



Low Carbon Society: *A Green Roadmap for India*

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INDIA: National Climate Change Action Plan

8 National Missions:

1. Solar Energy (20 GW by 2022; 2 GW off-grid; 20 m sq. m collectors)
2. Enhanced energy efficiency (Avoided capacity of 19000 MW by 2014-15)
3. Sustainable habitat
4. Water Sector (20% water use efficiency improvement)
5. Sustaining the Himalayan eco-system
6. A “Green India” (20 Mil. Hectare afforestation by 2020; Forest cover from 23 to 33%)
7. Sustainable agriculture (micro irrigation promotion in 40 m ha)
8. Strategic knowledge for climate change

Copenhagen: Commitments and Actions

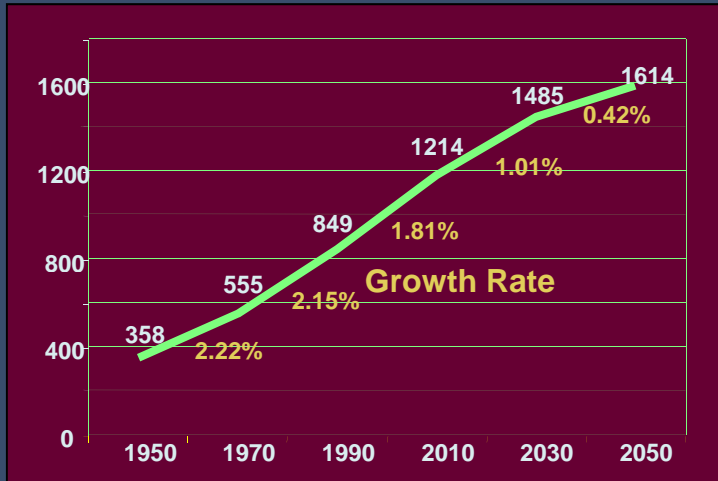
- 20 to 25% Emissions Intensity Reduction from 2005 to 2020 (1.5 to 1.9% decoupling)
 - Per Capita Emissions Below OECD Average (for ever)

Post-Copenhagen Domestic Action

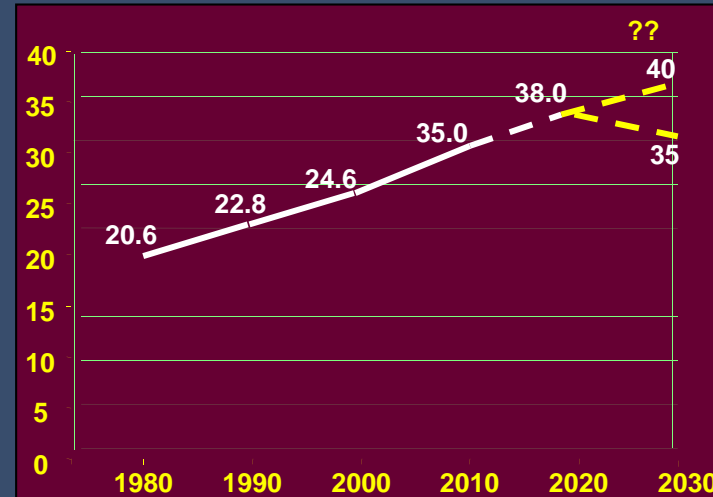
- **Carbon tax on coal to fund clean energy**
 - US \$1/ton on domestic & imported coal; fund to be used for Clean Energy)
- **Enhanced Energy Efficiency measures**
 - Mandate to reduce specific energy consumption;
 - Energy savings certificates & trading
 - Energy efficiency ratings mandatory for 4 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

Drivers of Economic Growth

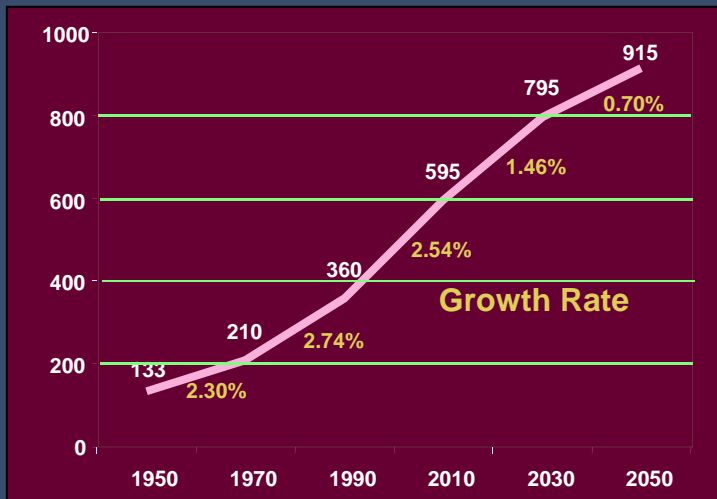
Population (Million)



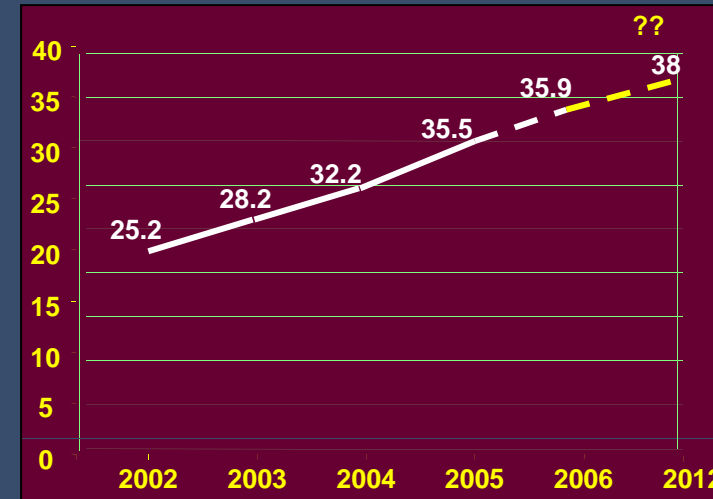
Savings Rate



Labor Force (Million)

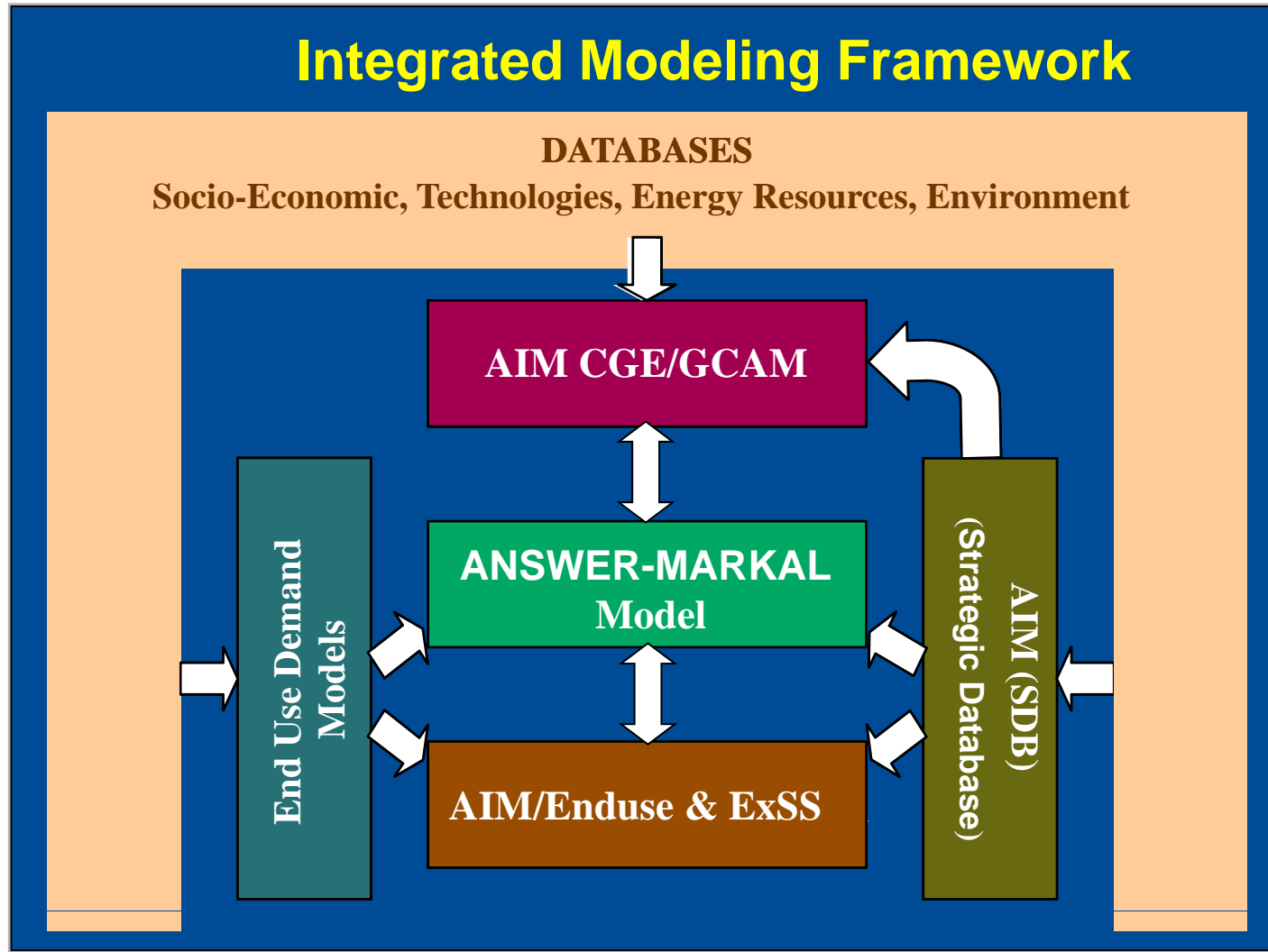


Investment Rate



LCS Scenarios and Modeling Framework

Integrated Modeling Framework



BAU Projections: Analysis with ANSWER-MARKAL Model

Assumptions

From 2005-2050:

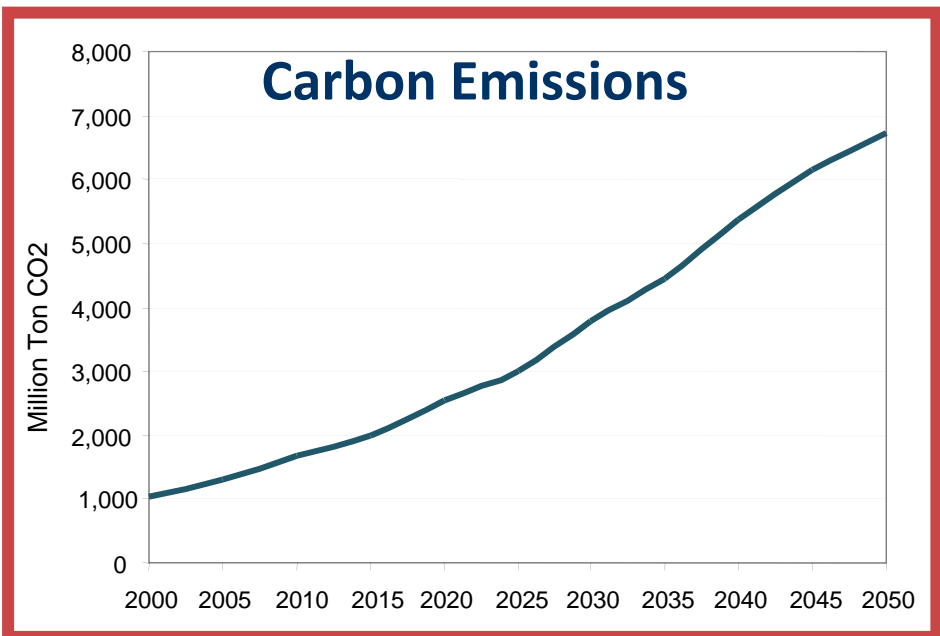
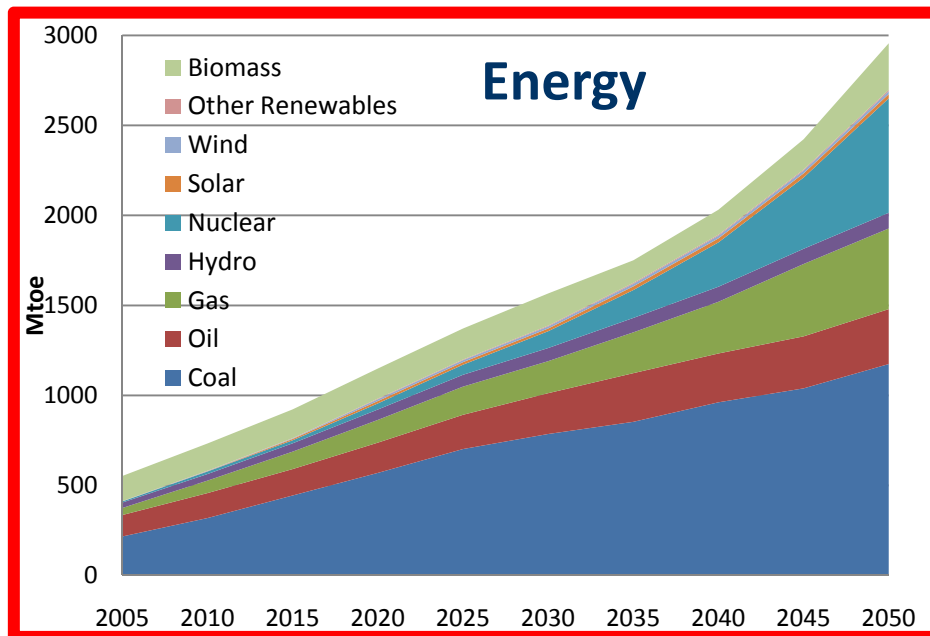
Annual Economic Growth: 7.34 %

Annual Population Growth: 0.8 %

Absolute Growth in 2050 over 2005

Economy 24 times

Population 1.43 times



Results: Energy and Carbon Intensity

Annual Improvement From 2005-2050:

Energy Intensity: 3.0 (%)

Carbon Intensity: 3.6 (%)

Decarbonization of Energy: -0.6 (%)

Ratios: 2050 over 2005

Final Energy Demand: 6.27

Energy Intensity: 0.26

Carbon Intensity: 0.19

Copenhagen Commitments: Risks?

Scenario	GDP (% Annual Growth)			Ratio: GDP / 2005 GDP		
	2005-20	2005-32	2005-50	2020	2032	2050
BAU (Medium Growth)	8.7%	8%	7.3%	3.5	8.0	24.2
High Growth	9.5%	9%	7.5%	3.9	10.2	25.9
Low Growth	7.3%	7%	6.9%	2.9	6.2	20.1
Very Low Growth	7.0%	6%	6.4%	2.8	4.8	16.3

Scenario Analysis: 2005-20

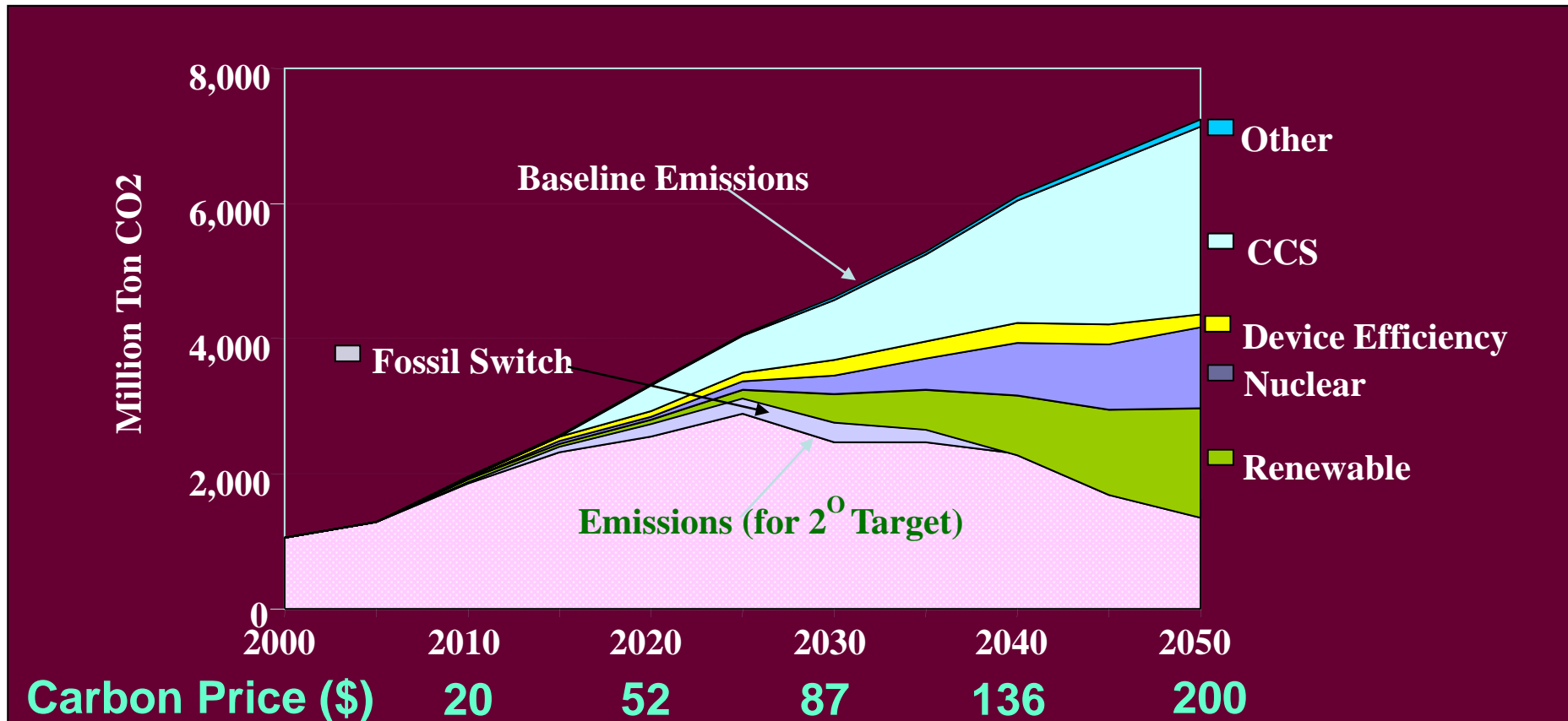
Scenario	GDP Growth	Emissions Growth	CO2 Intensity Decoupling	Ratio 2020 over 2005	
				GDP	Emissions
BAU (Medium Growth)	8.7%	5.7%	2.8%	3.5	2.2
High Growth	9.5%	5.6%	3.9%	3.9	2.3
Low Growth	7.3%	4.7%	2.5%	2.9	2.0
Very Low Growth	7.0%	4.6%	2.4%	2.8	2.0

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

The 2°C Stabilization Challenge:

What is a Reference Case?

Mitigation Options: Conventional



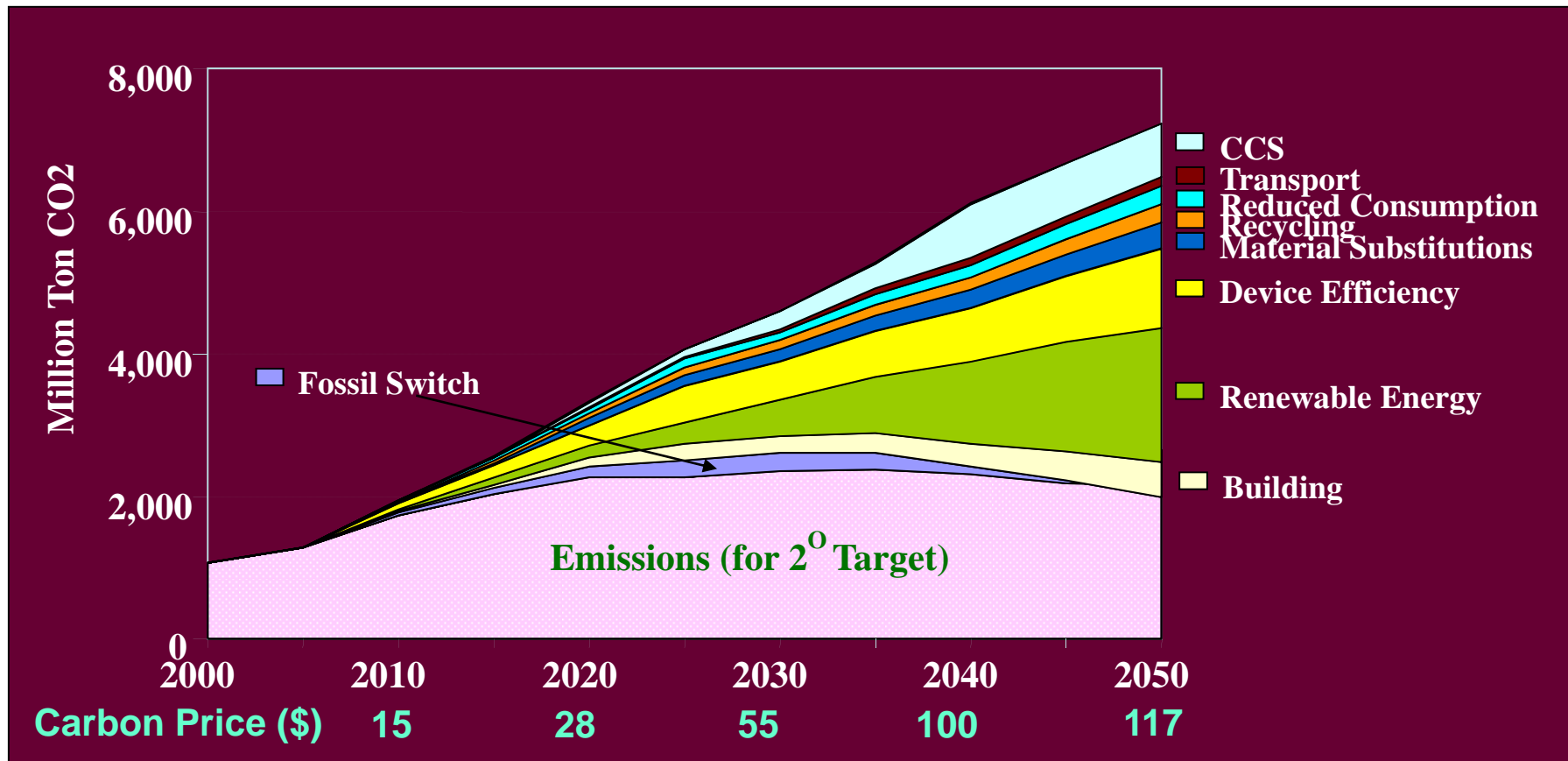
Conventional Development + Carbon price

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

Technology Co-operation Areas

- Energy Efficiency (Immediate Target)
- Renewable (2020 Targets)
- Nuclear/CCS (Long-term Targets)

Mitigation Options: Sustainability



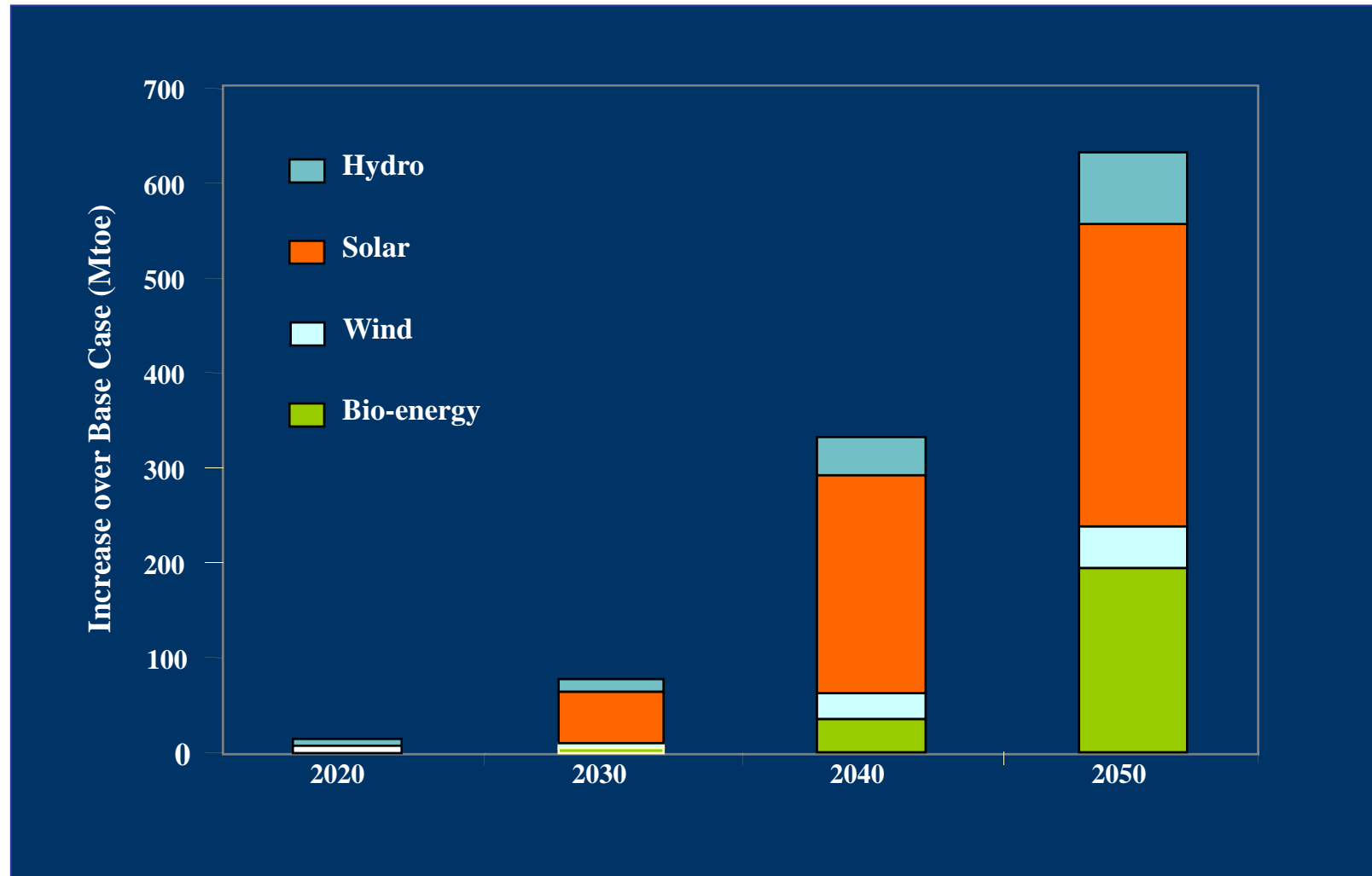
Sustainability Approach: aligning climate and sustainable development actions

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

Technology Co-operation Areas

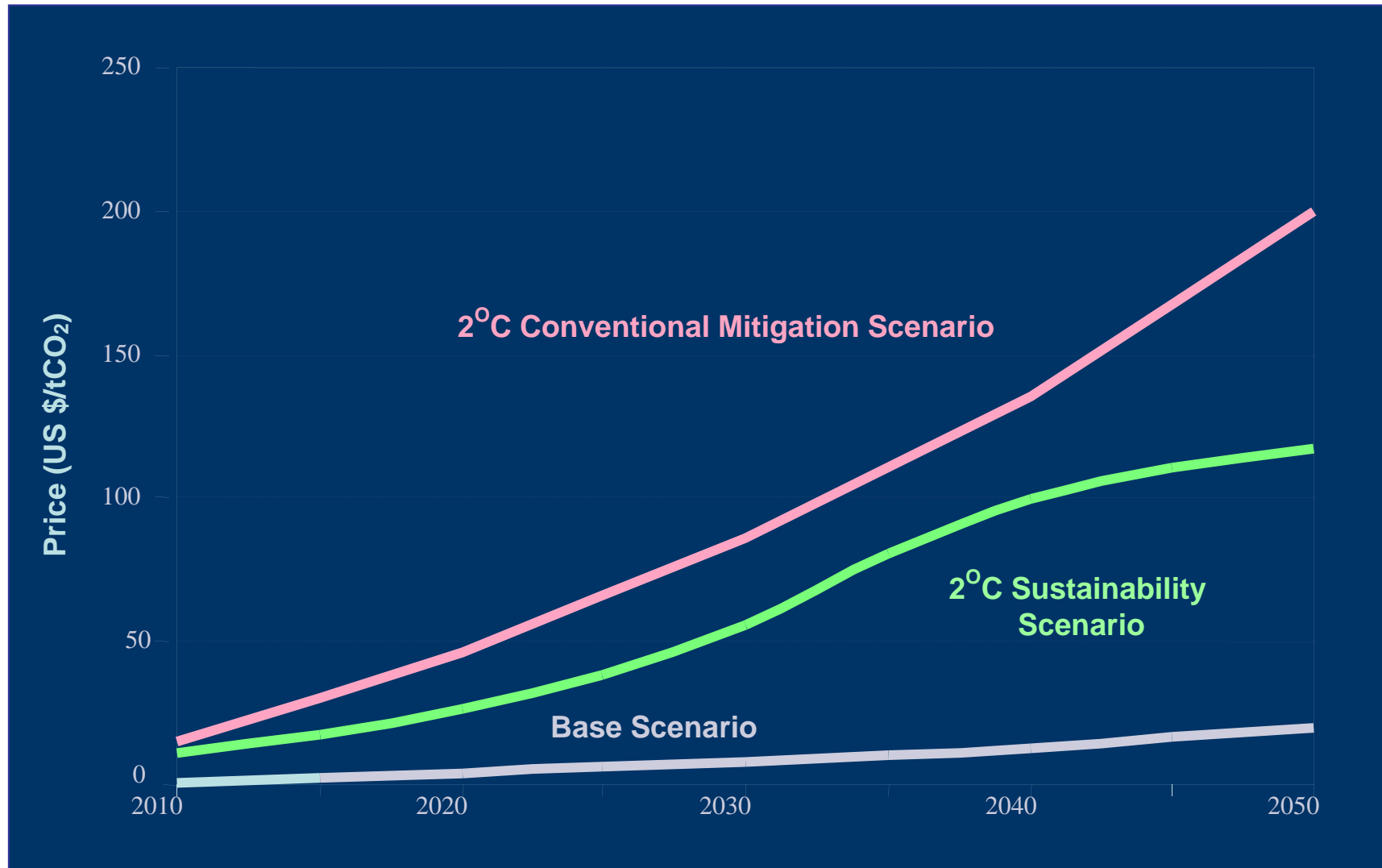
- Transport Infrastructure Technologies
- 3R, Material Substitutes, Renewable Energy
- Process Technologies
- Urban Planning, Behavioral Changes

Additional Renewable Energy (in Sustainability Scenario over Base Case)



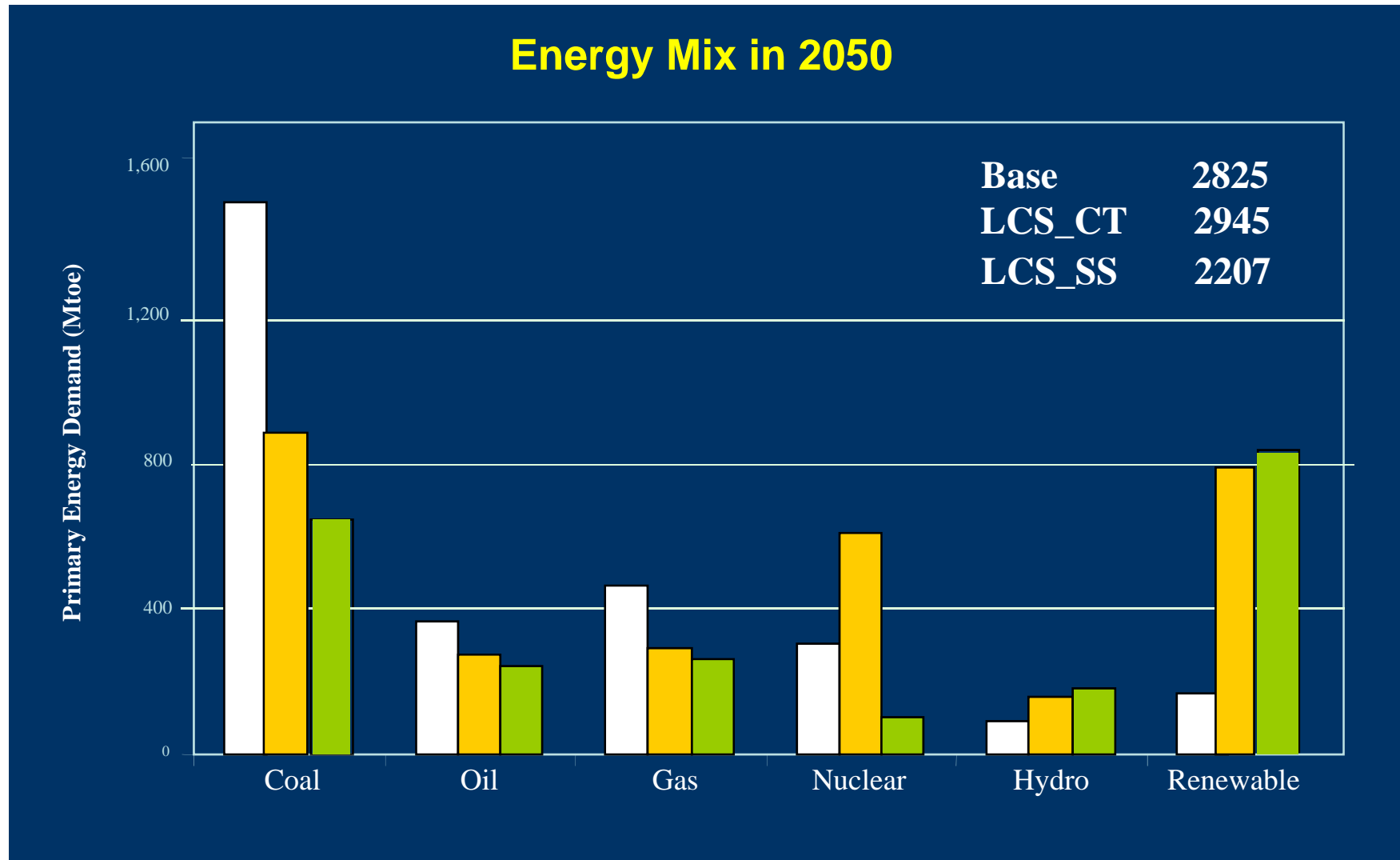
Analysis with ANSWER-MARKAL Model

LCS with Lower Carbon Prices



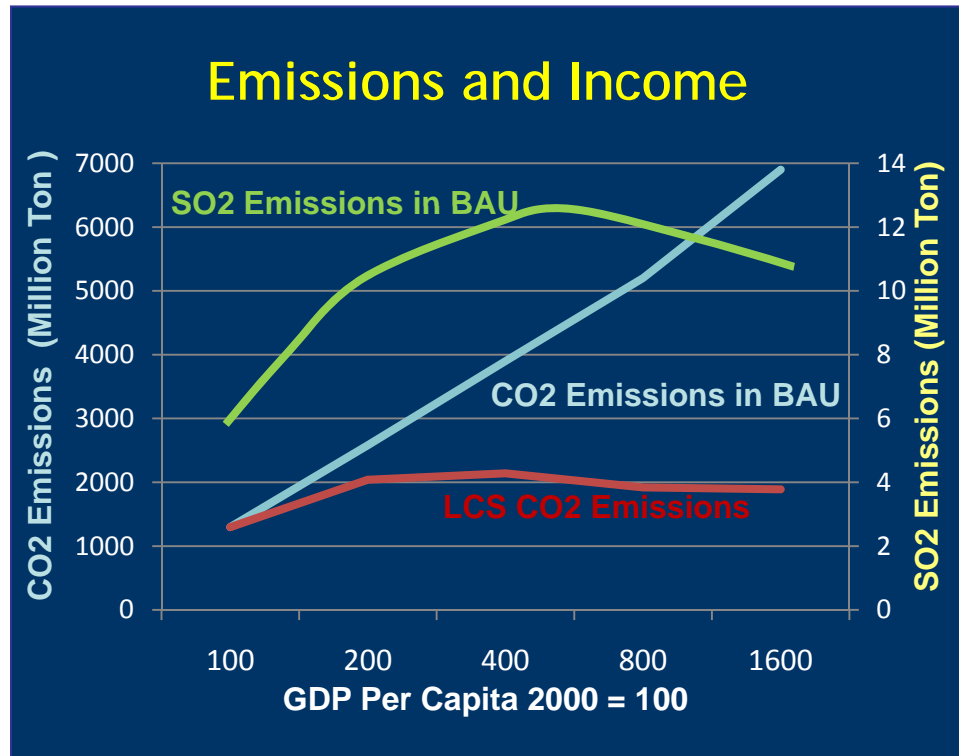
Analysis with ANSWER-MARKAL Model

Energy Security Co-benefits

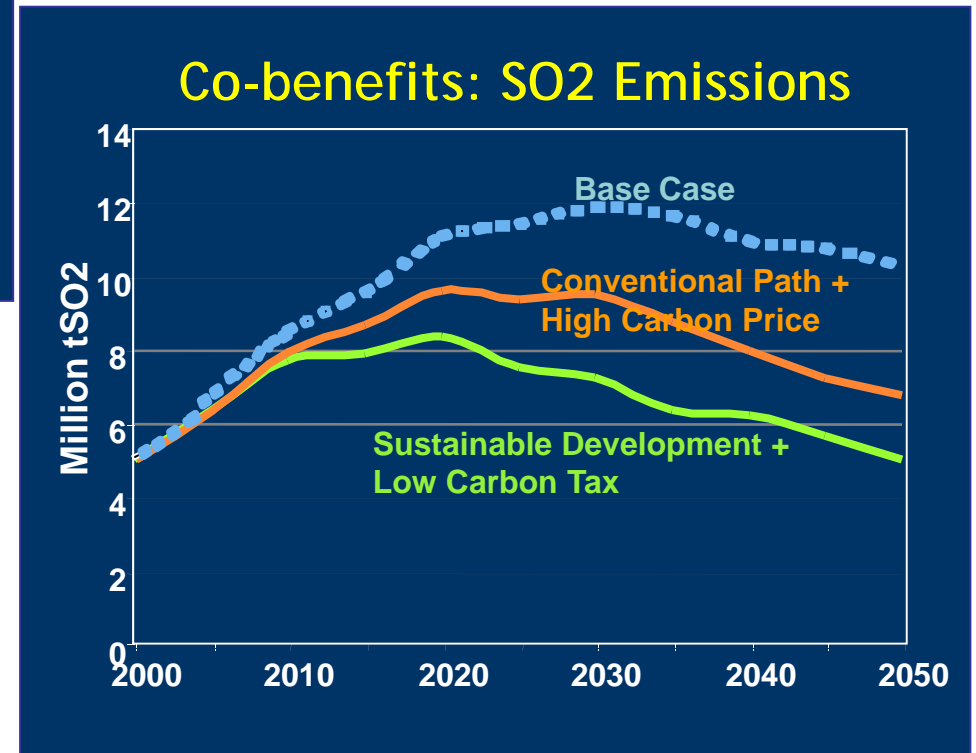


Analysis with ANSWER-MARKAL Model

Air Quality Co-benefits

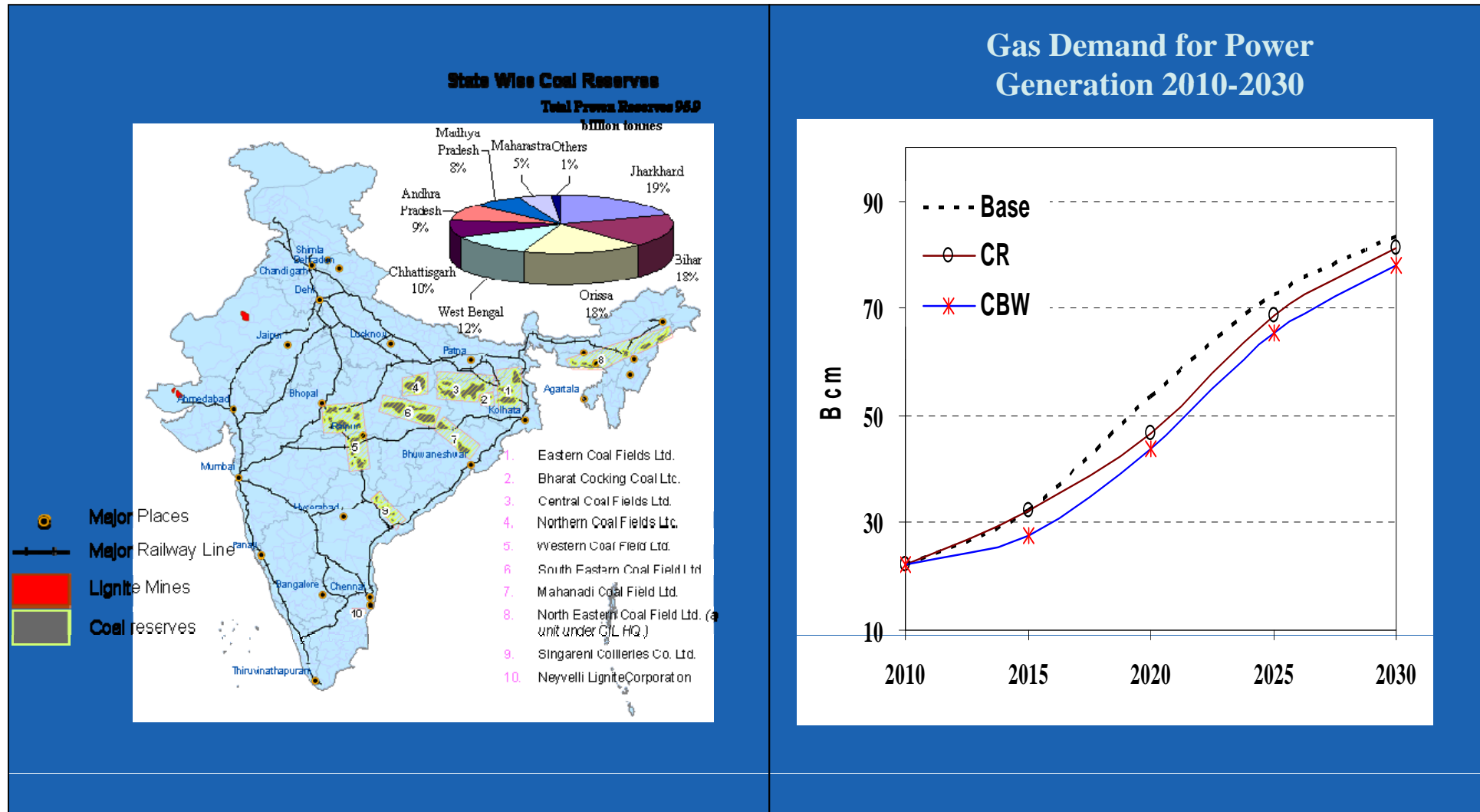


Analysis with ANSWER-MARKAL Model



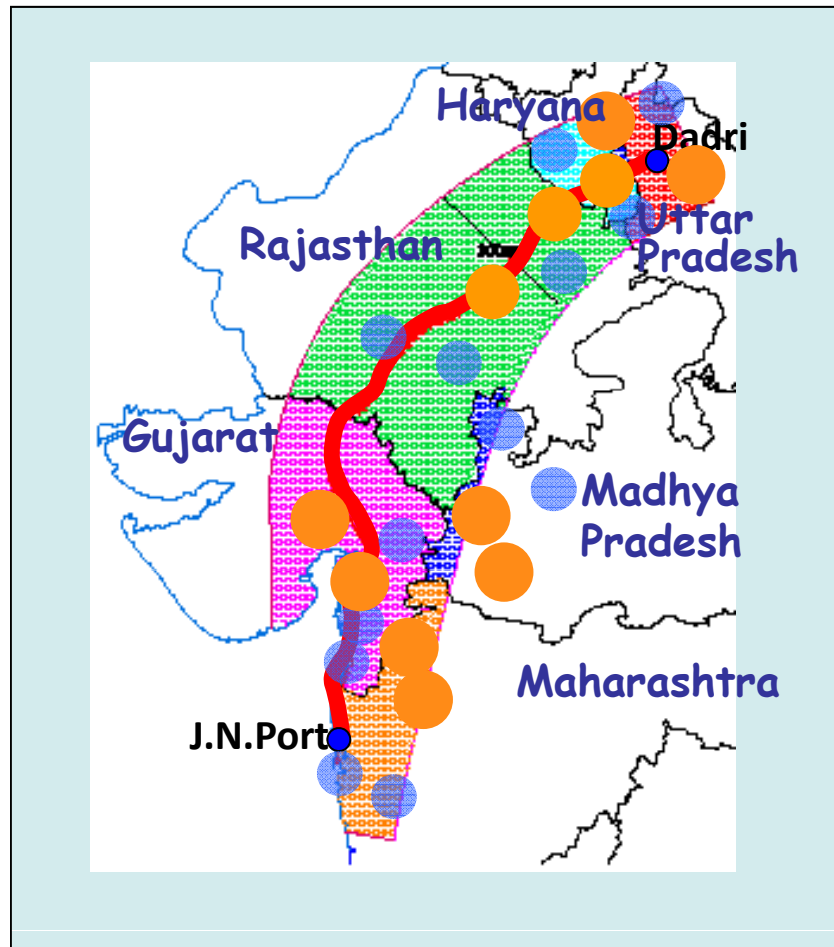
Infrastructures to Overcome Lock-ins - 1

Coal by Wire



Infrastructures to Overcome Lock-ins - 2

Train Corridors



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

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

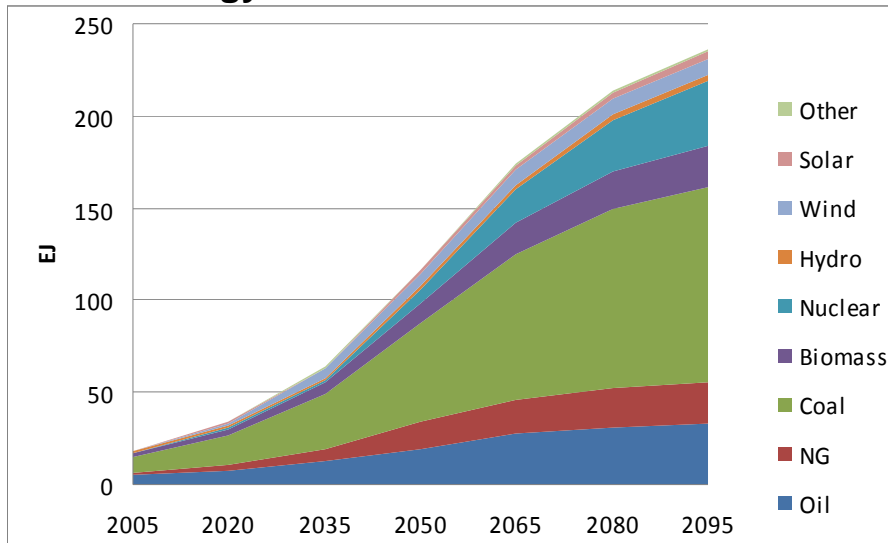
DMIC will result in substantial and sustained reduction in GHG since rail will replace road transport along this corridor



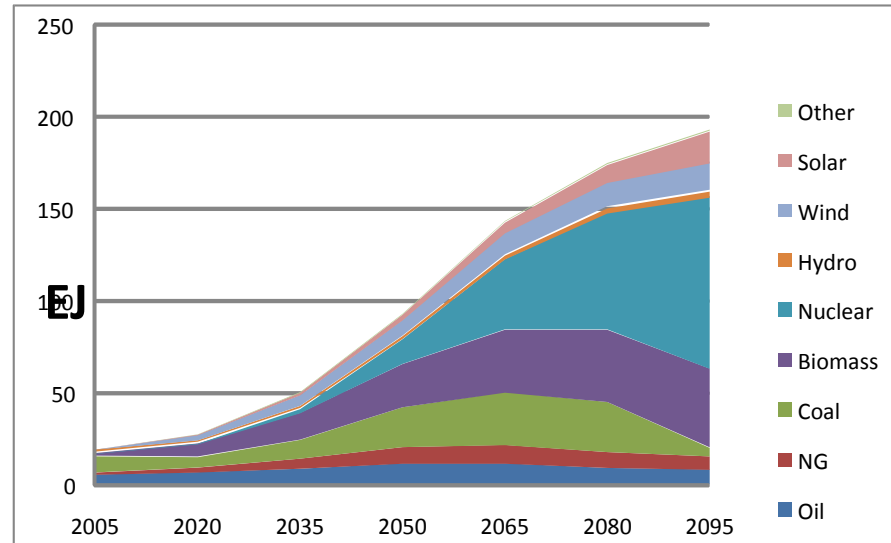
Analysis with ANSWER-MARKAL Model

Global & National Analysis: GCAM & AIM/CGE (1)

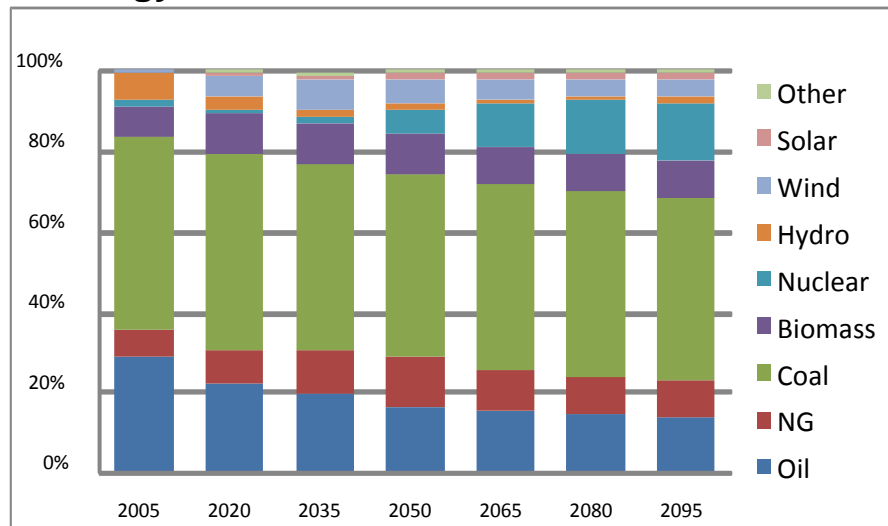
Energy in Base Case Scenario: INDIA



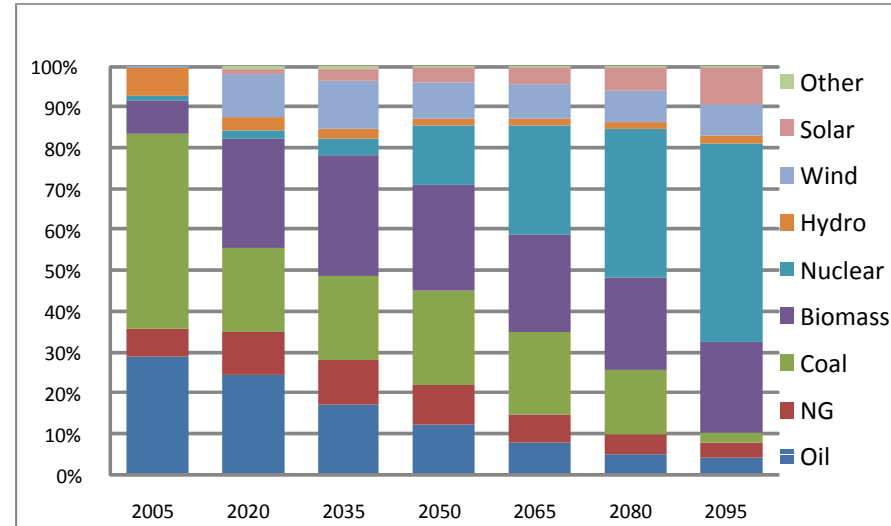
Energy in 450 ppmv Scenario: INDIA



Energy shares in Base Case Scenario: INDIA

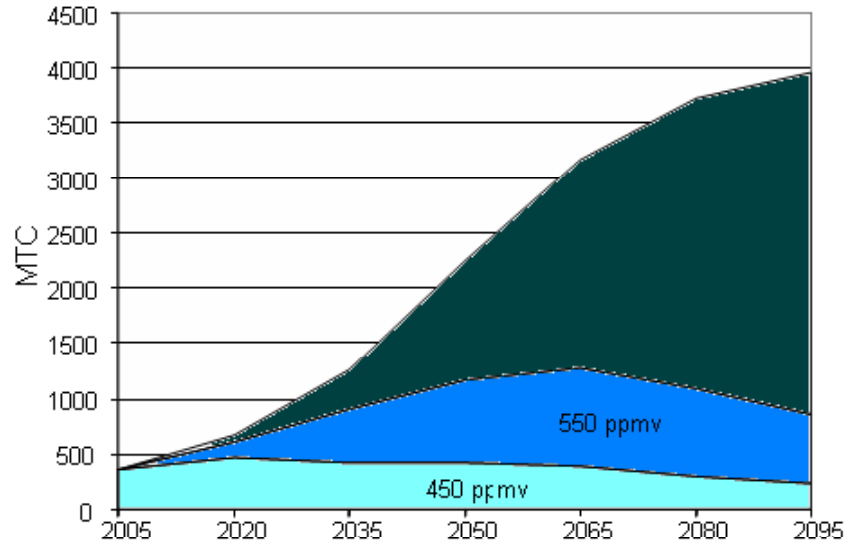


Energy shares in 450 ppmv Scenario: INDIA

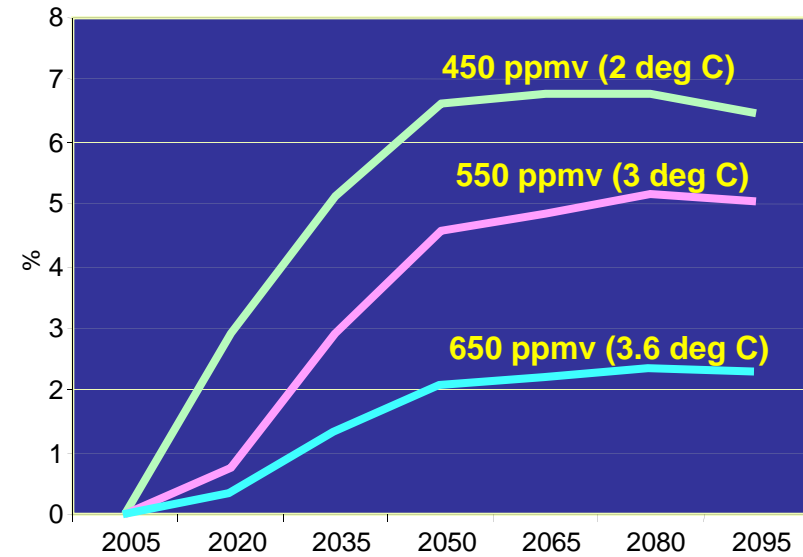


Global & National Analysis: GCAM & AIM/CGE (2)

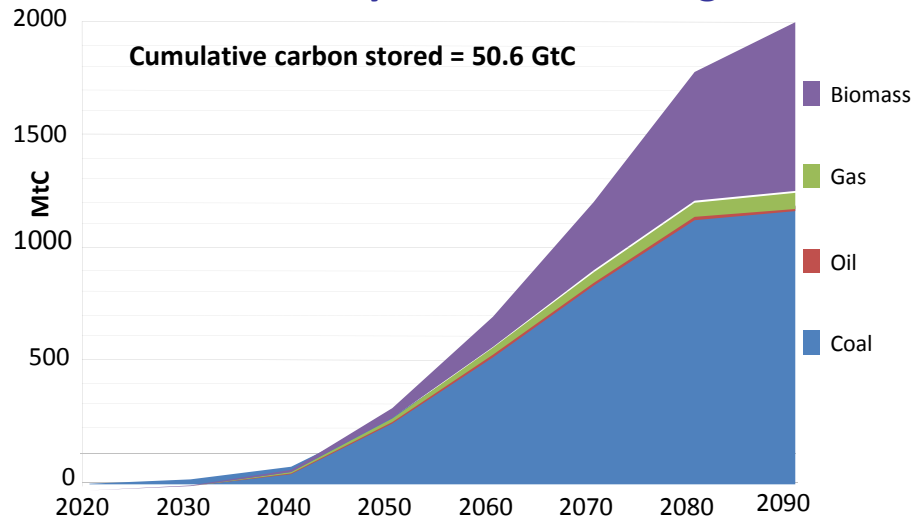
INDIA: Carbon Emissions



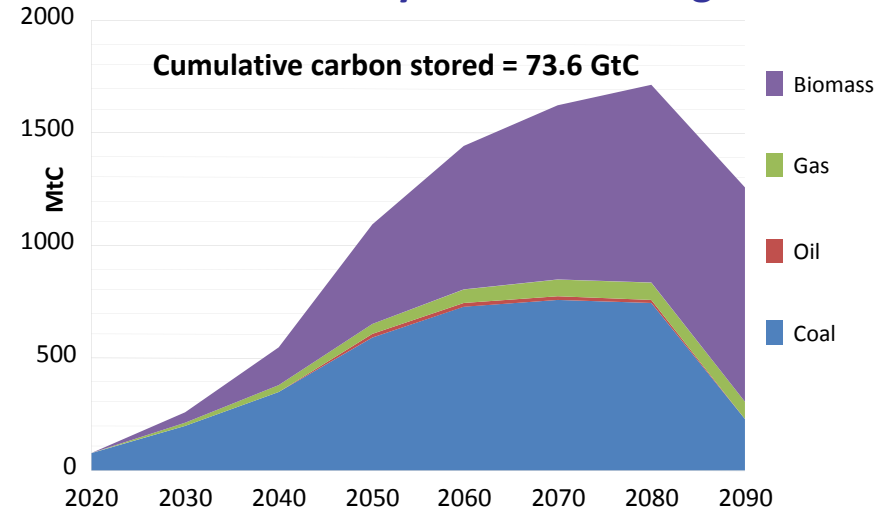
GDP Loss for India



CCS in Electricity- Scenario 3.6 deg C

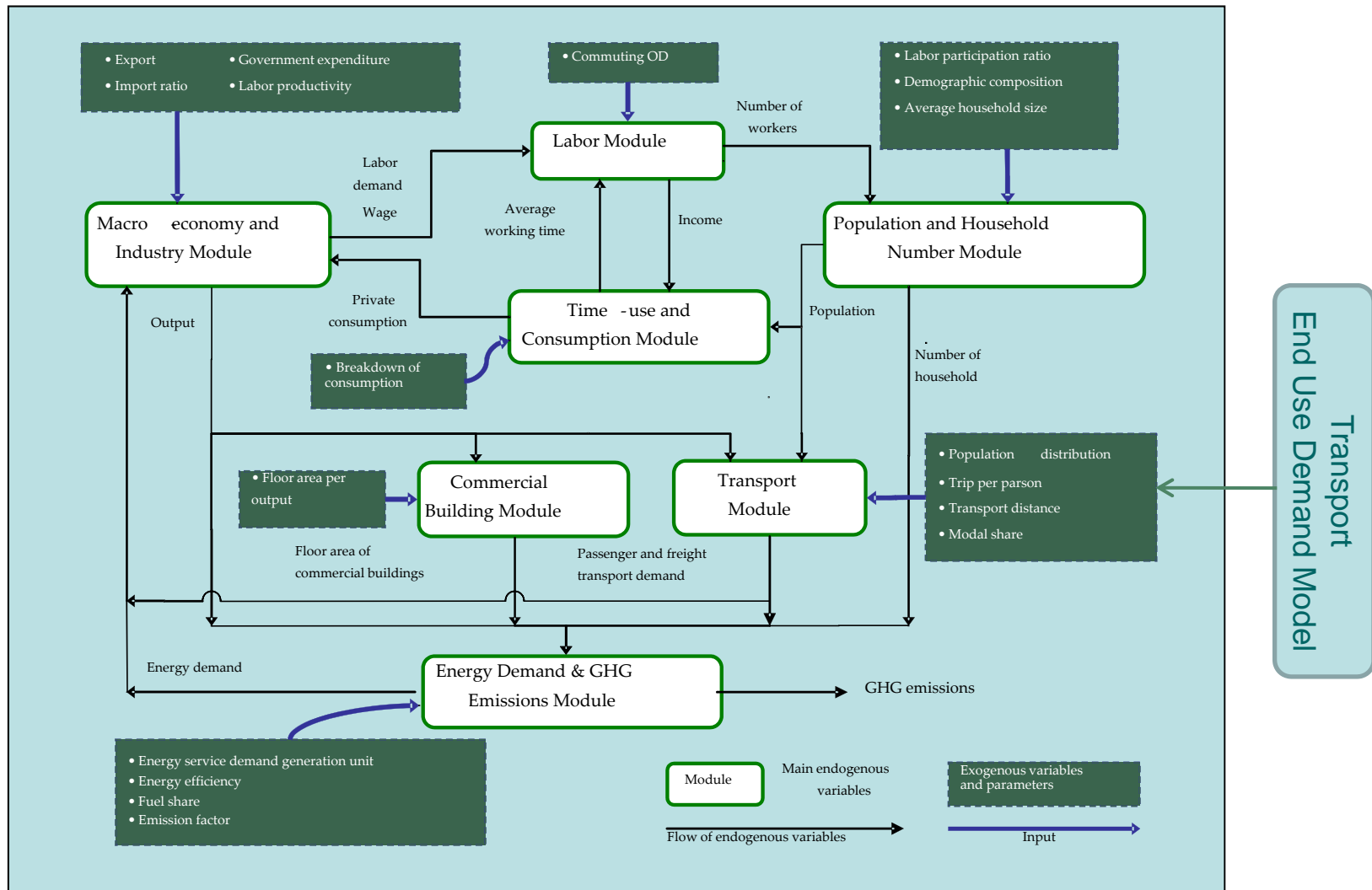


CCS in Electricity- Scenario 2 deg C



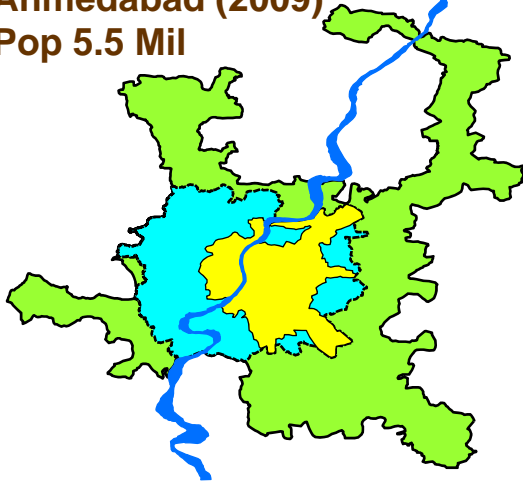
Low Carbon Cities

Extended Snapshot (ExSS) Model

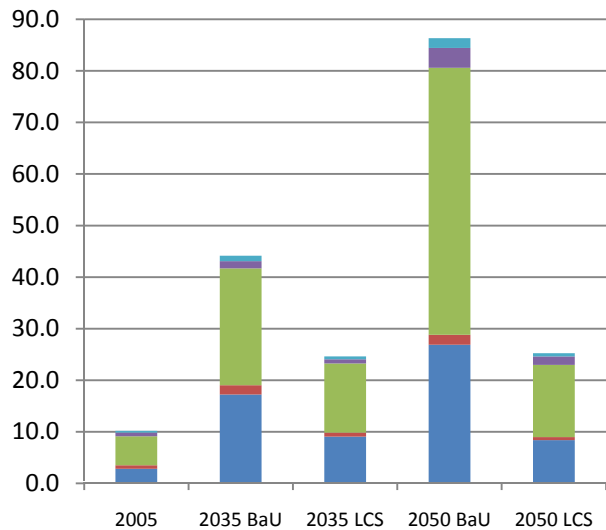
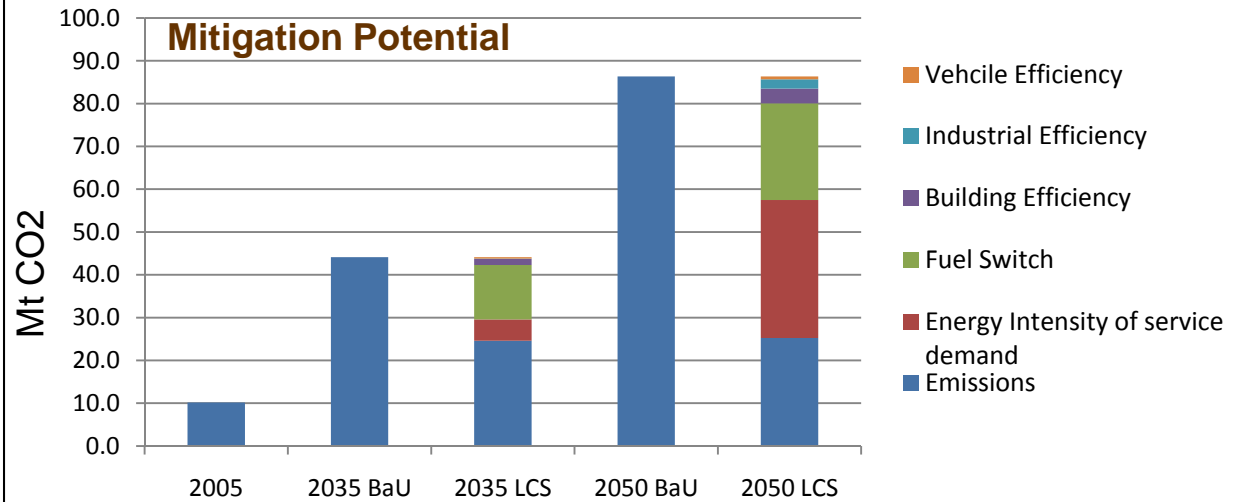


Co-benefits in City Planning: Ahmedabad

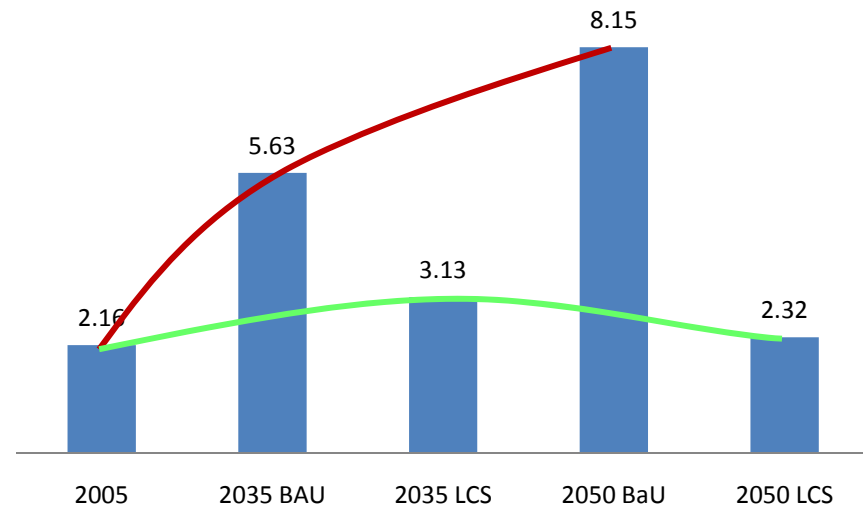
Ahmedabad (2009)
Pop 5.5 Mil



Mitigation Potential

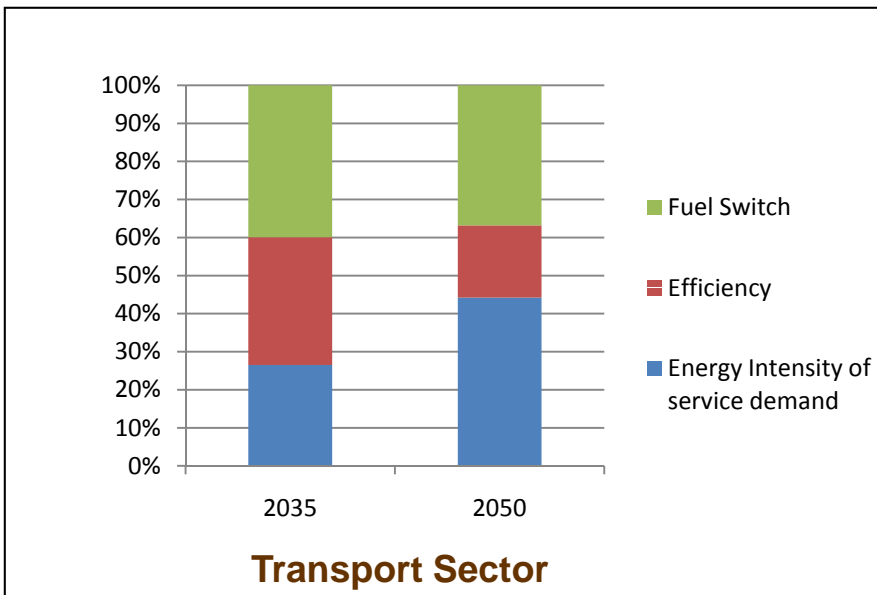
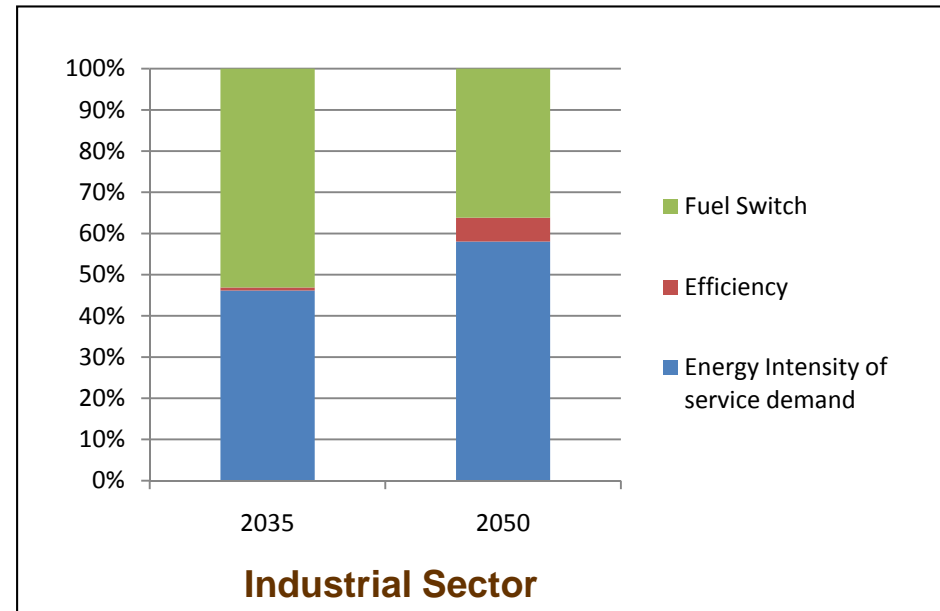
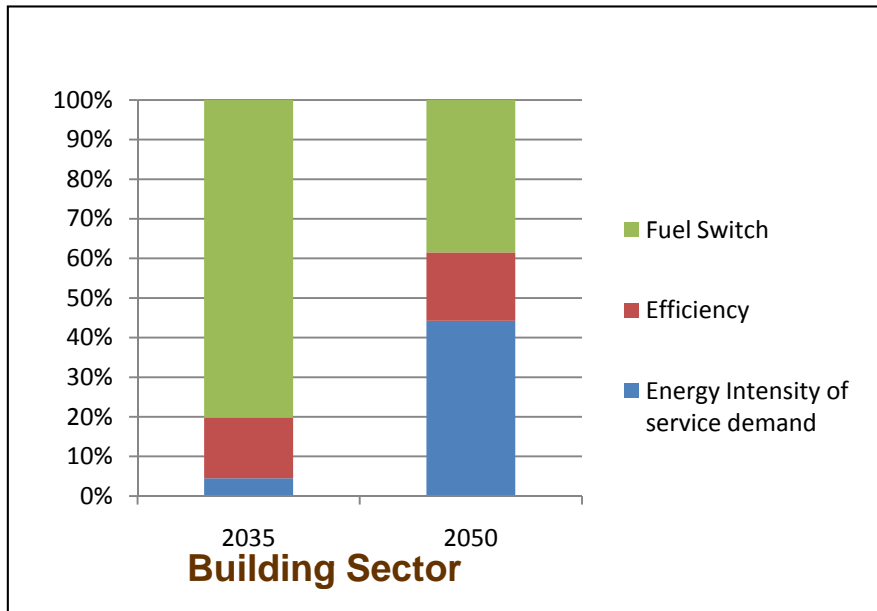


Sectoral CO2 Emissions (mt CO2)



Per Capita Emissions (t-CO2)

Sectoral Mitigation Options: Ahmedabad



- Short Term Mitigation (2035):
 - Fuel Switch
 - Technological Efficiency
- Long Term Mitigation (2050):
 - Energy Intensity of Demand

Conclusions

- **Linking Low Carbon Actions and Development Targets**
 - **For 2020:** Include climate commitments into BAU Assessment
 - **For Long-term:** Avoid technology and policy lock-ins into high emissions path
- **Modeling coordinated Bottom-up Actions under Top-down Vision and Policies**
- **'Paradigm Shift towards 'Co-benefits' and 'Co-operation':**
 - **Co-benefits** reduces welfare losses
 - Deliver LCS at **Low Carbon Price**
- **LCS would still need adaptation actions, but adaptation costs and risks shall be much lower**
- **LCS•RNet has helped:**
 - to **share experiences of different National LCS Research**
 - to link with **Global LCS Research**



Thank you