**Technical Support Document**
**for the Final**
**Clean Air Interstate Rule**

# Modeling of Control Costs, Emissions, and Control Retrofits for Cost Effectiveness and Feasibility Analyses

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**U.S. Environmental Protection Agency**
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# Modeling of Control Costs, Emissions, and Control Retrofits for Cost Effectiveness and Feasibility Analyses

## Overview

This Technical Support Document (TSD) describes EPA's use of the Integrated Planning Model (IPM) to develop estimates of SO2 and NOx emission control costs, projections of future emissions and emission reductions, and projections of capacity of future control retrofits, assuming controls on electricity generating units (EGUs). This TSD also describes EPA's use of the Technology Retrofitting Updating Model (TRUM) to develop marginal cost effectiveness curves for SO2 and NOx reductions from EGUs.

The EPA used IPM projections and TRUM marginal cost curves to conduct analyses contained in the CAIR Notice of Final Rulemaking (NFR) preamble in section IV, which is entitled "What Amounts of SO2 and NOx Emissions Did EPA Determine Should Be Reduced?" Specifically, EPA used these control cost estimates and marginal cost effectiveness curves to analyze the cost effectiveness of CAIR, as presented in section IV.A of the NFR preamble. Additionally, the Agency used the projections of control retrofit capacities to analyze the feasibility of CAIR, as presented in preamble section IV.C.

This TSD provides background on the IPM and TRUM models, and explains the following specific analyses for the CAIR NFR:

- Use of IPM to estimate average and marginal costs of SO2 and NOx controls
- Use of IPM to project future SO2 and NOx emissions and emission reductions
- Use of IPM to project capacity of future SO2 and NOx control retrofits
- Use of TRUM to examine changes in marginal costs at varying levels of SO2 and NOx reduction

## Background on EPA's IPM Analyses

EPA uses the Integrated Planning Model (IPM) to examine costs and, more broadly, analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous States and the District of Columbia. The IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. The National Electric Energy Data System (NEEDS) contains the generation unit records used to construct model plants that represent existing and planned/committed units in EPA modeling applications of IPM. The NEEDS 2004 includes basic geographic, operating, air emissions, and other data on all the generation units that are represented by model plants in EPA's version 2.1.9 update of IPM. Documentation for IPM, and the NEEDS database, are available in the CAIR rulemaking docket and also on EPA's website at www.epa.gov/airmarkets/epa-ipm/ .

Modeling applications of IPM produce forecasts for model plants, i.e., clusters of real life electricity generating units with similar characteristics. The model plant projections can be used to produce parsed results, which are unit-level results derived from the model plant projections. Projections for individual plants are based on data currently available and modeling parameters which are simplifications of the real world. It is likely that some future actions regarding individual plants could differ from model projections of actions; however, the aggregate impacts are expected to be appropriately characterized by the model. Where appropriate, EPA produced parsed results from IPM runs for use in analyzing CAIR.

The EPA used IPM to evaluate the cost and emissions impacts of the policies to limit annual emissions of SO2 and NOx, and ozone season emissions of NOx, that are required by CAIR – if all affected States choose to implement reductions by controlling EGUs – to be made from the electric power sector. For the CAIR Notice of Proposed Rulemaking (NPR), EPA used IPM version 2.1.6 and NEEDS 2003 to analyze cost and emissions impacts of the proposed rule. For the CAIR NFR, EPA updated IPM and NEEDS. The updated versions are named IPM version 2.1.9 and NEEDS 2004. This TSD describes the IPM runs that EPA used to estimate average and marginal costs of EGU controls, emissions and emission reductions, and control retrofits for the CAIR NFR.

The Regulatory Impact Analysis (RIA) for the CAIR NFR includes a list and description of each IPM run that supports EPA's analysis for the NFR (see RIA Table D-9). Data files for each of the IPM runs that EPA used for the NFR are available in the CAIR docket as well as on EPA's website. This TSD provides some additional description regarding the particular IPM runs that EPA used for its cost effectiveness and feasibility analyses, which are presented in section IV of the CAIR NFR preamble. Data files for the runs described in this TSD are available in the CAIR docket and on EPA's website, along with the other runs used for the NFR.

The IPM uses model run years to represent the full planning horizon being modeled. That is, several years in the planning horizon are mapped into a representative model run year, enabling IPM to perform multiple year analyses while keeping the model size manageable. Although IPM reports results only for model run years, it takes into account the costs in all years in the planning horizon. In EPA's v.2.1.9 update of IPM, the years 2008 through 2012 are mapped to run year 2010, and the years 2013 through 2017 are mapped to run year 2015.[1] In the CAIR NFR preamble, section IV, model outputs for 2009 and 2010 are from the 2010 run year, and model outputs for 2015 are from the 2015 model run year.

In its IPM modeling, EPA assumes interstate emissions trading for EGUs. Although States are not required to participate in an interstate EGU emissions trading program, EPA believes it is reasonable to evaluate control costs assuming States choose to participate in such a program since that will result in less expensive reductions. Also, note that EPA's IPM modeling accounts

[1] An exception was made to the run year mapping for an IPM sensitivity run that examined the impact of a NOx Compliance Supplement Pool (CSP). In that run the years 2009 through 2012 were mapped to 2010 and 2008 was mapped to 2008.

for the use of the existing title IV bank of SO2 allowances.

The final CAIR requires annual SO2 and NOx reductions in 23 States and the District of Columbia, and also requires ozone season NOx reductions in 25 States and the District of Columbia. Many of the CAIR States are affected by both the annual SO2 and NOx reduction requirements, and the ozone season NOx requirements.[2]

The EPA initially conducted IPM modeling for the final CAIR using a control strategy that is similar but not identical to the final CAIR requirements.[3] The control strategy that EPA initially modeled included three additional States (Arkansas, Delaware and New Jersey) within the region required to make annual SO2 and NOx reductions, however these three States are not required to make annual reductions under the final CAIR. The addition of these three States made a total of 26 States and the District of Columbia affected by annual SO2 and NOx caps for the initial model run. (Note that EPA is proposing to require annual SO2 and NOx reductions in Delaware and New Jersey.) The initial model run also included individual State ozone season NOx caps for Connecticut and Massachusetts, and did not include ozone season NOx caps for any other States. Several of the analyses for the final CAIR are based on this initial model run. In this TSD, we refer to this initial model run as the "CAIR 2004 analysis" run.

The Agency conducted revised final IPM modeling that reflects the final CAIR control requirements. The final IPM modeling includes regionwide annual SO2 and NOx caps on the 23 States and the District of Columbia that are required to make annual reductions, and includes a regionwide ozone season NOx cap on the 25 States and the District of Columbia that are required to make ozone season reductions. The EPA modeled the final CAIR NOx strategy as an annual NOx cap with a nested, separate ozone season NOx cap. In this TSD, we refer to this final model run as the "final CAIR policy."

The analyses in section IV of the CAIR NFR preamble are generally derived from the final CAIR policy run reflecting the final CAIR. However, some of EPA's analyses are based on the original CAIR policy run that reflected a similar but not identical control strategy to the final CAIR. Below, EPA explains how each IPM run was used for the analyses in section IV of the preamble. Note that the air quality analyses in section VI in the NFR preamble and the benefits analysis in section X, as well as the analyses presented in the Regulatory Impact Analysis (RIA),

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[2] The District of Columbia and the following 23 States must reduce annual SO2 and NOx emissions: Alabama, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

The District of Columbia and the following 25 States must reduce ozone season NOx emissions: Alabama, Arkansas, Connecticut, Delaware, Florida, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin.

[3] The EPA began its emissions and economic analyses for CAIR before the air quality analyses, which affect the States covered by the final rule, was completed.

are based on emissions projections from the initial CAIR policy run (the CAIR 2004 analysis run). As explained in section IV in the preamble, EPA believes that the differences between the CAIR 2004 analysis run and the final CAIR policy run have very little impact on projected control costs and emissions.

In section IV in the CAIR NFR preamble, EPA summarizes some cost and emissions projections that were previously presented in the NPR (published January 30, 2004). The IPM runs that the Agency used to develop those NPR cost and emissions projections were described in the NPR and in a supporting memo available in the CAIR docket (the memo is entitled "Memorandum to the OAR Docket from USEPA, Clean Air Markets Division re: Integrated Planning Model (IPM) Runs used in Developing the Proposed Interstate Air Quality Rule (IAQR) Emission Reduction and Cost-effectiveness Estimates," dated January 28, 2004). This TSD does not repeat descriptions of IPM runs from the NPR.

Here is a description of how EPA estimated control costs, emissions projections, and retrofit projections, using outputs from IPM runs:

- Marginal control costs. In the IPM runs, the marginal cost reflects what it would cost to obtain one additional ton of reduction beyond the amount reduced by the modeled control scenario, in a particular model run year. The marginal cost can be read directly as an output in the Environmental Measures Report, where it is labeled "constraint shadow price."
- Average control costs. To estimate average control costs, EPA compares the total annual production costs from a single-pollutant policy run to the Base Case run (for a particular model run year) and compares the total (SO2 or NOx) emissions from the single-pollutant policy run to the Base Case run, then divides the difference in production costs to the difference in emissions to get dollars/ton. The total annual production costs and total emissions are found in the Regional Summary Report. The total annual production cost in the Regional Summary Report does not include the cost of combustion controls because that cost is not included in IPM, but rather is calculated exogenously. See Table 1 in this TSD for combustion control costs that EPA used to calculate average control cost estimates presented in section IV in the NFR preamble.
- Emissions and Emission Reductions. The total emissions of SO2 or NOx emitted by all affected units in a particular policy scenario can be found in the Environmental Measures Report, listed under the specific policy constraint of interest. If a parsed file is produced, then the emissions at affected units can also be determined by summing the emissions for all affected units from the parsed file. (The emissions totals that are found in the Regional Summary Report are total national emissions – not only at affected plants.) To estimate emission reductions, EPA calculates the difference between the emissions in the Base Case run and the emissions in a policy case run.
- Control Retrofits. The capacity and type of emission control retrofits are found in the Regional Summary Report.

**Description of IPM Runs Used to Estimate Control Costs and Emissions**

**IPM Run ID: Base Case 2004**
**Description: EPA Base Case for 2004 Analyses**
This is the Base Case model run, which includes the national title IV SO2 cap and trade program, NOx SIP Call regional ozone season cap and trade program, and State-specific programs in Connecticut, Illinois, Maine, Massachusetts, Minnesota, Missouri, New Hampshire, New York, North Carolina, Oregon, Texas, and Wisconsin. New Source Review (NSR) settlement actions are included, as they existed on March 19, 2004 (see Exhibit 3-15 in the IPM v.2.1.9 Documentation Summary for more information about NSR settlements in the Base Case). This IPM run represents conditions without CAIR and without future State SIP actions for ozone and PM2.5. The EPA used the Base Case run to compare costs and emissions to CAIR policy runs in order to estimate average costs of CAIR, to present estimated emissions under Base Case conditions and estimated reductions under CAIR, and to estimate costs of some State programs. The EPA used parsed files produced from this IPM run to analyze State-level emission projections.

**IPM Run ID: CAIR 2004_Analysis**
**Description: CAIR 2004 Analysis Run**
This is the initial CAIR policy run, which EPA used for several analyses for the final CAIR. As explained above, EPA initially conducted IPM modeling for the final CAIR using a control strategy that is similar but not identical to the final CAIR requirements. This run included three additional States (Arkansas, Delaware, and New Jersey) within the region required to make annual SO2 and NOx reductions, although these three States are not required to make annual reductions under the final CAIR. With the addition of these 3 States, a total of 26 States and the District of Columbia are affected by annual SO2 and NOx caps in this run. In addition, this run included individual State ozone season NOx caps for Connecticut and Massachusetts, and did not include ozone season NOx caps for any other States.

Note that EPA is proposing to include 2 additional States – Delaware and New Jersey – with the CAIR region required to make annual SO2 and NOx emission reductions. Because the CAIR 2004 analysis run capped annual SO2 and NOx emissions in Arkansas, Delaware, and New Jersey, the original run is quite similar to what the final requirements will be if EPA's proposal to require annual reductions in those 2 additional States is finalized (although EPA is not proposing annual caps on emissions in Arkansas). However, the CAIR 2004 analysis run imposed ozone season NOx caps on Connecticut and Massachusetts only, whereas the final CAIR requires ozone season caps on all of the 25 States and DC that are affected by CAIR for ozone. The IPM run called **CAIR 2004_Final_DE and NJ**, described below, represents what the CAIR requirements will be if EPA finalizes its proposal to require annual SO2 and NOx reductions in Delaware and New Jersey, and that run includes an ozone season cap on all 25 States and DC that are affected by CAIR for ozone.

The Agency conducted revised final IPM modeling that reflects the final CAIR requirements. The IPM run that reflects the final CAIR policy is called run **CAIR 2004_Final**, which is described below. Cost and emissions projections for CAIR, as presented in section IV of the CAIR NFR preamble, are derived from the final CAIR policy run. However, some of the sensitivity analyses were developed using IPM runs that are based on the CAIR 2004 analysis

run.

**IPM Run ID: CAIR 2004_Final**
**Description: Final CAIR Policy Run**
This is the final CAIR policy run. This run includes regionwide annual SO2 and NOx caps on the 23 States and the District of Columbia that are required to make annual reductions, and includes a regionwide ozone season NOx cap on the 25 States and the District of Columbia that are required to make ozone season reductions. This run includes an annual NOx cap and a nested, separate ozone season NOx cap.

The District of Columbia and the following 23 States are included in regionwide annual SO2 and NOx caps in this run: Alabama, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

The District of Columbia and the following 25 States are included in regionwide ozone season NOx caps in this run: Alabama, Arkansas, Connecticut, Delaware, Florida, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin.

The EPA used the final CAIR policy run to estimate marginal costs of SO2 and NOx control under CAIR, and to develop projections of emissions under CAIR and emission reductions compared to the Base Case. The EPA used parsed files produced from this IPM run to analyze State-level emission projections.

**IPM Run ID: CAIR 2004_Final_DE and NJ**
**Description: CAIR Policy Run If DE and NJ Are Required to Make Annual Reductions**
This run represents the CAIR requirements if EPA finalizes its proposal to require annual SO2 and NOx emission reductions in Delaware and New Jersey. This run is the same as the final CAIR policy run, **CAIR 2004_Final**, except that these 2 additional States are included under the annual SO2 and NOx caps. The EPA used this run to develop projections of emissions and emission reductions if EPA finalizes its proposal to require annual SO2 and NOx reductions in Delaware and New Jersey. The EPA used parsed files produced from this IPM run to analyze State-level emission projections.

**IPM Run ID: CAIR 2004_No NOx**
**Description: CAIR SO2 Policy with Base Case NOx Policy**
This run uses the same SO2 policy as the initial CAIR policy run, **CAIR 2004_Analysis**, but for NOx the Base Case policy is used. As with the CAIR 2004 analysis run, modeling was based on a slightly different control region than that covered by the final rule (if EPA finalizes its proposal to require annual emission reductions in Delaware and New Jersey, then the SO2 region capped in this run will be the same as that final region, except that Arkansas was included in this run but would not be in the final region). The EPA used this model run to estimate costs of the SO2 policy alone. Specifically, we compared the annual costs of the Base Case with the annual costs

of this model run to get the costs of the SO2 policy alone, and we compared the annual SO2 emissions in the Base Case with the annual SO2 emissions in this model run. Using the annual costs of the proposed SO2 policy and the annual emission reductions, we calculated the estimated average costs of SO2 reductions.

**IPM Run ID: CAIR 2004_No SO2**
**Description: CAIR NOx Policy with Base Case SO2 Policy**
This IPM run used the same NOx policy as the initial CAIR policy run, **CAIR 2004_Analysis**, which includes a regionwide annual NOx cap on the District of Columbia and 26 States (the 23 States required by CAIR to make annual emission reductions plus Arkansas, Delaware, and New Jersey), and ozone season NOx caps on Connecticut and Massachusetts. Base Case SO2 policy was used for this run. As with the CAIR 2004 analysis run, modeling was based on a slightly different control region than that covered by the final rule (if EPA finalizes its proposal to require annual emission reductions in Delaware and New Jersey, then the NOx region capped in this run will be the same as that final region with the exception of Arkansas, although this run does not include a separate nested ozone season cap on all ozone States). The EPA used this model run to estimate costs of the NOx policy alone. Specifically, we compared the annual costs of the Base Case with the annual costs of this model run to get the costs of the NOx policy alone, and we compared the annual NOx emissions in the Base Case with the annual NOx emissions in this model run. Using the annual costs of the proposed NOx policy and the annual emission reductions, we calculated the estimated average costs of NOx reductions.

In addition, we used this run to estimate the average cost of NOx reductions during the months outside of the ozone season (non-ozone season reductions). That analysis is discussed further below (see the run ID **CAIR 2004_No SO2_Summer NOx_1**).

**IPM Run ID: CAIR 2004_EIA**
**Description: CAIR Policy Using Alternate Assumptions for Natural Gas Price and Electricity Growth**
The EPA performed a sensitivity analysis to evaluate the effect of varying our assumptions about natural gas price and electricity growth on the projected marginal costs of CAIR. This model run is the same as the initial CAIR policy run, **CAIR 2004_Analysis**, except for the different assumptions for natural gas price and electricity growth. Specifically, for this run EPA used the difference between EIA's estimates for well-head natural gas prices and minemouth coal prices to establish the difference between the natural gas and coal prices for this IPM run, increasing our natural gas price assumptions to be more similar to EIA's. For electricity growth in this IPM run, we replaced EPA's assumed annual growth of 1.6% with EIA's projection of annual growth of 1.8 %. As with the CAIR 2004 analysis run, modeling was based on a slightly different control strategy than that required by the final rule, but quite similar to what the final requirements will be if EPA finalizes its proposal to require annual reductions in Delaware and New Jersey.

**IPM Run ID: CAIR 2004_CSP**
**Description: Final CAIR Policy with Compliance Supplement Pool**
The EPA performed a sensitivity analysis to evaluate the effect of an annual NOx Compliance

Supplement Pool on the projected marginal costs of NOx control of CAIR. This run is the same as the final CAIR policy run, **CAIR 2004_Final**, except that an additional 200,000 tons is added to the annual NOx cap for the initial model run year. In other IPM runs in v.2.1.9, years 2008 through 2012 are mapped to model run year 2010, however in this run, year 2008 is mapped separately to model run year 2008 and years 2009 through 2012 are mapped to model run year 2010.

**IPM Run ID: CAIR 2004_No SO2_Summer NOx_1**
**Description: CAIR NOx Policy during Ozone Season Only in All CAIR States, with Base Case SO2 Policy**
In this IPM run, EPA applied ozone season NOx controls at CAIR levels in all States affected by CAIR (not only in States that are required to make ozone season NOx reductions), and Base Case SO2 policy. Specifically, EPA applied a regionwide ozone season NOx cap on the same 26 States plus the District of Columbia as in run **CAIR 2004_No SO2** (see above), and separate ozone season NOx caps on Connecticut and Massachusetts.

The EPA used this IPM run to estimate the average cost of NOx reductions during months outside the ozone season (non-ozone season reductions). The Agency compared the NOx emissions from this run to the NOx emissions from run **CAIR 2004_No SO2** (which included annual NOx reductions in all affected States except Connecticut and Massachusetts, which have ozone season reductions), to get an estimate of non-ozone season reductions. We also compared the total costs of the same two model runs, and used the difference in costs and the difference in emissions to estimate the average cost of NOx tons reduced during months outside of the ozone season. (For this IPM run, EPA assumed that Rhode Island – which was not found to be a significant contributor for 8-hour ozone or PM2.5 under CAIR, but is a NOx SIP Call State – would not trade with CAIR States. This was simply an assumption for modeling purposes, it does not reflect any assumption of future policy choices.)

**IPM Run ID: CAIR 2004_No SO2_Summer NOx_2**
**Description: CAIR NOx Policy during Ozone Season Only in 8-Hour Ozone States, with Base Case SO2 Policy**
The EPA used this IPM run to estimate the average and marginal costs of ozone season NOx reductions for CAIR. This run is quite similar to the run described above, with regionwide ozone season NOx controls at CAIR levels and Base Case SO2 policy. The difference between this run and the preceding run is in the region covered by the ozone season NOx caps. For the preceding run, ozone season NOx caps were applied to all States affected by CAIR, however, for this run ozone season caps were applied only to the subset of States that EPA found to be significant contributors for 8-hour ozone (25 States and the District of Columbia).

To estimate the average costs of ozone season NOx reductions for CAIR, EPA compared the total costs of the Base Case IPM run with the total costs of this IPM run and compared the NOx emissions in the Base Case run with the NOx emissions in this run. (For this IPM run, EPA assumed that Rhode Island – which was not found to be a significant contributor for 8-hour ozone under CAIR, but is a NOx SIP Call State – would not trade with CAIR States. This was

simply an assumption for modeling purposes, it does not reflect any assumption of future policy choices.)

**IPM Run ID: BART 2004_No NOx**
**Description: Nationwide BART SO2 Limits, with Base Case NOx Policy**
In this IPM run, EPA modeled the Regional Haze Requirements for Best Available Retrofit Technology (BART) as nationwide source specific SO2 limits of 90% SO2 reduction or 0.1 lb/mmBtu rate (except the 5-State WRAP region for which we did not model SO2 controls beyond what is done for the WRAP cap in the base case modeling). The SO2 limits were applied to all BART-eligible units of capacity greater than 100 MW. The EPA used this model run to estimate the average costs of BART SO2 controls for comparison with CAIR costs.

**IPM Run ID: BART 2004_No SO2**
**Description: Nationwide BART NOx Limits, with Base Case SO2 Policy**
In this IPM run, EPA modeled the Regional Haze Requirements for BART as a nationwide source specific NOx emission rate limit of 0.2 lb/mmBtu NOx. The NOx limit was applied to all units with capacity greater than 25 MW. The EPA used this model run to estimate the average costs of BART NOx controls for comparison with CAIR costs.

**IPM Run ID: CAIR 2004_SCR Bypass_NOx SIP Call**
**Description: CAIR Policy with Cost for Gas Bypass Duct Systems on Existing SCRs**
The EPA used this run as a sensitivity analysis to evaluate the effect of adding a gas bypass duct system to each existing SCR installation on the costs of CAIR. In this run, the cost of a gas bypass duct system was added for pre-1994 coal units with SCR that are located in the NOx SIP Call region or OTR. (This result is not presented in the NFR preamble section IV, but is in the RTC document.)

| Table 1 – Combustion Control Costs Used in Estimating Average Control Costs (dollars[1]/year) | | |
|---|---|---|
| **IPM Run ID** | **2009 / 2010** | **2015** |
| Base Case 2004 | $48,787,094 | $48,879,415 |
| CAIR 2004_No NOx | $48,787,094 | $48,879,415 |
| CAIR 2004_No SO2 | $90,952,515 | $91,044,836 |
| CAIR 2004_No SO2_Summer NOx_1 | $90,952,515 | $91,044,836 |
| CAIR 2004_No SO2_Summer NOx_2 | $79,044,348 | $79,136,668 |
| BART 2004_No NOx | $48,787,094 | $48,879,415 |
| BART 2004_No SO2 | $48,787,094 | $122,104,629 |

[1] 1999$

**Description of IPM Runs Used to Estimate Capacity of Control Retrofits for Feasibility Analyses**

The EPA used IPM to project the capacity of EGUs that would be retrofit with emission control devices for compliance with CAIR, in order to evaluate the feasibility of achieving the CAIR control levels in the available time period. The emission control devices in EPA's analysis include selective catalytic reduction (SCR) and Flue Gas Desulfurization (FGD). EPA provides a detailed discussion of its feasibility analyses in section IV.C in the CAIR NFR preamble. In addition, EPA provides further discussion in a TSD entitled "Boilermaker Labor and Installation Timing Analysis" that is available in the CAIR docket. The Agency used IPM to project the capacity of SCR and FGD retrofits that would occur for compliance with CAIR, as well as to project the capacity of retrofits that could occur under alternate scenarios. The IPM runs that EPA used for these analyses are described below.

**IPM Run ID: EPA216_IAQR_2003**
**Description: Policy Case for the CAIR NPR**
The EPA used this IPM run to project control retrofits under the conditions of the CAIR NPR. This run was described in the NPR.

**IPM Run ID: CAIR 2004_Analysis**
**Description: CAIR 2004 Analysis Run**
This is the CAIR 2004 analysis run, which EPA used for several analyses for the final CAIR. See description above.

**IPM Run ID: CAIR 2004_EIA**
**Description: CAIR Policy Using Alternate Assumptions for Natural Gas Price and Electricity Growth**
The EPA used this run as a sensitivity analysis to evaluate the effect of varying assumptions about natural gas price and electricity growth on the capacity of control retrofits. See description of this run above.

**IPM Run ID: CAIR 2004_EIA_SCR Costs**
**Description: CAIR Policy Using Alternate Assumptions for Natural Gas Price, Electricity Growth, and SCR Costs**
The EPA used this run as a sensitivity analysis to evaluate the effect of varying assumptions about natural gas price, electricity growth, and SCR costs on the capacity of control retrofits. In this run, the natural gas price and electricity growth assumptions are the same as in run **CAIR 2004_EIA**. For SCR costs in this run, EPA assumed 30% higher capital costs and fixed Operations and Maintenance costs for SCR on coal-fired units, compared to the costs in EPA's other IPM runs.

**IPM Run ID: CAIR 2004_EIA_One Phase**
**Description: CAIR Policy Using Alternate Assumptions for Natural Gas Price and Electricity Growth, with Implementation in One Phase Starting in 2010**
The EPA used this run as a sensitivity analysis to evaluate the effect of varying assumptions about natural gas price and electricity price, in addition to modifying the timing of the control requirements, on the capacity of control retrofits. In this run, the natural gas price and electricity growth assumptions are the same as in run **CAIR 2004_EIA**. In addition, this run is based on a policy with one control phase instead of two phases. In this run, the CAIR second phase (lower) regionwide SO2 and NOx emissions caps are implemented in 2010 instead of 2015.

**Background on EPA's TRUM Analyses**
The EPA developed marginal cost curves to examine the changes in marginal costs for EGUs at varying levels of SO2 and NOx emission reductions. These curves are presented in section IV in the CAIR NFR preamble[4]. The Agency developed these marginal cost curves using the Technology Retrofit and Updating Model (TRUM), a model that selects investment options and dispatches generation to meet electricity demand. For simplicity, TRUM was developed as a steady-state, single-region spreadsheet model supported by Visual Basic for Applications (VBA) code. The TRUM consists of a set of sample generating units with varying characteristics. The

[4] EPA used the marginal cost curve analysis solely to corroborate its findings concerning cost effectiveness of CAIR emission reductions. The marginal cost curve reflects only emissions reduction and cost information, and not other considerations. We note that it might be reasonable in a particular regulatory action to require emissions reductions past the knee of the curve to reduce overall costs of meeting the NAAQS or to achieve benefits that exceed costs. It should be noted that similar analysis for other source categories may yield different curves.

mix of generation types and sizes was chosen to mirror, in general terms, the nationwide mix of capacities. The TRUM relies on the same underlying data as IPM. For the final CAIR, EPA updated TRUM based on the IPM update (IPM version 2.1.9).

In the CAIR NPR, the Agency also presented marginal costs curves for SO2 and NOx reductions from EGUs. When the NPR was published, EPA provided a detailed description of its use of TRUM to develop such curves in a memo to the CAIR docket. That memo, which is entitled "Analysis of the Marginal Cost of SO2 and NOx Reductions" and dated January 28, 2004, is available in the CAIR docket and also on EPA's website. For a more detailed description of EPA's use of TRUM than is provided in this TSD, refer to the January 28, 2004 memo.