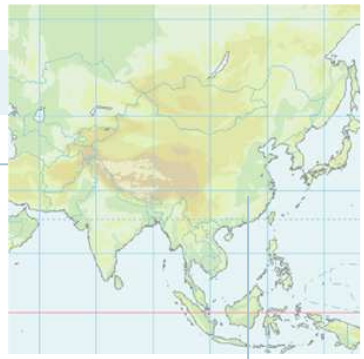


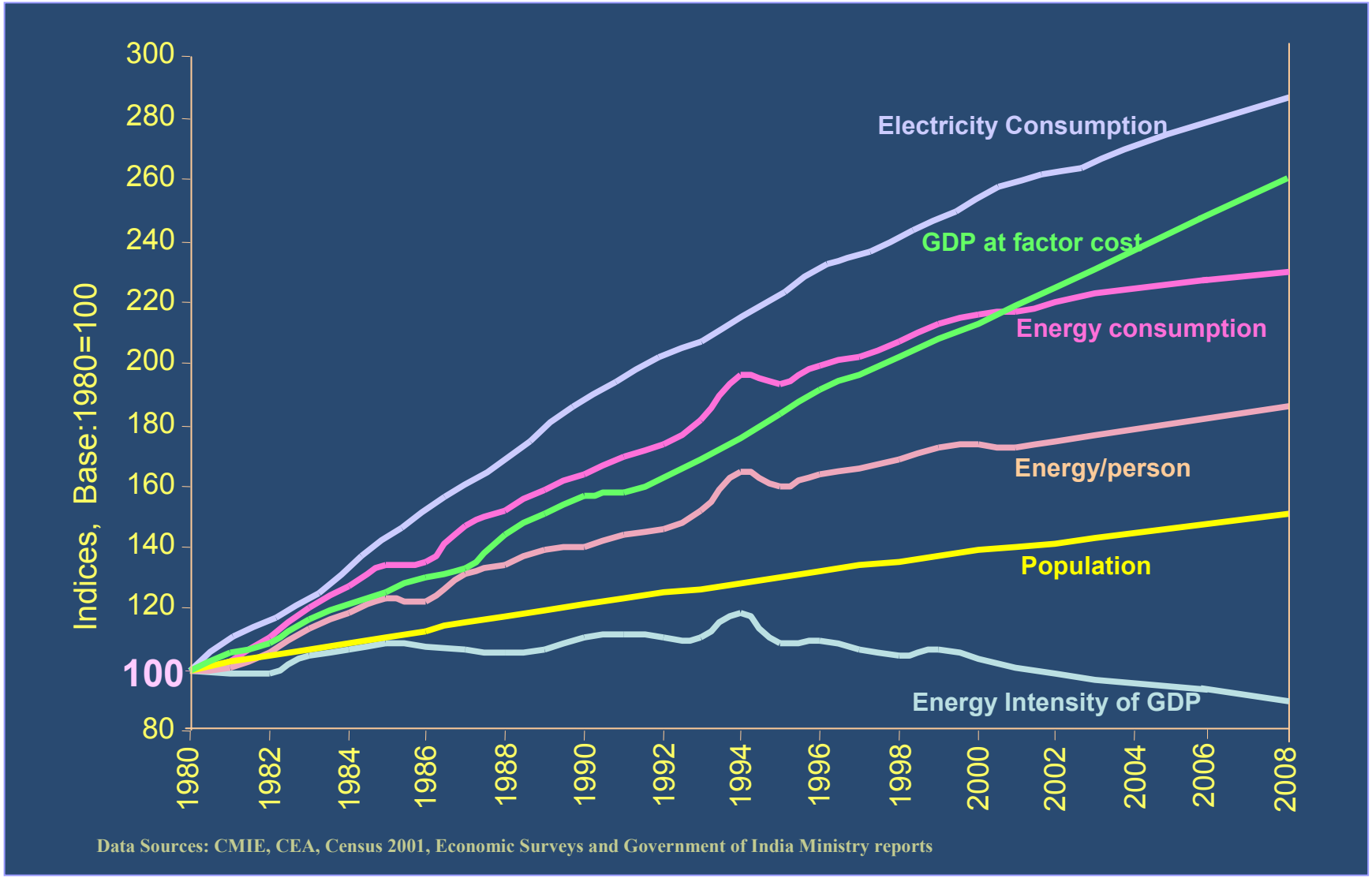
Low Carbon Scenarios for India:

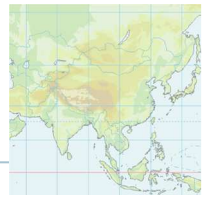
Modeling and New Scenarios Framework

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

Presented in the
'14th AIM International Workshop'
Tsukuba, Japan, February 15-16, 2009

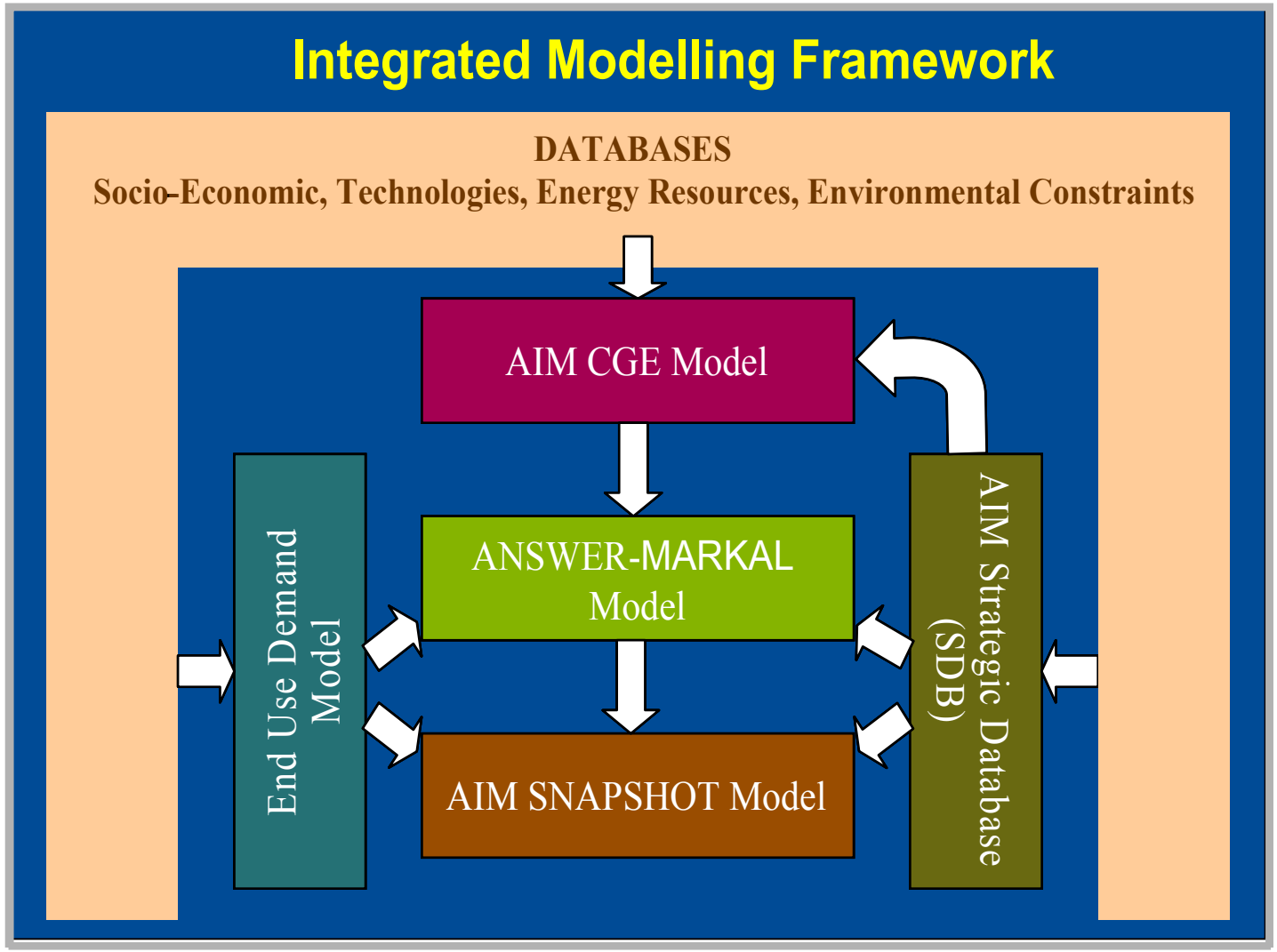
India Economy-Energy-Emissions Trends



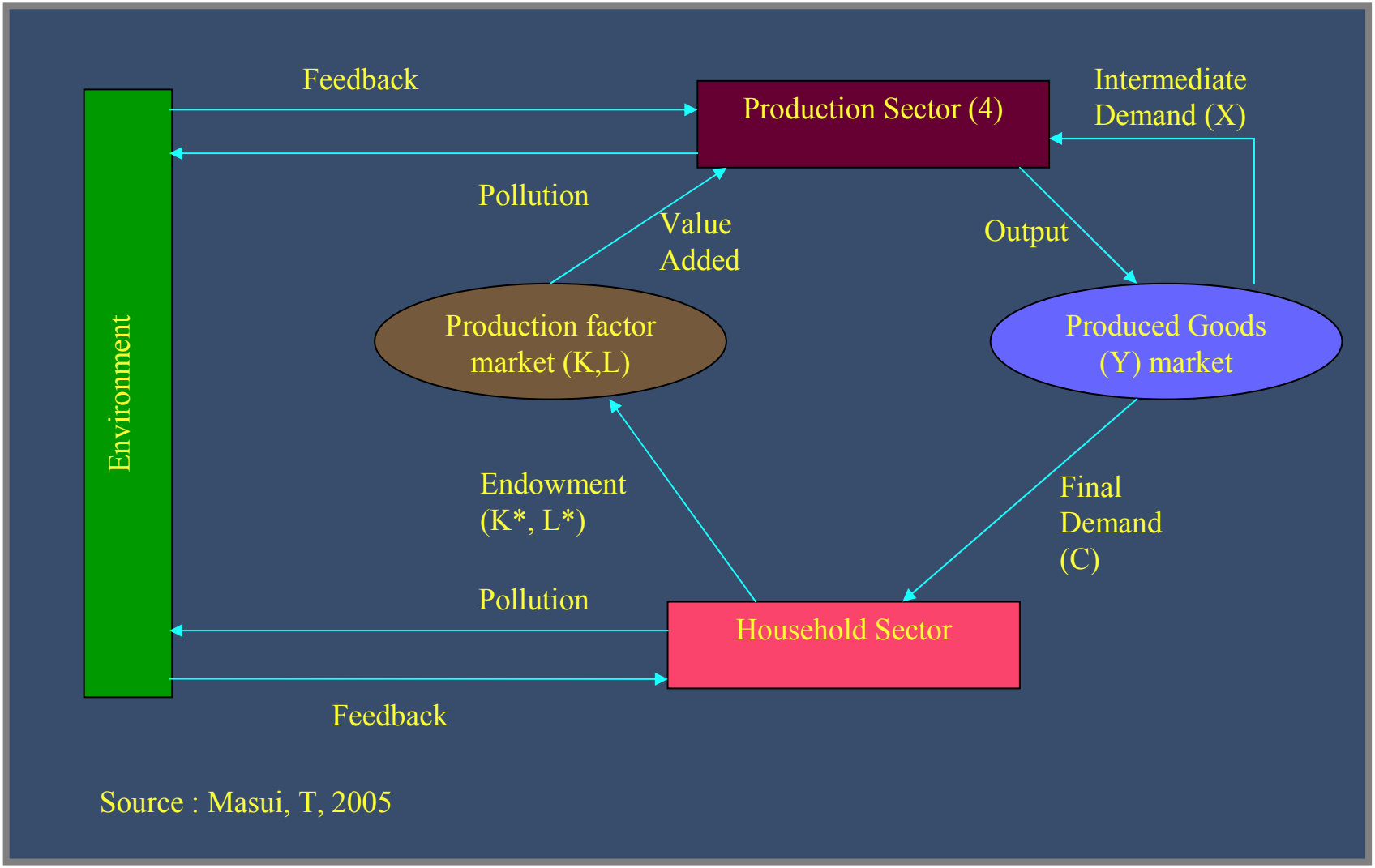


Modeling Framework

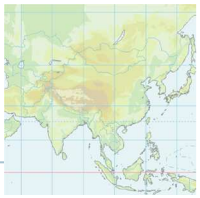
Integrated Modeling Framework



AIM CGE Framework

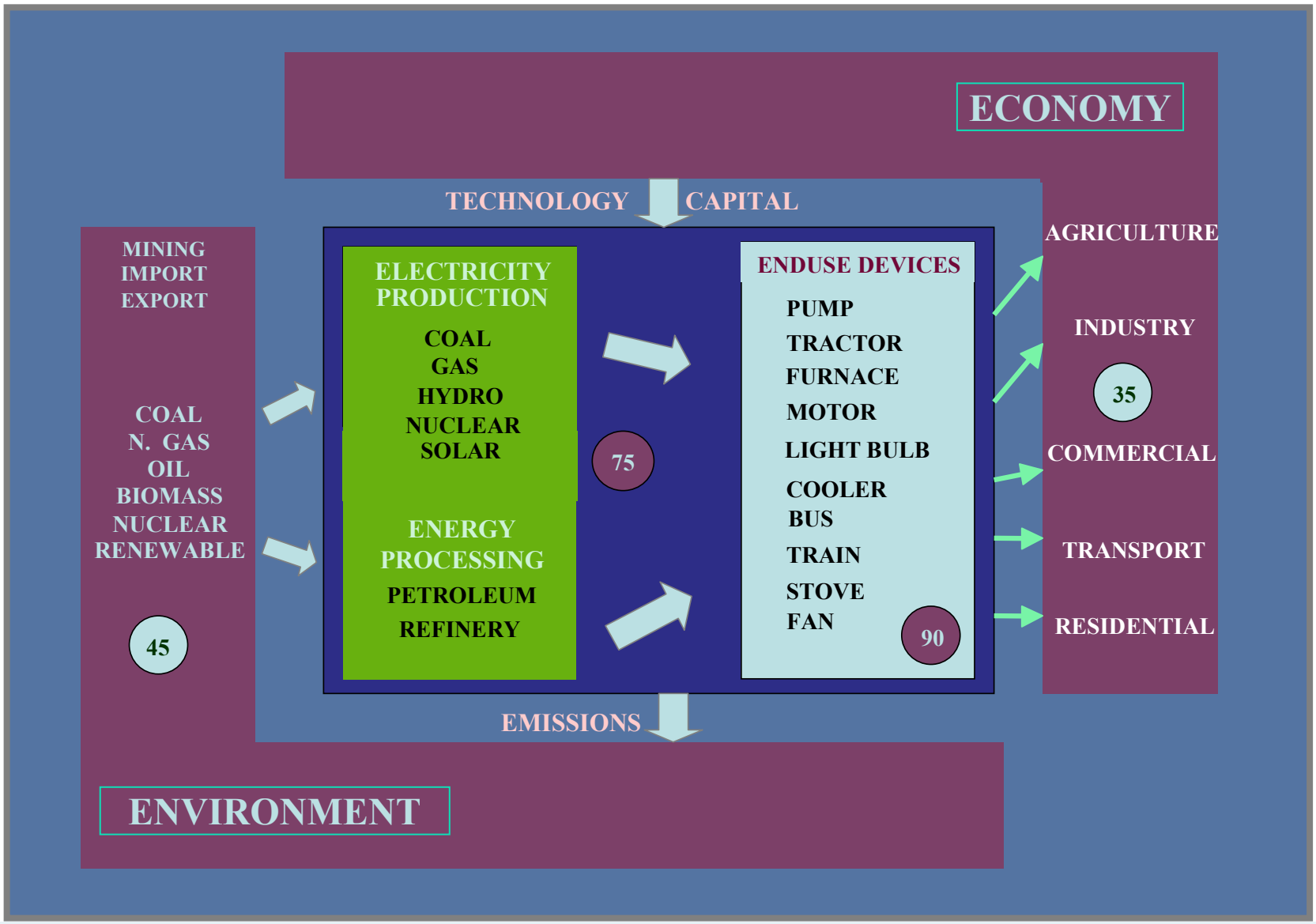


India AIM CGE Data Structure

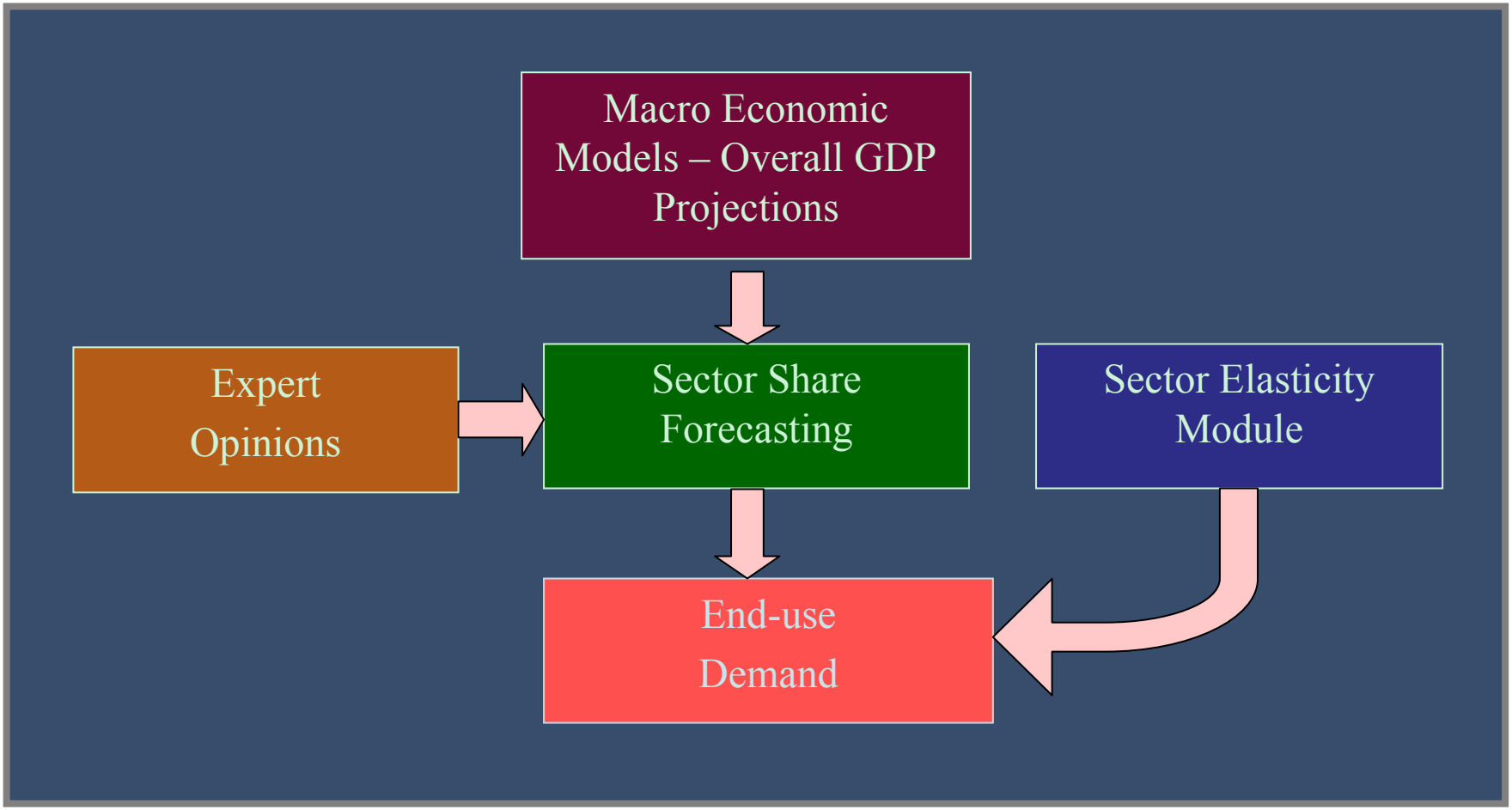


1. Indian I/O Table (1998-99)
   - 115 X 115 Commodity
2. Aggregated to
   - 8 Sector X 8 Sector
     - 5 Energy Sectors
       - Coal, Oil, Gas, Nuclear, Renewable
     - 3 Production Sectors
       - Agriculture, Manufacturing, Services
3. Exogenous Inputs
   - Carbon Tax trajectory
   - Fossil fuel prices

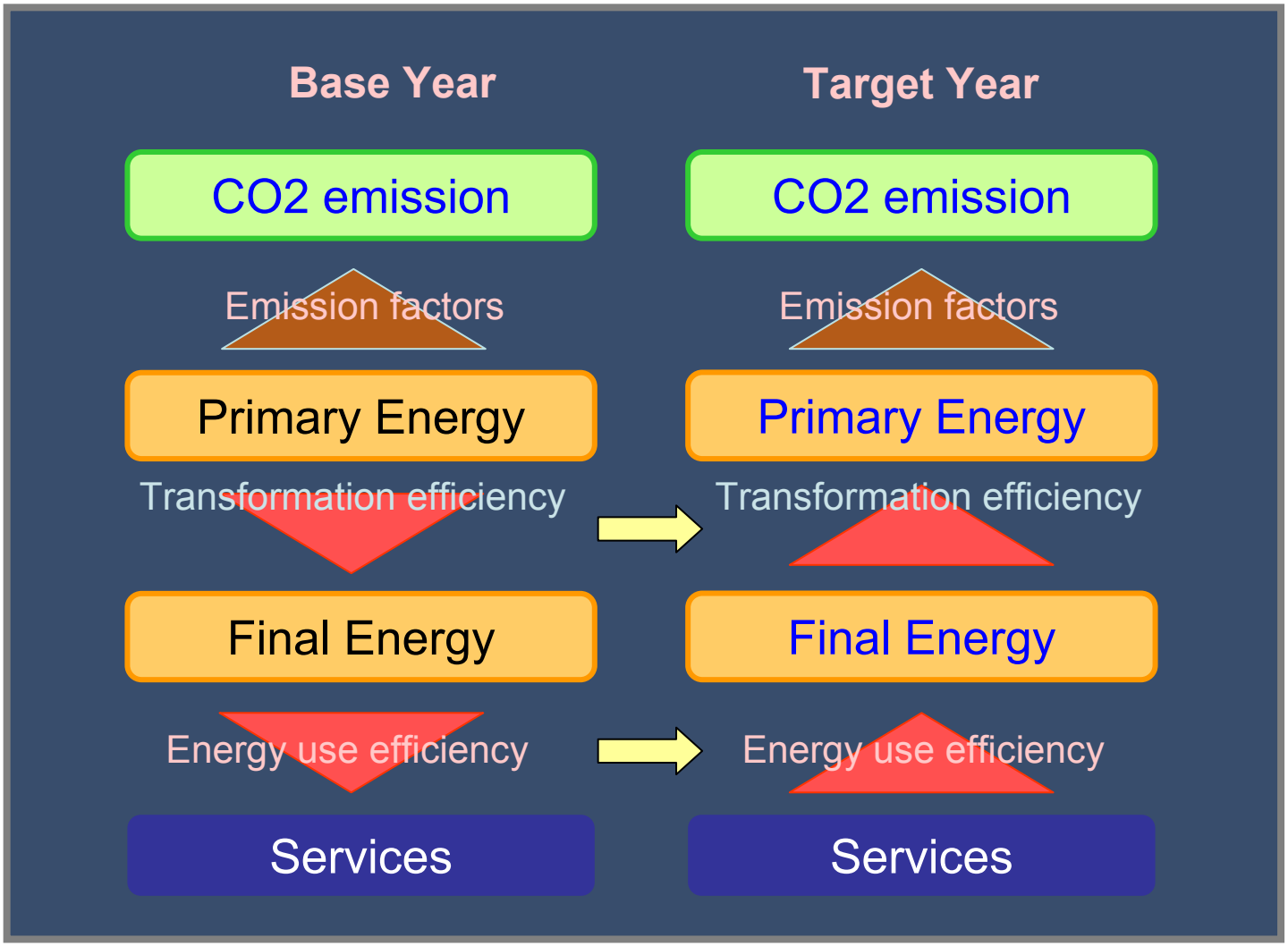
Energy Economy Environment System

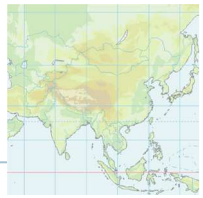


End-Use Demand Projection Model



AIM SNAPSHOT





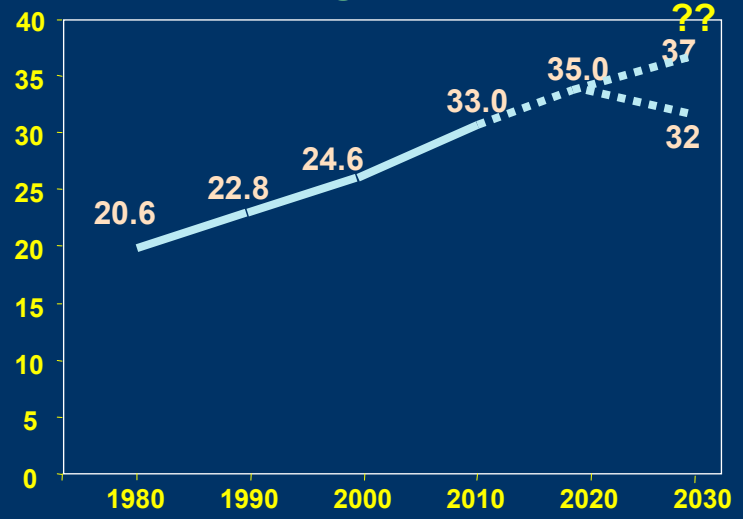
Base Case Projections

Base Scenario: Assumptions

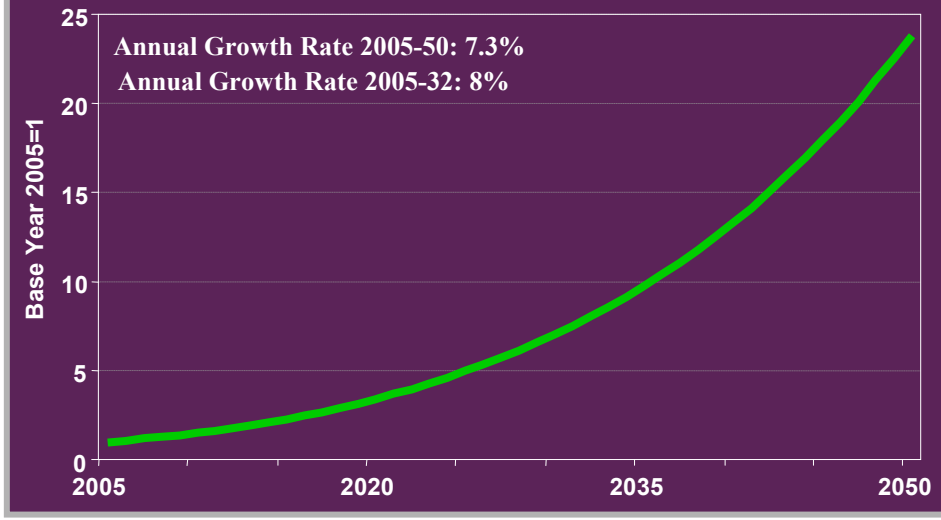
Base Scenario

1. GDP
   - Ann. Growth Rate: 7.2% from 2005-50
   - 2050 Economy: 23 times larger than 2005
2. Population
   - 2000: 1021 Million
   - 2050: 1593 Million
3. 650 ppmv CO2e Concentration Stabilization (or 550 CO2)
4. 4.7 W/m2 Radiative Forcing

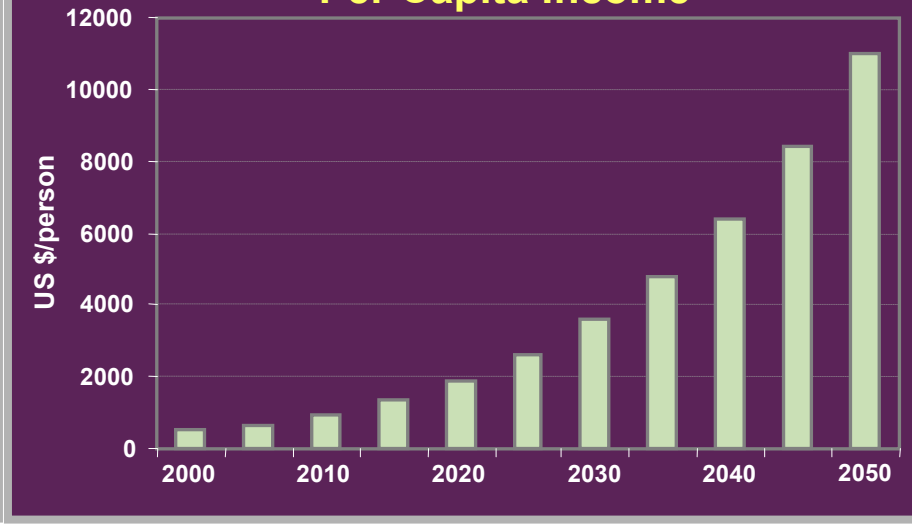
Savings Rate



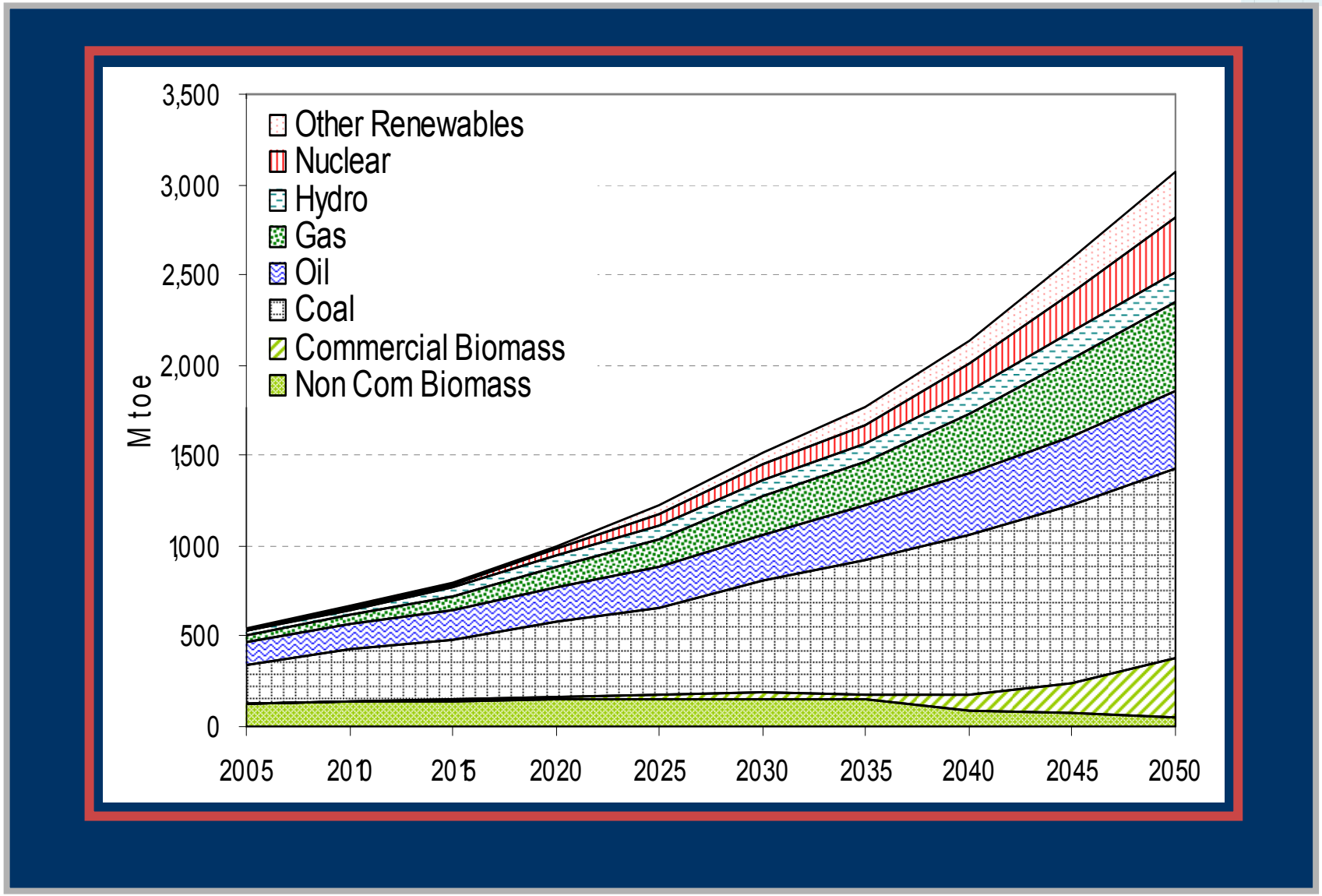
GDP



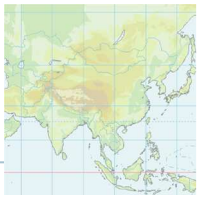
Per Capita Income

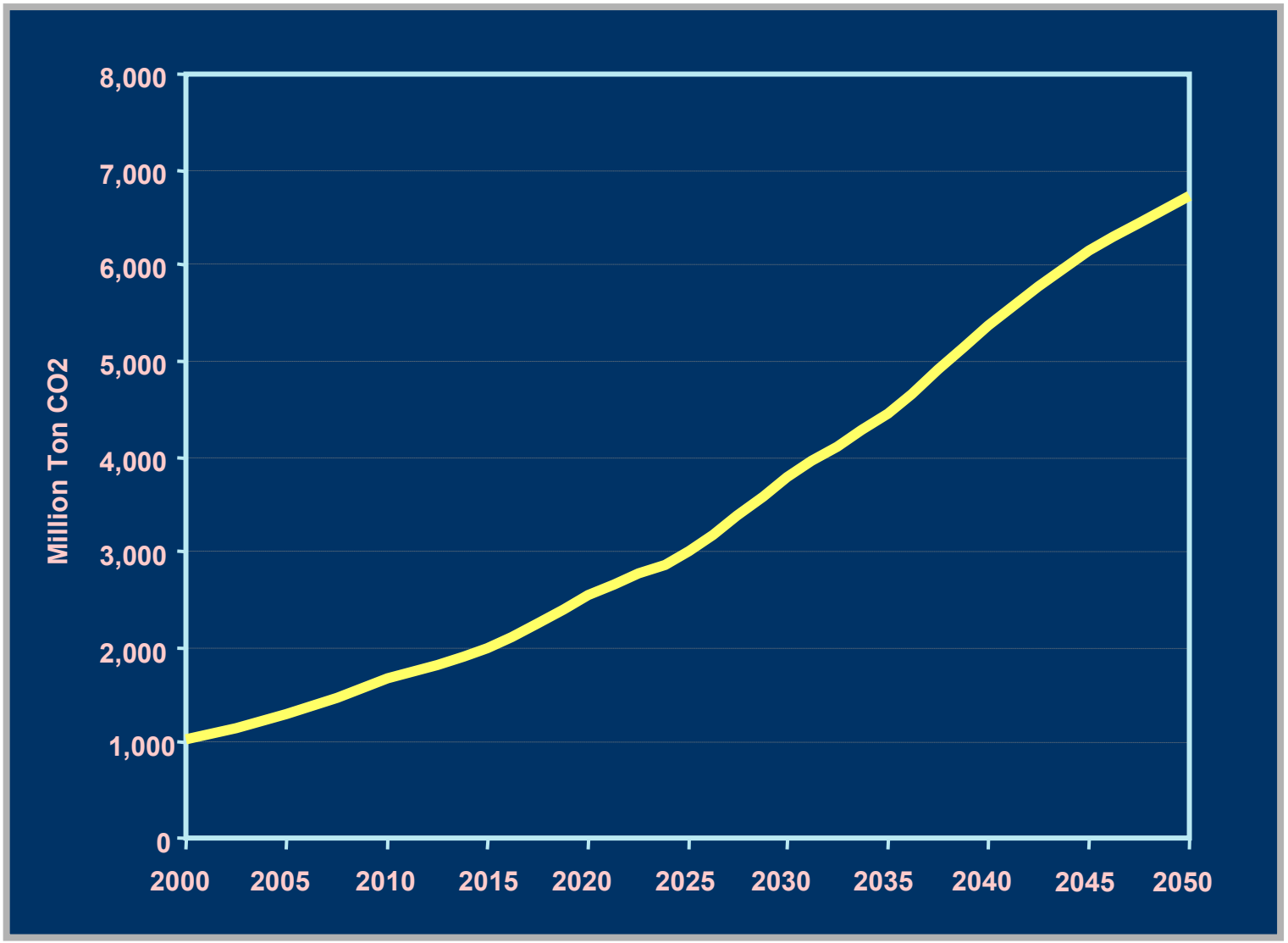


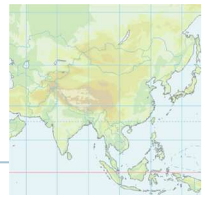
Future Energy Mix: India



Future Carbon Emissions: India

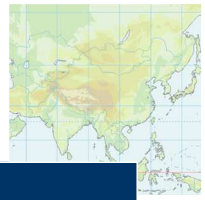






LCS through Conventional Climate Centric Vision

Alternate Development Visions



Stabilization Target and Visions

1. Global Stabilization Target Assumption:

- 550 ppmv CO2e Concentration
- 3.4 W/m2
- @ 3° C temperature increase (50:50)

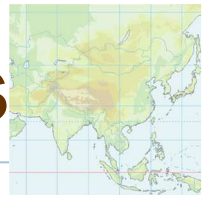
2. Two Development Pathways for India:

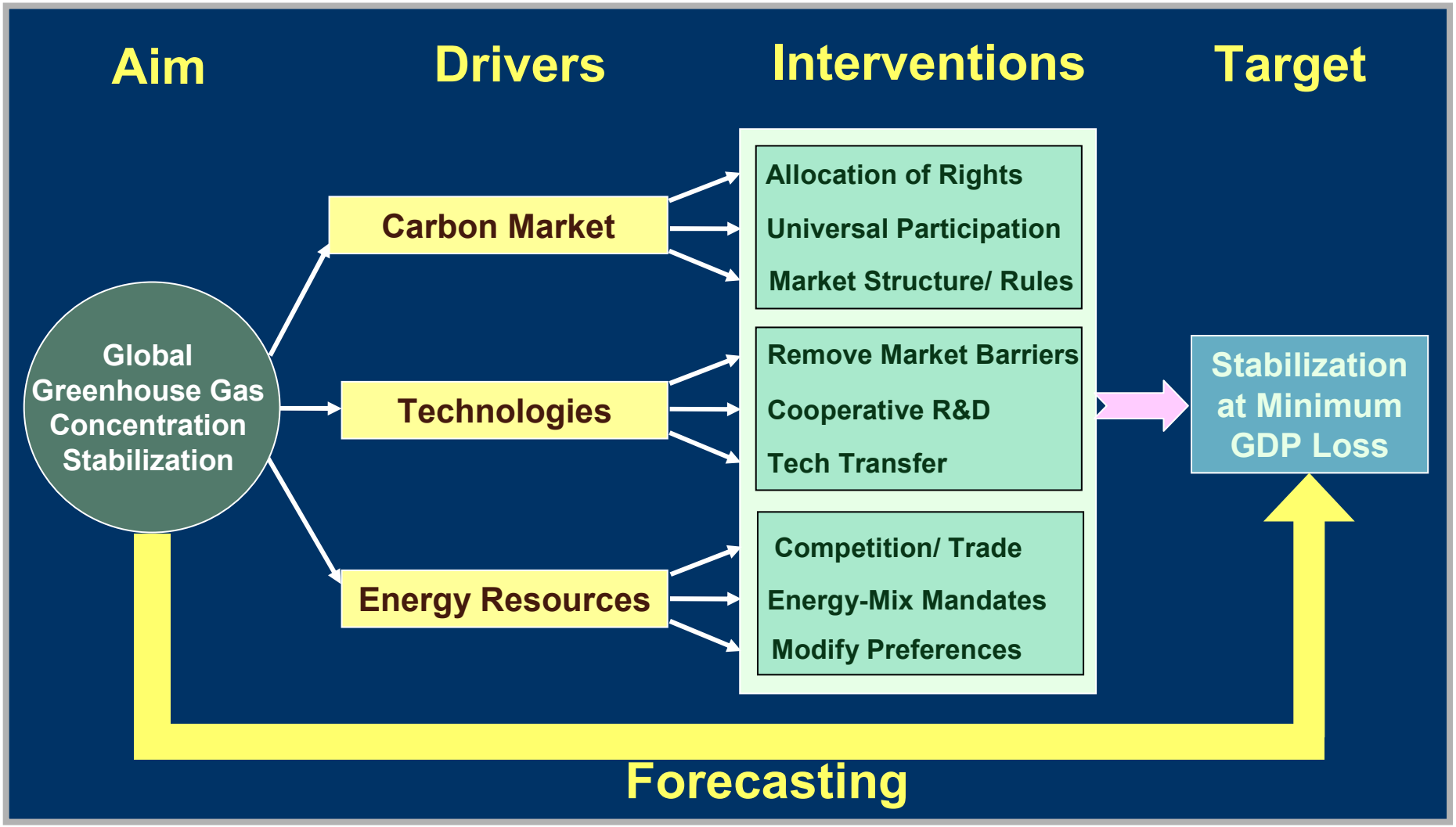
(with same total CO2 emissions from 2005 to 2050)

1. Conventional Vision: Climate Actions at Margin of Conventional Development path
2. 'Sustainability' Vision: Aligning Climate Actions with Mainstream Development Actions

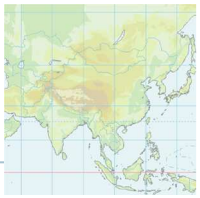
What path shall best deliver national development goals while fulfilling Climate Commitments?

LCS via Climate Centric Actions

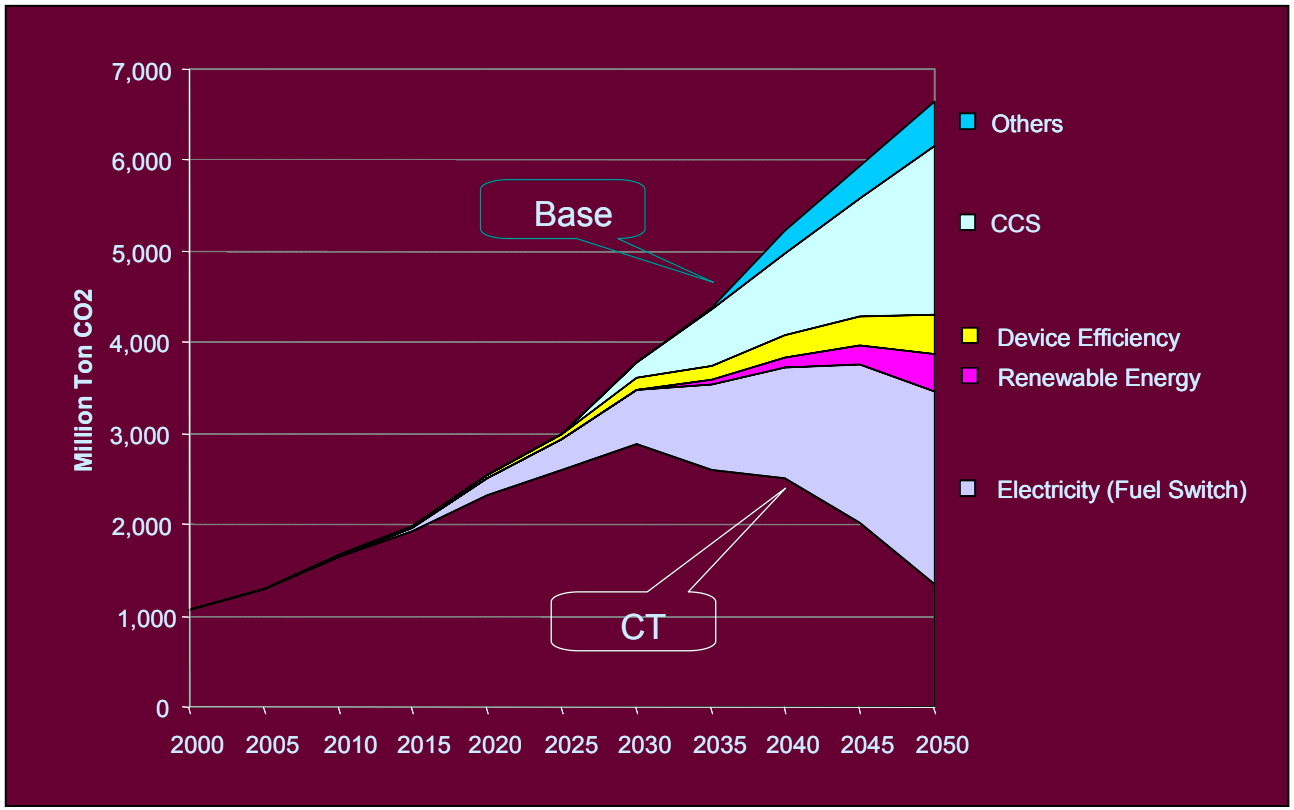


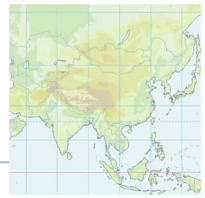


Vision I: Climate Centric Scenario



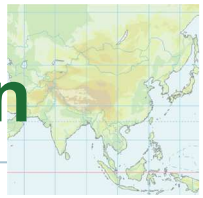
1. Top-down/Supply-side actions
2. High Carbon Price as main instrument
3. Climate Focused Technology Push





LCS with Sustainability

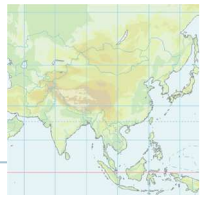
India: National Climate Change Action Plan

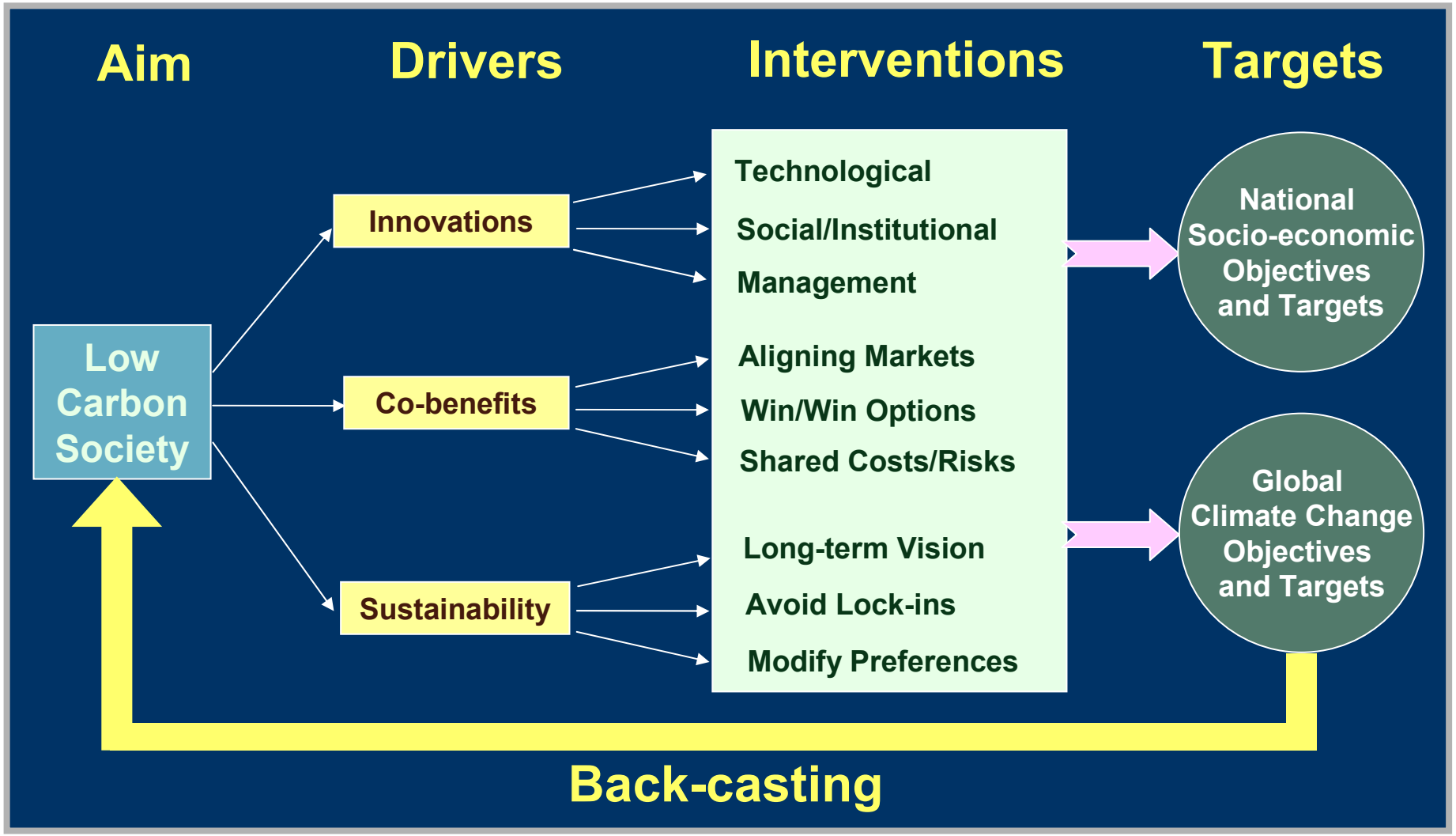


8 National Missions:

1. Solar Energy (100 MW PV/yr; 1000 MW Thermal by 2017)
2. Enhanced energy efficiency (10000 MW saving by 2012)
3. Sustainable habitat
4. Water Sector (20% water use efficiency improvement)
5. Sustaining the Himalayan eco-system
6. A “Green India” (6 Mil. Hectare afforestation; Forest cover from 23 to 33%)
7. Sustainable agriculture
8. Strategic knowledge for climate change

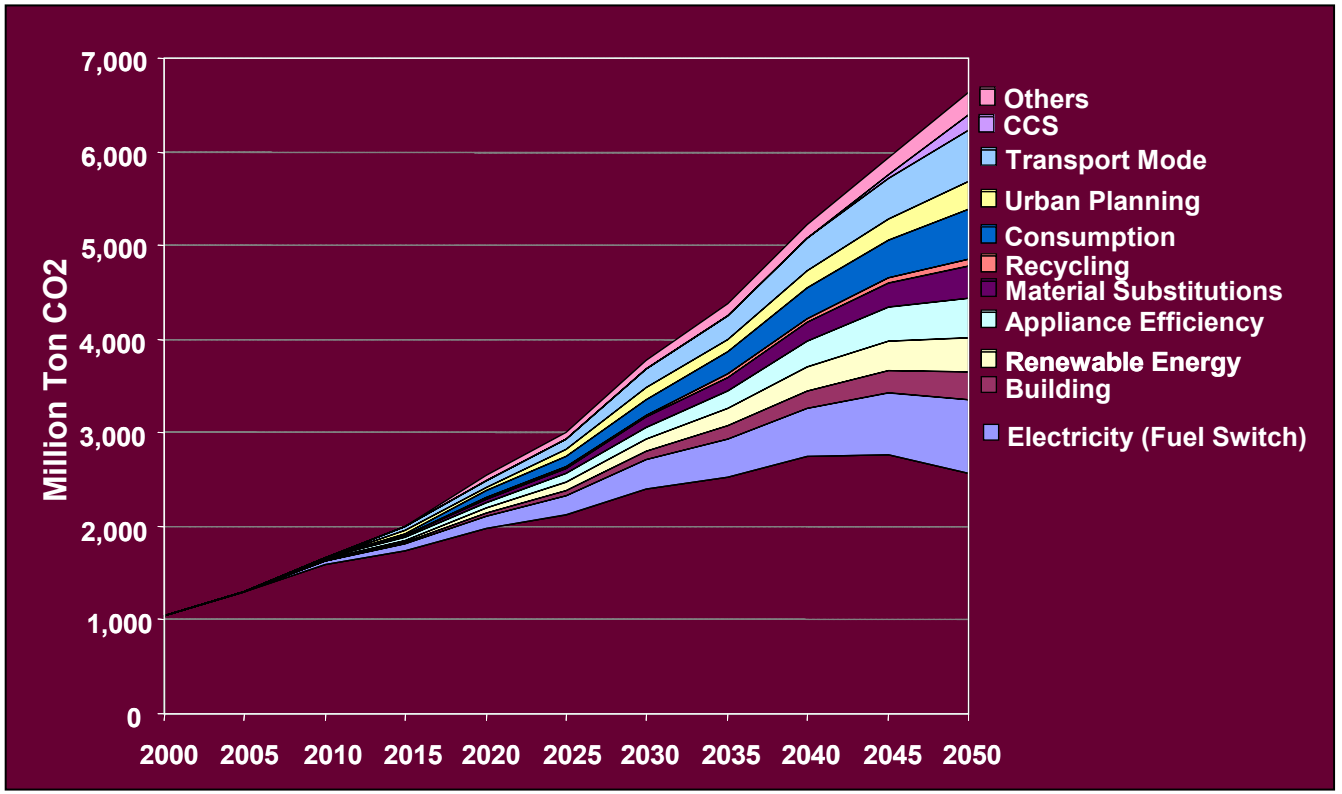
LCS with Sustainability





Vision II: Sustainability Scenario

1. Low Carbon Price
2. Bottom-up/Demand-side Actions
3. Behavioural Change
4. Diverse Technology Portfolio



Sustainable Cities: Planning and Infrastructures

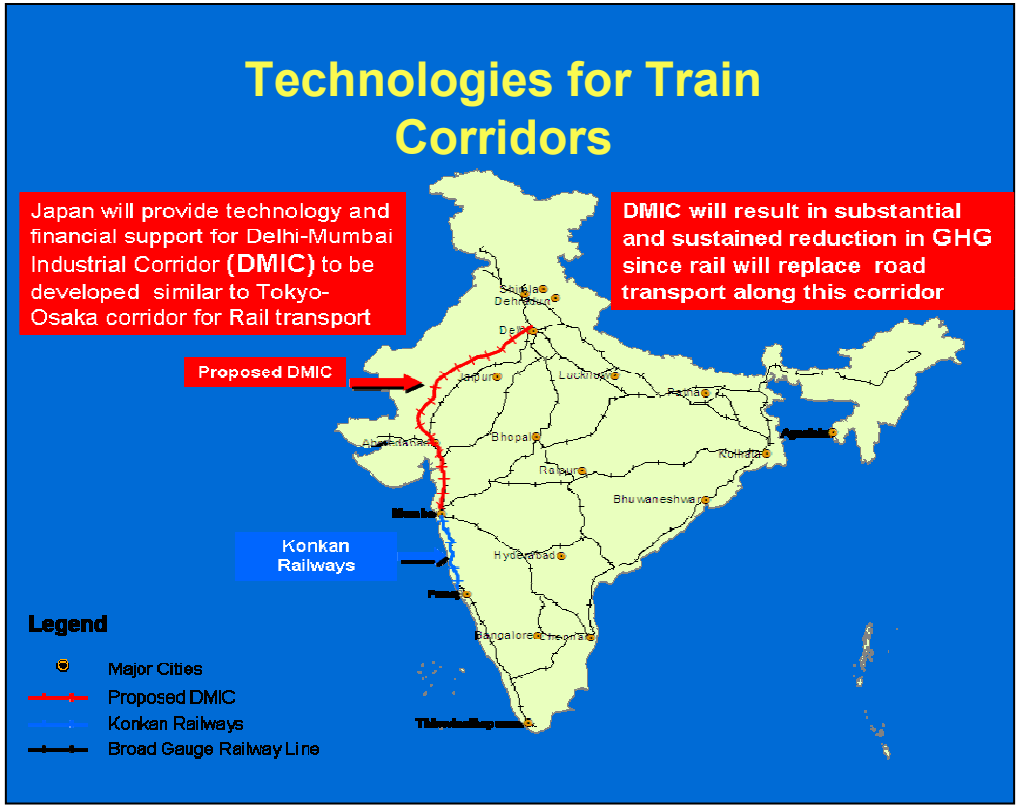
- Land-use Planning
- Building Choices
- Infrastructures
- Service Networks

Bus Rapid Transport System

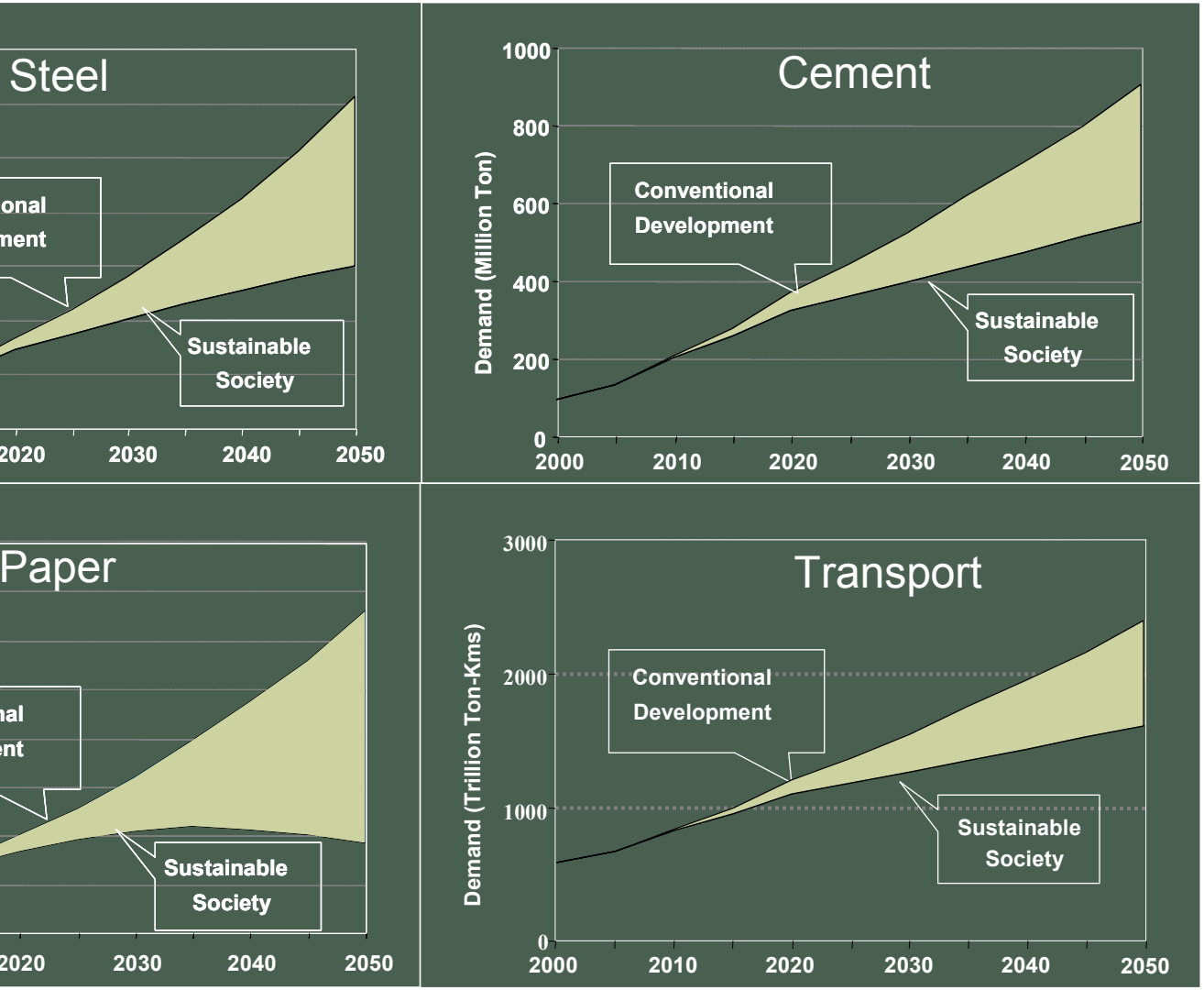
Technologies for Train Corridors

Japan will provide technology and financial support for Delhi-Mumbai Industrial Corridor (DMIC) to be developed similar to Tokyo-Osaka corridor for Rail transport

DMIC will result in substantial and sustained reduction in GHG since rail will replace road transport along this corridor

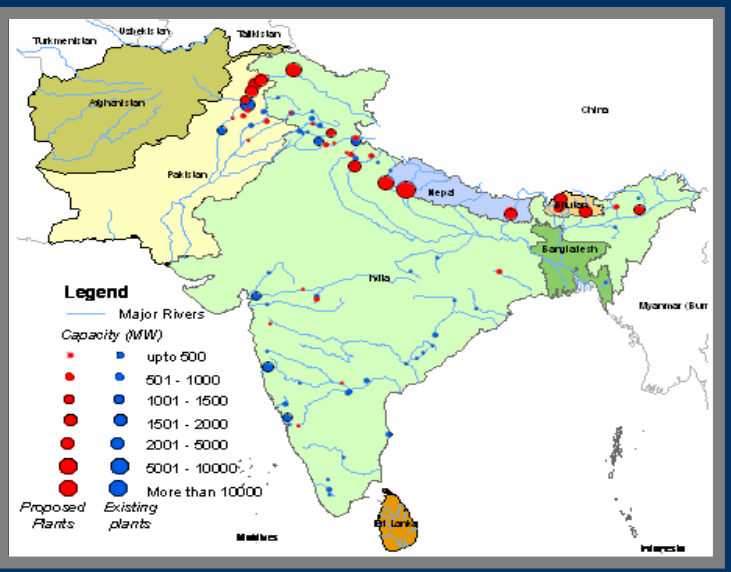


Dematerialization



Co-benefits of Energy Choices

MDG 1: Eradicate extreme poverty and hunger, MDG 7: Environmental Sustainability



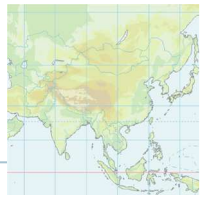
Co-benefits of South-Asia Integrated Energy-Water Market

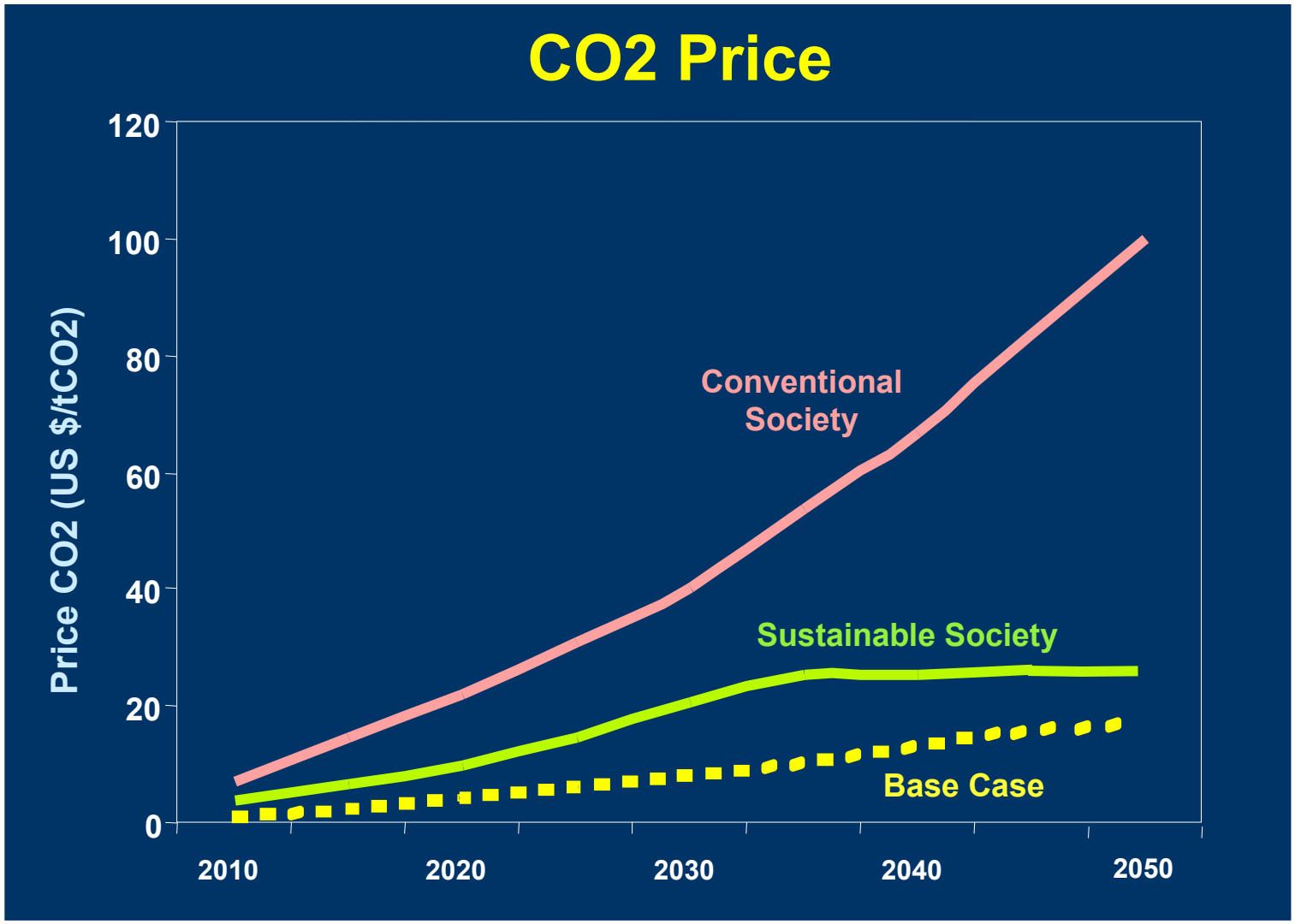
Benefit (Saving) Cumulative from 2010 to 2030		$ Billion	% GDP
Energy	60 Exa Joule	321	0.87
CO_2 Equiv.	5.1 Billion Ton	28	0.08
SO_2	50 Million Ton	10	0.03
	Total	359	0.98

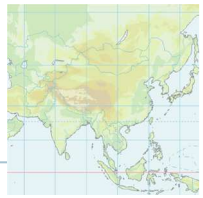
Spill-over Benefits / Co-Benefits

- 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)

LCS with Lower Carbon Prices

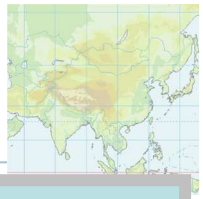


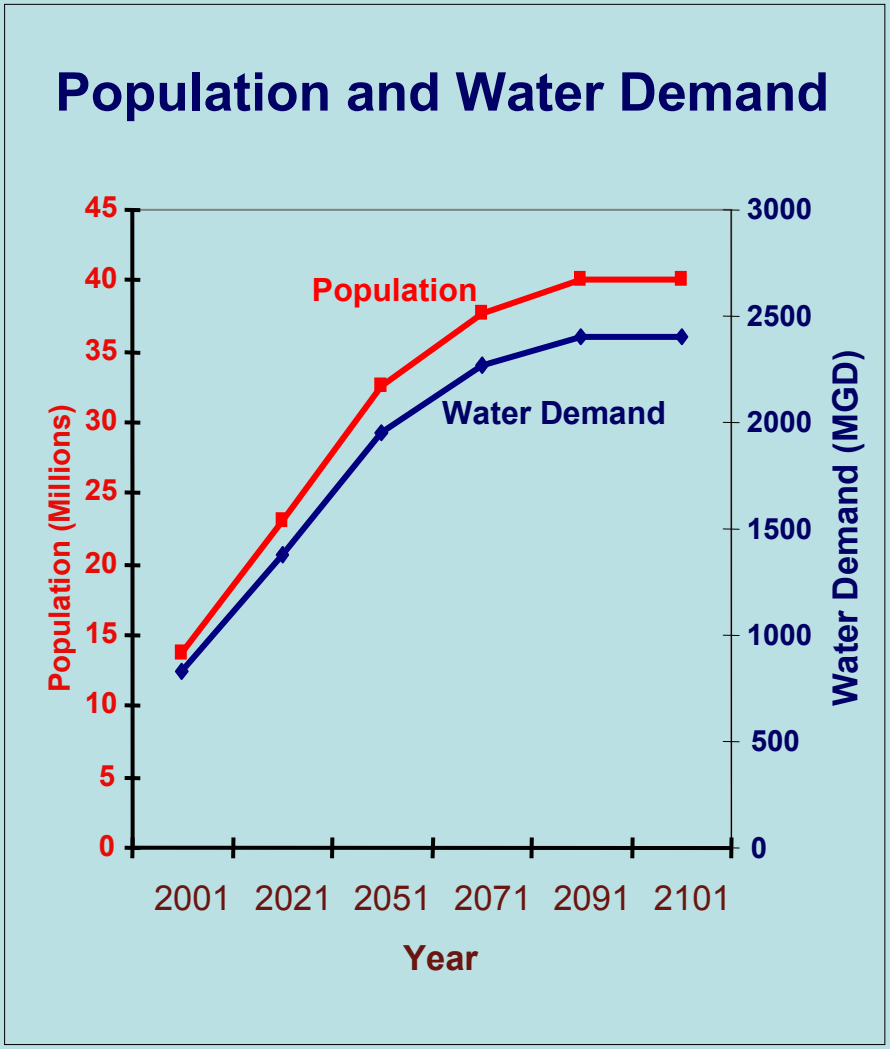


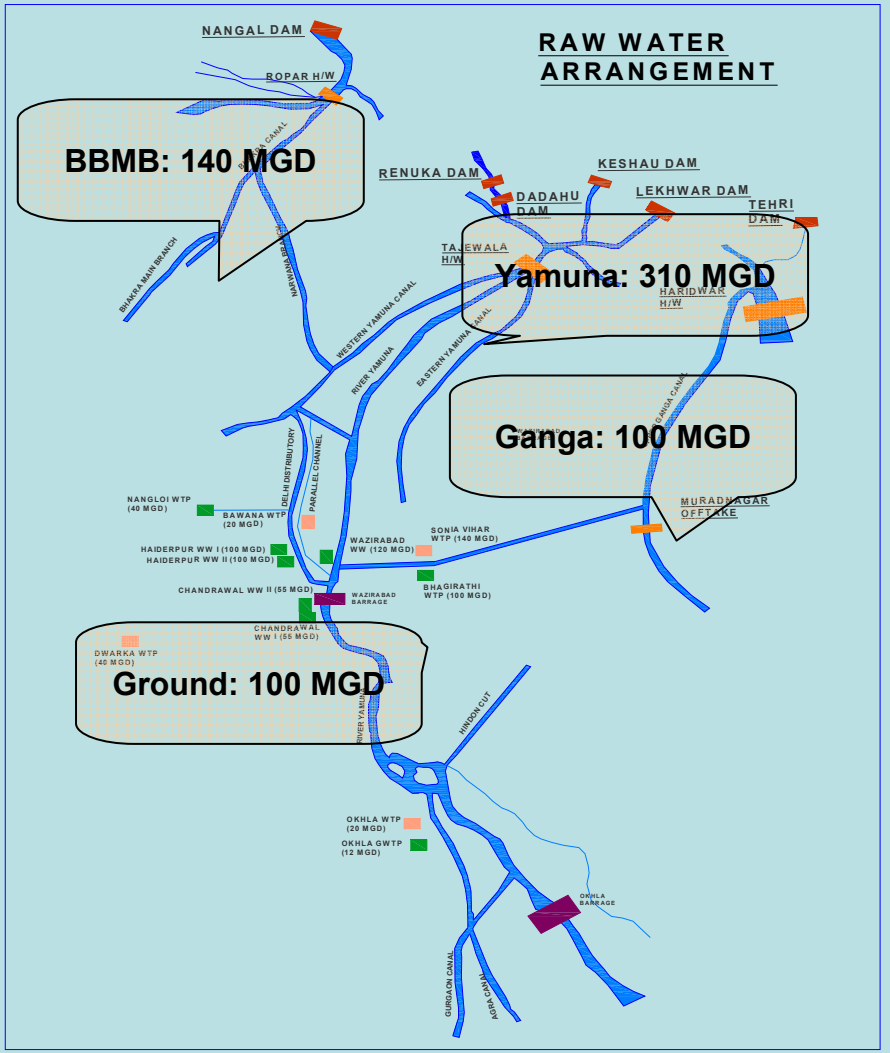


Climate Change Impacts and Adaptation

Water Availability: DELHI

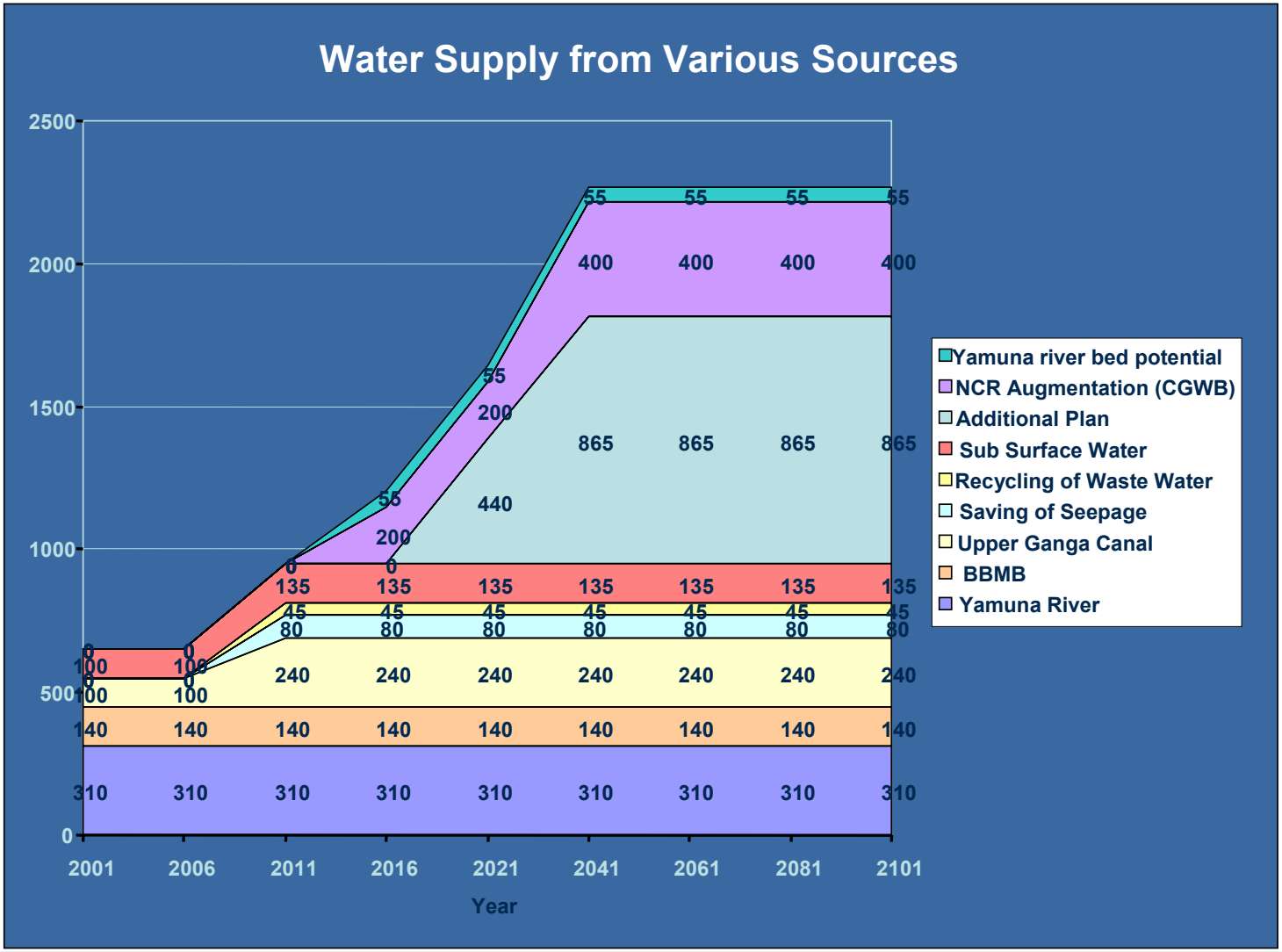






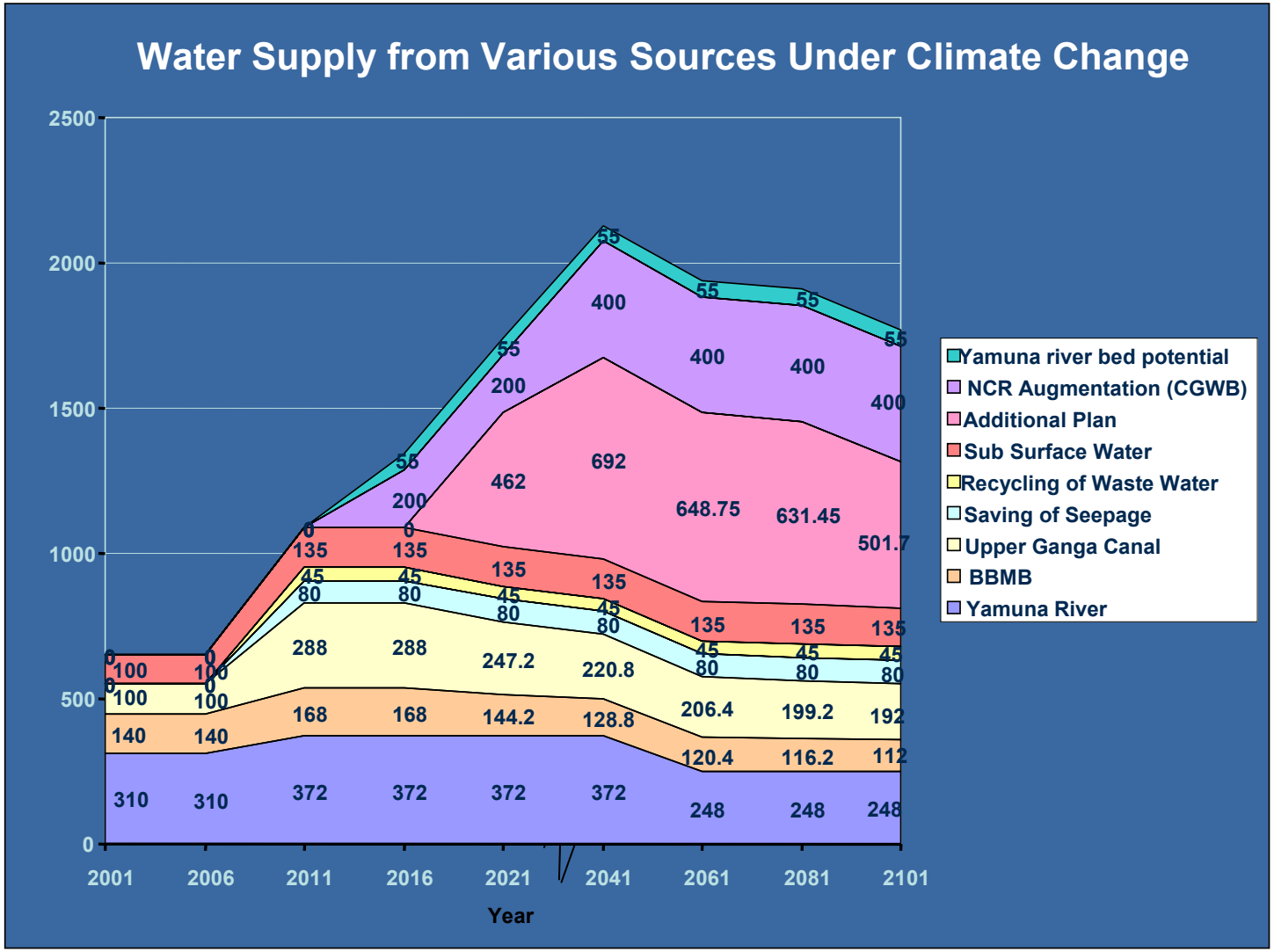
Water Availability: DELHI

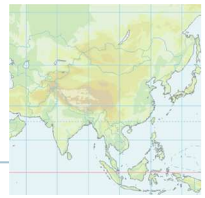
Existing and Envisaged Water Sources for Delhi (without Climate Change)



Water Availability: DELHI

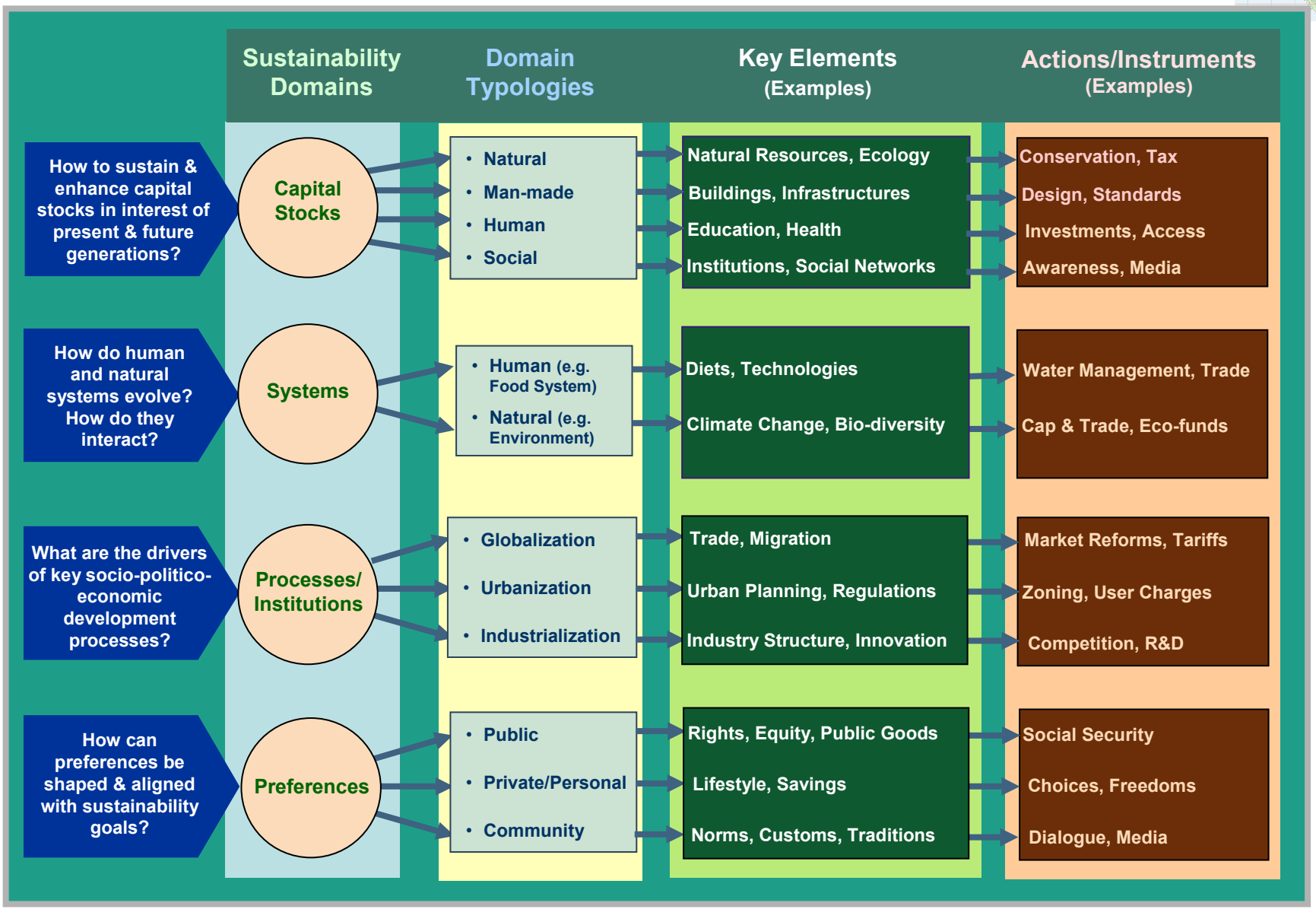
Existing and Envisaged Water Sources for Delhi under Climate Change



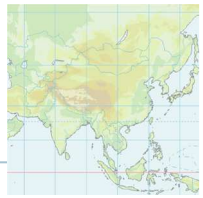


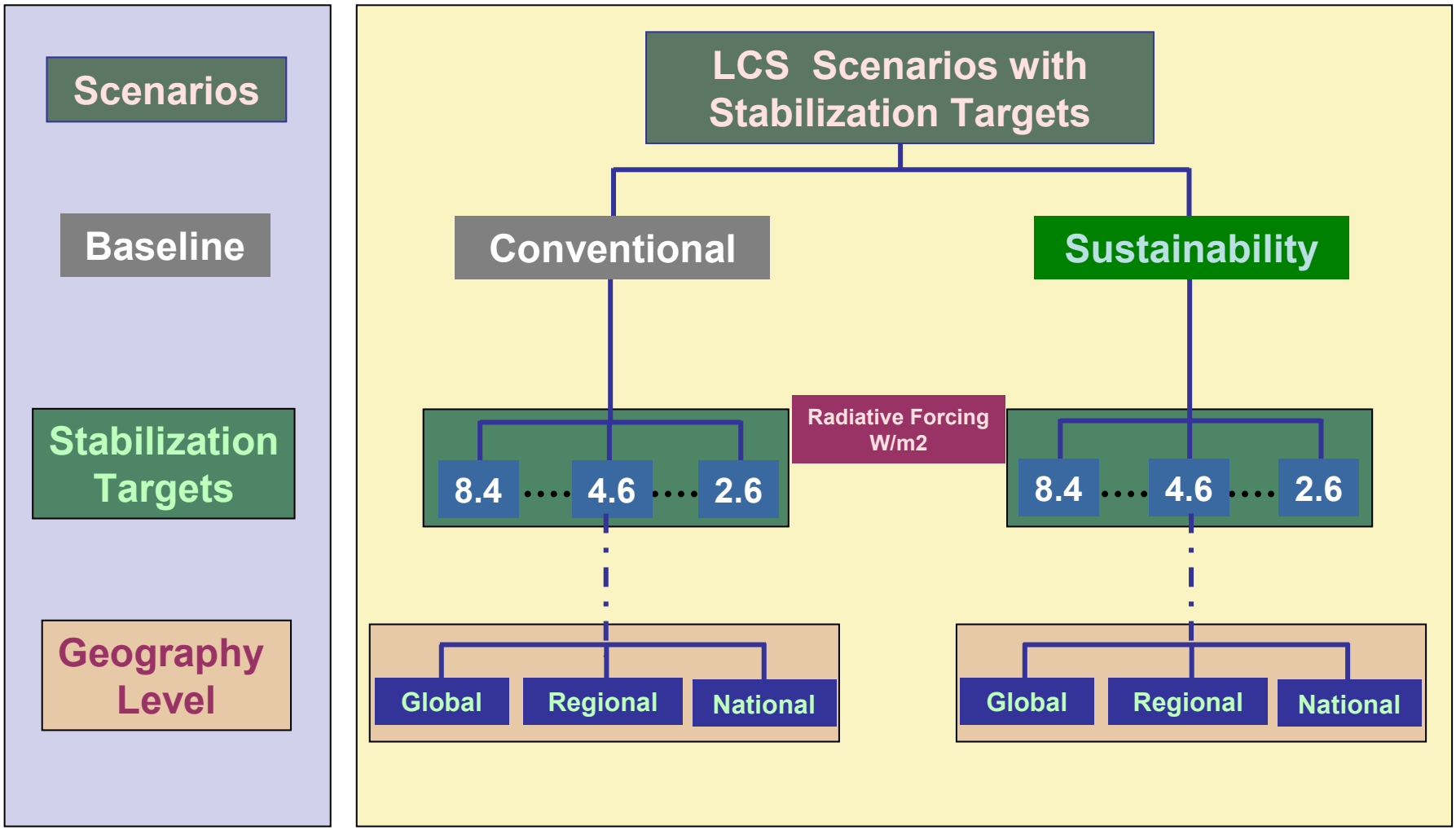
LCS Scenarios and Modeling: Next Plans

Sustainability: Domains, Elements and Actions

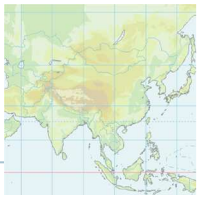


LCS Scenarios: Next Step



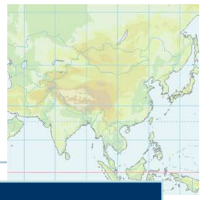


Next Plan: LCS Scenarios with Sustainability



- LCS Scenarios to focus on:
  - Behavioral Changes, Innovations and Co-benefits
  - Up-front decisions to avoid long-term lock-ins
- Sustaining Capital Stocks
  - Natural, Man-made, Human & Social
- Use Systems Approach for Analysis
  - Integration, Holistic/Long-term Vision, Dynamic Assessment
- Interventions to influence Drivers of Change
  - Assess and influence Processes
  - Institutions (to reduce transaction costs/risks and to sustain change)
- Shaping Stakeholder and Societal Preferences
  - Information, Awareness, Debates to arrived at informed choices

Next Plan: Modeling LCS with Sustainability



- **Mainstream climate actions in development plans**
  - Include **sustainability policies in Baseline**
  - Pay attention to that **avoids lock-ins** into **high emissions paths**
  - Ensure **bottom-up actions** coordinate with **top-down vision and policies**
- **Model 'Co-benefits' and 'Co-operation':**
  - **Co-benefits** as a **positive-sum** game
  - AIM achieving LCS that meets global target at **Low Carbon Price**
  - Focus on **behavior and drivers** that deliver Low Energy and Emissions Future
- **Model exclusive climate-centric actions for stabilization which are needed beyond sustainability policies**
- **Model adaptation to residual climate change, though in Low Carbon World climate risks shall be much lower**

Thank you