# Aligning Green Growth and Low Carbon Development in India

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

Presented at Seminar on: ***Green Growth & Low Carbon Development***
Organized by:
Danish Technical University, the Danish Ministry of Foreign Affairs & United Nations Environment Program - UNEP
Copenhagen, November 4, 2011

# Presentation Agenda

- **Assessment 2020:**
  - Copenhagen Commitment and Green Growth Actions
- **Assessment 2050: The $2^{O}C$ Stabilization**
  - Aligning 'Green Growth & Low Carbon Future'
  - Managing Multiple Transitions
- **Adapting to Residual Climate Change**
  - Climate Proofing Long-life Assets
  - Climate Proofing Cities
- **Conclusions**

# India NCCAP (June, 2008) - PMO

## National Climate Change Action Plan - 8 National Missions

### 1. Solar Energy: Targets by 2022

- 20 GW Grid Power + 2 GW Off-Grid Power
- 20 million Solar lighting system to replace 1 billion Liters of of Kerosene/yr (2.5 MT CO2/yr)

### 2. Enhanced energy efficiency

- Avoided capacity of 19000 MW by 2015

### 3. Sustainable habitat

- Green and Energy Efficient
- Comprehensive approach to manage water, wastewater and solid waste

### 4. Water Sector

- 20% water use efficiency improvement

### 5. Sustaining the Himalayan eco-system

### 6. A "Green India"

- 20 Mil. Ha afforestation by 2020; Forest cover from 23 to 33% in long-run

### 7. Sustainable agriculture

- Promotion of Micro Irrigation in 40 Mil. ha

### 8. Strategic knowledge for climate change

# Copenhagen Commitments and Actions (1)

## Copenhagen Commitments

- **20 to 25% Emissions Intensity Reduction from 2005 to 2020 (1.5 to 1.9% decoupling)**
- **Per Capita Emissions Below OECD Average (for ever)**

## Post-Copenhagen Domestic Action

- Carbon tax on coal to fund clean energy
  - US $1/ton on domestic & imported coal; fund to be used for Clean Energy
- Enhanced Energy Efficiency measures
  - Mandate to reduce specific energy consumption;
  - Energy savings certificates & trading
  - Energy efficiency ratings mandatory for 4 key appliances from Jan 2010
- Bachat Lamp Yojana – Mass distribution of CFLs
  - Help reduction in peak load
  - Potential reduction of 6 GW of electricity demand
- Mission on sustainable habitat
  - Energy efficiency in residential, commercial and urban transportation
  - Better management of water, wastewater and solid waste with recycling, reuse and energy creation

# Copenhagen Commitments and Actions (2)

- National Solar mission
  - Generating 20 GW of solar power by 2022
  - 2 GW of off-grid solar plants, 20 million sq. m of solar collectors
  - 20 million solar lighting systems
    - Displacing 1 billion liters of kerosene every year
- National Mission on Sustainable Habitat
  - Green and EE Buildings
    - Better program implementation and financial incentives
  - Comprehensive approach to manage water, wastewater and solid waste
    - Potential used for recycling, reuse and energy creation
  - Refurbishing Urban transportation to achieve energy efficiency
    - Vehicle Fuel efficiency standards
    - Enhance Supply of Cleaner Fuels (e.g. Gas)
- Green India Mission
  - Double the area to be taken up for afforestation/eco-restoration in the next 10 years
    - 20 million hectare area to be afforested/eco-restored
  - Incentive based special grant US $ 1.2 billion to states for forestry management

# Copenhagen Commitments and Actions (3)

## Other initiatives:

1. Energy Efficiency in Power Generation (Super-critical, IGCC, T&D)
2. Focus on Renewable Energy Technologies (Biomass, Small hydro, Wind)
3. Disaster Management
   (Risk management, Strong communication & information)
4. Coastal Area Protection
   (Early warning system, salinity tolerant crops, mangroves & coastal forests)
4. Health sector
   (Enhanced public health & assessment of health burden due to climate change)
6. Capacity Building
   (Central, State & Local levels for implementation of Action Plan)

# Copenhagen Commitments and Actions (4)

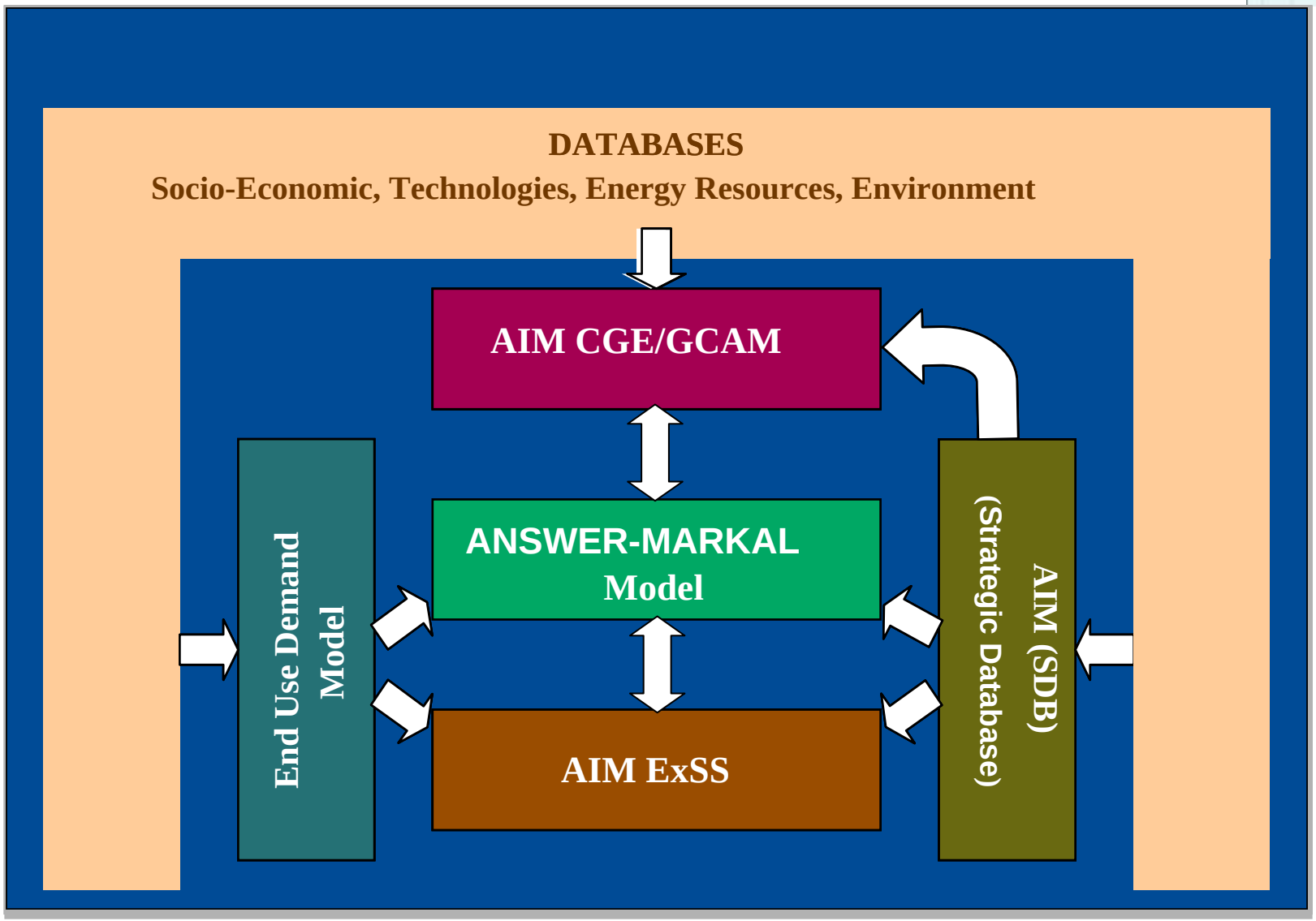
## Economic Instruments

- **Renewable Energy Certificates (REC)**
  - Entities (including States) accept Renewable Power Obligation
  - Certificates issued on Electricity Generation
  - Participating Entities sell Electricity at Feed-in Tariff price or at Grid Price
  - RECs are generated only for electricity sold to at Grid price
- **Energy Efficiency Certificates (EEC): Proposed Scheme**
  - Companied receive EE targets
  - Those who exceed EE targets receive EECs
  - Save 23 MT CO2 (from Oil) & 98 MT of CO2 (from Electricity) by 2015
- **Coal Tax**
  - US $1/ton on domestic & imported coal
  - Fund to be used for Clean Energy

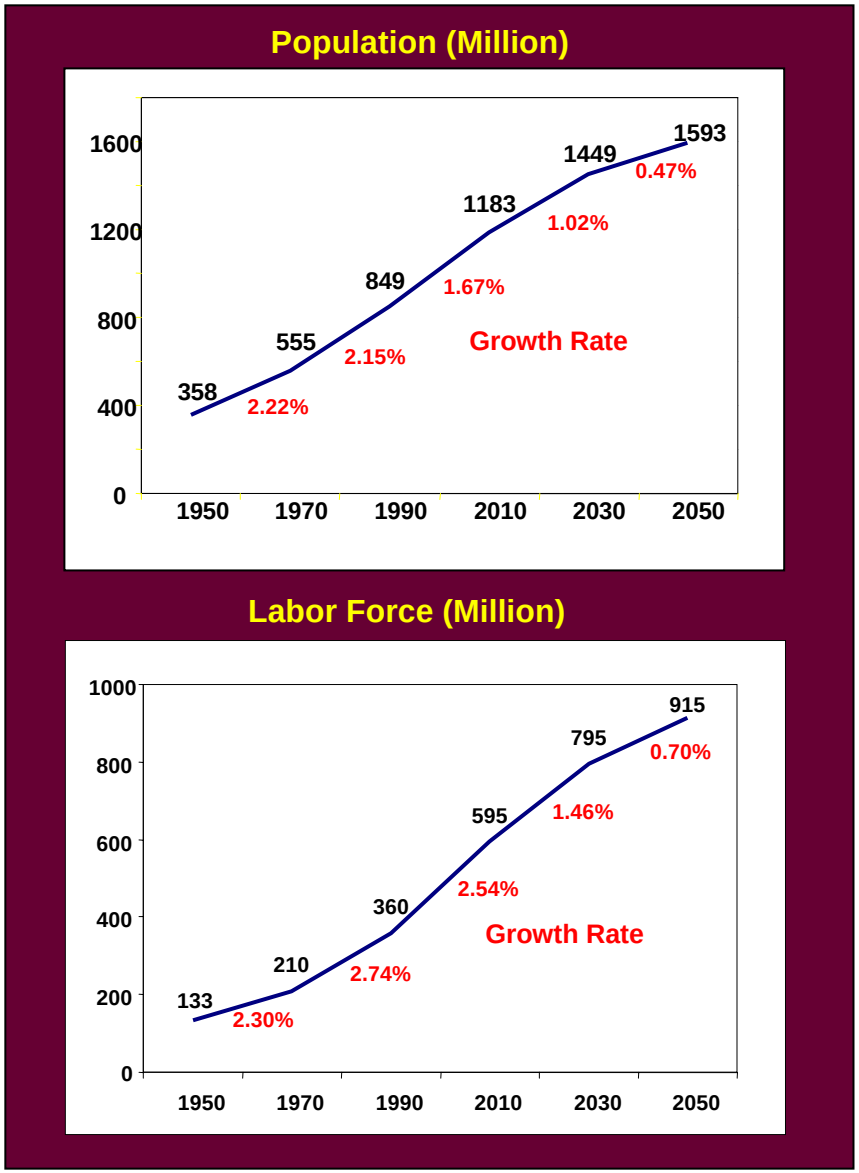
# The 2$^{O}$C Stabilization Challenge: Assessment 2050

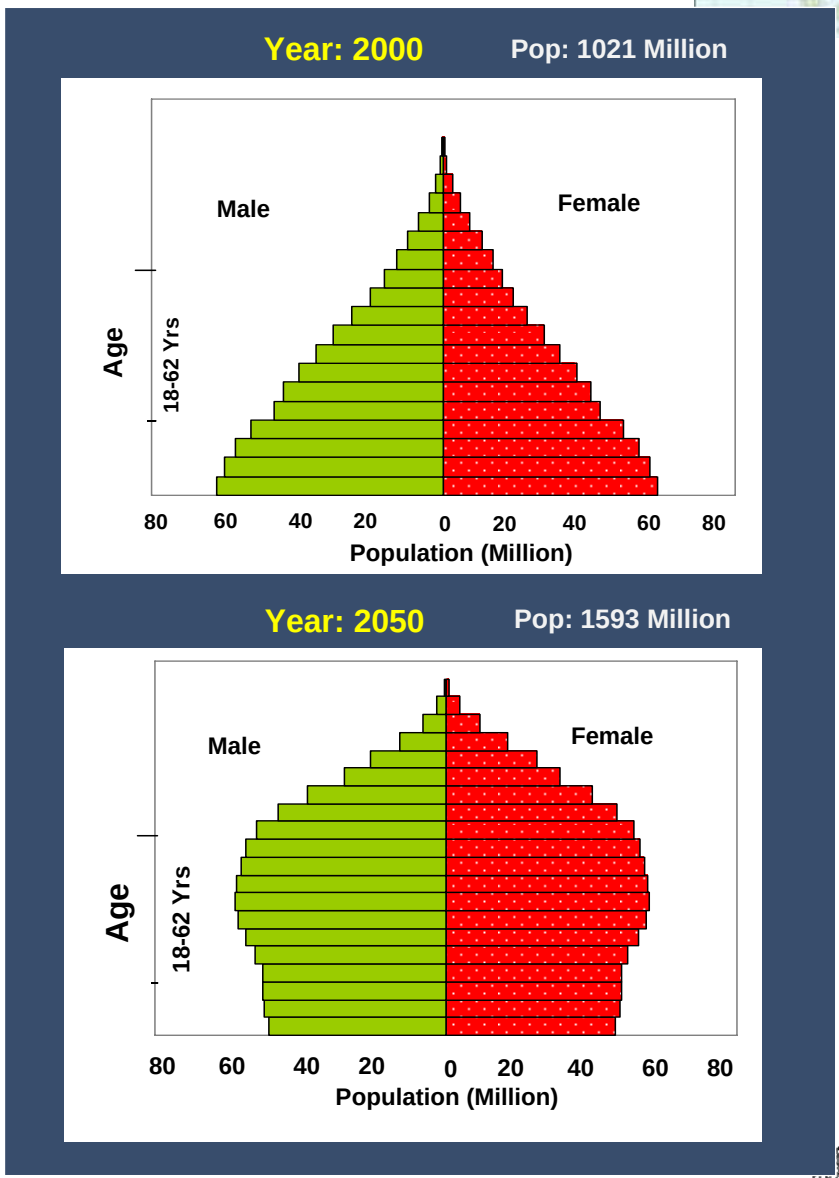
- Aligning ‘Green Growth & Low Carbon Future’
- Managing Multiple Transitions

# Integrated Multi-Model Structure



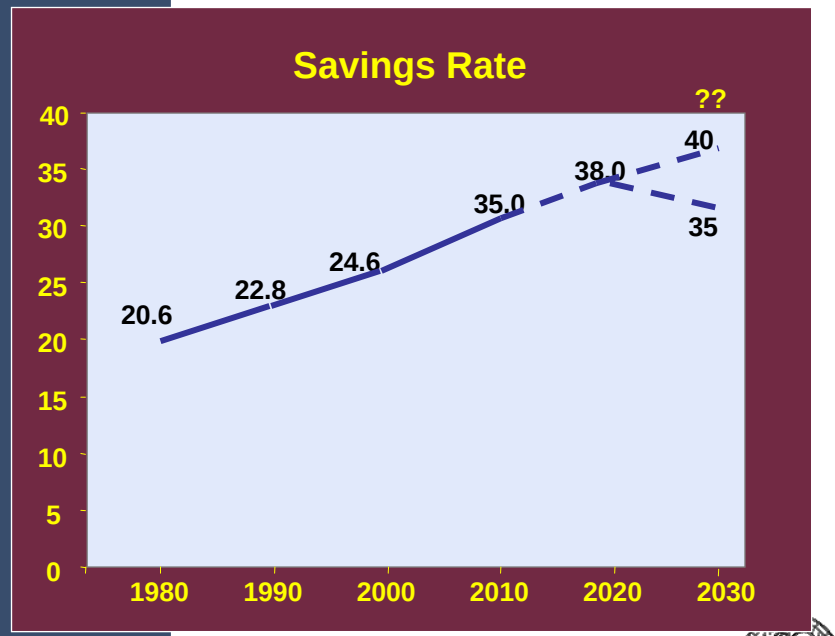
# India: Demographic Transition



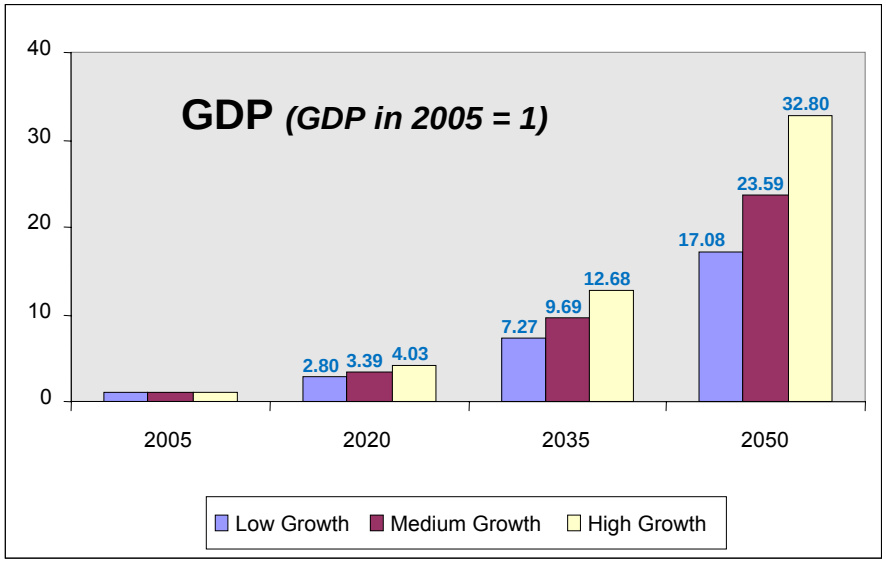



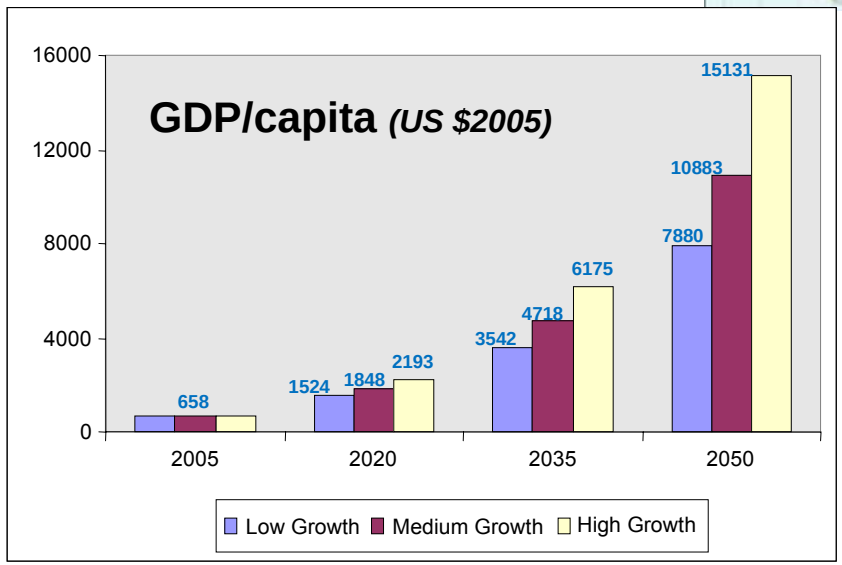
# Drivers of Economic Growth

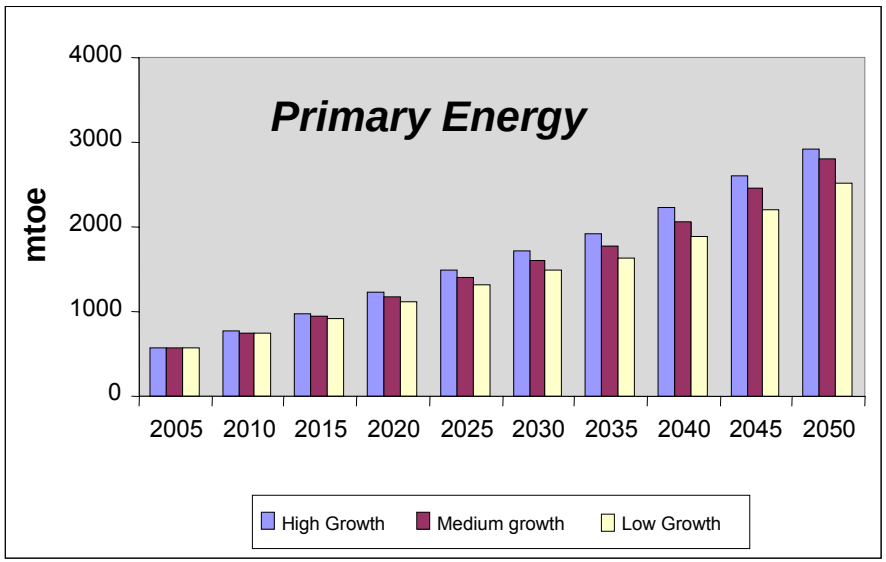
- **Human Capital**
  - High Labor Supply
  - Increasing Education
  - Migration (intra & inter county)
- **R&D**
  - Increasing Government/ Private Expenditure
  - International Knowledge Flows
  - R&D Collaborations
- **Technology**
  - Infrastructures
  - Learning, transfers, deployment
- **Behavioral Changes**
  - High Savings Rate
  - Changing Lifestyles
- **Governance**
  - Institutions
  - Laws
  - Policies

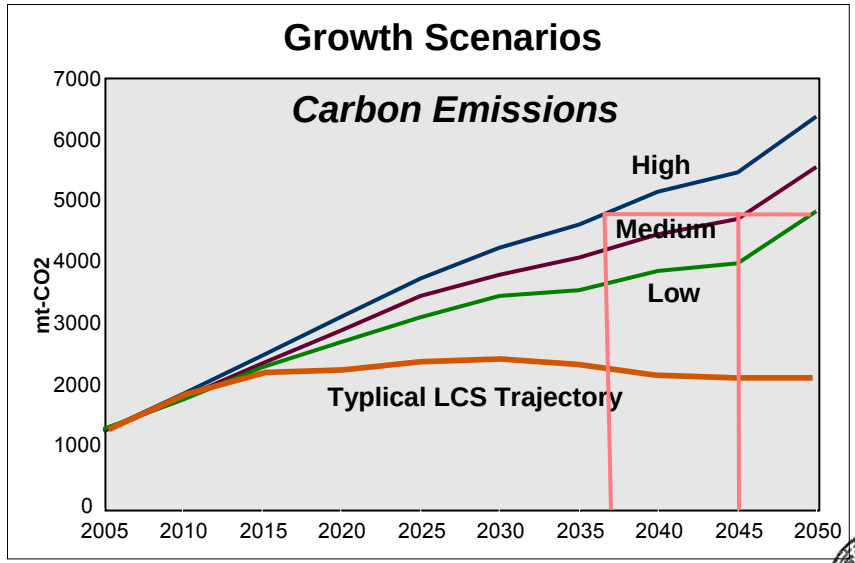


# GDP, Energy, Emissions: Growth Scenarios



# CO2 Intensity: Commitment vs. BAU

## Scenario Analysis: 2005-20

| Scenario | GDP Growth | Emissions Growth | CO2 Intensity Decoupling | Ratio 2020 over 2005 | |
|---|---|---|---|---|---|
| | | | | GDP | Emissions |
| BAU (Medium Growth) | 8.7% | 5.1% | 3.5% | 3.5 | 2.1 |
| High Growth | 9.5% | 5.6% | 3.9% | 3.9 | 2.3 |
| Low Growth | 7.3% | 4.7% | 2.5% | 2.9 | 2.0 |
| Very Low Growth | 7.0% | 4.6% | 2.4% | 2.8 | 2.0 |

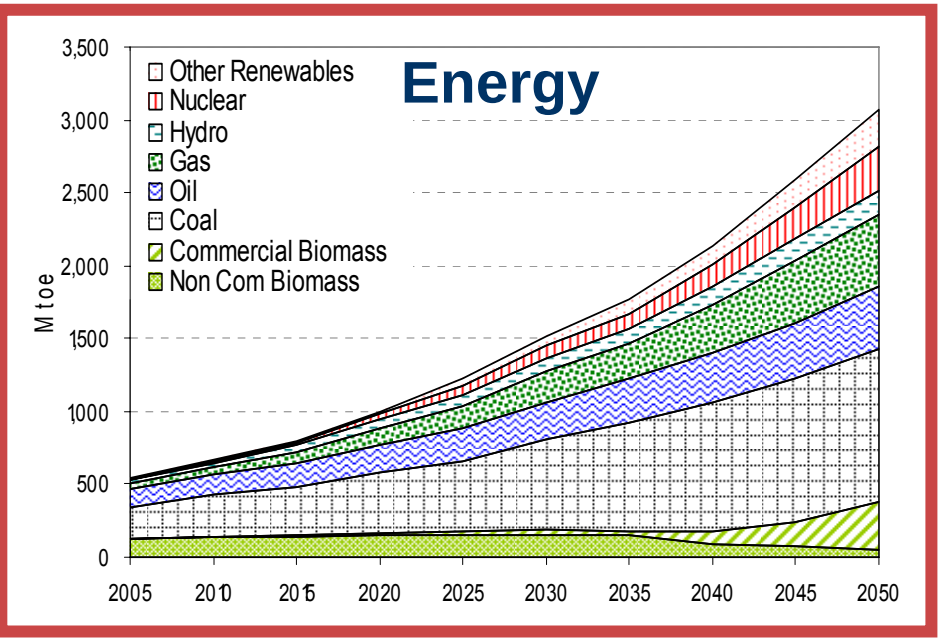
**India's Emissions Intensity Reduction Commitment requires 1.5 to 1.9% annual decoupling (2005-2020)**

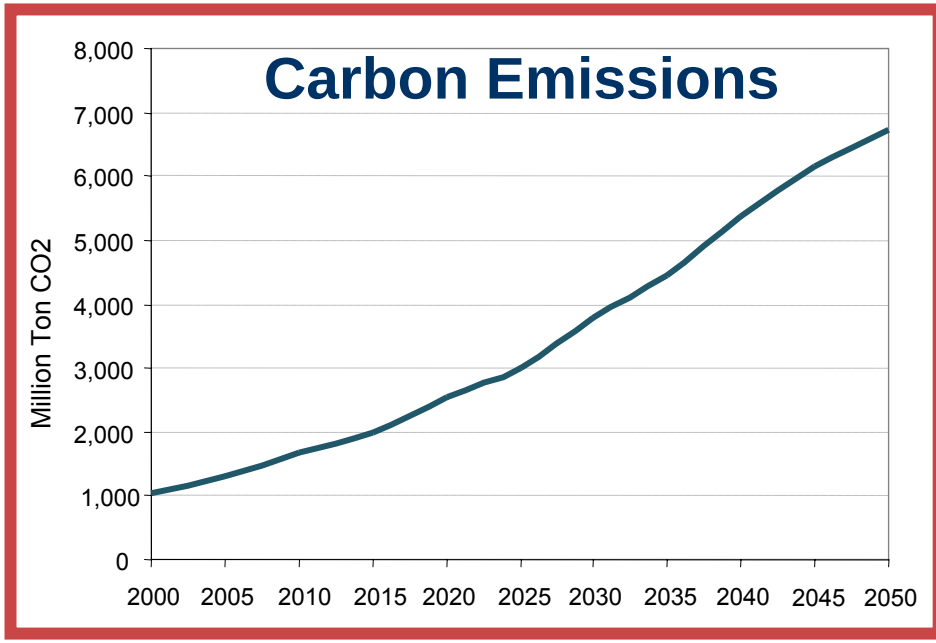
# BAU Projections

## Assumptions

From 2005-2050:
Annual Economic Growth: 7.2%
Annual Population Growth: 0.9%

Absolute Growth in 2050 over 2005
Economy 23 times
Population 1.56 times



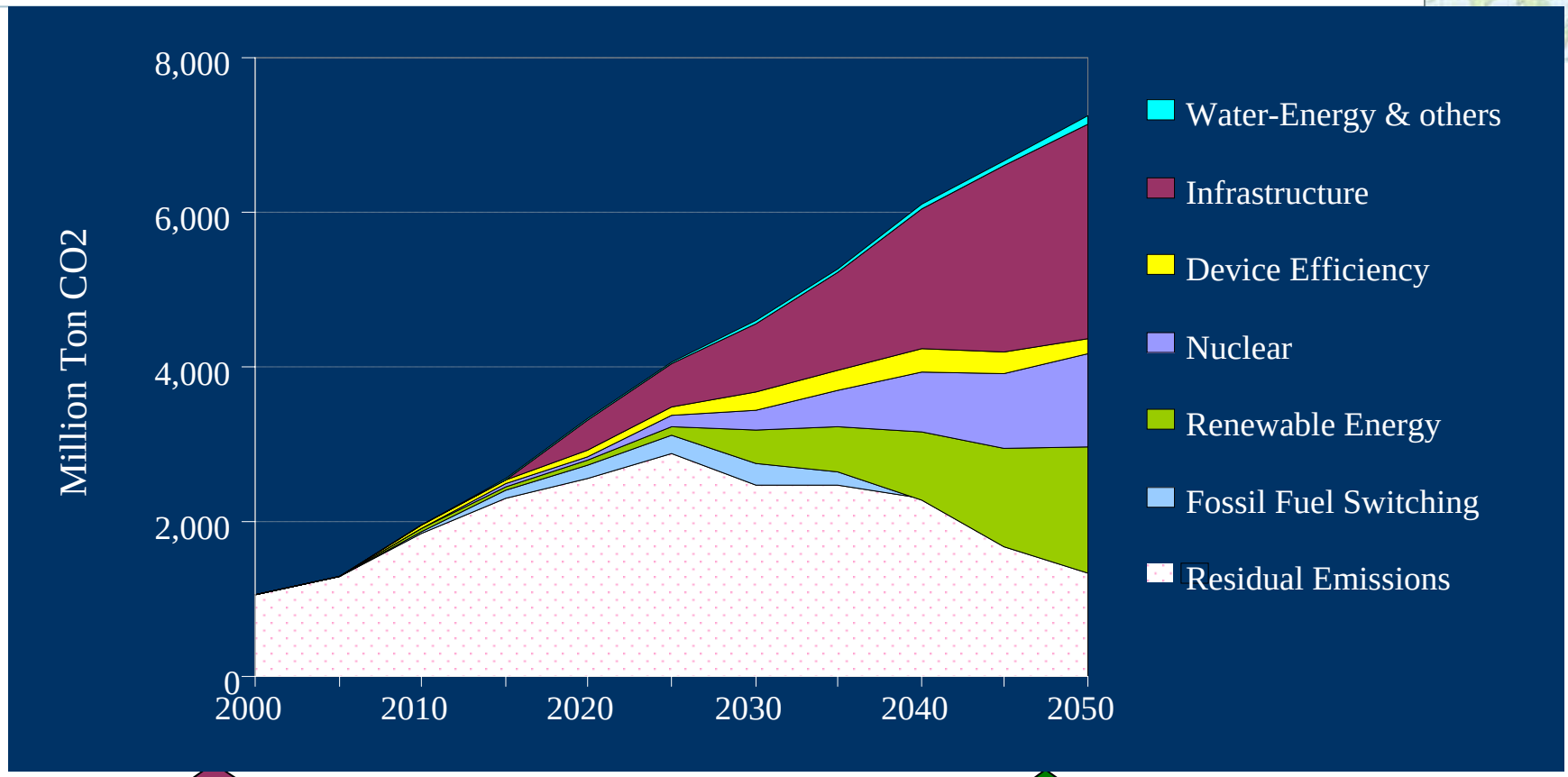




## Results: Energy and Carbon Intensity

Annual Improvement From 2005-2050:
Energy Intensity: 3.14 (%)
Carbon Intensity: 3.07 (%)
Decarbonization of Energy: -0.07 (%)

Ratios: 2050 over 2005
Energy Intensity: 0.249
Carbon Intensity: 0.257
Decarbonization of Energy: -3.1 (%)

# 2°C Stabilization: Climate-Centric Options




**Conventional Approach: transition with conventional path and carbon price**

- High Carbon Price
- Climate Focused Technology Push
- Top-down/Supply-side actions

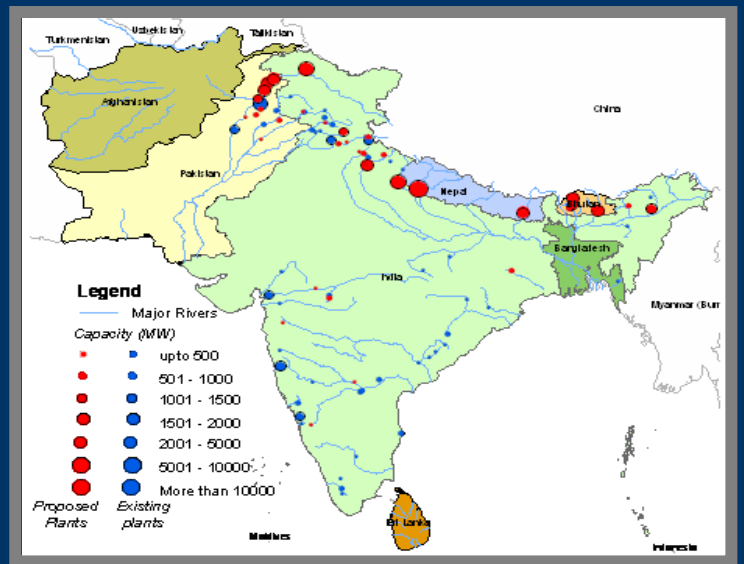
**Technology Co-operation Areas**

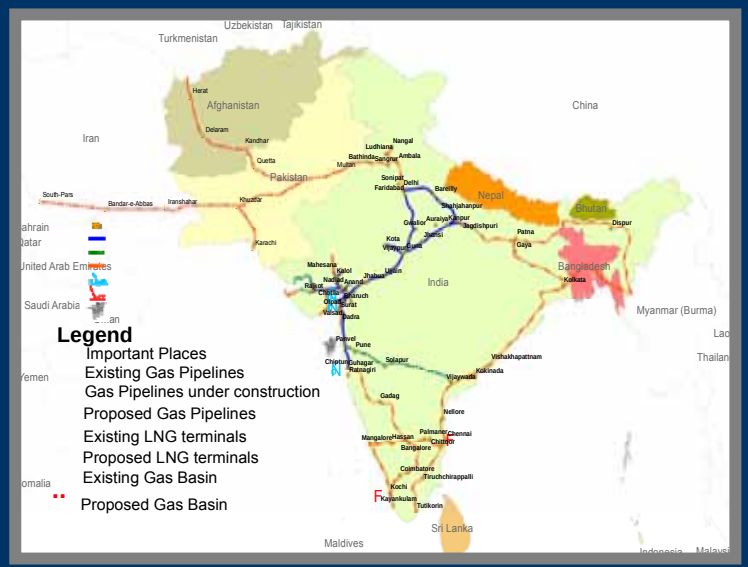
- Energy Efficiency
- Wind/Solar/Biomass/Small Hydro
- Nuclear/Low Carbon Infrastructure

# Aligning Development and Climate

## Co-benefits
## Lock-ins
## Social Value of Carbon
## Linking National, Regional and Global Policies

# Integrated Regional Energy Market: Co-benefits




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

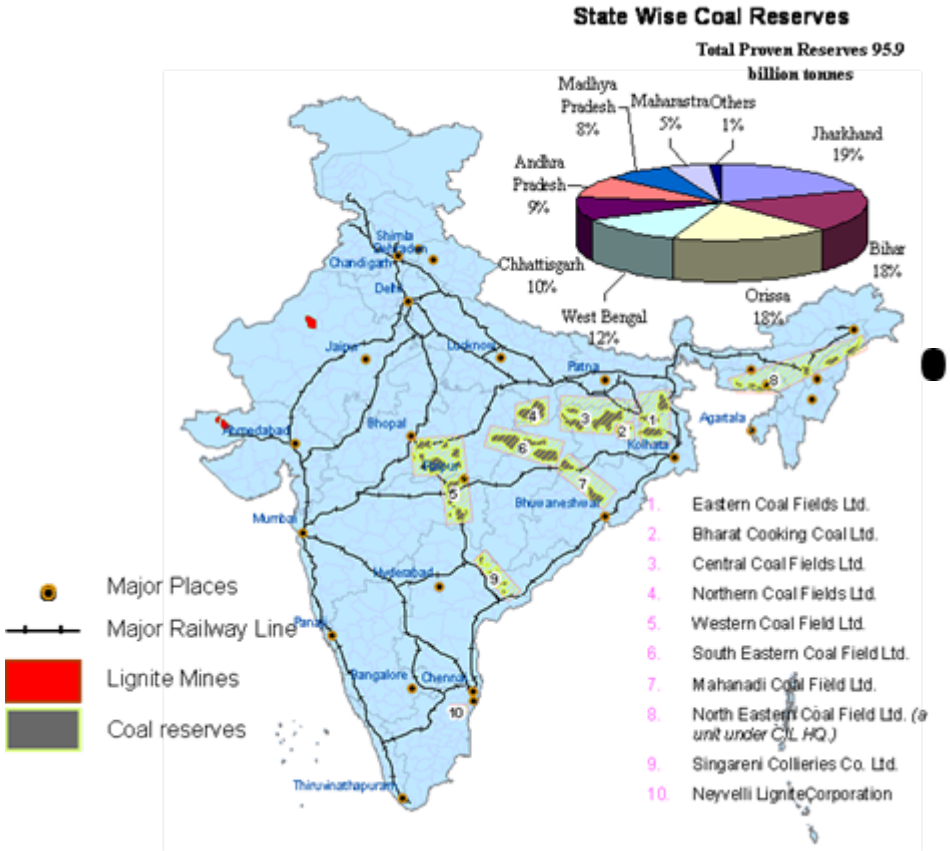
| Benefit (Saving) Cumulative from 2010 to 2030 | | $ Billion | % GDP |
|---|---|---|---|
| Energy | 60 Exa Joule | 321 | 0.87 |
| $CO_2$ Equiv. | 5.1 Billion Ton | 28 | 0.08 |
| $SO_2$ | 50 Million Ton | 10 | 0.03 |
| | Total | 359 | 0.98 |

## Spill-over Benefits / Co-Benefits

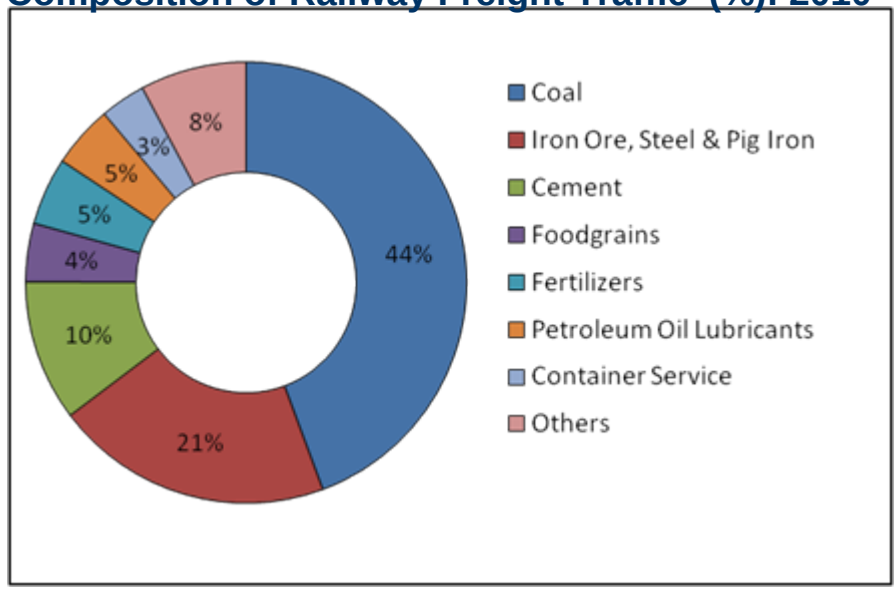
- More Water for Food Production (MDG1)
- 16 GW additional Hydropower (MDG1&7)
- Flood control (MDG1&7)
- Lower energy prices would enhance competitiveness of regional industries (MDG1)

# Infrastructures to Overcome Lock-ins (1)

## Coal by Wire

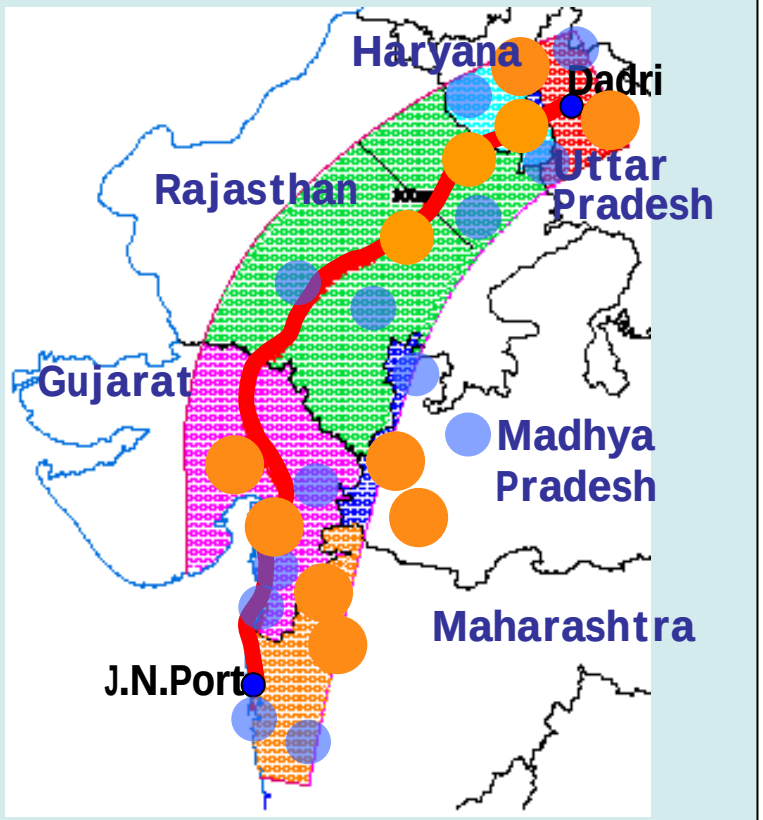



**Composition of Railway Freight Traffic (%): 2010**



# Infrastructures to Overcome Lock-ins - 2

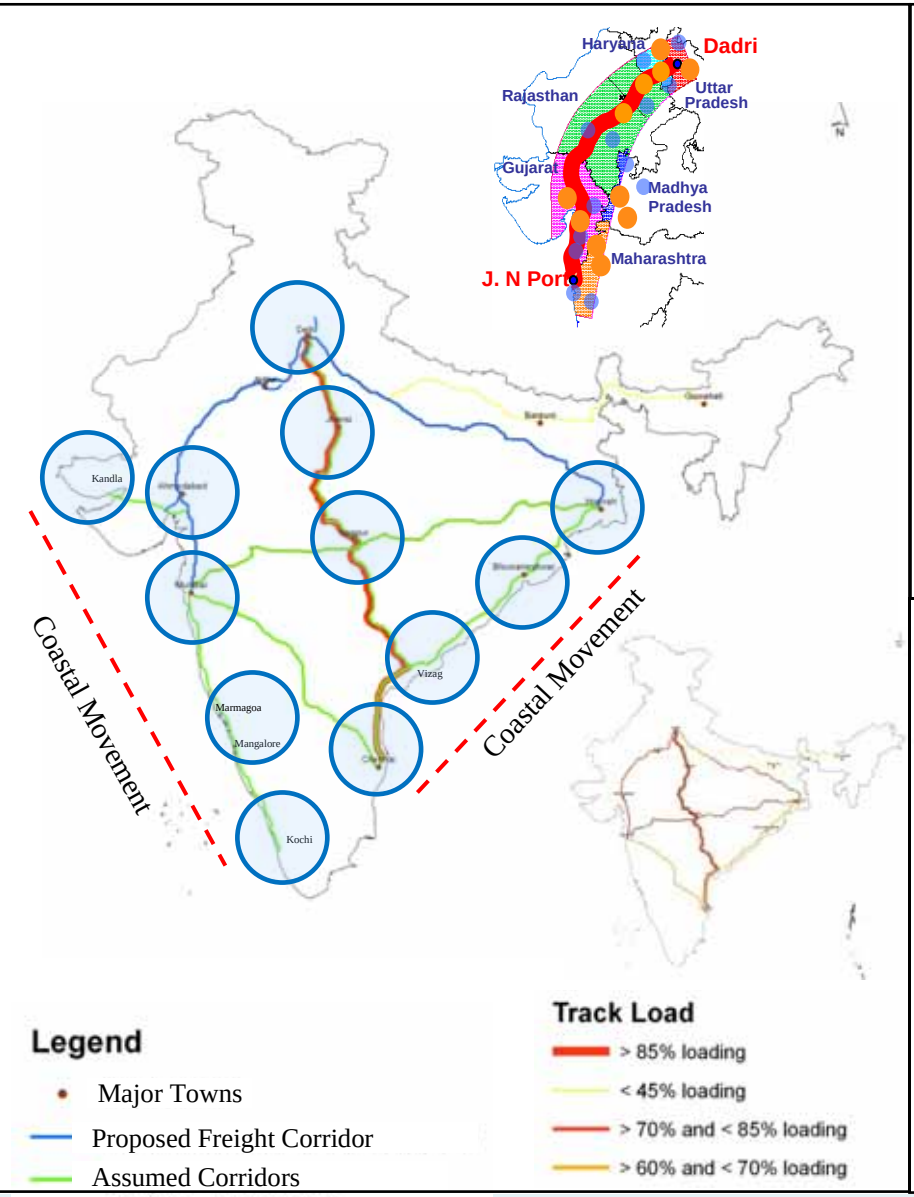
## Train Corridors

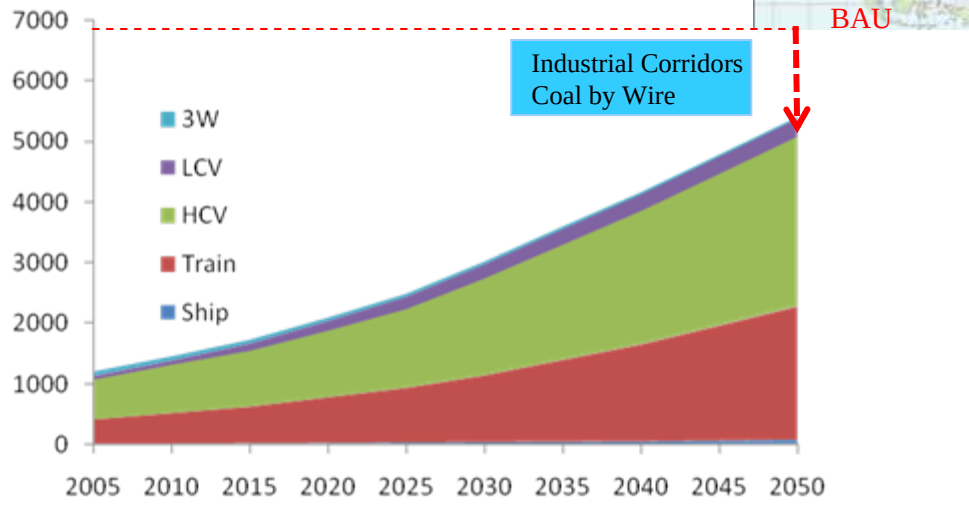



- Sustainable modal shift
- Efficient logistics
- Infrastructures investments
- Associated development

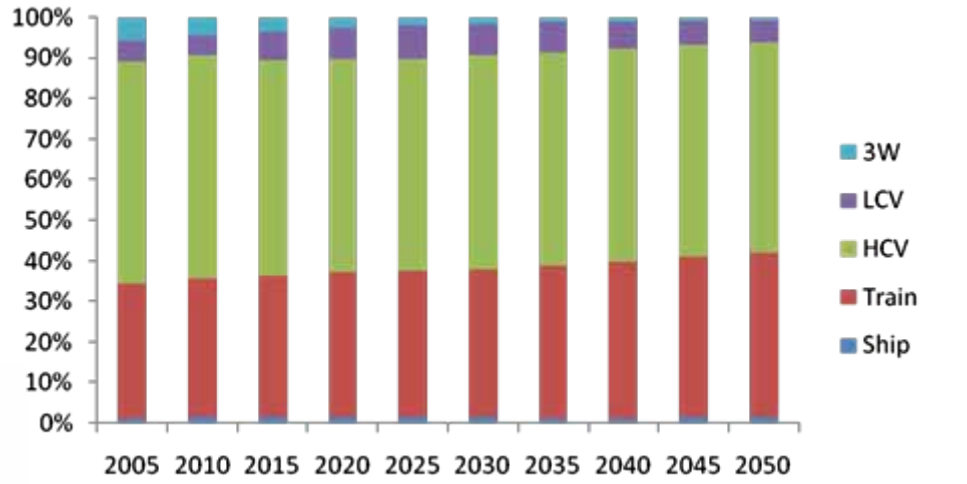
### Technologies for Train Corridors

# Transport Infrastructure: Avoiding Lock-ins (3)



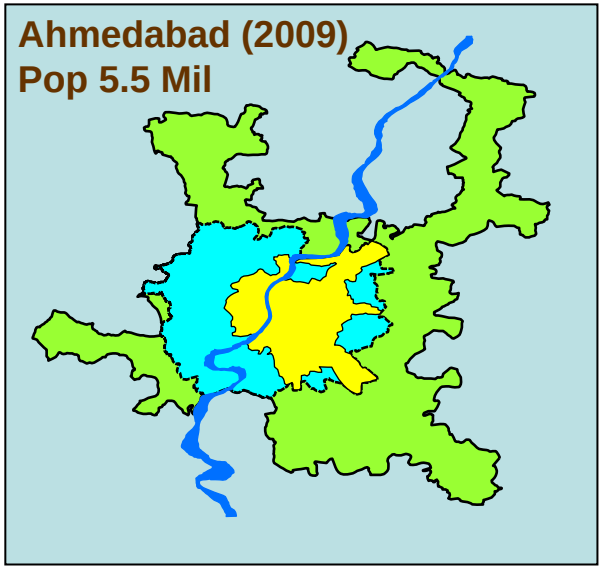



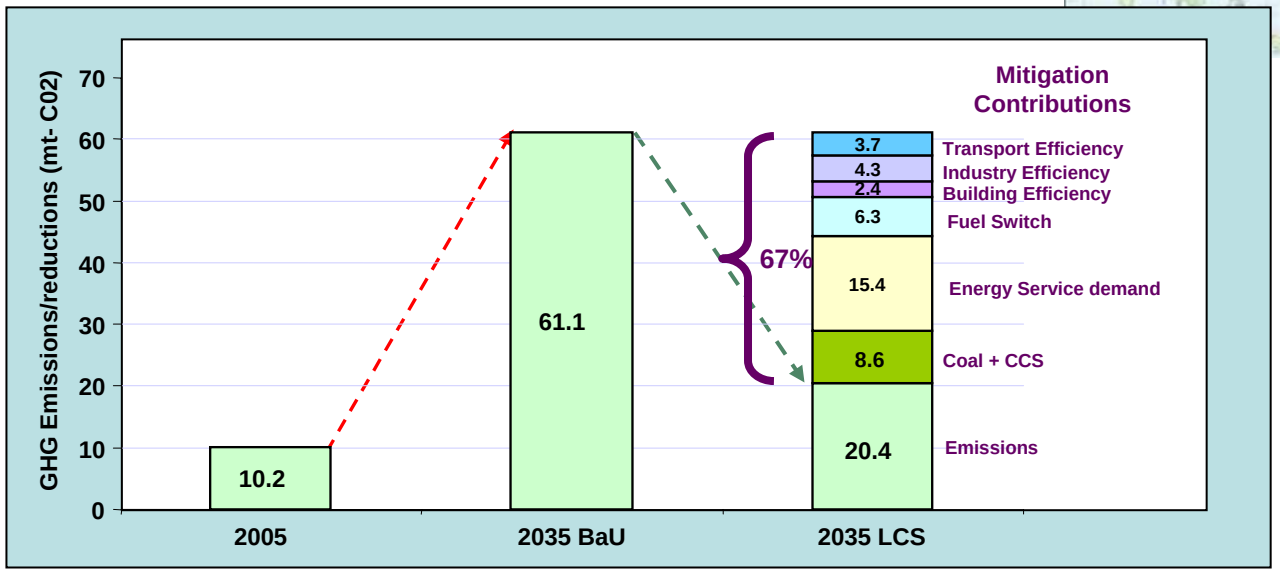

**Freight movement by transport infrastructure type (Bn Tkm)**

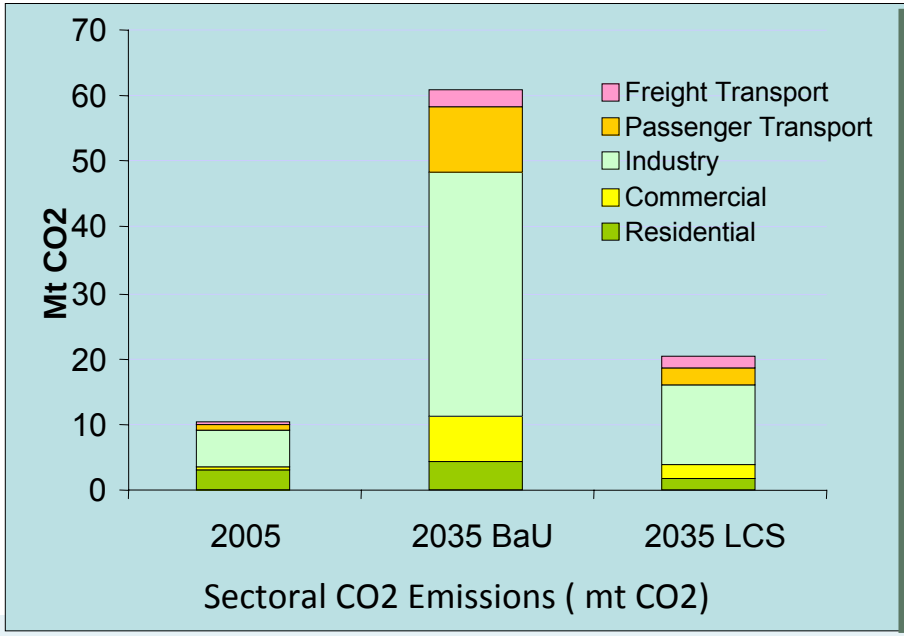


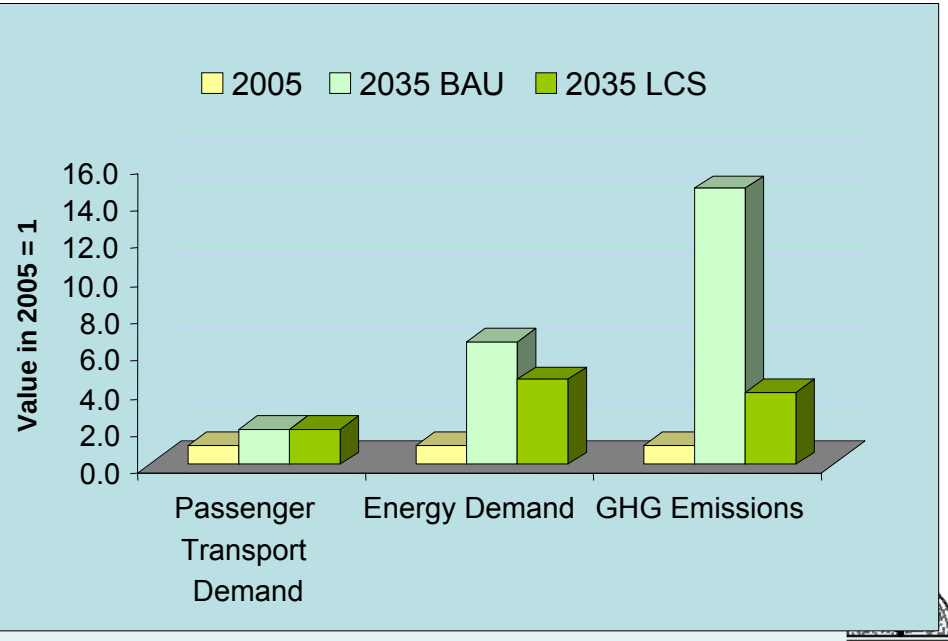

**Sectoral shares in freight transport infrastructure (%)**

# Co-benefits in City Planning: Ahmedabad (1)



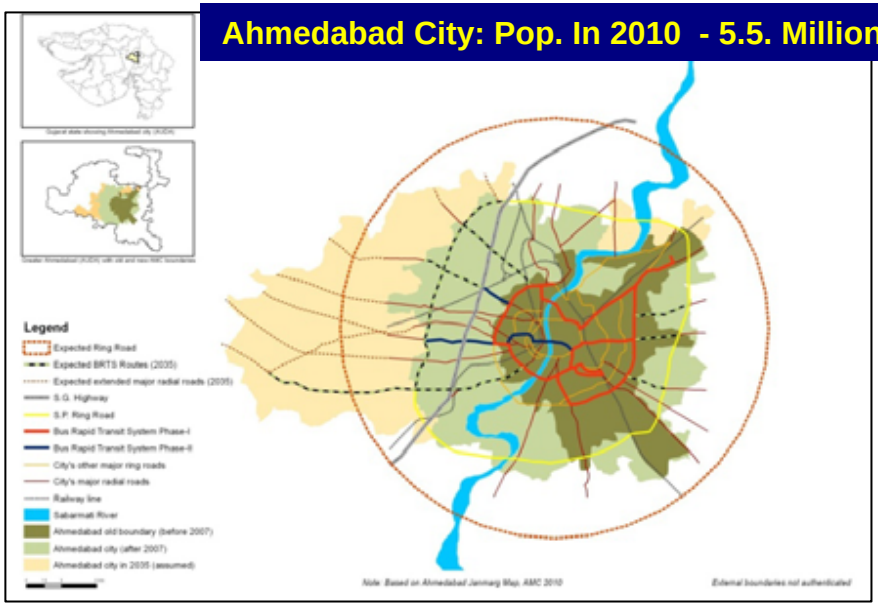



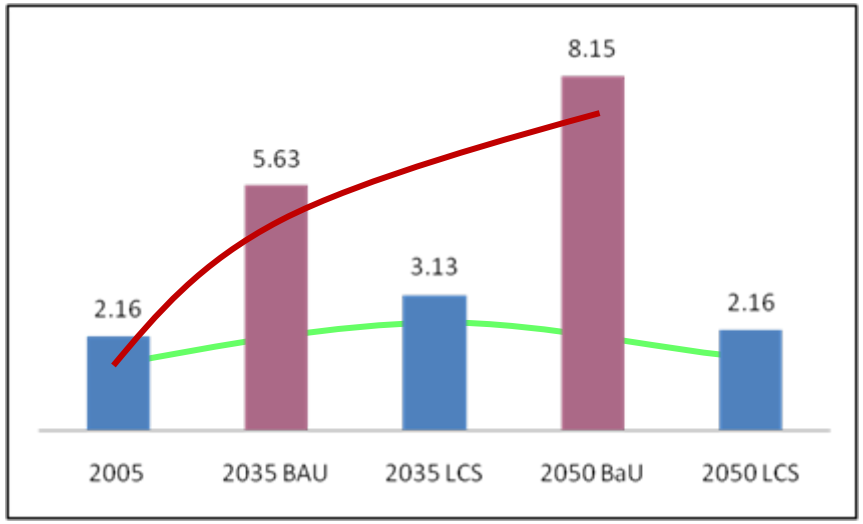



# Co-benefits in City Planning: Ahmedabad (2)

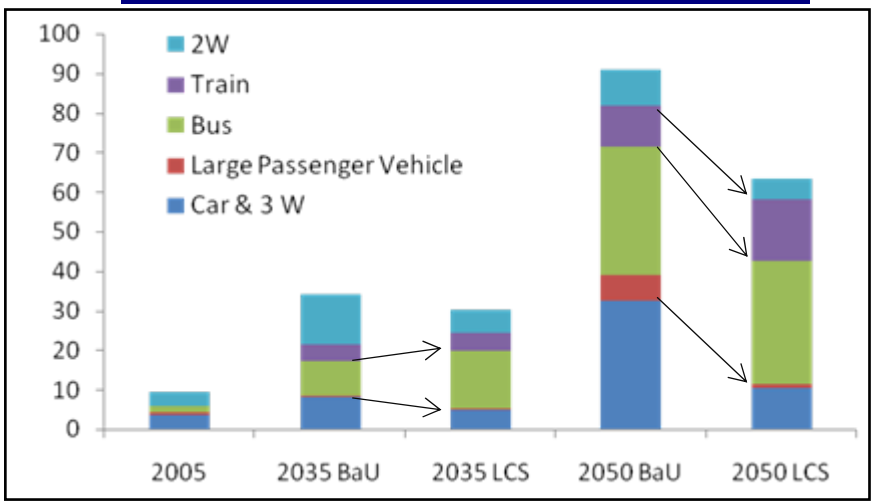
## Ahmedabad City: Pop. In 2010 - 5.5. Million



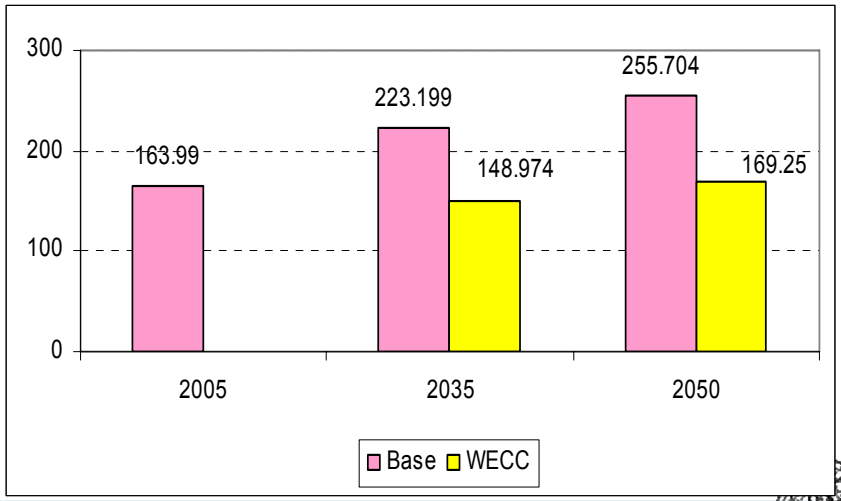

## Per Capita CO2 Emissions (Ton)




## Co-benefits: Transport Transitions

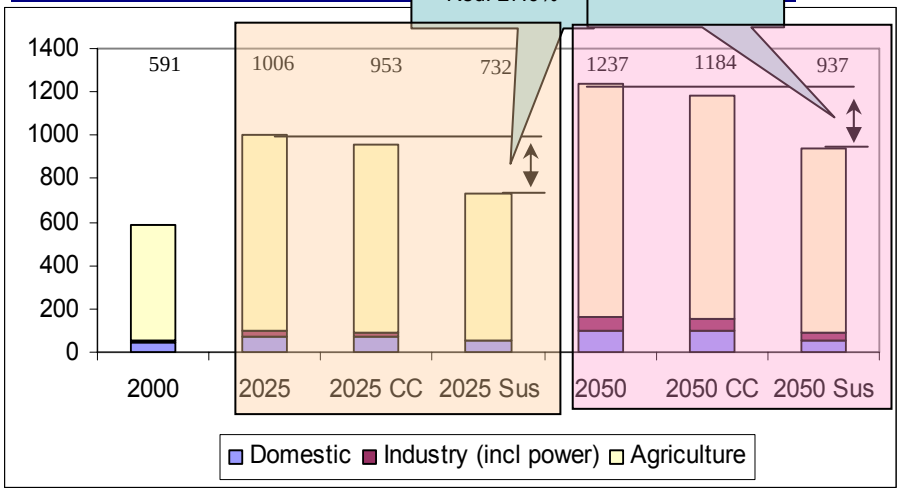



## Co-benefits: Water per capita (ML/million)

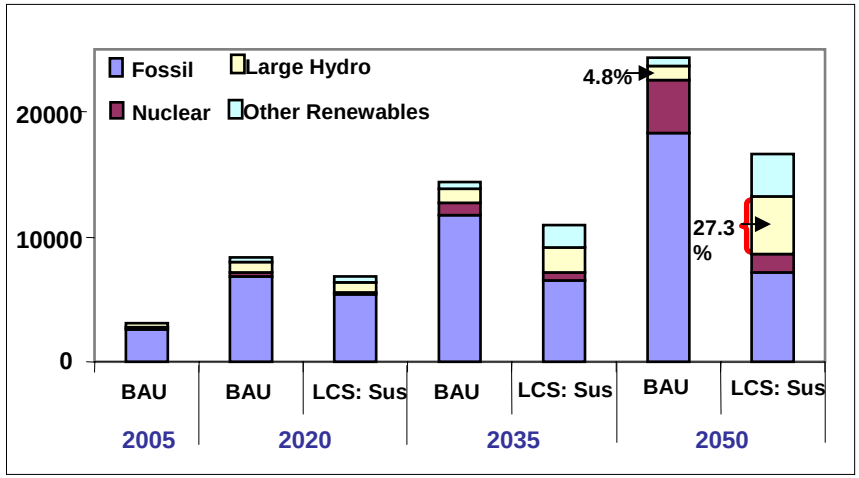


# Co-benefits: Energy-Water Nexus

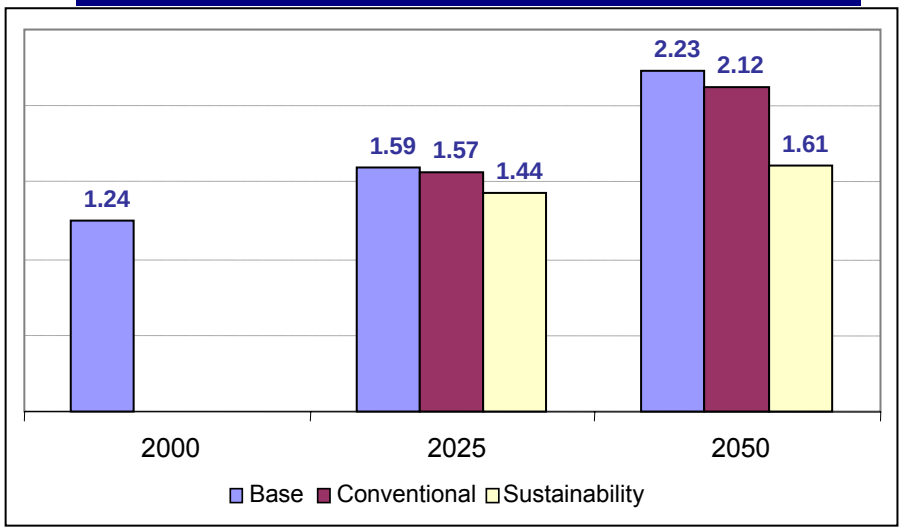
## Water Demand (BCM)



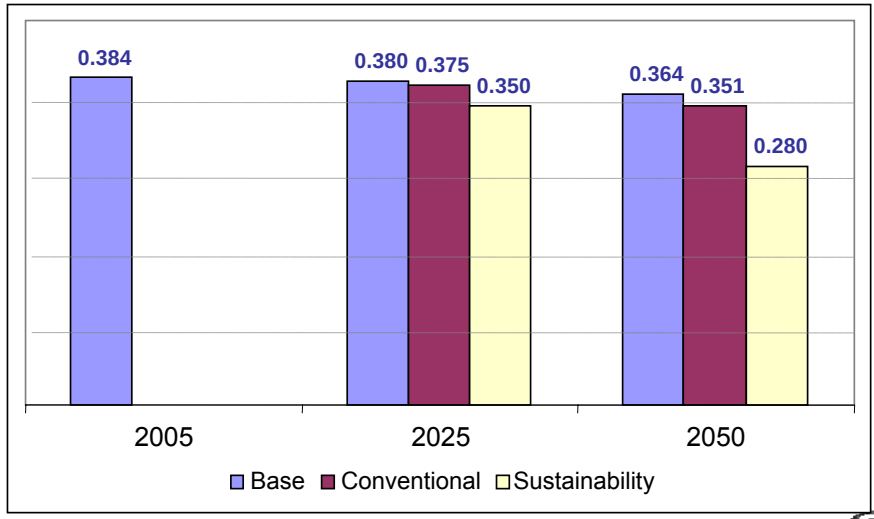

## Co-benefits: Increase in Hydro (PJ)



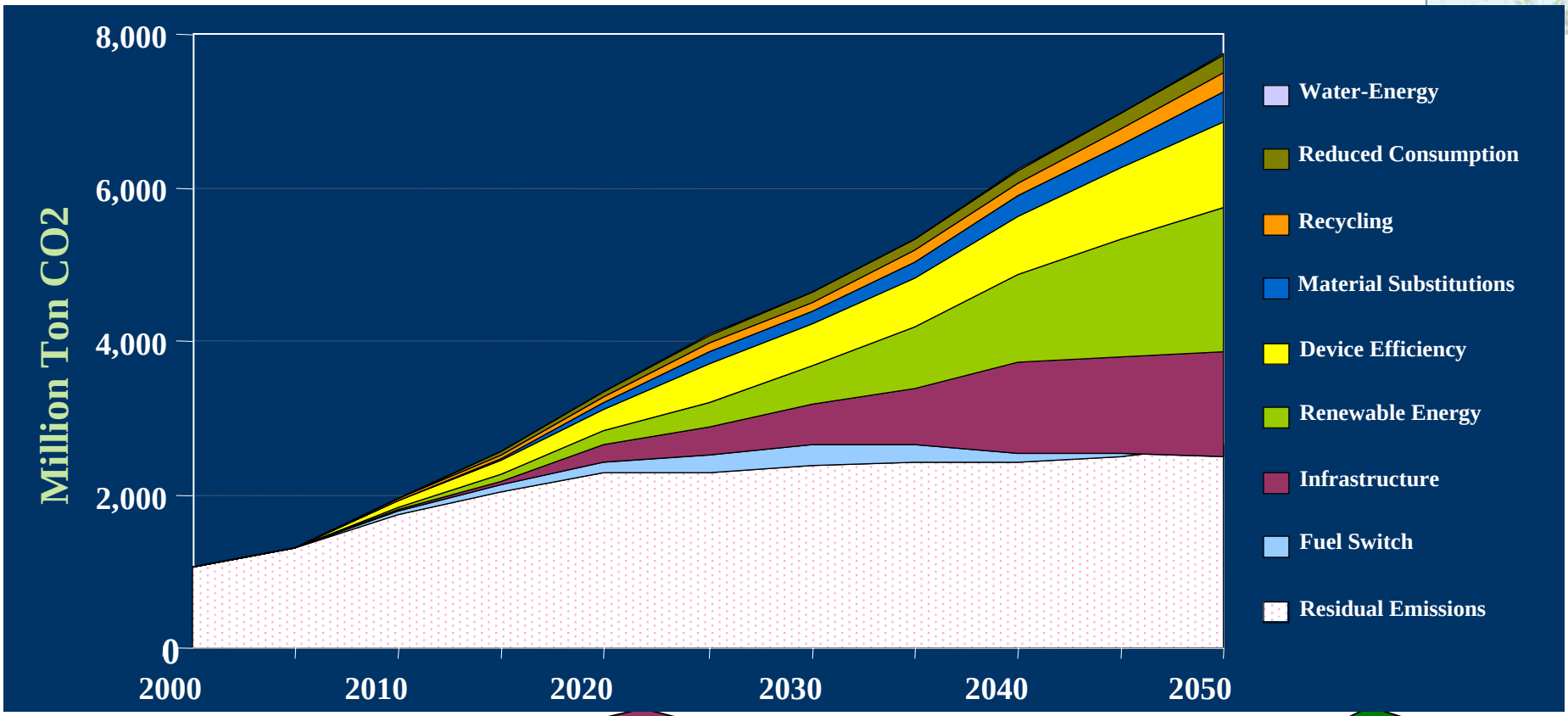

## Energy - Water decoupling (PJ/BCM)




## Water - CO2 decoupling (mt-CO2/BCM)



# 2°C Stabilization: Sustainability



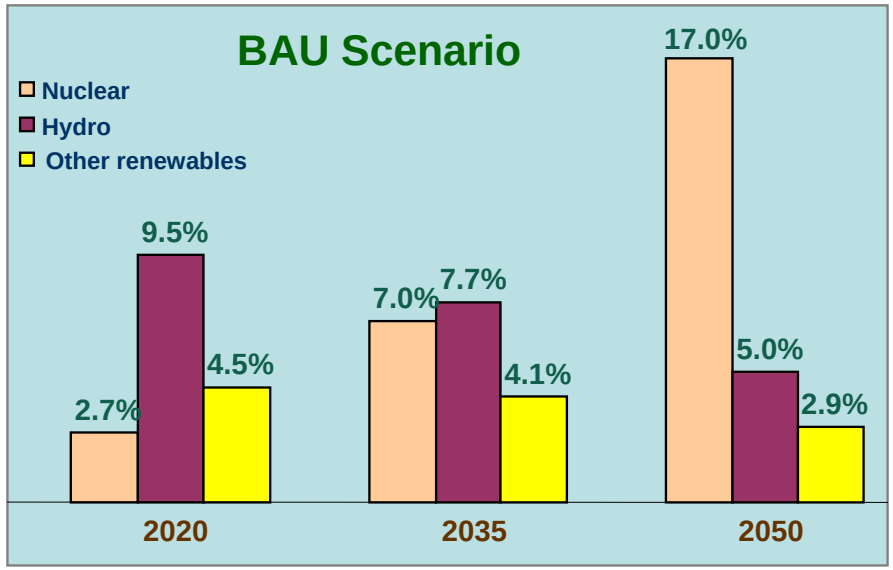

**Sustainability Approach: aligning climate and sustainable development actions**

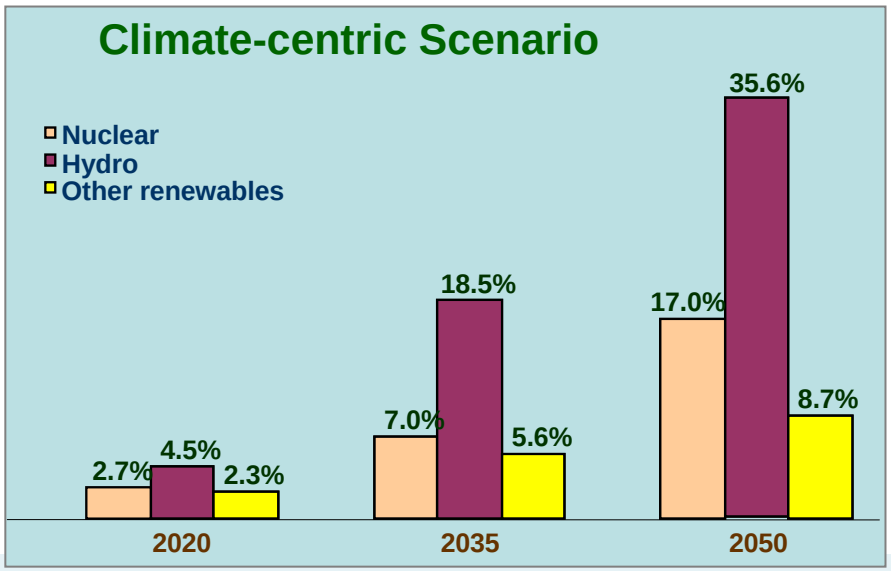
- Low Carbon Price
- Bottom-up/Demand-side actions
- Behavioural change
- Diverse Technology portfolio

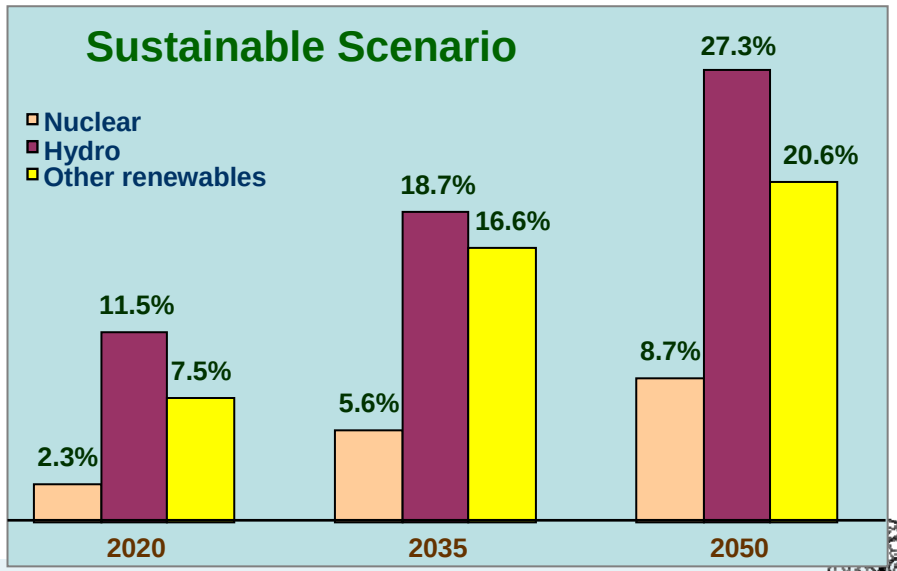
**Technology Co-operation Areas**

- Transport Infrastructure Technologies
- 3R, Material Substitutes, Renewable Energy
- Process Technologies
- Urban Planning, Behavioral Changes

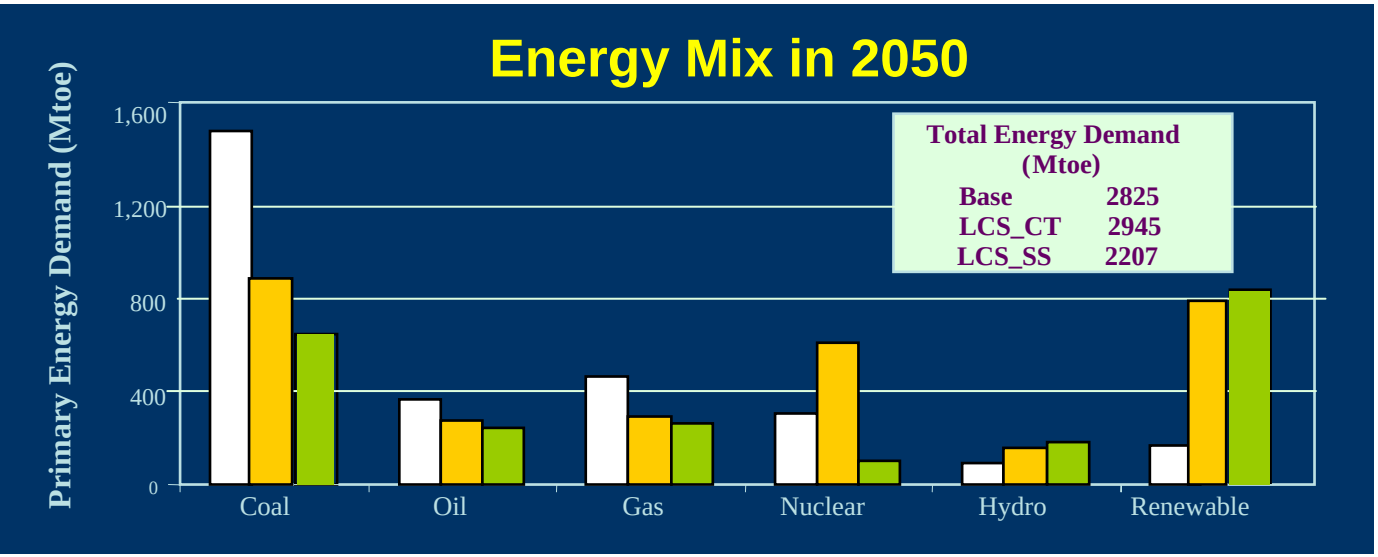
# Carbon-free Energy in Future Scenarios

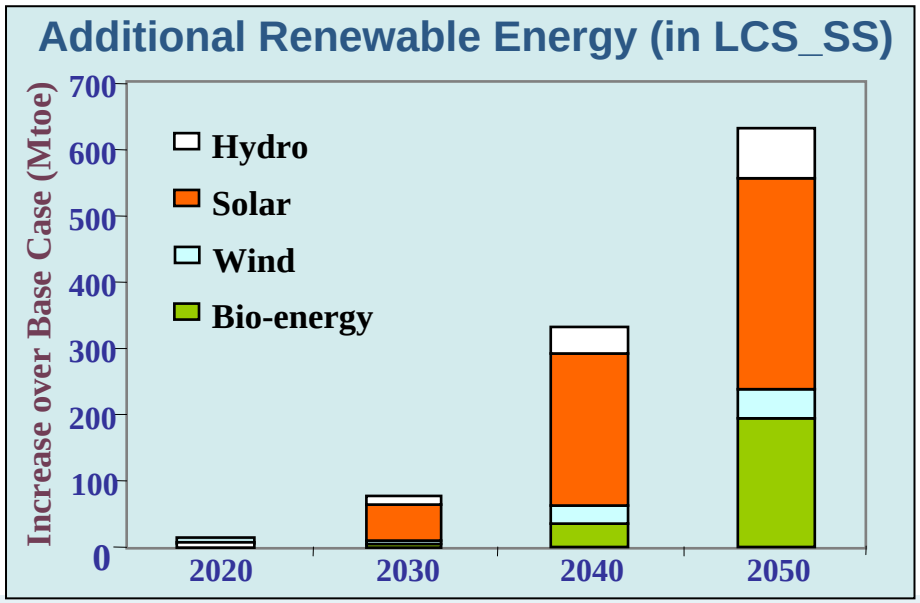


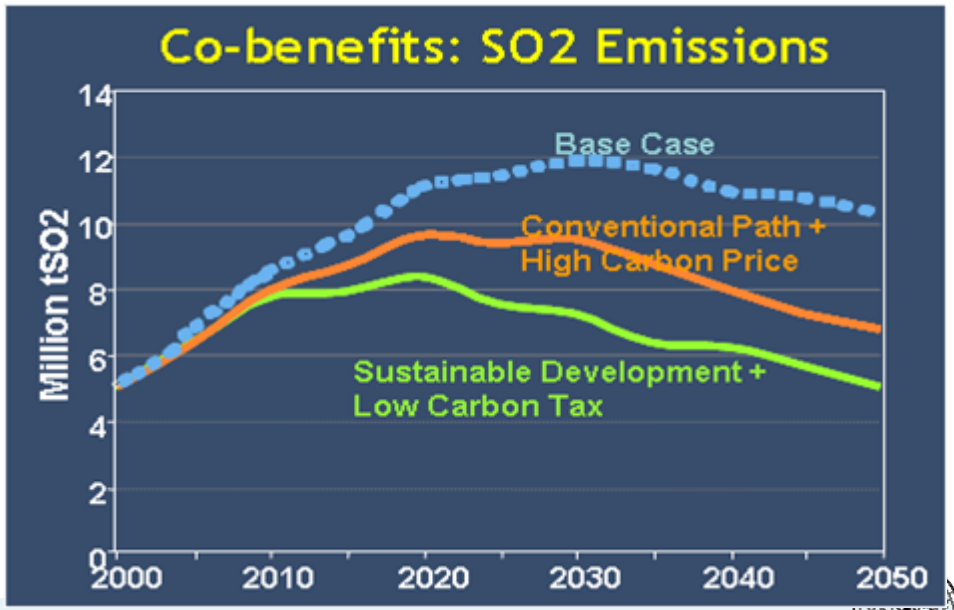



# Energy Security & Air Quality Co-benefits

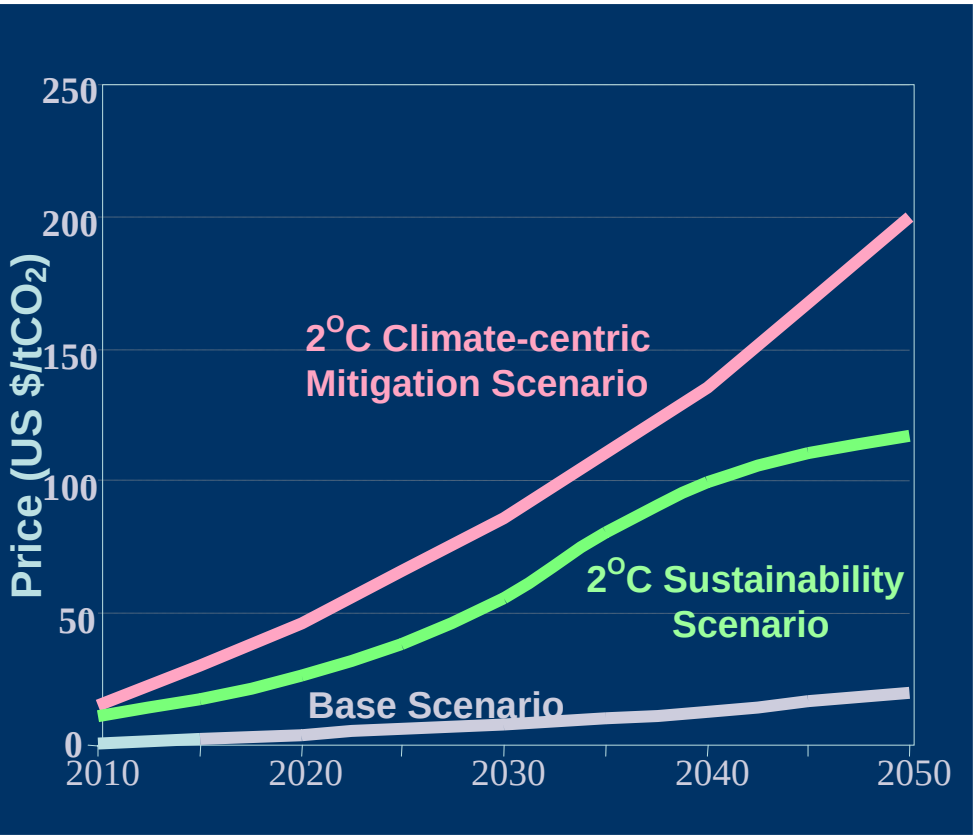


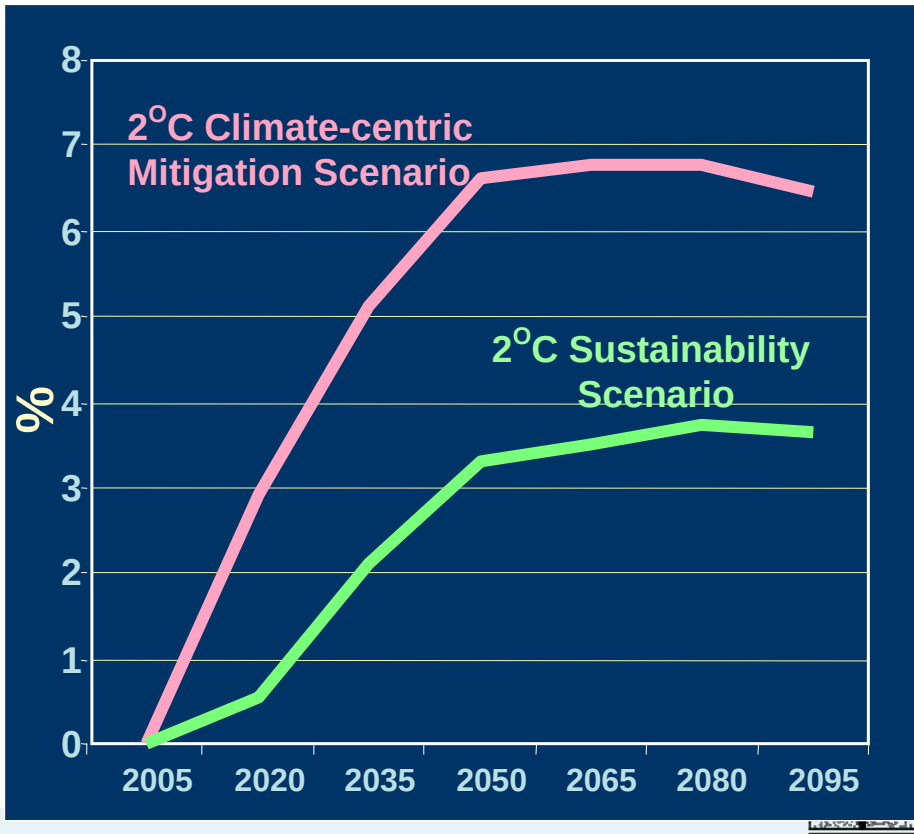



# Social vs. Market Value of Carbon

## Social Value of Carbon




## GDP Loss for India

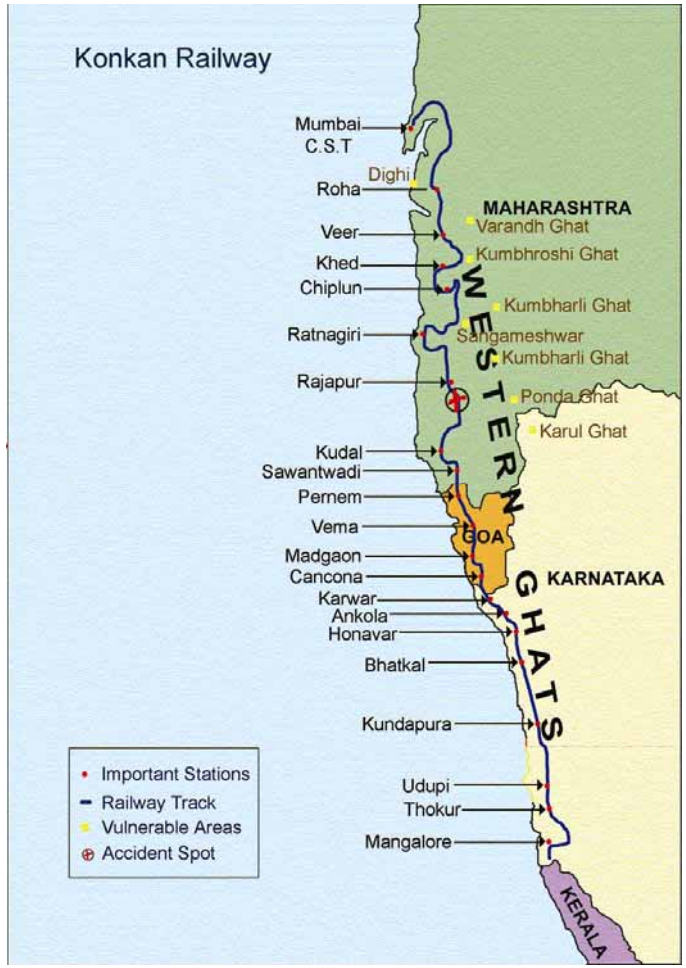


# Adapting to Residual Climate Change

- Climate Proofing Long-life Assets
- Climate Proofing Cities

# Konkan Railway: Impacts and Adaptation

- Presently 20% of repair and maintenance expenses on tracks, tunnels and bridges are due to climatic reasons.
- A recent accident on 21st June 2003 night, resulting in over 50 deaths, was caused by landslide. Consequent to the accident, maximum permissible speed of trains has been reduced from 120 Km/h to 75 Km/h.
- Identification of the vulnerable spots and installation of “Raksha Dhaga”. Present vulnerable regions in the northern zone are shown on the map. Future rainfall pattern shows that such events are likely to occur more frequently and with higher intensity.
- Adaptation measures should also consider no technological measures



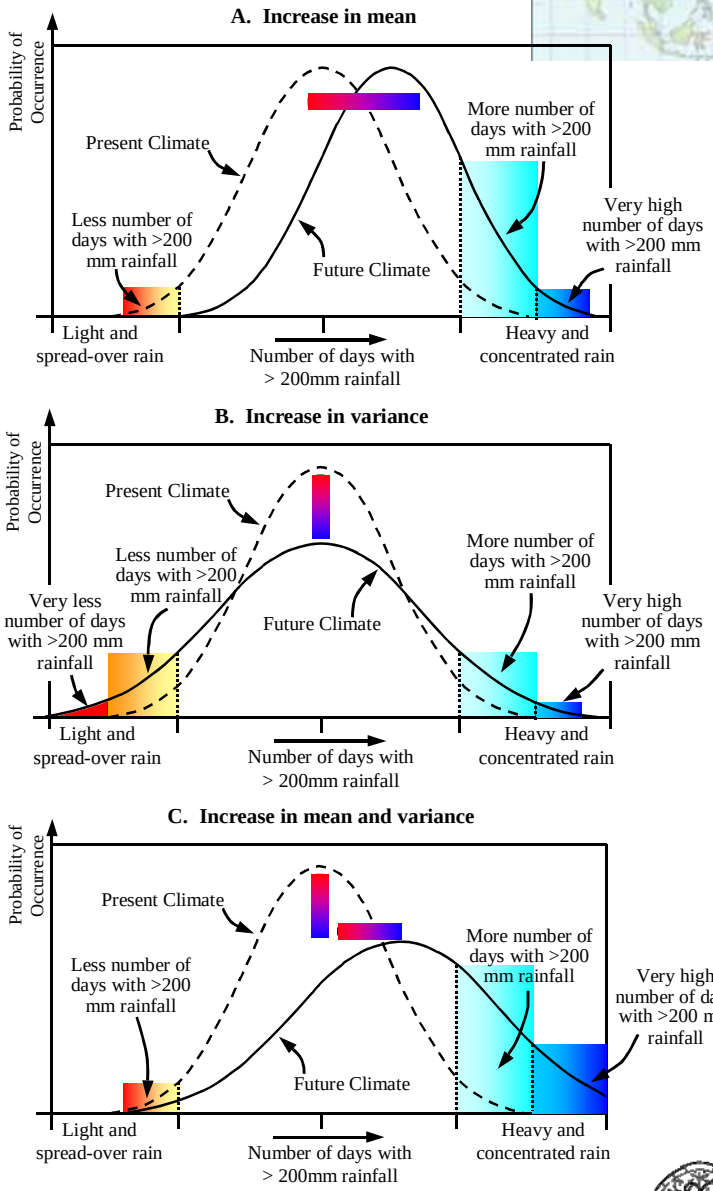
# Konkan Railway: Probability and Variability

**Increasing mean and variability of the number of days with heavy rainfall will adversely affect the infrastructure, if adequate adaptation measures are not taken.**

A. With increase in the mean, the probability of receiving heavy and concentrated rainfall increases resulting in increased threat to infrastructure

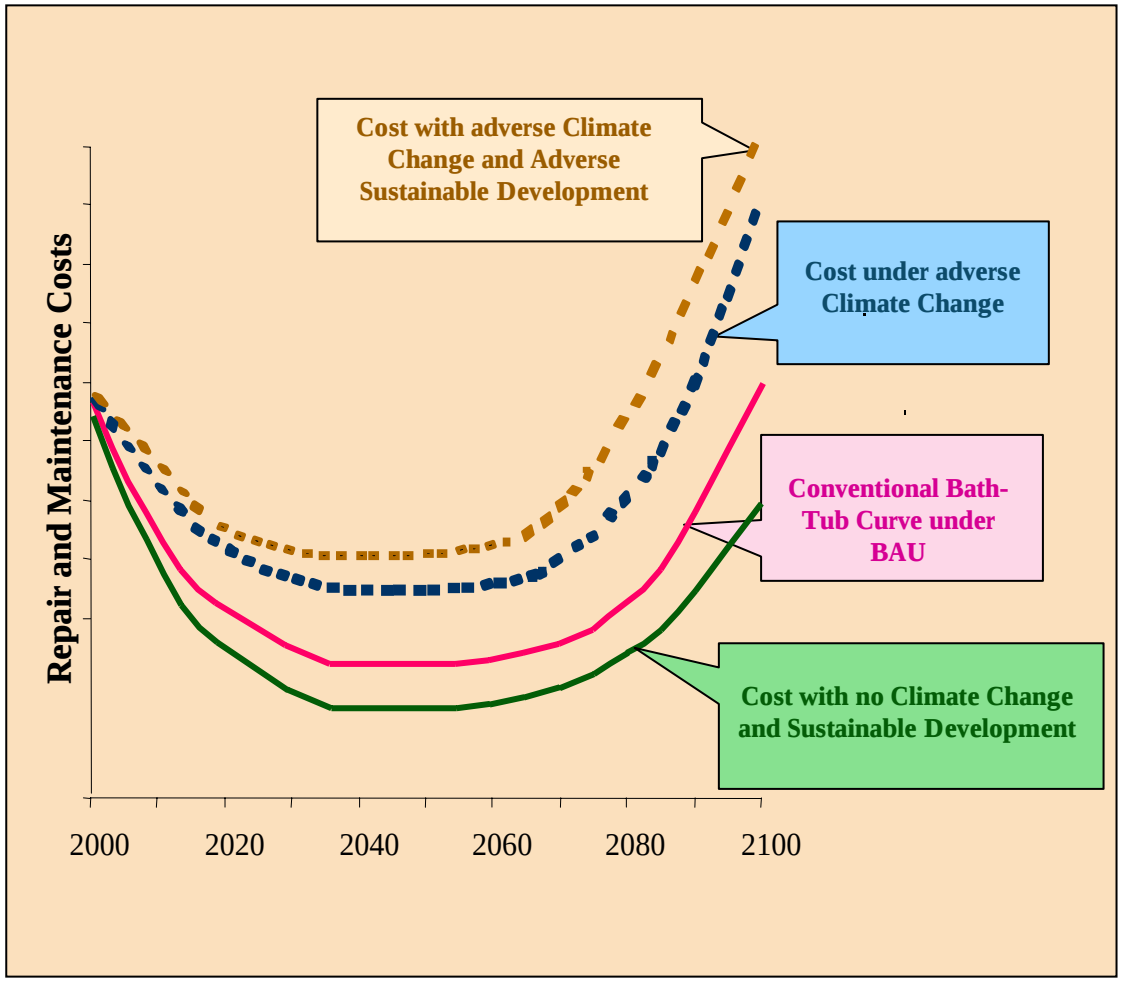
B. Increase in variability may cause extremely high concentration of rainfall. It may also result in many new locations getting high rainfall, and many existing locations with heavy rainfall getting more frequent and severe rainfall.

C. Simultaneous increase in mean and variability will make the system highly vulnerable as this will result in high number of days with heavy rainfall, scattered in time and space.



# Konkan Railway: Maintenance Costs

## Maintenance Cost Curves



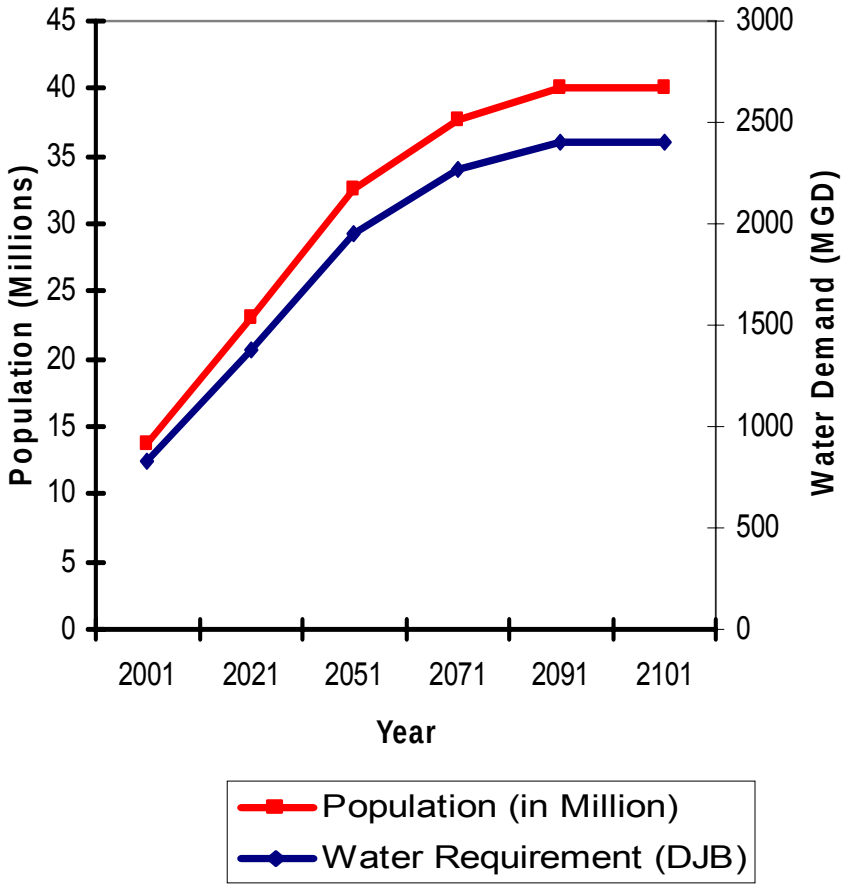

Long-life assets commissioned now will have higher failure rates after a ten when they become old. Climate Change and Unsustainable Development Policies shall exacerbate maintenance costs in future.

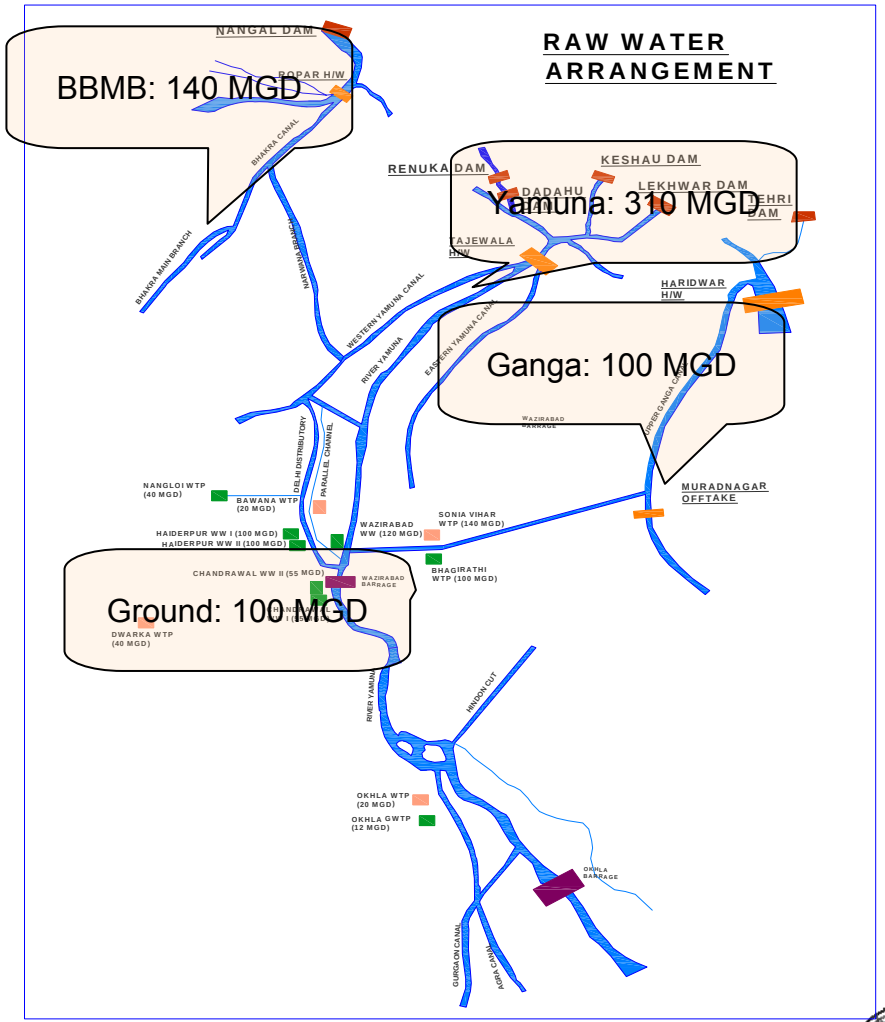
**For Konkan Railway:**

At present, 20% of repair and maintenance expenses on tracks, tunnels and bridges are due to climatic reasons.

# Water Availability (DELHI)

## Population, Demand and Sources

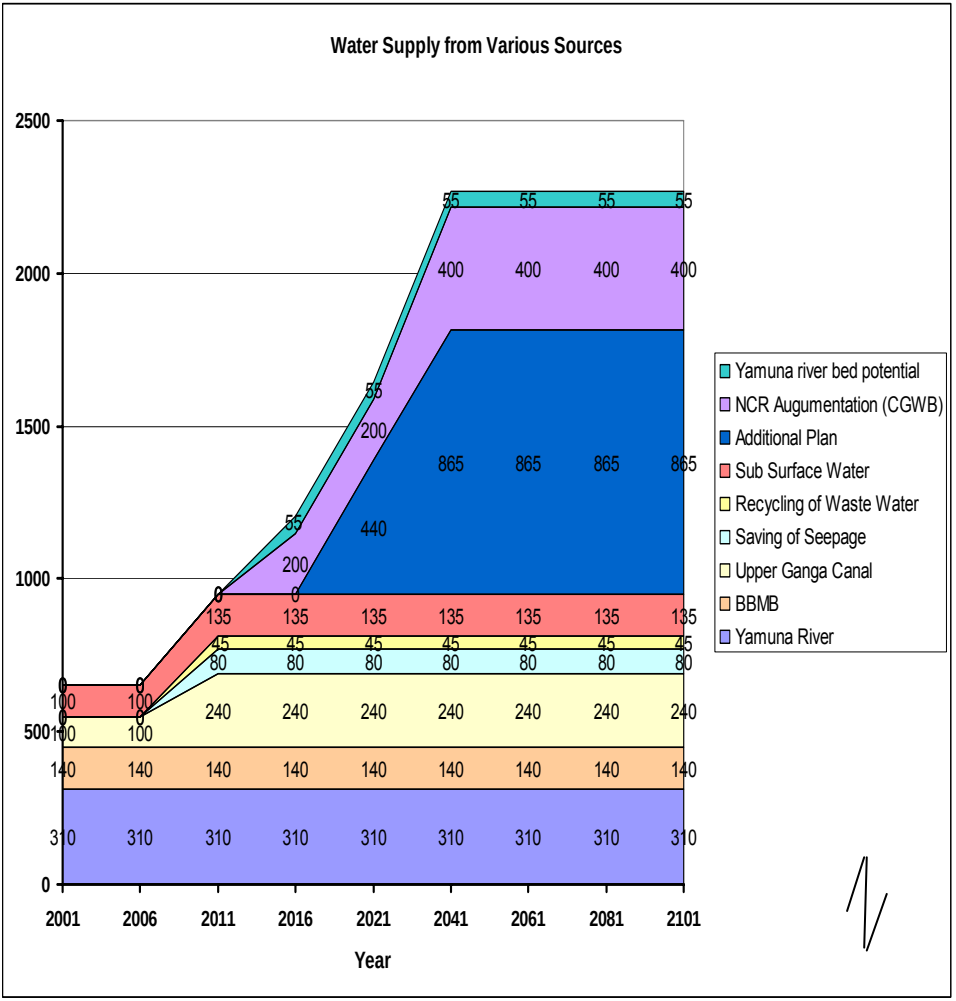


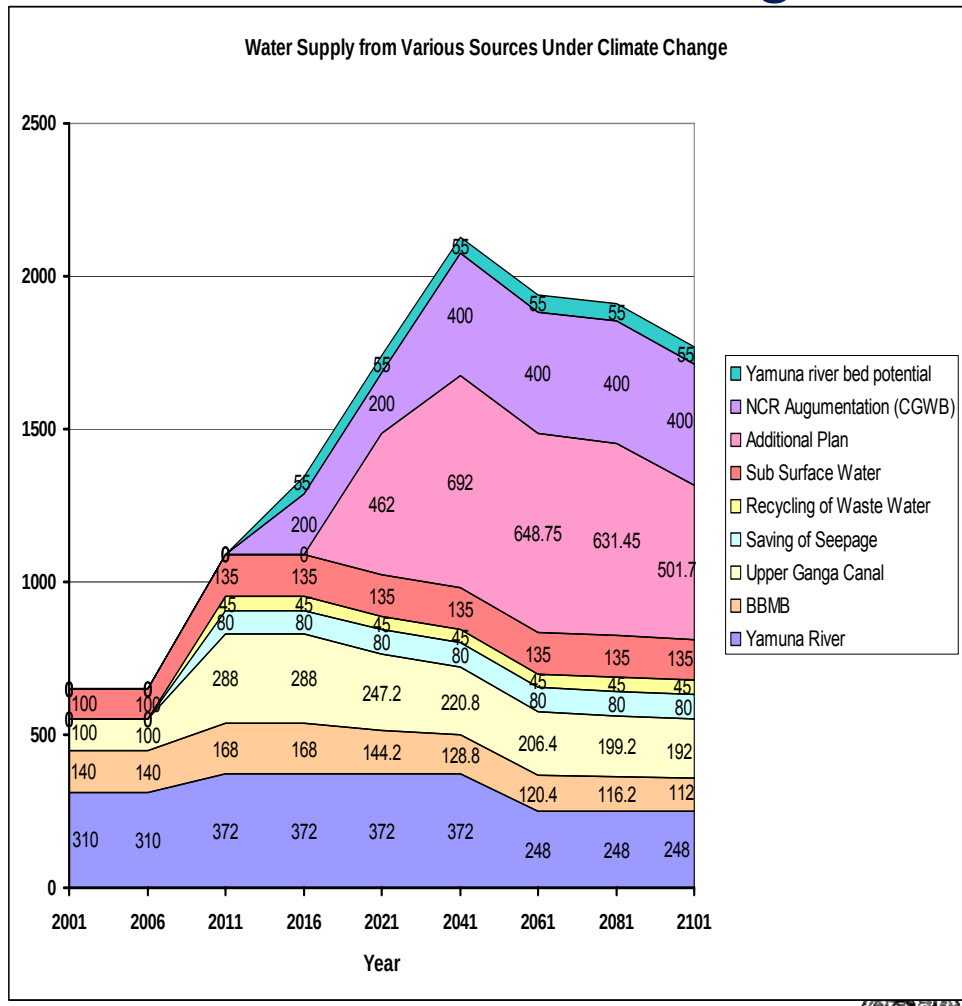
# Water Availability (DELHI)

## Existing and Envisaged Sources of Water

### No Climate Change




### BAU Climate Change



# Conclusions

- Green Growth elevates Low Carbon actions from the Margin to the Mainstream

- Green Growth reduces cost and risks of Climate Change Mitigation, Impacts and Adaptation

- Green Growth roadmap provides a practical way-out from the current climate negotiations gridlock

- Even in the Green Growth Scenario, Climate focused policies will still be needed for mitigation and adaptation to meet $2^{o}C$ Stabilization Challenge

# *Thank you*