USEPA's Baseline Power Sector Modeling: Comparison of Pre and Post IRA Projections

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Introduction: USEPA's Power Sector Modeling

- This presentation explores the emissions from electricity generation in the US in the presence of the Inflation Reduction Act (IRA)—which is transformational.
  - IRA impacts both electricity supply (generation mix) and demand (electrification).

- EPA's power sector modeling website provides information and documentation on resources and regulatory applications. https://www.epa.gov/power-sector-modeling
  - EPA routinely engages with state air quality planning officials, power company representatives, regional transmission organizations, federal and research organizations, and others working on power sector modeling, exchanging feedback on the data, assumptions, and structure of EPA's power sector analytical tools.

- EPA uses the Integrated Planning Model (IPM) to analyze the business-as-usual (reference case) emissions and projected impact of environmental policies on the electric power sector; in addition to complementary analytical tools and approaches informing power sector projections and regulatory actions.

Modeling Resources

- National Electric Energy Data System (NEEDS)
- EPA's Power Sector Modeling Platform v6 using IPM
  - Results Viewer
  - Previous Versions
- Retrofit Cost Analyzer
- Power Sector Labor Analysis Methodology
- Energy Resources for State, Local, and Tribal Governments
- Clean Air Power Sector Programs – Data & Tools

Regulatory Analysis

- Proposed Greenhouse Gas Standards and Guidelines
- Proposed MATS RTR
- Final Good Neighbor Plan
- 2015 Ozone NAAQS Actions
- Proposed Good Neighbor Plan
- Final Revised CSAPR Update Rule
- Proposed Revised CSAPR Update Rule
- Final ACE Rule
- Proposed ACE Rule
- Final CSAPR Close-Out
- Proposed CSAPR Close-Out
- Notice of Data Availability: Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone NAAQS

Related Tools and Data
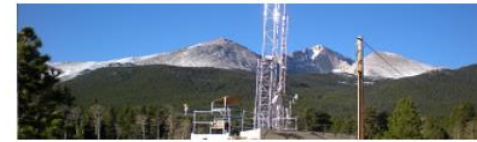
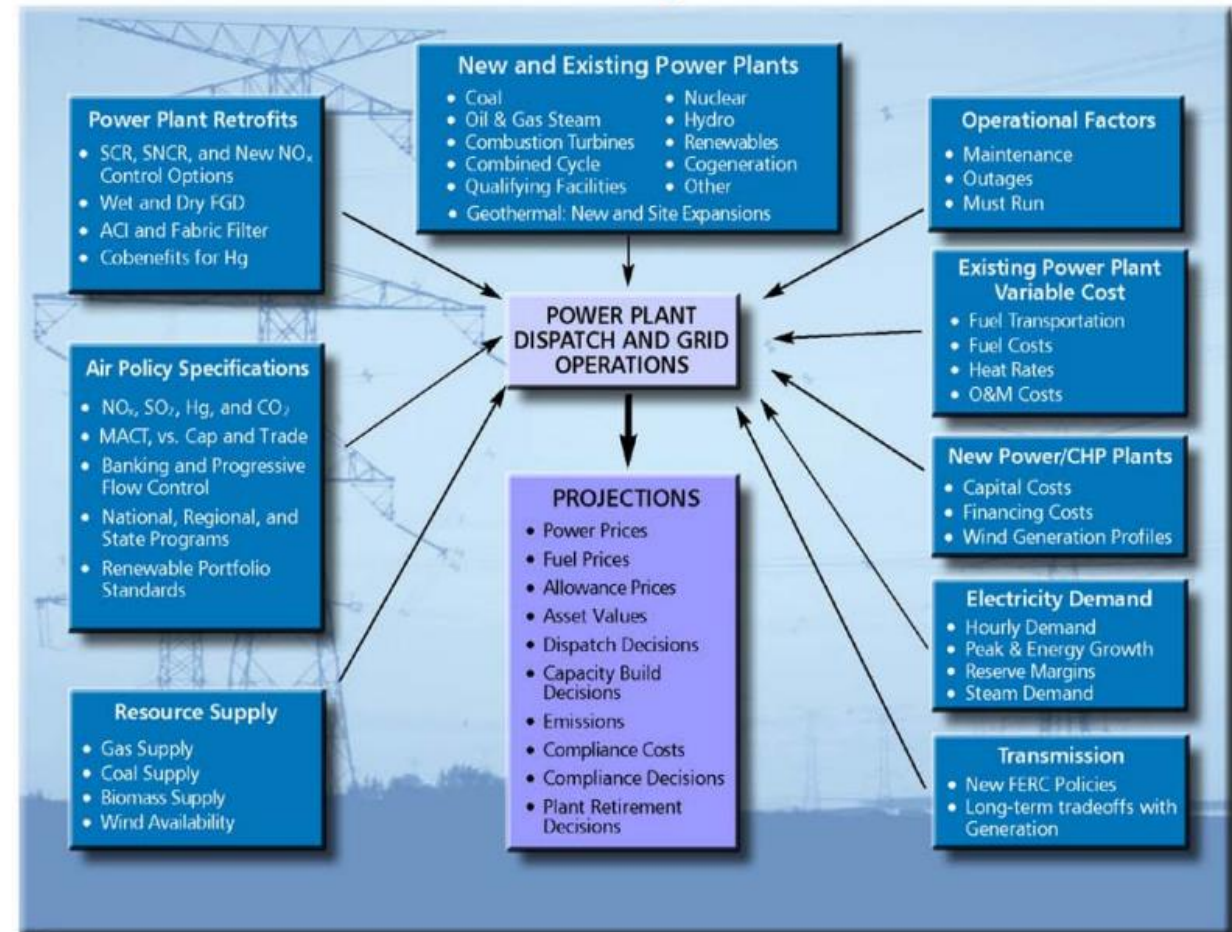- Clean Air Status and Trends Network(CASTNET)
- Air Quality Monitoring
- Emissions Inventories
- Power Plants and Neighboring Communities
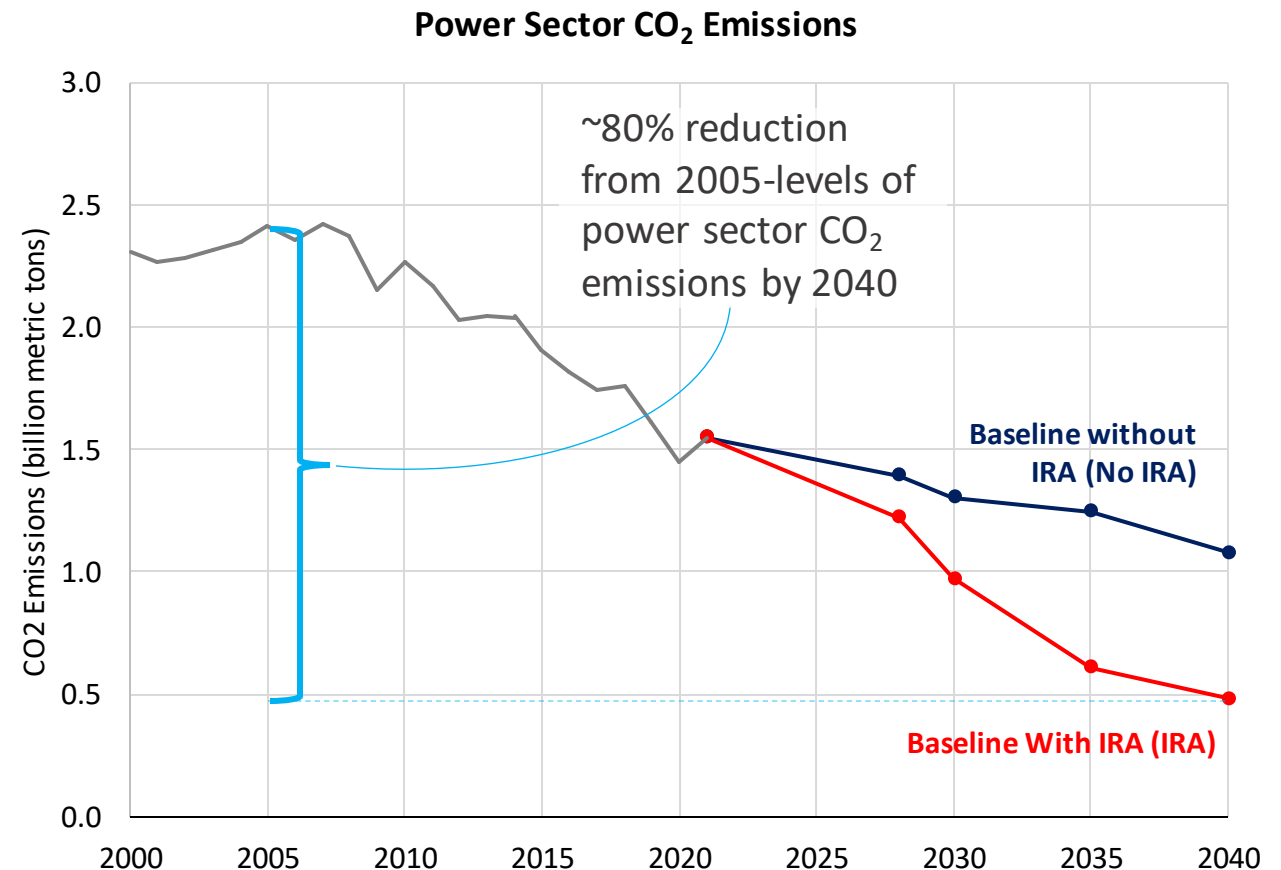 - EJScreen

Integrated Planning Model Framework

- IPM is a long-term dynamic linear programming model of the U.S. power sector that aims to meet energy and peak demand at lowest cost over the projection period subject to constraints including:
  - Transmission constraints
  - Fuel markets
  - Resource supply
  - Emissions limits

- IPM is populated with information related to operating units, planned builds, and planned retirements and is able to:
  - add new capacity,
  - retrofit or retire existing capacity, and
  - alter dispatch in order to meet demand over the projection period at the lowest cost

- Model results are not predictions but rather projections based on the input data and assumptions and methodologies used. Revisions to input assumptions continue as market and policy conditions evolve.

IPM® Modeling Structure

Power Plant Retrofits
- SCR, SNCR, and New NO$_x$ Control Options
- Wet and Dry FGD
- ACI and Fabric Filter
- Cobenefits for Hg

New and Existing Power Plants
- Coal
- Oil & Gas Steam
- Combustion Turbines
- Combined Cycle
- Qualifying Facilities
- Geothermal: New and Site Expansions
- Nuclear
- Hydro
- Renewables
- Cogeneration
- Other

Operational Factors
- Maintenance
- Outages
- Must Run

Existing Power Plant Variable Cost
- Fuel Transportation
- Fuel Costs
- Heat Rates
- O&M Costs

Air Policy Specifications
- NO$_x$, SO$_2$, Hg, and CO$_2$
- MACT, vs. Cap and Trade
- Banking and Progressive Flow Control
- National, Regional, and State Programs
- Renewable Portfolio Standards

POWER PLANT DISPATCH AND GRID OPERATIONS

PROJECTIONS
- Power Prices
- Fuel Prices
- Allowance Prices
- Asset Values
- Dispatch Decisions
- Capacity Build Decisions
- Emissions
- Compliance Costs
- Compliance Decisions
- Plant Retirement Decisions

New Power/CHP Plants
- Capital Costs
- Financing Costs
- Wind Generation Profiles

Electricity Demand
- Hourly Demand
- Peak & Energy Growth
- Reserve Margins
- Steam Demand

Resource Supply
- Gas Supply
- Coal Supply
- Biomass Supply
- Wind Availability

Transmission
- New FERC Policies
- Long-term tradeoffs with Generation

Note: Documentation for EPA's Power Sector Modeling Platform can be found here: https://www.epa.gov/power-sector-modeling

Summary of Inflation Reduction Act (IRA) Impacts

- IRA is expected to greatly drive down power sector CO_2 (and other pollutant) emissions in the coming decades

- EPA modeling of IRA impacts show major growth in clean and renewable technologies, driven by tax credit incentives, resulting in decreases in fossil fuel use

- Modeling results presented today are used to establish EPA's power sector baseline and are useful in informing EPA regulatory actions

- Ongoing analyses examine use of more advanced technology assumptions and demand side (electrification) impacts

Power Sector CO_2 Emissions

~80% reduction from 2005-levels of power sector CO_2 emissions by 2040

Baseline without IRA (No IRA)

Baseline With IRA (IRA)

CO2 Emissions (billion metric tons)

Results from the Baseline with IRA can be found here: https://www.epa.gov/power-sector-modeling/post-ira-2022-reference-case
Results from the Baseline without IRA can be found here: www.epa.gov/power-sector-modeling/pre-ira-2022-reference-case

Recent Updates to IPM

- IRA provisions now modeled include:
  - Clean Electricity Investment and Production Tax Credits (48E, 45Y)
  - Advanced Manufacturing Production Credit (45X)
  - Carbon Capture & Sequestration Tax Credit (45Q)
  - Existing Nuclear Tax Credit (45U)
  - Clean Hydrogen Fuels (45V)
- Other model updates include:
  - Updated plant file with announced retirements for coal
  - Updated natural gas supply curves
  - Added incremental demand (above AEO projections) from electrification expected in response to previously finalized vehicle standards
- The baseline scenario in this presentation does not include non-power-sector impacts from IRA, e.g., demand-side impacts

Emissions

Annual SO2 Emissions (thousand tons)

- Historic
- Pre-IRA 2022 Ref Case
- Post-IRA 2022 Ref Case

Annual NOx Emissions (thousand tons)

- Historic
- Pre-IRA 2022 Ref Case
- Post-IRA 2022 Ref Case

Ozone Season NOx Emissions (thousand tons)

- Historic
- Pre-IRA 2022 Ref Case
- Post-IRA 2022 Ref Case

Annual PM 2.5 Emissions (thousand tons)

- Historic
- Post-IRA 2022 Ref Case
- Pre-IRA 2022 Ref Case
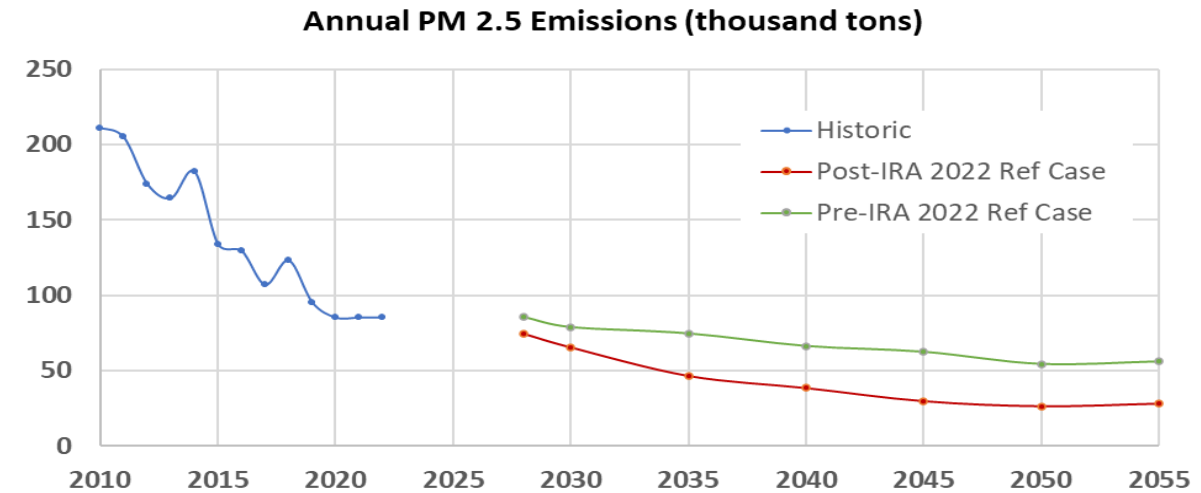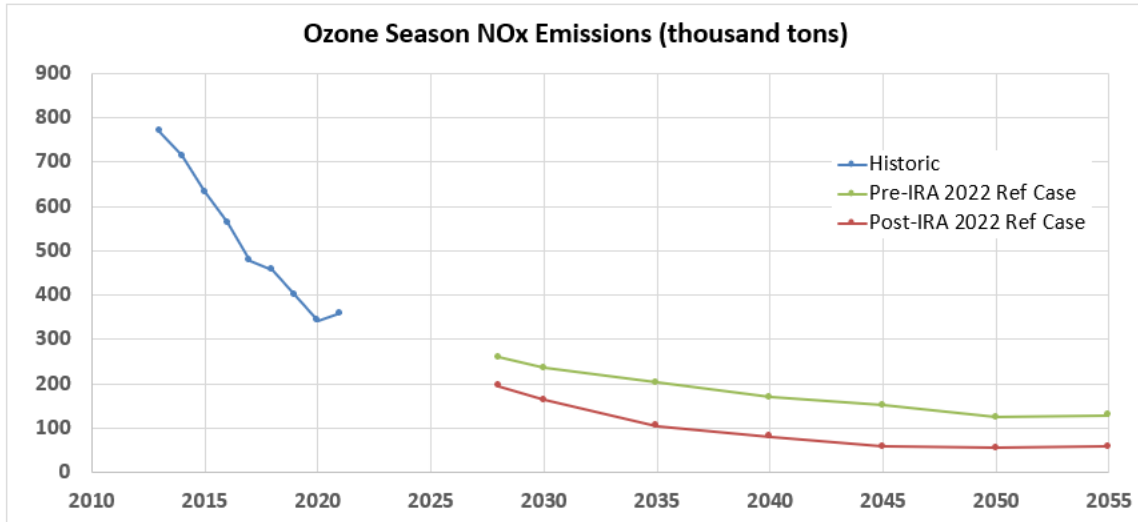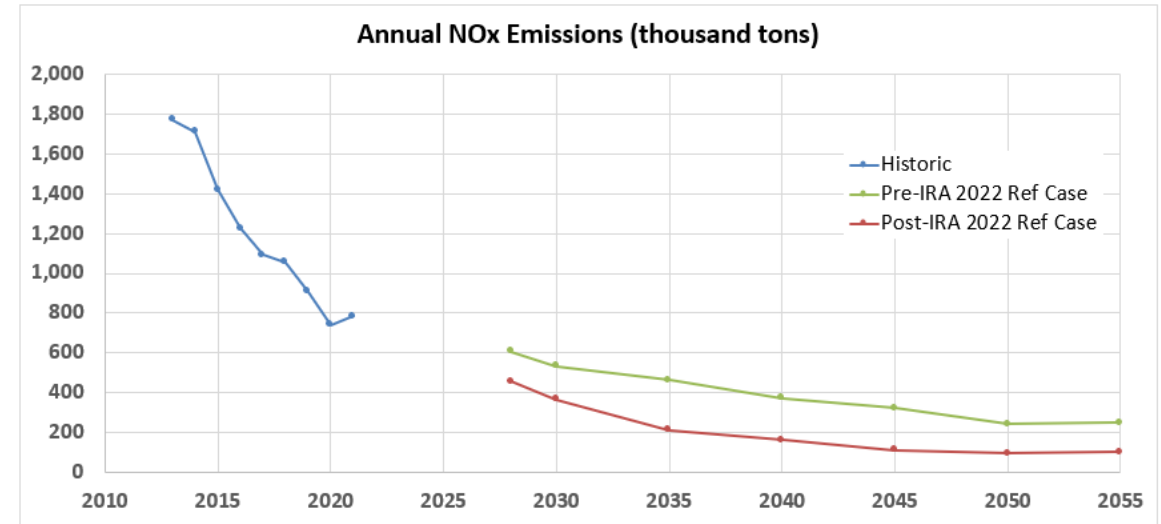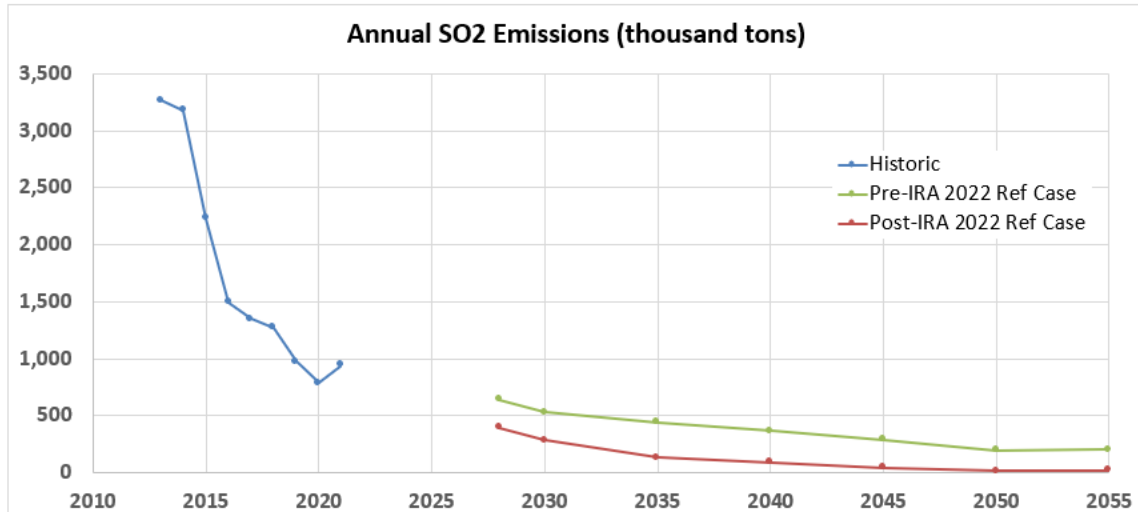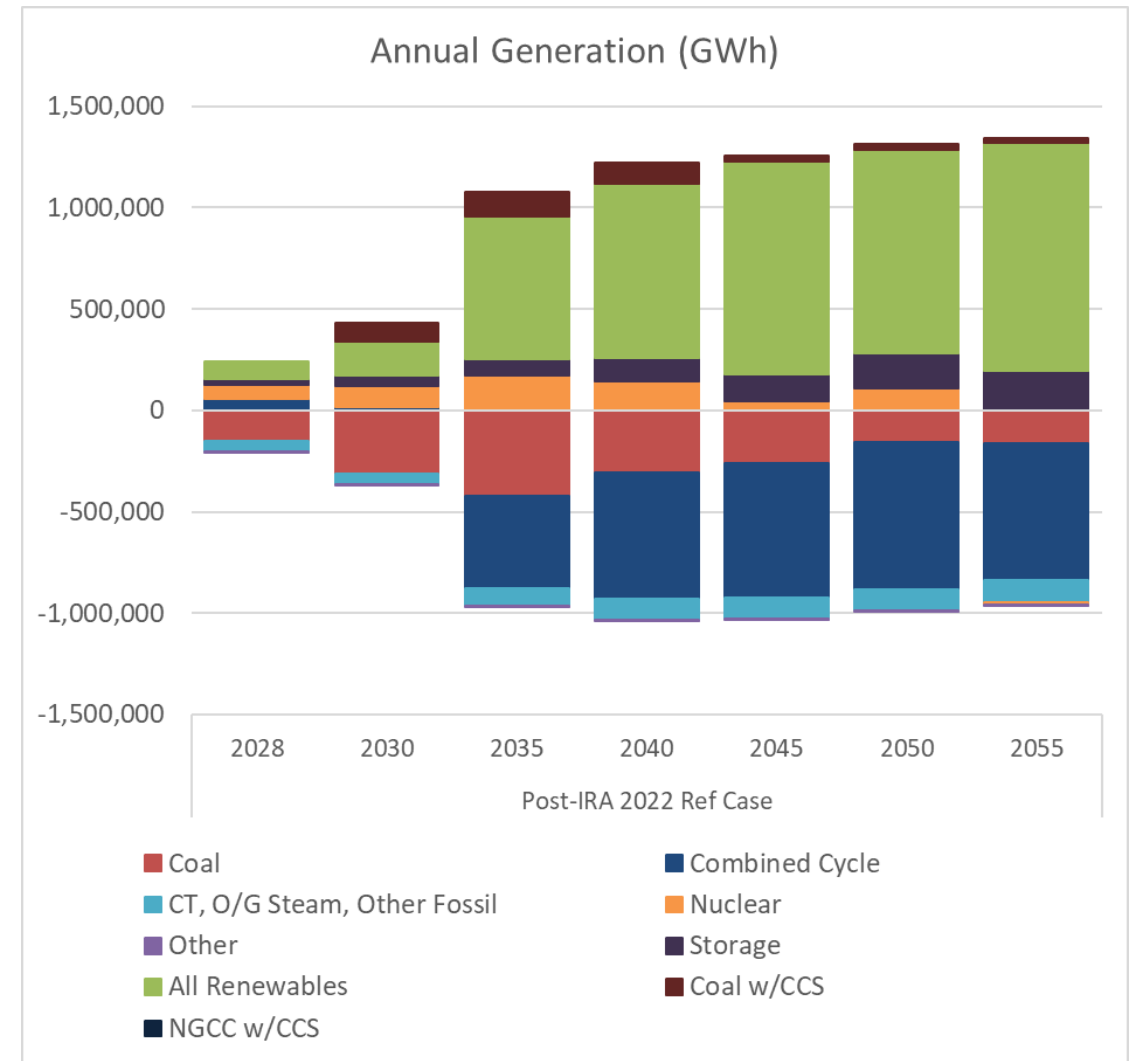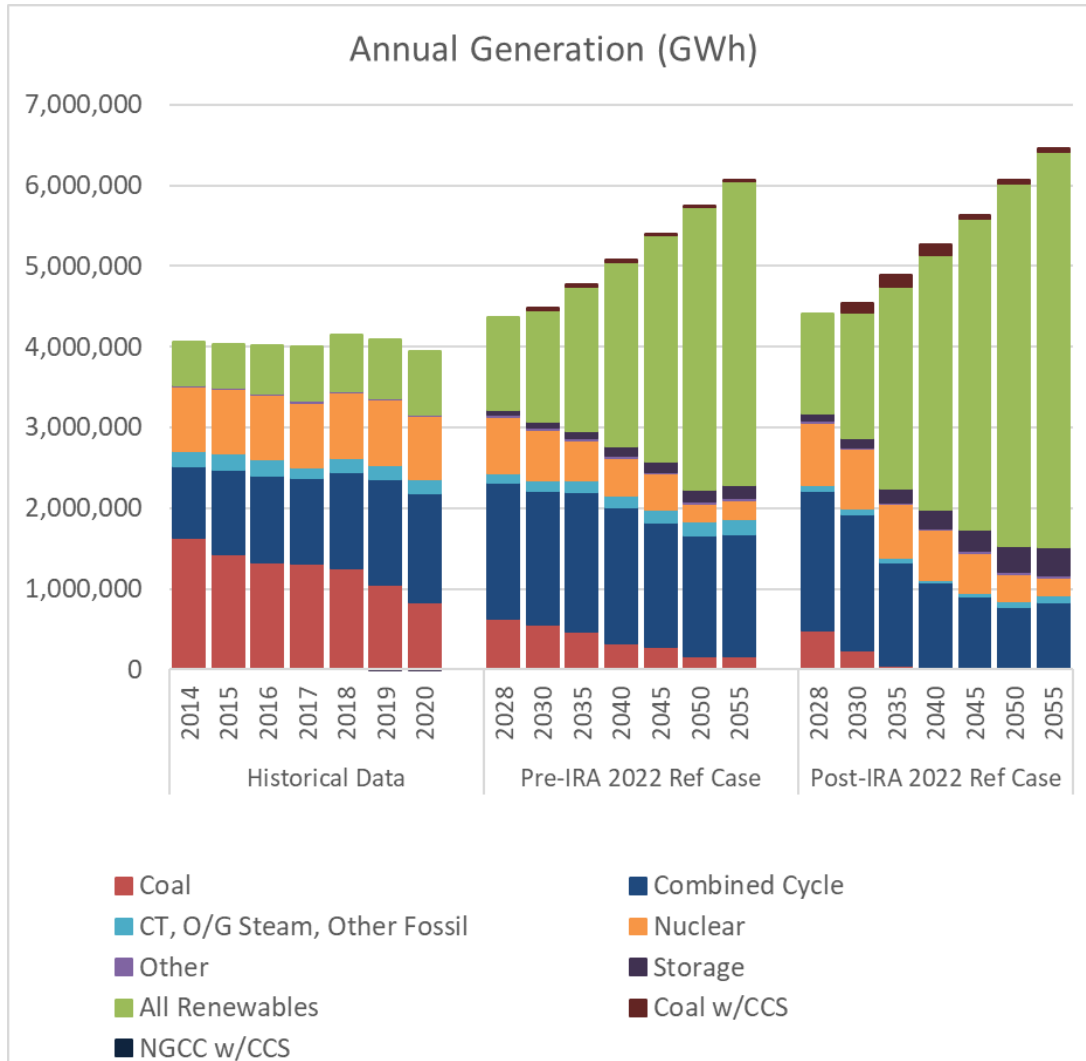
Generation Mix

Clean Electricity Generation

Clean Electricity Share of Generation by State in 2040 in Baseline without IRA
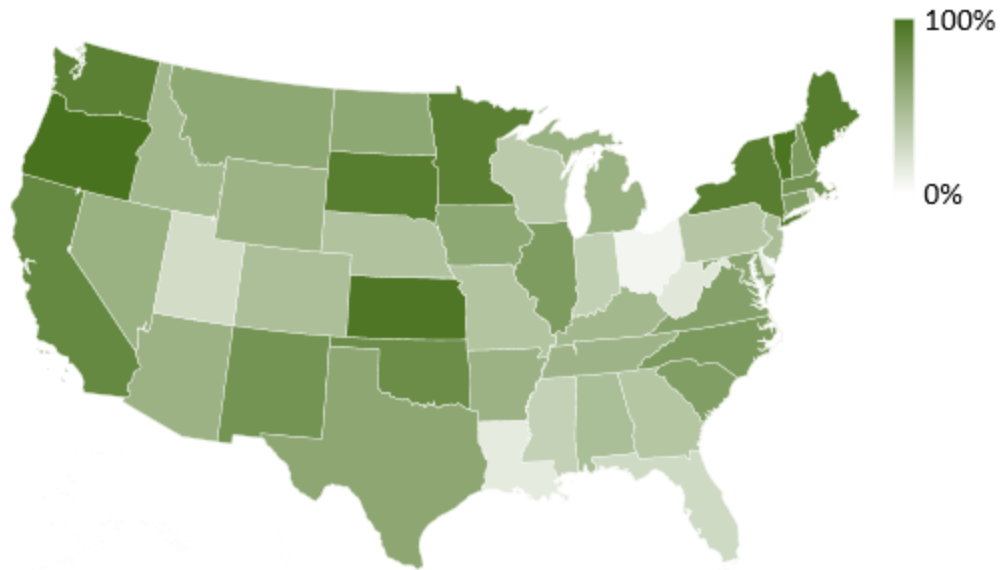
Clean Electricity Share of Generation by State in 2040 in Baseline with IRA
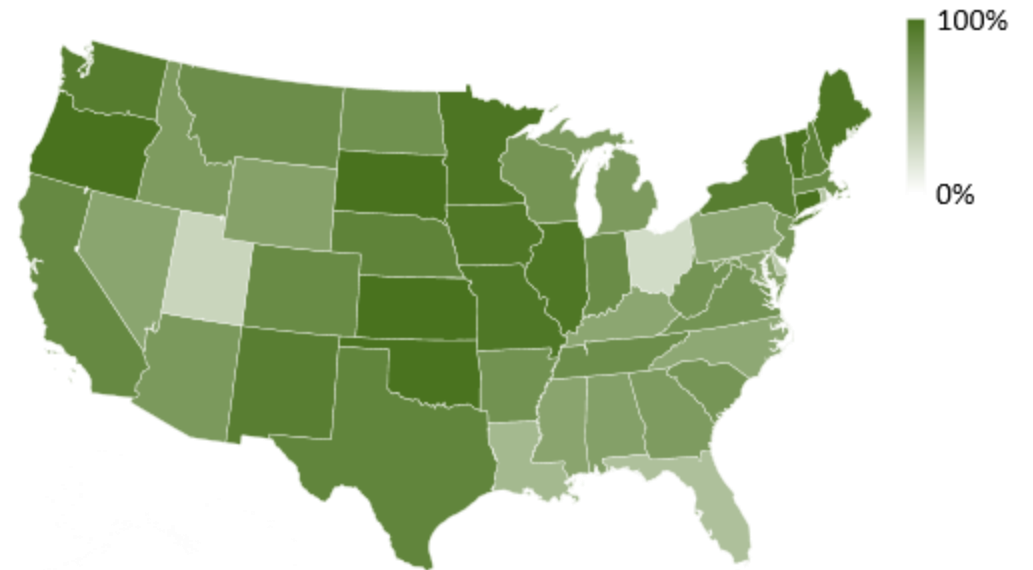
Coal Regional Results

Operating Coal Capacity by State in 2040 in Baseline without IRA
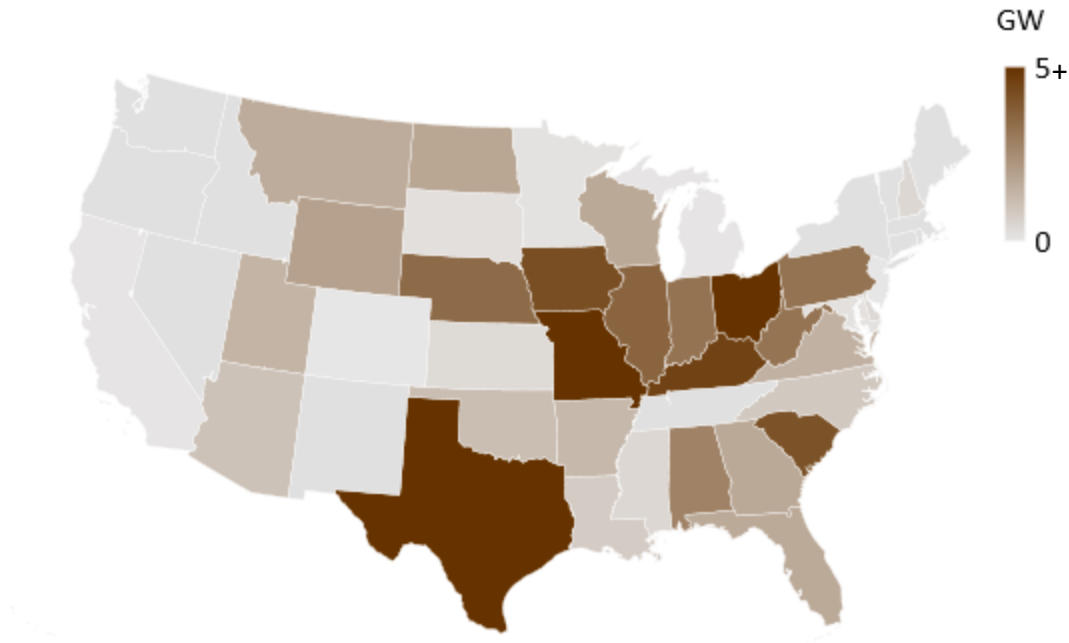
Operating Coal Capacity by State in 2040 in Baseline with IRA
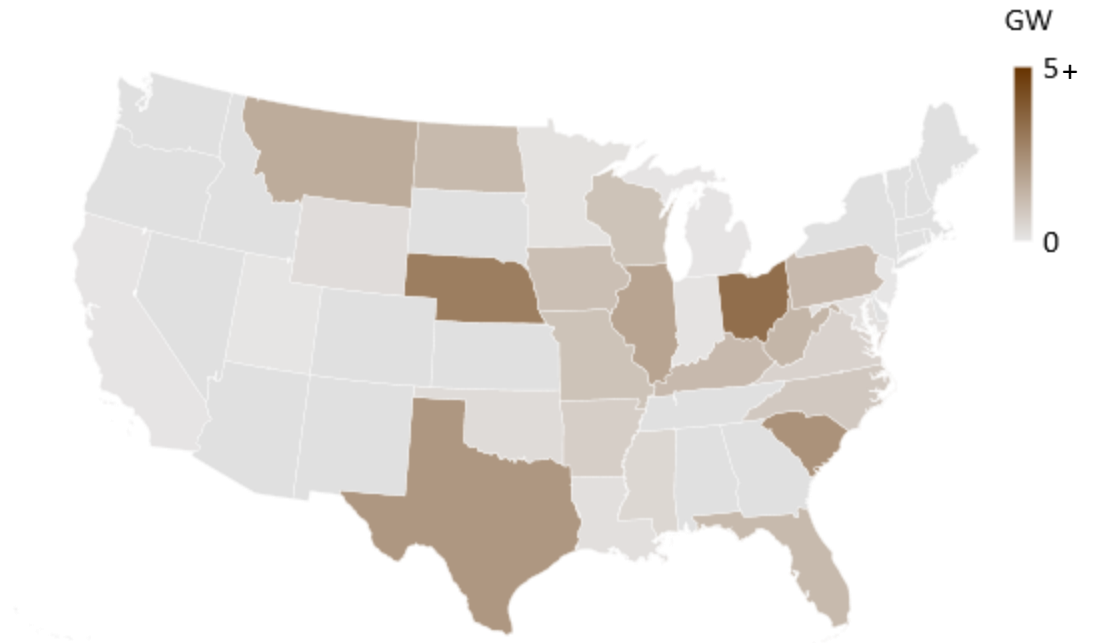
Natural Gas Regional Results

New Natural Gas Combined Cycle Capacity by State in 2040 in Baseline with IRA
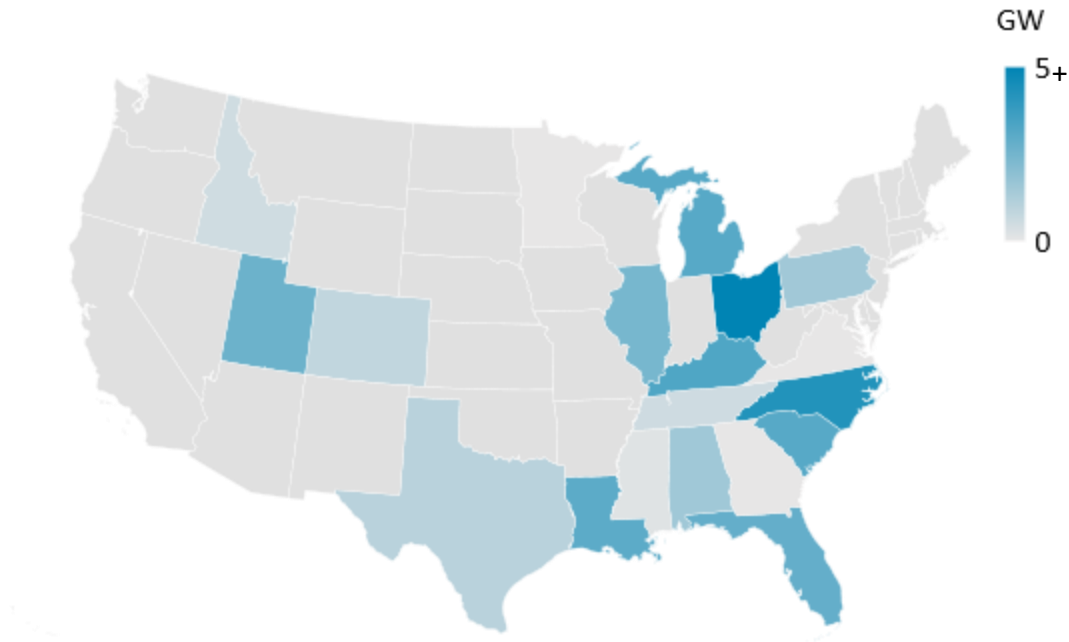
New Natural Gas Combustion Turbine Capacity by State in 2040 in Baseline with IRA
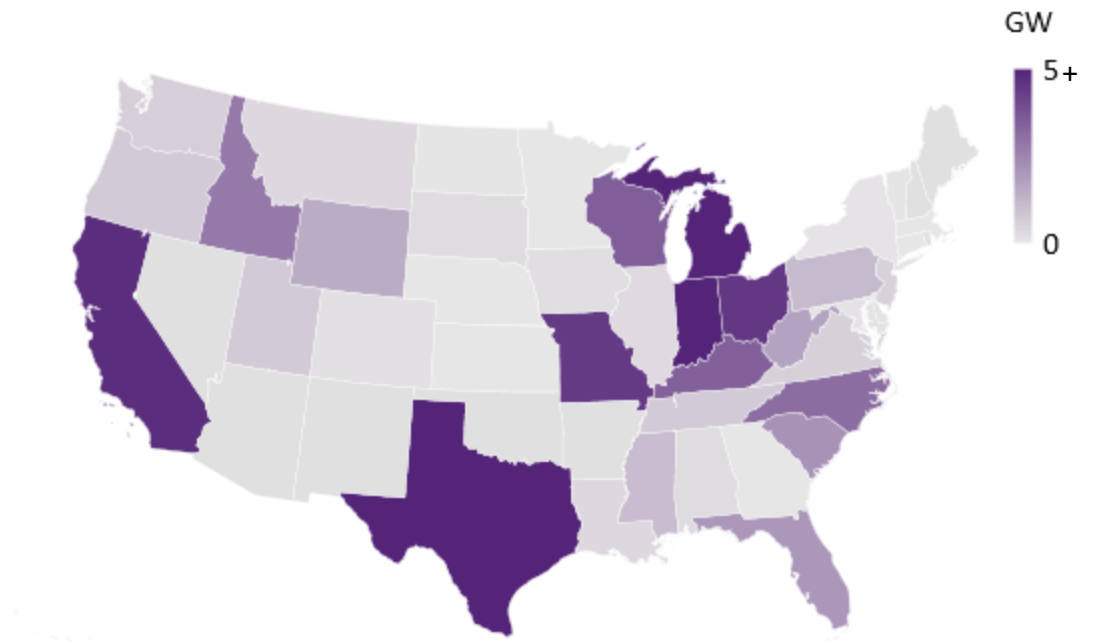
Conclusions

- Modeling results show an 80% reduction from 2005 levels of power sector CO_2 emissions by 2040, compared to a 55% reduction pre-IRA
  - Significant reductions in SO2, NOx, PM emissions
- Tax credits for renewables, storage, nuclear, and CCS lead to increases in generation from low and zero emitting generation resources
- These lower emitting technologies reduce the need for fossil fuel resources, both in terms of capacity and in generation
  - Cleaner generation in a number of states and counties will have desired EJ impacts
- EPA will continue assessing the potential role of advanced technology assumptions in modeling potential impacts of the IRA, including:
  - Rapid electrification growth
  - Improved RE technology manufacturing and costs
  - Improved energy storage costs and durations
  - Delivered hydrogen fuel prices
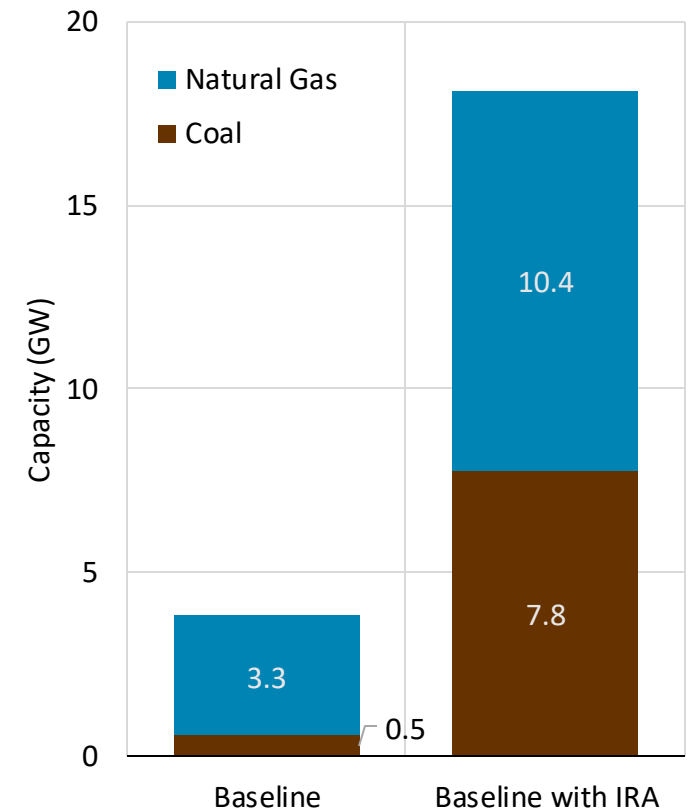- What is next?

Questions?

Appendix
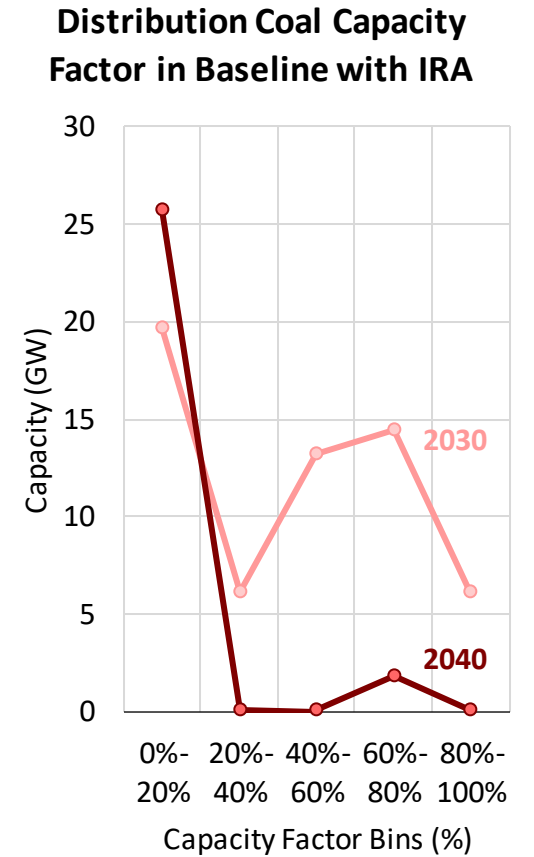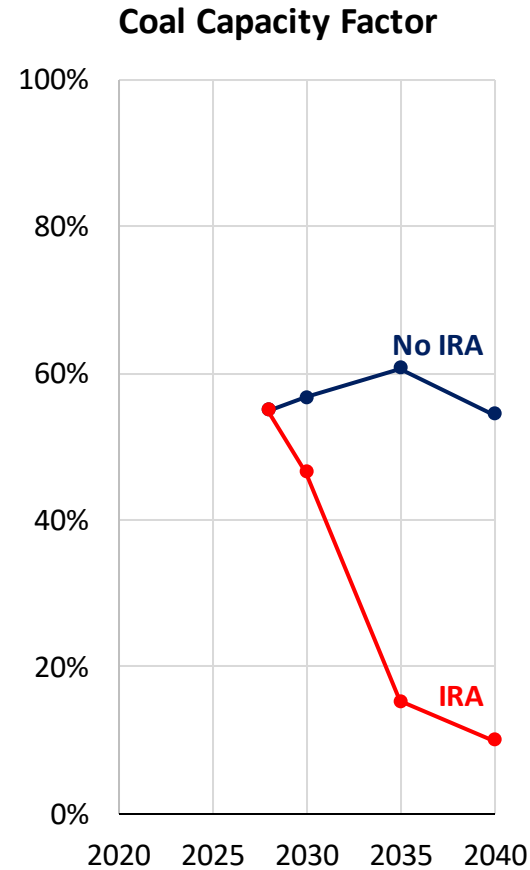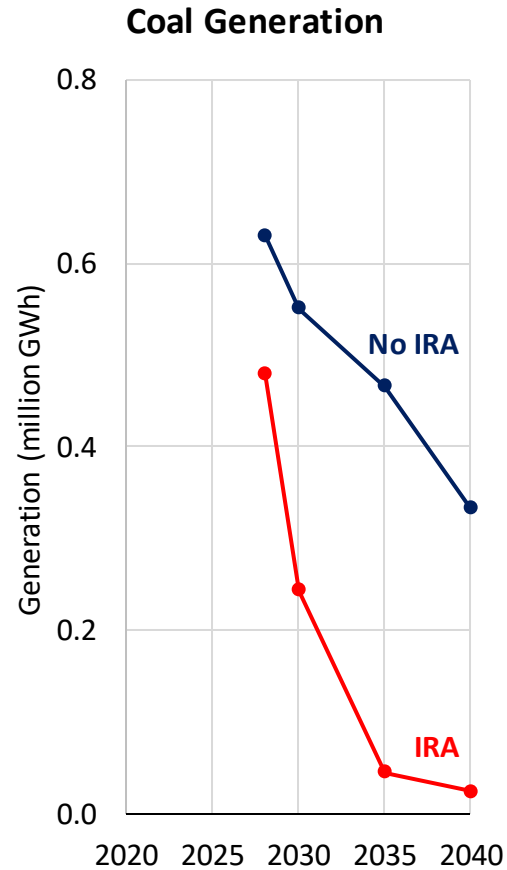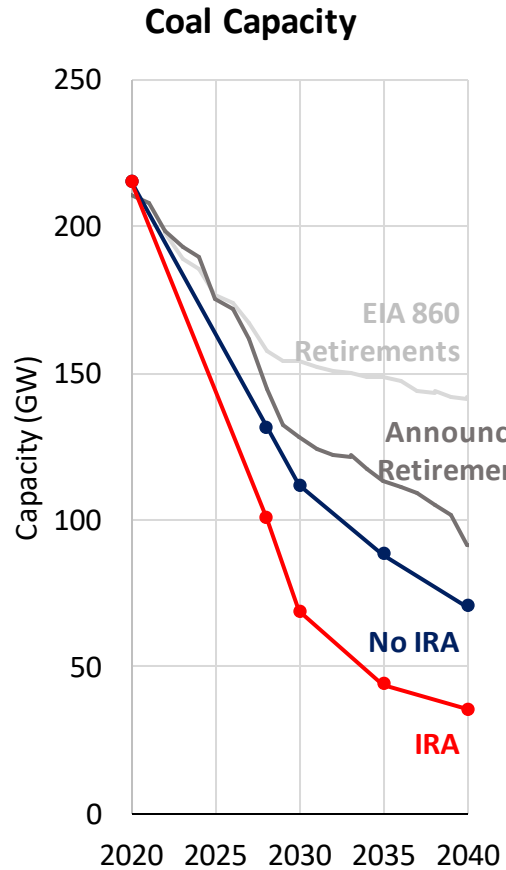
Coal and Natural Gas Capacity

Coal Capacity

Natural Gas Capacity
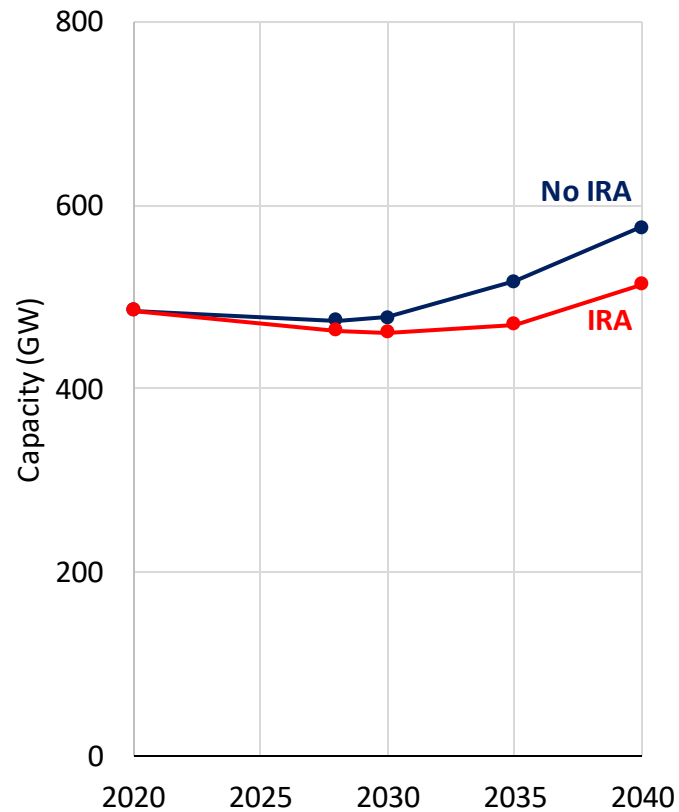
Retrofit CCUS Capacity in 2040

# Coal Deeper Dive

Coal Capacity

Capacity (GW) — 250, 200, 150, 100, 50, 0 — 2020, 2025, 2030, 2035, 2040

EIA 860 Retirements
Announced Retirements
No IRA
IRA

Coal Generation

Generation (million GWh) — 0.8, 0.6, 0.4, 0.2, 0.0 — 2020, 2025, 2030, 2035, 2040

No IRA
IRA

Coal Capacity Factor

100%, 80%, 60%, 40%, 20%, 0% — 2020, 2025, 2030, 2035, 2040

No IRA
IRA

Distribution Coal Capacity Factor in Baseline with IRA

Capacity (GW) — 30, 25, 20, 15, 10, 5, 0

Capacity Factor Bins (%): 0%-20%, 20%-40%, 40%-60%, 60%-80%, 80%-100%

2030
2040
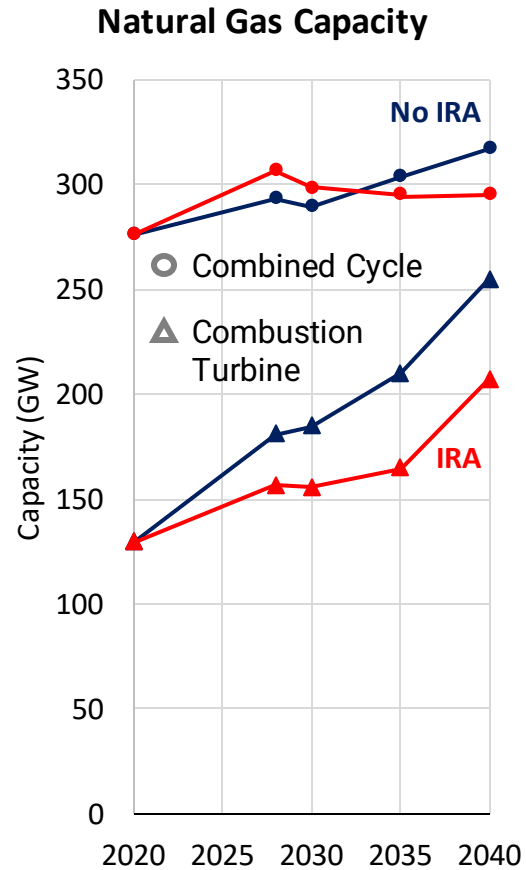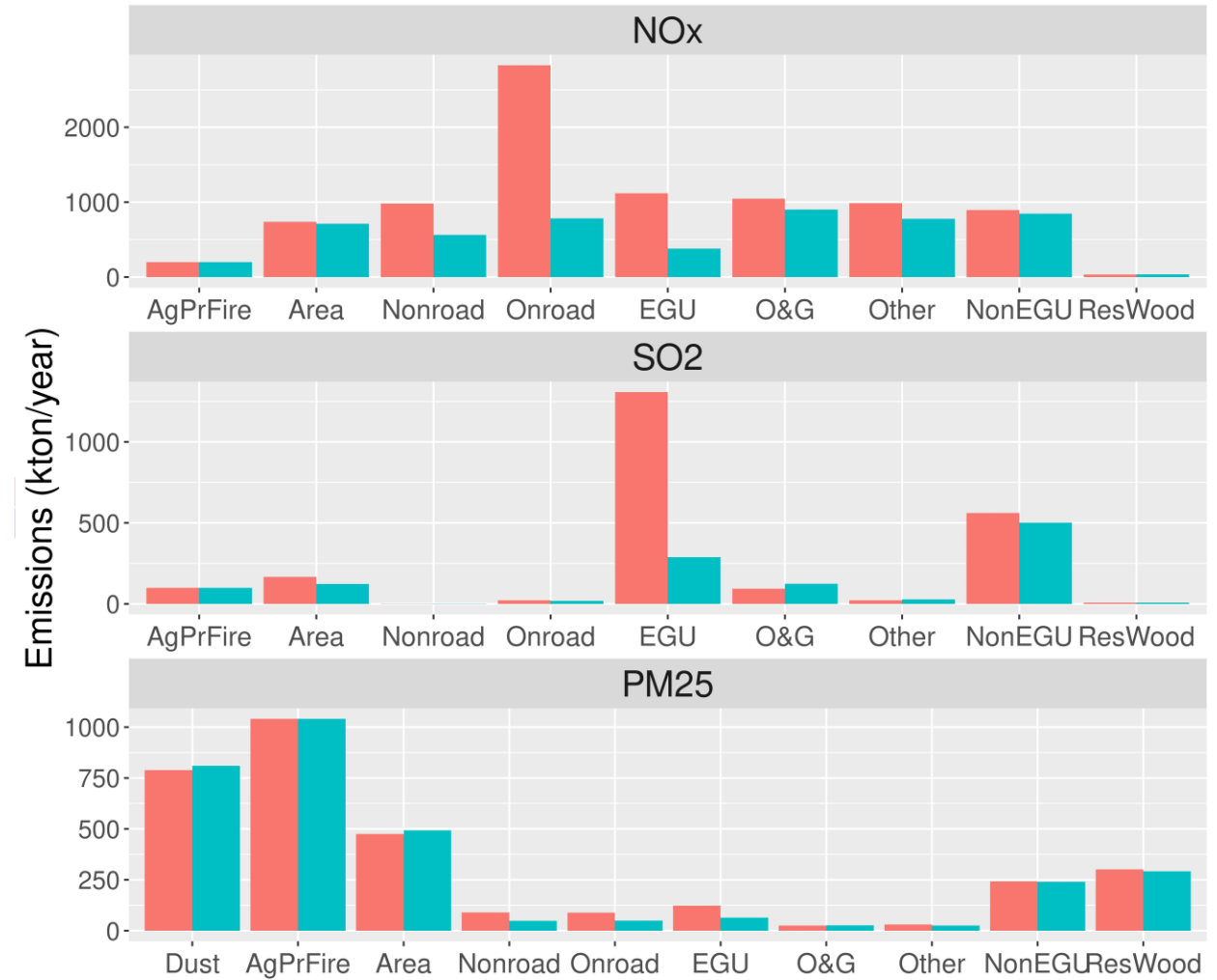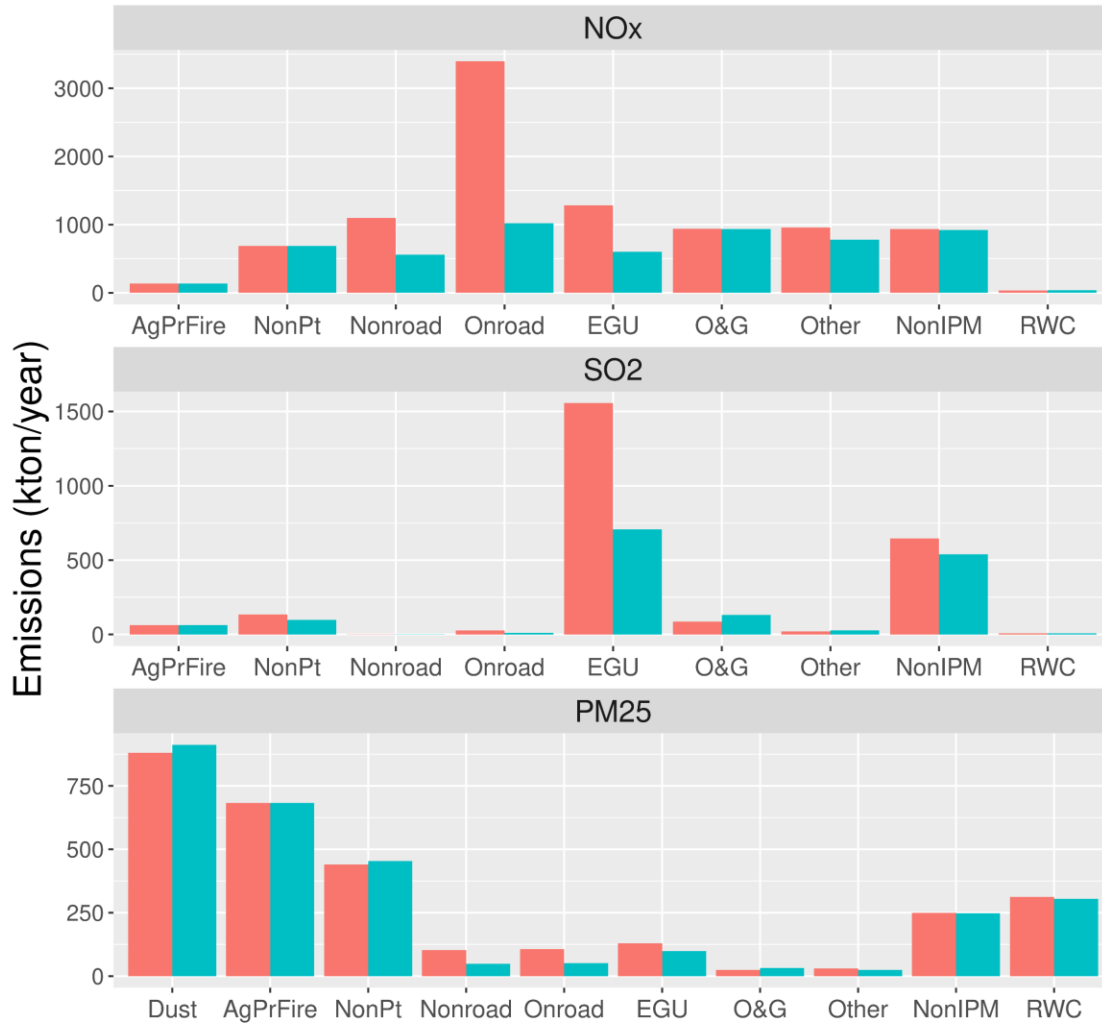
Note: EPA's National Electric Energy Data System (NEEDS) can be found here:
www.epa.gov/power-sector-modeling/national-electric-energy-data-system-needs

Natural Gas Deeper Dive
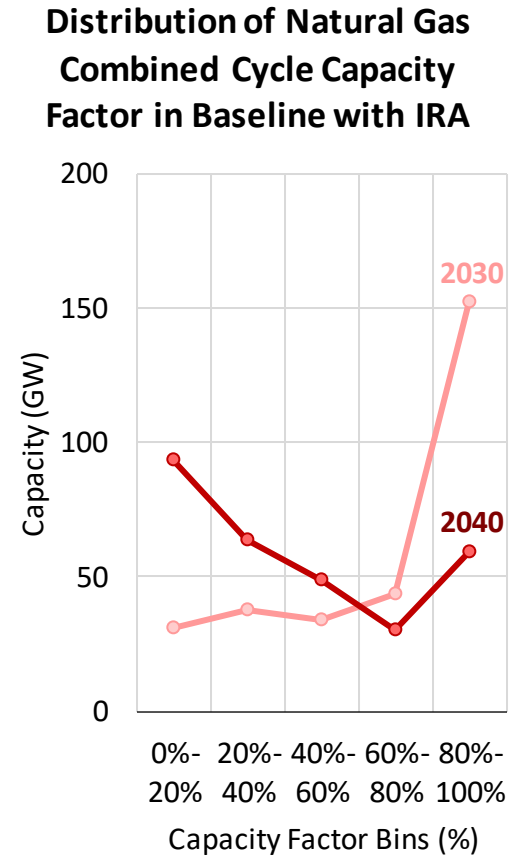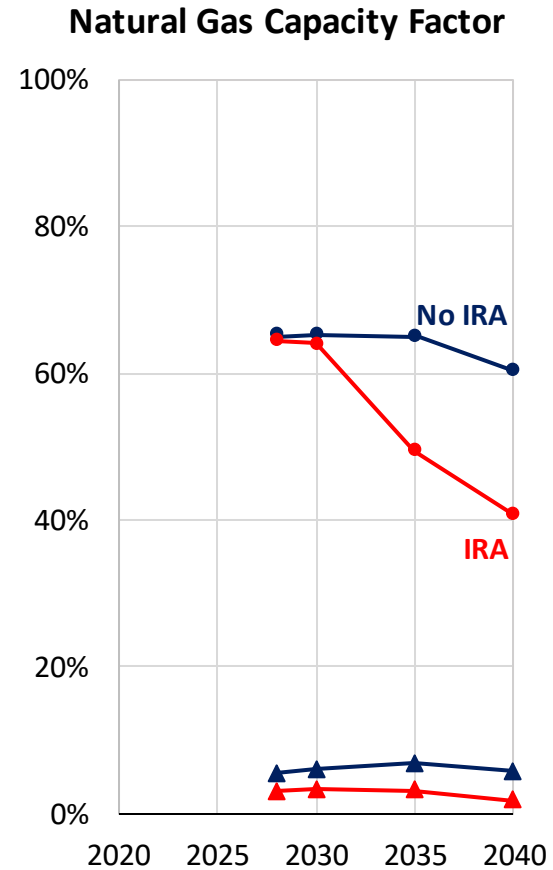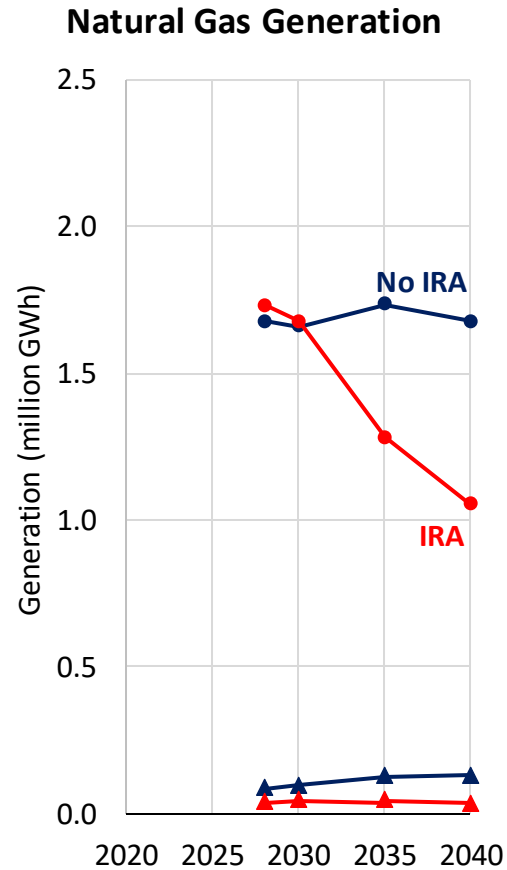
Pre and Post IRA Emissions

Historical (2019), Pre and Post IRA (2032) PM2.5 Concentrations