United States Environmental Protection Agency

EPA's November 2018 IPM v6 Reference Case

February 28, 2019

EPA's Power Sector Modeling Update

- Last year EPA released a major update to its power sector modeling platform, IPM v6 (on May 31st 2018) with accompanying
  - Full-fledged documentation
  - NEEDS
  - Results of a suite of runs
  - Results Viewer
- This presentation discusses latest updates to IPM v6 incremental to May 2018 version.
  - https://www.epa.gov/airmarkets/results-using-epas-power-sector-modeling-platform-v6

EPA projections are not predictions of what will happen, but rather modeled projections of what may happen given certain assumptions and methodologies.

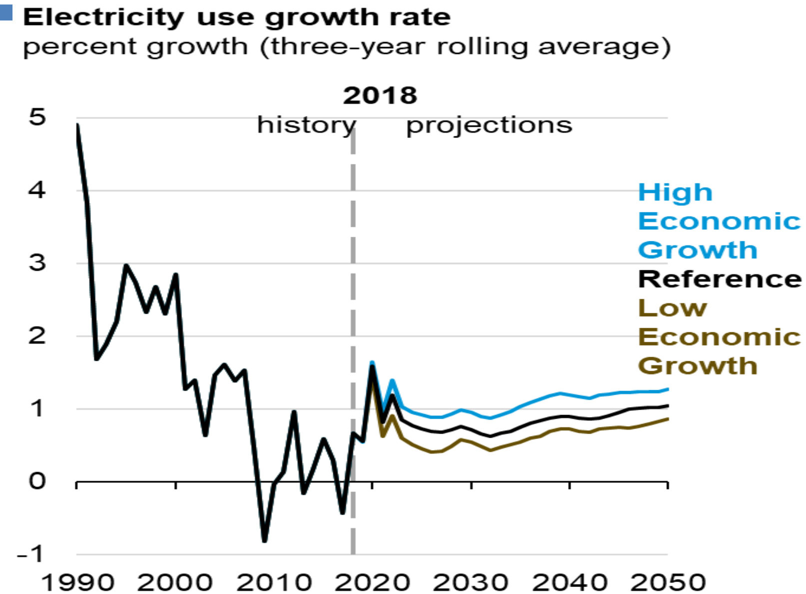
EPA's Power Sector Modeling Update

IPM v6 November 2018 Reference Case reflects latest data and regulations affecting the power sector.

- Updates incremental to the May 2018 Initial Run:
  - AEO 2018 demand (national)
  - Updated NEEDS
  - Changes to corporate income taxes based on the December 2017 Tax Reform Bill
  - Updated (higher) operating costs for nuclear units (from EIA)
  - More accurate (lower) NOx emission rates in CA and elsewhere for small fossil units
  - New State laws/regulations:
    - NY oil rule, energy storage mandates in CA, NY, NJ, OR and MA, revised RPS standards for CT and NJ
  - New energy storage projects

Putting Emissions Projections into Context

- What are the primary drivers?
  - Demand
  - Fuel resource availability/price
  - Generation technology costs
  - Environmental regulations

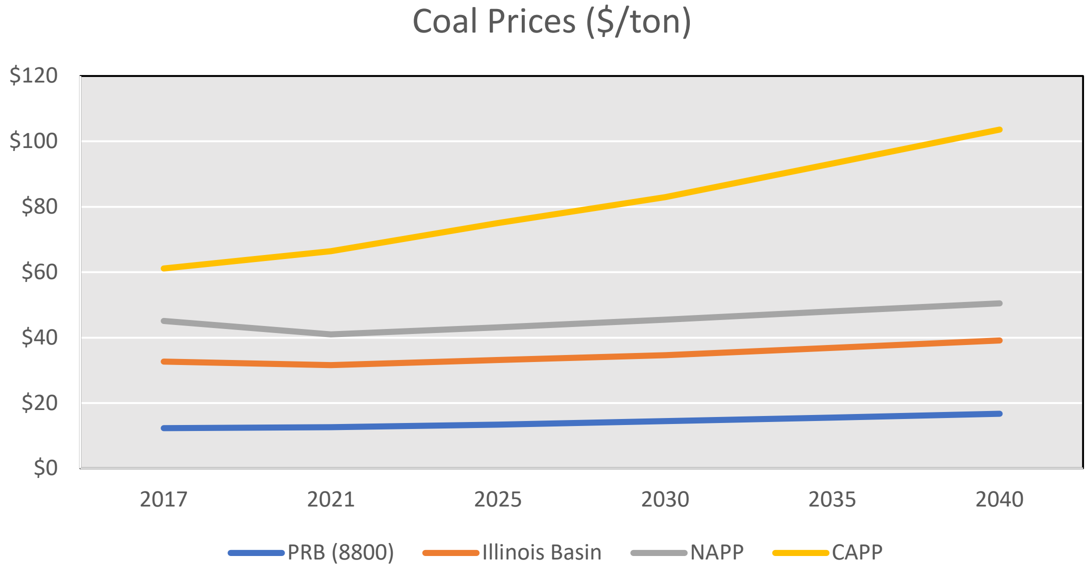


Source: US Energy Information Administration

- As electricity demand grows modestly, new capacity additions and the retirements of older/less-efficient fossil fuel units are shaped by
  - low natural gas prices
  - the continued decline in the capital cost of renewables
  - the near-term availability of renewable energy tax credits
- Type of projection tool/method

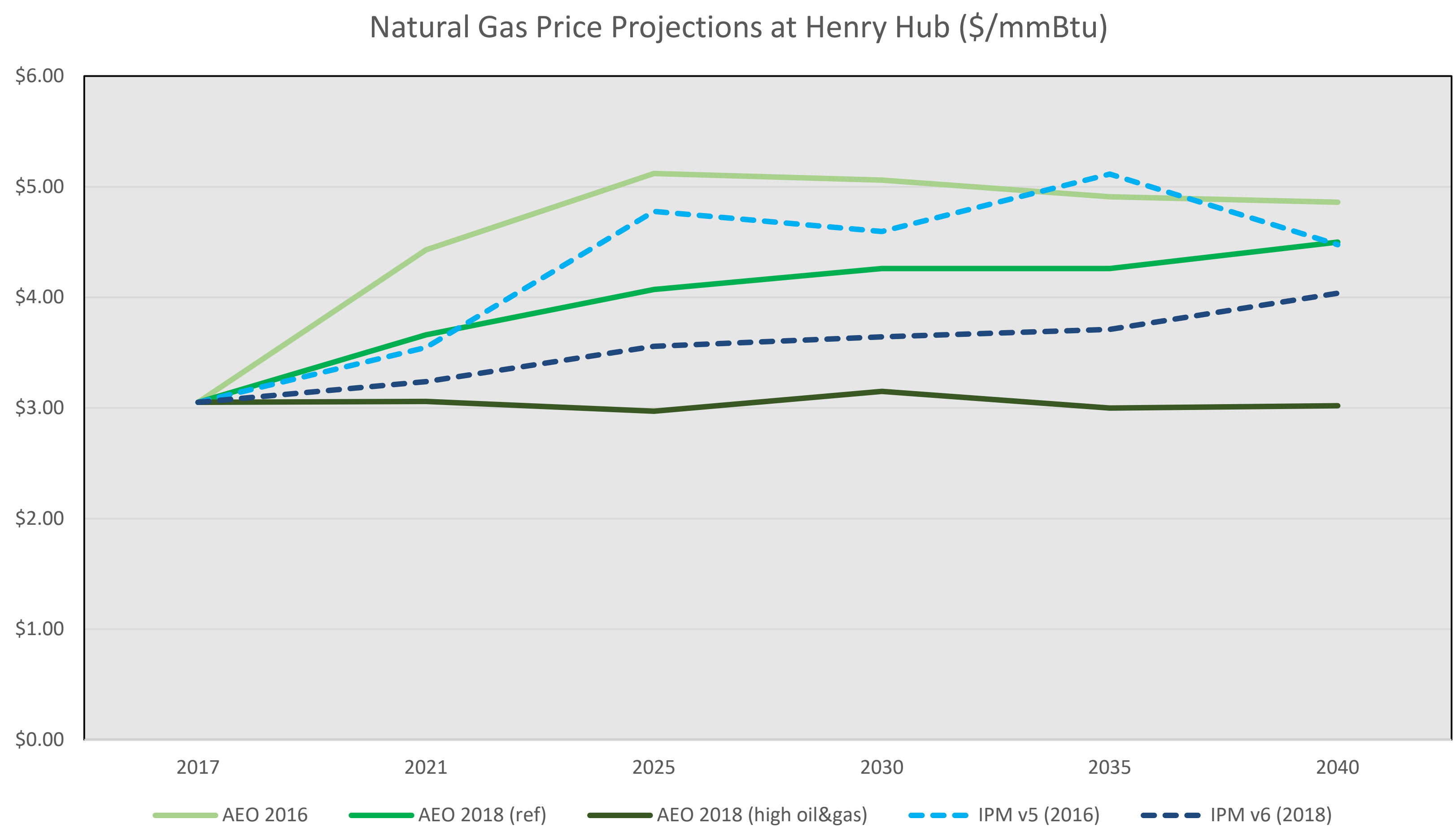
Factors Influencing NG Projections

- A confluence of factors occurring between 2017 and 2020 drives sharp growth in power sector natural gas consumption in EPA's outlook:
  1. Natural gas production expected to grow ~20%
  2. NGCC build out: 15% growth in NGCC fleet
  3. Natural gas pipeline capacity expected to expand (>40% in some areas)



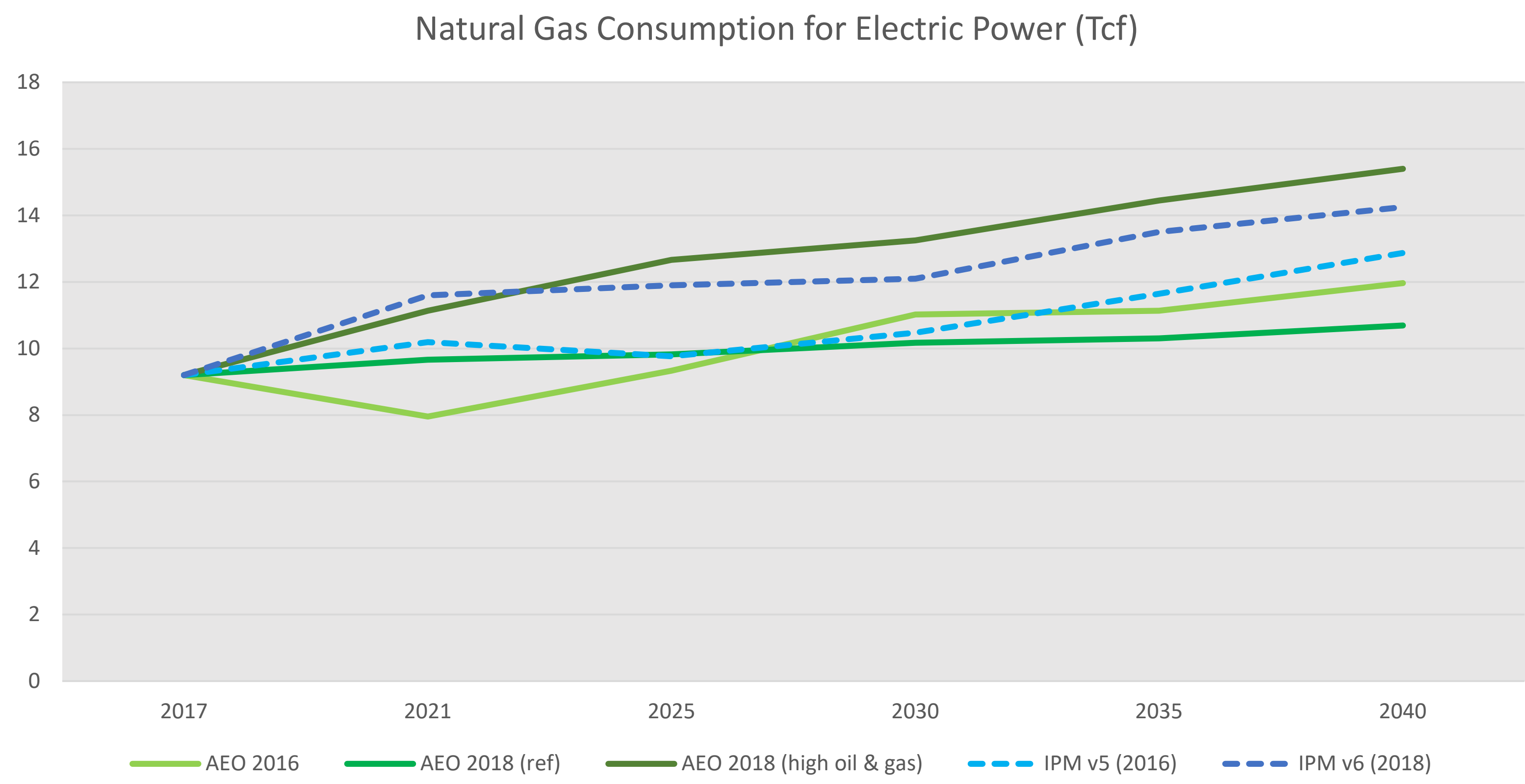
Natural Gas Price Projections

- Natural gas price outlooks have been revised down, driving additional coal to gas switching in projections
- IPM v.6 natural gas projections are informed by updated gas supply curves. Projections fall between the AEO reference case and high oil & gas productivity scenarios.



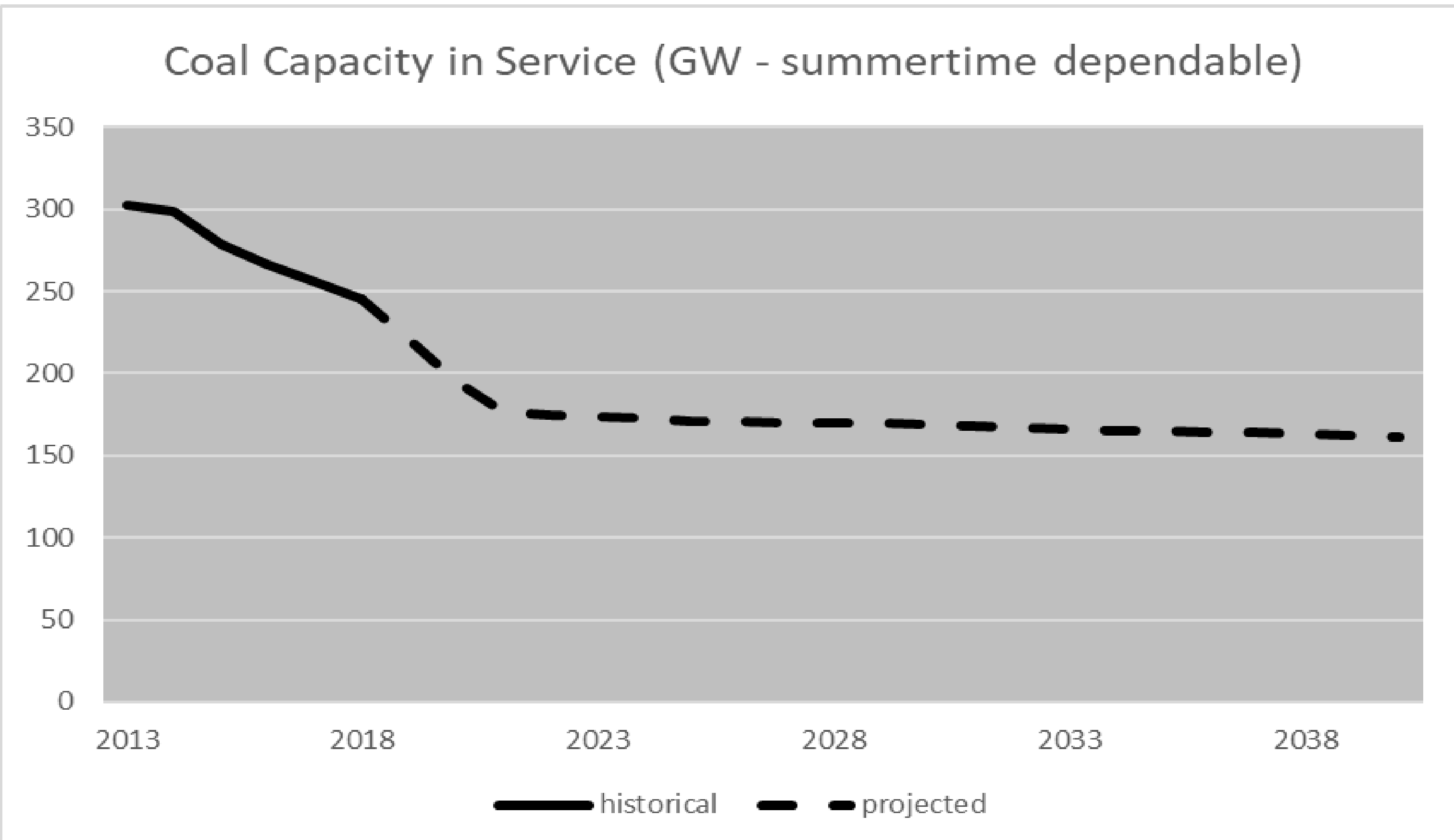
Natural Gas Consumption Projections

- Projected power sector consumption of natural gas is up 20% or more from historical maximum levels of ~ 10 Tcf, reflecting planned (15% increase in NGCC capacity alone from under construction capacity) and projected new builds.
- Also reflects higher projected capacity factors at NGCCs (in the 60% range)
- EPA projections are between the AEO 2018 reference case and high oil and gas productivity scenario



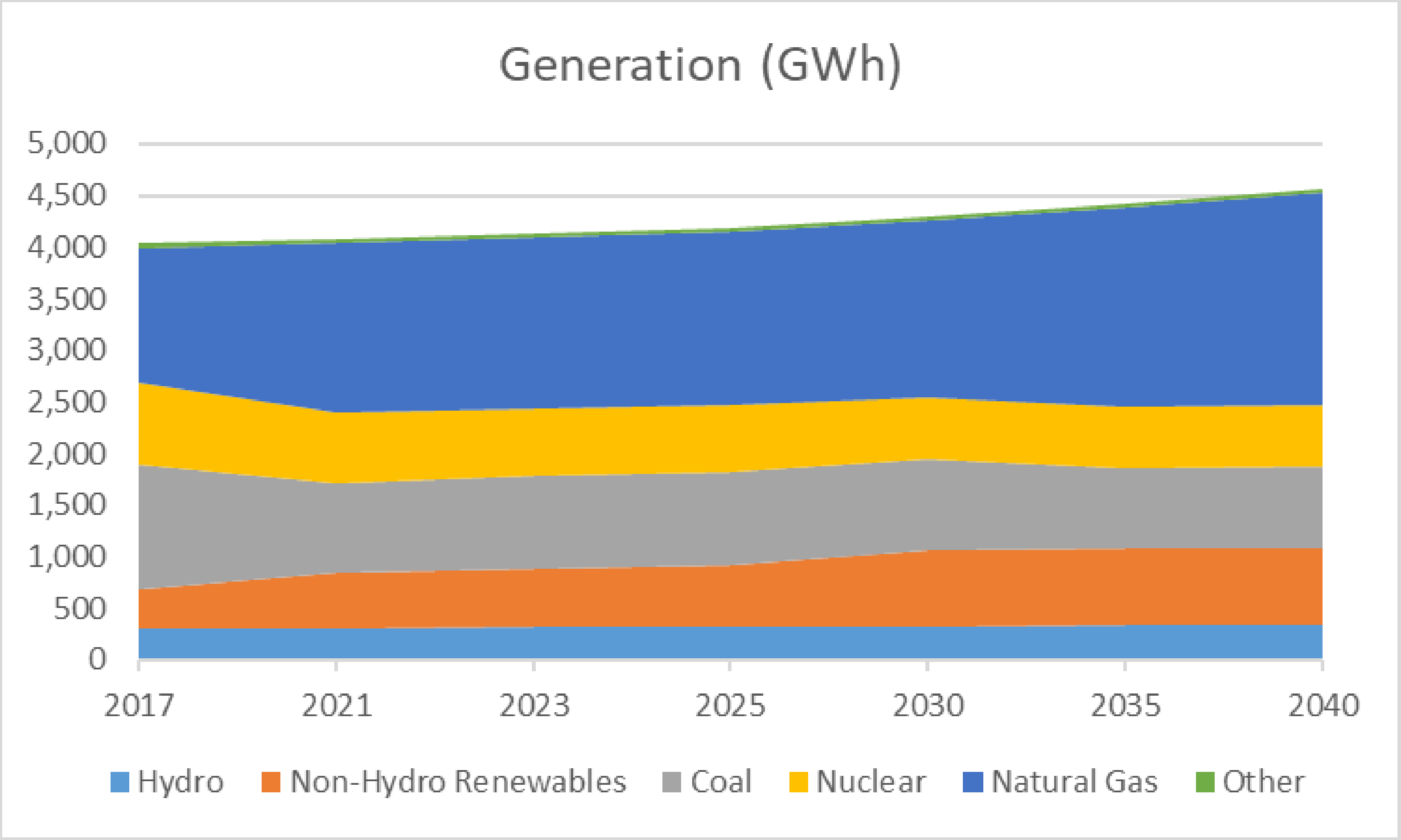
Retiring Coal Generation

- EPA projects the coal retirement trend to continue through early next decade, and then begin to level off.
- This near-term trend continuation is consistent with the pace of announced retirements.
  - At the end of 2020 NEEDS has 195 GW of coal remaining in service
  - IPM projects this capacity to drop to ~176 GW in 2021 and ~161 GW by 2040



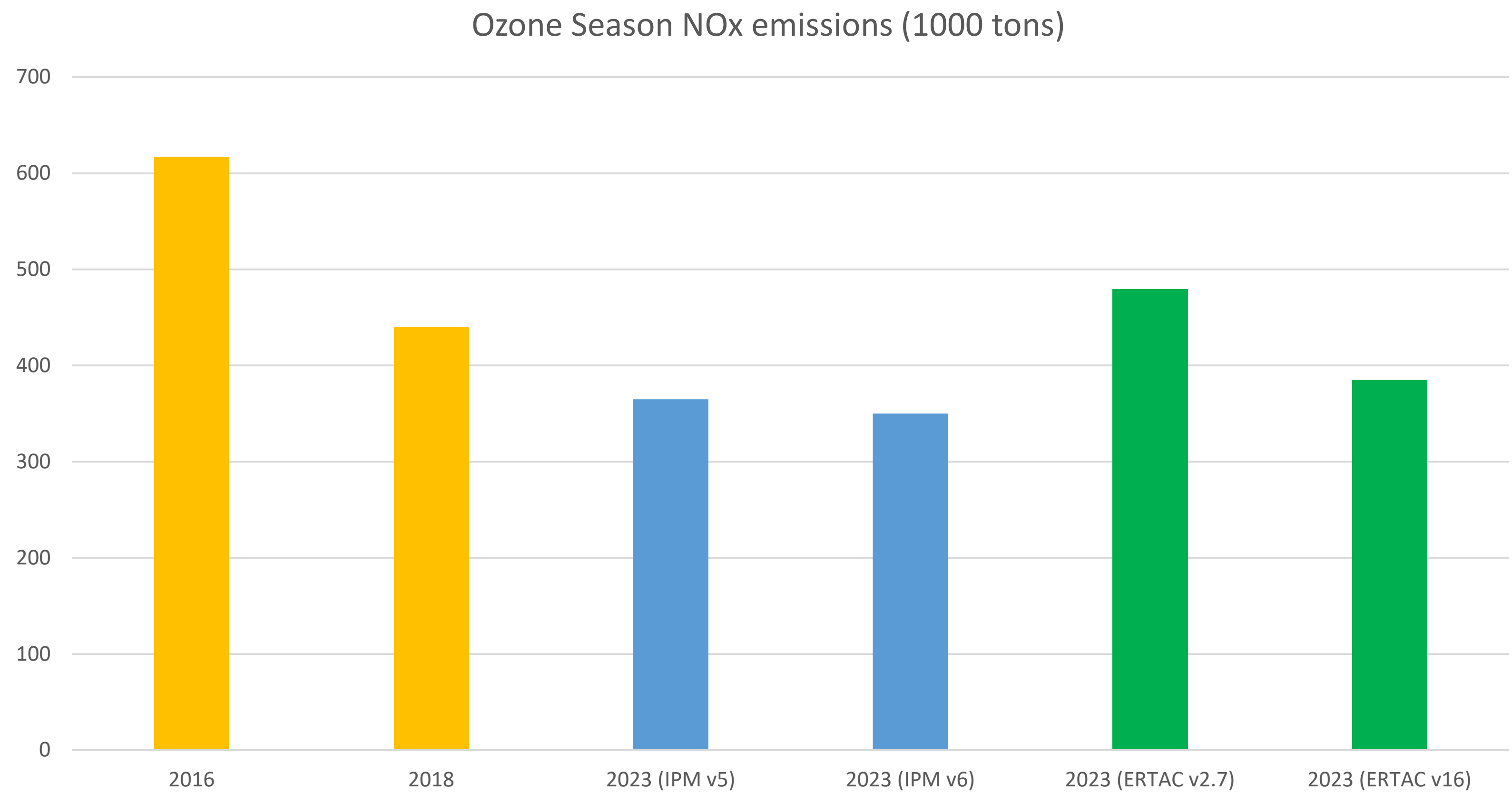
Changing Generation Portfolio

- As coal declines, it is replace by natural gas generation and renewables



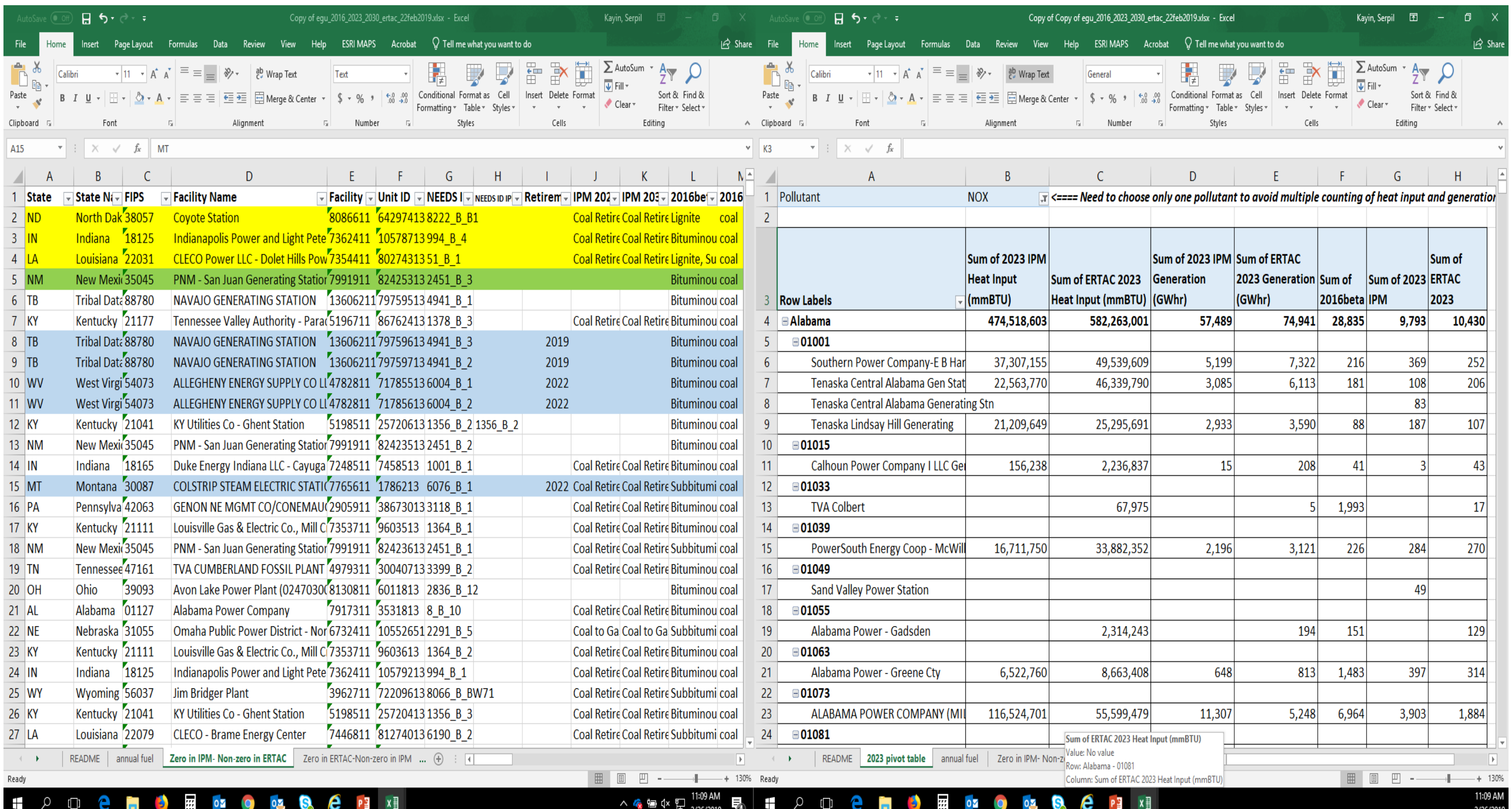
Ozone Season NOx Emissions

- IPM projections assume EGUs operate at the same Ozone Season NOx emission rate as observed in 2018 for CSAPR Update compliance (for those reporting data)
- Any announced control installations are factored into 2023 projections
- The decrease in projected emissions are largely driven by announced retirements and rate improvements



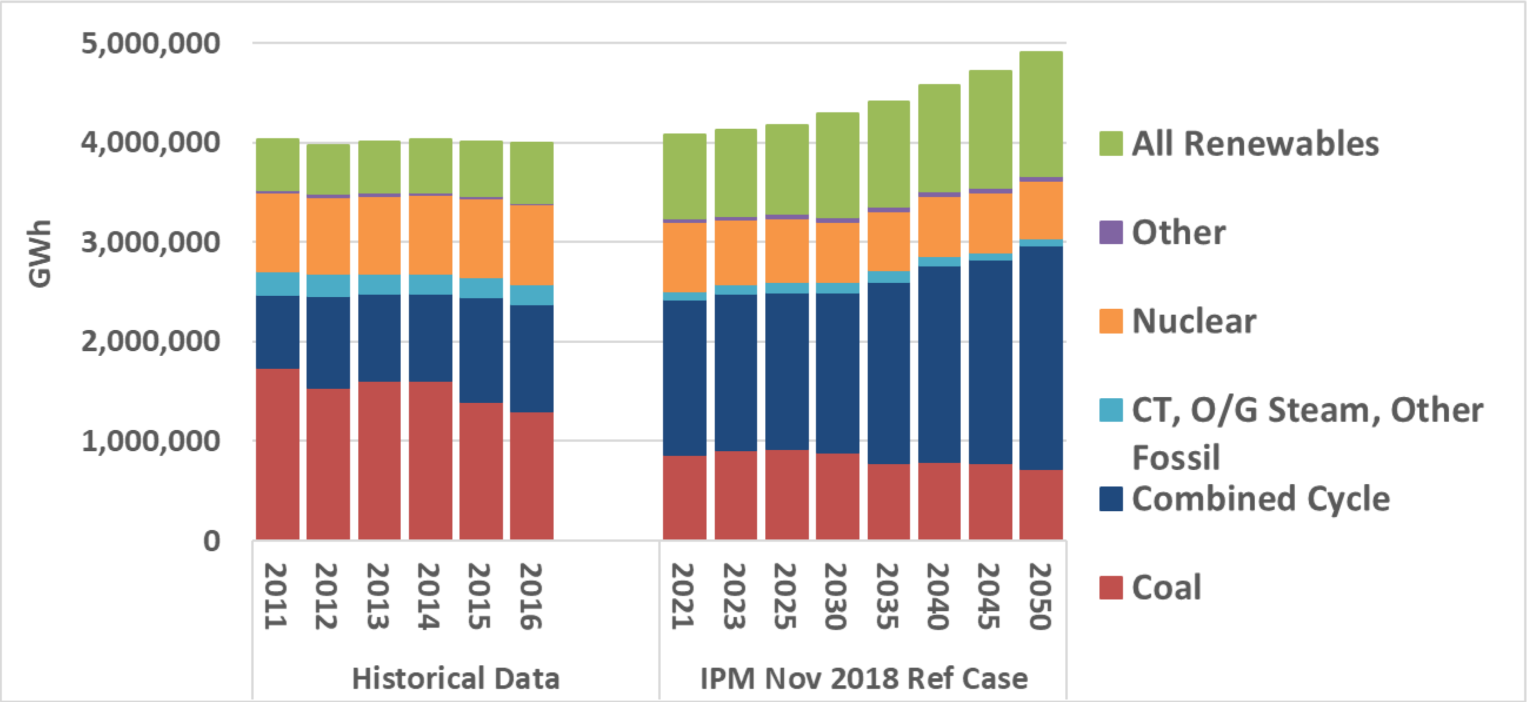
Comparing 2016 Beta Inventory with IPM and ERTAC Projections

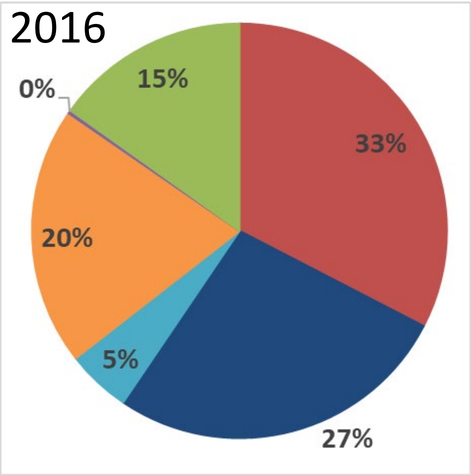
- The “annual fuel” tab has all units from IPM and ERTAC, matched as best as possible; includes all pollutants. The README file explains all of the columns.
- The “Zero in IPM- Non-zero in ERTAC” tab lists all of the NOx units where ERTAC has non-zero emissions in 2028, but IPM has zero emissions in 2030 (and the emissions are non-zero in 2016).
- The “Zero in ERTAC- Non-zero in IPM” worksheet lists all of the NOx units where IPM has non-zero emissions in 2028, but ERTAC has zero emissions in 2028 (and the emissions are non-zero in 2016).

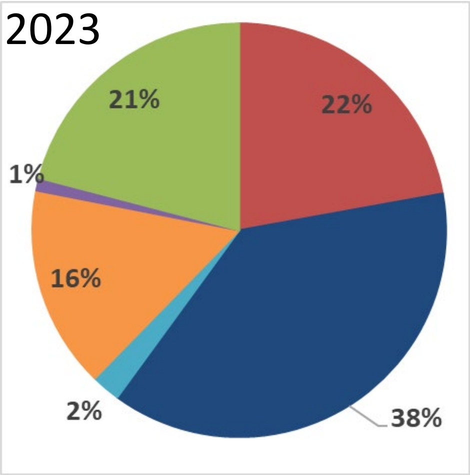


Using Results Viewer for both IPM and ERTAC Projections

Annual Generation (GWh) for IPM v6 November 2018 Reference Case

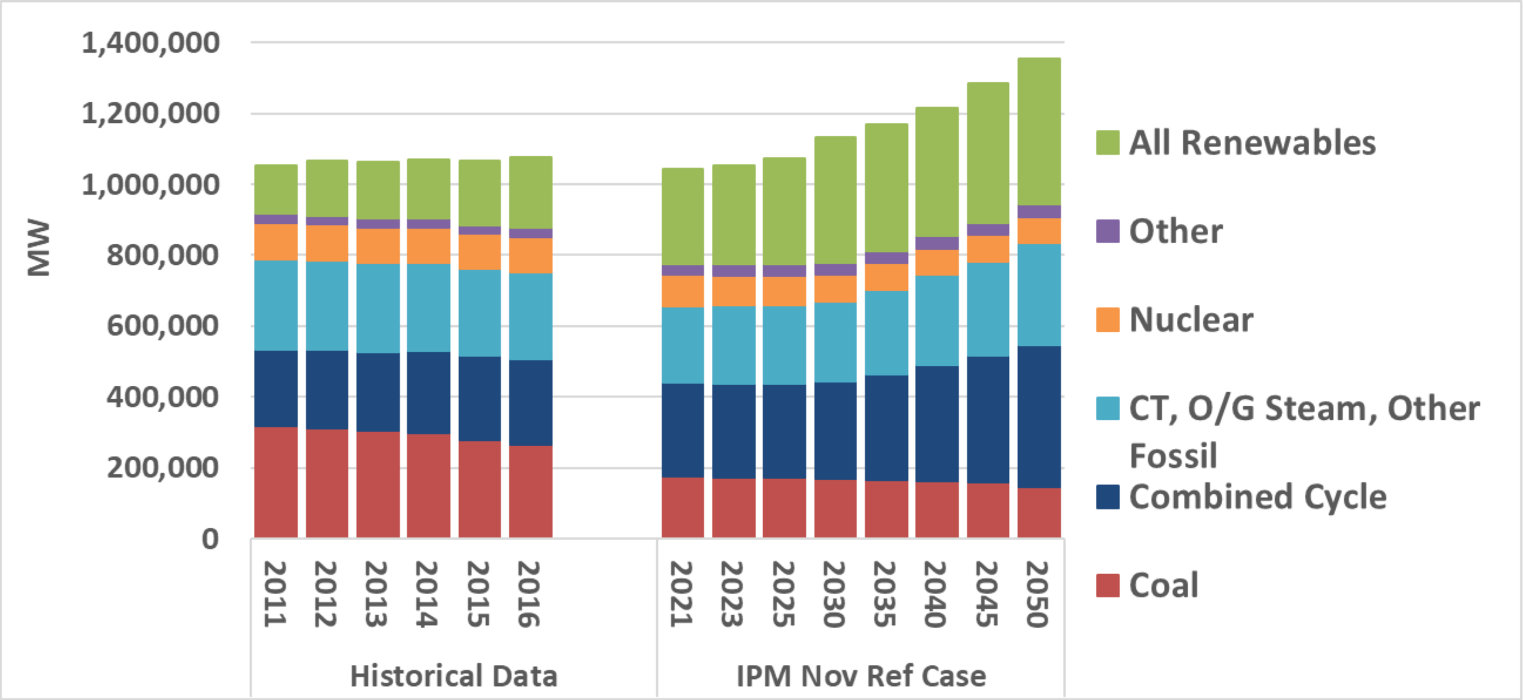


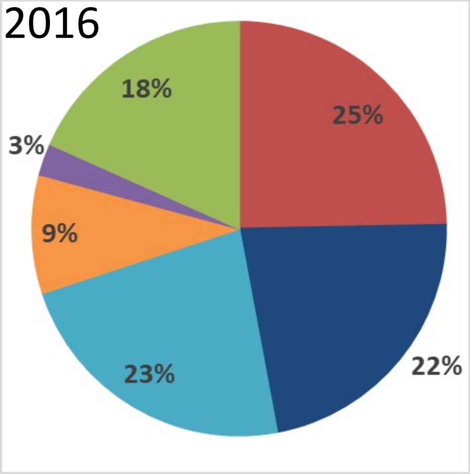


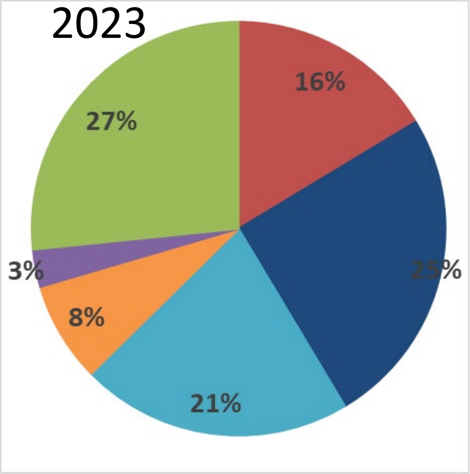


Historical Data is a combination of data reported to CAMD and EIA form 923. It currently is incomplete and excludes fossil fired EGUs < 25 MW.

Capacity (MW) for IPM v6 November 2018 Reference Case

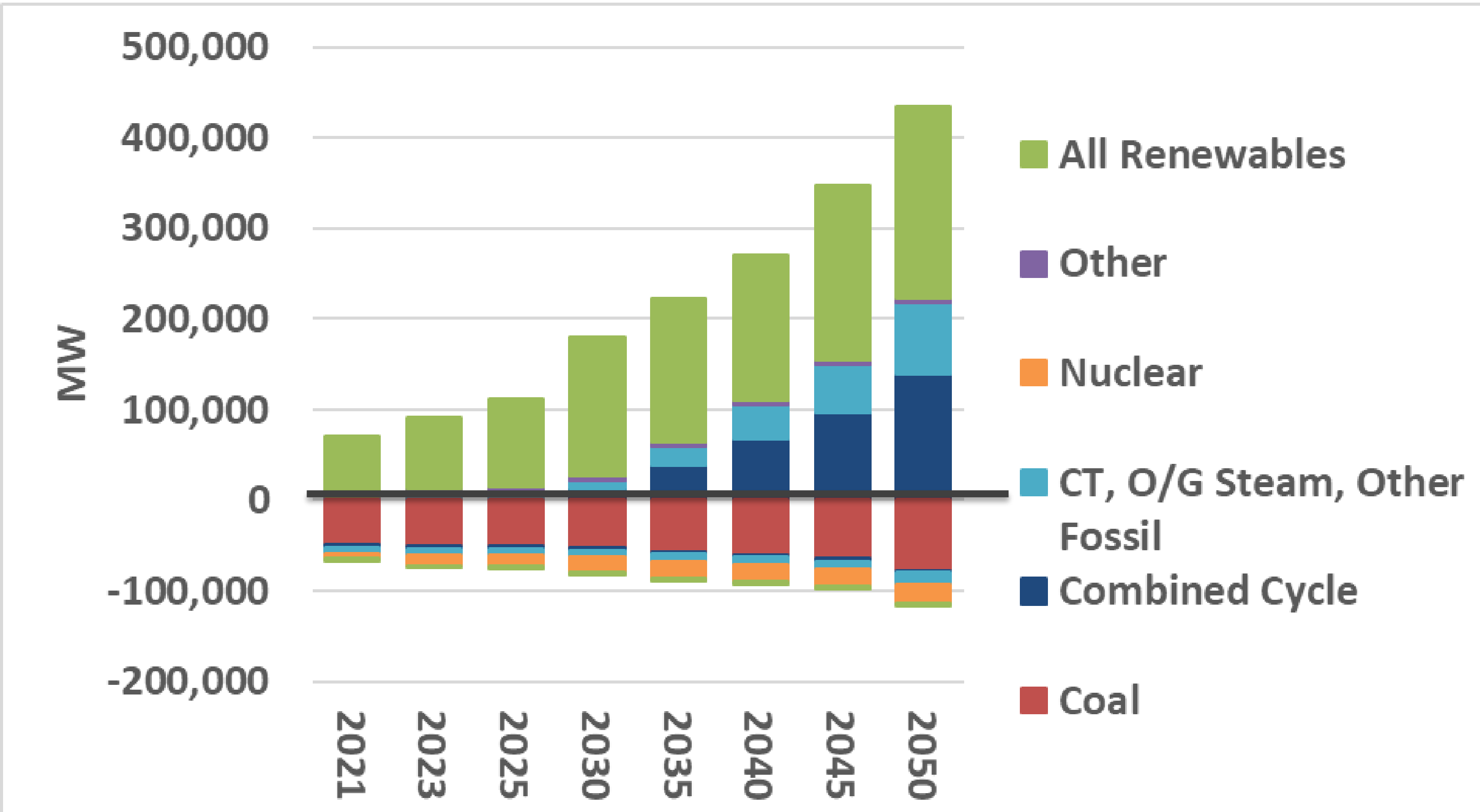




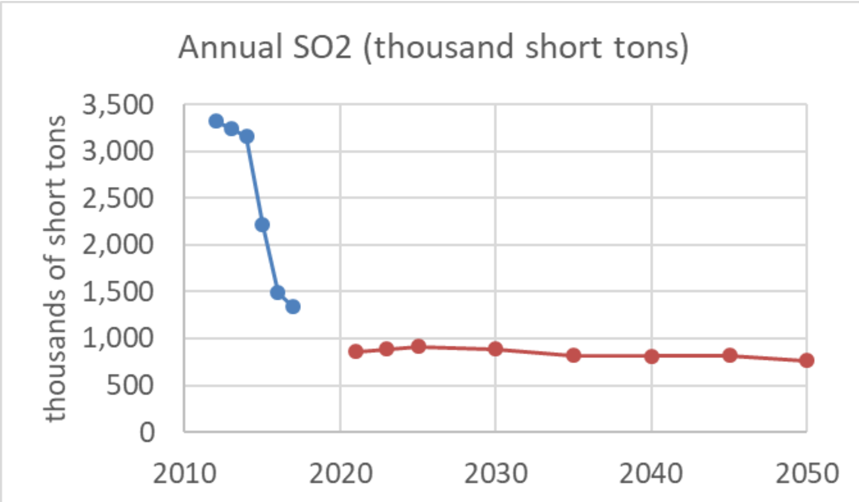


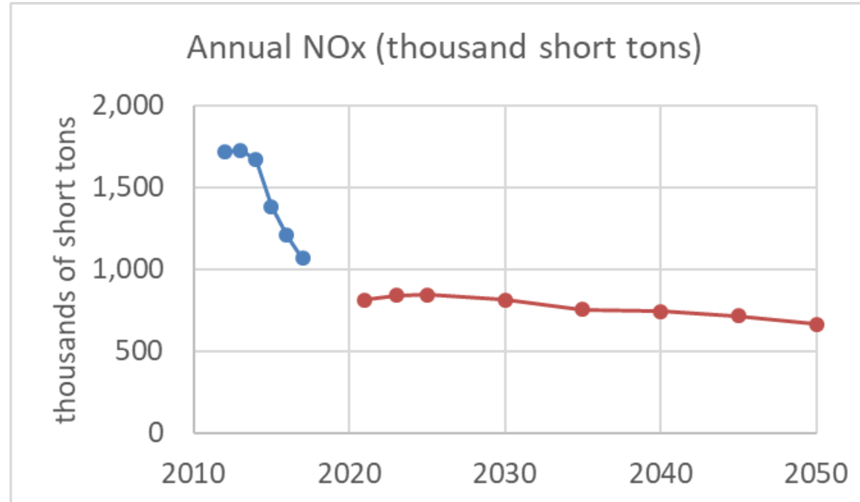
Historical Data is a combination of data reported to CAMD and EIA form 923. It currently is incomplete and excludes fossil fired EGUs < 25 MW.

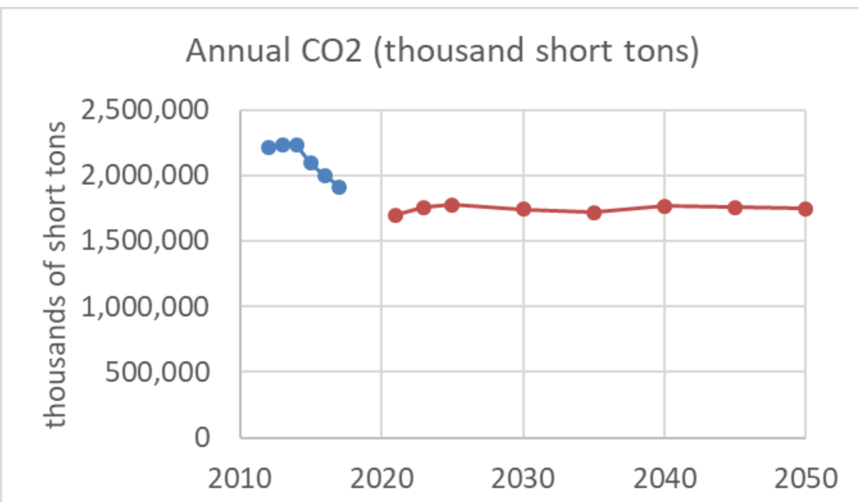
New and Retired Capacity (MW) for IPM v6 November 2018 Reference Case

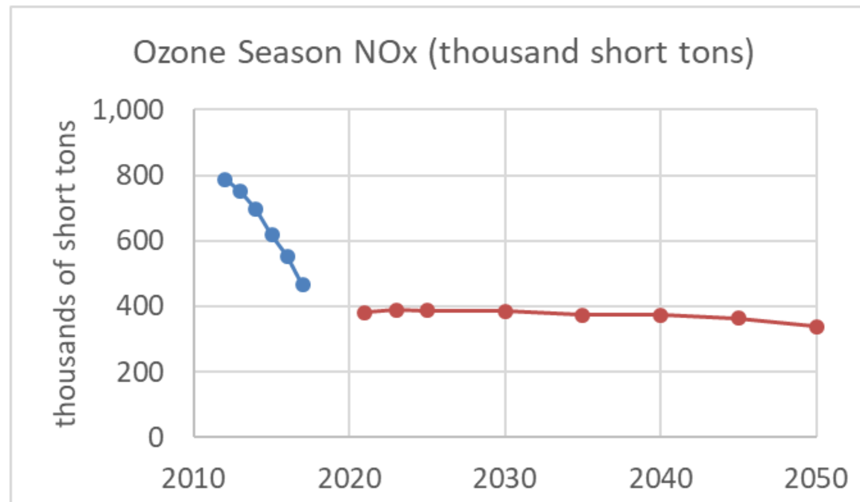


Emissions from Fossil > 25 MW, compared to CAMD data



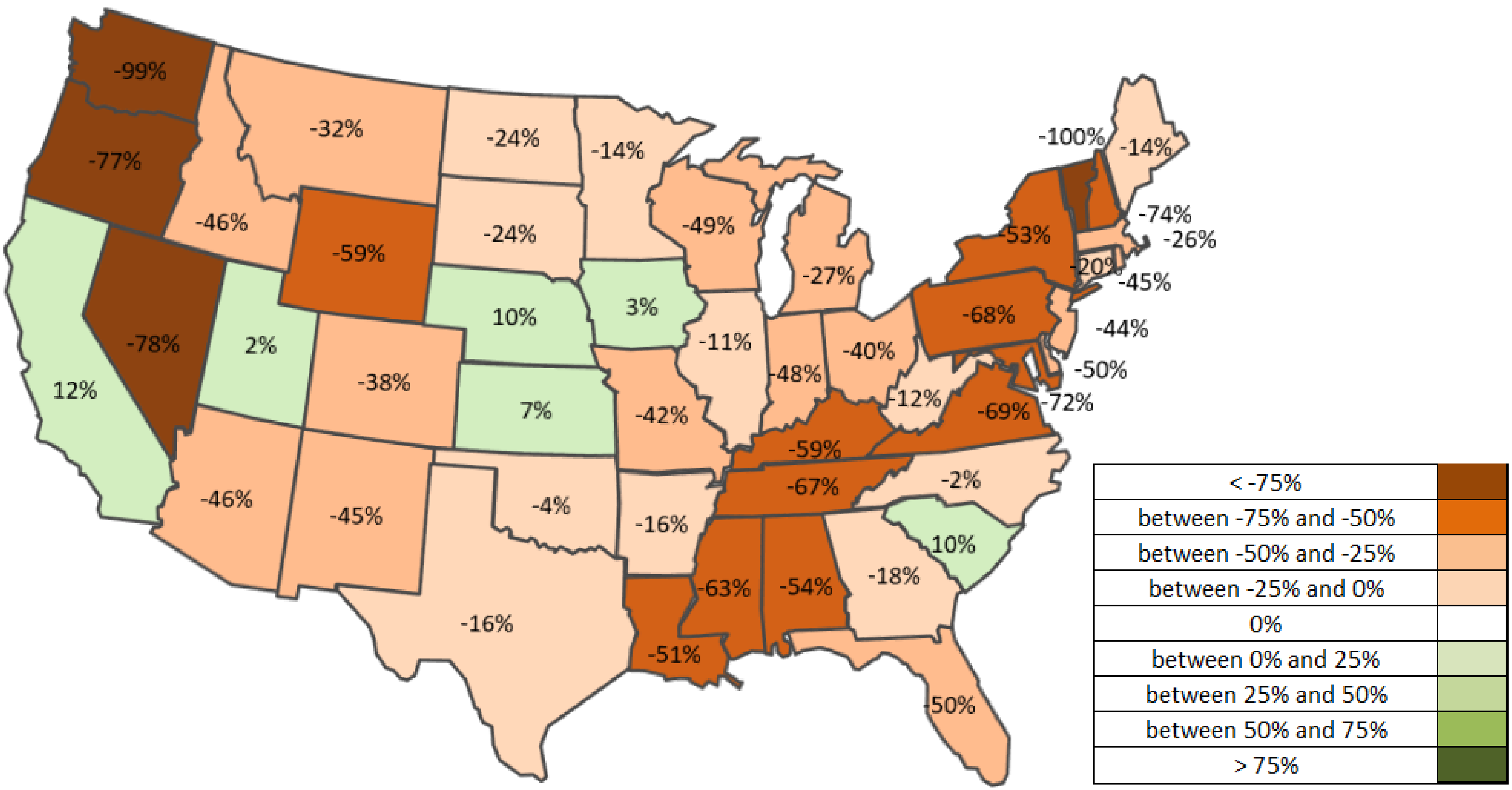




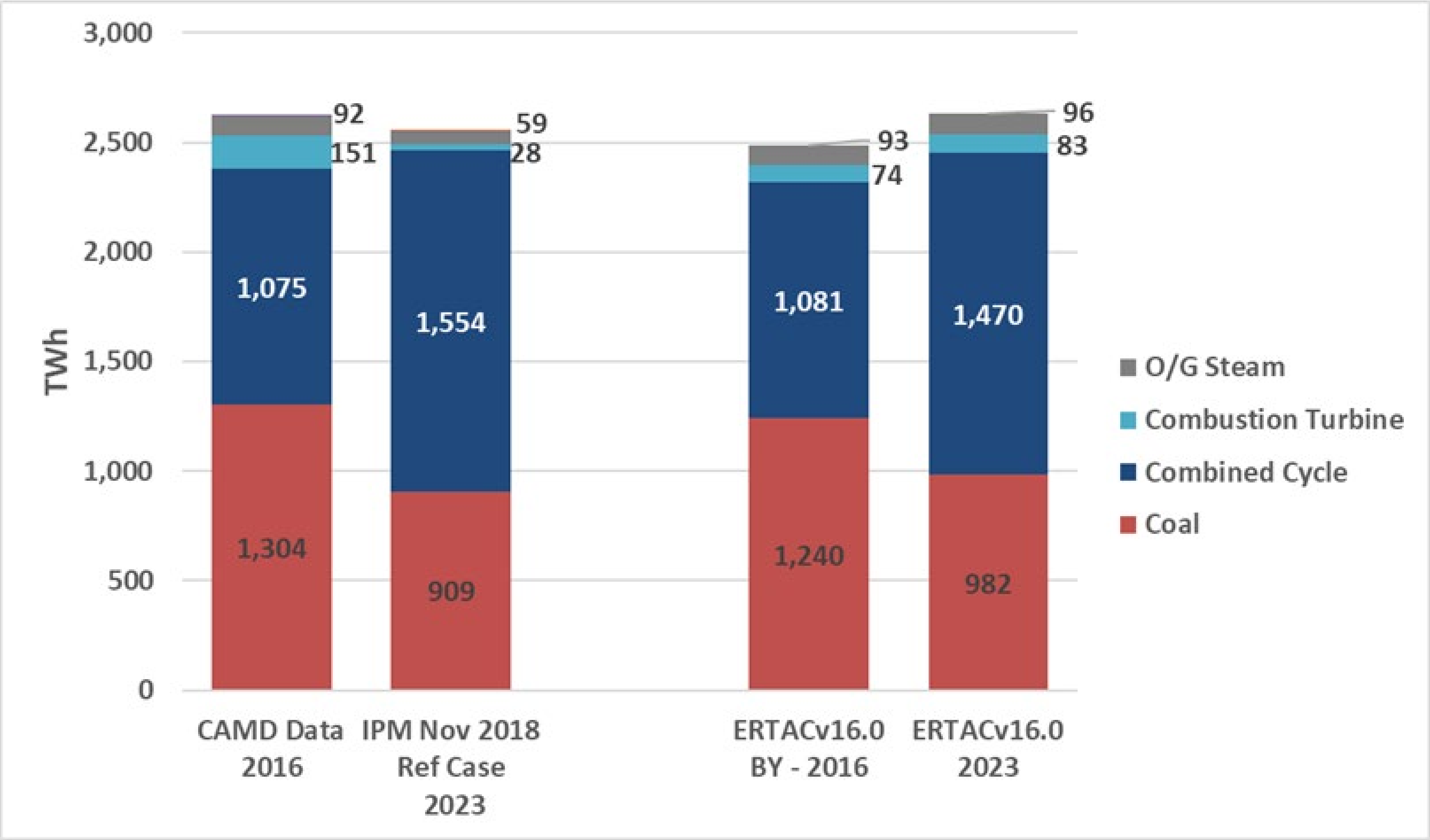


***Blue line** is historical CAMD data; **red line** is IPM v6 November 2018 Reference Case, fossil > 25 MW*

Percent change in Ozone Season NOx Emissions from 2016 CAMD data to **2023** IPM v6 November 2018 Reference Case, fossil > 25 MW

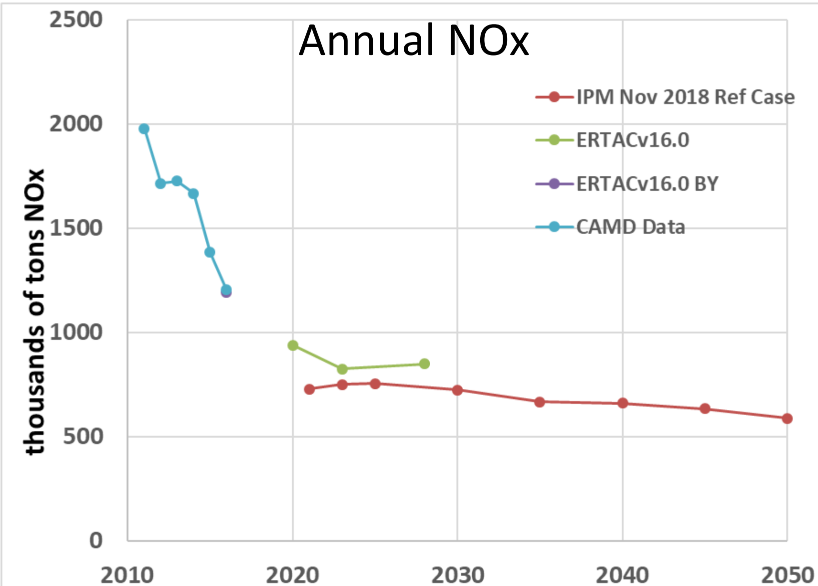


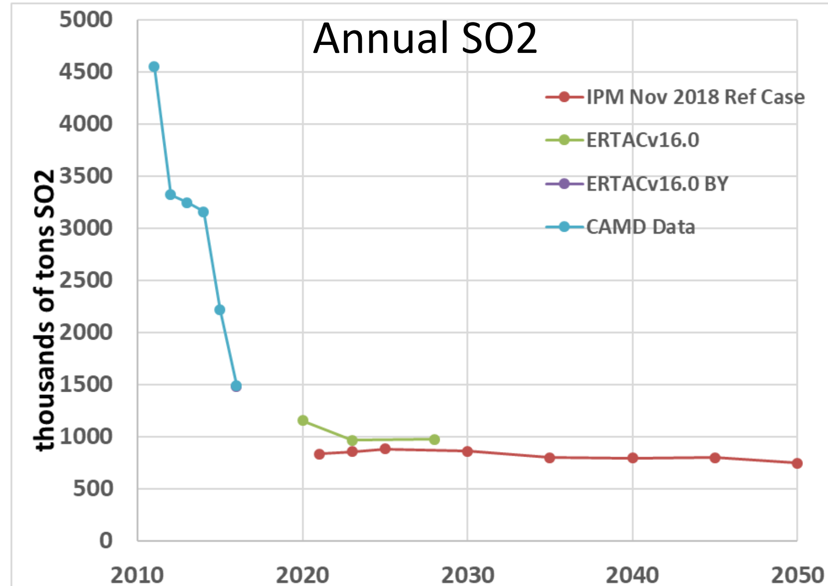
Annual Generation (TWh) **2016** and **2023** for IPM Nov 2018 Reference Case and ERTACv16.0

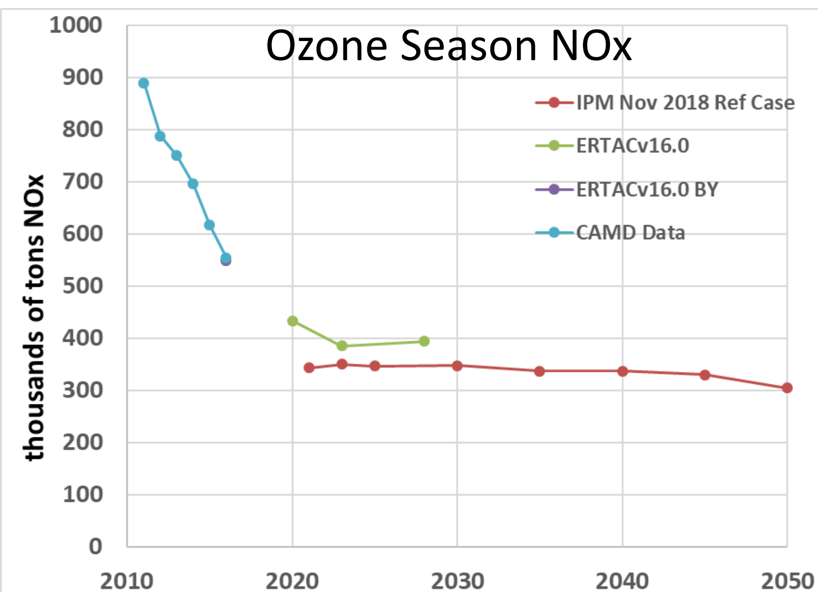


Comparing 2023 projections to relevant 2016 historical data sets. IPM data is for fossil units > 25 MW.

Emissions (thousands of tons) for IPM Nov 2018 Reference Case and ERTACv16.0

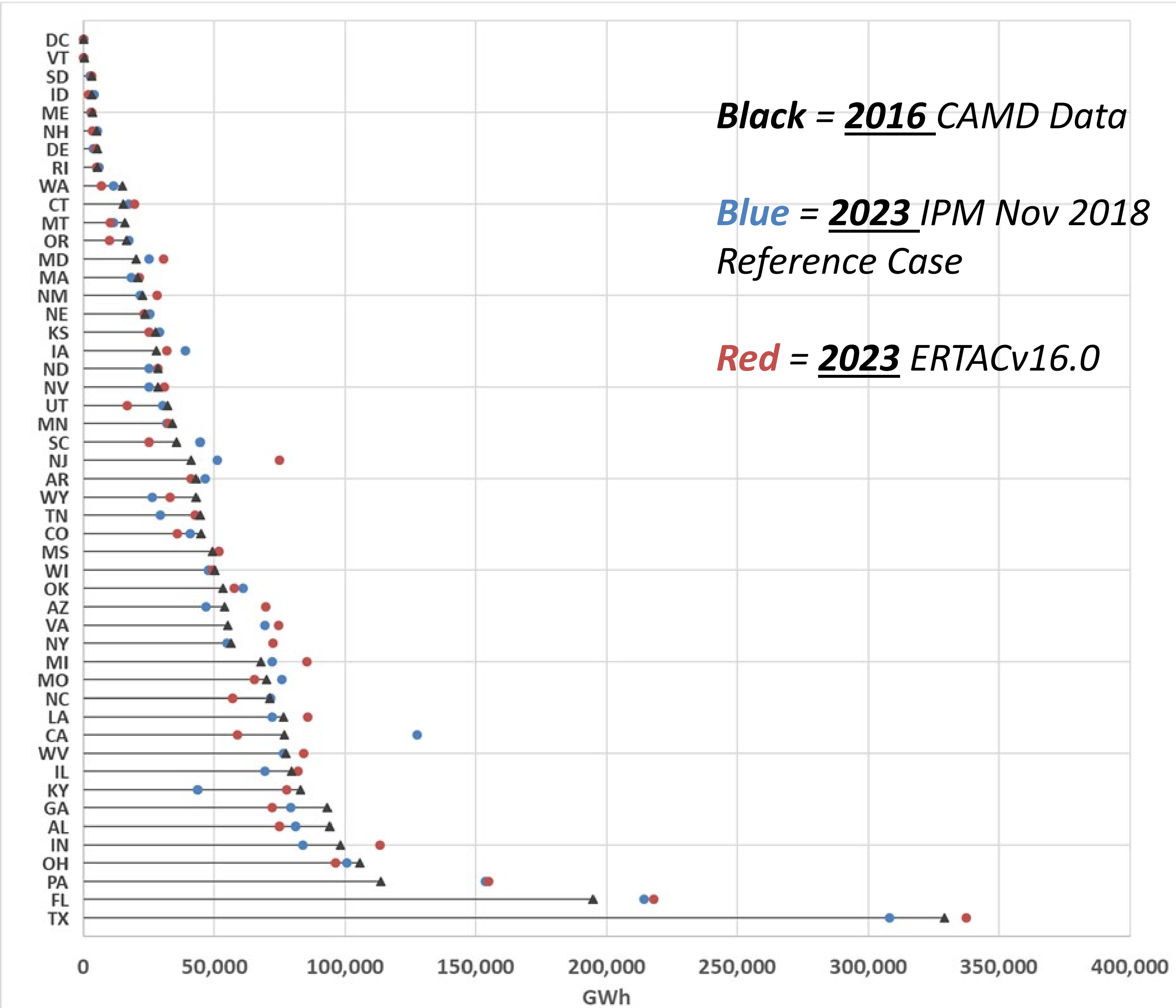




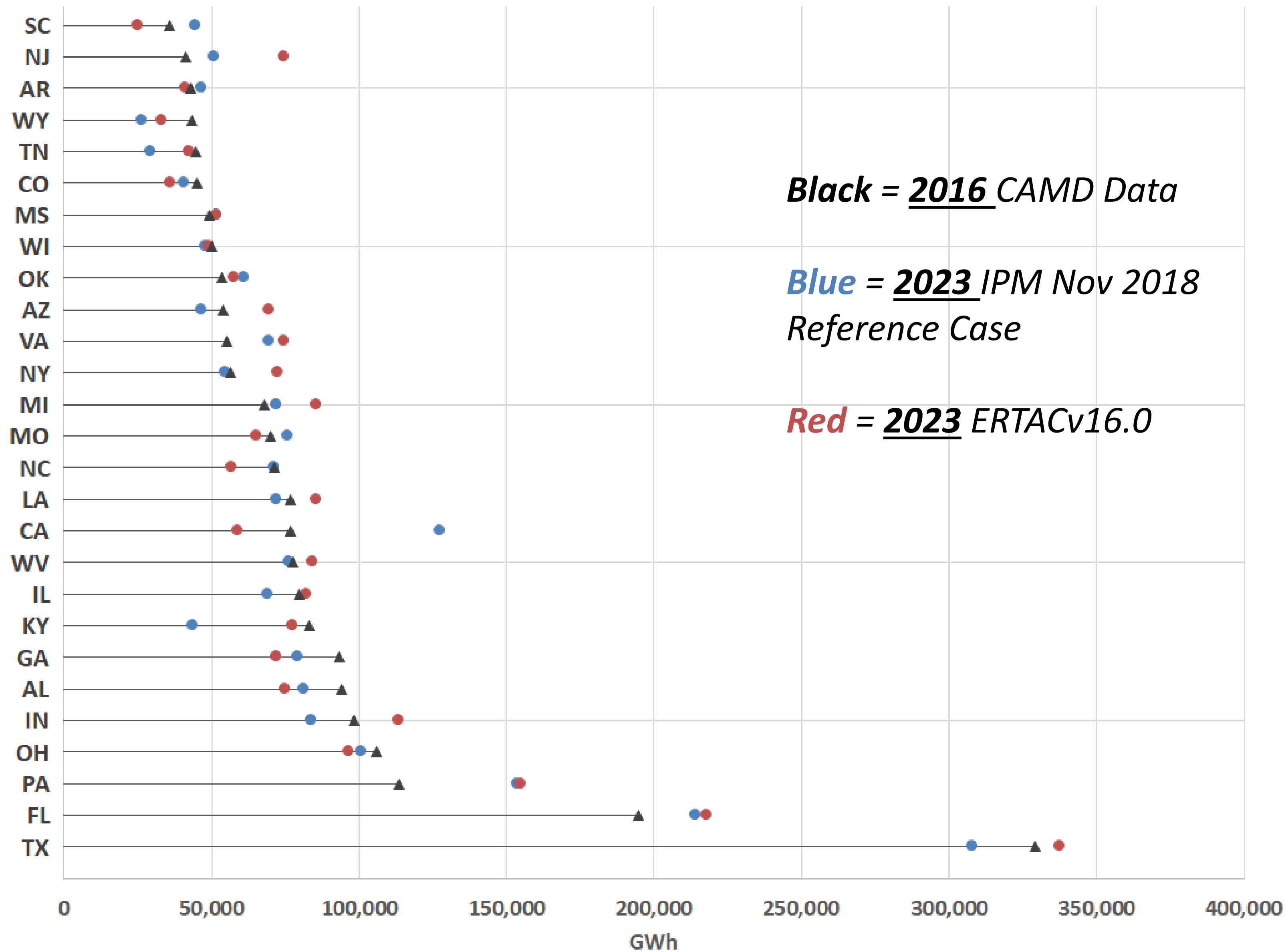


1) CAMD Data for 2016 very similar to ERTAC BY emissions (purple dot almost hidden)
2) Both IPM and ERTAC show decreases in SO2 and NOx from 2016 to 2023.
3) The differences in SO2 between IPM and ERTAC in 2023 are due to differences in generation from coal
4) The differences in NOx are driven by IPM's lower CT & O/G Steam generation and lower coal generation. [for OS NOx in 2023, difference in CT and O/G Steam generation is responsible for ~75% of the difference]

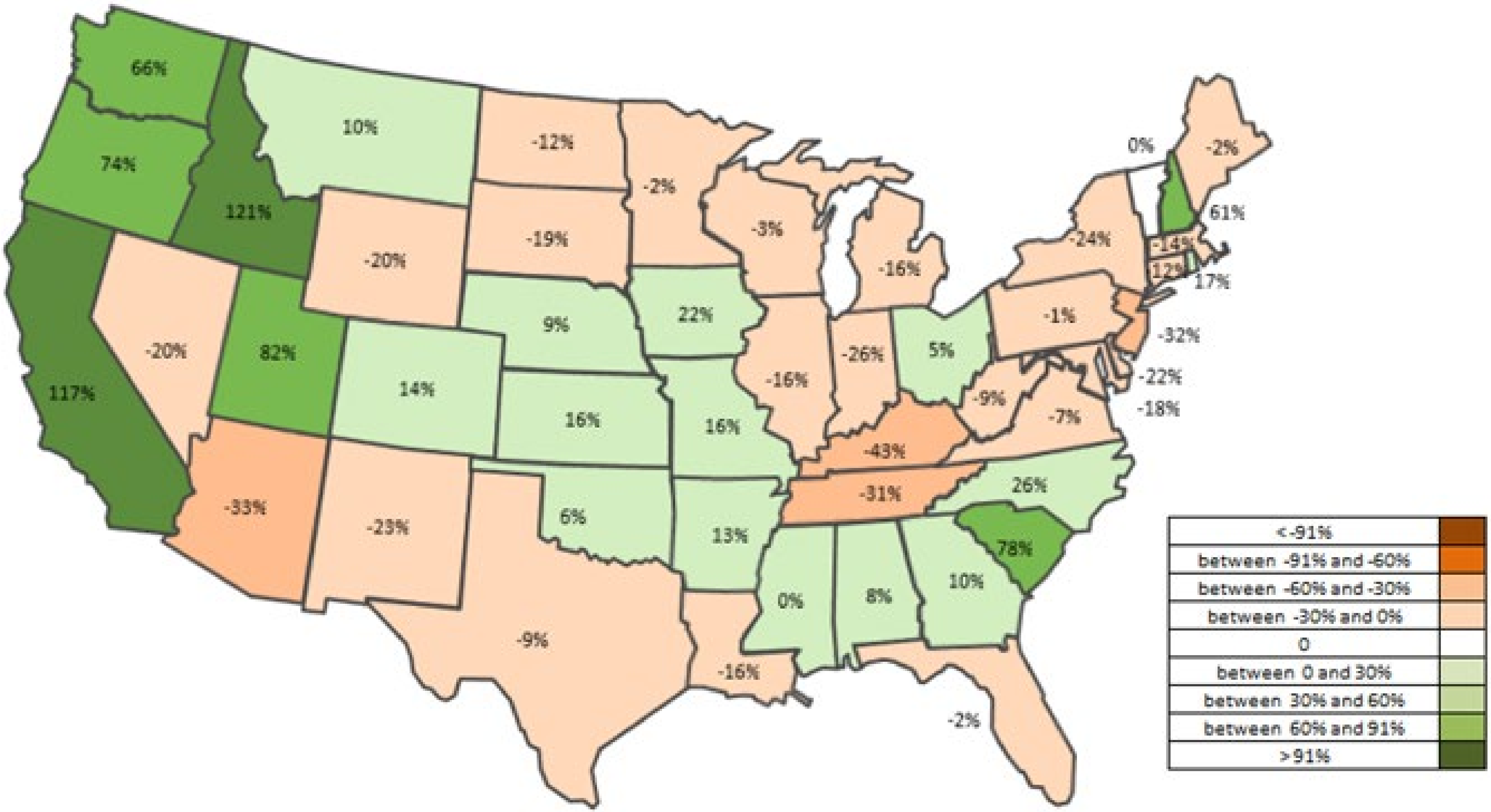
2023 Annual Generation by State



2023 Annual Generation by State (zooming in)

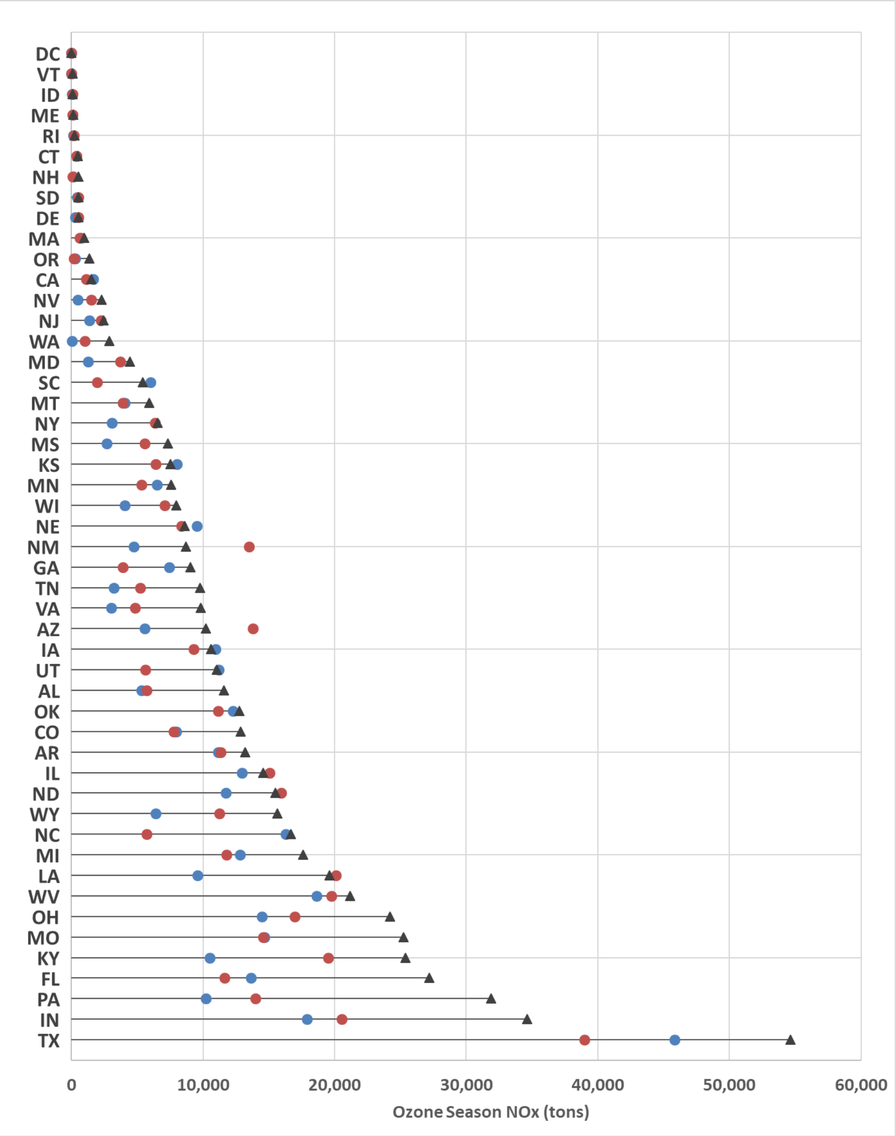


2023 Annual Generation in IPM as a Percent Change from ERTAC



Green states have more annual generation in IPM Nov 2018 Ref Case
Orange states have more annual generation in ERTACv16.0

2023 Ozone Season NOx emissions



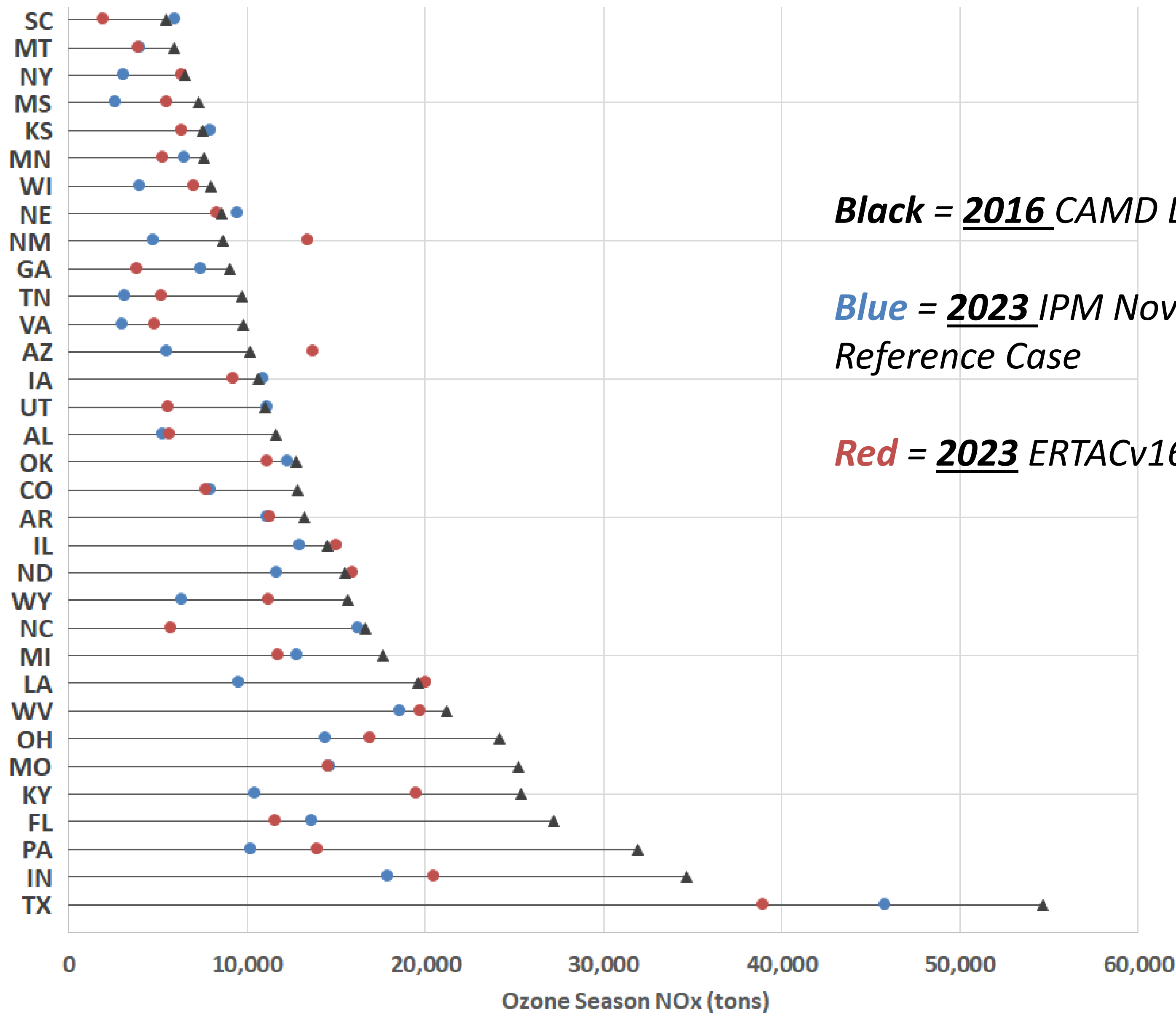
Ozone Season NOx (tons)

Black *=* ***<u>2016</u>*** *CAMD Data*

Blue *=* ***<u>2023</u>*** *IPM Nov 2018 Reference Case*

Red *=* ***<u>2023</u>*** *ERTACv16.0*

2023 Ozone Season NOx emissions (zooming in)

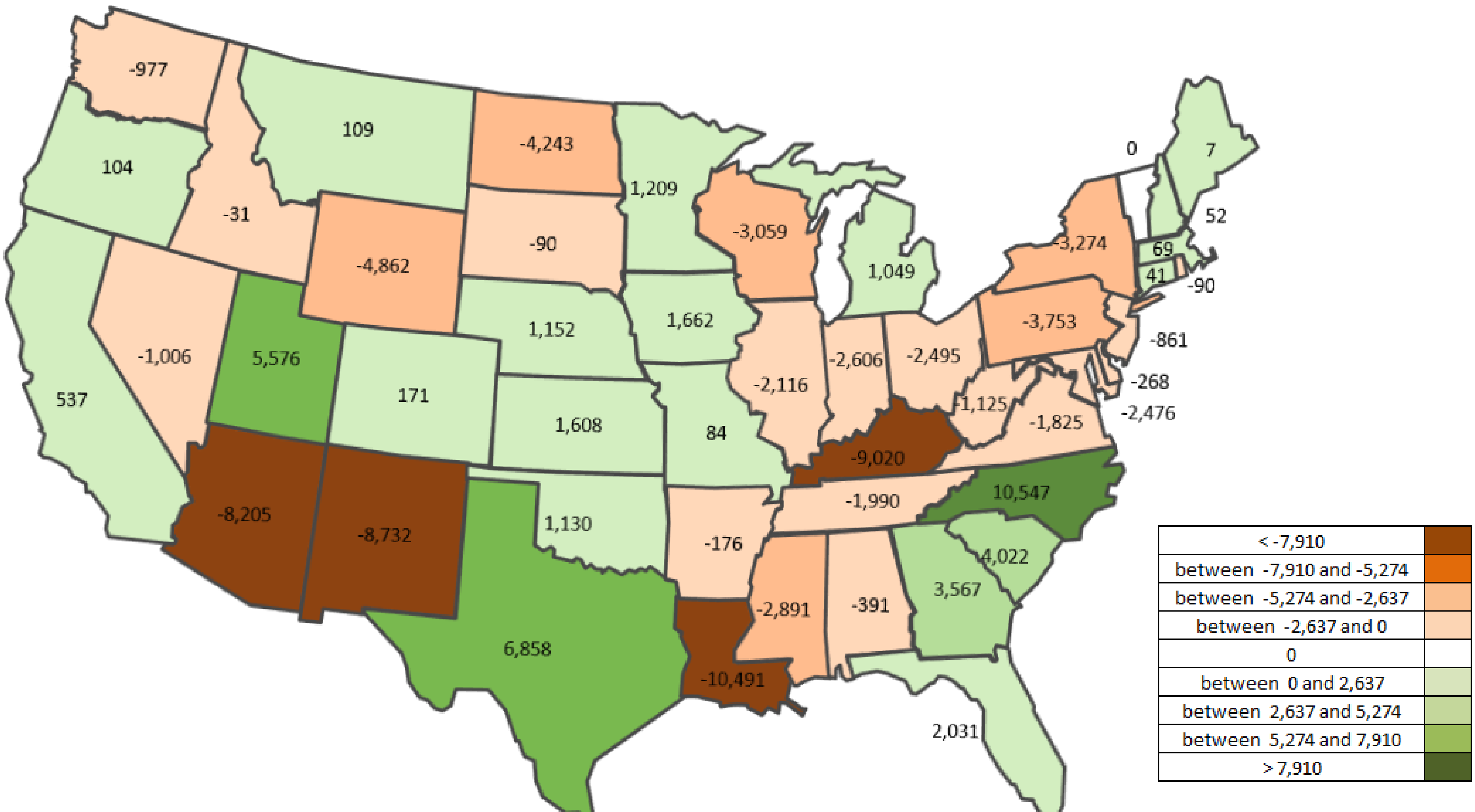


Black = ***2016*** *CAMD Data*

Blue = ***2023*** *IPM Nov 2018 Reference Case*

Red = ***2023*** *ERTACv16.0*

Difference in 2023 Ozone Season NOx (tons)
(IPM values as a change from ERTAC values)



Green states have more OS NOx emissions in IPM Nov 2018 Ref Case
Orange states have more OS NOx emissions in ERTACv16.0

Appendix

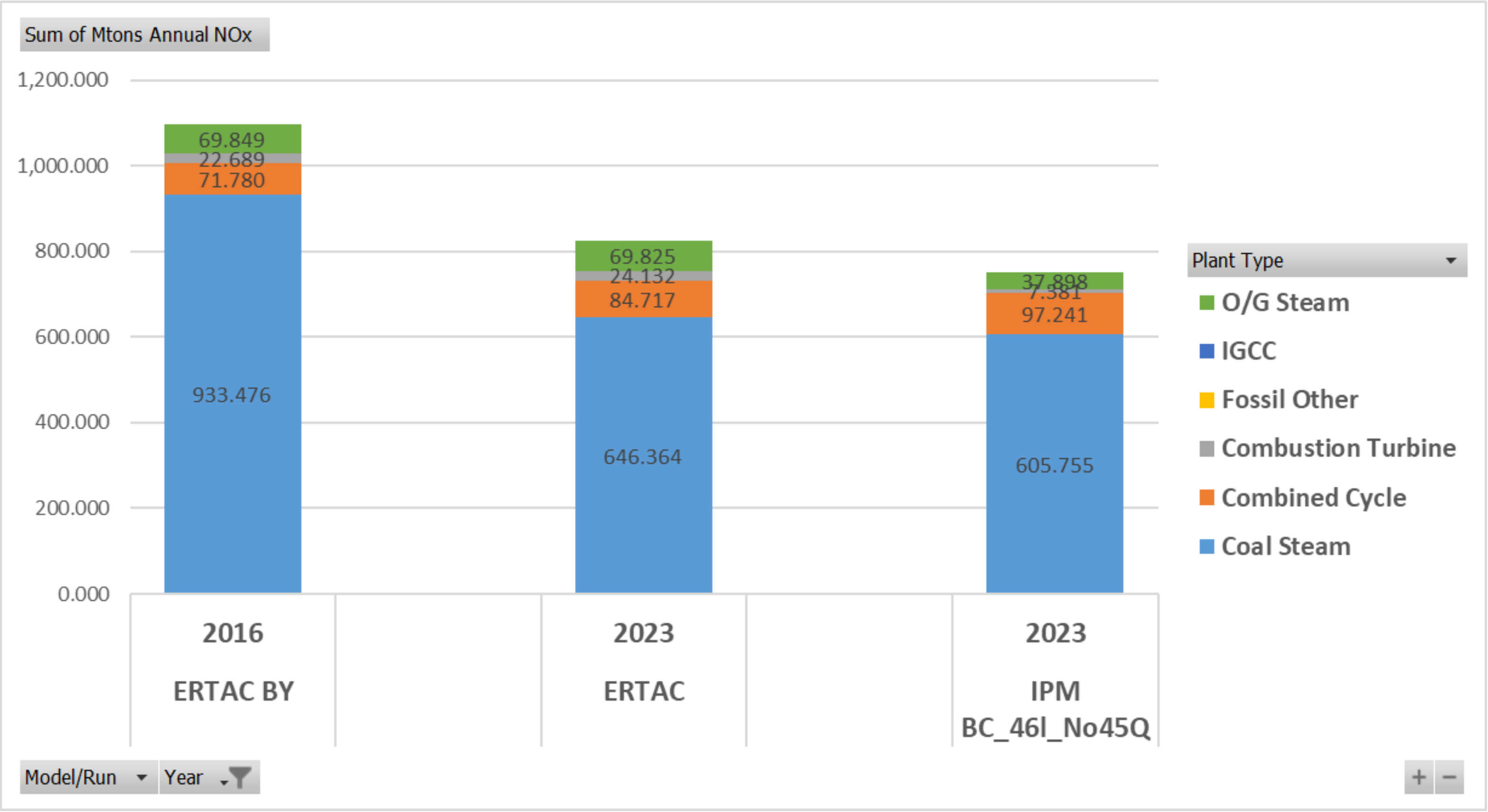
EPA's Power Sector Modeling Update

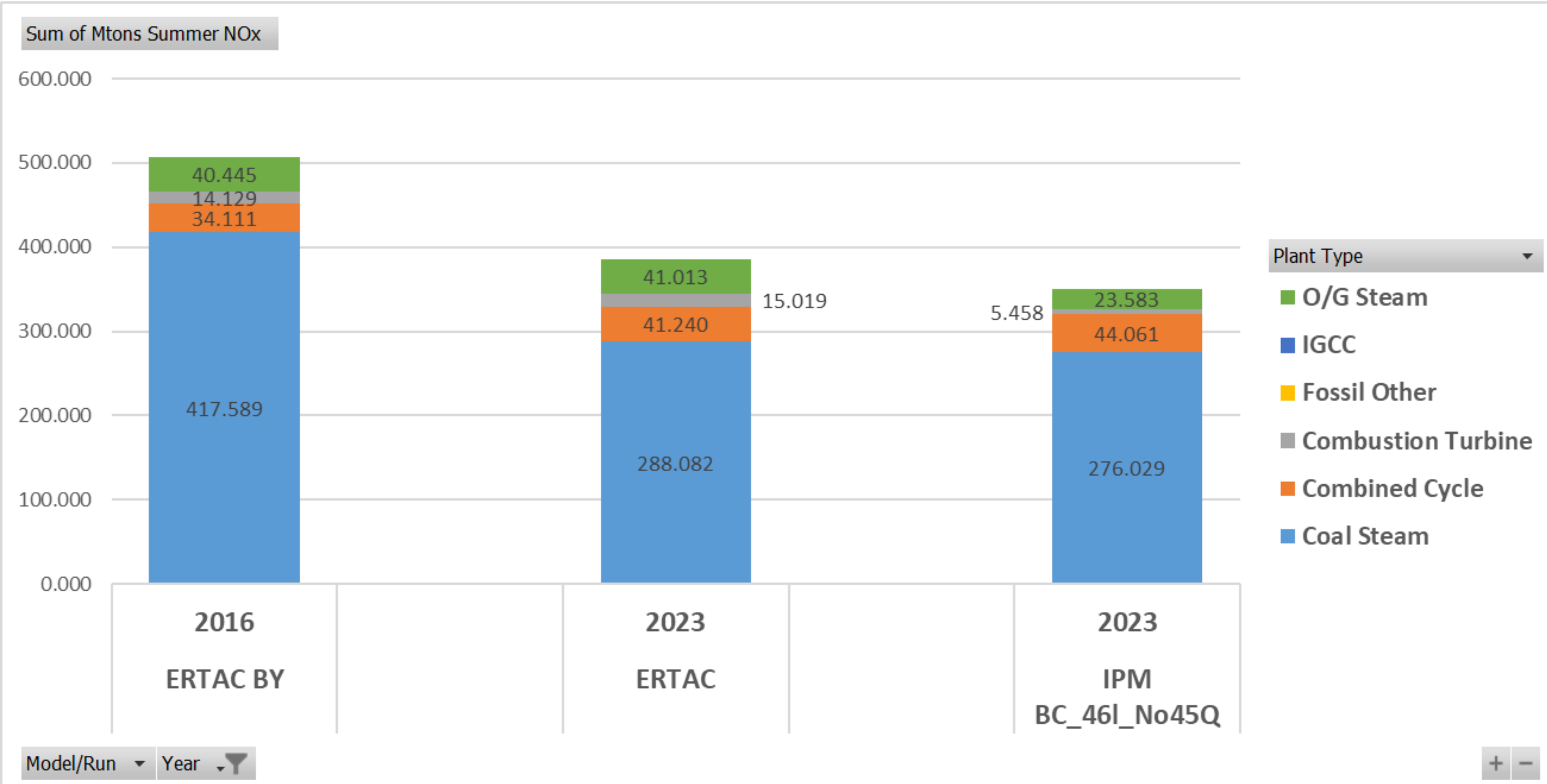
IPM v6 May 2018 initial run already incorporated a number of bottom-up data and structural platform updates compared to IPM v5. Some noteworthy ones:

- Time-of-day implementation of load segments
- NERC 2017 peak load/total load ratio projections through 2027, after that AEO peak/total ratios
- 60 year cost adder for nuclear life extension
- ATB 2017 (lower wind and solar costs)
- Latest data on committed units
- Hg EMF factors (all units comply with MATS without adding new retrofits)
- 2017 OS NOx rates
- Solar tariffs implementation
- CO2 risk premium for new fossil units (coal and NGCC) at 3% capital charge rate penalty

Type of Projection Method

- ERTAC EGU Forecasting Tool
  - Grows a base year hourly data into future projection years by employing scaling/growth factors using AEO demand projections by NEMS region and generation type.
  - Mimics historical base year unit level hourly behavior into the future; units are not retired beyond known/announced retirements.
  - ERTAC is currently using AEO high oil&gas case (switched from AEO ref case)
  - ERTAC is using 2016 NOx rates.
  - ERTAC's latest fleet reflects recent (2018) retirements.
- IPM
  - Makes retirement and new capacity addition decisions based on least-cost optimization.
  - Does not mimic a historical year dispatch behavior at the unit level.
  - IPM's gas price/consumption projections are usually closer to AEO high oil&gas than AEO Ref case.
  - IPM is using 2018 NOx rates.
  - IPM's latest fleet reflects recent (2018) retirements.
  - IPM outputs seasonal average values. Temporalization of unit level outputs into hourly data is done through a post-processing step.


Sum of Mtons Annual NOx
1,200.000
1,000.000
800.000
600.000
400.000
200.000
0.000
69.849
22.689
71.780
933.476
69.825
24.132
84.717
646.364
37.898
7.381
97.241
605.755
2016
ERTAC BY
2023
ERTAC
2023
IPM
BC_46l_No45Q
Plant Type
O/G Steam
IGCC
Fossil Other
Combustion Turbine
Combined Cycle
Coal Steam
Model/Run
Year



Sum of Mtons Summer NOx
600.000
500.000
400.000
300.000
200.000
100.000
0.000
40.445
14.129
34.111
417.589
41.013
15.019
41.240
288.082
5.458
23.583
44.061
276.029
2016
ERTAC BY
2023
ERTAC
2023
IPM
BC_46l_No45Q
Plant Type
O/G Steam
IGCC
Fossil Other
Combustion Turbine
Combined Cycle
Coal Steam
Model/Run
Year