

# Marginal Abatement Curves in the Energy-Systems GMM Model

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# Outline

- The energy-systems GMM model
- Multi-gas mitigation
- Implementing marginal abatement curves
- Some results
- Concluding remarks

# The Energy-Systems GMM Model

- Global, five-region, energy-systems MARKAL model (Barreto, 2001; Rafaj *et al.*, 2004)
- Calibrated to year-2000 statistics
- Endogenized technology learning
- Time horizon 2000-2050, 10-year steps
- Relative detail in energy supply technologies
- Stylized representation of end-use technologies

# Multi-gas Mitigation

- Inclusion of non-CO<sub>2</sub> GHGs is important for the examination of strategies to mitigate climate change
- The consideration of non-CO<sub>2</sub> GHGs may lead to noticeable effects on costs and composition of mitigation measures (Reilly *et al.*, 2003)
- Marginal abatement curves or bottom-up representation of mitigation technologies

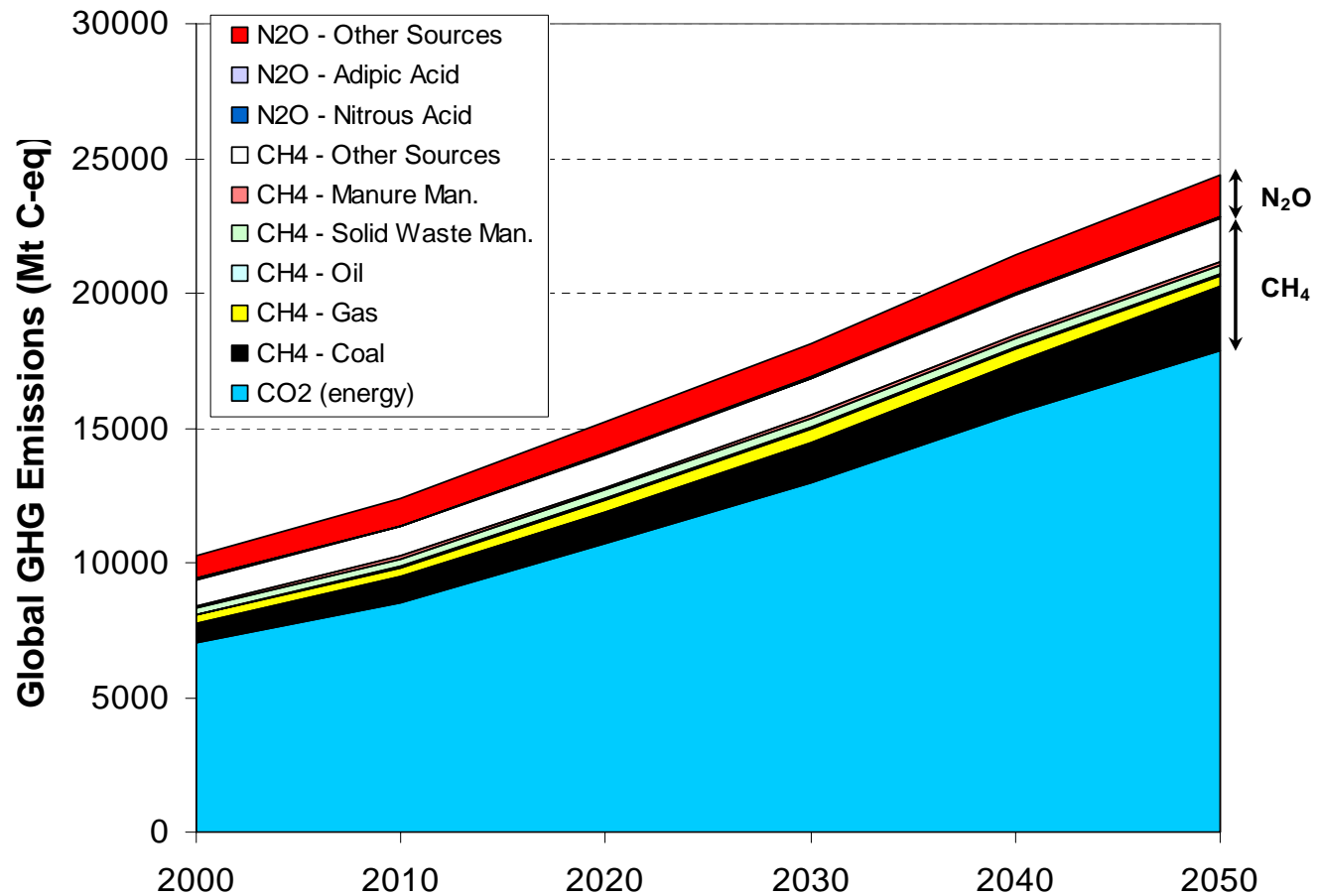
# Marginal Abatement Curves (MAC)

- Implementation of MACs for methane ( $\text{CH}_4$ ) and nitrous oxide ( $\text{N}_2\text{O}$ ) following approach of MERGE (Manne and Richels, 2003)
- Three categories: exogenous baseline, endogenous baseline, non-abatable emissions
- Data from the U.S EPA (2003) study, potentials are relative to baseline emissions
- Technical-progress multipliers to extrapolate abatement potentials beyond 2020

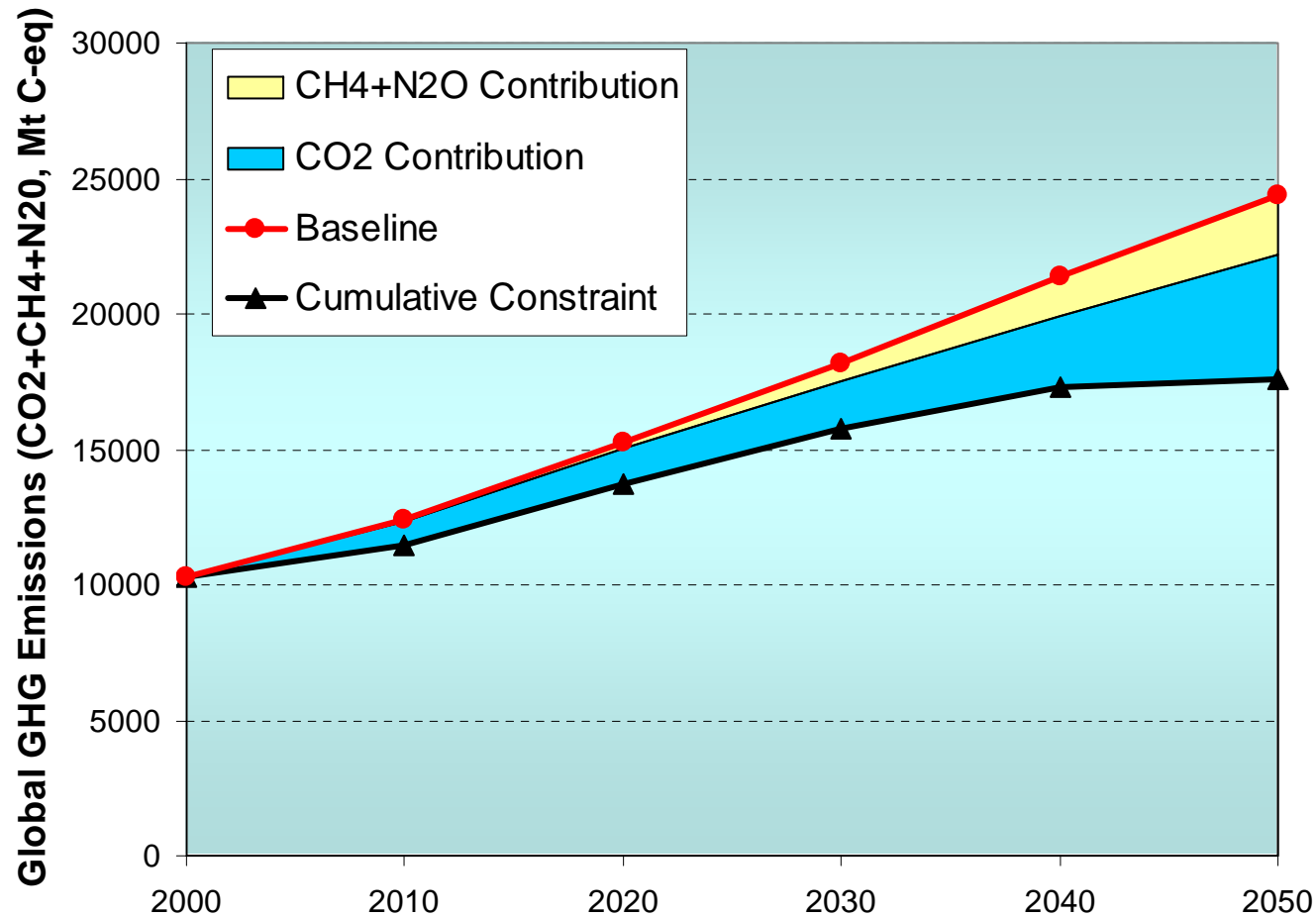
# Marginal Abatement Curves - 2

- Methane ( $\text{CH}_4$ ):
  - Energy-related baseline emissions are endogenous (coal, oil and gas)
  - Non-energy related baseline emissions are exogenous (solid waste and manure management)
- Nitrous oxide ( $\text{N}_2\text{O}$ ): exogenous baseline emissions (adipic and nitric acid production)
- Exogenous, non-abatable emissions:  $\text{CH}_4$  from enteric fermentation and rice paddies,  $\text{N}_2\text{O}$  from soils

# A Multi-gas Baseline Scenario

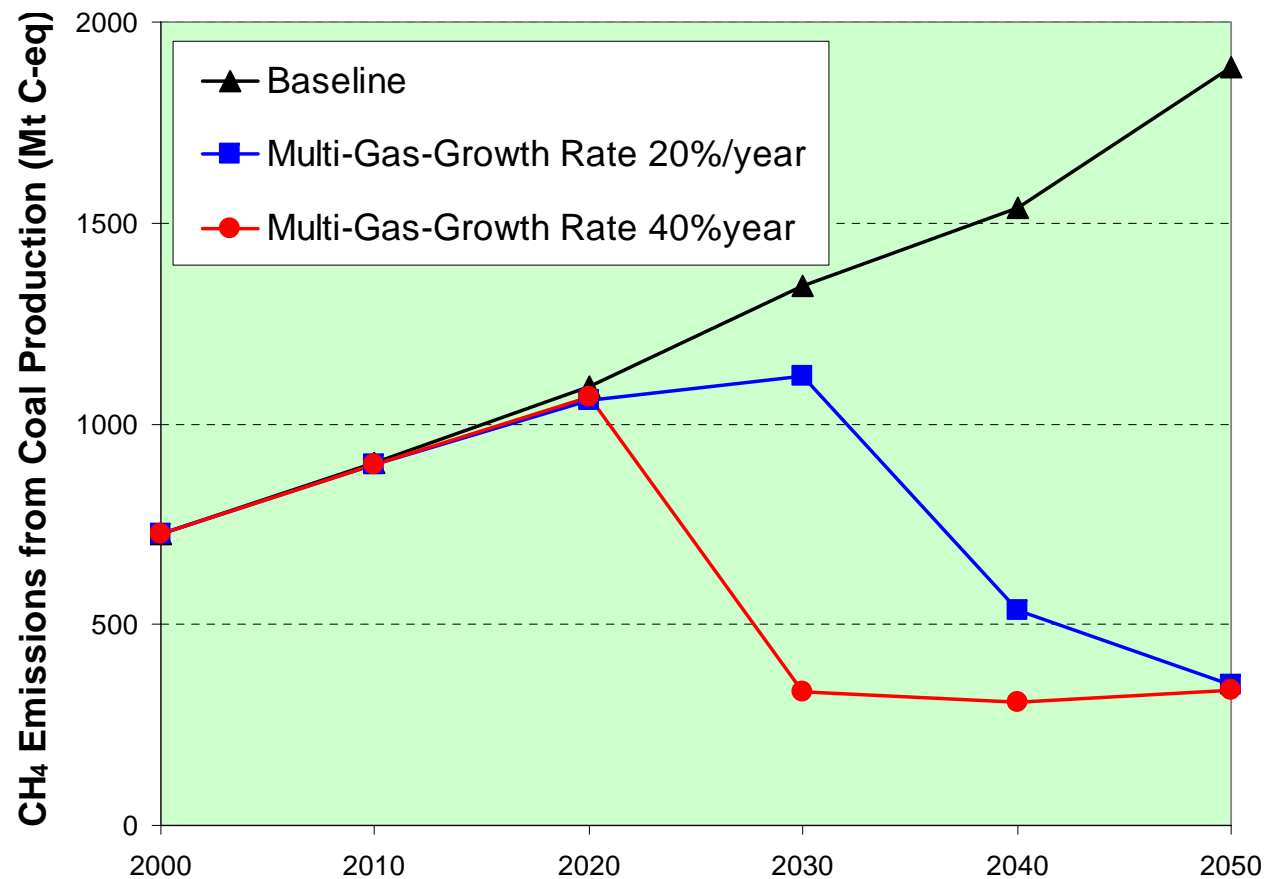


# An Illustrative Mitigation Scenario

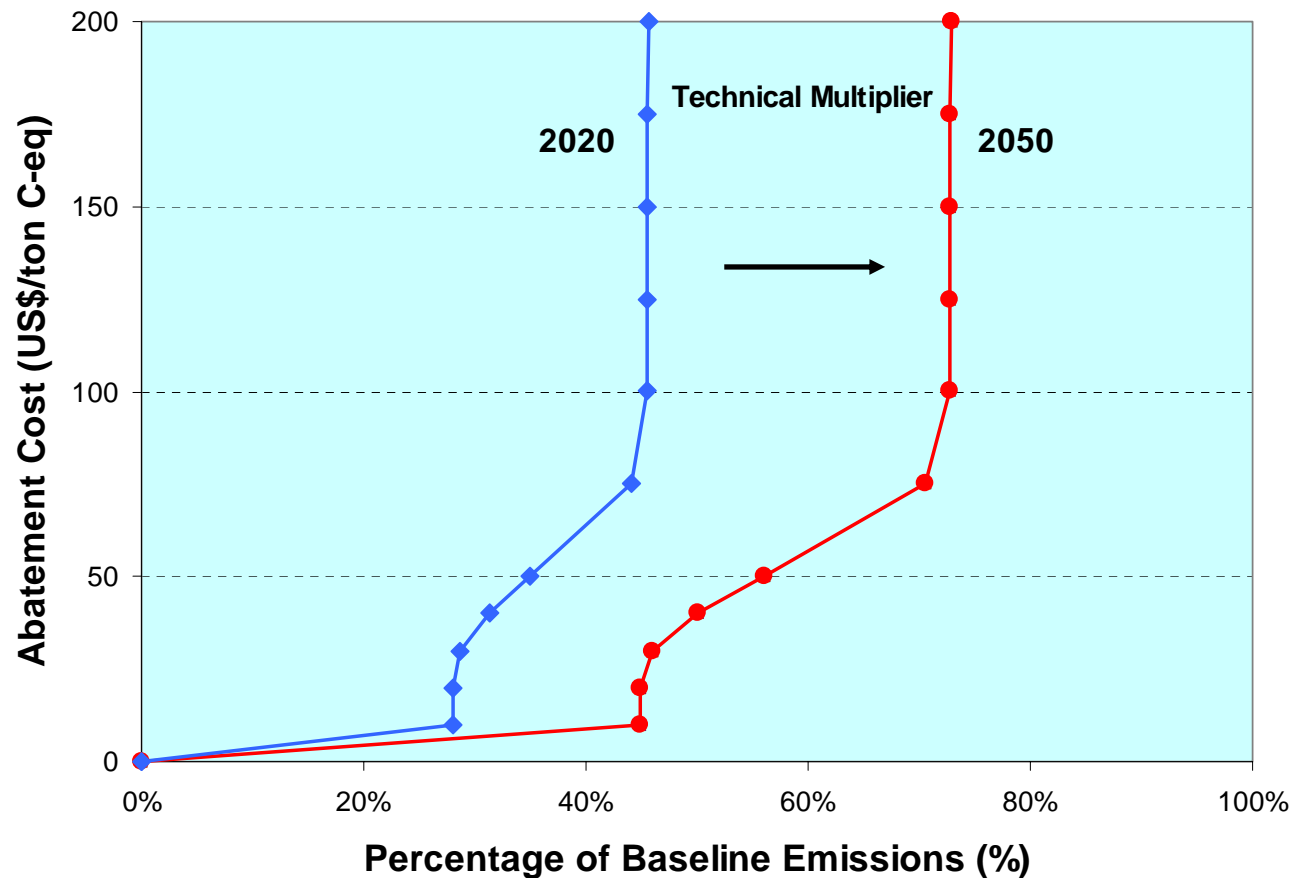




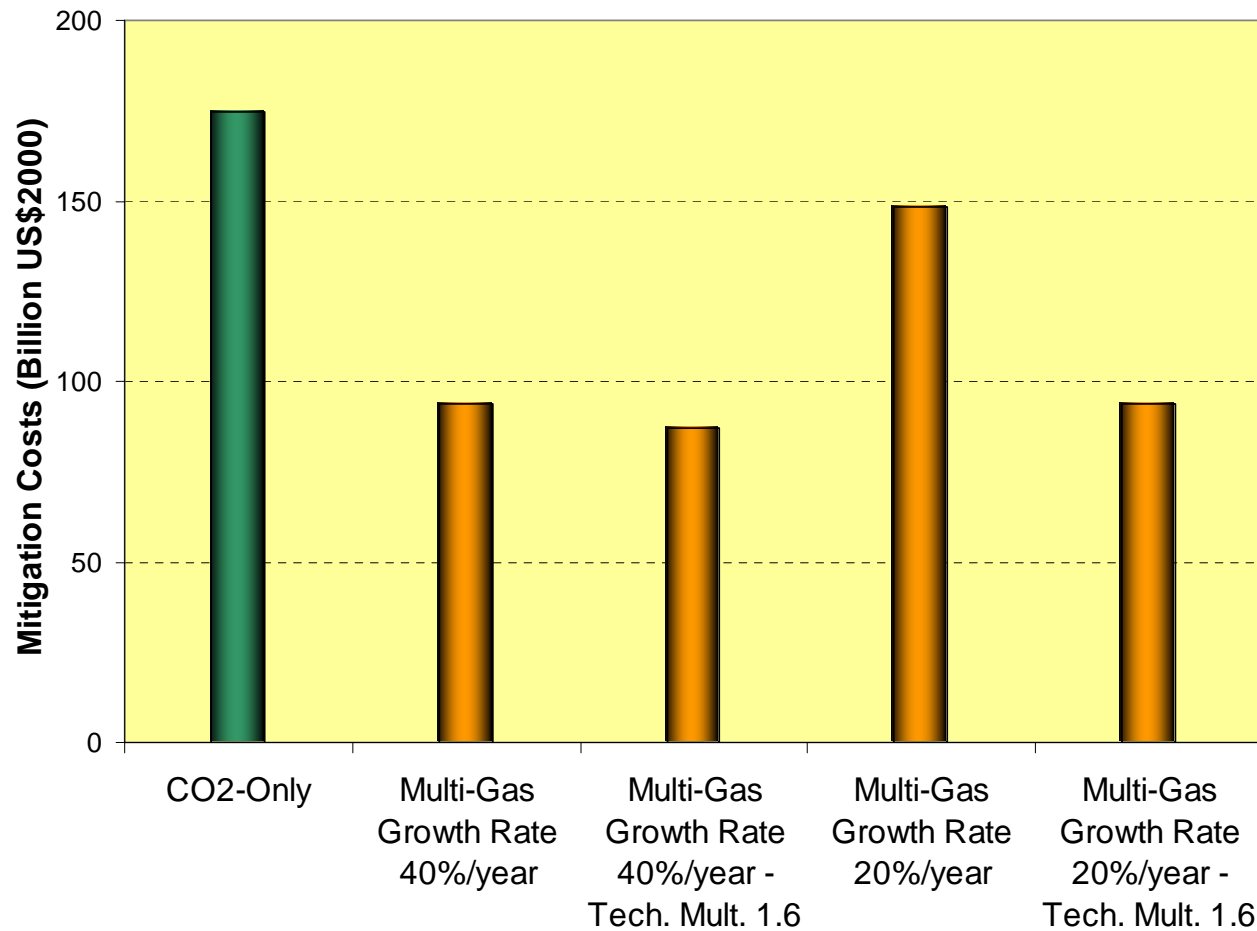
# Maximum Growth Rates for Non-CO<sub>2</sub> Abatement



# Technical Multipliers for Non-CO<sub>2</sub> Abatement Potentials



# Mitigation Costs



## Concluding Remarks

- Marginal abatement curves allow incorporating the effects of non-CO<sub>2</sub> GHGs (CH<sub>4</sub>, N<sub>2</sub>O) into the energy-systems GMM model
- Composition of mitigation strategies and mitigation costs depend on assumptions about potentials (technical multipliers) and growth rates for abatement of non-CO<sub>2</sub> GHGs
- Further work: Technical multipliers as a function of cumulative abatement (experience)?

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