Minnesota Pilot Project
Overview of Proposed Modeling Using IPM®

Presented by ICF International

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Introduction

- The US EPA is working with Minnesota to ensure stakeholders have the information and tools needed to meet upcoming electric utility sector rules in an integrated way. This approach will offer greater regulatory certainty to enable more informed investment decisions in the sector.

- ICF's Integrated Planning Model (IPM®), with detailed modeling of the power sector and expanded to represent emissions and emissions reduction opportunities for a broad range of sectors, is being used for this analysis. The IPM is the tool used by US EPA's Clean Air Markets Division for analysis of proposed regulations.

- The proposed model runs for this project are based on the US EPA's v4.10 Base Case using IPM. These proposed run specifications were developed during previous teleconferences with the Minnesota working group.

- Detailed documentation for the US EPA v4.10 Base Case assumptions are available at http://www.epa.gov/airmarkets/progsregs/epa-ipm/BaseCasev410.html

IPM® Overview

- Multi-regional, deterministic, dynamic linear programming model with perfect foresight.
- Long-term capacity expansion and production costing model for analyzing the electric power sector.
- Comprehensive natural gas supply, demand, and pipeline modeling capability.
- Finds the least-cost solution to meeting electricity and steam demand subject to environmental, transmission, fuel, reserve margin, and other system operating constraints.
- IPM has evolved over 30 years after millions of dollars in development costs.
- A core group of modelers update the tool on a continuous basis.

Run Definition Assumptions

Run Years

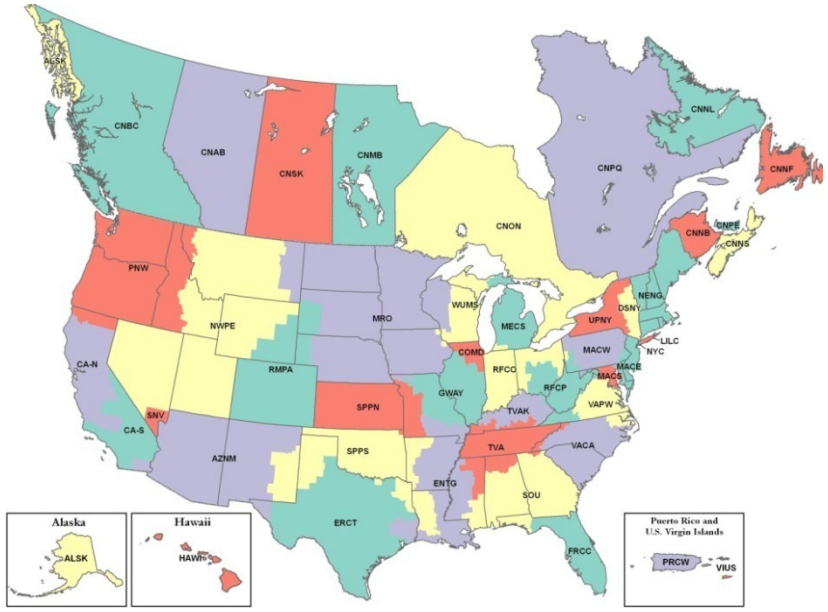
- IPM® is equipped with a year-mapping feature that enables simulations of long time horizons.
  - Several years in the time horizon can be mapped into a single run year.
  - Generation costs for all years that are mapped to a run year are computed and included in the objective function.
- The EPA Minnesota study will report six run years consistent with those in EPA v4.10 Base Case.

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

Each run year will be modeled with two seasons: Winter (October-April) and Summer (May-September).

Model Regions

- IPM Model regions are configured in order to:
  - Capture transmission bottlenecks.
  - Maintain consistencies with primary data sources.
  - Maintain consistency with NERC region and sub regions.
- The EPA Base Case models 32 model regions in the continental USA and 11 model regions in Canada.



Market Assumptions

Electricity Demand in IPM®

- Demand is represented in IPM® at a model region level by a combination of the following variables:
  - **Peak Demand** – The maximum power load (MW) requirement for a model region.
  - **Energy Demand** – The total energy requirement (MWh) for a model region, defined annually.
  - **Hourly Load Profiles** – The 24-hour shape of demand level, defined for 8760 hours of a base year, for each model region, scaled to meet peak and energy demand. Hourly load files are created from the historical load data filed by each region's utilities (FERC Form 714) for a normal weather year.
- EPA Base Case v4.10 uses the electricity demand assumptions from AEO 2010 Reference Case.

Supply in IPM®

- Supply in IPM® is defined by a combination of the following options:
  - **Existing Capacity** – The generating capacity currently available to the grid.
  - **Firmly Planned Capacity** – The generating capacity that is firmly planned to be built.
  - **New build Cost and Performance** – The specifications for new potential capacity types, including assumptions about technology improvement over time and resource potential.

Existing Capacity – IPM® Power Plant Database

- IPM® requires detailed information on all existing and planned and committed grid-connected electric generators and boilers in the continental U.S.
- The IPM power plant database will be based on EPA's National Electric Energy Data System (NEEDS). NEEDS database contains the generation unit records used to construct the "model" plants that represent existing and planned/committed units in EPA modeling applications of IPM. NEEDS includes basic geographic, operating, air emissions, and other data on these generating units.
- Existing and planned committed units in the database, with the exception of nuclear units, are not provided with a specific retirement year. However, IPM can endogenously retire power plants based on economics. The life extension cost estimates are based on EPA Base Case v4.10.

Emissions Control Technologies/Retrofits

Emissions Control Technologies/Retrofits

- Within the IPM® framework, units affected by air emissions regulations can comply by fuel-switching, buying allowances if the policy is market-based, reducing dispatch/shutting down, or installing emissions control technologies.

- EPA Base Case v4.10 using IPM explicitly models the most common existing control technologies, each of which impact the emissions rate for SO_2, NO_X, mercury, and CO_2 emissions. Emission reduction factors are applied to the input content of the fuel to reflect the technology.

Pollutant	Technology
SO_2	Wet Scrubber, Dry Scrubber
NO_x	SCR, SNCR
Mercury	ACI
CO_2	Carbon Capture, Biomass Cofiring

Air Regulatory Policies

Federal and Regional Air Regulations

- SO_2, NO_x and Mercury Regulations:
  - In 2004-2005, EPA had promulgated the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR) to control SO_2, NO_x and mercury emissions from the power sector.
  - Subsequently, CAIR and CAMR have been vacated by the courts.
  - Recently, EPA finalized the Cross-State Air Pollution Rule and is currently in the process of finalizing Mercury and Air Toxics Standards as replacement regulations to reduce SO_2, NO_x and mercury emissions from power plants. For this study, it is proposed that only the NO_x SIP Call and the Title IV SO_2 regulations be modeled in the Base Case.
  - Any policy already on the books (e.g., state policies, NSR settlements) are included in the EPA Base Case v4.10.

Description of Proposed Runs

Run ID	Run Description	Incremental EE for All States	Transport Rule	Toxics Rule	Coal Ash Rule	Section 316 (b)	NSPS
Run 1	Base Case 1 - w/o EE	No	No	No	No	No	No
Run 2	Policy Case 1 - Base Case 1 + Toxics + Transport Rule + Coal Ash*	No	Yes	Yes	Yes	No	No
Run 3	Policy Case 2 - Policy Case 1 + NSPS 1	No	Yes	Yes	Yes	No	Yes
Run 4	Policy Case 3 - Policy Case 1 + NSPS 2**	No	Yes	Yes	Yes	No	Yes
Run 5	Policy Case 4 - Policy Case 1 + NSPS 3**	No	Yes	Yes	Yes	No	Yes
	Runs with Incremental Energy Efficiency						
Run 6	Base Case 2 - Base Case 1 + EE	Yes	No	No	No	No	No
Run 7	Policy Case 5 - Base Case 2 + Toxics + Transport Rule + Coal Ash*	Yes	Yes	Yes	Yes	No	No
Run 8	Policy Case 6 - Policy Case 5 + NSPS 1	Yes	Yes	Yes	Yes	No	Yes
Run 9	Policy Case 7 - Policy Case 5 + NSPS 2**	Yes	Yes	Yes	Yes	No	Yes
Run 10	Policy Case 8 - Policy Case 5 + NSPS 3**	Yes	Yes	Yes	Yes	No	Yes

* Inclusion of Coal Ash Rule is not certain; final decision will be made by EPA later in this process.

** Specifications of NSPS variants will depend upon the final rule, which is unknown.