Competitiveness of Terrestrial Greenhouse Gas Offsets: Are They a Bridge to the Future?

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Introduction

- Can agriculture and forestry provide a short term bridge to a longer term reduced-emissions future?
- How significant a contribution could agriculture and forestry make relative to non-agricultural (e.g., energy and industrial) mitigation possibilities?

Methodology for Assessment

- Models
  - FASOMGHG
  - Second Generation Model
- FASOMGHG coverage
  - FASOMGHG simulates production of 22 traditional crops, 3 biofuel crops, and 29 animal products in 63 U.S. regions, plus 8 forest commodities in a 100 year simulation
- Prospects for global analysis
  - Capabilities of FASOMGHG are not yet available for the globe
  - Modeling activities in Europe and Asia

FASOMGHG Overview

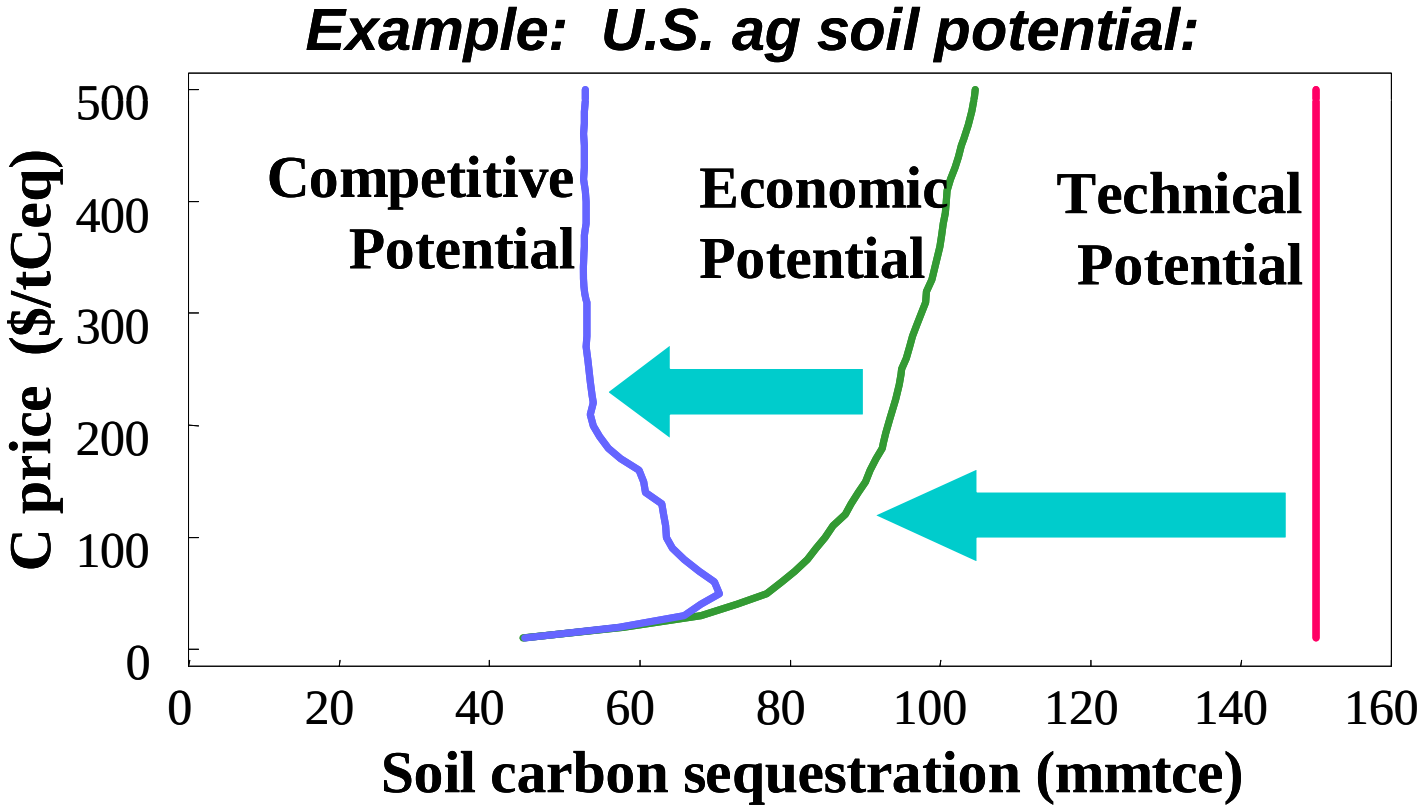
- Intertemporal, mathematical programming model depicting land transfers and other resource allocations among agricultural and forestry sectors in the U.S.
- 10-year time steps through 2100
- Endogenous variables
  - Commodity and factor prices
  - Production, consumption, export, and import quantities
  - Management strategy
  - Resource use
  - Economic welfare
- Greenhouse gas accounting
  - Carbon dioxide emissions and absorption
  - Methane emissions
  - Nitrous oxide emissions

FASOMGHG Activities

		GHG affected		
Mitigation strategy	**Strategy Nature**	**CO_2**	**CH_4**	**N_2O**
Biofuel production	Offset	X	X	X
Crop mix alteration	Emission, Sequestration	X		X
Rice acreage reduction	Emission		X	
Crop fertilizer rate reduction	Emission	X		X
Other crop input alteration	Emission	X		
Crop tillage alteration	Sequestration	X		
Grassland conversion	Sequestration	X		
Irrigated /dry land conversion	Emission	X		X
Livestock management	Emission		X	
Livestock herd size alteration	Emission		X	X
Livestock system change	Emission		X	X
Liquid manure management	Emission		X	X

Concepts for Assessing Mitigation Potential

Example: U.S. ag soil potential:



Greenhouse Gas Mitigation Options (SGM with FASOMGHG)

- Terrestrial
  - Soil sequestration
  - Forest management
  - Afforestation
  - Biofuel offsets
  - Crop energy management
- Non-CO_2 greenhouse gases
  - Exogenous marginal abatement cost curves
  - Developed by U.S. EPA for Energy Modeling Forum
  - Covers agriculture and industry
- Energy efficiency and fuel switching
- CO_2 capture and storage (CCS)

Second Generation Model

- SGM characteristics
  - Computable general equilibrium model of United States and other world regions
  - Five-year time steps from 1990 through 2050
  - Capital stocks are industry specific with a new vintage for each model time step
- CO_2 capture and storage with electric power
  - Engineering cost model for capture process from David and Herzog, 2000, “The Cost of Carbon Capture,” Proceedings of the Fifth International Conference on Greenhouse Gas Control Technologies
  - Constant cost of carbon disposal ($40 per tC)

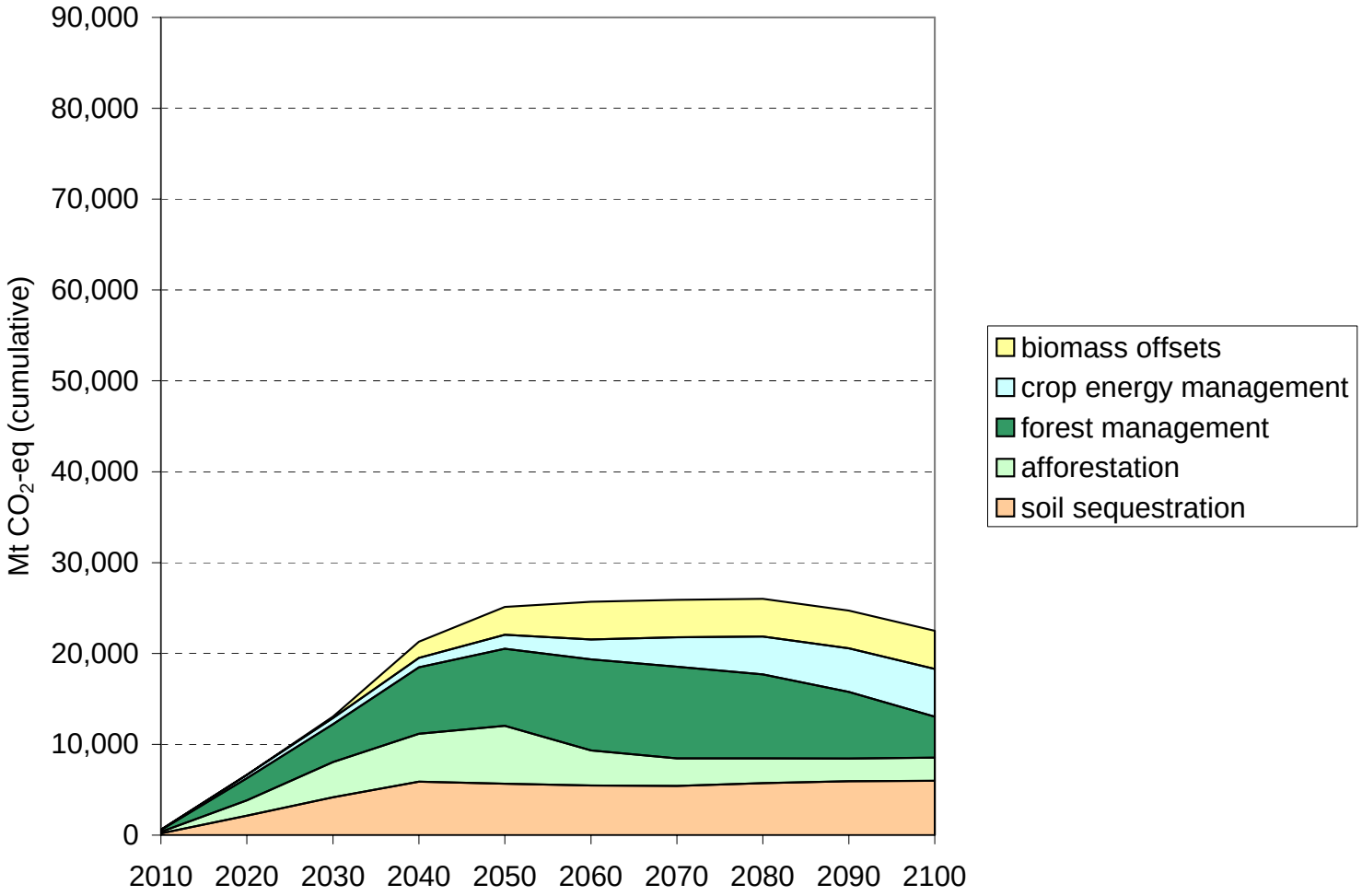
Synchronizing the Models

- Results from both FASOMGHG and SGM are path dependent
  - Level of greenhouse gas mitigation depends on current carbon price and time path of previous carbon prices (FASOMGHG also depends on future prices)
  - Consequence of dynamic structures in FASOMGHG and SGM
- Same time path of carbon prices is applied to FASOMGHG and SGM for consistency
- Options for carbon price paths
  - Hotelling
  - Constant carbon (dioxide) prices
- Following results at \$5, \$15, \$30, \$50 per t of CO_2-eq
  - Corresponds to prices of \$18.33, \$55.00, \$110.00, \$183.33 per t of carbon equivalent
  - Carbon dioxide prices start in 2010 and held constant thereafter

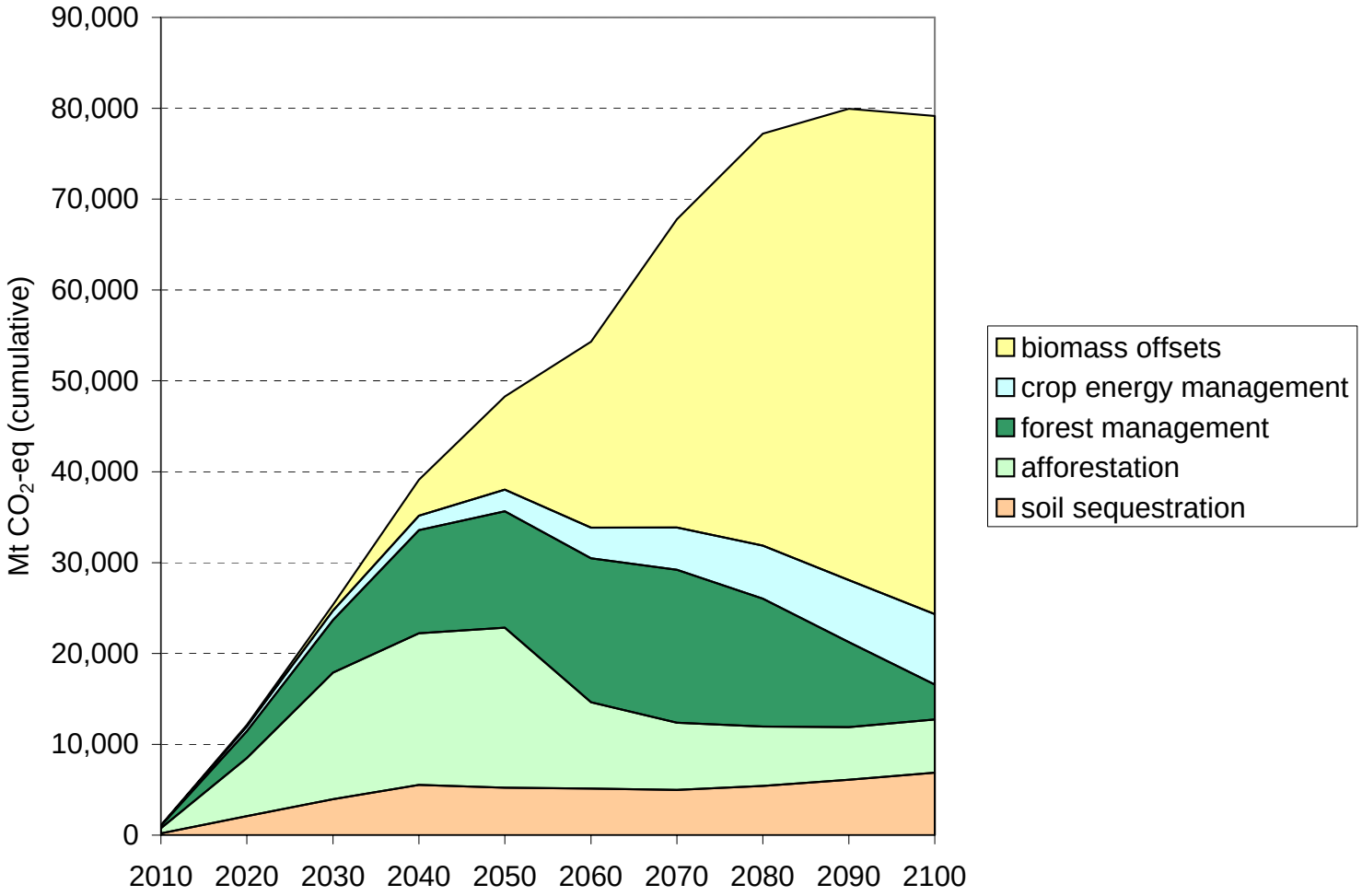
FASOMGHG Results

- Results reported as cumulative amount of CO_2-eq sequestered or emissions avoided over time
  - More accurate picture of dynamics
  - Soil sequestration saturates after three decades
  - Quantity of sequestered carbon may decline in later decades, especially when trees are harvested
- Charts shown for \$15 and \$30 per t CO_2-eq for 2010 through 2100

FASOMGHG Results ($15 per t CO_2-eq)



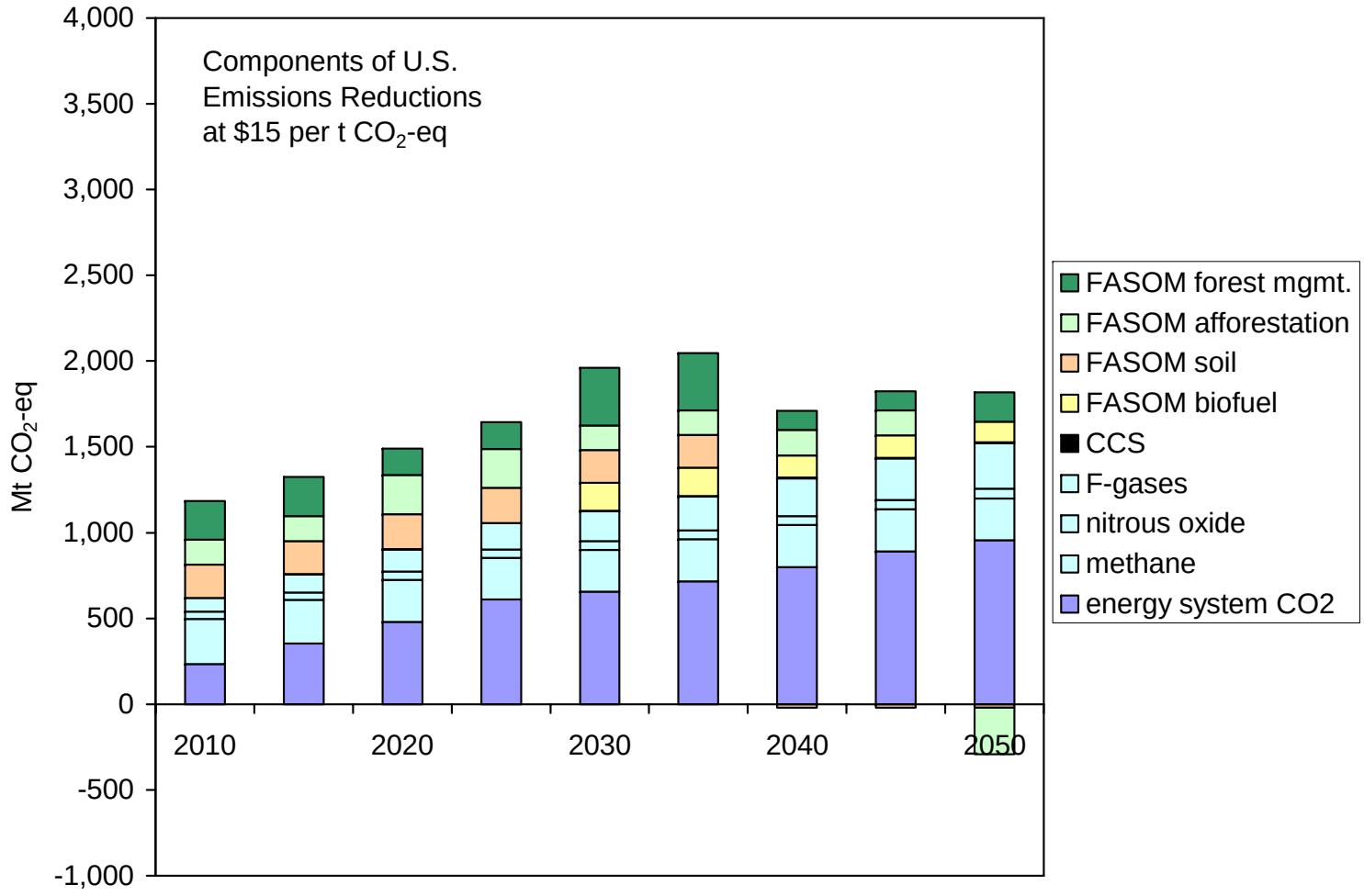
FASOMGHG Results ($30 per t CO_2-eq)



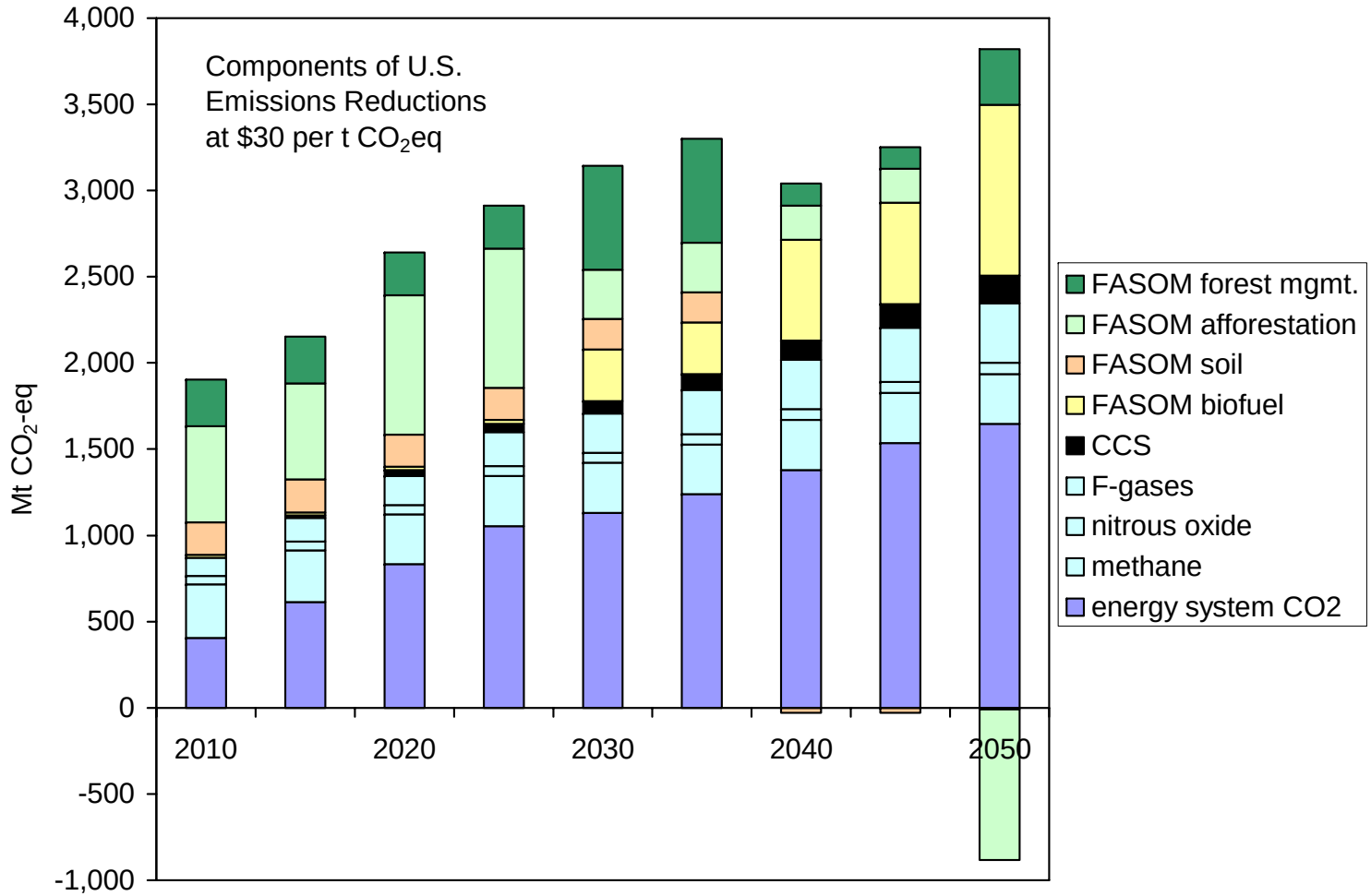
Combined Results

- FASOMGHG output converted from cumulative quantities to annual increments
- Mitigation potential is summed every five years across FASOMGHG and SGM
- Charts shown for $15 and $30 per t CO_2-eq for 2010 through 2050
- Annual increments for soil sequestration and afforestation can be negative in later decades

Combined Results ($15 per t CO_2-eq)



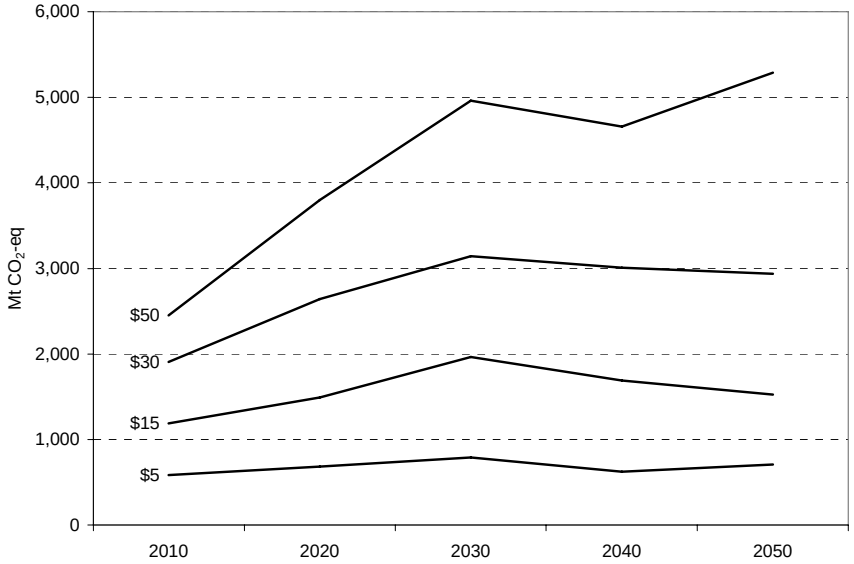
Combined Results ($30 per t CO_2-eq)



Strategic Comparison (1)

- Total mitigation potential across time and carbon prices
- Mitigation potential increases with CO_2 price, as expected
- Mitigation potential grows slowly over time at low CO_2 prices
  - Masks underlying trends in individual options
  - Terrestrial sequestration contribution decreases rapidly after initial decades

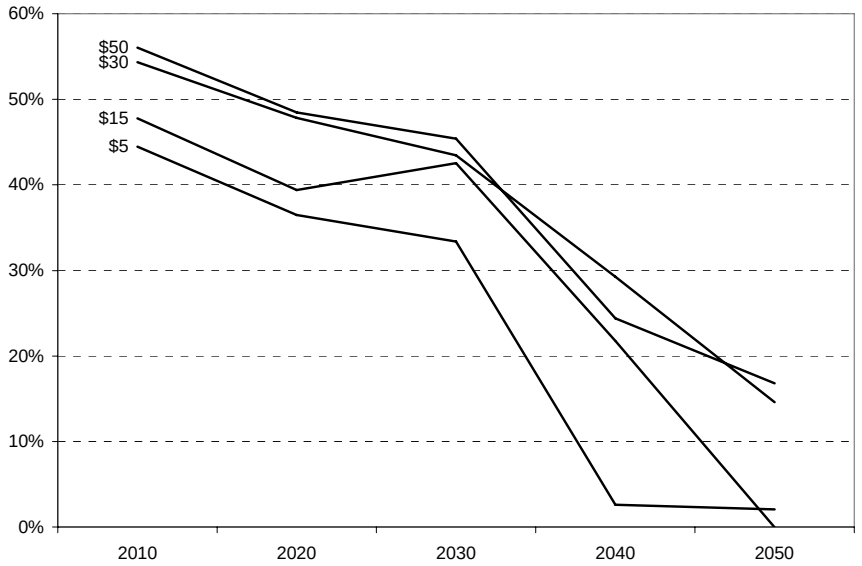
Total Mitigation Potential



Strategic Comparison (2)

- Contribution of terrestrial options
  - Large percentage of total in first three decades, even at high carbon prices
  - Biofuel offsets provide most of terrestrial contribution in later decades, but only at higher carbon prices

Terrestrial Fraction of Mitigation



Conclusions

- Terrestrial sequestration options are available in the early years of a carbon policy
  - Buy time to develop energy system alternatives that are capital intensive
  - However, terrestrial sequestration eventually saturates
  - Biofuels play an increasing role over time and at higher carbon prices
- Non-CO_2 greenhouse gas mitigation options are also available early relative to options in the energy system
- What is needed for global analysis?
  - Development of FASOMGHG for regions other that U.S.
  - Assessment of CO_2 capture and storage capabilities globally
  - Revisit non-CO_2 marginal abatement costs curves, especially in developing countries