A Comparison of Emission Projection Methods for NOx and SO2 Emissions From Electricity Generating Units

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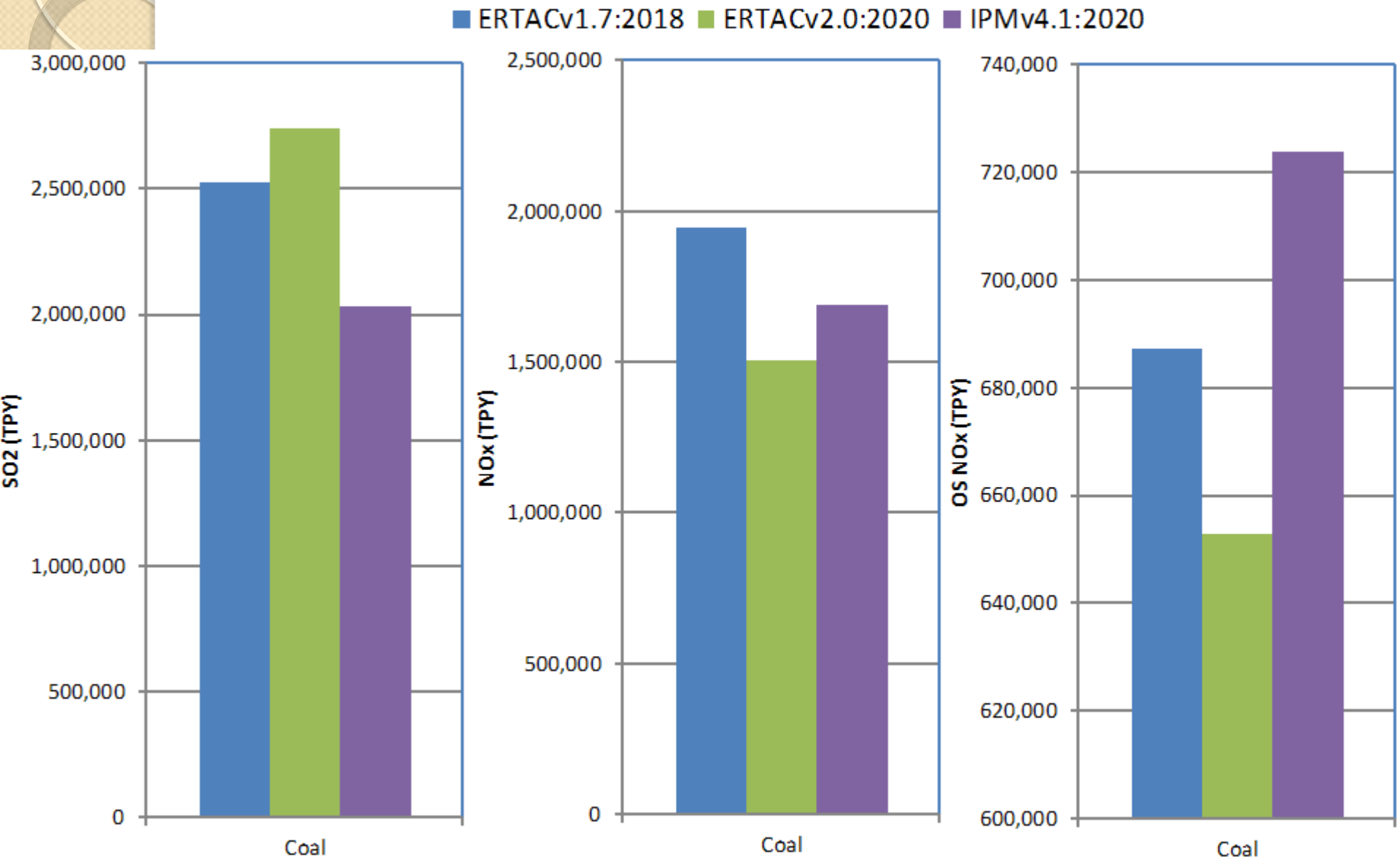
Emission Projection Methods

	ERTAC EGU Projection Tool	SEMAP	IPM
Description	• Heat input/generation projection with controls • Explicit energy demand distribution among units in the same fuel type in the same region • Open-source (Python and SQLite) • Easy and free to run	• Simple linear growth and control factor application • No explicit consideration about energy demand among units • Straightforward implementation	• Considers complex economic interactions among energy sectors including renewables and nuclear • Proprietary model • States do not have ability to replicate nor run sensitivity cases. "Black Box" - Details about how the model predicted certain unit-level outputs are not known. • Expensive to run
Temporal/Spatial Coverage	• Hourly • Continental United States	• Annual • SEMAP States: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV	• Annual and Ozone season • Continental United States Plus
Base Year	2007 (v1.7) and 2011 (v2.0)	2007	2006
Projection Year	2017, 2018, and 2020	2018 (v1c)	2020
Growth/Control Information	• AEO2013 growth factor: annual, peak, and non-peak GFs • Control data supplied by states	• AEO2012 annual growth factor • Control data supplied by SESARM states	• AEO 2010 information • NEEDS v4.1

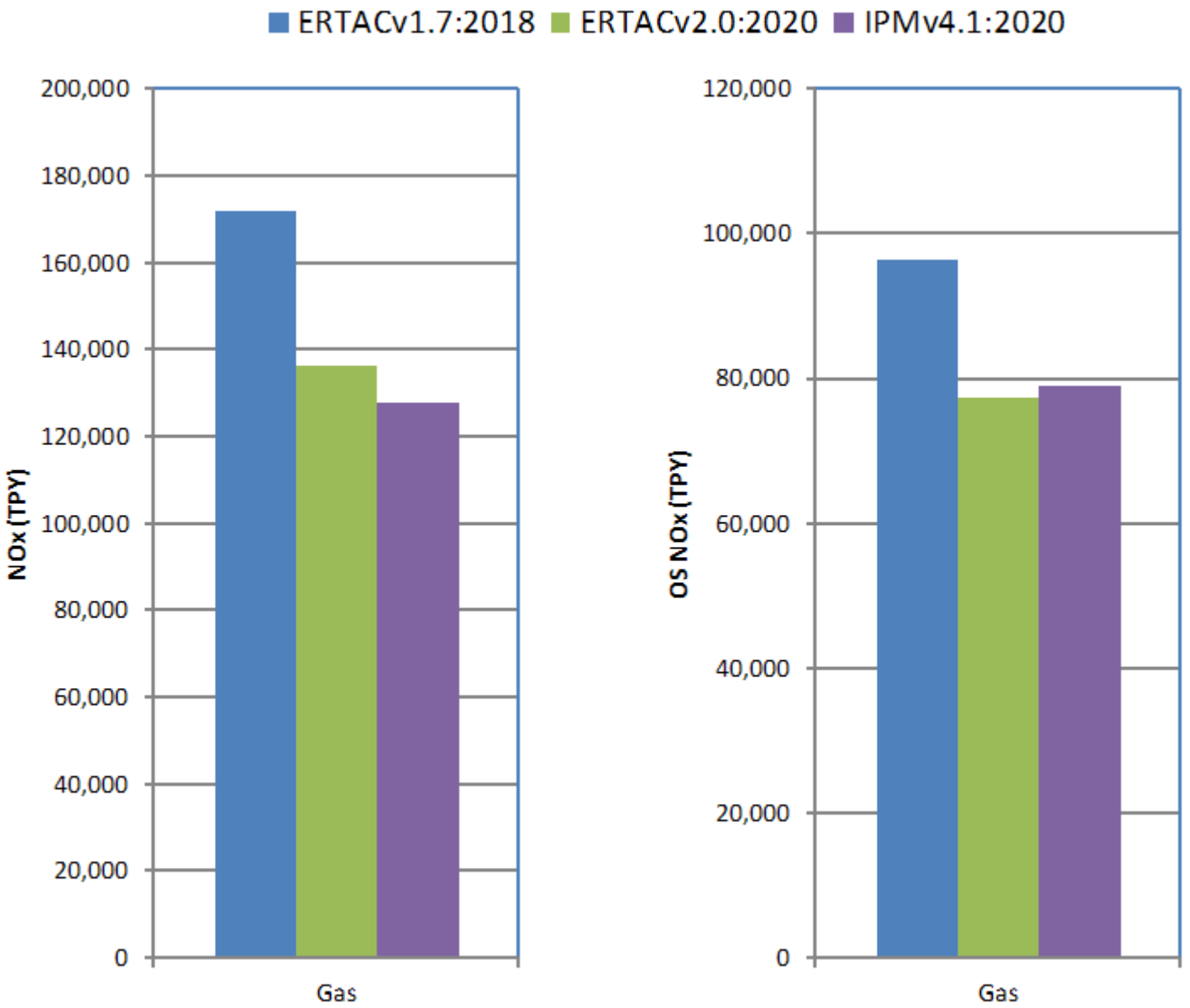
Challenges in Cross-comparison

- Different levels for emissions
  - IPM and ERTAC – Unit level
  - SEMAP –Pseudo-Unit level (originally, process level)
- Fuel type mapping
  - Fuel types are not necessarily same among IPM, ERTAC, and SEMAP
    - All of ERTAC gas types are mapped to the generic 'Gas' type
    - IPM's "Natural Gas" type was mapped to the generic 'Gas' type
    - Some units burn more than one type of fuel
  - SEMAP approach does not need fuel types explicitly
    - ORIS ID/CAMD Unit ID and Facility ID/State Unit ID were used to map fuel types from ERTAC data to SEMAP data followed by simpler fuel type mapping procedure
- Base year and projection year differences
  - For this analysis, the following dataset were used: ERTAC v1.7 for 2018, SEMAP v1c for 2018, ERTAC v2.0 for 2020, and IPM v4.1 for 2020
- Labeling for effective cross-comparison
  - Some unique keys/names for the same units/facilities across all models

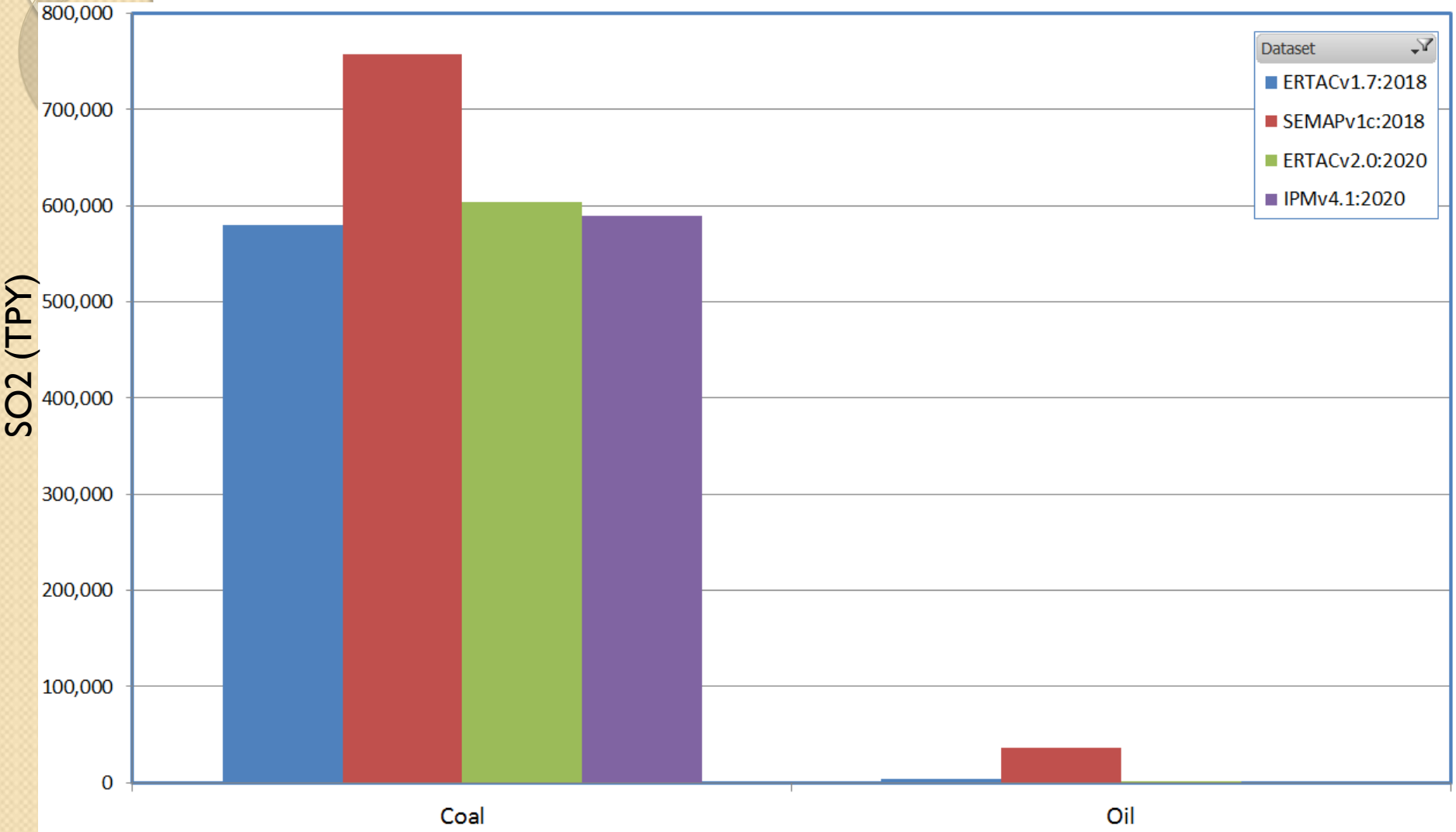
Coal: ERTAC and IPM Continental United States



Gas: ERTAC and IPM Continental United States



SO2, Coal & Oil: ERTAC, IPM, and SEMAP
SE States: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV



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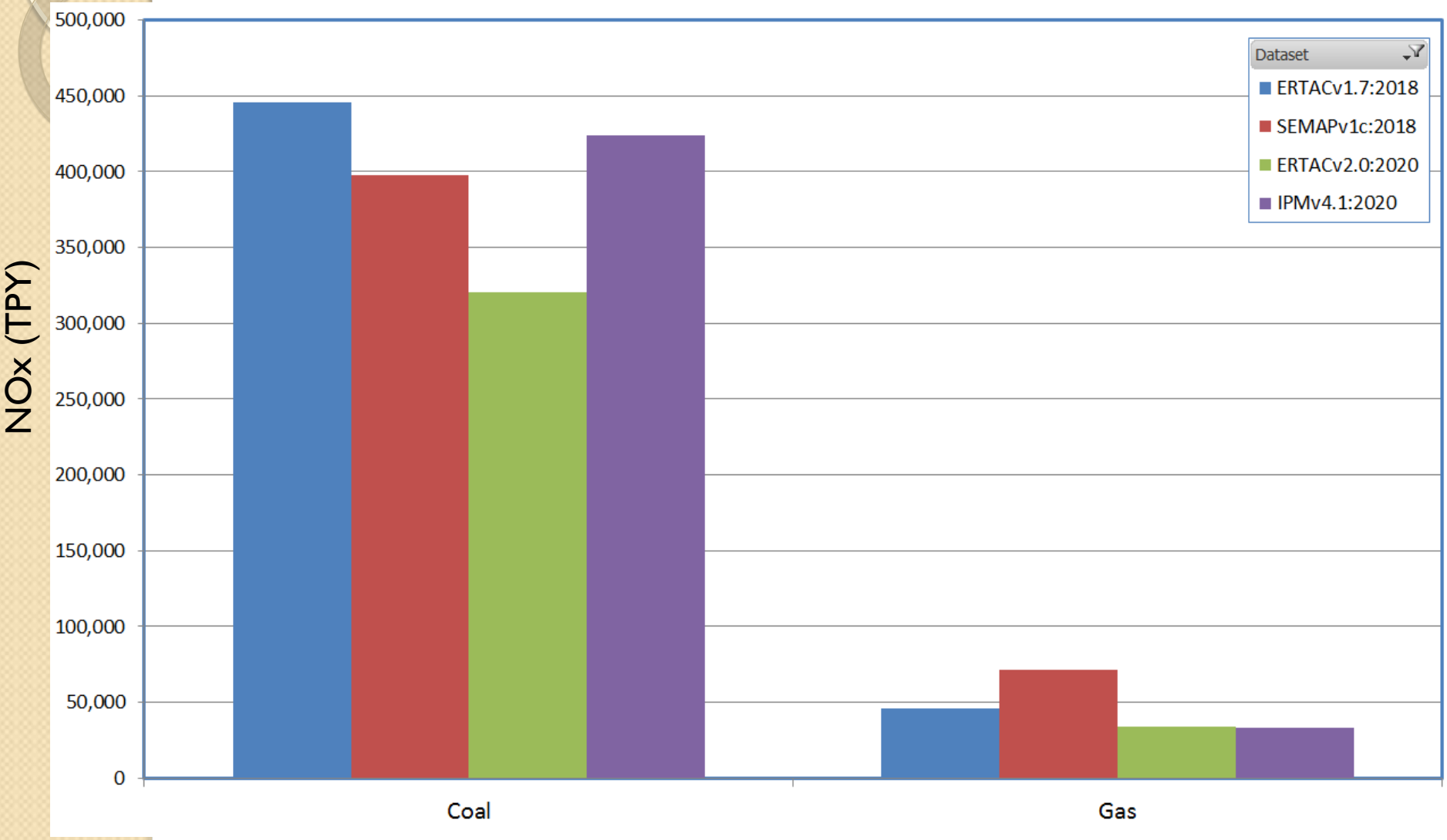
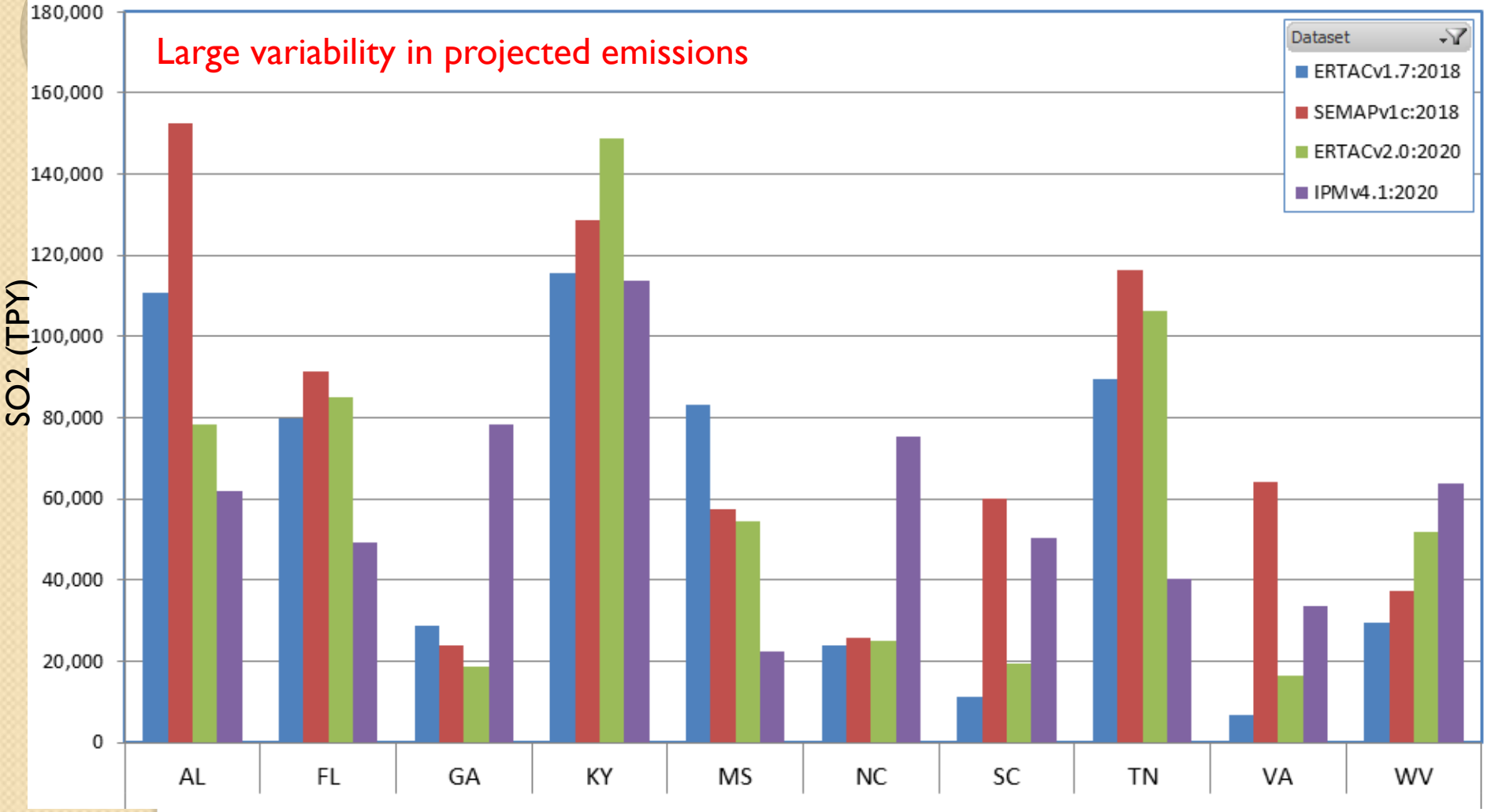


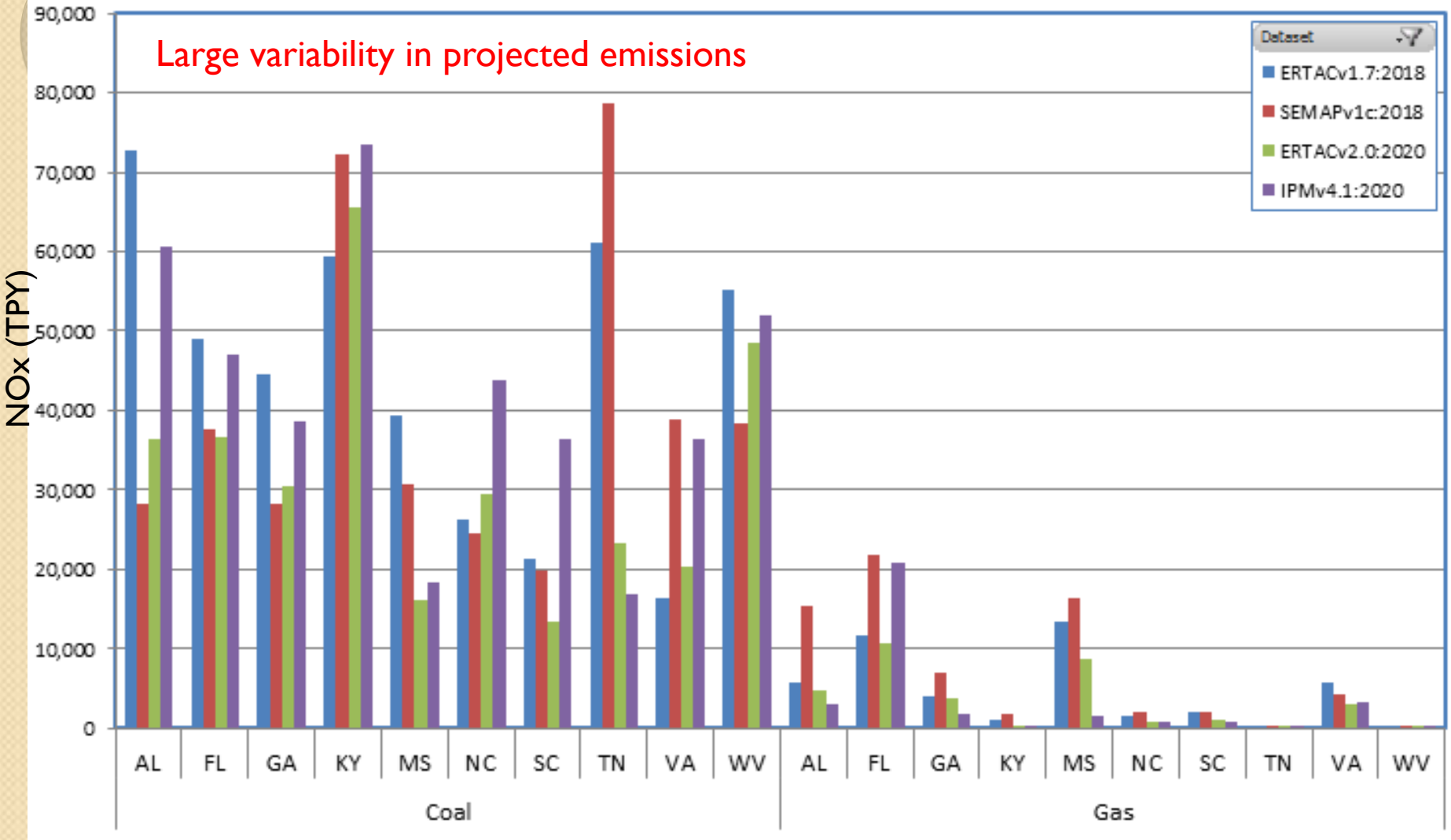
SO2, Coal

SE States: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV

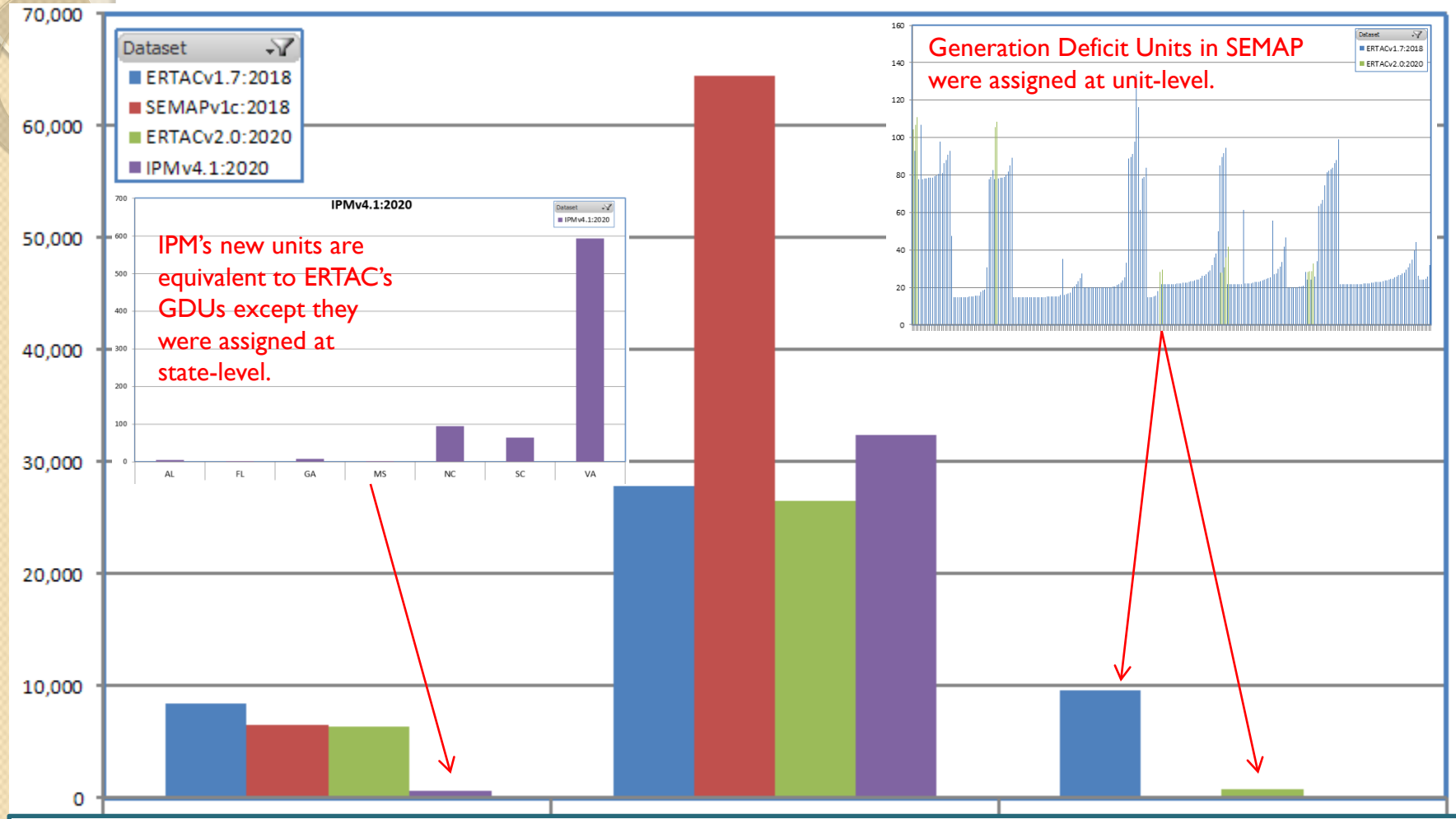


NOx, Coal and Gas

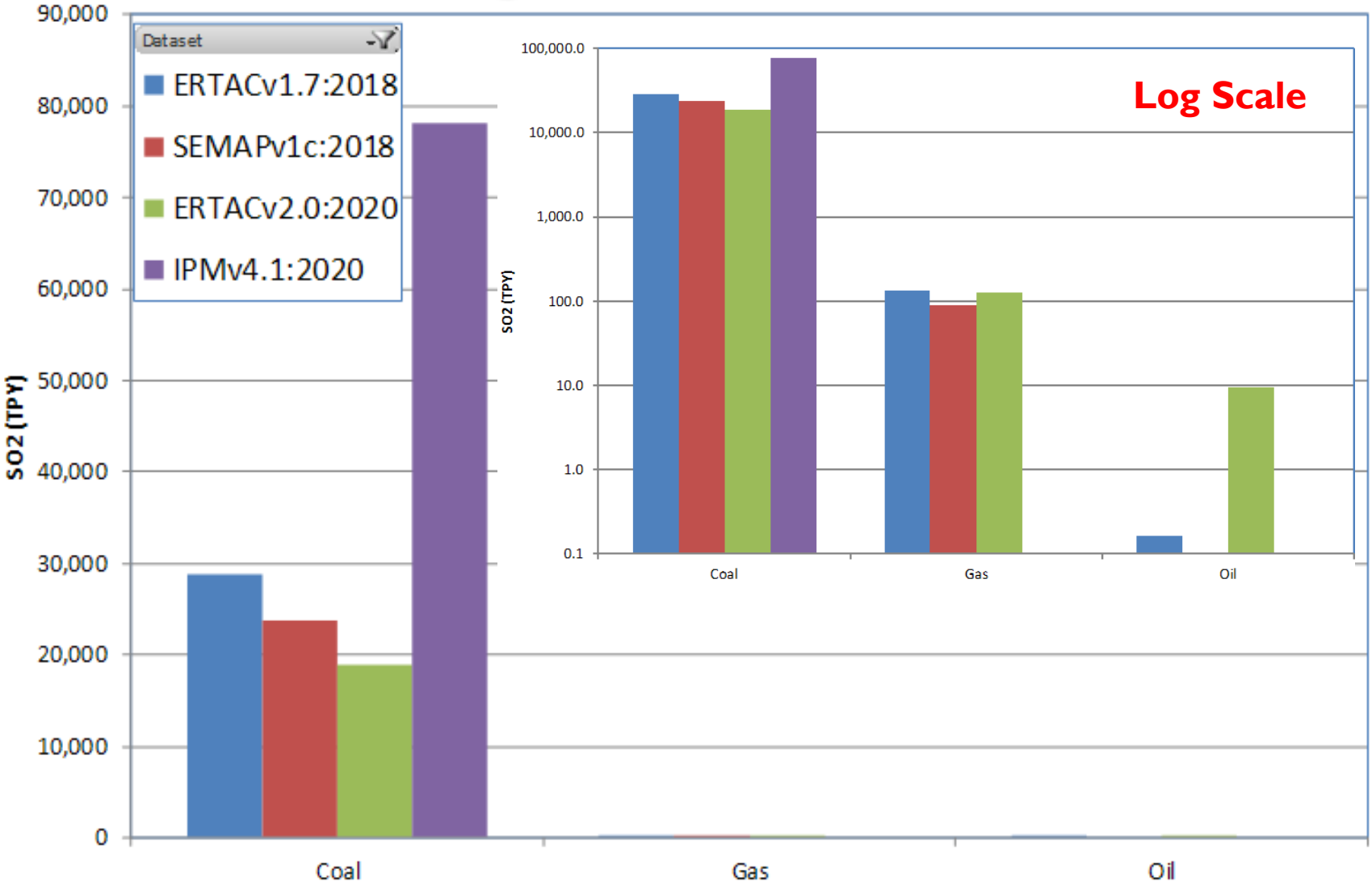
SE States: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV



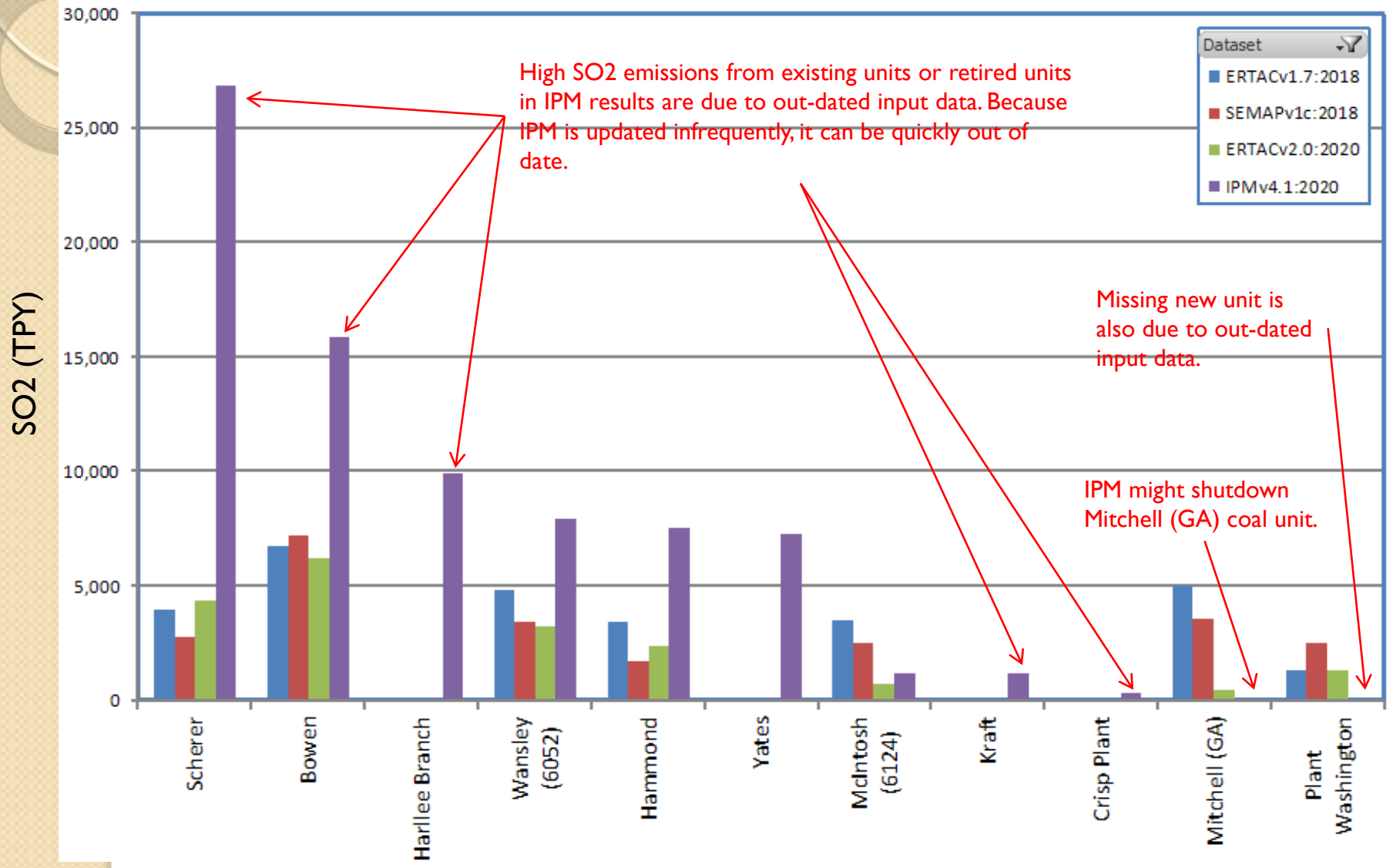
NOx, Gas, New Unit and/or Generation Deficit Unit SE States: AL, FL, GA, KY, MS, NC, SC, TN, VA, and WV



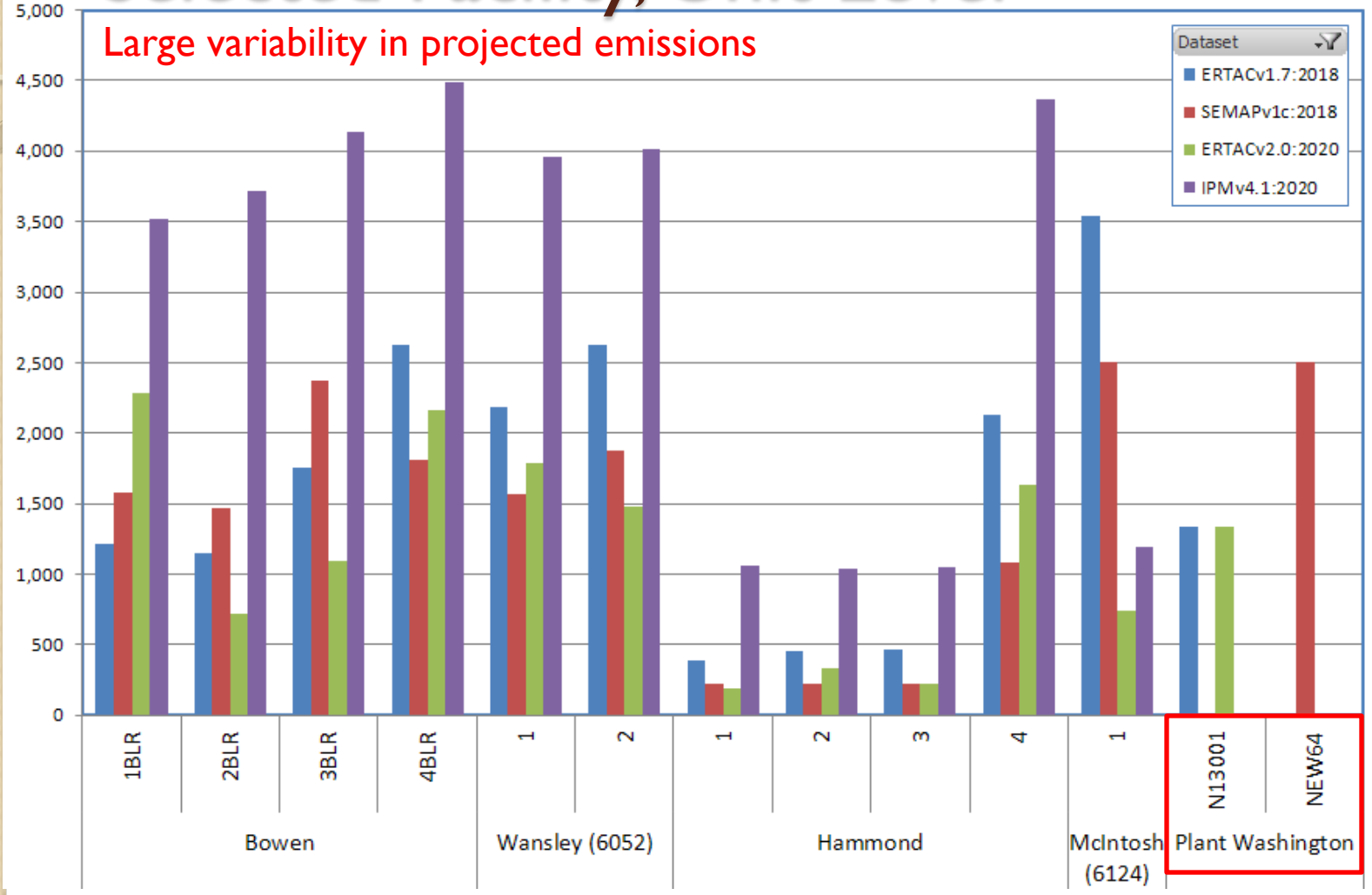
SO2, Georgia


Dataset
ERTACv1.7:2018
SEMAPv1c:2018
ERTACv2.0:2020
IPMv4.1:2020
SO2 (TPY)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Coal
Gas
Oil
Log Scale
100,000.0
10,000.0
1,000.0
100.0
10.0
1.0
0.1

SO2, Georgia, Coal, Facility

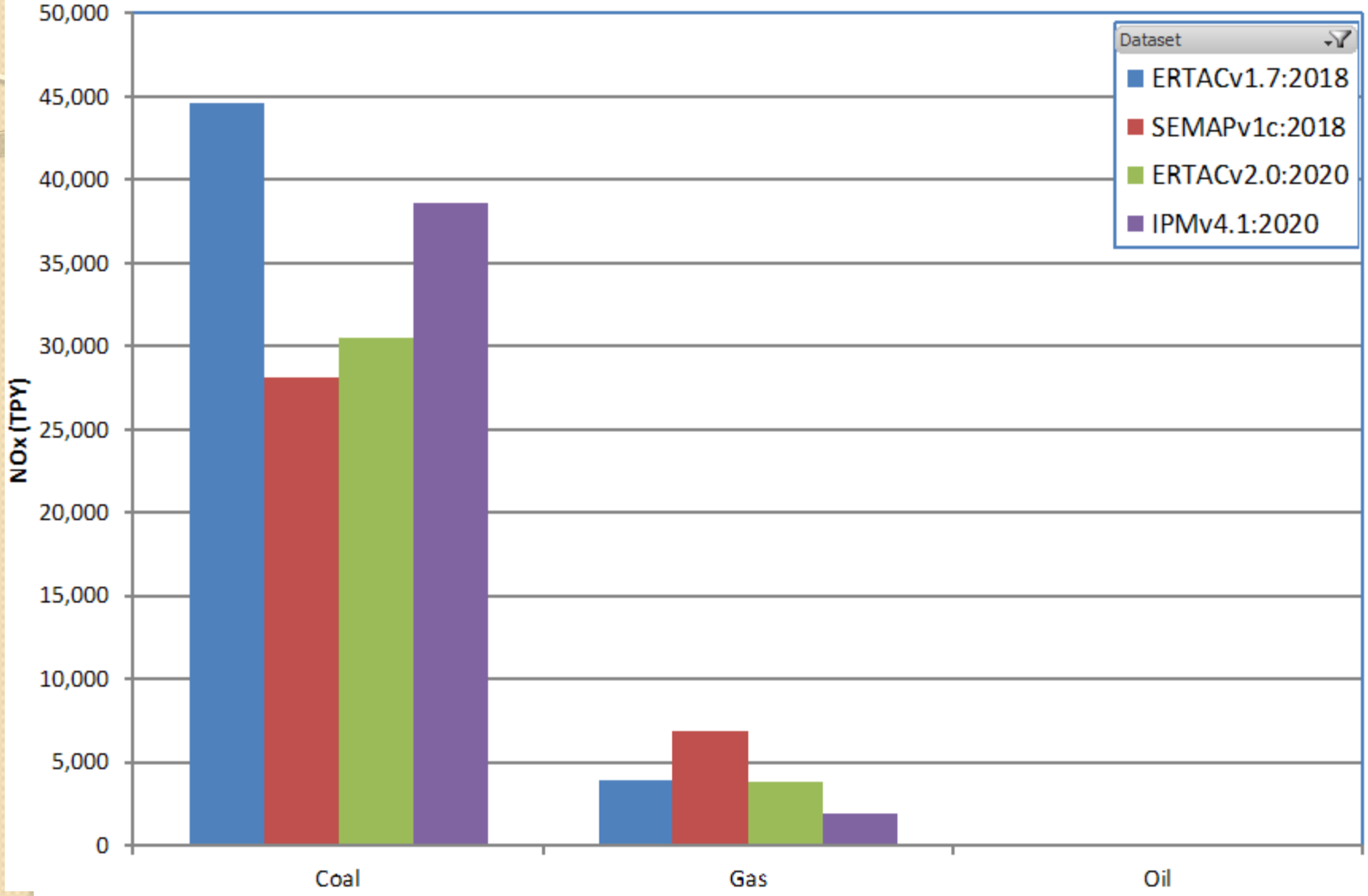


SO2, Georgia, Coal, Selected Facility, Unit Level

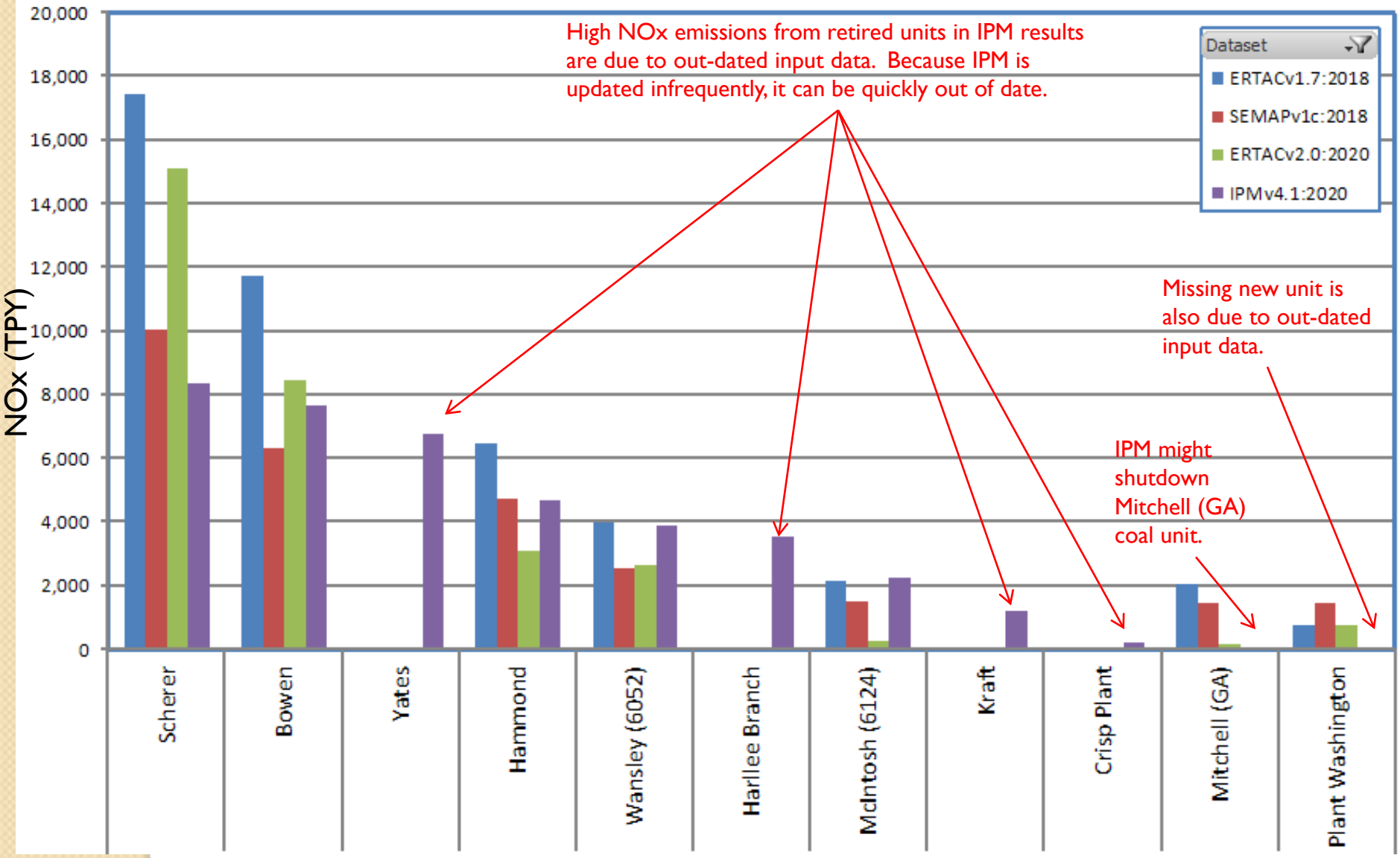


ERTAC and SEMAP use different names for new units.

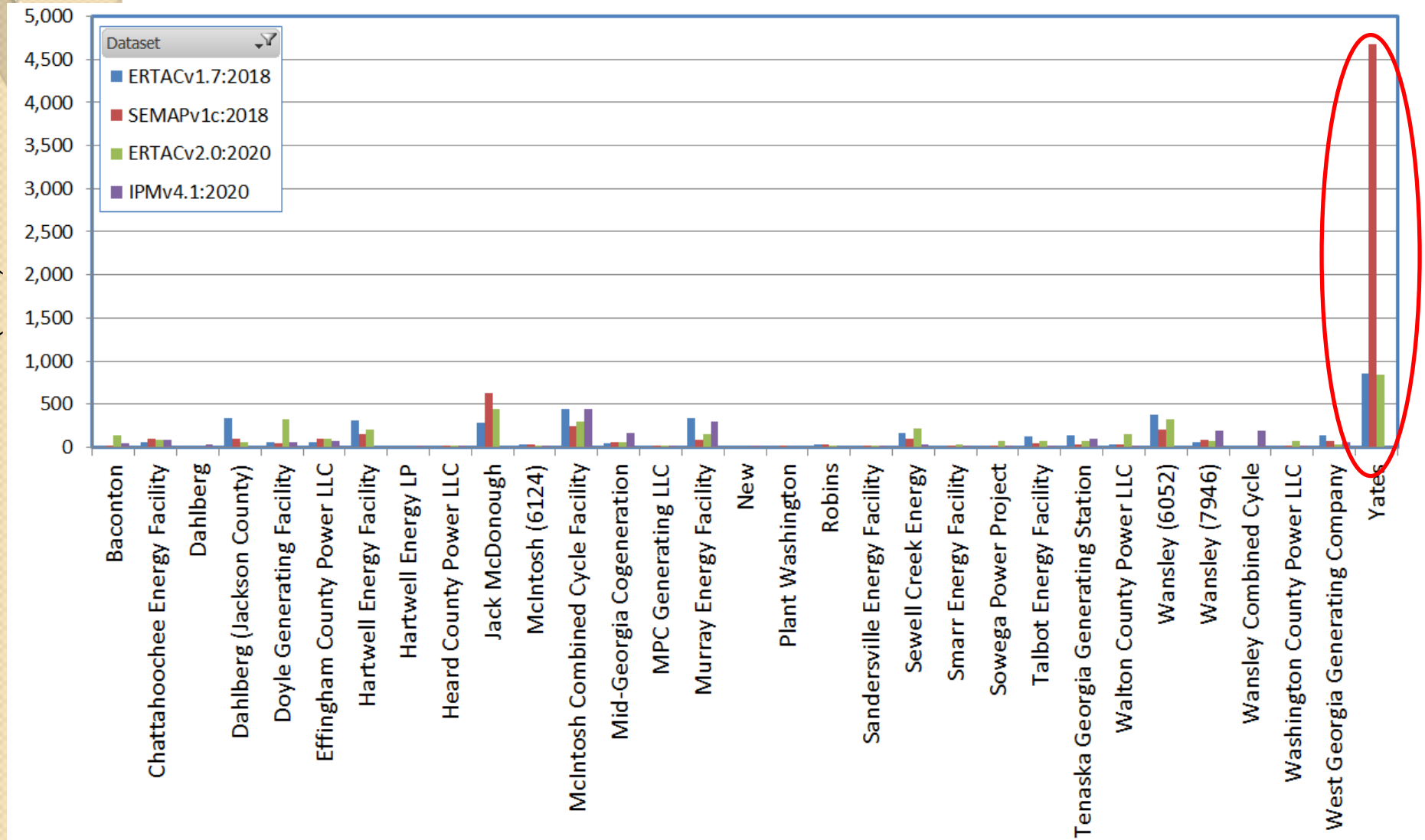
NOx, Georgia


50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
NOx (TPY)
Coal
Gas
Oil
Dataset
ERTACv1.7:2018
SEMAPv1c:2018
ERTACv2.0:2020
IPMv4.1:2020

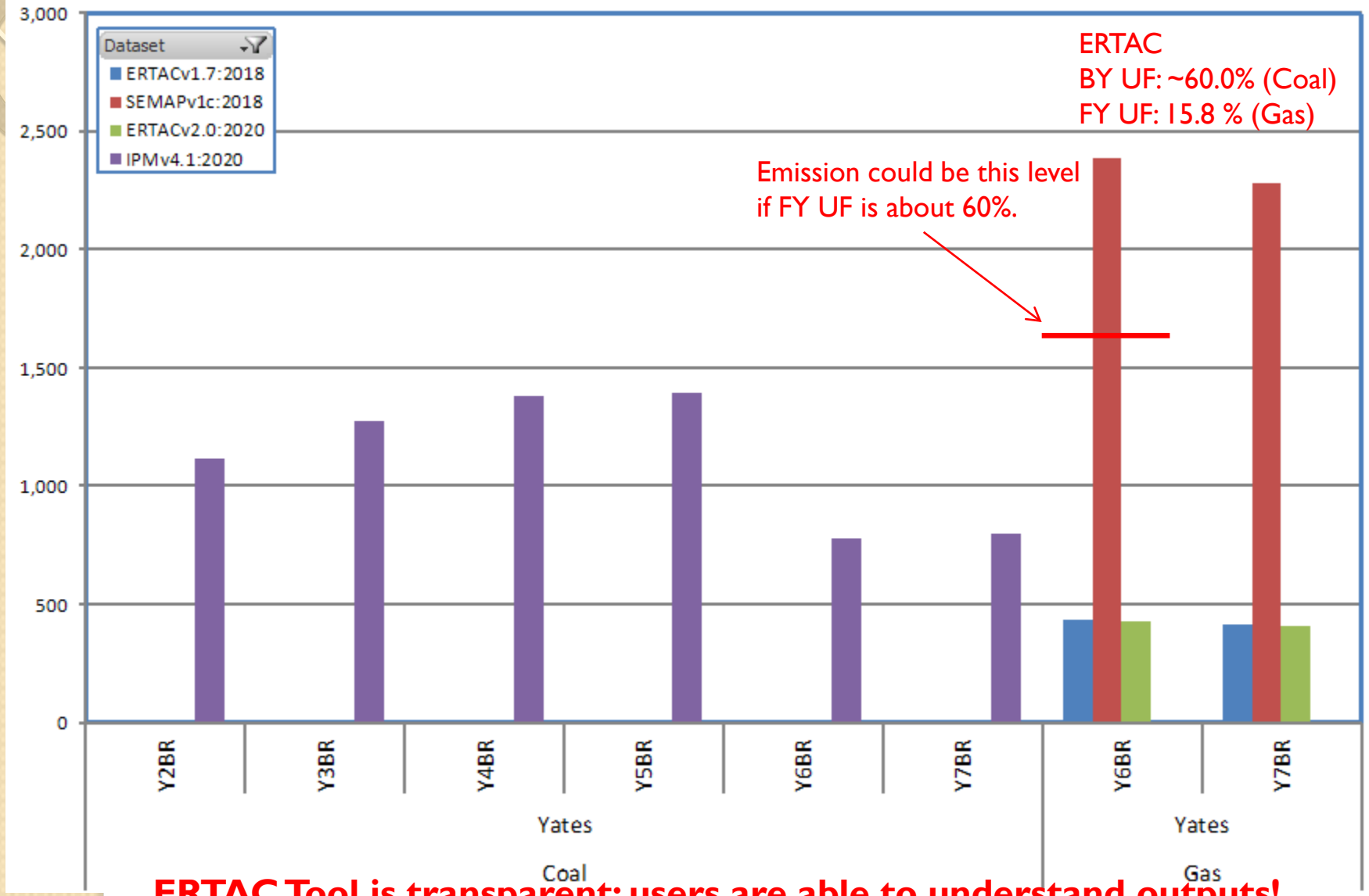
NOx, Georgia, Coal, Facility Level



NOx, Georgia, Gas, Facility Level



NOx, Georgia, a specific facility, Unit Level



ERTAC Tool is transparent; users are able to understand outputs!

Summary

- ERTAC and IPM approaches produced comparable annual SO2 and NOx emissions at national level.
  - However, OS NOx can be very different between ERTAC and IPM.
- ERTAC, SEMAP, and IPM provided comparable annual SO2 and NOx emissions at regional level.
- At state level and/or unit-level, however, projected emissions with different approaches showed great variability.
- IPM's new units are equivalent to ERTAC's GDUs except IPM's new units are assigned at state-level while ERTAC's GDU's are at unit-level.
- When ERTAC model produces GDUs, users can determine the reason by analyzing outputs and inputs.

Conclusions

- For some units, IPM predicted much higher SO2 emission rates than SEMAP or ERTAC.
- For some units, three methods produced very different NOx emissions.
- IPM created new generation units and assigned no generation to a planned unit (i.e. Plant Washington).
  - This is likely due to out-dated NEEDS DB.
- ERTAC Tool is transparent; users are able to determine the reasons for outputs.
- Cross-comparison of results of different EGU emission projection approaches provides valuable insights.
- A cross-walk table needs to be developed to conduct this type of cross-comparison efficiently and more accurately.

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