

**Technical Support Document
for EPA's Multi-pollutant Analysis**

**Methodology for Analysis of Allocation Approaches in
Proposed Multi-Pollutant Legislation**

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The EPA has conducted a comprehensive 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 approach to reducing emissions from the power sector. The analysis is based on air quality, health benefits, and power sector modeling projections and estimates 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 108th)
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)

EPA analyzed the allocation approaches in five bills as part of its comprehensive analysis of multi-pollutant legislation. This technical support document summarizes the allocation provisions in each bill, the impacts analyzed by EPA, and the methodology used the analysis.

1. Summary of Allocation Provisions in Multi-pollutant Bills and Impacts Analyzed by EPA

The allocations approach of each bill is discussed in greater detail in each bill’s respective analytical package, but is summarized briefly in Table 1. This table also indicates what aspects of the allocations approach were analyzed by EPA. EPA did not analyze the allocation provisions of CAIR and CAMR, in which SO₂ allowance allocations occur under Title IV, and NO_x and Hg allowance allocations are determined by the States, using the budgets assigned to them by EPA.

Table 1. Summary of Allocation Provisions in Multi-pollutant Bills and EPA Analysis

Bill	Summary of Allocation Provisions	Impacts Analyzed by EPA
Clean Air Planning Act (Carper, S.843)	For SO ₂ , allocations based on title IV methodology; uses updating, output-based allocations, updated over time for NO _x , Hg, and CO ₂ .	Allowance distribution, total value of allowances for existing coal- and gas-fired generation; impact of updating methodology.
Clean Power Act (Jeffords, S.150)	Primarily “auction-like” provision with allowances distributed to households, various non-producers, affected sources, and also set aside for renewable energy and efficiency projects.	Allowance distribution, total value of allowances for existing coal- and gas-fired generation, cost of allowance purchases to power sector, transactions costs.
Clear Skies (Inhofe, S.131)	Relies on title IV allocations for SO ₂ (93%; 7% allocated to sources not receiving title IV allowances); uses proportional historic heat input for NO _x and Hg, with fuel adjustment factors for NO _x , and coal-type adjustment factors for Hg.	Allowance distribution, total value of allowances for existing coal- and gas-fired generation.

Clear Skies (Managers' Mark)	Relies on title IV allocations for SO ₂ (88%; 7% allocated to sources not receiving title IV allowances); uses proportional historic heat input for NO _x and Hg, with fuel adjustment factors for NO _x , and coal-type adjustment factors for Hg.	Allowance distribution, total value of allowances for existing coal- and gas-fired generation.
Clear Skies 2003 (S.485)	Initial allocations rely primarily on free distribution. Over time an increasing amount of allowances are auctioned. The direct distribution methods are: For SO ₂ , allocations tied to title IV (95%; 5% allocated to sources not receiving title IV allowances); for NO _x and Hg, allocations based on proportional historic heat input, adjusting for coal type for Hg.	Allowance distribution, total value of allowances for existing coal- and gas-fired generation; cost of allowance purchases to power sector.

2. Estimated Allocation of Allowances

In order to estimate the impacts of allocation methodology, EPA first estimated the allowances each affected unit would receive and the allowances that would be allocated to other non-affected entities, placed in set-asides, or designated for auction. Some simplifying assumptions were made in distributing allowances. For analysis of Clear Skies 2003 (S. 485), Clear Skies (Inhofe, S. 131), and Clear Skies (Managers' Mark), EPA used existing title IV allowance allocations to determine SO₂ allocations, and used Acid Rain Program heat input data from 1998 to 2000, using the annual average for those three years, in order to calculate NO_x and Hg allocations based on proportional heat input.

For the Clean Air Planning Act (Carper, S. 843) unit-level generation data for 2010 was calculated from the 2010 Base Case parsed file, with the assumption made that it would correspond to recent historic proportional generation, and generation data for use in allocating 2020 allowances was calculated from the parsed file for 2015, to reflect that the methodology calls for annual updating of allowance allocations with more recent proportional generation. New unit set-asides for S. 843 were assumed to be equal in size to projected emissions from units coming online after 2003 for NO_x and Hg in 2010, and projected emissions from units coming online between 2012 and 2015 for NO_x and Hg and in 2020. The generation shares from new units for corresponding on-line years were used for SO₂ and CO₂ in 2010 and 2020.

For the Clean Power Act (Jeffords, S. 150) the allocations that were distributed to existing affected units were distributed based on projected generation calculated from IPM baseline parsed output, rather than using unit level generation data from 2003 as is specified in the bill. This simplifying assumption ensured that unit-level generation data would be readily available for all facilities included in EPA modeling, and required the assumption that the relative proportions of generation by fuel in the baseline parsed data would be consistent with historic data from 2003.

3. Description of Analysis Applicable to All Bills

3.1 Value of allowances by pollutant in 2010 and 2020.

For each bill, EPA estimated the total annual value of allowances by each pollutant. The value of allowances was determined based on the projected marginal costs from IPM for SO₂, NO_x, Hg, and for S. 150, CO₂. For S. 843, the value of CO₂ allowances was calculated based on projected offset price. The annual value of allowances for each pollutant is determined by multiplying the cap for that pollutant as specified by the bill by the projected allowance price for that pollutant.

3.2 Value of allowance allocations by type of holder, and percentage distribution of allowances by type of holder, 2010 and 2020.

For each bill, after estimating allocations for units included in IPM parsed outputs, EPA then estimated the total value of allowances over all pollutants included in the bill, for each category of recipient (or type of set-aside) described in the bill. Allowance recipient or set-aside categories, and the bills that they apply to, are listed below. Estimates of allowance value include only the allowances allocated in that particular year (2010 and 2020) and not any banked allowances or future year allocations.

3.2.1 Categories of Allowance Recipients and Set-asides in Legislative Bills.

Existing Coal: includes all units burning coal as a primary fuel, including IGCC, that are projected to be operating in the IPM parsed output (applies to all bills).

Existing Gas: includes all units burning gas as a primary fuel that are projected to be operating in the IPM parsed output (applies to all bills).

Existing Other: includes units burning fossil waste, as well as retired (or not operating) coal and gas units, as projected by IPM parsed output (applies to all bills).

New: The set of allowances designated for distribution to new units. (applies to Clean Air Planning Act (Carper, S. 843), Clear Skies (Inhofe, S. 131), Clear Skies 2003 (S. 485) for SO₂ only, and Clear Skies (Managers' Mark)).

SO₂ Technology Set-aside: A set aside of 250,000 SO₂ allowances (83,334 vintage 2010, 83,333 vintage 2011, and 83,333 vintage 2012) for which units planning to install SO₂ control technologies and burn Eastern bituminous coal can apply. (applies only to Clear Skies 2003 (S. 485) Clear Skies (Inhofe, S. 131), and Clear Skies (Managers' Mark)).

Auction: The set of allowances not distributed freely to affected sources, but instead, allocated by auction (applies only to Clear Skies 2003 (S. 485)).

Transition Assistance: The set of allowances designated for distribution to dislocated workers, communities, and producers of electricity-intensive products (applies only to the Clean Power Act (Jeffords, S. 150)).

Renewable: The set of allowances designated for distribution to renewable electricity generating units, energy efficiency projects, and “clean energy” sources (applies only to the Clean Power Act (Jeffords, S. 150)).

Biological and Geological Carbon Sequestration: the set of allowances designated for distribution to entities that carry out biological or geological carbon sequestration of CO₂ produced by an electricity generating facility (applies only to the Clean Power Act (Jeffords, S. 150)).

Consumers: The set of allowances allocated to households that consume electricity. (applies only to the Clean Power Act (Jeffords, S. 150)).

3.3 Value of Allowance Allocations to, and Value of Allowance Demand from, Existing Coal-fired and Natural Gas-fired Units, 2010 and 2020.

For each bill, EPA estimated the extent to which existing coal units and existing gas units, as two separate groups, would be net sellers or net purchasers of allowances. For Existing Coal, EPA took the total value of allocations of allowances for all pollutants included in the bill, as calculated for existing coal above. As discussed above, estimates of allowance value include only the allowances allocated in that particular year (2010 and 2020) and not any banked allowances or future year allocations. Demand for allowances for existing coal was calculated by totaling projected emissions for each pollutant included in the bill from the IPM parsed output for units classified as Existing Coal, multiplied by allowance price for each pollutant, respectively, as projected by IPM. For S. 843, the value of CO₂ allowances was calculated based on projected offset price. This same process was repeated for units categorized as Existing Gas.

4. Description of Analysis of Bill-Specific Allocation Provisions

4.1 Impact of the Auction Provision, Clear Skies 2003 (S. 485).

EPA estimated the present value of allowances that would be auctioned, as compared with the present value of allowances that were allocated for free, over the period 2010 (2008 for NO_x) - 2030, and 2010 (2008 for NO_x) - 2061 (the first year in which all allowances are auctioned). This was done by, for each year, calculating the value of allowances auctioned, and the value of allowances allocated for free. The value of allowances was determined using the projected marginal costs from IPM for SO₂, NO_x, and Hg. S. 485 specifies for each year, the quantity of allowances to be auctioned and the quantity of allowances to be allocated for free. The present value of the streams of auctioned allowance value and allocated allowance value were calculated using a discount rate of 5.34%, which is equivalent to the discount rate used for calculating the net present value of costs from IPM.

4.2 Impact of the “Auction-like” Provision, Clean Power Act (Jeffords, S. 150).

Under S. 150, the power sector must purchase the majority of allowances necessary for compliance from households or other institutions that allowances have been allocated to

for transition assistance or as an incentive for clean or renewable energy use or production. This is essentially the equivalent of an auction, but with additional transaction costs due to the extent to which allowances are dispersed, and the small quantities in which they would be dispersed.

To estimate the value of allowances that must be purchased by the power sector, rather than allocated for free, EPA repeated the methodology used in analysis of the auction in S. 485, described above. The percentage of allowances allocated to existing affected units for the first 10 years of the program, is specified in S. 150. After 2019, EPA assumed that the percentage of allowances allocated for free to these units would fall to zero. While this is not specified in the bill, the percentage starts at 10% in 2010 and is decreased by 1% each year. EPA estimated the present value of the streams of “auctioned” allowance value and allocated allowance value for the period 2010 and 2030.

In addition to the present value calculations, EPA also estimated the potential transactions costs that could result from the allocation provisions in S. 150. In EPA modeling of S. 150, only CO₂ allowances are projected to have a monetary value, and SO₂ and NO_x allowance prices are projected to be zero. However, because holding allowances to cover all emissions is a compliance requirement, affected sources will need to acquire sufficient allowances for all three pollutants from the numerous entities that hold them. For CO₂, EPA assumed that acquiring CO₂ allowances would result in an additional transaction cost of 1.5% of the value of the allowance for allowances purchased from households and entities receiving allowances for transition assistance.¹

EPA based its analysis of the transactions cost from acquiring NO_x and SO₂ allowances on literature that estimates the effect of monetary incentives on survey response rates. The rationale behind this is that an individual holding some small quantity of allowances with little or no value is unlikely to spend the time and effort to make it available to electricity producers unless some financial incentive is provided. Likewise, an individual who receives a survey is more likely to take the time to submit a response if some financial incentive is provided, and this likelihood should increase as the financial incentive increases. A somewhat general finding of the literature on survey research is that well-designed surveys on a topic of high interest to the respondents could achieve a response rate of 60%. Monetary incentives have been shown to increase this response rate by up to 20% for payments up \$5 or more and up to 10% for payments of \$1-\$2.²

EPA estimated transactions costs for SO₂ and NO_x as follows: respondents face an opportunity cost of their time, assumed to be 20 minutes, and valued at \$3.00, based on

¹ EPA assumed that transactions costs were equal to 1.5% of the allowance value in regulatory impact analyses for the 126 FIP and the Clean Air Interstate Rule. This assumption is based on market research conducted by ICF consulting.

² See: Baumbgartner, R. and P. Rathbun. 1996. “Prepaid Monetary Incentives and Mail Survey Response Rates” Presented at the Joint Statistical Meetings, Chicago, IL; Lesser, V., et al. 2001. “Quantifying the Influence of Incentives on Mail Survey Response Rates and their Effects on Nonresponse Error.” Proceedings of the Annual Meeting of the American Statistical Association; and Ulrich, C.M., et al. 2005. “Does it Pay to Pay? A Randomized Trial of PrePaid Financial Incentives and Lottery Incentives in Surveys of Nonphysician Healthcare Professionals.” *Nursing Research* 54: 178-183.

estimates of the value of an hour of leisure time from Bureau of Labor Statistics. The total transaction cost per household for an affected source is assumed to be equal to the monetary payment provided to respondents (EPA evaluated \$5 and \$10 payments), as well as compensation for lost leisure time, and costs of mailing and packaging (estimates range from \$0.70 to \$1.30).³ EPA used projections of the number of households from *Statistical Abstract of the United States: 2004-2005*. Because, under S. 150, SO₂ and NO_x emissions are projected to be below the cap, the power sector would not need the entire set of allowances allocated to households. EPA estimated the response rate to be equal to the tons of emissions projected for 2010 and 2020, divided by the total number of allowances issued to households and entities for transition assistance, in those two years, respectively. This response rate was multiplied by the number of households and estimated transaction cost in order to determine the total transaction cost for each of the two pollutants.

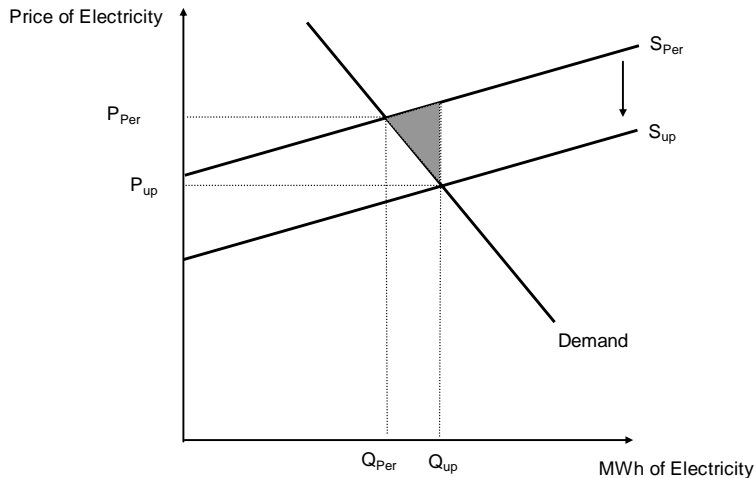
4.3 Impact of Updating Allowance Allocations Clean Air Planning Act (Carper, S. 843).

Under S. 843, allowance allocations for the year 4 years in advance are calculated using a unit's three most recent years of generation data. While this methodology is clearly laid out for NO_x, Hg, and CO₂, it is not clear from the bill that SO₂ allocations were to be updated over time using more recent heat input data than was used for allocations under title IV. In analyzing the potential economic impact of using an updating methodology, EPA assumed that SO₂ allowance allocations were not updated over time with more recent data for title IV units, but that new unit allowance allocations were updated.

Updating allowance allocations based on generation creates an incentive for electricity producers to increase supply relative to a permanent allocation scheme, because of the potential to secure additional allowances as a result of doing so. The result is a downward shift in the supply curve, and a lower equilibrium price and higher equilibrium quantity of electricity demanded, and a lower revenue on the initial quantity of output. At the same time, however, because of increased generation, allowance prices increase as a result of this increased generation, such that overall compliance costs are greater. The result is a deadweight loss, as indicated by the shaded triangle in Figure 1.

Figure 1. Impact of Updating Allowances Allocation with Generation on the Electricity Market

³ From: Turner, Jim. 2003. How much will it cost.? (Direct Mail Essentials). *Bank Marketing*. Available online at http://www.findarticles.com/p/articles/mi_go1476/is_200306/ai_n8677248.



Estimating the potential deadweight loss from updating allowance allocations under S. 843 required estimating the magnitude of the generation incentive that is created by the knowledge that future year allowance allocations will be updated based on current generation, as well as the increase in generation that would result from such an incentive. An electricity producer, when weighing the marginal costs and marginal benefits of each additional MWh of generation, would, under the allocation methodology in S. 843, take into account the present value of additional allowances that would be expected in the future from each additional MWh of generation in the present.

EPA estimated the size of the generation subsidy by first calculating the present value of the total projected value of allowances (number of allowances issued multiplied by the projected allowance price) for each pollutant, for the future allowance vintage year being evaluated, assuming a discount rate of 5.34%.⁴ EPA calculated the size of the subsidy in \$/MWh by taking the discounted total present value of allowances for that pollutant, divided by projected generation for affected units (or new units only, in the case of SO₂) for the allowance vintage year being evaluated.⁵ EPA then determined the total per MWh subsidy by summing over all relevant pollutants.

After estimating the size of the subsidy created by updating, EPA then calculated the percentage decrease in retail electricity price that would be result from the subsidy, by dividing the subsidy by the projected national retail price for the applicable model year. EPA then calculated the percentage change in demand due to a lower retail price, assuming a retail price elasticity of demand of 0.16 in 2010 for the years 2008-2012, and 0.20 for the years 2013 and 2014, and then calculated the associated increase in generation by adjusting projected generation by the calculated percentage. The retail price elasticity of demand assumptions used in these calculations are consistent with those used in the demand response analysis that was done for each bill.

⁴ Present value was calculated for the second year of every three year period from the years 2006 to 2015 because allocations for the year 4 years in advance are based on the most recent three years of generation. For example, allocations for 2020 would be completed in 2016, using generation data from 2013-2015.

⁵ This was done using the corresponding model year from IPM.

The size of the deadweight loss is equivalent to an “inefficiency triangle,” the area of which is equal to $(1/2) * (\text{subsidy in } \$/\text{MWh}) * (\text{calculated generation increase})$. EPA estimated the deadweight loss for each of the years 2007 – 2014, which would provide generation data to be used in allowance allocations for the years 2013 through 2020.⁶ The present value of the efficiency loss over the years 2007-2014 was calculated using a discount rate of 5.34%. EPA estimated the present value of this efficiency loss over the years 2007 through 2014 (which reflect allocations through 2020) of \$58 million.

As is discussed in the technical package for the Clean Air Planning Act (Carper, S. 843), the impact of the allowance updating methodology would act to somewhat offset the demand response to increasing electricity prices that result from the constraints in the bill. The demand response would be offset by approximately 14,000 GWh in 2010 (about a 17% offset of demand response), and by approximately 15,000 GWh in 2014 (about a 68% offset).⁷ This interaction is important to consider in evaluating the impacts of S. 843.

⁶ Updating does not affect allowance allocations prior to 2013.

⁷ 2014 was the last year evaluated in the analysis of the inefficiency loss. This loss is compared with the demand response for the 2015 IPM model run year.