

7. Set-up Parameters and Rules

The EPA Base Case v.5.13 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.5.13 extends from 2016 through 2054, with IPM seeking the least cost solution that meets all constraints and minimizes the net present value of system cost. The seven 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.5.13

Run Year	Years Represented
2016	2016 - 2017
2018	2018
2020	2019 - 2022
2025	2023 - 2027
2030	2028 - 2033
2040	2034 - 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. The decision to retrofit or retire is endogenous to IPM and based on the least cost approach to meeting demand subject to modeled system and operational constraints. IPM is capable of modeling retrofits and retirements at each applicable model unit at three different points in time, referred to as three stages. 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.5.13 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 retirement as an option in stage one. Third stage retrofit options are offered to coal-steam plants only.

Table 7-2 presents the first stage retrofit options available by plant type; Table 7-3 presents the second and third stage retrofit options available to coal-steam plants. The cost of multiple retrofits on the same model plant, whether installed in one or multiple stages, are additive. In linear programming models such as IPM, projections of pollution control equipment capacity and retirements are limited to the pre-specified combinations listed in Table 7-2 and Table 7-3 below.

Table 7-2 First Stage Retrofit Assignment Scheme in EPA Base Case v.5.13

Plant Type	Retrofit Option 1st Stage	Criteria
Coal Steam		
	Coal 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 – Non FBC Boilers	All 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 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 (with and without 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	
	DSI	All unscrubbed and non FBC coal steam boilers 25 MW or larger with Fabric Filter and burning less than 2 lbs/MMBtu SO ₂ coal.
	DSI + Fabric Filter	All unscrubbed and non FBC-coal steam boilers 25 MW or larger without Fabric Filter and with CESP or HESP and burning less than 2 lbs/MMBtu SO ₂ coal.
	DSI + SCR	Combination options – Individual technology level restrictions apply
	DSI + SNCR	
	ACI + DSI	
	ACI + DSI + SCR	
	ACI + DSI + SNCR	
	Heat Rate Improvement	All coal steam boilers with a heat rate larger than 9,500 Btu/kWh
	Coal-to-Gas	All coal steam boilers that are 25 MW or larger
Integrated Gasification Combined Cycle		
	IGCC Retirement	All integrated gasification combined cycle units
Combined Cycle		
	CC Retirement	All combined cycle units
Combustion Turbine		
	CT Retirement	All combustion turbine units
Nuclear		
	Nuclear Retirement	All nuclear power units

Plant Type	Retrofit Option 1 st Stage	Criteria
Oil and Gas Steam		
	Oil/Gas 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 and Third Stage Retrofit Assignment Scheme in EPA Base Case v.5.13

Plant Type	Retrofit Option 1 st Stage	Retrofit Option 2 nd Stage	Retrofit Option 3 rd Stage
Coal Steam			
	NO _x Control Option ^a	SO ₂ Control Option	Heat Rate Improvement
		HCl Control Option	Heat Rate Improvement
		CO ₂ Control Option	None
		Heat Rate Improvement	CO ₂ Control Option
		Coal Retirement	None
	SO ₂ Control Option ^b	NO _x Control Option	Heat Rate Improvement
		CO ₂ Control Option	None
		Heat Rate Improvement	CO ₂ Control Option
		Coal Retirement	None
	Hg Control Option ^c	NO _x Control Option	Heat Rate Improvement
		SO ₂ Control Option	Heat Rate Improvement
		HCl Control Option	Heat Rate Improvement
		CO ₂ Control Option	None
		Heat Rate Improvement	CO ₂ Control Option
		Coal Retirement	None
	CO ₂ Control Option ^d	None	None
	NO _x Control Option ^a + SO ₂ Control Option ^b	CO ₂ Control Option	None
		Heat Rate Improvement	CO ₂ Control Option
		Coal Retirement	None
	NO _x Control Option ^a + Hg Control Option ³	SO ₂ Control Option	Heat Rate Improvement
		HCl Control Option	Heat Rate Improvement
		CO ₂ Control Option	None
		Heat Rate Improvement	CO ₂ Control Option
		Coal Retirement	None
	SO ₂ Control Option ^b + Hg Control Option ³	NO _x Control Option	Heat Rate Improvement
		CO ₂ Control Option	None
		Heat Rate Improvement	CO ₂ Control Option
		Coal Retirement	None
NO _x Control Option ^a + SO ₂ Control Option ^b + Hg Control Option ^c	CO ₂ Control Option	None	
	Heat Rate Improvement	CO ₂ Control Option	
	Coal Retirement	None	
HCl Control Option ^e	NO _x Control Option	Heat Rate Improvement	
	SO ₂ Control Option	Heat Rate Improvement	
	Heat Rate Improvement	None	
	Coal Retirement	None	
NO _x Control Option ^a + HCl Control Option ^e	SO ₂ Control Option	Heat Rate Improvement	
	Heat Rate Improvement	None	
	Coal Retirement	None	
Hg Control Option ^c + HCl Control	NO _x Control Option	Heat Rate Improvement	

Plant Type	Retrofit Option 1 st Stage	Retrofit Option 2 nd Stage	Retrofit Option 3 rd Stage
	Option ^e	SO ₂ Control Option	Heat Rate Improvement
		Heat Rate Improvement	None
		Coal Retirement	None
	NO _x Control Option ^a + HCl Control Option ^e + Hg Control Option ^c	SO ₂ Control Option	Heat Rate Improvement
		Heat Rate Improvement	None
		Coal Retirement	None
	Heat Rate Improvement	NO _x Control Option	None
		SO ₂ Control Option	None
		HCl Control Option	None
		CO ₂ Control Option	None
		Coal Retirement	None
	Coal-to-Gas	NO _x Control Option	None
		Oil/Gas Retirement	None
Coal Retirement	None	None	
Oil and Gas Steam			
	NO _x Control Option ^a	Oil/Gas Retirement	None
	Oil/Gas Retirement	None	None

Notes:

- ^a "NO_x Control Option" implies that a model plant may be retrofitted with one of the following NO_x control technologies: SCR, SNCR - non-FBC, or SNCR - FBC
- ^b "SO₂ Control Option" implies that a model plant may be retrofitted with one of the following SO₂ control technologies: LSFO scrubber or LSD scrubber
- ^c "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: ACI or ACI + Toxecon
- ^d "CO₂ Control Option" implies that a model plant may be retrofitted with carbon capture and storage technology
- ^e "HCl Control Option" implies that a model plant may be retrofitted with a DSI (with milled Trona)

7.3 Emissions Trading and Banking

Five environmental air regulations included in EPA Base Case v.5.13 involve regional trading and banking of emission allowances⁴⁸: The three programs of the Clean Air Interstate Rule (CAIR) – Annual SO₂, Annual NO_x, and Ozone Season NO_x; the Regional Greenhouse Gas Initiative (RGGI) for CO₂; and the West Region Air Partnership's (WRAP) program regulating SO₂ (adopted in response to the federal Regional Haze Rule). Table 7-4 below summarizes the key parameters of these five trading and banking programs as incorporated in EPA Base Case v.5.13. EPA Base Case v.5.13 does not include any explicit assumptions on the allocation of emission allowances among model plants under any of the programs. The NO_x SIP Call requirements for ozone season NO_x for the state of Rhode Island are also included in EPA Base Case v.5.13.⁴⁹

Intertemporal Allowance Price Calculation

Under a perfectly competitive cap-and-trade program that allows banking (with a single, fixed future cap and full "banking" allowed), the allowance price always increases by the discount rate between periods if affected sources have allowances banked between those two periods. This is a standard economic result for cap-and-trade programs and prevents sources from profiting by arbitraging allowances between two periods.

⁴⁸ For a detailed discussion of the assumptions modeled for all environmental air regulations in the EPA Base Case v.5.13, refer to Chapter 3.

⁴⁹ For more information on individual state emission caps and constraints, see the All Constraints worksheet in the SSR file.

The EPA Base Case v.5.13 uses the same discount rate assumption (4.77%) that governs all intertemporal economic decision-making in the model in order to compute the increase in allowance price for cap-and-trade programs when banking is engaged as a compliance strategy. This approach is based on the assumption that allowance trading is a standard activity engaged in by generation asset owners and that their intertemporal investment decisions as related to allowance trading will not fundamentally differ from other investment decisions. For more information on how this discount rate was calculated, please see Section 8.2.

Table 7-4 Trading and Banking Rules in EPA Base Case v.5.13

Coverage	CAIR Annual SO ₂	CAIR Annual NO _x	CAIR - Ozone Season NO _x	WRAP- SO ₂	RGGI - CO ₂
	All fossil units > 25 MW ^a	All fossil units > 25 MW ¹	All fossil units > 25 MW ^b	All fossil units > 25 MW ^d	All fossil units > 25 MW ^e
Timing	Annual	Annual	Ozone Season (May - September)	Annual	Annual
Size of Initial Bank (MTons)	pre 2010: 5,985.768 2010-2014: 22,298.08 2015-2015: 2,333.776	2016: 1,514.702	2016: 740.665	The bank starting in 2018 is assumed to be zero	2016: 107,743
Rules					
Total Allowances (MTons)	2016 -2054: 8,950	2016 -2054: 1,242	2016 -2054: 484.5	2018 - 2054: 89.6	2016: 68,459 2017: 66,297 2018: 64,188 2019: 62,132 2020: 60,128 2021 - 2054: 78,175
Total Allowances Less NSR (MTons)	2016 - 2017: 8,808 2018: 8,740 2019: 8,682 2020 - 2054: 8,662	2016 -2054: 1,242	2016 -2054: 484.5	NA	NA
Retirement Ratio	2016 - 2054: 2.86	2016 - 2054: 1.0	2016 - 2054: 1.0	2016 - 2054: 1.0	2016 - 2054: 1.0

Notes:

- ^a Alabama, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Michigan, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.
- ^b Alabama, Arkansas, Connecticut, Delaware, District of Columbia, 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.
- ^c Rhode Island is the only NO_x SIP Call state not covered by the CAIR Ozone Season NO_x program.
- ^d New Mexico, Utah, Wyoming
- ^e Connecticut, Delaware, Maine, New Hampshire, New York, Vermont, Rhode Island, Massachusetts, Maryland