7 Set-up Parameters and Rules

The EPA Base Case v.4.10 includes a number of assumptions that affect the way IPM treats the analysis time horizon, retrofit assignments, and environmental specifications for trading and banking. This section provides an overview of those assumptions.

7.1 Run Year Mapping

Although IPM is capable of representing every individual year in an analysis time horizon, individual years are typically grouped into model run years to increase the speed of modeling. While the model makes decisions only for run years, information on non-run years can be captured by mapping run years to the individual years they represent.

The analysis time horizon for EPA Base Case v.4.10 extends from 2012 through 2054 with IPM seeking the least cost solution that meets all constraints and minimizes net present values over this 43-year period. The six years designated as "model run years" and the mapping of calendar years to run years is shown in Table 7-1.

Table 7-1 Run Years and Analysis Year Mapping Used in the EPA Base Case v.4.10

Run Year	Years Represented
2012	2012 - 2013
2015	2014 - 2016
2020	2017 - 2024
2030	2025 - 2034
2040	2035 - 2045
2050	2046 - 2054

7.2 Retrofit Assignments

In IPM, model plants that represent existing generating units have the option of maintaining their current system configuration, retrofitting with pollution controls, or retiring early. The decision to retrofit or retire is endogenous to IPM and based on the least cost approach to meeting the system and other operating constraints included in the EPA Base Case v.4.10. IPM is capable of modeling retrofits and early retirements in two stages, enabling model plants to install two different sets of retrofits incrementally at different points in time. At each stage a retrofit set may consist of a single retrofit (e.g. LSFO Scrubber) or pre-specified combinations of retrofits (e.g., ACI + LSFO Scrubber +SCR). In EPA Base Case v.4.10 first stage retrofit options are provided to existing coal-steam and oil/gas steam plants. These plants, as well as combined cycle plants, combustion turbines, and nuclear plants, are also given early retirement as an option in stage 1. Second stage retrofit options are provided to coal-steam plants only.

Table 7-2 and Table 7-3 present the first and second stage retrofit options respectively. The costs of multiple retrofits on the same model plant, whether installed in one or two stages, are assumed to be additive. In linear programming models like IPM, projections of pollution control equipment capacity and early retirements that can occur over the modeling time horizon are limited to those retrofit and retirement options that have been pre-specified when setting up the modeled scenario. While the model decides endogenously whether and how much of each retrofit option to install, it cannot provide a retrofit that was not pre-specified before the modeling scenario was run. Table 7-2 and Table 7-3 show all the retrofit options available in EPA Base Case v.4.10.

Table 7-2 First Stage Retrofit Assignment Scheme in EPA Base Case v.4.10

Plant Type	Retrofit Option 1st Stage	Criteria
Coal Steam	Coal Early Retirement	All coal steam boilers
	Coal Steam SCR	All coal steam boilers that are 25 MW or larger and do not possess an existing SCR control option
	Coal Steam SNCR – Cyclone Boilers	All cyclone coal steam boilers that are 25 MW or larger and smaller than 100 MW, and do not possess an existing post combustion NO_x control option
	Coal Steam SNCR – Non Cyclone Boilers and Non FBC Boilers	All non cyclone and non FBC coal steam boilers that are 25 MW or larger and smaller than 100 MW, and do not possess an existing post combustion NO_x control option
	Coal Steam SNCR – FBC Boilers	All coal FBC units that are 25 MW or larger and do not possess an existing post combustion NO_x control option
	LSD Scrubber	All unscrubbed and non FBC coal steam boilers 25 MW or larger and burning less than 3 lbs/MMBtu SO_2 coal
	LSFO Scrubber	All unscrubbed and non FBC coal steam boilers 25 MW or larger
	CO_2 Capture and Storage	All scrubbed coal steam boilers 400 MW or larger
	ACI - Hg Control Option (MPAC/ SPAC/ SPAC+ Toxecon)	All coal steam boilers larger than 25 MW that do not have an ACI and have an Hg EMF greater than 0.1. Actual ACI technology type will be based on the boilers fuel and technology configuration. See discussion in Chapter 5.
	LSD Scrubber + SCR	Combination options – Individual technology level restrictions apply
	LSD Scrubber + SNCR	
	LSFO Scrubber + SCR	
	LSFO Scrubber + SNCR	
	ACI + SCR	
	ACI + SNCR	
	ACI + LSD Scrubber	
	ACI + LSFO Scrubber	
	ACI + LSD Scrubber + SCR	
	ACI + LSFO Scrubber + SCR	
	ACI + LSD Scrubber + SNCR	
	ACI + LSFO Scrubber + SNCR	
Combined Cycle	CC Early Retirement	All combined cycle units
Combustion Turbine	CT Early Retirement	All combustion turbine units
Nuclear	Nuclear Early Retirement	All nuclear power units
Oil and Gas Steam	Oil/Gas Early Retirement	All O/G steam boilers
	Oil and Gas Steam SCR	All O/G steam boilers 25 MW or larger that do not possess an existing post combustion NO_x control option

Table 7-3 Second Stage Retrofit Assignment Scheme in EPA Base Case v.4.10

Plant Type	Retrofit Option 1st Stage	Retrofit Option 2nd Stage[5]
Coal Steam	NO_x Control Option[1]	SO_2 Control Option and/or Hg Control Option and/or CO_2 Control Option
	SO_2 Control Option[2]	NO_x Control Option and/or Hg Control Option and/or CO_2 Control Option
	Hg Control Option[3]	CO_2 Control Option
	CO_2 Control Option[4]	None
	NO_x Control Option[1] + SO_2 Control Option[2]	Hg Control Option
	NO_x Control Option[1] + Hg Control Option[3]	CO_2 Control Option
	SO_2 Control Option[2] + Hg Control Option[3]	CO_2 Control Option
	NO_x Control Option[1] + SO_2 Control Option[2] + Hg Control Option[3]	CO_2 Control Option

Notes:
[1] "NO_x Control Option" implies that a model plant may be retrofitted with one of the following NO_x control technologies:
SCR, SNCR - cyclone, SNCR - non-cyclone, or SNCR - FBC
[2] "SO_2 Control Option" implies that a model plant may be retrofitted with one of the following SO_2 control technologies:
LSFO scrubber or LSD scrubber

[3] "Hg Control Option" implies that a model plant may be retrofitted with one of the following activated carbon injection technology options for reduction of mercury emissions:
MPAC, SPAC, or SPAC + Toxecon

[4] "CO_2 Control Option" implies that a model plant may be retrofitted with carbon capture and storage technology
[5] Retrofits with multiple 2nd stage options may install any combination of the listed options.

7.3 Trading and Banking

Four regional or national environmental air regulations included in EPA Base Case v.4.10 involve trading and banking of emission allowances[47]: NO_x SIP Call program, the Title IV SO_2 program, the West Region Air Partnership's (WRAP) program regulating SO_2 (as part of the federal Regional Haze Rule), and the Regional Greenhouse Gas Initiative (RGGI) for CO_2. Table 7-4 below summarizes the key parameters of these four trading and banking programs as incorporated in EPA Base Case v.4.10. Trading and banking are modeled on a U.S. system-wide basis for the Title IV SO_2 program and on a regional basis for the other three programs. EPA Base Case v.4.10 does not include any explicit assumptions on the allocation of emission allowances among model plants under any of the four programs.

[47] For a detailed discussion of the assumptions of all the environmental air regulations included in the EPA Base Case v.4.10, see chapter 3.

Table 7-4 Trading and Banking Rules in EPA Base Case v.4.10

	SIP Call - Ozone Seasons NO_x	Title IV - SO_2	WRAP- SO_2	RGGI - CO_2
Coverage	All fossil units > 25 MW[1]	All fossil units > 25 MW	All fossil units > 25 MW[2]	All fossil units > 25 MW[3]
Timing	Ozone Season (May - September)	Annual	Annual	Annual
Size of Initial Bank	The bank starting in 2012 is assumed to be zero	The bank starting in 2012 is assumed to be 11 million tons	The bank starting in 2018 is assumed to be zero	The bank starting in 2012 is assumed to be zero
Total Allowances (MTons)	2012 - 2054: 527.5	2012: 19,679 2013: 8,407 2014: 8,397 2015: 8,327 2016: 8,312 2017: 8,287 2018: 8,169 2019: 8,155 2020 - 2054: 8,153	2018 - 2054: 144.7	2012 - 2014: 188,077 2015: 183,375 2016: 178,673 2017: 173,971 2018 - 2054: 169,269

Notes:
[1] Alabama, Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Tennessee, Virginia, West Virginia
[2] Arizona, New Mexico, Oregon, Utah, Wyoming
[3] Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, Vermont, Rhode Island, Massachusetts, Maryland

7.4 Post-2030 Modeling Assumptions and Capabilities

Previous EPA base cases had at most a usable modeling time horizon out to year 2030. EPA Base Case v.4.10 has the capability to model out to 2050. However, bottom up models like IPM, which is used to build the EPA base case, require input data at the finest possible level of granularity. Preferably, such data would be based on gathered information obtained through regulatory submittals, surveys, and scientific, engineering, economic, and commercial assessments specifically related to the particular characteristics of the issue being modeled. Past 2030 or 2035 such information is rarely available.

As a result, a two tiered approach was taken to the inputs used to build EPA Base Case v.4.10. Prior to 2030 assumptions would be based to the greatest extent possible on verifiable empirical data gathered from the best available sources vetted using cross-checks against alternative data sources. Beyond 2030 a pragmatic approach was taken. Where credible empirical data was available, it would be used. Where empirical data was not available, technically plausible, explicitly articulated assumptions would be used to extrapolate pre-2030 assumptions out to 2050. While perhaps not optimal, such an approach was seen as potentially valuable, if only because it would focus attention on the long-range assumptions needed for bottom-up modeling and, in doing so, elicit comments from the interested public and technical experts. This could lead to future improvements in the long-range inputs with possible side benefits for all projections whether based on bottom-up, top-down or hybrid modeling approaches.

A corollary of this two tiered approach to input assumptions is that the modeling results past 2030 should be viewed somewhat differently from those prior to 2030. The pre-2030 modeling results are expected to bear scrutiny at a fine level of granularity (answering questions like the plausibility of a particular generating unit being retrofit with a dry SO_2 scrubber and a SCR in a particular model run year or of another generating unit being retired by IPM in a certain year).

The post-2030 modeling results are not intended to be examined at such a fine grain level. Instead, the post-2030 modeling capability is designed to serve two purposes: The first purpose is to ensure that EPA Base Case v.4.10 takes into account the potential impact of post-2030 policy provisions on pre-2030 modeling results. For example, it would be useful to have the capability to project the impact on pre-2030 modeling results of a provision in a Climate Change bill that takes effect in 2042. The second purpose is to give a broad sense of directional trends beyond 2030. For example, using current technology cost and performance assumptions, the long-range modeling capability could provide a picture of the likely composition of the power sector in 2040 or 2050 with and without policy intervention. To take fuller advantage of this capability, five generic placeholder future generation technologies have been included in EPA Base Case v.4.10. While not playing a role in the base case itself, their presence allows a user to define their cost and performance characteristics at a later time and to perform sensitivity analysis to see the possible impact of new technologies on post-2030 trends.

Table 7-5 shows the underlying post-2030 modeling assumptions incorporated in EPA Base Case v.4.10 for key modeling parameters.

Table 7-5 Post-2030 Assumptions in EPA Base Case v.4.10

Topic	Post-2030 Assumptions
POWER SYSTEM OPERATION	
Model Regions	Same as pre-2030
Electric Load Modeling	
Electric Load Growth	Post 2035 growth rate is based on AEO 2010 2025-2035 growth rate
Net Internal Demand (Peak Demand)	Post 2035 growth rate is based on AEO 2010 2025-2035 growth rate
Load Duration Curves (LDCs)	2007 load curves adjusted to post 2030 energy and peak load projections. LDCs include six segments per season in run years 2012, 2015, 2020, and 2030 and four segments in 2040 and 2050.
Transmission	
Interregional Transmission Capability	Same as pre-2030
Transmission Link Wheeling Charge	Same as pre-2030
Transmission Losses	Same as pre-2030
International Imports	
Mexico	Same as 2030
Canada	Endogenously Modeled
Capacity, and Dispatch	
Availability	Same as pre-2030 for all plant types except nuclear Same as 2030 for nuclear
Capacity Factor	Same as 2030
Turndown	Same as pre-2030
Reserve Margins	Same as pre-2030
Power Plant Lifetimes	Same as pre-2030
Existing Environmental Regulation	
SO_2 Regulations	Same as 2030

Topic	Post-2030 Assumptions
NO_x Regulations	Same as 2030
State Specific Environmental Regulations	Same as 2030
New Source Review (NSR)	Same as 2030
Emission Assumptions for Potential (New) Units	Same as pre-2030
Capacity Deployment Constraints	Run year specific
GENERATING RESOURCES	
National Electric Energy Data System (NEEDS)	Same as pre-2030
Existing Units and Planned/Committed Units	
Population of Existing Units	Same as pre-2030
Capacity	Same as pre-2030
Plant Location	Same as pre-2030
Online Year	Same as pre-2030
Unit Configuration	Same as pre-2030
Model Plant Aggregation	Same as pre-2030
Cost and Performance of Existing Units	Same as pre-2030
Heat Rates	Same as pre-2030
NO_x Rates	Same as pre-2030
Potential Units	
Cost and Performance of Potential Conventional Technologies	Same as pre-2030
Cost and Performance of Potential Renewable Technologies	
Biomass	Same as 2030
Wind	Same as 2030
Solar	Same as 2030
Geothermal	Same as pre-2030
Landfill Gas	Same as 2030
Short Term Cost Adder	None
Regional Adjustment Factor	Same as pre-2030
Nuclear Units	
Existing Nuclear Units	
VOM and FOM Cost Assumptions for Nuclear Units	Same as pre-2030 (adjusted for life extension costs)
Nuclear Upratings (MW)	None
Nuclear Scheduled Retirements (MW)	Retirement at age 60 years
Potential Nuclear Units	Same as 2030
EMISSION CONTROL TECHNOLOGIES	
Sulfur Dioxide Control Technologies	
Limestone Forced Oxidation (LSFO)	Same as pre-2030
Lime Spray Drying (LSD)	Same as pre-2030
FGD Engineering Cost Equations	Same as pre-2030
Nitrogen Oxides Control Technology	
Combustion Controls	Same as pre-2030
Post-combustion Controls	Same as pre-2030
SCR and SNCR Engineering Cost Equations	Same as pre-2030
Mercury Control Technologies	
Mercury Content of Fuels	Same as pre-2030

Topic	Post-2030 Assumptions
Mercury Emission Modification Factors	Same as pre-2030
Mercury Control Capabilities	Same as pre-2030
ACI Engineering Cost Equations	Same as pre-2030
CO_2 Sequestration	
CO_2 capture	Same as pre-2030
CO_2 transport	Same as pre-2030
CO_2 storage cost curves	Same as pre-2030
SETUP PARAMETERS AND RULES	
Run Year Mapping	Run year specific
Retrofit Assignments	Same as pre-2030
FINANCIAL ASSUMPTIONS	
Methodology	
Capital Charge Rates for Investments	Same as 2030
Discount Rate for Capital and Non-Capital Costs	Same as pre-2030
FUEL ASSUMPTIONS	
Coal	
Coal Markets	Same as pre-2030
Coal Supply Curves	2030 cost-adjusted for labor productivity
Coal Transportation Costs	2030 cost-adjusted for fuel price changes
Coal Assignments	Same as pre-2030
Emission Factors	Same as pre-2030
Natural Gas	
Resources Data and Reservoir Description	
Field Development and Production Forecast Methodology	Same as pre-2030
Lower 48 States U.S. Resources	Same growth as pre-2030
Canada Resources	Same growth as pre-2030
Treatment of Frontier Resources	Alaska North Slope starts 2040
Exploration and Production (E&P) Technology Characterization	Same as 2030
End Use Demand Characterization	Same growth as pre-2030
Pipeline and Transport	
Existing pipelines	Same as pre-2030
Potential pipeline costs	Same growth as pre-2030
Emission Factors	Same as pre-2030
Fuel Oil	
Prices	Same as 2035
Emission Factors	Same as pre-2030
Biomass	
Biomass Supply Curves	Same as 2035
Emission Factors	Same as pre-2030
Nuclear Fuel Prices	Same as 2030