Indian Energy System and Global Stabilization Regimes

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Energy Solutions for CO2 Peak and Subsequent Decline

14 - 15 September 2009, Roskilde, Denmark

Introduction

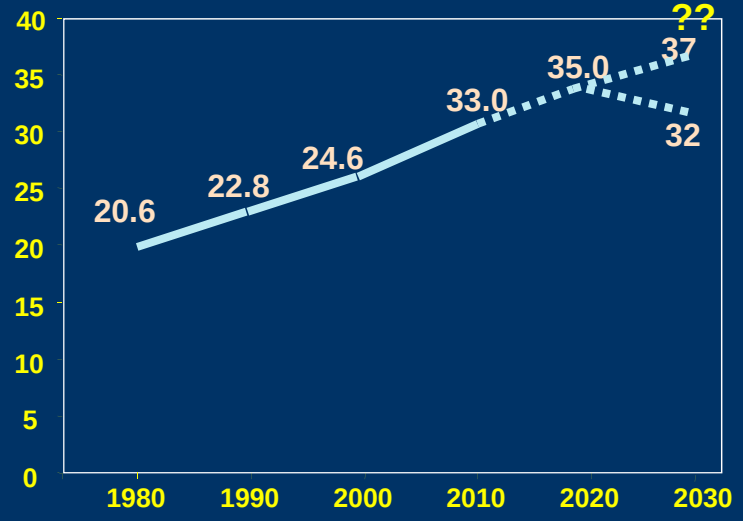
- Scenarios for Low Carbon Development
- Technological Cooperation
- Renewable: Potential, Co-benefits and Conflicts
- Conclusions

Base Scenario: Assumptions

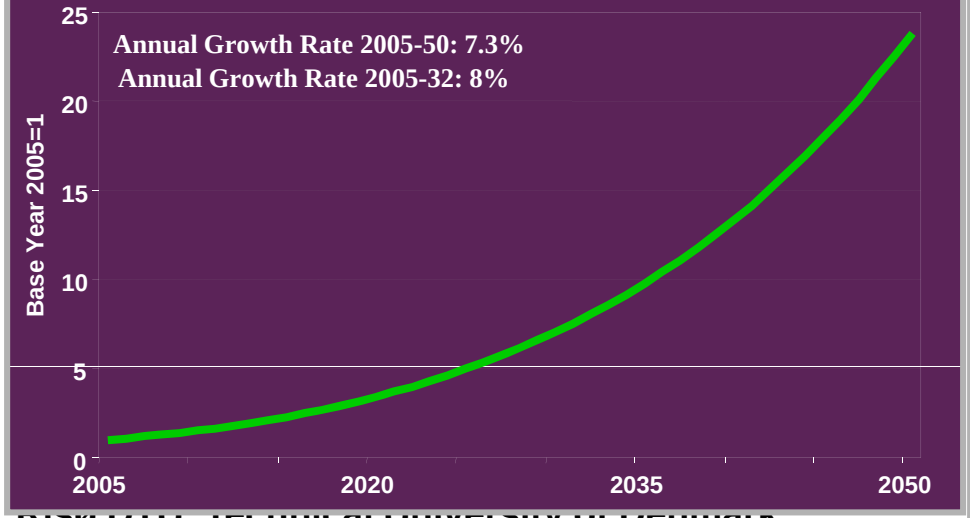
Base Scenario

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)

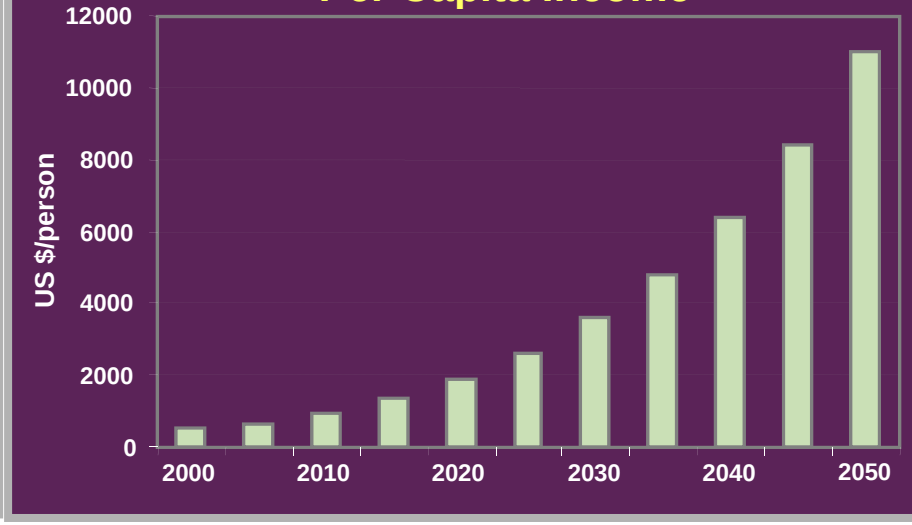
Savings Rate



GDP

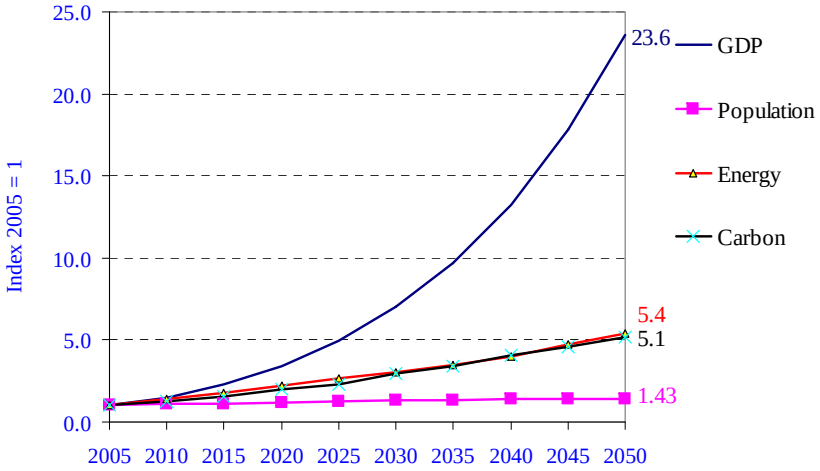


Per Capita Income

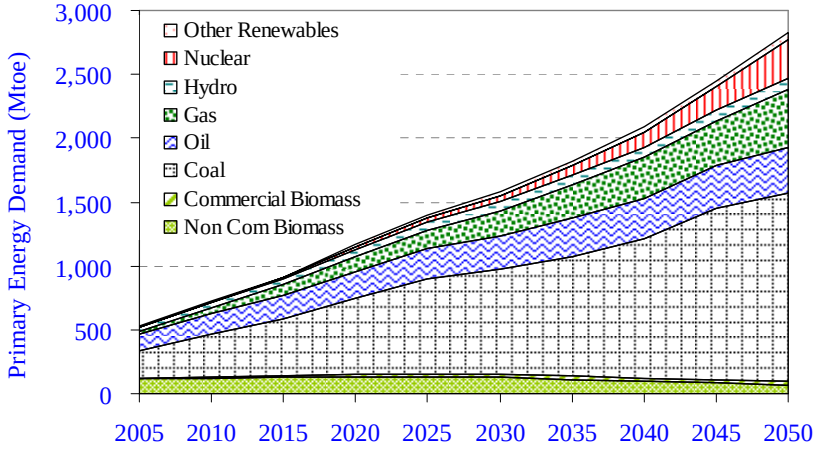


Energy and Carbon: Base Case

GDP, Energy & Carbon Emissions



Energy



Modeling Alternate Development Visions

Stabilization Target and Visions

1. **Global Stabilization Target Assumption:**
   - 550 ppmv CO2e Concentration
   - 450 ppmv CO2e Concentration
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**

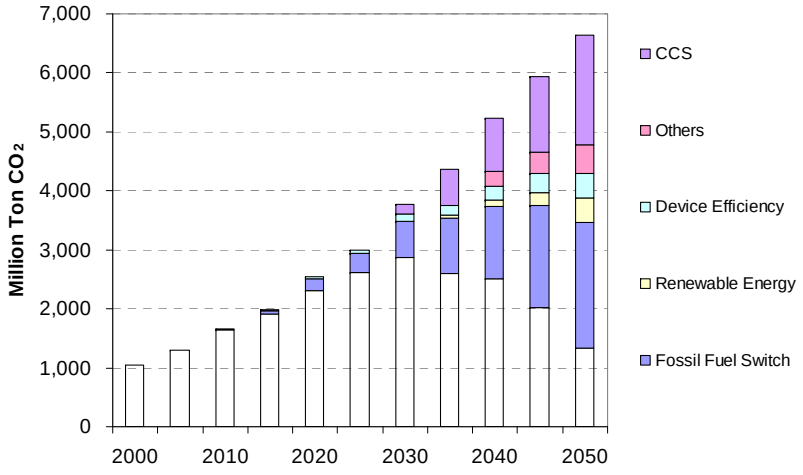
What path shall best deliver national development goals while fulfilling Climate Commitments?

CO_2 Mitigation under 550 ppmv CO_2e stabilization

Conventional Vision

Policy Drivers

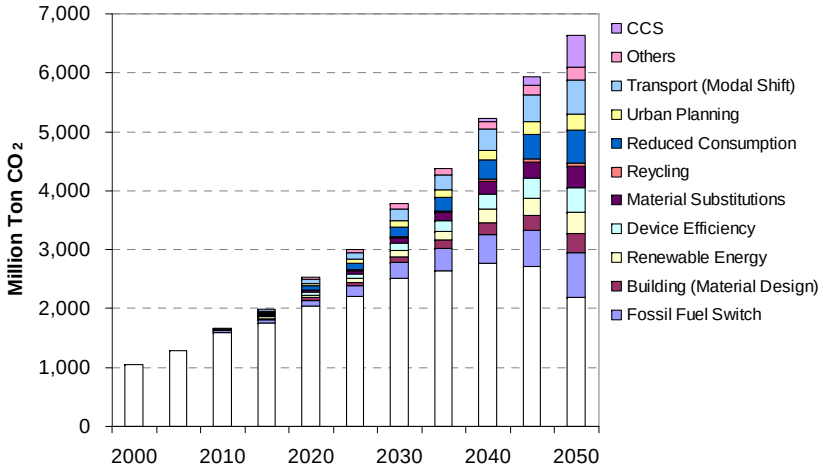
1. Top-down/Supply-side actions
2. High Carbon Price as main instrument
3. Climate Focused Technology Push



Sustainable Vision

Policy Drivers

1. Innovations in technology, institutions
2. Co-operation
3. Long term perspective

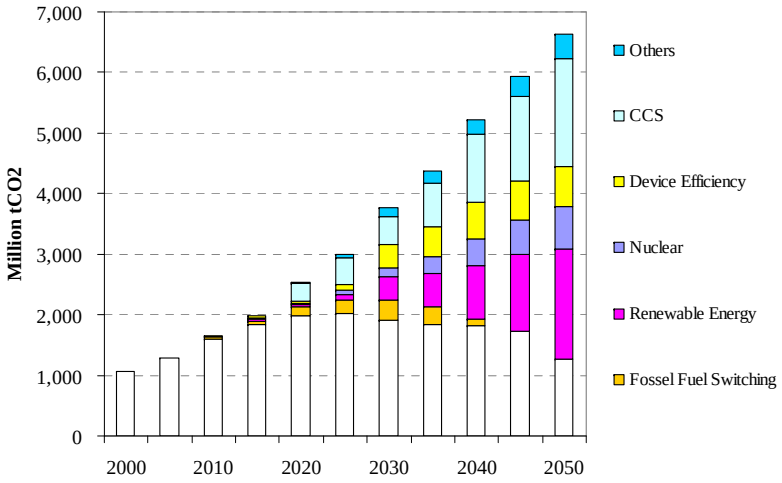


Cumulative Mitigation 2005 – 2050 62.6 Billion tCO_2

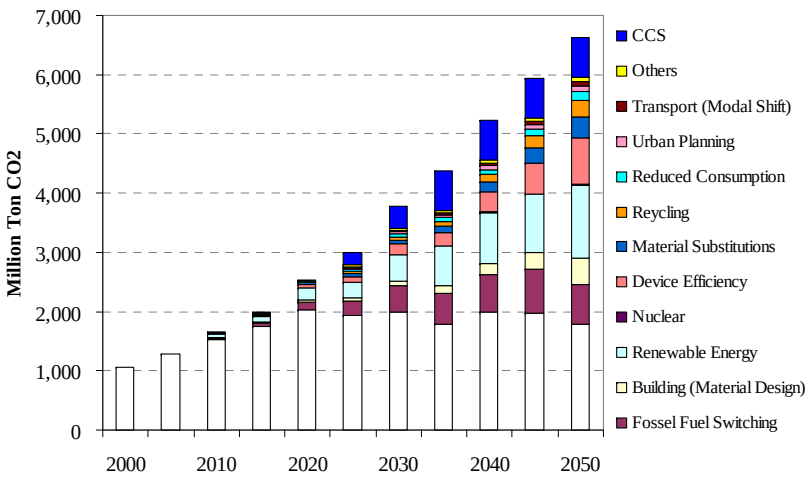
Source: Shukla, P R, Subash Dhar, and Diptiranjan Mahapatra (2008), "Low Carbon Society Scenarios for India," Climate Policy, 8, S156-S76.

CO_2 Mitigation under 450 ppmv CO_2e stabilization

Conventional Vision



Sustainable Vision



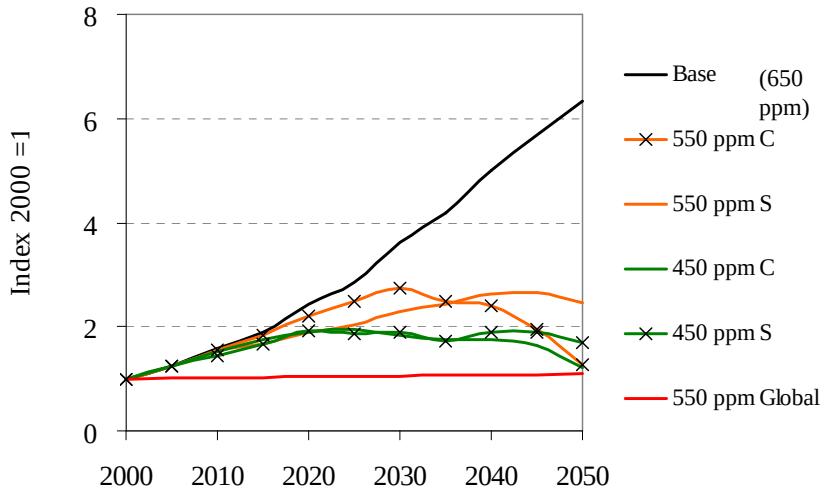
Cumulative Mitigation 2005 – 2050 71.4 Billion tCO_2

Preliminary Results

Risø DTU, Technical University of Denmark

India Vs Global

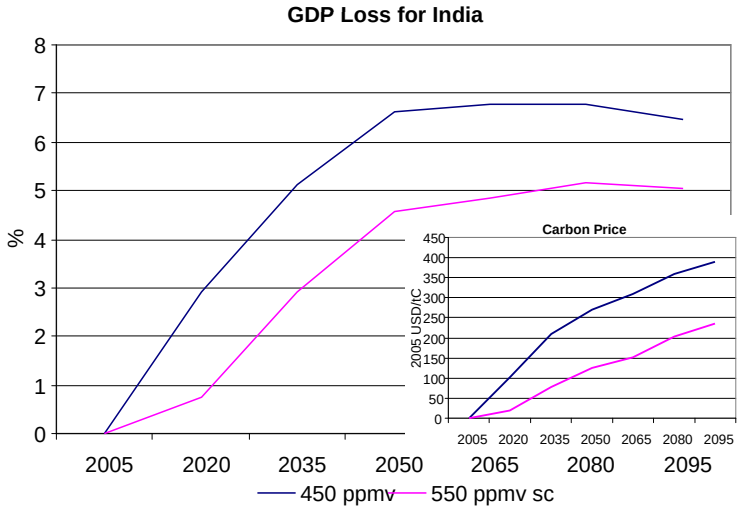
Mitigation Pathways



C is Conventional Vision

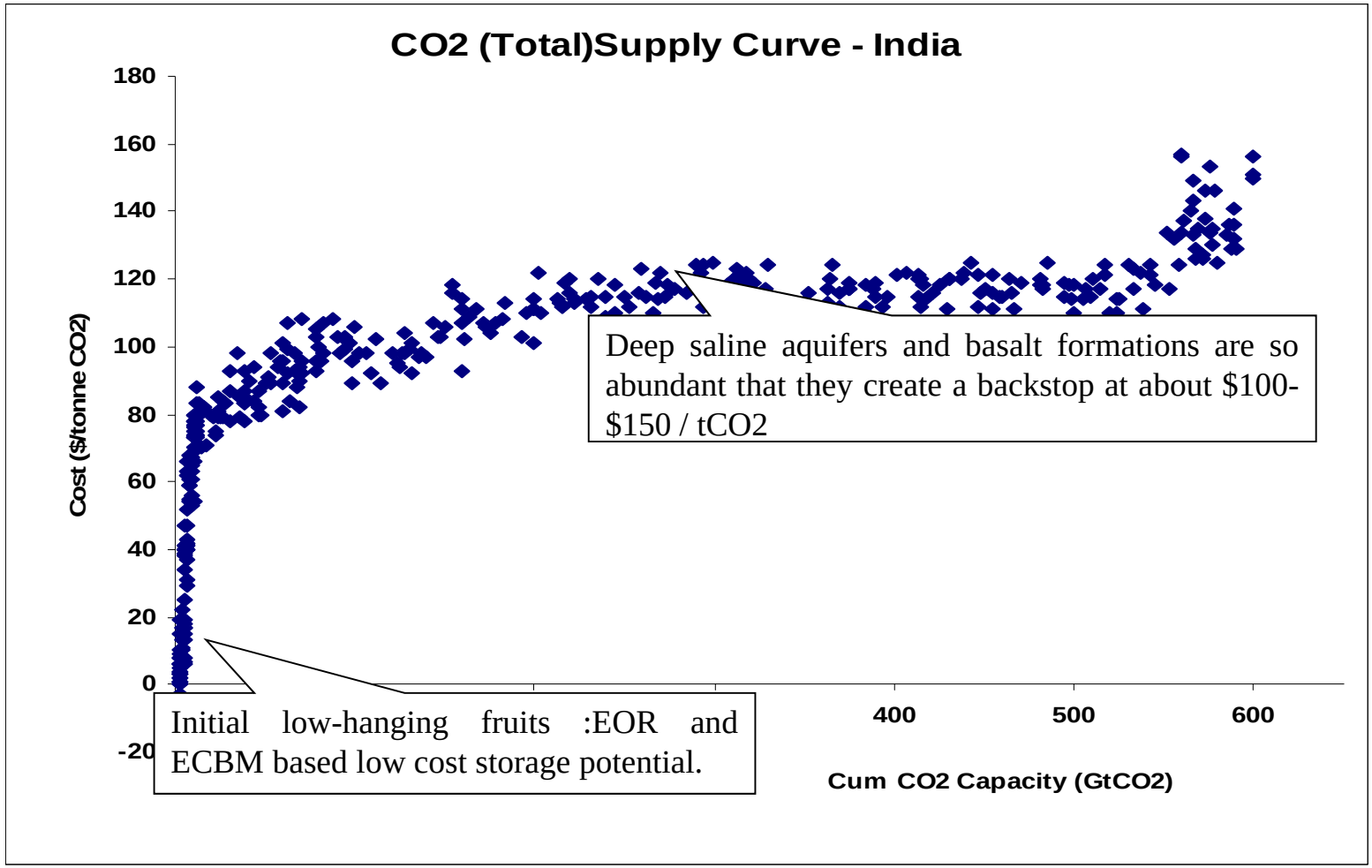
S is Sustainable Vision

GDP Loss and Carbon Tax



Technology Cooperation

Carbon Capture & Storage Supply Curve



- **Long run Carbon capture & storage cost for India –100-150$ / t CO2**
- **Additional geological investigation**

Carbon Capture and Storage

Technology Cooperation Tasks

- **Short-term:** Geological Mapping, Pilot Investment
- **Medium-term:** Technology and Knowledge transfer
- **Long-term:** Development of National Industry, Costs

Policy Instruments for Cooperation

- **Government Agreements:** UNFCCC, Bilateral
- **Carbon Price**
- **Energy Security/ Local Emissions**

Rong Dong Oilfield Project (approved under CDM) in Vietnam by Nippon Oil Corporation reduces 0.68 Million Ton CO_2 per year.

CO_2 Post-Combustion Capture from flue gas stream of a gas fired power plant for urea production in Malaysia using chemical Absorption Process Technology from Mitsubishi Heavy Industries. 0.2 million ton CO_2 Capture per year

Coal Gasification Plant producing Synthetic Gas In North Dakota, USA capturing 3.3. $MtCO_2$ per year during Pre-combustion.

Wind Power

Technology Cooperation Tasks

- Wind Potential Mapping
- Turbine Technology Transfer
- Private-Private Technology Collaboration
- National Industry / Scale Economy
- Technology Export

Policy Instruments for Cooperation

- National Subsidies
- Renewable Targets / Commitments
- Carbon Price

Bio-Energy

Technology Cooperation Tasks

- Choice of Biomass and Production Methods
- Private-Private Technology Collaboration
- National Industry / Scale Economy
- 2nd Generation Bio fuels

Policy Instruments for Cooperation

- Fuel-Mix Norms
- Renewable Energy Targets

Jatropha Plantation in India

Jatropha plant

Bio-diesel Extraction Plant

Sugarcane Plantation

Corn Field

Switch Grass

Poplar Trees

Nuclear Technology

Technology Cooperation Tasks

- Technology Supply (e.g. Gen III, Gen IV)
- Fuel Access

Policy Instruments for Cooperation

- Government Initiative/ Agreements
- International Supervision: e.g. IAEA
- National Energy Mix (Targets): Energy Security

Inside view of Kamini reactor, 100 MW
Went critical in Sept 96, using U-233 fuel

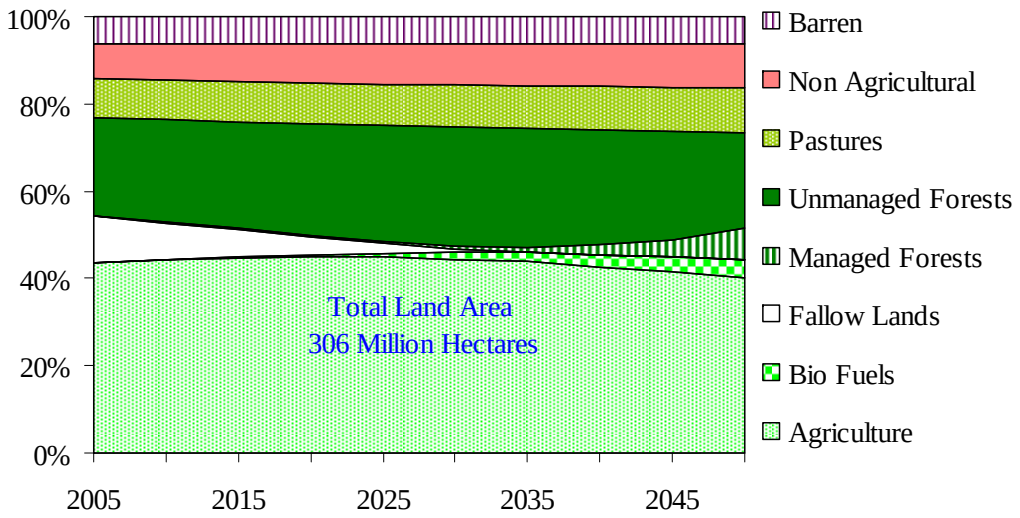
India's First 540 MWe Nuclear Power Plant (Started 09/2005)

2X1000MWe VVER reactors under construction at Koodankulam (Going Critical in 2008)

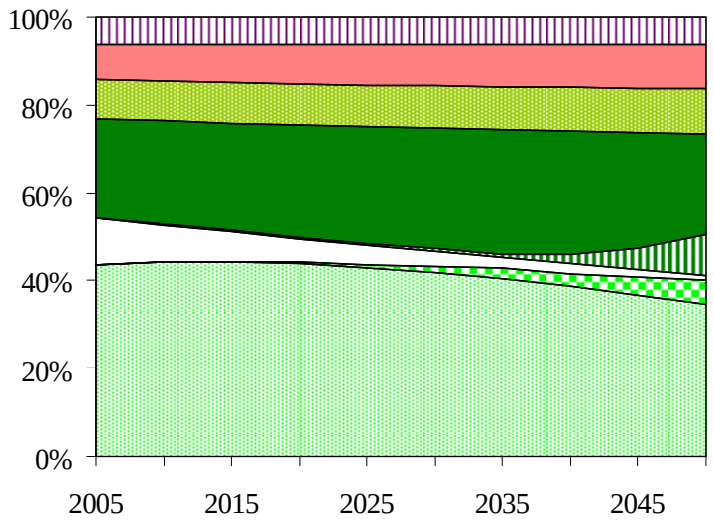
Renewable: Potentials, Co-operation & Conflicts

Bio Fuels: Co Benefits and Conflicts

Base Case



550 ppmv with Sustainable Vision



- **Rural Employment / Farm Income (from waste lands): :**
  Large scale employment potential in Jatropha plantation, seed collection and extraction

- **Energy Security**
  Imported fossil oil is replaced

- **Environment**
  Neutral carbon emissions, Rehabilitates waste land

- **Water and Food Security**
  Land and energy crop choices are vital to avoid conflicts with other sustainability goals

Hydro

Key Issues

- Co products in terms of irrigation, flood control
- Participation in Peak and Off Peak Markets
- Regional co-operation among South Asian countries and within states

Base Case

- Maximum Potential – 150 GW by 2050 in Base Case (GoI, 2006)

Stabilization Scenarios with Sustainability

- Maximum Potential – Increased to 250 GW by 2050 (Shukla et.al., 2009)
  - Increased co-operation would allow greater trade in electricity within South Asian countries

GoI (2006), "Integrated Energy Policy: Report of the Expert Committee." New Delhi: Planning Commission.

Shukla, P R, Amit Garg, and Subash Dhar (2009 (In press)), "Integrated Regional Assessment for South Asia: A Case Study," in Integrated Regional Assessment of Climate Change, C. G. Knight and J. Jäger, Eds.: Cambridge Universities Press.

Wind

Key Issues

- Land Availability for on shore - 12 ha/MW (MNES, 2008)
- Low availability ~15% currently create problems for grids

Base Case

- Maximum Potential – 65 GW by 2050 in Base Case (GoI, 2006)

Stabilization Scenario

- Maximum Potential – Increased to 200 GW by 2050

Solar PV & Concentrated Solar

Key Issues

- Land Availability

Base Case

- Maximum Potential – 1200 Mtoe/year in Base Case taking around 2 million hectares of barren land besides innovative use of urban spaces.

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

Conclusion

- **Strong Stabilization not possible without Renewable, Nuclear and CCS**
- **Need for Technology cooperation**
- **Supporting International and domestic policies**
- **Larger role for renewable in 450 ppm stabilization scenario**
- **However, Land main constraint for renewable**
- **Renewable would require regional markets and global technologies therefore**
  - **Cooperation at regional and global level**
  - **Greater understanding of local and regional dynamics essential**

Thanks

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