NIES, Tsukuba
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Book Chapters

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Chapter 1. Introduction

1.1 Climate Policy Modeling

1.2 Integrated Modeling - Linking Science with Policy

1.3 The AIM Paradigm

1.4 AIM Modeling Approach

1.5 AIM Structure

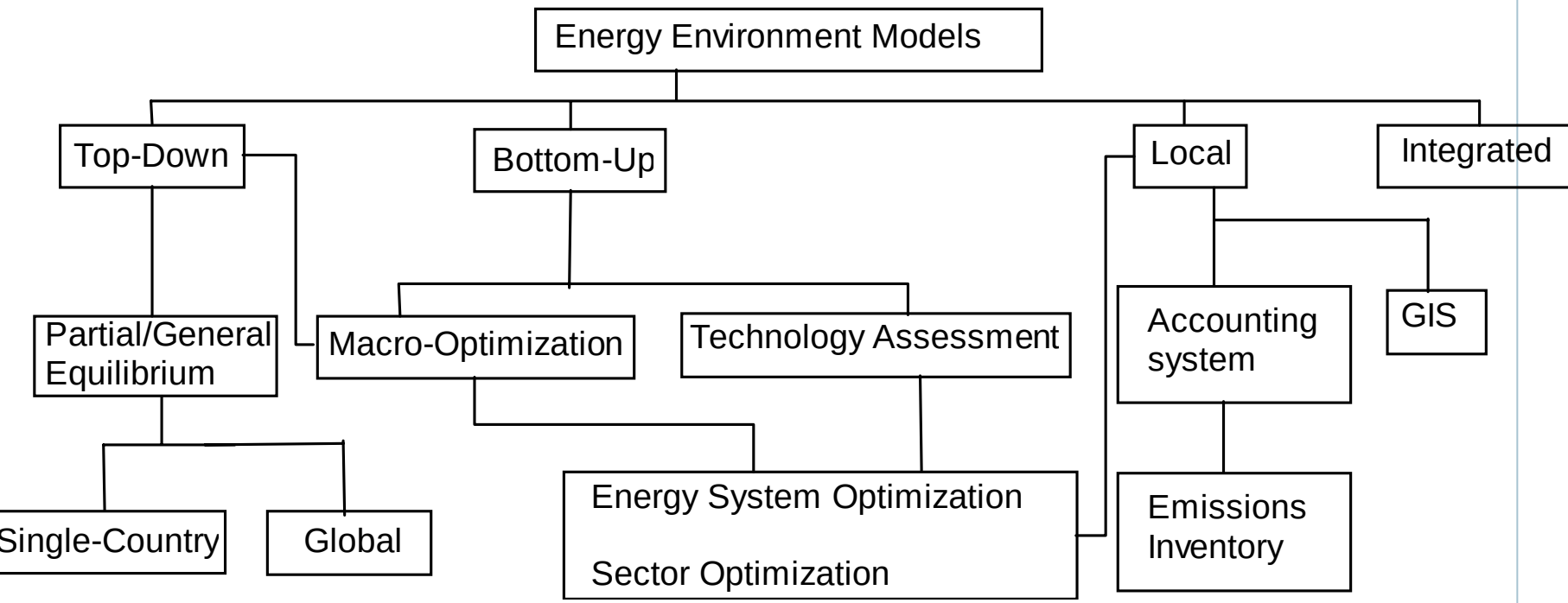
1.6 AIM Scope

1.7 Overview of AIM Applications for India

1.8 AIM Inputs in National and International Assessments

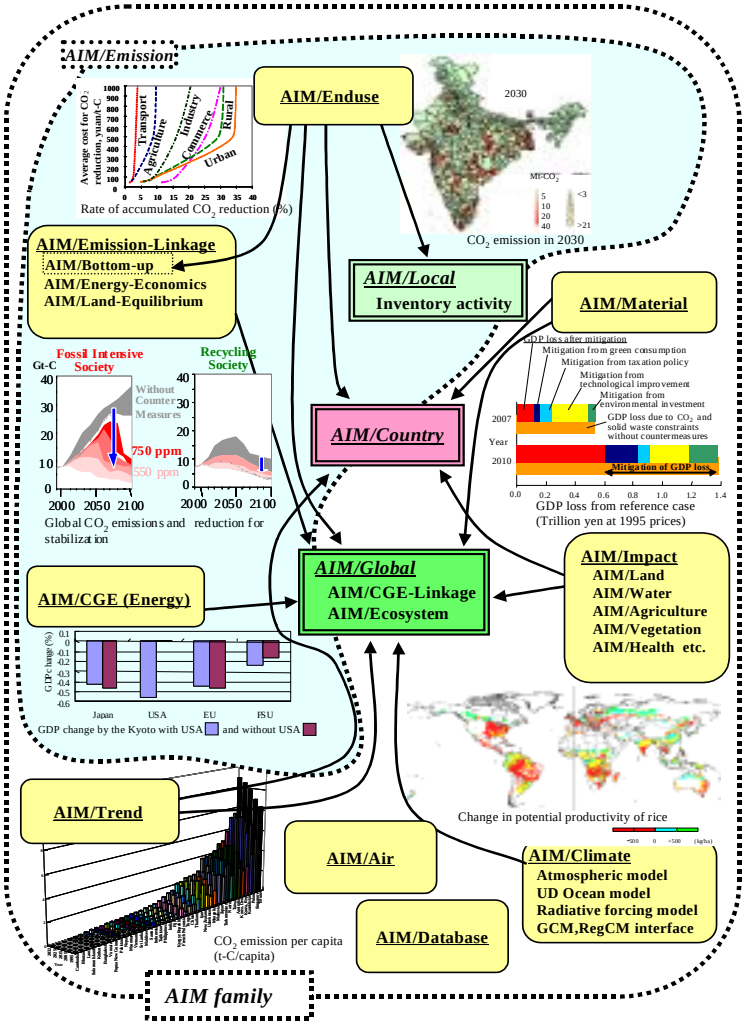
Chapter 1. Introduction

Classification of energy-environment models

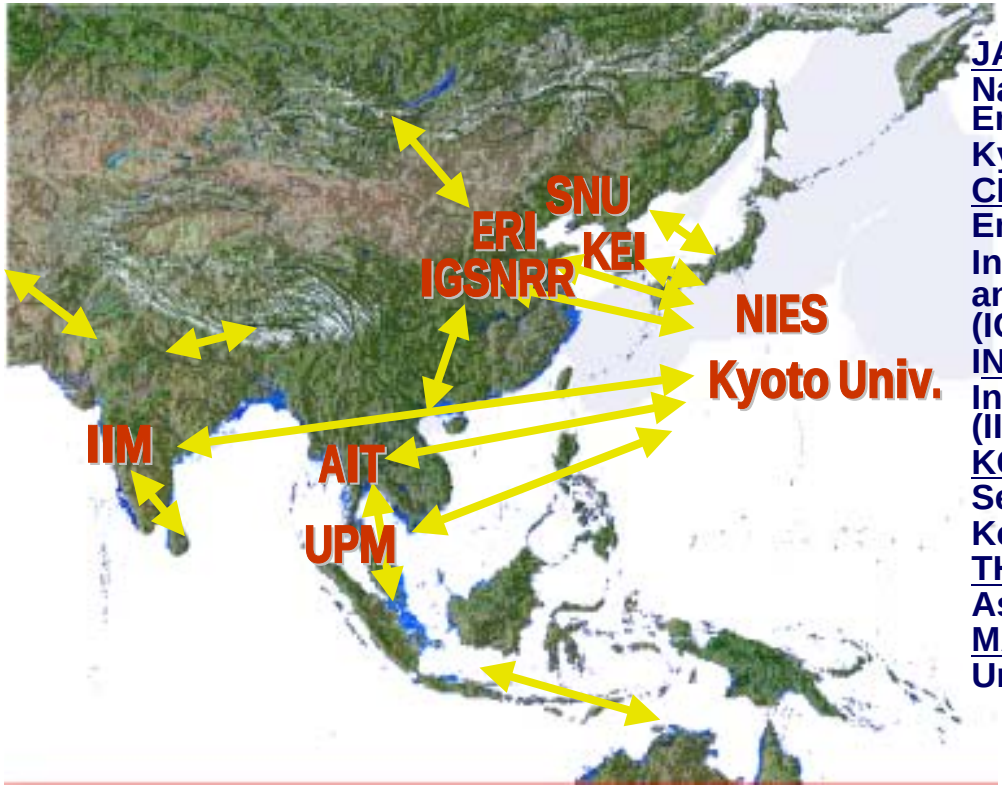


Chapter 1. Introduction

AIM family of models



AIM Cooperation in Asia-Pacific region



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National Institute for Environmental Studies (NIES)
Kyoto University
CHINA
Energy Research Institute (ERI)
Institute of Geographical Science and Natural Resources Research (IGSNRR)
INDIA
Indian Institute of Management (IIM)
KOREA
Seoul National University (SNU)
Korea Environment Institute (KEI)
THAILAND
Asian Institute of Technology (AIT)
MALAYSIA
University Putra Malaysia (UPM)

Chapter 1. Introduction

Component models in AIM applied to India

	Area of application	Brief description	Location in this book
AIM/Enduse	Analysis of GHG emissions mitigation and local air pollution control	A bottom-up technology selection model within a country's energy, environment and economic system	Chapter 2 and Chapter 3
AIM/Local	Estimating and analyzing future emissions from LPS and area sources	Bottom-up linear programming model, which selects a combination of technologies with least cost while satisfying demand and supply constraints.	Chapter 4
AIM/Material	Estimates economic and environmental effects of environmental investment, mainly focusing on solid waste management.	A top-down macro economic model based on computable general equilibrium (CGE) framework.	Chapter 5
AIM/Trend	Estimation of future economic, energy, and environmental trends	An econometric model which calculates relationships between each parameter by regression method and extrapolates these relationships for future projections.	Chapter 6
AIM/Database	Supporting AIM models	Contains various types of datasets including statistics, outputs by AIM, outputs by other modelers, and estimates by international organizations and governments	Chapter 7

Chapter 2. Indian Scenarios and the AIM/ENDUSE Database

2.1 AIM/Enduse model structure

2.2 Indian scenarios

2.3 Data development

2.4 Demand projections

2.5 Sectoral process representation in AIM

2.6 Global and Indian energy intensity and emission trends

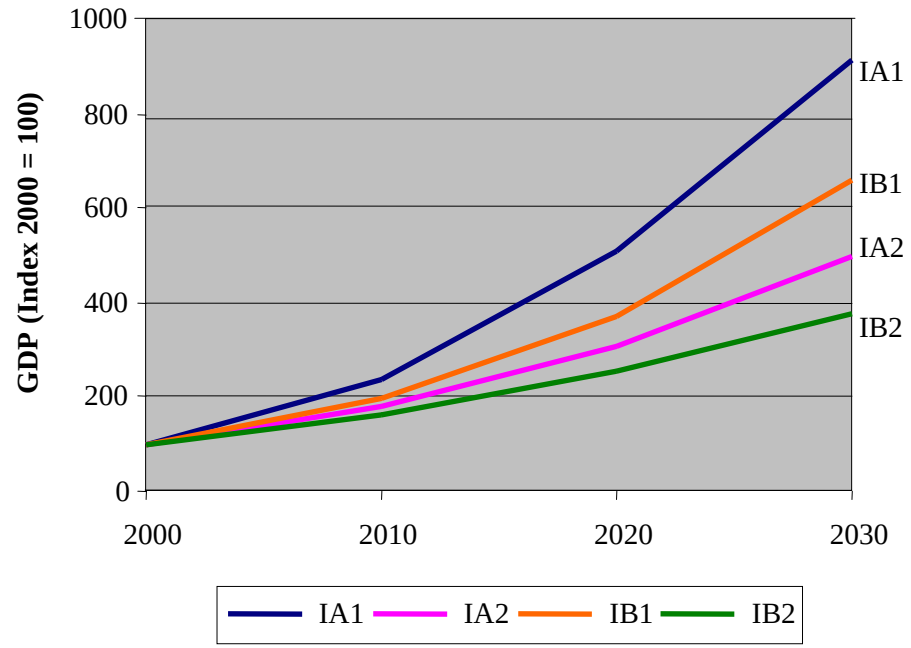
Matrix of Indian Scenarios

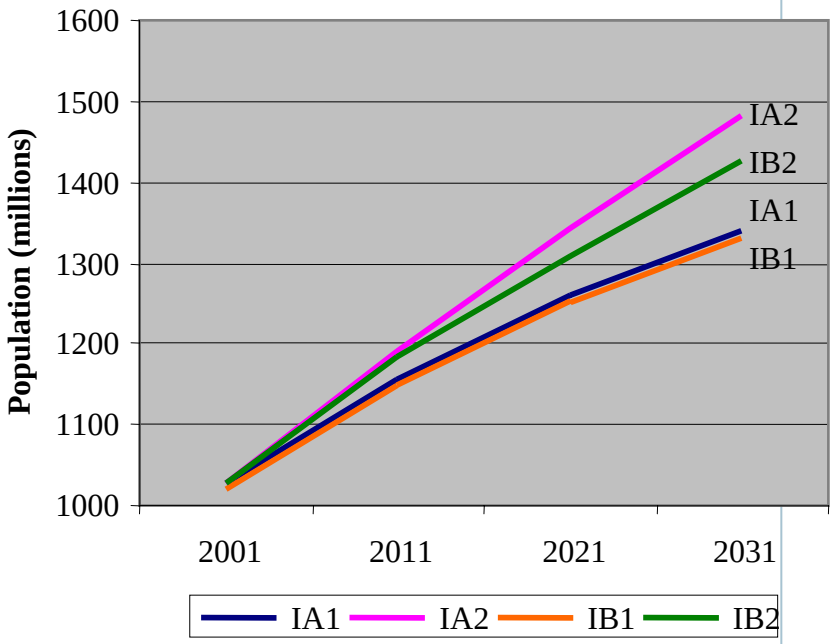
Market integration

Governance	Integrated	Fragmented
Centralization	IA1 China	IA2 Pre-reform (Mixed Economy Model)
Decentralization	IB1 Sustainable Development	IB2 Self Reliance Model

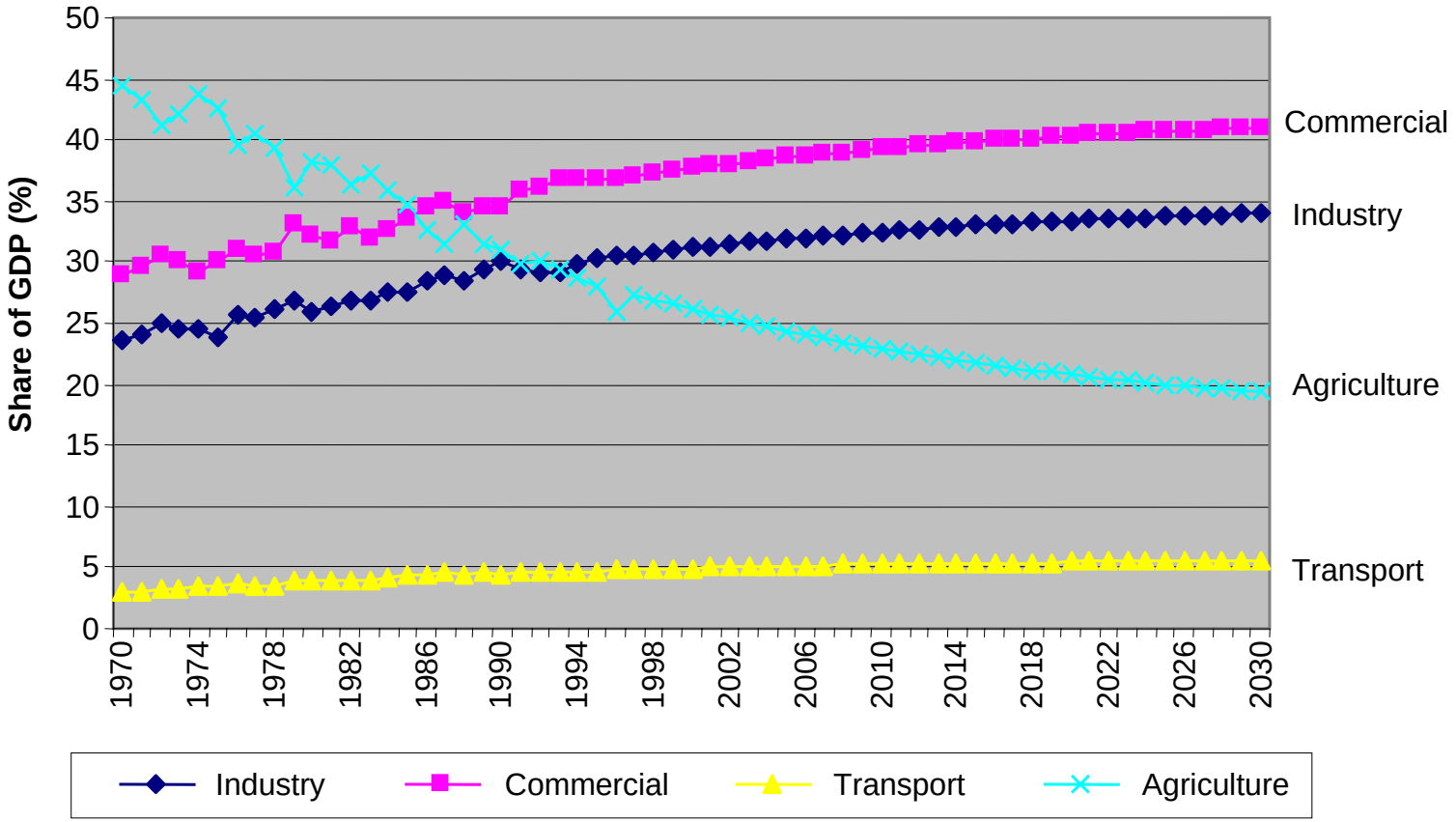
Chapter 2. Indian Scenarios and the AIM/ENDUSE Database

GDP and Population Projection for Indian Scenarios





Sectoral GVA in Reference Scenario (IA2)

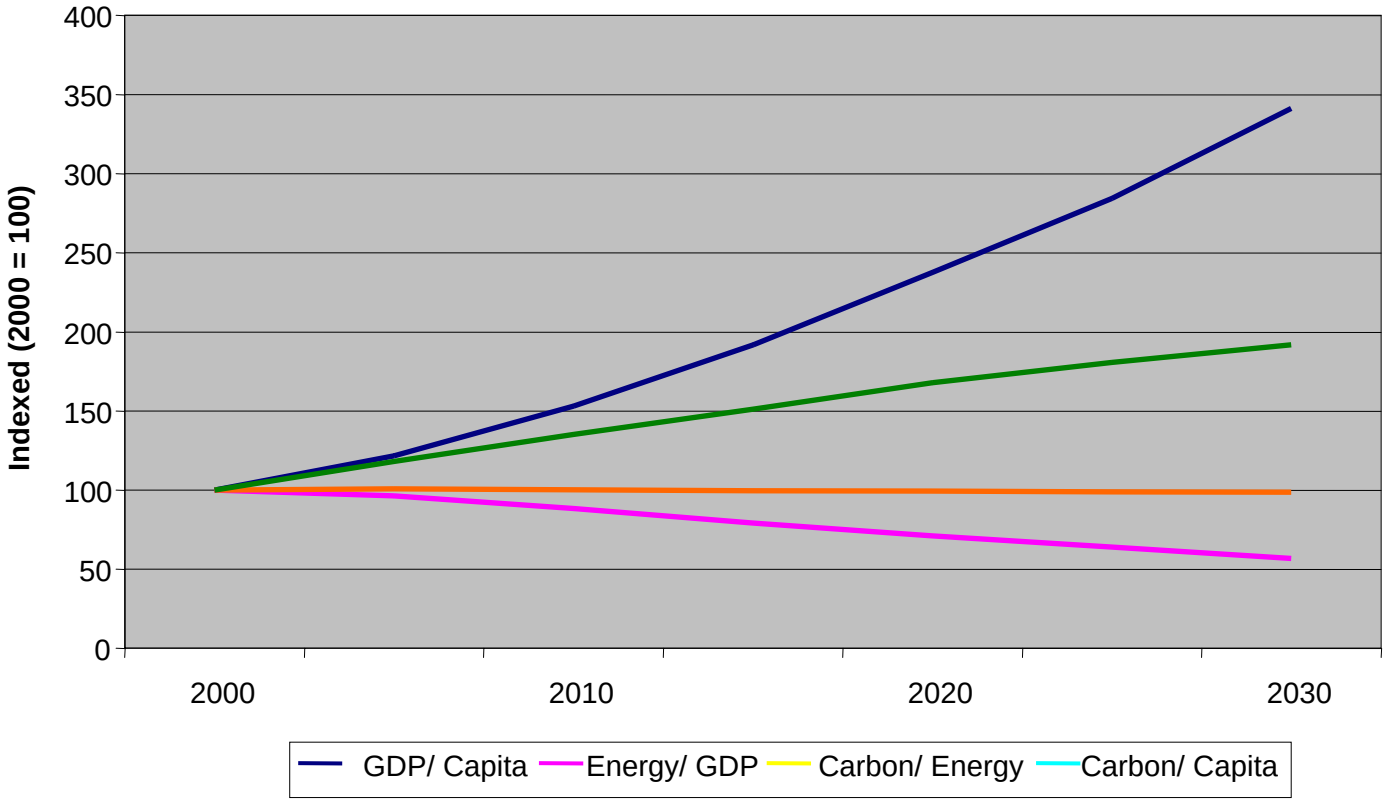


Energy intensity of various industries (PJ/million tons) in (IA2) Scenario

Industry	1995	2000	2005	2010	2015	2020	2025	2030
Steel	55.4	48.3	42.9	37.6	32.3	29.9	27.9	26.1
Cement	4.4	4.3	4.2	4.1	3.9	3.8	3.7	3.7
Fertilizers	46.1	36.2	37.6	34.7	34.1	30.8	29.9	28.8
Brick	2.6	2.4	2.3	2.2	2.2	2.1	2.10	2.0
Pulp and paper	20.4	19.6	19.1	18.7	18.4	18.2	17.9	17.8
Textiles	3.5	3.4	3.4	3.3	3.2	3.1	3.1	3.0
Sugar	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7
Chlor alkali	14.1	14.4	13.9	13.6	13.3	13.3	13.2	12.7
Aluminium	114.4	113.9	109.7	107.7	104.9	102.0	99.3	96.5

Chapter 2. Indian Scenarios and the AIM/ENDUSE Database

Future intensity trends in India (IA2 Scenario)



Chapter 3. AIM/ENDUSE Model Application

3.1 Aggregate national results

3.2 Analysis for select End-use sectors

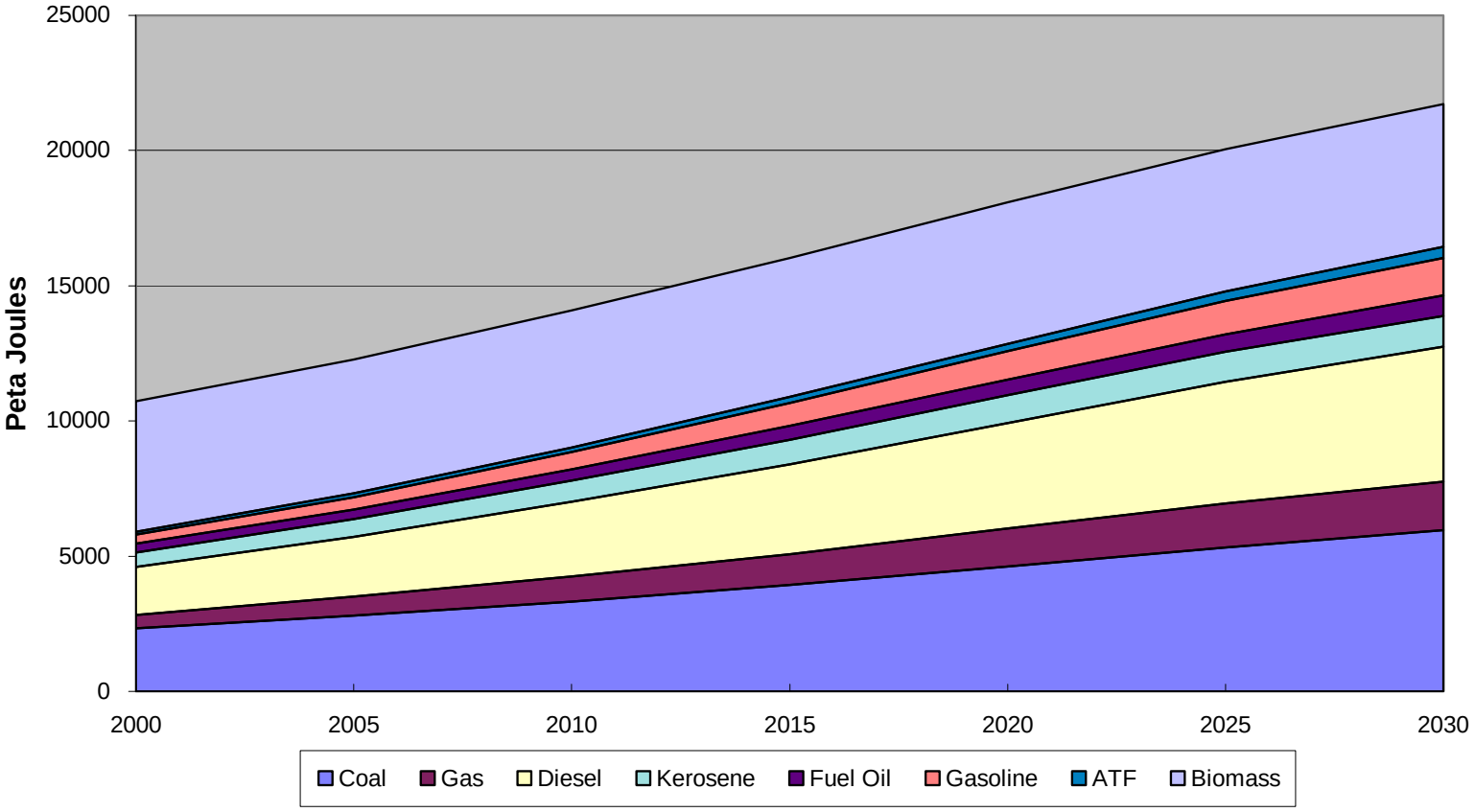
3.3 Non-CO2 GHG analysis

3.4 Interaction between models

3.5 Conclusions

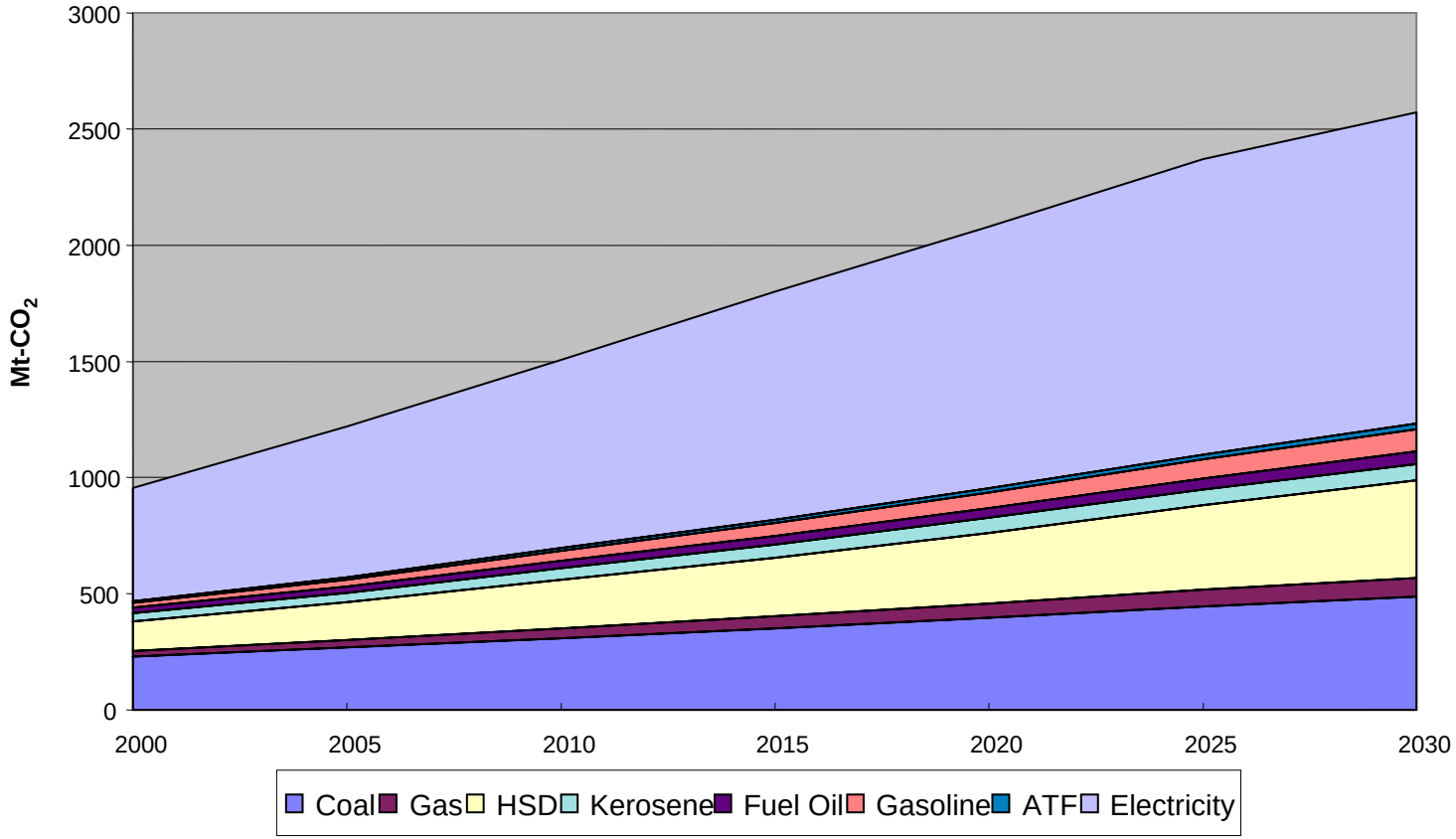
Chapter 3. AIM/ENDUSE Model Application

Fuel wise Primary Energy Consumption under IA2 scenario

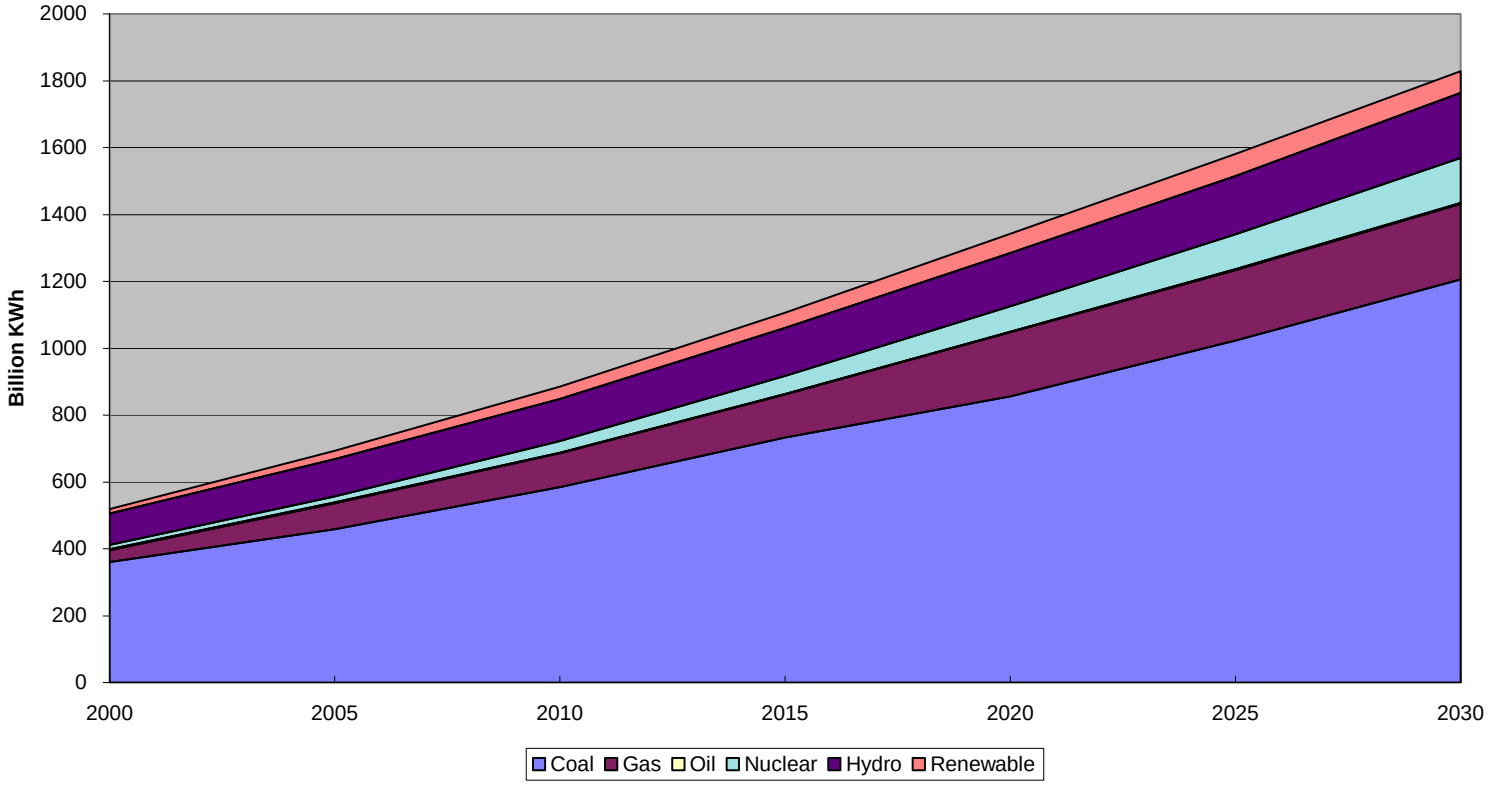


Chapter 3. AIM/ENDUSE Model Application

Fuel-wise CO_2 Emissions under IA2 scenario

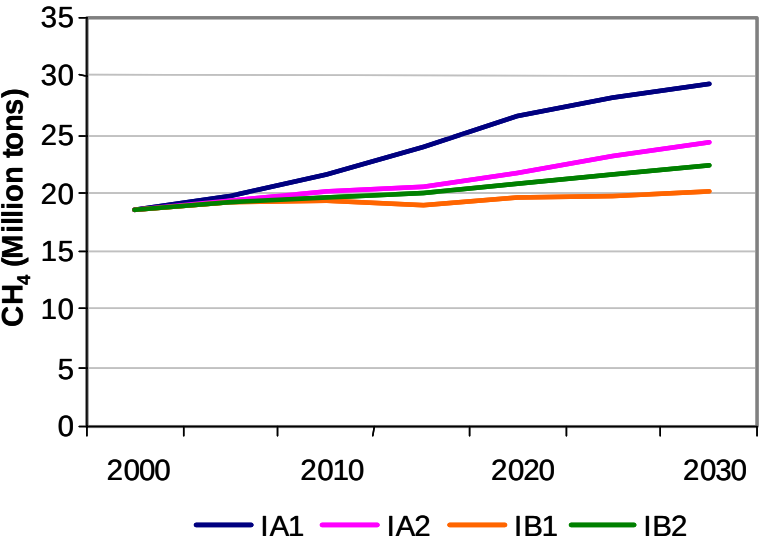


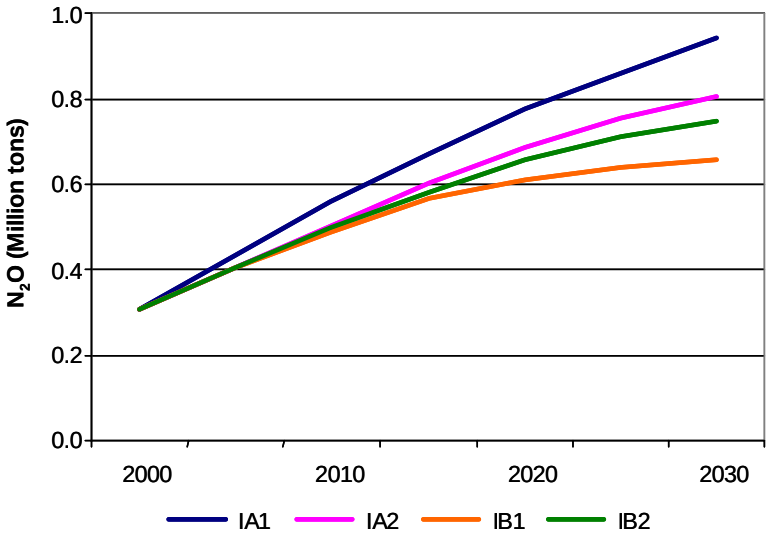
Electricity Generation Mix under IA2 scenario



Chapter 3. AIM/ENDUSE Model Application

Future methane and N_2O emissions under alternate scenarios





Chapter 4. AIM/Local Model Application

4.1 Introduction

4.2 Model Structure

4.3 AIM/Local Database System

4.4 Data Development for the AIM/Local model in India

4.5 Indian Emissions Analysis

4.6 CO2 Emission Mitigation and Co-benefits

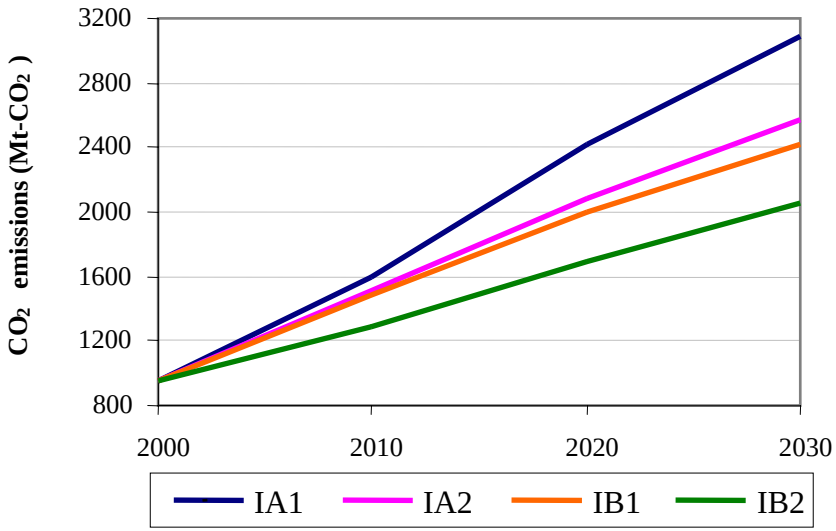
4.7 Urban Applications

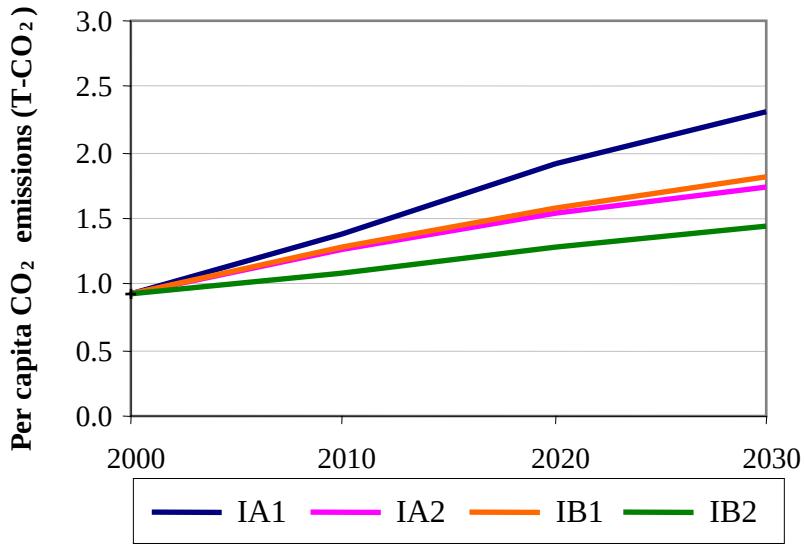
4.8 Interaction with other models (AIM/End use and AIM/Air Model)

4.9 Policy insights and conclusions

Chapter 4. AIM/Local Model Application

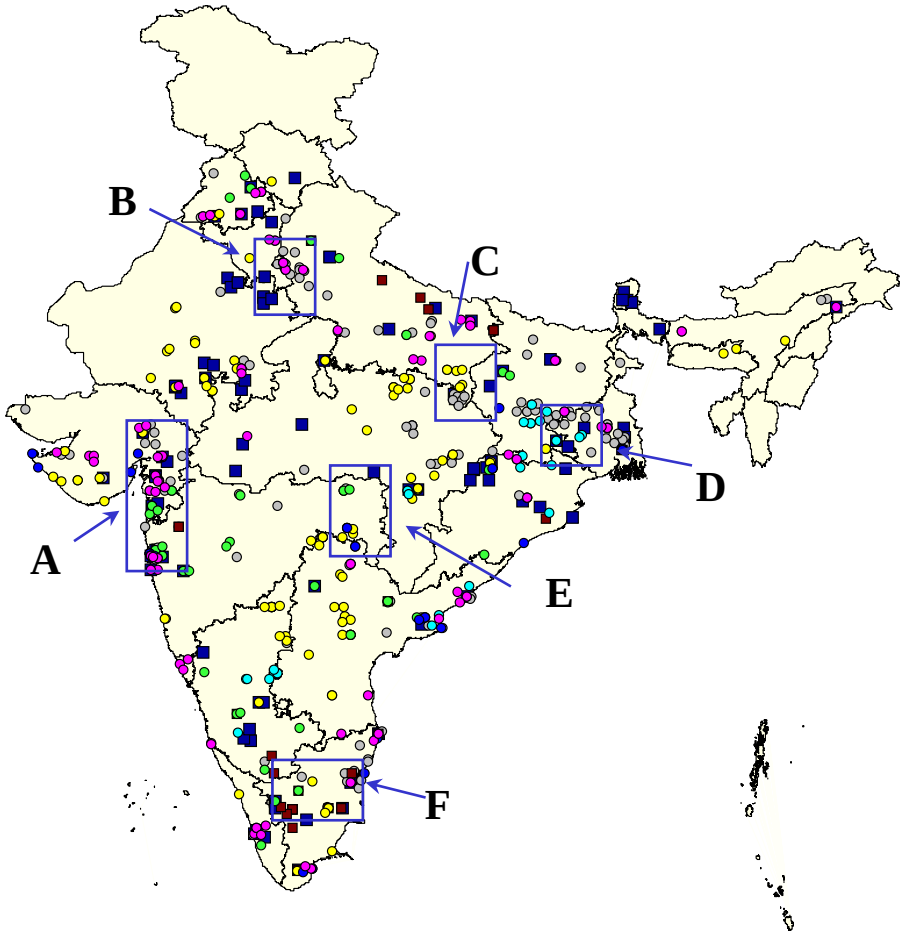
Growth in CO_2 emissions and Per capita CO_2 emissions under alternate scenarios





Chapter 4. AIM/Local Model Application

Regional Spread of Large Point Sources



- Power
- Paper
- Steel
- Sugar
- Cement
- Caustic soda
- Fertilizer
- Others

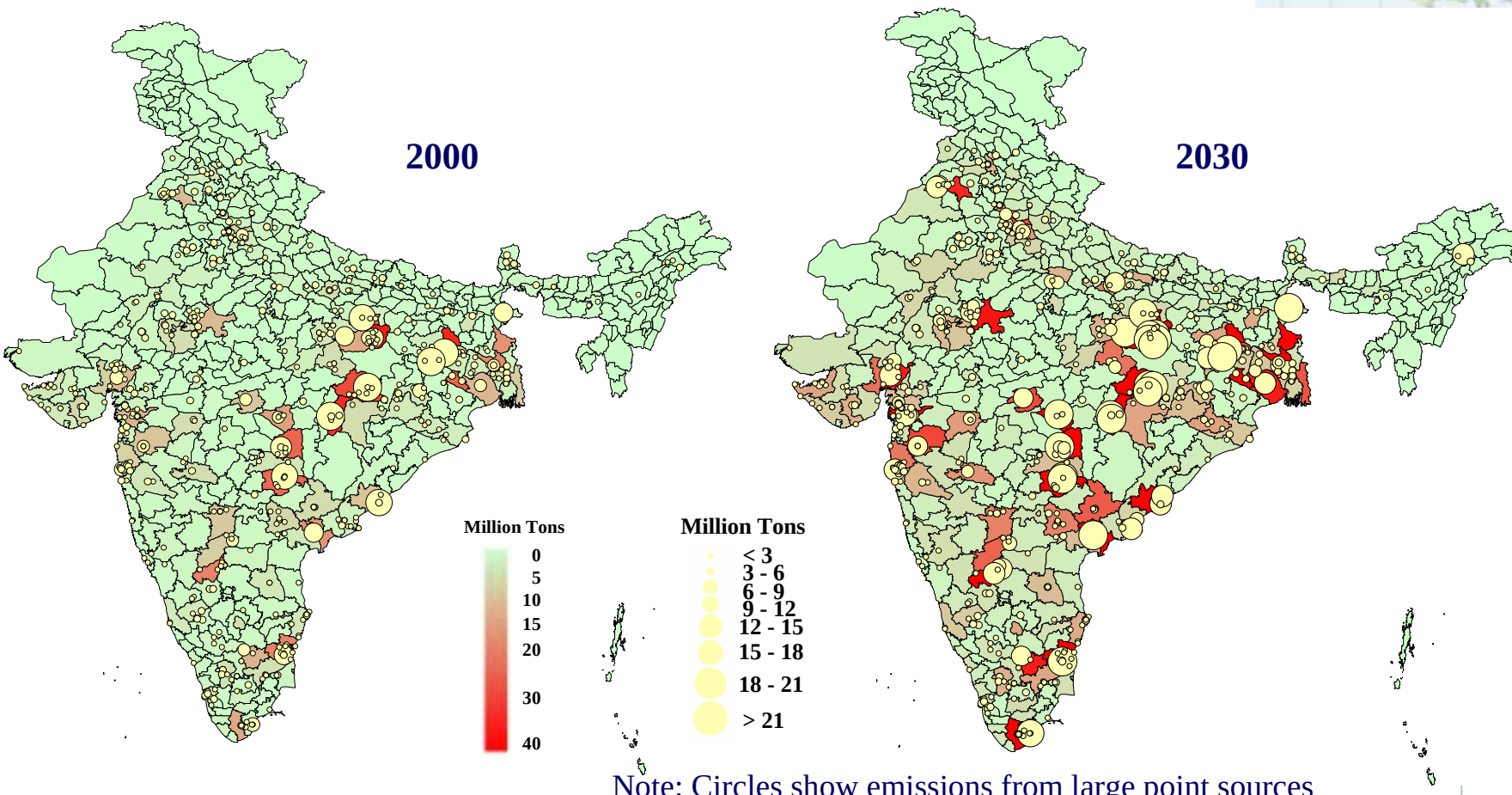
Regional Details	
A	Golden corridor
B	Delhi
C	Northeast India coal mine
D	East India coal mine
E	Central India coal mine
F	Southern region

LPS Coverage

Sector	Sub-sectors	LPS covered			
		2000	2010	2020	2030
Energy	Power (coal & Oil)	82	111	131	150
	Power (natural gas)	12	17	20	23
	Steel	11	17	23	29
	Cement *	85	98	110	123
	Fertilizer	31	41	52	62
	Paper	33	38	43	48
	Sugar	28	28	29	30
	Caustic Soda	19	21	23	26
Industrial processes	H_2SO_4 manufacturing	63	64	66	68
	Aluminium (Al)	3	4	5	5
	Copper ore smelting (Cu)	8	9	10	11
	Lead ore smelting (Pb)	5	6	7	8
	Zinc ore smelting (Zn)	3	4	5	5
Total		**383**	**458**	**524**	**588**

Chapter 4. AIM/Local Model Application

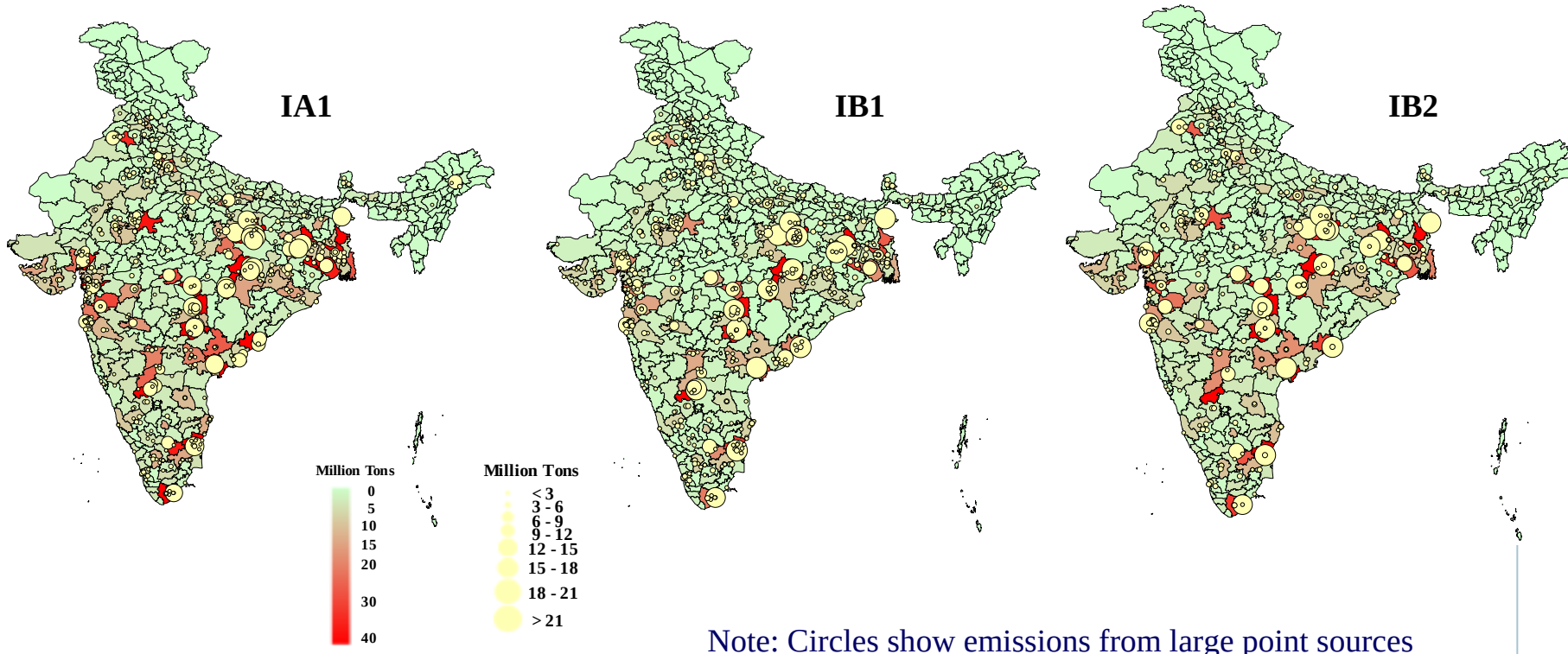
Regional distribution of CO_2 emissions for IA2 Scenario



Note: Circles show emissions from large point sources

Chapter 4. AIM/Local Model Application

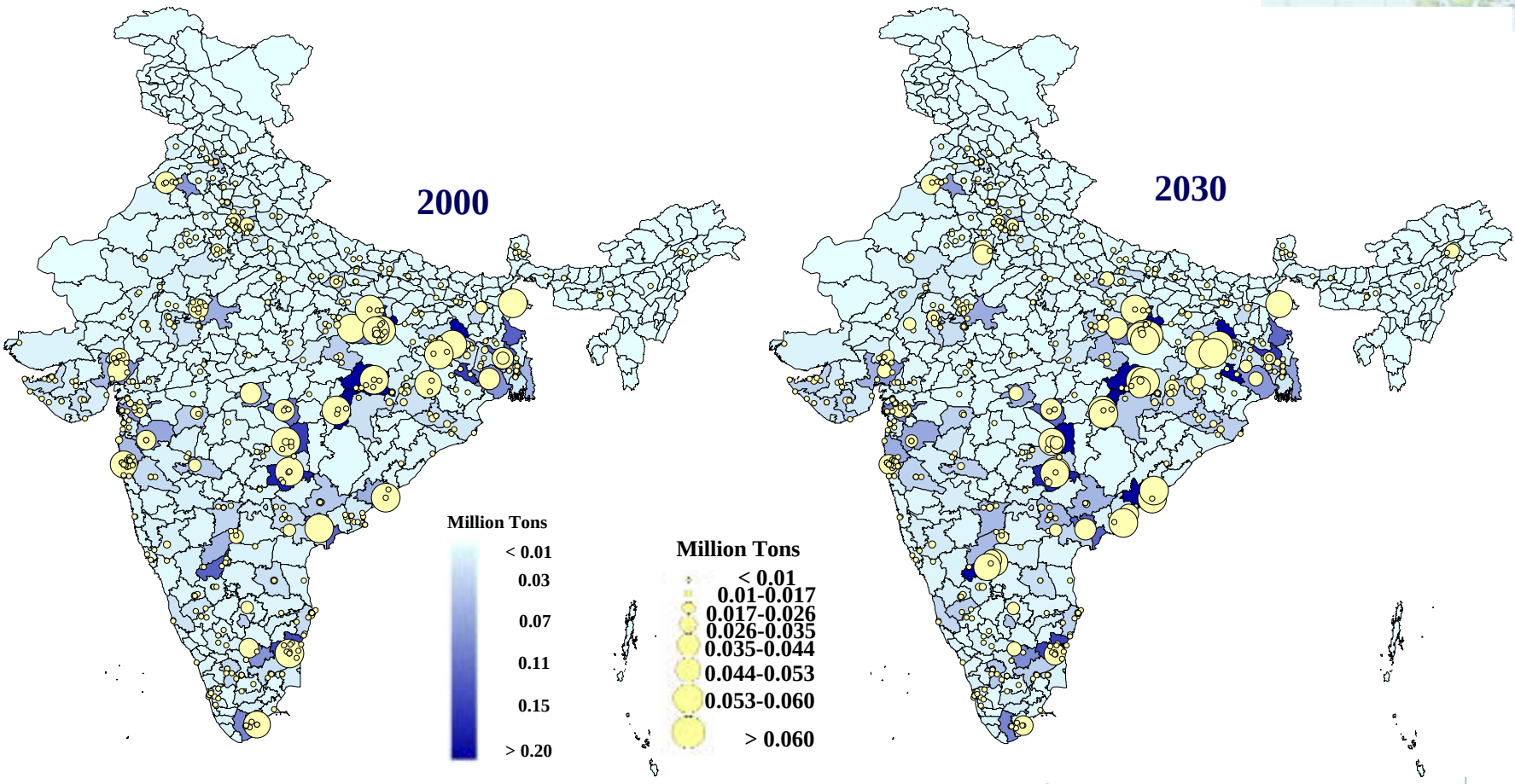
Regional distribution of CO_2 emissions for Different Scenarios (2030)



Note: Circles show emissions from large point sources

Chapter 4. AIM/Local Model Application

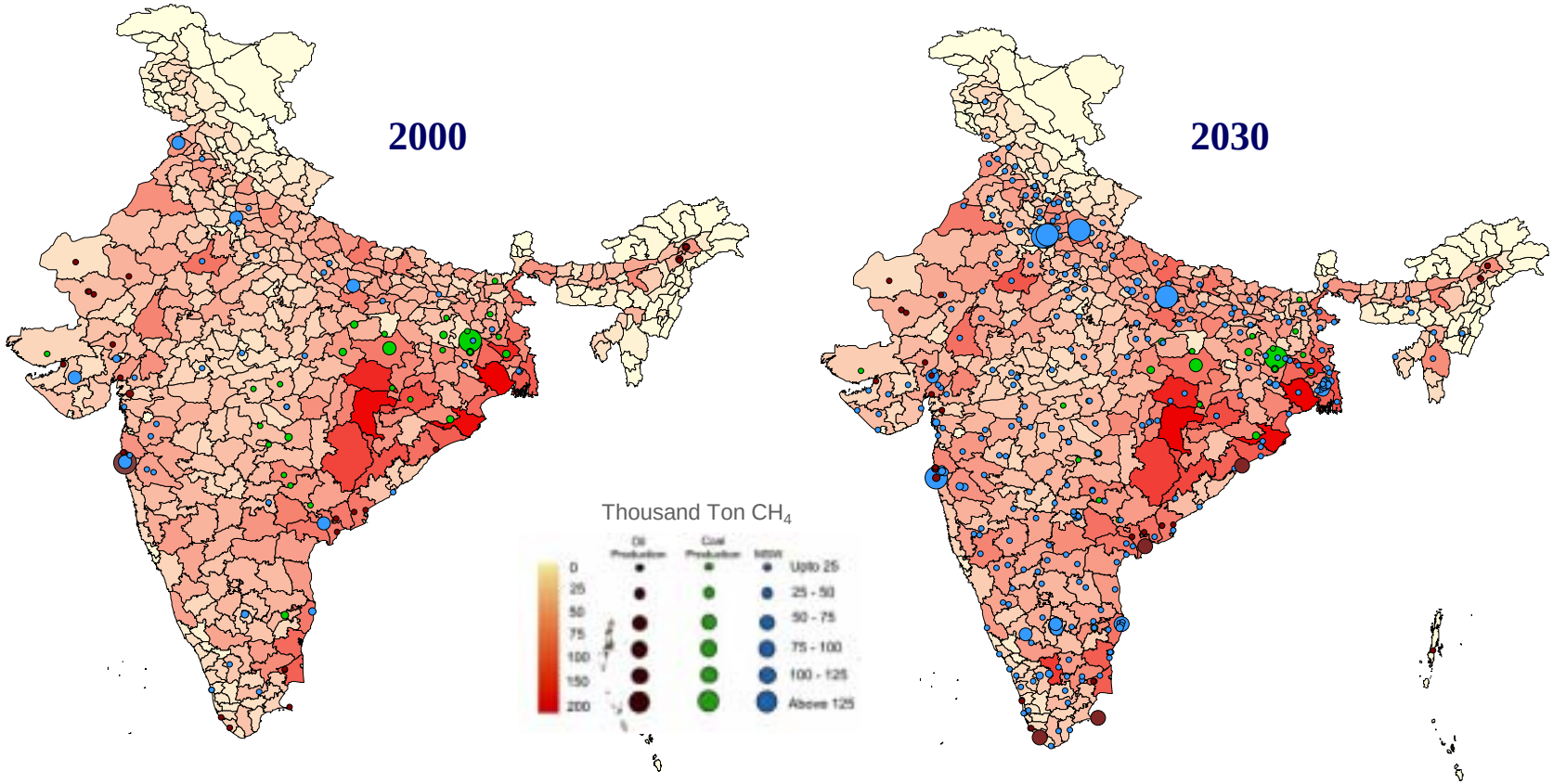
Regional distribution of SO_2 emissions for IA2 Scenario



Note: Circles show emissions from large point sources

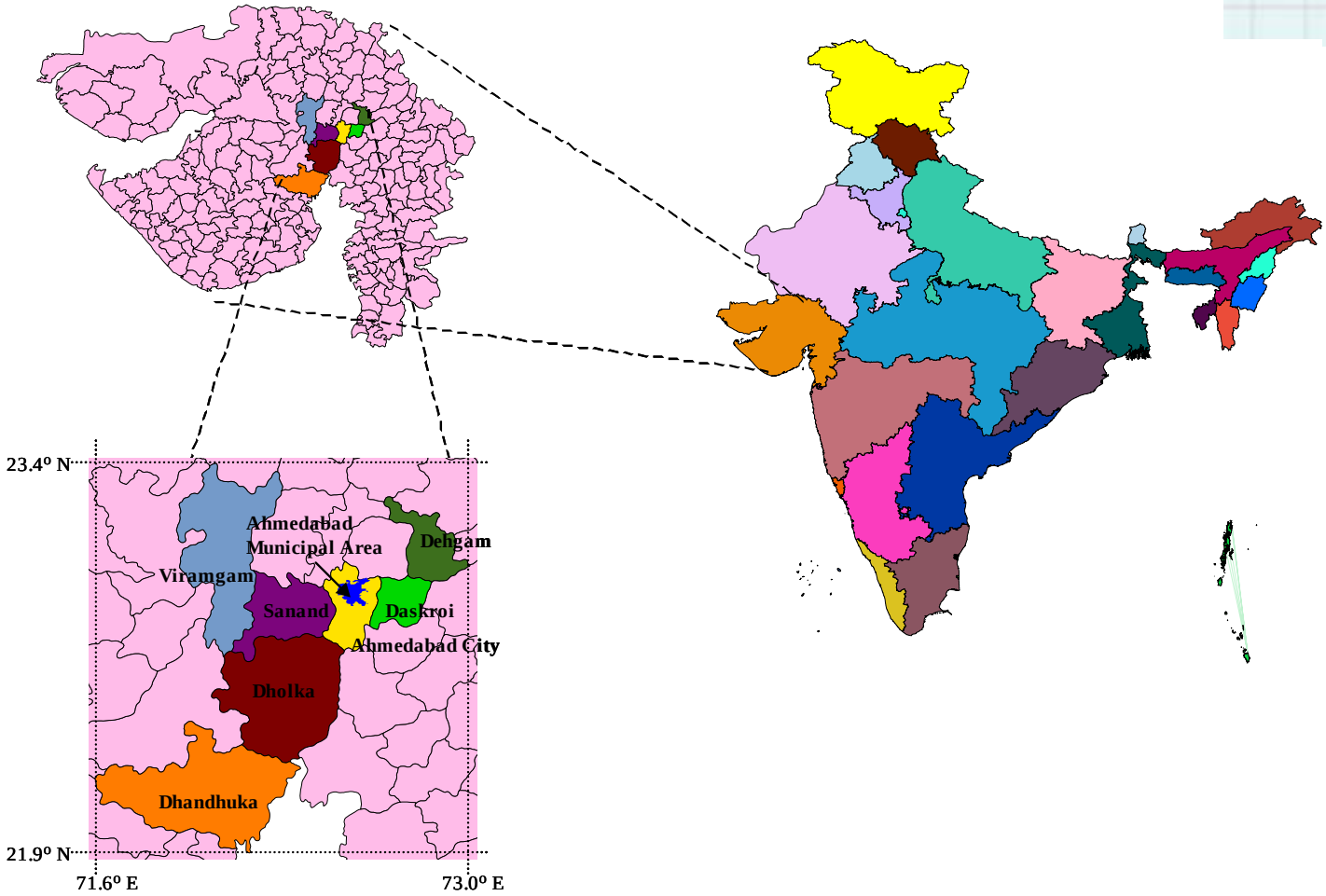
Chapter 4. AIM/Local Model Application

Regional distribution of CH_4 emissions for IA2 Scenario



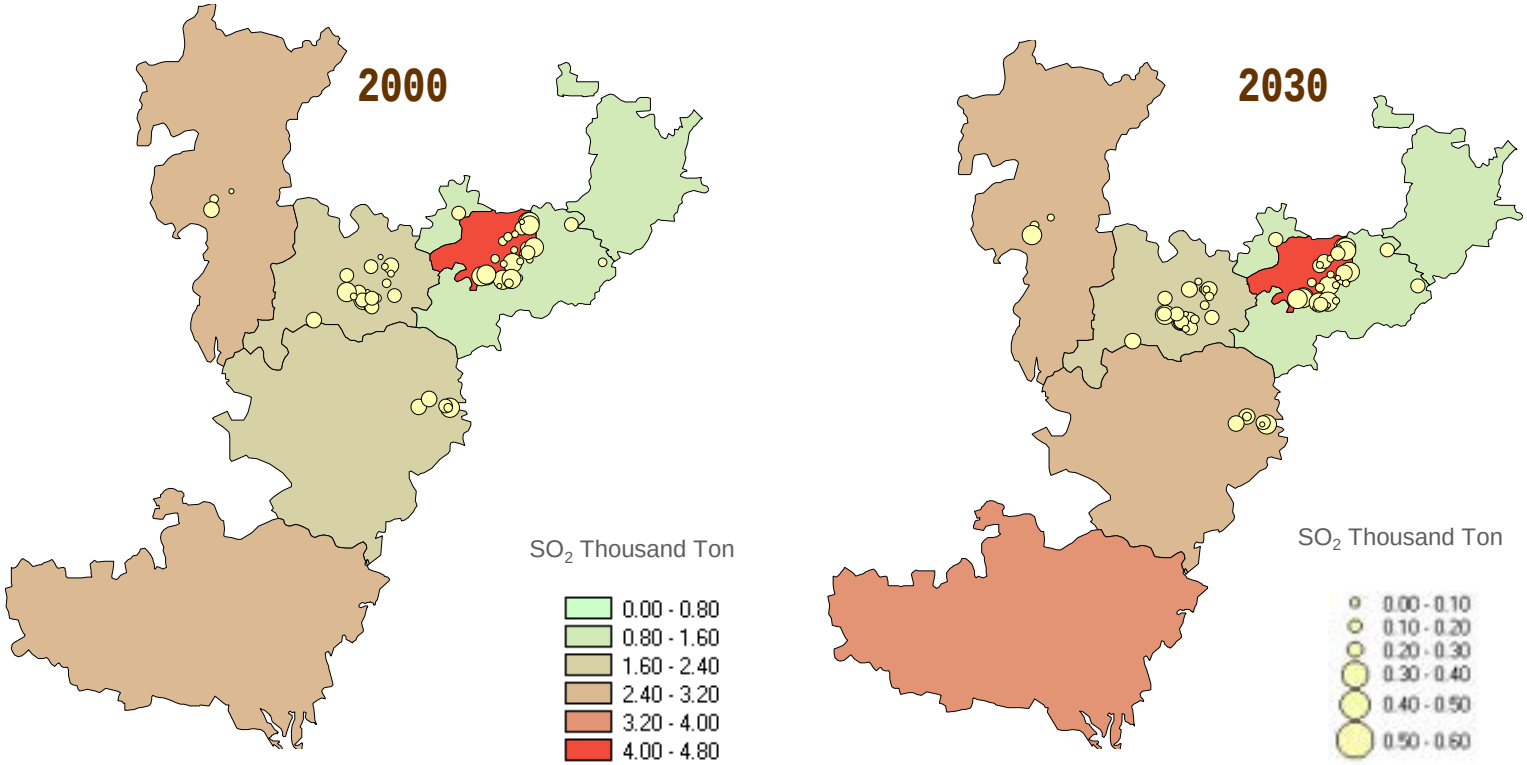
Note: Circles show emissions from large point sources

Ahmedabad District Location and Talukas



Chapter 4. AIM/Local Model Application

Regional distribution of SO_2 emissions in Ahmedabad District for Reference (IA2) scenario



Note: Circles show emissions from large point sources

Chapter 5. AIM/Material Model Application

5.1 Model Structure

5.2 Data Development

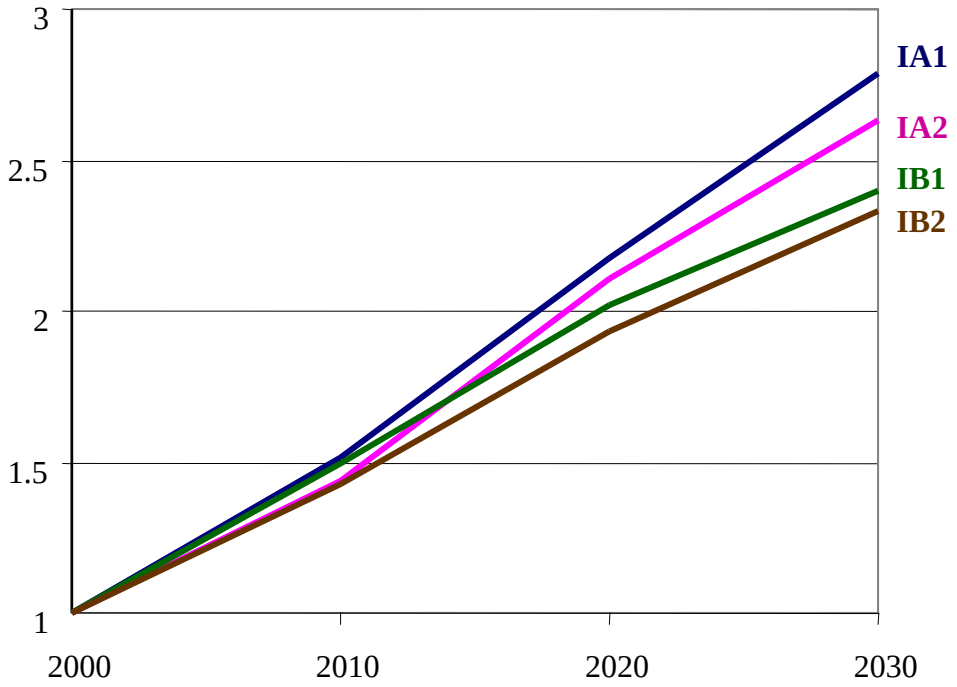
5.3 Applications for India

5.4 Results

5.5 Conclusions

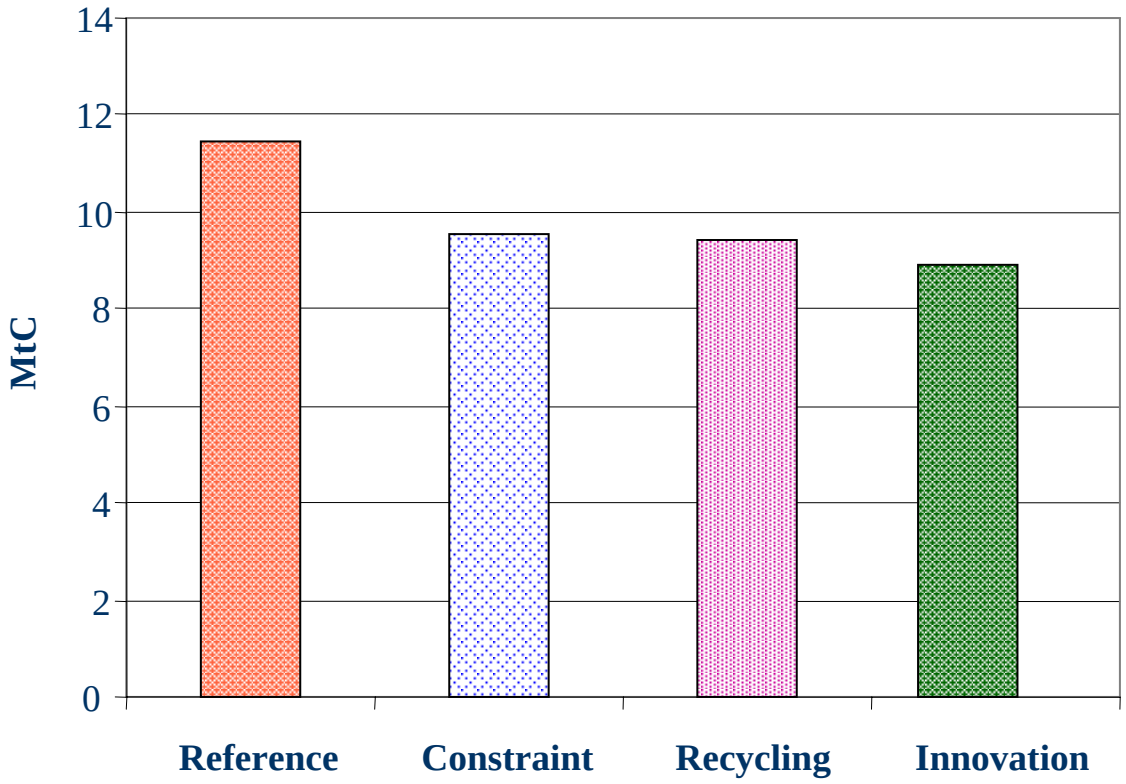
Chapter 5. AIM/Material Model Application

Solid Waste Generation for Indian Emission Scenarios (Index Year 2000 = 1)

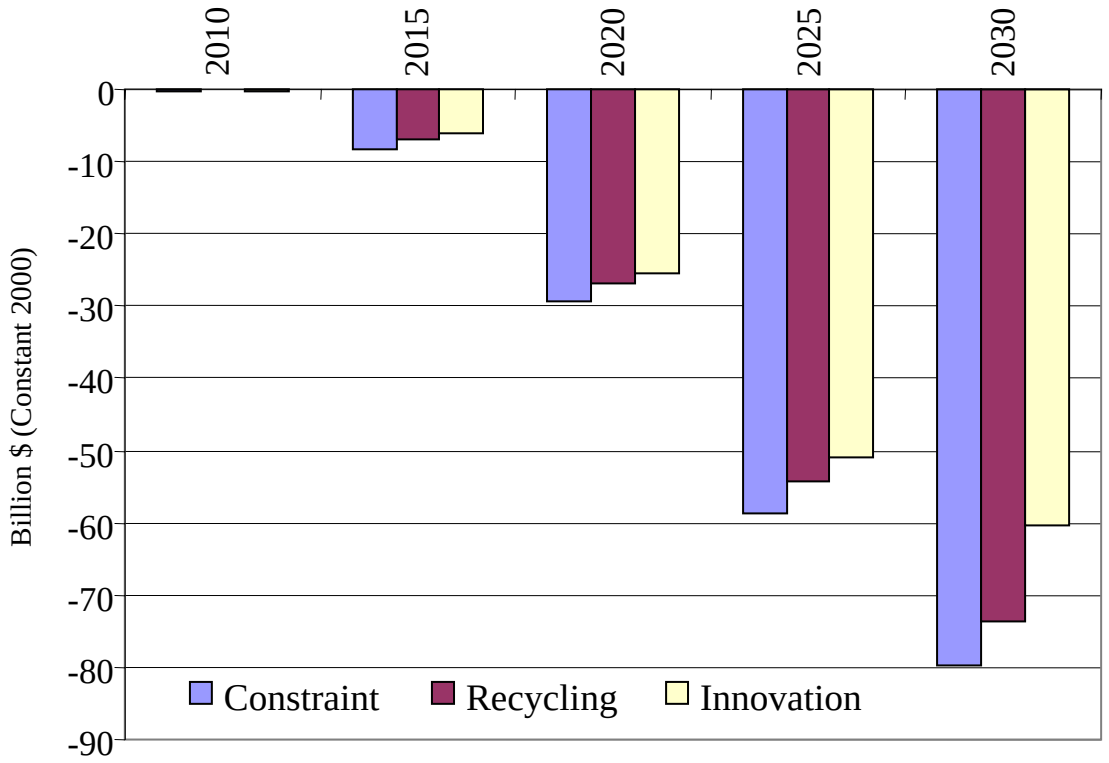


Chapter 5. AIM/Material Model Application

Cumulative CO_2 emissions from India (2000-2030)



Change in GDP over Reference (IA2) Scenario



Chapter 6. AIM/Trend Model Applications for South Asia

6.1 Introduction

6.2 Structure of the AIM/Trend model

6.3 AIM/Trend Model Applications

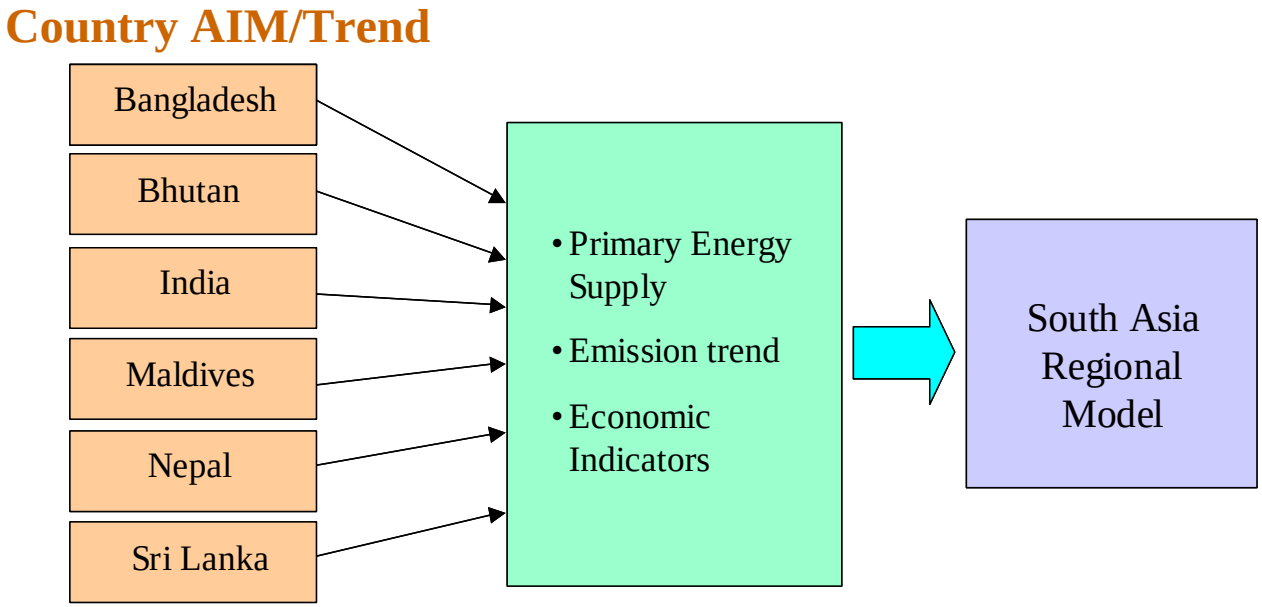
6.4 Policy Implications

6.5 Conclusion

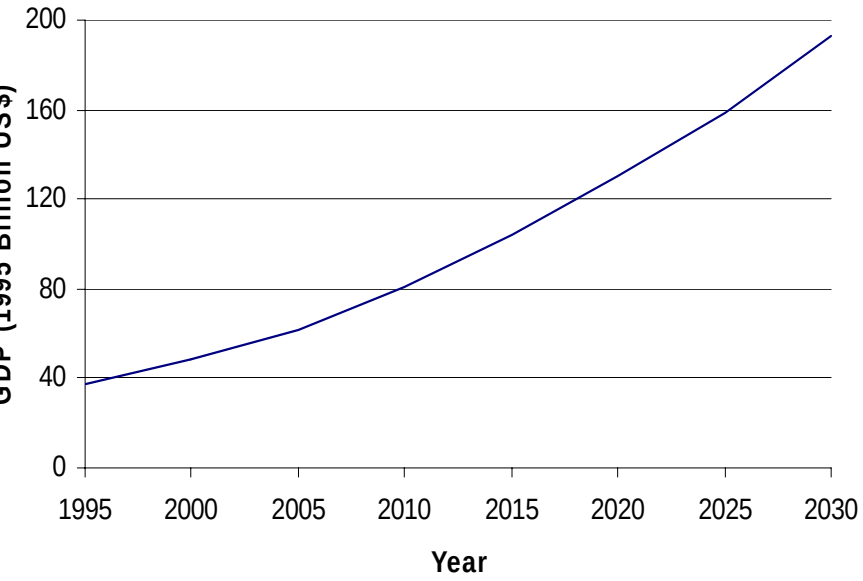
Chapter 6. AIM/Trend Model Applications for South Asia

Future demographic, economic, energy and environment trends for India and several other South Asian countries

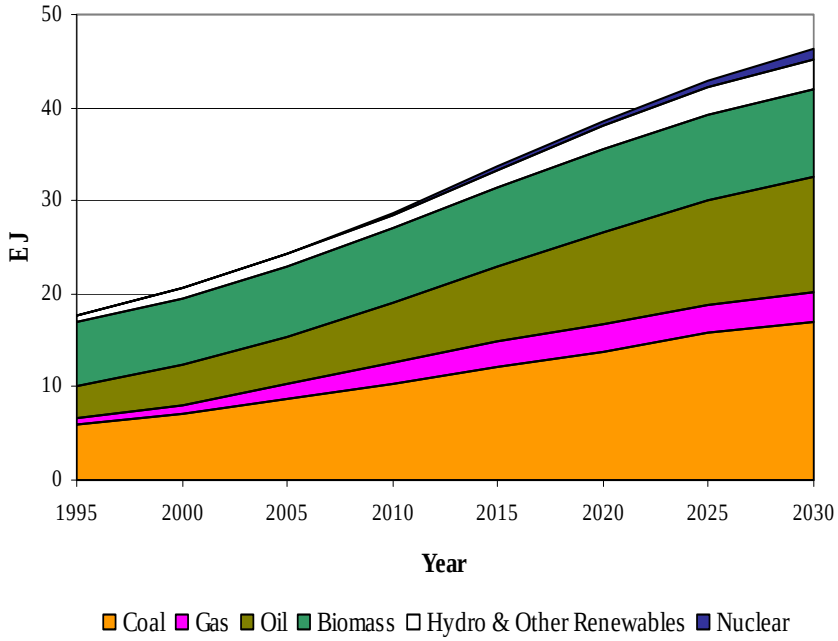
Aim/Trend linked to bottom-up model to develop South Asian regional energy cooperation scenarios



rojections for South Asian Countries

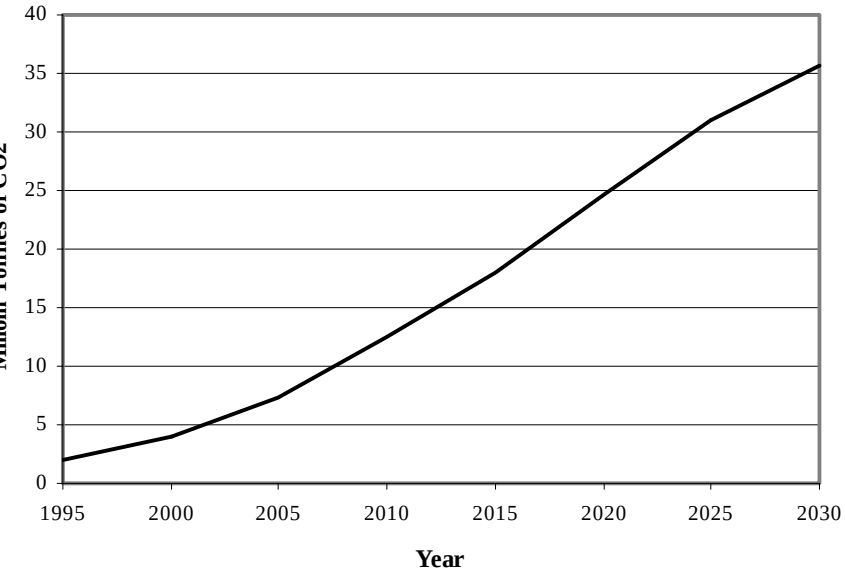


GDP trend for Bangladesh

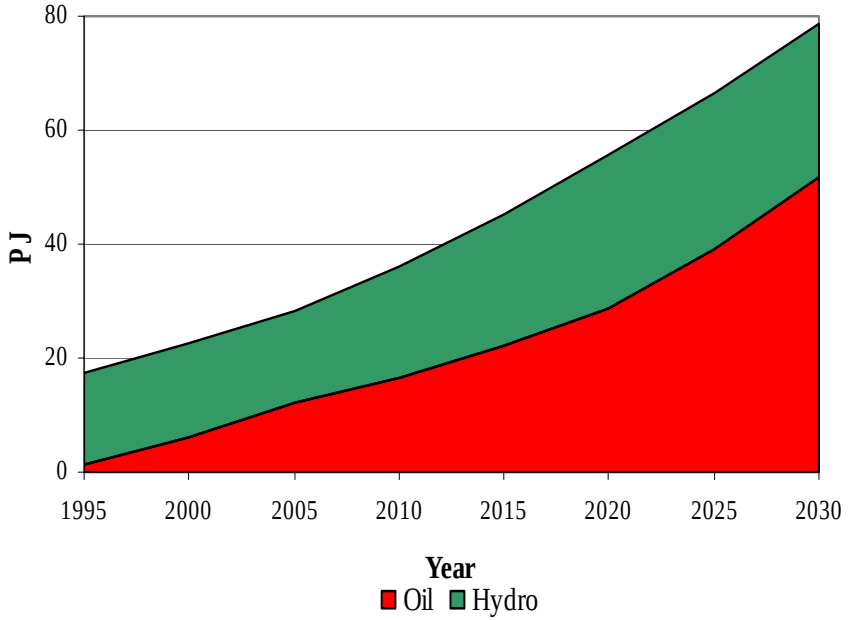


Total Primary energy supply for India

rojections for South Asian Countries (Cont..)



Carbon emission trend for Nepal



Electricity generation mix for Srilanka

Policy Implications and Conclusion

- Analysis indicates a definite trend of increasing energy imports among countries in the region.
- Increasing dependence on external sources can be reduced through regional cooperation
- Supporting robust trade in energy has far-reaching social, economic, energy and environmental security benefits for the region.
- The trend model has emerged as a robust tool for individual country analysis and for analyzing regional scenarios.

Chapter 7. AIM Database and Emissions Inventories

7.1 Strategic data requirements

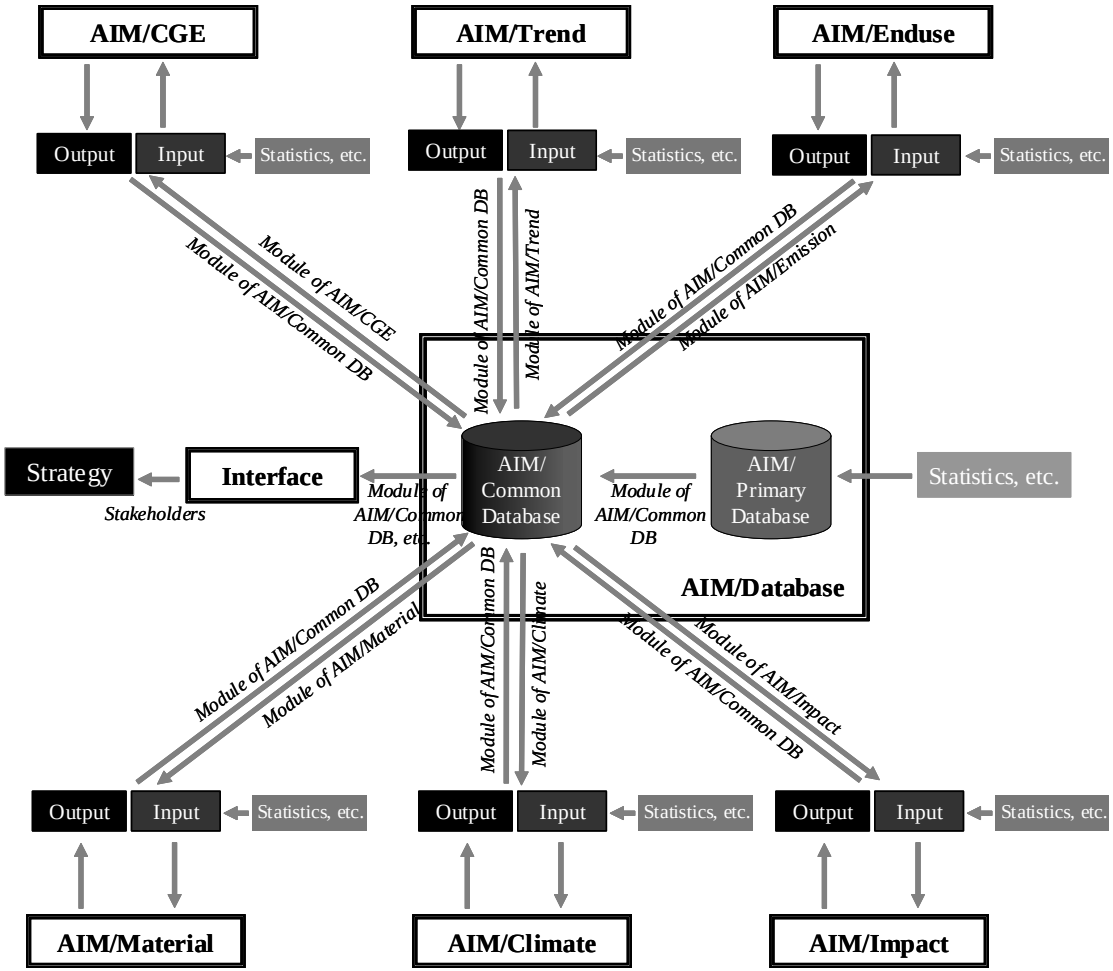
7.2 Data structure

7.3 Functional databases

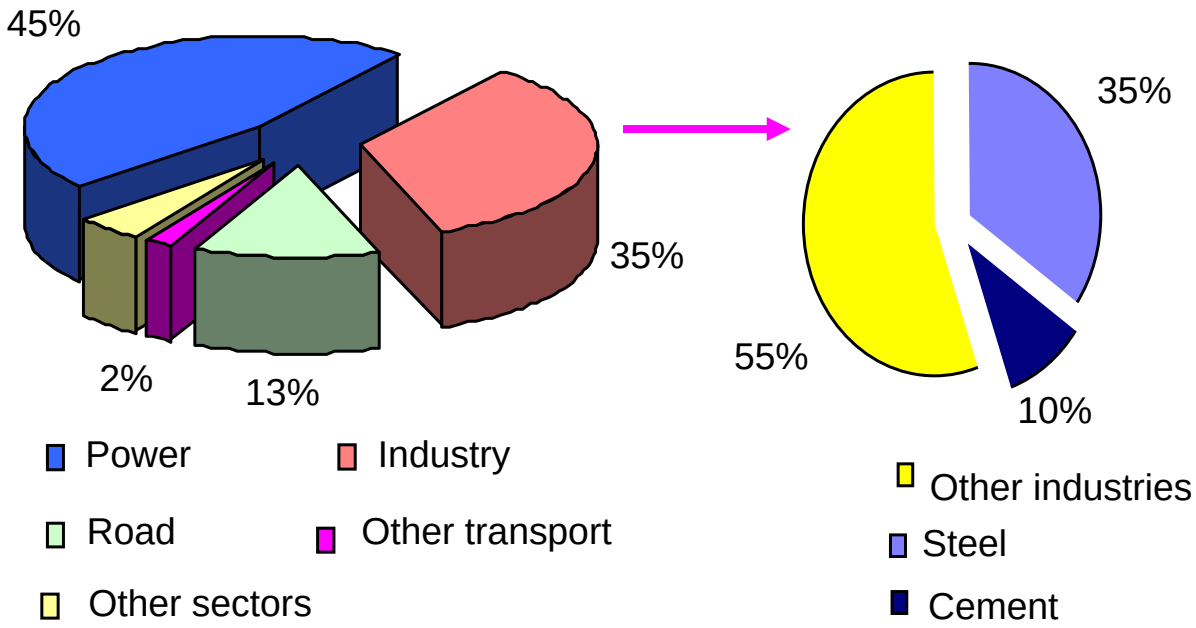
7.4 Indian emissions inventory: A case study in data management

7.5 Conclusions

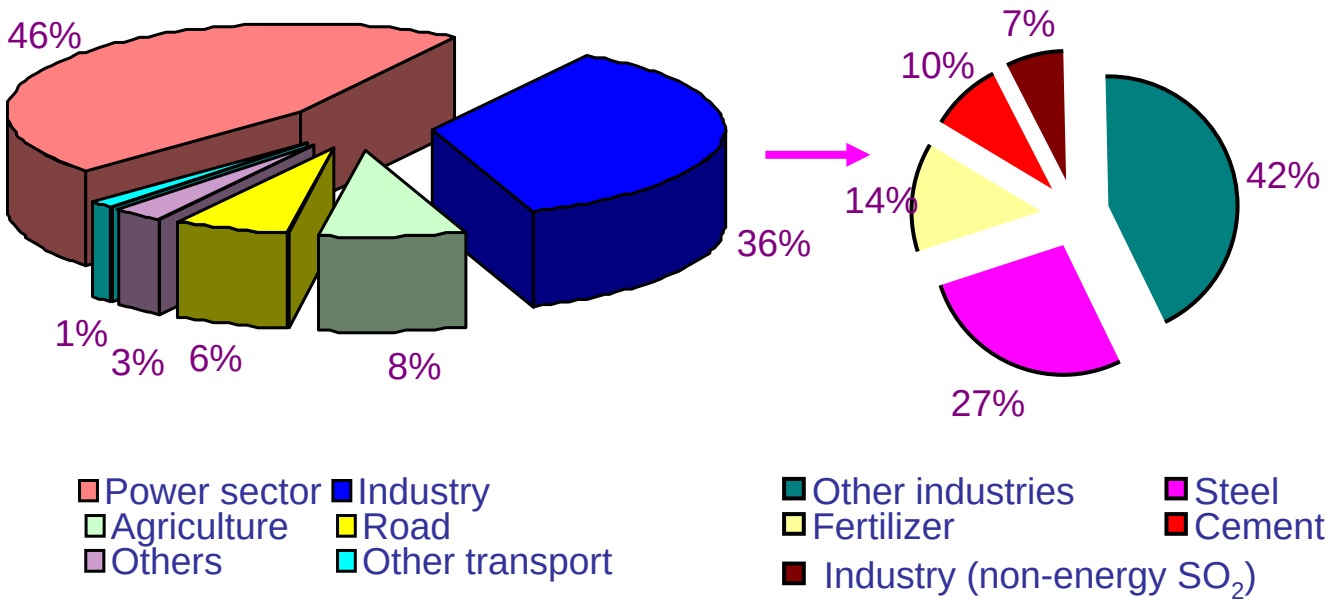
Outline of the AIM/Database



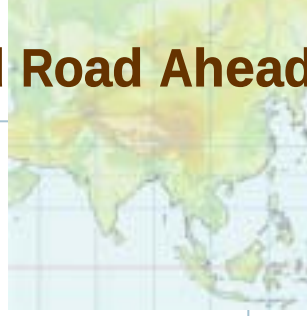
Sectoral Contribution of CO2 emissions



Sectoral Contribution of SO2 emissions



Chapter 8. Conclusions: Policy Insights, AIM Cooperation and Road Ahead



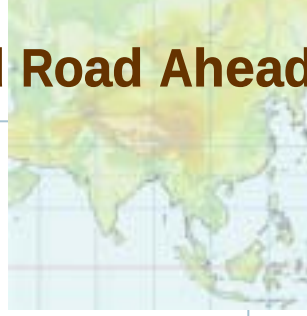
8.1 Indian assessments and policy insights

8.2 Contribution to modeling capacity building by AIM cooperation

8.3 Innovative applications and new model development

8.4 Road ahead

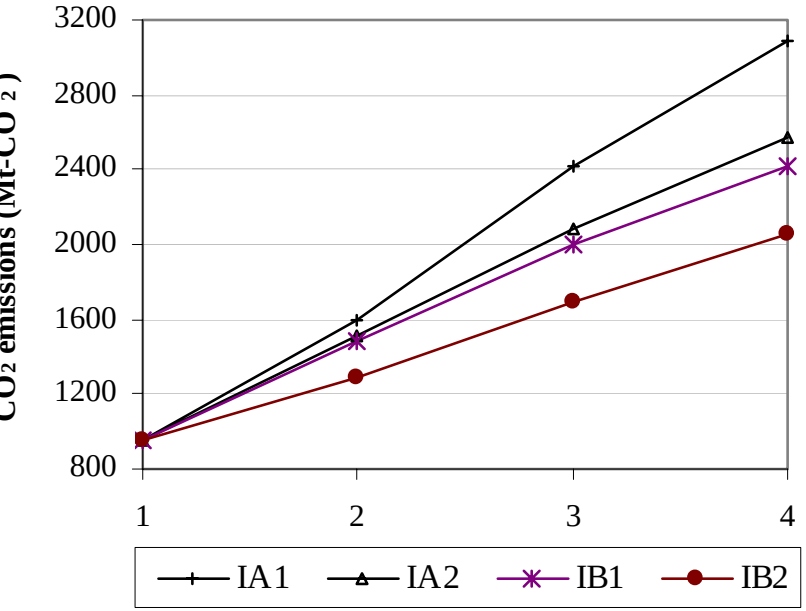
Chapter 8. Conclusions: Policy Insights, AIM Cooperation and Road Ahead

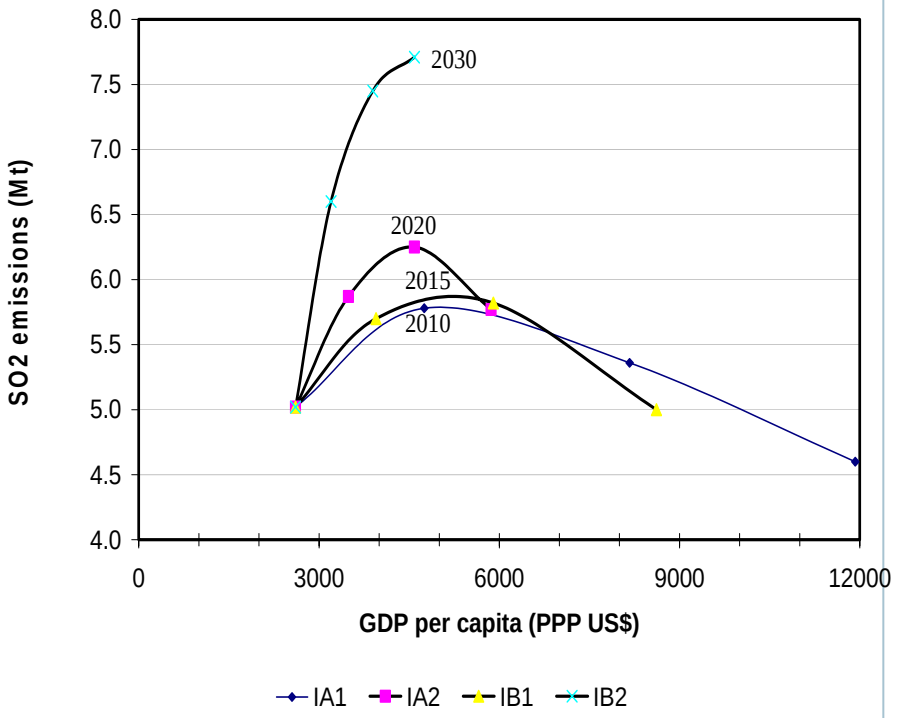


- What are the projected CO_2 emissions under alternate scenarios for India?
- What are the projected per capita CO_2 emissions under alternate scenarios for India?
- What are the projected CO_2 emission intensities under alternate scenarios for India?
- What are the projected non-CO_2 GHG emissions under alternate scenarios for India?
- What are the projected SO_2 emissions under alternate scenarios for India?
- What are linkages and disjoints between GHG and local emissions?
- What is the sectoral CO_2 mitigation potential and flexibility of technological options in the short, medium and long-term?
- What other flexibilities are potentially possible for mitigation?
- What are the cost implications of carbon mitigation?
- What is the linkage between sustainable development and carbon mitigation?
- What is the linkage between local environmental concerns and global emissions?
- What are the implications of regional energy cooperation in South Asia?
- How does modeling help to answer some of the above questions?

Chapter 8. Conclusions: Policy Insights, AIM Cooperation and Road Ahead

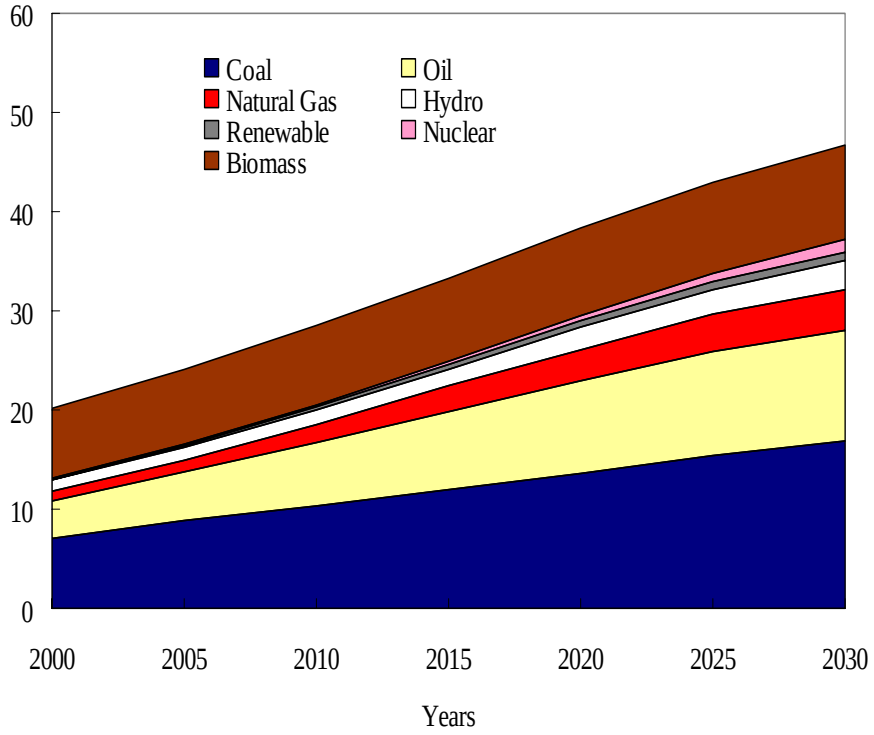
Answering policy questions…

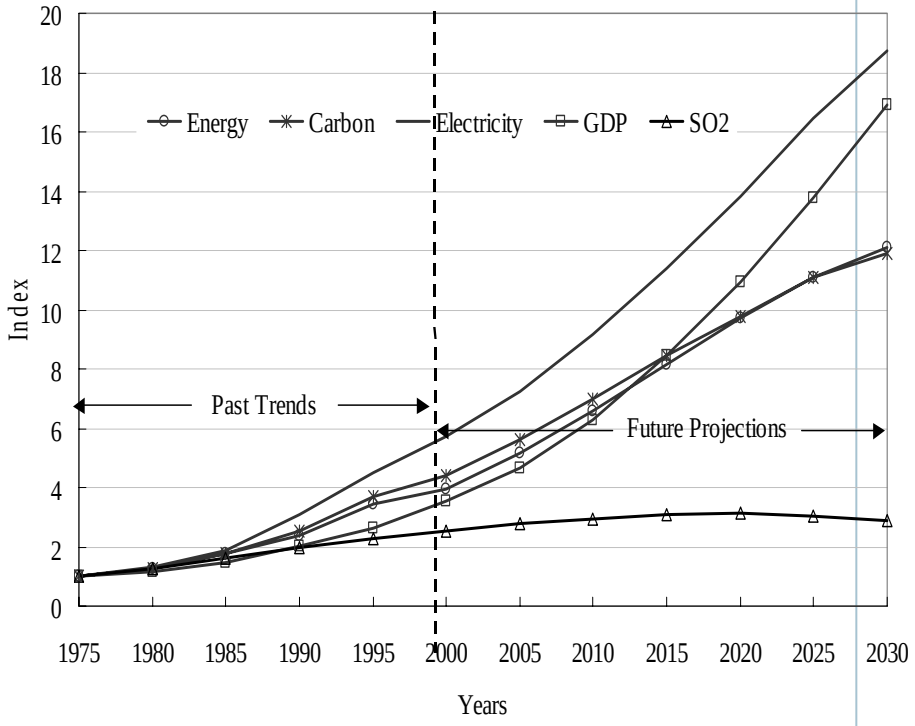




Chapter 8. Conclusions: Policy Insights, AIM Cooperation and Road Ahead

Answering policy questions….

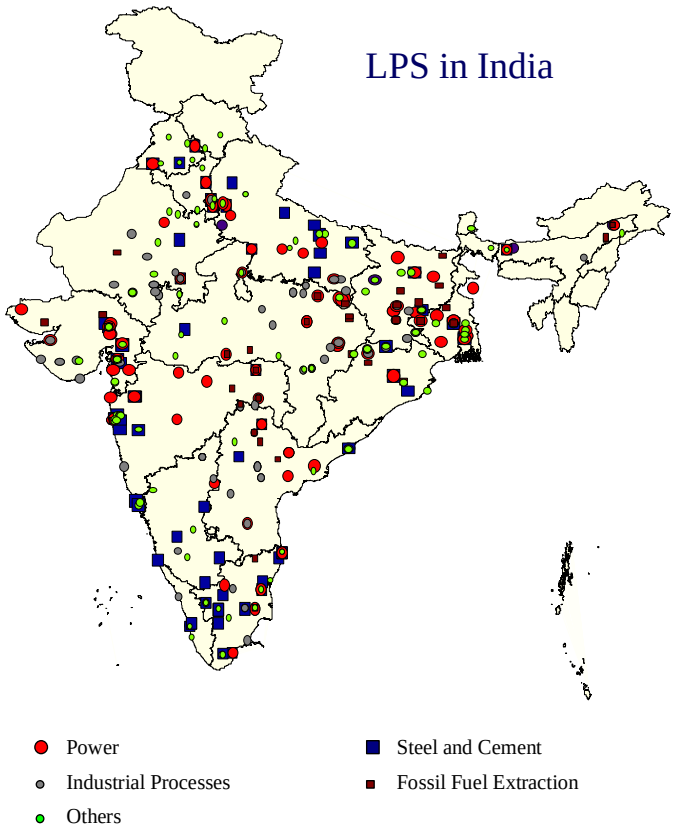




Managing SO_2 Emissions: Case of LPS

LPS spread in different urban centers

LPS	Number	Share of all-India SO_2 emissions (%) in 1995
Power Plants	94	45
Steel	11	7
Cement	85	5
Fertilizer	31	6
Sugar	28	0.09
Paper	33	0.043
Total	282	63.52

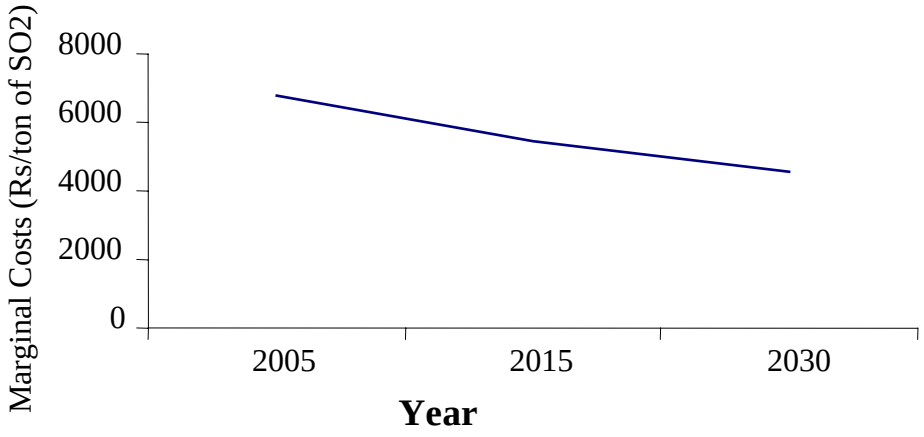


Need for a national policy as well as local-specific policies

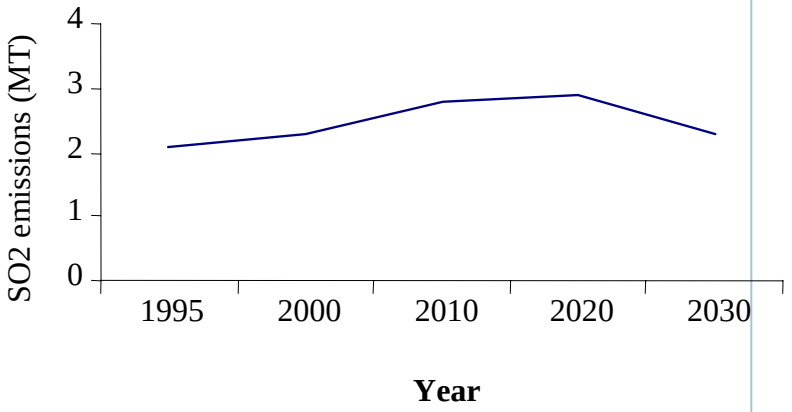
Emission Cap-and-Trade vis-à-vis Technology Policy

45% cost- savings over 30 years in the emissions cap and trade instrument

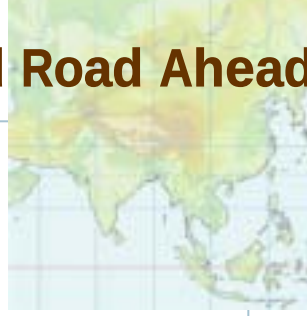
Marginal costs for SO_2 mitigation



SO_2 Emissions Cap Trajectory



Annual average cost savings over a 30 year period is Rs. 3600 million ($80 million)



Road Ahead

- Data Development
- Close interface with policymakers
- Capacity building
- Focused Modeling
- Evolving Modeling Paradigms
- Modeling Protocols
- Regional and Global Networking

APPRECIATION

Our thanks to

AIM Team members from all countries

NIES

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Indian Policymakers

and

Morita-san's family