U.S. Environmental Protection Agency
Office of Atmospheric Programs

Offsets in EPA Analyses of S. 2191, S. 1766, and S. 280

at

EPRI GHG Emissions Offsets Workshop

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EPA's Analysis Team

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	Dick Goettle, DJA (IGEM)
	ICF International (IPM)

Policy Comparison:

Lieberman-Warner (S. 2191) – Bingaman-Specter (S. 1766) – Lieberman-McCain (S. 280)

Major Provisions

- Coverage of US GHG Emissions (based on 2005 GHG inventory)
  - S. 280: ~73%
  - S. 1766: ~83%
  - S. 2191: ~87%
- Cap rate of decline
  - S. 280: Step down decrease every 10 years
  - S. 1766: Annual decrease
  - S. 2191: Annual decrease
- CCS Bonus Allowances
  - S. 280: No
  - S. 1766: Yes
  - S. 2191: Yes
- International Reserve Allowance Requirement
  - S. 280: No
  - S. 1766: Yes
  - S. 2191: Yes
- Safety valve
  - S. 280: No safety valve
  - S. 1766: $12/ton of CO_2e in 2012 rising at a real rate of 5%
  - S. 2191: No safety valve
- Use of offsets
  - S. 280: 30% of compliance from domestic offsets and international credits
  - S. 1766: Unlimited specified domestic offsets can be used to meet the emission cap level
    - Specified offset project categories include CH_4 from landfills, coal mines, and animal waste, and SF_6 from electric power systems
    - The President can implement an international offset program, allowing not more than 10% of compliance to be met through this program
  - S. 2191: 15% of compliance from domestic offsets; and 15% of compliance from international credits

Policy Comparison:

Lieberman-Warner (S. 2191) – Bingaman-Specter (S. 1766) – Lieberman-McCain (S. 280)

Scenarios from EPA Analyses

- The same reference case was used for EPA's analyses of S. 280, S. 1766, and S. 2191
  - EPA Reference Scenario
    - Does not include any additional climate policies or measures to reduce international GHG emissions
    - For domestic projections, benchmarked to AEO 2006 (which does not include the Energy Independence and Security Act).
    - For international projections, uses CCSP Synthesis and Assessment Report 2.1 A MiniCAM Reference
- Policy case assumptions from EPA's analyses of S. 280, S. 1766, and S. 2191
  - Substantial growth in nuclear power (nuclear power generation increases by ≈150% from 782 bill. kWh in 2005 to 1,982 bill. kWh in 2050) reflecting possible future policies to promote this technology in S. 2191 and elsewhere
  - Widespread international actions by developed and developing countries over the modeled time period. International policy assumptions are based on those used in the recent MIT report, "Assessment of U.S. Cap-and-Trade Proposals"
    - Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050
    - Group 2 countries (rest of world) adopt a policy beginning in 2025 that returns and holds them at year 2015 emissions levels through 2034, and then returns and maintains them at 2000 emissions levels from 2035 to 2050

EPA Models and Corresponding GHG Mitigation

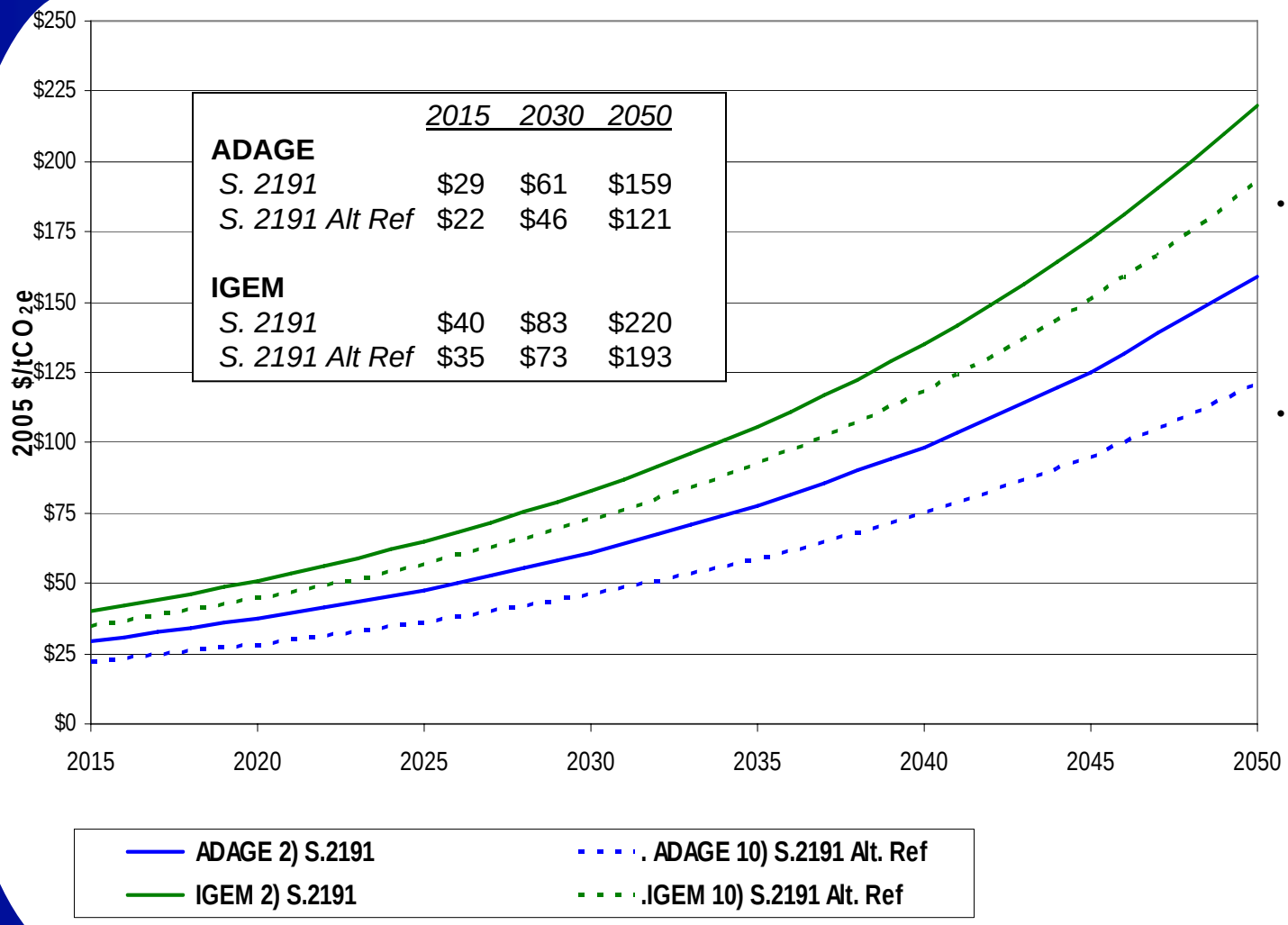
Sectors		Economy-wide Computable General Equilibrium (CGE) Models		Models Used to Provide Inputs to CGEs				Partial Equilibrium Model (Uses CGE Outputs)
		ADAGE	IGEM	NCGM	FASOM	GTM	MiniCAM	IPM
Domestic	Electricity Generation	All GHGs	All GHGs					CO_2, NOx, SO_2
	Transportation	All GHGs	All GHGs					
	Industry	All GHGs	All GHGs	CH_4, N_20, F-gases				
	Commercial	All GHGs	All GHGs					
	Agriculture (& Forestry)	All GHGs	All GHGs		CO_2, CH_4, N_20			
	Residential	All GHGs	All GHGs	CH_4, N_20,				
International Credits*				CH_4, N_20, F-gases		CO_2	CO_2, CH_4, N_20, F-gases	

* International allowance and domestic offset markets were analyzed using EPA's spreadsheet tool which combines results from the NCGM, FASOM, GTM and MiniCAM models.

ADAGE Applied Dynamic Analysis of the Global Economy (Ross, 2007)
IGEM Intertemporal General Equilibrium Model (Jorgenson, 2007)
IPM Integrated Planning Model (EPA, 2007)
NCGM EPA's non-CO_2 GHG spreadsheet tools for estimating projections and mitigation of CH_4, N_2O, and F-gases (EPA, 2005)
FASOMGHG Forest and Agriculture Sector Optimization Model, GHG version (EPA, 2005)
GTM Global Timber Model (Sohngen, 2006)
MiniCAM Mini-Climate Assessment Model (Edmonds, 2005)

Results: Scenario 2 – S. 2191, Scenario 10 – S. 2191 Alt. Ref.

GHG Allowance Prices

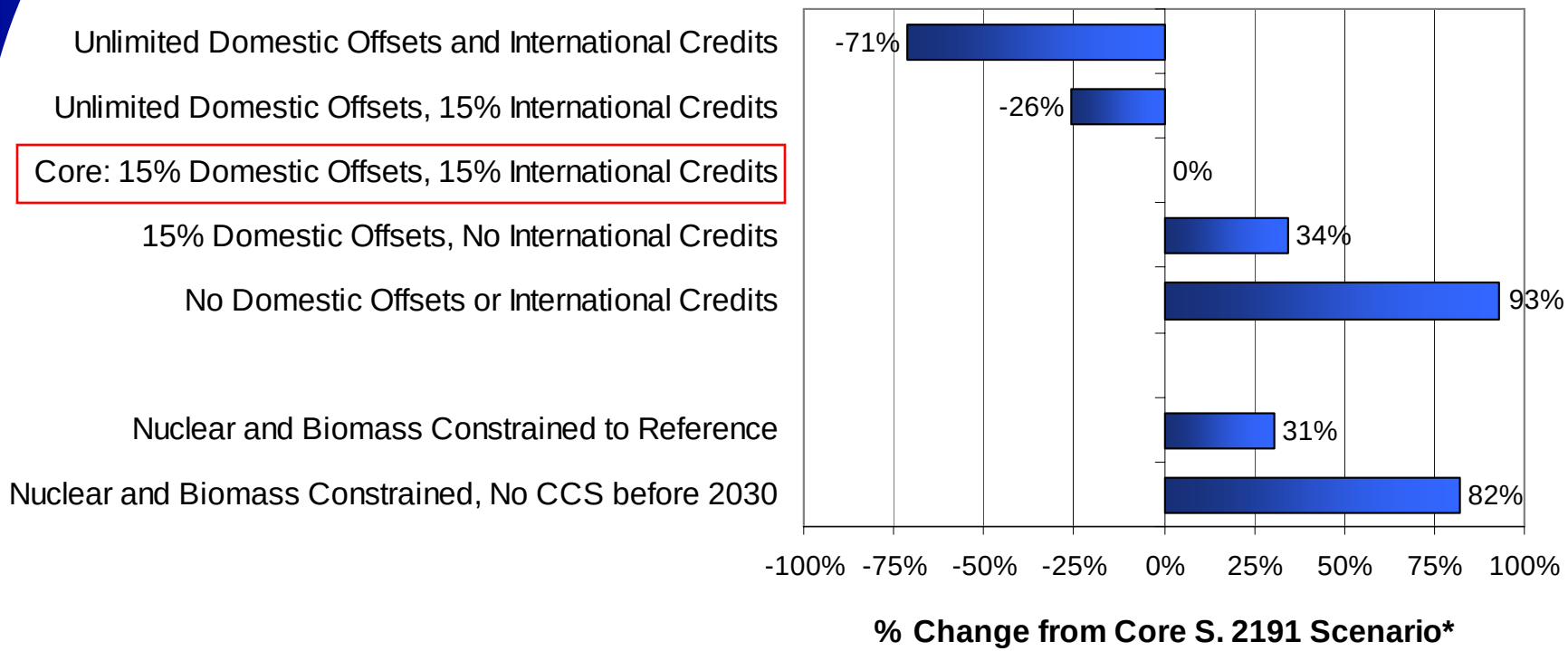


	2015	2030	2050
ADAGE			
S. 2191	$29	$61	$159
S. 2191 Alt Ref	$22	$46	$121
IGEM			
S. 2191	$40	$83	$220
S. 2191 Alt Ref	$35	$73	$193

- The $61 - $83 range of 2030 allowance prices only reflects differences in the models and does not reflect other scenarios or additional uncertainties discussed elsewhere.
- Note that although the offset price differs from the allowance price, these prices do reflect the use of offsets and international credits.

Availability of Offsets and Technology Significantly Influence Costs

Marginal Cost of GHG Abatement in 2030 - Sensitivity Cases



- The availability and use of offsets – both domestic and international – has an impact on allowance prices comparable to the impact from the availability of technologies. This needs to be weighted against the integrity of those reductions and the size of international credit payments.

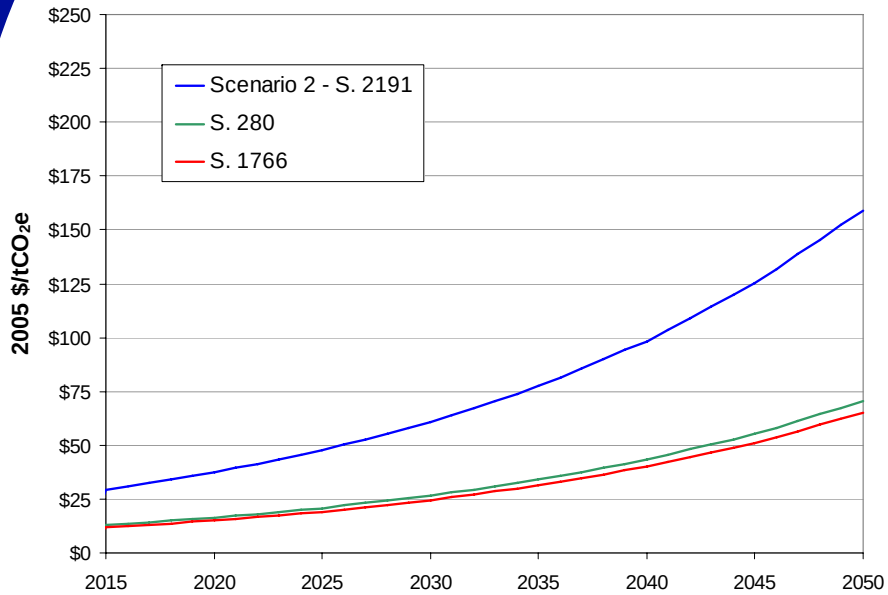
* Scenario 2 from EPA's analysis of S. 2191: S. 2191 as written (15% of compliance obligation from domestic offsets, 15% from international credits), assumes 150% increase in nuclear power between now and 2050, assumes CCS available after 2015.

Policy Comparison:

Lieberman-Warner (S. 2191) – Bingaman-Specter (S. 1766) – Lieberman-McCain (S. 280)

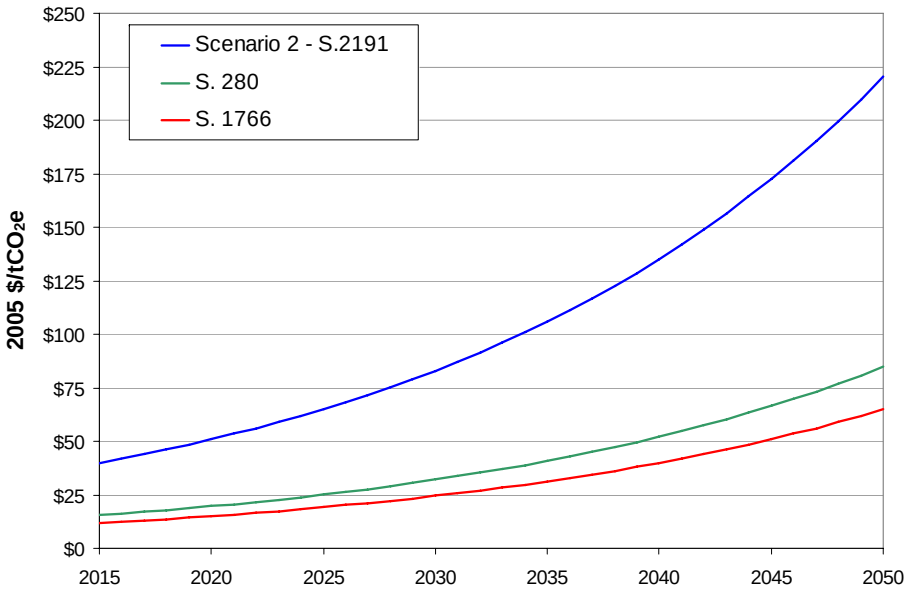
GHG Allowance Prices

ADAGE



	2015	*2030*	*2050*
ADAGE			
S. 2191	$29	$61	$159
S. 1766	$12	$25	$65
S. 280	$13	$27	$70

IGEM

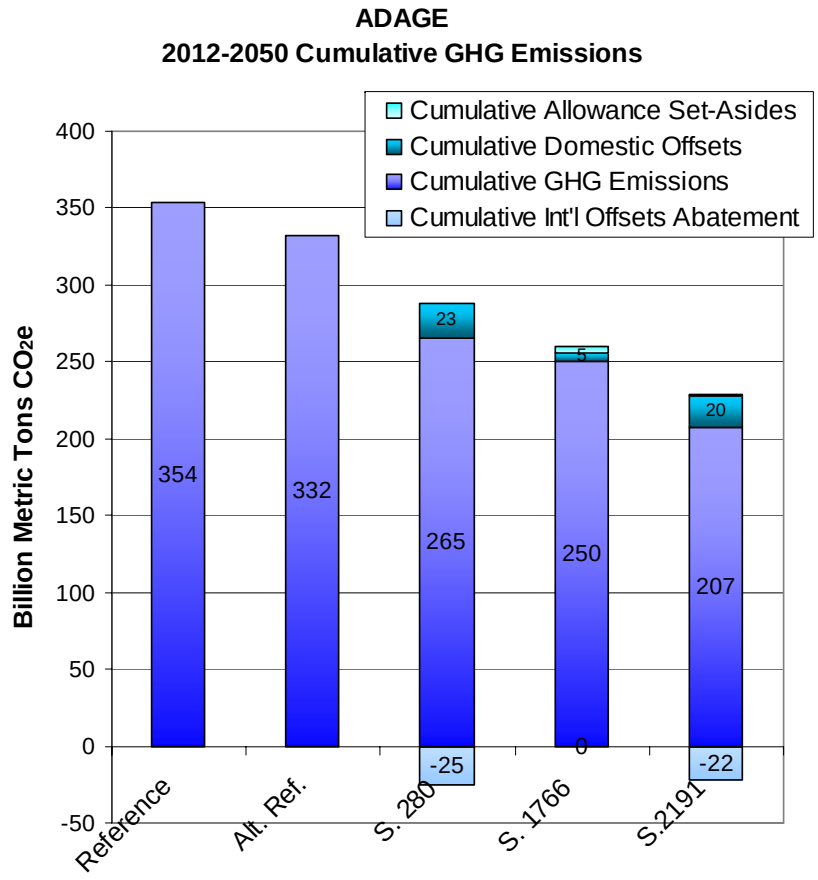


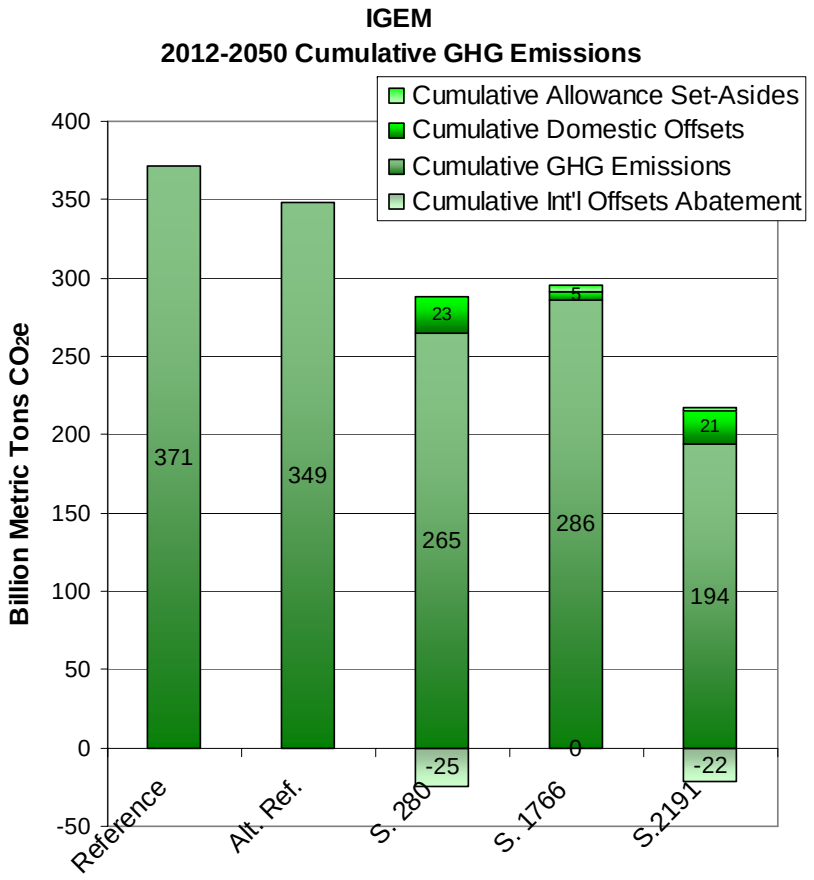
	2015	*2030*	*2050*
IGEM			
S. 2191	$40	$83	$220
S. 1766	$12	$25	$65
S. 280	$15	$327	$85

Policy Comparison:

Lieberman-Warner (S. 2191) – Bingaman-Specter (S. 1766) – Lieberman-McCain (S. 280)

2012 – 2050 Cumulative U.S. GHG Emissions (Billion Metric Tons CO_2e)

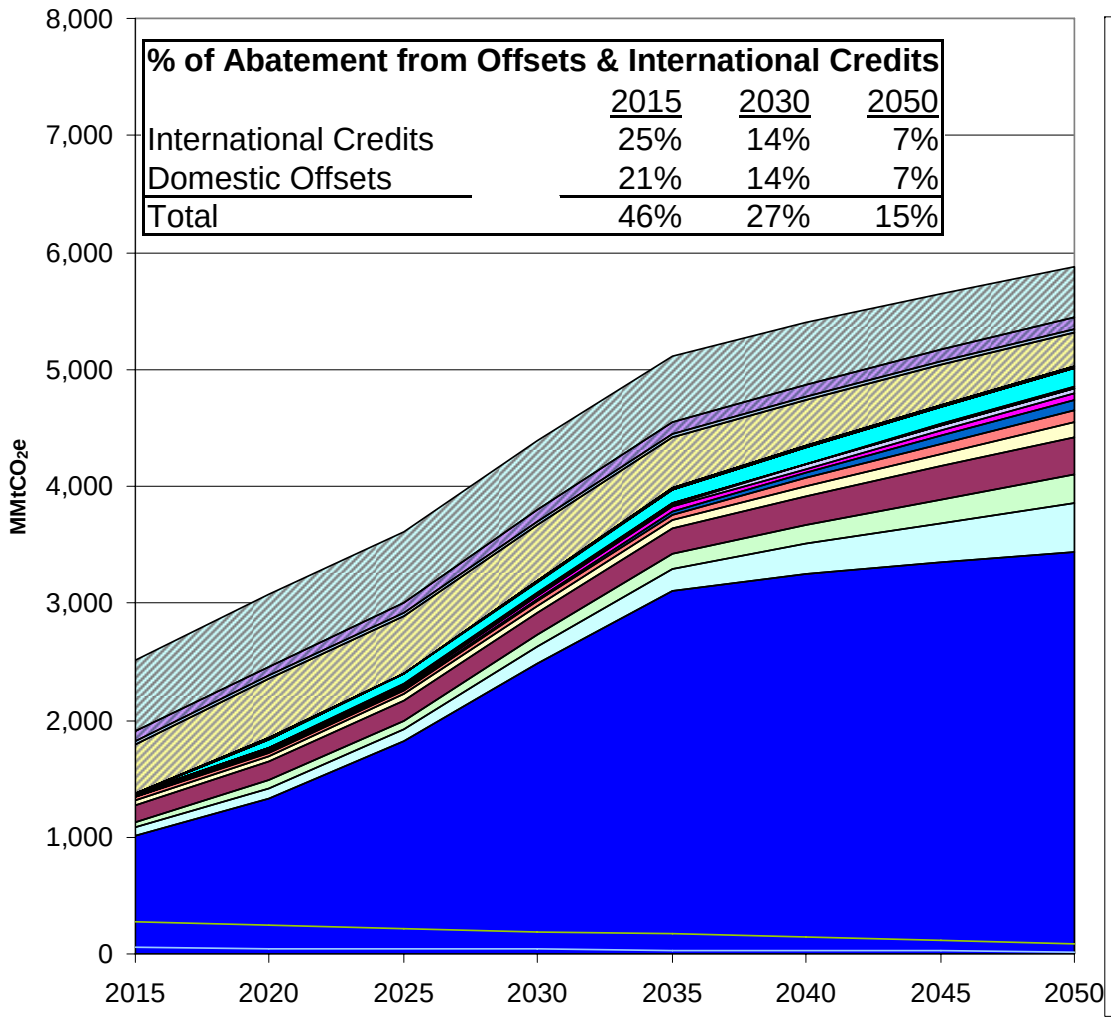




	ADAGE			IGEM		
% Reduction from Reference	*S. 280*	*S. 1766*	*S. 2191*	*S. 280*	*S. 1766*	*S. 2191*
GHG Emissions	-19%	-27%	-35%	-22%	-20%	-42%
GHG Emissions w/ Domestic Offsets	-25%	-29%	-41%	-29%	-23%	-48%
GHG Emissions w/ Domestic & Int'l Offsets	-32%	-29%	-48%	-35%	-23%	-54%

Results: Scenario 2 - S. 2191

Sources of GHG Abatement (ADAGE)



% of Abatement from Offsets & International Credits

	2015	2030	2050
International Credits	25%	14%	7%
Domestic Offsets	21%	14%	7%
Total	46%	27%	15%

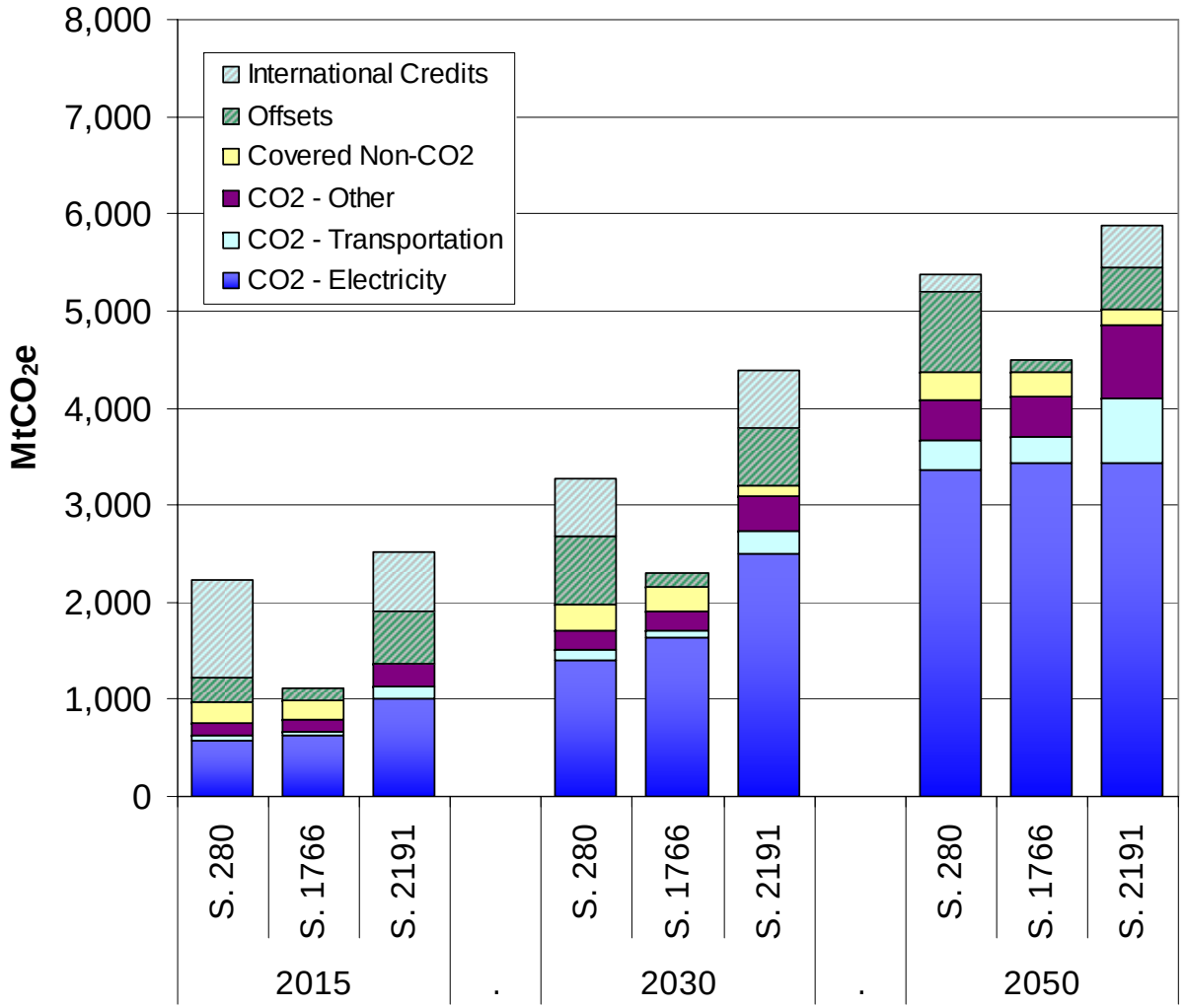
- International Credits
- Offsets - Landfill/Coal Mine CH4
- Offsets - Nat Gas/Oil Sector CH4
- Offsets - Ag/Forestry
- SF6 - Energy-Int Man
- SF6 - Electricity
- PFC - Energy-Int Man
- PFC - Other Manuf
- CH4 - Nat. Gas
- CO2 - Agriculture
- CO2 - Coal
- CO2 - Natural Gas
- CO2 - Services
- CO2 - Crude Oil
- CO2 - Petroleum
- CO2 - Other Manuf
- CO2 - Energy-Int Man
- CO2 - Transport
- CO2 - Residential - Autos
- CO2 - Electricity
- Allowance Set-Asides - Ag/Forestry
- Allowance Set-Asides - Landfill/Coal Mine

- S. 2191 allows offsets and international credits to each make up 15% of the total allowance submissions requirement.
- The quantity of offsets and international credits allowed decreases as allowance submissions decrease.
- Since the quantity of offsets allowed is decreasing over time and the quantity of abatement is increasing over time, offsets make up a large fraction of abatement in the early years of the policy, and there contribution to total abatement decreases over time.

Policy Comparison:

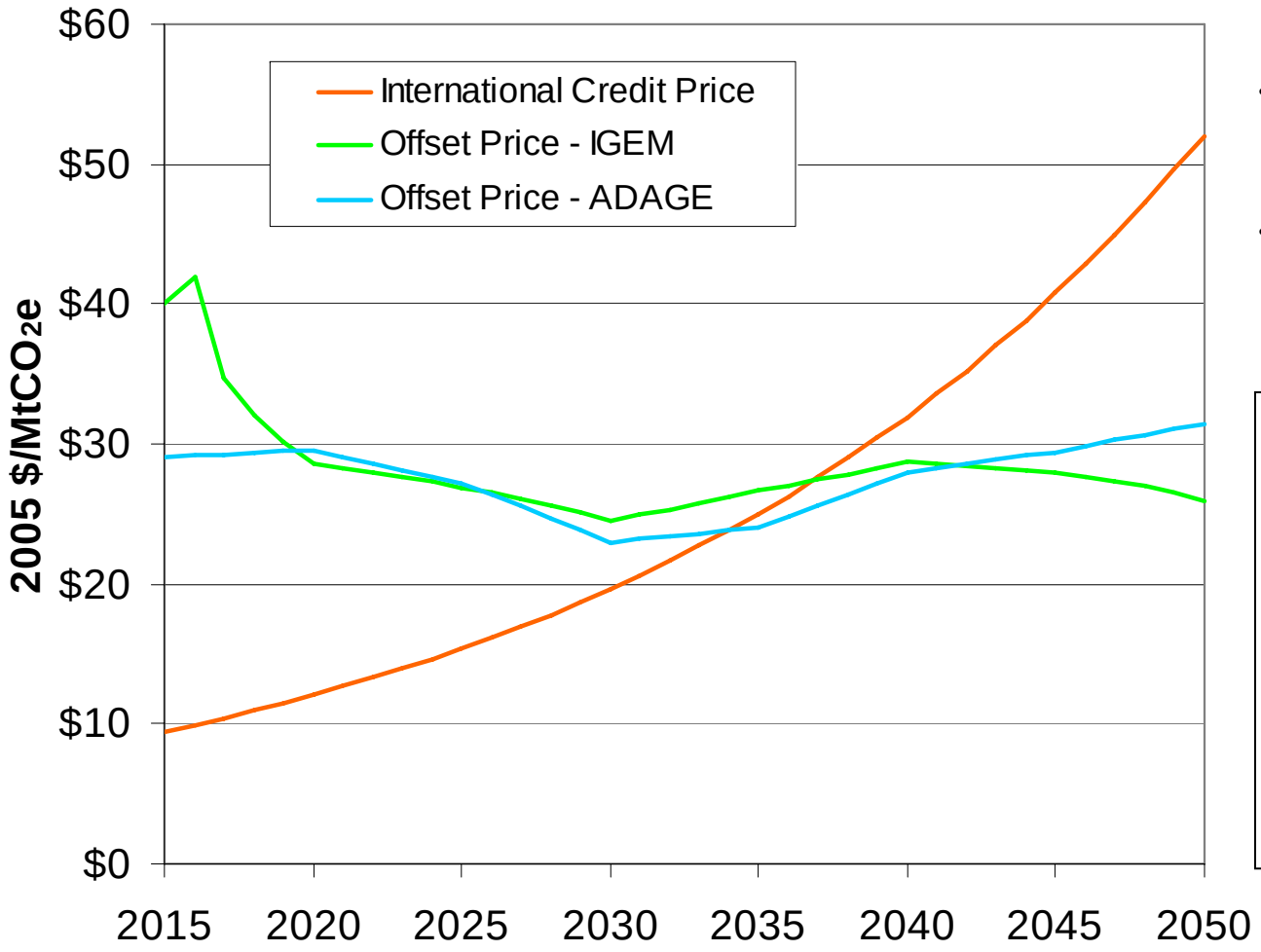
Lieberman-Warner (S. 2191) – Bingaman-Specter (S. 1766) – Lieberman-McCain (S. 280)

Sources of GHG Abatement (ADAGE)



Results: Scenario 2 - S. 2191

Offset and International Credit Prices



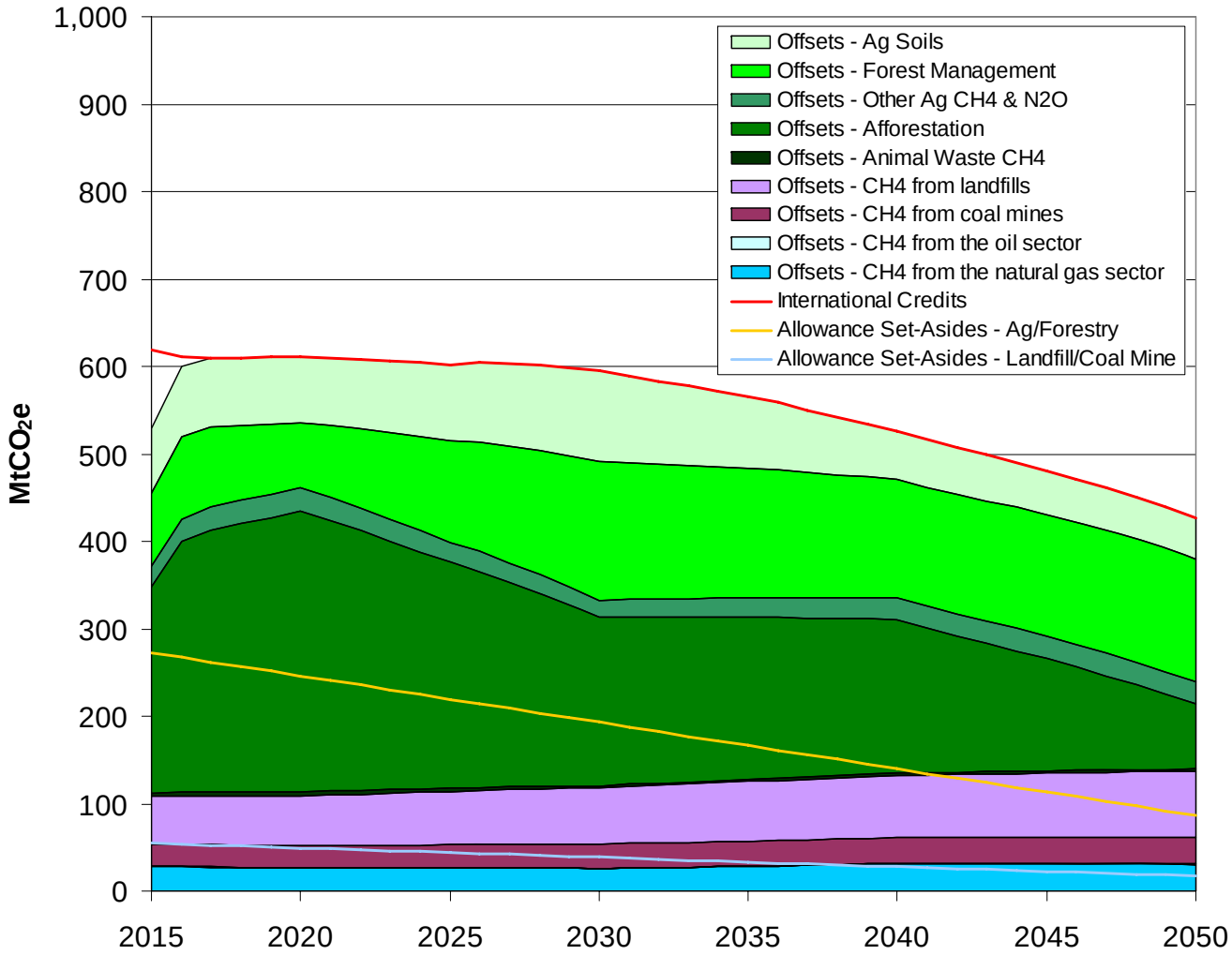
- S. 2191 limits the use of offsets and international credits to 15% of allowance submissions.
- The 15% limit on the use of domestic offsets is binding in IGEM starting in 2017, and in ADAGE starting in 2015.
- The international credit price is driven by the international demand and supply of GHG abatement.

International Action

- Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050.
- Group 2 countries (rest of world) adopt a policy beginning in 2025 that returns and holds them at year 2015 emissions levels through 2034, and then returns and maintains them at 2000 emissions levels from 2035 to 2050.

Results: Scenario 2 - S. 2191

Allowance Set-Aside, Offset, and International Credit Abatement (IGEM)

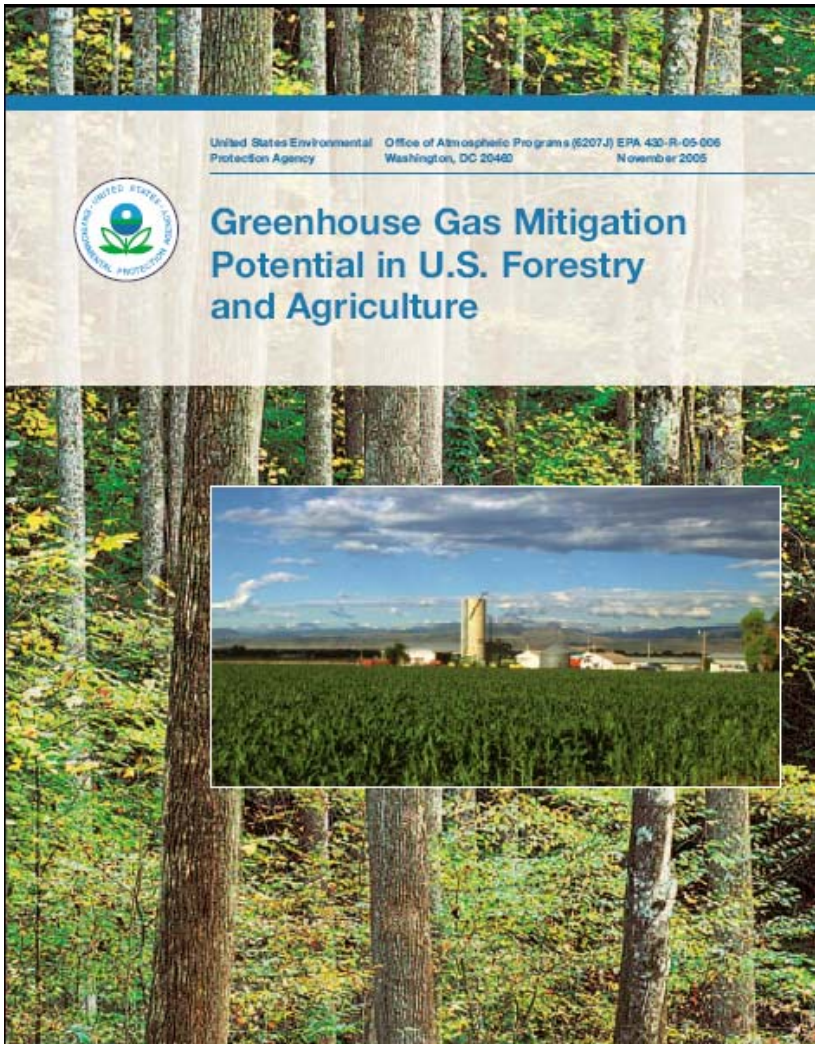


- The total quantity of abatement from domestic offsets is limited to 15% of allowance submissions in each year.
- The quantity of abatement from international credits is similarly limited to 15% of allowance submissions in each year.
- The quantity of abatement from allowance set-asides is proscribed by the bill, 4% of allowances in each year are set aside for Ag/Forestry abatement projects, and 1% are set aside for landfill and coal mine CH_4 abatement projects.
- Because the offset price is lower than the GHG allowance price, projects that are eligible for both allowance set-asides and offsets would prefer to be in the allowance set-aside program.

Offset Data Sources

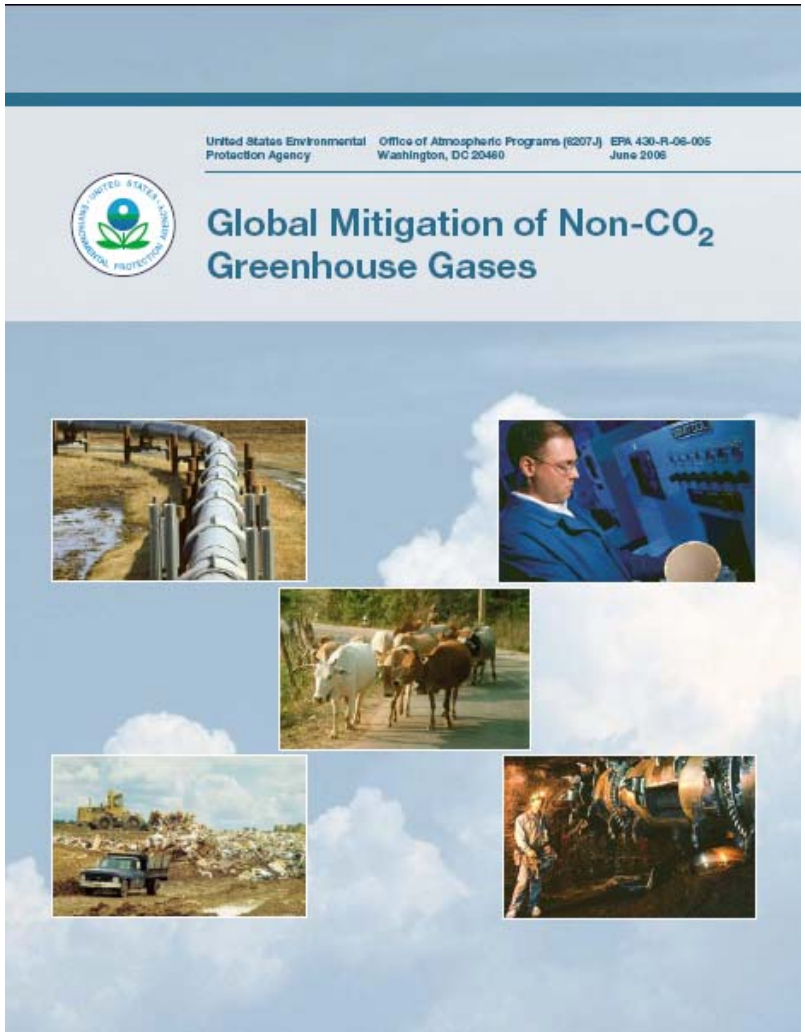
- USEPA, 2005b. Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture, U.S. Environmental Protection Agency, EPA 430-R-05-006, Washington, D.C., November 2005.

- Domestic Forestry and Agriculture Offset MACs
  - Animal Waste CH_4
  - Other Ag CH_4 & N_2O
  - Afforestation
  - Forest Management
  - Ag Soils



Offset Data Sources

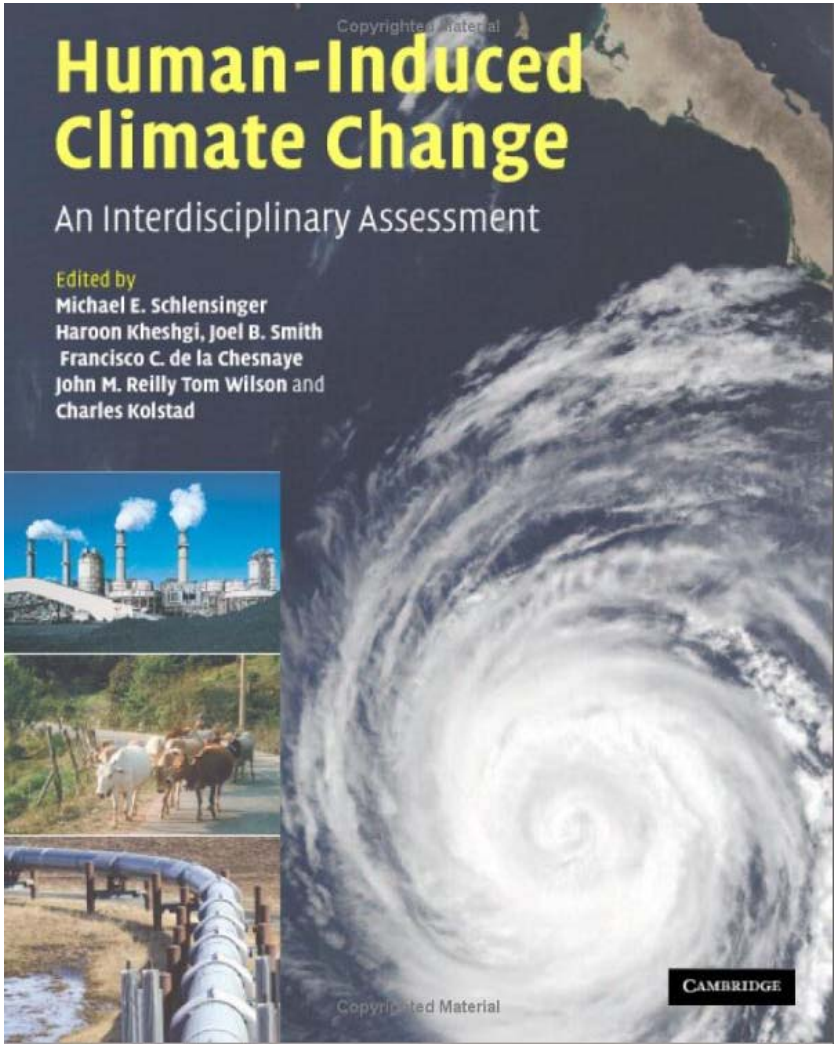
- USEPA, 2006. Global Mitigation of Non-CO2 Greenhouse Gases, U.S. Environmental Protection Agency, EPA 430-R-06-005, Washington, D.C., June 2006.
- Domestic & International Offset and Capped Non-CO_2 MACs
  - CH_4 from landfills
  - CH_4 from coal mines
  - CH_4 from the natural gas sector
  - CH_4 from the oil sector
  - N_20 from adipic acid production
  - N_20 from nitric acid production
  - F-Gases (11 source catagories)
- International Offset MACs
  - CH_4 and N_2O from livestock manure management
  - CH_4 from livestock entric fermentation
  - CH_4 and N_2O, and soli carbon from paddy rice
  - N_2O and soil carbon from cropland



Offset Data Sources

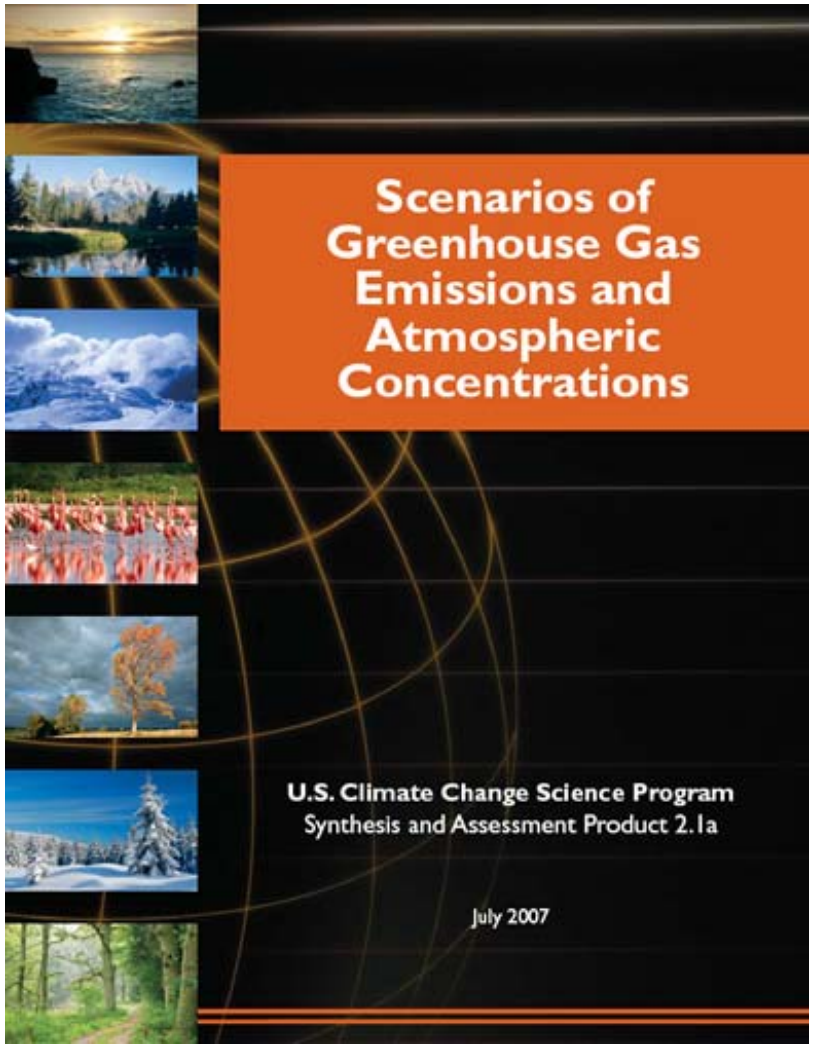
- GTM Reference:
  - Sohngen, B. and R. Mendelsohn. 2006. "A Sensitivity Analysis of Carbon Sequestration." In Human-Induced Climate Change: An Interdisciplinary Assessment. Edited by M. Schlesinger. Cambridge: Cambridge University Press.

- International forest carbon sequestration MACs



Offset Data Sources

- MiniCAM Reference:
  - USCCSP, 2006, Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations. Report by the U.S. Climate Change Science Program and approved by the Climate Change Science Program Product Development Advisory Committee.
- International energy related CO_2 MACs



Domestic Offset MAC Construction

- The following steps were taken to generate the capped and offset schedules for domestic non-CO_2 emissions, biofuels, and terrestrial sinks:
  - For each source type, emissions were divided into capped and non-capped emissions.
  - For each mitigation option, a determination was made as to whether the option applied to a capped or non-capped emissions source.
  - For each mitigation option, a determination was made regarding potential eligibility for a future mitigation program.
    - Note that eligibility was not determined for methane from the natural gas and oil sectors. In these cases, uniform adjustments were applied.
  - Capped and offset mitigation cost schedules were constructed with the eligible or adjusted options. Rising carbon price pathways were run for agriculture, forestry, and biofuels mitigation.

International Offset MAC Construction

- The following steps were taken to generate the international non-CO_2 and terrestrial sinks offset schedules:
  - The timing of regional participation in carbon market systems was designated.
  - For each mitigation option a determination was made regarding potential eligibility for a future U.S. mitigation program taking into consideration whether or not the country where the mitigation is taking place is assumed to have a climate policy in place or not.
    - Note that eligibility was not determined for methane from the natural gas and oil sectors, so uniform adjustments were applied.
  - Offset mitigation cost schedules were constructed with eligible or adjusted options for group 1 and group 2 countries. Rising carbon price pathways were run for forestry and energy related CO_2 emissions mitigation.

CH_4 from landfills Mitigation Table

Domestic

Mitigation option	Model application capped/non-capped emissions designation	Indication of eligibility for mitigation	Adjustments
Anaerobic digestion 1 (AD1)	non-capped	yes	none
Anaerobic digestion 2 (AD2)	non-capped	yes	none
Composting 1 (C1)	non-capped	no	none
Composting 2 (C2)	non-capped	no	none
Mechanical Biological Treatment	non-capped	no	none
Heat Production	non-capped	yes	none
Increased Oxidation	non-capped	no	none
Direct Gas Use (profitable at base price)	non-capped	yes	none
Electricity Generation	non-capped	yes	none
Direct Gas Use (profitable above base price)	non-capped	yes	none
US-Flaring (F) - profitable above base price	non-capped	yes	none

International - Group 1

Mitigation option	Model application capped/non-capped	Indication of eligibility for		Adjustments	
		2010-2025	2025-2050	2010-2025	2025-2050
Anaerobic digestion 1 (AD1)	non-capped	yes	yes	none	none
Anaerobic digestion 2 (AD2)	non-capped	yes	yes	none	none
Composting 1 (C1)	non-capped	no	no	none	none
Composting 2 (C2)	non-capped	no	no	none	none
Mechanical Biological Treatment	non-capped	no	no	none	none
Heat Production	non-capped	yes	yes	none	none
Increased Oxidation	non-capped	no	no	none	none
Direct Gas Use (profitable at base price)	non-capped	yes	yes	none	none
Electricity Generation	non-capped	yes	yes	none	none
Direct Gas Use (profitable above base price)	non-capped	yes	yes	none	none
EU-Flaring (F)	non-capped	yes	yes	none	none

International Forest Carbon Sequestration Mitigation Table

Category: International forest carbon sequestration

Group 1 mitigation eligibility

Mitigation option	Model application capped/non-capped	Indication of eligibility for		Adjustments	
		2010-2025	2025-2050	2010-2025	2025-2050
Afforestation	Non-capped	Y	Y	none	none
Forest management: rotation age, input management	Non-capped	Y	Y	none	none
Avoided deforestation	Non-capped	Y	Y	none	none

Group 2 mitigation eligibility

Mitigation option	Model application capped/non-capped	Indication of eligibility for		Adjustments	
		2010-2025	2025-2050	2010-2025	2025-2050
Afforestation	Non-capped	Y	Y	none	none
Forest management: rotation age, input management	Non-capped	N	Y	none	none
Avoided deforestation	Non-capped	N	Y	none	none

International Energy Related CO_2 Mitigation Table

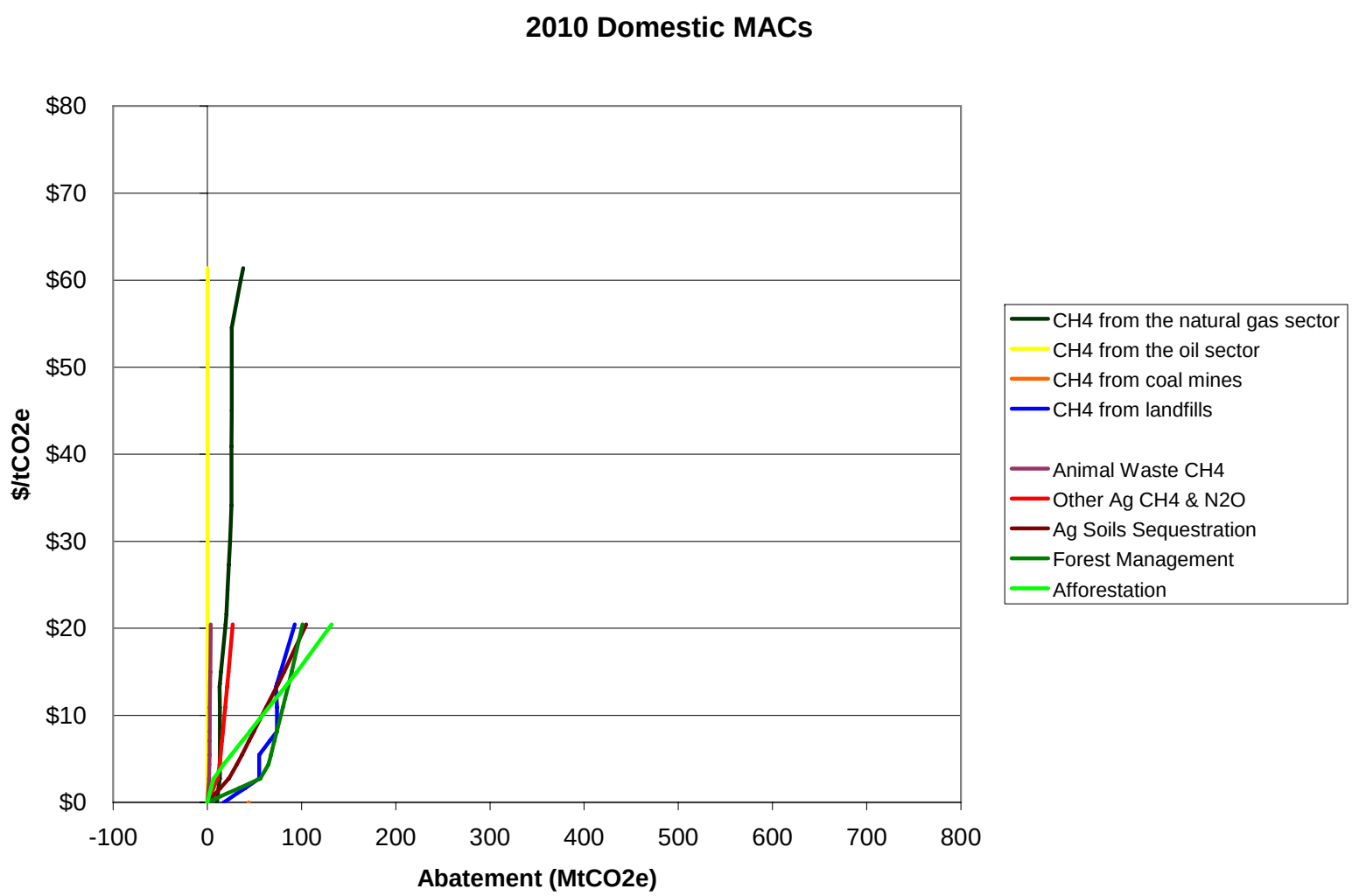
Group 1 mitigation eligibility

Mitigation option	Model application capped/non-capped	Indication of eligibility for	Adjustments		
			2010 & 2015	2020	2025-2050
All energy CO2 emissions mitigation options	non-capped	yes	none	none	none

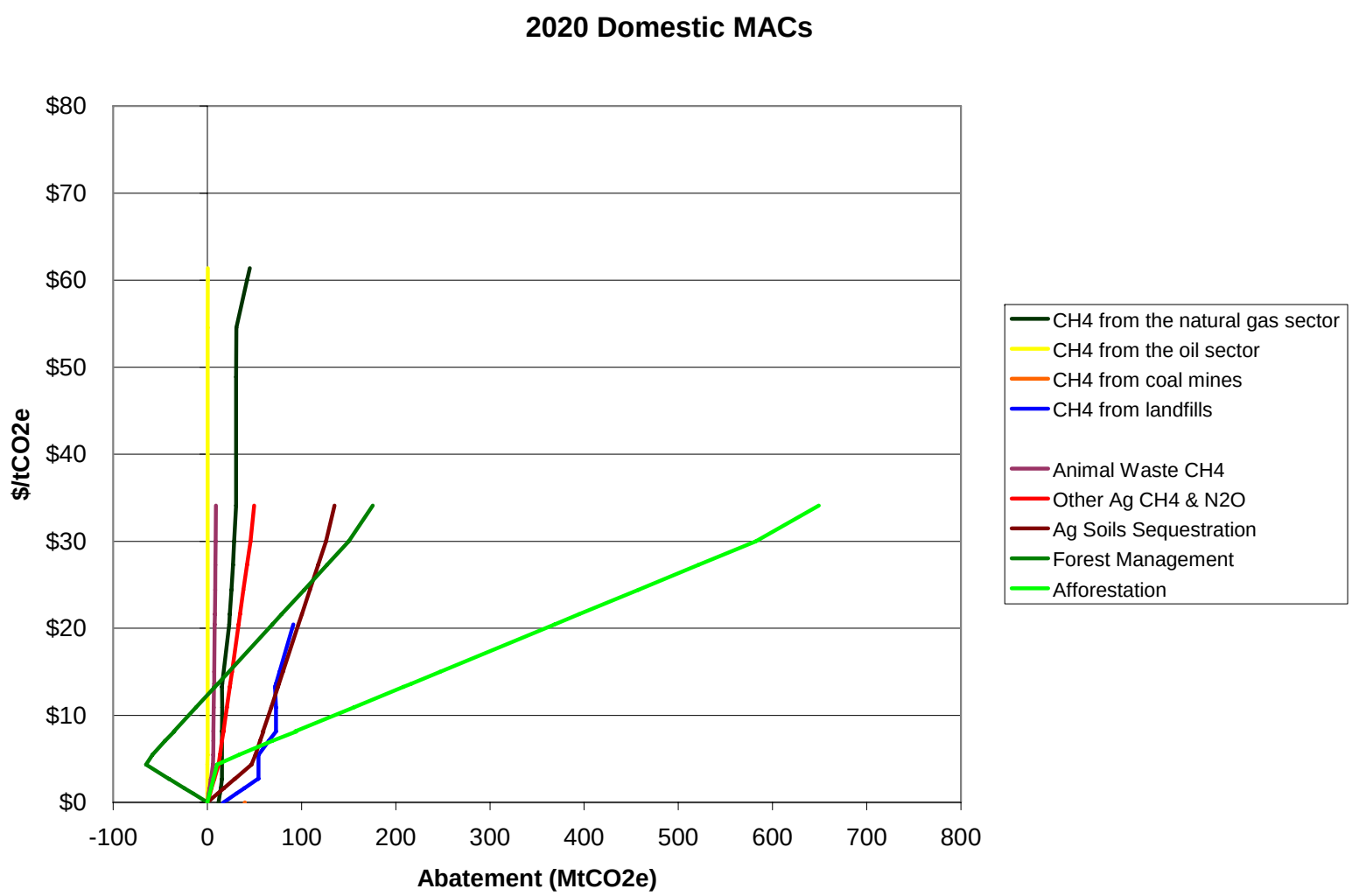
Group 2 mitigation eligibility

Mitigation option	Model application capped/non-capped	Indication of eligibility for	Adjustments		
			2010 & 2015	2020	2025-2050
All energy CO2 emissions mitigation options	non-capped	yes	-90%	-75%	none

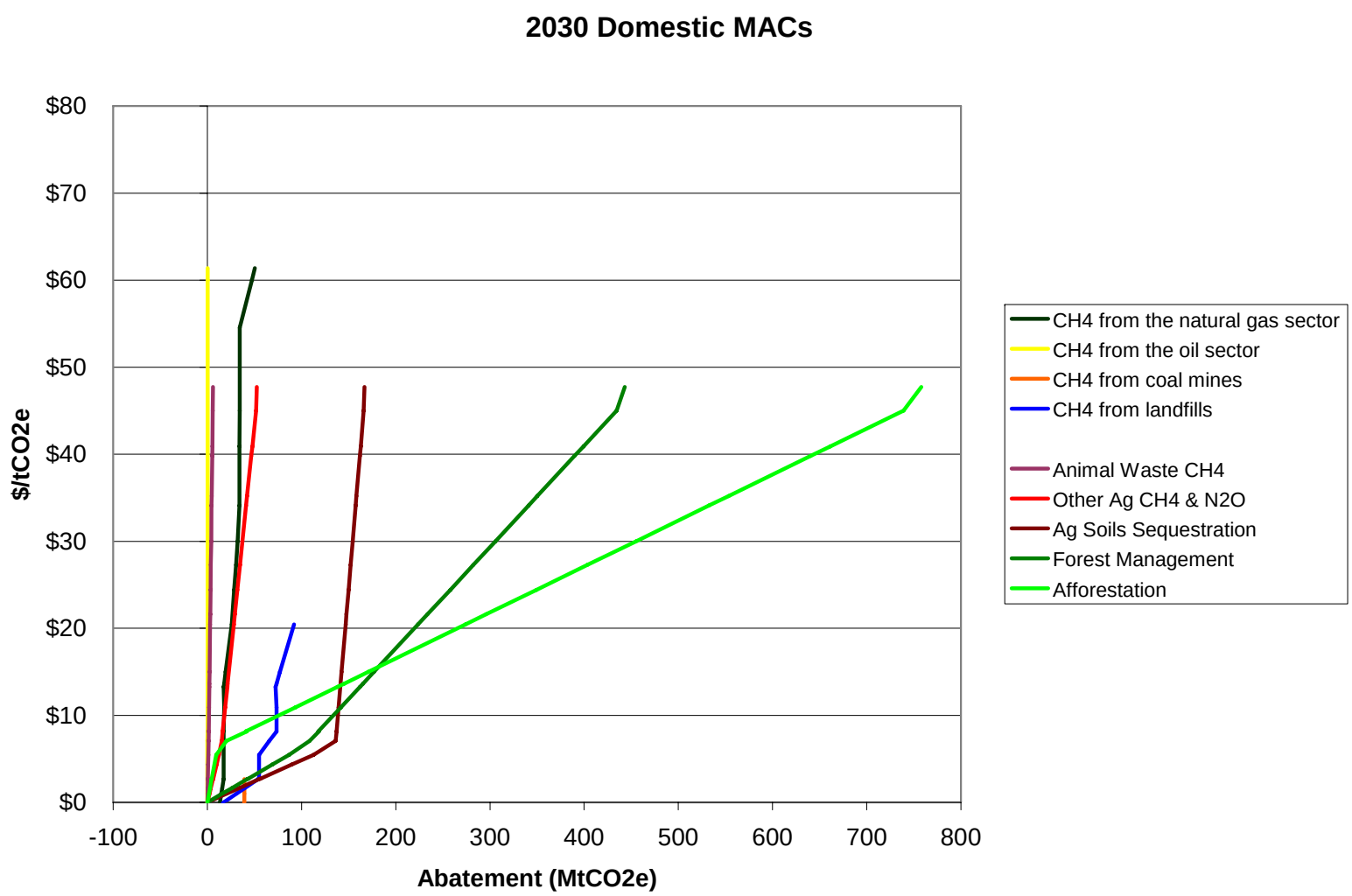
2010 Domestic Offset MACs



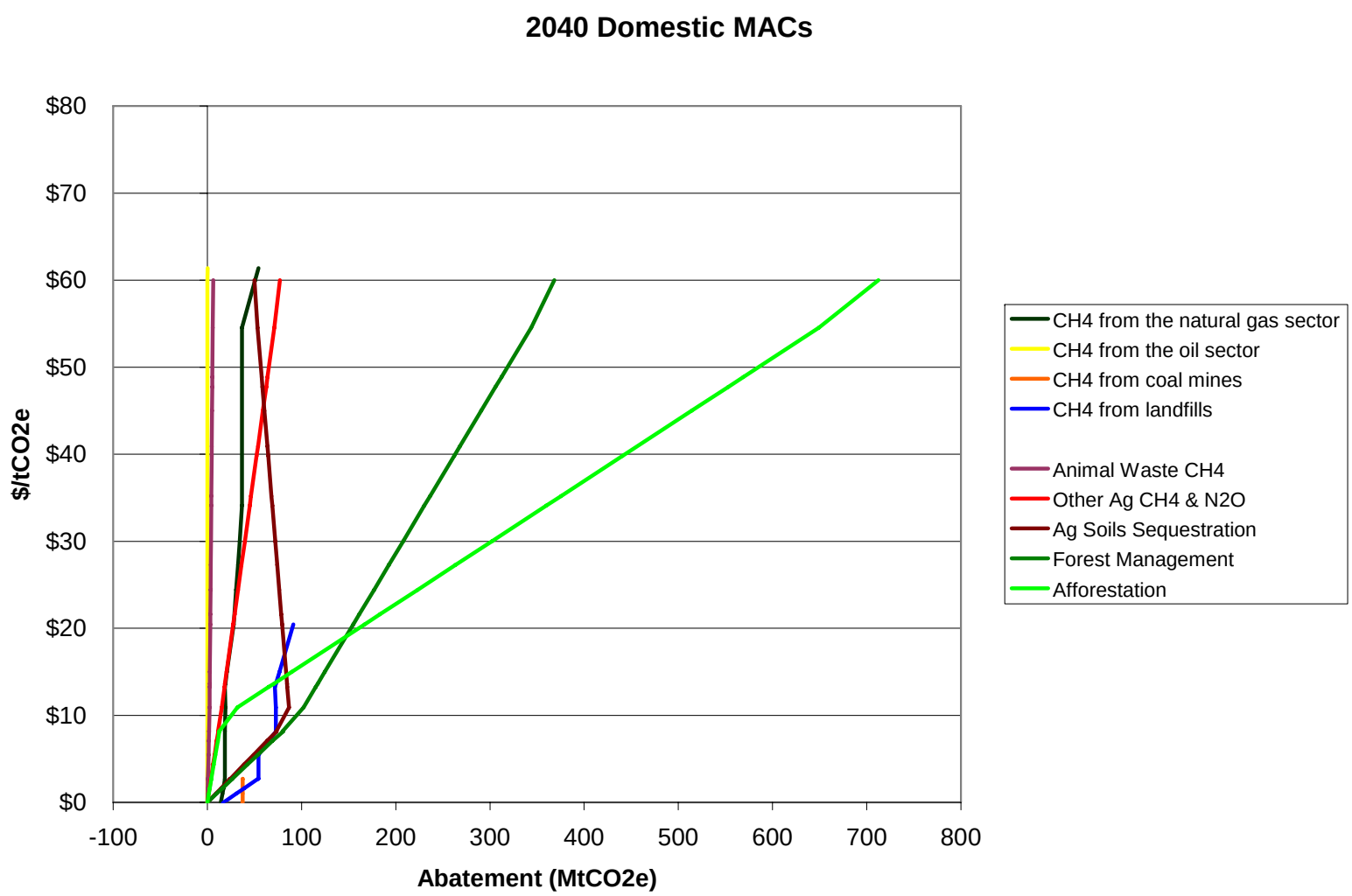
2020 Domestic Offset MACs



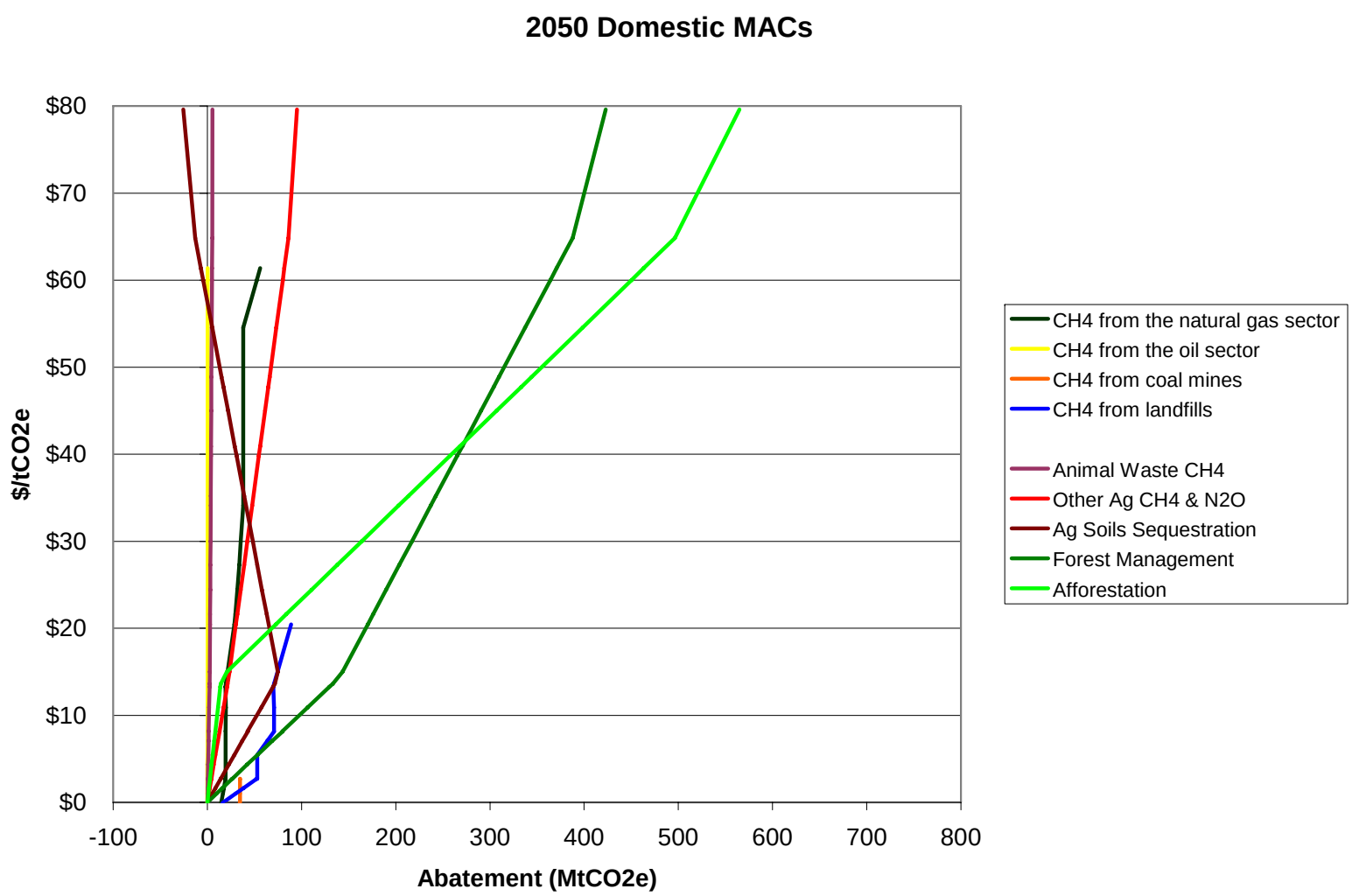
2030 Domestic Offset MACs



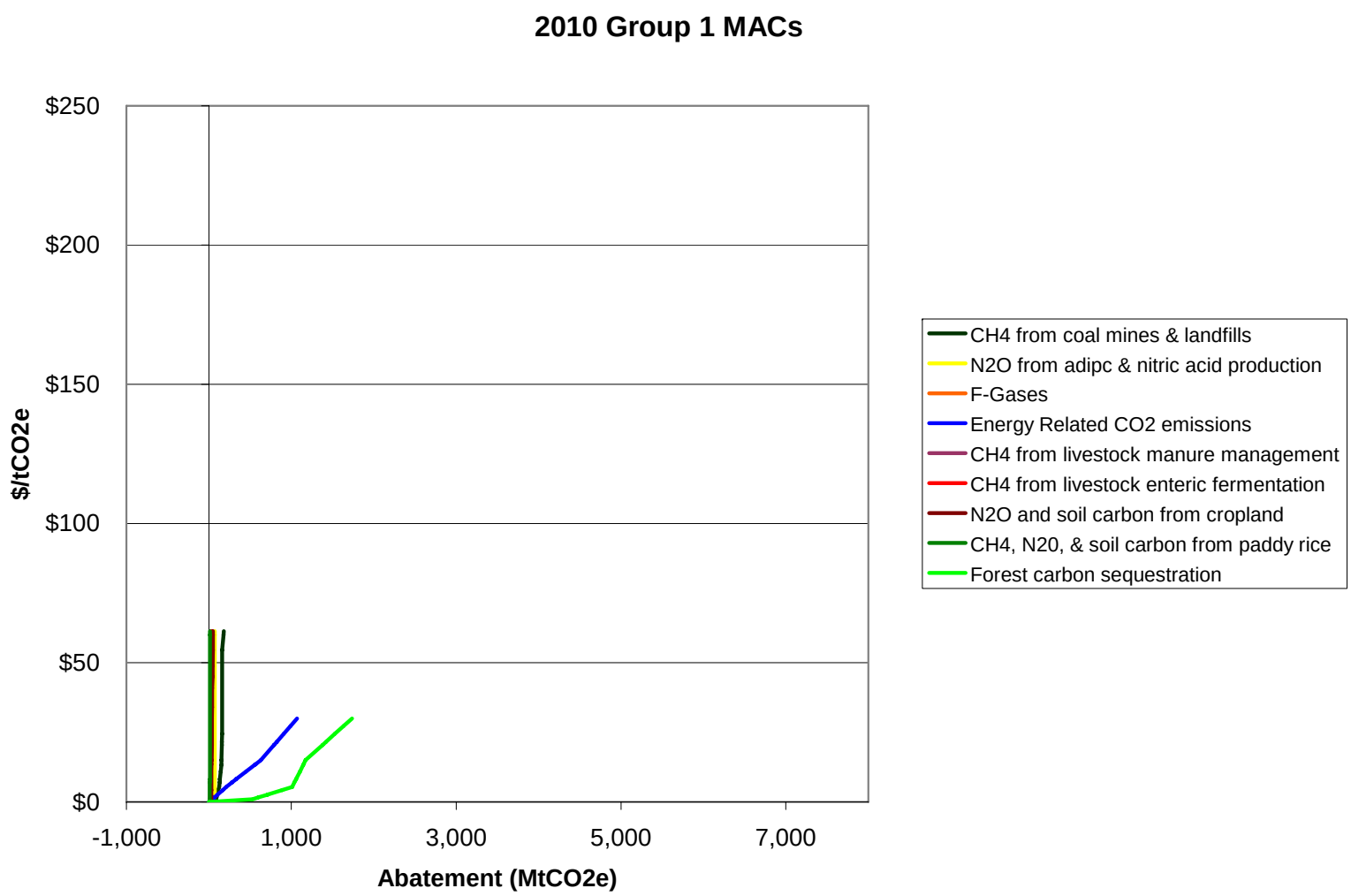
2040 Domestic Offset MACs



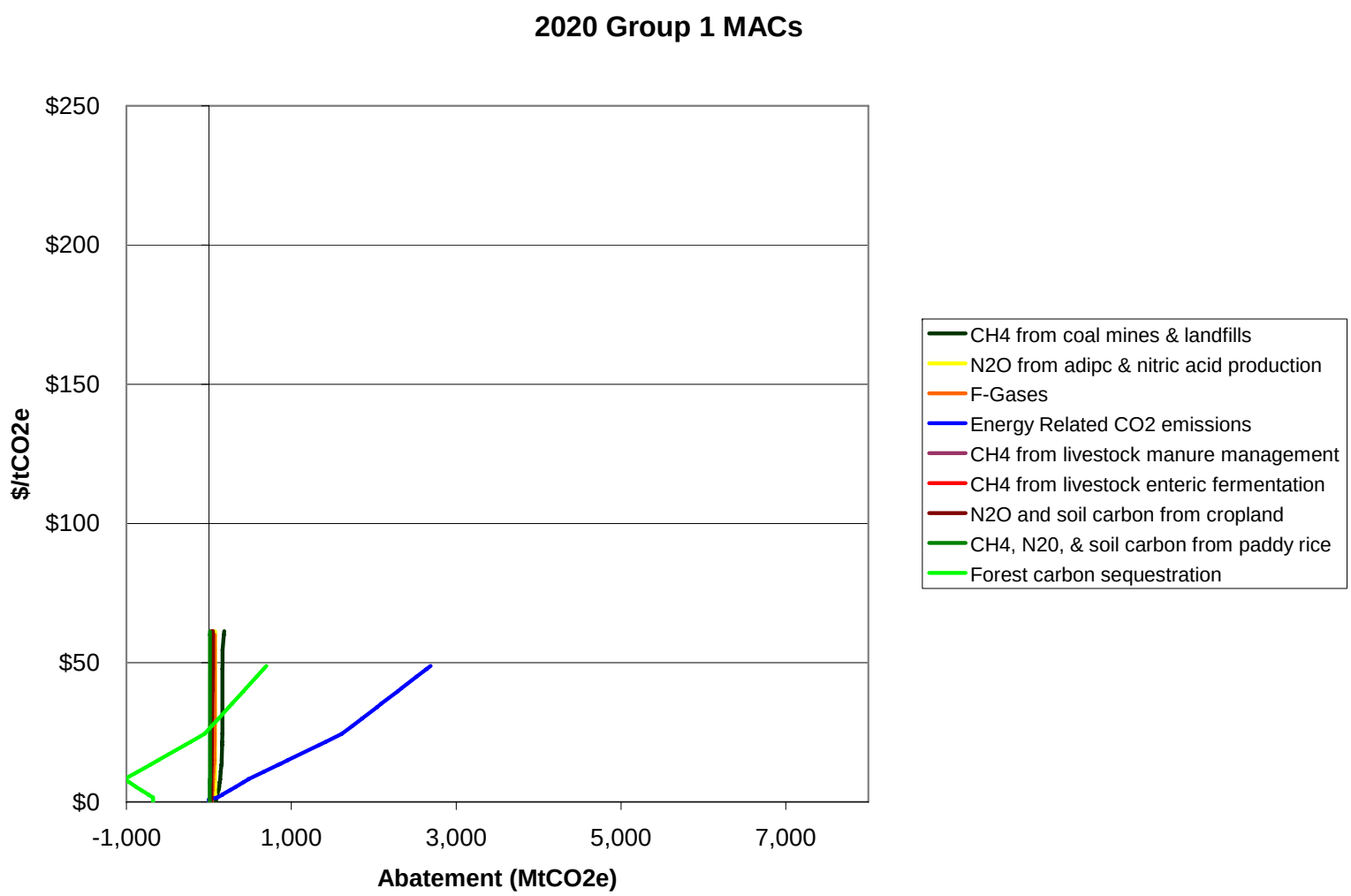
2050 Domestic Offset MACs



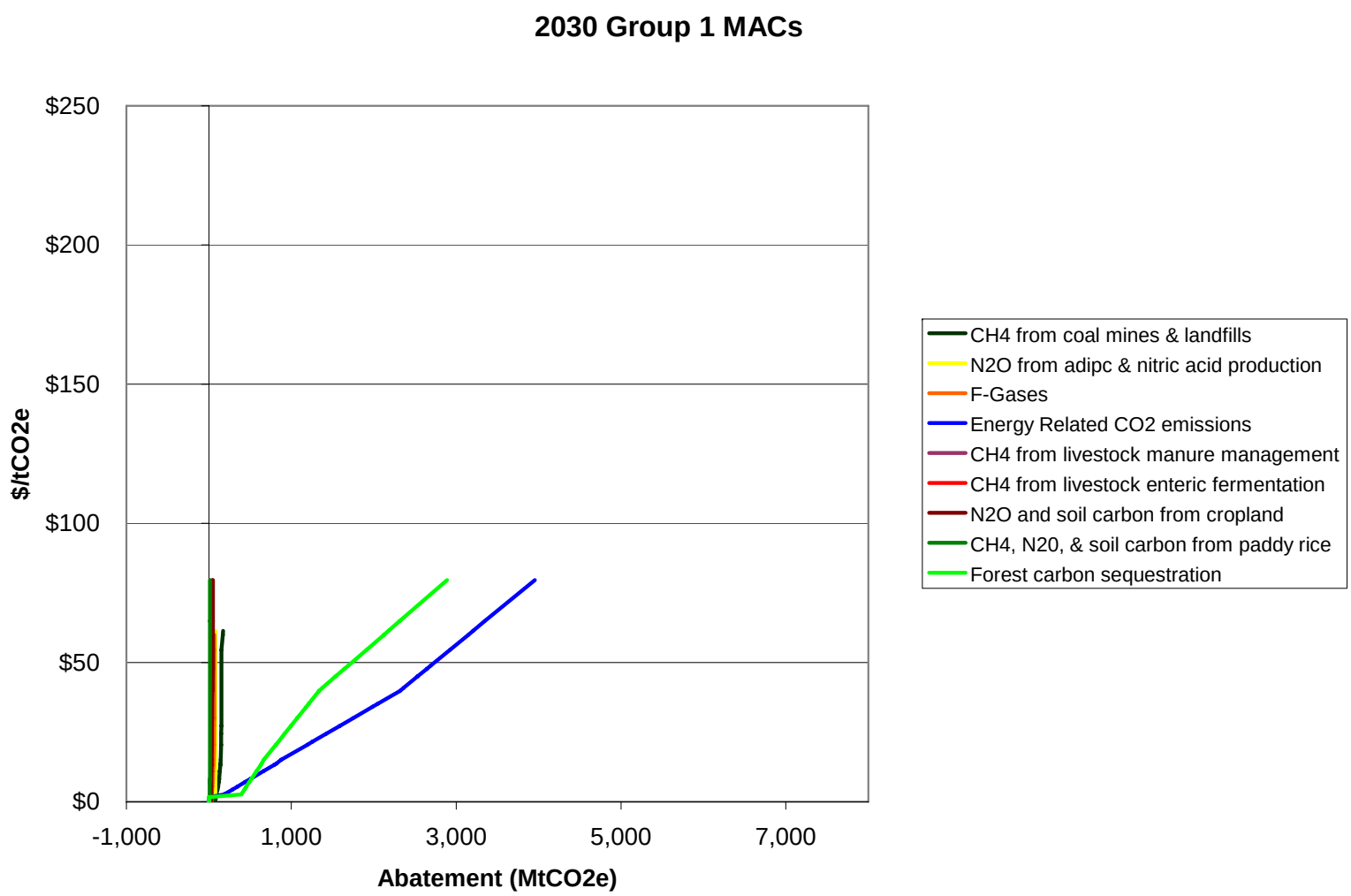
2010 Group 1 Abatement MACs



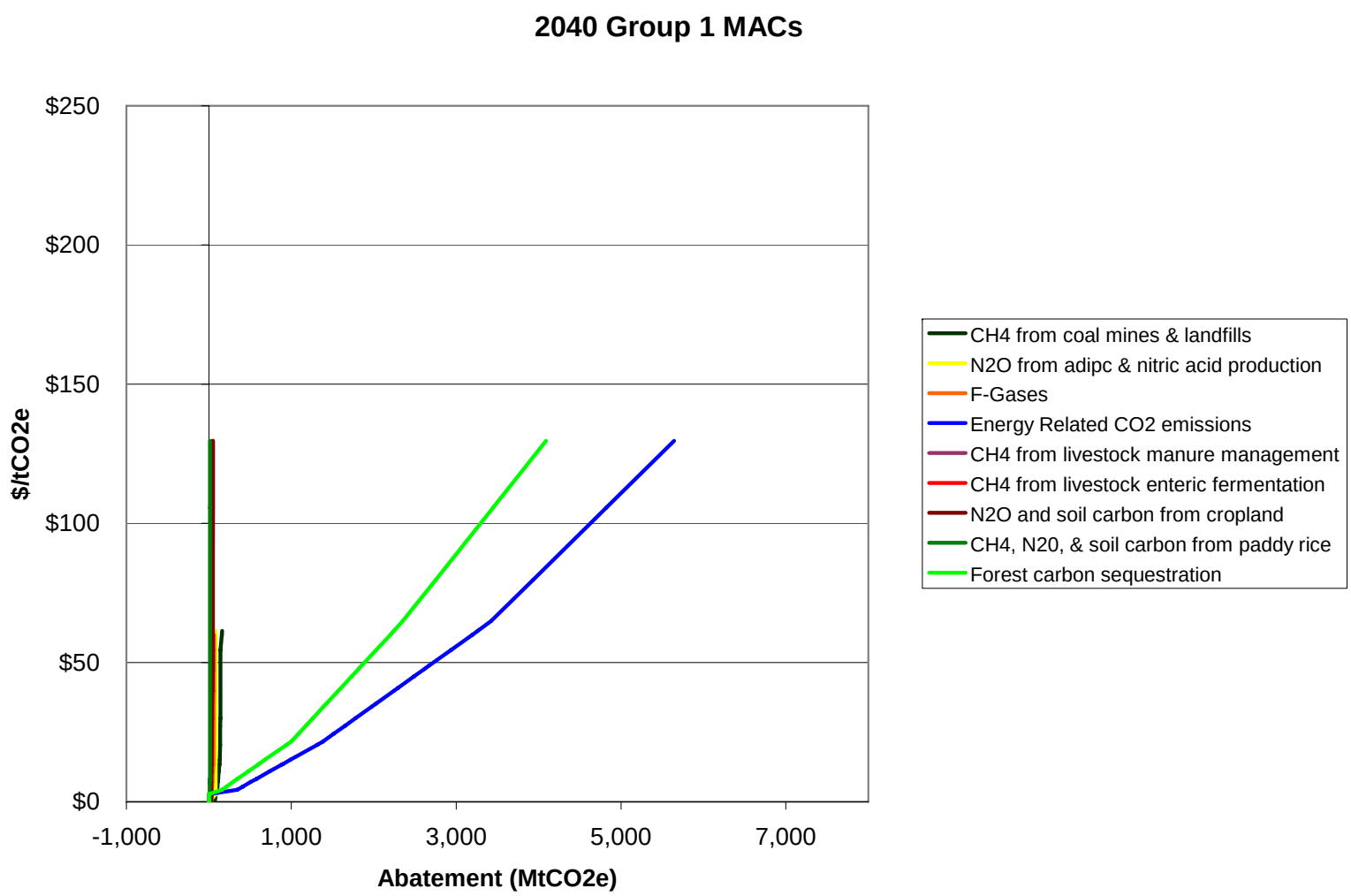
2020 Group 1 Abatement MACs



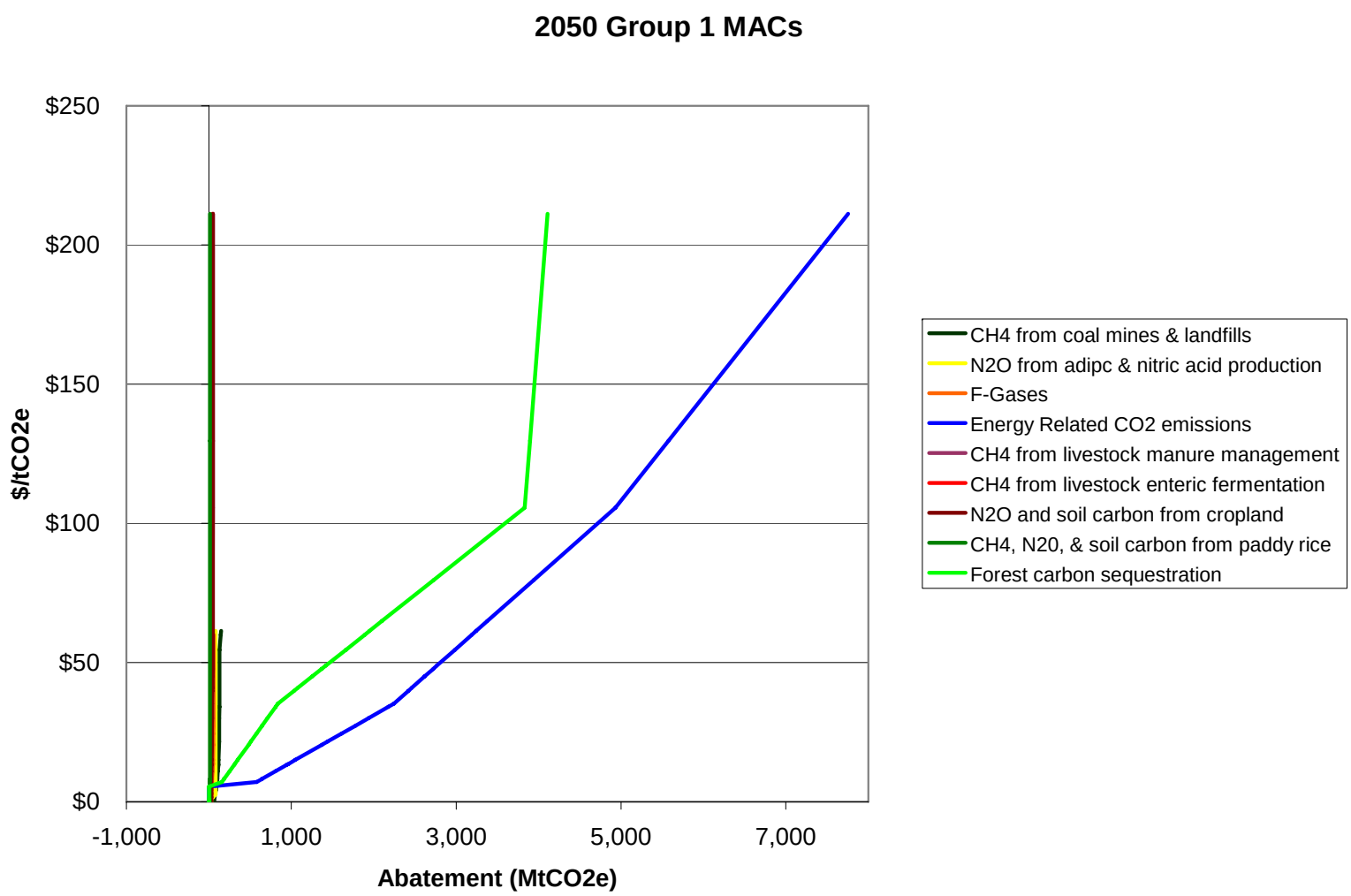
2030 Group 1 Abatement MACs



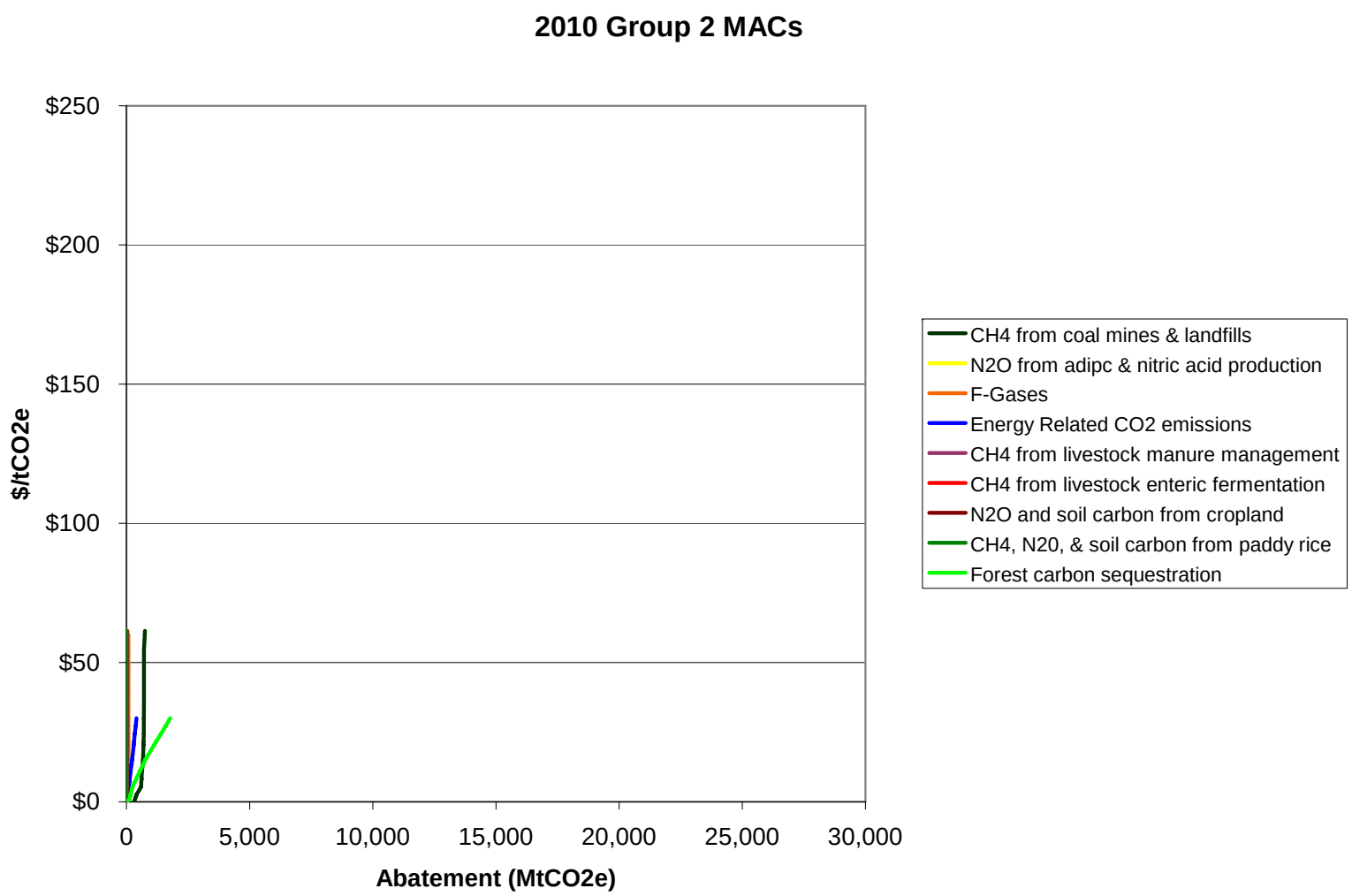
2040 Group 1 Abatement MACs



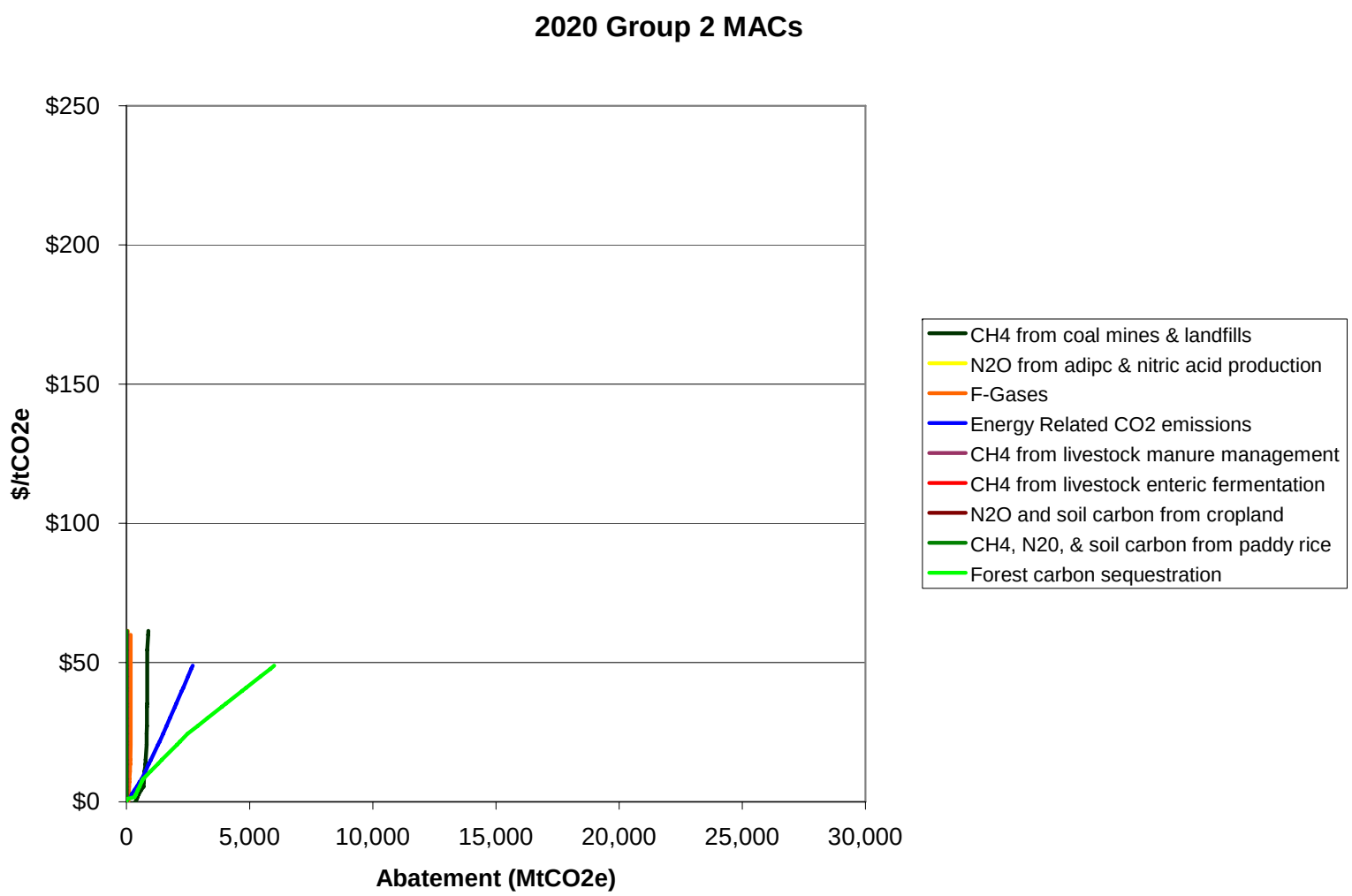
2050 Group 1 Abatement MACs



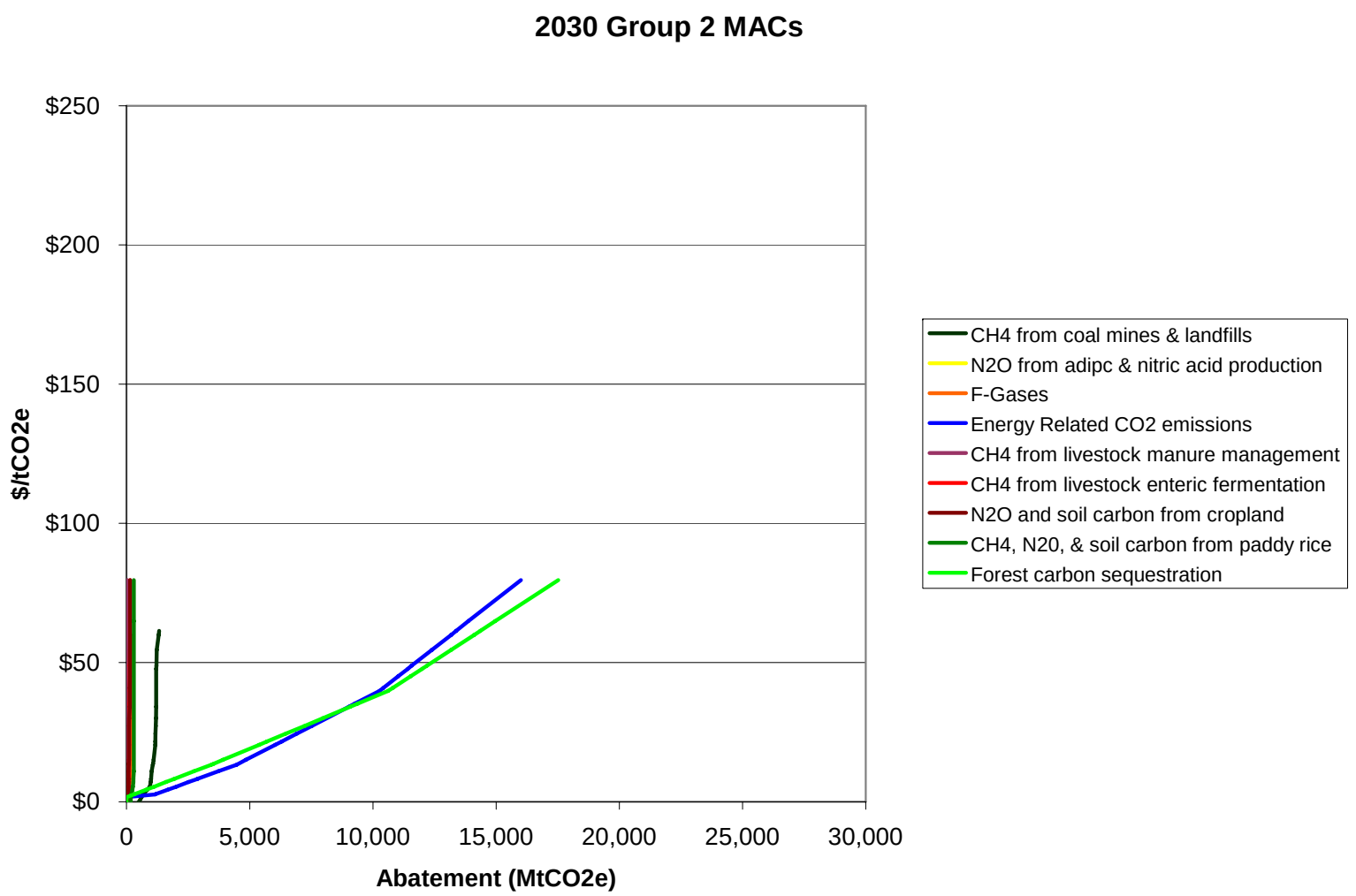
2010 Group 2 Abatement MACs



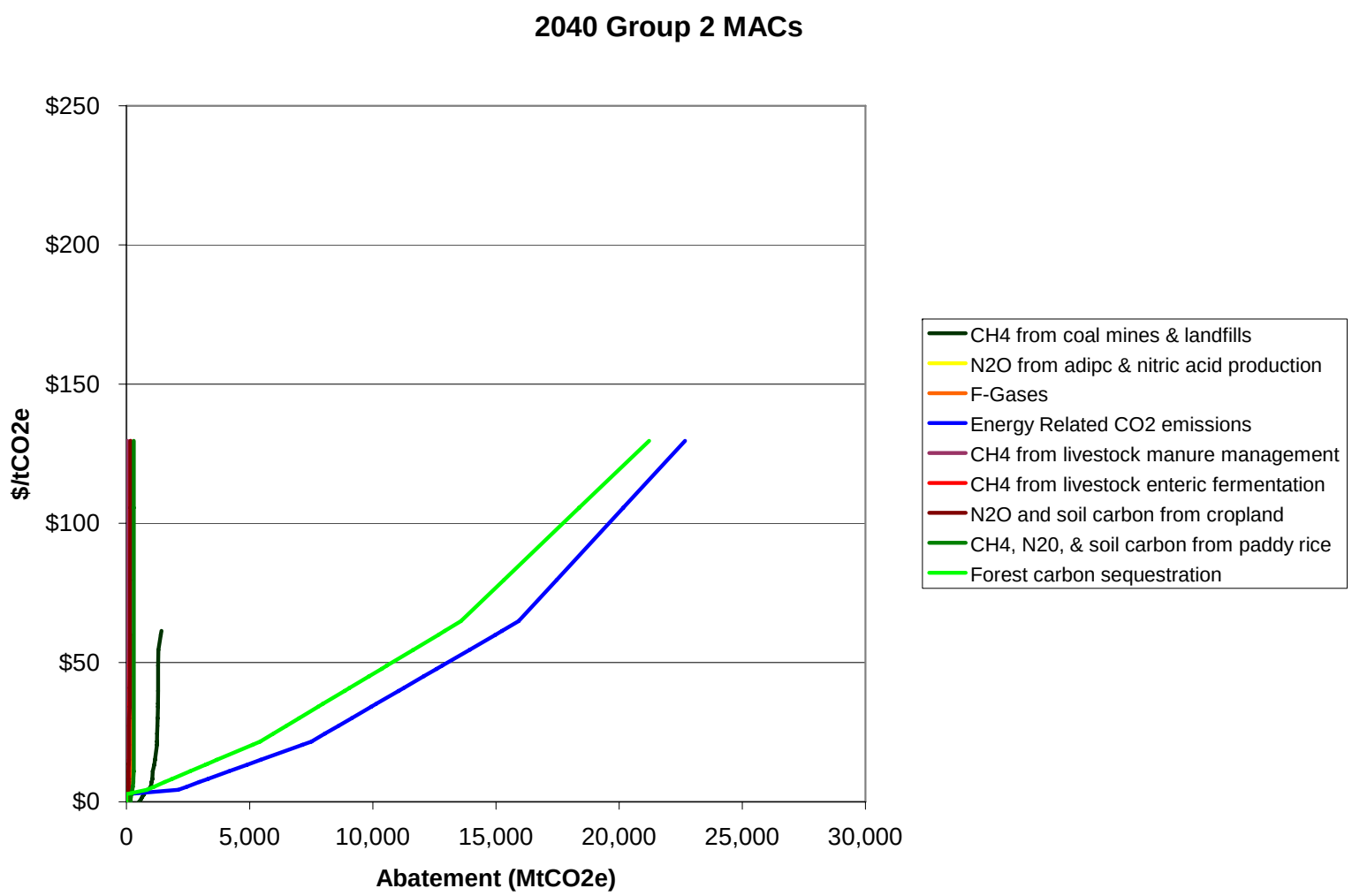
2020 Group 2 Abatement MACs



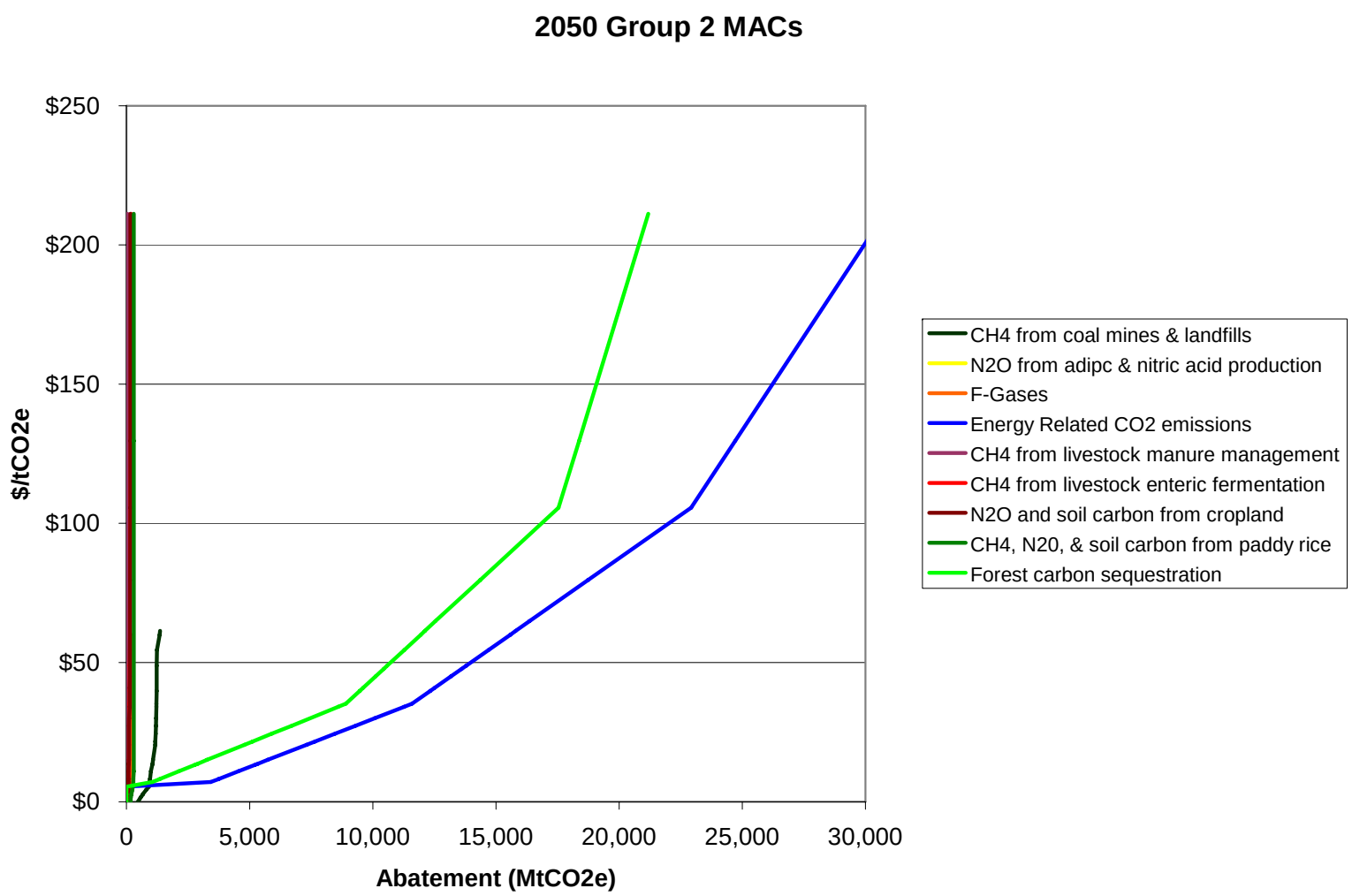
2030 Group 2 Abatement MACs



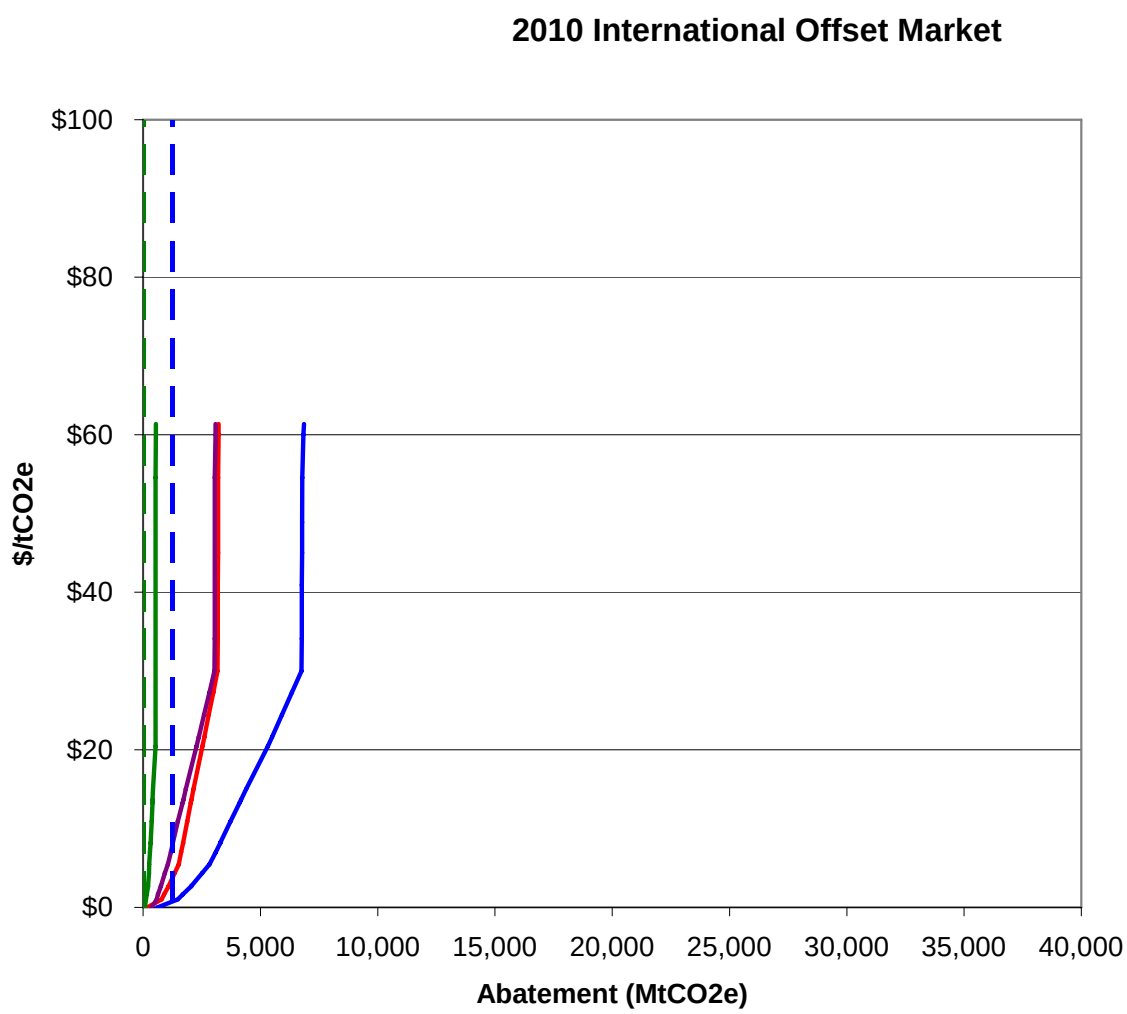
2040 Group 2 Abatement MACs



2050 Group 2 Abatement MACs



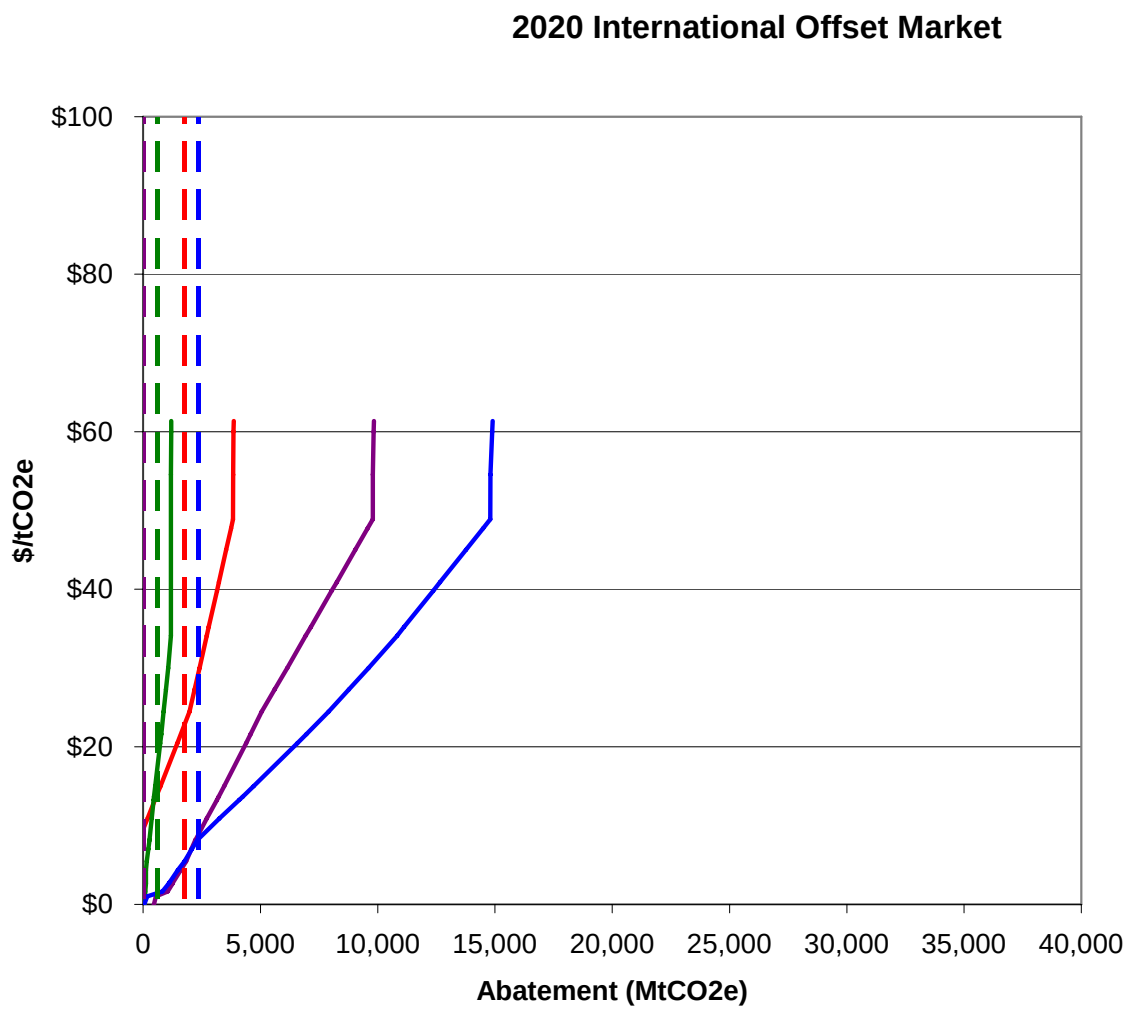
Aggregate MACs & Abatement Demand 2010



International Action

- Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050.
- Group 2 countries (rest of world) adopt a policy beginning in 2025 that returns and holds them at year 2015 emissions levels through 2034, and then returns and maintains them at 2000 emissions levels from 2035 to 2050.

Aggregate MACs & Abatement Demand 2020



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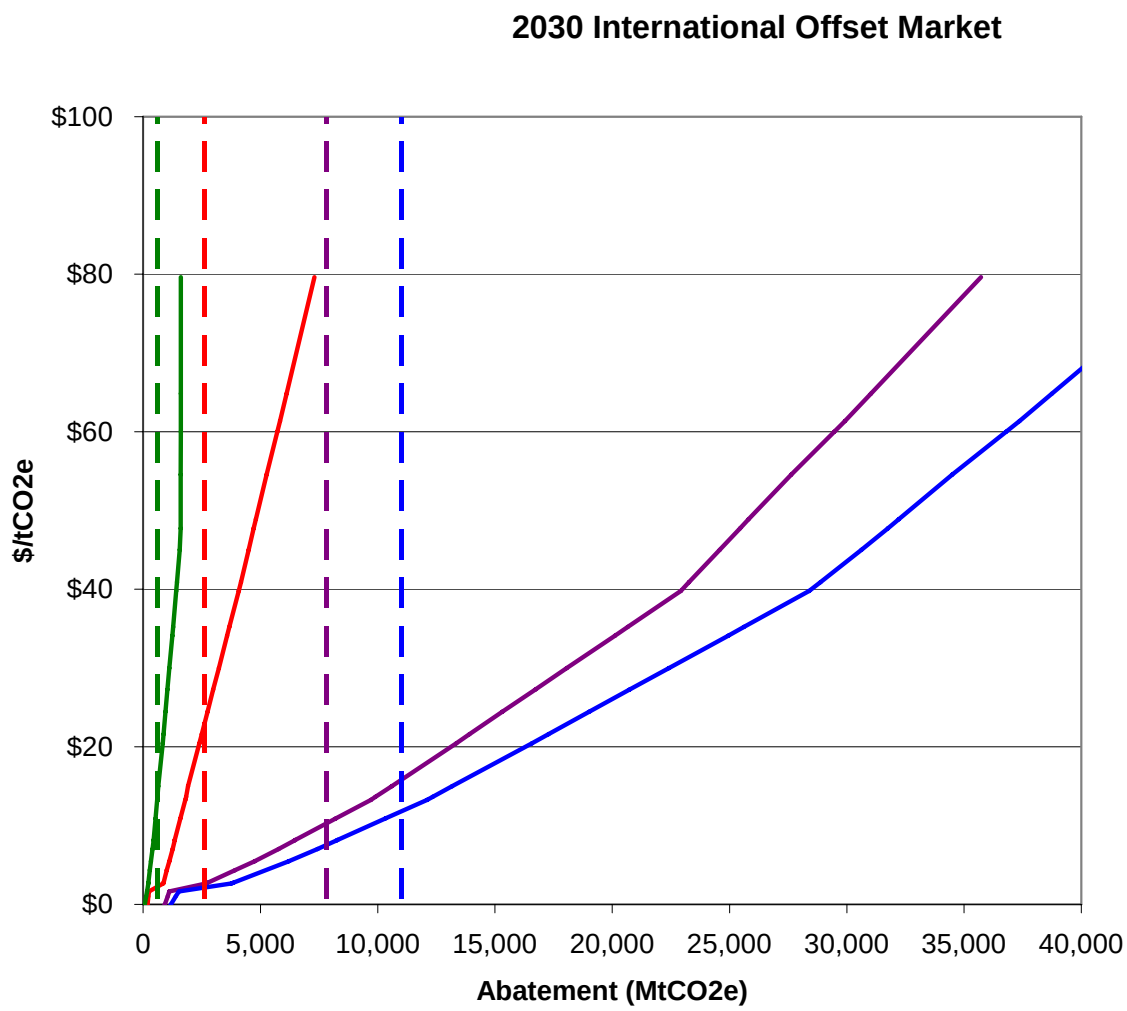
Aggregate MACs & Abatement Demand 2030



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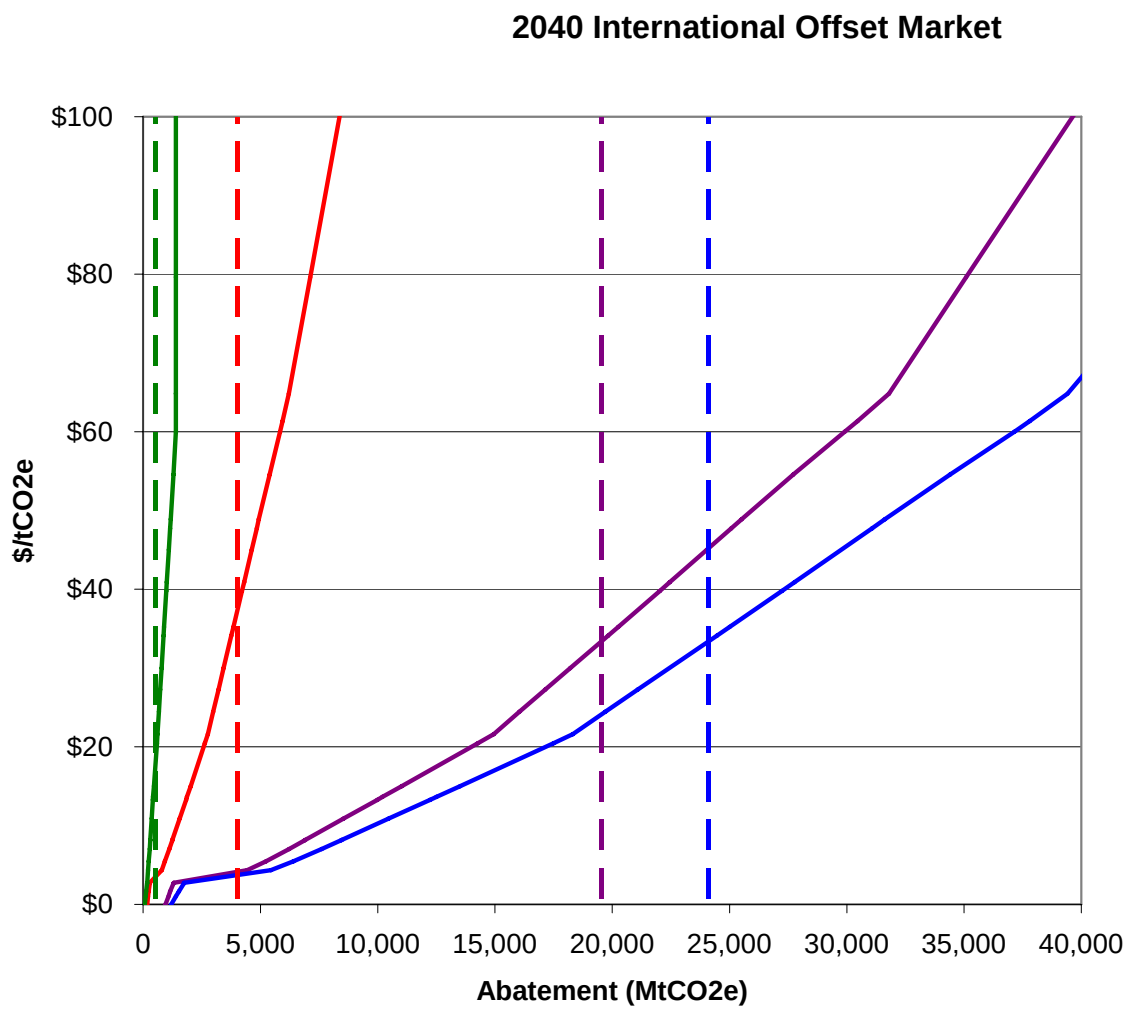
Aggregate MACs & Abatement Demand 2040



International Action

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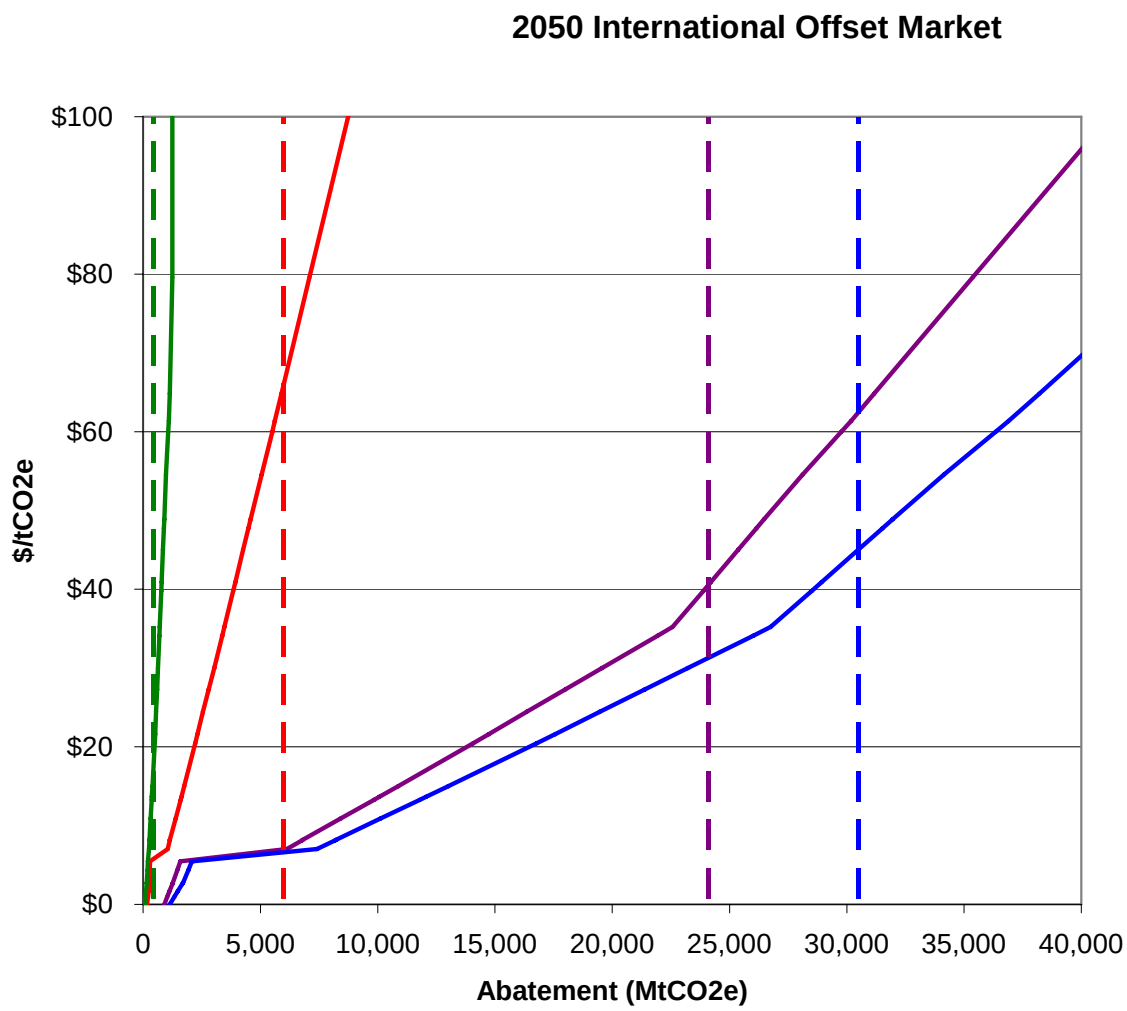
Aggregate MACs & Abatement Demand 2050



International Action

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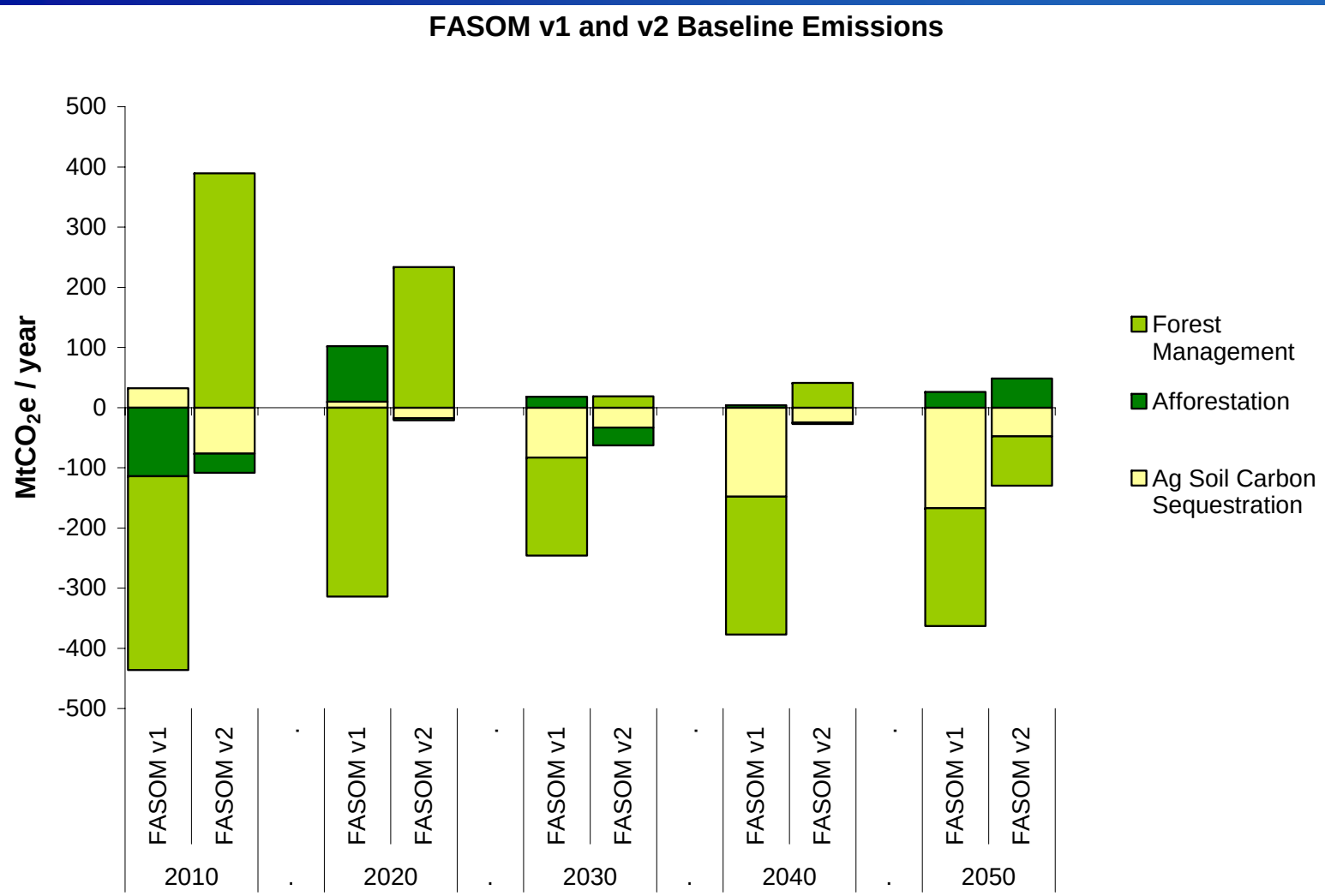
Preliminary Updated FASOM Baseline



Preliminary Updated FASOM Baseline

- Strong growth in demand for agricultural commodities is increasing rents for ag land
  - This is one cause for reversion in private forestland
    - (FASOM does not currently include public forests in the baseline because timber harvests are generally determined exogenously by federal policies).
  - There are many drivers increasing demand for agricultural commodities
    - e.g. increased demand for biofuels;
    - population and GDP growth;
    - changes in consumer preferences (e.g. increased demand for meat and other crops in Asia);
    - trade distortions;
    - weather.
- **Beyond the agricultural drivers, some changes have been made that would impact forestry**
  - Large transfers of forest land from traditional industrial owners to timber investment management organization and REITs.
  - Domestic production costs that are high relative to some regions and change in trade assumptions.
  - Increasing reliance on nonfederal timber and expanded use of plantations on private timberlands.
  - Change in outlook for Canadian timber harvests associated with insect outbreaks.
- **Agricultural Soil Carbon**
  - Baseline tilling practices have changed, and thus more farmers are doing no till or less till practices in the baseline. Some of this could be attributed to the biofuels policy.
  - Furthermore, if there are more biofuel specific crops (e.g. switchgrass) that can put more carbon in the soil, then we would expect to have a larger baseline, especially in the first 30 years.

Contact info

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The full analytical package and data annex* are available at:
www.epa.gov/climatechange/economics/economicanalyses.html

* Note that the Data Annex includes all of the offset marginal abatement cost curves discussed in this presentation.