Appendix D. EPA Memorandum on Offsets

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF AIR AND RADIATION
OFFICE OF ATMOSPHERIC PROGRAMS
CLIMATE CHANGE DIVISION

MEMO

TO: John Conti, EIA, Andy Kydes, EIA, and Dan Skelly, EIA

FROM: Steven Rose, Shaun Ragnauth, Jules Siedenburg, Christa Clapp, Allen Fawcett

CC: Dina Kruger, Francisco de la Chesnaye, Reid Harvey

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SUBJECT: EPA S.280 mitigation cost schedules for capped sectors and domestic and international offsets

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Purpose

EIA has requested EPA's greenhouse gas emissions projections and mitigation cost schedules for: (a) domestic and international non-CO_2 greenhouse gases (GHGs), (b) domestic and international terrestrial carbon sinks, (c) domestic biomass fuel substitutes for fossil fuel use, and (d) international energy-related CO_2. The emissions projections and mitigation cost schedules are included with this memorandum, as well as estimated international demands for offsets. Below we provide an overview of EPA's methods for producing the mitigation cost schedules and international offsets demand. The memo consists of a brief background discussion of relevant portions of the S.280 bill, followed by an overview of EPA's methods, including mitigation cost schedule categories and data sources.

Background

Section 121 of S.280 requires GHG emissions allowances for emissions from "covered entities." Sections 104 and 144 provide the EPA Administrator, in coordination with the Secretary, the Secretary of Energy, and the Secretary of Agriculture, discretion in establishing CO_2 and non-CO_2 GHG emission reduction and carbon sequestration standards for domestic reductions by covered entities and domestic and international reductions as mitigation activities that provide additional allowances to offset covered entity emissions. Section 144 lists four offset alternatives for helping to meet the domestic cap:

1. Tradable allowances from another nation's market in greenhouse gas emissions

2. Net increases in sequestration (which by Section 3 of S.280 “sequestration” includes terrestrial sequestration while also allowing for inclusion of geologic sequestration)
3. Emissions reductions by “non-covered entities” (in covered and non-covered sectors)
4. Developing country greenhouse gas emissions reduction projects (details in Section 145)

As a result of these provisions, EPA has evaluated the domestic and international non-energy CO_2 and non-CO_2 emissions and sequestration mitigation options and defined their potential eligibility for future capped (i.e., covered) and offset allowance programs. The next section summarizes EPA’s methods for and results from defining eligibility for the following mitigation categories:

(a) Domestic non-CO_2 GHG emissions reductions – capped and offset
(b) Domestic biomass fuel substitutes (liquid and solid) for fossil fuel use – capped
(c) International non-CO_2 GHG emissions reductions – offset
(d) Domestic and international increases in terrestrial carbon sinks (soil and plant carbon stocks) – offset
(e) International energy-related CO_2 mitigation – offset

<u>Methodology Overview</u>

EPA’s March 6, 2007 memo to EIA (“Emissions that Fall under the Cap under S.280”) identified U.S. emissions from “covered sectors,” “covered entities,” and “non-covered entities” as defined in S.280. The memo also described EPA’s recommendation for adjusting the 2012 6,130 $MMTCO_2e$ cap, based on the allocation of emissions sources into economic sectors in 2004. We have applied the information in EPA’s March 6th memo to EPA’s economy-wide domestic modeling structure and designated U.S. sectors as either capped sectors or non-capped sectors, where sectors designated as capped are, as a whole, subject to the S.280 emissions caps over time, and sectors designated as non-capped can provide offset emissions allowances. Overall, EPA is designating emissions sources associated with electricity generation, transportation, and industry (as defined in EPA’s March 6 memo) as capped, and all other sources as non-capped.

We have applied the capped/non-capped sector designations to EPA’s domestic mitigation cost modeling for non-CO_2 GHGs, terrestrial sinks, and biofuel substitutes. Per Section 144, we have characterized all international CO_2 and non-CO_2 GHG mitigation options as offset activities. We, therefore, generate four different types of mitigation cost schedules:

1. Domestic capped
2. Domestic offsets
3. International offsets – Group 1 countries
4. International offsets – Group 2 countries

The international country groupings (Group 1 and Group 2) and related time periods are discussed further below.

As noted in the Background section, S.280 gives the EPA Administrator, in consultation with others, discretion to establish emission reduction and offset standards. Therefore, EPA has evaluated each individual domestic and international mitigation option to determine potential eligibility and feasibility over time for a future mitigation program. The mitigation cost schedules therefore represent the costs associated with the "eligible" mitigation options. This detailed vetting of individual options, based on EPA's substantial emissions inventory and mitigation program expertise, substitutes and improves upon previous post-processing adjustments to the mitigation cost schedules of 50 percent domestically and 90 and 75 percent internationally (USEPA, 2005a; USEPA, 2001).[36] Exceptions are methane emissions from the natural gas and oil sectors, and international energy-related CO_2 emissions.[37]

The following four steps were taken to generate the capped and offset schedules for domestic non-CO_2 emissions, biofuels, and terrestrial sinks:

1. For each source type, emissions were divided into capped and non-capped emissions
2. For each mitigation option, a determination was made as to whether the option applied to a capped or non-capped emissions source
3. For each mitigation option, a determination was made regarding potential eligibility for a future mitigation program. Eligibility was not determined for methane from the natural gas and oil sectors (see footnote 2). In this case, uniform adjustments were applied.
4. Capped and offset mitigation cost schedules were constructed with the eligible or adjusted options. Rising carbon price pathways were run for agriculture, forestry, and biofuels mitigation (discussed below).

The following three steps were taken to generate the international non-CO_2 and terrestrial sinks schedules:

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[36] Adjustments were made following the methodology developed in cooperation with the White House Council of Economic Advisors for the use of mitigation schedules to analyze an offsets program (USEPA, 2001 and USEPA, 2005a). The adjustments were meant to take into account the difficulties in measuring, monitoring, and verifying offset reductions in countries without a market-based greenhouse gas emissions policy, as well as the lack of a clear market signal that the allowance price in the model run assumes. EPA's detailed vetting of mitigation technologies for this S.280 analysis considered these and other issues in determining the eligibility of each mitigation option.

[37] For methane from the gas and oil sectors, we were not able to vet the extensive list of complex mitigation technologies given time constraints. Therefore, we applied a 50 percent reduction both domestically and for international regions assumed to have a market-based emissions policy. We applied a 75 percent reduction internationally for the periods before a market-based emissions policy is assumed to be in place. For international energy-related CO_2 emissions, the full abatement potential is available as a potential offset when a region has a market based greenhouse gas policy in place. When a region does not have a market-based emissions policy in place, the abatement potential is reduced by 90 or 75 percent, depending on the year.

1. The timing of regional participation in carbon market systems was designated.
2. For each mitigation option a determination was made regarding potential eligibility for a future U.S. mitigation program. Eligibility was not determined for methane from the natural gas and oil sectors, so uniform adjustments were applied.
3. Offset mitigation cost schedules were constructed with eligible or adjusted options for the two country groupings. Rising carbon price pathways were run for forestry and CO_2 emissions mitigation (discussed below).

International energy-related CO_2 abatement schedules were developed using the MiniCAM model. Specifically, the model was run using the reference case developed for the U.S. Climate Change Science Program Synthesis and Assessment Product 2.1a ("CCSP SAP 2.1a", USCCSP, 2006). Rising carbon price pathways, as discussed below, were run for all regions to generate the CO_2 mitigation cost schedules. Adjustments were made to the resulting schedules as noted above.

A 5% discount rate was applied across our analyses.

Rising prices – In order to capture very important investment behavior associated with price expectations, we ran rising carbon price pathways (vs. constant) in our dynamic modeling for estimating mitigation supplies for domestic agriculture, forestry, and biofuels, as well as international forestry and energy-related CO_2 emissions mitigation. For domestic agriculture, forestry, and biofuels we draw from two rising price scenarios from USEPA (2005b): \$3/tCO_2eq in 2010 rising at 4%/yr with a cap of \$30/tCO_2eq, and \$20/tCO_2eq in 2010 rising at \$1.30/yr with a cap of \$75/tCO_2eq. For international forestry and international energy-related CO_2 emissions, we ran four exogenous rising carbon price pathways: \$1, \$5, \$15, and \$30/tCO_2eq in 2010 rising at 5%/year and capped at \$250/tCO_2eq. The resulting average annual mitigation estimates over time for 2010-2050 are provided for the four price scenarios.

Country groupings – The Group 1 and 2 country groupings are listed in Table 1. Group 1 countries are assumed to participate in carbon market systems (i.e., take on national emissions caps) throughout the S.280's time horizon (2010-2050). Group 2 countries are assumed not to be participating in carbon market systems until 2025, after which they are assumed to participate in a system through 2050. These assumptions are drawn directly from MIT's new analysis of cap-and-trade programs (Paltsev *et al.*, 2007).

Table 1: Region Groupings

Region		Timing of national emissions cap 2012-2025	2025-2050
Group 1	Europe	x	x
	Japan	x	x
	Canada	x	x
	Australia	x	x
	New Zealand	x	x
Group 2	Rest of World		x

Notes:
1. Europe includes EU-15, Eastern Europe, and Non-EU Europe
2. Rest of World includes Africa, CIS, Latin America and the Caribbean, Middle East, South/SE Asia

<u>*International carbon policies*</u> – Also drawn from MIT's analysis are the emissions cap levels adopted by the Group 1 and Group 2 countries, as described below in Table 2. Group 1 countries follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050. Group 2 countries adopt a policy beginning in 2025 that returns and holds them at year 2015 emissions levels through 2034, and then returns and maintains them at 2000 emissions levels from 2035 to 2050.

Table 2: Regional Emissions Caps

Year	Emissions Cap Levels: Group 1	Group 2
2010	5.0% below 1990 levels	No Cap
2015	5.3% below 1990 levels	No Cap
2020	7.0% below 1990 levels	No Cap
2025	10.3% below 1990 levels	2015 levels
2030	15.1% below 1990 levels	2015 levels
2035	21.5% below 1990 levels	2000 levels
2040	29.4% below 1990 levels	2000 levels
2045	38.9% below 1990 levels	2000 levels
2050	50.0% below 1990 levels	2000 levels

<u>*International demand for abatement*</u> – The emissions cap levels described in Table 2 are subtracted from reference case emissions for Group 1 and Group 2 countries in order to determine their respective demands for emissions abatement. The reference case emissions paths used were derived from the MiniCAM model's CCSP SAP 2.1a reference case (USCCSP, 2006). To facilitate modeling of the availability of international offsets to the S.280 domestic program, we have included our estimates for international emissions abatement demand.

<u>*Summary of the data files provided*</u> – Table 3 summarizes the 25 data files that accompany this memo. They include 24 files with mitigation schedules, one for each mitigation category considered by EPA, and one file with the international derived demand for GHG abatement. For each of the mitigation files, Table 3 lists the types of mitigation supply schedules provided and the data source from which the schedules were

Table 3: Data files provided

#	Mititigation category	Domestic: Capped	Domestic: Offset	International offsets: Group 1	International offsets: Group 2	Data source
1	CH_4 from landfills	--	2010, 2020+	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
2	CH_4 from coal mines	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
3	CH_4 from the natural gas sector	--	2010, 2020+	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
4	CH_4 from the oil sector	--	2010, 2020+	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
5	N_2O from adipic acid production	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
6	N_2O from nitric adic production	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
7	HFC from refrigeration and air conditioning	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
8	HFC, HFE, and PFC from solvents	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
9	HFC from foams	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
10	HFC from aerosols - MDI	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
11	HFC from aerosols - Non-MDI	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
12	HFC from fire extinguishing	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
13	PFC from aluminum production	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
14	HFC-23 from HCFC-22 production	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
15	PFC and SF_6 from semiconductor manufacturing	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
16	SF_6 from electric power systems	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
17	SF_6 from magnesium (Mg) production	2010, 2020+	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
18	Domestic agriculture, forest, and biofuel (includes biofuel energy supply)	2010-2050	2010-2050	--	--	USEPA (2005b)
19	Intl CH_4 & N_2O from livestock manure management	--	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
20	Intl CH_4 from livestock enteric fermentation	--	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
21	Intl CH_4, N_2O, & soil carbon from paddy rice	--	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
22	Intl N_2O & soil carbon from cropland	--	--	2010, 2020+	2010, 2020, 2025-2050	USEPA (2006)
23	Intl forest carbon sequestration	--	--	2010-2050	2010-2050	Sohngen and Mendelsohn (2006)
24	Intl energy-related CO_2 emissions reductions	--	--	2010-2050	2010-2050	USCCSP (2006)

#	Additional data file	Domestic: Capped	Domestic: Offset	International: Group 1	International: Group 2	Data source
25	Intl derived abatement demand	--	--	2010-2050	2010-2050	USCCSP (2006)

Notes:

1. Domestic baseline projections include reductions from voluntary programs.
2. Baseline projections for SF_6 from electric power systems, PFC and SF_6 from semiconductor manufacturing, SF_6 from magnesium production, PFC from aluminum production, and HFC-23 from HCFC-22 production incorporate the planned reductions from the "Technology-Adoption" baselines (EPA, 2006).
3. 2020+ schedules are to be applied for the period 2020-2050.
4. For domestic agriculture, forests, and biofuel, international forest, and international energy-related CO_2 reductions, mitigation pathways are provided for the entire period 2010-2050 from the rising carbon price runs discussed in the text.
5. In addition to mitigation supply, biofuel energy supply is also provided in the Domestic agriculture, forest, and biofuel spreadsheet.

derived. Each mitigation file includes projected baseline emissions, mitigation eligibility designations, and the mitigation cost schedules.

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