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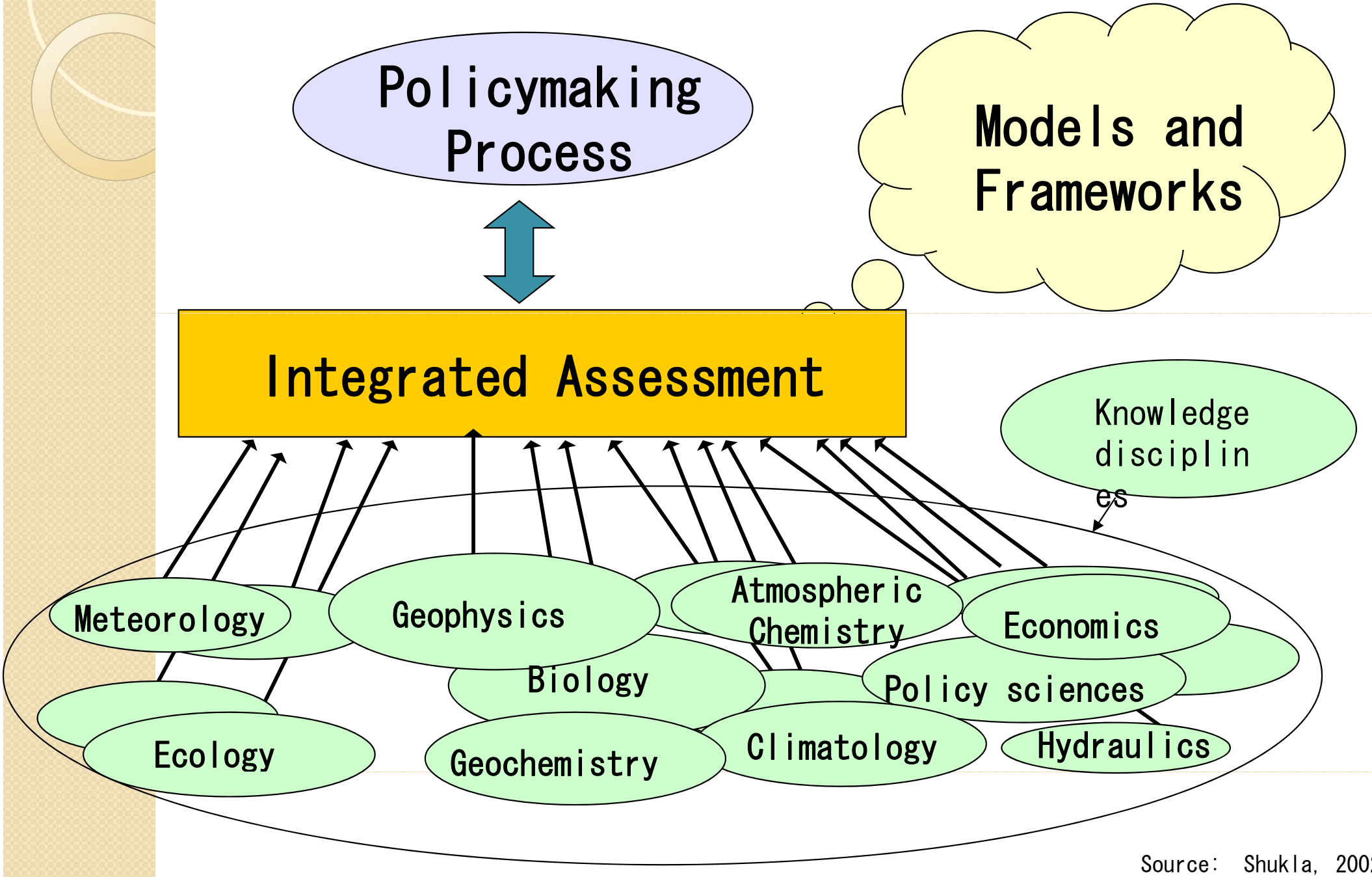
Integrated Assessment Models and Climate Policy Development

Ram M. Shrestha
Emeritus Professor
Asian Institute of Technology
Thailand

What is Integrated Assessment?

- Integrated Assessment (IA) is an attempt to integrate information from and across disciplines to help in the process of developing policy responses (Parson,1994).
- All IAMs "share the defining trait that they incorporate knowledge from more than one field of study" (Weyant, 1996).
- An IAM is a model that includes both human activity and some key aspects of the physical relationships driving climate change. (Kolstad, 1998)

Multiple Interfaces of Environmental Assessment



Source: Shukla, 2002

What is Integrated Assessment?

- IAMs are models "that combine knowledge from multiple disciplines, with the aim of shedding light on policy questions." (Tol, 2006)
- An integrated assessment model (IAM) is a model, which combines scientific and socio-economic aspects of climate change primarily for the purpose of assessing policy options for climate change control. (Kainuma et al., 2003)
- IA is characterized as a multidisciplinary, policy-relevant research. (Tol and Vellinga, 1997)

Some Key Climate Policy Questions (1)

- What are the costs and benefits of policies/measures to decarbonize the economy and develop a low carbon society?
- When should a GHG mitigation option be introduced?
- How much damage could be avoided by GHG abatement over short, medium and long term (next 30, 50 or 100 years)?
- Which sectors offer potential for cost effective GHG emission abatements?
- What will a climate stabilization policy cost?
- How much of adaptation and abatement measures would be optimal?

Some Key Climate Policy Questions (2)

- How could a GHG emission reduction target be attained?
- Which technologies and resources are cost effective for GHG emission reduction?
  - co-benefits?
  - direct and indirect costs?
  - effect on the GDP?
- How can sustainable development policies be aligned with climate change policies?
- What are the best GHG abatement policies in terms of economic

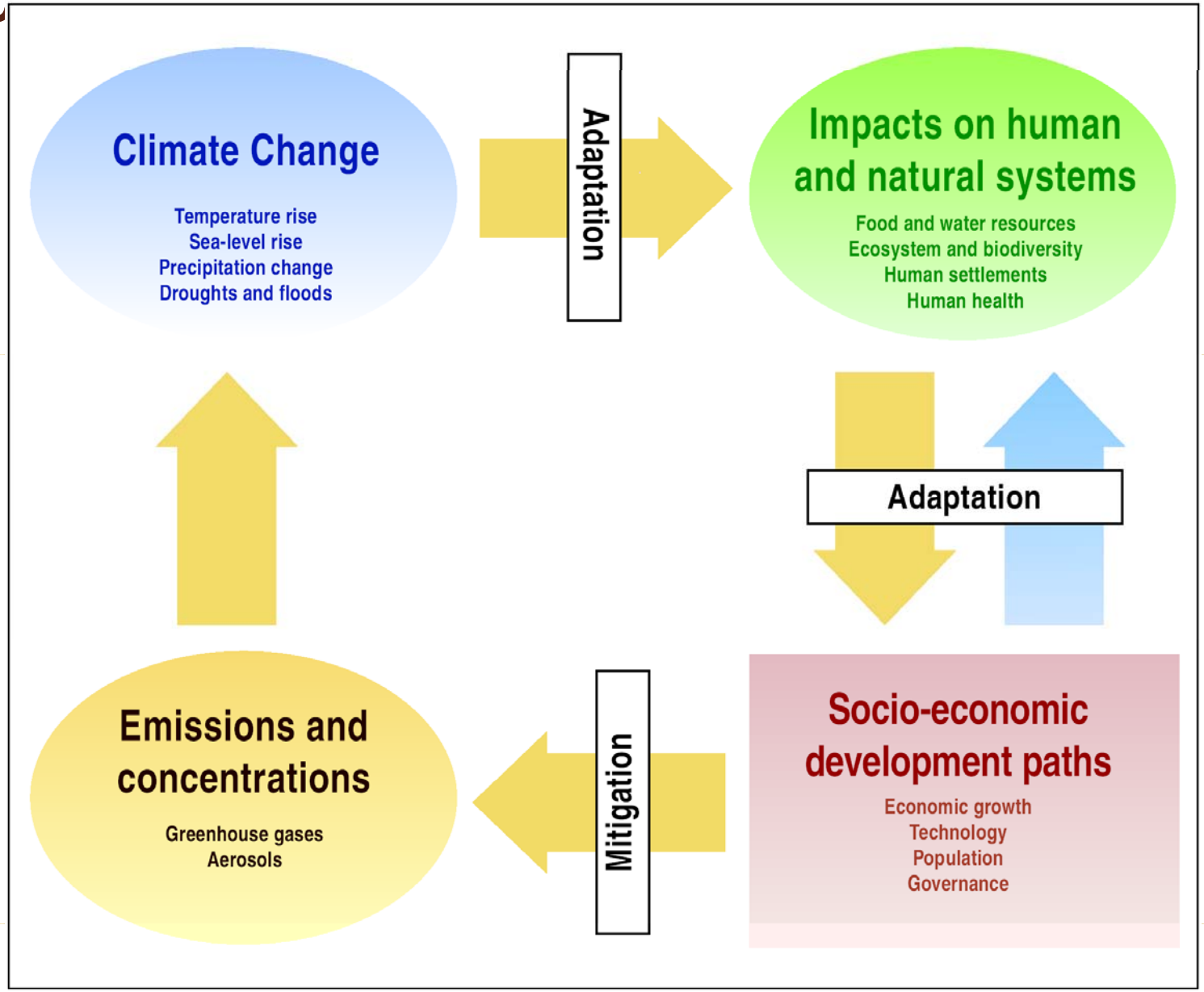
Why IAMs?

- Climate change has multi-sectoral/multi-faceted impacts
- Climate or low carbon policies/strategies affect GHG emissions and generate several co-benefits
- Every policy or strategy has a cost; not free.
- Assessment of a low carbon policy involves evaluation of multi-sectoral impacts and cost of the policy
  - Costs and benefits can be both direct and indirect.
  - Integrated assessments needed to capture the multisectoral costs and benefits of a

History of IAMs

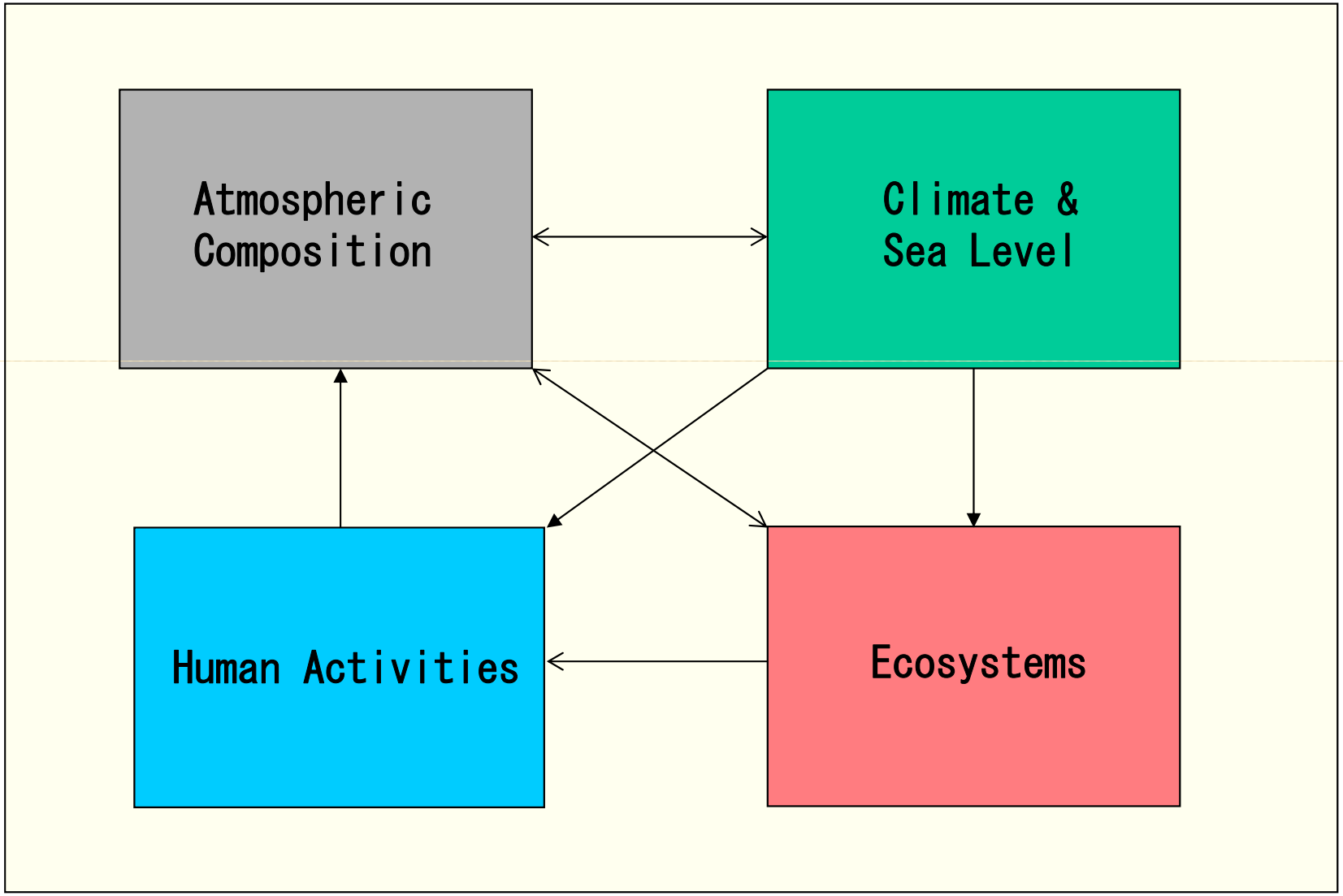
- RAINS model for analysis of acid rain problem in Europe in 1980s
- Only two IAMs for climate change existed before 1992:
  - Nordhaus (1989, 1991) and Rotmans (1990)
- A recent survey reviewed over 30 IAMs

Integrated Framework For Climate Change



Source: Shukla, 2002

Climate Change Related Inter-linkages



Climate Change Related Inter-linkages

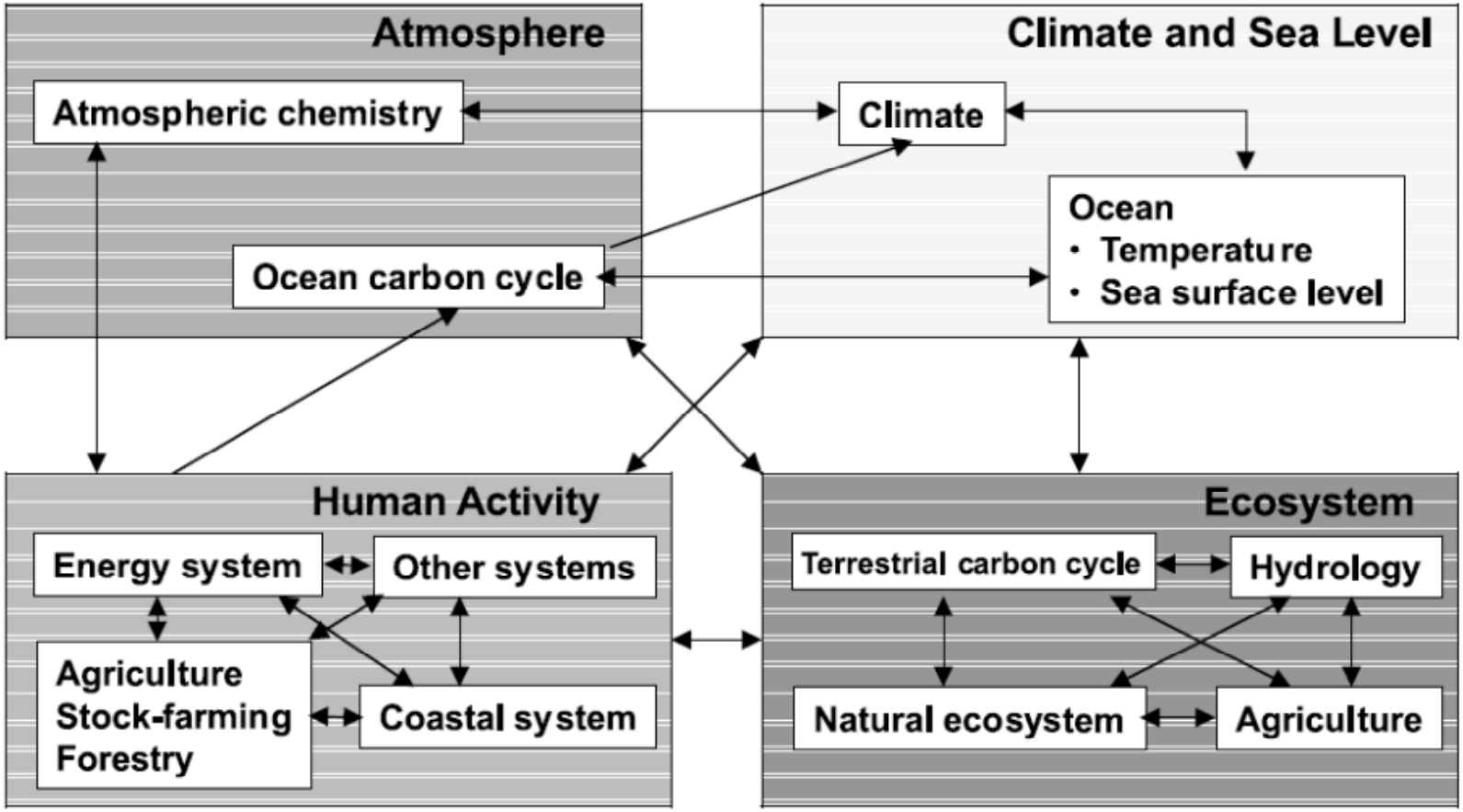
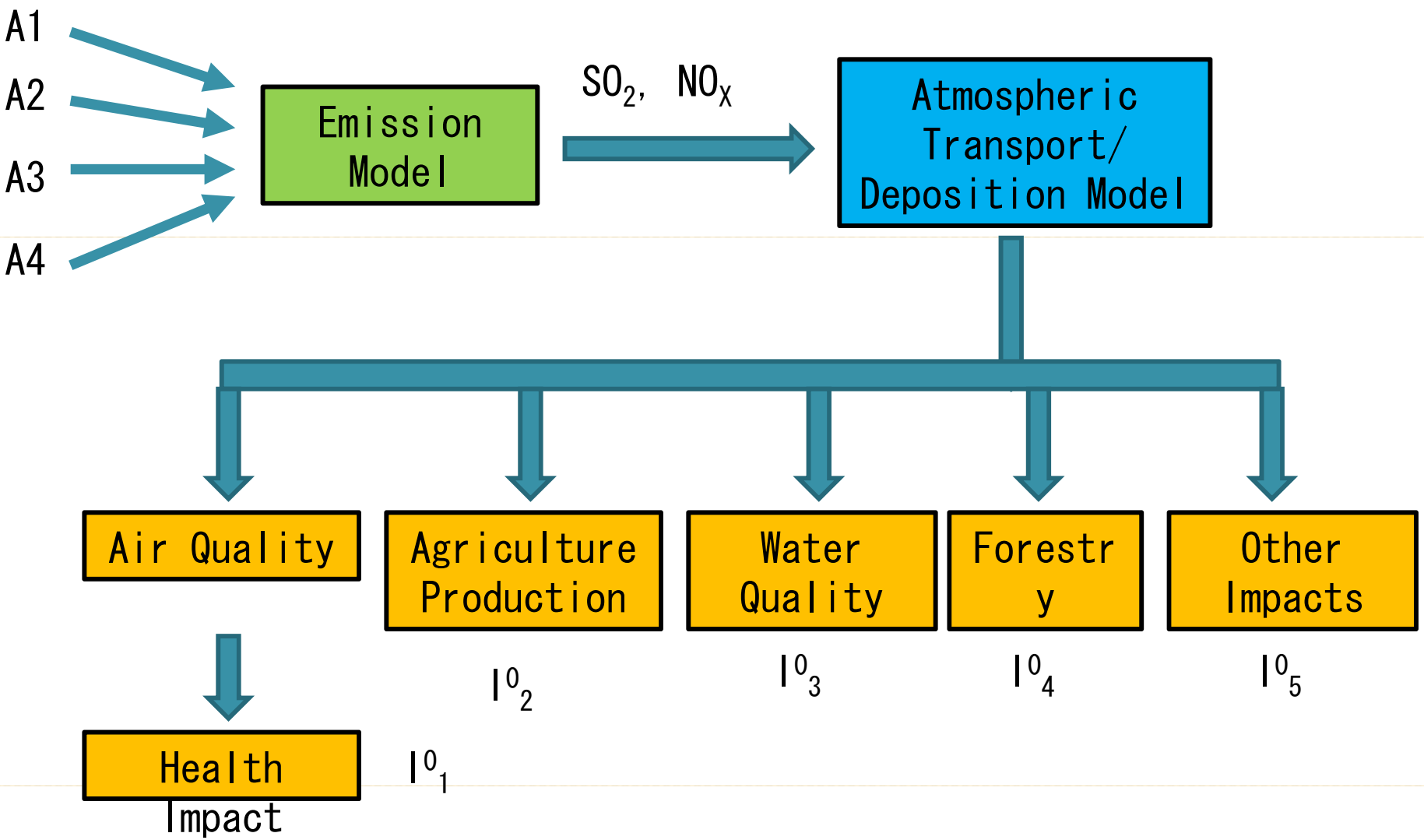


Fig. 18. Integrated framework for climate change assessment.

Source: Weyant, 1996

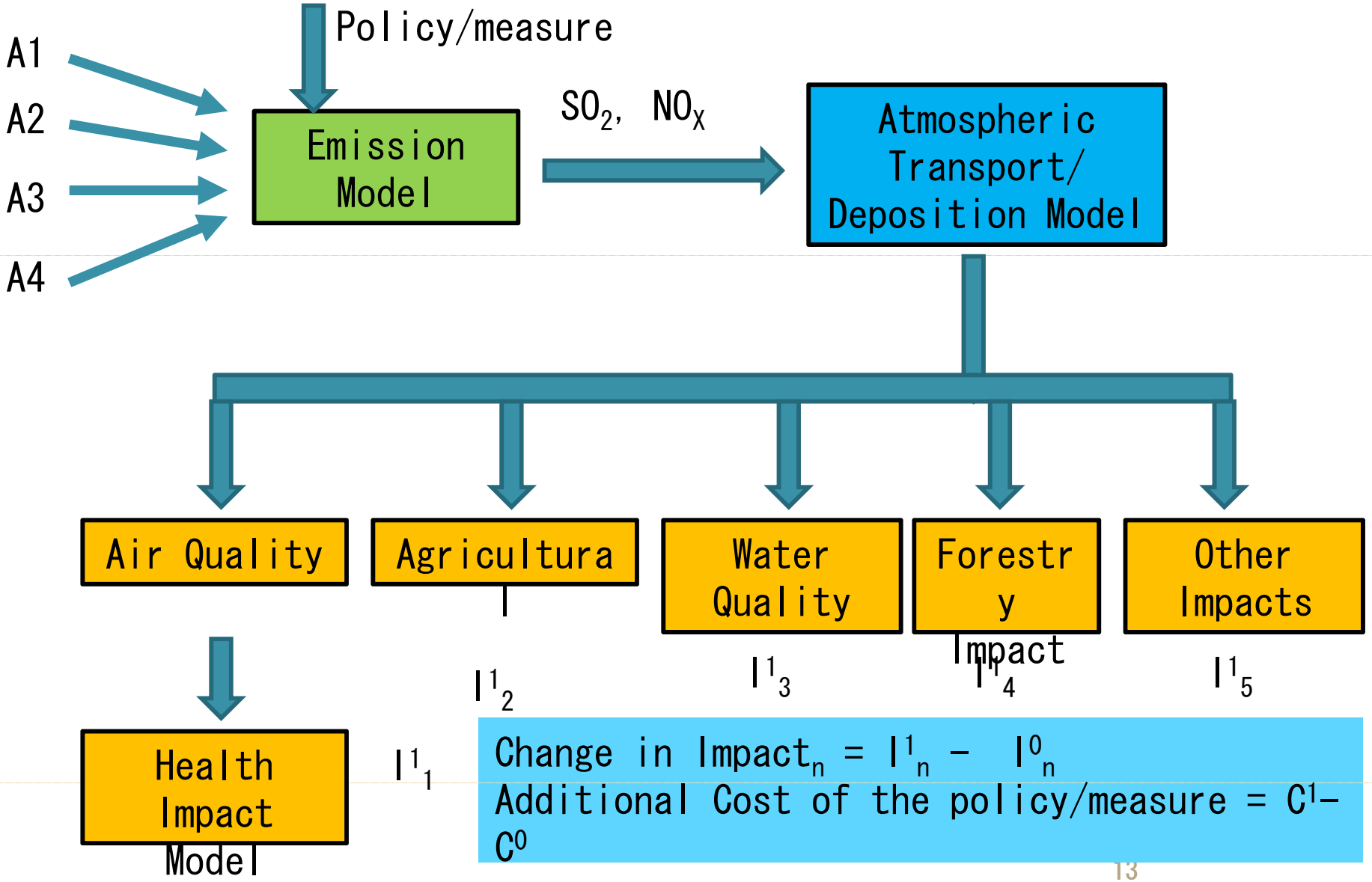
IAM Application: Acid Rain Impact Assesment (1)

Impacts without any control policy/measure



IAM Application: Acid Rain Impact Assesment (2)

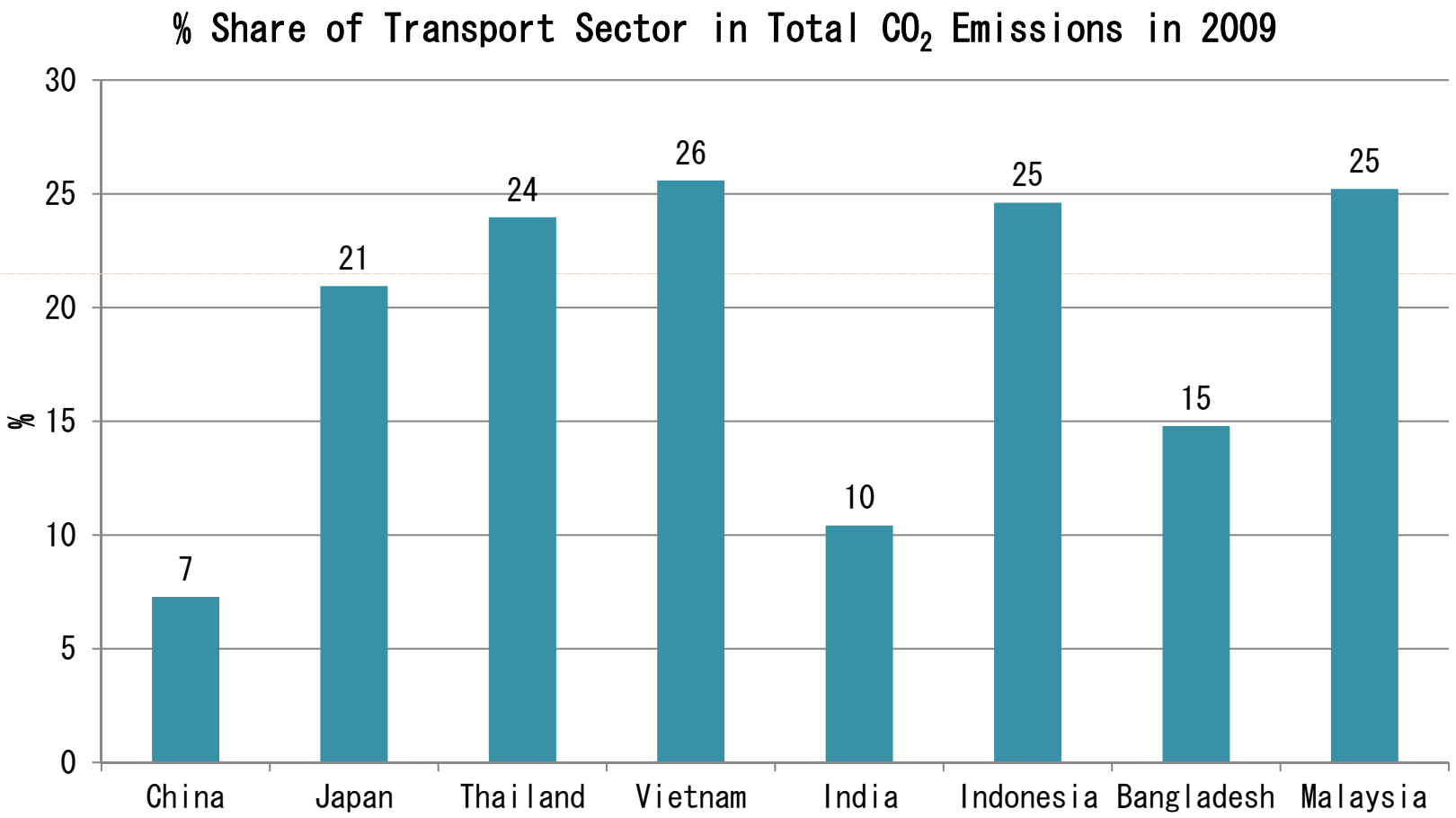
Impacts with a control policy/measure



Some IAM Applications of LCS Policy Analyses:

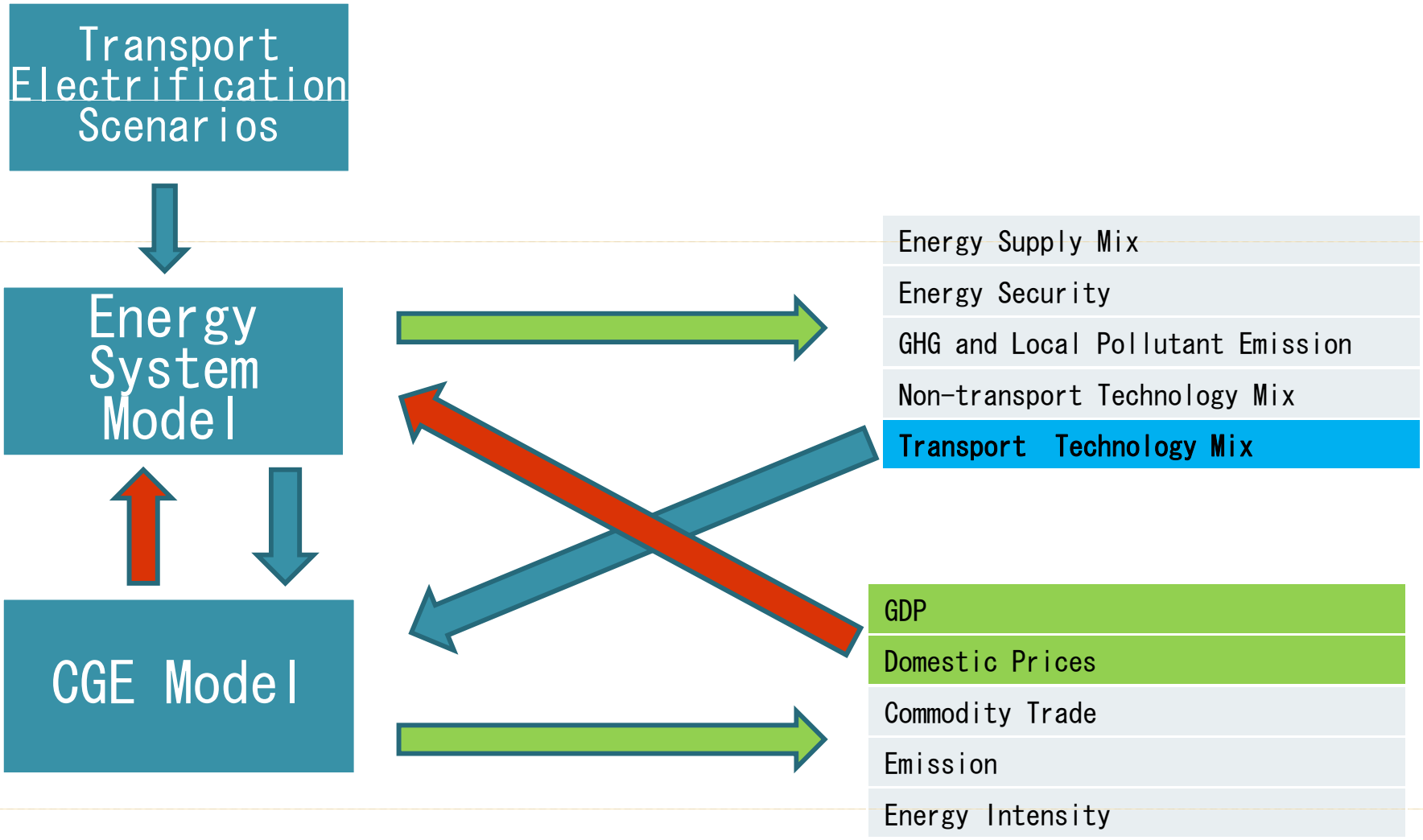
Case of Nepal

Share of Transport Sector in Total CO_2 Emissions in Selected Asian Countries



Source: IEA, 2011

Low carbon transport policy analysis: Case of Nepal



Source: Shakya, Kumar and Shrestha, 2012

~~Low carbon~~ transport policy analysis: Case of Nepal:

Scenario description

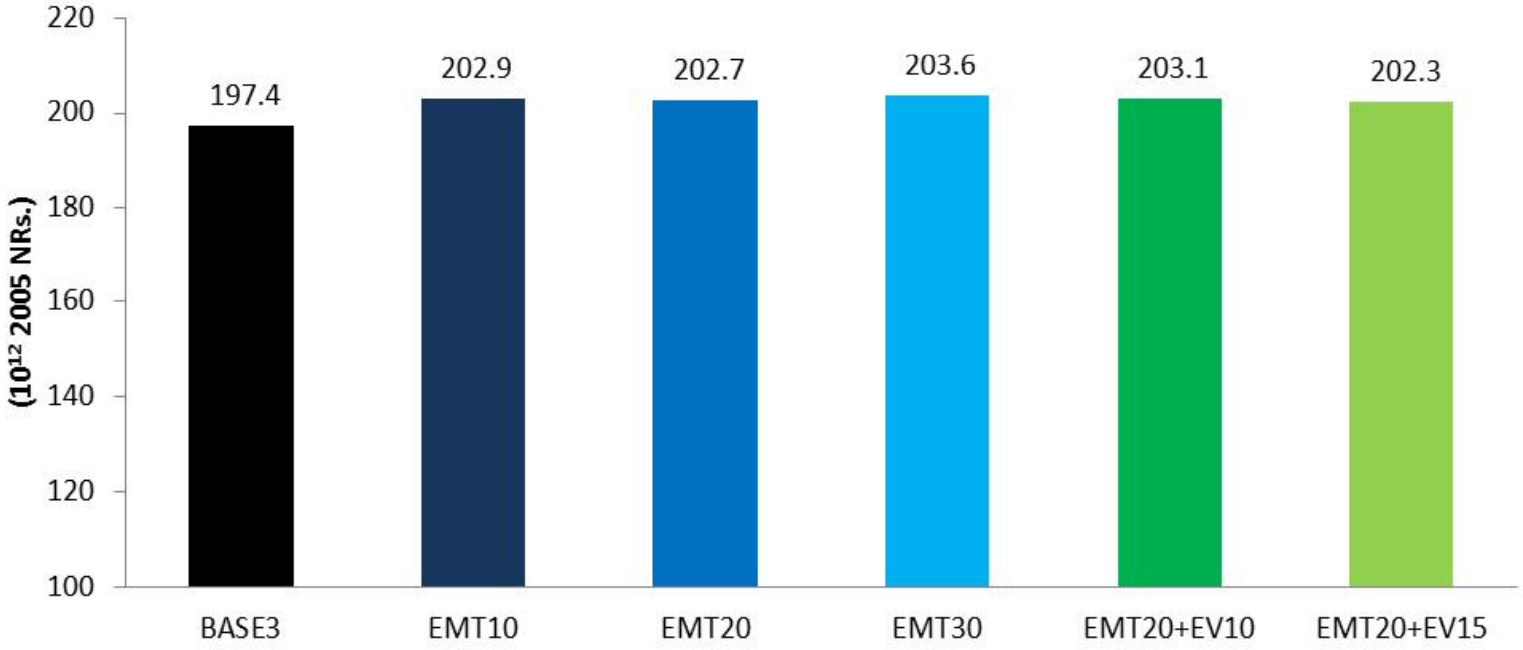
Transport Electrification Scenarios description (up to 35% transport electrification from electric mass transport and electric vehicles)

	Electric Mass Transport		Electric Vehicle	
Scenario	2020	2050	2015	2050
EMT10	10%	10%		
EMT20	10%	20%		
EMT30	10%	30%		
EMT20+EV10	10%	20%	10%	10%
EMT20+EV15	10%	20%	10%	15%

Source: Shakya, Kumar and Shrestha, 2012

Low carbon transport policy analysis: Case of Nepal: Effect on GDP

Figure: Estimated cumulative undiscounted real GDP at 2005 price during 2005–2050



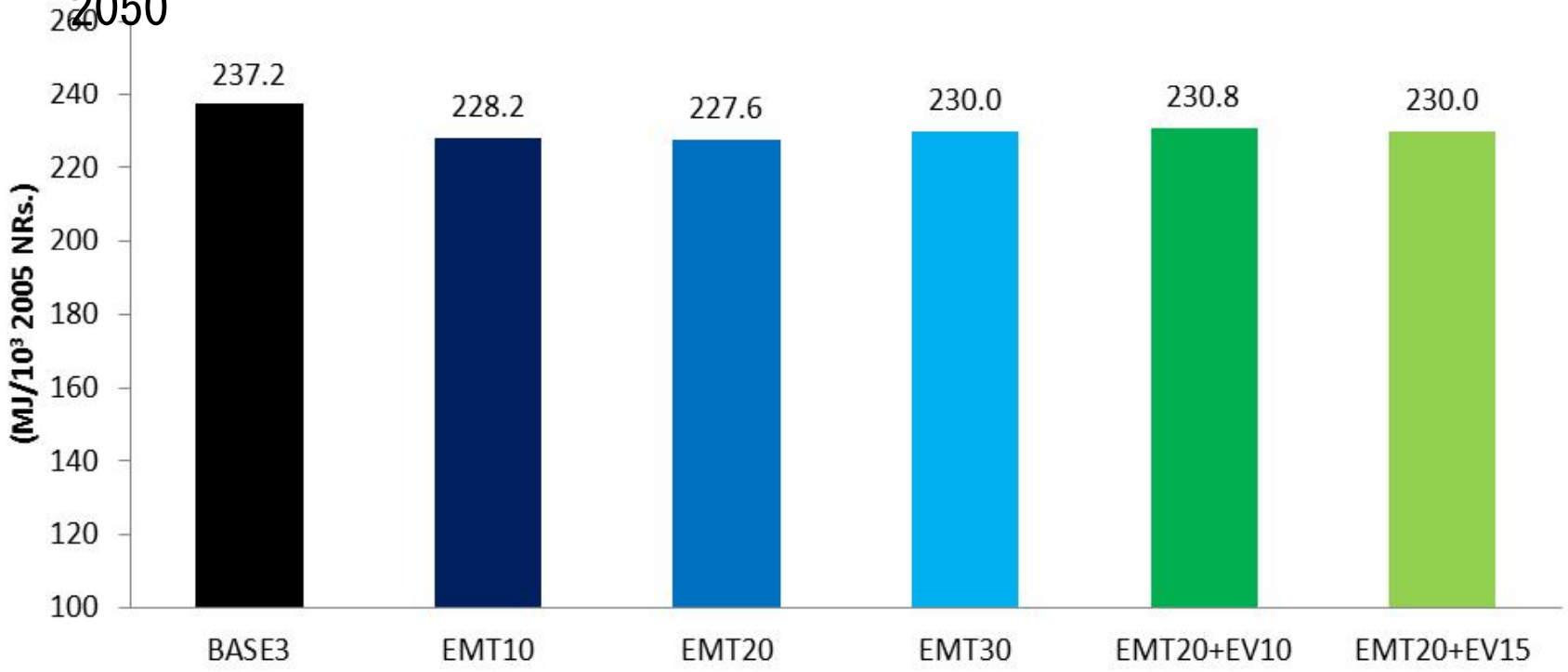
- Increase in cumulative GDP during 2005 to 2050 in the range of 2.5% under EMT20+EV15 to 3.1% under EMT30

Source: Shakya, Kumar and Shrestha, 2012

Low carbon transport policy analysis: Case of Nepal

Effect on Energy Intensity

Estimated average energy intensity of GDP during 2005-2050



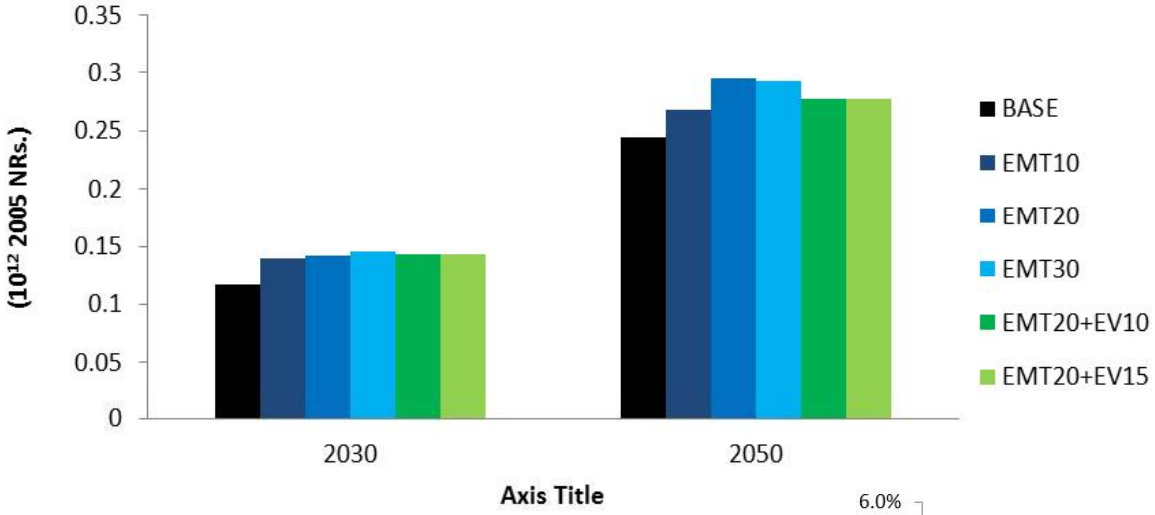
- The average energy intensity of GDP decreases in the range of 2.7% under EMT20+EV10 to 4.1% under EMT20

Source: Shakya, Kumar and Shrestha, 2012

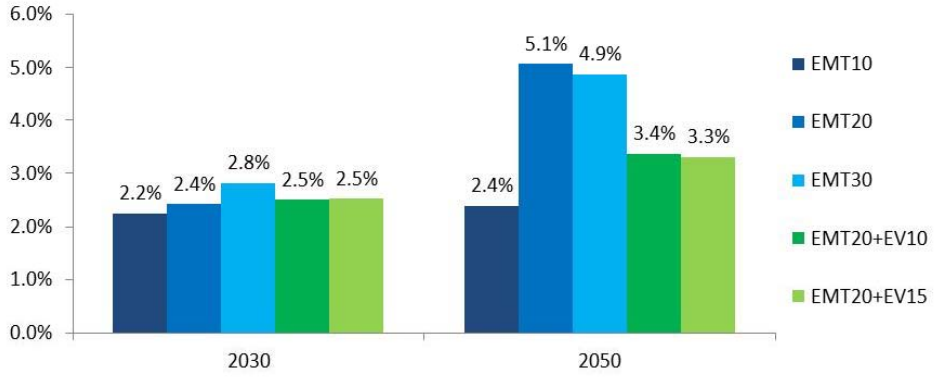
~~Low carbon~~ transport policy analysis: Case of Nepal

Effect on Investment Requirements

Estimated additional investment in transport and electricity sectors



Additional investment in transport and electricity sectors as a % of Base case investment



- Additional investment in transport and electricity sectors (at 2005 prices) in 2050: 2.4% to 5.1%

  Source: Shakya et al. (2012)

LCS Policy Analyses: Case of Thailand

Source: Bundit et al. (2012)

LCS Policy Analyses: Case of Thailand

Scenario Definition

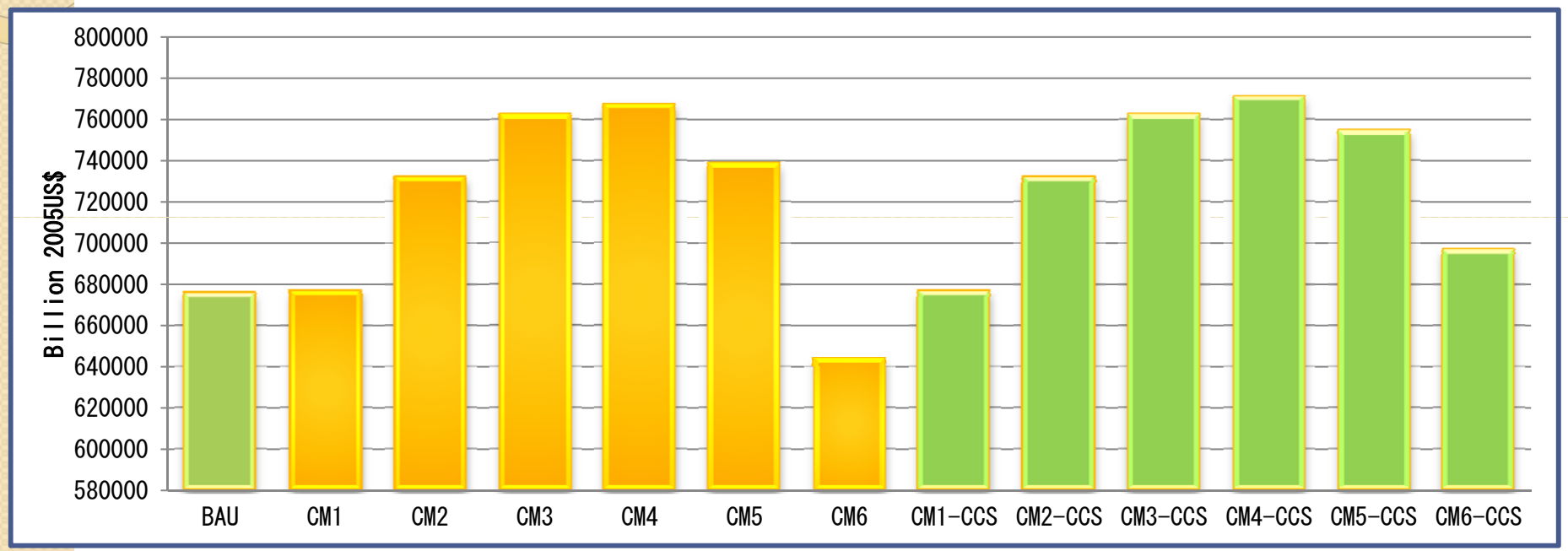
Scenario	GHG mitigation	Emission trading (%)	CCS technology
BAU	Off	Off	Off
CM1	On	Off	Off
CM2	On	On with 20%	Off
CM3	On	On with 40%	Off
CM4	On	On with 60%	Off
CM5	On	On with 80%	Off
CM6	On	On with 100%	Off
CM1-CCS	On	Off	On
CM2-CCS	On	On with 20%	On
CM3-CCS	On	On with 40%	On
CM4-CCS	On	On with 60%	On
CM5-CCS	On	On with 80%	On
CM6-CCS	On	On with 100%	On

A "On" word indicates that the particular option/measure is considered in the scenario, while a 'Off' word shows that the particular option is not considered.

Source: Bundit et al. (2012)

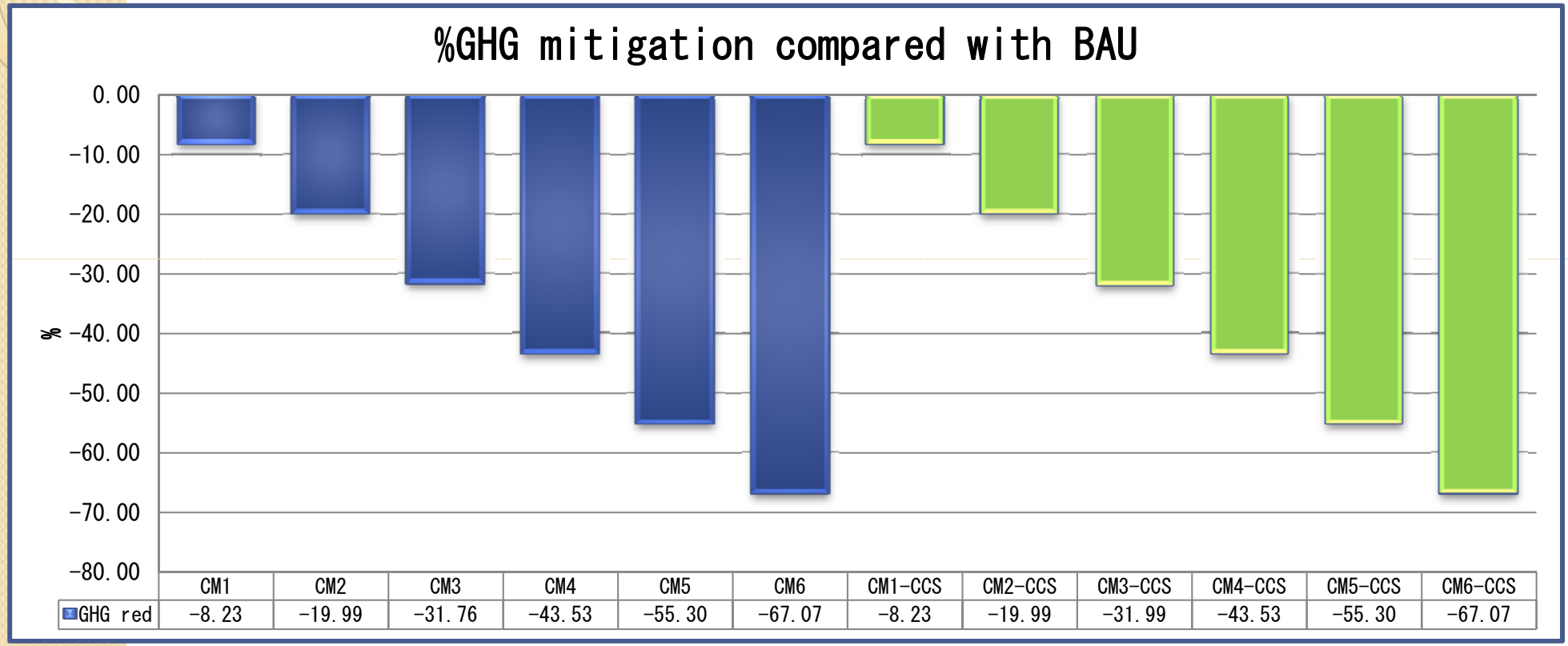
Effect on Gross Domestic Product (GDP): Thailand

GDP due to GHG mitigation policy and counter measures in 2050



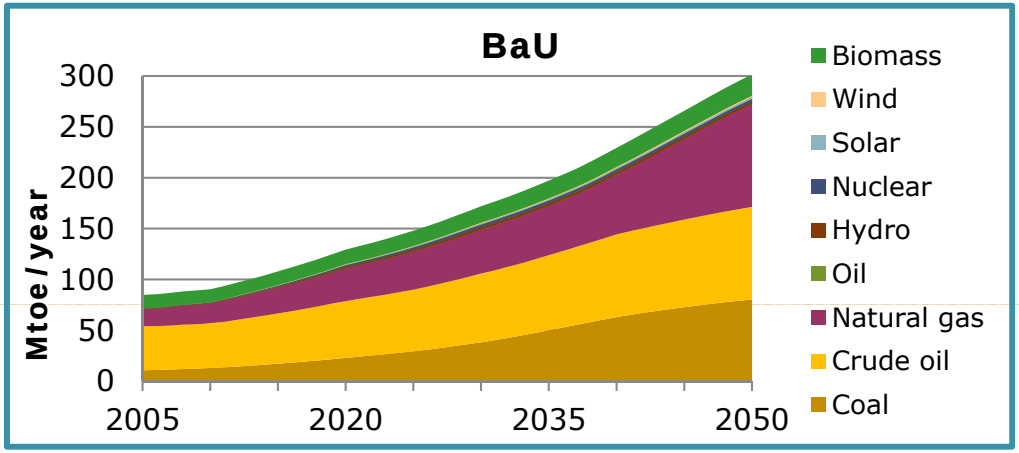
- GDPs would slightly increase (0.13%) in the CM1 and the CM1-CCS scenarios. Both scenarios are not considered on emission trading option.
- Increasing emission trading volume would increase GDP; at 60% emission trading, GDP increases by 11.30% and 12.08% in the CM4 and CM4-CCS scenarios, respectively.
- Source: Bundit et al. (2012)

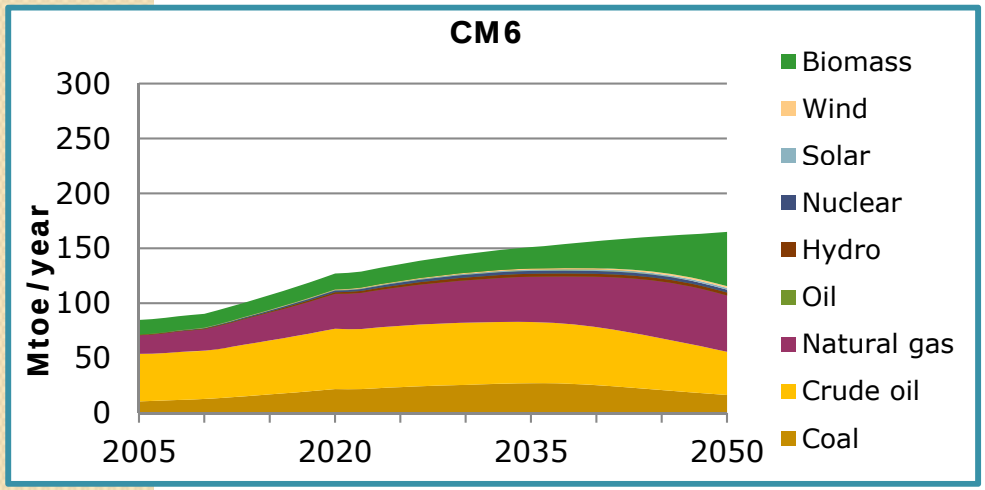
GHG emissions in 2050: Thailand

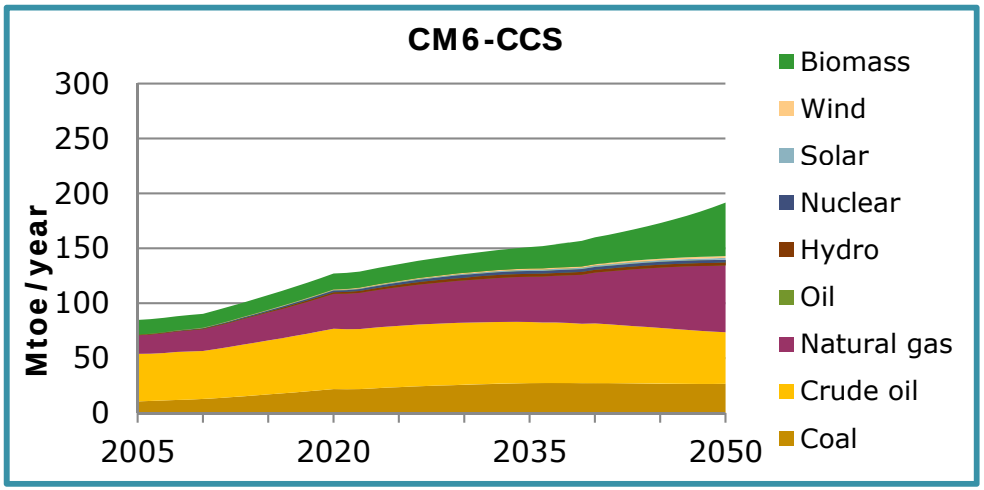


Source: Bundit et al. (2012)

Total Primary Energy Supply: Thailand



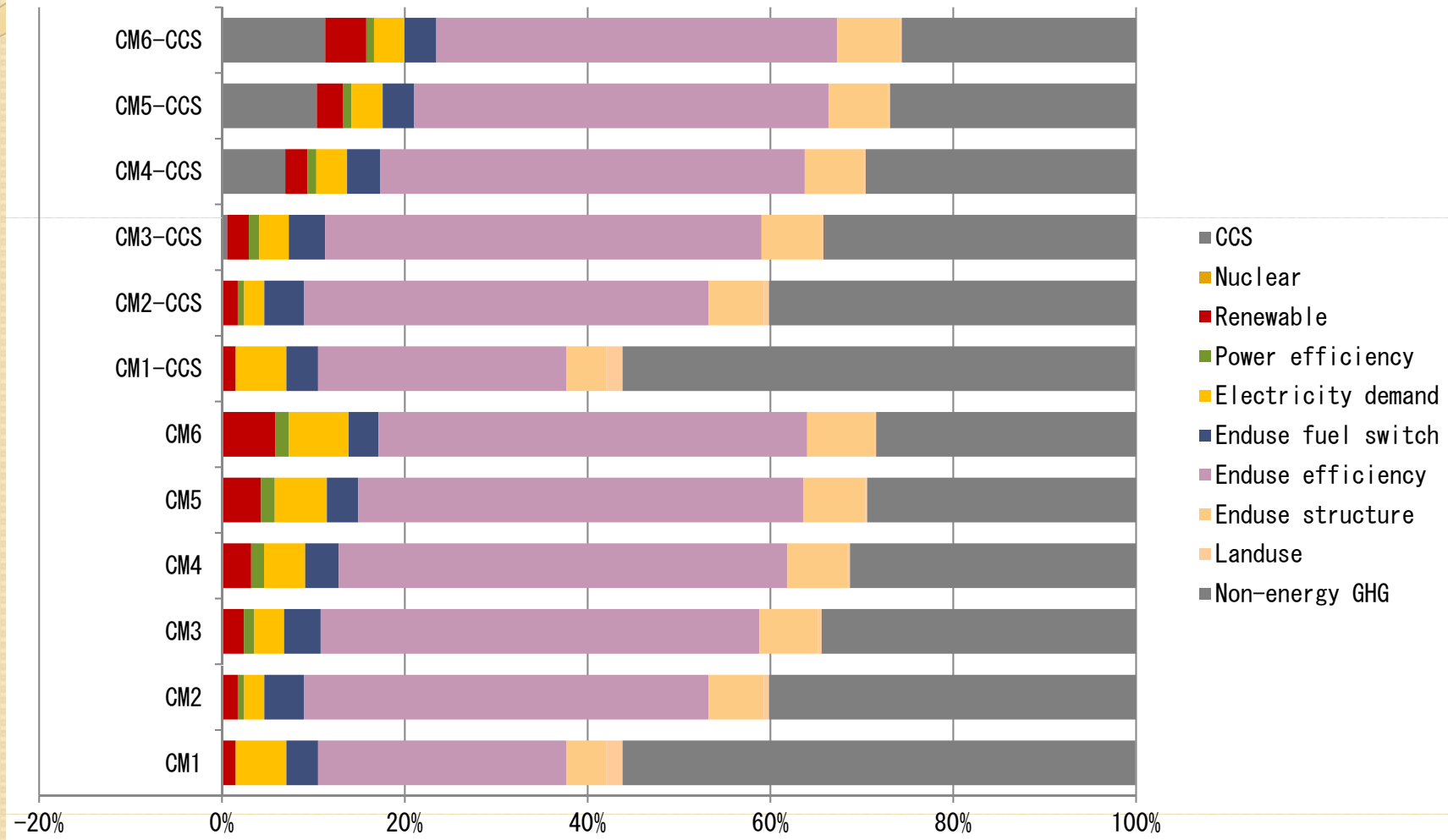




❖ In the CM6 and CM6-CCS scenarios, TPES is 163 and 192 Mtoe; i.e., 48.4% and 36.5% reduction from the BAU scenario, respectively.

Source: Bundit et al. (2012)

Structure of GHG Reduction: Thailand



Source: Bundit et al. (2012)

IAMs Applications for LCS Policy Analyses: A Case of Japan

Carbon Reduction Potential and Economic Impacts in Japan (1)

- Climate Policies analyzed: (a) Carbon tax, (b) carbon tax plus subsidy on energy saving investments
- Issue analyzed:
  - How big should be the carbon tax to meet the GHG reduction target related to energy consumption to meet the obligation under the Kyoto Protocol in the First Commitment period?
  - What would be the GDP loss due to carbon tax?
- Models used: AIM/Enduse, AIM/CGE (Global), AIM/Material

Source: Masui et al., 2004

Carbon Reduction Potential and Economic Impacts in Japan (2)

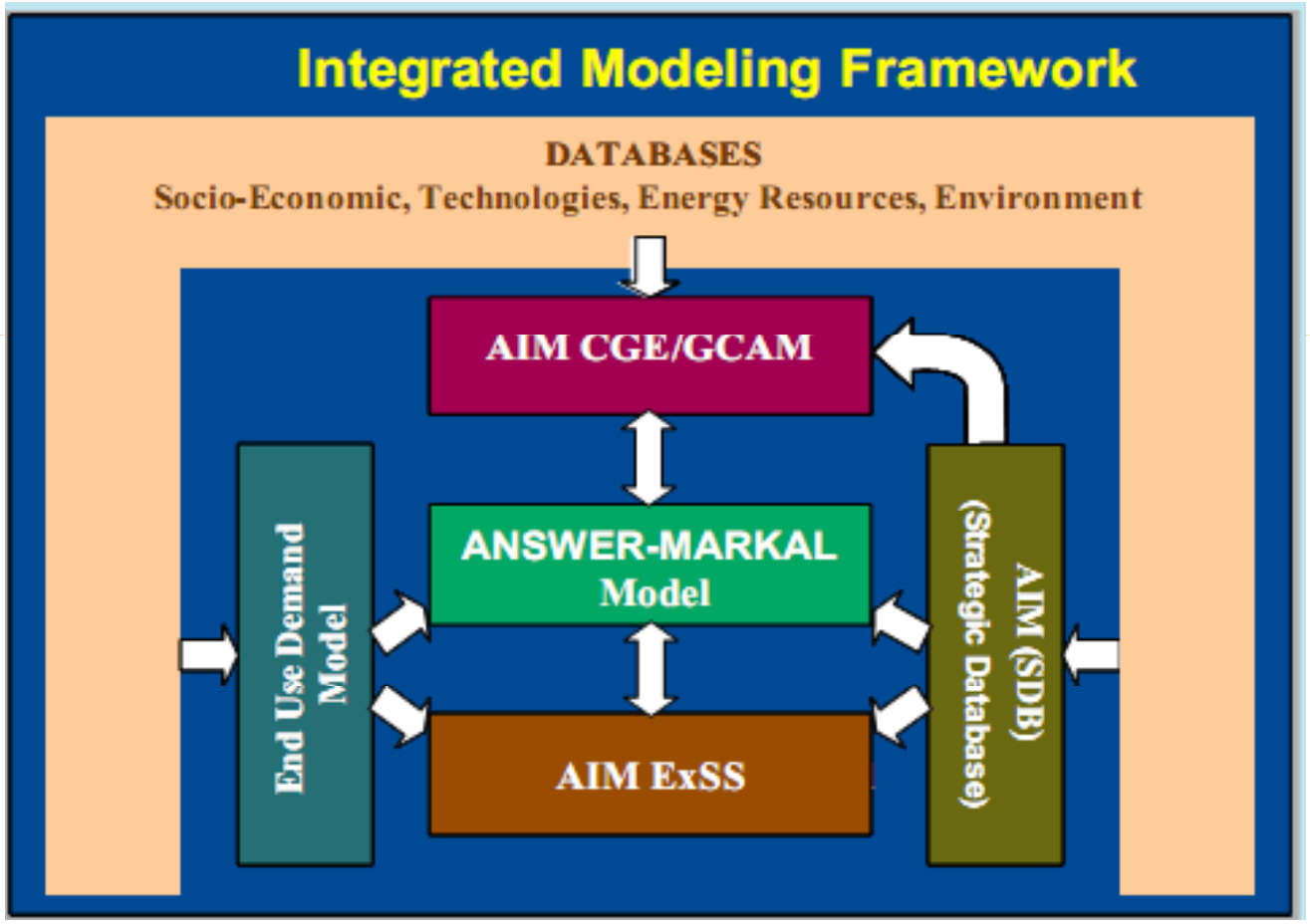
- Findings:

1. If only carbon tax is used to reduce carbon emission, the carbon tax required to achieve the target would be about 45,000 Japanese yen/tC in the First commitment period of the Kyoto Protocol.
2. If the carbon tax revenue is utilized to subsidize CO2 reduction countermeasures (i.e., energy saving investment) (Carbon tax + subsidy case), the carbon tax rate needed to achieve the target would be much smaller (about 3,400 Japanese yen/tC).
3. The GDP loss in Japan by introducing the carbon tax and subsidy policy would be 0.061% compared to the GDP in the reference scenario in the first commitment period.

Source: Masui et al., 2004

IAM Application for LCS Policy Analyses: A Case of India

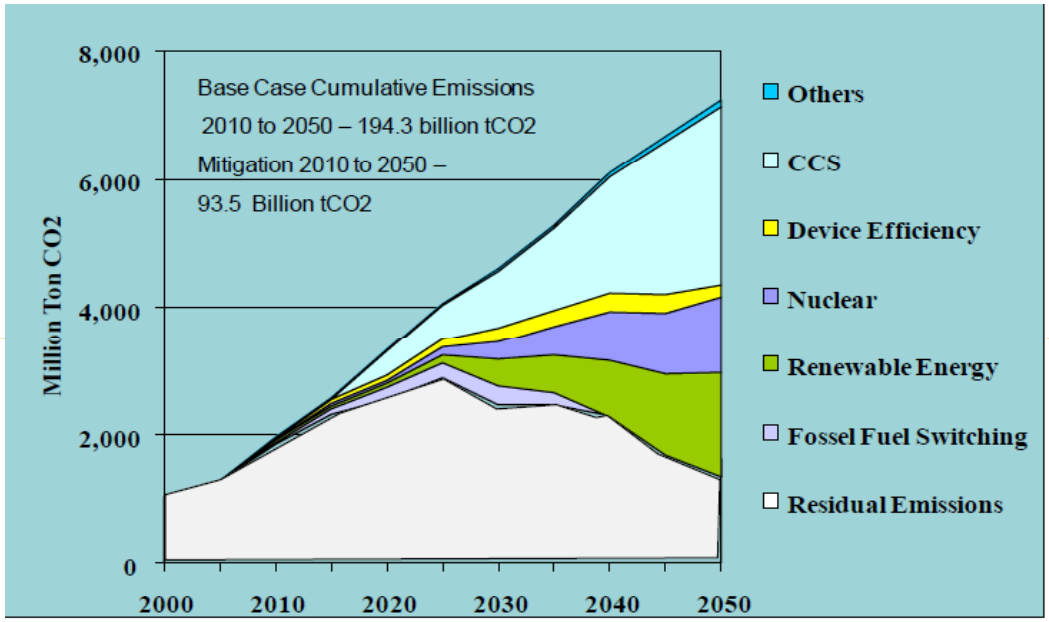
Integrated Assessment of Low Carbon Strategies for India (1)



The framework contains a top down model (AIM CGE) which is soft linked with a bottom-up model (ANSWER MARKAL) which in turn is soft linked to AIM SNAPSHOT model.

Source: IIMA,

Integrated Assessment of Low Carbon Strategies for India (2)



Mitigation Options in Carbon Tax Scenario

- Carbon tax pathway assumes carbon price that aligns India's emissions to an optimal 450 ppmv CO2e stabilization global response.
- Total CO2 mitigation of 93.5 billion tCO2 for the 450 ppmv CO2e stabilization scenario achieved through extensive use of advance technologies like CCS and nuclear energy predominantly on the supply side.
- CO2 reduction primarily due to decoupling energy and carbon; actual energy consumption increases as compared to the base case

Source: IIMA,

Integrated Assessment of Low Carbon Strategies for India (1): Final Energy Demand in 2050 vs. 2005

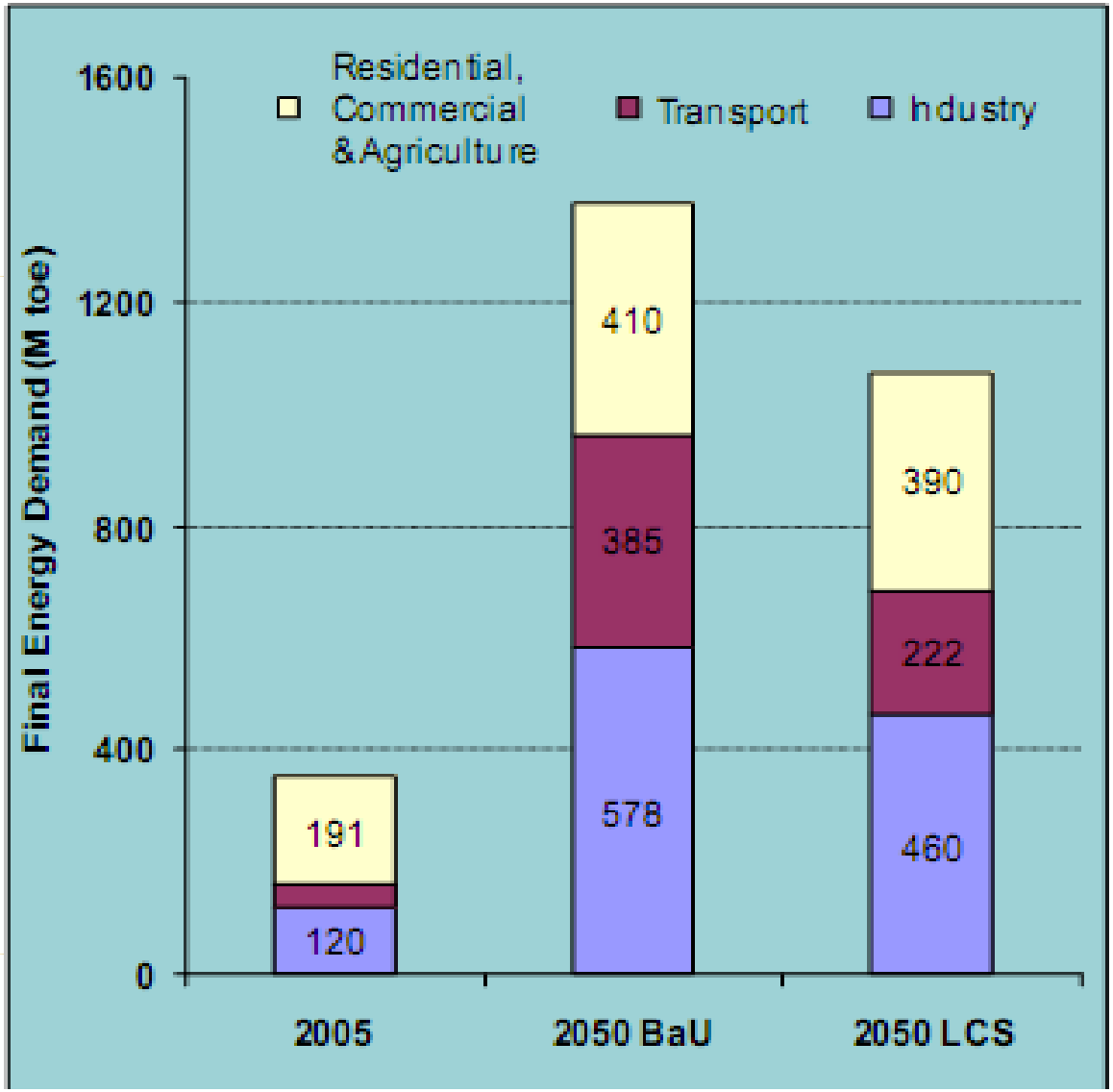
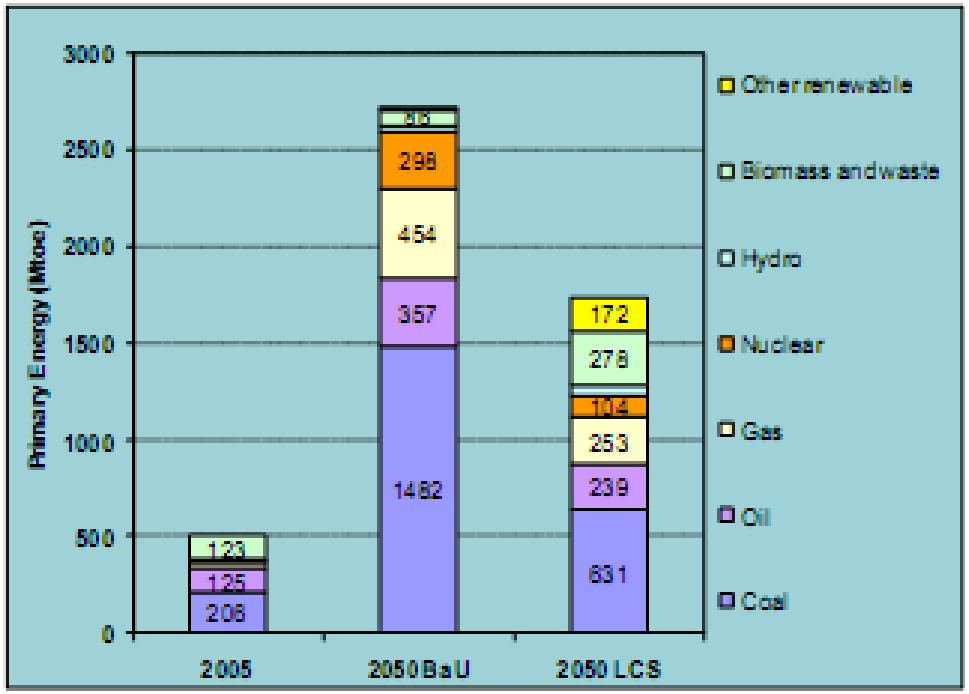


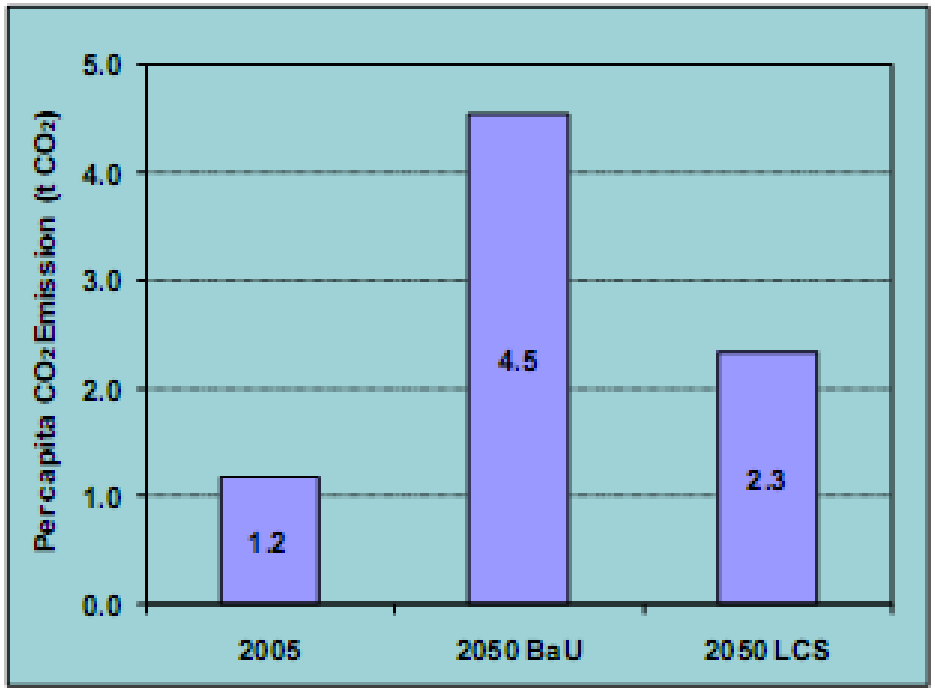
Figure:

Source: IIM,

Integrated Assessment of Low Carbon Strategies for India (3):



Primary Energy Demand



GHG Emissions per Capita

Source: IIM,

Strengths and limitations/constraints of Integrated Assessment Models (IAMs)

- Main strength of IAMs:
  - Their ability to calculate the consequences of different assumptions and to interrelate several factors simultaneously.
- IAMs – not predictive models
- Issues of uncertainties in data inputs and results
- IAMs often constrained by the quality and character of the assumptions and data used.
  - "A model is only as good as its

Thank You

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