

Non-CO₂ Greenhouse Gases in the Second Generation Model

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EMF-21: Multi-Gas Mitigation and Climate Change

- Study Objective: Compare and contrast “CO₂-only” mitigation with “multi-gas” mitigation for given global emissions scenarios and targets
- Analysis sponsored by the Stanford Energy Modeling Forum
 - forum within which energy experts from government, industry, universities, and other research organizations meet to study energy and environmental issues, including global climate change

EMF 21: “CO₂-Only” Scenario

- Long-term, “CO₂-Only” Stabilization Scenario
 - Stabilize radiative forcing at 4.5 Wm⁻² relative to pre-industrial times by 2150
 - This corresponds to an equilibrium temperature change of 3.0° C, for a 2.5° C per CO₂ doubling climate sensitivity
 - Policy only controls CO₂ emissions

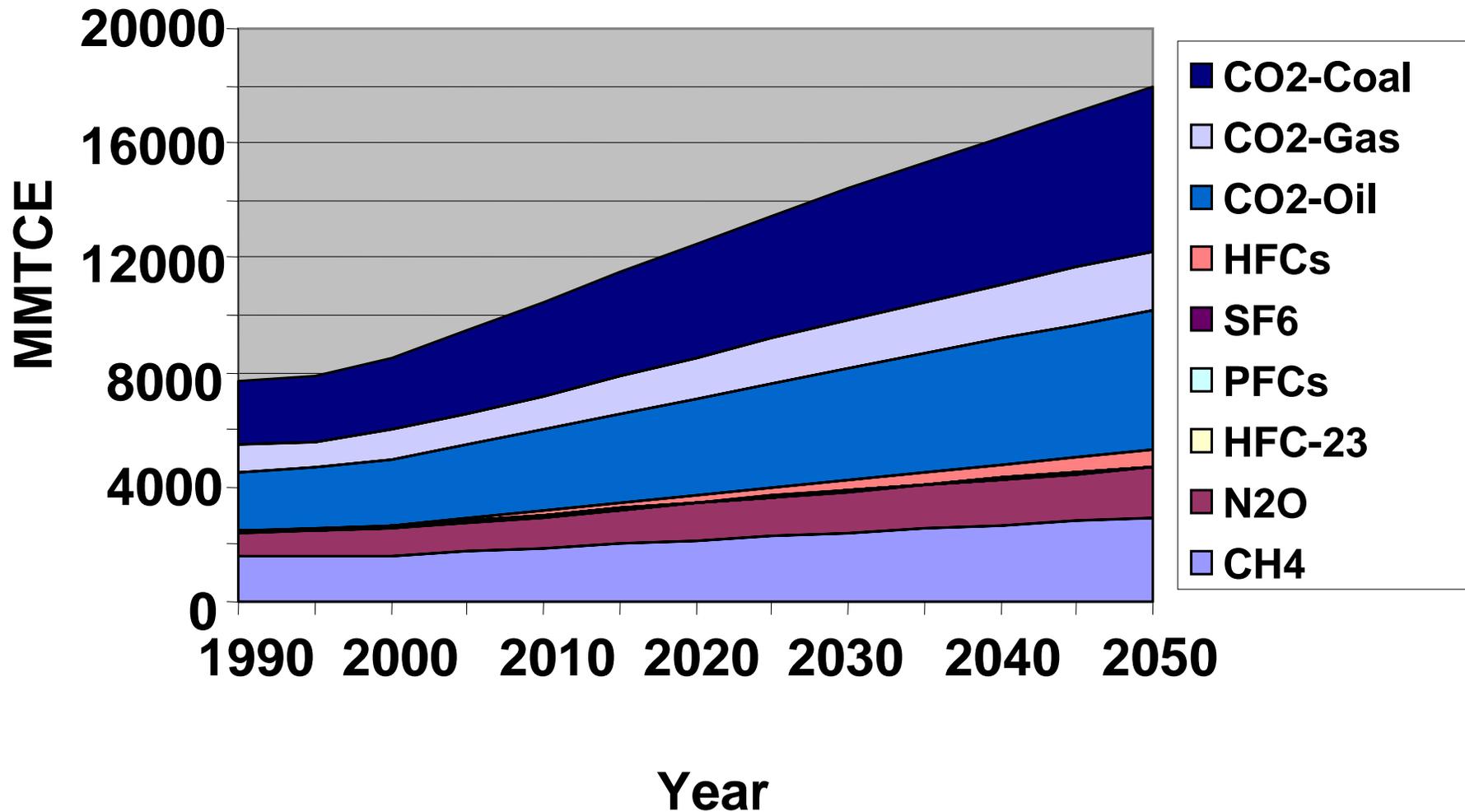
EMF 21: “Multi-Gas” Scenarios

- Long-term, “Multi-Gas” Stabilization Scenario
 - Stabilize radiative forcing at 4.5 Wm^{-2} relative to pre-industrial times by 2150
 - This corresponds to an equilibrium temperature change of 3.0° C , for a 2.5° C per CO_2 doubling climate sensitivity
 - Policy controls on all greenhouse gases (i.e., CO_2 , CH_4 , N_2O , HFCs, HFC-23a, PFCs, and SF_6)
 - Emissions targets based on total carbon equivalent emissions

Second Generation Model (SGM)

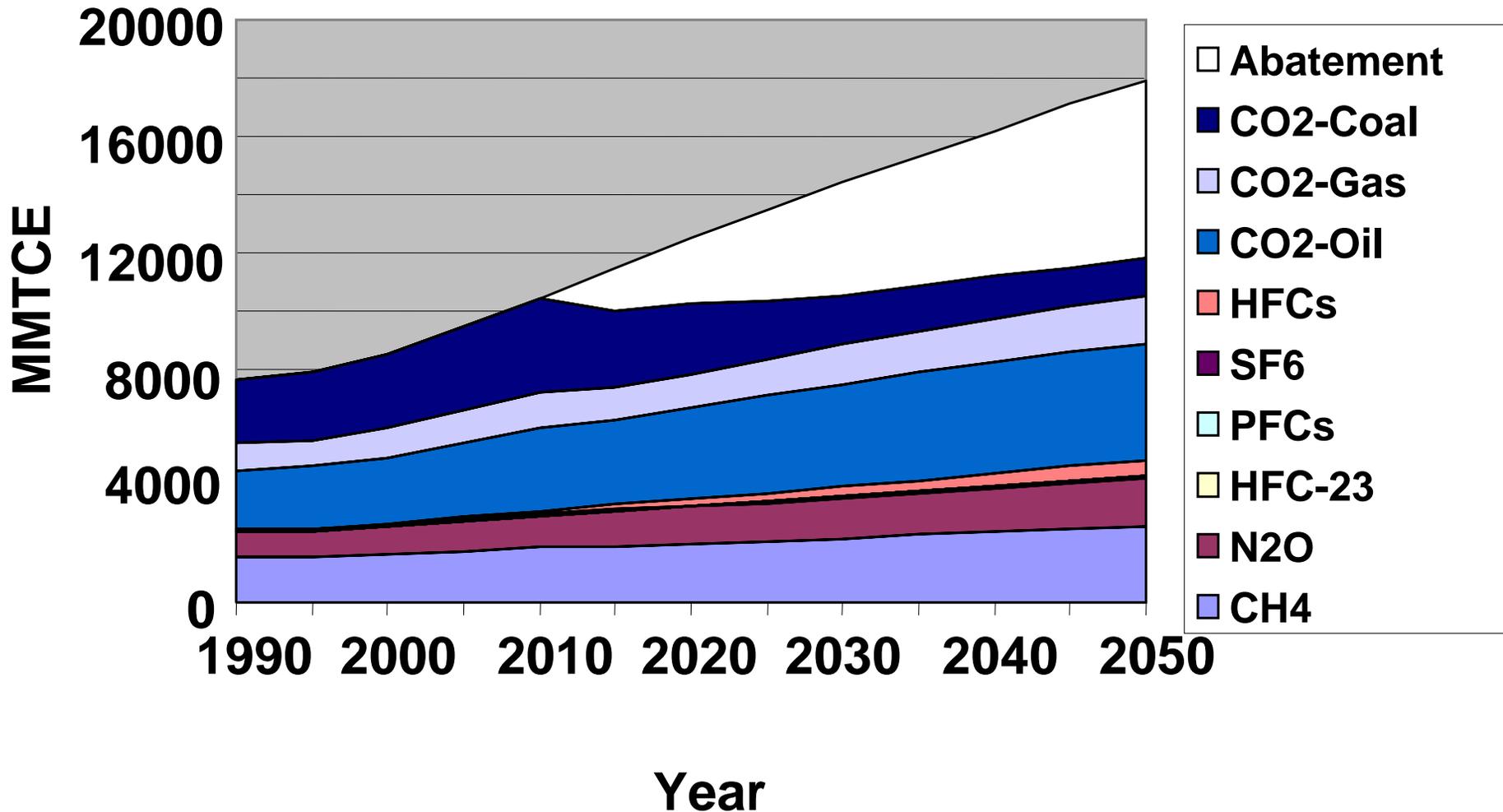
- Set of 13 regional dynamic recursive CGE models
 - U.S., Aus. & NZ, Canada, Eastern Europe, Former Soviet Union, India, Japan, Korea, Mexico, Middle East, Western Europe, Rest of World
- Emphasis on energy transformation, energy consumption, and greenhouse gas emissions
- Model runs from 1990 – 2050 in five-year time steps
- Keeps track of capital stocks in five-year vintages by sector
- Energy balance is maintained throughout the model time horizon
- 7 gases: CO₂, CH₄, N₂O, HFCs, HFC-23, PFCs, SF₆

SGM "Reference Case" Emissions



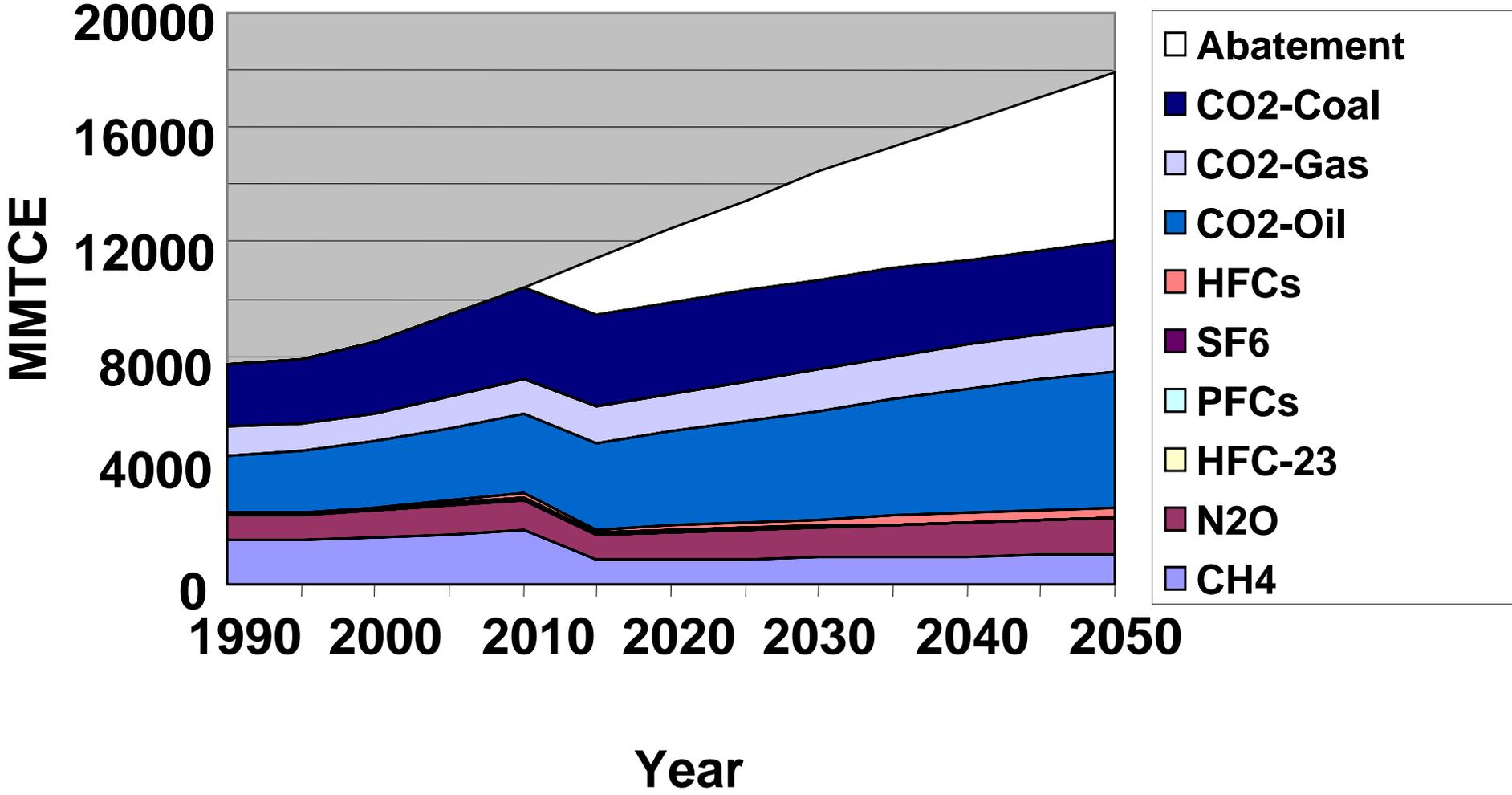
- **29% of Emissions from Non-CO₂ GHGs in 2050**

SGM “CO₂-Only” Policy Emissions



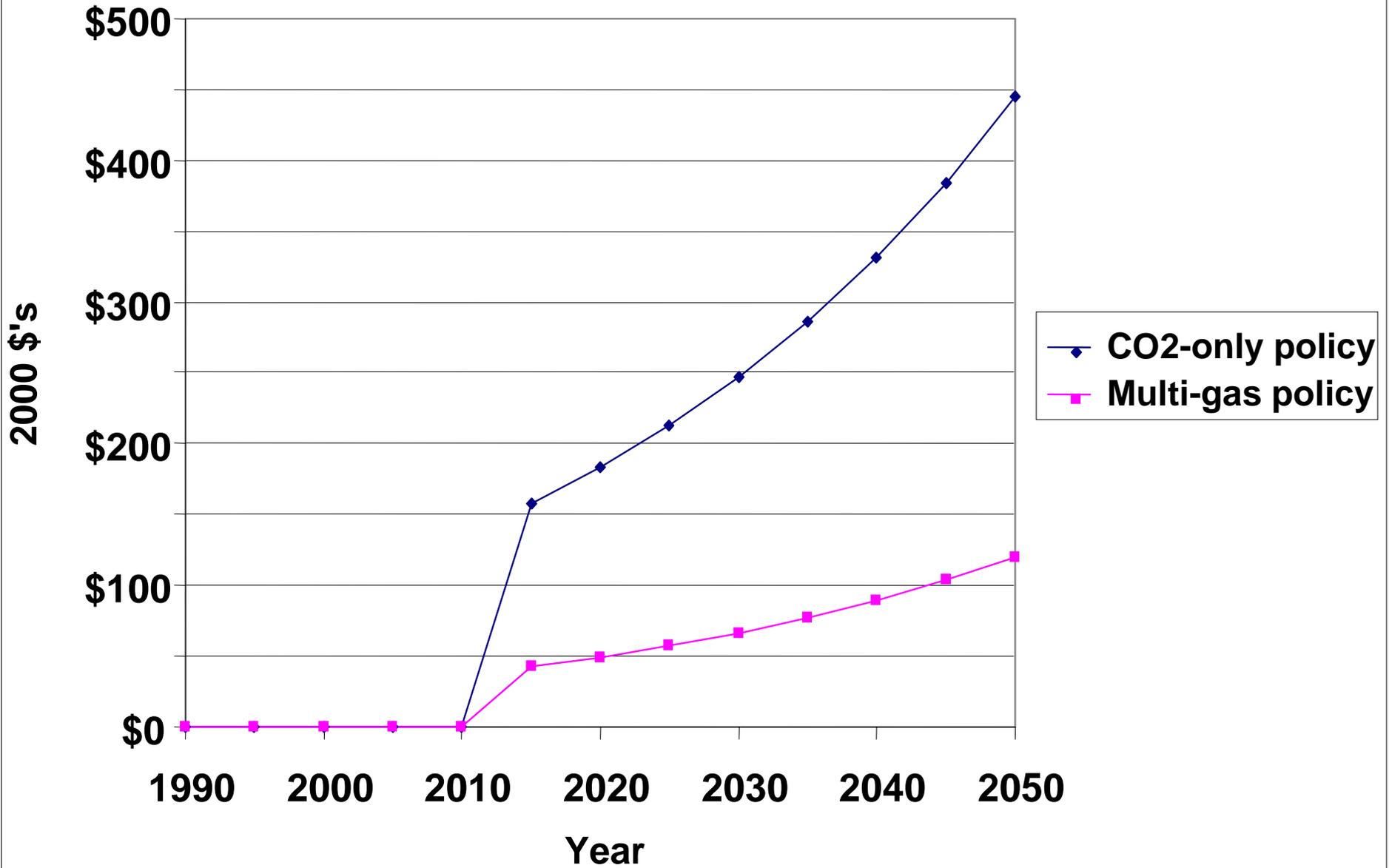
- 41% of Emissions from non-CO₂ GHGs in 2050

SGM “Multi-Gas” Policy Emissions

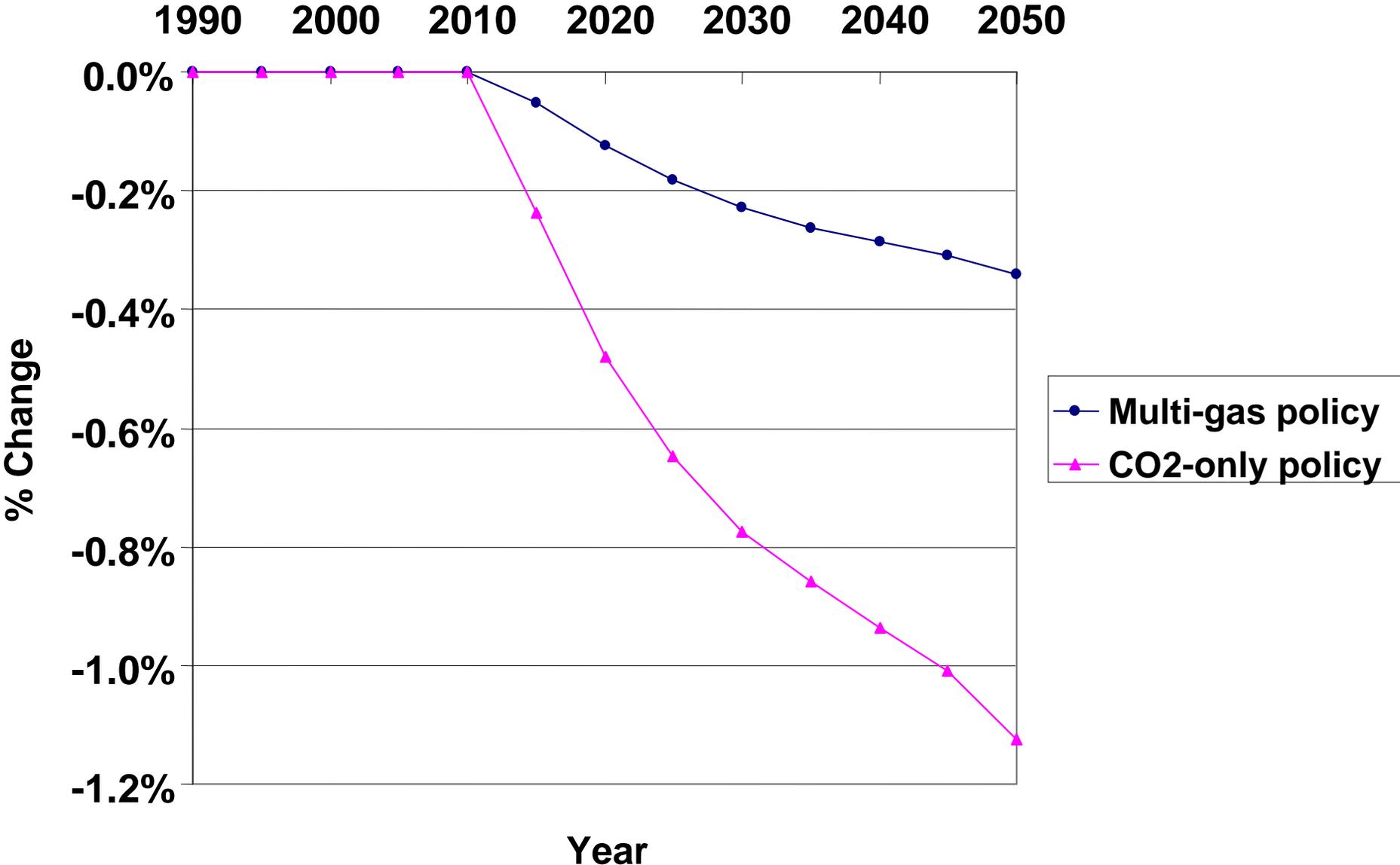


• 22% of Emissions from non-CO₂ GHGs in 2050

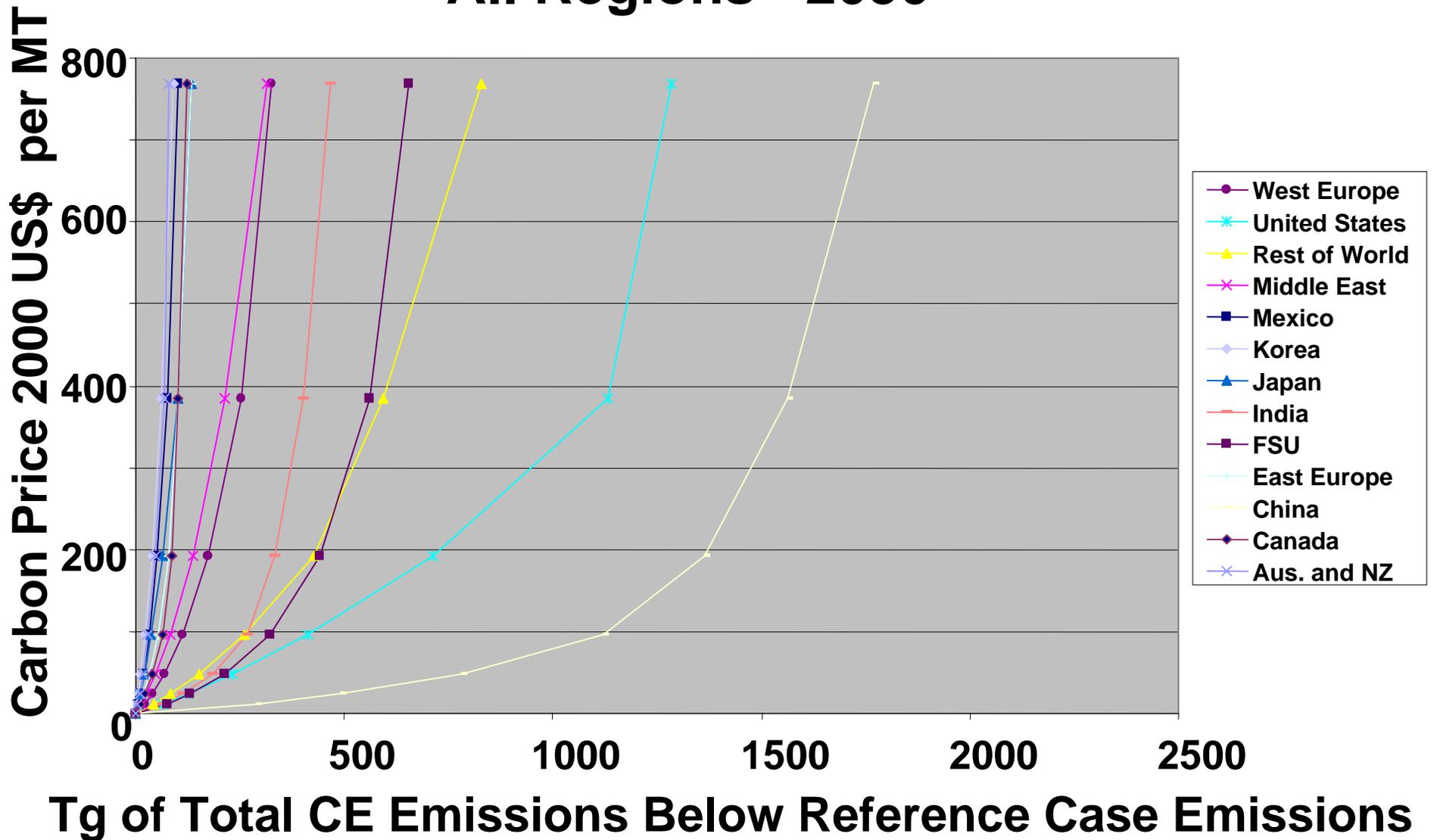
SGM Carbon (Equivalent) Price



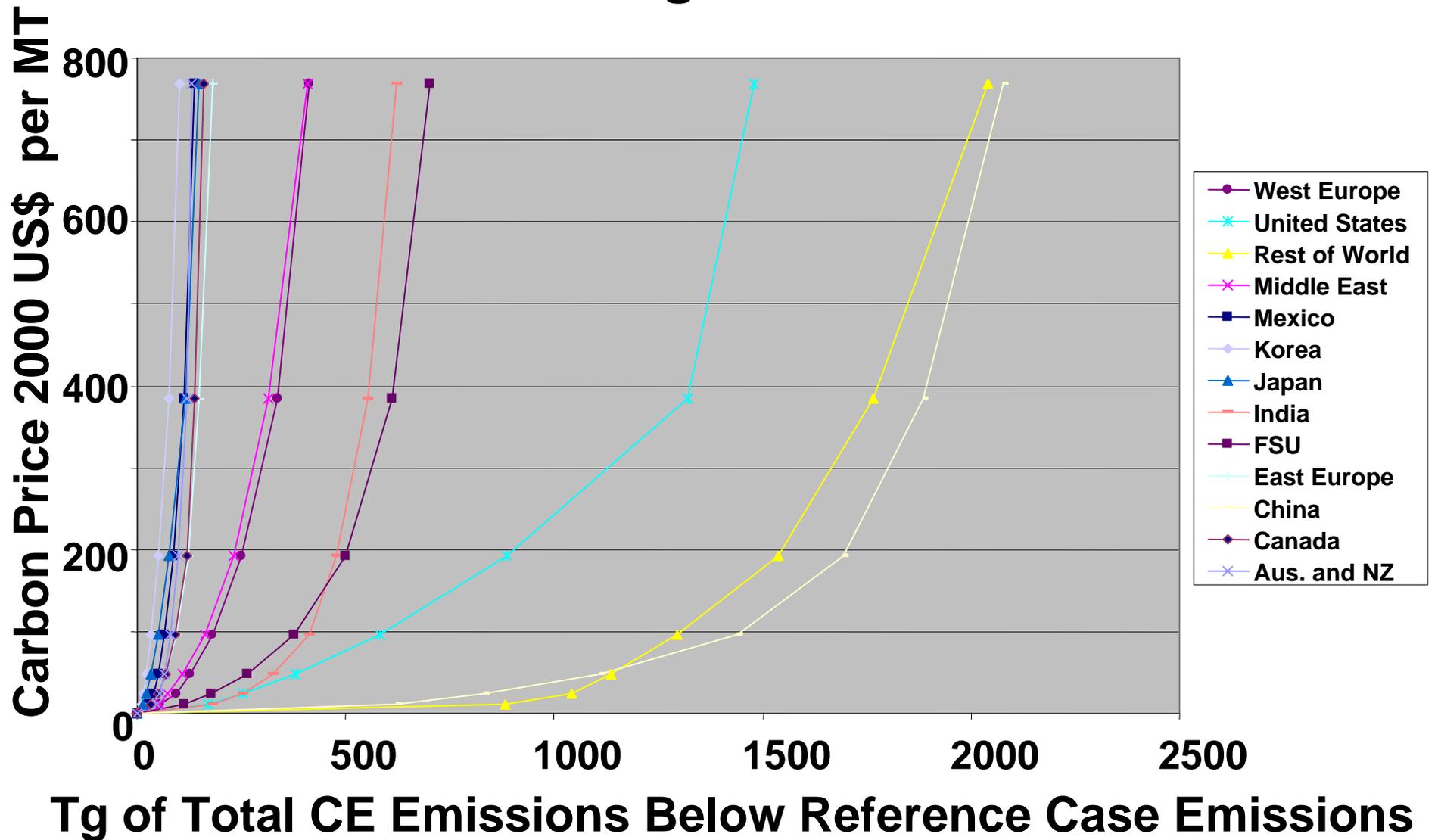
SGM % Change in Global GNP



“CO₂-Only” Policy - Marginal Abatement Curves All Regions - 2050



“Multi-Gas” Policy- Marginal Abatement Curves All Regions - 2050



Multi-Gas and Terrestrial Mitigation Options in SGM-USA

SGM-USA

- SGM-USA is a single-country recursive CGE model
 - Incorporates additional features not available in the global version of SGM
 - Often used as a “test bed” for new options in the model before they are implemented in the global SGM

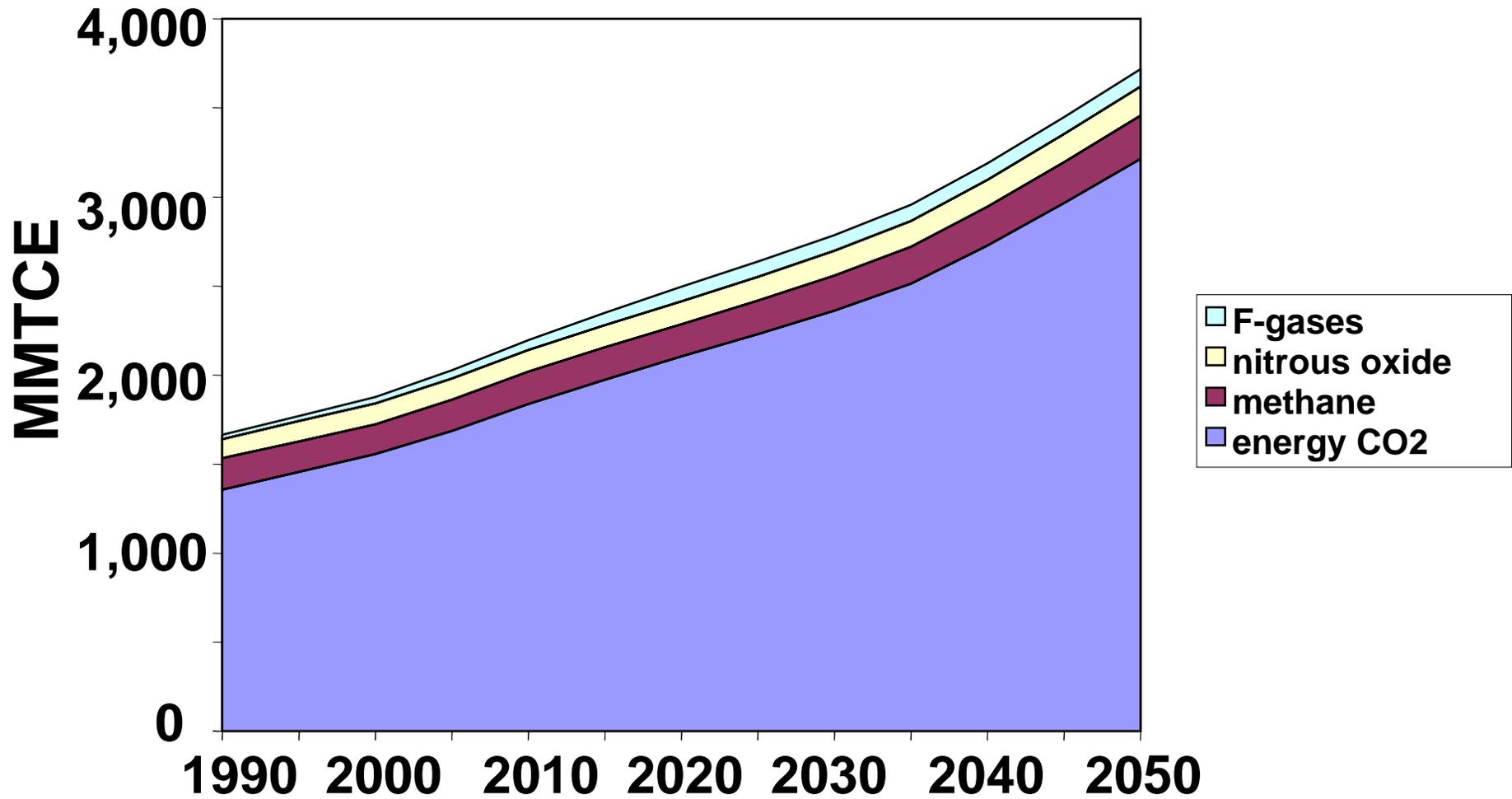
Range of Mitigation Options Within SGM-USA

- Range of mitigation options within SGM-USA
 - CO₂ from energy system
 - From traditional oil, gas, and coal as in the Global SGM
 - Also from advanced energy generation technologies (IGCC, NGCC)
 - Non-CO₂ greenhouse gases
 - Methane, Nitrous Oxide, F-gases
 - Energy Modeling Forum (EMF-21) baselines and marginal abatement cost curves

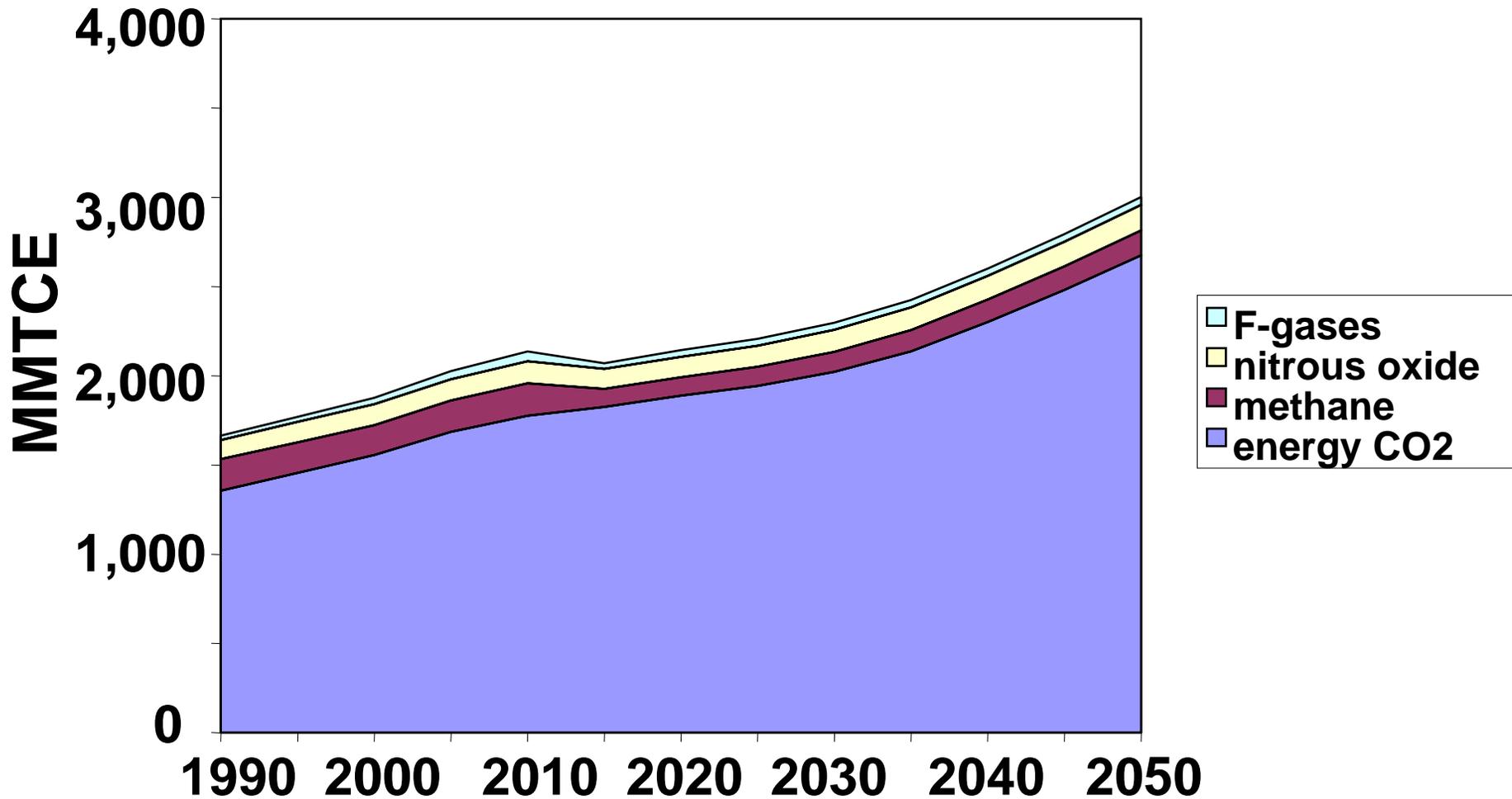
Range of Mitigation Options Within SGM-USA

- Carbon Capture and Storage from Electric Power
 - IGCC, NGCC, and PC all with carbon capture and storage
 - 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)
- Terrestrial Offsets
 - Soil sequestration, Afforestation, Biofuel Offsets from McCarl, B.A. and Schneider, U.A. 2001. “Greenhouse Gas Mitigation in U.S. Agriculture and Forestry” *Science*

U.S. Carbon Equivalent Emissions (baseline)

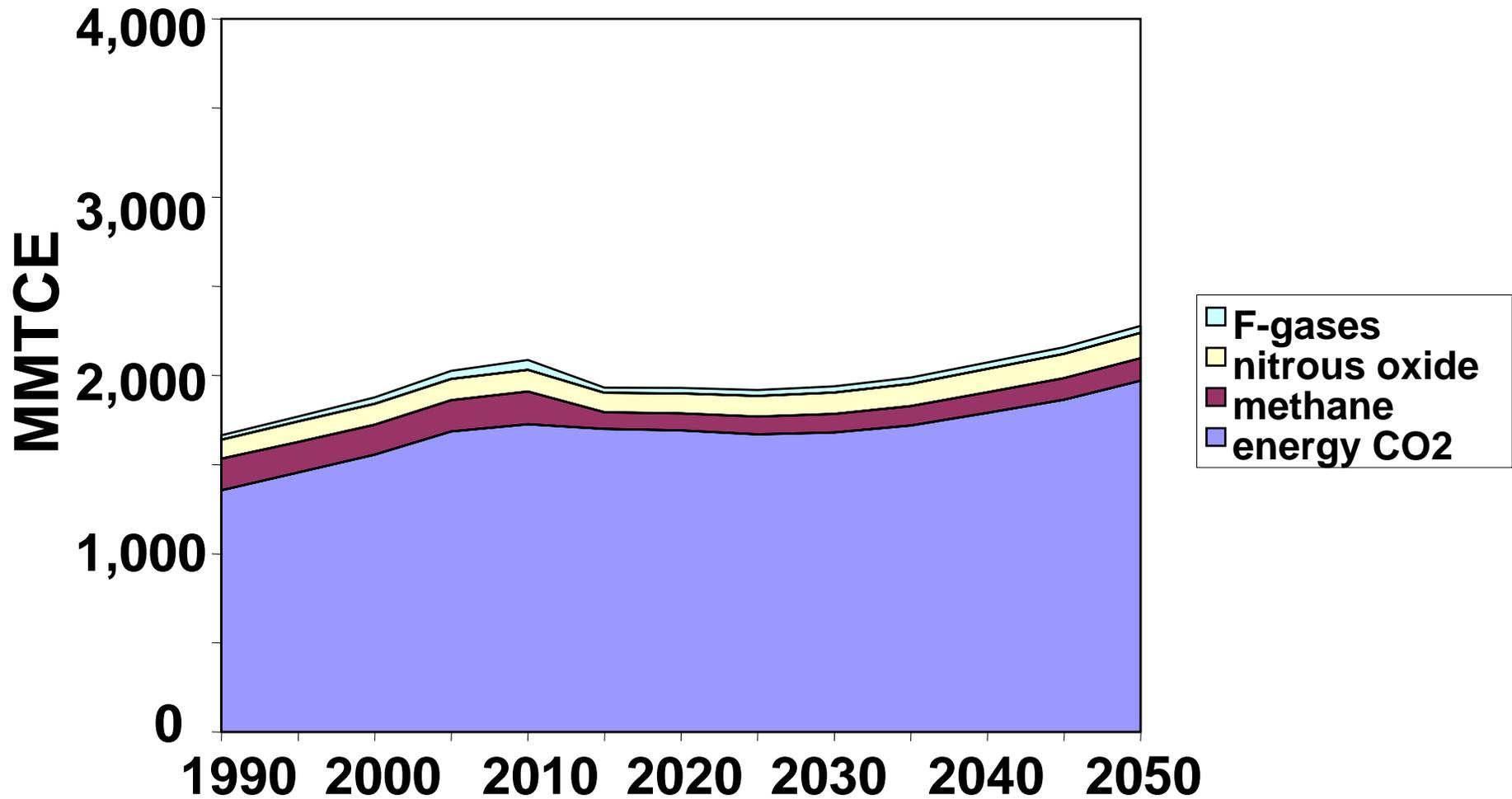


U.S. Carbon Equivalent Emissions (\$100 constant)



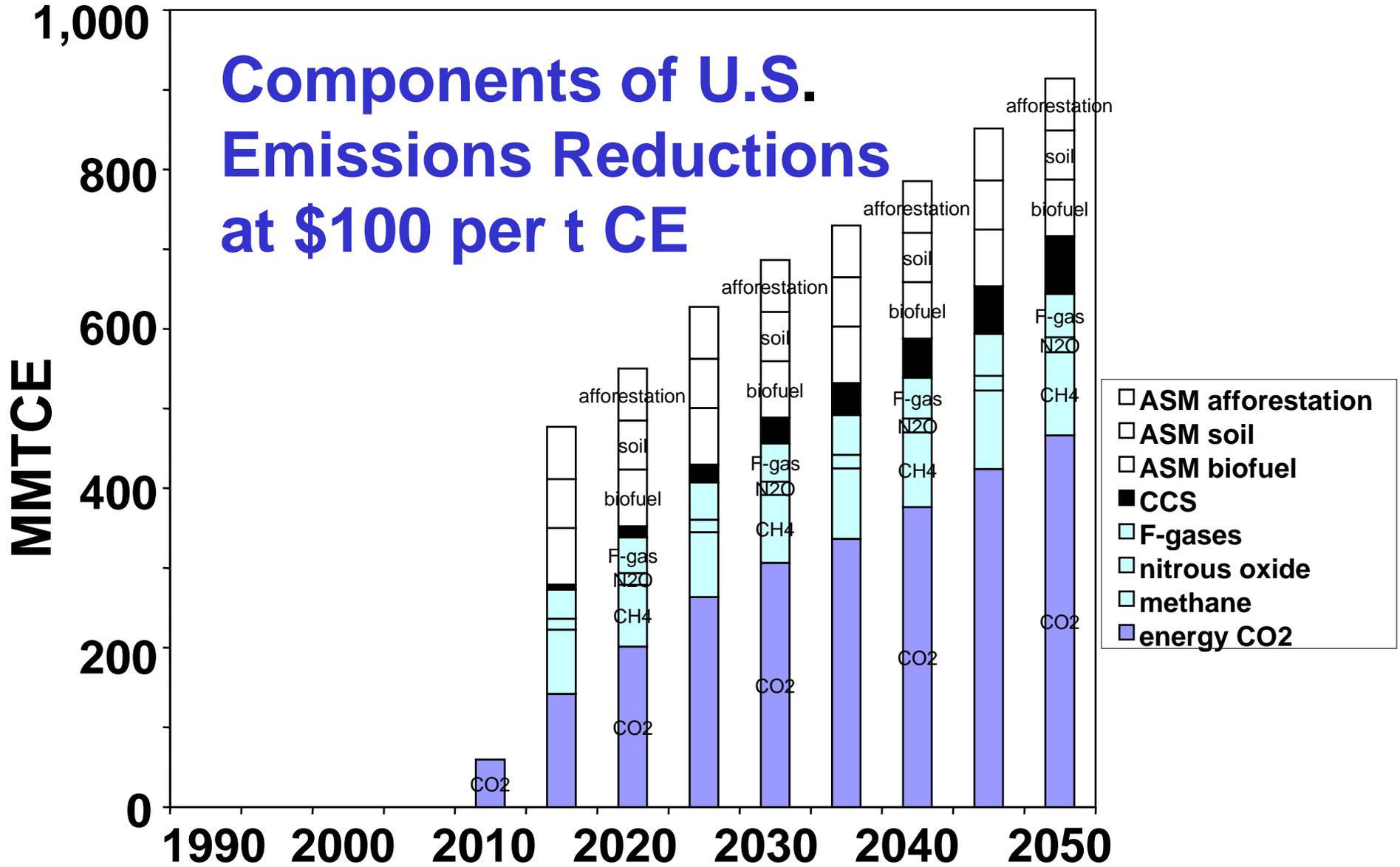
- Emissions roughly return to 2010 levels in 2020

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



- Emissions roughly return to 2000 levels in 2020

Components of U.S. Emissions Reductions at \$100 per t CE



Components of U.S. Emissions Reductions at \$200 per t CE

