U.S. Environmental Protection Agency
Office of Atmospheric Programs

EPA Analysis of the Low Carbon Economy Act of 2007

S. 1766 in 110th Congress

Appendix

January 15, 2008

The full analysis is available at:
www.epa.gov/climatechange/economicanalyses.html

Appendix 1: Scenario Comparison Tables

Analytical Scenarios

Table: Scenario Definitions

	Ref	TAP	International Action	Domestic Offsets	International Offsets	Non-Specified Offsets	CCS Subsidy	CCS	Nuclear
1) Core Reference									
	Standard	n/a	None	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766									
	Standard	Yes	MIT	Unlimited	None	None	Yes	Unrestricted	150% increase
3) S. 1766 - No TAP									
	Standard	No	MIT	Unlimited	None	None	Yes	Unrestricted	150% increase
4) S. 1766 - 10% Int'l Offsets									
	Standard	Yes	MIT	Unlimited	10% limit	None	Yes	Unrestricted	150% increase
5) S. 1766 - Unlimited Int'l Offsets									
	Standard	Yes	MIT	Unlimited	Unlimited	None	Yes	Unrestricted	150% increase
6) S. 1766 - No TAP, 10% Int'l Offsets									
	Standard	No	MIT	Unlimited	10% limit	None	Yes	Unrestricted	150% increase
7) S. 1766 - No TAP, Unlimited Int'l Offsets									
	Standard	No	MIT	Unlimited	Unlimited	None	Yes	Unrestricted	150% increase
8) S. 1766 - No CCS Subsidy									
	Standard	Yes	MIT	Unlimited	None	None	No	Unrestricted	150% increase
9) S. 1766 - No TAP, No CCS Subsidy									
	Standard	No	MIT	Unlimited	None	None	No	Unrestricted	150% increase
10) S. 1766 - No CCS, Low Nuclear									
	Standard	Yes	MIT	Unlimited	None	None	Yes	None	75% increase
11) S. 1766 - Alternative Int'l Action									
	Standard	Yes	Alternative	Unlimited	None	None	Yes	Unrestricted	150% increase

Analytical Scenarios (con't)

Table: Scenario Definitions (continued)

	Ref	TAP	International Action	Domestic Offsets	International Offsets	Non-Specified Offsets	CCS Subsidy	CCS	Nuclear
12) High Technology Reference									
	High Tech	n/a	None	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology									
	High Tech	Yes	MIT	Unlimited	None	None	Yes	Unrestricted	150% increase
14) S. 1766 High Technology - No TAP									
	High Tech	No	MIT	Unlimited	None	None	Yes	Unrestricted	150% increase
15) S. 1766 High Technology - 10% Int'l Offsets									
	High Tech	Yes	MIT	Unlimited	10% limit	None	Yes	Unrestricted	150% increase
16) S. 1766 High Technology - Unlimited Int'l Offsets									
	High Tech	Yes	MIT	Unlimited	Unlimited	None	Yes	Unrestricted	150% increase
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets									
	High Tech	No	MIT	Unlimited	10% limit	None	Yes	Unrestricted	150% increase
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets									
	High Tech	No	MIT	Unlimited	Unlimited	None	Yes	Unrestricted	150% increase
19) S. 1766 High Technology - No CCS Subsidy									
	High Tech	Yes	MIT	Unlimited	None	None	No	Unrestricted	150% increase
20) S. 1766 High Technology - No TAP, No CCS Subsidy									
	High Tech	No	MIT	Unlimited	None	None	No	Unrestricted	150% increase

Scenario Comparison

GHG Allowance Prices (2005$/tCO2e)

Table: Allowance Price Comparisons (2005 $/tCO2e)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766								
ADAGE	$12	$15	$19	$25	$31	$40	$51	$65
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
3) S. 1766 - No TAP								
ADAGE	$27	$35	$44	$57	$72	$92	$117	$149
IGEM	$29	$37	$48	$61	$78	$99	$127	$162
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$10	$13	$17	$22	$28	$35	$45	$57
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$21	$27	$35	$45	$57	$73	$93	$118
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$10	$13	$17	$22	$28	$35	$45	$57
8) S. 1766 - No CCS Subsidy								
ADAGE	$12	$15	$19	$25	$31	$40	$51	$65
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	$28	$36	$46	$59	$75	$95	$121	$155
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	$12	$15	$19	$25	$32	$40	$51	$65
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	$12	$15	$19	$25	$32	$40	$51	$65
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

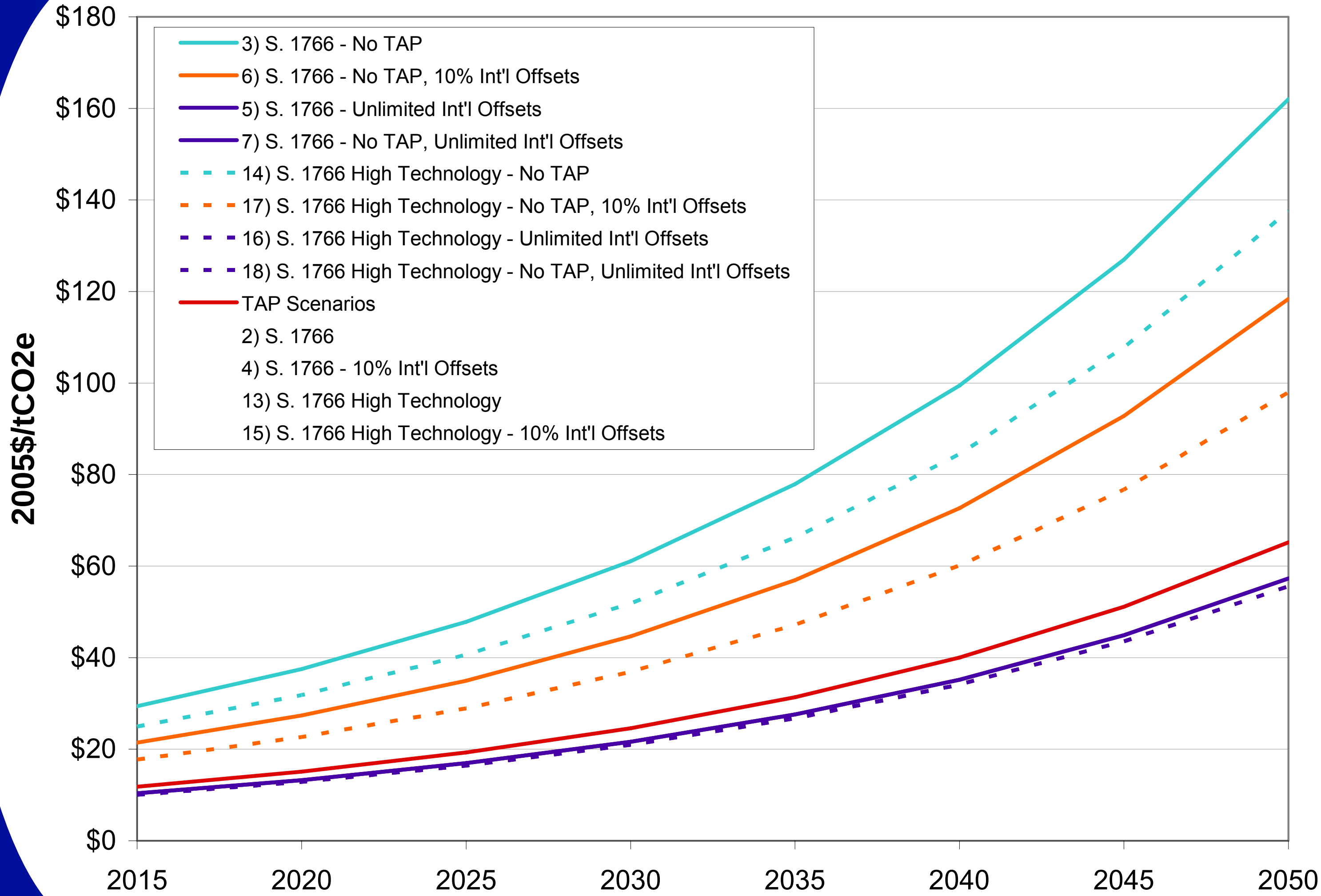
Scenario Comparison

GHG Allowance Prices (2005$/tCO2e)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	$12	$15	$19	$25	$31	$40	$51	$65
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
14) S. 1766 High Technology - No TAP								
ADAGE	$19	$24	$31	$39	$50	$64	$82	$104
IGEM	$25	$32	$41	$52	$66	$84	$108	$138
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$10	$13	$16	$21	$27	$34	$44	$56
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$18	$23	$29	$37	$47	$60	$77	$98
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$10	$13	$16	$21	$27	$34	$44	$56
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	$12	$15	$19	$25	$31	$40	$51	$65
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	$21	$27	$35	$45	$57	$72	$92	$117
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

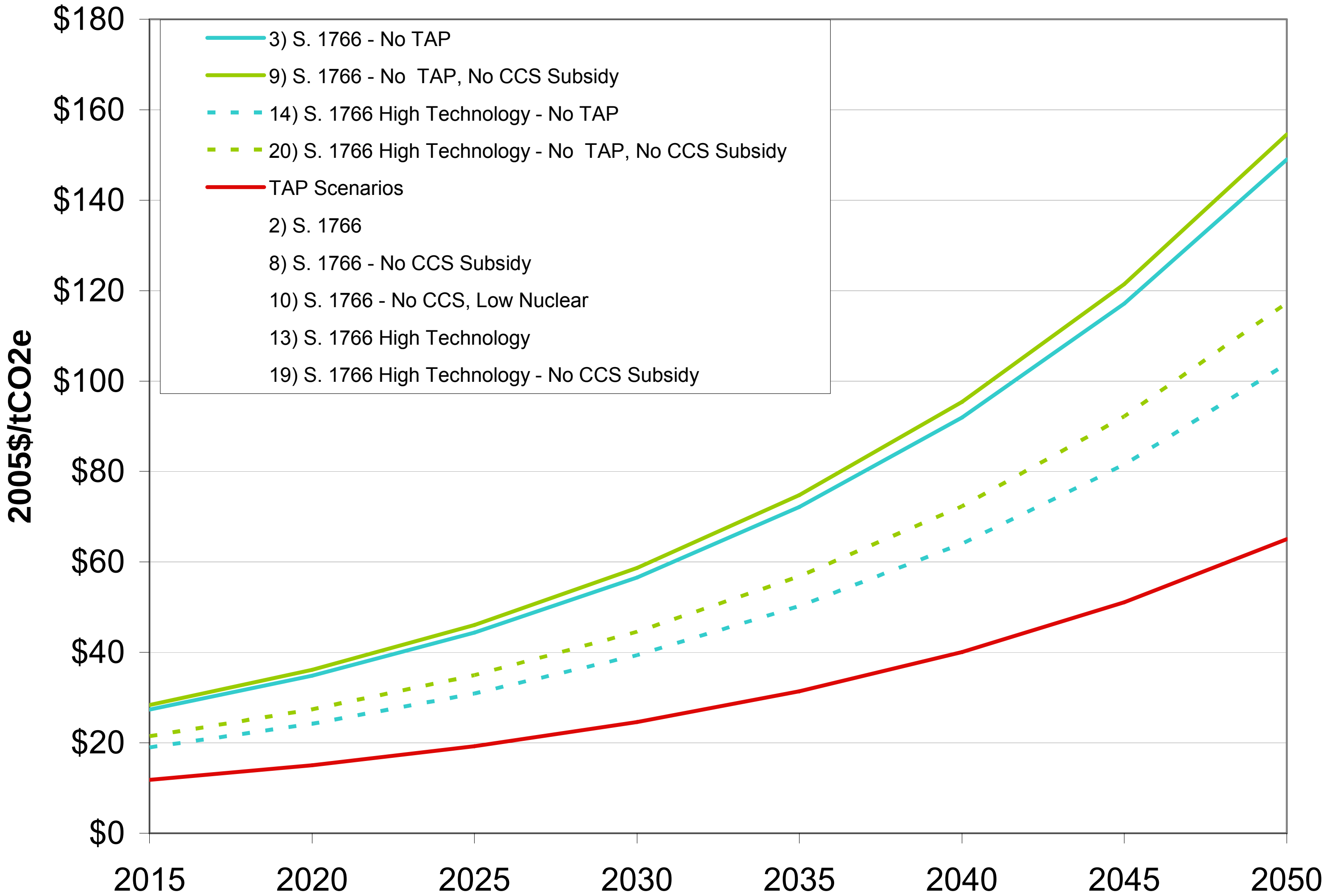
GHG Allowance Prices (IGEM)



- In the unlimited offset scenarios, the emissions target is met at an allowance price lower than the TAP, so in the scenarios where the TAP is available and international offsets are unlimited, the TAP is not triggered. Therefore, scenarios 5 & 7 are equivalent to each other, and scenarios 13 & 15 are equivalent to each other.

Scenario Comparison

GHG Allowance Prices (ADAGE)



Scenario Comparison

International Offset Price Comparisons (2005$/$tCO_2e$)

	2015	2020	2025	2030	2035	2040	2045	2050
4) S. 1766 - 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
6) S. 1766 - No TAP, 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
	$10	$13	$17	$22	$28	$35	$45	$57
15) S. 1766 High Technology - 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
	$10	$13	$16	$21	$27	$34	$44	$56

Scenario Comparison

Consumption Impacts

(Percentage Change from Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766								
ADAGE	-0.2%	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%	-0.6%	-0.8%
IGEM	0.0%	-0.2%	-0.3%	-0.5%	-0.6%	-0.8%	-0.9%	-1.1%
3) S. 1766 - No TAP								
ADAGE	-0.4%	-0.5%	-0.7%	-0.9%	-1.0%	-1.3%	-1.6%	-1.9%
IGEM	-0.1%	-0.5%	-0.8%	-1.1%	-1.4%	-1.7%	-2.1%	-2.5%
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	0.0%	-0.2%	-0.3%	-0.5%	-0.6%	-0.8%	-1.0%	-1.2%
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.6%	-0.7%	-0.9%	-1.0%
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.1%	-0.4%	-0.6%	-0.8%	-1.1%	-1.3%	-1.6%	-1.9%
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.6%	-0.7%	-0.9%	-1.0%
8) S. 1766 - No CCS Subsidy								
ADAGE	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%	-0.6%	-0.7%	-0.8%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	-0.4%	-0.5%	-0.7%	-1.0%	-1.2%	-1.4%	-1.6%	-2.0%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%	-0.6%	-0.8%	-1.1%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	-0.2%	-0.3%	-0.4%	-0.5%	-0.6%	-0.6%	-0.7%	-0.8%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

Consumption Impacts
(Percentage Change from High Tech Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	-0.2%	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%	-0.6%	-0.8%
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.5%	-0.7%	-0.8%	-1.0%
14) S. 1766 High Technology - No TAP								
ADAGE	-0.2%	-0.3%	-0.4%	-0.5%	-0.7%	-1.0%	-1.2%	-1.5%
IGEM	-0.1%	-0.4%	-0.6%	-0.8%	-1.1%	-1.3%	-1.6%	-2.0%
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.1%	-0.2%	-0.3%	-0.4%	-0.5%	-0.7%	-0.8%	-1.0%
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.5%	-0.6%	-0.7%	-0.9%
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.1%	-0.3%	-0.5%	-0.6%	-0.8%	-1.0%	-1.2%	-1.5%
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.5%	-0.6%	-0.7%	-0.9%
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	-0.3%	-0.3%	-0.3%	-0.3%	-0.4%	-0.5%	-0.6%	-0.8%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	-0.2%	-0.3%	-0.4%	-0.7%	-0.9%	-1.1%	-1.3%	-1.6%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

Consumption Impacts

(Billion 2005$, Change from Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766								
ADAGE	-$31	-$47	-$52	-$70	-$98	-$127	-$188	-$267
IGEM	-$3	-$24	-$47	-$76	-$116	-$161	-$218	-$293
3) S. 1766 - No TAP								
ADAGE	-$48	-$75	-$115	-$184	-$234	-$335	-$451	-$606
IGEM	-$13	-$60	-$110	-$173	-$258	-$361	-$486	-$643
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$4	-$25	-$49	-$78	-$119	-$166	-$224	-$301
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$3	-$22	-$44	-$69	-$106	-$149	-$202	-$271
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$9	-$44	-$84	-$131	-$198	-$277	-$374	-$497
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$3	-$22	-$44	-$69	-$106	-$149	-$202	-$271
8) S. 1766 - No CCS Subsidy								
ADAGE	-$31	-$48	-$54	-$72	-$101	-$145	-$190	-$268
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	-$48	-$76	-$118	-$189	-$264	-$345	-$465	-$626
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	-$33	-$50	-$56	-$75	-$106	-$156	-$237	-$349
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	-$24	-$40	-$61	-$91	-$127	-$155	-$203	-$256
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

Consumption Impacts

(Billion 2005$, Change from High Tech Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	-$30	-$46	-$49	-$65	-$90	-$122	-$179	-$258
IGEM	-$5	-$24	-$44	-$67	-$98	-$138	-$188	-$258
14) S. 1766 High Technology - No TAP								
ADAGE	-$23	-$37	-$60	-$108	-$166	-$248	-$338	-$463
IGEM	-$12	-$49	-$88	-$137	-$202	-$283	-$384	-$513
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$6	-$26	-$45	-$68	-$98	-$139	-$191	-$259
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$5	-$21	-$38	-$59	-$87	-$123	-$171	-$236
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$8	-$36	-$66	-$100	-$148	-$208	-$284	-$384
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$5	-$21	-$38	-$59	-$87	-$123	-$171	-$236
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	-$31	-$47	-$51	-$67	-$94	-$129	-$180	-$256
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	-$29	-$47	-$75	-$129	-$194	-$277	-$372	-$507
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

GDP Impacts

(Percentage Change from Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766								
ADAGE	-0.3%	-0.4%	-0.4%	-0.5%	-0.6%	-0.6%	-0.7%	-0.9%
IGEM	-0.7%	-0.9%	-1.2%	-1.4%	-1.7%	-2.0%	-2.4%	-2.9%
3) S. 1766 - No TAP								
ADAGE	-0.6%	-0.6%	-0.6%	-0.8%	-1.0%	-1.4%	-1.8%	-2.2%
IGEM	-1.5%	-1.9%	-2.4%	-2.9%	-3.5%	-4.1%	-4.7%	-5.5%
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.7%	-0.9%	-1.2%	-1.4%	-1.7%	-2.1%	-2.5%	-2.9%
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.6%	-0.8%	-1.0%	-1.2%	-1.5%	-1.8%	-2.1%	-2.5%
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-1.1%	-1.5%	-1.9%	-2.3%	-2.7%	-3.2%	-3.8%	-4.4%
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.6%	-0.8%	-1.0%	-1.2%	-1.5%	-1.8%	-2.1%	-2.5%
8) S. 1766 - No CCS Subsidy								
ADAGE	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%	-0.6%	-0.7%	-0.9%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	-0.6%	-0.6%	-0.6%	-0.9%	-1.1%	-1.4%	-1.8%	-2.3%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	-0.2%	-0.4%	-0.5%	-0.6%	-0.7%	-0.8%	-1.0%	-1.3%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	-0.2%	-0.3%	-0.3%	-0.4%	-0.6%	-0.7%	-0.9%	-1.1%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

GDP Impacts

(Percentage Change from High Tech Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	-0.3%	-0.4%	-0.4%	-0.5%	-0.5%	-0.6%	-0.7%	-0.9%
IGEM	-0.7%	-0.8%	-1.0%	-1.3%	-1.5%	-1.9%	-2.3%	-2.7%
14) S. 1766 High Technology - No TAP								
ADAGE	-0.4%	-0.4%	-0.3%	-0.5%	-0.6%	-0.9%	-1.2%	-1.5%
IGEM	-1.3%	-1.6%	-2.0%	-2.4%	-2.8%	-3.4%	-4.0%	-4.7%
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.7%	-0.8%	-1.0%	-1.3%	-1.5%	-1.9%	-2.3%	-2.7%
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.5%	-0.7%	-0.9%	-1.1%	-1.3%	-1.6%	-2.0%	-2.4%
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.9%	-1.2%	-1.5%	-1.8%	-2.2%	-2.6%	-3.1%	-3.7%
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-0.5%	-0.7%	-0.9%	-1.1%	-1.3%	-1.6%	-2.0%	-2.4%
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%	-0.6%	-0.7%	-0.9%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	-0.4%	-0.5%	-0.4%	-0.6%	-0.8%	-1.0%	-1.3%	-1.7%
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

GDP Impacts

(Billion 2005$, Change from Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766								
ADAGE	-$47	-$78	-$102	-$124	-$171	-$200	-$279	-$401
IGEM	-$117	-$182	-$264	-$370	-$511	-$692	-$916	-$1,199
3) S. 1766 - No TAP								
ADAGE	-$94	-$110	-$128	-$219	-$301	-$470	-$675	-$952
IGEM	-$256	-$386	-$547	-$757	-$1,034	-$1,369	-$1,777	-$2,268
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$119	-$184	-$266	-$373	-$515	-$699	-$926	-$1,211
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$101	-$157	-$228	-$320	-$443	-$600	-$795	-$1,049
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$195	-$297	-$426	-$594	-$818	-$1,095	-$1,431	-$1,839
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$101	-$157	-$228	-$320	-$443	-$600	-$795	-$1,049
8) S. 1766 - No CCS Subsidy								
ADAGE	-$46	-$84	-$108	-$130	-$176	-$217	-$284	-$402
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	-$72	-$92	-$102	-$168	-$240	-$353	-$496	-$710
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	-$42	-$79	-$113	-$146	-$209	-$268	-$382	-$547
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	-$33	-$50	-$78	-$117	-$188	-$244	-$342	-$451
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

GDP Impacts

(Billion 2005$, Change from High Tech Reference)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	-$47	-$77	-$100	-$121	-$165	-$200	-$281	-$396
IGEM	-$113	-$167	-$237	-$331	-$462	-$636	-$856	-$1,131
14) S. 1766 High Technology - No TAP								
ADAGE	-$63	-$73	-$75	-$129	-$195	-$307	-$448	-$649
IGEM	-$214	-$316	-$449	-$622	-$855	-$1,150	-$1,512	-$1,946
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$111	-$164	-$234	-$330	-$460	-$634	-$853	-$1,130
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$94	-$139	-$199	-$279	-$398	-$551	-$743	-$984
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$158	-$236	-$335	-$469	-$650	-$887	-$1,178	-$1,537
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	-$94	-$139	-$199	-$279	-$398	-$551	-$743	-$984
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	-$47	-$81	-$106	-$128	-$175	-$209	-$285	-$396
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	-$72	-$92	-$102	-$168	-$240	-$353	-$496	-$710
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

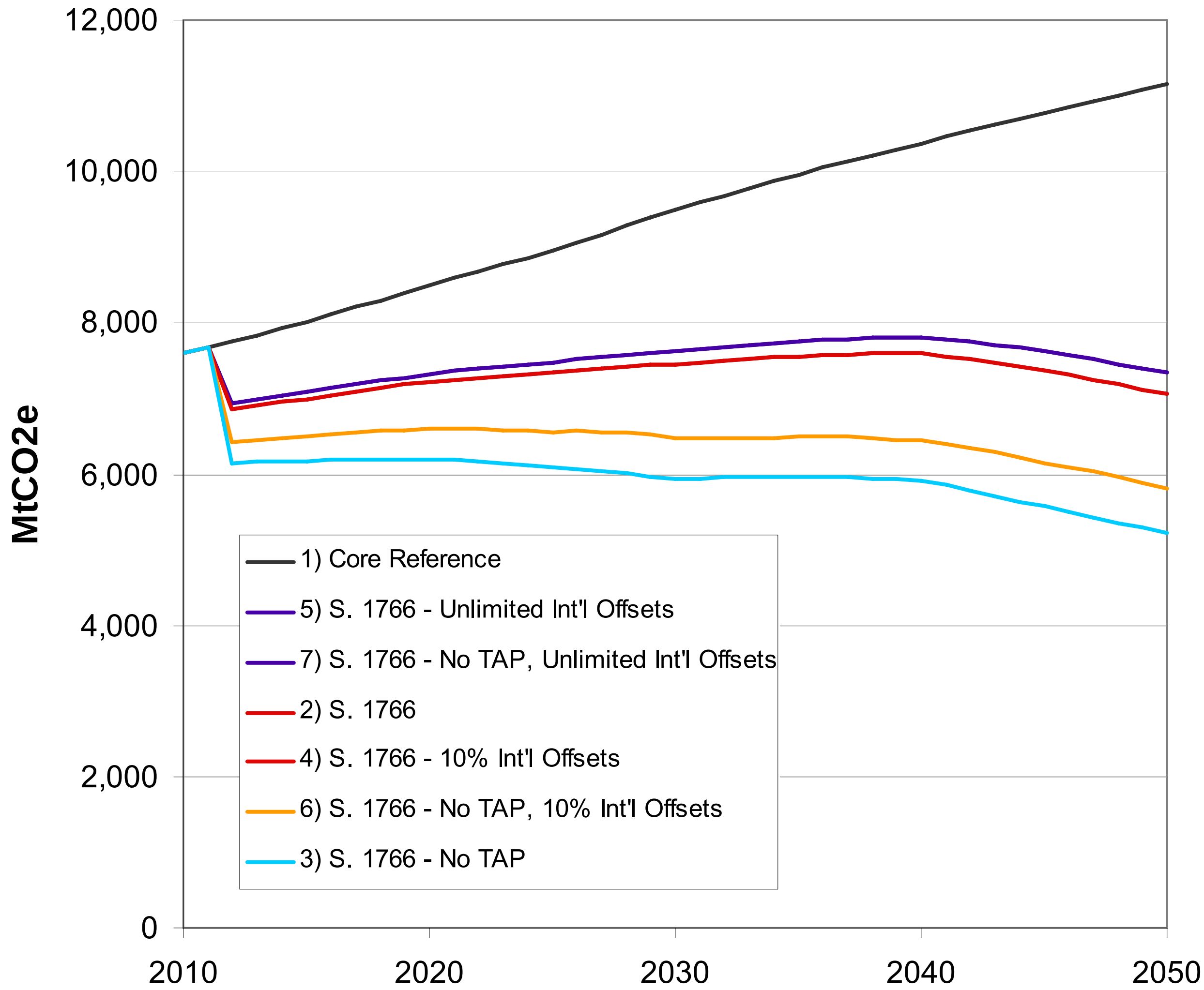
Scenario Comparison

Total U.S. GHG Emissions ($MtCO_2e$)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	7,830	8,264	8,626	9,089	9,452	9,786	10,068	10,312
IGEM	8,011	8,494	8,958	9,493	9,954	10,370	10,765	11,148
2) S. 1766								
ADAGE	6,853	6,965	6,937	6,911	6,618	6,477	6,177	5,880
IGEM	6,996	7,221	7,331	7,448	7,558	7,592	7,365	7,051
3) S. 1766 - No TAP								
ADAGE	6,277	6,255	6,063	5,732	5,300	5,278	5,234	5,128
IGEM	6,176	6,202	6,078	5,932	5,964	5,914	5,570	5,229
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	6,996	7,221	7,331	7,448	7,558	7,592	7,365	7,051
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	7,080	7,328	7,463	7,622	7,750	7,809	7,615	7,338
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	6,497	6,601	6,557	6,472	6,496	6,447	6,153	5,808
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	7,080	7,328	7,463	7,622	7,750	7,809	7,615	7,338
8) S. 1766 - No CCS Subsidy								
ADAGE	6,853	6,991	6,986	7,006	6,793	6,475	6,184	5,892
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	6,251	6,245	6,087	5,820	5,314	5,250	5,201	5,094
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	6,861	7,001	7,072	7,216	7,214	7,200	7,090	6,908
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	6,826	6,938	6,897	6,854	6,538	6,374	6,055	5,770
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

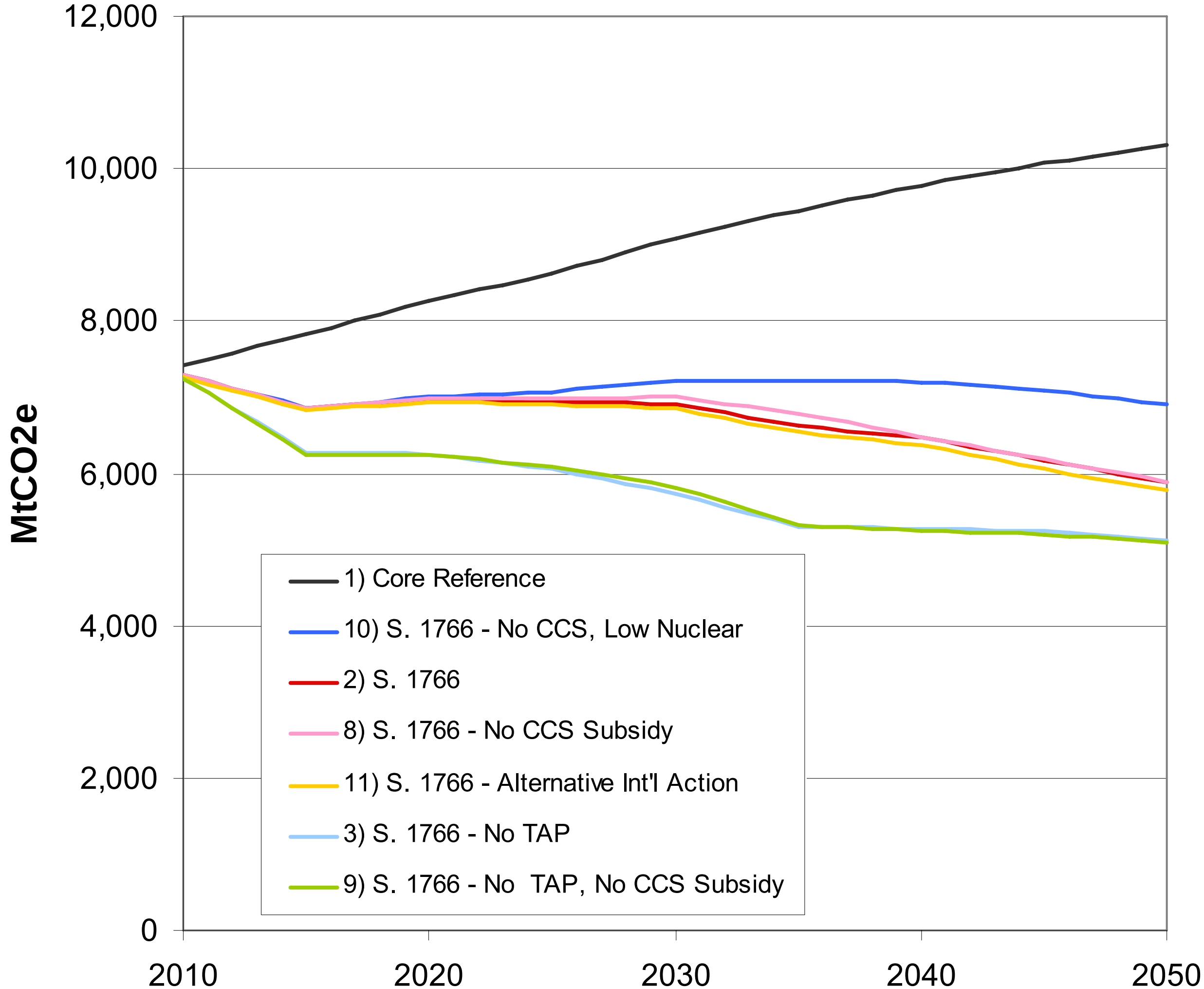
Scenario Comparison

Total U.S. GHG Emissions ($MtCO_2e$) (IGEM)



Scenario Comparison

Total U.S. GHG Emissions ($MtCO_2e$) (ADAGE)



Scenario Comparison

Total U.S. GHG Emissions ($MtCO_2e$)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	7,618	7,896	8,121	8,442	8,779	9,088	9,349	9,576
IGEM	7,804	8,129	8,451	8,850	9,255	9,615	9,953	10,279
13) S. 1766 High Technology								
ADAGE	6,629	6,588	6,498	6,460	6,235	6,203	6,054	5,809
IGEM	6,827	6,954	6,996	7,049	7,150	7,180	6,952	6,641
14) S. 1766 High Technology - No TAP								
ADAGE	6,318	6,219	6,048	5,810	5,389	5,223	5,229	5,191
IGEM	6,200	6,199	6,072	5,878	5,930	5,899	5,593	5,237
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	6,827	6,954	6,996	7,049	7,150	7,180	6,952	6,641
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	6,926	7,075	7,147	7,244	7,363	7,420	7,233	6,965
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	6,518	6,575	6,534	6,477	6,500	6,466	6,175	5,841
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	6,926	7,075	7,147	7,244	7,363	7,420	7,233	6,965
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	6,628	6,612	6,543	6,545	6,388	6,200	6,054	5,808
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	6,861	7,001	7,072	7,216	7,214	7,200	7,090	6,908
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

Covered GHG Emissions - Offsets

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
2) S. 1766								
ADAGE	5,797	5,891	5,866	5,828	5,553	5,432	5,176	4,927
IGEM	5,791	5,996	6,145	6,326	6,331	6,221	5,952	5,588
3) S. 1766 - No TAP								
ADAGE	5,247	5,211	5,013	4,685	4,294	4,296	4,291	4,224
IGEM	5,018	5,035	5,015	4,999	4,796	4,525	4,129	3,740
4) S. 1766 - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	5,144	5,377	5,572	5,844	5,910	5,861	5,653	5,349
5) S. 1766 - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	5,014	5,104	5,022	4,863	4,806	4,608	4,253	3,779
6) S. 1766 - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	4,678	4,791	4,873	5,006	4,911	4,697	4,412	4,081
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	5,014	5,104	5,022	4,863	4,806	4,608	4,253	3,779
8) S. 1766 - No CCS Subsidy								
ADAGE	5,797	5,918	5,915	5,922	5,727	5,431	5,183	4,938
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9) S. 1766 - No TAP, No CCS Subsidy								
ADAGE	5,222	5,202	5,035	4,769	4,307	4,270	4,260	4,191
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10) S. 1766 - No CCS, Low Nuclear								
ADAGE	5,805	5,928	6,000	6,129	6,142	6,141	6,062	5,916
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11) S. 1766 - Alternative Int'l Action								
ADAGE	5,785	5,876	5,826	5,771	5,476	5,334	5,061	4,823
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

Covered GHG Emissions - Offsets

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	5,575	5,516	5,430	5,380	5,174	5,161	5,050	4,849
IGEM	5,624	5,731	5,812	5,927	5,922	5,809	5,540	5,179
14) S. 1766 High Technology - No TAP								
ADAGE	5,293	5,168	4,987	4,747	4,361	4,227	4,269	4,267
IGEM	5,037	5,021	4,986	4,940	4,762	4,510	4,152	3,749
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	4,977	5,112	5,239	5,446	5,501	5,448	5,240	4,940
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	4,924	4,968	4,908	4,824	4,805	4,669	4,376	3,980
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	4,688	4,754	4,823	4,958	4,900	4,721	4,439	4,115
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	4,924	4,968	4,908	4,824	4,805	4,669	4,376	3,980
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	5,574	5,540	5,474	5,465	5,326	5,157	5,051	4,848
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	5,204	5,108	4,983	4,812	4,481	4,368	4,183	4,165
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

Electricity: Fossil Fuel Generation (Billion kWh)

(ADAGE)

	2015	2020	2025	2030	2035	2040	2045	2050
1) Core Reference								
Fossil	3,208	3,449	3,676	3,981	4,265	4,536	4,787	5,017
Fossil w/ CCS	0	0	0	0	0	0	0	0
Nuclear	837	879	879	879	879	879	879	879
Other, non-fossil	414	433	452	470	477	484	491	499
2) S. 1766								
Fossil	2,884	2,954	2,815	2,580	1,957	1,517	757	0
Fossil w/ CCS	0	37	112	305	758	1,193	1,753	2,363
Nuclear	904	962	1,134	1,338	1,576	1,729	1,917	2,094
Other, non-fossil	492	582	672	764	909	1,048	1,257	1,467
3) S. 1766 - No TAP								
Fossil	2,668	2,553	2,075	1,224	119	6	0	-
Fossil w/ CCS	0	185	554	1,293	2,438	2,473	2,369	2,223
Nuclear	930	992	1,170	1,382	1,597	1,764	1,937	2,118
Other, non-fossil	503	596	694	795	908	1,058	1,267	1,477
8) S. 1766 - No CCS Subsidy								
Fossil	2,884	2,991	2,889	2,732	2,261	1,538	783	36
Fossil w/ CCS	0	0	37	152	453	1,054	1,722	2,312
Nuclear	904	963	1,134	1,338	1,577	1,754	1,918	2,097
Other, non-fossil	492	582	672	764	909	1,055	1,259	1,468
9) S. 1766 - No TAP, No CCS Subsidy								
Fossil	2,657	2,576	2,168	1,461	253	3	0	0
Fossil w/ CCS	0	147	443	1,036	2,132	2,468	2,361	2,213
Nuclear	931	993	1,172	1,384	1,623	1,766	1,938	2,120
Other, non-fossil	503	598	696	799	926	1,058	1,267	1,478
10) S. 1766 - No CCS, Low Nuclear								
Fossil	2,900	3,009	3,026	3,080	3,024	2,969	2,804	2,589
Fossil w/ CCS	0	0	0	0	0	0	0	0
Nuclear	887	942	1,032	1,138	1,263	1,357	1,462	1,577
Other, non-fossil	492	582	673	764	910	1,059	1,278	1,502

Scenario Comparison

Electricity: Fossil Fuel Generation (Billion kWh)

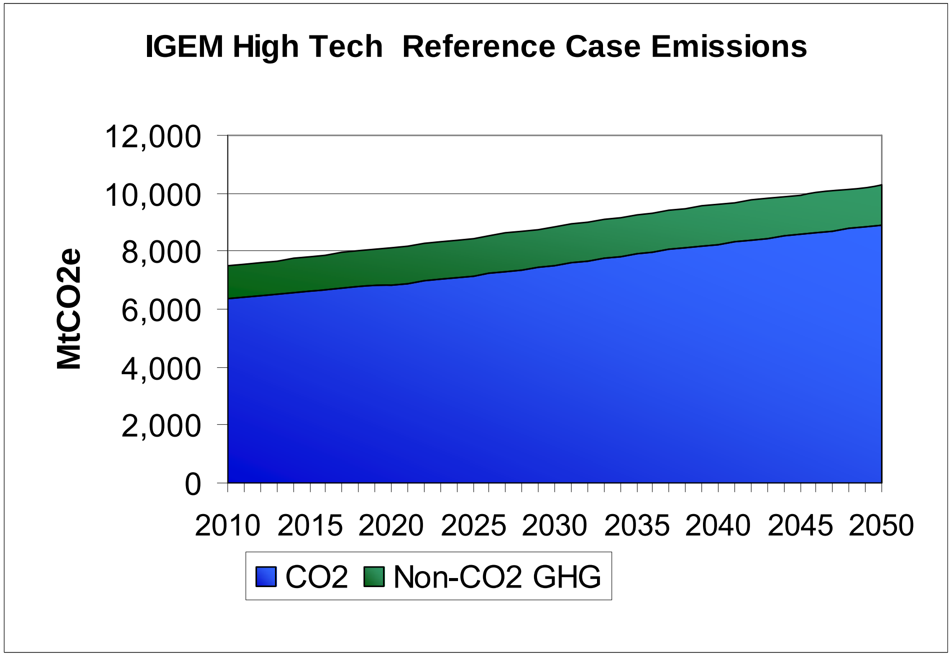
(ADAGE)

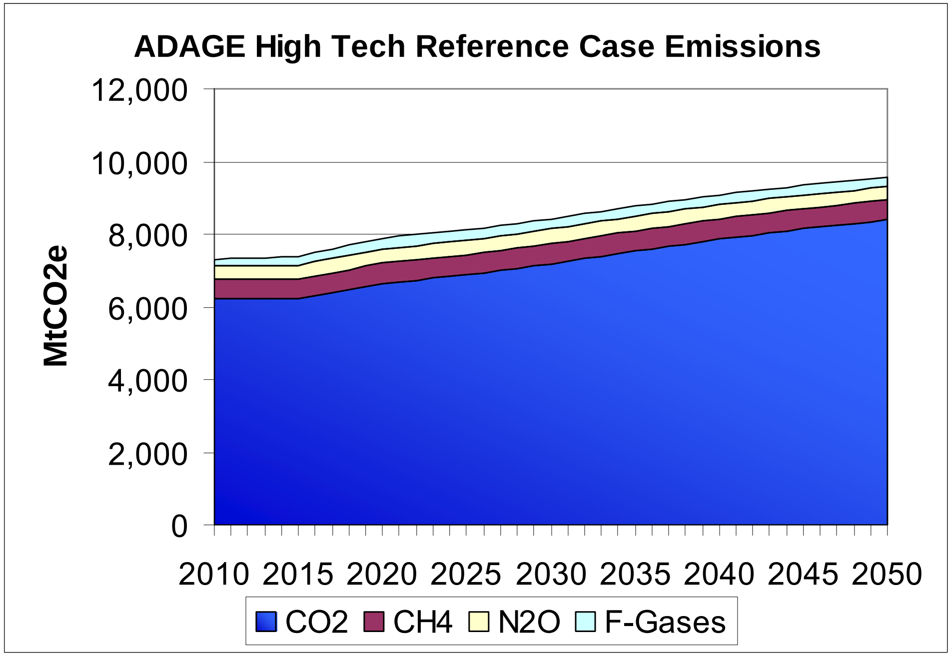
	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
Fossil	3061	3244	3431	3621	3886	4138	4372	4587
Fossil w/ CCS	0	0	0	0	0	0	0	0
Nuclear	814	864	864	916	916	916	916	916
Other, non-fossil	417	441	456	480	486	493	499	507
13) S. 1766 High Technology								
Fossil	2716	2737	2567	2320	1811	1629	1271	771
Fossil w/ CCS	0	37	112	261	596	710	879	1215
Nuclear	905	964	1135	1339	1577	1741	1918	2089
Other, non-fossil	495	588	673	769	912	1053	1267	1474
14) S. 1766 High Technology - No TAP								
Fossil	2609	2541	2166	1539	523	0	0	0
Fossil w/ CCS	0	112	371	865	1727	2152	2047	1909
Nuclear	919	980	1156	1365	1600	1767	1933	2100
Other, non-fossil	499	594	682	781	919	1064	1270	1479
19) S. 1766 High Technology - No CCS Subsidy								
Fossil	2716	2774	2640	2467	2097	1632	1278	770
Fossil w/ CCS	0	0	37	112	296	677	871	1215
Nuclear	905	964	1135	1340	1580	1748	1918	2089
Other, non-fossil	495	588	673	769	913	1055	1267	1474
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
Fossil	2574	2560	2311	1843	1025	594	0	0
Fossil w/ CCS	0	51	176	500	1149	1518	2029	1886
Nuclear	923	985	1162	1373	1610	1774	1935	2104
Other, non-fossil	501	596	685	787	931	1068	1272	1481

Appendix 2: High Technology Scenarios

Results: Scenario 12 – High Technology Reference

U.S. GHG Emissions





- CO_2 emissions grow at a faster rate than non-CO_2 GHG emissions
- IGEM non-CO_2 emissions are modeled in aggregate; ADAGE non-CO_2 emissions are modeled by type of gas

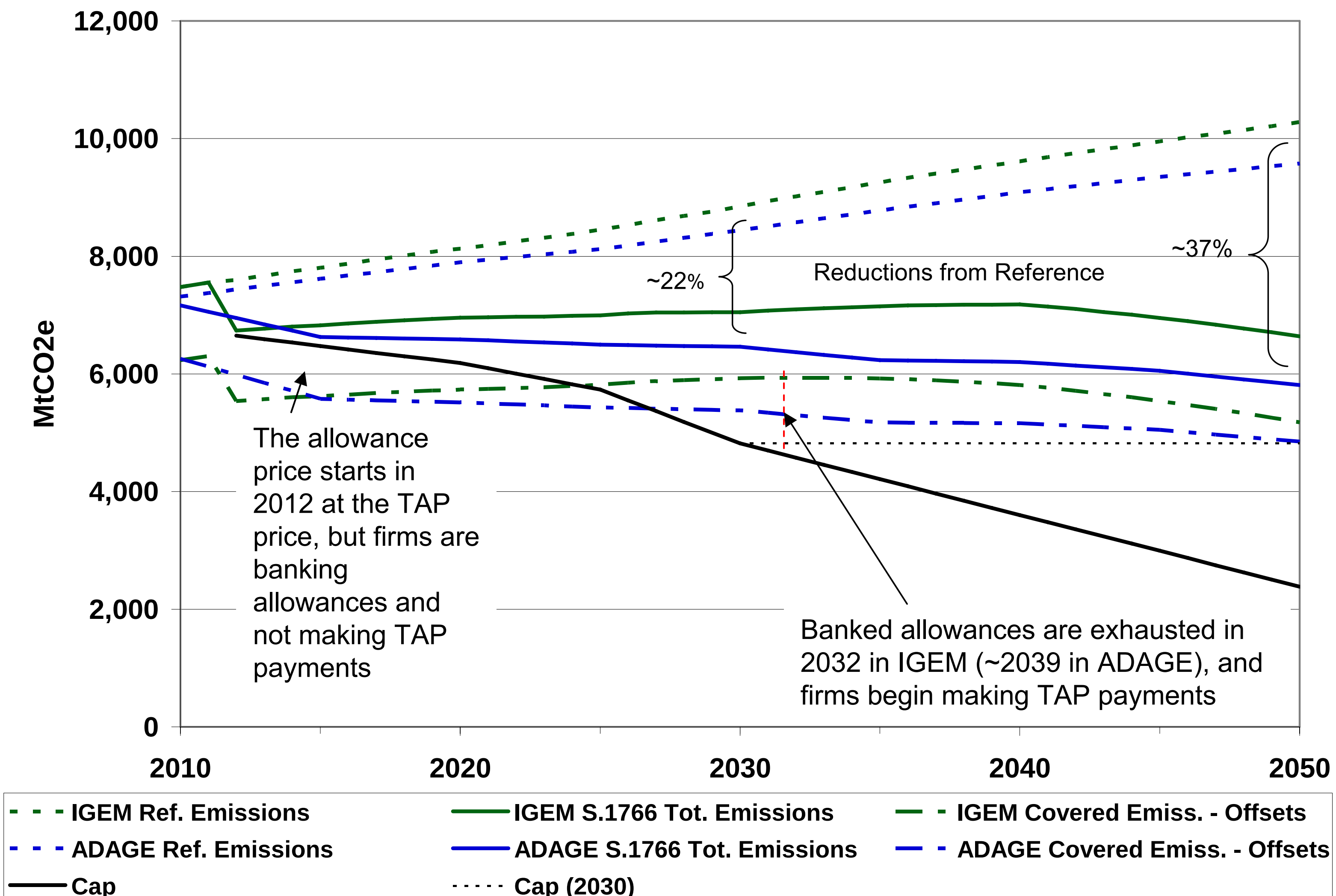
Results: Scenarios 13 & 14 - S. 1766 High Technology

U.S. GHG Emissions

- The following figures show the emissions results of S. 1766 with TAP.
- The two dotted lines at the top are the High Technology Reference Scenario emissions of IGEM and ADAGE.
- At the bottom of the figure, the black line is the cap on covered sector emissions with additional reductions to at least 60% below 2006 levels by 2050.
  - The additional reductions are triggered if the President determines that the 5 largest trading partners of the U.S. are taking comparable actions with respect to greenhouse gas emissions (which is assumed in this scenario).
  - If the tighter caps are not triggered, the cap level remains constant after 2030, which is represented here by the dotted black line.
- The dashed blue and green lines show the emissions of covered sectors, taking into account purchases of offsets.
  - Note that if the cap were binding, these emissions would be equivalent to the total emissions allowed under the cap, but the time path would reflect the banking of allowances in the early years, as entities would "over comply" to avoid higher allowance prices in later years.
  - Initially, the dashed blue and green lines are below the cap, which represents the banking of allowances. Between 2020 and 2025, the dashed blue and green lines cross above the cap level, and firms begin drawing down the bank of allowances. By approximately 2030, the bank of allowances is exhausted, and firms begin purchasing TAP allowances.
  - Since the TAP is triggered in this scenario, the total emissions less offsets over the entire time period exceeds the emissions allowed under the cap.
  - The total emissions less offsets over the entire time period also exceeds the less stringent cap that remains constant after 2030.
- The solid blue and green lines show total U.S. emissions under S. 1766. These levels include emissions from non-covered and exempt entities.

Results: Scenario 13 - S. 1766 High Technology

U.S. GHG Emissions



Results: Scenario 13 - S. 1766 High Technology

U.S. GHG Emissions

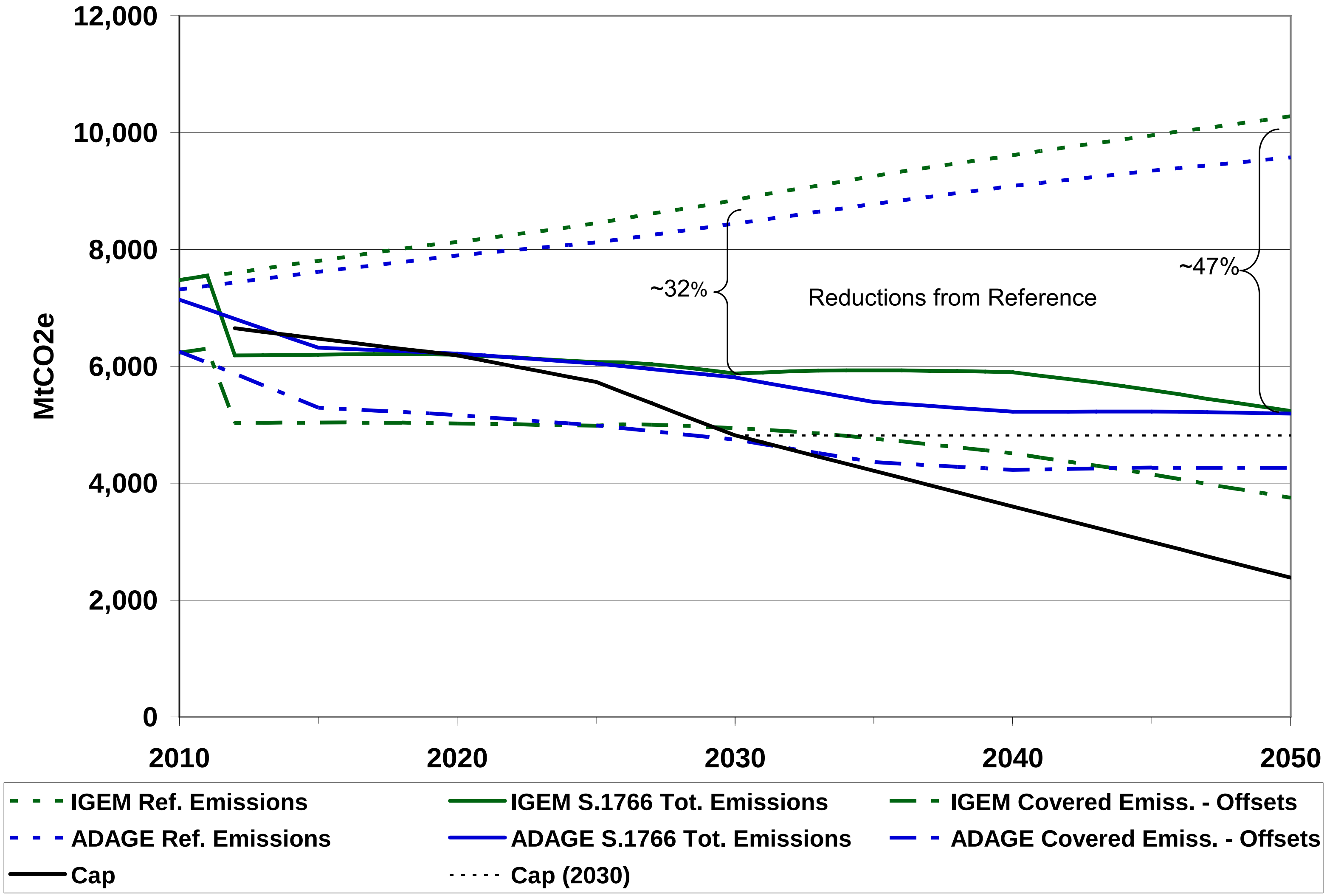
- In 2030, compared with the High Technology Reference Scenario, total U.S. emissions under S. 1766 are reduced by 1,801 $MtCO_2e$ (20 percent reduction) and 1,982 $MtCO_2e$ (23 percent reduction) in IGEM and ADAGE, respectively.

	2030	
	IGEM	**ADAGE**
% Below High Tech	20%	23%
% Below 1990 Levels	-13%	-3%
% Below 2000 Levels	1%	11%

	2050	
	IGEM	**ADAGE**
% Below High Tech	35%	39%
% Below 1990 Levels	-6%	7%
% Below 2000 Levels	7%	19%

Results: Scenario 14 - S. 1766 High Technology, No TAP

U.S. GHG Emissions



Results: Scenario 14 - S. 1766 High Technology, No TAP

U.S. GHG Emissions

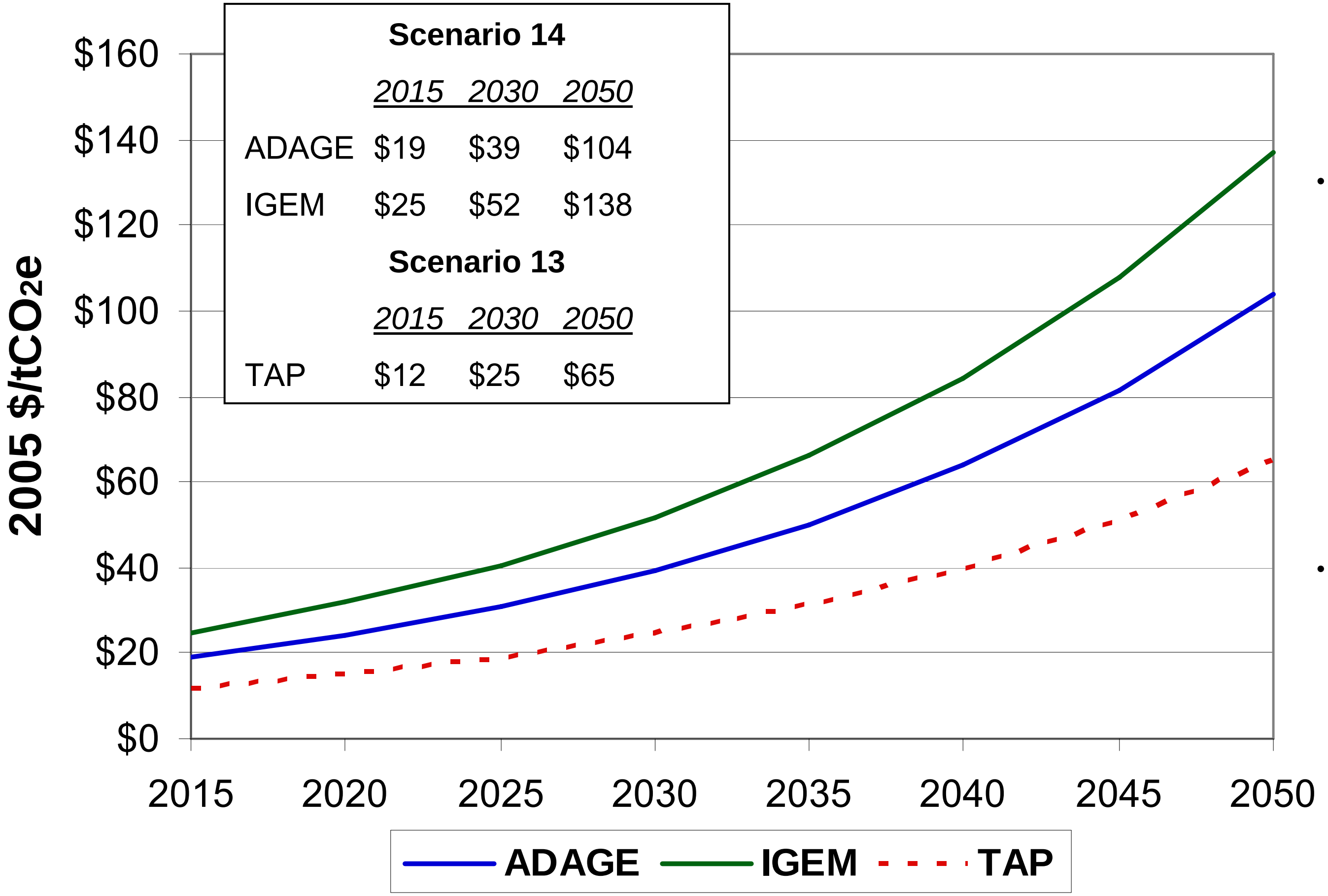
- *In 2030, compared with the High Technology Reference Scenario, total U.S. emissions under S. 1766 are reduced by 1,801 $MtCO_2e$ (20 percent reduction) and 1,982 $MtCO_2e$ (23 percent reduction) in IGEM and ADAGE, respectively.*

	2030	
	IGEM	**ADAGE**
% Below Ref	34%	31%
% Below 1990 Levels	6%	7%
% Below 2000 Levels	18%	21%

	2050	
	IGEM	**ADAGE**
% Below Ref	49%	46%
% Below 1990 Levels	16%	17%
% Below 2000 Levels	27%	27%

Results: Scenario 13 – S. 1766 High Technology and Scenario 14 – S. 1766 High Technology, No TAP

GHG Allowance Prices



- The \$39 - \$52 range of 2030 allowance prices only reflects differences in the models and does not reflect other scenarios or additional uncertainties discussed elsewhere.
- Even though TAP payments are not made before 2032 in IGEM, or 2039 in ADAGE, the allowance price follows the TAP price over the entire time horizon. This happens because the 5% interest rate that determines the rate of growth of the allowance price with banking is the same as the 5% rate at which the TAP price increases. As a result, there is no kink in the allowance price path when the TAP is triggered.
- Compared to *Scenario 3 – S. 1766, No TAP*, the allowance prices in *Scenario 14 – S. 1766 High Technology, No TAP*, fall 30% in ADAGE and 15% in IGEM.

Results: Scenario 13 – S. 1766 High Technology and Scenario 14 – S. 1766 High Technology, No TAP

GHG Allowance Prices

- The previous chart shows the allowance prices from ADAGE and IGEM under S. 1766 based on the assumptions of the High Technology Case, with and without the TAP (the TAP price is the same in both models).
- The allowance price is equal to the marginal cost of abatement in the U.S.
- S. 1766 allows the banking of allowances, as a result the allowance prices in both models grow at the exogenously set 5% interest rate.
  - If instead the allowance price were rising faster than the interest rate, firms would have an incentive to increase abatement in order to hold onto their allowances, which would be earning a return better than the market interest rate. This would have the effect of increasing allowance prices in the present, and decreasing allowance prices in the future. Conversely, if the allowance price were rising slower than the interest rate, firms would have an incentive to draw down their bank of allowances, and use the money that would have been spent on abatement for alternative investments that earn the market rate of return. This behavior would decrease prices in the present and increase prices in the future. Because of these arbitrage opportunities, the allowance price is expected to rise at the interest rate.
- The terminal year for banking is assumed to be 2050 in this analysis. If later terminal year for banking was used instead, or if the terminal year for banking was endogenously determined, the allowance prices and costs of the policy would be higher, as a non-zero bank of emissions in 2050 would imply greater total emissions reductions.
  - A terminal ear for banking of 2050 ensures that the cumulative covered emissions less offsets over the time period from 2012 – 2050 are equal to the cumulative emissions allowed under the cap. An assumption about the terminal year for banking is required for the models used in this analysis, and the assumption of 2050 is consistent with the time horizon of the models. If the terminal year for banking were not fixed, we would expect an increase in the allowance price beginning in 2012, so that in whichever year the bank of allowances is exhausted, the allowance price would not have to increase more than the usual 5% in order to meet the cap. The 2050 terminal year for banking used in this analysis is consistent with the treatment of banking through 2050 in the recent MIT report, “Assessment of U.S. Cap-and-Trade Proposals”.
- IGEM runs in annual time steps, so the policy is implemented in 2012. ADAGE runs in 5 year time steps, so the policy is implemented in 2015.
- Note that the range of allowance price presented here simply represents the results of the two models and should not be interpreted as a confidence interval.

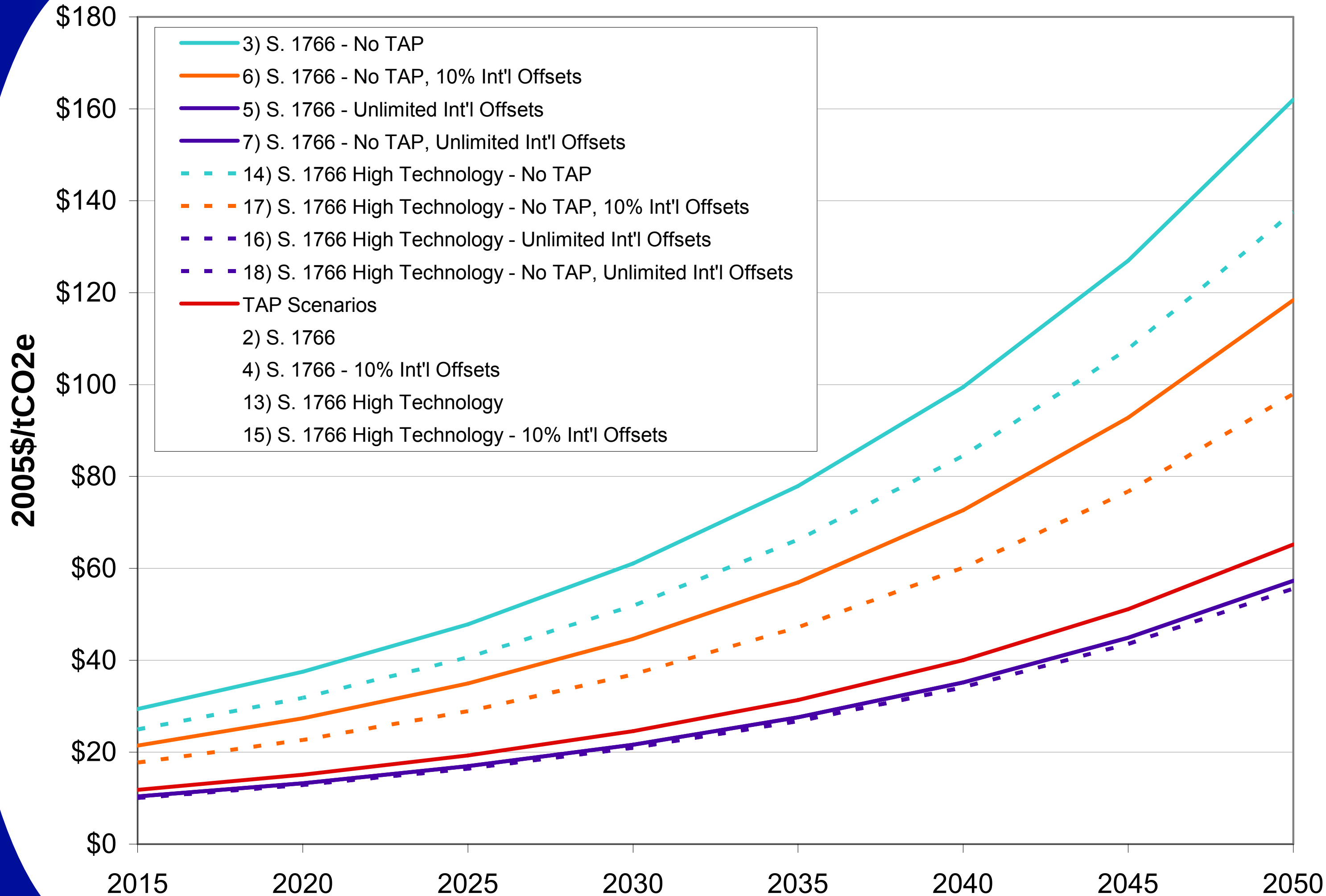
Scenario Comparison

GHG Allowance Prices (2005$/tCO2e)

	2015	2020	2025	2030	2035	2040	2045	2050
12) High Technology Reference								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13) S. 1766 High Technology								
ADAGE	$12	$15	$19	$25	$31	$40	$51	$65
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
14) S. 1766 High Technology - No TAP								
ADAGE	$19	$24	$31	$39	$50	$64	$82	$104
IGEM	$25	$32	$41	$52	$66	$84	$108	$138
15) S. 1766 High Technology - 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
16) S. 1766 High Technology - Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$18	$23	$29	$37	$47	$60	$77	$98
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
ADAGE	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IGEM	$10	$13	$16	$21	$27	$34	$44	$56
19) S. 1766 High Technology - No CCS Subsidy								
ADAGE	$12	$15	$19	$25	$31	$40	$51	$65
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
20) S. 1766 High Technology - No TAP, No CCS Subsidy								
ADAGE	$21	$27	$35	$45	$57	$72	$92	$117
IGEM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Scenario Comparison

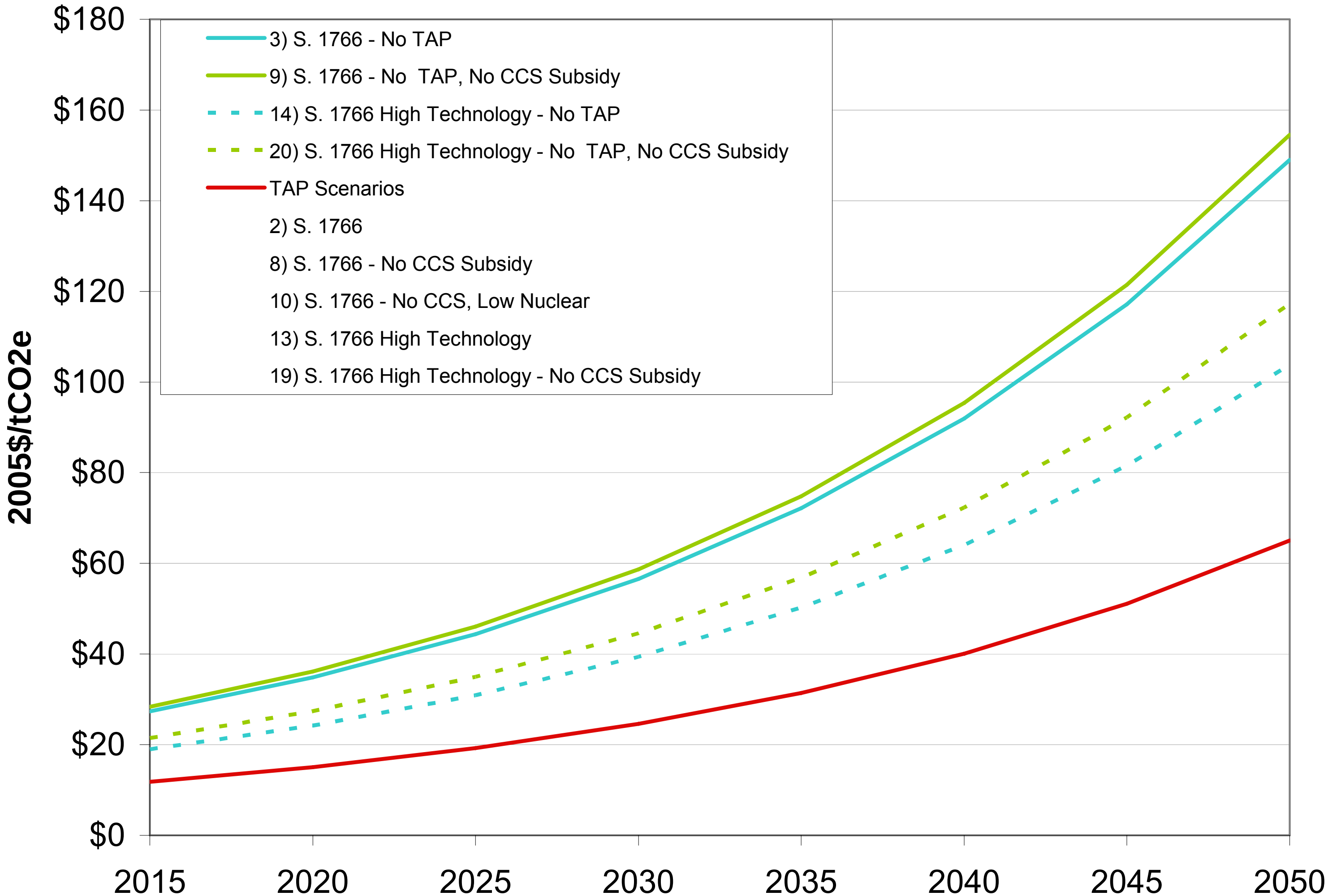
GHG Allowance Prices (IGEM)



- In the unlimited offset scenarios, the emissions target is met at an allowance price lower than the TAP, so in the scenarios where the TAP is available and international offsets are unlimited, the TAP is not triggered. Therefore, scenarios 5 & 7 are equivalent to each other, and scenarios 13 & 15 are equivalent to each other.

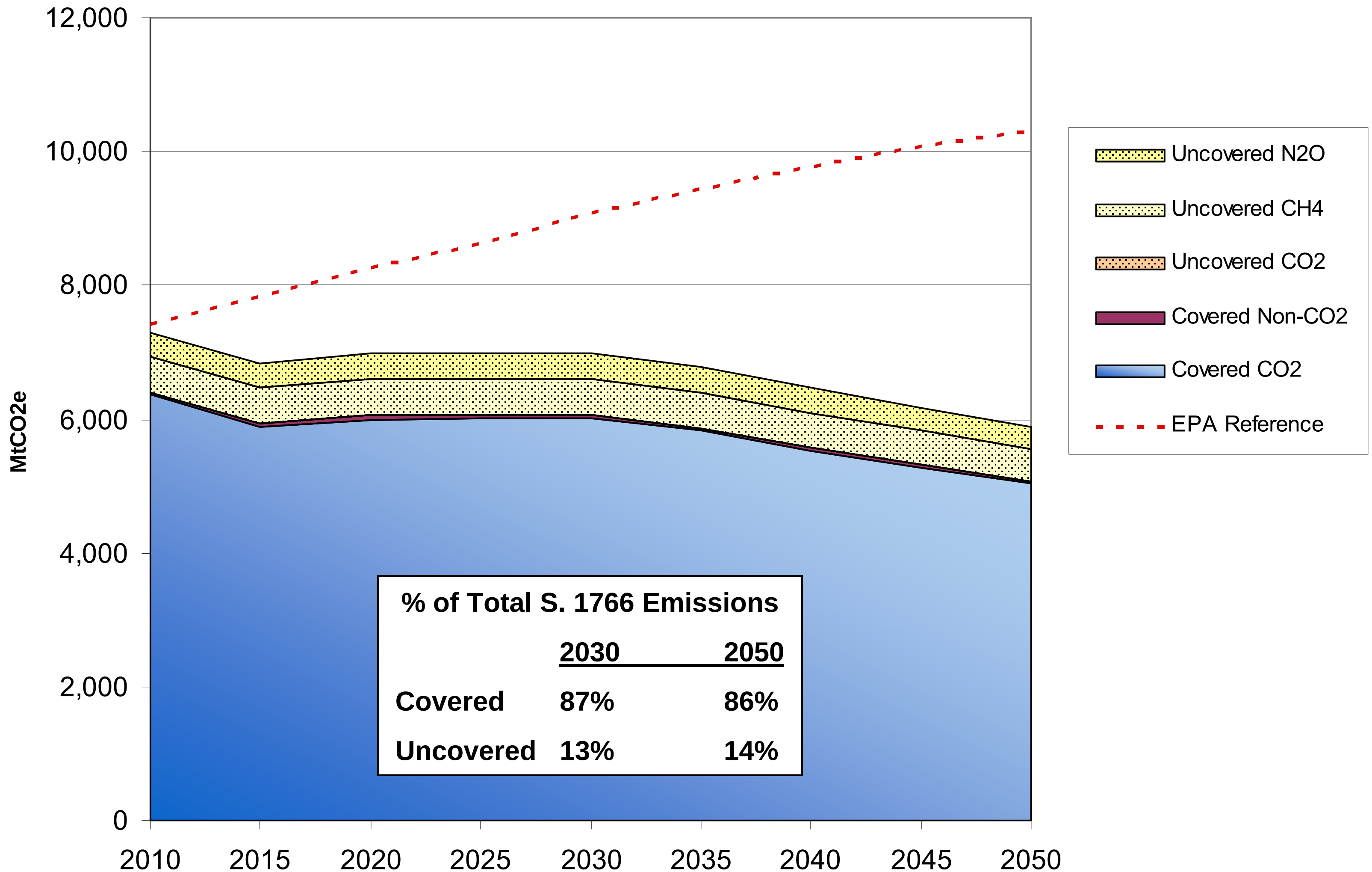
Scenario Comparison

GHG Allowance Prices (ADAGE)



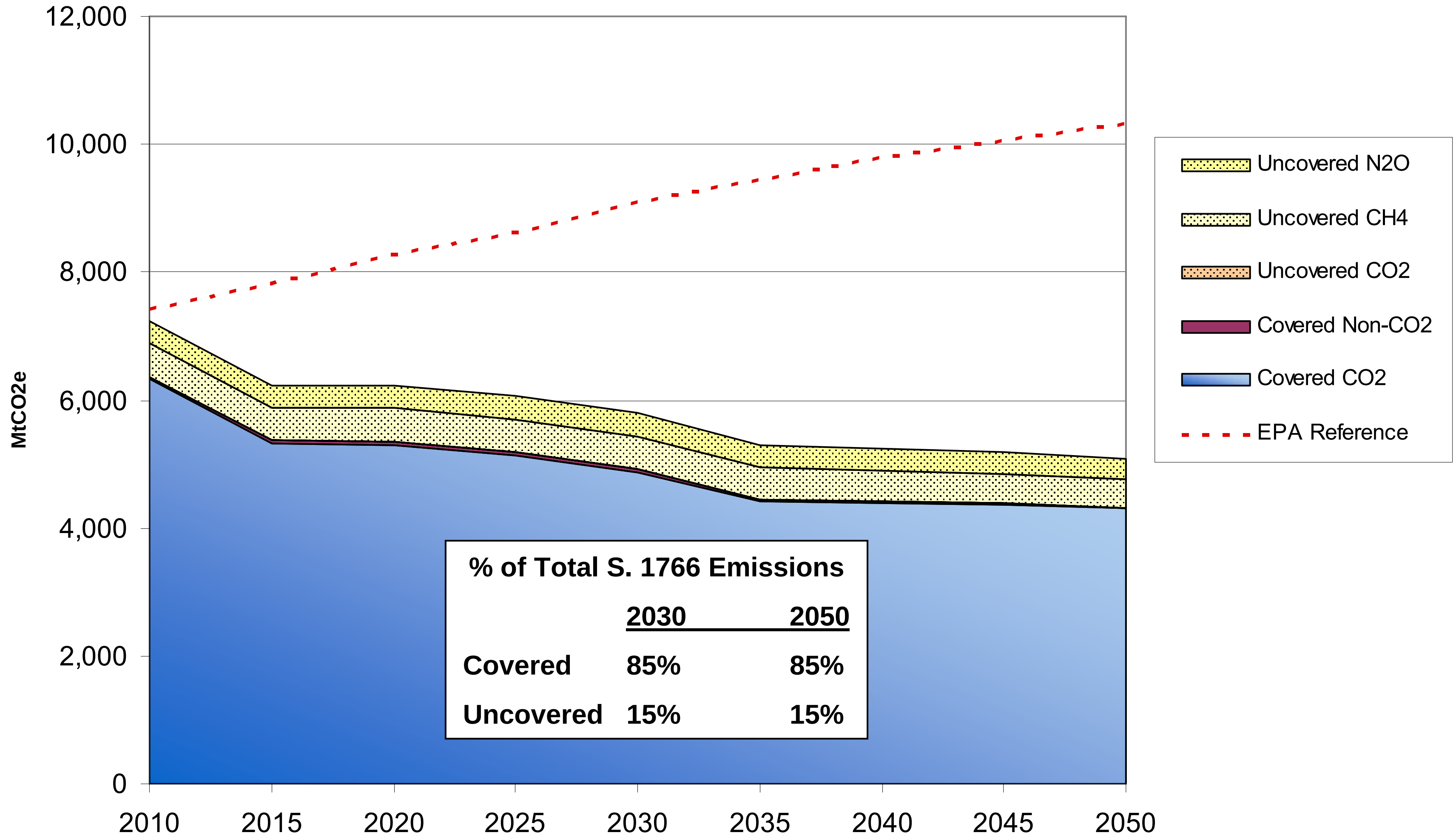
Results: Scenario 13 - S. 1766 High Technology

Total U.S. GHG Emissions (ADAGE)



Results: Scenario 14 - S. 1766 High Technology, No TAP

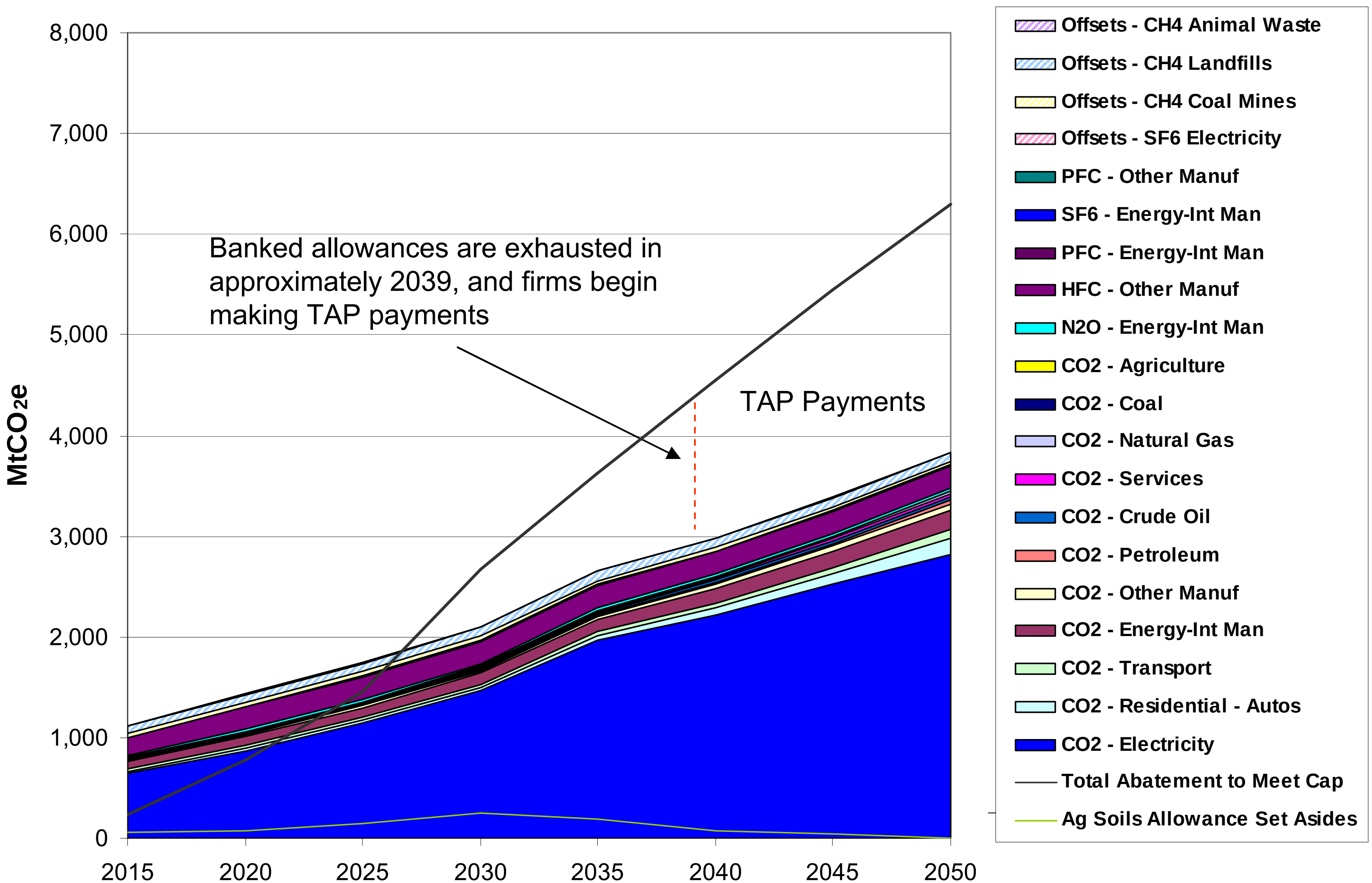
Total U.S. GHG Emissions (ADAGE)



% of Total S. 1766 Emissions	2030	2050
Covered	85%	85%
Uncovered	15%	15%

Results: Scenario 13 - S. 1766 High Technology

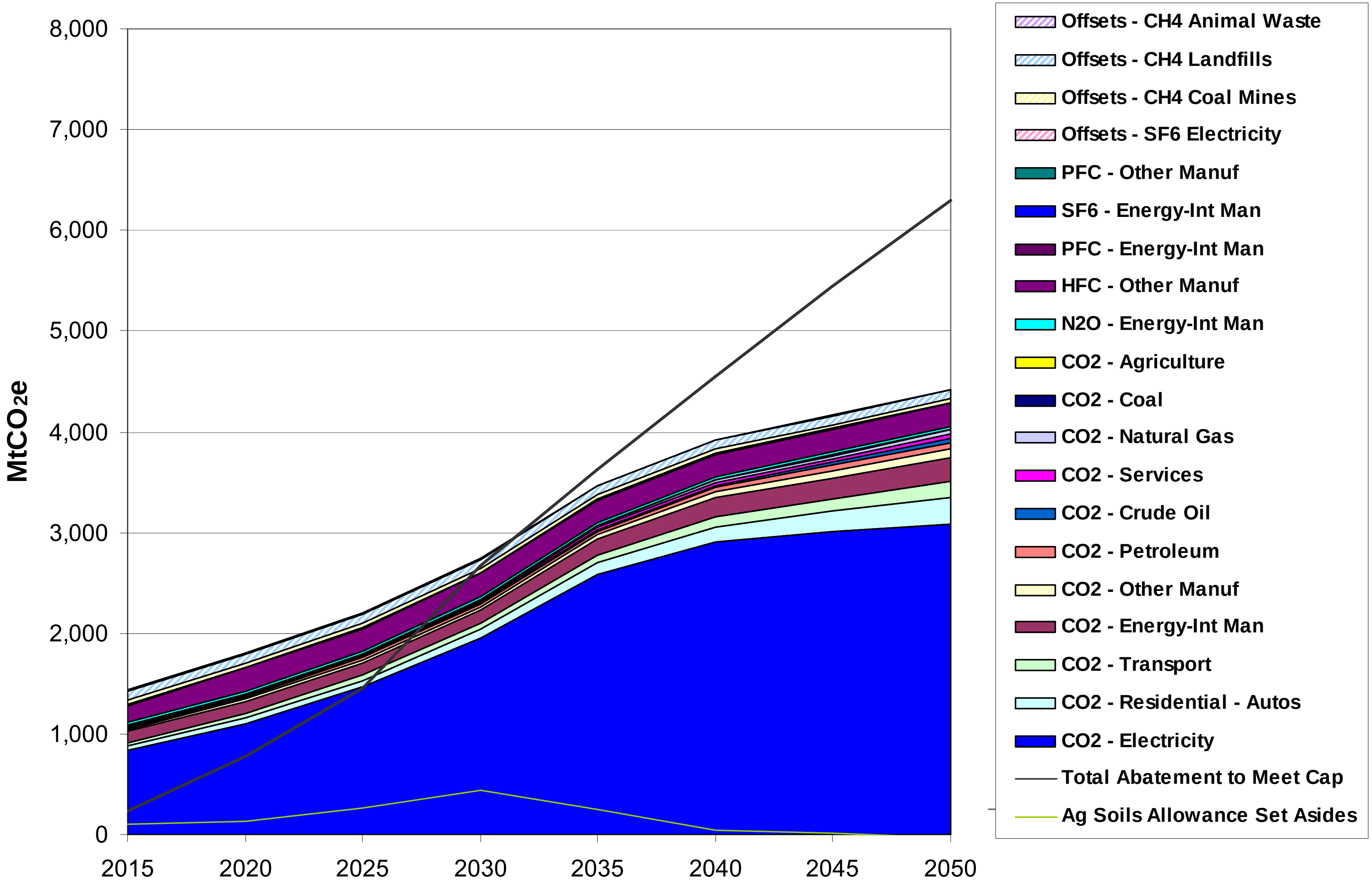
Sources of GHG Abatement (ADAGE)



- Because GHG emissions are lower in the High Technology reference case, the cumulative abatement required to meet the cap in the High Technology scenarios is approximately 16% lower than in scenarios using the standard reference case.
- In the early years firms bank allowances, in approximately 2027 firms begin drawing down the bank, which is exhausted by ~2039, after which firms make TAP payments.
- The light blue line at the bottom represents additional abatement from ag-soils allowance set-asides that does not contribute to meeting the cap.

Results: Scenario 14 - S. 1766 High Technology, No TAP

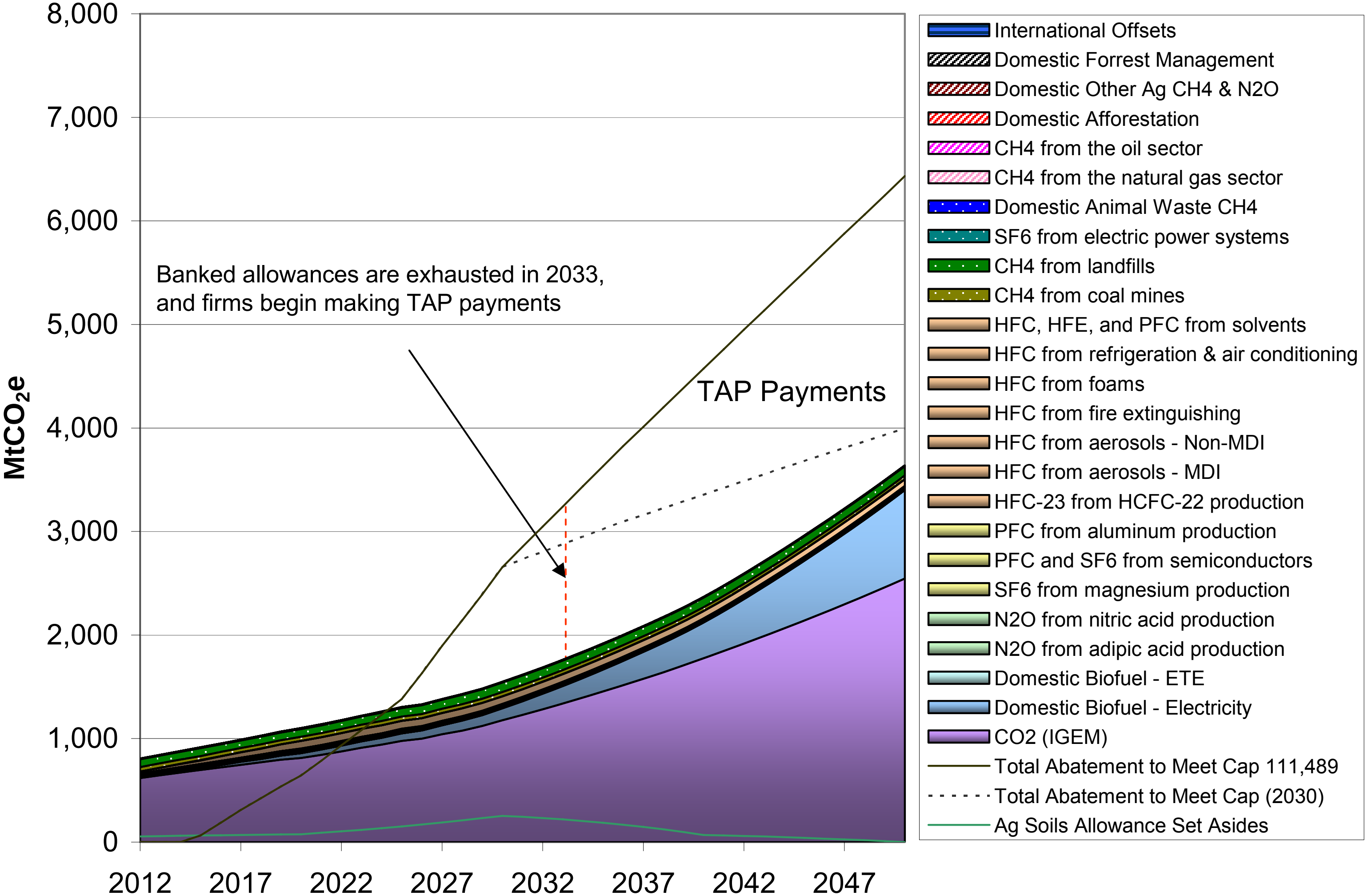
Sources of GHG Abatement (ADAGE)



- The solid black line at the top of the graphic represents the total abatement required to meet the cap (without banking).
- In the early years, firms over comply and build up a bank of allowances that is used up in later years.
- The area under the black line is equal to the stacked areas, so over the entire time frame the GHG abatement is sufficient to meet the cap.
- The light blue line at the bottom represents additional abatement from ag-soils allowance set-asides that does not contribute to meeting the cap

Results: Scenario 13 - S. 1766 High Technology

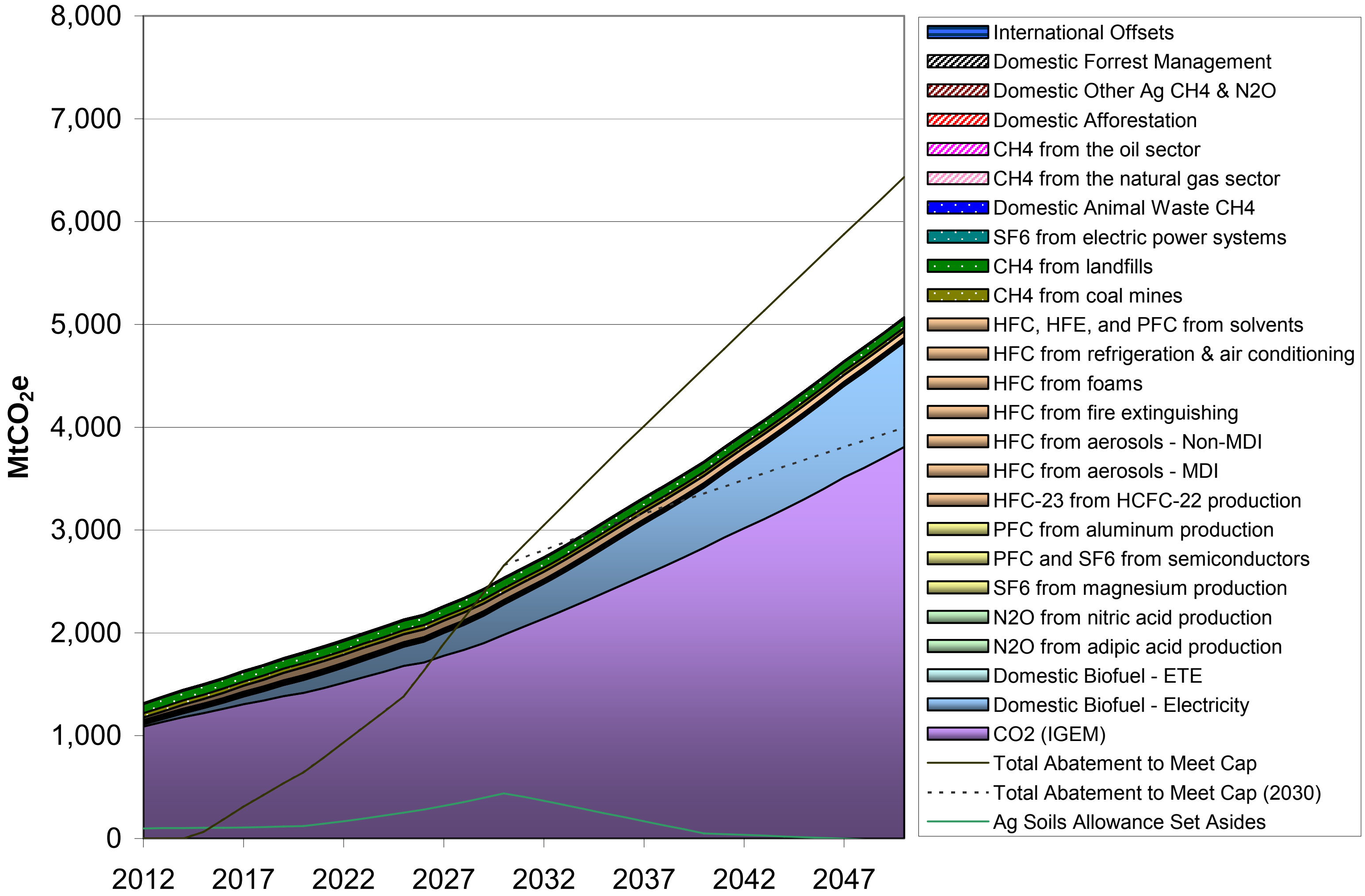
Sources of GHG Abatement (IGEM)



- Because GHG emissions are lower in the High Technology reference case, the cumulative abatement required to meet the cap in the High Technology scenarios is approximately 16% lower than in scenarios using the standard reference case.
- In the early years firms bank allowances, after 2025 firms begin drawing down the bank, which is exhausted by 2033, after which firms make TAP payments.
- With this looser cap, TAP payments begin in 2034, and the size of the TAP payments is smaller.
- The cumulative number of tons for which TAP payments are made is 25% lower than in *Scenario 2 – S. 1766*.

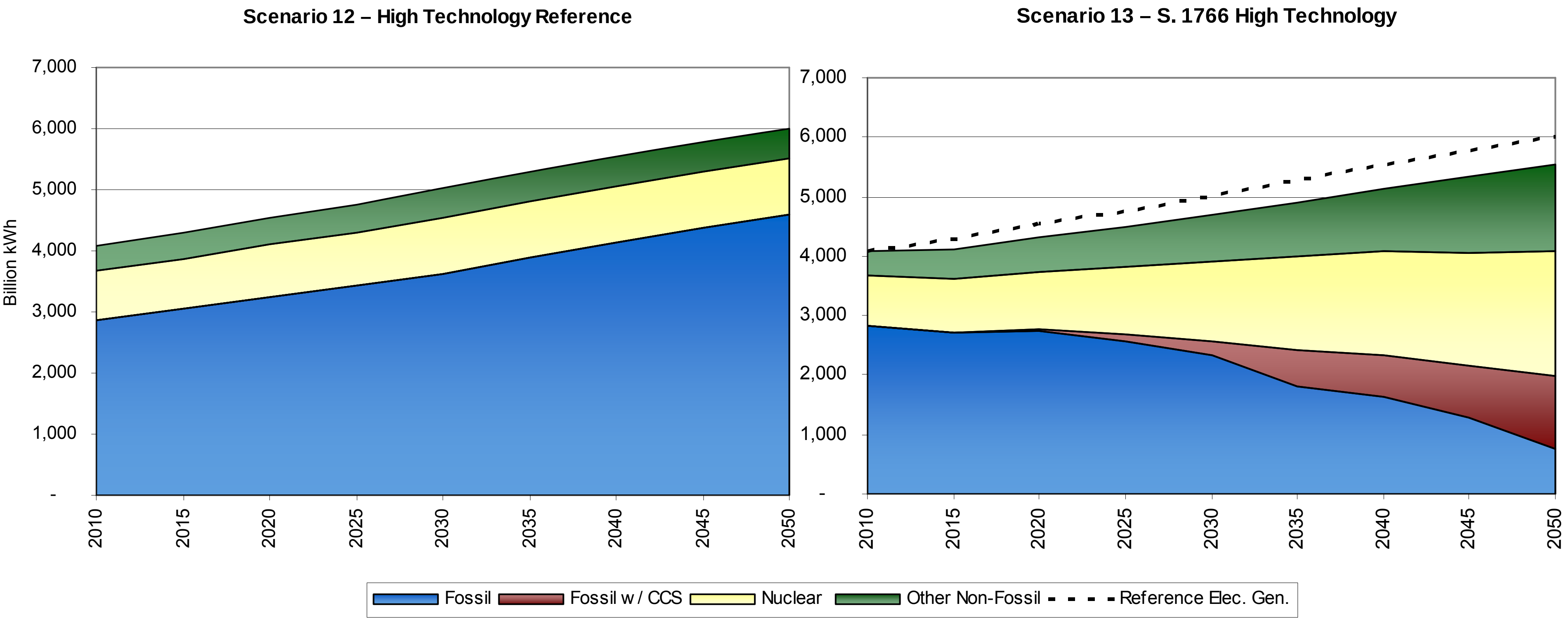
Results: Scenario 14 - S. 1766 High Technology, No TAP

Sources of GHG Abatement (ADAGE)



- The solid black line at the top represents the total amount of abatement required to meet the cap (without banking).
- In the early years firms bank allowances, after 2030 firms begin drawing down the bank, which is exhausted in 2050.
- The cumulative amount of abatement over the 2012-2050 time period is enough to comply with the cap.
- The dotted black line represents the total amount of abatement (without banking) required to meet the cap assuming that the cap remains constant after 2030.
- The light blue line at the bottom represents additional abatement from ag-soils allowance set-asides that does not contribute to meeting the cap

U.S. Electricity Generation, mid-term results (ADAGE)

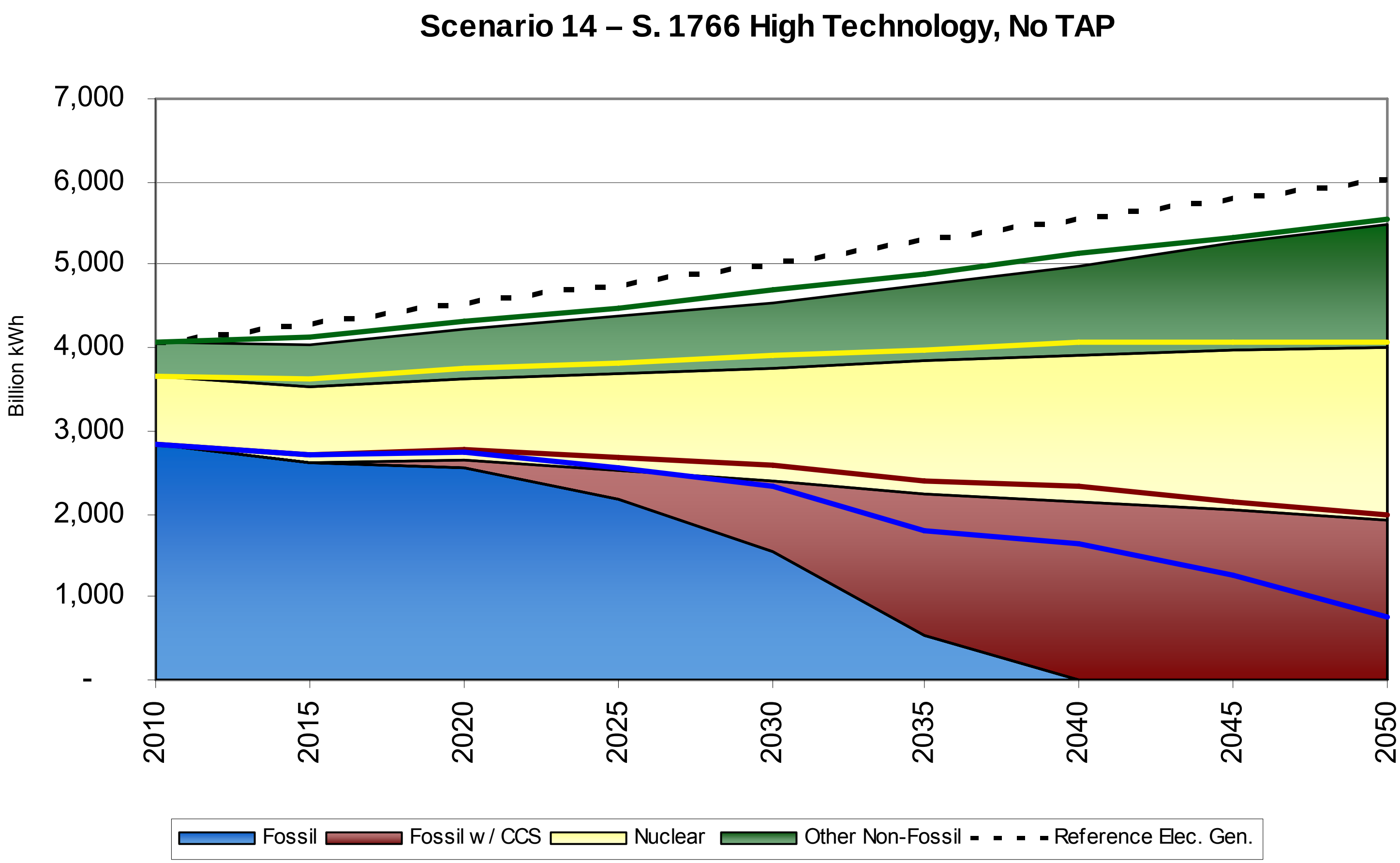


- Under High Technology assumptions, CCS plays a less significant role than core technology assumptions.
- CCS deployment begins in 2020 (the same year as in Scenario 2 – S. 1766), but does not reach full saturation in the timeframe of this analysis.

Note: Other non-fossil includes hydro, geothermal, wind, solar, biomass and municipal solid waste.

Results: Scenario 14 – S. 1766 High Technology, No TAP

U.S. Electricity Generation, mid-term results (ADAGE)



- In the absence of the TAP, CCS deploys beginning in 2020 but to a much greater degree than in High Technology Scenario 13.
- Full saturation of CCS on fossil generation is reached in 2040, but the penetration is not as rapid as under the core technology assumptions.

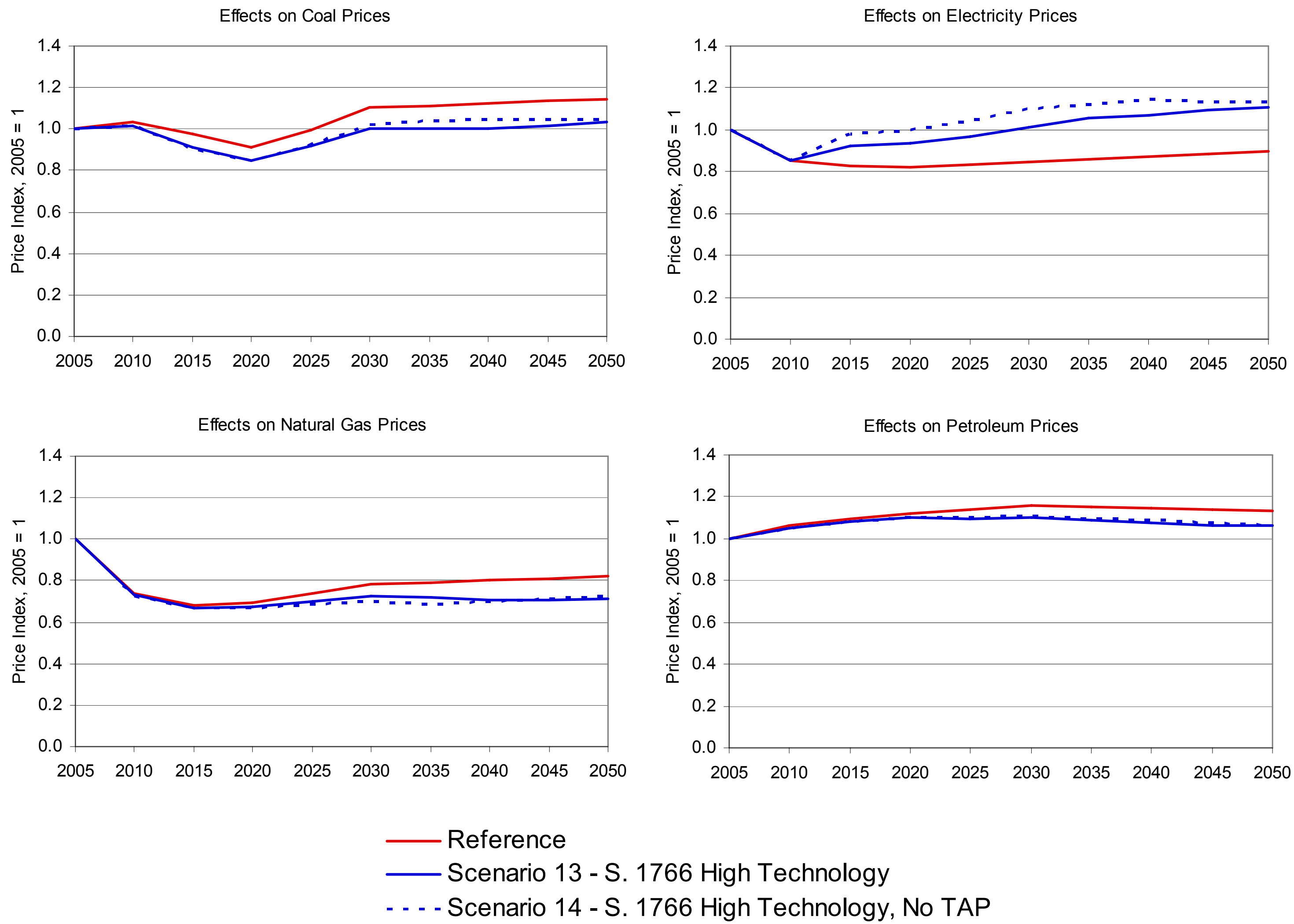
Note: Other non-fossil includes hydro, geothermal, wind, solar, biomass and municipal solid waste.

U.S. Electricity Generation, mid-term results (ADAGE)

- Electricity generation grows at a slower rate under S. 1766 due to efficiency gains and reduced consumption.
- Generation technology mix shifts towards non-GHG-emitting technologies such as nuclear and CCS.
- In Scenario 13 with the TAP advanced coal with CCS begins to deploy by 2020, but does not reach full saturation under the High Technology assumptions.
- In Scenario 14 without the TAP advanced coal with CCS begins to deploy by 2020, and by 2040 CO2 emissions from all fossil-fuel generated electricity are being captured and stored.
- Cost assumptions for transportation and storage of CO2 are based on the Battelle 2006 report “Carbon Dioxide Capture and Geologic Storage.” Capture costs are based on AEO 2006 assumptions.
- Nuclear generation increases by ~150% by 2050 based on exogenous assumptions from the U.S. CCSP Synthesis and Assessment Report 2.1a (MiniCAM Level 1 Scenario), which are consistent with the IPM nuclear assumptions.

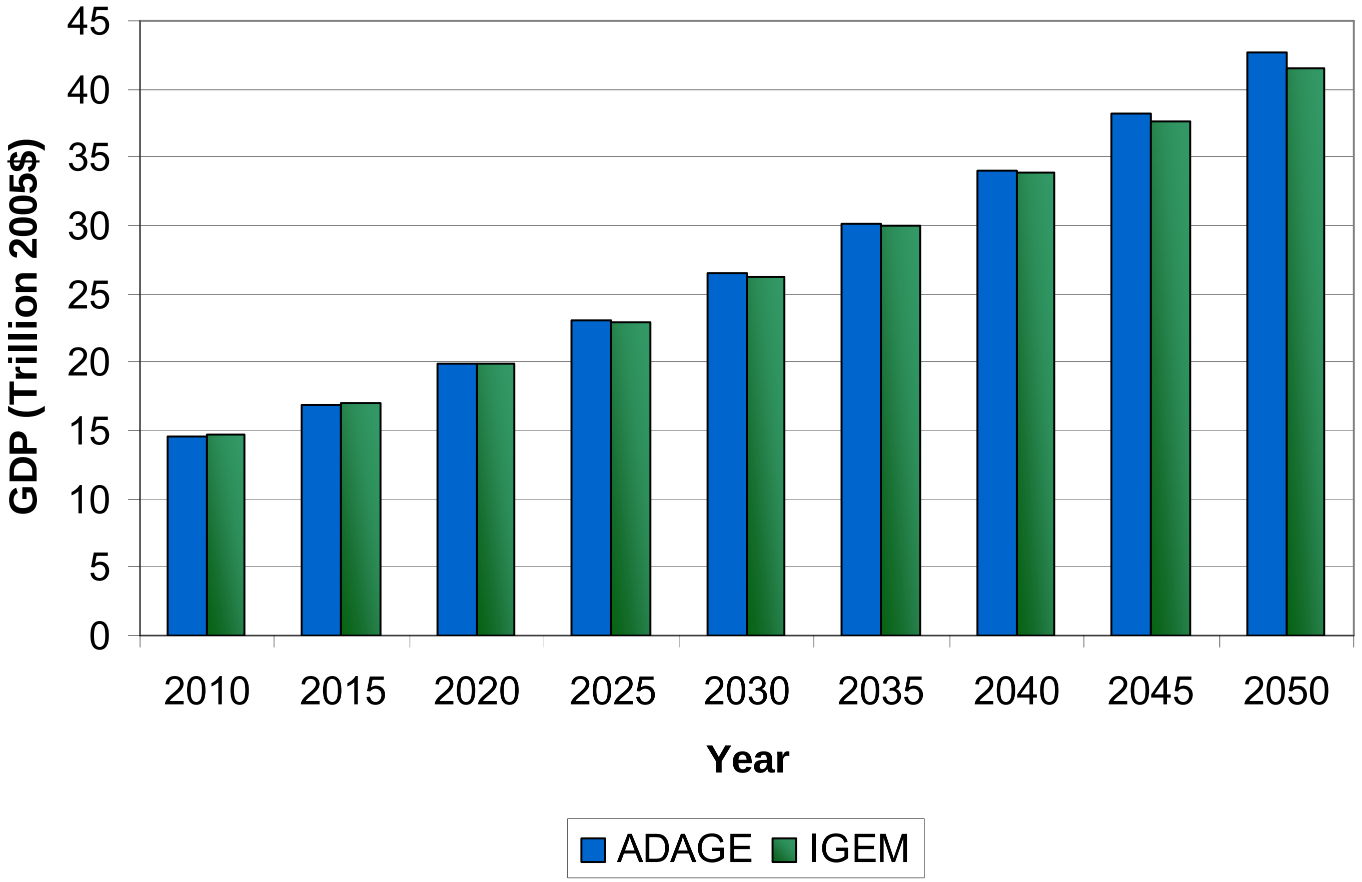
Results: Scenario 12 – High Technology Reference; Scenario 13 – S. 1766 High Technology; and Scenario 14 – S. 1766 High Technology, No TAP

Fuel Prices (ADAGE)



Results: Scenario 12 – High Technology Reference

GDP



- GDP growth to 2030 is benchmarked to AEO2006
- Average annual GDP growth from 2010 to 2030 is ≈3%.
- Differences in GDP growth in the later years are due to differences in underlying model assumptions

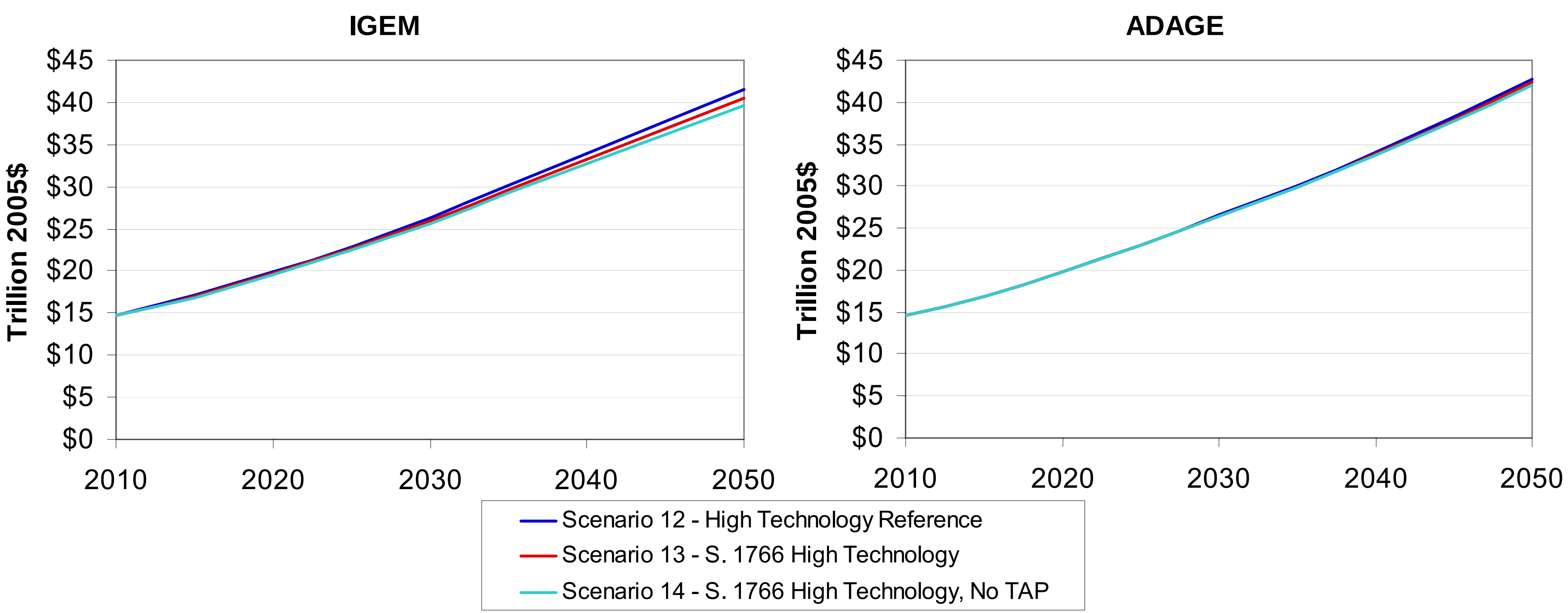
Results: Scenario 13 – High Technology, S. 1766 and Scenario 14 – S. 1766 High Technology, No TAP

GDP (Billion 2005$)

	2010	2020	2030	2040	2050	Average Annual Growth 2010-2050
Scenario 12 - High Technology Reference						
ADAGE	$14,638	$19,873	$26,509	$34,019	$42,747	2.72%
IGEM	$14,732	$19,848	$26,282	$33,882	$41,575	2.63%
Scenario 13 - S. 1766 High Technology						
ADAGE	$14,619	$19,797	$26,388	$33,819	$42,351	2.69%
IGEM	$14,680	$19,681	$25,951	$33,245	$40,444	2.57%
Absolute Change						
ADAGE	-$19	-$77	-$121	-$200	-$396	*-0.02 Percentage Points*
IGEM	-$52	-$167	-$331	-$636	-$1,131	*-0.06 Percentage Points*
% Change						
ADAGE	-0.13%	-0.39%	-0.46%	-0.59%	-0.93%	
IGEM	-0.36%	-0.84%	-1.26%	-1.88%	-2.72%	
Scenario 14 - S. 1766 High Technology, No TAP						
ADAGE	$14,615	$19,801	$26,380	$33,712	$42,098	2.68%
IGEM	$14,636	$19,532	$25,660	$32,732	$39,629	2.52%
Absolute Change						
ADAGE	-$23	-$73	-$129	-$307	-$649	*-0.04 Percentage Points*
IGEM	-$96	-$316	-$622	-$1,150	-$1,946	*-0.11 Percentage Points*
% Change						
ADAGE	-0.16%	-0.37%	-0.49%	-0.90%	-1.52%	
IGEM	-0.65%	-1.59%	-2.37%	-3.39%	-4.68%	

Results: Scenario 13 – High Technology, S. 1766 and Scenario 14 – S. 1766 High Technology, No TAP

GDP (Trillion 2005$)



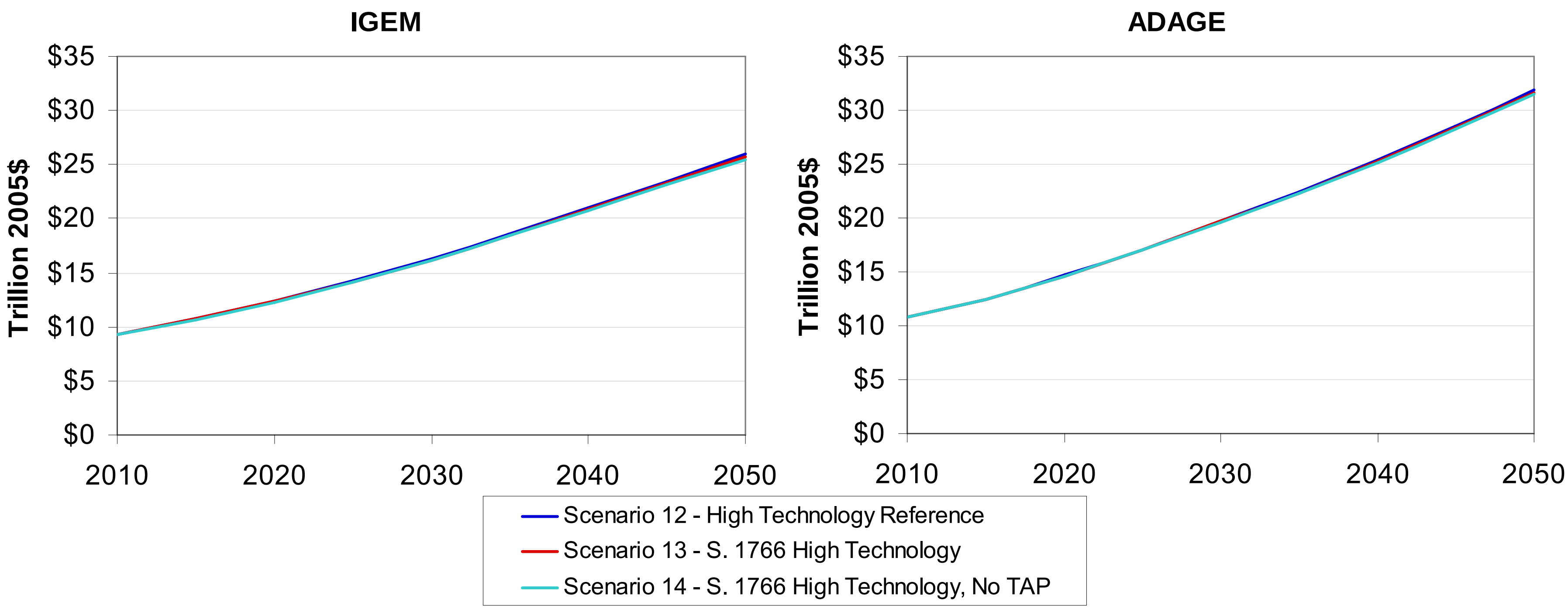
Results: Scenario 13 – High Technology, S. 1766 and Scenario 14 – S. 1766 High Technology, No TAP

Consumption (Billion 2005$)

	2010	2020	2030	2040	2050	Average Annual Growth 2010-2050
Scenario 12 - High Technology Reference						
ADAGE	$10,797	$14,673	$19,760	$25,382	$31,914	2.75%
IGEM	$9,245	$12,366	$16,280	$21,017	$25,964	2.62%
Scenario 13 - S. 1766 High Technology						
ADAGE	$10,822	$14,628	$19,695	$25,260	$31,656	2.72%
IGEM	$9,257	$12,342	$16,213	$20,879	$25,706	2.59%
Absolute Change						
ADAGE	$26	-$46	-$65	-$122	-$258	*-0.03 Percentage Points*
IGEM	$13	-$24	-$67	-$138	-$258	*-0.03 Percentage Points*
% Change						
ADAGE	0.24%	-0.31%	-0.33%	-0.48%	-0.81%	
IGEM	0.14%	-0.19%	-0.41%	-0.66%	-0.99%	
Annual Change per Household (2005$)						
ADAGE	$200	-$323	-$424	-$756	-$1,534	
IGEM	$106	-$180	-$453	-$850	-$1,460	
Scenario 14 - S. 1766 High Technology, No TAP						
ADAGE	$10,850	$14,637	$19,652	$25,135	$31,451	2.70%
IGEM	$9,269	$12,317	$16,143	$20,734	$25,450	2.56%
Absolute Change						
ADAGE	$53	-$37	-$108	-$248	-$463	*-0.05 Percentage Points*
IGEM	$24	-$49	-$137	-$283	-$513	*-0.06 Percentage Points*
% Change						
ADAGE	0.49%	-0.25%	-0.55%	-0.98%	-1.45%	
IGEM	0.26%	-0.40%	-0.84%	-1.35%	-1.98%	
Annual Change per Household (2005$)						
ADAGE	$408	-$260	-$706	-$1,534	-$2,752	
IGEM	$201	-$368	-$926	-$1,745	-$2,906	

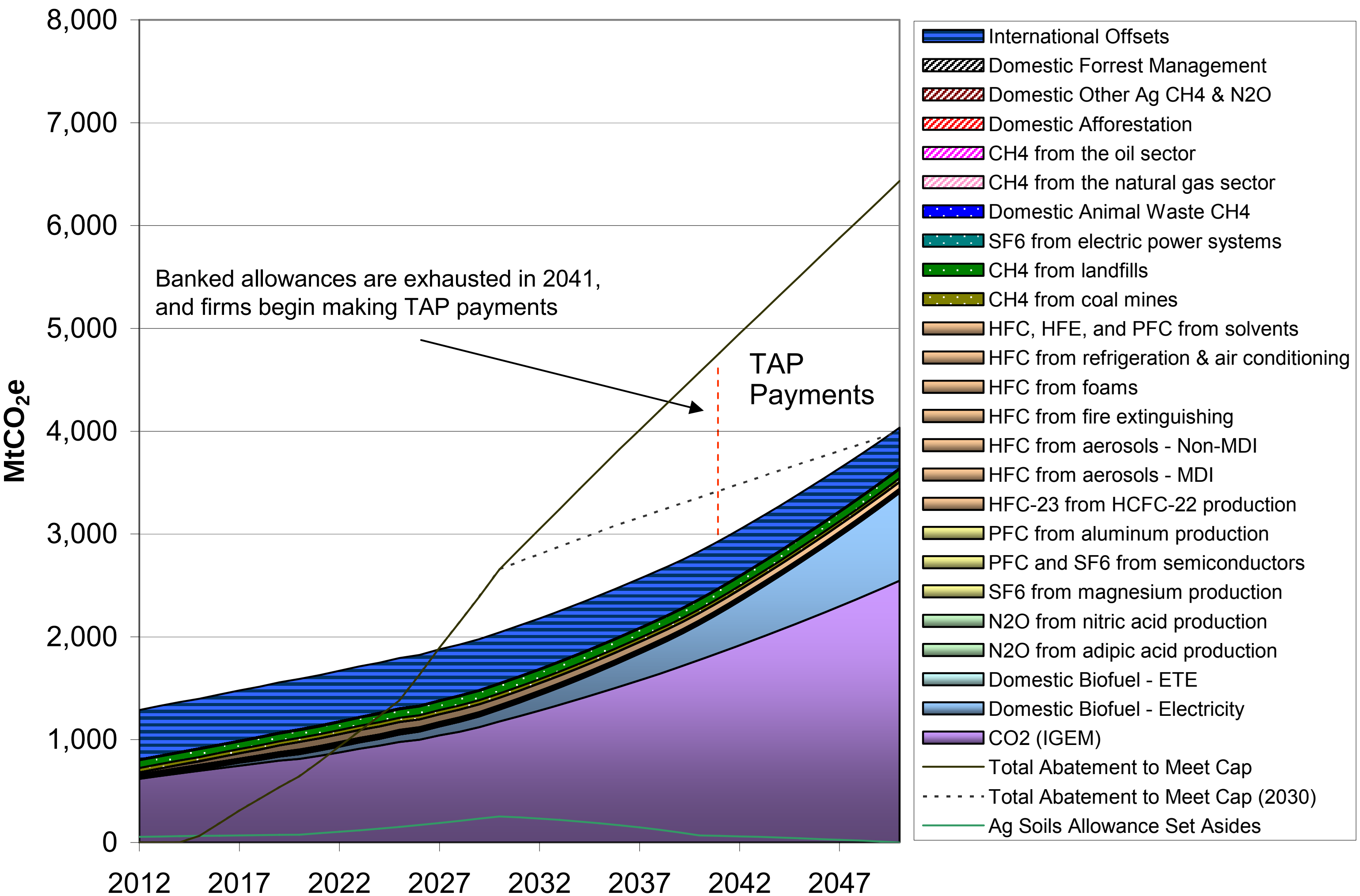
Results: Scenario 13 – High Technology, S. 1766 and Scenario 14 – S. 1766 High Technology, No TAP

Consumption (Trillion 2005$)



Results: Scenario 15 - S. 1766 High Technology, 10% Int'l Offsets

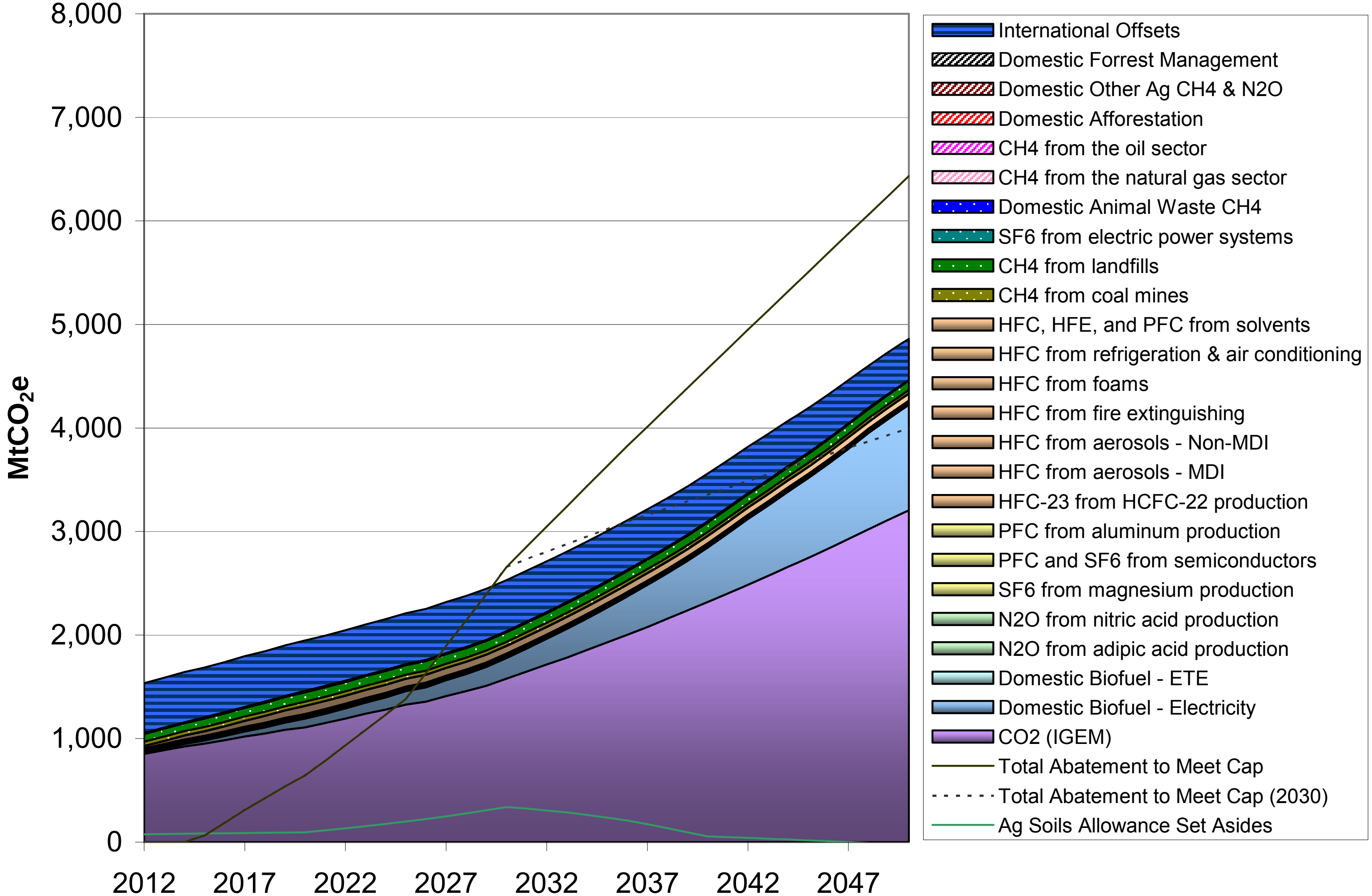
Sources of GHG Abatement (IGEM)



- Compared to *Scenario 4 – S. 1766, 10% Int'l Offsets*, the year in which firms begin to make TAP payments is moved back four years due to the assumptions associated with the high technology scenarios.
- The cumulative number of tons for which TAP payments are made is 38% lower than in *Scenario 4 – S. 1766, 10% Int'l Offsets*.

Results: Scenario 17 - S. 1766 High Technology, No TAP, 10% Int'l Offsets

Sources of GHG Abatement (IGEM)



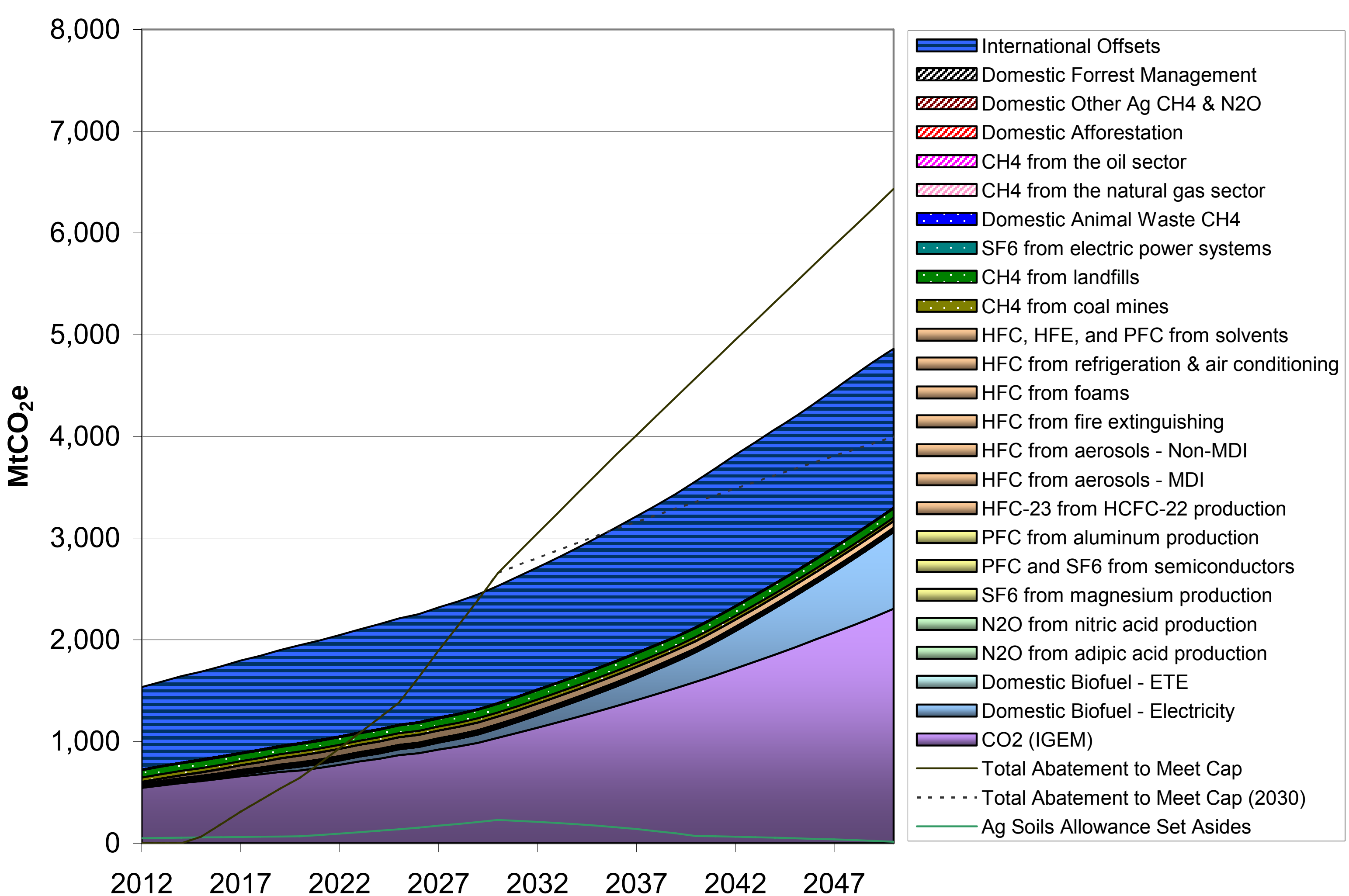
Results: Scenario 15 – S. 1766 High Technology, 10% Int'l Offsets and Scenario 17 – S. 1766 High Technology, No TAP, 10% Int'l Offsets

Sources of GHG Abatement (IGEM)

- The previous two charts show, for the IGEM model, the sources of CO_2 and non-CO_2 GHG abatement under S. 1766 in scenario 15 with the TAP and a 10% limit on international offsets, and scenario 17 without the TAP and a 10% limit on international offsets.
- In scenario 15 with the TAP, the emissions cap is exceeded, so the TAP is triggered even with the extra abatement from international offsets.
- IGEM does not break out CO_2 emissions by sector, so the bottom purple area represents all energy related CO_2 emissions abatement within IGEM.
  - The other sources of abatement represented here are derived EPA's non-CO2 GHG spreadsheet tools for estimating projections and mitigation of CH4, N2O, and F-gases (NCGM), and the Forest and Agriculture Sector Optimization Model, GHG version (FASOMGHG).
  - International offsets are derived from the Mini Climate Assessment Model (MiniCAM) and the Global Timber Model (GTM).
- The area toward the top of the chart shaded with dotted colors show emissions reductions from domestic offset projects.
- The blue striped area represents international offsets.
- Although S. 1766 places no restrictions on the amount of domestic offsets that may be used, only a limited set of offset project types are allowed.
  - As a result, offsets provide a relatively small portion of emissions reductions.
  - If non-specified offset projects (sources shaded with hashed lines in the legend) were allowed, they would provide a significant amount of abatement at the allowance prices in both of these scenarios.
- The light blue line at the bottom represents GHG abatement from ag/soils allowance set-asides. This abatement is additional to the abatement in covered sectors and offset projects that is used to meet the cap.

Results: Scenario 16 - S. 1766 High Technology, Unlimited Int'l Offsets, or Scenario 18 - S. 1766 High Technology, No TAP, Unlimited Int'l Offsets

Sources of GHG Abatement (IGEM)



- With unlimited international offsets, the TAP is not triggered, and thus the emissions cap is binding even when the TAP is an option.
- The use of international offsets will also have the result of increasing domestic emissions, since some of the abatement required to meet the cap is now occurring abroad.

Results: High Technology International Offsets Sensitivity Scenarios (15, 16, 16, 17)

Allowance Price (IGEM)

Table: Allowance Price Comparisons (2005 $/tCO2e)

	2015	2020	2025	2030	2035	2040	2045	2050
2) S. 1766								
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
3) S. 1766 - No TAP								
IGEM	$29	$37	$48	$61	$78	$99	$127	$162
4) S. 1766 - 10% Int'l Offsets								
IGEM	$12	$15	$19	$25	$31	$40	$51	$65
5) S. 1766 - Unlimited Int'l Offsets								
IGEM	$10	$13	$17	$22	$28	$35	$45	$57
6) S. 1766 - No TAP, 10% Int'l Offsets								
IGEM	$21	$27	$35	$45	$57	$73	$93	$118
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
IGEM	$10	$13	$17	$22	$28	$35	$45	$57

Results: High Technology
International Offsets Sensitivity Scenarios (15, 16, 16, 17)

International Offset Price (IGEM)

Table: International Offset Price Comparisons (2005 $/tCO2e)

	2015	2020	2025	2030	2035	2040	2045	2050
4) S. 1766 - 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
6) S. 1766 - No TAP, 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
7) S. 1766 - No TAP, Unlimited Int'l Offsets								
	$10	$13	$17	$22	$28	$35	$45	$57
15) S. 1766 High Technology - 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
	$9	$12	$15	$19	$25	$32	$40	$52
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
	$10	$13	$16	$21	$27	$34	$44	$56

Results: High Technology
International Offsets Sensitivity Scenarios (15, 16, 16, 17)

GDP and Consumption (IGEM)

Table: GDP Comparisons (% Change from Reference) (continued)

	2015	2020	2025	2030	2035	2040	2045	2050
13) S. 1766 High Technology								
IGEM	-0.7%	-0.8%	-1.0%	-1.3%	-1.5%	-1.9%	-2.3%	-2.7%
14) S. 1766 High Technology - No TAP								
IGEM	-1.3%	-1.6%	-2.0%	-2.4%	-2.8%	-3.4%	-4.0%	-4.7%
15) S. 1766 High Technology - 10% Int'l Offsets								
IGEM	-0.7%	-0.8%	-1.0%	-1.3%	-1.5%	-1.9%	-2.3%	-2.7%
16) S. 1766 High Technology - Unlimited Int'l Offsets								
IGEM	-0.5%	-0.7%	-0.9%	-1.1%	-1.3%	-1.6%	-2.0%	-2.4%
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
IGEM	-0.9%	-1.2%	-1.5%	-1.8%	-2.2%	-2.6%	-3.1%	-3.7%
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
IGEM	-0.5%	-0.7%	-0.9%	-1.1%	-1.3%	-1.6%	-2.0%	-2.4%

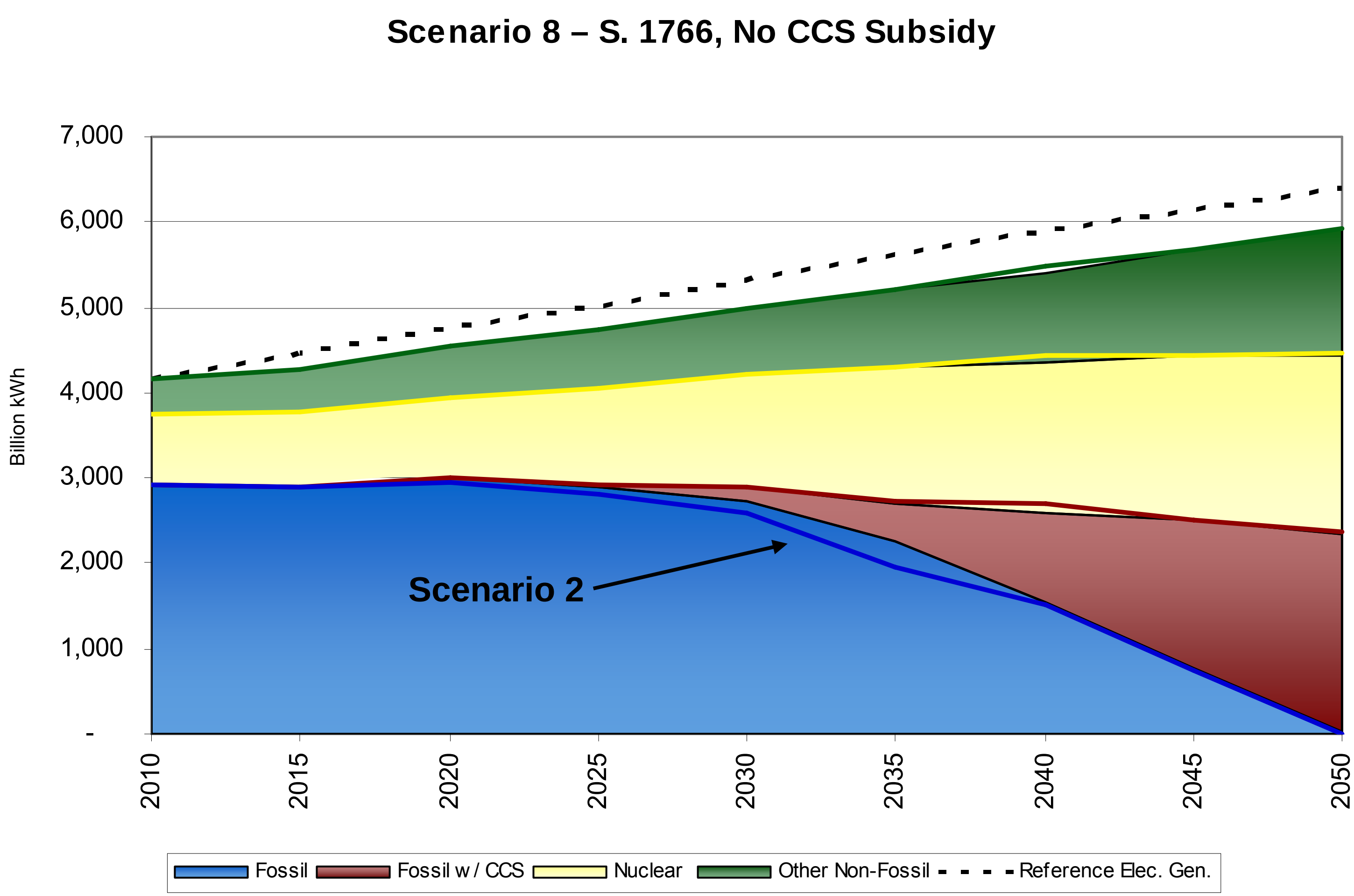
Table: Consumption Comparisons (% Change from Reference) (continued)

	2015	2020	2025	2030	2035	2040	2045	2050
13) S. 1766 High Technology								
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.5%	-0.7%	-0.8%	-1.0%
14) S. 1766 High Technology - No TAP								
IGEM	-0.1%	-0.4%	-0.6%	-0.8%	-1.1%	-1.3%	-1.6%	-2.0%
15) S. 1766 High Technology - 10% Int'l Offsets								
IGEM	-0.1%	-0.2%	-0.3%	-0.4%	-0.5%	-0.7%	-0.8%	-1.0%
16) S. 1766 High Technology - Unlimited Int'l Offsets								
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.5%	-0.6%	-0.7%	-0.9%
17) S. 1766 High Technology - No TAP, 10% Int'l Offsets								
IGEM	-0.1%	-0.3%	-0.5%	-0.6%	-0.8%	-1.0%	-1.2%	-1.5%
18) S. 1766 High Technology - No TAP, Unlimited Int'l Offsets								
IGEM	0.0%	-0.2%	-0.3%	-0.4%	-0.5%	-0.6%	-0.7%	-0.9%

Appendix 3: Additional Information

Results: Scenario 8 – S. 1766, No CCS Subsidy

U.S. Electricity Generation, mid-term results (ADAGE)

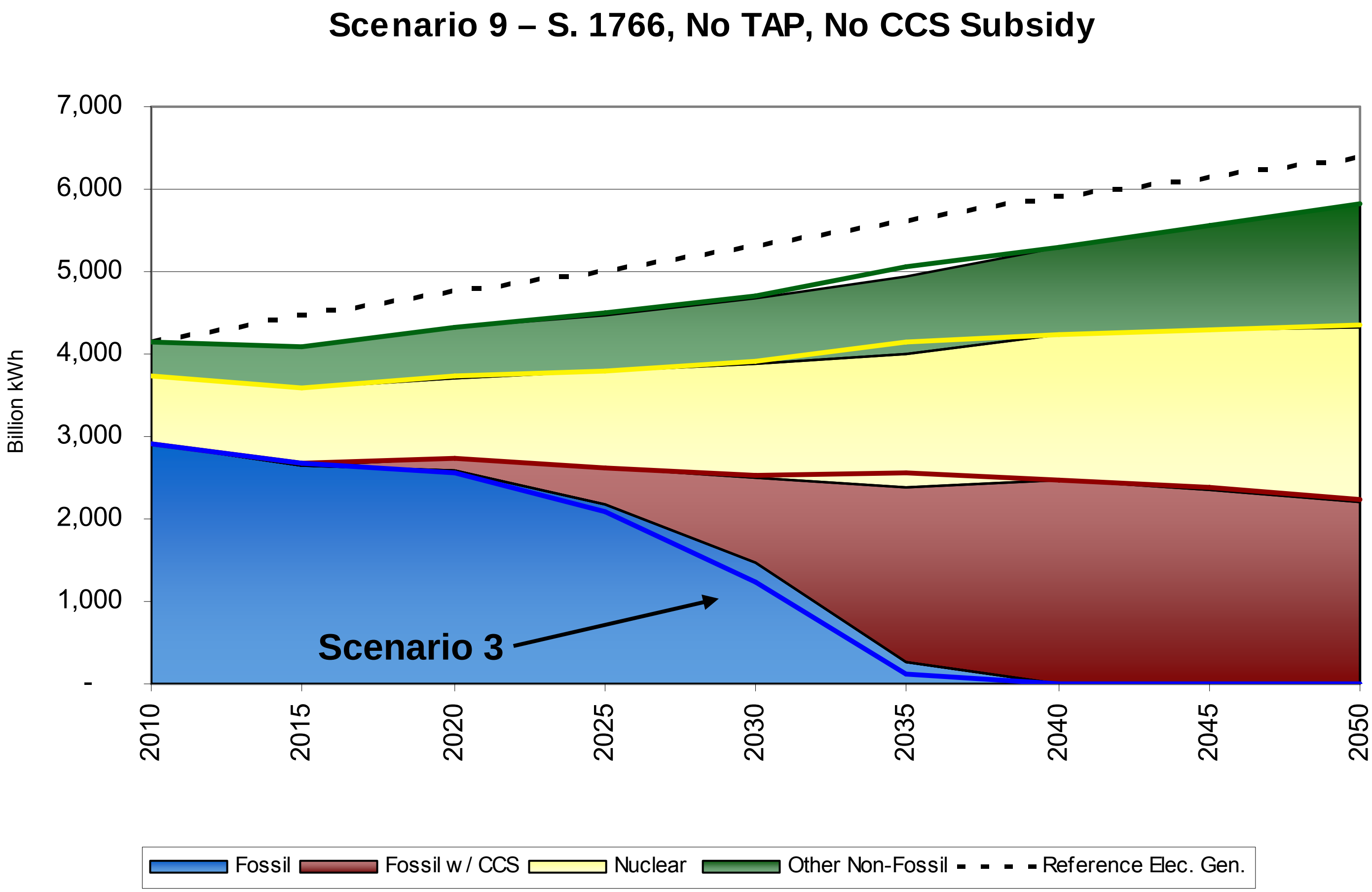


- Bonus allowances for CCS accelerate the rate of penetration of CCS in the early years.

Note: Other non-fossil includes hydro, geothermal, wind, solar, biomass and municipal solid waste.

Results: Scenario 9 - S. 1766, No TAP, No CCS Subsidy

U.S. Electricity Generation, mid-term results (ADAGE)

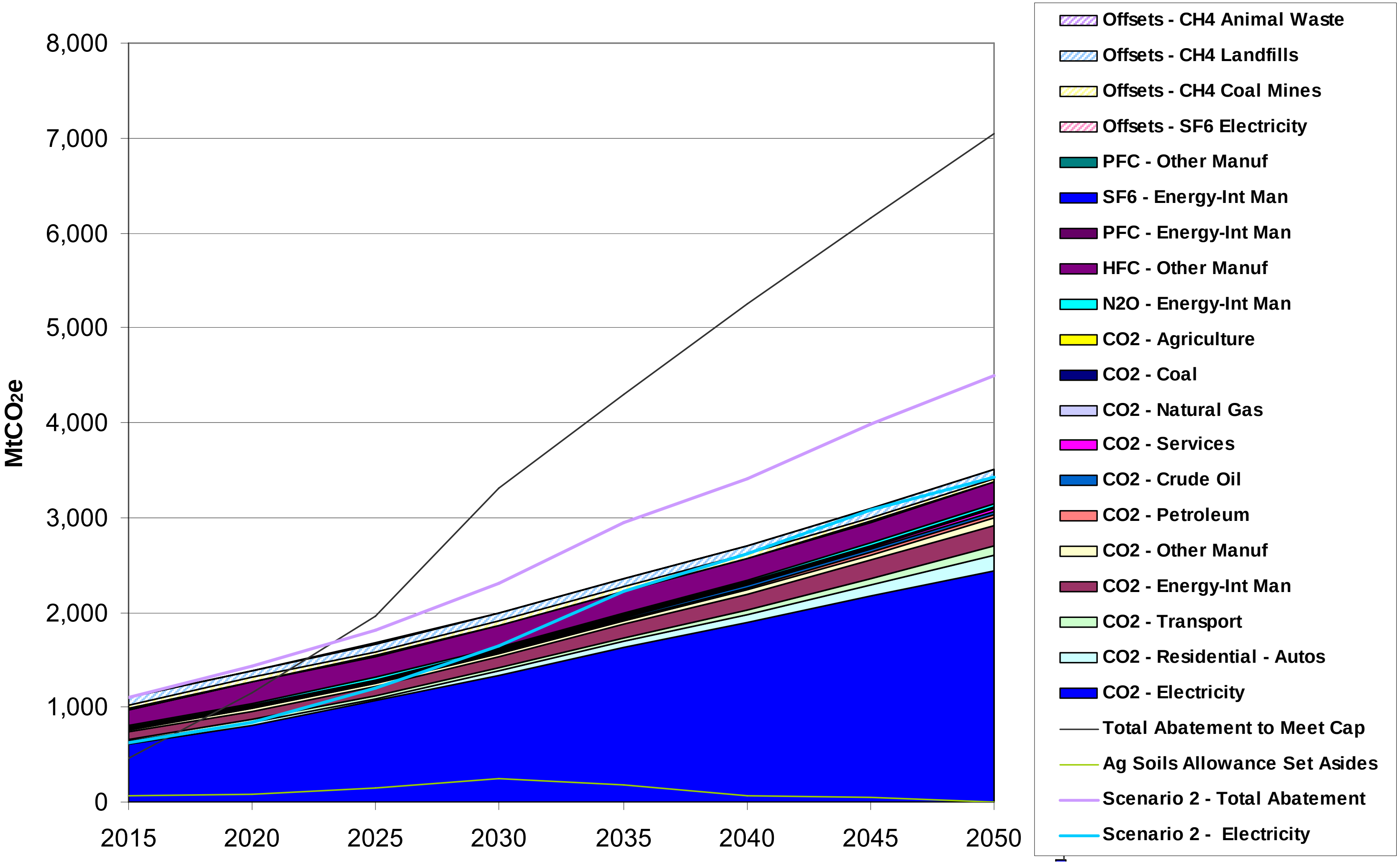


- Under Scenario 9, full CCS deployment occurs in 2040.
- Compared with Scenario 3 - S. 1766, No TAP - the CCS bonus allowances slightly accelerate the rate of CCS penetration.

Note: Other non-fossil includes hydro, geothermal, wind, solar, biomass and municipal solid waste.

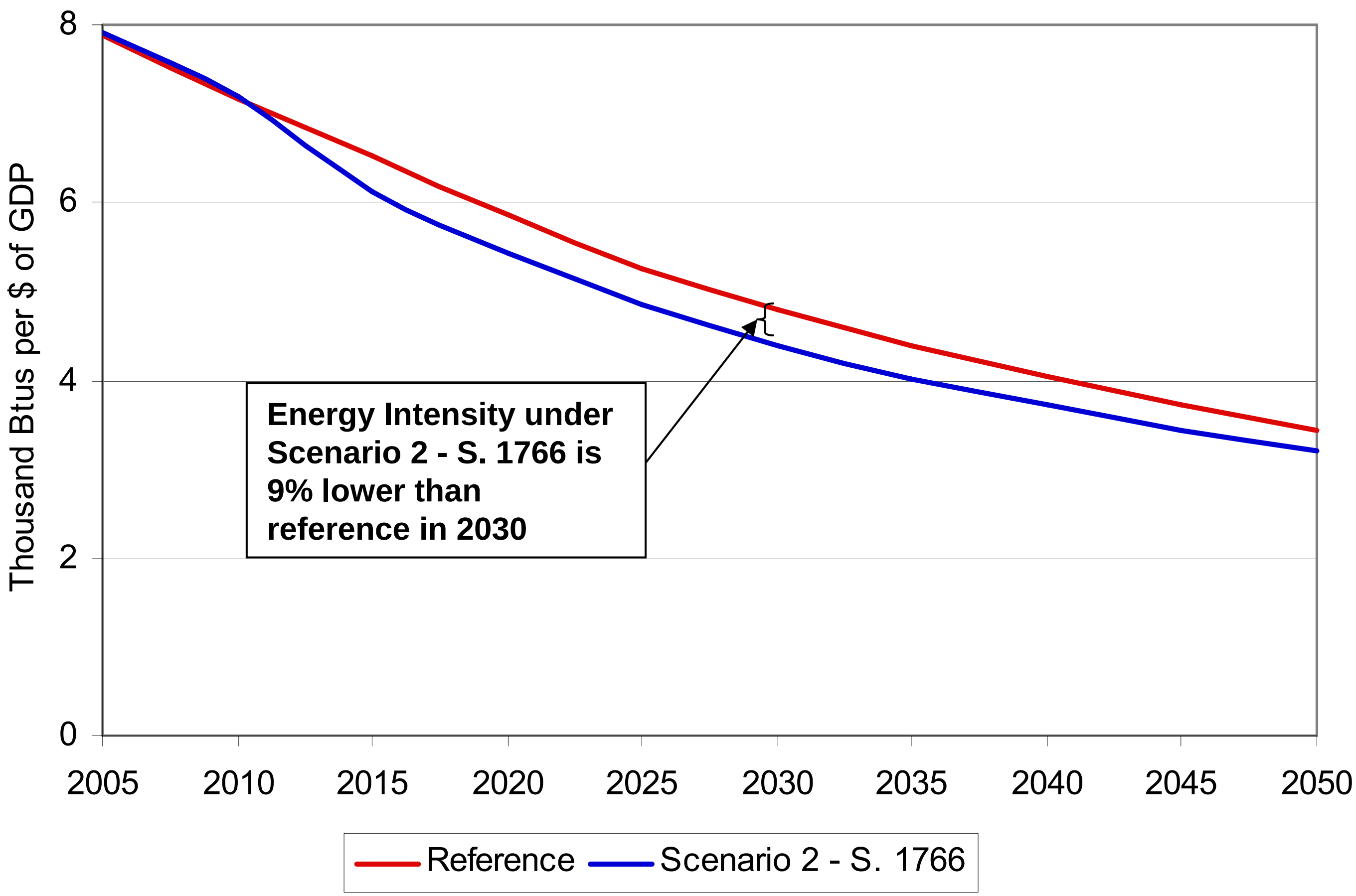
Results: Scenario 10 – S. 1766, No CCS & Low Nuke

Sources of GHG Abatement (ADAGE)



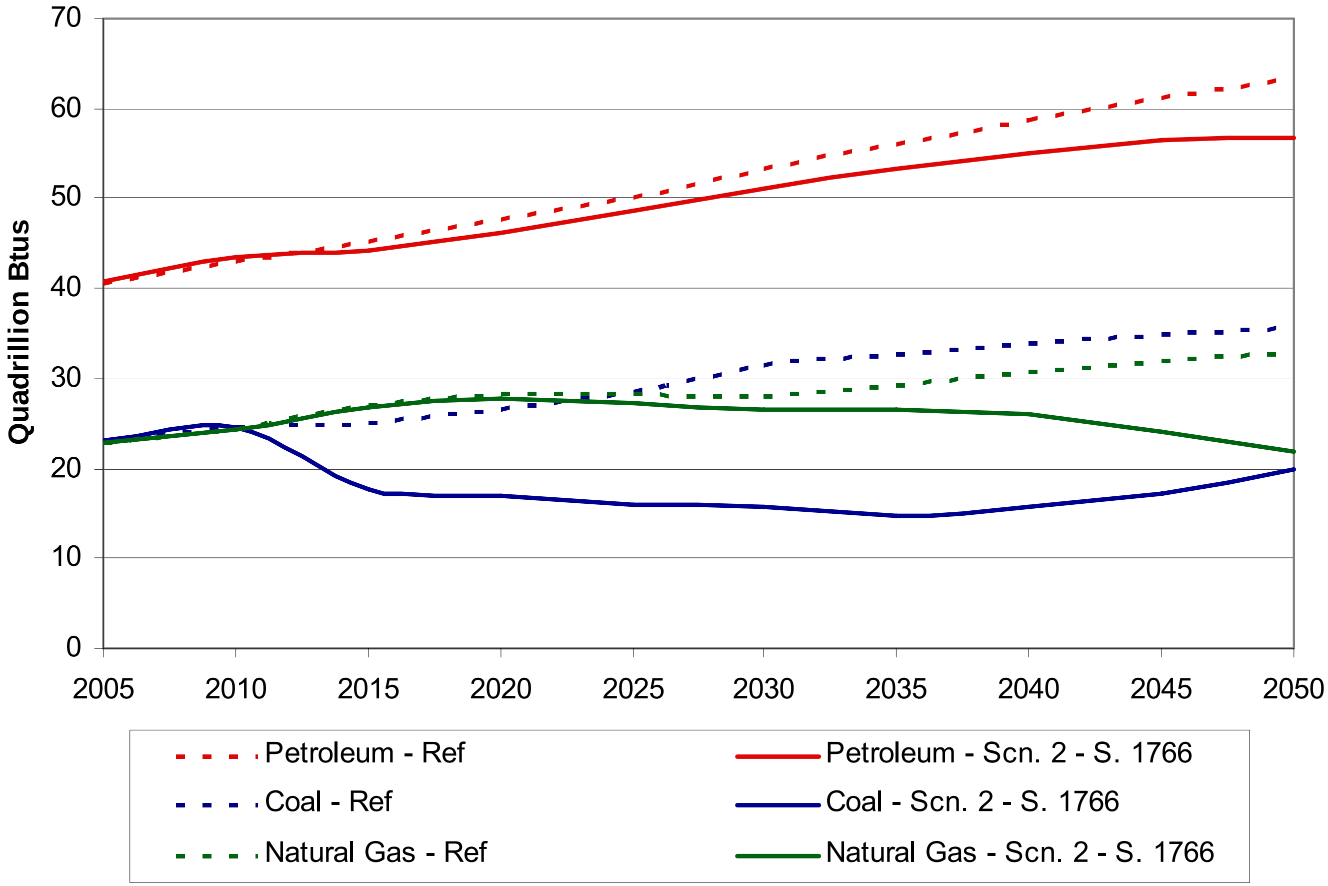
Results: Scenario 2 – S. 1766

Energy Intensity (ADAGE)



Results: Scenario 2 – S. 1766

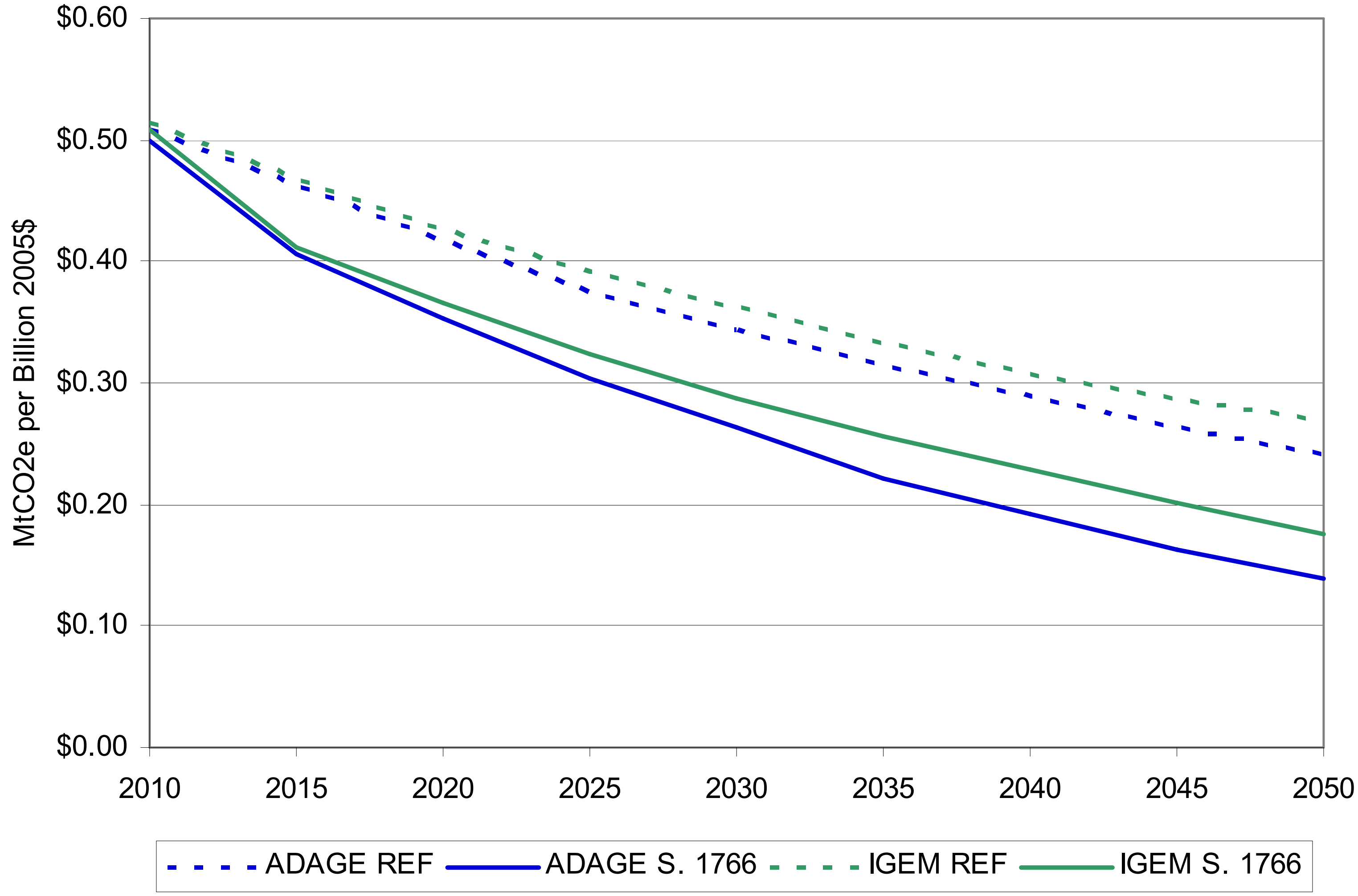
Primary Energy Use (ADAGE)



- Growth in petroleum use is less under S. 1766 than in the Reference Scenario.
- Coal use falls as S. 1766 is implemented and fuel-switching to natural gas occurs, then rises again in the later years as advanced coal plants with CCS are deployed.
  - Note that the IPM analysis shows a much smaller impact on near-term coal usage.
- The natural gas use trend follows an opposite path to the coal use trend. Natural gas use increases in the earlier years as fuel-switching occurs, and then falls in the later years as CCS is deployed.

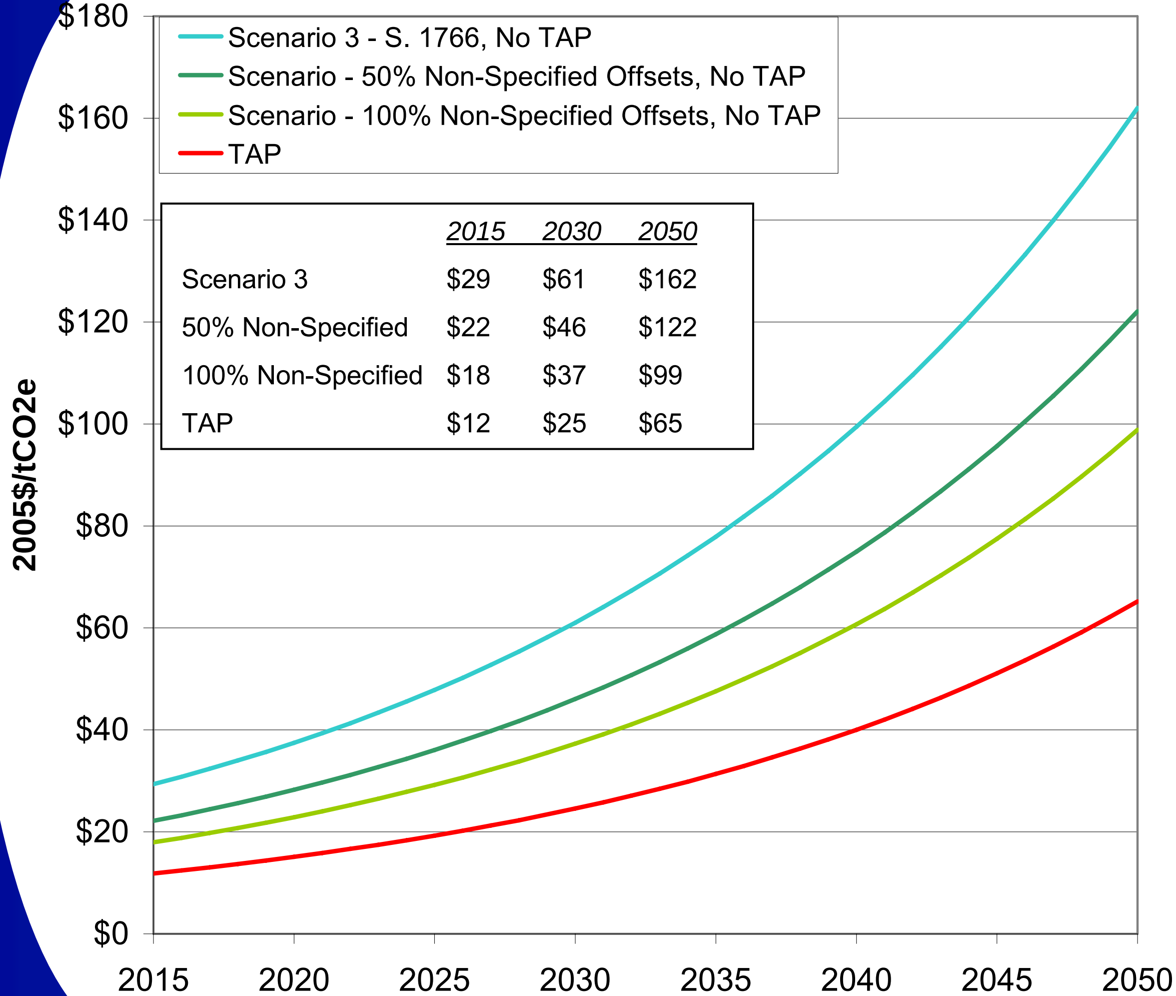
Results: Scenario 2 – S. 1766

GHG Intensity



Results: Scenario - S. 1766 50% Non-Specified Offsets, No TAP, Scenario - S. 1766 50% Non-Specified Offsets, No TAP

Allowance Price (IGEM)

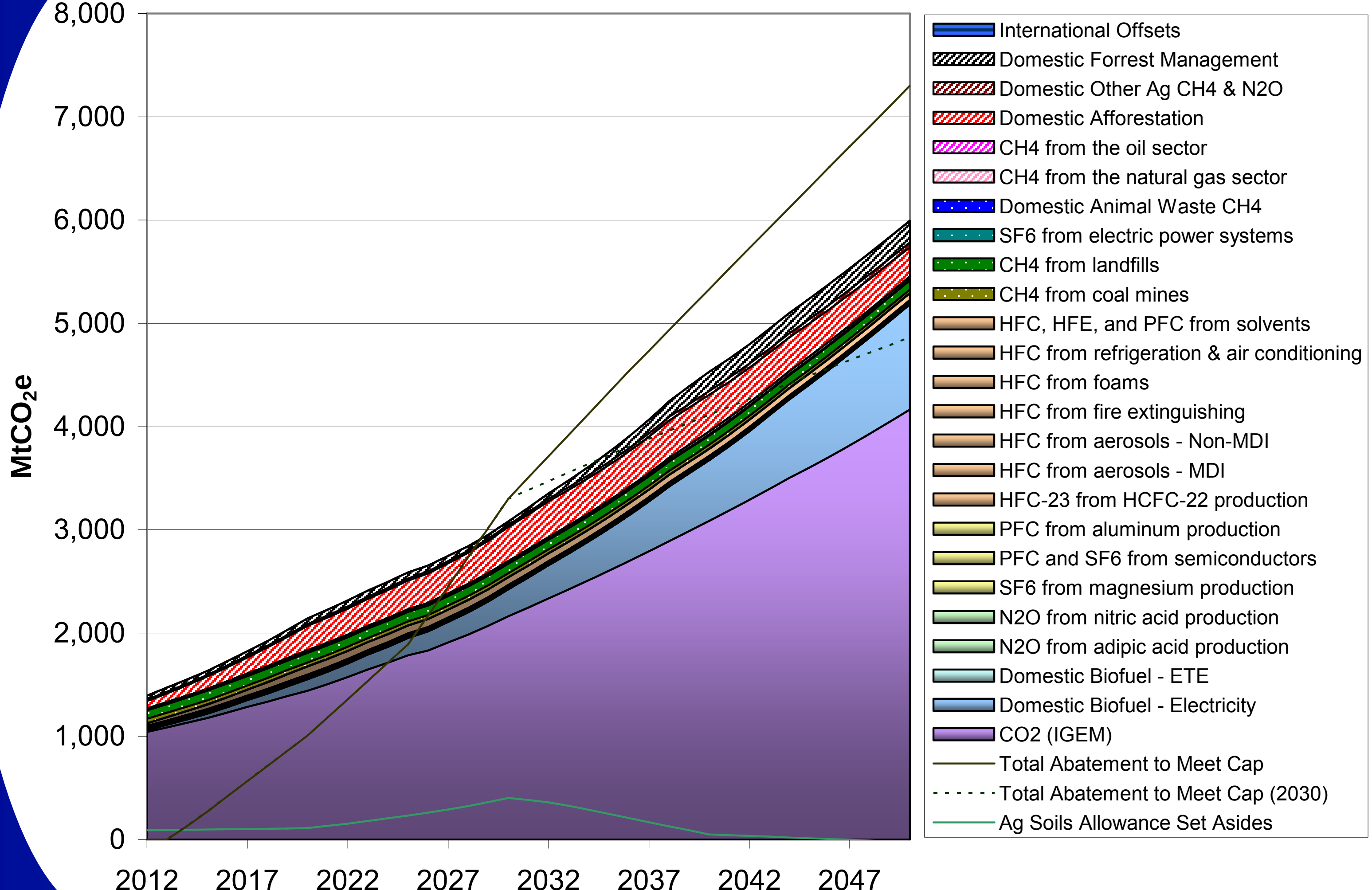


	2015	2030	2050
Scenario 3	$29	$61	$162
50% Non-Specified	$22	$46	$122
100% Non-Specified	$18	$37	$99
TAP	$12	$25	$65

- S. 1766 allows the unlimited use of specified domestic offsets
  - Specified offset project categories include CH_4 from landfills, coal mines, and animal waste, and SF_6 from electric power systems
  - For other offset project categories, the President may distribute less than 1 credit for each ton of greenhouse gas emissions reduced or sequestered.
- In order to determine the impact of restricting the use of non-specified offsets, a reduced form version of IGEM was used to determine the allowance price and sources of GHG abatement when non-specified offsets were allowed to be used on a ½ credit for each ton of GHG emissions reduced (50% Non-Specified Offsets) basis, and on a 1 credit for each ton reduced (100% Non-Specified Offsets) basis.
- Non-specified offsets categories include forest management, afforestation, CH_4 from the oil sector, CH_4 from the natural gas sector, and non-animal agricultural waste CH_4 and N_2O.

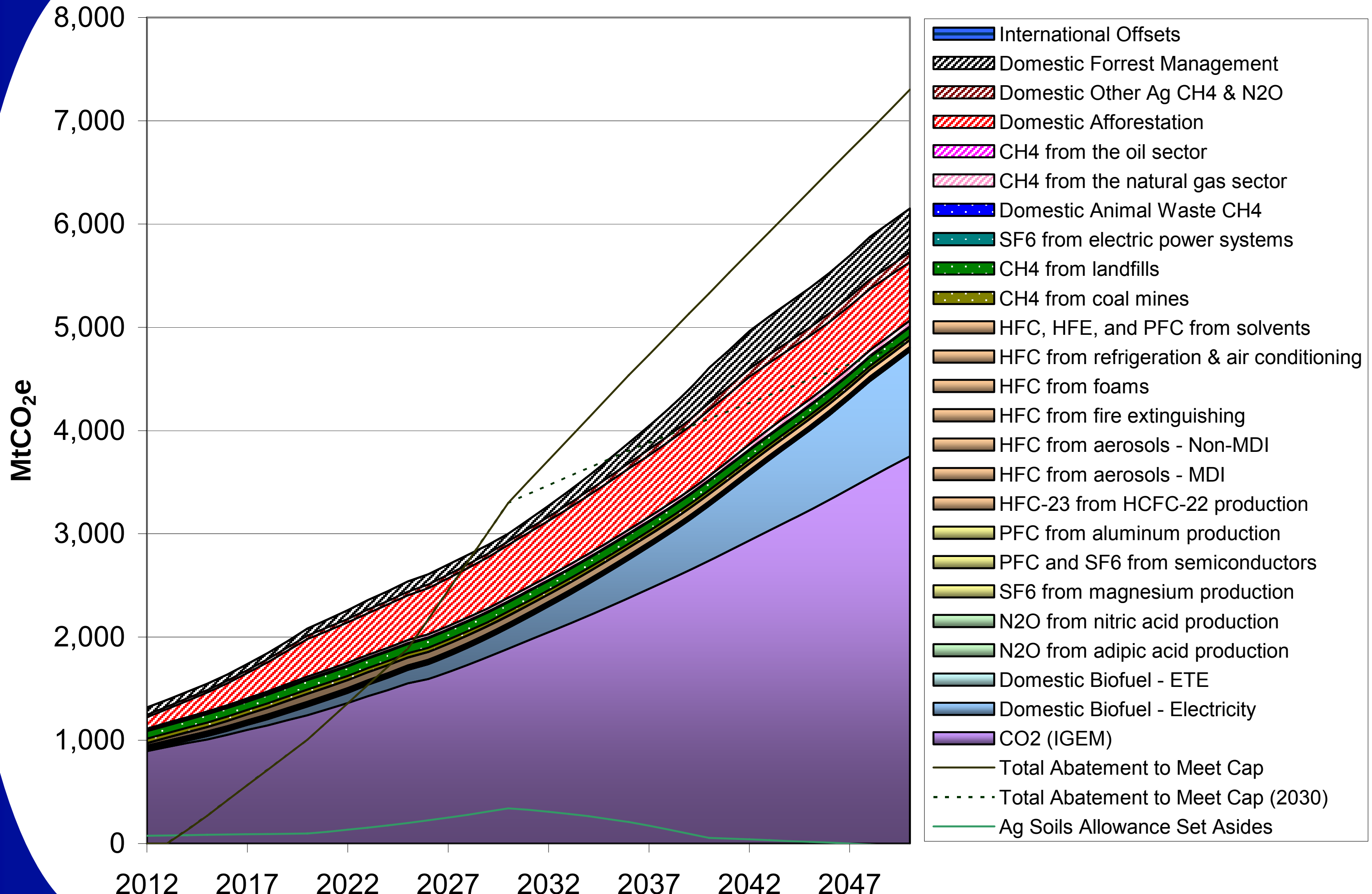
Results: Scenario - S. 1766 50% Non-Specified Offsets, No TAP

Sources of GHG Abatement (IGEM)



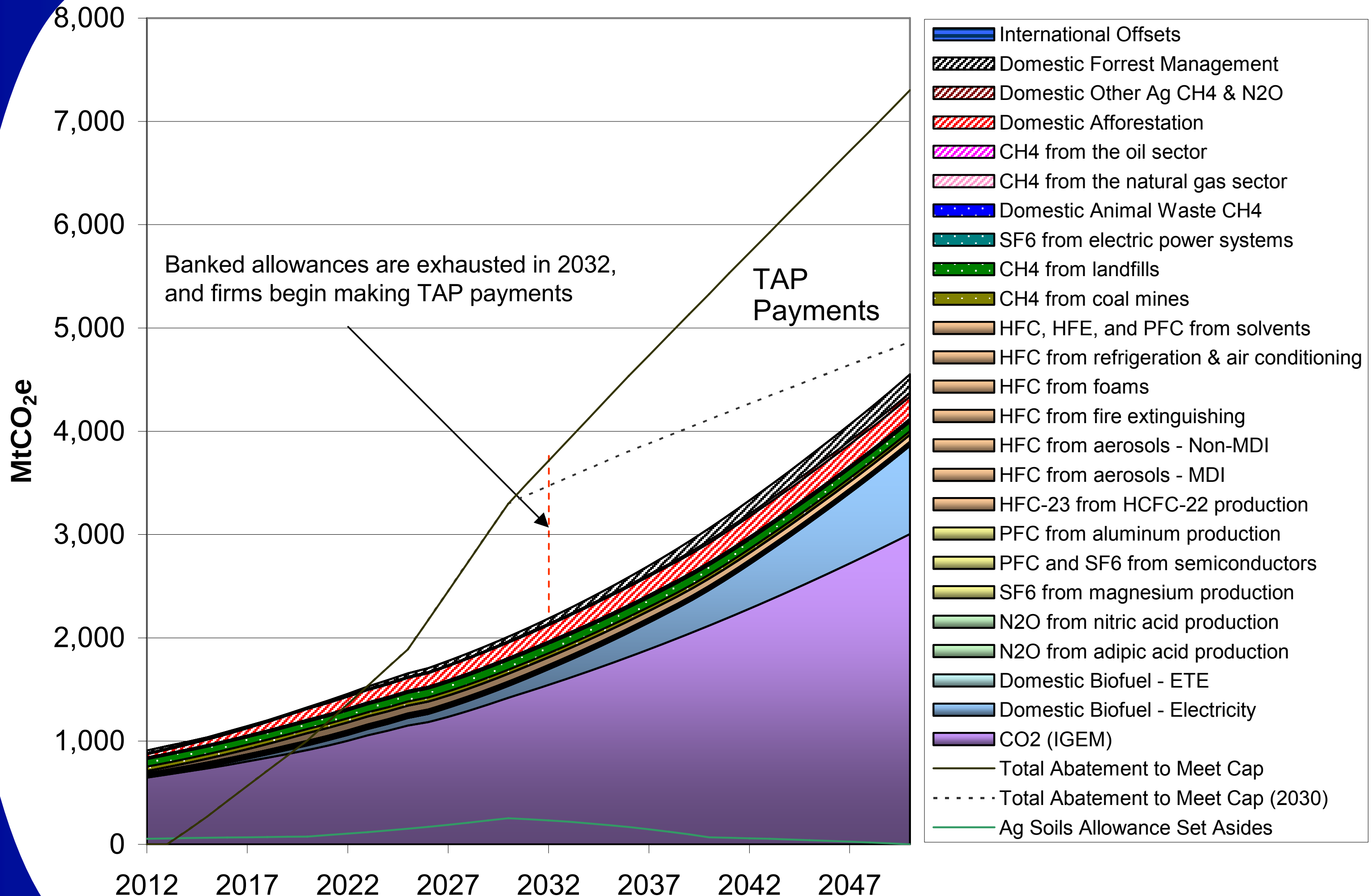
Results: Scenario - S. 1766 100% Non-Specified Offsets, No TAP

Sources of GHG Abatement (IGEM)



Results: Scenario - S. 1766 50% Non-Specified Offsets

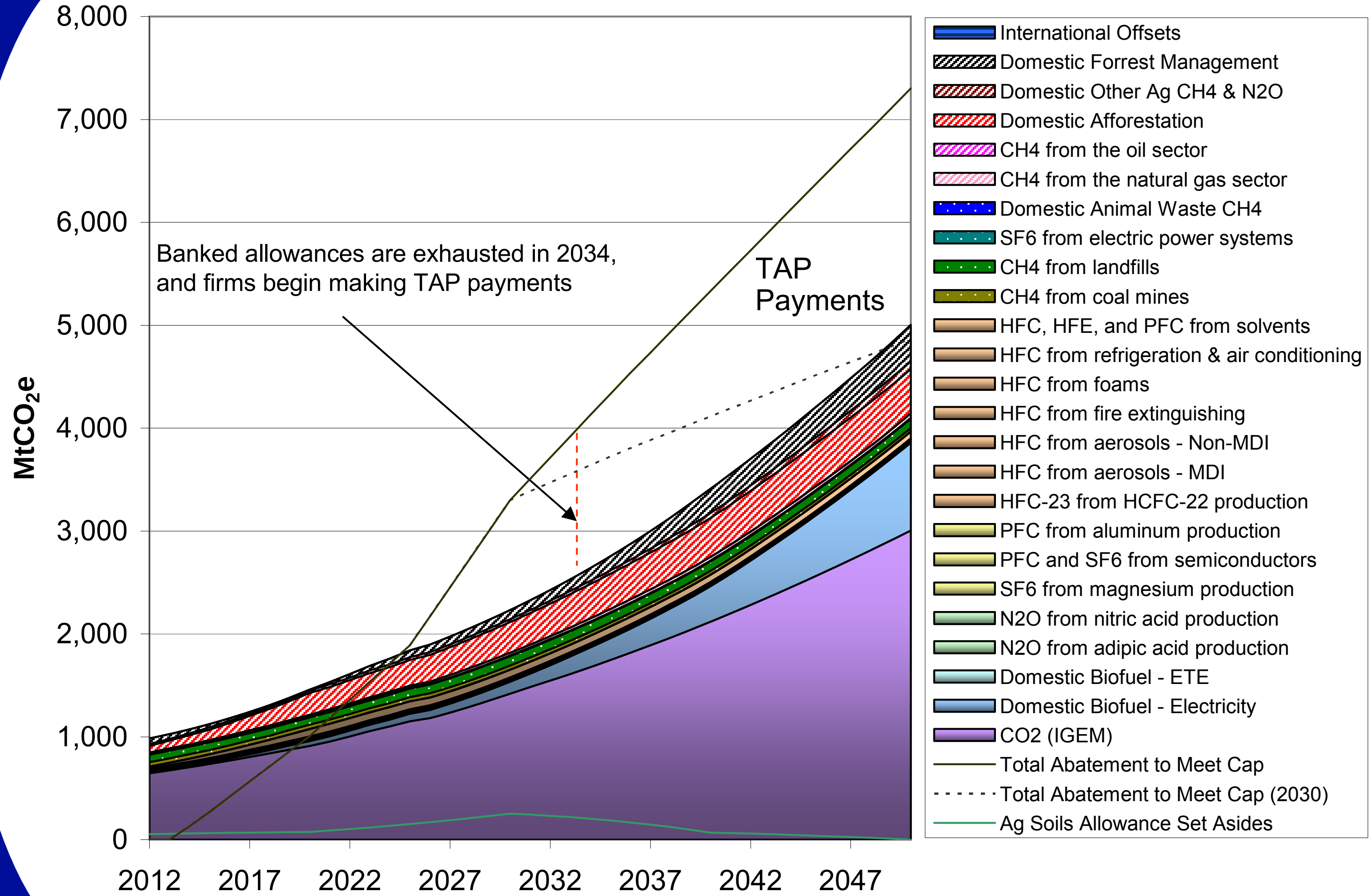
Sources of GHG Abatement (IGEM)



- Compared to *Scenario 2 – S. 1766*, the year in which firms begin to make TAP payments is moved back two years by allowing 50% non-specified offsets.
- The cumulative number of tons for which TAP payments are made is 18% lower than in *Scenario 2 – S. 1766*.

Results: Scenario - S. 1766 100% Non-Specified Offsets

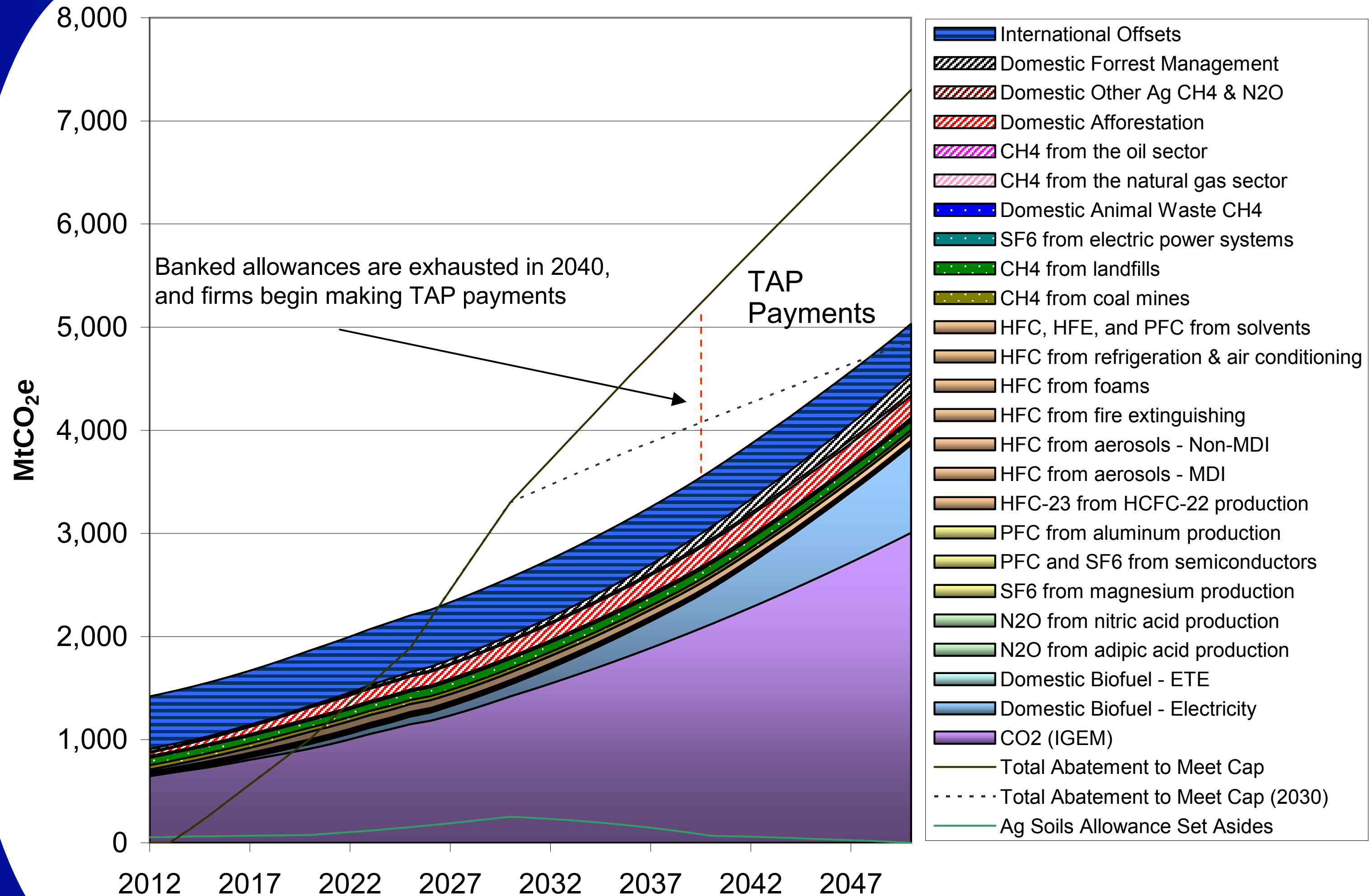
Sources of GHG Abatement (IGEM)



- Compared to *Scenario 2 – S. 1766*, the year in which firms begin to make TAP payments is moved back four years by allowing 100% non-specified offsets.
- The cumulative number of tons for which TAP payments are made is 37% lower than in *Scenario 2 – S. 1766*.

Results: Scenario - S. 1766 50% Non-Specified Offsets, 10% International Credits

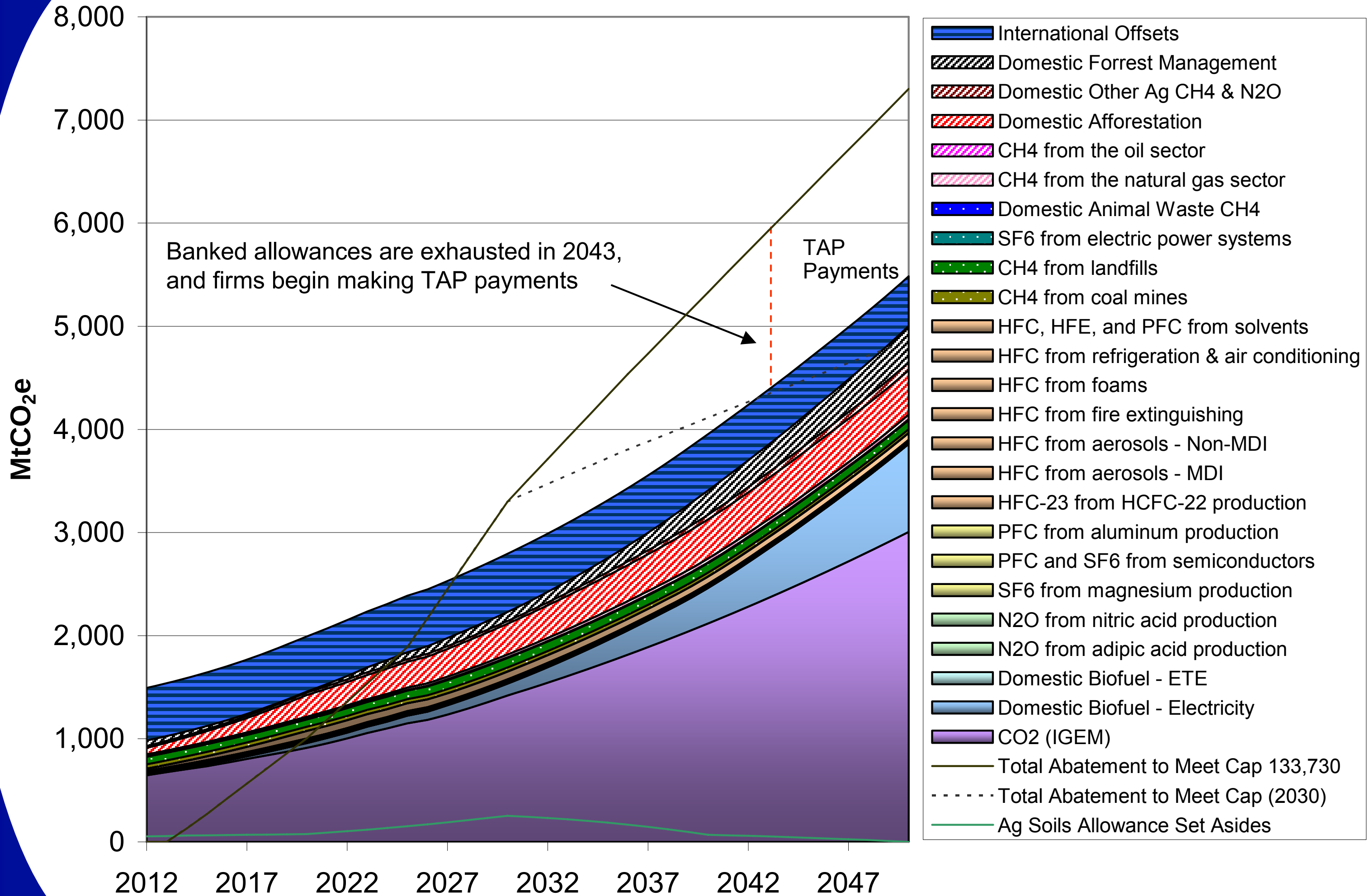
Sources of GHG Abatement (IGEM)



- Compared to *Scenario 2 – S. 1766*, the year in which firms begin to make TAP payments is moved back ten years by allowing 50% non-specified offsets and 10% international credits.
- The cumulative number of tons for which TAP payments are made is 58% lower than in *Scenario 2 – S. 1766*.

Results: Scenario - S. 1766 100% Non-Specified Offsets, 10% International Credits

Sources of GHG Abatement (IGEM)



- Compared to *Scenario 2 – S. 1766*, the year in which firms begin to make TAP payments is moved back ten years by allowing 50% non-specified offsets and 10% international credits.
- The cumulative number of tons for which TAP payments are made is 76% lower than in *Scenario 2 – S. 1766*.

Results: Scenario 2 - S. 1766

Fuel Price Adders for 2050 (ADAGE)

	2005 Price	2050 Producer Price	2050 Cost of Carbon Content	2050 End - User Price
Metric Ton of CO_2	n/a		$65.04	
Metric Ton of Carbon	n/a		$238.48	
Barrel of Oil	$50.28	$53.04	$27.84	$80.88
Gallon of Gasoline	$2.34	$2.47	$0.57	$3.04
Short Ton of Coal	$36.79	$38.74	$143.77	$182.51
Short Ton of Coal w/ CCS	$36.79	$38.74	$14.38	$53.12
tCf of Natural Gas	$7.51	$5.72	$3.54	$9.26

- The 2030 price is obtained by multiplying the 2030 index price in ADAGE by the 2005 price from EIA's 2006 Monthly Energy Review.
- The cost of carbon content is simply the product of the physical carbon content of the fuel and the allowance price, which in this scenario is determined by the TAP.
- The consumer price is simply the sum of the price and the cost of carbon content.
- CCS technology for coal fired power generation captures and stores 90% of carbon emissions, which lowers the cost of carbon content by 90%, and lower the consumer price accordingly.
- The cost of the carbon content increases the price of gasoline by 23%, increases the price of oil by 52%, increases the price of natural gas by 62%, increases the price of coal by 371%, and increases the price of coal used with CCS by 37%.
- Bonus allowances for CCS are not considered here.

Results: Scenario 13 - S. 1766 High Technology

Fuel Price Adders for 2050 (ADAGE)

		2050		
	2005 Price	**Producer Price**	**Cost of Carbon Content**	**End - User Price**
Metric Ton of CO_2	n/a		$65.04	
Metric Ton of Carbon	n/a		$238.48	
Barrel of Oil	$50.28	$53.38	$27.84	$81.22
Gallon of Gasoline	$2.34	$2.48	$0.57	$3.06
Short Ton of Coal	$36.79	$38.09	$143.77	$181.86
Short Ton of Coal w/ CCS	$36.79	$38.09	$14.38	$52.47
tCf of Natural Gas	$7.51	$5.34	$3.54	$8.88

- The 2030 price is obtained by multiplying the 2030 index price in ADAGE by the 2005 price from EIA's 2006 Monthly Energy Review.
- The cost of carbon content is simply the product of the physical carbon content of the fuel and the allowance price, which in this scenario is determined by the TAP.
- The consumer price is simply the sum of the price and the cost of carbon content.
- CCS technology for coal fired power generation captures and stores 90% of carbon emissions, which lowers the cost of carbon content by 90%, and lower the consumer price accordingly.
- The cost of the carbon content increases the price of gasoline by 23%, increases the price of oil by 52%, increases the price of natural gas by 66%, increases the price of coal by 377%, and increases the price of coal used with CCS by 38%.
- Bonus allowances for CCS are not considered here.

Results: S. 1766 Scenario 2 – S. 1766

2030 Sectoral Results (Sectors 1 - 18) (IGEM)

Sector	2007	2030				
		Reference		S. 1766 Scenario 2		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Agriculture, forestry, fisheries	492	991	101%	997	103%	1%
Metal mining	80	158	98%	153	92%	-3%
Coal mining	29	40	39%	28	-5%	-32%
Crude oil and gas extraction	159	232	46%	221	39%	-5%
Non-metallic mineral mining	16	14	-11%	14	-15%	-4%
Construction	1151	1578	37%	1548	35%	-2%
Food and kindred products	565	1155	104%	1182	109%	2%
Tobacco manufactures	32	58	79%	60	86%	4%
Textile mill products	83	230	178%	225	172%	-2%
Apparel and other textile products	78	218	180%	215	177%	-1%
Lumber and wood products	148	331	124%	322	118%	-3%
Furniture and fixtures	100	225	125%	219	120%	-3%
Paper and allied products	217	555	156%	542	150%	-2%
Printing and publishing	243	440	81%	435	79%	-1%
Chemicals and allied products	515	1400	172%	1346	161%	-4%
Petroleum refining	296	389	31%	351	18%	-10%
Rubber and plastic products	218	550	152%	536	146%	-2%
Leather and leather products	13	34	167%	34	163%	-1%

Results: S. 1766 Scenario 2 – S. 1766

2030 Sectoral Results (Sectors 19 - 35) (IGEM)

Sector	2007	2030				
		Reference		S. 1766 Scenario 2		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Stone, clay and glass products	116	249	114%	243	109%	-2%
Primary metals	205	448	119%	428	109%	-4%
Fabricated metal products	317	625	97%	607	91%	-3%
Non-electrical machinery	631	2387	278%	2318	267%	-3%
Electrical machinery	448	3276	631%	3186	612%	-3%
Motor vehicles	513	1095	114%	1066	108%	-3%
Other transportation equipment	219	420	92%	413	89%	-2%
Instruments	252	566	125%	556	121%	-2%
Miscellaneous manufacturing	66	176	166%	173	161%	-2%
Transportation and warehousing	681	1284	89%	1261	85%	-2%
Communications	517	1137	120%	1135	120%	0%
Electric utilities (services)	384	548	43%	508	32%	-7%
Gas utilities (services)	51	60	20%	54	7%	-11%
Wholesale and retail trade	2495	4703	89%	4617	85%	-2%
Finance, insurance and real estate	2642	6075	130%	6041	129%	-1%
Personal and business services	4304	8108	88%	8092	88%	0%
Government enterprises	449	842	87%	833	85%	-1%

Results: S. 1766 Scenario 2 – S. 1766

2050 Sectoral Results (Sectors 1 - 18) (IGEM)

Sector	2007	2050				
		Reference		S. 1766 Scenario 2		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Agriculture, forestry, fisheries	492	1459	197%	1475	200%	1%
Metal mining	80	246	208%	230	188%	-7%
Coal mining	29	51	77%	25	-14%	-51%
Crude oil and gas extraction	159	313	97%	279	76%	-11%
Non-metallic mineral mining	16	18	15%	17	8%	-6%
Construction	1151	2189	90%	2114	84%	-3%
Food and kindred products	565	1788	216%	1903	237%	6%
Tobacco manufactures	32	91	183%	101	214%	11%
Textile mill products	83	394	377%	378	358%	-4%
Apparel and other textile products	78	397	411%	388	399%	-2%
Lumber and wood products	148	609	313%	576	290%	-5%
Furniture and fixtures	100	339	239%	323	223%	-5%
Paper and allied products	217	973	348%	926	327%	-5%
Printing and publishing	243	686	182%	669	175%	-3%
Chemicals and allied products	515	2530	391%	2340	354%	-7%
Petroleum refining	296	460	55%	362	22%	-21%
Rubber and plastic products	218	868	298%	826	279%	-5%
Leather and leather products	13	60	367%	58	351%	-3%

Results: S. 1766 Scenario 2 – S. 1766

2050 Sectoral Results (Sectors 19 - 35) (IGEM)

Sector	2007	2050				
		Reference		S. 1766 Scenario 2		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Stone, clay and glass products	116	451	287%	439	277%	-3%
Primary metals	205	739	261%	674	229%	-9%
Fabricated metal products	317	985	211%	931	194%	-6%
Non-electrical machinery	631	4465	608%	4220	569%	-5%
Electrical machinery	448	7466	1567%	7069	1479%	-5%
Motor vehicles	513	1818	255%	1729	237%	-5%
Other transportation equipment	219	677	210%	656	200%	-3%
Instruments	252	861	242%	835	232%	-3%
Miscellaneous manufacturing	66	317	379%	306	364%	-3%
Transportation and warehousing	681	1932	184%	1860	173%	-4%
Communications	517	1849	258%	1845	257%	0%
Electric utilities (services)	384	704	83%	597	55%	-15%
Gas utilities (services)	51	64	27%	49	-3%	-24%
Wholesale and retail trade	2495	7024	182%	6778	172%	-4%
Finance, insurance and real estate	2642	9879	274%	9785	270%	-1%
Personal and business services	4304	12226	184%	12191	183%	0%
Government enterprises	449	1249	178%	1222	172%	-2%

Results: S. 1766 Scenario 3 – S. 1766, No TAP

2030 Sectoral Results (Sectors 1 - 18) (IGEM)

Sector	2007	2030				
		Reference		S. 1766 Scenario 3		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Agriculture, forestry, fisheries	492	991	101%	1006	104%	2%
Metal mining	80	158	98%	148	85%	-7%
Coal mining	29	40	39%	20	-32%	-51%
Crude oil and gas extraction	159	232	46%	208	31%	-10%
Non-metallic mineral mining	16	14	-11%	13	-19%	-9%
Construction	1151	1578	37%	1519	32%	-4%
Food and kindred products	565	1155	104%	1217	115%	5%
Tobacco manufactures	32	58	79%	63	95%	9%
Textile mill products	83	230	178%	219	165%	-5%
Apparel and other textile products	78	218	180%	212	173%	-2%
Lumber and wood products	148	331	124%	312	111%	-6%
Furniture and fixtures	100	225	125%	214	114%	-5%
Paper and allied products	217	555	156%	528	143%	-5%
Printing and publishing	243	440	81%	430	76%	-2%
Chemicals and allied products	515	1400	172%	1282	149%	-8%
Petroleum refining	296	389	31%	309	4%	-21%
Rubber and plastic products	218	550	152%	523	140%	-5%
Leather and leather products	13	34	167%	33	158%	-3%

Results: S. 1766 Scenario 3 – S. 1766, No TAP

2050 Sectoral Results (Sectors 19 - 35) (IGEM)

Sector	2007	2030				
		Reference		S. 1766 Scenario 3		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Stone, clay and glass products	116	249	114%	239	105%	-4%
Primary metals	205	448	119%	408	99%	-9%
Fabricated metal products	317	625	97%	589	86%	-6%
Non-electrical machinery	631	2387	278%	2251	257%	-6%
Electrical machinery	448	3276	631%	3097	592%	-5%
Motor vehicles	513	1095	114%	1038	102%	-5%
Other transportation equipment	219	420	92%	406	86%	-3%
Instruments	252	566	125%	547	117%	-3%
Miscellaneous manufacturing	66	176	166%	170	157%	-3%
Transportation and warehousing	681	1284	89%	1235	81%	-4%
Communications	517	1137	120%	1134	119%	0%
Electric utilities (services)	384	548	43%	466	21%	-15%
Gas utilities (services)	51	60	20%	46	-9%	-24%
Wholesale and retail trade	2495	4703	89%	4529	82%	-4%
Finance, insurance and real estate	2642	6075	130%	6012	128%	-1%
Personal and business services	4304	8108	88%	8076	88%	0%
Government enterprises	449	842	87%	823	83%	-2%

Results: S. 1766 Scenario 3 – S. 1766, No TAP

2050 Sectoral Results (Sectors 1 - 18) (IGEM)

Sector	2007	2050				
		Reference		S. 1766 Scenario 3		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Agriculture, forestry, fisheries	492	1459	197%	1505	206%	3%
Metal mining	80	246	208%	217	172%	-12%
Coal mining	29	51	77%	16	-46%	-69%
Crude oil and gas extraction	159	313	97%	245	54%	-22%
Non-metallic mineral mining	16	18	15%	16	2%	-11%
Construction	1151	2189	90%	2053	78%	-6%
Food and kindred products	565	1788	216%	2030	259%	14%
Tobacco manufactures	32	91	183%	112	248%	23%
Textile mill products	83	394	377%	363	339%	-8%
Apparel and other textile products	78	397	411%	377	385%	-5%
Lumber and wood products	148	609	313%	548	271%	-10%
Furniture and fixtures	100	339	239%	310	210%	-8%
Paper and allied products	217	973	348%	885	308%	-9%
Printing and publishing	243	686	182%	653	168%	-5%
Chemicals and allied products	515	2530	391%	2153	318%	-15%
Petroleum refining	296	460	55%	278	-6%	-40%
Rubber and plastic products	218	868	298%	791	263%	-9%
Leather and leather products	13	60	367%	55	334%	-7%

Results: S. 1766 Scenario 3 – S. 1766, No TAP

2050 Sectoral Results (Sectors 19 - 35) (IGEM)

Sector	2007	2050				
		Reference		S. 1766 Scenario 3		
	Output ($Billions)	Output ($Billions)	Percent Change from 2007	Output ($Billions)	Percent Change from 2007	Percent Change from Reference
Stone, clay and glass products	116	451	287%	438	276%	-3%
Primary metals	205	739	261%	623	204%	-16%
Fabricated metal products	317	985	211%	887	180%	-10%
Non-electrical machinery	631	4465	608%	4030	539%	-10%
Electrical machinery	448	7466	1567%	6751	1408%	-10%
Motor vehicles	513	1818	255%	1660	224%	-9%
Other transportation equipment	219	677	210%	640	193%	-5%
Instruments	252	861	242%	815	224%	-5%
Miscellaneous manufacturing	66	317	379%	298	350%	-6%
Transportation and warehousing	681	1932	184%	1793	163%	-7%
Communications	517	1849	258%	1844	257%	0%
Electric utilities (services)	384	704	83%	505	32%	-28%
Gas utilities (services)	51	64	27%	36	-30%	-45%
Wholesale and retail trade	2495	7024	182%	6566	163%	-7%
Finance, insurance and real estate	2642	9879	274%	9727	268%	-2%
Personal and business services	4304	12226	184%	12168	183%	0%
Government enterprises	449	1249	178%	1195	166%	-4%

Results: Scenario 2 – S. 1766

International Trade Leakage – All Sectors (ADAGE)

Change in Trade Quantities		2010	2020	2030	2040	2050
Agriculture	U.S. Imports from Group 1	-3.2%	-4.0%	-1.8%	-2.3%	-1.7%
	U.S. Exports to Group 1	3.8%	4.9%	4.1%	5.3%	3.9%
	U.S. Imports from Group 2	1.6%	3.8%	-3.2%	-4.5%	-4.3%
	U.S. Exports to Group 2	-3.9%	-7.1%	-3.2%	-3.5%	-2.5%
Energy-Intensive Manufacturing	U.S. Imports from Group 1	-0.9%	-1.1%	0.0%	-0.6%	-0.7%
	U.S. Exports to Group 1	1.2%	1.7%	-0.7%	-1.3%	-2.1%
	U.S. Imports from Group 2	3.5%	5.9%	-5.7%	-9.9%	-11.0%
	U.S. Exports to Group 2	-3.6%	-6.5%	0.6%	3.3%	5.0%
Other Manufacturing	U.S. Imports from Group 1	1.3%	1.7%	2.6%	2.7%	2.8%
	U.S. Exports to Group 1	-1.1%	0.5%	0.0%	-1.0%	-1.4%
	U.S. Imports from Group 2	2.4%	3.1%	0.1%	-2.0%	-3.6%
	U.S. Exports to Group 2	-2.9%	-5.4%	-4.5%	-3.1%	-2.1%
Services	U.S. Imports from Group 1	1.3%	0.8%	1.4%	1.7%	1.3%
	U.S. Exports to Group 1	-0.5%	0.1%	0.9%	0.5%	-0.3%
	U.S. Imports from Group 2	2.4%	3.0%	2.3%	0.6%	-1.4%
	U.S. Exports to Group 2	-2.8%	-4.2%	-6.7%	-6.0%	-3.3%
Transportation Services	U.S. Imports from Group 1	-1.1%	0.7%	1.6%	1.3%	3.3%
	U.S. Exports to Group 1	2.4%	0.1%	-1.2%	-2.9%	-6.2%
	U.S. Imports from Group 2	4.7%	8.3%	-0.5%	-4.7%	-5.9%
	U.S. Exports to Group 2	-3.3%	-8.1%	-5.1%	-4.6%	-3.6%

Results: Scenario 11 - S. 1766, Alternative International Action

International Trade Leakage – All Sectors (ADAGE)

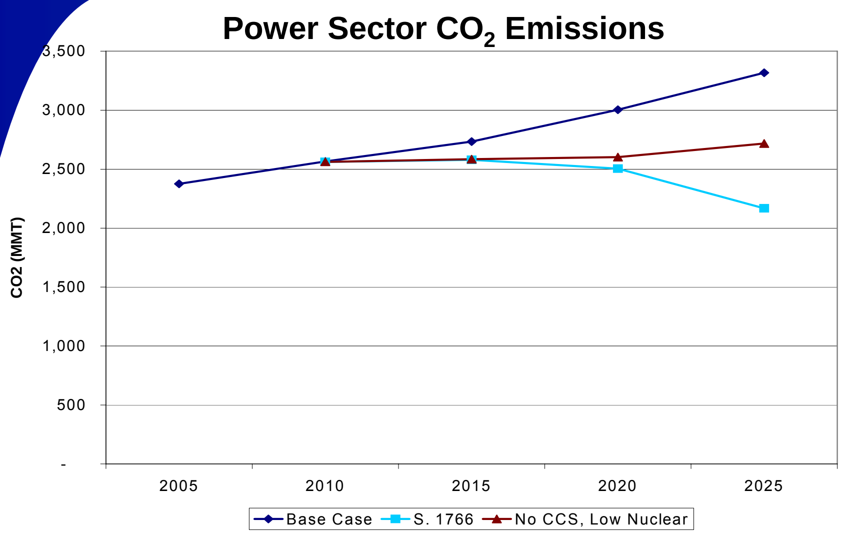
Change in Trade Quantities		2010	2020	2030	2040	2050
Agriculture	U.S. Imports from Group 1	-2.1%	-2.0%	-2.2%	0.4%	3.4%
	U.S. Exports to Group 1	2.4%	2.2%	2.5%	0.8%	-0.9%
	U.S. Imports from Group 2	0.9%	2.2%	2.9%	4.5%	6.4%
	U.S. Exports to Group 2	-2.3%	-3.9%	-4.7%	-5.4%	-6.2%
Energy-Intensive Manufacturing	U.S. Imports from Group 1	-0.8%	-0.5%	-0.5%	1.0%	2.8%
	U.S. Exports to Group 1	0.9%	0.5%	0.5%	-0.3%	-1.1%
	U.S. Imports from Group 2	2.0%	2.4%	1.5%	0.0%	-1.6%
	U.S. Exports to Group 2	-2.2%	-3.3%	-3.9%	-4.4%	-4.8%
Other Manufacturing	U.S. Imports from Group 1	0.3%	0.1%	0.2%	0.7%	1.6%
	U.S. Exports to Group 1	-0.6%	-0.7%	-0.6%	-0.8%	-1.1%
	U.S. Imports from Group 2	1.5%	1.6%	1.6%	1.5%	1.7%
	U.S. Exports to Group 2	-1.5%	-2.1%	-2.5%	-3.1%	-3.4%
Services	U.S. Imports from Group 1	0.6%	0.0%	0.0%	0.0%	0.2%
	U.S. Exports to Group 1	-0.1%	0.0%	-0.1%	-0.1%	-0.1%
	U.S. Imports from Group 2	1.2%	1.0%	1.2%	1.3%	1.5%
	U.S. Exports to Group 2	-1.8%	-2.1%	-2.4%	-2.8%	-3.1%
Transportation Services	U.S. Imports from Group 1	-0.3%	1.9%	0.3%	1.7%	5.1%
	U.S. Exports to Group 1	1.6%	-1.3%	-2.9%	-6.0%	-9.3%
	U.S. Imports from Group 2	3.1%	5.7%	5.5%	6.4%	8.9%
	U.S. Exports to Group 2	-1.9%	-5.5%	-8.1%	-10.9%	-13.6%

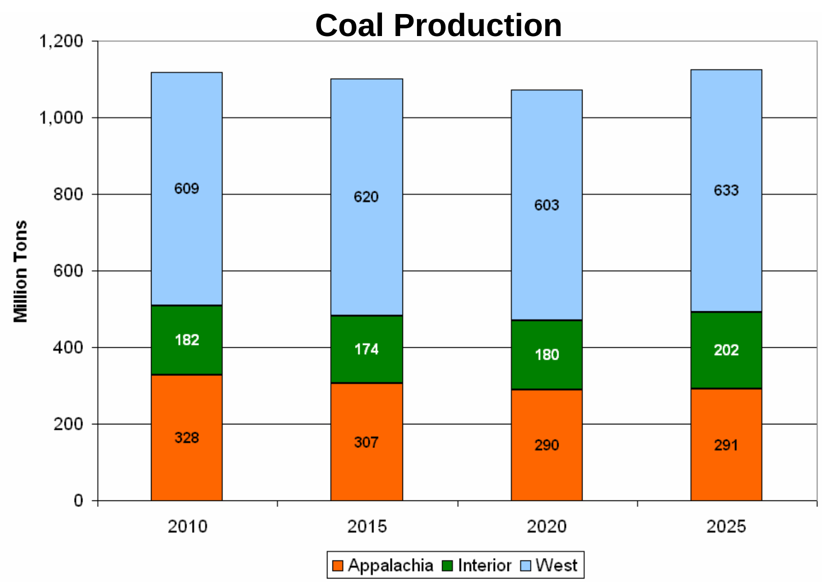
Appendix
Detailed Near-Term Electricity Sector Modeling Results and Sensitivities

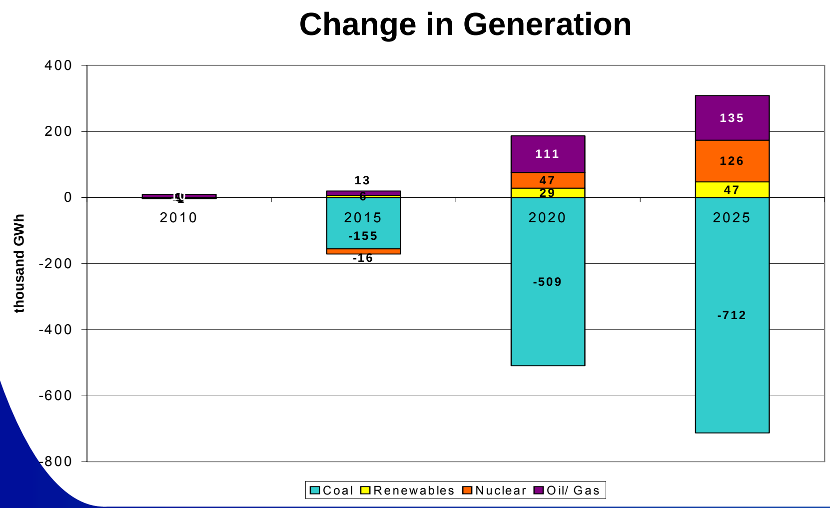
Determining Capacity Constraint in IPM for Advanced Coal with CCS

- EPA decided that a constraint for CCS capacity in IPM was appropriate and consistent with constraints put on other technology options (i.e., nuclear, renewables).
- Final constraint was developed using the historical capacity additions data for coal. This constraint generally limits the addition of new CCS capacity to no more than 70 GW per 5-year period.
- Using this upper limit results in 99 GW of new coal with CCS capacity being built by 2025 (cumulative) and appears to be in line with other recent studies.
  - EPRI assumed that 90% of new coal built after 2020 has CCS resulting in around 70 GW of new capacity by 2025 and close to 100 GW by 2030.
  - National Commission on Energy Policy in July 2007 projected the addition of 80 GW of coal capacity with CCS by 2025.
- This constraint has been added to IPM since the S. 280 analysis. The S. 280 IPM results would not be affected because no CCS was built in the near-term.

No CCS and Less New Nuclear Capacity (Scenario 10) Near-Term Results



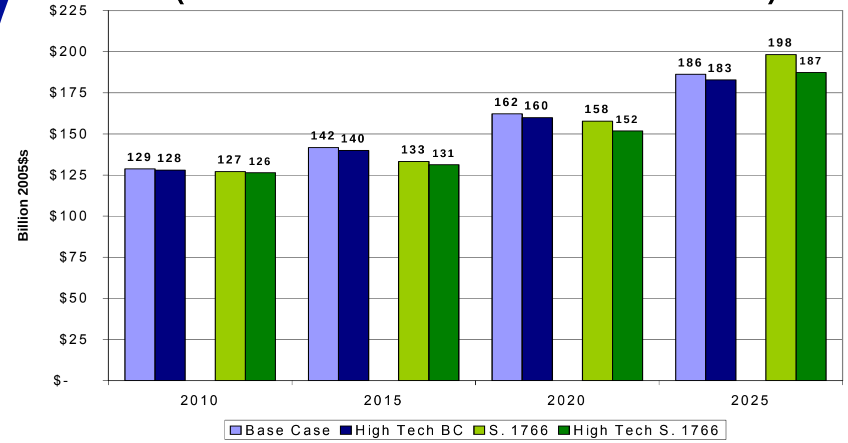




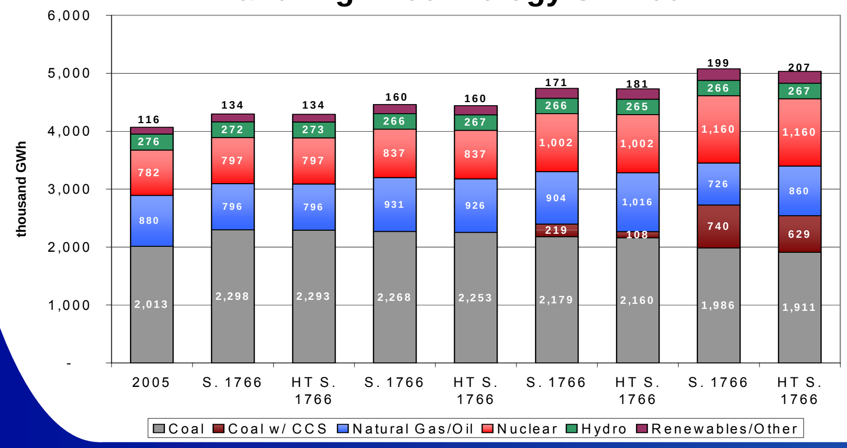
- GHG emissions from the power sector are higher when no CCS is constructed
- Coal production and generation declines
- More generation would come from from gas and renewables

High Technology Base and Policy Cases (Scenarios 12 and 13)

Total Power Sector Production Cost for Electricity Generation
(does not include cost of allowances or offsets)



Projected Generation Mix with S. 1766 and High Technology S. 1766



- Costs to the power sector in the high technology policy case are about $10 billion, or 5%, less than costs in the main policy case in 2025
- Under the high technology policy case, more natural gas capacity is built and less adv. coal with CCS is deployed relative to the main policy case for S. 1766

Appendix 5: Comparison to EPA's Analysis of S. 280

Side by Side Comparison of S. 1766 and S. 280

Bill	Low Carbon Economy Act	Climate Stewardship and Innovation Act
Sponsors	Bingaman, Specter	Lieberman, McCain
Bill Info	July 11, 2007 (S. 1766)	January 12, 2007 (S.280)
Jurisdiction	The President	EPA
Coverage	**Economy-wide** • Upstream for petroleum, natural gas and fluorinated gases • Downstream at coal facilities and non-fuel emissions	**Economy-wide** • Upstream petroleum and fluorinated gases • Downstream stationary sources
Caps/ Timing Safety Valve	**Declining Cap** • 2012: 6,652 million metric tons of CO_2 equivalent ($MtCO_2e$) • 2013-2019: less than 6,652 $MtCO_2e$ • 2020: 6,188 $MtCO_2e$ (2006 levels) • 2021-2029: less than 6,188 $MtCO_2e$ **<u>2030-on: 4,819 MMT CO2E (1990 levels)</u>** • $12 safety valve price (Technology Accelerator Payment), increasing 5% above inflation annually **<u>President may set an emission reduction goal of 60% below 2006 levels by 2050 contingent upon international effort</u>**	**Declining Cap** • 2012-2019: less than 6,130 $MtCO_2e$ • 2020-2029: less than 5,239 $MtCO_2e$ • 2030-2049: less than 4,100 MtCO2e • 2050-on: less than 2,096 $MtCO_2e$ **<u>2050: 60% below 1990 levels</u>**
Offsets	• Streamlined procedures for certain specified project types • Other unspecified eligible projects could be given less than 1 to 1 credit • 5% of allowances set aside for agricultural sequestration annually • Up to 10% of compliance met with international credits, after first 5 years	• Up to 30% of compliance met with domestic offsets and international credits
International Linkages	• The President may allow use of international credits, after first 5 years • 5 year review for participation of "major trading partners"	• Allows use of international credits (see above)

Major Provisions of S. 1766 and S. 280 w/ Cost Impacts

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

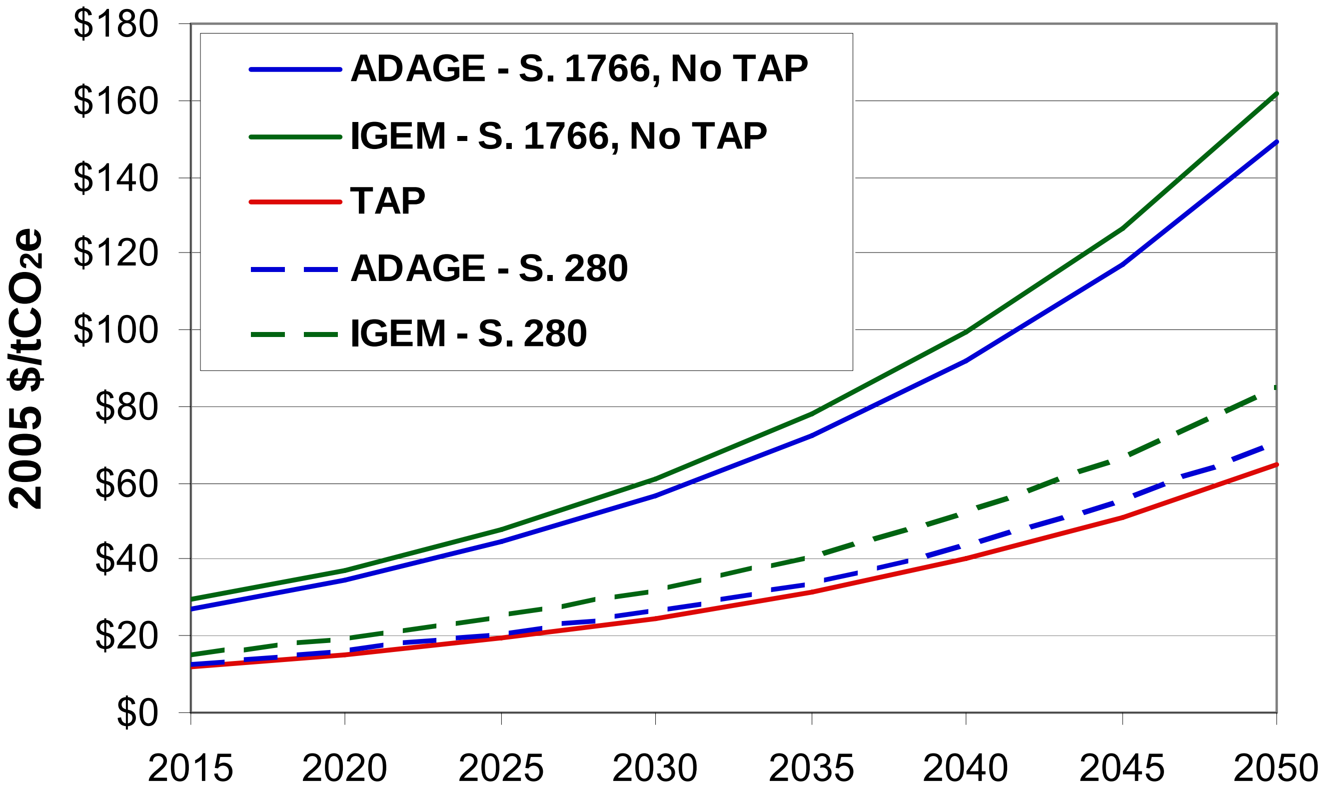
Modeling Approach

Several updates were made in the S. 1766 analysis as compared with the S. 280 analysis:

- Assumptions
  - The renewables assumptions in ADAGE were updated in the S. 1766 analysis to include a biomass response curve for electricity generation from the FASOM model.
  - The interaction between ADAGE and IPM is different in the S. 1766 analysis. Given the predictable allowance price path under the TAP feature of S. 1766, IPM used its internal electricity demand response rather than incorporating the demand response from ADAGE.
- Results reported
  - We are reporting regional impacts form the ADAGE model in the S. 1766 analysis.
  - We are also reporting international leakage from ADAGE in the S. 1766 analysis.

S. 280 Comparison: Scenario 2 – S. 1766 and Scenario 3 – S. 1766, No TAP

GHG Allowance Prices



Scenario 3 – S. 1766, No TAP

	2015	2030	2050
ADAGE	$27	$57	$149
IGEM	$29	$61	$162

Scenario 2 – S. 1766

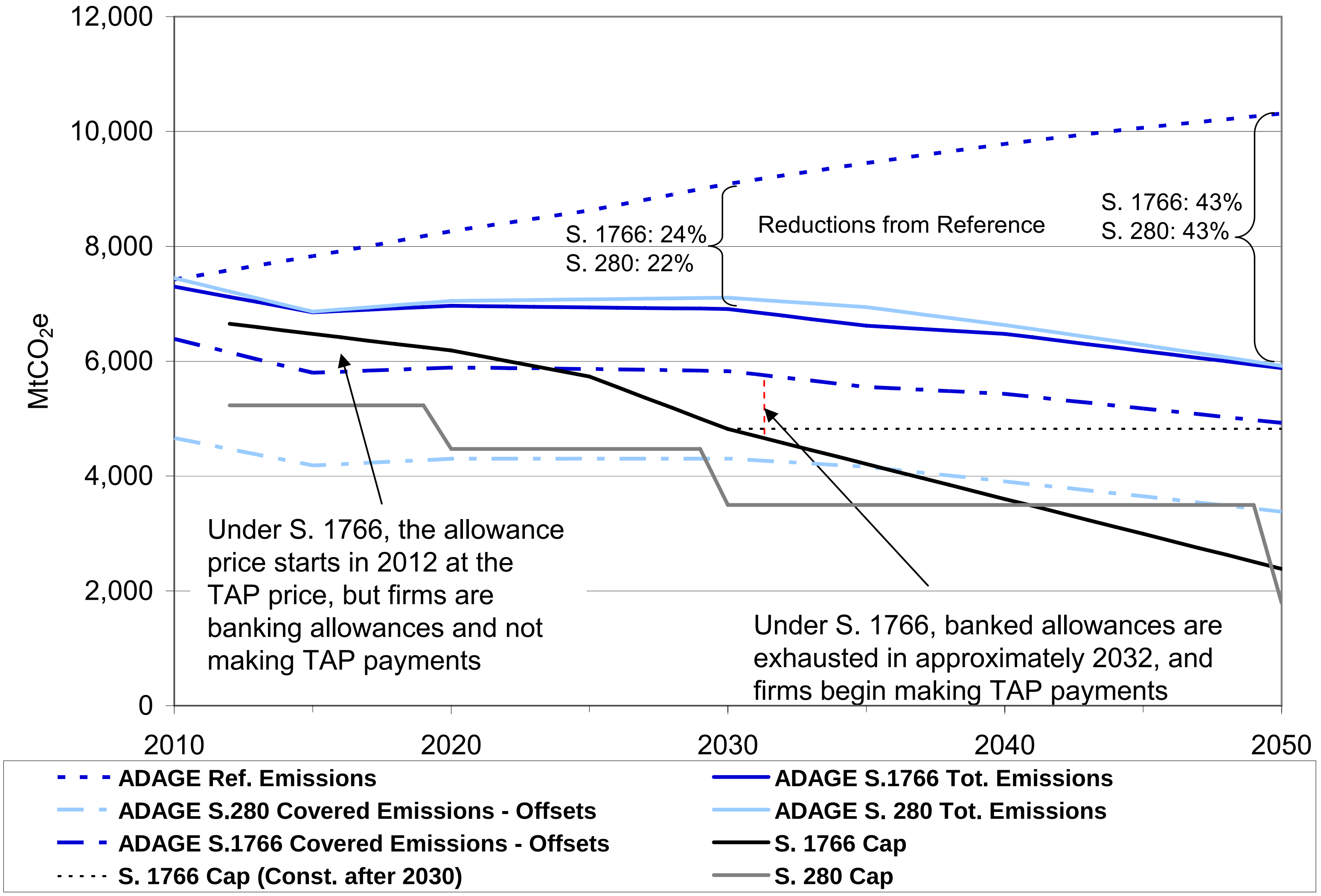
	2015	2030	2050
TAP	$12	$25	$65

S. 280

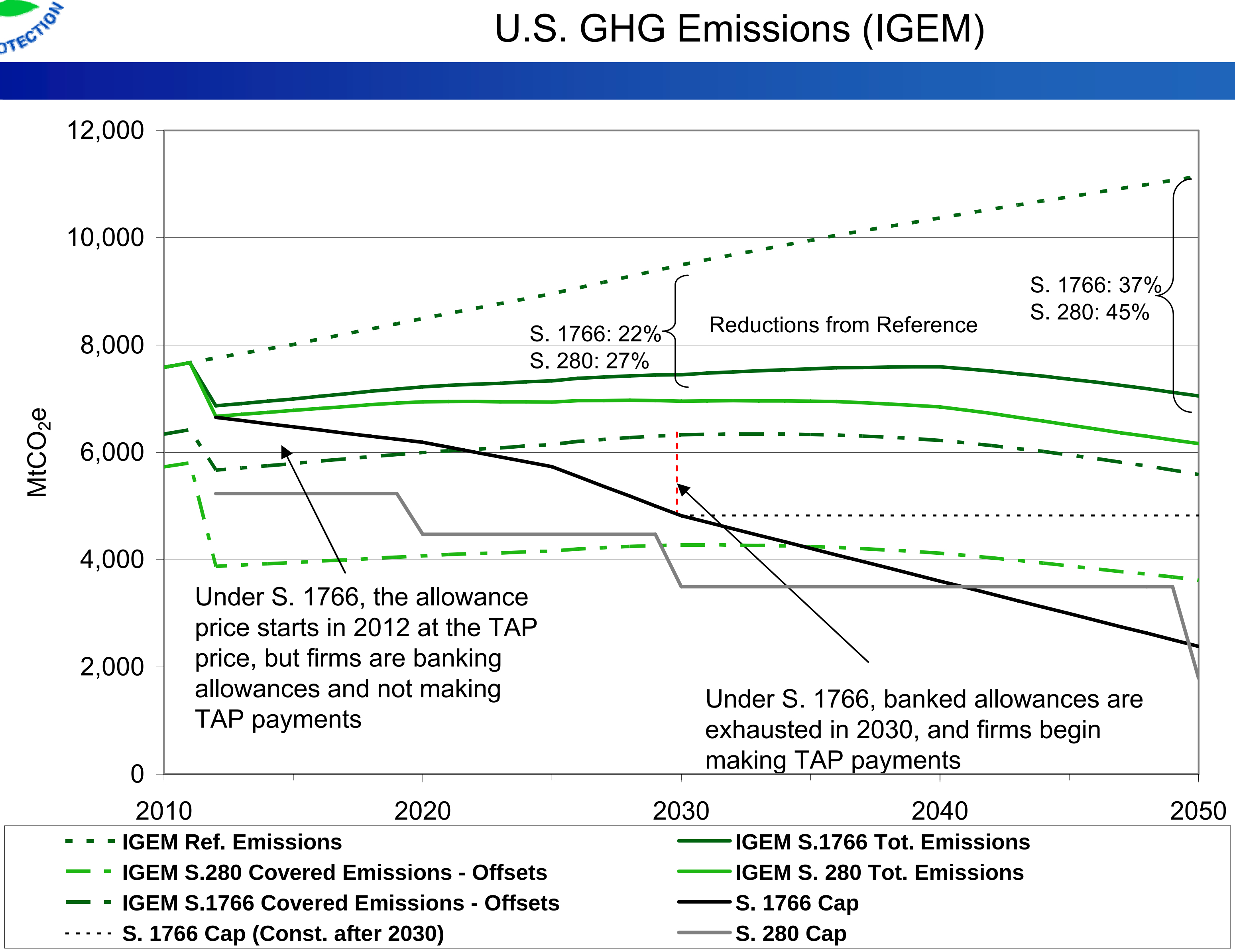
	2015	2030	2050
ADAGE	$13	$27	$70
IGEM	$15	$32	$85

S. 280 Comparison: Scenario 2 – S. 1766

U.S. GHG Emissions (ADAGE)

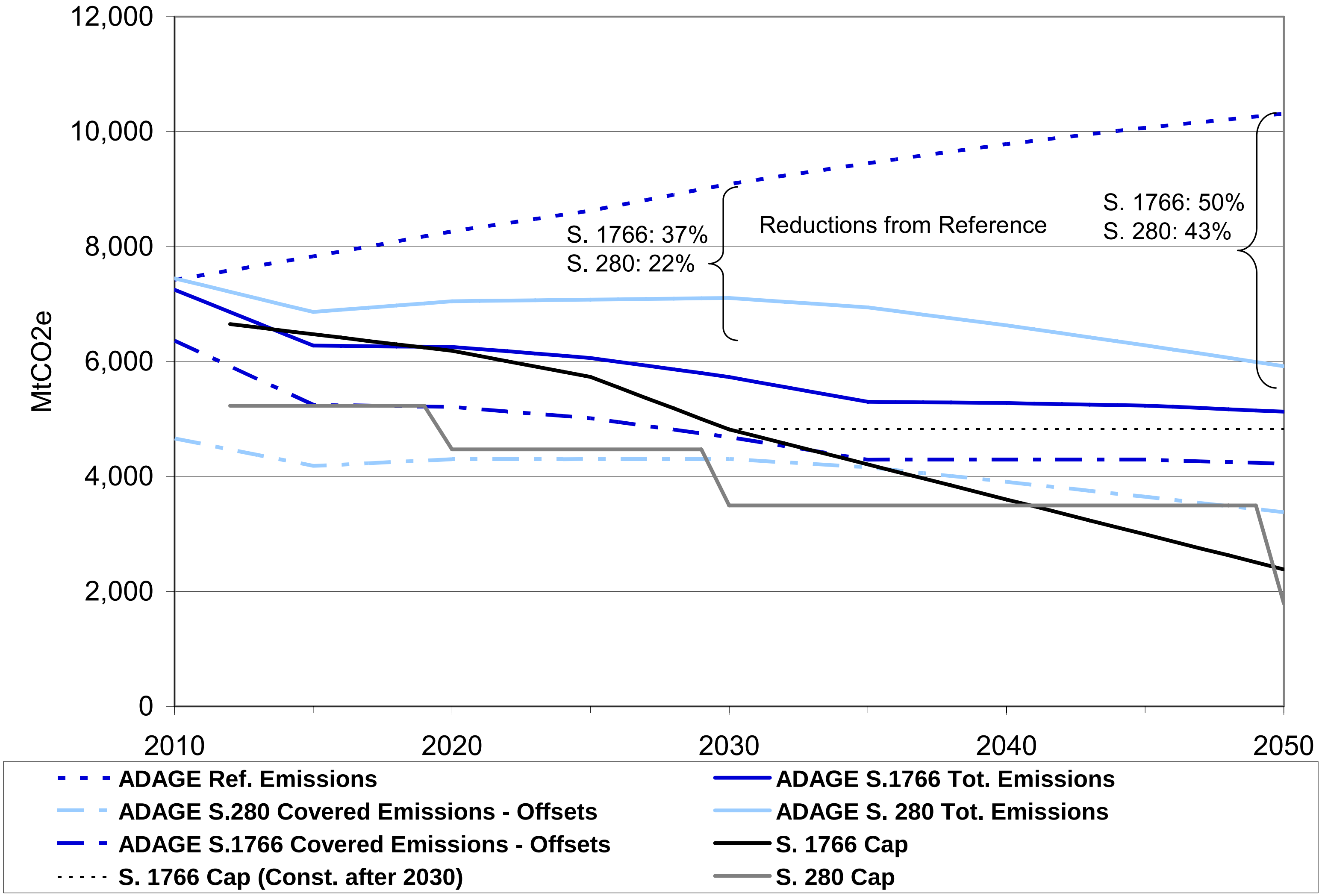


S. 280 Comparison: Scenario 2 – S. 1766

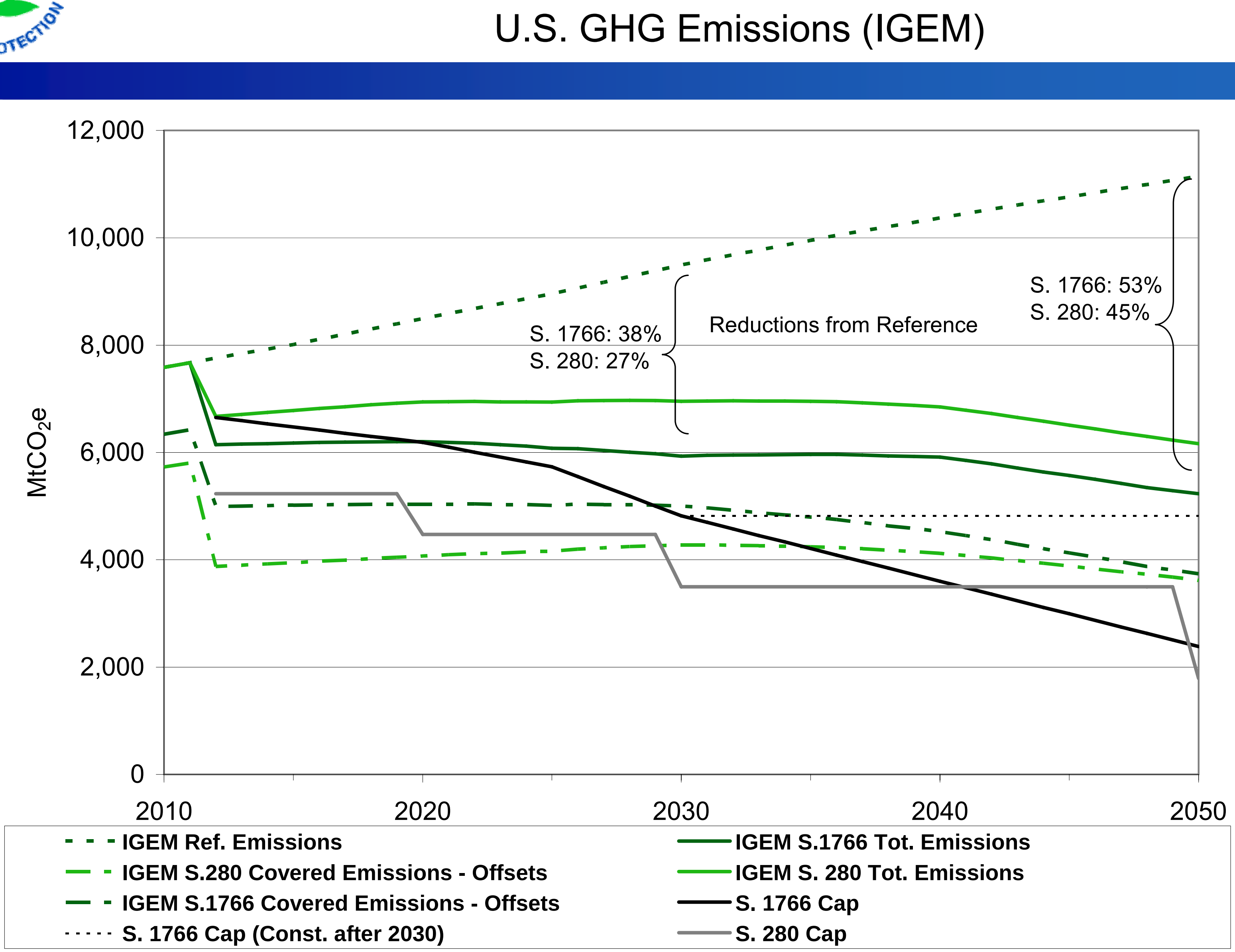


S. 280 Comparison: Scenario 3 – S. 1766, No TAP

U.S. GHG Emissions (ADAGE)

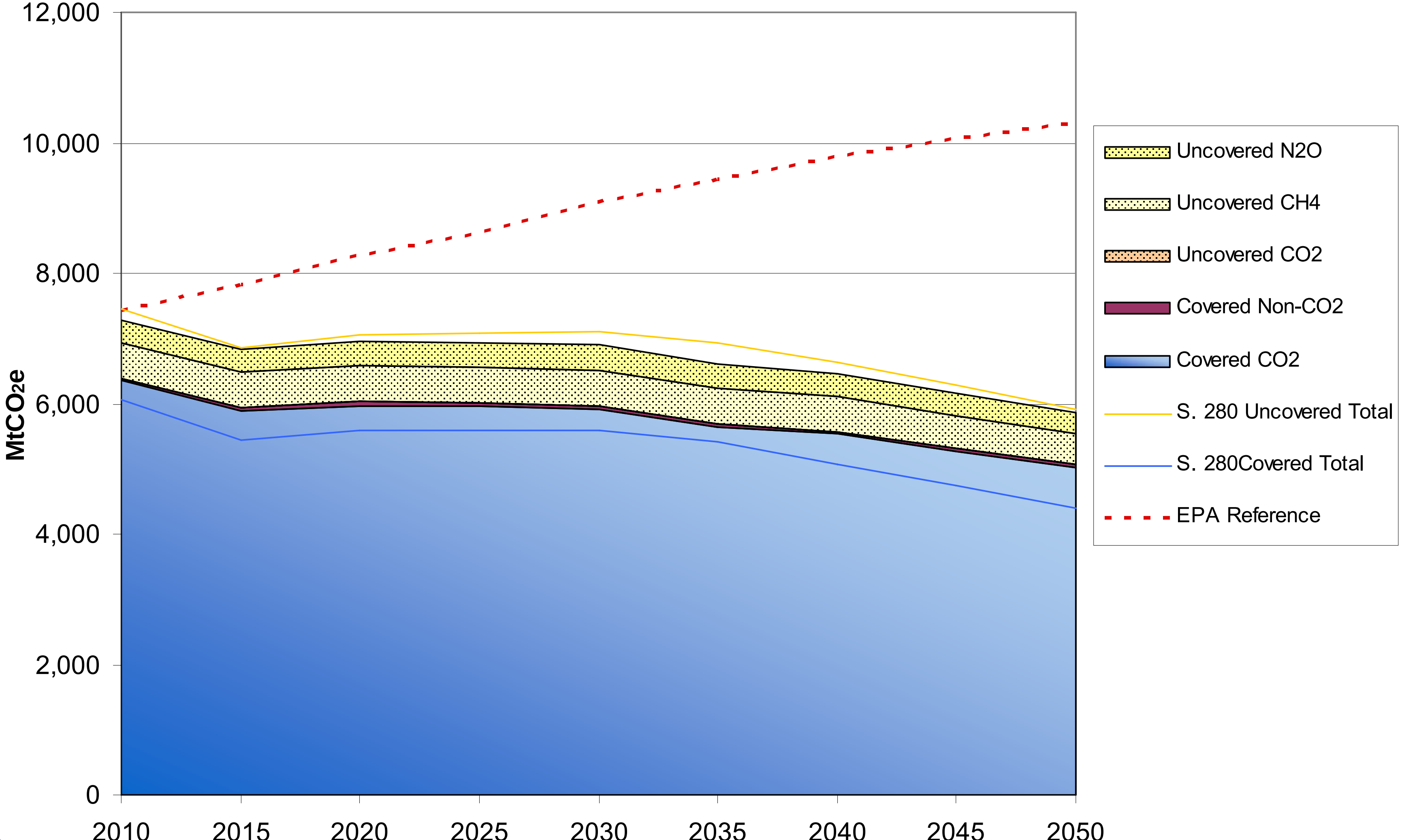


S. 280 Comparison: Scenario 3 – S. 1766, No TAP



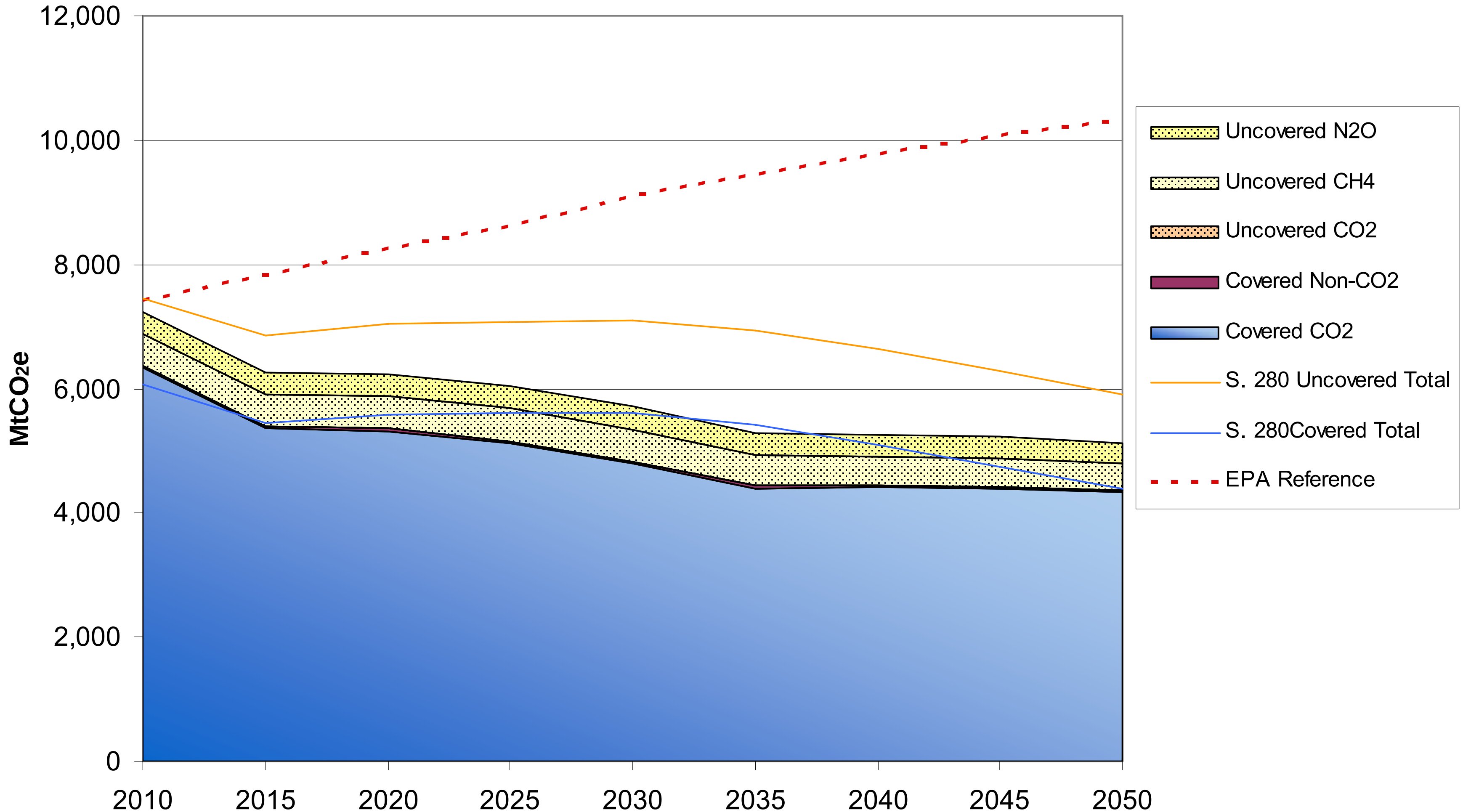
S. 280 Comparison: Scenario 2 - S. 1766

Total U.S. GHG Emissions (ADAGE)



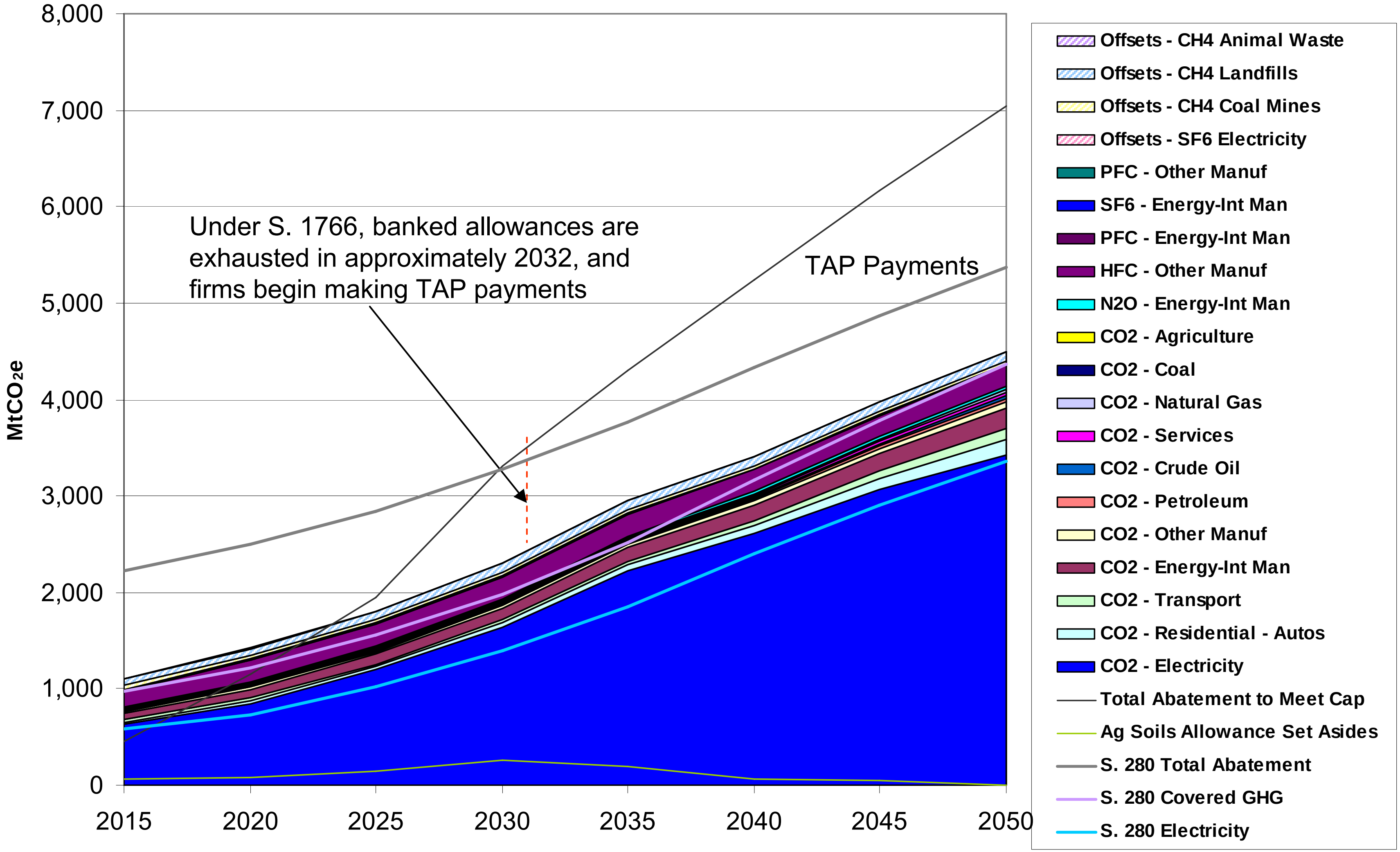
S. 280 Comparison: Scenario 3 - S. 1766, No TAP

Total U.S. GHG Emissions (ADAGE)



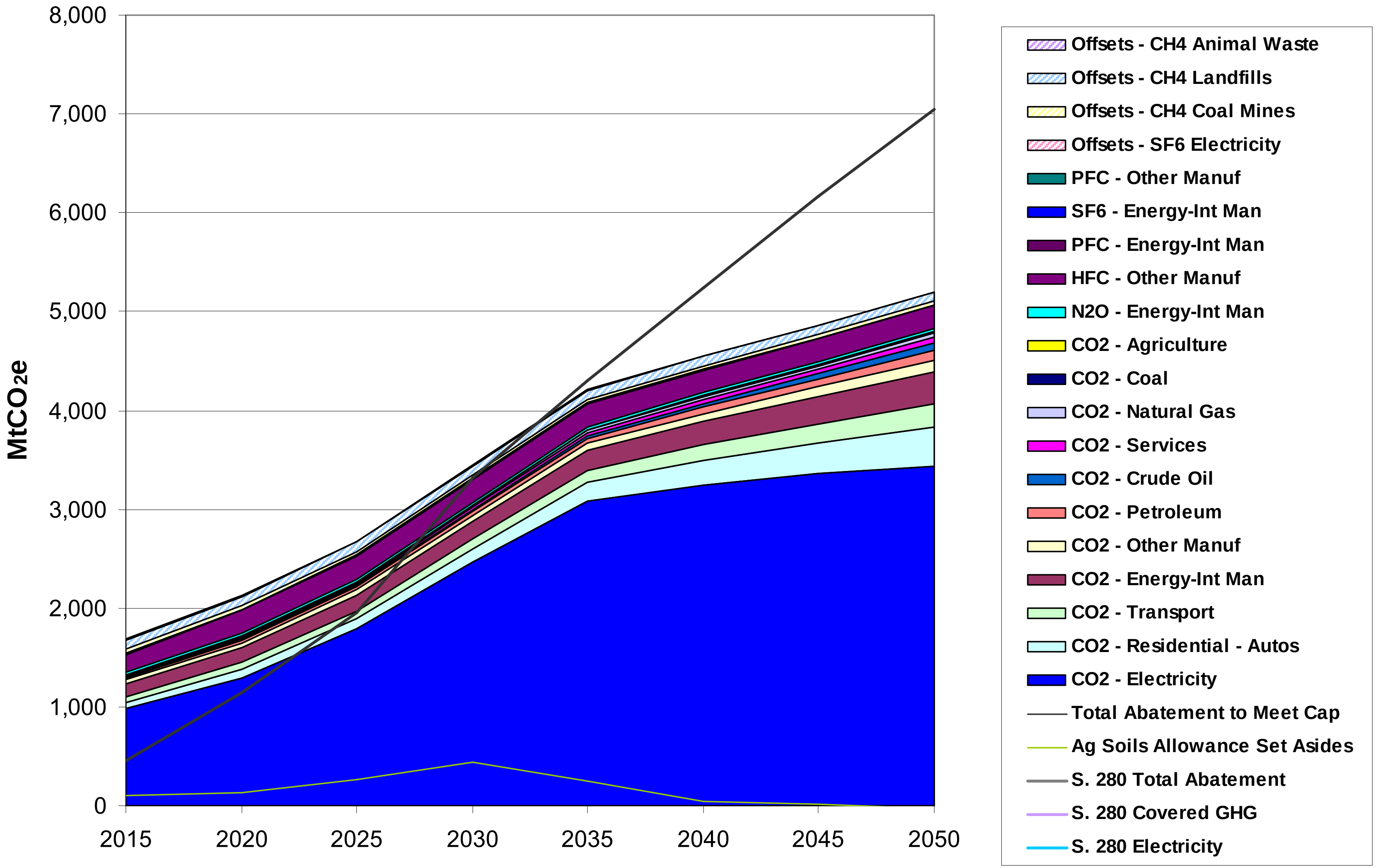
S. 280 Comparison: Scenario 2 - S. 1766

Sources of GHG Abatement (ADAGE)



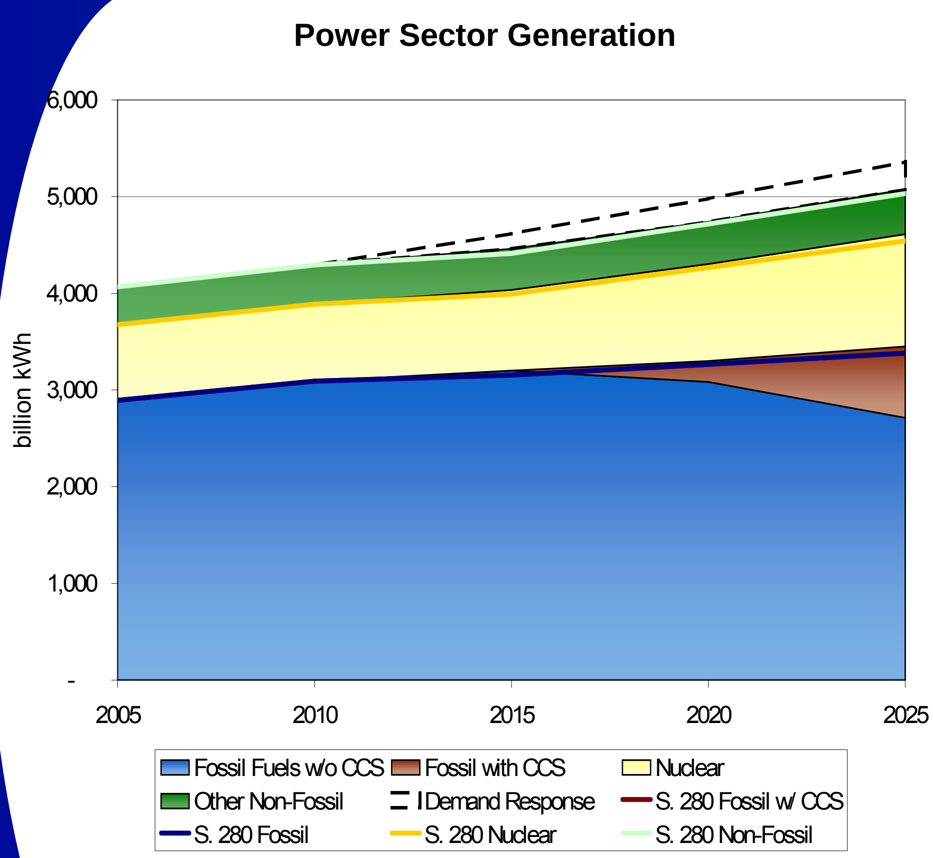
S. 280 Comparison: Scenario 3 - S. 1766, No TAP

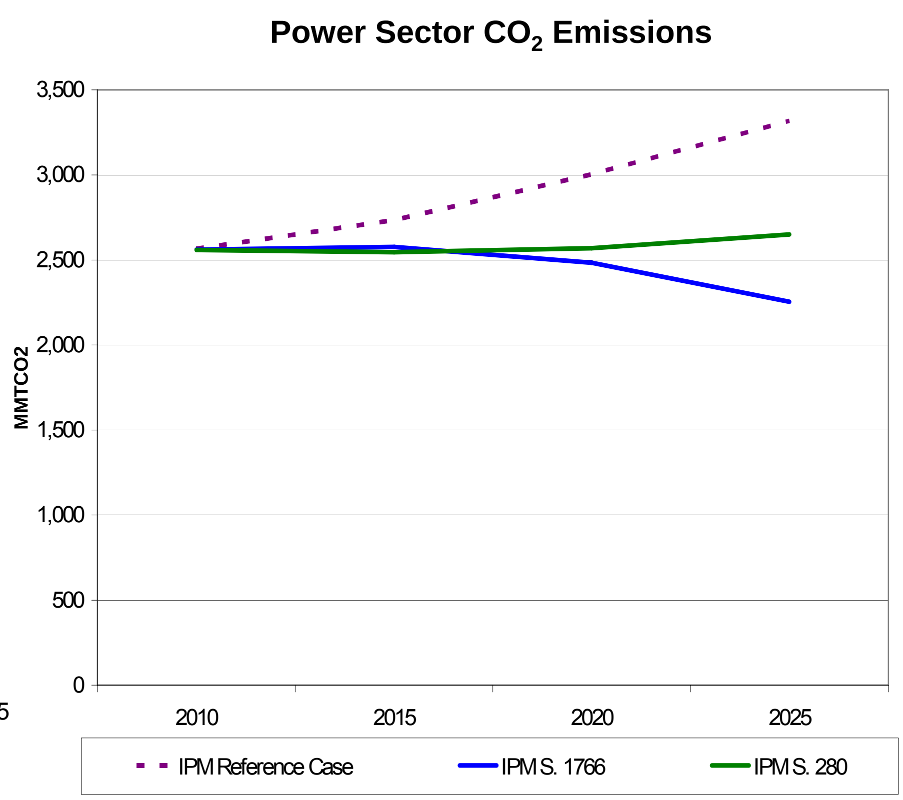
Sources of GHG Abatement (ADAGE)



S. 280 Comparison: Scenario 2 - S. 1766

Electricity Generation and CO_2 Emissions: Near-Term Results of S. 1766 and S. 280 (IPM)

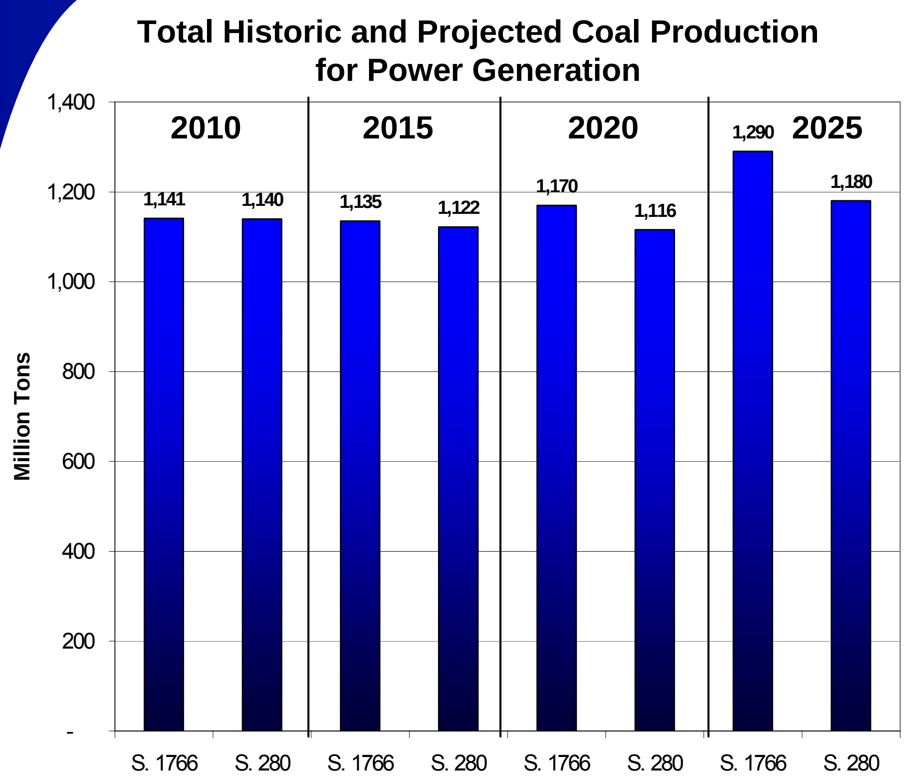


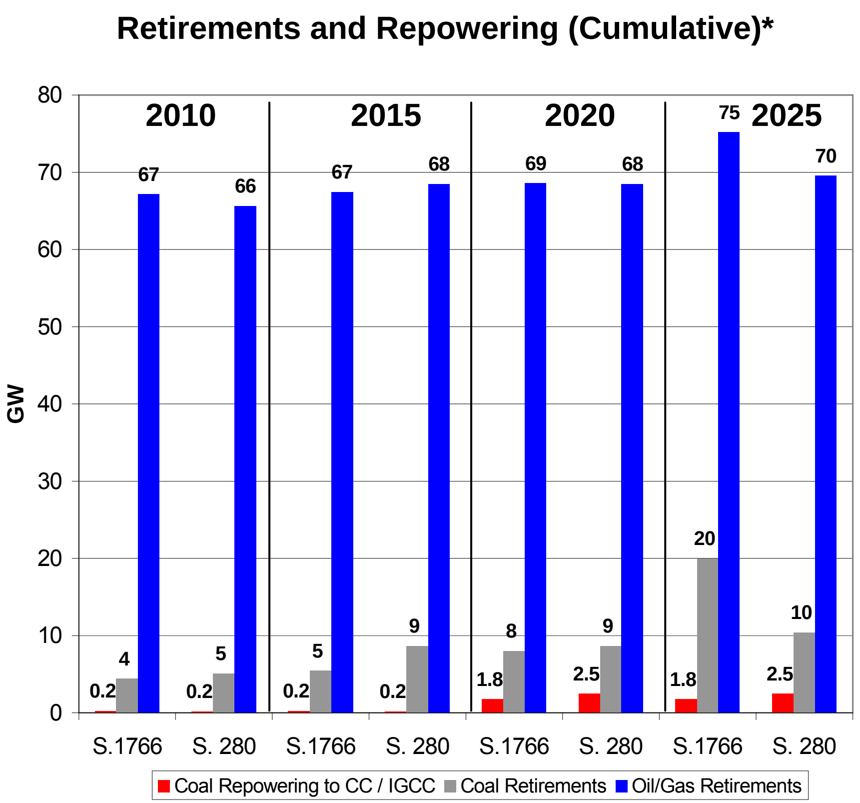


In the near-term, there was no advanced coal with CCS deployed under S. 280 and GHG emissions were higher relative to S. 1766. Additional GHG reductions are largely due to greater/ earlier adv. coal with CCS in S. 1766.

S. 280 Comparison: Scenario 2 - S. 1766

Coal Production and Generation Retirements/Repowerings (IPM)



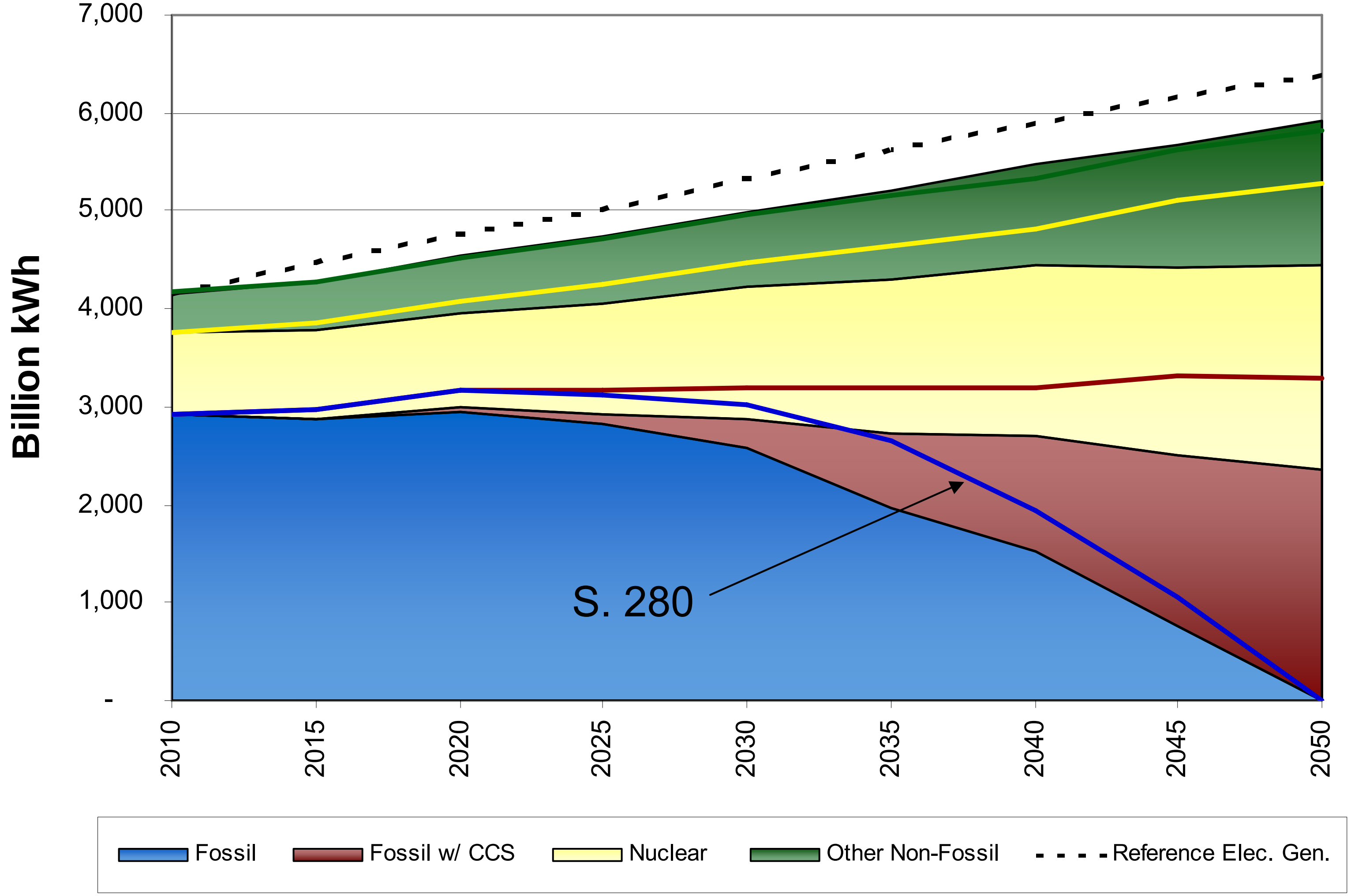


Both coal production for electricity and retirements of fossil generation are higher in S. 1766 mainly as a result of greater/ earlier deployment of adv. coal with CCS.

* Many of the retired coal units are older, less efficient units operating at lower capacity rates.

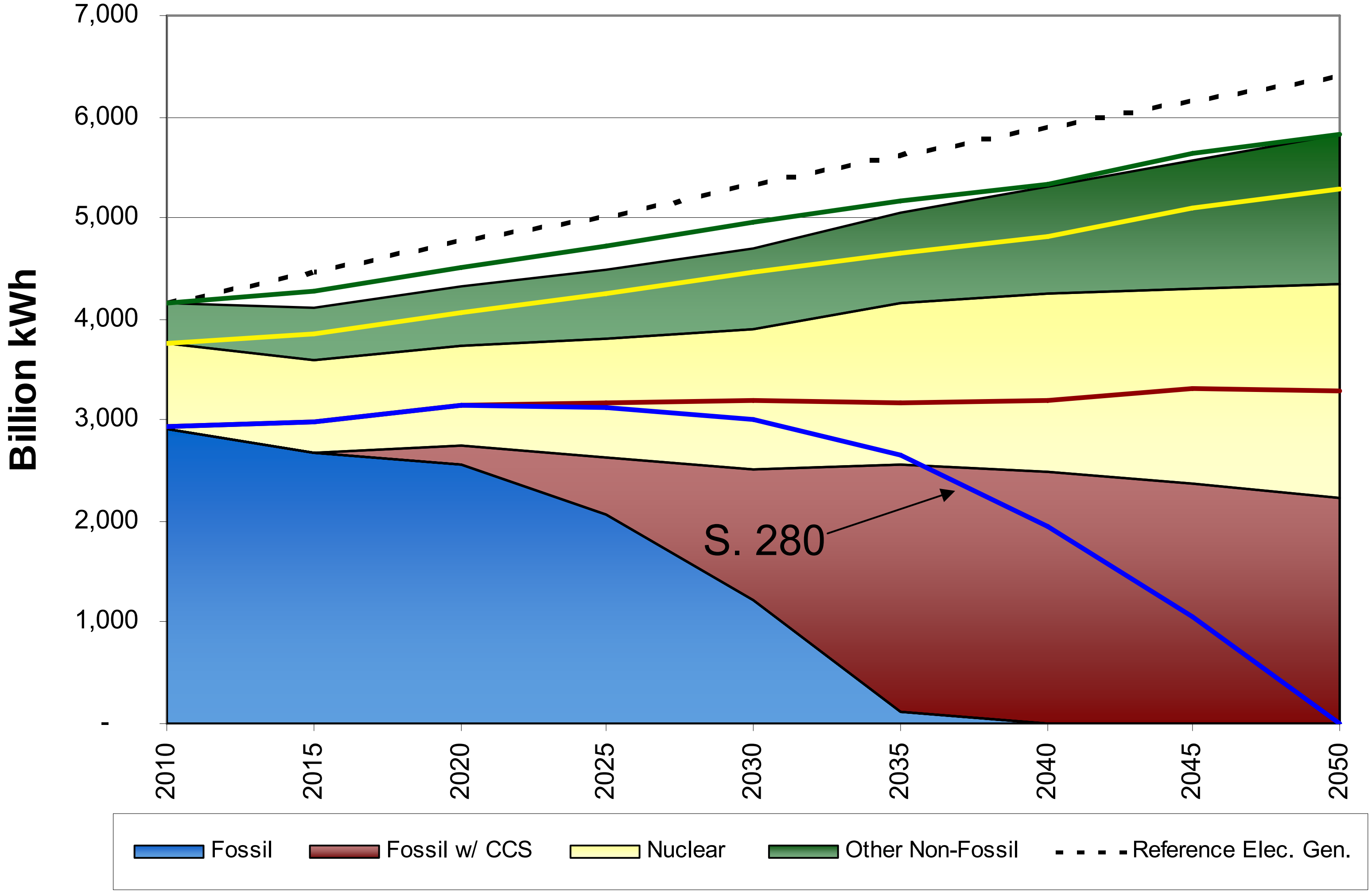
S. 280 Comparison: Scenario 2 - S. 1766

U.S. Electricity Generation, mid-term results (ADAGE)



S. 280 Comparison: Scenario 3 - S. 1766, No TAP

U.S. Electricity Generation, mid-term results (ADAGE)



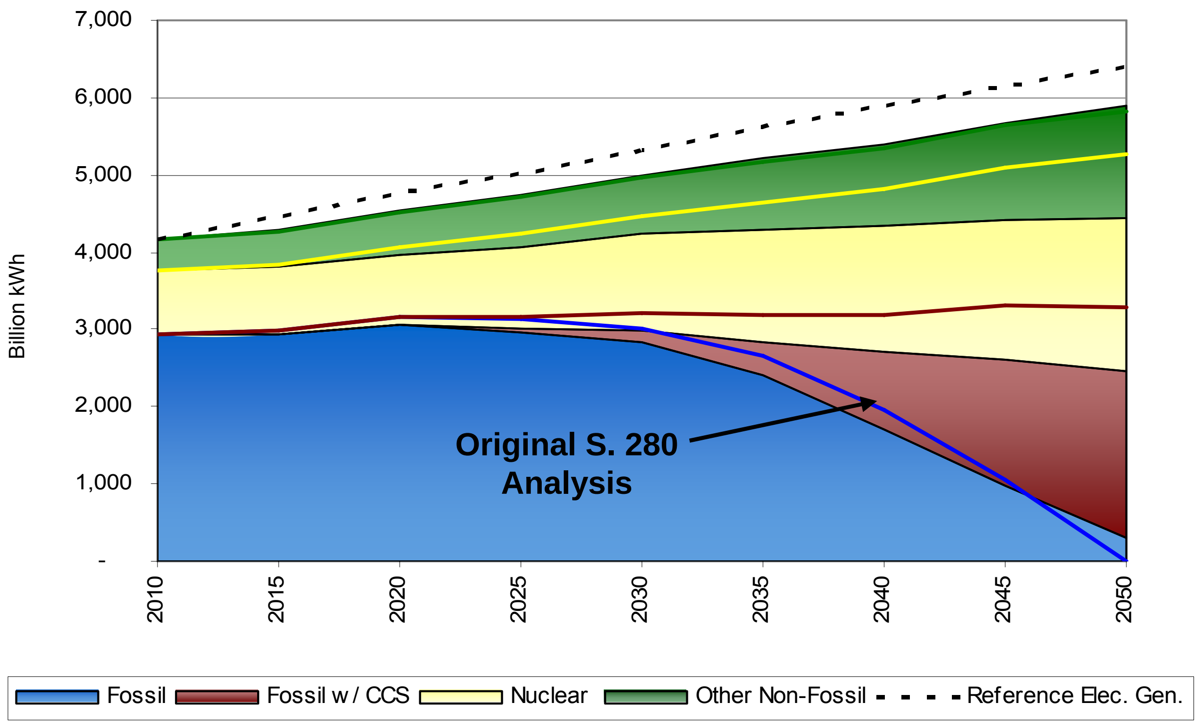
S. 280 Other Non-Fossil Generation Sensitivity

(ADAGE)

- The representation of renewable energy in ADAGE changed between the S. 280 analysis and the S. 1766 analysis.
- For the S. 280 analysis, much of the non-fossil electricity generation in ADAGE was exogenously fixed, so the analysis showed very little increase in renewable energy compared to the reference case.
- For this analysis of S. 1766, ADAGE augmented its representation of other non-fossil generation with the response curves for biomass electricity generation from the FASOM model.
- The following results show the impact of including this updated representation of biomass electricity generation on the ADAGE ‘S. 280 Senate Scenario’ from EPA’s analysis of S. 280.
    - Other non-fossil electricity generation grows by ~250% from 2010 to 2050. In comparison, the original S. 280 analysis showed growth of ~30% over the same time period.
    - With increased renewable electricity generation, less fossil with CCS generation is required.
    - Allowance prices start at ~ $1.8 lower in 2015 than in EPA’s original S. 280 analysis. The allowance price is $23.0 in 2030, and $60.8 /t$CO_2$e in 2050. In comparison, the original S. 280 analysis yielded allowance prices of $26.6 in 2030, and $70.3 /t$CO_2$e in 2050.
    - GDP impacts are slightly smaller (-0.51% in 2030, and -1.06% in 2050). Under the original S. 280 analysis, GDP impacts were -0.55% in 2030, and -1.07% in 2050.

S. 280 Other Non-Fossil Generation Sensitivity

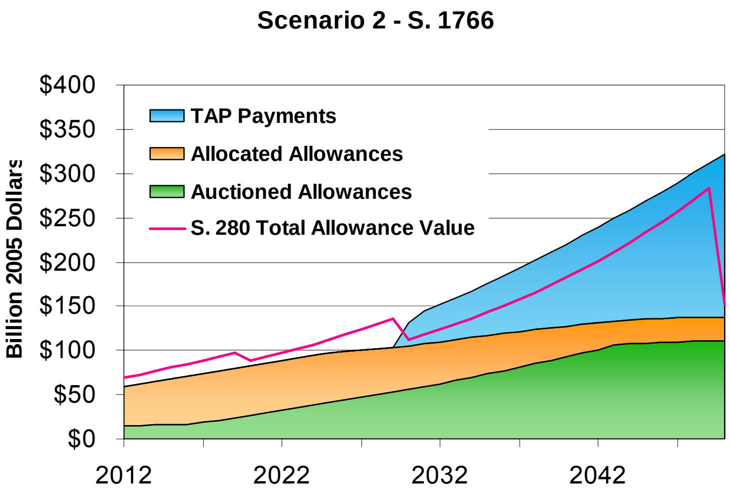
(ADAGE)

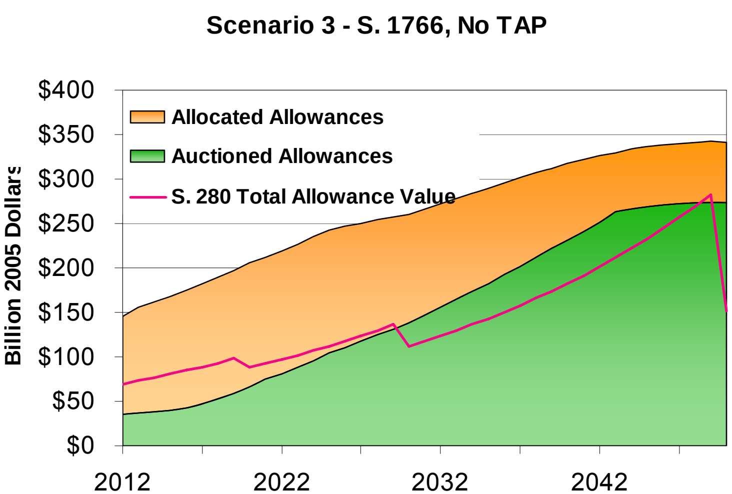


- Increased other non-fossil electricity generation eases up some of the pressure on CCS to deploy rapidly.
- CCS does not fully penetrate by 2050, in contrast to the original S. 280 analysis.

S. 280 Comparison: Scenario 2 – S. 1766 and Scenario 3 – S. 1766, No TAP

Value of Allocated & Auctioned Allowances, and TAP Payments (IGEM)





Value of Allowances (Billion 2005 Dollars)

		2012	2030	2050
S. 1766 Scn. 2	Allocated	$45	$49	$28
	Auctioned	$14	$56	$110
	TAP	$0	$26	$185
S. 1766 Scn. 3	Allocated	$111	$122	$68
	Auctioned	$35	$138	$273
S. 280	Total	$70	$112	$152

- In IGEM we assume that the policy is deficit and revenue neutral, which implies that the market outcomes are invariant to the auction / allocation spilt
  - Private sector revenues from allocated allowances accrue to employee-shareholder households, and the government adjusts taxes lump sum to maintain deficit and spending levels.
  - Allowance auction revenues flow to the U.S. government, and are redistributed to households lump sum to the extent that deficit and spending levels are maintained. If auction revenues were directed to special funds instead of returned directly to households as modeled, the reduction in household annual consumption and GDP would likely be greater. If the auction revenues were instead used to lower distortionary taxes, the costs of the policy would be lower.
- In IPM the auction / allocation split affects market outcomes because regulated electric utilities, which are explicitly modeled, are allowed to pass on the cost of auctioned allowances to consumers, but are not allowed to pass on the cost of allocated allowances.

S. 280 Comparison: Scenario 2 – S. 1766

GDP (Billion 2005$)

	2010	2020	2030	2040	2050	Average Annual Growth 2010-2050
Scenario 1 - Reference						
ADAGE	$14,620	$19,820	$26,438	$33,958	$42,696	2.72%
IGEM	$14,767	$19,898	$26,234	$33,795	$41,468	2.61%
Scenario 2 - S. 1766						
ADAGE	$14,604	$19,742	$26,315	$33,758	$42,295	2.69%
IGEM	$14,716	$19,715	$25,864	$33,103	$40,269	2.55%
Absolute Change						
ADAGE	-$17	-$78	-$124	-$200	-$401	*-0.02 Percentage Points*
IGEM	-$51	-$182	-$370	-$692	-$1,199	*-0.07 Percentage Points*
% Change						
ADAGE	-0.12%	-0.39%	-0.47%	-0.59%	-0.94%	
IGEM	-0.35%	-0.92%	-1.41%	-2.05%	-2.89%	
S. 280 Senate Scenario						
ADAGE	$14,606	$19,749	$26,306	$33,750	$42,266	2.69%
IGEM	$14,678	$19,645	$25,754	$32,937	$40,040	2.54%
Absolute Change						
ADAGE	-$3	-$72	-$146	-$229	-$457	*-0.02 Percentage Points*
IGEM	-$55	-$206	-$419	-$779	-$1,332	*-0.07 Percentage Points*
% Change						
ADAGE	-0.02%	-0.36%	-0.55%	-0.67%	-1.07%	
IGEM	-0.37%	-1.04%	-1.60%	-2.31%	-3.22%	

S. 280 Comparison: Scenario 3 – S. 1766, No TAP

GDP (Billion 2005$)

	2010	2020	2030	2040	2050	Average Annual Growth 2010-2050
Scenario 1 - Reference						
ADAGE	$14,620	$19,820	$26,438	$33,958	$42,696	2.72%
IGEM	$14,767	$19,898	$26,234	$33,795	$41,468	2.61%
Scenario 3 - S. 1766, No TAP						
ADAGE	$14,587	$19,710	$26,219	$33,489	$41,744	2.66%
IGEM	$14,657	$19,512	$25,477	$32,426	$39,200	2.49%
Absolute Change						
ADAGE	-$33	-$110	-$219	-$470	-$952	*-0.05 Percentage Points*
IGEM	-$110	-$386	-$757	-$1,369	-$2,268	*-0.13 Percentage Points*
% Change						
ADAGE	-0.23%	-0.56%	-0.83%	-1.38%	-2.23%	
IGEM	-0.74%	-1.94%	-2.89%	-4.05%	-5.47%	
S. 280 Senate Scenario						
ADAGE	$14,606	$19,749	$26,306	$33,750	$42,266	2.69%
IGEM	$14,678	$19,645	$25,754	$32,937	$40,040	2.54%
Absolute Change						
ADAGE	-$3	-$72	-$146	-$229	-$457	*-0.02 Percentage Points*
IGEM	-$55	-$206	-$419	-$779	-$1,332	*-0.07 Percentage Points*
% Change						
ADAGE	-0.02%	-0.36%	-0.55%	-0.67%	-1.07%	
IGEM	-0.37%	-1.04%	-1.60%	-2.31%	-3.22%	

S. 280 Comparison: Scenario 2 – S. 1766

Consumption (Billion 2005$)

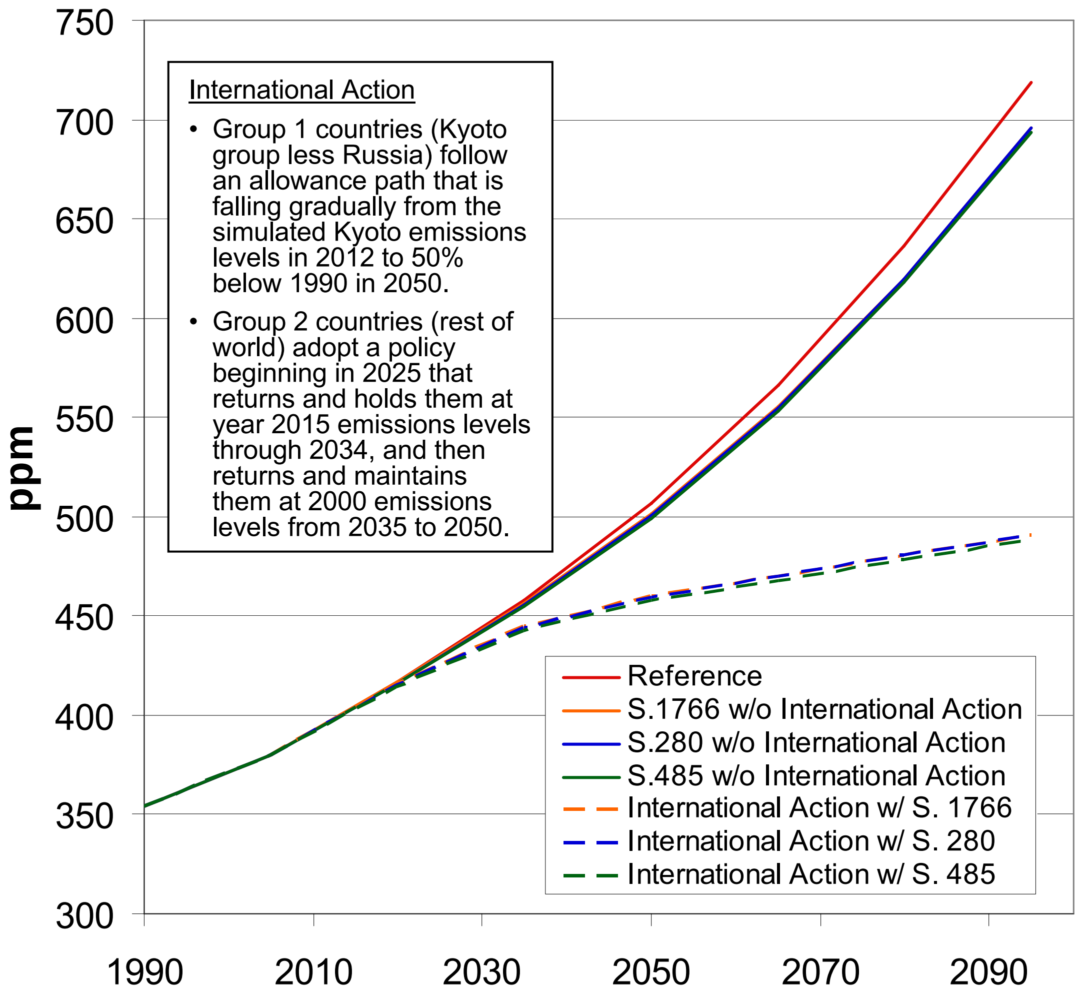
	2010	2020	2030	2040	2050	Average Annual Growth 2010-2050
Scenario 1 - Reference						
ADAGE	$10,783	$14,638	$19,721	$25,350	$31,887	2.75%
IGEM	$9,244	$12,375	$16,269	$20,970	$25,898	2.61%
Scenario 2 - S. 1766						
ADAGE	$10,811	$14,591	$19,651	$25,223	$31,619	2.72%
IGEM	$9,257	$12,351	$16,193	$20,809	$25,605	2.58%
Absolute Change						
ADAGE	$28	-$47	-$70	-$127	-$267	*-0.03 Percentage Points*
IGEM	$13	-$24	-$76	-$161	-$293	*-0.03 Percentage Points*
% Change						
ADAGE	0.26%	-0.32%	-0.36%	-0.50%	-0.84%	
IGEM	-0.35%	-0.92%	-1.41%	-2.05%	-2.89%	
Annual Change per Household (2005$)						
ADAGE	$214	-$333	-$459	-$785	-$1,590	
IGEM	$111	-$176	-$512	-$992	-$1,660	
S. 280 Senate Scenario						
ADAGE	$10,834	$14,630	$19,647	$25,174	$31,571	2.71%
IGEM	$9,236	$12,315	$16,138	$20,725	$25,486	2.57%
Absolute Change						
ADAGE	$43	-$14	-$75	-$172	-$306	*-0.04 Percentage Points*
IGEM	$14	-$31	-$93	-$197	-$351	*-0.04 Percentage Points*
% Change						
ADAGE	0.40%	-0.10%	-0.38%	-0.68%	-0.96%	
IGEM	0.15%	-0.25%	-0.57%	-0.94%	-1.36%	
Annual Change per Household (2005$)						
ADAGE	$331	-$100	-$489	-$1,067	-$1,822	
IGEM	$115	-$230	-$625	-$1,211	-$1,990	

S. 280 Comparison: Scenario 3 – S. 1766, No TAP

Consumption (Billion 2005$)

	2010	2020	2030	2040	2050	Average Annual Growth 2010-2050
Scenario 1 - Reference						
ADAGE	$10,783	$14,638	$19,721	$25,350	$31,887	2.75%
IGEM	$9,244	$12,375	$16,269	$20,970	$25,898	2.61%
Scenario 3 - S. 1766, No TAP						
ADAGE	$10,847	$14,562	$19,537	$25,015	$31,281	2.68%
IGEM	$9,273	$12,315	$16,095	$20,609	$25,255	2.54%
Absolute Change						
ADAGE	$64	-$75	-$184	-$335	-$606	*-0.06 Percentage Points*
IGEM	$29	-$60	-$173	-$361	-$643	*-0.07 Percentage Points*
% Change						
ADAGE	0.60%	-0.52%	-0.93%	-1.32%	-1.90%	
IGEM	0.31%	-0.48%	-1.07%	-1.72%	-2.48%	
Annual Change per Household (2005$)						
ADAGE	$495	-$533	-$1,199	-$2,074	-$3,604	
IGEM	$238	-$443	-$1,171	-$2,222	-$3,640	
S. 280 Senate Scenario						
ADAGE	$10,834	$14,630	$19,647	$25,174	$31,571	2.71%
IGEM	$9,236	$12,315	$16,138	$20,725	$25,486	2.57%
Absolute Change						
ADAGE	$43	-$14	-$75	-$172	-$306	*-0.04 Percentage Points*
IGEM	$14	-$31	-$93	-$197	-$351	*-0.04 Percentage Points*
% Change						
ADAGE	0.40%	-0.10%	-0.38%	-0.68%	-0.96%	
IGEM	0.15%	-0.25%	-0.57%	-0.94%	-1.36%	
Annual Change per Household (2005$)						
ADAGE	$331	-$100	-$489	-$1,067	-$1,822	
IGEM	$115	-$230	-$625	-$1,211	-$1,990	

Global CO_2 Concentrations (MiniCAM)



* Reference scenario emissions come from the Climate Change Science Program (CCSP) Synthesis and Assessment Product 2.1a MiniCAM reference case.

In the reference scenario,* Global CO2 concentrations rise from historical levels of 354 parts per million (ppm) in 1990 to 718 ppm in 2095.

Effect of S. 1766, S. 280, and S. 485

Assuming no one in the international community changes their current policies, the global CO_2 concentrations in 2095 are estimated as follows:

- If the U.S. adopts either S. 1766 or S.280, CO_2 concentrations in 2095 are estimated to be 23 ppm lower than the reference scenario, or 696 ppm.
- If the U.S. adopts S. 485, CO_2 concentrations in 2095 are estimated to be 25 ppm lower than the reference scenario, or 694 ppm.

Effect of International Action plus Senate Bills

Assuming the international community takes the actions described in the diagram to the left, the global CO2 concentrations in 2095 are estimated as follows:

- If the international community takes action and the U.S. adopts S. 1766 or S. 280, CO2 concentrations are reduced from 718 ppm to 491 ppm in 2095, to which the U.S. contributes a 23 ppm reduction.
- If the international community takes action and the U.S. adopts S. 485, CO2 concentrations are reduced from 718 ppm to 489 ppm in 2095, to which the U.S. contributes a 25 ppm reduction.
- While CO_2 concentrations are significantly reduced in the scenarios with international action, they are not on a stabilization trajectory.

The work presented here does not include an assessment of the costs or economic impacts associated with achieving the specified reductions. EPA is currently producing an analysis of the economic impacts of S. 1766 that is due to the Senators' offices by November 15, 2007. EPA's economic analysis of S. 280 is available at: www.epa.gov/climatechange/economicanalyses.html

Appendix 6: Model Descriptions

Intertemporal General Equilibrium Model (IGEM)

- IGEM is a model of the U.S. economy with an emphasis on the energy and environmental aspects.
- It is a dynamic model, which depicts growth of the economy due to capital accumulation, technical change and population change.
- It is a detailed multi-sector model covering 35 industries.
- It also depicts changes in consumption patterns due to demographic changes, price and income effects.
- The model is designed to simulate the effects of policy changes, external shocks and demographic changes on the prices, production and consumption of energy, and the emissions of pollutants.
- The main driver of economic growth in this model is capital accumulation and technological change. It also includes official projections of the population, giving us activity levels in both level and per-capita terms.
- Capital accumulation arises from savings of a household that is modeled as an economic actor with "perfect foresight."

- This model is implemented econometrically which means that the parameters governing the behavior of producers and consumers are statistically estimated over a time series dataset that is constructed specifically for this purpose.
- This is in contrast to many other multi-sector models that are calibrated to the economy of one particular year.
- These data are based on a system of national accounts developed by Jorgenson (1980) that integrates the capital accounts with the National Income Accounts.
- These capital accounts include an equation linking the price of investment goods to the stream of future rental flows, a link that is essential to modeling the dynamics of growth.

- The model is developed and run by Dale Jorgenson Associates for EPA.
- Model Homepage: http://post.economics.harvard.edu/faculty/jorgenson/papers/papers.html

Applied Dynamic Analysis of the Global Economy (ADAGE)

- ADAGE is a dynamic computable general equilibrium (CGE) model capable of examining many types of economic, energy, environmental, climate-change mitigation, and trade policies at the international, national, U.S. regional, and U.S. state levels.
- To investigate policy effects, the CGE model combines a consistent theoretical structure with economic data covering all interactions among businesses and households.
- A classical Arrow-Debreu general equilibrium framework is used to describe economic behaviors of these agents.

- ADAGE has three distinct modules: International, U.S. Regional, and Single Country.
- Each module relies on different data sources and has a different geographic scope, but all have the same theoretical structure.
- This internally consistent, integrated framework allows its components to use relevant policy findings from other modules with broader geographic coverage, thus obtaining detailed regional and state-level results that incorporate international impacts of policies.
- Economic data in ADAGE come from the GTAP and IMPLAN databases, and energy data and various growth forecasts come from the International Energy Agency and Energy Information Administration of the U.S. Department of Energy.
- Emissions estimates and associated abatement costs for six types of greenhouse gases (GHGs) are also included in the model.

- The model is developed and run by RTI International for EPA.
- Model Homepage: http://www.rti.org/adage

Non-CO_2 GHG Models

- EPA develops and houses projections and economic analyses of emission abatement through the use of extensive bottom-up, spreadsheet models.
- These are engineering–economic models capturing the relevant cost and performance data on over 15 sectors emitting the non-CO_2 GHGs.
- For the emissions inventory and projections, all anthropogenic sources are covered. For mitigation of methane, the sources evaluated include coal mining, natural gas systems, oil production, and solid waste management.
- For mitigation of HFC, PFC, and SF6, the sources evaluated include over 12 industrial sectors.
- For mitigation of nitrous oxide, sources evaluated include adipic and nitric acid production.
- Only currently available or close-to-commercial technologies are evaluated.
- The estimated reductions and costs are assembled into marginal abatement curves (MACs).
- MACs are straightforward, informative tools in policy analyses for evaluating economic impacts of GHG mitigation. A MAC illustrates the amount of reductions possible at various values for a unit reduction of GHG emissions and is derived by rank ordering individual opportunities by cost per unit of emission reduction. Any point along a MAC represents the marginal cost of abating an additional amount of a GHG.
- The total cost of meeting an absolute emission reduction target can be estimated by taking the integral of a MAC curve from the origin to the target.
- Global mitigation estimates are available aggregated into nine major regions of the world including the U.S. and are reported for the years 2010, 20015 and 2020.
- The data used in the report are from *Global Mitigation of Non-CO_2 Greenhouse Gases* (EPA Report 430-R-06-005). www.epa.gov/nonco2/econ-inv/international.html

Forest and Agriculture Sector Optimization Model-GHG

- FASOM-GHG simulates land management and land allocation decisions over time to competing activities in both the forest and agricultural sectors. In doing this, it simulates the resultant consequences for the commodity markets supplied by these lands and, importantly for policy purposes, the net greenhouse gas (GHG) emissions.
- The model was developed to evaluate the welfare and market impacts of public policies and environmental changes affecting agriculture and forestry. To date, FASOMGHG and its predecessor models FASOM and ASM have been used to examine the effects of GHG mitigation policy, climate change impacts, public timber harvest policy, federal farm program policy, biofuel prospects, and pulpwood production by agriculture among other policies and environmental changes.
- FASOMGHG is a multiperiod, intertemporal, price-endogenous, mathematical programming model depicting land transfers and other resource allocations between and within the agricultural and forest sectors in the US. The model solution portrays simultaneous market equilibrium over an extended time, typically 70 to 100 years on a ten year time step basis.
- The results from FASOMGHG yield a dynamic simulation of prices, production, management, consumption, GHG effects, and other environmental and economic indicators within these two sectors, under the scenario depicted in the model data.
- The principal model developer is Dr. Bruce McCarl, Department of Agricultural Economics, Texas A&M University.
- The data used in the report are from *Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture* (EPA Report 430-R-05-006). http://www.epa.gov/sequestration/greenhouse_gas.html.
- Model Homepage: http://agecon2.tamu.edu/people.faculty/mccarl-bruce/FASOM.html

Global Timber Model (GTM)

- GTM is an economic model capable of examining global forestry land-use, management, and trade responses to policies. In responding to a policy, the model captures afforestation, forest management, and avoided deforestation behavior.
- The model estimates harvests in industrial forests and inaccessible forests, timberland management intensity, and plantation establishment, all important components of both future timber supply and carbon flux. The model also captures global market interactions.
- The model is a partial equilibrium intertemporally optimizing model that maximizes welfare in timber markets over time across approximately 250 world timber supply regions by managing forest stand ages, compositions, and acreage given production and land rental costs. The model equates supply and demand in each period, and predicts supply responses to current and future prices. The 250 supply regions are delineated by ecosystem and timber management classes, as well as geo-political regional boundaries. The model runs on 10-year time steps.
- The model has been used to explore a variety of climate change mitigation policies, including carbon prices, stabilization, and optimal mitigation policies.
- The principal model developer is Brent Sohngen, Department of Agricultural, Environmental, and Development Economics, Ohio State University. Other key developers and collaborators over the life of the model include Robert Mendelsohn, Roger Sedjo, and Kenneth Lyon. For this analysis, the model was run by Dr. Sohngen for EPA.
- Website for GTM papers and input datasets: http://aede.osu.edu/people/sohngen.1/forests/ccforest.htm#gfmod

Mini-Climate Assessment Model (MiniCAM)

- The MiniCAM is a highly aggregated integrated assessment model that focuses on the world's energy and agriculture systems, atmospheric concentrations of greenhouse gases (CO_2 and non-CO_2) and sulfur dioxide, and consequences regarding climate change and sea level rise.
- It has been updated many times since the early eighties to include additional technology options. MiniCAM is capable of incorporating carbon taxes and carbon constraints in conjunction with the numerous technology options including carbon capture and sequestration.
- The model has been exercised extensively to explore how the technology gap can be filled between a business-as-usual emissions future and an atmospheric stabilization scenario.
- The MiniCAM model is designed to assess various climate change policies and technology strategies for the globe over long time scales. It is configured as a partial equilibrium model that balances supply and demand for commodities such as oil, gas, coal, biomass and agricultural products.
- The model runs in 15-year time steps from 1990 to 2095 and includes 14 geographic regions.
- The model is developed and run at the Joint Global Change Research Institute, University of Maryland. Model Homepage: http://www.globalchange.umd.edu

The Integrated Planning Model (IPM)

- EPA uses the Integrated Planning Model (IPM) to analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia.
- IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector.
- The model provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints.
- IPM can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon dioxide (CO_2), and mercury (Hg) from the electric power sector.
- The IPM was a key analytical tool in developing the Clean Air Interstate Regulation (CAIR) and the Clean Air Mercury Rule (CAMR).
- IPM provides both a broad and detailed analysis of control options for major emissions from the power sector, such as power generation adjustments, pollution control actions, air emissions changes (national, regional/state, and local), major fuel use changes, and economic impacts (costs, wholesale electricity prices, closures, allowance values, etc.).
- The model was developed by ICF Resources and is applied by EPA for its Base Case. IPM® is a registered trademark of ICF Resources, Inc.
- EPA's application of IPM Homepage: http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html

National Energy Modeling System (NEMS)

- When Senators Lieberman and McCain requested that EPA analyze S. 280, they sent a similar request to the Energy Information Administration (EIA).
- EIA is using NEMS for its analysis of S. 280.
- NEMS is also used to produce the Annual Energy Outlook (AEO).
- NEMS represents domestic energy markets by explicitly representing the economic decision making involved in the production, conversion, and consumption of energy products.
- Where possible, NEMS includes explicit representation of energy technologies and their characteristics.
- NEMS is organized and implemented as a modular system.
  - For each fuel and consuming sector, NEMS balances the energy supply and demand, accounting for the economic competition between the various energy fuels and sources.
  - The modules represent each of the fuel supply markets, conversion sectors, and end-use consumption sectors of the energy system.
  - NEMS also includes a macroeconomic and an international module.
  - For purposes of S.280 analysis, NEMS is augmented with a representation of greenhouse gas emissions outside of the energy sector and uses marginal abatement curves to represent opportunities to reduce them.
- NEMS includes regional detail (nine Census divisions).
- NEMS runs in annual time steps through 2030.

Differences between NEMS and IGEM / ADAGE

- Analysis Time Frame
  - ADAGE and IGEM report through 2050
  - NEMS reports through 2030
- Technology Detail
  - ADAGE and IGEM are top-down models with limited technology detail
  - NEMS is a bottom-up model with extensive technology detail
- Macroeconomic Effects
  - NEMS Macroeconomic Activity Module is based on the Global Insight Model of the U.S. Economy, which is a macroeconomic forecasting model.
    - Based on estimated relationships at an aggregate level, using adaptive rather than rational expectations.
    - Forecasts effects at the aggregate level, such as how GDP and unemployment, are affected by changes in inflation or fiscal and monetary policies.
    - These types of models can capture short- and medium-term disequilibrium adjustments in response to exogenous shocks. They can address short and medium-term transition costs of energy policies as the economy transitions to a long-run growth path. They have more detailed government sectors and a well-defined set of fiscal policies. In addition, they can incorporate accommodating monetary policies.
  - IGEM and ADAGE are Computable General Equilibrium models
    - Structural models based on microeconomic foundations.
    - They build up their representation of the whole economy through the interactions of multiple agents (e.g. households and firms), whose decisions are based upon optimization.
    - These models are best suited for capturing long-run equilibrium responses, and unique characteristics of specific sectors of the economy.

Appendix 7: Request Letter from Senators Bingaman and Specter

Request Letter from Senators Bingaman and Specter

United States Senate
WASHINGTON, DC 20510

July 26, 2007

The Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Ave. NW
Washington, DC 20460

Dear Administrator Johnson:

We are writing to request that EPA estimate the economic impacts, focusing especially on near-term impacts (e.g., 2012-2030), of the "Low Carbon Economy Act" of 2007 (S.1766), which we introduced on July 11th. We would like EPA to analyze our bill under two sets of assumptions: (1) under EPA's base assumptions used for its analysis of the "Climate Stewardship and Innovation Act" of 2007 and (2) under a case using high-technology assumptions. We feel that the latter case better reflects the complementary measures that we see as necessary and beneficial to reduce greenhouse gas emissions and reflects the substantial funding that our program provides for the development and deployment of advanced energy technologies, so we ask that you use this as the policy case from which to base any sensitivity analyses. In both cases, please assume that the 2050 target is 60 percent below 2006 emissions levels.

We believe EPA's analysis of the "Low Carbon Economy Act" would prove useful to us and other members of the Senate as we craft measures to combat global climate change. We anticipate that the Senate will vote on climate change legislation this Fall, and it is imperative that we have economic impact assessments by October 1st of this year.

In addition, we request that EPA prepare two charts on greenhouse gas concentrations. First, we ask for a chart showing each major-emitting nation's historic contribution to greenhouse gas concentrations. Second, we would like a chart showing the effects of the emission targets of three climate bills—Sens. Lieberman and McCain's "Climate Stewardship and Innovation Act" of 2007, Sens. Kerry and Snowe's "Global Warming Reduction Act" of 2007, and our "Low Carbon Economy Act" of 2007—on global greenhouse gas concentrations, projected to 2050, assuming that developing countries do not reduce their emissions; and the "Low Carbon Economy Act" of 2007 assuming developing countries begin to reduce absolute emissions starting in 2020 and reach 2006 emission levels by 2050. We request that these charts be provided by late-August in order to maximize their usefulness.

Given the tight timeline, we ask that EPA begin this process by meeting with our staff as soon as possible to discuss the parameters, methods, and duration of the analysis. Please call Jonathan Black with the Senate Committee on Energy and Natural Resources at (202)224-6722 or Tom Dower with Senator Specter at (202)224-9027.

Thank you for your assistance with this analysis.

Sincerely,

Jeff Bingaman

Arlen Specter