Incorporating Non-CO_2 Gases and Agriculture Land Use Issues in MiniCAM

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UNIVERSITY OF MARYLAND

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Energy Research Institute

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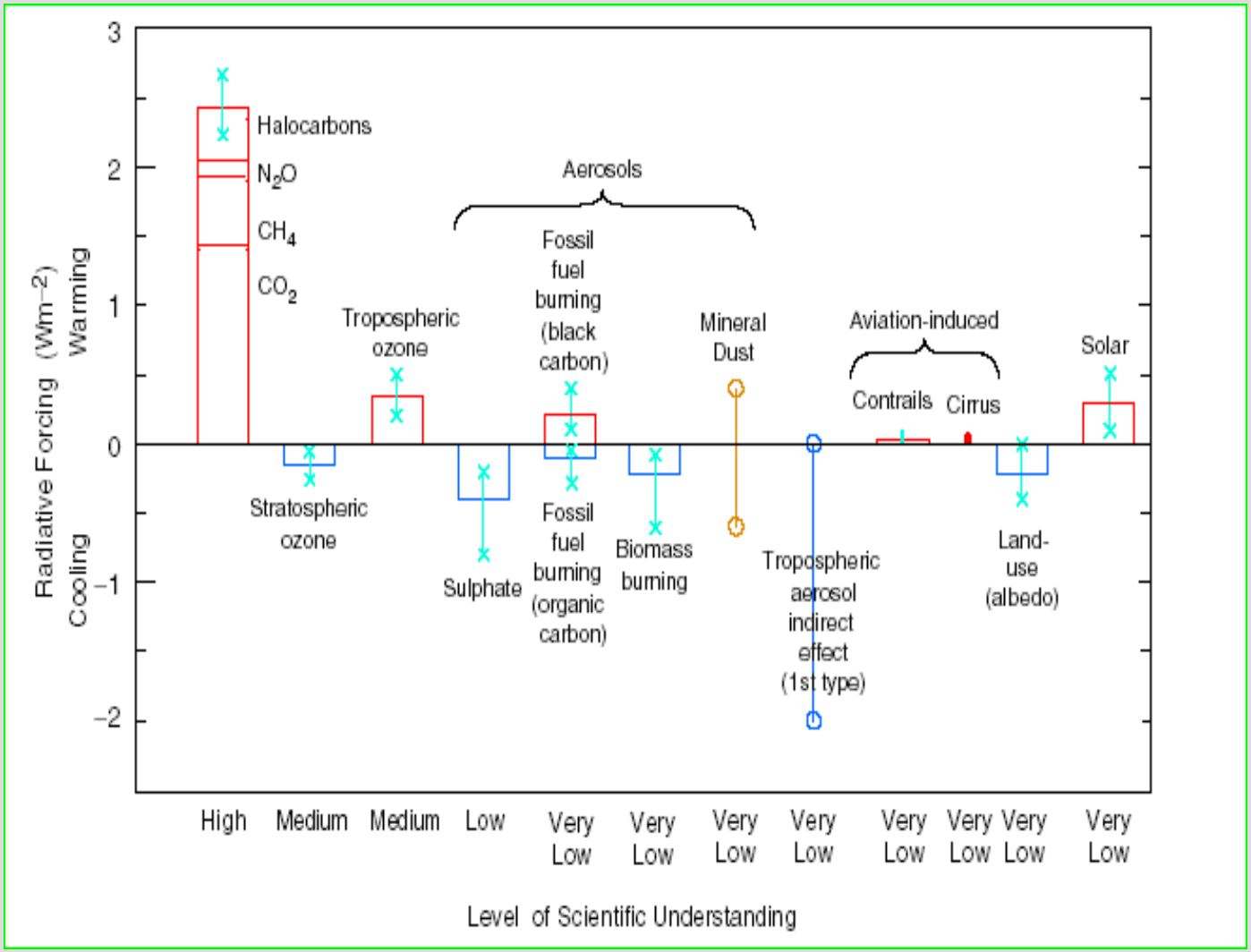
Major Points

Land-use and non-CO_2 greenhouse gas emissions are important.

- They are a major component shaping present and potential future radiative forcing.
- Non-CO_2 greenhouse gases have the potential to dramatically lower the cost of stabilizing net radiative forcing.
- Land-use emissions are driven by demand for land to provide human services such as agronomy.
- Stabilization of greenhouse gas concentrations have important feedbacks to land-use and land-use emissions.

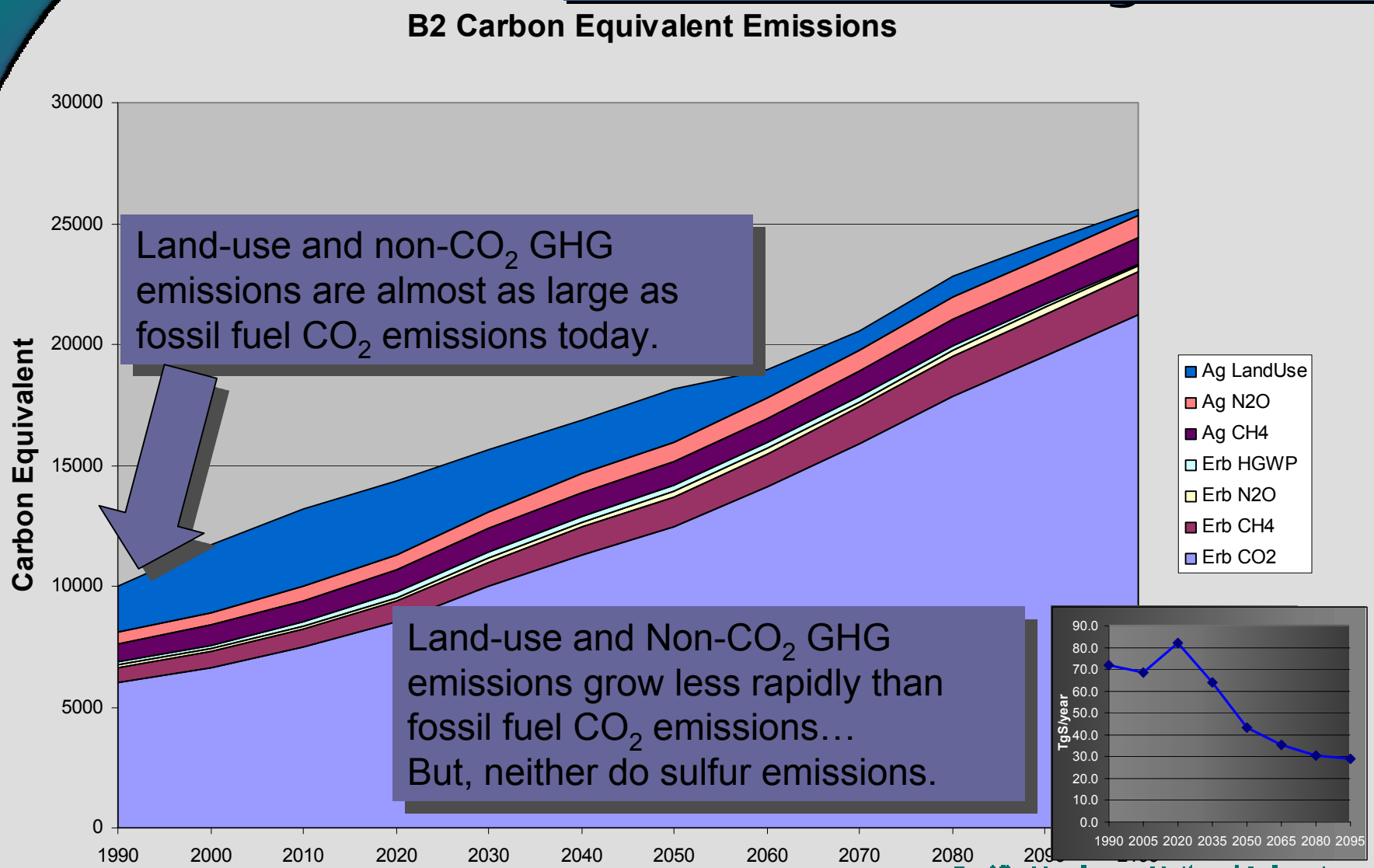
Why Land-use and Non-CO_2 GHGs?

Taken together, land-use and non-CO_2 GHG emissions are almost as large as fossil fuel CO_2 emissions today.



Global, annual-mean radiative forcings (Wm-2) due to a number of agents for the period from pre-industrial (1750) to present (late 1990s; about 2000) IPCC, WG1 TAR, Technical Summary, Page 37.

Land-Use and Non-CO_2 GHG Emissions Are Significant



Land-use and non-CO_2 GHG emissions are almost as large as fossil fuel CO_2 emissions today.

Land-use and Non-CO_2 GHG emissions grow less rapidly than fossil fuel CO_2 emissions…
But, neither do sulfur emissions.

Land-use and Non-CO_2 GHGs in MiniCAM

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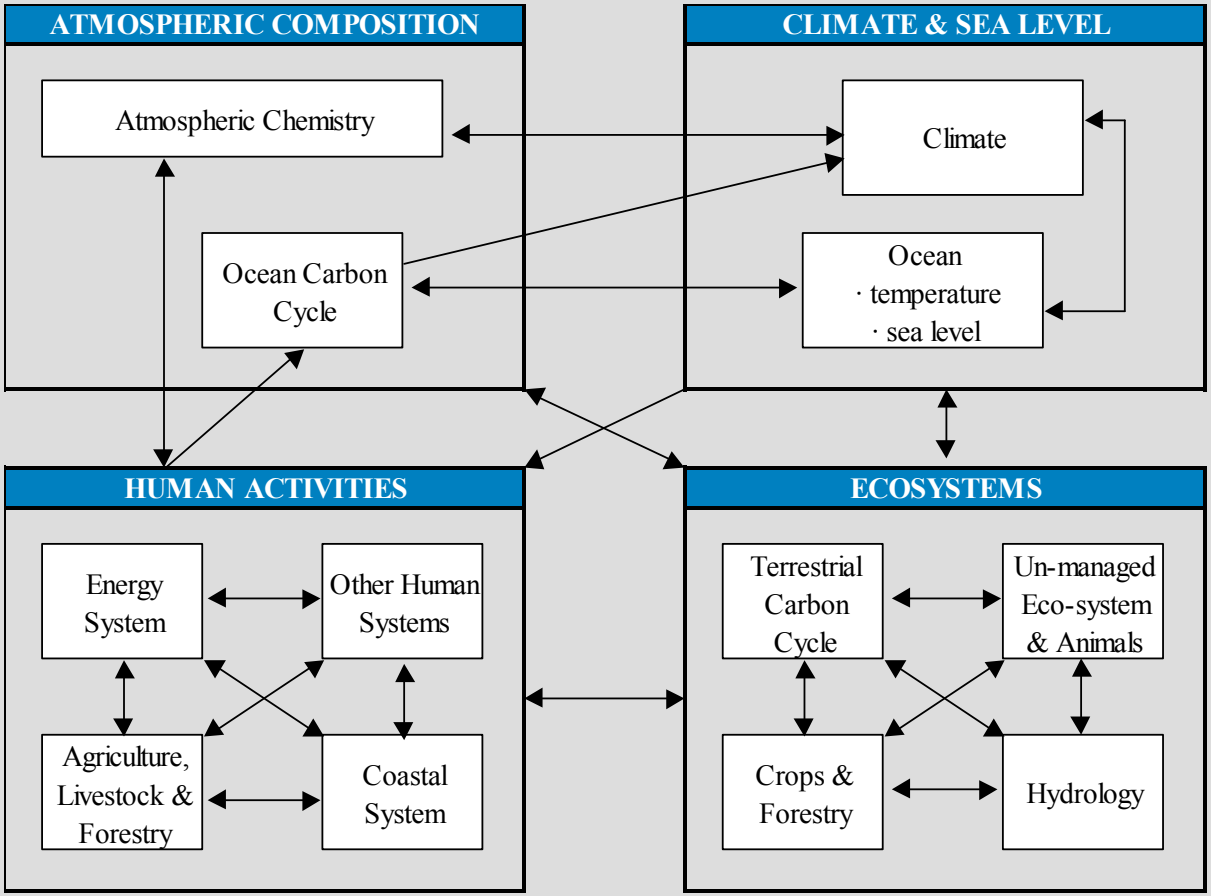
ATMOSPHERIC COMPOSITION
Atmospheric Chemistry
Ocean Carbon Cycle
CLIMATE & SEA LEVEL
Climate
Ocean
· temperature
· sea level
HUMAN ACTIVITIES
Energy System
Other Human Systems
Agriculture, Livestock & Forestry
Coastal System
ECOSYSTEMS
Terrestrial Carbon Cycle
Un-managed Eco-system & Animals
Crops & Forestry
Hydrology

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Key Characteristics

- Energy-agriculture-economy market equilibrium
- 17 global regions
- 15-year time steps
- Multiple greenhouse gases
- Internally generated demographics
- Land resource constraints
- **70+ energy technology options**

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MiniCAM Regions

1. **US**
2. Canada
3. W. Europe
4. Australia & New Zealand
5. Japan
6. Eastern Europe
7. Former Soviet Union
8. **China**
9. Mid-East
10. Africa
11. Latin America
12. **Korea**
13. Southeast Asia
14. India
15. *Mexico*
16. *Argentina*
17. *Brazil*

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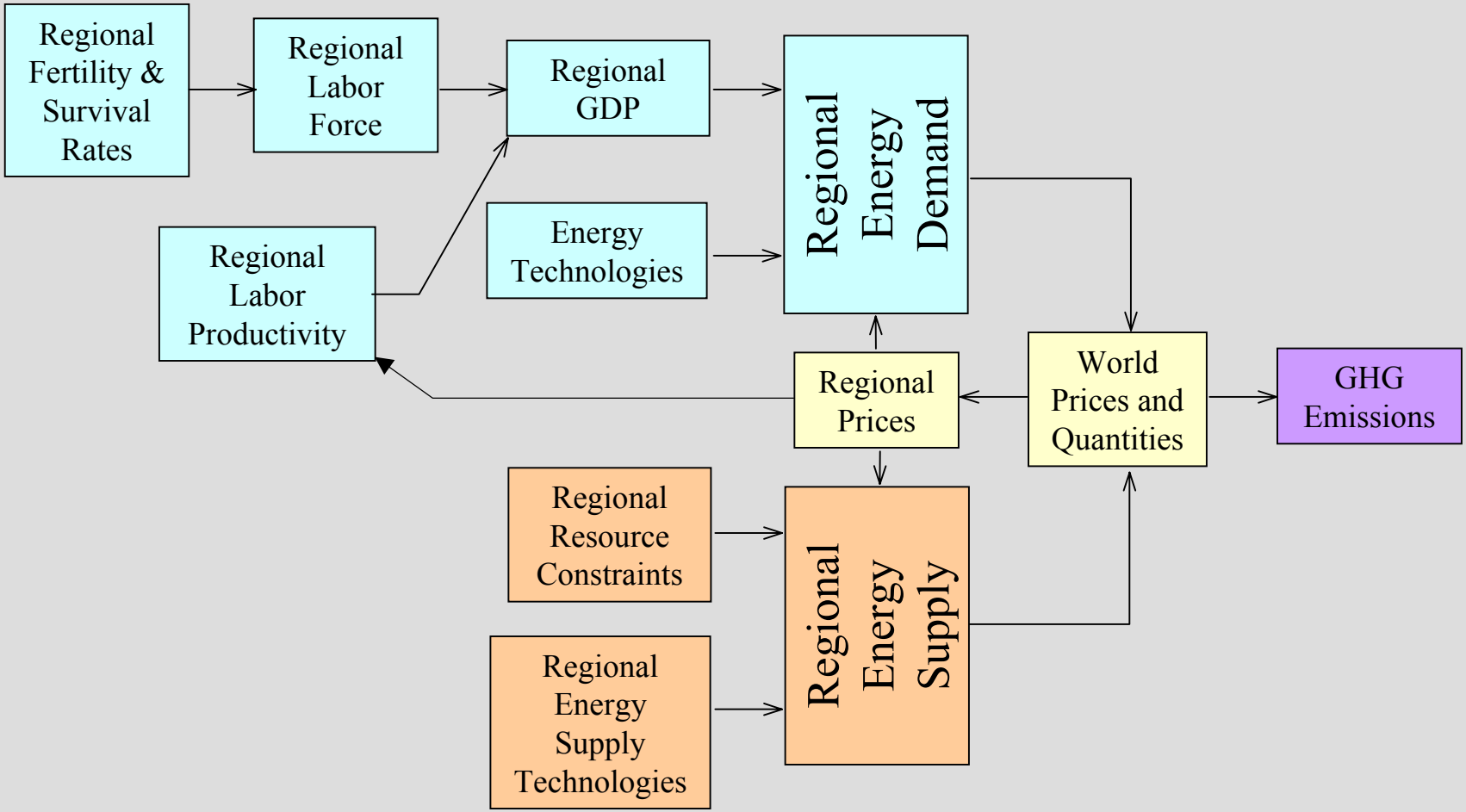
Regional Fertility & Survival Rates
Regional Labor Force
Regional GDP
Regional Energy Demand
Regional Labor Productivity
Energy Technologies
Regional Prices
World Prices and Quantities
GHG Emissions
Regional Resource Constraints
Regional Energy Supply
Regional Energy Supply Technologies

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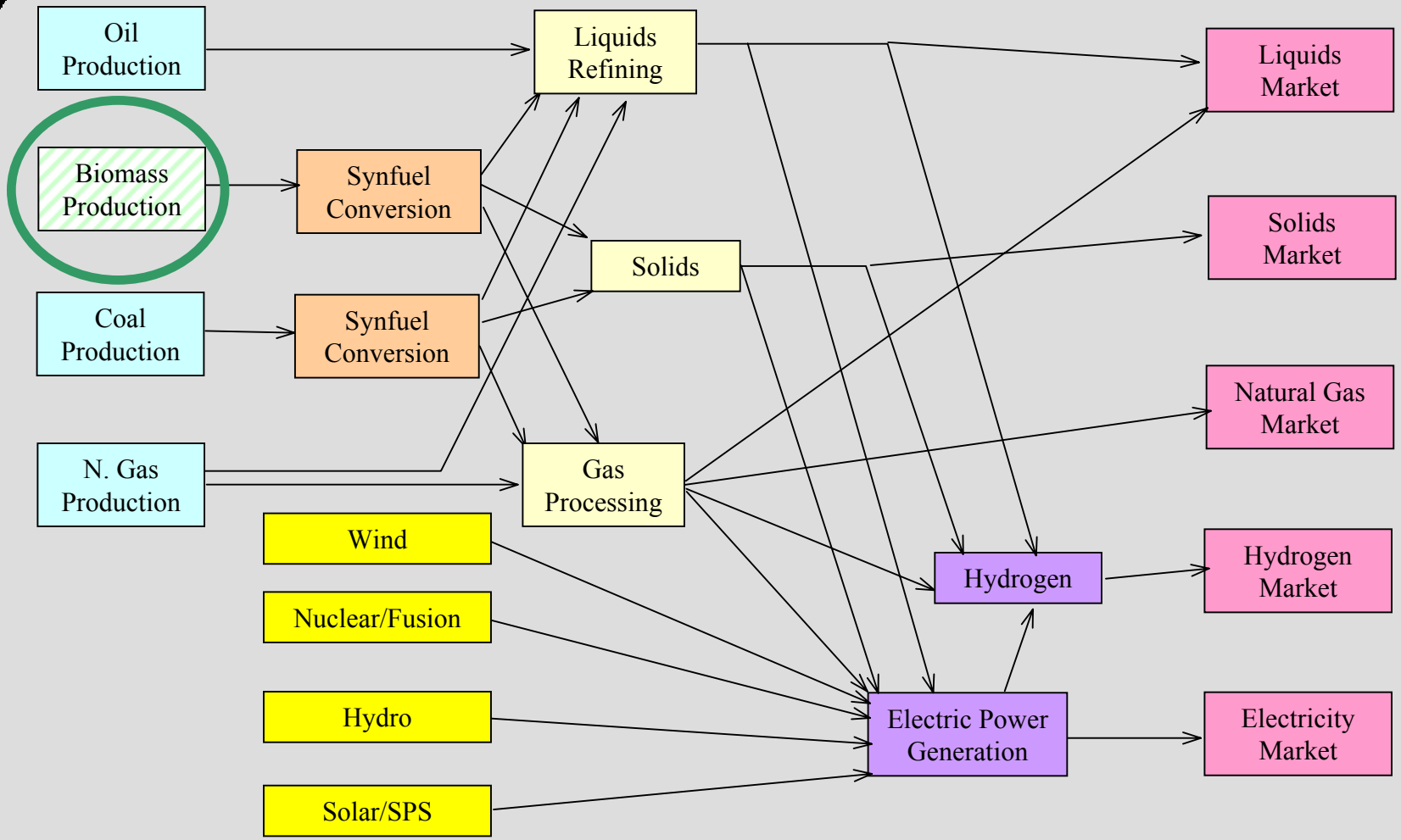

energy system

Non-CO_2 GHGs

Emissions Methodology

Emissions = **Em_factor** • Driver • **(1 – Control(GDP/Cap))** • (1 – **MAC(C_Price)**) • (**1 – USER(T)**)

Where

Em_factor = Emissions Factor. Either input by technology, or derived from input base-year emissions. All CH4 and N2O emissions factors are currently derived by the model directly from base-year emissions data.

Control(GDP/Cap) = Emissions controls due to non-climate policy (*e.g.*, SO2 or NOx)

MAC(C_Price) = Emissions controls due to non-climate policy as a function of the price of carbon (or GHG) using Marginal Abatement Curves (MACs). MAC's adapted from EPA studies.

USER(T) = User-defined reductions in emissions intensity over time.

MiniCAM Emissions Drivers

Source	Emissions Driver
Methane	
Enteric Fermentation	Livestock Production
Animal Waste	Livestock Production
Rice Cultivation	Rice Production
Stationary	Traditional biomass
Mobile	Transportation oil
Coal Mining	<production, consumption>
Natural Gas	Gas production + consumption
Petroleum Systems	Oil production
Landfills	Function based on historical relationships between income, waste-generation rates, and land-filling rates
Nitrous Oxide	
Fertilizer	Crop Production
Manure	Livestock Production
Stationary	Coal electric
Mobile	Transportation oil
Adipic Acid	GDP

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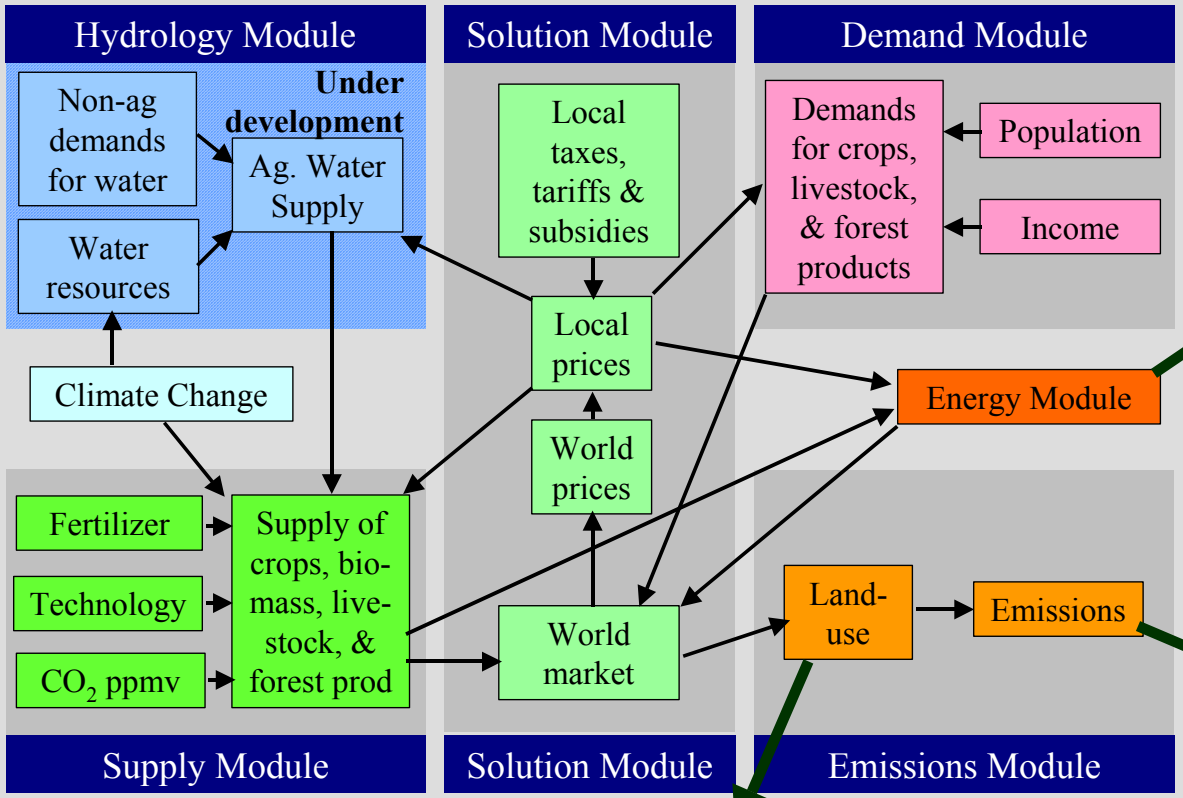

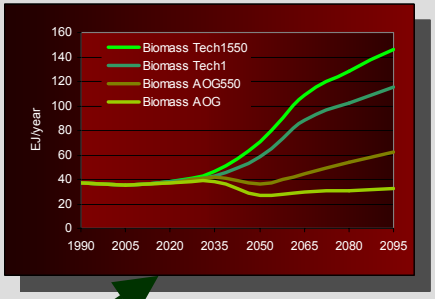

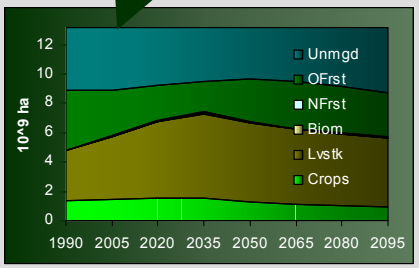

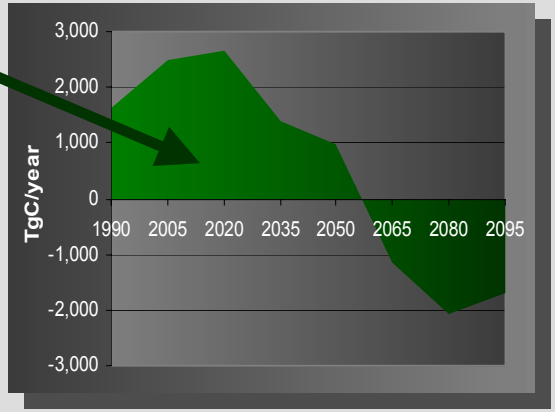

agriculture-land-use

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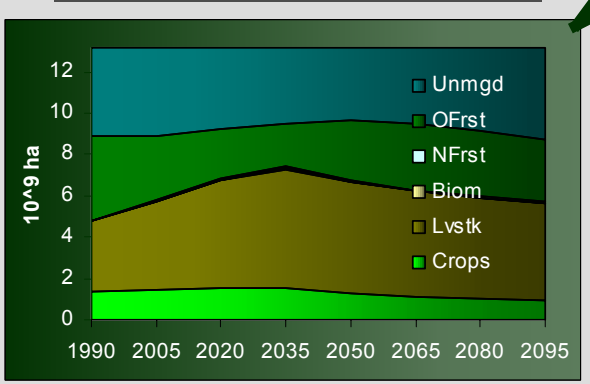
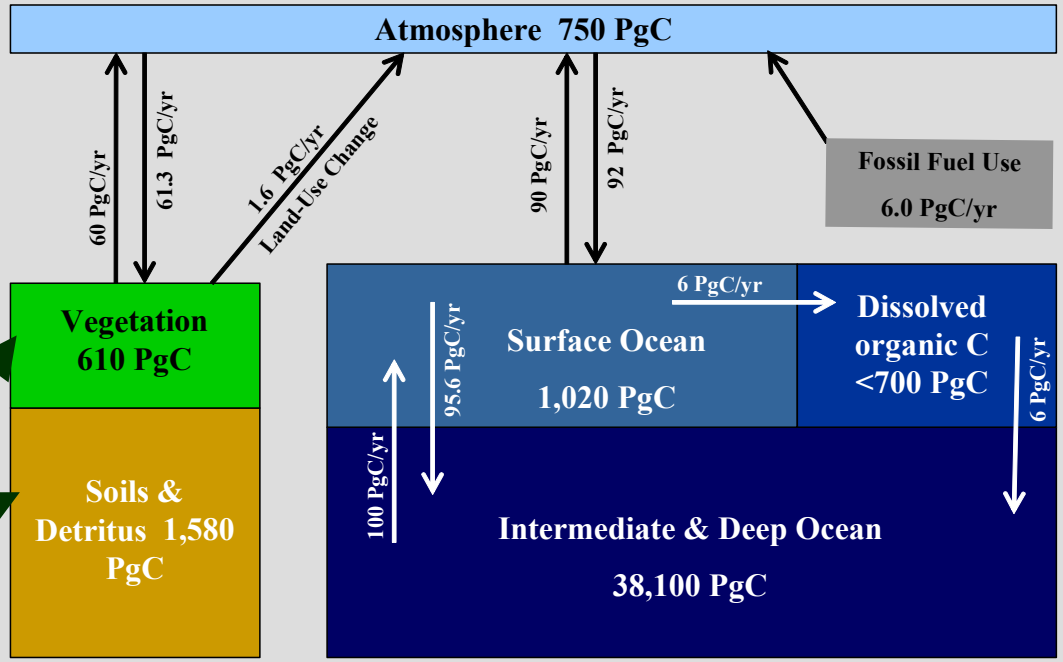
LAND-USE EMISSIONS

Changes in regional land uses alter carbon stocks, and generate emissions.

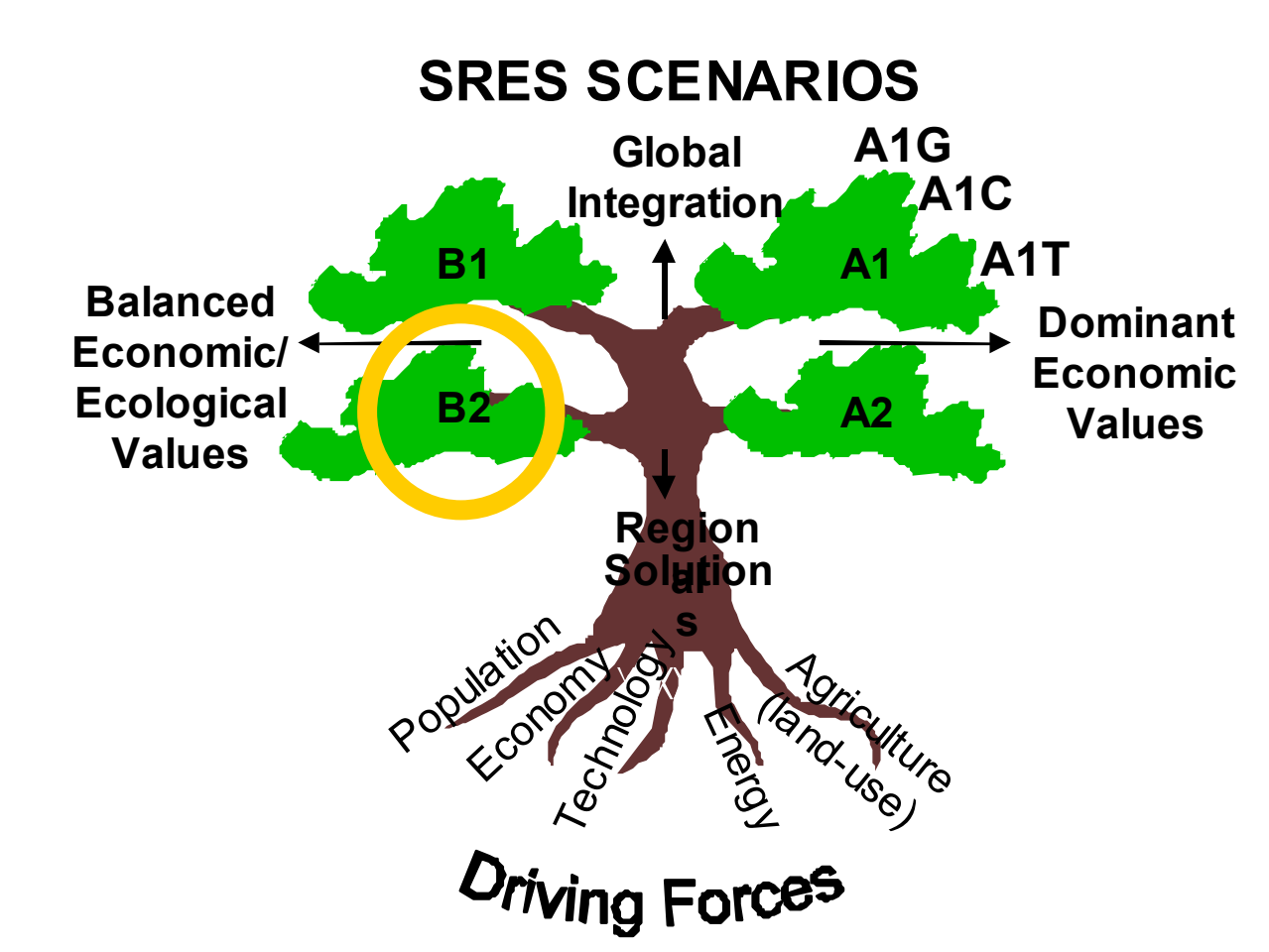




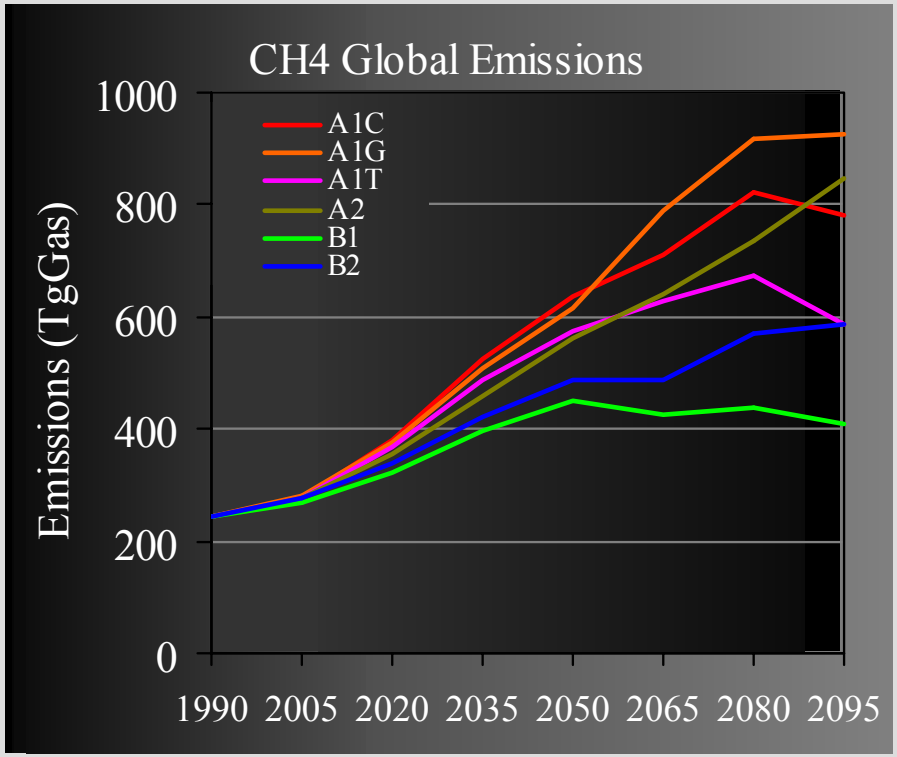
Non-CO_2 Greenhouse Gases

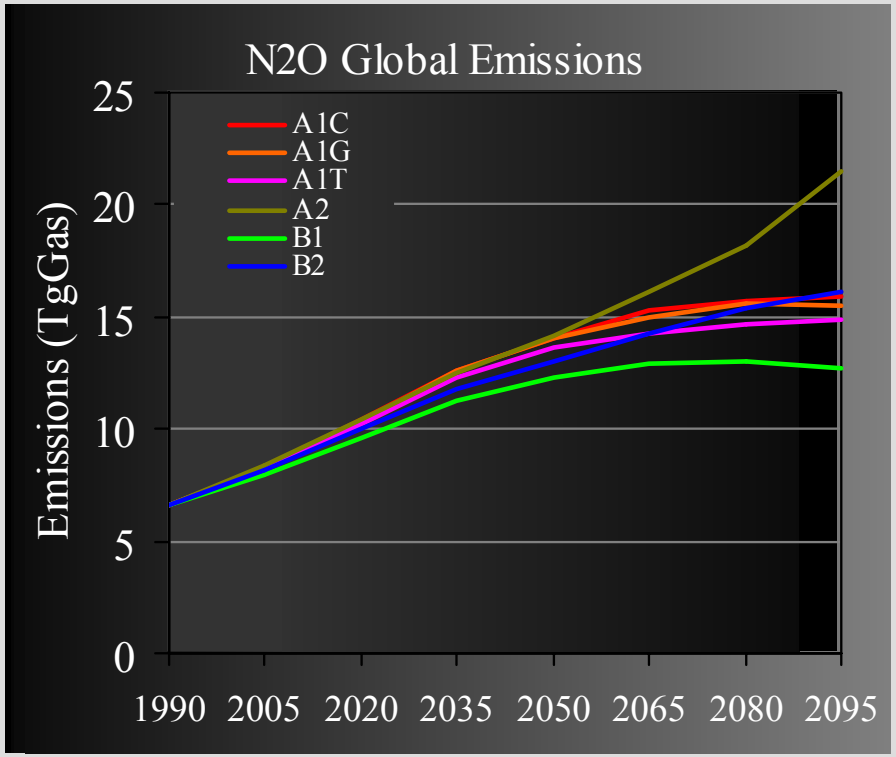
Reference CO_2 Emissions

Using the IPCC SRES scenarios … B2

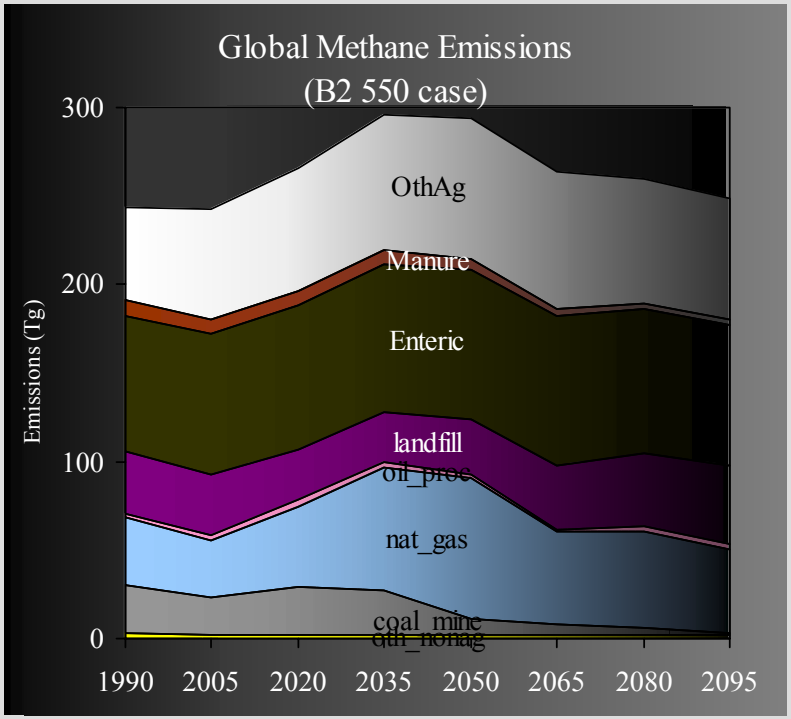


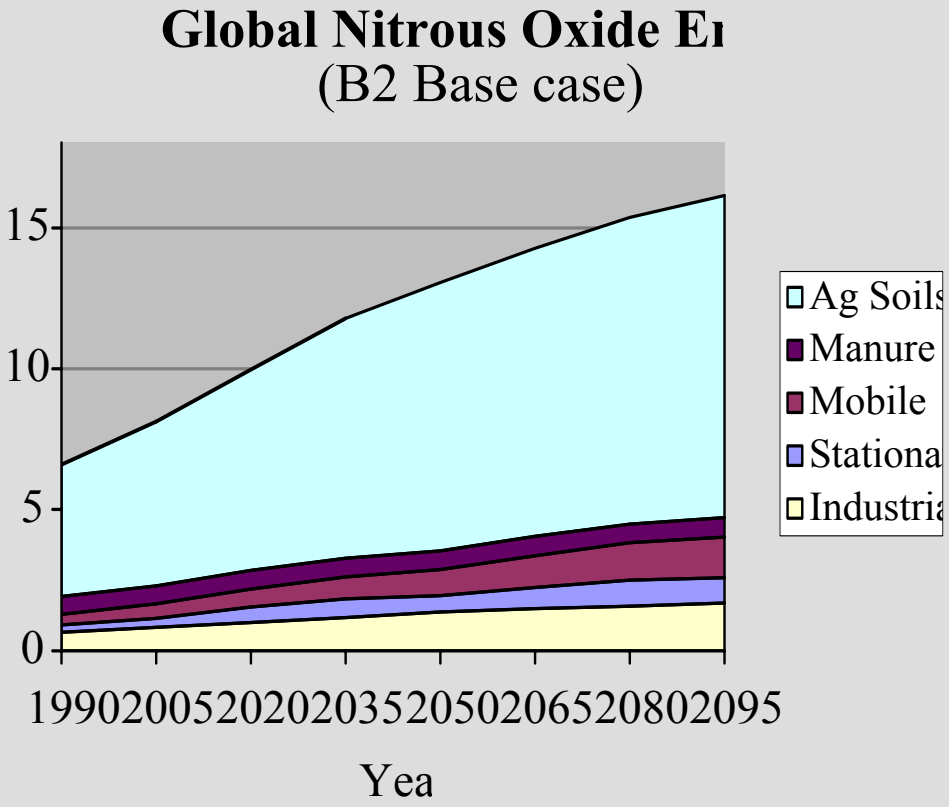
MiniCAM SRES Emissions





MiniCAM SRES Emissions





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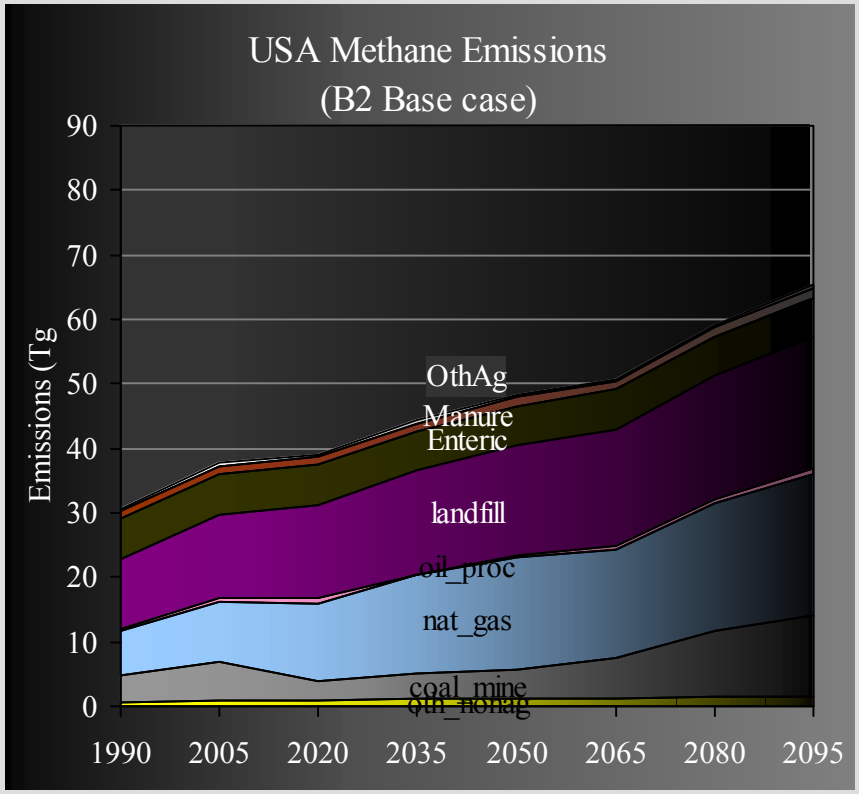

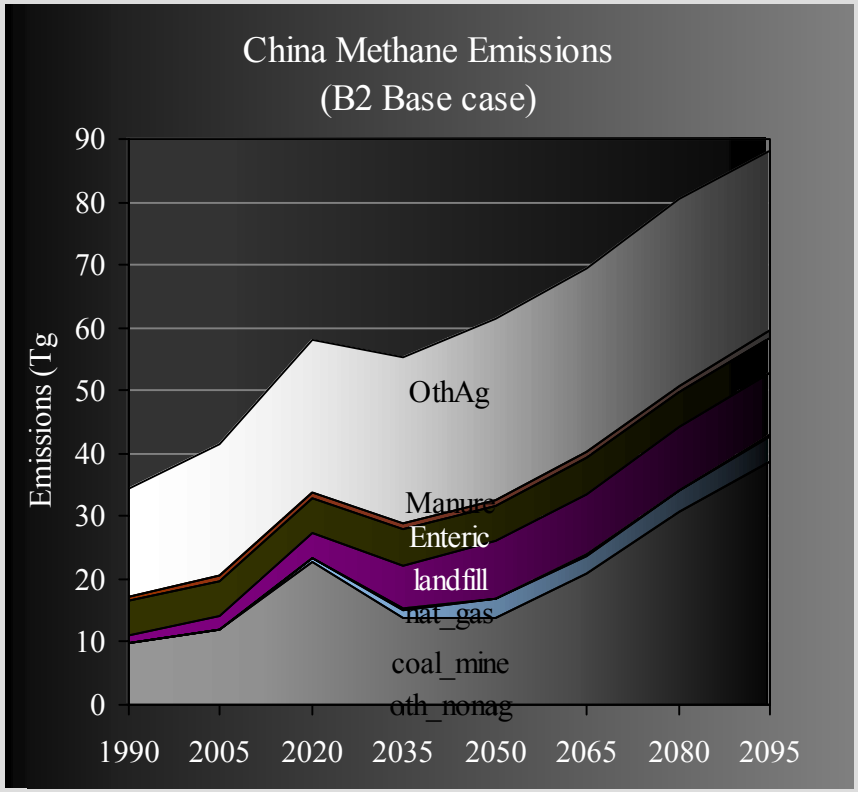

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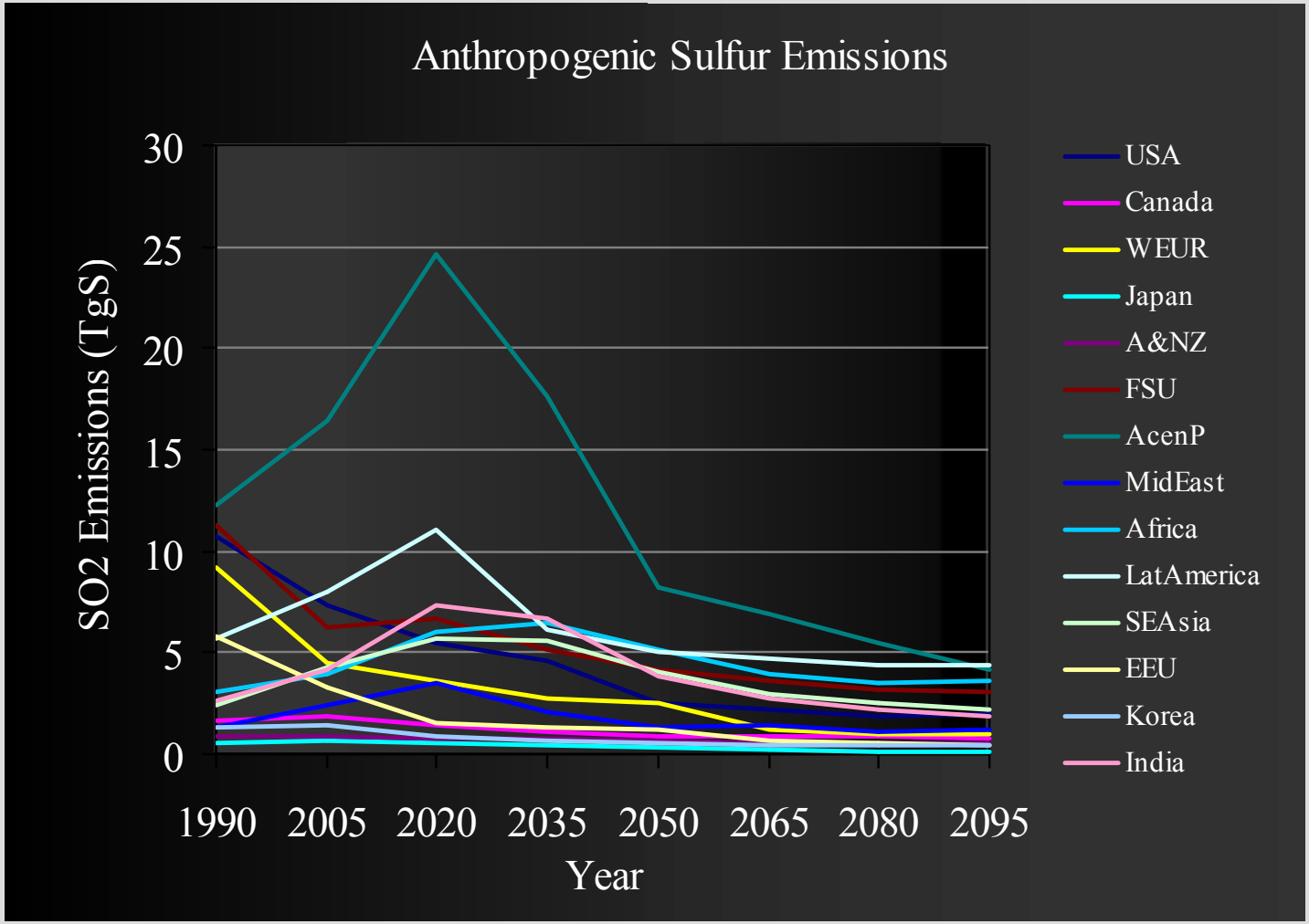
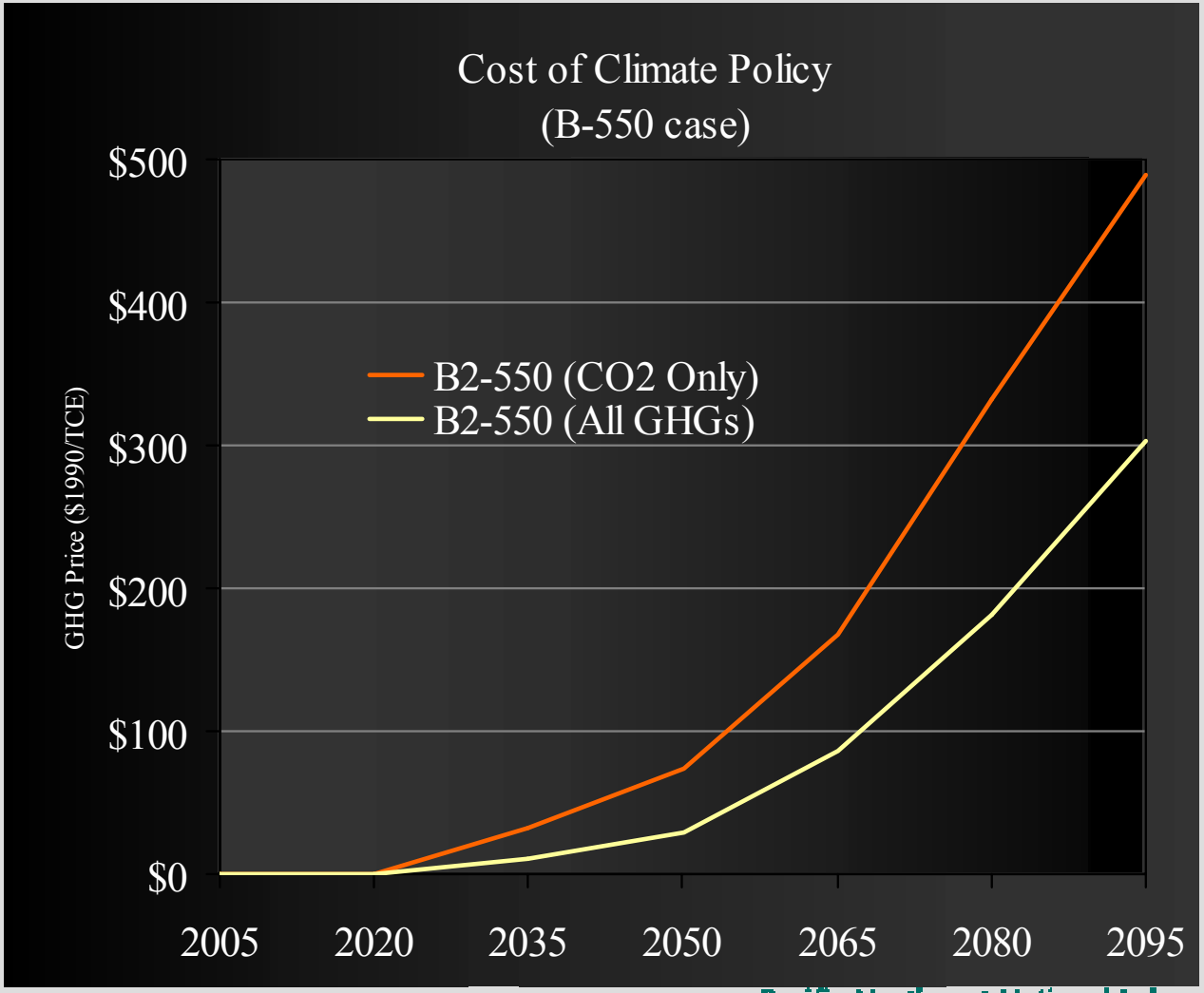


Stabilization

Without Carbon Capture and Disposal Technologies

MiniCAM SRES Emissions

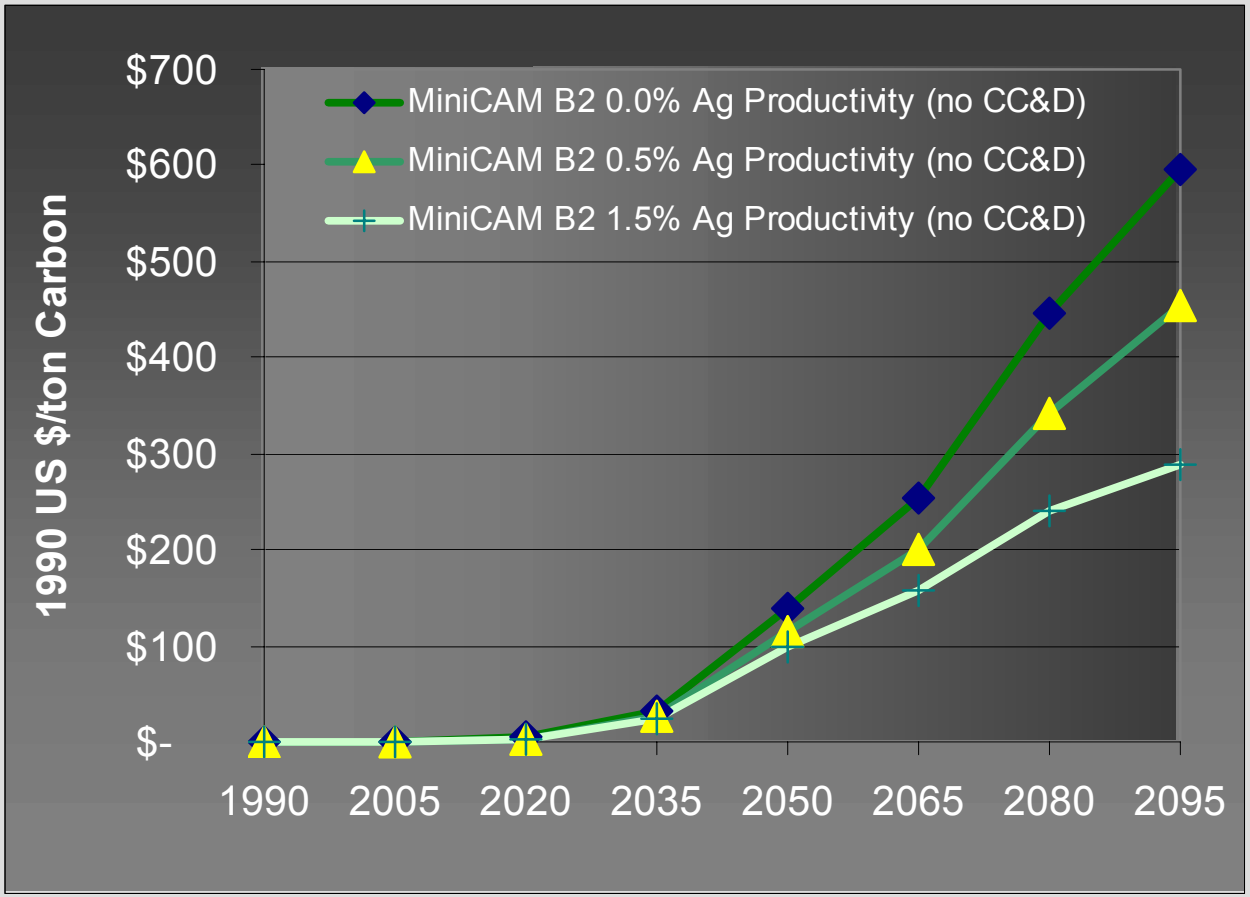
- carbon value
  - uniformly & efficiently applied over time and space



stabilization

Common carbon value

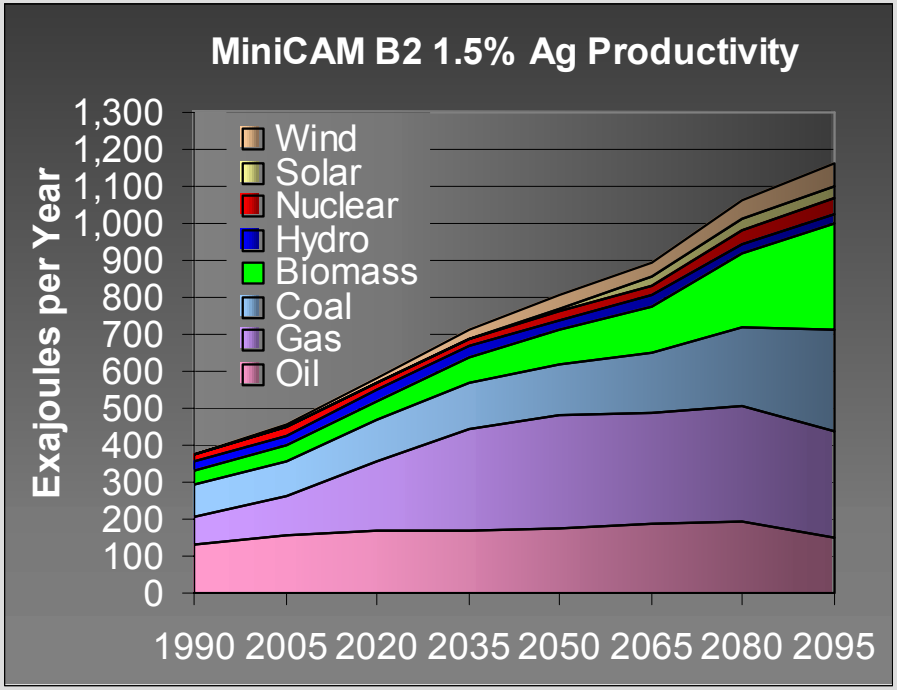
- Common carbon value
- Uniformly & efficiently applied over time and space



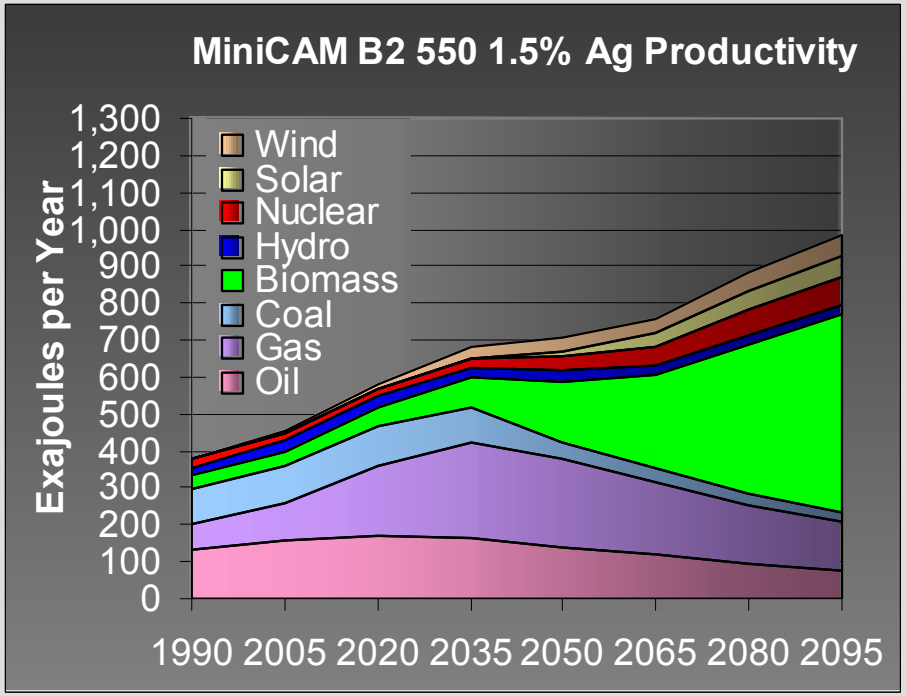
stabilization

- Stabilization implies significant growth in modern commercial biomass.

MiniCAM B2 Reference



MiniCAM B2 550 Stabilization

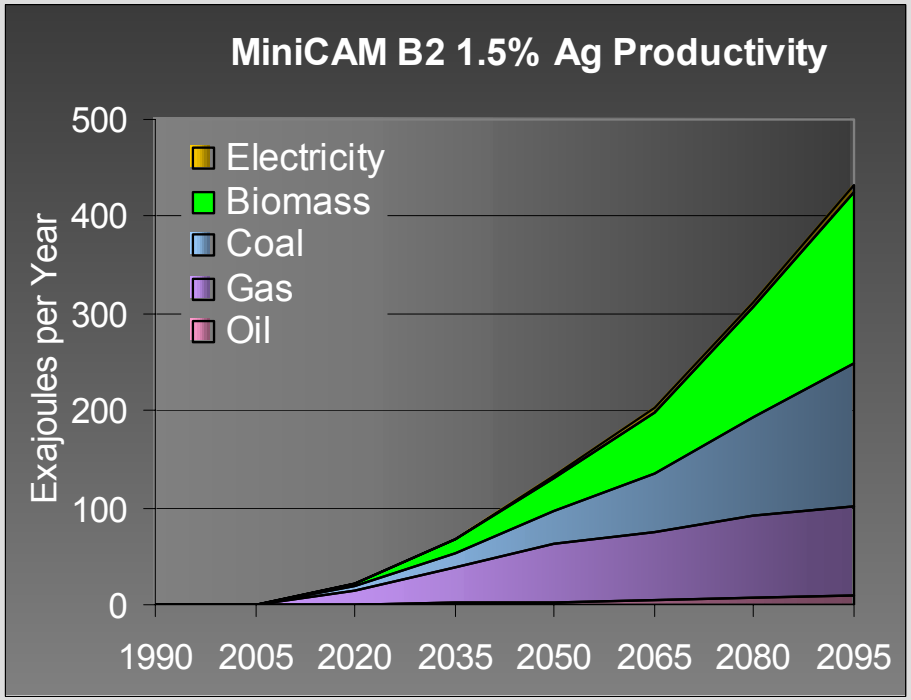


Primary Energy (EJ/year)

stabilization

Biomass is an attractive input to H2 production

MiniCAM B2 Reference



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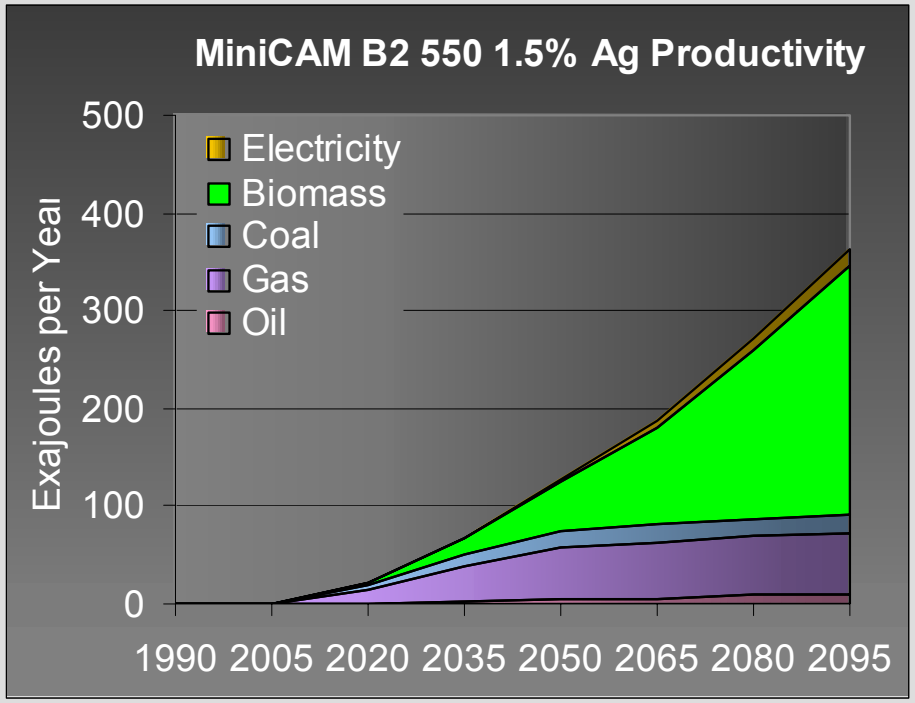
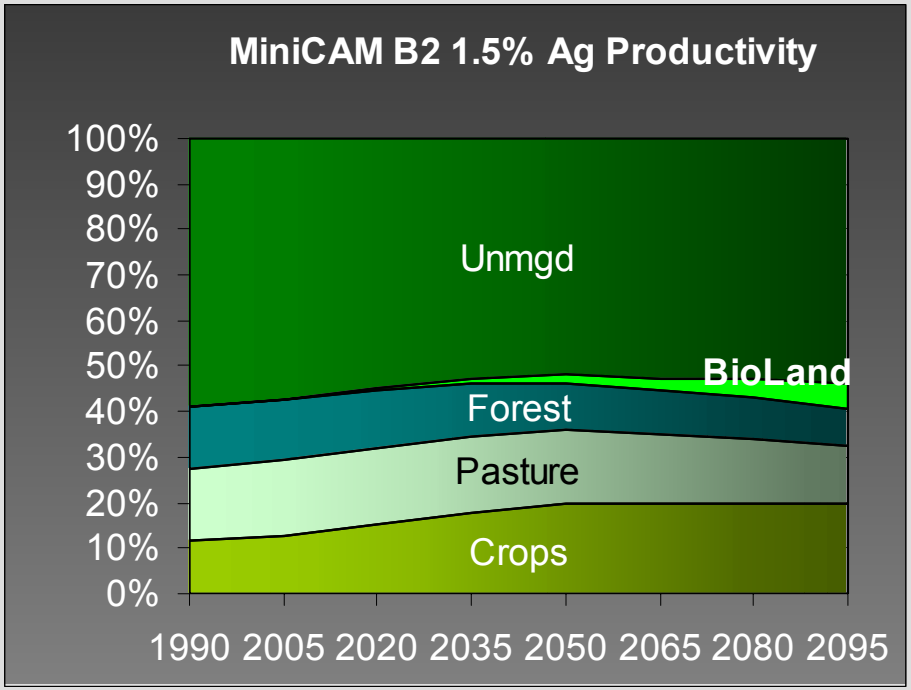


H_2 production—EJ/yr

stabilization

Stabilization could dramatically change land use.

MiniCAM B2 Reference



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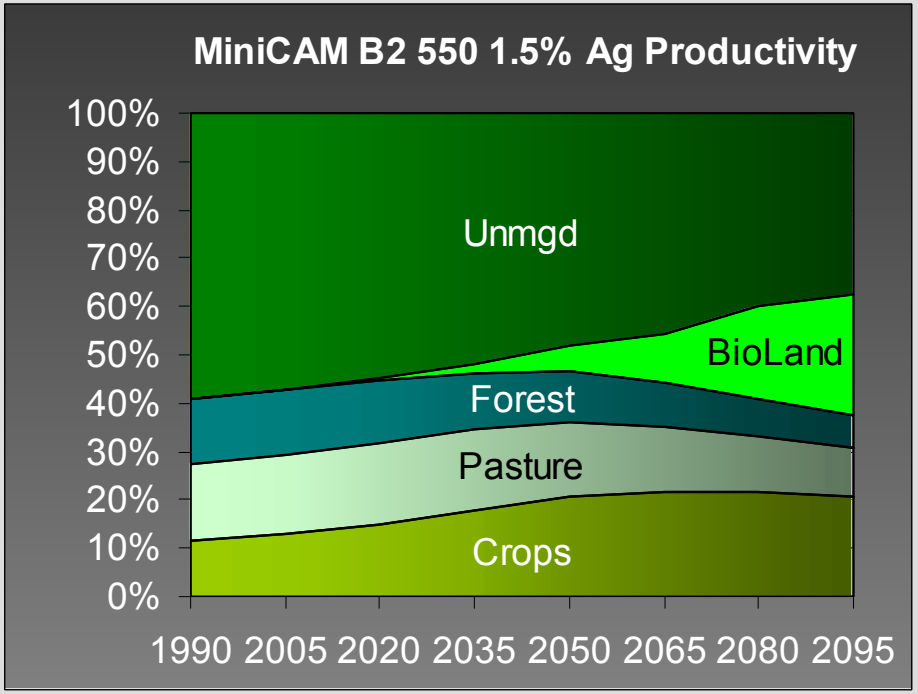
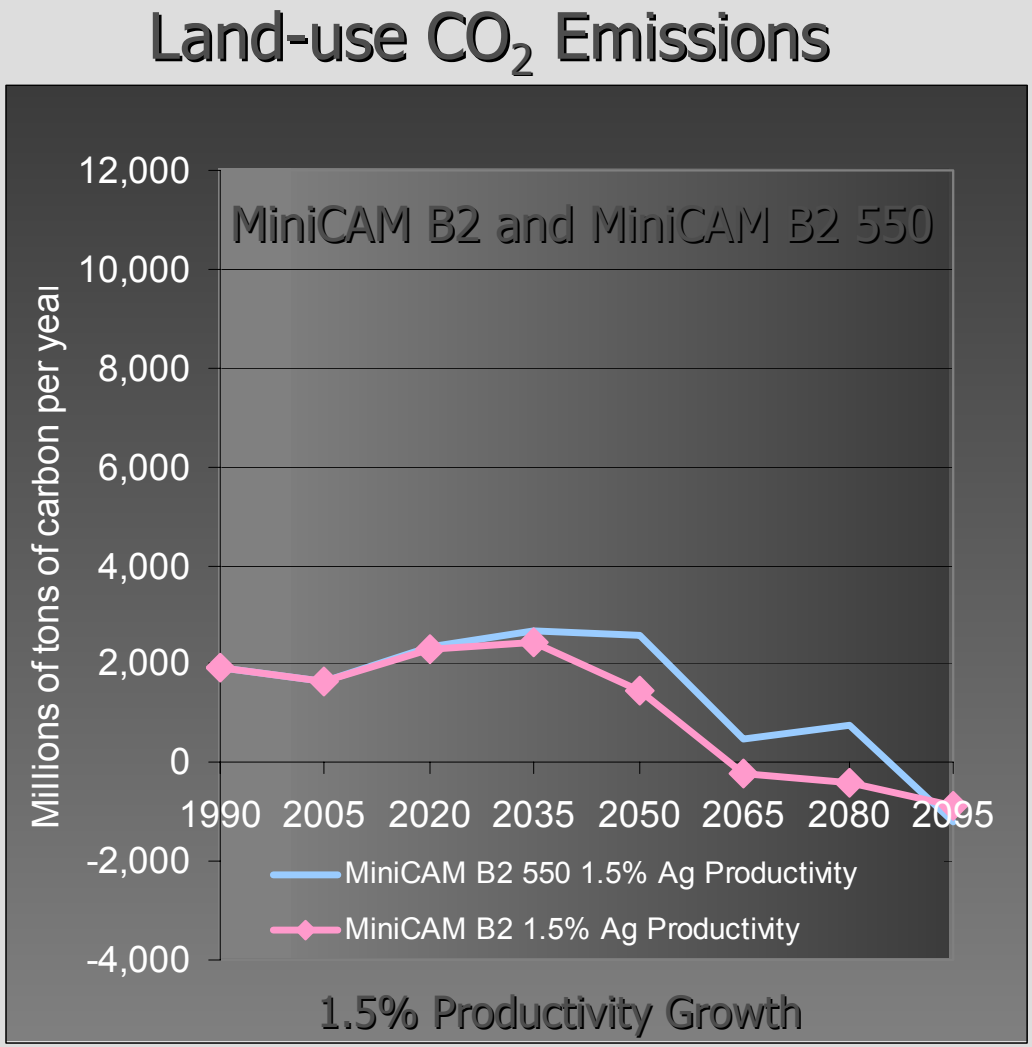


stabilization

- Stabilization increases land-use emissions in the second half of the century with a WRE emissions trajectory.



Final Thoughts

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- Stabilization of greenhouse gas concentrations have important feedbacks to land-use and land-use emissions.