Technical Support Document
for EPA's Multi-Pollutant Analysis

Analysis of Carbon Dioxide Offsets Provisions of the Clean Air Planning Act of 2003 (S. 843)

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This technical support document is part of a comprehensive EPA analysis of various multi-pollutant proposals that have been introduced in the Senate. The proposals are designed to reduce emissions from the power sector, and EPA has agreed to perform detailed modeling for five legislative proposals and to present that information along with modeling results of EPA's recent regulatory actions to reducing emissions from the power sector. The analysis is based on air quality, health benefits, and power sector modeling and provides projections for each proposal for the years 2010, 2015, and 2020. The following proposals and regulations were analyzed:

1. The Clean Power Act (Jeffords, S.150 in 109th)
2. The Clean Air Planning Act (Carper, S.843 in 108th)
3. The Clear Skies Act of 2005 (Inhofe, S.131 in 109th)
4. The Clear Skies Act of 2003 (Inhofe, S.485 in 109th)
5. The Clear Skies Act of 2005 (Manager's Mark of S.131 in 109th)
6. The Clean Air Interstate Rule, The Clear Air Mercury Rule, and The Clean Air Visibility Rule (EPA promulgated rules, 2005)

This document describes the approach used to analyze the carbon dioxide (CO_2) emission reduction provisions of the Clean Air Planning Act (S. 843). The bill would establish a cap-and-trade allowance system for the U.S. power sector, and allow covered units to meet the CO_2 cap requirement by acquiring reductions of emissions of any greenhouse gas (GHG) from projects in any sector, anywhere in the world. As these emissions reductions projects are used by affected sources to "offset" their CO_2 emissions, these are called "offset projects" and generate allowances which may be traded. EPA assumed, based on previous analyses, that allowances generated by reducing emissions from projects outside of the electricity sector would be less expensive for affected sources than measures taken within generating units. The compliance strategy for S. 843, therefore, is for affected sources to make on-system reductions of SO_2, NO_X and Hg to meet those respective caps, but to purchase "offsets" to meet the CO_2 cap.

In order to analyze the GHG provisions of this bill, EPA required modeling tools capable of representing global GHG mitigation for fossil fuel consumption, non-CO_2 greenhouse gases, and agro-forestry options. EPA is currently unaware of a single model capable of representing all of these options, and, therefore, elected to use a suite of modeling tools. EPA conducted the analysis by using the models to develop a supply curve for offsets. This supply curve is constructed by using "marginal abatement cost" (MAC) curves that represent the level of emissions abatement available at a given price in each sector.1 The models were only used to develop MAC curves – the methodology to aggregate these MAC curves into a supply curve for offsets and to obtain allowance price and total cost results was developed by EPA. All of the models used by EPA have been used by the Energy Information Administration (EIA) of the Department of Energy (DOE) and/or by the Stanford Energy Modeling Forum.[2]

[1]The primary MACs used are available at http://www.epa.gov/airmarkets/mp in the file titled 'Marginal Abatement Cost Schedules.'

[2]The Stanford Energy Modeling Forum (EMF) is composed of leading researchers and modelers in the field of energy economics.

To represent fossil fuel mitigation options, EPA used a range of respected models: the Second Generation Model (SGM) developed by the DOE's Pacific Northwest National Laboratory; the Emissions Prediction and Policy Analysis (EPPA) model, developed by Massachusetts Institute of Technology; the Model for Evaluating the Regional and Global Effects of GHG Reduction Policies (MERGE) developed at Stanford University, and the Intertemporal General Equilibrium Model (IGEM) model developed by researchers at Harvard University.

Non-CO_2 greenhouse gas abatement is represented through a series of peer-reviewed models developed at EPA, and forestry and land use mitigation is represented by two respected university models: The Forestry and Agricultural Sector Optimization Model (FASOM) from Texas A&M University, and the Global Timber Model (GTM) developed at Yale University and Ohio State University.

EPA aggregated the MAC curves for fossil fuel use, non-CO_2 gases and sequestration into representations of the total GHG emission reduction potential for specific sets of countries. The regions are the U.S., the Kyoto region (composed of the developed country parties to the Kyoto Protocol), and developing countries. EPA used four separate models for fossil fuel based emissions mitigation, and, because these models produce differing marginal abatement cost curves, there is a range of results. EPA has more experience with the SGM than with EPPA, MERGE, or IGEM, and the reported results show the SGM result, accompanied by a range defined by using the four models. MAC curves are not available for all sectors for 2015, so EPA calculated results for 2010 and 2020, and derived results for 2015 through linear interpolation.

Because the GHG offset program allows for international offsets, the analysis must consider the effects of other possible demand for international GHG emission reduction projects - specifically, the European Union Emissions Trading Scheme and the Kyoto Protocol. EPA assumes that U.S. firms under S. 843 would participate in a global market for emission reductions, contributing to the global demand. The total demand curve used in the analysis consists of the U.S. emission reduction requirement under S. 843, and the international requirement under Kyoto.

The U.S. requirement is calculated as the difference between the CO_2 emissions projected by the Integrated Planning Model (adjusted to account for the "co-benefits" of CO_2 emission reductions achieved through controls projected to be used to comply with the bill's requirements for reductions in SO_2, NO_X, and Hg), and the S. 843 cap level. The bill creates a two-phase cap on CO_2 emissions – the first phase runs from 2009 to 2012 and is set at 2006 emissions levels for the power industry; in the second phase, the cap level is set at the industry's 2001 emissions levels. EPA used EIA sources for the 2006 and 2001 emissions levels in this analysis. The first phase cap level is 2.655 billion short tons of CO_2 (656.9 million metric tons of carbon equivalent), and the second phase cap is 2.454 billion short tons of CO_2 (607.2 million metric tons of carbon equivalent). To calculate the international demand for offsets, EPA projected emissions for these countries and calculated caps ("assigned amounts" in the language of the Kyoto Protocol), by using EIA sources for CO_2 emissions and EPA sources for non-CO_2 GHG emissions. The international price of GHG offsets in the EPA analysis is sensitive to projections of emissions, and it also sensitive to assumptions about the behavior of Kyoto Parties.

Developed country parties to the Kyoto Protocol are able to trade emission reduction credits amongst themselves, and it is anticipated that Eastern European and Former Soviet Union countries will be sellers in this market, and that the Western European countries, Canada, and Japan would be buyers. Under the Kyoto rules, the Eastern European and Former Soviet countries are projected by EIA to have substantial excess emissions - the so-called "hot air." These countries have the potential to maximize the revenue they receive under the Kyoto Protocol by limiting the supply of emission reductions, thus raising the price for offsets. EPA analyzed this effect using a methodology developed by MIT, which suggests that the Eastern European and Former Soviet countries will optimize their income from selling emissions reduction credits by selling approximately 55 percent of their available reduction credits. EPA does not explicitly assume that Kyoto countries would be willing to sell offsets to U.S. affected units, but the interaction of the Kyoto buyers and sellers affects the global price for emission reductions. Furthermore, Kyoto rules allow for emission reductions in developing countries, and EPA assumes that they would compete directly with U.S. firms for projects.

The Kyoto Protocol currently requires emission reductions from participating developed countries through 2012. EPA assumed in this analysis that the Kyoto Parties would not all agree to targets after 2012, but that the European Union would continue to enforce its "Emission Trading Scheme" (ETS) through 2020. EPA assumed that the ETS would allow for emission reduction projects in other countries.[3]

EPA used a methodology developed in cooperation with the White House Council of Economic Advisors for the use of MAC curves to analyze an offsets program.[4] This methodology involves imposing a region-specific restriction on the number of offsets available at any given price - in practice this involves allowing use of only a certain percentage of the MAC curves. The curves for each region - the U.S., the Kyoto parties, and developing countries, respectively - are adjusted to account for expected differences between an optimal emissions trading program and a stringent offsets program. The adjustments account for differences in the incentives for entities under the respective programs. In a cap-and-trade program, all capped sources are encouraged to seek emission reductions so that they may either sell allowances or minimize their allowance purchases. Under an offsets program, entities in sectors not subject to the emissions cap are not required to reduce emissions, and only do so if they enter into agreements with affected sources. Not all entities have incentives to make reductions in an offset program, and this is represented in the analysis through the restrictions on the MAC curves. For 2010, the developed country parties to the Kyoto Protocol are participating in an emissions trading program, not an offset program, and their contribution to the global supply of emissions reductions is represented by 100 percent of the Kyoto Region MAC. By 2020, only the EU is assumed to be in an emissions trading system, while the Eastern European, Former Soviet Union, Canadian, and Japanese emission reductions would be available as project level offsets. EPA did not disaggregate the European Union from the Kyoto Region, but calculated a

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[3] EPA performed a sensitivity analysis in which all Kyoto Parties are assumed to agree to maintain their targets through 2020.

[4] U.S. EPA, 2001. "Analysis of Multi-Emissions Proposals for the U.S. Electricity Sector, Requested by Senators Smith, Voinovich, and Brownback," at http://www.epa.gov/air/meproposalsanalysis.pdf

MAC adjustment based on the assumption that the EU represents approximately 35 percent of 2020 Kyoto region emissions, and the 65 percent of remaining emissions are from other countries. The region specific percentage adjustments are shown in Table 1.

Table 1. Regional MAC Adjustments

Region	**Offsets Available**
U.S.	50 percent
Kyoto Region	100 percent (2010); 51 percent (2020)
Developing Countries	10 percent (2010); 25 percent (2020)

The analysis also assumes that firms purchasing offsets would be subject to transaction costs as they acquire allowances through emissions reductions projects. These are the costs of finding a project or a broker, negotiating with project partners and with regulators, attorney fees, monitoring and insurance costs, etc. To account for transaction costs, EPA used an estimate from a draft of a forthcoming report by DOE's Lawrence Berkeley National Laboratory[5] which describes these costs for a large sample of current projects and calculates the weighted average project transaction costs for emission reductions to be approximately $0.33 per short ton.[6]

Because the bill allows affected sources to bank allowances for future use, EPA assumed that affected sources would pursue an inter-temporally optimal strategy for purchasing offsets. This calculation used the IPM discount rate of 5 percent per year. EPA found that the banking provision lowered the costs of the policy and that sources would "overcomply" in the early period to avoid higher costs in the later period.

Using the adjusted regional MACs as the supply curve for offsets, the demand projected from U.S. affected sources and the Kyoto region, and accounting for the transaction costs, EPA calculated the equilibrium prices for GHG allowances under S. 843. The total cost is equivalent to the area under the U.S. marginal abatement cost curve, plus the cost of emission reductions purchased from other countries, plus the total of the transaction costs. Table 2 shows the results – the result for the SGM-based modeling is shown first, followed by the range of results using all four models in parentheses.

Table 2. Results

Scenario: Kyoto ends in 2012, EU Caps Continue	**2010**	**2015**	**2020**
Price of Allowances (1999$/STCO2E) (*Range)*	1.14 (*1.12 – 1.56*)	1.44 *(1.40–1.98)*	1.74 (*1.68-2.39*)
Total Cost (Million 1999$) (*Range)*	308 *(308 – 479)*	771 *(725 -1,053)*	1,233 (*1,143-1,627*)

[5] Antinori, Camille, et al. 2005 (Forthcoming). "Assessing Transaction Costs of Project-based Carbon Dioxide Emissions Trading."
[6] All prices and costs given in 1999 U.S. dollars.