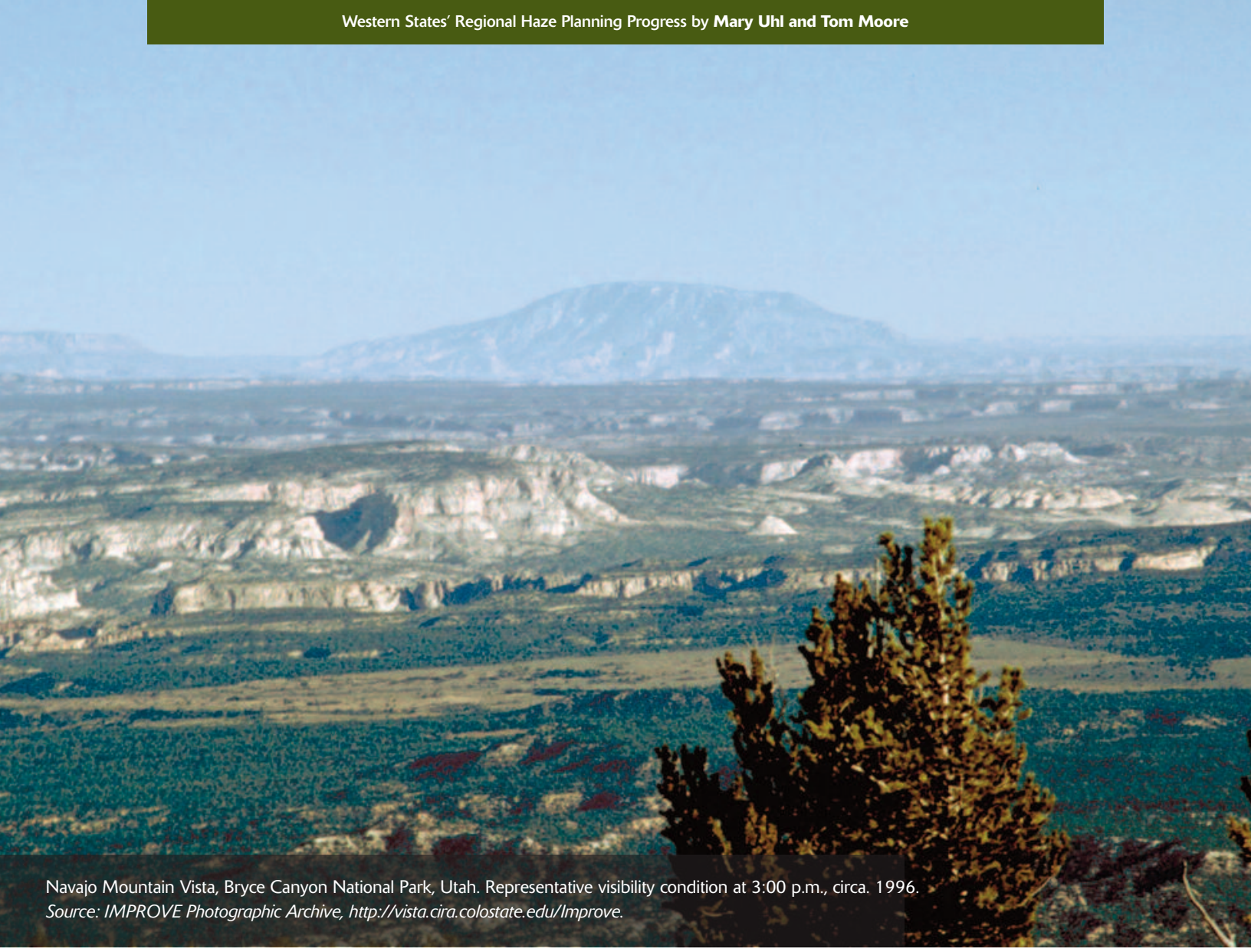


Navajo Mountain Vista, Bryce Canyon National Park, Utah. Representative visibility condition at 3:00 p.m., circa. 1996.
*Source: IMPROVE Photographic Archive, http://vista.cira.colostate.edu/Improve.*

# Western States' Progress toward Submittal of Second Planning Period Regional Haze SIPs

An overview of WESTAR–WRAP member states' progress in the second regional haze planning period.

**The U.S. Environmental Protection Agency's (EPA) Regional Haze Rule** requires states to control air pollution to make progress toward the U.S. Clean Air Act (CAA) goal of remedying existing and preventing future visibility impairment in all 156 federal Class I areas in the United States. The CAA specifies that national parks larger than 6,000 acres and wilderness areas larger than 5,000 acres that were in existence in 1977 should be protected from regional haze that impairs visibility. The regional haze rule specifies that these Class I areas should attain "natural conditions" by 2064 and states should make progress in controlling air pollution to meet this goal in a somewhat linear fashion over subsequent 10-year periods.

The Western States Air Resources Council (WESTAR; http://www.westar.org) states have made considerable progress to evaluate regional haze in western Class I areas for the second planning period of the Regional Haze Rule. Over 75% (118) of the 156 Class I areas in the United States are located in the 15-state WESTAR, Western Regional Air Partnership (WESTAR–WRAP) region, shown in Figure 1. These 15 states are working collaboratively through the WRAP (http://www.wrapair2.org) process for regional haze analysis in a similar way as in the first planning period, albeit with significantly more knowledge about regional haze in the west and significantly less funding due to the lack of a congressional appropriation for the second regional haze planning period.

WRAP has formed a regional haze planning workgroup with membership from all of the WESTAR and WRAP member agencies, anticipating submittal of a second planning period state or tribal implementation plan (SIP/TIP) to guide the regional collaboration that occurs to assist air agencies with complex, multi-state analysis and avoid duplication. The WRAP regional haze planning process ensures efficient use of limited funding. Other WRAP workgroups—including the Fire and Smoke Workgroup, Tribal Data Workgroup, Regional Technical Operations Workgroup, and Oil and Gas Workgroup—contribute work products and deliverables to enhance the western regional haze work. WESTAR–WRAP members understood at the initiation of analysis for the second planning period that there were several western-specific areas of regional haze analysis that needed work to improve the accuracy of the data that air agency decision-making relies upon. Some of that work is detailed in this article. The WRAP Workplan[1] contains detailed information regarding schedule and the workgroups' activities and products.

## Electric Generating Unit Emissions

The work to complete the second planning period technical analysis necessitated a hard look at Electric Generating Unit (EGU) emissions trends in the West. In the first planning period, nearly every western state had several EGUs to analyze within the best available retrofit technology (BART) framework required by the Regional Haze Rule. For the second planning period, a group of state air quality staff and representatives from western utilities convened for several months to develop the western 2018 and 2028 projected EGU emissions with on-the-books and on-the-way controls.[2]

Given that EGU emissions significantly contribute to regional haze formation in the West, the projected emissions are important to the western regional haze modeling and control

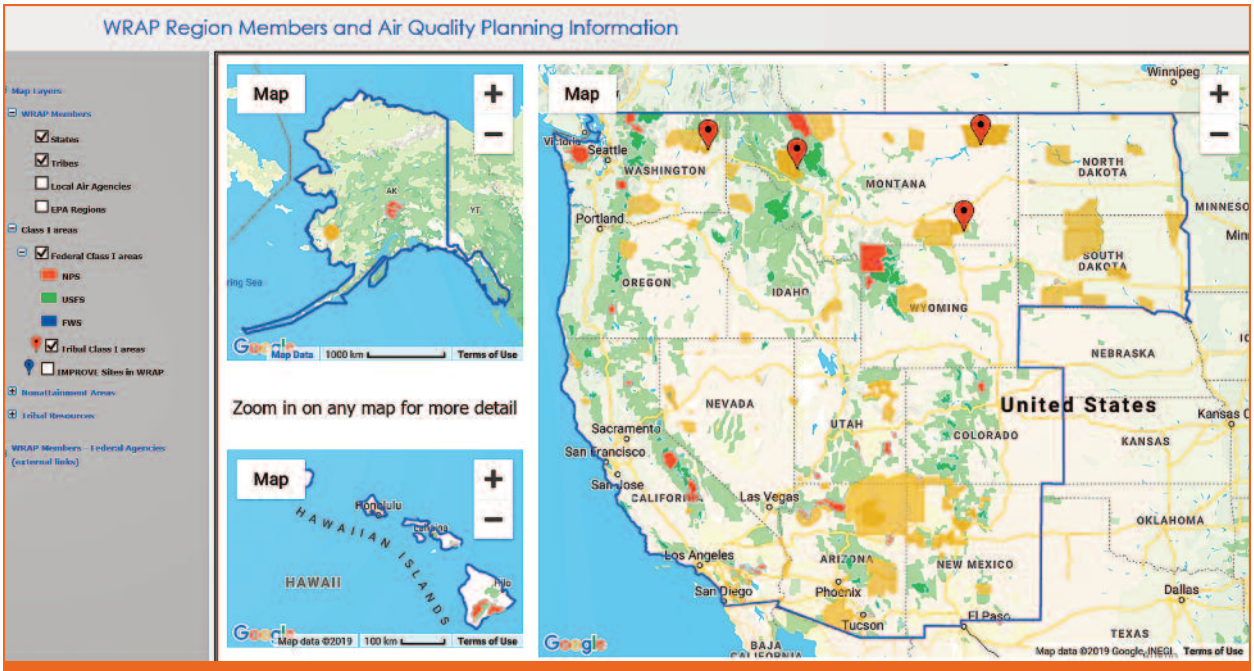



**Figure 1.** The 15-state WESTAR–WRAP region.

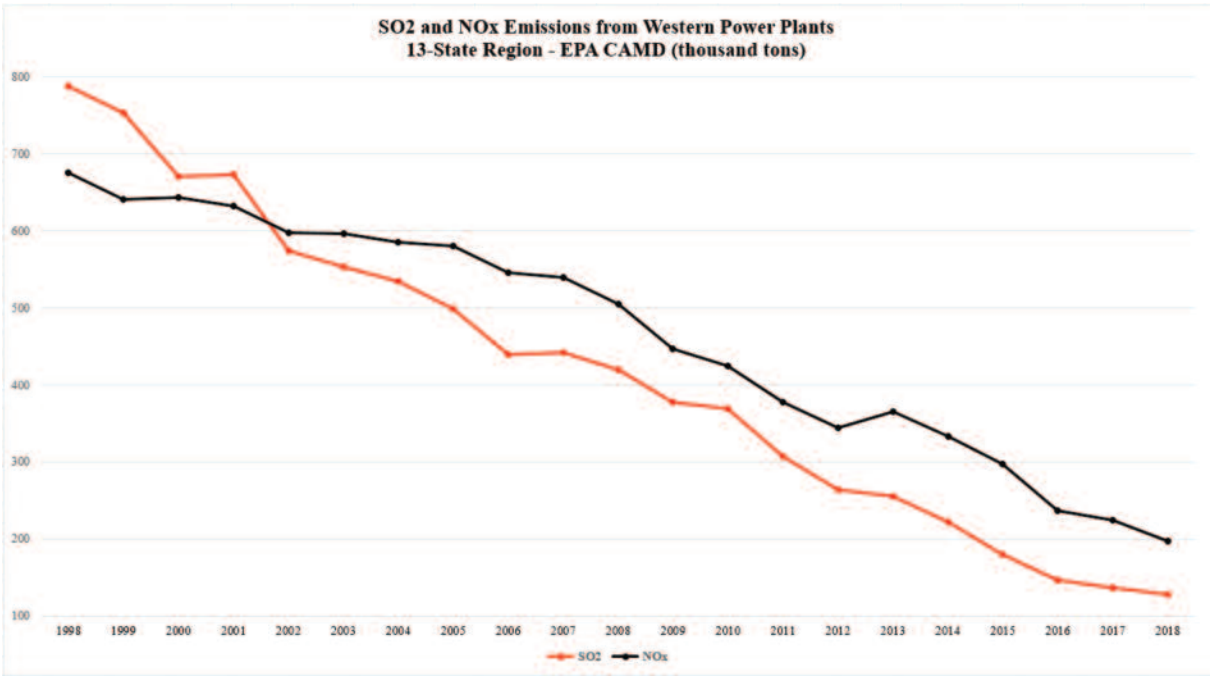



**Figure 2.** Emissions of $SO_2$ and $NO_x$ from western EGUs, 1998–2018.

strategy analysis. The addition of controls at some power plants and EGU shutdowns that occurred during the first planning period or are projected to occur in the second planning period show a stark decrease in EGU emissions across the western states. Figure 2 shows the significant reductions in emissions of $SO_2$ and $NO_x$ from EGUs from 1998 through 2018, and Figure 3 shows further reduction scenarios by 2028 in western states under two similar projection methods.

## Oil and Gas Emissions

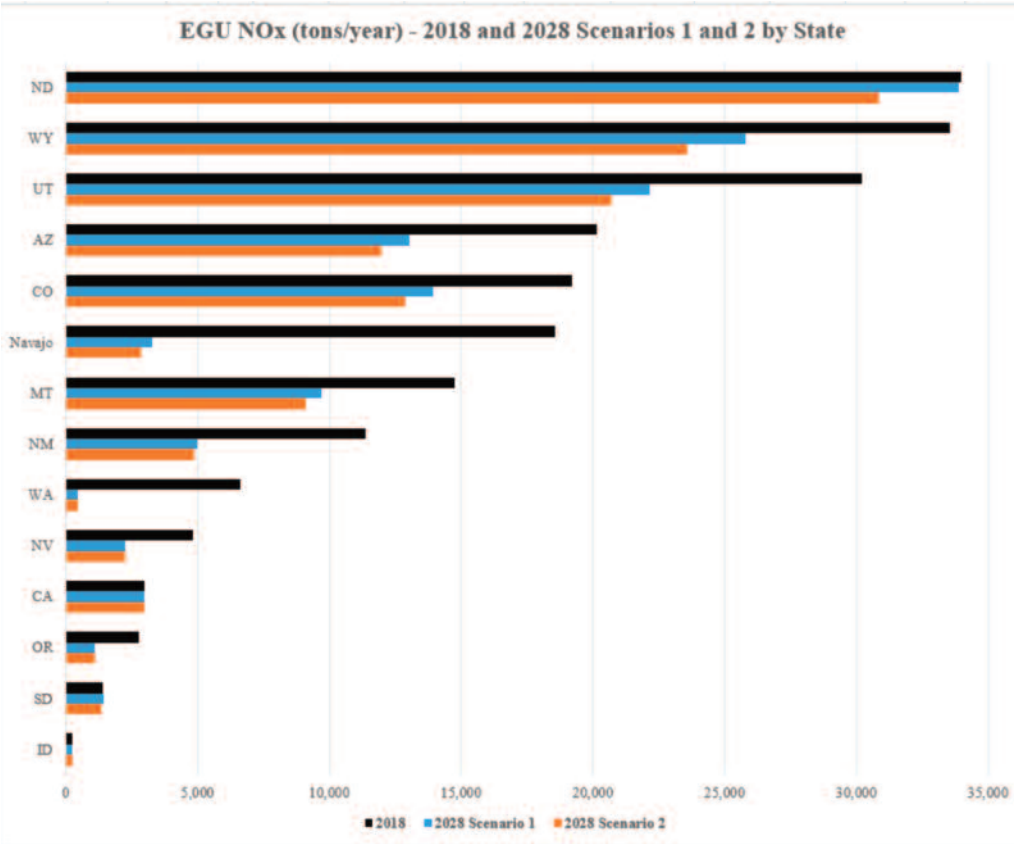
Similar to the need for EGU trend analysis, oil and gas trend analysis was undertaken by the western states as oil and gas exploration and production activity has increased across the west since the first planning period. The WRAP Oil and Gas Work Group (OGWG)[3] prepared a survey and the survey results were used to develop an improved baseline inventory over the 2014 National Emissions Inventory (NEI, complied by EPA) oil and gas inventory for intermountain western states where oil and gas emissions may be significant contributors to regional haze. The survey results are now being used to develop the 2023 on-the-books/on-the-way inventory for the oil and gas sector. Figure 4 shows the $NO_x$ and VOC emissions changes in the inventory estimates from a new 2014–2017 representative planning baseline inventory starting from the initial 2014 NEI estimates. States may consider additional controls beyond the books for oil and gas sources for the final 2028 run. This project will finish with the projection and inclusion of these emissions reductions in the final model run.

## Projection of Future Visibility Conditions

Trends in monitored visibility data metrics have been extensively evaluated by EPA, federal land management agencies, and now in the WRAP process for states to use in the regional haze analysis in this second planning period.[4] Missing data for key years during the 2000–2017 trend period at monitoring sites tracking progress for regional haze were filled using substituted data.[5] The regional haze planning process requires setting a future reasonable progress goal for visibility in deciviews by 2028 at each Class I area by applying regional photochemical grid modeling (PGM) results.

EPA technical guidance[6] offers detailed and extensive procedures for selecting and applying modeling results from historic and future projections' modeling and adjusting those by using selected historical monitoring data to normalize the ratio of the modeling results. For regional haze planning in particular, these adjustments called relative response factors, or RRFs, are made for each chemical species in the IMPROVE equation, then totaled and converted to the deciview haze index, as follows:

- Model results are used in a relative sense to develop RRFs between future and historic model-predicted concentrations of each component.



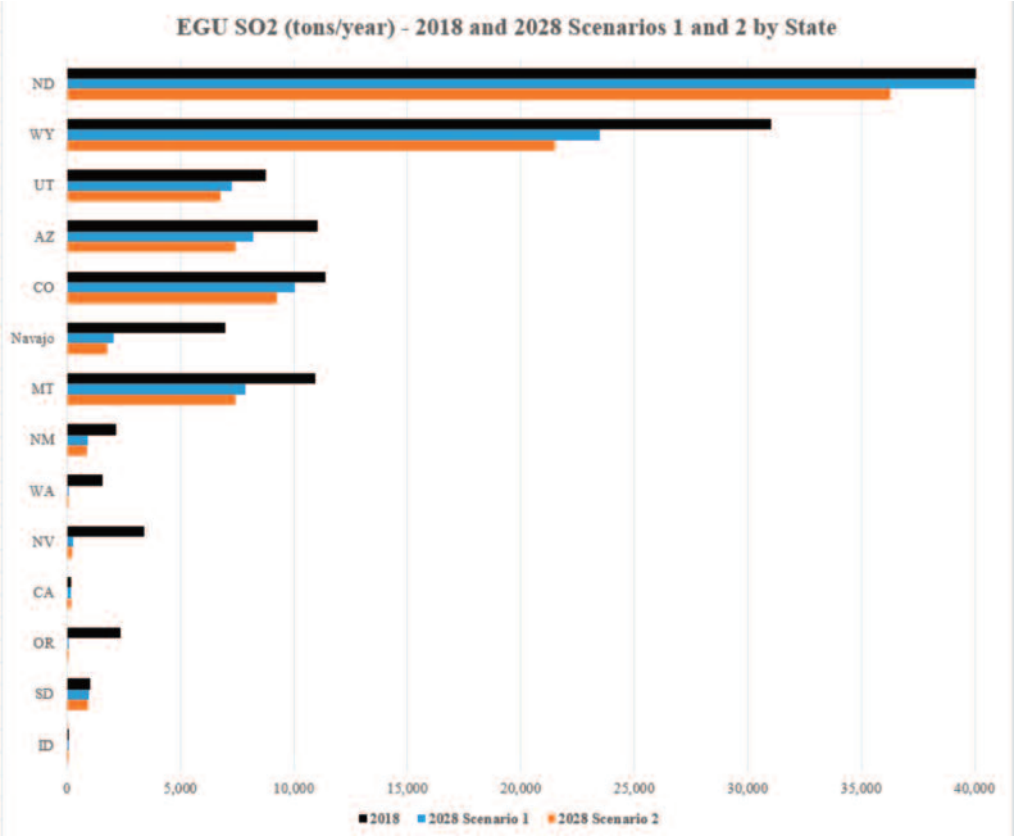
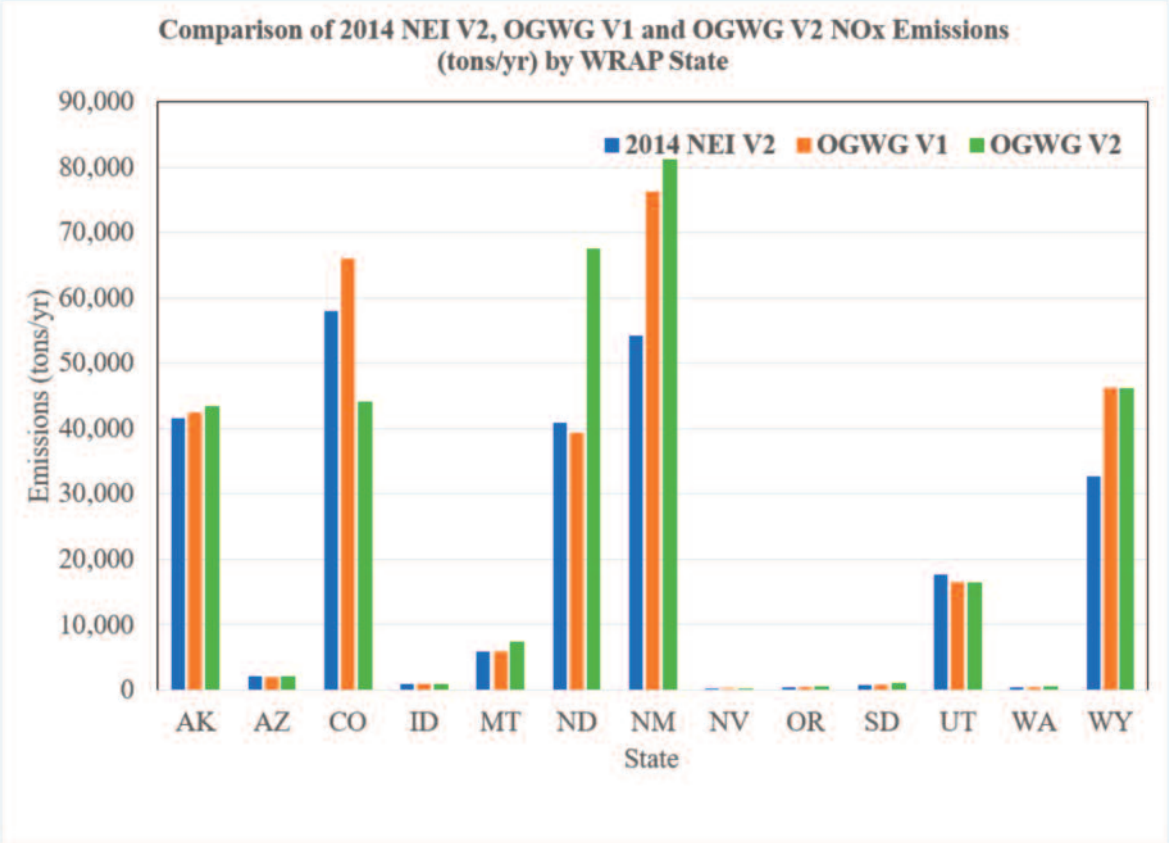




**Figure 3.** Emissions reduction scenarios for (a) $NO_x$ and (b) $SO_2$ from western EGUs,



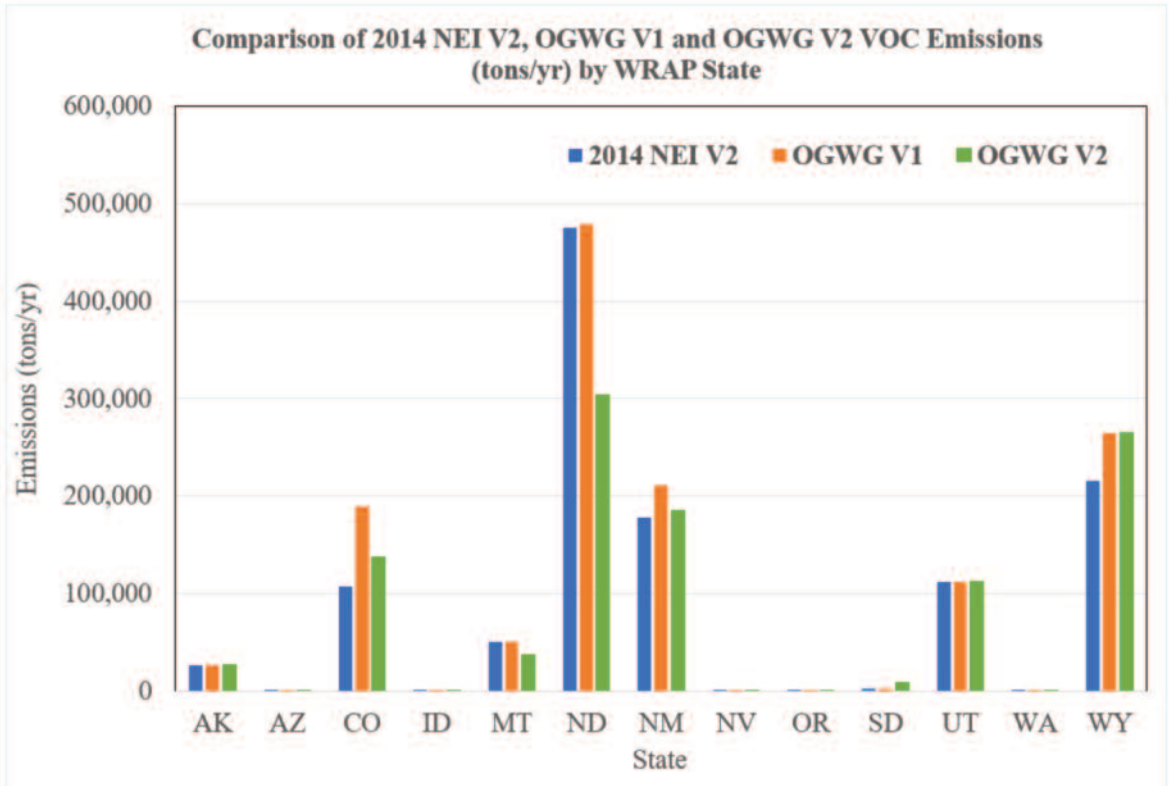




**Figure 4.** Comparison of NEI and OGWG data for emissions of (a) $NO_x$ and (b) VOC from western states, 2014–2017.

- Component-specific RRFs are multiplied by selected historic monitored values to estimate future component concentrations.
- Estimates of future component concentrations are consolidated to provide an estimate of future air quality.

The typical future visibility projection method uses PGM model results for base year (BY, e.g., 2014) and future year (FY, e.g., 2028) to scale current years (CYs) IMPROVE $PM_{2.5}$ concentrations through relative response factors (RRFs), as follows:

- RRF = PGM(FY) / PGM(BY)
- $PM_{2.5}$(FY) = IMPROVE_$PM_{2.5}$(CY) × RRF
- Separate RRFs for:
  - Most Impaired and Clearest Days
  - IMPROVE Site (Class I area)
  - $PM_{2.5}$ Species ($SO_4$, $NO_3$, EC, OMC, PMF, and PMC)
- Convert to deciview for developing reasonable progress goals (RPGS) comparisons to uniform rate of progress (URP) "Glide Path".

In the WESTAR–WRAP analysis, RRFs will be developed using historical monitoring data by year from a multi-year time period bracketing the annual historical modeling period, while emphasizing the most recent five years to align with the regional haze averaging period and account for changing and varying source quantity and mix. The WRAP baseline modeling for the second planning period is thoroughly evaluating PGM performance against monitoring data specific to CY2014. The CY2014 meteorological modeling has also been thoroughly evaluated and those data will be used in all subsequent second planning period modeling scenarios.

In the WESTAR–WRAP region, the emissions affecting regional haze planning vary quite a bit year-to-year within and across the region for certain source types (fire, dust), or are changing rapidly before and after 2014 due to control programs from the first planning period and operational changes (EGUs, O&G). Existing PGM configurations and information are leveraged for use in a western United States-focused PGM with nested grid domains, as shown in Figure 5, a regional modeling domain containing more than 100 Class I areas.

Owing to these emissions changes and variations, a "current representative baseline" emission scenario has been identified and is being compiled for use as the historic modeling scenario for planning in order to support robust control strategy planning and provide a solid assessment of likely progress to improve visibility. The baseline scenario will use 2014 meteorology and will contain emissions data from 2014, such as mobile sources, Canada, Mexico, and other emissions sources not controllable by states, as well as adjustments to selected large industrial sources as specified by individual states, more recent and representative EGU (c. 2018) and O&G (c. 2014–2017) emissions rates, and a baseline fire emissions inventory.[7] This baseline modeling scenario will then be the basis to project emissions to represent "rules on the books" or expected effects of enacted emissions controls and sectors' growth and changes by 2028 for all sectors, rather than projecting from CY2014. Also, states will need to true up emissions used for regional haze planning to the 2017 NEI when it is released.[8]

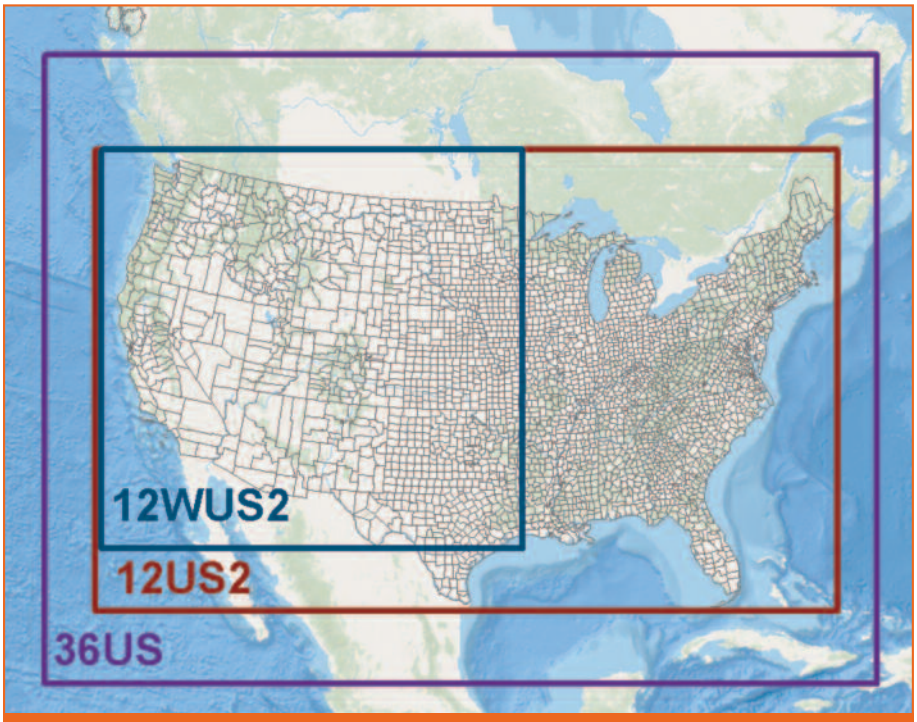



**Figure 5.** Photochemical grid modeling (PGM) domain for the WESTAR-WRAP region.

The analysis in EPA guidance for RRFs recommends six steps and requires a fair amount of data processing and management for states to evaluate as they consider setting 2028 reasonable progress goals. WESTAR–WRAP has

developed the Technical Support System Version 2 (TSSv2; (http://views.cira.colostate.edu/tssv2) for second round planning, building on the TSS developed and used extensively in first round planning. The TSSv2 is a delivery system for technical products directly supporting state planners and regional haze implementation plans for the 15 states and 100+ Class I areas in the WESTAR–WRAP region. The multi-year period of historical monitoring data for input to the RRF calculations at each Class I area will be included in a TSSv2 data visualization tool as options to select, to allow a comprehensive analysis of the effect of selecting specific monitoring data as RRF inputs to modulate modeled visibility change estimates.

The effect of significant natural and international emissions impacting western Class I areas as estimated by the regional PGM analysis effort may be larger than the enacted changes in future U.S. anthropogenic emissions, given how clean these Class I area monitoring sites are trending on the sampling days not overwhelmingly impacted by wildfire and dust storms. The effect of natural sources and international transport will be characterized with PGM simulations within available resources. An important analysis to support visibility goal-setting by individual western states at their Class I areas is to resolve the expected improvement as estimated by the PGM with all emissions versus the glide path estimates developed with statistical analysis to derive selected days with highest sulfate and nitrate impacts in the monitoring data. The goal of the PGM modeling and implications for methods to select RRFs, is to apply the most robust and well-performing PGM results to estimate future visibility improvement, even as natural and international sources vary and increase.

## Conclusion

Western states are on target to complete their SIPs by the July 2021 deadline. The western states' regional haze analysis for the second planning period has stark differences to the analysis completed in the first planning period. EGU emissions have substantially declined due to retirements and controls at coal-fired power plants throughout the West and will continue to decline through the second planning period. Oil and gas sector emissions have increased and the quantitative representation of these emissions in the western regional haze modeling has improved due to the iterative work undertaken in the west to understand these emissions over the past 15 years.

States in the West, with one exception, do not have the ability to control the major anthropogenic contributor to haze formation: mobile sources. The WESTAR–WRAP tools utilized by western states in the first planning period have been improved and expanded to allow for additional state analyses. Finally, though there remains much work to be done on natural and international emissions, WESTAR–WRAP has planned for modeling simulations and methodologies to aid states in accounting for these impacts.

The western states have built upon the lessons learned in the first planning period to successfully work toward new tools and methodologies for understanding regional haze in the second planning period. Regional haze planning in the future will require additional improvements in analysis of anthropogenic emissions, as well as improvements to quantify natural and international emissions. **em**

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## References

1. 2018–2019 WRAP Workplan Update; Western Regional Air Partnership, April 3, 2019. See https://www.wrapair2.org/pdf/2018-2019 WRAP Workplan update Board Approved April.3.2019.pdf.
2. EGU Emissions Analysis Project; Western Regional Air Partnership. See https://www.wrapair2.org/EGU.aspx.
3. The WRAP Oil and Gas Work Group (OGWG); Western Regional Air Partnership. See https://www.wrapair2.org/ogwg.aspx.
4. Monitoring Data & Glide Path Summary Document (2018); Western Regional Air Partnership. See https://www.wrapair2.org/pdf/final%20MDGPS%20summary%20document%20Feb27-2019.pdf.
5. Recommendations for Data Substitutions (2018); Western Regional Air Partnership. See https://www.wrapair2.org/pdf/Memo%20-%20donor%20site%20recommendations%20for%20data%20substitutions.pdf.
6. Memorandum: Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.5, and Regional Haze; From Richard A. Wayland, Director, Air Quality Assessment Division, U.S. Environmental Protection Agency, to Regional Air Division Directors, Regions I - I 0; dated November 29, 2018. See https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf.
7. Representative Baseline and Future Fire Scenarios (RBFFS) Working Group; Western Regional Air Partnership. See https://www.wrapair2.org/RBFFSWG.aspx.
8. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations; U.S. Environmental protection Agency (2017). See https://www.epa.gov/sites/production/files/2017-07/documents/ei_guidance_may_2017_final_rev.pdf.