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Land Use, Technology, and Climate Mitigation

Leon Clarke
Representing the Integrated Modeling and Energy Group
at the Joint Global Change Research Institute

Green Economies Dialogue
Brasilia
April 16, 2012

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U.S. DEPARTMENT OF ENERGY | Office of Science

Introduction

- My remarks will use the broad issue of long-term climate change mitigation as a basis to illustrate broader themes.
- I will rely heavily on “integrated assessment” modeling research we have conducted at the Joint Global Change Research Institute (JGCRI).
- I will focus on:
  - Linkages between climate mitigation goals and land use
  - The role of technology in climate mitigation

Acknowledgements

Thanks to the organizers of this meeting.

Thanks to the sponsors of the Global Energy Technology Strategy Program (GTSP) and the Integrated Modeling and Energy Program at JGCRI more generally for research support.

Mitigation choices will have a large influence on land use patterns

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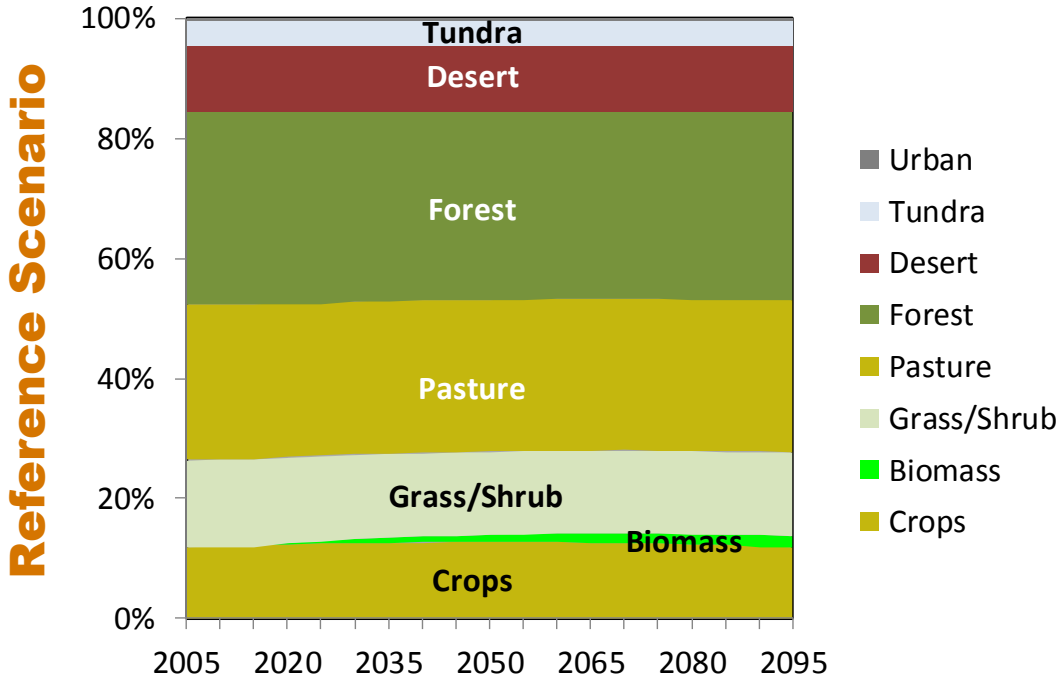
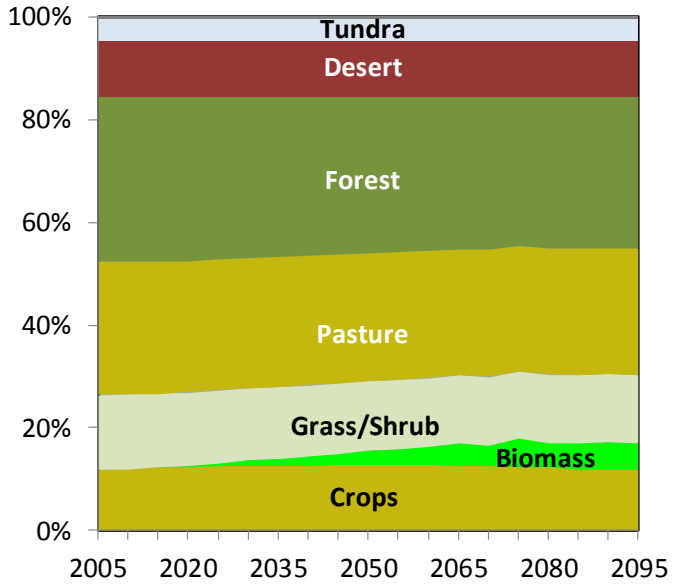
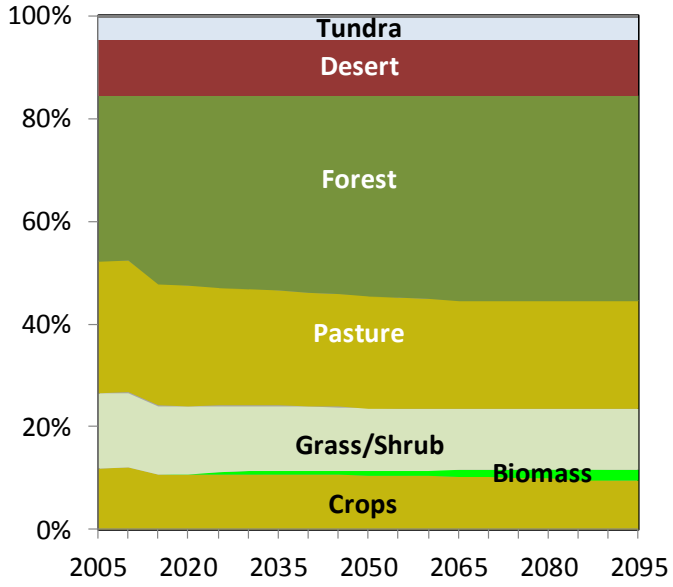
550 ppmv CO2-e Stabilization Scenario When Terrestrial Carbon is NOT Valued





550 ppmv CO2-e Stabilization Scenario When ALL Carbon is Valued



Mitigation choices will have a large influence on land use patterns

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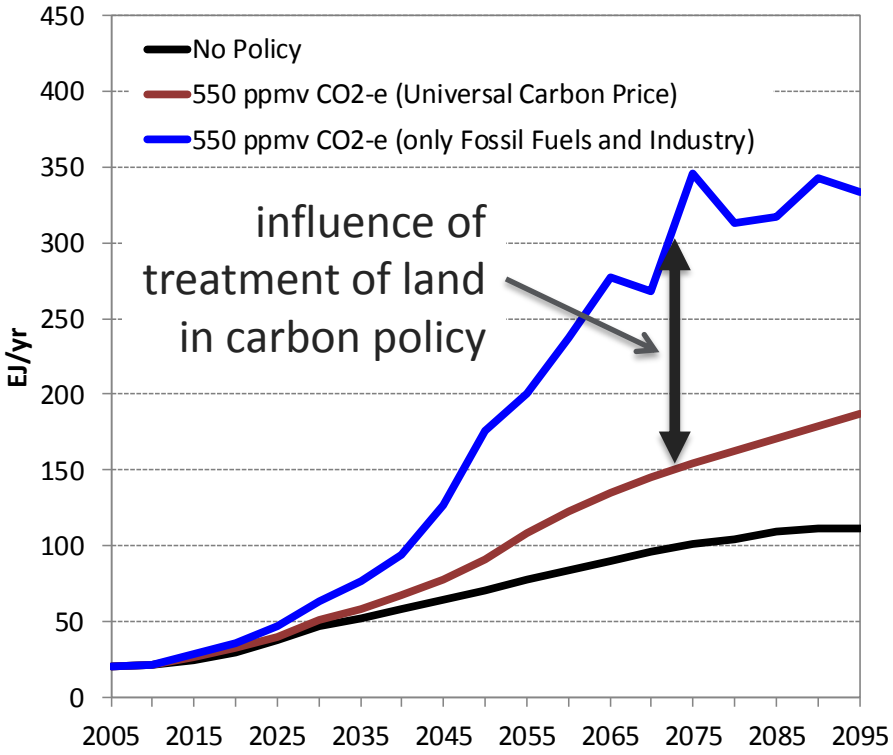
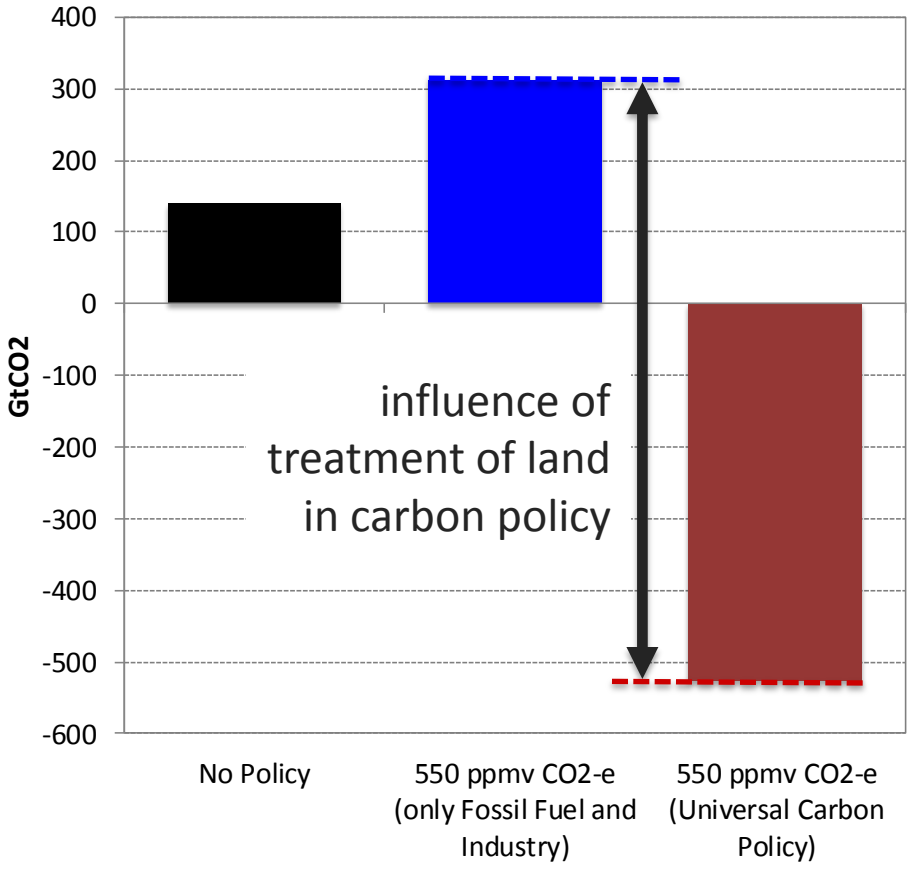
Bioenergy Production



Cumulative Net Land Use Change Emissions 2005 through 2095



What happens to cumulative emissions as we protect forests?

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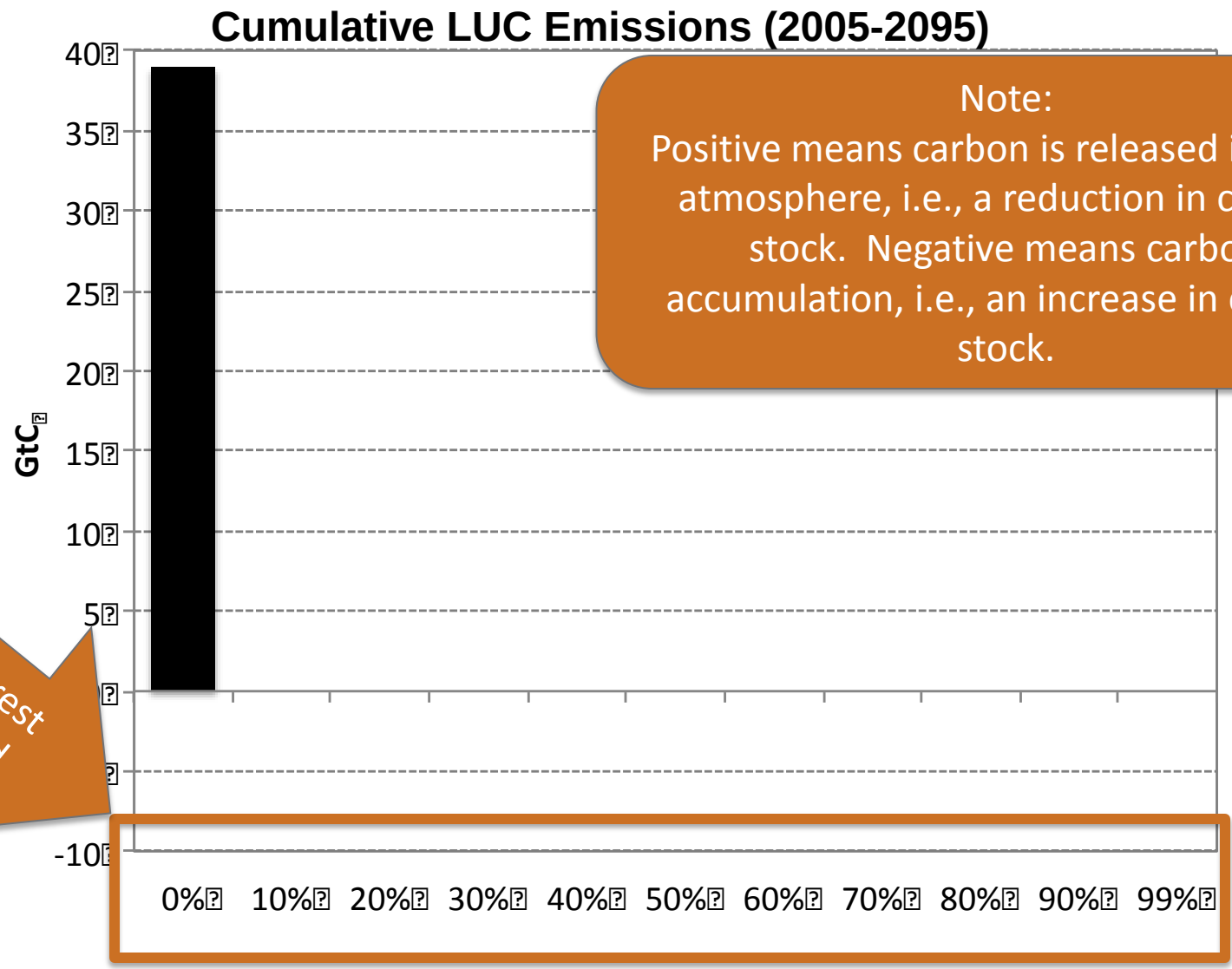

Note:
Positive means carbon is released into the atmosphere, i.e., a reduction in carbon stock. Negative means carbon accumulation, i.e., an increase in carbon stock.

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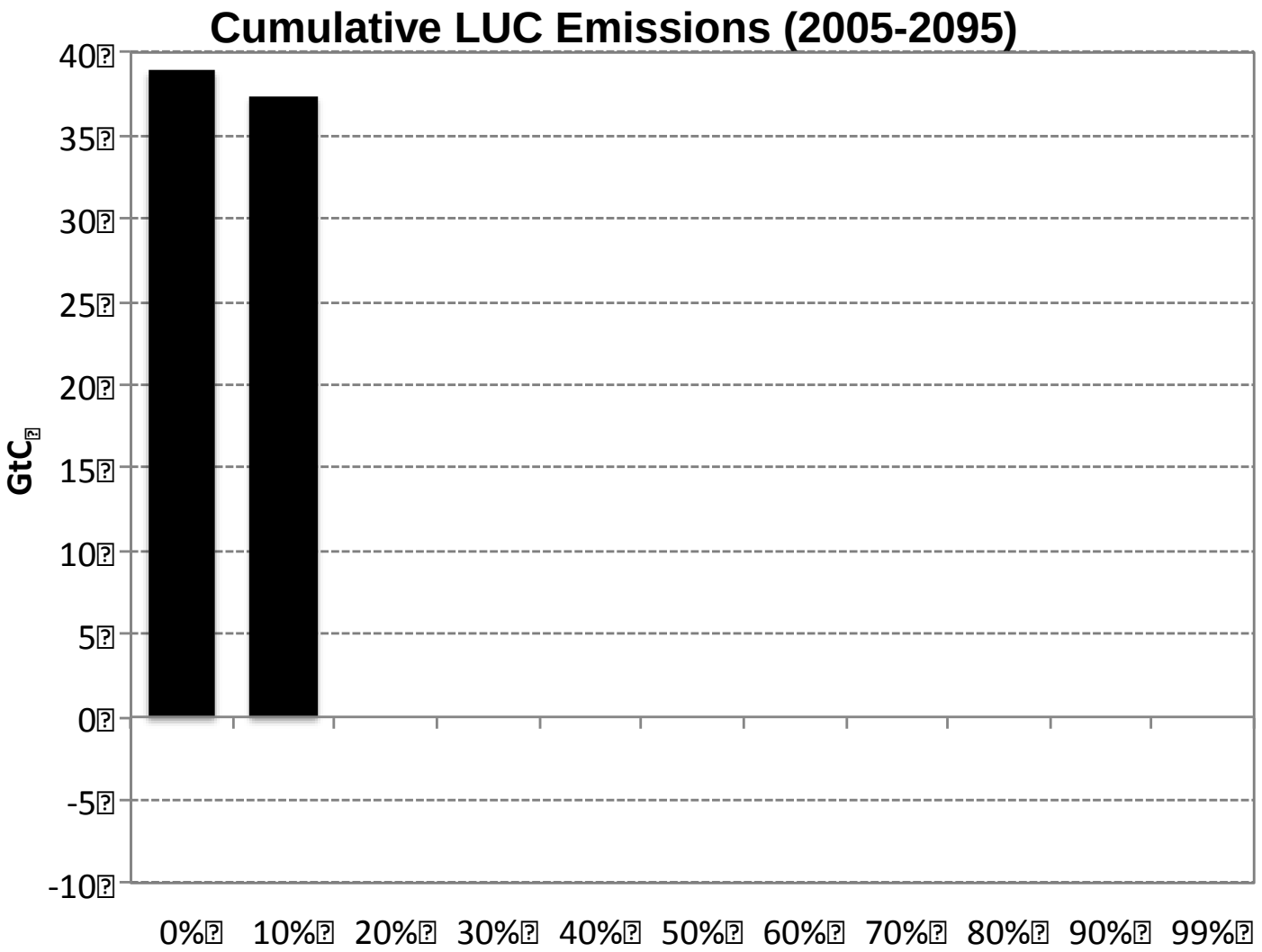

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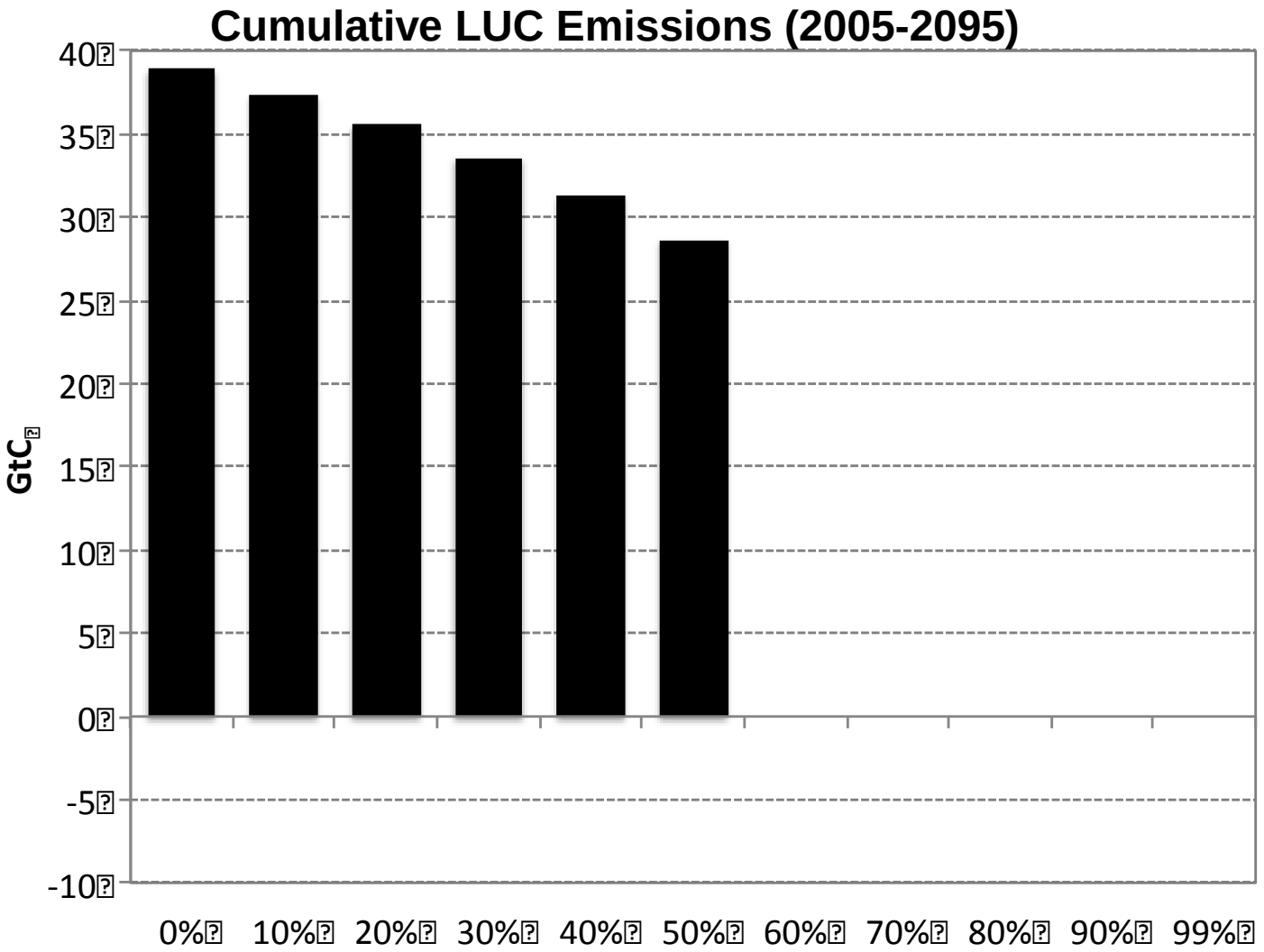

What happens to cumulative emissions as we protect forests?

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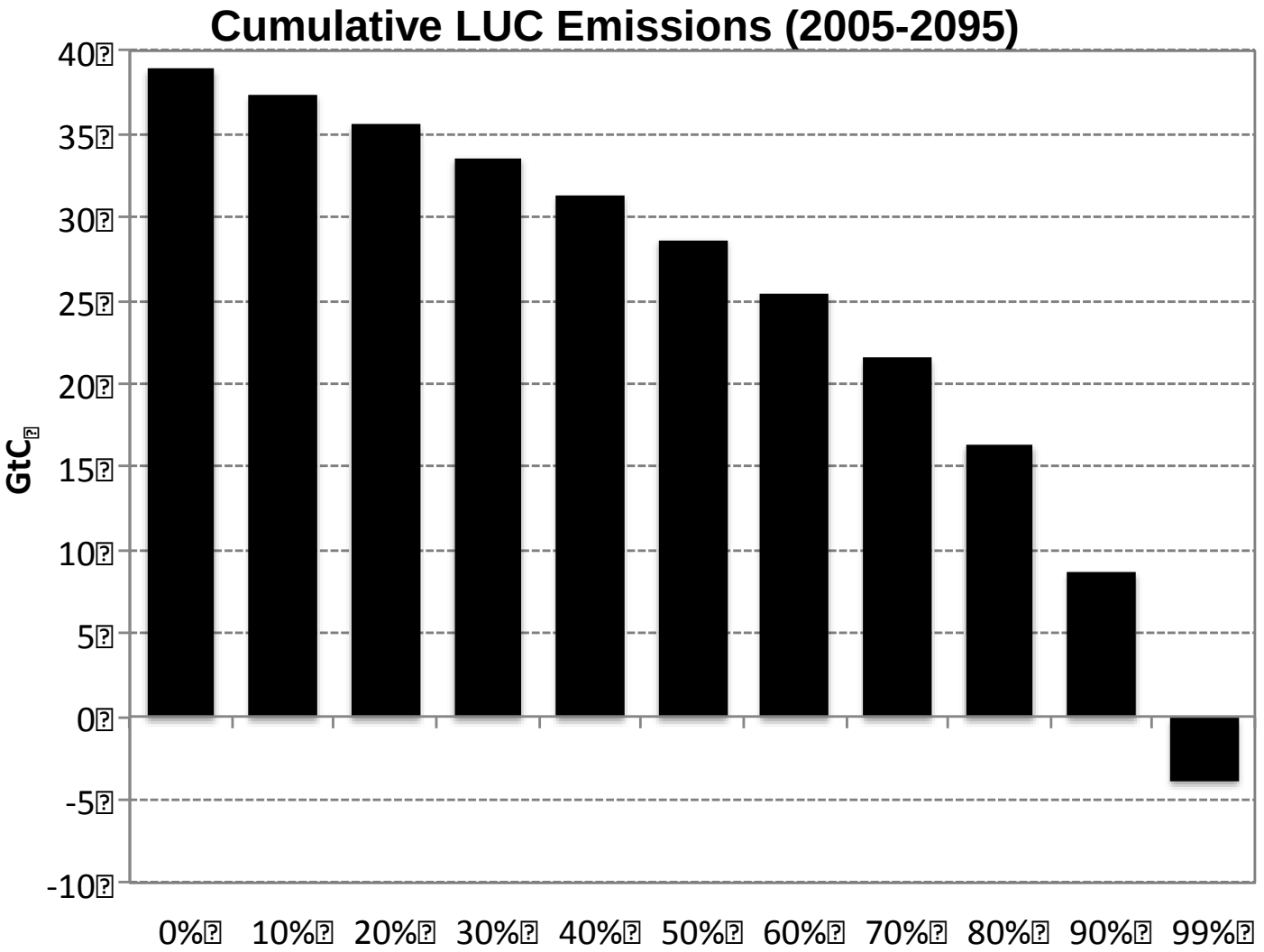

Unless we protect more than 80% of forests, total forest area declines.

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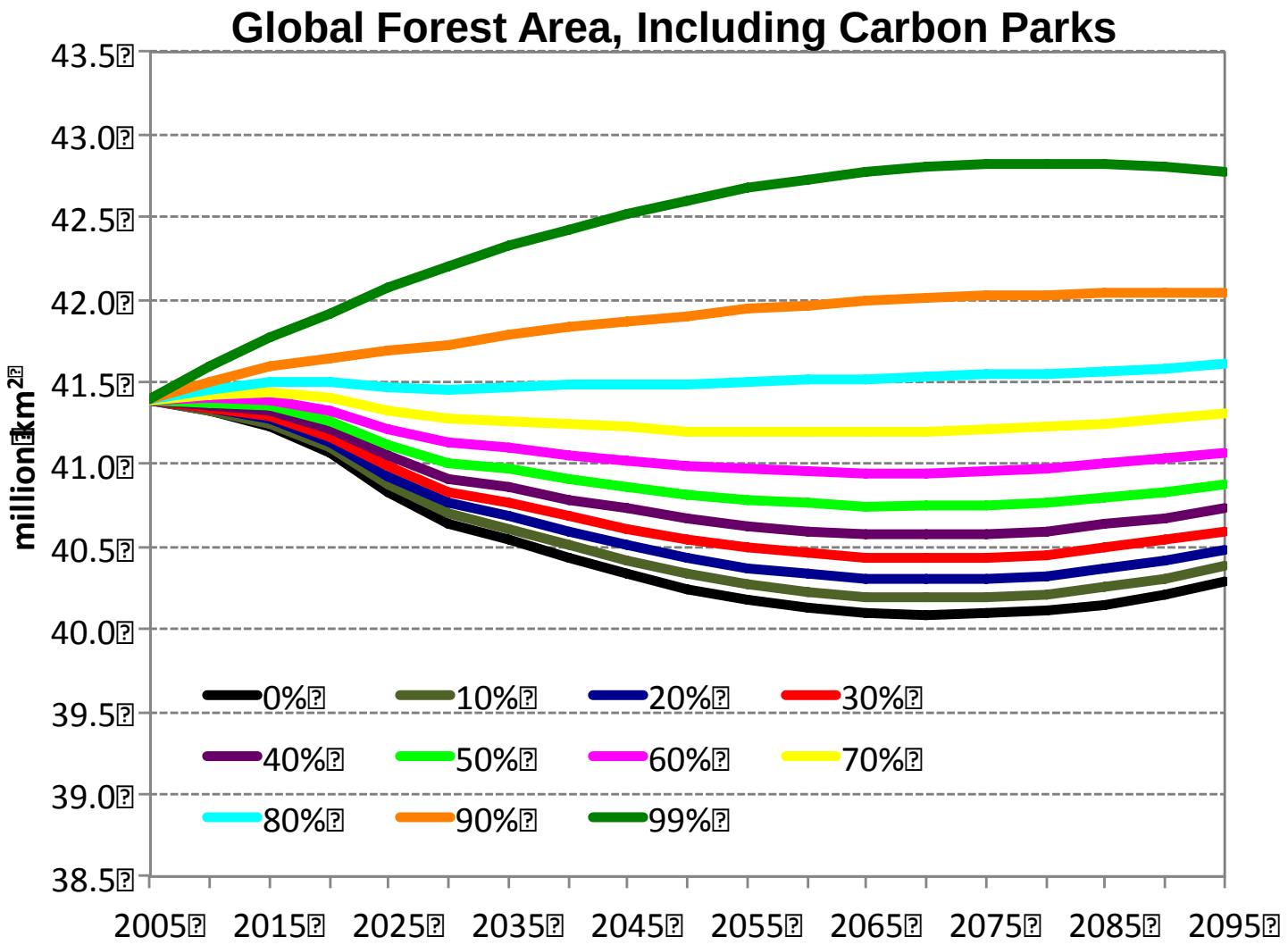

Climate change will interact with land use and associated agricultural markets.

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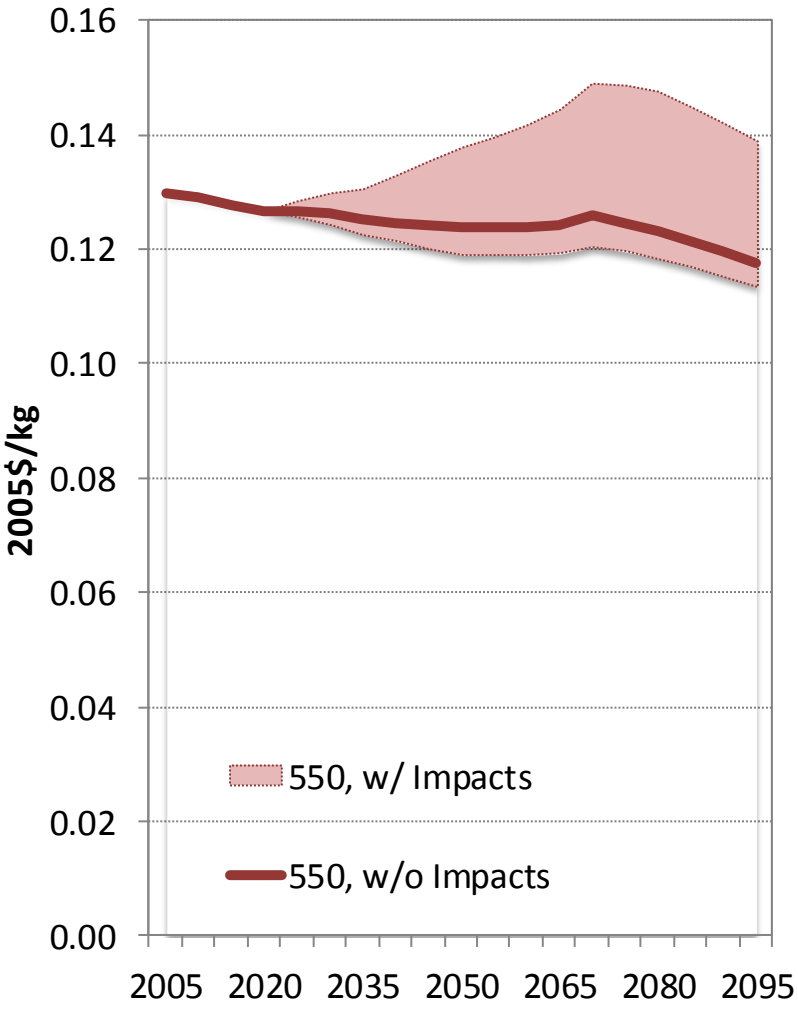
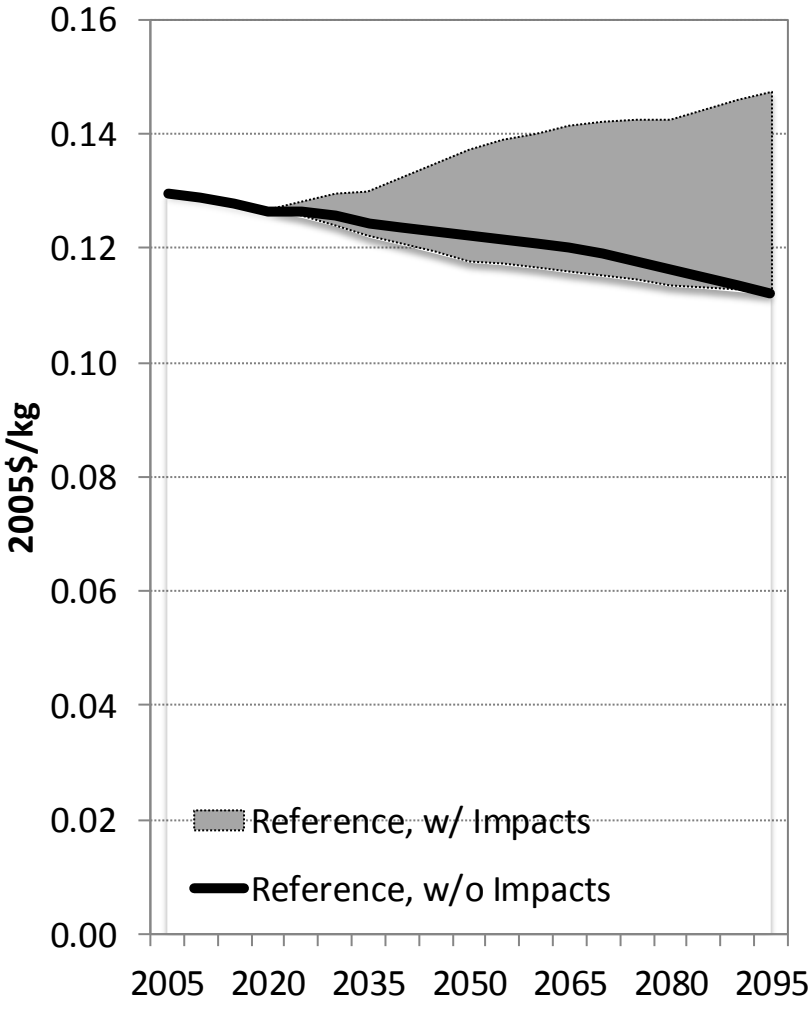
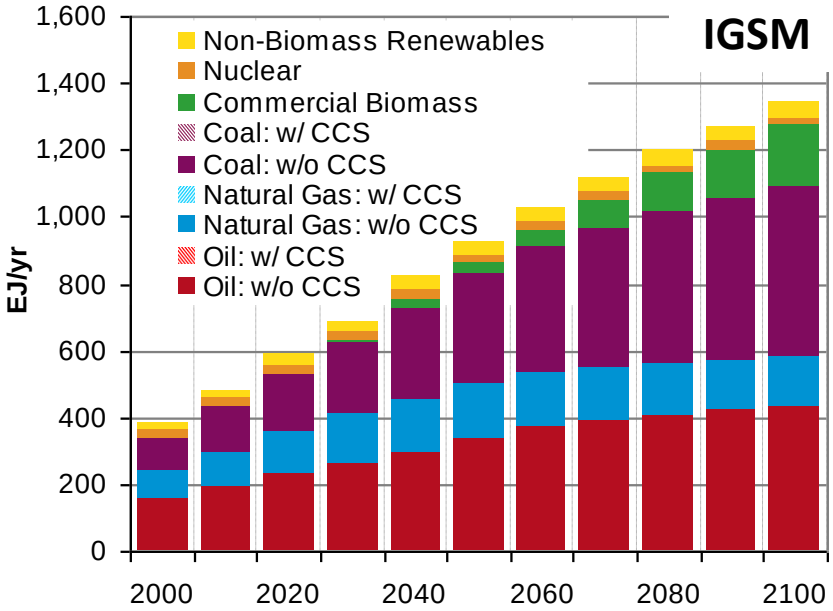
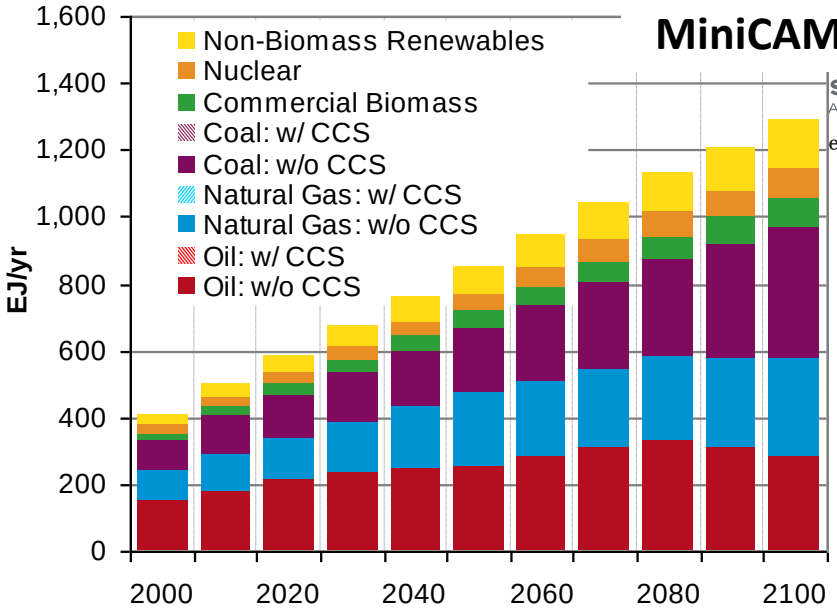
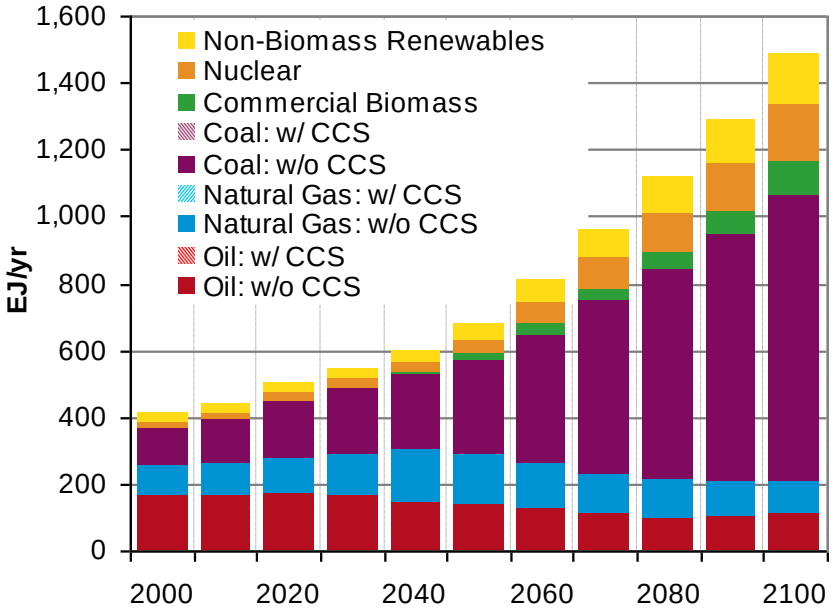
Global wheat prices with and without climate change and climate change mitigation (No explicit land policy)









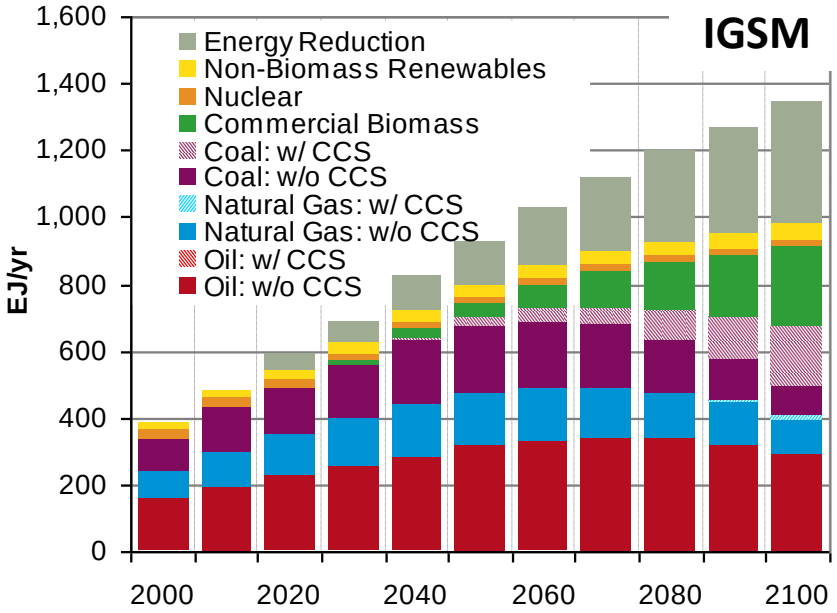


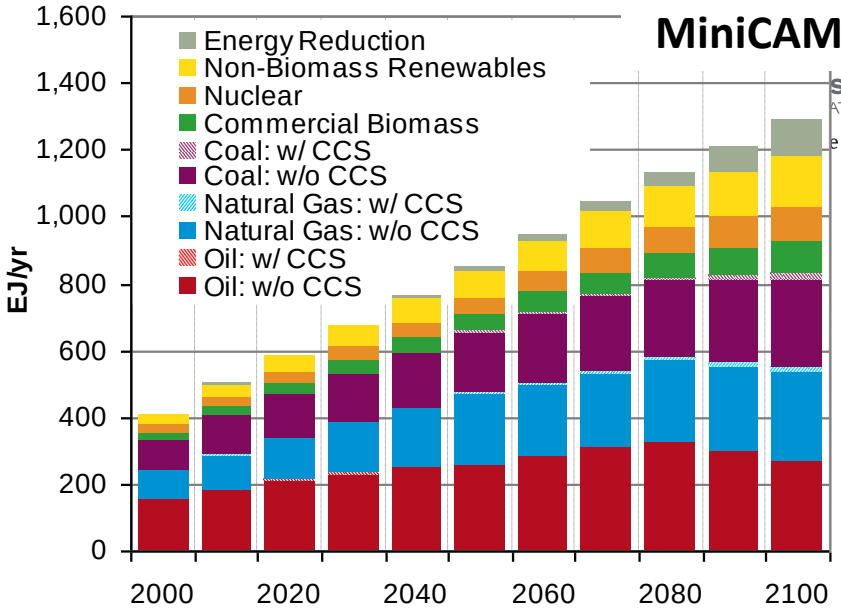
MERGE

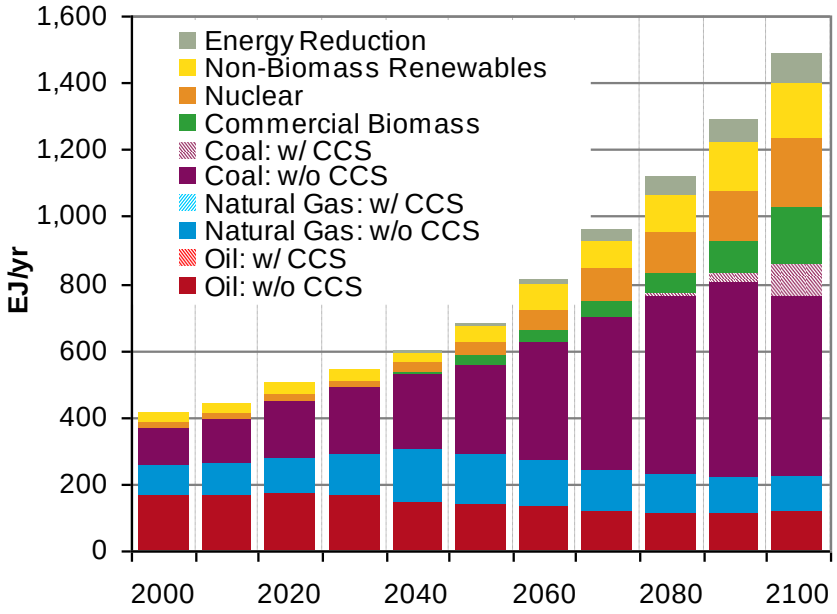
Primary Energy from the CCSP Scenarios

(Reference Scenario)

From ***CCSP Product 2.1a: Scenarios of Emissions and Greenhouse Gas Concentrations***



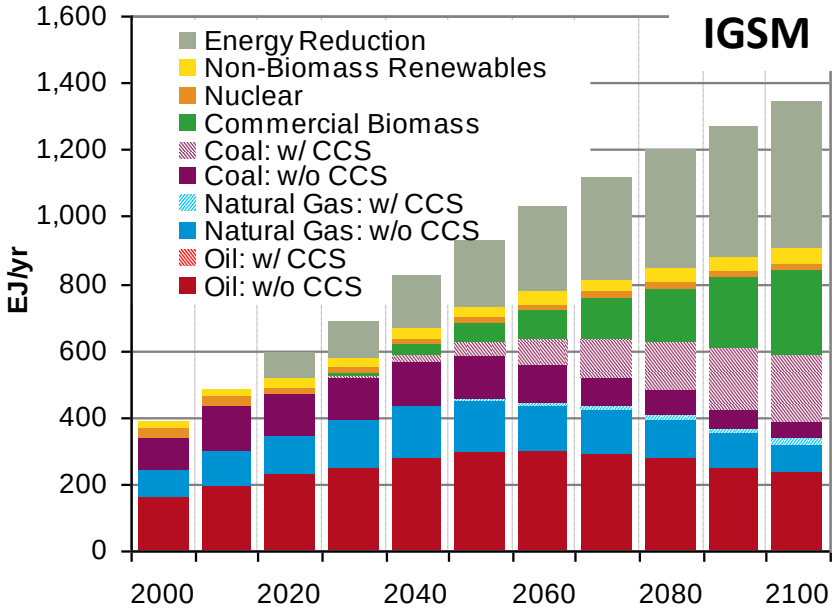


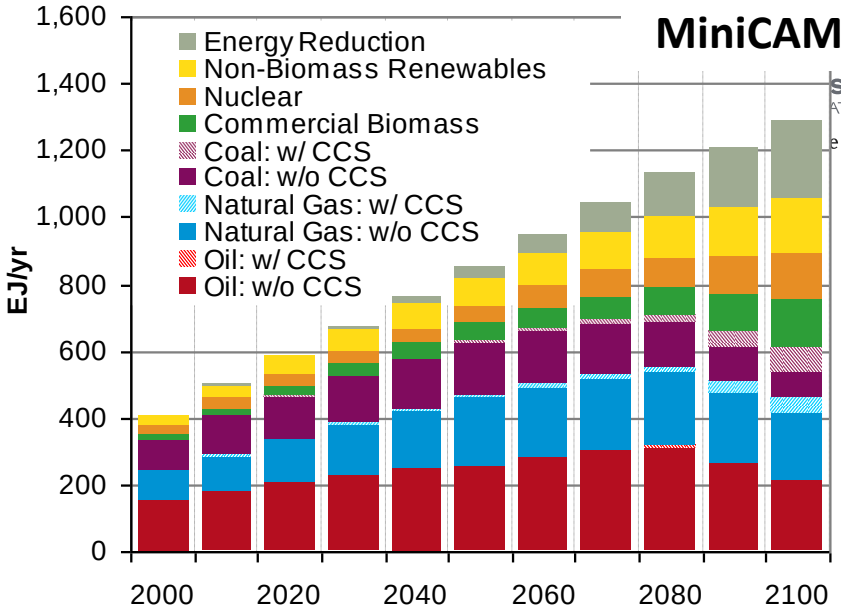


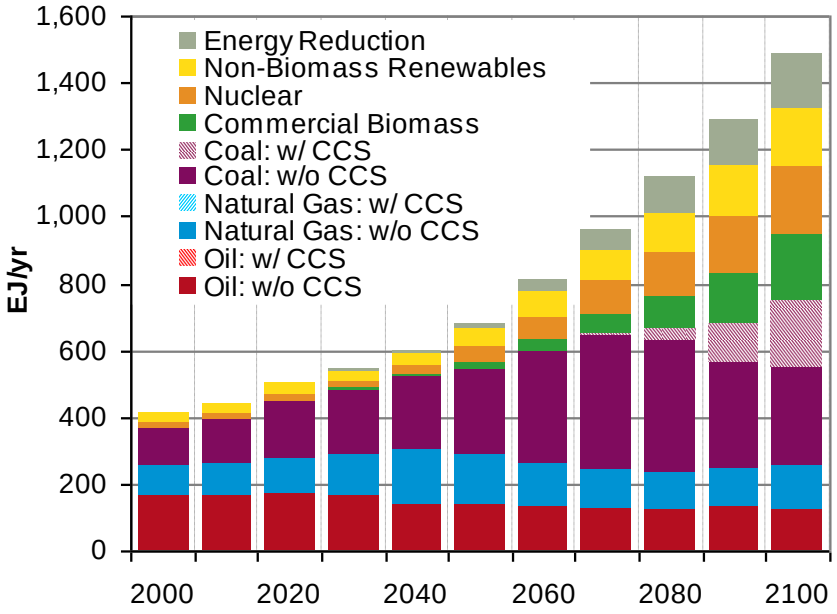
Primary Energy from the CCSP Scenarios

(≈ 750 ppmv CO_2)

From ***CCSP Product 2.1a: Scenarios of Emissions and Greenhouse Gas Concentrations***







Primary Energy from the CCSP Scenarios

(≈ 650 ppmv CO_2)

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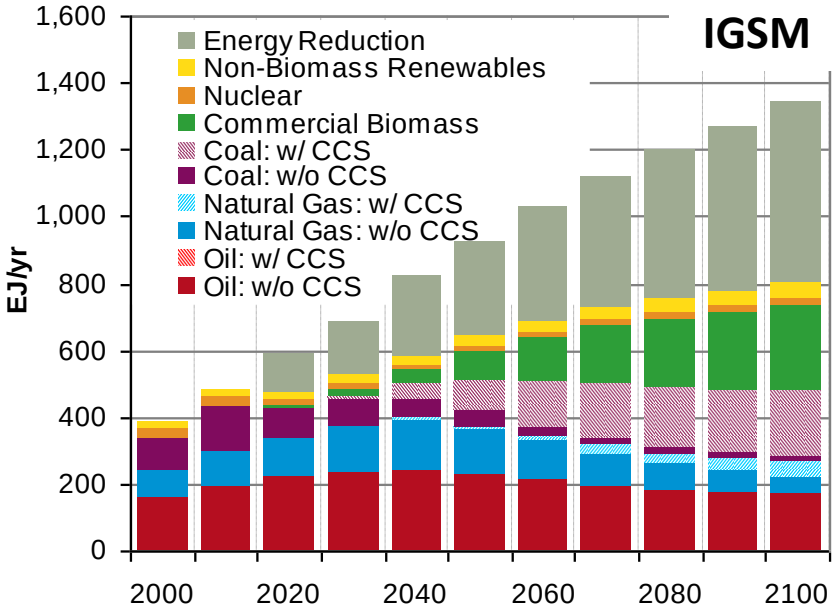

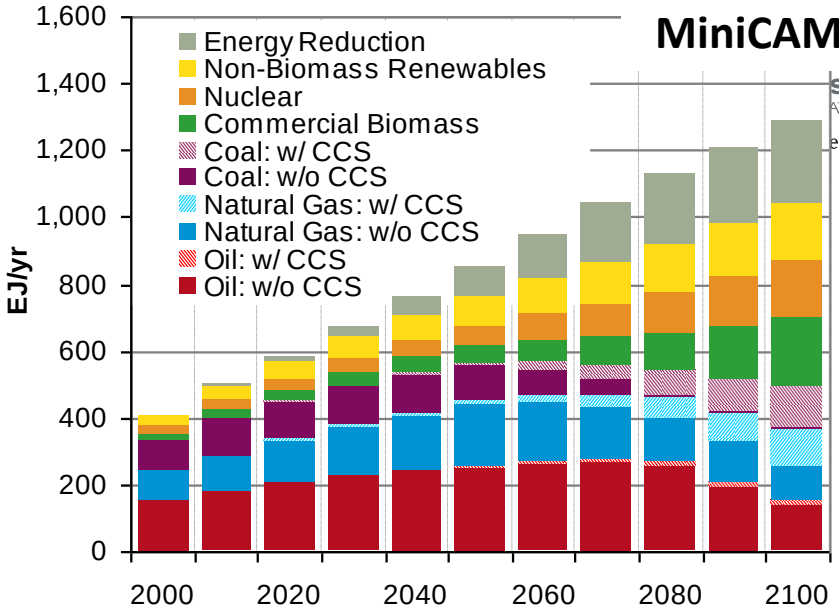

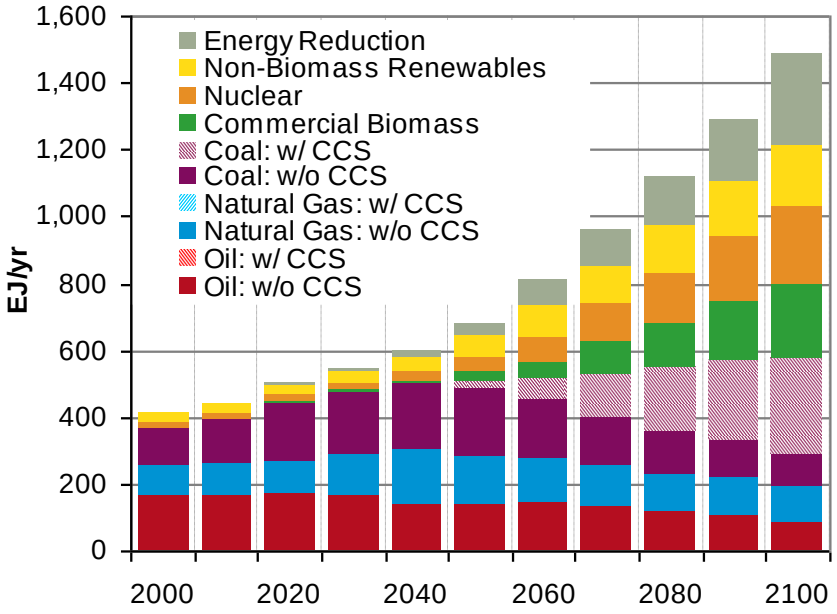

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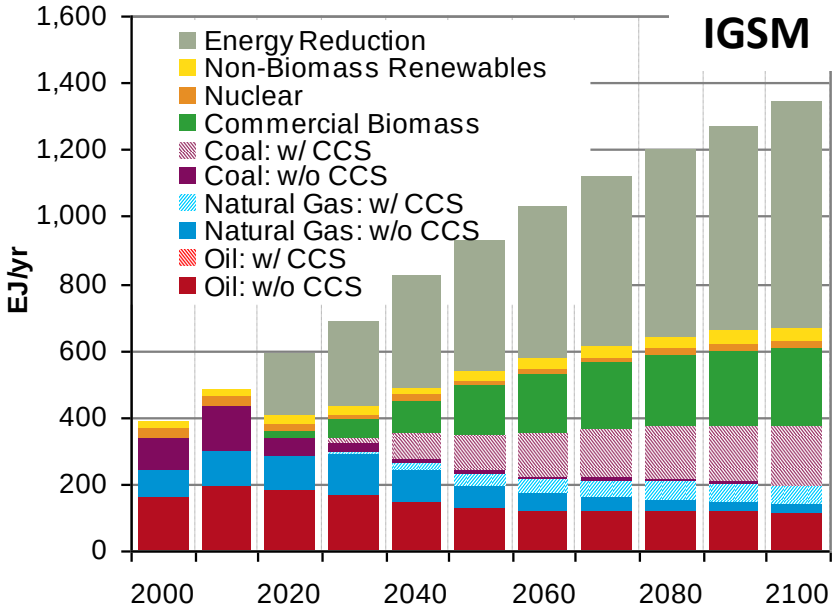

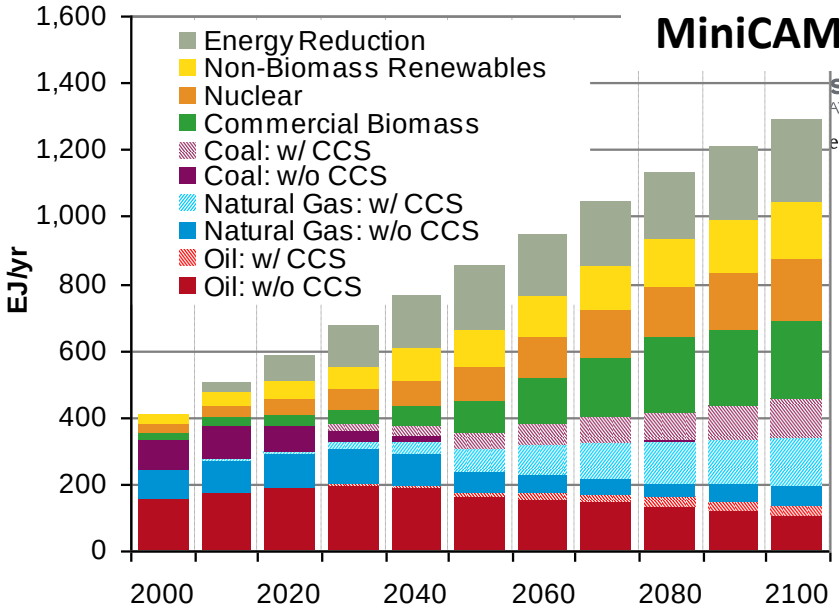

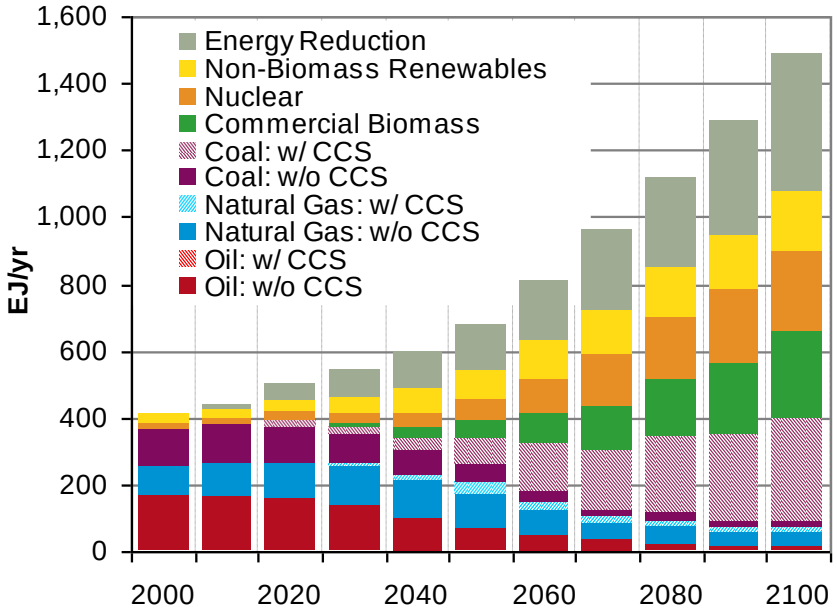

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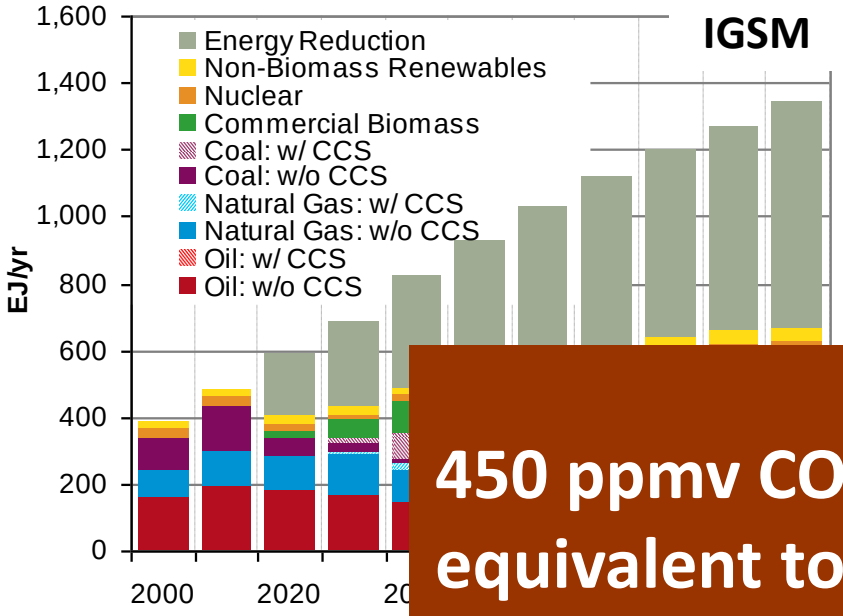

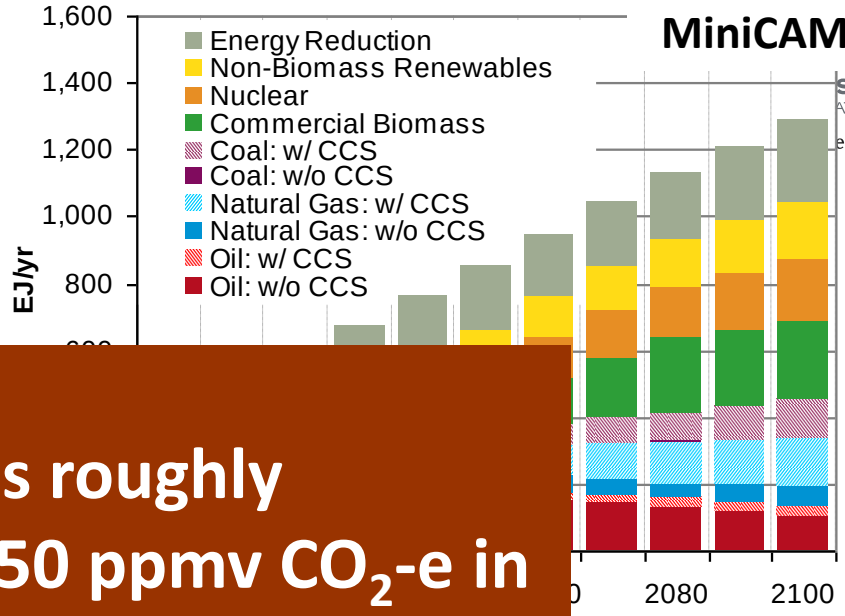

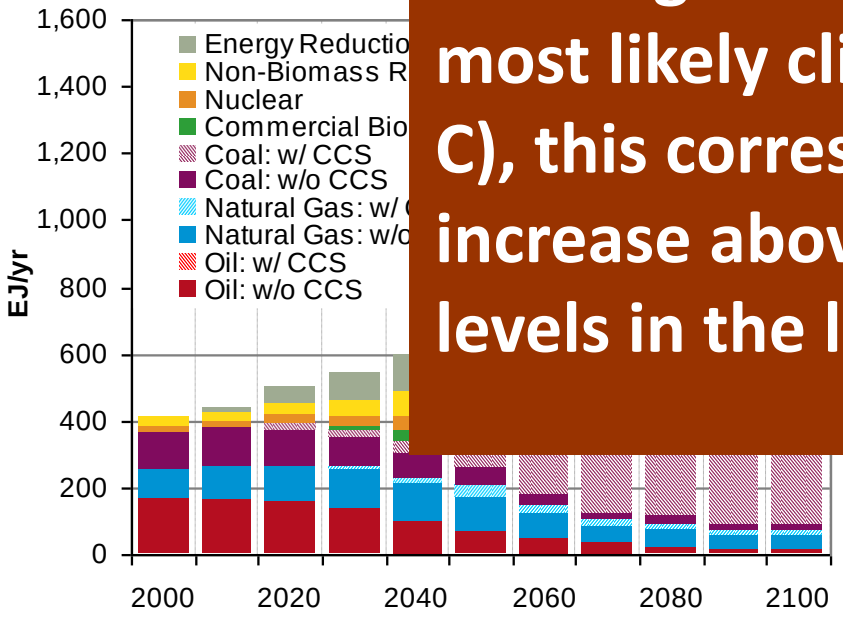

450 ppmv CO_2 is roughly equivalent to 550 ppmv CO_2-e in the long-term. At the IPCC's most likely climate sensitivity (3° C), this corresponds to a 3° C increase above preindustrial levels in the long-term.

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CO_2)

MERGE

From ***CCSP Product 2.1a: Scenarios of Emissions and Greenhouse Gas Concentrations***

There are differing views on the role of technology in climate mitigation.

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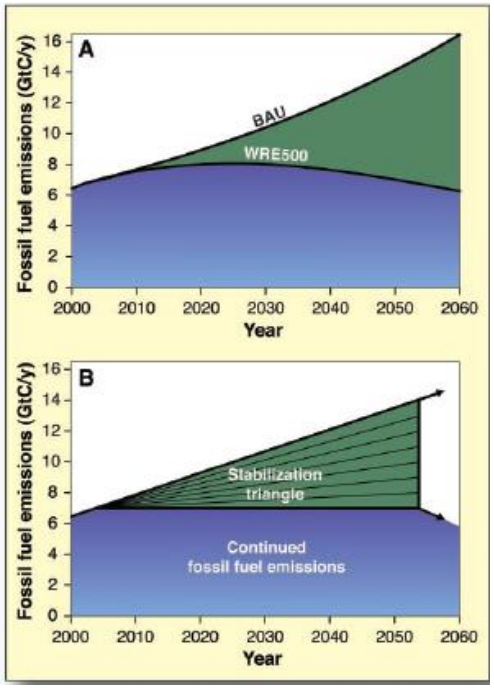
Hoffert, M. et al. (2002). challenged the notion that "*known technological options could achieve a broad range of atmospheric CO_2 stabilization levels, such as 550 ppm, 450 ppm or below over the next 100 years or more*"


Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet

Hoffert, M., et al. (2002), Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet. *Science* 298(1):981-987.



Pacala, S. and R. Socolow. (2004) indicate that *Humanity can solve the carbon and climate problem in the first half of this century simply by scaling up what we already know how to do."*

Pacala, S. and R. Socolow. (2004), Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. ***Science 305***:968-972

An important role of technology is to reduce the costs of mitigation

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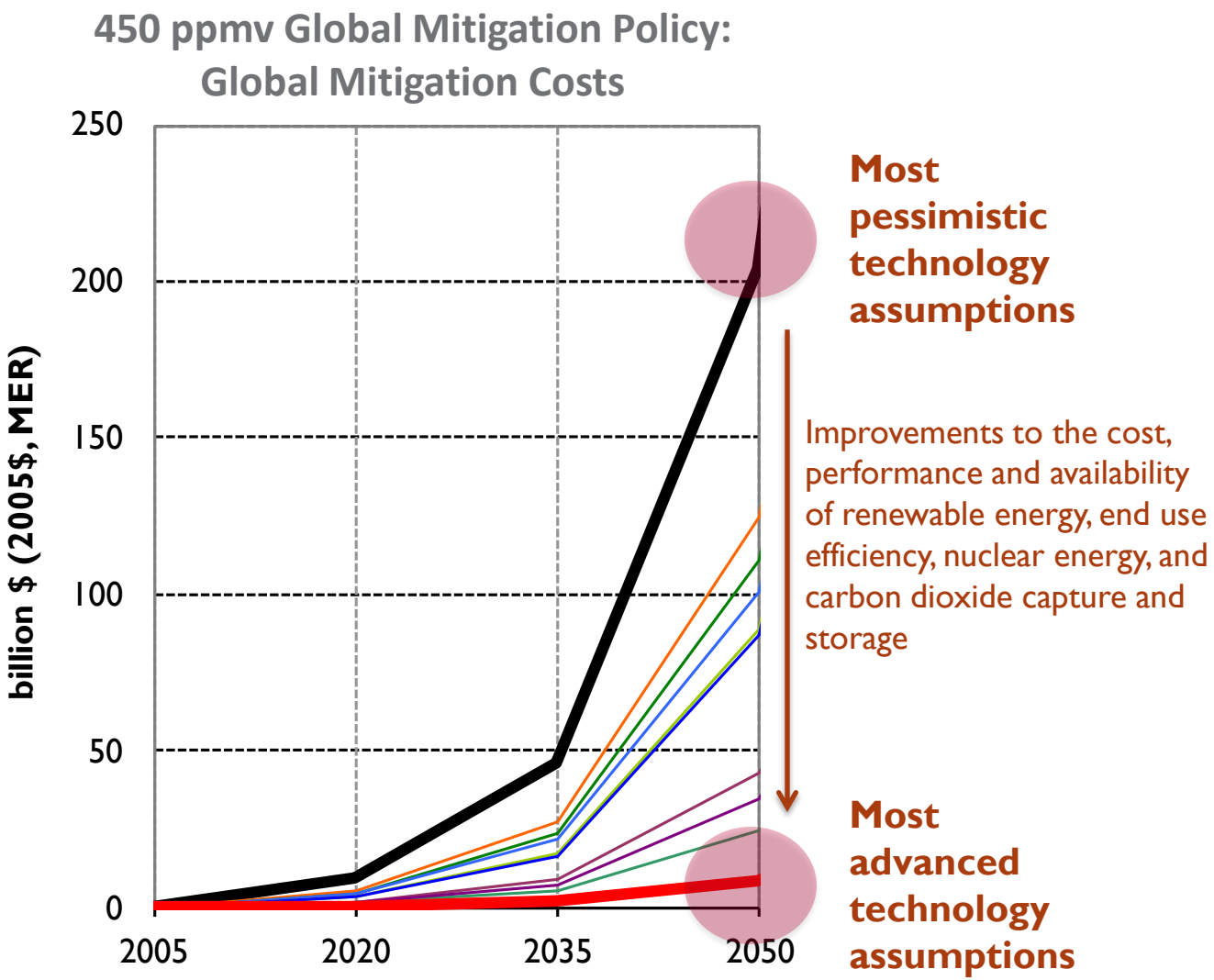

Recent research has explored the unique role of bioenergy coupled with CO_2 capture and storage in enabling very low stabilization levels

Technology for climate change is not only important in the energy sector.

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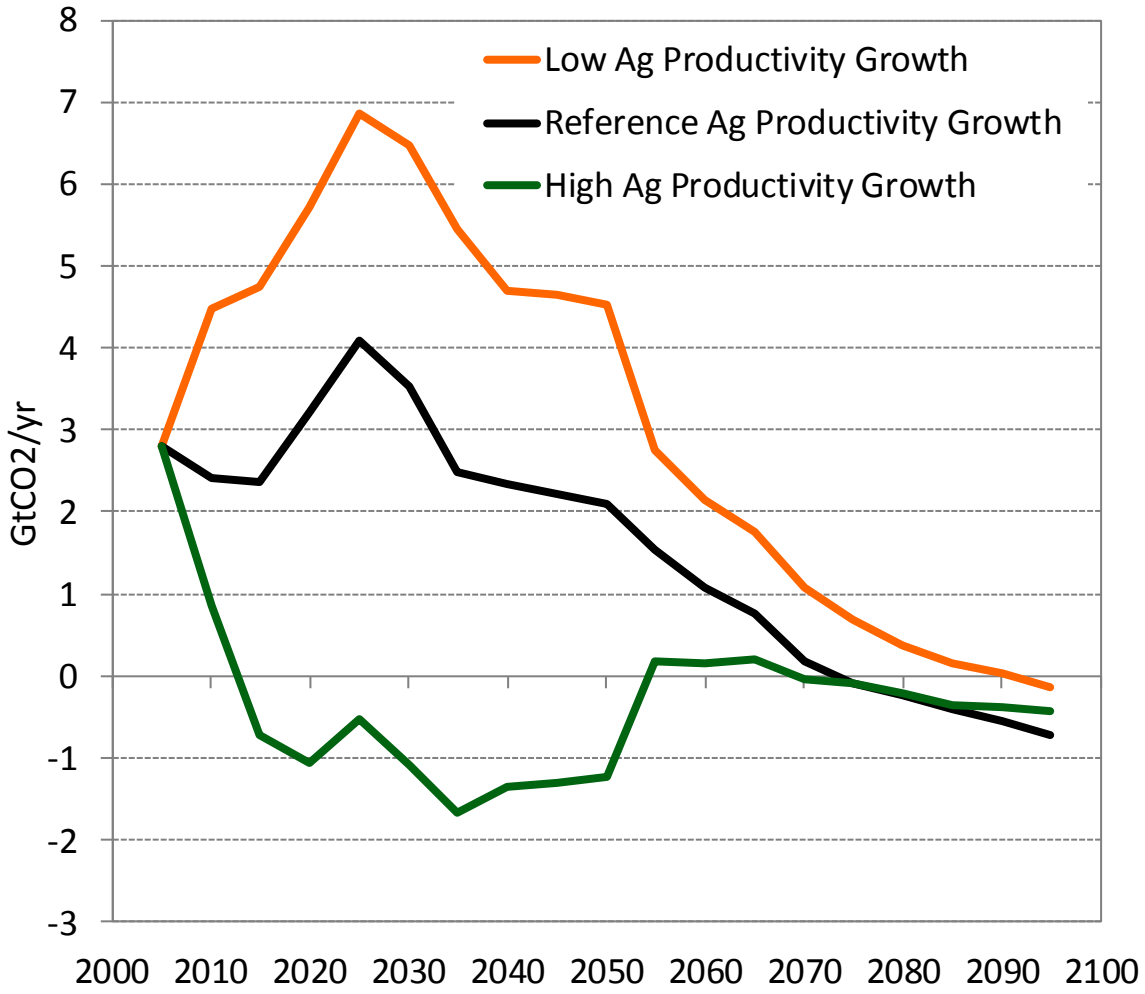
Cumulative Emissions from 2005-2095

- No crop productivity growth after 2005:
  - **290 GtCO2**
- FAO assumptions through 2050 and 0.25%/yr crop productivity growth afterwards:
  - **140 GtCO2**
- High convergence through 2050 and 0.25%/yr crop productivity growth afterwards:
  - **-37 PgC**
- The difference is **36 ppmv** CO2 by 2095



Technology alone is not enough to stabilize greenhouse gas concentrations

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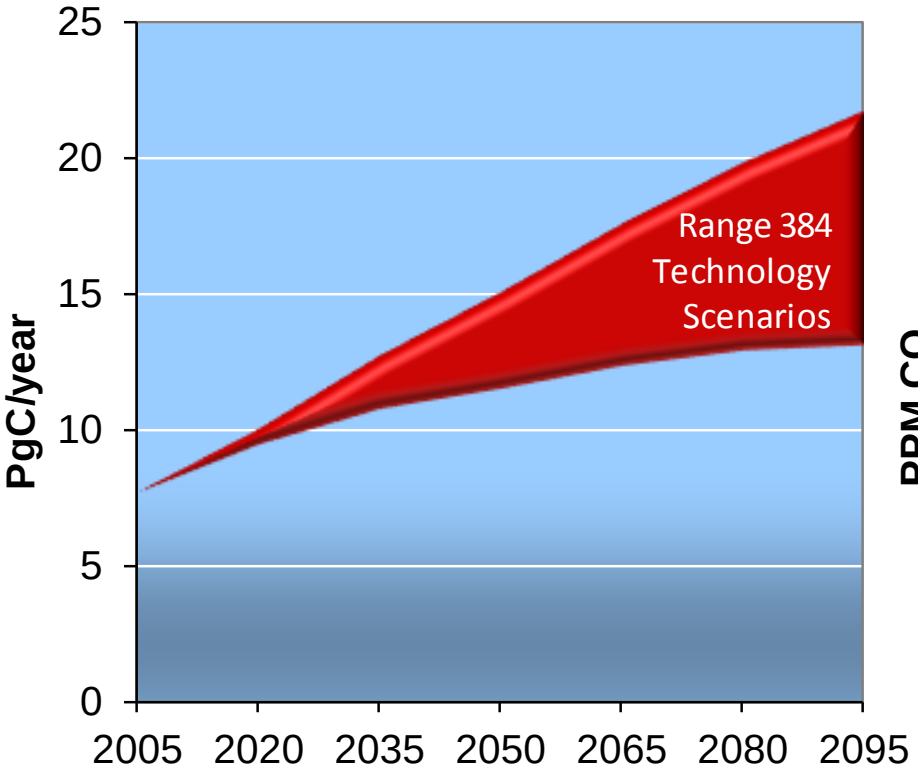
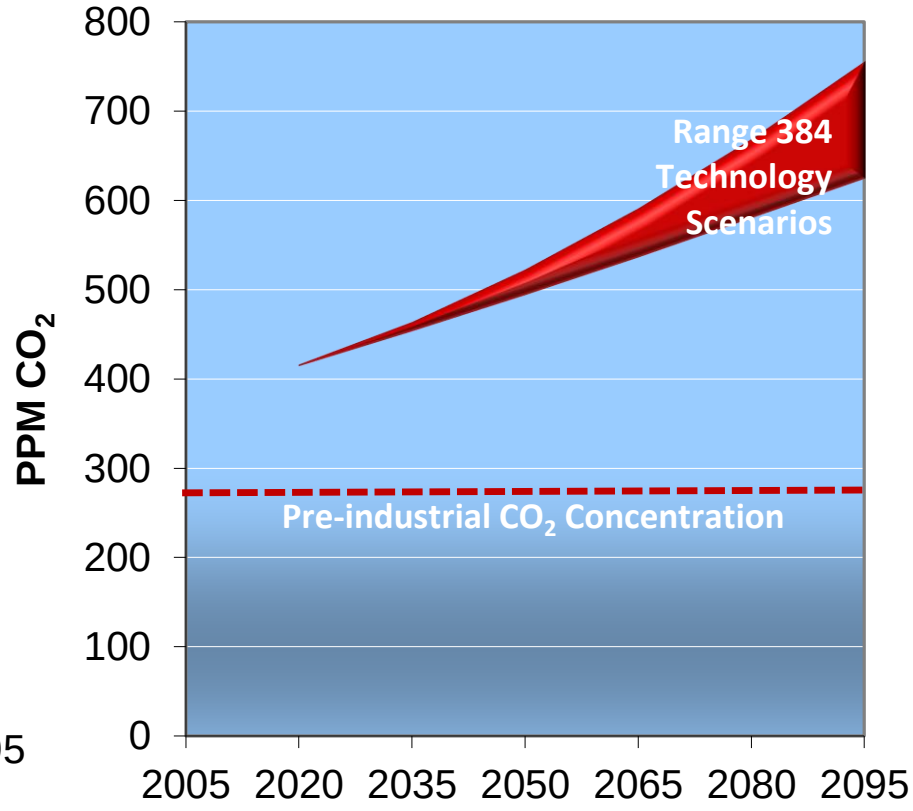
Range over 384 technology scenarios WITHOUT any explicit climate policy





Final Thoughts

- Climate change mitigation is tightly linked to land use patterns.
- Global trade makes land use “leakage” as or more challenging than industrial sector “leakage”.
- Meeting climate stabilization goals will require a dramatic transformation of the energy system.
- A primary role of technological change in climate mitigation is to reduce costs.
- Agricultural technological change is a key lever in climate mitigation.

- Addressing land use in the context of climate is different than addressing fossil and industrial emissions

Questions