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Potential Impacts on Phoenix Area Ozone Air Quality from a Proposed Renewable Energy Ballot Initiative

Prepared for:

Arizona Public Service

June 5, 2018

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* The opinions expressed herein do not necessarily represent the views of NERA Economic Consulting or any other NERA consultants.

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EXECUTIVE SUMMARY

NERA Economic Consulting (NERA) has been engaged by Arizona Public Service (APS) to describe the potential impacts on the Phoenix area's ozone air quality that might be the expected result of a Renewable Energy ballot initiative (hereafter "the Initiative") proposed by Clean Energy for a Healthy Arizona. The Initiative would require investor-owned utilities and electric cooperatives to generate at least 50% of their annual sales of electricity from renewable energy sources by 2030, with additional requirements on distributed energy resources.

Our analysis of the proposed Initiative, which accounts for recent emissions-to-ozone impact modeling and projected future electricity generation to serve Arizona demand, leads us to the following key findings:

1. **The Initiative cannot be expected to improve reported levels of ozone pollution in areas where most Arizonans live because it targets power plant emissions that, in total, already have very little impact on the Phoenix area's ozone levels (based on the average over all high ozone days), and which the Initiative would reduce by only a miniscule amount.**

    - Based on a set of Phoenix area air quality studies using the most up-to-date science and emissions levels from seven years ago (*i.e.*, 2011) we find that *all* power plant emissions serving Arizonans contributed less than 1% on average to the Phoenix area's ozone levels on days when ozone rose above the standard for safe ozone exposure issued by the U.S. Environmental Protection Agency (EPA) in 2015. (This estimate includes power plants that would not be covered by the Initiative.)

    - Stated in units used to measure ozone pollution levels ("parts per billion" or ppb), the U.S. EPA has determined that outdoor peak ozone levels of up to 70 ppb are protective of the public health with an adequate margin of safety. In comparison, we estimate that total 2011 ozone-forming power plant emissions that would be covered by the Initiative contributed an average of less than 0.5 ppb to total ozone in the Phoenix area on ozone days exceeding that 70 ppb level. These ozone-forming power plant emissions have been declining since 2011.

    - Using relevant electricity system data and analyses to assess how the covered electricity systems could comply with the Initiative, we estimate that the vast majority of its incremental reductions in power plant ozone-forming emissions will occur in areas that have the least per-ton and miniscule total impact on ozone in the Phoenix area, where a majority of Arizonans live.

    - Analysis also indicates that the Initiative may actually cause *increases* in power plant ozone-forming emissions in locations that have the most per-ton impact on the air quality where most Arizonans live. This is because gas-fired units already operating in the Phoenix area are projected to be run more intensively under the Initiative to maintain reliable electricity supply while incorporating more generation from intermittent renewable sources.

- Thus, we estimate that there will be very little change in the already minimal contribution of power plants to the Phoenix area's ozone levels. For example, we estimate compliance with the Initiative will reduce the Phoenix area's population-wide outdoor ozone exposures by an average of about 0.03 ppb in 2025 and less than 0.05 ppb in 2030 on days with weather patterns that are associated with peak ozone concentrations in Phoenix.

- Not inconsistent with our findings, EPA's analysis in its 2014 Regulatory Impact Analysis for the ground-level ozone National Ambient Air Quality Standards predicted no change in 2025 ozone design values at any of 28 monitors in Maricopa/Pinal counties from a much larger hypothetical change in NO_X emissions from Arizona electric generators.

- For air quality compliance tracking, daily ozone concentrations are reported to the U.S. EPA rounded to the nearest 1 ppb. Thus, changes in air pollution around Phoenix due to the Initiative may have no effect at all on Phoenix's ability to meet EPA's air pollution health standard.

2. **One key reason for these miniscule ozone impacts due to the Initiative is that the vast majority of ozone in Phoenix today is due to uncontrollable sources and vehicles.**

- Studies of the Phoenix area's high-ozone days find that about two-thirds of the ozone comes from much larger volumes of emissions in areas far from Arizona, or from natural sources (*e.g.*, wildfires).

- Vehicles contribute another very large share. Studies find that emissions from vehicles driven in Arizona (including construction and other off-road equipment) account for half or more of all the Phoenix area's man-made causes of ozone on high-ozone days.

3. **The Initiative thus will have no measurable impact on asthma rates.**

- The U.S. EPA associates rising risk of experiencing an asthma attack or other respiratory disease exacerbation (among people with pre-existing asthma or other respiratory disease) with days when outdoor ozone exceeds 70 ppb on an 8-hour average basis. For the reasons explained above, we find that the Initiative is exceedingly unlikely to have any impact on the number of days when Arizonans face 8-hour average ozone levels of 70 ppb or more.

- The changes in ozone estimated to result from the Initiative are also so small in absolute (ppb) terms that they will not affect numbers of emergency room visits for asthma or other illness on high ozone days to any measurable degree.

I. INTRODUCTION AND POLICY BACKGROUND

NERA Economic Consulting (NERA) has been engaged by Arizona Public Service (APS) to evaluate the potential impacts on the Phoenix area's ozone air quality as a result of a proposed Renewable Energy ballot initiative put forth by Clean Energy for a Healthy Arizona, which we will hereafter refer to as "the Initiative." This section provides a brief summary of the policy background relevant to the Initiative and outlines the analysis of its impacts that follows in the rest of this report.

Arizona already has a Renewable Energy Standard (RES) in effect. The current RES requires investor-owned utilities (*i.e.*, Arizona Public Service and Tucson Electric Power) and electric cooperatives serving Arizona customers to meet 15% of their in-state retail electricity load with qualified renewable resources by 2025, with an interim target of 7% for 2017.[1] Arizona's Renewable Energy Standard & Tariff requires utilities subject to the RES to file annual implementation plans showing how they plan to comply with the rules.[2]

Arizona Public Service (APS) filed its "2017 Renewable Energy Standard Compliance Report" in March 2018, and demonstrated that in 2017 renewable resources met 10.4% of its retail sales (12.9% of retail sales including all rooftop solar), well ahead of the 7% interim requirement.[3] Tucson Electric Power (TEP) filed its "Compliance Report and Renewable Energy Data for 2017" in April 2018 also reporting that its renewable resources had been 10.4% of its retail sales.[4]

In February 2018, Clean Energy for a Healthy Arizona filed an initiative petition with the Arizona Secretary of State for a proposed Constitutional Amendment that would "require electricity providers to generate at least 50% of their annual sales of electricity from renewable energy sources."[5] This target of 50% would apply to 2030, with interim targets in 2020 through 2030. The Initiative's interim target for 2025 is 28%, which is almost double the 15% required under the current RES. Additionally, the Initiative includes a related provision requiring an increasing annual share of energy from distributed energy resources, which ramps up from 3% of sales in 2020 to 10% by 2030 (5.5% in 2025).[6] Supporters of the Initiative must gather 226,000 signatures by July 5 for the measure to be included on the ballot for elections in November 2018.

[1] See http://programs.dsireusa.org/system/program/detail/268.

[2] See http://www.azcc.gov/divisions/utilities/electric/environmental.asp.

[3] Arizona Public Service. 2018. "2017 Renewable Energy Standard Compliance Report," filed with Arizona Corporation Commission, March 30, available at: http://images.edocket.azcc.gov/docketpdf/0000187011.pdf.

[4] Tucson Electric Power Company. 2018. "Compliance Report and Renewable Energy Data for 2017," filed with Arizona Corporation Commission, April 2, available at: http://images.edocket.azcc.gov/docketpdf/0000187067.pdf.

[5] Clean Energy for a Healthy Arizona, Application for Serial Number Initiative Petition, February 20, 2018, Serial Number Issued: C-04-2018.

[6] Distributed energy resources count towards the overall renewable energy requirements, so that can be thought of as a subset of the overall RES.

If it is then approved by voters in November, the Initiative would become a Constitutional Amendment to the state Constitution.

The "affected utilities" subject to the Initiative are all public service corporation entities serving retail electricity load within Arizona. It is our understanding that this primarily refers to APS and TEP, plus a few much smaller companies, including electric cooperatives. Of some relevance to understanding the impacts of the Initiative, its requirements would not apply to the various electricity providers in Arizona that are not public service corporation entities and which currently supply about 40% of the state's retail electricity needs. (Salt River Project accounts for almost all of this.)

Clean Energy for a Healthy Arizona makes several claims regarding the Initiative, including:

> *"Clean energy will benefit ALL Arizonans with lower costs, cleaner air, and a healthier future. Less pollution and cleaner air from a stronger renewable energy standard will mean fewer emergency room visits for asthma, fewer hospital admissions for non-fatal heart attacks, and fewer lost sick days – for all Arizonans."*[7]

Notably, no studies were cited to support these claims.

It is reasonable to ask what the relevant scientific information indicates may be expected to occur if the Initiative were to be passed into law. This report describes the relevant available evidence and explains why that evidence tells us that claims such as those made by Clean Energy for a Healthy Arizona are unsupportable.

To evaluate the potential impacts on the Phoenix area's ozone levels resulting from compliance with the Initiative, the authors of this report have performed the following tasks:

- Evaluated the current status of ozone in the Phoenix area, including a review of scientific studies that have documented the sources that contribute to the area's ozone levels (Section II); and

- Assessed the potential changes in NO_X emissions from compliance with the Initiative, and the likely impact such changes might have on ozone levels in the Phoenix area (Section III).

[7] https://cleanhealthyaz.com/myth-vs-fact/ (accessed May 14, 2018).

II. OZONE IN THE PHOENIX AREA

Ground-level ozone is produced from many different sources – both naturally-occurring and man-made. It also comes from local sources and those transported from afar. The mix of sources varies considerably by region, making it important for this analysis to understand the sources from which it is formed in the Phoenix area.

A. What is Ozone and How Is It Regulated?

Ground-level ozone in the ambient air we breathe is created by chemical reactions of nitrogen oxides (NO_X) and volatile organic compounds (VOCs) in the presence of sunlight. NO_X and VOC are emitted by many types of sources throughout the world, including substantial quantities from natural sources (*e.g.*, as a result of lightning, wildfires, and normal biological processes in soils and plants).[8] The relative contributions to total ground-level ozone from these many types of man-made and natural sources vary substantially with the location in question. Thus, managing ozone concentrations requires location-specific considerations. This study focuses on contributions to ozone concentrations experienced by most Arizonans.

The U.S. Environmental Protection Agency (EPA) establishes National Ambient Air Quality Standards (NAAQS) that apply to all locations in the U.S. to ensure that ambient ozone concentrations are protective of the public's health with an adequate margin of safety to account for scientific uncertainty in the health effects evidence. Because scientific evidence on health effects continuously improves, the NAAQS are routinely updated. The ozone NAAQS was most recently updated in 2015. The ozone NAAQS is designed to minimize the frequency of days when the average ozone concentration rises into a range that has been associated via health effects research with higher risk of asthma attacks occurring among asthmatics. It thus concerns itself with the maximum 8-hour average level of outdoor ozone that occurs each day. The 2015 ozone NAAQS set a limit on this 8-hour average at 70 parts per billion (ppb). More specifically, the ozone NAAQS requires that this 70 ppb level not be exceeded more than four times per year, averaged over a three-year period.

To determine the status of each location across the country in meeting ("attaining") this health standard, air quality regulators monitor ozone throughout the country on an hourly basis, and calculate a "design value" for each monitor that is the 3-year average of each year's fourth highest maximum daily 8-hour ozone concentration. If the design value is less than or equal to 70 ppb at all monitors in an airshed, that area would be in attainment with the 2015 NAAQS, meaning that its air quality is deemed protective of that area's public health from ozone-related impacts. Areas that do not meet this standard will be subject to a strict set of regulatory

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[8] For additional information about the science of ground-level ozone formation, see EPA's 2013 Integrated Science Assessment for Ozone and Related Photochemical Oxidants: Federal Register, Vol. 78, No. 32 / Friday, February 15, 2013, Integrated Science Assessment for Ozone and Related Photochemical Oxidants. Available at: https://www.govinfo.gov/content/pkg/FR-2013-02-15/html/2013-03471.htm.

requirements intended to reduce the frequency of days with ozone levels above the NAAQS level. These requirements are increasingly stringent depending on the degree to which the design value exceeds the NAAQS level, which is known as the nonattainment classification level.

B. Current Regulatory Status of Ozone in the Phoenix Area

In April 2018, the EPA issued final ozone designations for the 2015 ozone NAAQS for the Phoenix area. The Phoenix-Mesa area, which includes parts of Gila, Maricopa, and Pinal counties and is where most Arizona's population lives (more than 65% of Arizona's population in 2017 lives in these three counties), has been designated as nonattainment with a "Marginal" classification. A marginal classification means that the area's ozone design value is between 71 ppb and 81 ppb (but not including 81 ppb).[9] This designation requires the state to develop emissions inventories and implement a preconstruction permitting program to provide additional air quality safeguards to ensure attainment by 2020.[10,11]

C. What are the Sources of Ozone in the Phoenix Area?

While the Phoenix area has been designated as nonattainment with the 2015 ozone NAAQS, the designation itself provides no information on the sources that contribute to the area's ozone levels, or cost-effective ways to reach attainment. However, multiple scientific studies exist that identify the primary contributors to ozone in the Phoenix area. Our review of two such recent studies finds that they both conclude that the vast majority of ozone in Phoenix, both recently and as far into the future as 2030, is due to 1) uncontrollable sources, and 2) vehicles.

1. "U.S. Background" Levels of Ozone

Researchers at Sonoma Technology, Inc. (STI) evaluated the "background" ozone emissions in the Phoenix area (and three other urban areas) using an air quality analysis method called "source apportionment modeling."[12] In this study, U.S. background ozone refers to the combination of ozone contribution from natural sources (*i.e.*, in the absence of any global man-

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[9] U.S. EPA. 2014. "Additional Air Quality Designations for the 2015 Ozone National Ambient Air Quality Standards," Available at: https://www.epa.gov/sites/production/files/2018-04/documents/placeholder.pdf.

[10] U.S. EPA. 2014. "EPA's Proposal to Update the Air Quality Standards for Ground-Level Ozone: Designations, Monitoring And Permitting Requirements." Available at: https://www.epa.gov/sites/production/files/2015-08/documents/requirements_proposal_update_standards_2014.pdf.

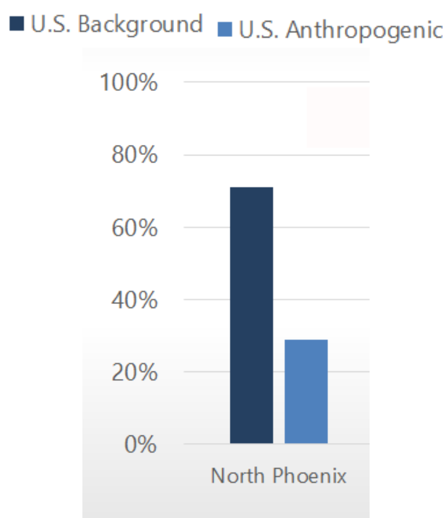
[11] See https://www.epa.gov/ozone-pollution/ozone-naaqs-timelines. It is possible the 2020 attainment date could be pushed back because EPA's final designations and classifications were not released until April 2018 (schedule for October 2017).

[12] Craig K, Erdakos G, Baringer L, and Chang SY. 2017. "Source Apportionment Modeling to Investigate Background, Regional, and Local Contributions to Ozone Concentrations in Denver, Phoenix, Detroit, and Atlanta." Presentation at 16th Annual CMAS Conference, October 23, 2017. This type of analysis is the state-of-the-art for identifying location-specific causes of ambient pollution levels in order to prepare effective locally-tailored plans for reducing the current pollution.

made emissions) and man-made (or "anthropogenic") sources outside of the U.S. The latter are considered background because they cannot be restricted by U.S. regulations, and cannot be controlled by U.S. emitters.

As shown in Figure 1, STI found that U.S. background ozone contributed 71% of the ozone at the North Phoenix monitor in 2011 on days when the monitored peak 8-hour ozone was greater than 70 ppb (*i.e.*, on days when ozone levels exceed what the U.S. EPA considers to be protective of public health).[13] The remaining 29% was attributable to U.S. man-made emissions, both inside Arizona (21%) and in other states (8%). For the Phoenix area, most of the U.S. background was found to be attributable to emissions transported from Asia and Mexico and wildfires throughout the U.S. West – none of which can be controlled by U.S. or Arizona policy.

Figure 1: Ozone Source Contributions at North Phoenix Monitor in 2011
(Average contributions on days when monitored peak 8-hour ozone exceeded 70 ppb)

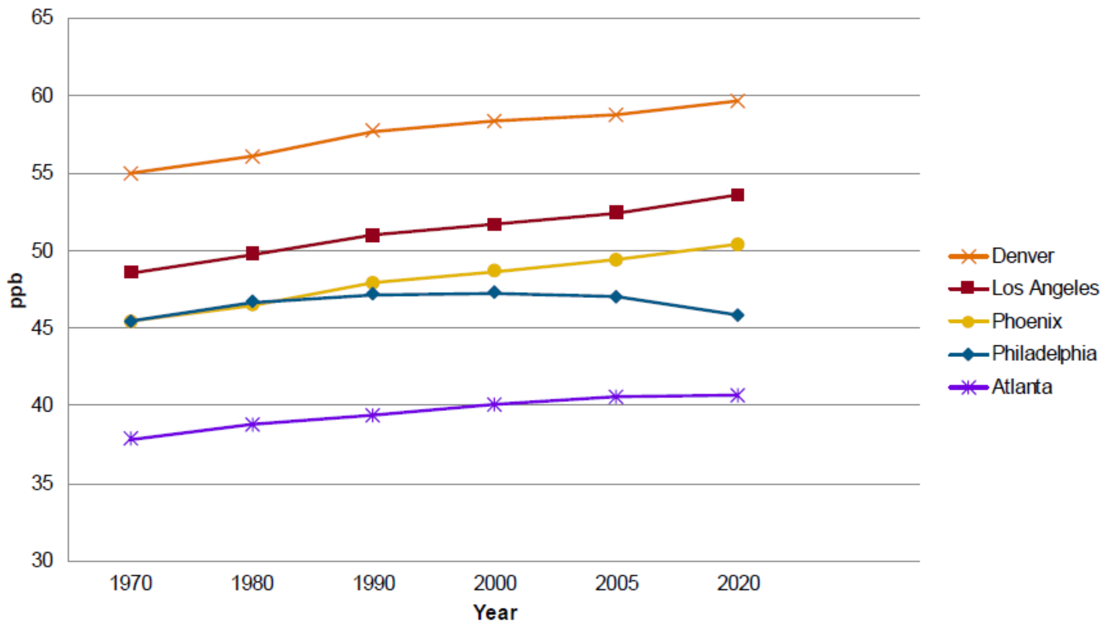


Source: Slide 18, Craig K, Erdakos G, Baringer L, and Chang SY. 2017. "Source Apportionment Modeling to Investigate Background, Regional, and Local Contributions to Ozone Concentrations in Denver, Phoenix, Detroit, and Atlanta," presentation at 16th Annual CMAS Conference, October 23, 2017.

Also, air quality modeling by Ramboll Environ for the period from 1970 through 2020 has concluded that the average percentage contribution of U.S. background sources to elevated ambient ozone in the Phoenix area has been increasing since 1970 (from about 45 ppb) and is projected to continue increasing through 2020 (to more than 50 ppb). Figure 2 presents their findings. The projected 50 ppb in 2020 for Phoenix represents approximately 70% of the area's total ozone concentration, consistent with results from STI's study shown in Figure 1.

[13] There are over two dozen ozone monitors in the Phoenix area, of which the North Phoenix monitor has historically had the highest ozone readings.

Figure 2: U.S. Background Ozone Concentrations at Five Major U.S. Cities
(4th Highest Maximum Daily 8-Hour Average)



Source: Slide 17, Kumar, N. Mid-Atlantic States Section Annual Workshop, "Ozone: Challenges, Trends, Strategies, and New Developments." New Brunswick, NJ, October 12th, 2017.

2. Anthropogenic Sources

To understand how to most effectively reduce ozone in the Phoenix area, it is helpful to more closely study the U.S. man-made sources that contribute to the area's ozone, because these are the sources that U.S. or Arizona policy can potentially address. STI conducted a later study, built upon its earlier assessment of U.S. background ozone, that estimated contributions to Phoenix area ozone monitors from different non-background sources in different geographic regions surrounding Phoenix and Arizona more generally.[14]

The 2018 study estimated source contributions for multiple source-location groupings around Arizona for existing 43 monitors across the state, 29 of which are located throughout the Phoenix area.[15] The density of the network in the Phoenix area reflects that this is where the majority of Arizonans live, and also is the portion of the state with ozone concentrations that exceed the national health standard. The analysis was based on 2011 emissions levels. As we will discuss, those levels have generally declined since 2011, and so too has the frequency with which ozone rises above the health standard. The associated report provides the most detailed results for the North Phoenix monitor in the Phoenix area (which has historically had the highest ozone

[14] The STI study results are reported in EPRI (2018), "Modeling Analysis of Ozone Source Contributions in Denver, Phoenix, Atlanta, and Detroit," #3002013588.

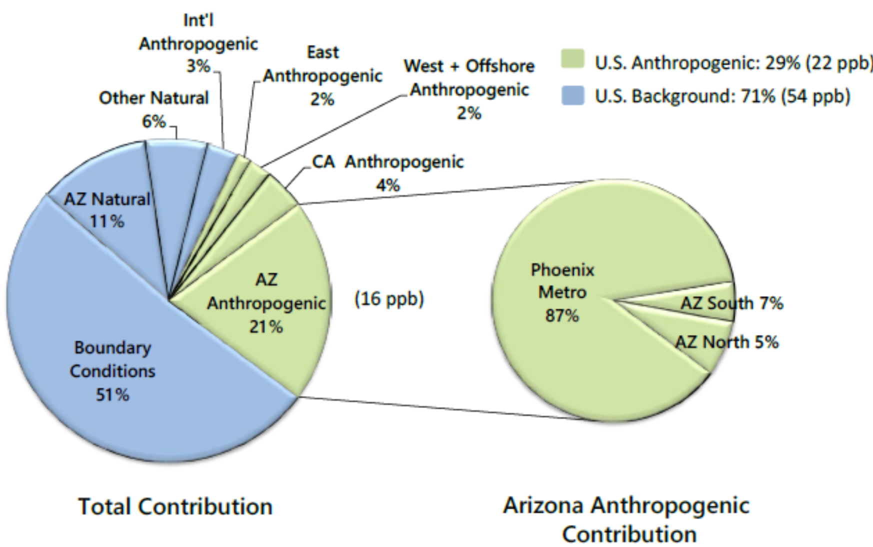
[15] Appendix B of the study includes 29 monitors in the Phoenix area (defined as Maricopa or Pinal county), while a map of the Phoenix-Mesa nonattainment area (Figure 5-1 in EPRI 2018) only lists 28 monitors. The monitor not shown is the Fort McDowell monitor (ID 40135100).

readings) but our evaluation in this report takes into account results provided in the report for all 29 Phoenix area monitors evaluated in the study.

Figure 3 reproduces a figure from that report showing the source contributions at the North Phoenix monitor in 2011 on days when the monitored peak 8-hour ozone was greater than 70 ppb. (It registered 22 such high-ozone days in 2011.) Of the 29% of the ozone from anthropogenic sources, the report found that 28% of this is due to ozone-causing emissions released in states other than Arizona (particularly to its West). This leaves only 21% of the total Phoenix area's ozone coming from man-made sources within Arizona.

The right side of Figure 3 shows the shares of Arizona's estimated man-made ozone sources contributed by three areas within Arizona. This sophisticated air quality modeling effort found the vast majority (87%) of Arizona's estimated man-made ozone sources were attributable to emissions in the Phoenix metro area (defined as Maricopa and Pinal counties in the report). Table 1 presents the 2011 NO_X emissions for the Phoenix area, with a breakout of the electric generating unit (EGU) emissions, showing that EGUs accounted for less than 2% of Phoenix area NO_X emissions in 2011.

Figure 3: Source Contributions for the North Phoenix Monitor in 2011 – Total Ozone and Anthropogenic Ozone from Arizona Sources
(Averages when monitored peak 8-hour ozone greater than 70 ppb)



Source: Figure 5-2 from EPRI (2018).

Table 1: 2011 NO_X Emissions (Tons) in Phoenix Area

	All Sector	EGUs
Maricopa County	86,732	1,645
Pinal County	13,640	119
Total Phoenix Area	100,372	1,764

Source: 2011 National Emissions Inventory, U.S. EPA.

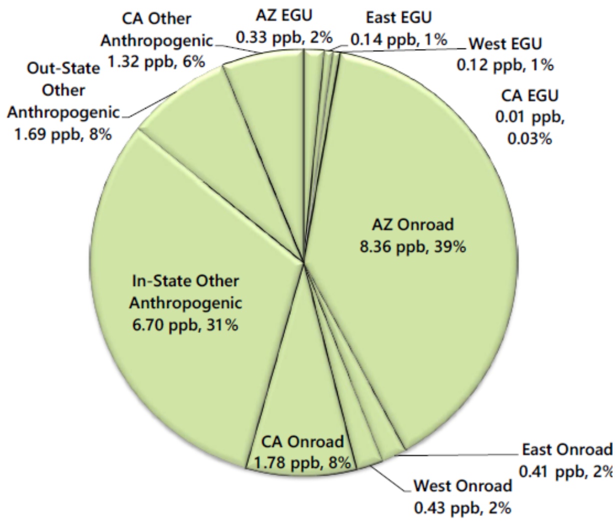
Figure 4 (also reproduced from the same report) provides additional details on the location and sources of the U.S. anthropogenic contributions. The research found that onroad emissions (both within Arizona and surrounding states) accounted for the majority of the U.S. anthropogenic contributions (51%) to ozone levels near that monitor.[16] Within Arizona, onroad vehicles are estimated to account for 54% of all man-made ozone-forming emissions.[17] In contrast, EGUs accounted for approximately 4% of the U.S. anthropogenic contributions (0.8% of total ozone contribution)—and only half of that is from EGUs in Arizona.[18] Stated in ppb, the average amount of ozone attributed to Arizona EGUs in 2011 at this single monitor was 0.33 ppb, with another 0.14 ppb from EGUs located east of Arizona (a portion of which is used to serve APS and TEP customers, and thus has emissions that could be affected by the Initiative).

[16] Including offroad mobile sources increases the share of mobile sources to 57% of the U.S. anthropogenic contribution (total mobile source contributions are included in Appendix B of the report).

[17] Total Arizona shares of man-made ozone-forming emissions are: AZ onroad is 39%, AZ EGU is 2%, and In-State Other Anthropogenic is 31%.

[18] EGUs serving Arizona customers, AZ EGUs and some portion of East EGUs, contribute about 0.6% to the Phoenix area's total ozone level

Figure 4: Source Contributions for the North Phoenix Monitor in 2011 – U.S. Anthropogenic Sources
(Averages when monitored peak 8-hour ozone greater than 70 ppb, percentages are share of U.S. anthropogenic)



Source: Figure 5-3 from EPRI (2018).

A 2017 presentation of preliminary findings from STI's modeling for the Fountain Hills monitor in the Phoenix area (which is more on the eastern side of the metro area) showed very similar results to those for the North Phoenix monitor.[19] The report presents somewhat more aggregated results for all of the monitors across the state. For the 29 monitors in the Phoenix area, the average contributions from all Arizona EGUs ranged from 0.00 ppb to 0.85 ppb, averaging 0.31 ppb. The contributions from EGUs outside of Arizona (which included east, west, and California contributions in aggregate) ranged from 0.01 ppb to 0.47 ppb, averaged 0.19 ppb. While this indicates a fairly wide variability in the EGU impact across monitors in the area, in all cases the EGU ppb contribution is a small fraction of the total ozone (keeping in mind that total ozone exceeded 70 ppb in each case).

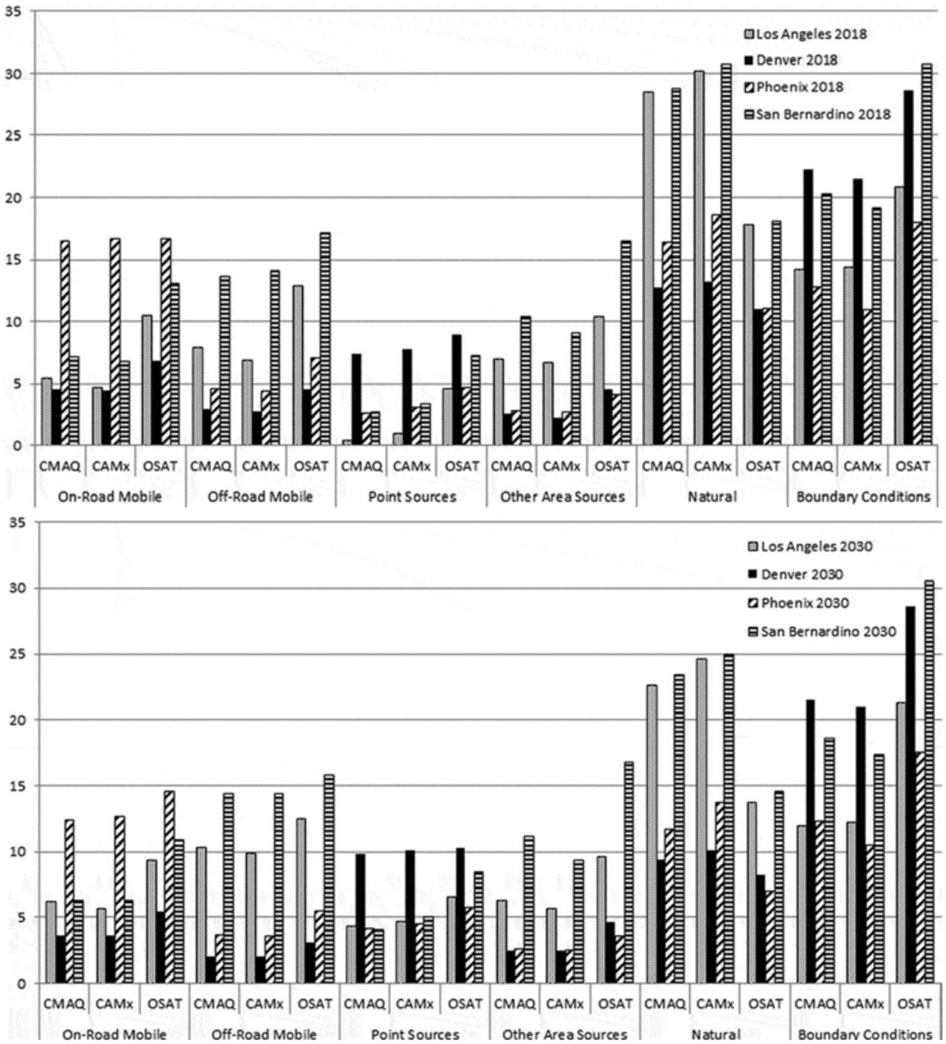
Another study of source attribution for the Phoenix area was prepared by a different set of researchers and published in the *Journal of the Air & Waste Management Association* (Collet *et al.*, 2014).[20] Its findings are broadly similar to those described above, even though this study focused on contributions projected to occur in the future years 2018 and 2030, after a number of emissions regulations would have been more fully implemented. As shown in Figure 5, Collet *et al.* also found the largest share of ozone in the Phoenix area is expected to be from natural and

[19] Kumar, N. Mid-Atlantic States Section Annual Workshop, "Ozone: Challenges, Trends, Strategies, and New Developments." New Brunswick, NJ, October 12th, 2017.

[20] Collet S, Minoura H, Kidokoro T, Sonoda Y, Kinugasa Y, Karamchandani P, Johnson J, Shah T, Jung J, and DenBleyker A. 2014. "Future year ozone source attribution modeling studies for the eastern and western United States," *Journal of the Air & Waste Management Association*, 64:10, 1174-1185, DOI: 10.1080/10962247.2014.936629.

boundary conditions, and that mobile sources (on-road and off-road) would be the largest U.S. man-made sources. The study did not break out contribution from EGUs specifically, but only reported contribution for a category called "all point sources." All point sources were projected to account for a small share of projected ozone in the Phoenix area in 2018 and 2030, but it is not possible to infer what fraction of that was attributable to EGUs.

Figure 5: Projected Source Contribution for 2018 and 2030 Summer Ozone Design Values



Source: Figures 5 and 6, Collet S, Minoura H, Kidokoro T, Sonoda Y, Kinugasa Y, Karamchandani P, Johnson J, Shah T, Jung J, and DenBleyker A. 2014. "Future year ozone source attribution modeling studies for the eastern and western United States," *Journal of the Air & Waste Management Association*, 64:10, 1174-1185, DOI: 10.1080/10962247.2014.936629.

D. Summary

In summary, the studies of the Phoenix area's ozone demonstrate the following:

1. On high-ozone days about two-thirds of the Phoenix area's ozone comes from much larger volumes of emissions from areas far from Arizona (*e.g.*, Mexico) or from natural sources (*e.g.*, wildfires).

2. Vehicles driven in Arizona (onroad and offroad) account for half or more of the area's man-made causes of ozone on high-ozone days.

3. Although the EGU contribution to ozone varies across the area, EGUs targeted by the Initiative have, on average, contributed less than 0.7% to total ozone experienced in Phoenix area in 2011, or less than 0.5 ppb.[21]

As we will show in the next section, it is reasonable to expect that the ppb contributions of EGUs are lower now that estimated for 2011, and that they will be substantially lower by the time the Initiative would start to have significant incremental effect on the share of renewables in electricity sold by the affected companies.

[21] This includes a portion of Arizona electric generators (e.g., excludes generators serving load for Salt River Project) and a portion of East electric generators such as those located in New Mexico that serve APS and TEP customers.

III. POLICY ANALYSIS

Our review of available scientific studies of the Phoenix area's ozone in the prior section leads us to conclude that EGUs that could be covered by the Initiative accounted in 2011 for a less than 0.5 ppb average contribution to ozone on days when the area's air quality exceeded the U.S. EPA's health standards. In the present setting of increasingly stringent emissions regulations, it is reasonable to expect that the change will be substantially smaller than the total EGU contribution estimated to have occurred seven years ago. In this section we turn to the question of how much change in the area's ozone levels might be expected from implementation of the Initiative.

To make evidence-based estimates of the potential impact of the Initiative on levels of ozone pollution in the Phoenix area, it is necessary to project how EGU emissions will change between 2011 and 2020-2030 in the absence of the Initiative, how compliance with the Initiative would be achieved (to determine changes in NO_X emissions by location), and then assess potential impacts from those emission changes on the Phoenix area's ozone.

A. Estimated NO_X Emissions Changes Due to the Initiative

As described in Section I, the Initiative would require an increasingly larger share of renewable generation from 2020 through 2030. As new renewable generation is required to comply with the Initiative, this would displace generation from some existing generators. To the extent that the additional renewables resulting from the Initiative would displace coal- or gas-fired generation, it would result in some reductions in NO_X emissions from EGUs. However, because the Initiative does not count nuclear generation (*i.e.*, Palo Verde) as a renewable resource, the potential also exists that the Initiative could displace nuclear generation, which does not emit any NO_X emissions, thus reducing the overall efficacy of the Initiative reducing ozone-forming emissions.[22] Further, because of the intermittency of renewables generators like solar photovoltaic (PV) panels and wind turbines, there will likely be a need for new natural gas-fired generation to ensure reliability of supply, and such back up generation will offset at least some of the NO_X emissions reductions otherwise expected from projected fossil plant closures. Given these system operational complexities, some system modeling is necessary to develop an estimate of the net effect of the Initiative's targets. It is important that such an analysis also account for system wide emissions changes expected to occur in the absence of the Initiative in order to estimate the change in emissions that would be attributable to the Initiative itself. That is, it is necessary to compare emissions in a case where the Initiative is implemented to a base case that reflects no new policy.

[22] The nuclear plant most likely to be affected is Palo Verde, located in the Phoenix area.

The two primary electricity suppliers that would be affected by the Initiative are Arizona Public Service (APS) and Tucson Electric Power (TEP).[23] As such, our analysis of NO_X emission changes focus on changes from the generating units that are used to serve the customers of these two utilities. Both APS and TEP are projected to exceed their 2025 renewables obligations of 15% under the current Arizona RES (with at least 4.5% coming from distributed generation), without the Initiative in effect. In addition, several existing coal units are projected to retire in the Base Case before 2025 (Navajo units 1 through 3, APS's Cholla units 1 and 3, and TEP's San Juan units 1 and 2.) TEP's H. Wilson Sundt plant has also converted from coal to natural gas. Together, these actions are projected to lower Arizona EGU NO_X emissions by about 50% relative to 2011 NO_X emissions, and to lower EGU NO_X emissions in San Juan county, New Mexico by about 30%. Thus the EGU contributions to the area's ozone level that were already small in 2011 will likely be reduced by 2025 even without the Initiative in place. Our methodology for determining the further changes in emissions from this base case that would be necessary to fully comply with the Initiative's renewables targets is described in detail in Appendix A, with results presented in summary format below.

Table 2 presents the combined incremental changes in NO_X emissions from our estimates of a reasonably-realistic scenario of actions to comply with the Initiative, for 2025 and 2030. That is, they reflect the emissions in in the scenario that fully complies with the Initiative's targets minus those projected for the same year in the base case. Almost all of the incremental NO_X emission reductions are projected to occur in San Juan county, New Mexico, while the next largest reduction is in Apache county in the far northeast of Arizona. The reductions in San Juan county are attributable to the Four Corners power plant, and almost all of those are associated with APS's ownership share; the reductions in Apache county are attributable to TEP's Springerville units. The "Phoenix area," (*i.e.*, Maricopa and Pinal counties), is projected to experience increased NO_X emissions in 2025 and small reductions in 2030. The projected increases are due to greater utilization of several natural gas-fired units that already exist in that area, necessitated by the need to smooth out rapid fluctuations in wind or solar generation. All Arizona counties together combined are projected to have reduced NO_X emissions equal to 2,035 tons in 2025 and 2,724 tons in 2030.

Note that new gas-fired unit capacity is shown in the "New" column. For purposes of estimating the potential ozone impacts from the Initiative, we have assumed that the increases in emissions attributable to new units (as opposed to increased dispatch of the already existing gas units) occur in San Juan county. This reduces their impact on ozone in the Phoenix area to a very small amount that has no meaningful role in our estimated impacts of the Initiative on ozone.[24]

[23] Electric cooperatives, which we understand would also be covered by the Initiative, account for a much smaller share of NO_X emissions, and thus, inclusion of them in the analysis would probably have only minimal effect on our results.

[24] If we were to assume that the new gas units would be located closer to the Phoenix area -- where the load is centered, and where the Palo Verde plant (which is projected to shut down in this analysis) is located -- then we might find that the Initiative would actually increase ozone in some parts of the Phoenix area. Although it may not

Table 2: Change in NO_X Emissions from Implementation of Initiative – Combined APS and TEP

	Maricopa	Pinal	Apache	Coconino	Pima	Navajo	Cochise	Yuma	New	San Juan (NM)	Luna (NM)
2025	134	-3	-2,164	0	0	0	0	-1	720	-18,101	0
2030	-124	-7	-2,590	0	0	0	0	-2	579	-16,344	0

B. Estimated Impact of NO_X Reductions on Phoenix Area Ozone

Changes in ozone-forming emissions due to the Initiative do not automatically translate into changes in ozone exposures. To assess what those changes might be with precision requires a sophisticated analysis applying these emissions reductions as inputs to the types of photochemical air quality models that have been used to develop the understanding of source contributions to the Phoenix area's ozone levels summarized in Section II. Nevertheless, it is possible to obtain very general insights about the magnitude of the potential changes in ozone from the estimated emissions changes in Table 2 using the existing atmospheric model run results, as we discuss next. Although we caution that uncertainties are associated with the following rough numerical estimates because they involve linear extrapolations of phenomena that are highly non-linear, we also note that the changes we are estimating here are very small, and even large approximation errors due to altered photochemical conditions by the time the Initiative would be having its effect will unlikely affect those general insights. The numerical calculations we conduct in this section are in fact consistent with (and more refined than) the types of calculations that the U.S. EPA has employed for its regulatory impact analyses for its ozone NAAQS rules.[25] We do note, however, that the following type of analysis would not be appropriate for use in developing an ozone compliance strategy for the Phoenix area – and it is not being used to address such a question in this report.

1. Distance and Direction of the Emissions Changes Matter

Changes in NO_X emissions allow us to better understand how these changes might or might not lead to changes in ozone air quality in the Phoenix area. Except for areas very close to a source of NO_X, its average ozone contribution to surrounding locations will become smaller per ton emitted as the NO_X is transported through the atmosphere. Broadly speaking, the impact per ton will tend to be smallest in the direction that the wind blows least frequently. These are highly-complex phenomena, however, which is why they are studied using use highly-sophisticated air quality models, and our analysis relies on rough approximations derived from the air quality modeling exercise of STI described in Section II.C. However, we first motivate the findings that

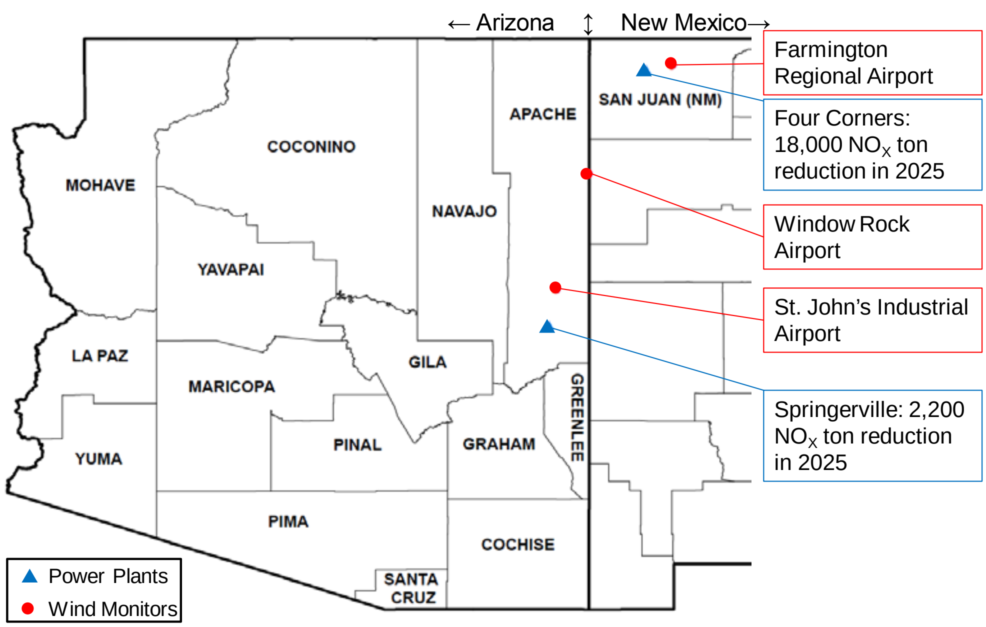
be physically realistic to assume they will be sited near the Four Corners plant instead, this minimizes the estimate of their potential offsetting effect on Phoenix area ozone reductions due to the Initiative, as discussed in the next section.

[25] U.S. EPA. 2014. "Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone," available at: https://www3.epa.gov/ttnecas1/regdata/RIAs/20141125ria.pdf.

can be inferred from such models using a simple concept called a "wind rose." A wind rose summarizes the direction and strength of wind in a particular location based on historical measurements. The orientation of each "petal" of a rose show the direction from which the wind sometimes blows, and the length of the petal indicates the relative frequency with which it blows from that direction. (Although of less importance here, the colors shown in each petal indicate the wind speeds when the wind is coming from that particular direction.) We first present wind rose data to help provide some insight about the reasons for the results of the more sophisticated models, which may otherwise seem too opaque (like "black boxes") to non-modelers.

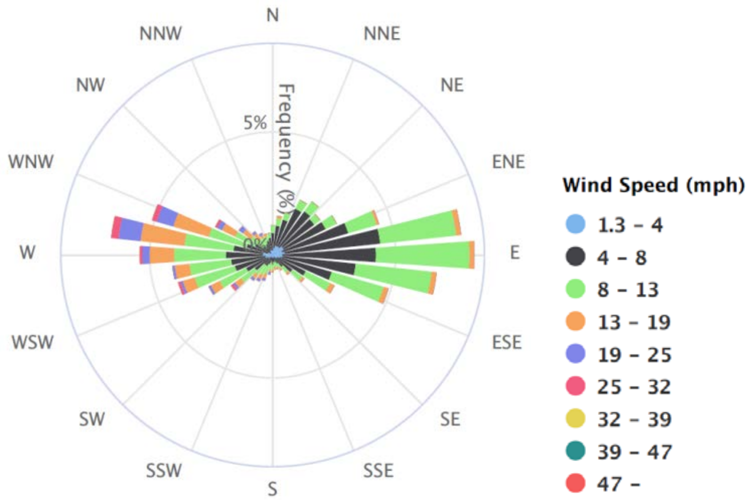
Figure 6 provides a map of Arizona and adjacent New Mexico counties, and shows (as blue triangles) the location of the two power plants that contribute almost all of the NO_X emission reductions from compliance with the Initiative (*i.e.*, Four Corners in San Juan county New Mexico and Springerville in Apache county). In addition, the map shows (as red dots) the location of three wind monitors in San Juan and Apache county.

Figure 6: Map of Arizona Counties, Primary Sources for EGU NO_X Reductions, and Wind Rose Locations



The two primary locations projected to experience any significant change in NO_X emissions are San Juan county (New Mexico) and Apache county (Arizona), each of which is more than 150 miles from the Phoenix area. If the wind were to frequently blow towards the Phoenix area from these two locations then there would be greater likelihood that a change in their NO_X emissions on a given day would affect the ozone concentrations in the Phoenix area. Figure 7 presents the wind rose in San Juan county (New Mexico); it shows that on average over the past eight years, wind most has typically blown from the east or from the west. This suggests that NO_X emissions from the Four Corners power plant in San Juan county (New Mexico) do not typically move in the direction of the Phoenix area, which is southwest of San Juan county.

Figure 7: Wind Rose for San Juan County (NM) Farmington Regional Airport



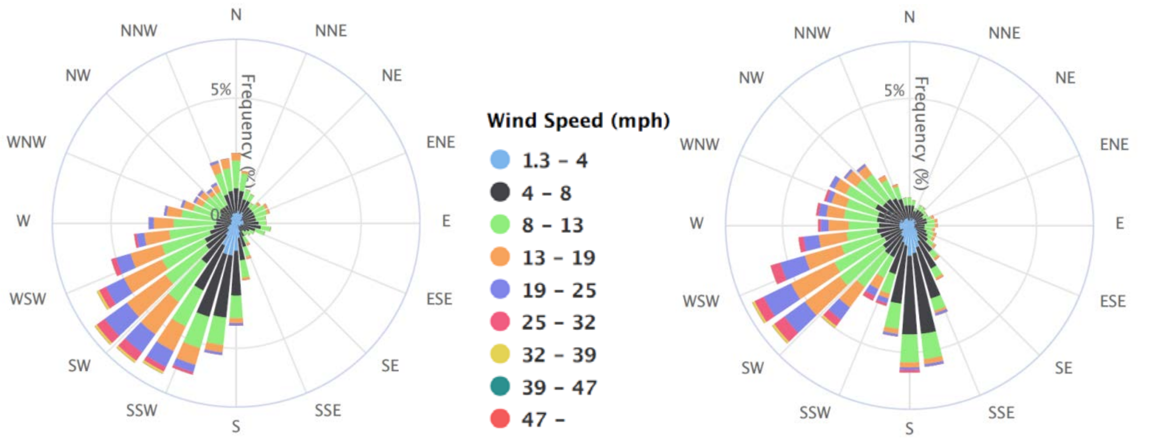
Source: http://mrcc.isws.illinois.edu/CLIMATE/Hourly/WindRose2.jsp, data for January 1, 2010 through April 17, 2018.

Similarly, Figure 8 shows wind roses for two locations in Apache county. The Phoenix area is west (and slightly south) of the Springerville power plant in Apache county. Both wind roses for Apache county show that winds are almost always from the southwest and therefore tend to blow away from the Phoenix area.

With these wind patterns, one should not be surprised to learn that complex air modeling exercises find a quite small contribution to Phoenix area ozone from these two large EGU NO_X sources, one of which we have estimated is likely to make the lion's share of NO_X emissions reductions as a result of the Initiative.

Figure 8: Wind Roses for Apache County (AZ)

Window Rock Airport St. John's Industrial Airport



Source: http://mrcc.isws.illinois.edu/CLIMATE/Hourly/WindRose2.jsp, data for January 1, 2010 through April 17, 2018.

2. Numerical Estimates of Average Ambient Ozone Changes in the Phoenix Area

Figure 3 and Figure 4 from the STI analysis showed the relative contributions of different sources to the Phoenix area's ozone in 2011, based on the North Phoenix monitor. If we assume that the relative 2011 relationship will remain roughly the same over time, we can roughly approximate the general magnitude of a potential incremental impact on the Phoenix area's ozone in 2025 and 2030 due to compliance with the Initiative based on our estimates of the projected incremental changes in NO_X emissions in those years due to compliance with the Initiative.

As an example, STI's analysis indicated Arizona EGU emissions contributed 2% of man-made source ozone, or 0.4% of total ozone at the North Phoenix monitor.[26] Additionally, Figure 3 shows that emissions in Northern and Southern Arizona contribute only a small fraction of that highest-ozone monitor's total man-made contribution, with 87% of the contribution coming from manmade emissions within the Phoenix area itself. If this average impact per ton emitted were the same for EGU emissions as for all tons on average, emission reductions in Apache county would likely have very little impact on the Phoenix area's ozone.

Using actual 2011 EGU emissions from EPA's National Emissions Inventory (NEI)[27] and the information from Figure 3 and Figure 4, the authors of this report calculated an estimate of the average ppb of ozone per 10,000 NO_X tons in the Phoenix area, in Northern Arizona, in Southern

[26] 0.4% is based on calculations using data from the EPRI report's Appendix B for the North Phoenix monitor (0.33 ppb / 75.5 ppb). It varies from 0.0% to 1.1% over all the monitors in the Phoenix area.

[27] See https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data.

Arizona, and East (Table 3).[28] Using these ppb per ton values, and assuming a roughly proportional actual impact if emissions are reduced, one can disaggregate the AZ EGUs' contributions to ozone between Phoenix area EGUs, Northern Arizona EGUs, and Southern Arizona EGUs. They are very approximate because they assume a similar ozone impact per ton emitted even though the atmospheric mixture of ozone-forming compounds is modified whenever emissions from certain sources in the region are changed by a significant amount. Nevertheless, such approximations can indicate the general magnitude of changes that might be expected, pending availability of more detailed atmospheric modeling of the specific change scenarios of interest.

Table 3: Using 2011 NO_X Emissions and Source Contributions to Estimate Approximate ppb per Ton Impact of Changes in Emissions by Source Type/Location (North Phoenix monitor location)

Source	Source Contribution (ppb)	2011 NO_X (Tons)	ppb per 10,000 NO_X tons
AZ (All Sources)	15.4	283,144	0.54
Phoenix Area (All Sources)	13.4	100,372	1.34
N AZ (All Sources)	0.8	111,547	0.074
S AZ (All Sources)	1.1	71,226	0.16
Phoenix Area (EGU)	0.11	1,764	0.64
N AZ (EGU)	0.17	47,032	0.035
S AZ (EGU)	0.05	6,475	0.076
East (EGU)	0.14	55,976	0.025

Source: 2011 National Emissions Inventory, Figure 5-2 and 5-3 from "Modeling Analysis of Ozone Source Contributions in Denver, Phoenix, Atlanta, and Detroit."

Using the North Phoenix monitor as an example, Table 4 shows the details on the calculation of the reductions in Phoenix area ozone in 2025 and 2030 that may be expected from imposition of the Initiative. The calculation relies on the ppb per 10,000 tons from the STI source contribution analysis and the NERA authors' analysis of the projected changes in EGU NO_X emissions due to compliance with the Initiative. **It suggests that the emissions that are projected to be reduced by the Initiative would reduce ozone at the North Phoenix monitor location by an average of 0.04 ppb and 0.06 ppb on high ozone days in the years 2025 and 2030, respectively.** We have also noted that the impact from EGU emissions appears to vary across the region. Using the more approximate information for all other Phoenix area monitors, **we estimate that the average change across the entire area might be on the order of 0.03 ppb in 2025 and 0.05 ppb in 2030 as a result of the increased renewables requirements under the Initiative**.[29]

[28] We defined East EGU as EGU NO_X emissions in San Juan county, New Mexico plus emissions for the Four Corners power plant, which is reported as part of the Navajo Nation (Arizona, New Mexico & Utah) in the EPA's NEI.

[29] Specifically, for other monitors the report provides the ppb contribution from all in-state EGUs as a group, and from all out-of-state EGU monitors as a group for the average of all days when those respective monitors exceeded

Table 4: Calculation of Implied Ozone Changes in Phoenix Area

	Phoenix Area	AZ N	AZ S	East EGU	Total
2025					
Change in NO_X	+131	-2,164	-1	-17,382	
x ppb per 10,000 tons	0.64	0.035	0.076	0.025	
Implied Change in ppb	+0.008	-0.008	-0.00001	-0.04	**-0.043**
2030					
Change in NO_X	-131	-2,590	-2	-15,765	
x ppb per 10,000 tons	0.64	0.035	0.076	0.025	
Implied Change in ppb	-0.008	-0.009	-0.00001	-0.04	**-0.057**

Notes: Phoenix Area counties: Maricopa and Pinal; AZ N counties: Apache, Navajo, Mohave, Yavapai, and Coconino; AZ S counties: Pima, Greenlee, Cochise, La Paz, Yuma, Gila, Santa Cruz, and Graham; East EGU assumed to be San Juan county in New Mexico only and includes the net emissions changes of the projected coal unit retirements and the "new" gas unit additions.

a. Assessing Uncertainty in the Estimated Impact of the Initiative on Phoenix Area Ozone

To explore the degree of uncertainty in our estimates of the range of potential ozone changes in the Phoenix area, we performed a sensitivity analysis in which we changed two assumptions from our initial estimates described above. First, we revised our estimates of the relative ppb-per-ton impact on Phoenix ozone from sources in any part of the state. As can be seen in Table 3, the source apportionment analysis found that a NO_X ton emitted by an EGU in the N. Arizona region has, on average, only about 5% as much impact on ozone levels at the North Phoenix monitor as a ton emitted by an EGU located inside the Phoenix area. Similarly, it found that a NO_X ton emitted by an EGU in the S. Arizona region has only about 11% as much impact on ozone levels at the North Phoenix monitor as a ton emitted by an EGU located inside the Phoenix area. This can be inferred to be the case for that single monitor (although it was also reported for the Fountain Hills monitor) based on the more detailed analysis results that have been reported for those two specific monitors. For the remaining 28 monitors, the report only provides ozone contributions from all in-state EGUs in aggregate, without regard to the location within the state. In assessing the average ppb impact across the entire region, we applied those same relative impacts to the total in-state EGU contributions to ozone at each individual monitor. This is not an unreasonable assumption, given that the results were so similar for two of the

70 ppb. To develop this estimate of the change in ozone due to the Initiative, we assumed the same relative ppb-per-ton impact from in-state sources as shown in Table 3, but scaling the absolute ppb-per-ton upwards or downwards as necessary to match the absolute ppb contribution from all EGU in-state sources at each monitor. We took a simple average of these monitor-specific results. Given the broad distribution of the monitors around the Phoenix area (see Figure 5-1 of EPRI, 2018), we present this spatial-average change as a first approximation of a population-weighted average ozone exposure change. The next section provides some assessment of the degree of uncertainty in this estimate.

monitors that are not particularly close to each other. Nevertheless, it represents a significant extrapolation and the sensitivity of our results to this assumption merits evaluation. We thus applied a very extreme alternative assumption, which was that the ppb-per-ton impact on all Phoenix area concentrations of a ton emitted by EGUs in either the north or south regions of the state would have exactly the same impact as a ton emitted within the Phoenix region. This extreme alternative assumption has the effect of giving much more weight to the NO_X emissions reductions projected to occur under the Initiative.[30] Because it is inconsistent with the available analytical evidence, results based on it should be viewed solely as an indication of the potential range of error in our estimates based on extrapolations from that analysis.

Second, the results provided for all monitors in the Phoenix area aggregated out-of-state EGU ozone contributions for EGUs in east, west and CA. In our base estimate for the average impact across all area monitors, we assumed the East EGU contribution was the same proportion of the total out-of-state as at the North Phoenix monitor. For our sensitivity case, we have assumed that all of the out-of-state EGU ppb at each monitor was attributable to EGUs located to the east of the state. This change results in a greater ozone contribution assigned to East EGUs where there is the greatest quantity of projected NO_X reductions.

The estimated impacts on ozone changes in the Phoenix area from this sensitivity are thus overstated, but useful for placing an upper bound on the uncertainty in our estimates of the potential ozone exposure change that the Initiative would provide to residents of the Phoenix area. Using these two alternative assumptions, we estimate an average change across the Phoenix airshed in ozone concentrations on high-ozone days of 0.07 ppb in both 2025 and 2030. Given the extreme alternative assumptions for this sensitivity case, we believe that it should be viewed as an upper bound on how large the average ozone impact change would be across the entire Phoenix area on high-ozone days.

b. Comparison to USEPA's 2014 Analysis of Ozone

The U.S. EPA has used similar ppb-per-ton approximations to assess the potential emissions reduction needs to achieve alternative potential ozone NAAQS levels in the 2014 Regulatory Impact Analysis (RIA) for the proposed ozone NAAQS. However, in order to estimate those ppb-per-ton factors, it first performed detailed photochemical air quality model scenarios for a 2025 base case and 12 sensitivity cases in which EGU NO_X emissions were varied from base case levels.[31] We reviewed results from EPA's analysis to assess its consistency with the

[30] For example, based on the North Phoenix monitor, which has a total ppb attributable to in-state EGUs of 0.33 ppb resulting from total 2011 Arizona EGU NO_X emissions of 55,271 tons, this alternative assumption assigns a ppb per 10,000 ton emitted by any EGU anywhere in the state of 0.06. This gives 70% more impact per ton to Phoenix area ozone concentrations to EGU NO_X reductions in N. AZ and only 9% as much impact per ton to EGU NO_X changes that occur within the Phoenix area.

[31] U.S. EPA. 2014. "Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone," available at: https://www3.epa.gov/ttnecas1/regdata/RIAs/20141125ria.pdf.

analysis we have presented above. We found that the limitations of EPA's modeling made it such that it could not be effectively utilized to make specific ozone impact estimates for the Phoenix area. In particular, the emission reductions used to calculate the ppb-per-ton factor were region-wide emission reductions (where Arizona was aggregated with New Mexico, Nevada, Utah, Colorado, and Wyoming). Another important limiting factor is that EPA projected that all 28 monitors it evaluated in Maricopa and Pinal counties would have design values below 70 ppb by 2025 in their Base Case.[32] Thus, EPA's RIA did not assess any emissions changes for the Phoenix area.

Nevertheless, we find an important indicator in that EPA RIA that corroborates our finding that our estimated changes in EGU NO_X emissions due to the Initiative will have miniscule impacts on Phoenix area ozone concentrations. The first of EPA's 12 sensitivity cases was one in which they removed only some EGU NO_X emissions. For Arizona, this sensitivity case removed 12,645 tons of NO_X from in-state EGUs in 2025. This reduction, which is approximately four to six times larger than the projected NO_X reductions in Arizona from the Initiative, did not change any of the projected design values (stated in their standard precision of the nearest 1 ppb) for any of the 28 Maricopa/Pinal county monitors.[33] Despite its limitations, this result of EPA's analysis supports our conclusion that the Initiative will have little to no change on the Phoenix area's ozone levels.

c. Summary of Findings on Ozone Impacts

NERA estimates that there will be very little change in the already minimal contribution of EGUs to the Phoenix area's ozone levels. The region-wide change in ozone due to compliance with the Initiative would likely be about 0.03 ppb in 2025 and less than 0.05 ppb in 2030, on days with weather patterns that are associated with peak ozone concentrations in Phoenix.

EPA's 2014 ozone regulatory impact analysis suggests that the Phoenix area is likely to be in attainment with the 70 ppb ozone standard by 2025, and that reductions in EGU NO_X emissions that are several times larger than those projected by the Initiative would have no impact on reported ozone levels in the Phoenix area.

C. Impacts on Health Outcomes

Some proponents of the Initiative have asserted that the Initiative would reduce emergency room visits for asthma and other forms of health impacts. We note that U.S. EPA considers the evidence that ozone exposure causes people to develop asthma or other chronic conditions to

[32] U.S. EPA. 2014. "Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone," Table 3A-8. Note that EPA's analysis also did not include the Fort McDowell monitor, but did not provide any reason for this exclusion.

[33] U.S. EPA. 2014. "Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone," Table 3A-8.

remain inconclusive. The NAAQS standard has been set to protect the public health from heightened risk that individuals who already have asthma will experience an asthma attack as a result of elevated ozone on any given day.[34] The U.S. EPA has found that people who already have asthma are likely more susceptible to having asthma attacks when ozone daily peaks rise above the national ambient air quality health standard, which is currently set at 70 ppb.[35] Our analysis has thus considered the average changes to ozone concentrations due to the Initiative on days when ozone exceeds that level.

Our analysis estimates that the average change in ozone in the Phoenix area due to the Initiative will be far smaller than 1 ppb, which is the level of precision with which ozone concentrations are reported when calculating whether an area is in attainment with the national health standard for ozone. In fact, our estimate of the average change at the worst case monitor is too small to be expected to change the rounded value of reported ozone. Thus, **the Initiative is very unlikely to have any impact on the number of days when the Phoenix area faces ozone levels in excess of 70 ppb.** It thus has almost no prospect of altering whether Arizona's air is deemed safe from a public health perspective. Additionally, the estimated absolute ppb changes are so small, even on worst-case days, that there is little chance that they will produce any measurable reduction in the levels of emergency room visits or sick days among those who are already susceptible to asthma attacks or other respiratory disease exacerbations.

[34] U.S. EPA. 2014. "Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards," pp. 3-37 to 3-42, available at: https://www3.epa.gov/ttn/naaqs/standards/ozone/data/20140829pa.pdf.

[35] *Federal Register*, Vol. 80, No. 206 / Monday, October 26, 2015, National Ambient Air Quality Standards for Ozone.

IV. SUMMARY

NERA has reviewed the Initiative and evaluated what general magnitude of change it can be expected to have on ozone concentrations in the Phoenix area. We have also looked at available scientific studies with information on the sources that contribute to ozone levels in the Phoenix area and have the following three findings:

1. The Initiative cannot be expected to improve reported levels of ozone pollution in areas where most Arizonans live because it targets power plant emissions that, in total, already have very little impact on the Phoenix area's ozone levels (based on the average over all high ozone days), and which the Initiative would reduce by only a miniscule amount.

2. The vast majority of ozone in the Phoenix area is due to uncontrollable sources (*e.g.*, U.S. background) and vehicles, not the EGU emissions that would be potentially affected by the Initiative.

3. Thus, the Initiative has little prospect of altering the determination of Arizona's attainment status for the national health standard for ozone, nor will it result in any measurable reduction in asthma rates.

APPENDIX A. DETAILS ON METHODOLOGY FOR DETERMINING NO_X EMISSION CHANGES FROM COMPLIANCE WITH THE INITIATIVE

A. APS

Electric utilities routinely conduct analyses to project their system operations to serve their customers' demand for electricity on a reliable, 24-7 basis. The computer tools to support such planning are called "electricity system models." APS has used its own electricity system model that it uses on a standard basis for all of its long-range planning to project how it would operate its system, what units would be shuttered, and what electricity generating sources would be built to serve their customers beyond 2030 for a Base Case and an Initiative Case. The outputs of this modeling analysis that were provided to NERA were annual (and monthly) fuel consumption by thermal generating unit for the units that are used to meet their Arizona electricity load.[36] NERA converted APS's projected fuel consumption values (in Btus) to NO_X emissions (in tons) by applying each unit's calculated weighted average 2016-2017 NO_X rate based on NO_X tons and heat input reported to EPA.[37] Also, each existing unit was mapped to the county in which it is located. With this information, we calculated the change in NO_X emissions as a result of the implementation of the Initiative on APS. These summary findings for 2025 and 2030 are presented by county in Table 5.

Table 5: Change in NO_X Emissions from Implementation of Initiative - APS

	Maricopa	Pinal	Navajo	Cochise	Coconino	Yuma	New	San Juan (NM)
2025	134	-3	0	0	0	-1	610	-18,101
2030	-124	-7	0	0	0	-2	478	-16,134

Table 5 shows a few key results:

- Almost all of the NO_X reductions are located outside of Arizona in San Juan county (New Mexico). This reflects the projected closure of Four Corners units 4 and 5 as a key part of APS's compliance with the Initiative; and
- The Initiative is projected to increase NO_X emissions in Maricopa county in 2025 as some existing natural gas-fired resources (both combined cycle and combustion turbine) generate more under the Initiative to provide reliability support to the additional renewables generation, which tends to fluctuate rapidly will changes in sunlight levels or wind.

[36] Note that both APS and TEP rely on some generators located outside of Arizona to meet their Arizona electricity load. These plants include Four Corners, San Juan, and Luna.

[37] See https://ampd.epa.gov/ampd/.

- APS also predicts that it will need to build additional gas capacity (combined cycle and combustion turbines), given the closures of coal-fired baseload capacity. The analysis does not determine where these new units will be sited. For purposes of our analysis we assume they would be located outside of Arizona in "East." This is merely an assumption for this single analysis, selected because it that results in the most minimal impact of their increased NO_X emissions on our conclusions, and it does not imply that any decision on this matter has been made by APS.

Another result of APS's system compliance modeling that cannot be seen in Table 5 is that the Palo Verde nuclear power plant, of which APS owns a share, is projected to shut down by 2025 as a result of the Initiative.[38] This dilutes the emissions-reduction benefits of the Initiative compared to a policy that would net out nuclear generation from the retail sales to which RES targets are applied, and is reflected in our estimates of NO_X emissions changes.

B. TEP

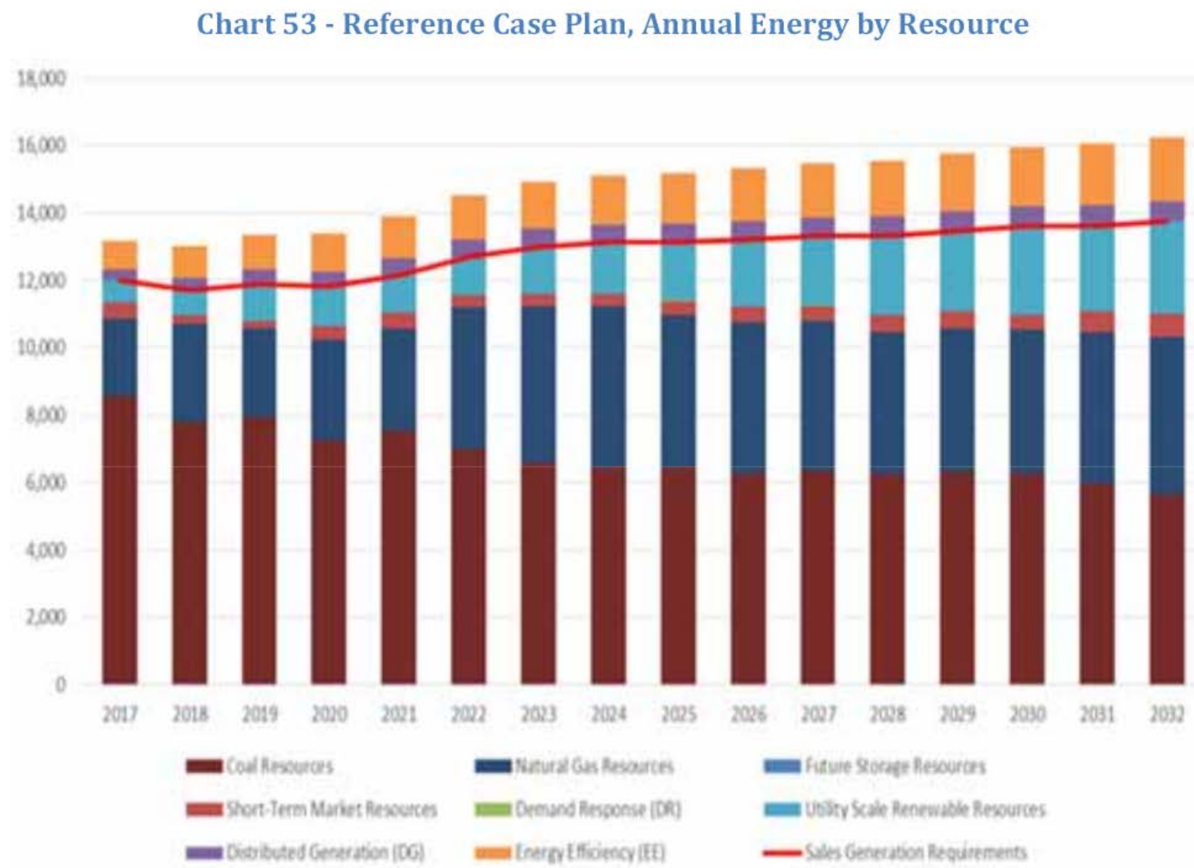
NERA did not have access to system planning analyses for TEP's compliance. We instead relied upon information in TEP's 2017 Integrated Resource Plan (IRP).[39] The IRP presented the following information that we used to develop both a Base Case and a Policy Case with the Initiative implemented:

- Projected retail sales (Table 2 of IRP);
- Existing thermal resources, capacity, and percentage TEP ownership (Table 18 of IRP);
- Planned retirement dates for existing resources (pages 203-206 of IRP);
- Planned base case additions (pages 260, 262, and 279 of IRP); and
- Base case annual energy by resource (Chart 53 of IRP, and reproduced in Figure 9).

[38] Palo Verde's impact is not directly shown in Table 5 because as a nuclear unit, Palo Verde does not emit NO_X so there is no change in the plant's NO_X emissions whether or not it generates.

[39] Tucson Electric Power Company. 2017. "2017 Integrated Resource Plan," available at: https://www.tep.com/wp-content/uploads/2016/04/TEP-2017-Integrated-Resource-FINAL-Low-Resolution.pdf.

Figure 9: TEP Base Case Annual Energy by Resource



From this information, the present authors developed a base case of NO_X emissions for 2025 and 2030 by converting the generation by unit into fuel consumption (based on calculated net heat rates from EPA data) and average NO_X emission rates (from EPA data).

To construct the Policy Case for 2025 and 2030 it was necessary to apply the required renewables percentage to TEP's projected sales (and also apply the required distributed generation percentage to those). The required distributed generation was netted from Base Case projected sales to calculate the Policy Case projected sales, and the renewables percentage was applied to this revised projected sales number to determine the quantity of renewables generation required to comply with the Initiative. The generation to meet remaining electricity load was filled in after netting out required renewables generation. This was filled in first by including Base Case generation from a planned new combined cycle, and adding to that generation from two existing combined cycles (Gila River and Luna) since the flexibility from the natural gas-fired units is assumed to be necessary to assist with the intermittency of the new renewables. Four Corners was phased out (similar to assumptions by APS), while other coal generation (from Springerville units 1 and 2) declined because there was not demand for its generation.

Based on this not implausible representation of a potential TEP compliance approach, we calculated the change in NO_X emissions as a result of the implementation of the Initiative on TEP. These summary findings for 2025 and 2030 are presented by county in Table 6. Note that new units are shown in the "New" column, and are treated as in the same manner as for APS.

Table 6: Change in NO_X Emissions from Implementation of Initiative - TEP

	Maricopa	Apache	Coconino	Pima	New	San Juan (NM)	Luna (NM)
2025	0	-2,164	0	0	110	0	0
2030	0	-2,590	0	0	101	-210	0

Table 6 shows that the largest decline in NO_X emissions from TEP's projected compliance with the Initiative is from Apache county (the Springerville coal plant), and there is no change in NO_X emissions in Maricopa county.

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