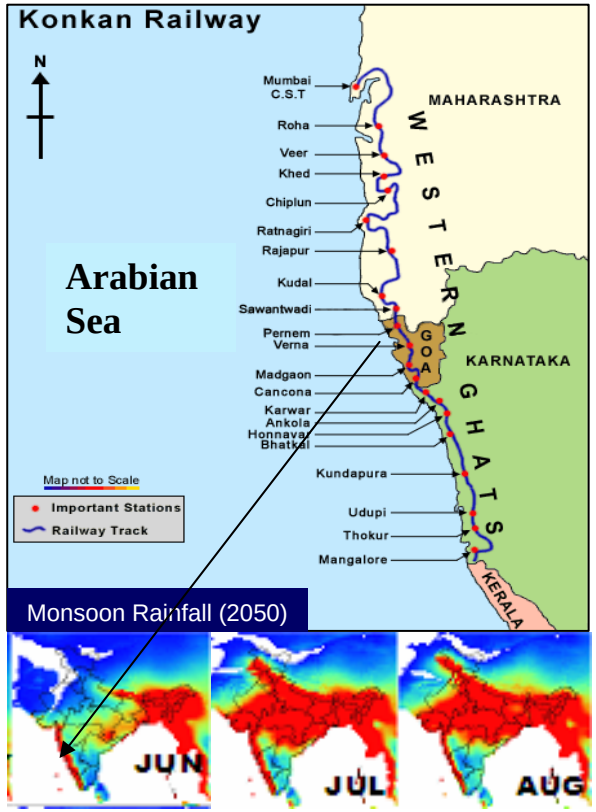


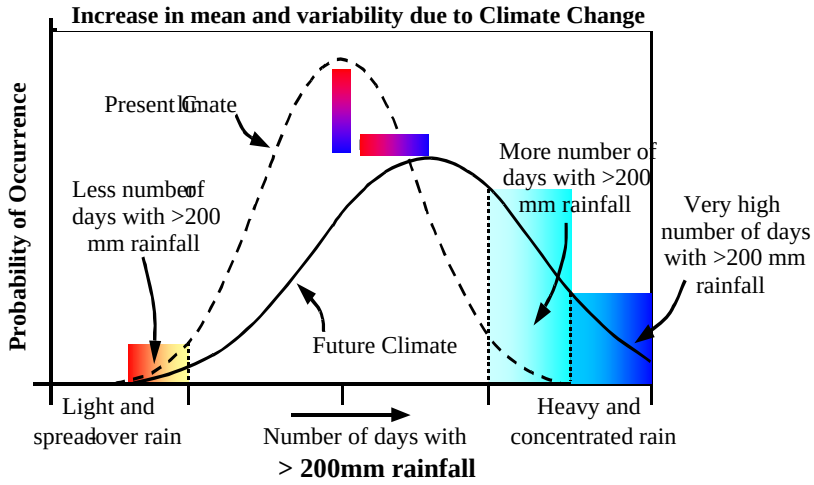
Benefit (Saving) Cumulative from 2010 to 2030		$ Billion	% GDP
Energy	60 Exa Joule	321	0.87
CO_2 Equiv.	5.1 Billion Ton	28	0.08
SO_2	50 Million Ton	10	0.03
	Total	359	0.98

Spillover Benefits:

- 16 MW additional Hydropower
- Flood control
- Lower energy prices would enhance competitiveness of regional industries

Infrastructure and Climate





Conclusions

- Data and assessment capability problems in developing countries can be overcome by cooperative modeling (e.g. multi-national teams as in AIM project)
- Modeling assessment deliver robust results and insights for crafting policies, measures, instruments and technology strategies for transitions to low carbon society by 2050.
- Strategies for low carbon future should begin with shaping endogenous development path
- Stabilization would require mitigation even in low endogenous emission scenarios
- Achieving cost-effective global transition to low carbon future would call for substantial mitigation and adaptation actions in Developing Countries
- Stabilization would significantly alter energy system
- Policies and measures for achieving "*National Sustainable Development Goals*" provide climate friendly opportunities
- Aligning development and climate actions would accrue multiple dividends from co-benefits/spillovers and reduce '*climate burden*'