Climate Change: India's Perspectives

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IRADe Integrated Research and Action for Development

IRADe: Profile

- Activities
  - Research projects
  - Training and capacity building
  - Policy advocacy
  - Networking and dissemination
- Energy Policy Analysis
  - Stanford University, UNDP, Energia, MNES, Petrofed
- Environment and climate change
  - UNEP, MOEF, Reliance Industries

Outline of Presentation

- India's Emissions
- Impact of Climate Change
- Model and Scenarios
- Policies
- Suggestions for International Negotiations

What does it mean in per capita terms?

Compared to an average Indian citizen, an average U.S. citizen consumes:

			*Equiv. population of USA
6	times	Cereal	1470
4	times	Milk	980
52	times	Meat	12740
6	times	Fertilizers	1470
7	times	Cement	1715
6.4	times	Cotton & wood fabrics	1568
245	times	Copper	60025
22	times	Iron and Steel	5390
85	times	Aluminum	20825
54	times	Organic Chemicals	13230
28	times	Inorganic Chemicals	6860

What does it mean in per capita terms?

Compared to an average Indian citizen, an average U.S. citizen consumes.

			*Equiv. population of USA
320	times	Cars	78400
102	times	Commercial Vehicles	24990
14	times	Solid Fuels	3430
61	times	Liquid Fuels	14945
227	times	Gas	55615
46	times	Electricity	11270
35	times	Total Energy	8575
27	times	Total Carbon dioxide Emissions	6615

*** Equivalent USA population =**

population x Per cap. cons. of USA
a commodity Per cap. cons. of India

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Why should India be Concerned about Climate Change?

Risk of Sea Level Rise

- Total area of 5763 km2 along the Coastal States of India - ***0.41% could be inundated*** and almost **7.1 million** - ***4.6 % of coastal population could be affected*** for one meter sea level rise *(TERI, 1996)*
- Intrusion of sea-water in the ground water.
- Temperature can reduce agricultural and fishing incomes.
- One-meter sea level rise it would displace 7 million persons in India *(ADB, 1995).*

Risk of Extreme Events

- In the cyclone in Andhra Pradesh in India in 1996, more than 1,000 people died and there was huge property loss.
- Frequent storms in Orissa

Impact of Climate Change

	ΔT 2.5°C to 4.9 °C
Rice Yield	**-15% to -42%**
Wheat Yield	**-25% to -55%**

(Without carbon fertilization effect)

With fertilization smaller but similar impact

With adaptation

ΔT + 2°C + 7% Precipitation GDP_{Agri} ↓ 7%

ΔT + 3.5°C + 15% Precipitation GDP_{ag} ↓ 25%

⇒ Poverty ↑ ⇒ Hunger ↑

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Economic Models: The India Model

- Multi-sectoral, inter-temporal optimising model
- Endogenous income distribution
- Focus on Welfare effects (incidence of absolute poverty)
- Consumption is sensitive to relative prices.
- Dynamically optimal.

Model Structure I

- Model maximises the present discounted value of utility corresponding to the per capita consumption.
- Time horizon: 35 years
- Eight commodities or Goods: Agriculture, Coal, oil, Electricity, Industry, Transport, Services, Gas.
- Alternative methods of producing the same good are permitted.
- Model constrained to ensure consistency.

Model Structure II

- Exports, Imports, Savings bounded above to rule out unrealistic results.
- Endogenous income distribution with a constant lorenz ratio and exogenous population growth.
- Stationary state at the end of the period under consideration.
- Optimal solution found simultaneously for all time-periods (not the usual year by year optimality).
- Solver: **GAMS**

Model Structure III

- **Emission Inventory**:
  - Both production and consumption activities pollute.
  - Emission coefficient is derived for each activity and for each fuel and pollutant.
  - Stock accounting also included.
- **Carbon reduction options**:
  - Activity level reduction
  - Change in composition of production (more polluting goods imported)
  - Technical options to mitigate pollution without loss of output.
    - Input reduction
    - Fuel switching

Scenarios Analysed

- Business-as-usual (BAU)
- 10% (cumulative) Carbon emission reductions: C10
- 20% (cumulative) Carbon emission reductions
- Oil price shock (of 300%) [foreign investment of up to 3% of GDP]
- Oil price shock (of 300%) – with lower foreign investments (limited to 2% of GDP)
- COR (Capital output Ratio) falling (indicating technical progress)

Results I

- Average GDP growth rate (BAU): 5.03%
- Growth in Carbon emission (1996 to 2030): 1034 to 2984 million tonnes.
- A 10% reduction in Carbon emission: not much of an impact in the medium run (15th year, C10 of table 1)
- GDP and consumption levels fall (marginally) in the long run (34th year)
- A 20% reduction has significant adverse effects on both GDP and PC (per capita) consumption (GDP falls by 2.87% in the 34th year).
- Model postpones losses to the end of the period due to: discounting of future consumption.
- There is a shift away from coal based-activities (especially in the long-run)

Results II

- Oil price shocks tend to have long-term impacts (contrary to conventional belief that these merely cause temporary deviations from equilibrium) and cause losses of large magnitudes.
- Impact of oil price shocks similar to those of carbon emission constraints (except for the implications for carbon emissions which, in this case, tend to rise)
- **Parameter Sensitivity of the Model**
- Important parameters of the model :
  - Savings rate (endogenous but bounded), COR (exogenous), Oil price (exogenous), discount rate (exogenous).

Conclusions

- The Model's results indicate that India stands to lose significantly on committing to reduce emissions.
- Magnitude of these losses are uncertain and difficult to estimate, given the specificity of various models and their consequent incomparability.
- Estimates of magnitudes (or even directions) of the effects of carbon emission restrictions on the economy depend crucially on the underlying structure of the model and models developed for a particular structure (or a purpose) are unlikely to be directly useful for other circumstances or purposes.

Conclusions (continued)

- Binding commitments to emission reduction must be on a *quid pro quo* basis, in return for equally binding compensation flows that should mute the costs of cleaner development, especially its impact on poverty.

India's Efforts to Reduce GHG emissions

- Emphasis on energy conservation
- Promotion of renewable energy
- Abatement of air pollution
- Afforestation and wasteland development
- Economic reforms and subsidy removal
- Fuel substitution policies

Motivation for Energy Conservation

- Energy Scarcity or unavailability
- Lack of capital for new plants
- Scarcity of non-renewable fossil fuel resources
- Concern for air pollution
- Increasing oil imports

Institutional Setup

- Petroleum Conservation Research Centre (PCRA)
  - To reduce oil imports
  - Oil exploration, production and refining
- Energy management Centre (EMC)
  - Training, research and implementation
- Ministry of Non-Conventional Energy Sources (MNES)
  - Energy conservation
- Power Finance Corporation (PFC)
  - Improve supply-side efficiencies

Promotion of Renewable Energy: Major Activities

- Cogeneration
- Conservation
- Geothermal energy improved stoves etc.

India yet to show progress in the area of reducing cost

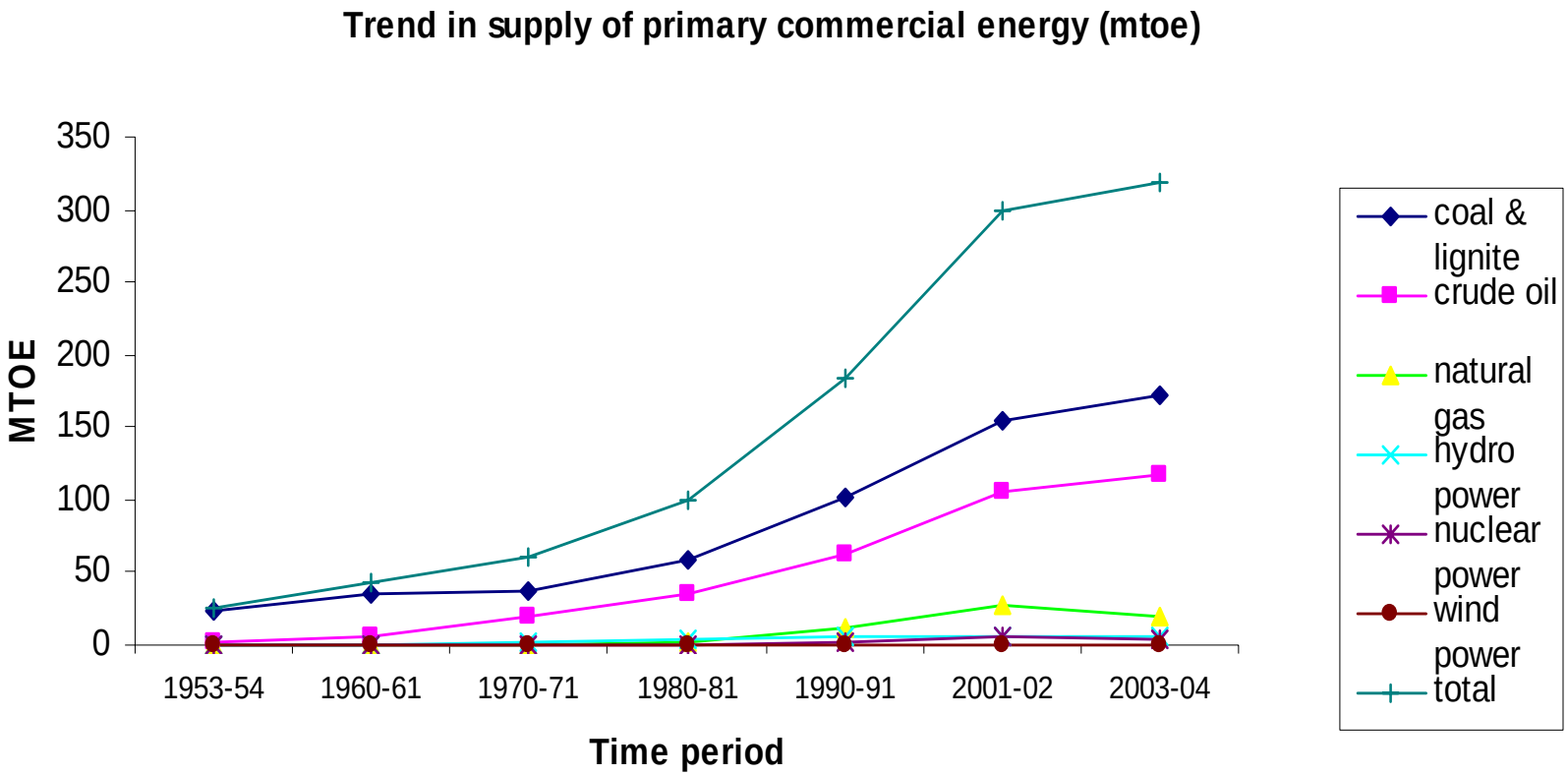
Fuel Substitution: From Biomass to Fuels

- Substitution of non-commercial energy by commercial energy
  - Increasing overall efficiency
- Shift from ‘old biomass’ to fossil fuels
- ‘Old biomass’
  - Carbon neutral but may result in deforestation
- ‘New biomass’
  - Biogasification, improved stoves, efficient kilns and biofuels

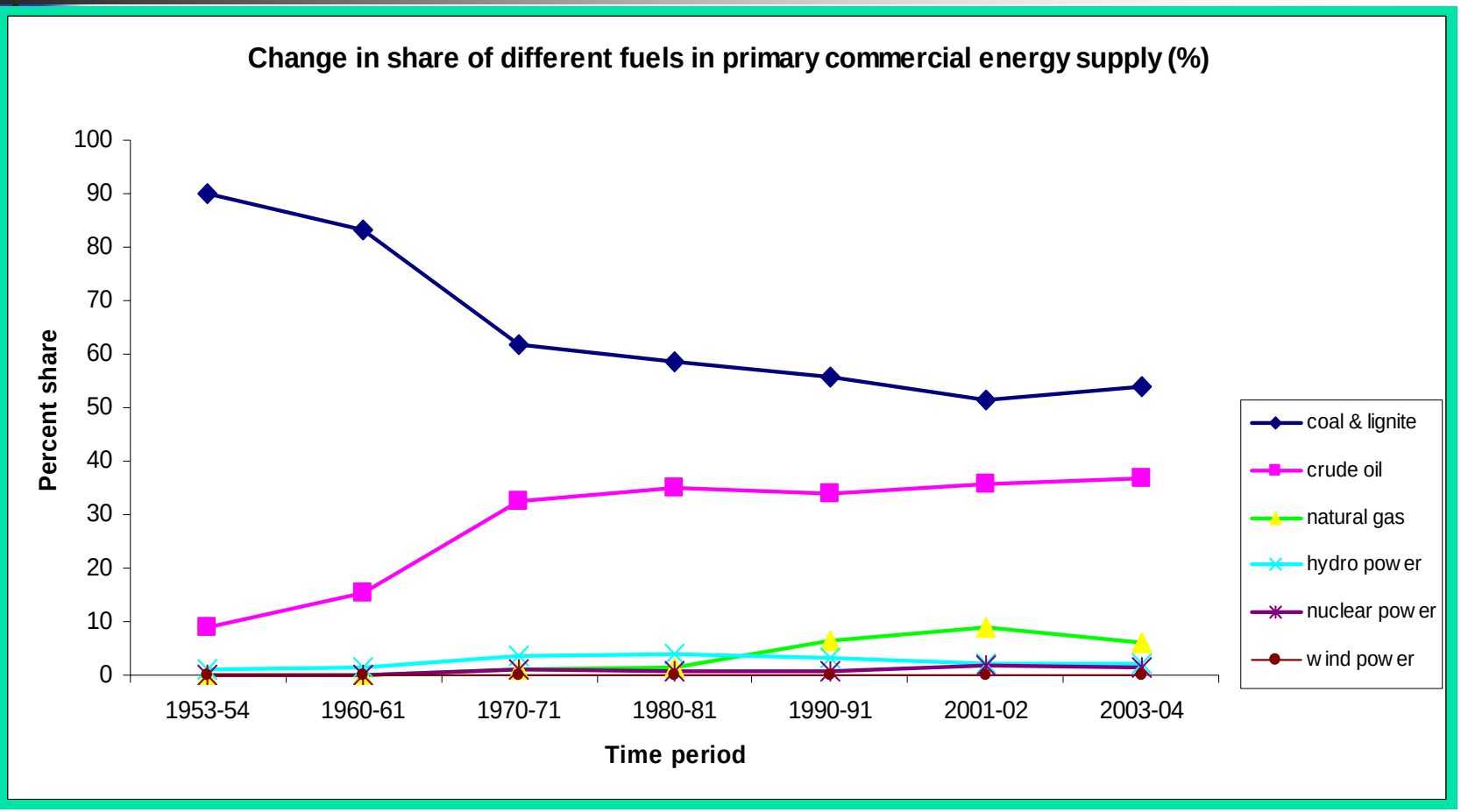
Coal Substitution

- Increased use of oil and gas due to liberalization
- Coal use in railways phased out
- Efficiency likely to increase with private sector entry

Trend in Supply of Primary Commercial Energy (MTOE)



Change in Share of Different Fuels in Primary Commercial Energy Supply (%)



The Dark Side: Compulsory Energy Savings

- Lack of electrical appliances
- Lack of water pipes: trips to water resources on foot
- Lack of fuel: dependence on biomass
- Lack of fans and heating: reduced productivity
- Lack of infrastructure: energy savings at the cost of human welfare

Resource Conservation and Recycling

- Driven by poverty and lower income
  - Some items used for generations (e.g. clothing, furniture)
  - Recycling of paper, bottles, textiles common
  - Vehicles and machinery not thrown away

Per Capita Emission Principle

- Recognized in the UN FCCC
  - Netherlands vs. India
- Within EU: Portugal and Germany
- South Korea, Saudi Arabia, and Argentina have higher emissions than Brazil, China, and India
- Incentive to stay below the global average

Carbon Dioxide Emissions and Shares

Countries	Total CO2 Emissions (Billion Tonnes)		Share of CO2 Emmisions	
	1991	2002	1991	2002
Annex – I	10.67	11.85	46.72	46.34
Brazil	0.21	0.31	0.94	1.23
China	2.52	3.51	11.03	13.72
India	0.73	1.22	3.19	4.77
BCI	3.46	5.04	15.16	19.72
Remaining	5.13	7.25	22.45	28.34
Total	19.27	24.14	84.33	94.40
Global	22.85	25.58	100.00	100.00

Measures Taken

- Motivation for implementation of energy efficient options
- Afforestation and Wasteland Development
- Programmes of afforestation supported by government
- Rate of deforestation has decreased in the 1990's

CO_2 Emissions – Per Capita and Growth

Countries	Per Capita CO2 Emissions (Tonnes)		Growth (%)
	1991	2002	1991-02
Annex – I	11.95	12.40	0.96
Brazil	1.47	1.80	3.53
China	2.16	2.71	3.05
India	0.84	1.17	4.81
BCI	1.59	2.01	3.48
Remaining	2.55	2.77	3.19
Total	3.59	3.88	2.07
Global	4.25	4.11	1.03

Population

Countries	Population (Billion)		Population Share		Population Growth (%)
	1991	2002	1991	2002	1991-02
Annex-I	**0.89**	**0.96**	**16.63**	**15.35**	**0.61**
Brazil	0.15	0.17	2.72	2.80	1.64
China	1.17	1.29	21.69	20.77	0.95
India	0.86	1.04	16.07	16.69	1.71
BCI	**2.17**	**2.51**	**40.48**	**40.27**	**1.31**
Remaining	**2.01**	**2.62**	**37.48**	**42.06**	**2.42**
Total	**5.08**	**6.08**	**94.59**	**97.67**	**1.65**
Global	**5.37**	**6.23**	**100.00**	**100.00**	**1.35**

CO_2 Emission and Developing Countries

Countries	Per Capita Emissions (Tonnes)		Total Emissions	
	1991	**2002**	**1991**	**2002**
AGA (50)	6.46	8.30	2219.07	2762.10
BGA (110)	1.08	1.23	1736.29	2501.71
AGA+BGA	**2.02**	**2.23**	**3955.36**	**5263.82**
Brazil	1.47	1.80	214.15	313.47
China	2.16	2.71	2520.99	3509.91
India	0.84	1.17	727.82	1219.81
BCI	**1.59**	**2.01**	**3462.86**	**5043.20**

Lead by Annex I Countries

	dC/dt: Growth of Emissions			d^2C/dt^2: Rate of Change of Growth	
	Annex I	Non-Annex I		Annex I	Non-Annex I
1980-2000	> 0	>> 0		< 0	≥ 0
2000-2020	≤ 0	> 0		< 0	≤ 0
2020-2050	< 0	≤ 0		< 0	≤ 0
2050-2100	<< 0	< 0		<< 0	< 0

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Thank You