

Competitiveness of Soil Carbon as an Option: Is it a Bridge to the Future?

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Overview

- ▶ Simulate a range of mitigation options in the United States
 - Terrestrial sequestration and biofuel offsets
 - Non-CO₂ greenhouse gases
 - CO₂ from energy system
 - CO₂ capture and storage from electric power
- ▶ No single model can simulate all activities and processes
- ▶ Develop strategy to determine relative contribution of mitigation options under hypothetical carbon policies
 - Multiple sources
 - Dynamics of capital stock turnover and saturation
 - Run a series of carbon price experiments

Mitigation Options

▶ Terrestrial Offsets

- Soil sequestration, Afforestation, Biofuel Offsets
- Agricultural Sector Model (McCarl, B.A. and Schneider, U.A. 2001. “Greenhouse Gas Mitigation in U.S. Agriculture and Forestry.” *Science* **294**, 2481-2482.)
- FASOM used for recent results on dynamics

▶ Non-CO₂ Greenhouse Gases

- Methane, Nitrous Oxide, F-gases
- Energy Modeling Forum (EMF-21) baselines and marginal abatement cost curves

▶ Energy System

- CO₂ emissions from energy combustion; CO₂ capture and storage (CCS) from electricity generation
- Battelle Second Generation Model

Carbon Price Experiments

Carbon Price in First Time Step (2015)

Hotelling Rate	\$50	\$100	\$150	\$200	\$300
0%					
1%					
2%					
3%					
4%					

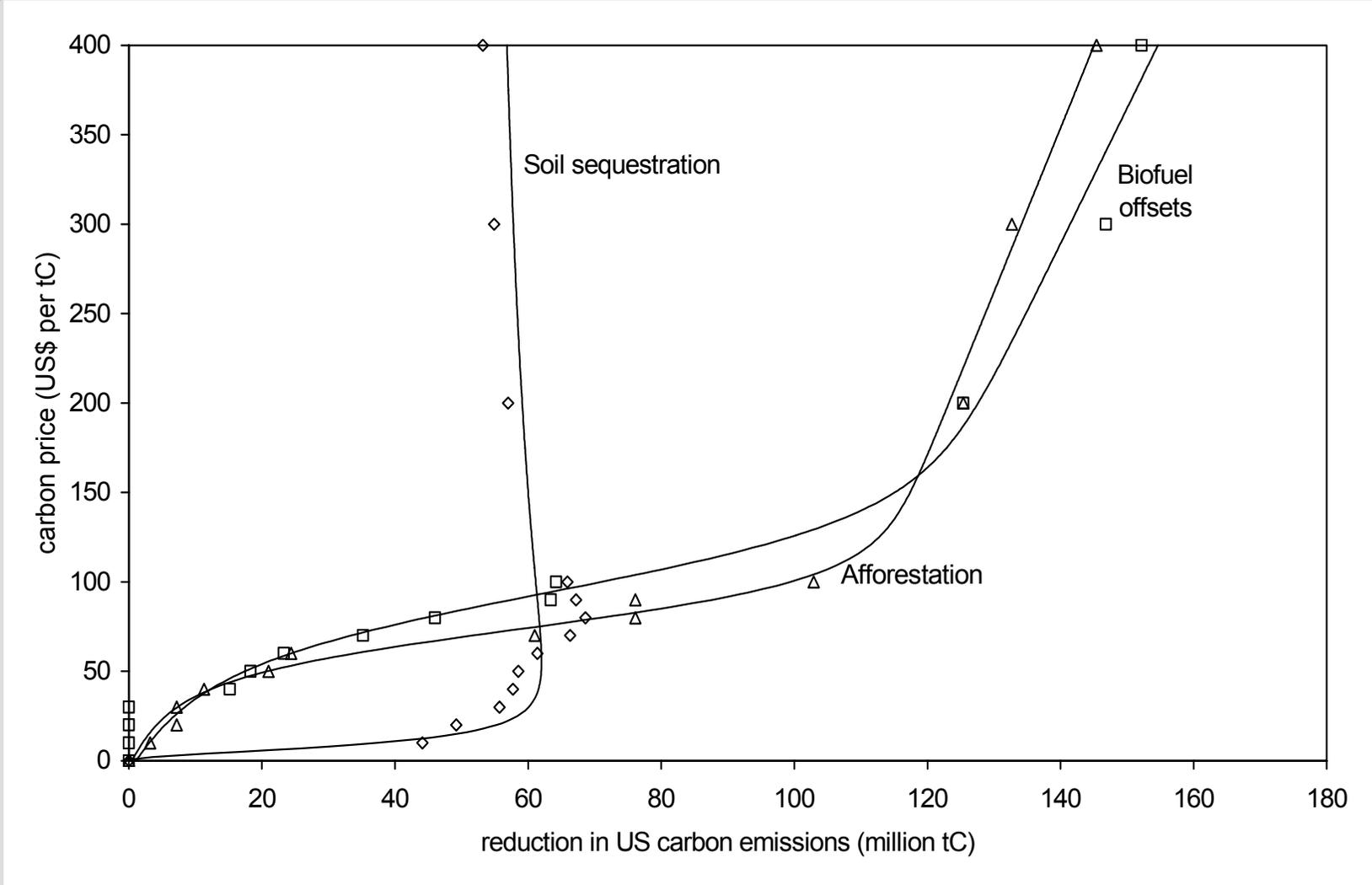
Mitigation Assessment in Agriculture

- ▶ Multi-period analysis of agriculture and forest response
- ▶ Examines overall and component response at varying carbon prices
- ▶ Simultaneous across all agricultural greenhouse gas mitigation strategies
- ▶ Simultaneous modeling of other agricultural environmental problems
- ▶ Based on life-cycle comparisons

GHG activities in FASOM

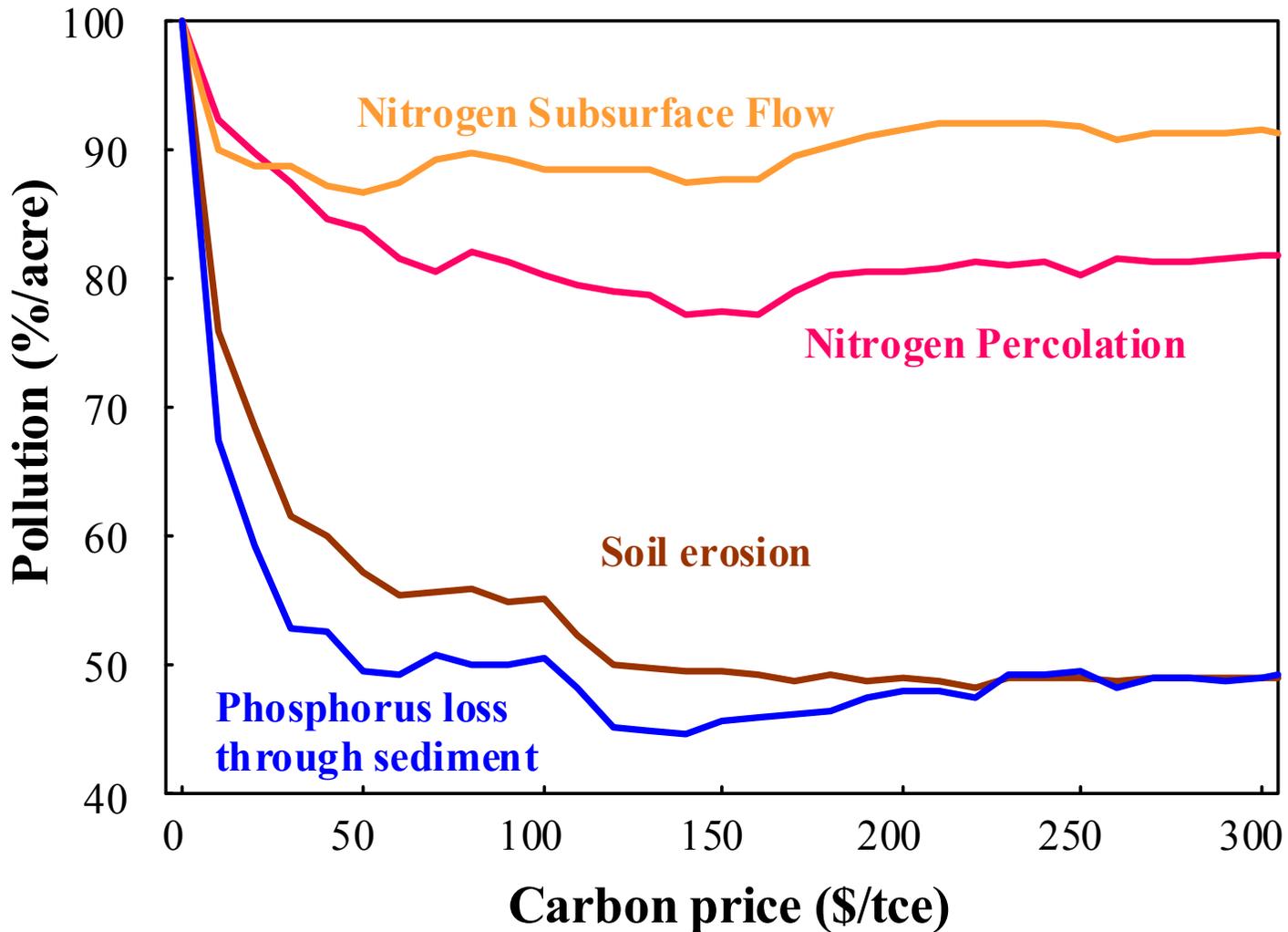
- ▶ Multiple GHG strategy setup
- ▶ Detailed GHG emission accounting
 - Forest carbon
 - Soil carbon
 - N₂O
 - CH₄
 - Fuel use carbon emissions
- ▶ National GHG balance
- ▶ GWP weighted sum of all GHG accounts
- ▶ GHG policy implementation

Reduction in carbon emissions from three activities simulated in the Agricultural Sector Model



Source: McCarl and Schneider (2001)

Multi-environmental Impacts



Source: Pattanayak, S.K., A.J. Sommer, B.C. Murray, T. Bondelid, B.A. McCarl, and D. Gillig, "Water Quality Co-Benefits of Greenhouse Gas Reduction Incentives in Agriculture and Forestry," Report to EPA, 2002.

Second Generation Model

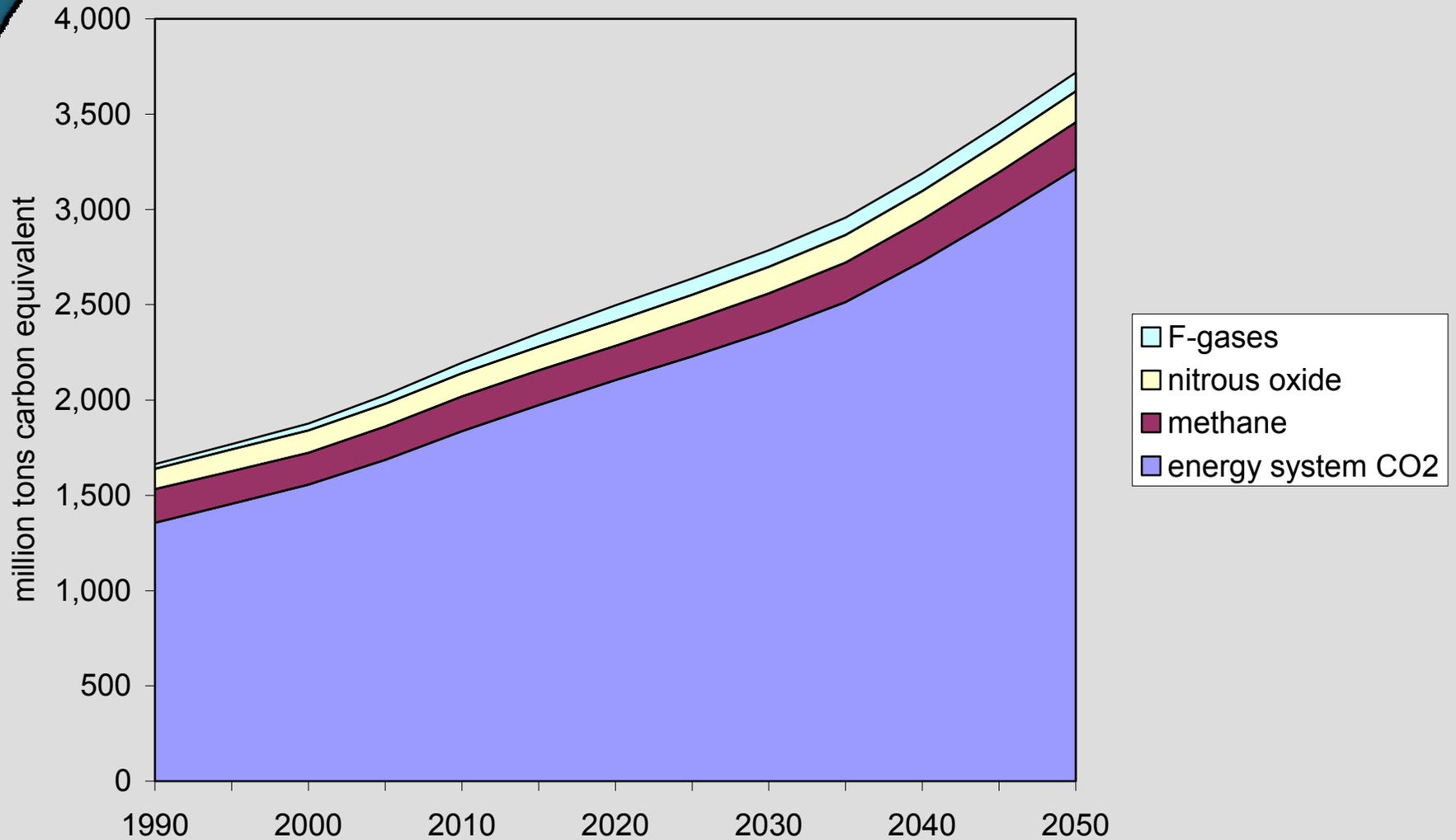
▶ SGM characteristics

- 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

▶ Carbon capture and disposal from 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 CO₂ storage (\$40 per tC)

U.S. Carbon Equivalent Emissions (baseline)

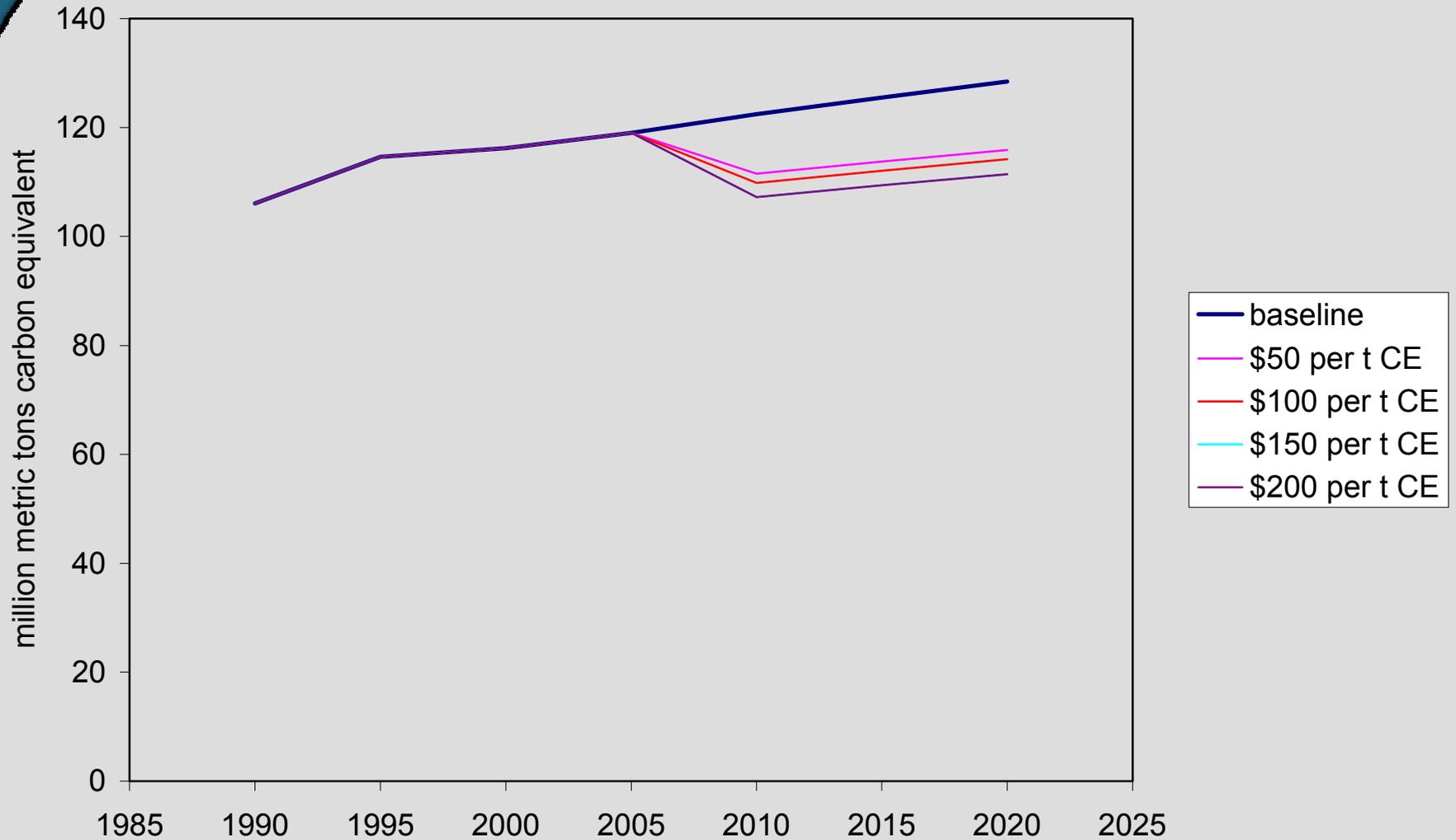


- F-gases
- nitrous oxide
- methane
- energy system CO2

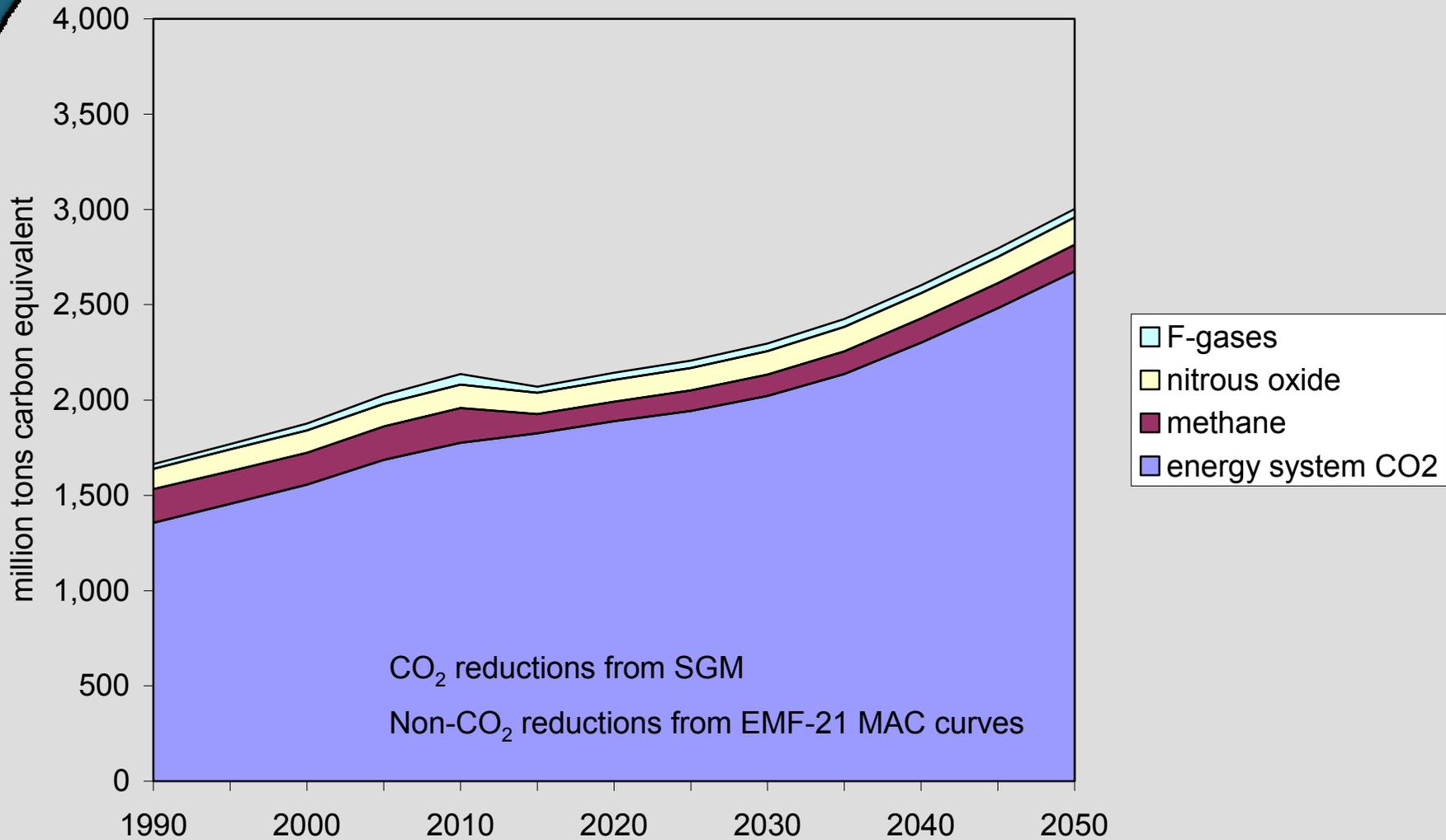
EMF-21 Baseline and Mitigation for USA: Methane



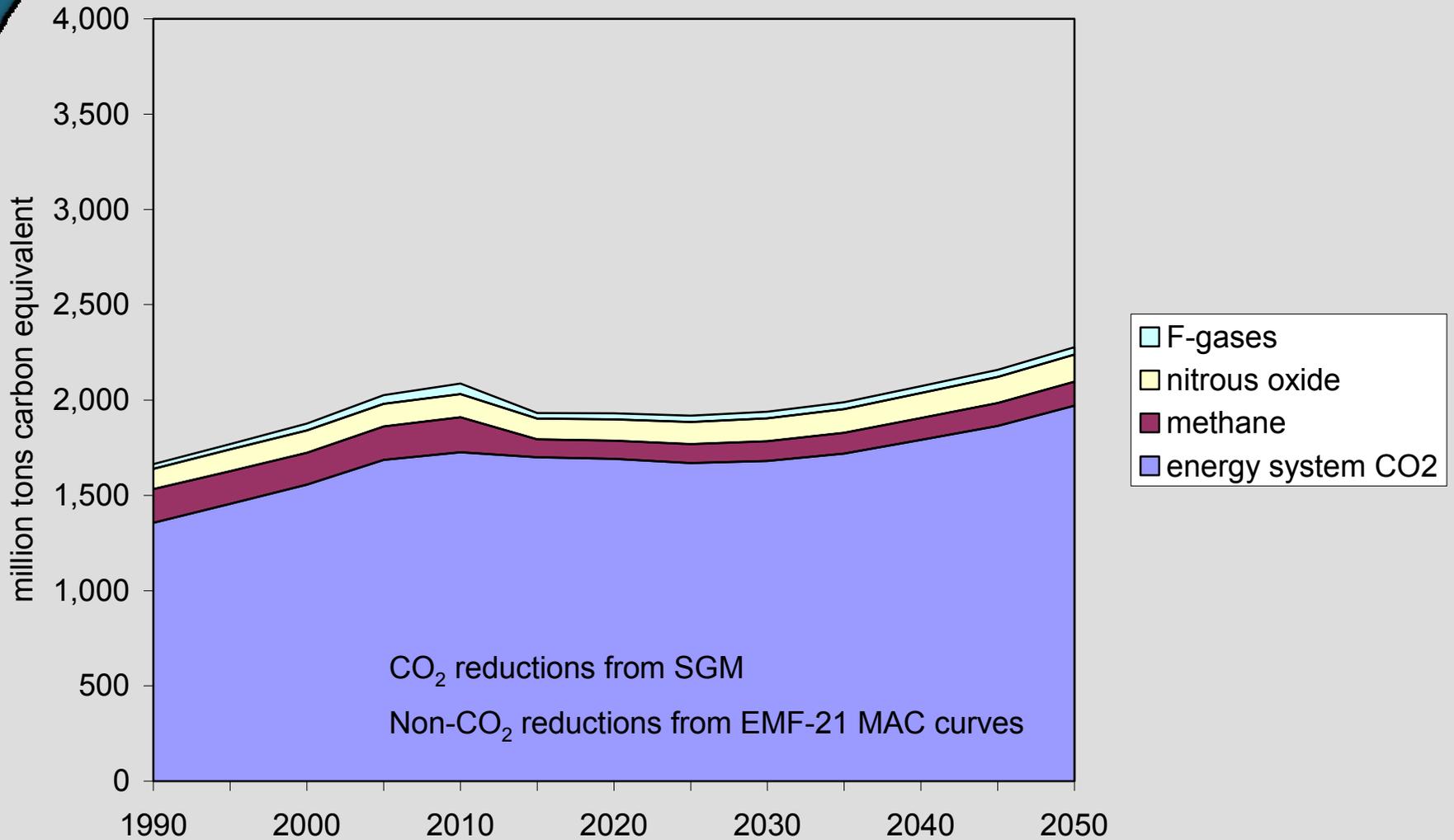
EMF-21 Baseline and Mitigation for USA: Nitrous Oxide



U.S. Carbon Equivalent Emissions (\$100 constant)

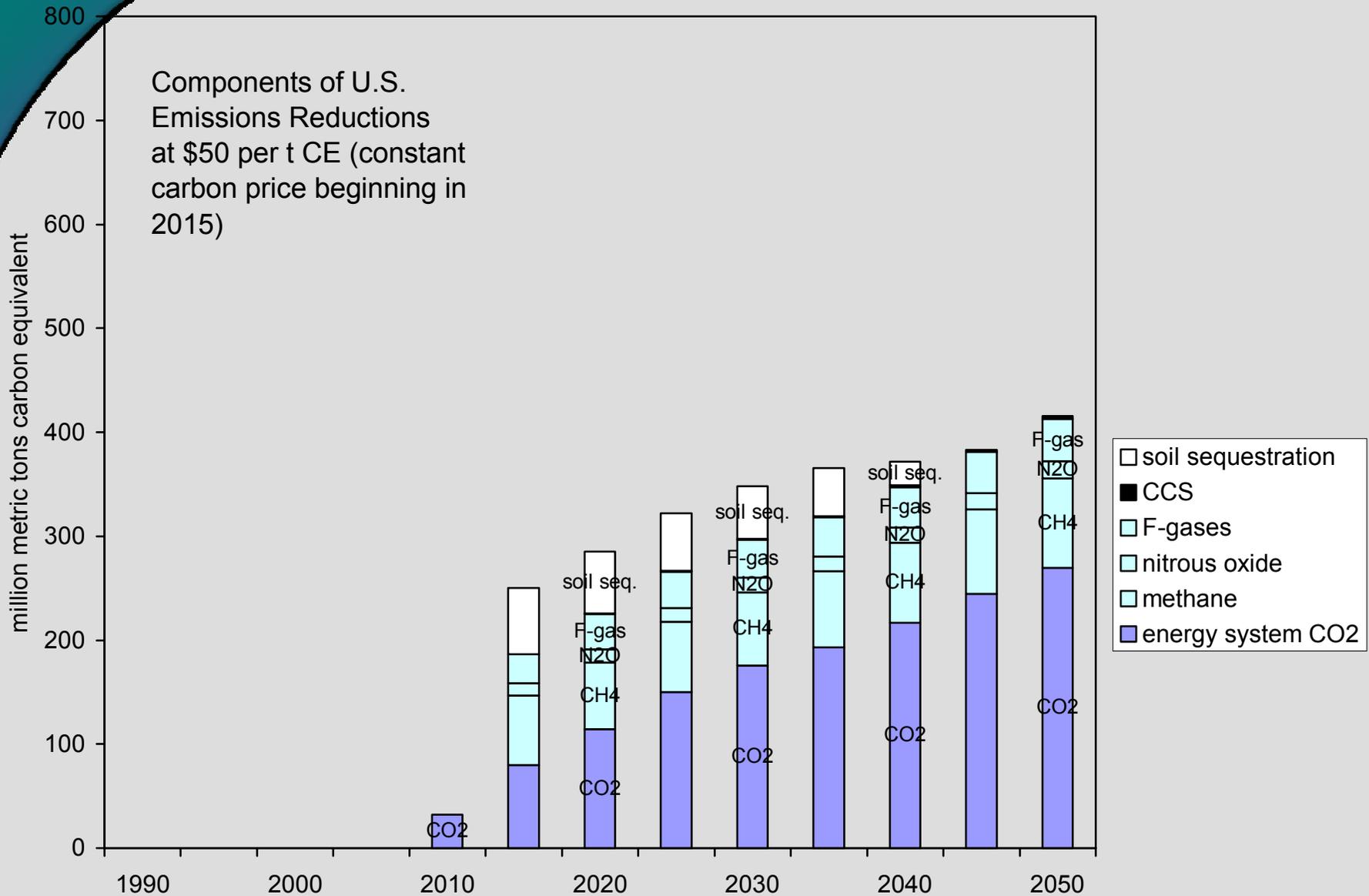


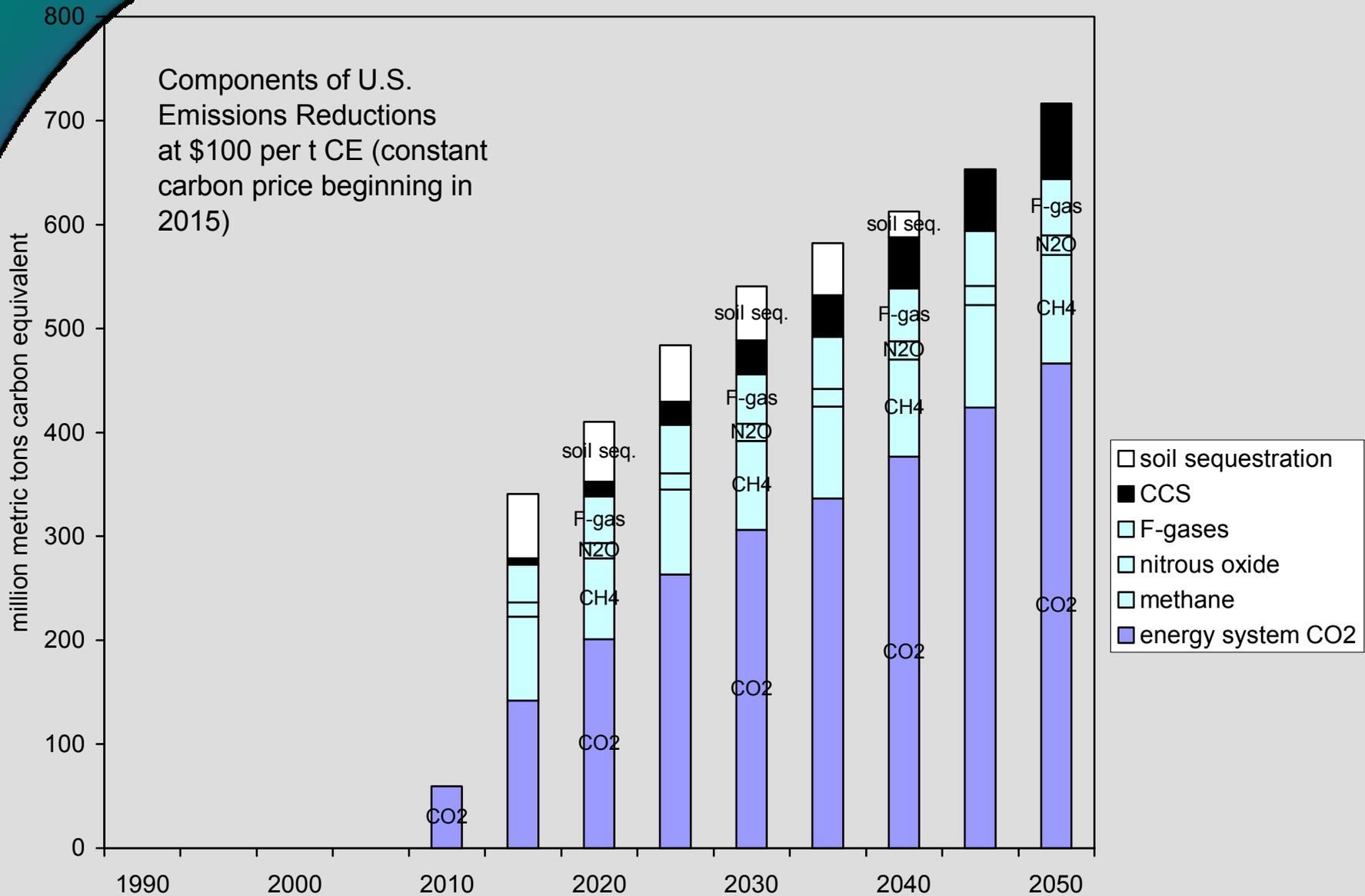
U.S. Carbon Equivalent Emissions (\$200 constant)



Combining Results across Mitigation Options

- ▶ Soil carbon
 - Cost-effective in short term at low carbon prices
 - Saturates after 20 or 30 years
- ▶ CO₂ Capture and Storage
 - Cost-effective at higher carbon prices
 - Limited in short term by turnover of existing capital stock
 - Large future potential
- ▶ Non-CO₂ greenhouse gases
 - Cost-effective at low carbon prices in the short term
- ▶ Energy end-use reductions
 - Increases along with carbon price
 - Limited in short term by turnover of existing capital stock





Other Considerations

- ▶ Will terrestrial mitigation options operate at same carbon price margin as options from energy system? Real-world policy proposals place constraints on allowed offsets.
- ▶ Understanding what is in the baseline and what is not
- ▶ Dynamic considerations
 - Capital stock dynamics: How soon will you see emissions reductions?
 - Saturation
 - Permanence
 - Transactions costs
 - Interactions between mitigation options