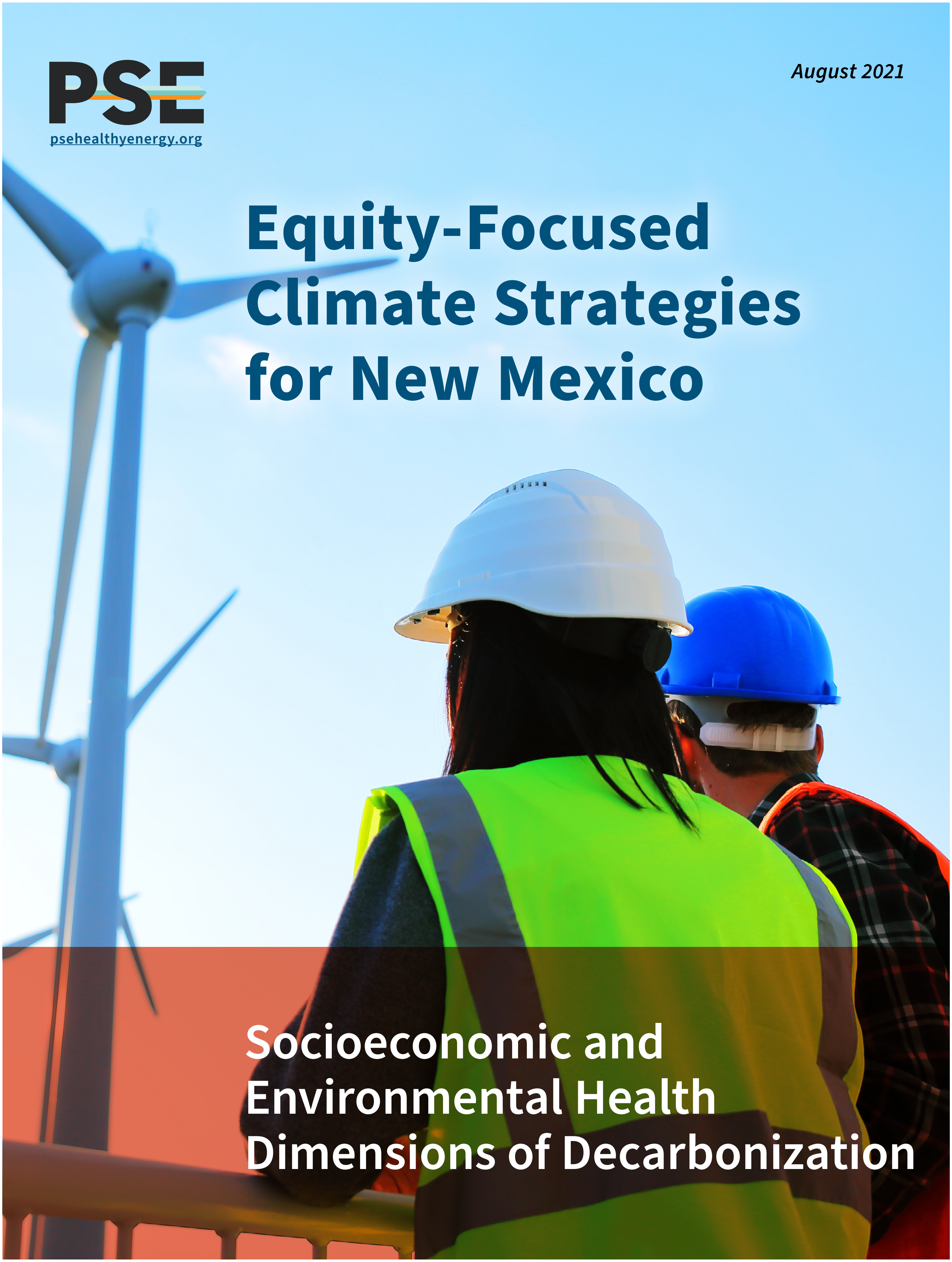

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Equity-Focused Climate Strategies for New Mexico

Socioeconomic and Environmental Health Dimensions of Decarbonization

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About PSE Healthy Energy

Physicians, Scientists, and Engineers for Healthy Energy (PSE) is a multidisciplinary, non-profit research institute that studies the way energy production and use impact public health and the environment. We share our work and translate complex science for all audiences. Our headquarters is located in Oakland, California.

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A forthcoming companion report by Evolved Energy, NRDC, Sierra Club, and Gridlab, 2021 will be available at: ***https://gridlab.org/works/western-states-deep-decarbonization/***

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Table of Contents

1. Introduction and Background

1.1 Motivation

In the face of a warming climate and associated climate change impacts, the State of New Mexico is embarking on an ambitious multi-decade effort to dramatically cut greenhouse gas emissions while confronting a growing need to build climate resilience. The State recently set targets to expand renewable electricity generation while slashing economy-wide greenhouse gas emissions. It is now developing pathways and policies to achieve these goals.

New Mexico's current fossil fuel-based energy infrastructure—including coal mining, oil and gas production and processing, and fossil fuel storage, transmission and use—is not only a source of greenhouse gas emissions, but also a source of health-damaging air pollutant emissions across the state. Transforming the energy system not only impacts pollution and public health, but also holds implications for the financial well-being of New Mexican households.

Low-income households often struggle to pay for the electricity and fuels they rely on to power their homes and vehicles, a concern particularly relevant to New Mexico as a state with one of the highest poverty rates in the country.[1] Rural and indigenous populations face access barriers to reliable electricity, and some households lack access to electricity altogether. Many of these households rely heavily on wood and other polluting fuels to power their homes, creating a risk of ongoing exposure to indoor air pollution. These social inequities impact every sector of the economy, and decarbonization efforts should consider these existing disparities when developing clean energy transition strategies to distribute benefits more evenly across the New Mexico population.

In this report, we use the phrase energy equity to encompass the participation and inclusion of historically marginalized populations in the energy economy—including energy ownership, production, and use—in order to shape energy policy that is more equitable, accessible, and economically beneficial.[2,3] In parallel, environmental equity ensures that no population faces a disproportionate share of environmental pollution and that all populations have access to the benefits of a clean environment and an opportunity to participate in the environmental policy decision-making process.[4]

As New Mexico reshapes its energy system to reduce greenhouse gas emissions, it simultaneously has a unique opportunity to address the uneven environmental public health and economic burdens that the current energy system places on the New Mexico population. In this analysis, we assess opportunities and strategies to integrate pollution reduction, resilience to climate impacts (e.g. heat waves), and energy and environmental equity into the state's decarbonization plans, with a focus on

1 US Census Bureau. 2019 American Community Survey. Accessed February 2021. Available at: https://www.census.gov/programs-surveys/acs.

2 US Department of Energy. Office of Economic Impact and Diversity. The Equity in Energy Initiative (2020).

3 California Energy Commission. SB 350 Barriers Study (2016).

4 US Environmental Protection Agency. Environmental Equity: Reducing Risk for All Communities (1992).

New Mexico's most environmentally burdened and socio-demographically vulnerable communities.[5] New Mexico faces a complicated landscape as it approaches these challenges, including the third highest poverty rate of any state in the US (18.2 percent);[6] a sizable rural population with limited access to electricity, capital investment, and other resources; and an oil and gas sector responsible for more than half of the state's greenhouse gas emissions.[7] As New Mexico also has a particularly diverse population, the majority of which is of a racial minority, it is critical that decarbonization policies consider the varied needs and circumstances of different racial groups across the state. New Mexico has the highest percentage of Hispanic populations in the US (49 percent) and among the highest percentage of Native American populations (11 percent),[8] population subsets that, along with other racial minority groups, could benefit from policies tailored to their specific environmental and socioeconomic burdens.

To better understand the technical approaches New Mexico could follow to achieve its climate targets, Evolved Energy Research—working with Sierra Club, NRDC, and GridLab—recently modeled four potential decarbonization pathways from 2020-2050.[9] These pathways rely on energy efficiency, renewable energy, and electrification measures to reduce fossil fuel use in buildings, transportation, power generation, and industry, along with a concurrent phase-out of oil and gas production. While the locations of greenhouse gas emission sources are not important from a climate perspective (a greenhouse gas emitted anywhere in the world contributes to climate change globally), many greenhouse gases are co-emitted with air pollutants that contribute to local health impacts. These health-damaging air pollutants include, but are not limited to, criteria air pollutants and hazardous air pollutants. As such, in this report, we add spatial dimensions to these techno-economic statewide decarbonization pathways to better understand the ways in which climate policy could reduce—or exacerbate—disparities in health-damaging air pollutant emissions, energy cost burdens, and vulnerability to climate change impacts in different communities throughout the state.[10]

Rapid and effective decarbonization across economic sectors is a critical step to the protection of the climate and has a direct impact on the health and safety of all communities. However, a reduction in greenhouse gas emissions alone does not always guarantee a concurrent decrease in emissions of health-damaging air pollutants[11] nor does it necessarily reduce cost burdens of energy access in any one community.[12] Moreover, recent research indicates that even though overall air pollution levels have declined nationwide over time, disparities in exposure between neighborhoods have persisted for decades.[13] As such, it is advisable that solutions to existing disparities with respect to environmental pollution and energy cost burdens should be explicitly engineered into decarbonization policies to ensure that health, financial, and climate resilience benefits of this transition are maximally and equitably realized. Prioritizing the reduction of emissions and cost burdens in places that are disproportionately burdened with polluting infrastructure and energy affordability challenges would generate more equitable health and

5 We use the phrase "socio-demographically vulnerable" to describe populations whose socioeconomic and demographic characteristics, such as income levels and racial or ethnic composition, are associated with increased risk of adverse outcomes when exposed to environmental health, social, and economic stressors.

6 US Census Bureau. "2019 Poverty Rate in the United States." (2020). Accessed Apr. 2021. Available at: https://www.census.gov/library/visualizations/interactive/2019-poverty-rate.html

7 Tabor, Laura *et al*. New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

8 US Census Bureau. "Quickfacts: New Mexico." (2019). Accessed Feb. 2021. Available at: https://www.census.gov/quickfacts/fact/table/NM,US/PST045219

9 Evolved Energy, GridLab, NRDC, and Sierra Club. Climate Action in New Mexico *(Full Report Forthcoming)*. (2021).

10 An economy-wide clean energy transition away from fossil fuels will also have job impacts in some sectors and communities and provide workforce development opportunities in others. These workforce considerations will be addressed in a forthcoming companion report authored by Inclusive Economics in Summer 2021.

11 Smith, Kirk R., *et al*. Public Health Benefits of Strategies to Reduce Greenhouse-Gas Emissions: Health Implications of Short-Lived Greenhouse Pollutants. *The Lancet*. 374.9707 (2009): 2091-2103.

12 Shonkoff, Seth B., *et al*. The Climate Gap: Environmental Health and Equity Implications of Climate Change and Mitigation Policies in California—A Review of the Literature. *Climatic Change* 109.1 (2011): 485-503.

13 Colmer, Jonathan, *et al*. Disparities in $PM_{2.5}$ Air Pollution in the United States. *Science* 369.6503 (2020): 575-578.

economic outcomes than policies focused exclusively on carbon-equivalent emission reductions irrespective of location and demographics. Such strategies might include targeted efficiency measures for low-income households, for example, or the near-term phase-out of oil and gas production and remediation of oil and gas production sites near environmentally overburdened or socio-demographically vulnerable communities.

To provide an analytical basis for decarbonization pathway decisions that simultaneously address health and economic disparities, we undertake the following:

1. Identify regions and populations currently facing high cumulative emissions from fossil fuel production and use.
2. Characterize household energy and vehicle fuel cost burdens and clean energy access across the state.
3. Identify decarbonization strategies that simultaneously reduce health-damaging air pollution and energy cost burdens while increasing climate resilience.

After discussing our findings and conclusions, we provide actionable policy and research recommendations that emerge from our analyses in this report.

1.2 **Background**

Worldwide, the planet's average surface temperature has warmed approximately 2˚F since the late 1800s,[14] but this warming is unevenly distributed; average temperatures across New Mexico in 2020, for example, had increased by more than 3˚F. In 2020, the entire western side of New Mexico measured its warmest August on record and counties like Hidalgo reported temperatures as much as 7˚F warmer than average.[15] The entire state entered 2021 in a drought, with more than half of its territory facing "exceptional" drought.[16] In the coming decades, the state is projected to face an increasing number of extreme heat days,[17] growing wildfire threats (70 percent of the population lives in high fire risk areas at the wildland-urban interface),[18] and drought,[19] in addition to other changes in weather and precipitation patterns.

To help mitigate climate change, New Mexico has committed to transitioning away from fossil fuels and reducing economy-wide greenhouse gas emissions by 2030 through a combination of goals set by Governor Lujan Grisham through Executive Order 2019-003,[20] the state's Energy Transition Act.[21] The state's core climate goals are summarized in **Table 1**.

The State of New Mexico's Interagency Climate Change Task Force, working with Colorado State University, has analyzed current emissions, climate projections, and the impact of climate policies on achieving these

14 NASA Jet Propulsion Laboratory. "Global Climate Change: Vital Signs of the Planet." Oct. 2, 2020. Available at: https://climate.nasa.gov/evidence/

15 NOAA National Centers for Environmental information, "Climate at a Glance: County Time Series." Accessed Jan. 29, 2021. Available at: https://www.ncdc.noaa.gov/cag/

16 US Drought Monitor. "New Mexico." *The National Drought Mitigation Center.* Accessed Jan. 29, 2021. Available at: https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?NM

17 Climate Impact Lab, "Climate Impact Map." 2020. Available at: http://www.impactlab.org/map/

18 Kenward, Alyson *et al.* Western Wildfires: A Fiery Future. *Climate Central* (2016).

19 NASA's Scientific Visualization Studio. "Megadroughts in U.S. West Projected to be Worst of the Millennium." Feb. 12, 2015. Available at: https://svs.gsfc.nasa.gov/4270

20 Governor Lujan Grisham. Executive Order 2019-003: Executive Order on Addressing Climate Change and Energy Waste Prevention (2019).

21 New Mexico State Legislature. SB-489: Energy Transition Act (2019).

targets.[22] However, their report only briefly addresses air pollution from fossil fuel use and energy equity concerns. New Mexico is not alone in this omission: decarbonization planning nationwide frequently fails to account for public health, environmental impacts, and social equity. Models that do take health impacts into account, however, find that it is possible to increase health co-benefits by prioritizing them alongside decarbonization goals. Incorporating health co-benefits not only improves societal wellbeing, but can improve the cost-effectiveness of decarbonization by reducing medical expenditures associated with the health impacts of air pollution.[23]

For example, Driscoll *et al.* (2015) found that power sector decarbonization policies emphasizing demand-side energy efficiency yielded the greatest public health benefits,[24] and Fann *et al.* (2011) illustrated strategies to maximize health benefits and reduce inequality in pollution burdens by focusing on multi-pollutant reductions in vulnerable communities.[25] These examples illustrate a few possible ways to build energy and environmental equity into decarbonization plans, although there are many ways in which energy systems intersect with such considerations. Below, we provide a contextual overview of the primary public health and social equity dimensions evaluated in this report.

Public Health

The development, production, and extraction of oil and gas, the mining of coal, and the use of these fossil fuels in buildings, power plants, transportation, and industry can contribute to a wide array of public health impacts, most directly through air and water pollution. This report uses air pollution as its primary indicator of public health hazards and risks due to publicly available air pollution emissions data and the resultant ease of comparing air pollutant data across sectors. Air pollution impacts on human health result from both the emissions of primary air pollutants, including particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and volatile organic compounds (VOCs), and from the secondary formation of air pollutants (e.g., ozone and $PM_{2.5}$) in the atmosphere from precursors including nitrogen oxides (NO_x), SO_2, and VOCs.

The health impacts of PM, NO_x, SO_2, and ozone are well-established. These compounds are included in a class of criteria air pollutants regulated through National Ambient Air Quality Standards set by the US Environmental Protection Agency (EPA).[26] Acute and chronic exposure to ozone and $PM_{2.5}$ are associated with adverse cardiovascular and respiratory health outcomes such as asthma and heart attacks, as well as other poor

TABLE 1. Key New Mexico climate targets.

Category	Year	Target
Statewide greenhouse gas reductions	2030	45% below 2005 levels
Electricity generation	2030	50% renewable energy

22 Tabor, Laura *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

23 Scovronick, Noah, *et al.* The Impact of Human Health Co-Benefits on Evaluations of Global Climate Policy. *Nature Communications* 10.1 (2019): 1-12.

24 Driscoll, Charles T., *et al.* US Power Plant Carbon Standards and Clean Air and Health Co-Benefits. *Nature Climate Change* 5.6 (2015): 535-540.

25 Fann, Neal, *et al.* Maximizing Health Benefits and Minimizing Inequality: Incorporating Local-Scale Data in the Design and Evaluation of Air Quality Policies. *Risk Analysis: An International Journal* 31.6 (2011): 908-922.

26 US Environmental Protection Agency. “Criteria Air Pollutants” (2020). Available at: https://www.epa.gov/criteria-air-pollutants

health outcomes including premature mortality.[27] NO_2 and SO_2 are associated with respiratory irritation and difficulty breathing, in addition to their roles alongside other NO_x and SO_x compounds as ozone and $PM_{2.5}$ precursors.[28,29] In addition to criteria air pollutants such as those listed above, EPA regulates hazardous air pollutants, including some VOCs, typically due to their role in elevating the risk of cancer or other serious health effects.[30]

The health impacts of emissions from the combustion of fossil fuels tend to be most elevated for those living near and downwind from these activities, but can also extend across broader regions, hundreds of miles from the pollution source. Conversely, exposure can also be very localized. For example, residential combustion of natural gas, propane, fuel oil, and wood for heating, cooking, and other uses can contribute to elevated concentrations of air pollutants and exposure via poor indoor air quality.[31,32]

Primary pollutant emissions, from both fossil fuel production and use (based on available data), across New Mexico's commercial, industrial, power, residential, and transportation sectors are shown in **Figure 1**. As noted above, many of these primary pollutants also contribute to the secondary formation of ozone and particulate matter. Furthermore, direct emissions of carbon dioxide do not fully reflect the lifecycle greenhouse gas emissions of fossil fuel use—for example, methane leakage throughout the production, processing, transmission, and use of natural gas is another significant source of greenhouse gas emissions. This methane leakage is estimated to increase the radiative forcing of natural gas combustion by 92 percent over a twenty-year time period.[33] **Figure 1** includes fugitive methane leakage estimates derived from the New Mexico Greenhouse Gas Emissions Inventory and Forecast.[34] These estimates, while high, may actually be an underestimate: oil and gas production has increased in recent years, and bottom-up methods of estimating fugitive methane leaks typically underestimate those found by instead measuring atmospheric concentrations above oil and gas fields (see **Box 1** in **Section 2.4.2**). It is worth noting that in 2019, New Mexico produced roughly six times the natural gas and seven times the oil that it consumed in-state.[35,36,37] Therefore, while some of the state's upstream methane emissions are associated with in-state consumption, the majority of these emissions are associated with production for export.

27 Pope III, C. Arden, and Douglas W. Dockery. Health Effects of Fine Particulate Air Pollution: Lines that Connect. *Journal of the Air & Waste Management Association* 56.6 (2006): 709-742.

28 US Environmental Protection Agency. "Nitrogen Dioxide Pollution." Accessed Apr. 2021. Available at: https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects

29 US Environmental Protection Agency. "Sulfur Dioxide Pollution." Accessed Apr. 2021. Available at: https://www.epa.gov/so2-pollution/sulfur-dioxide-basics#effects

30 US Environmental Protection Agency. "Health and Environmental Effects of Hazardous Air Pollutants". Accessed Apr. 2021. Available at: https://www.epa.gov/haps/health-and-environmental-effects-hazardous-air-pollutants

31 Seals, Brady and Andee Krasner. Health Effects from Gas Stove Pollution. *Rocky Mountain Institute* (2020).

32 Semmens, Erin O., *et al.* Indoor Particulate Matter in Rural, Wood Stove Heating Homes. *Environmental Research* 138 (2015): 93-100.

33 Alvarez, Ramón A., *et al.* Assessment of Methane Emissions from the US Oil and Gas Supply Chain. *Science* 361.6398 (2018): 186-188.

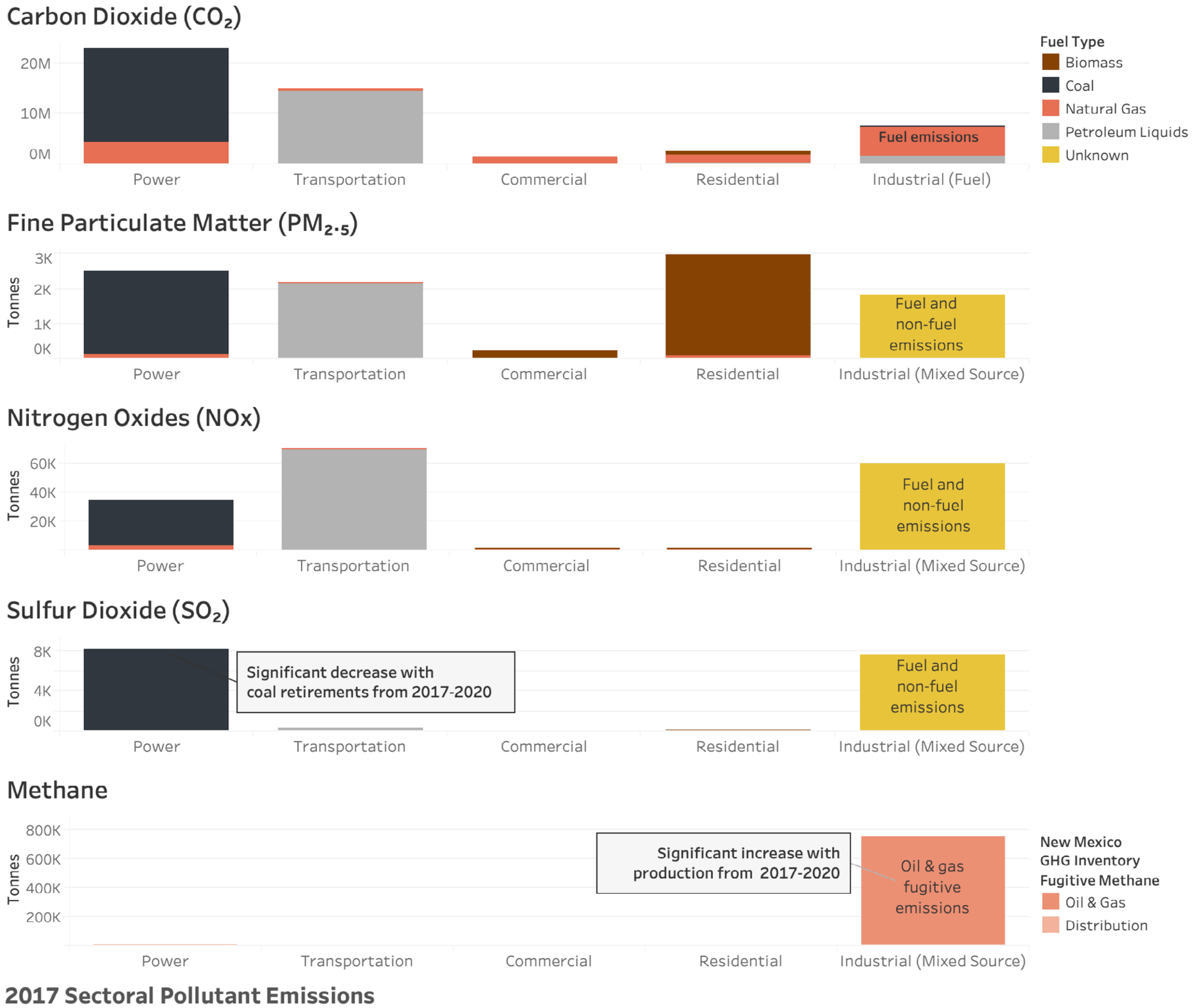
34 Energy+Environmental Economics. New Mexico Greenhouse Gas Emissions Inventory and Forecast (2020).

35 US Energy Information Administration. "State Energy Data System (SEDS): 2019." Accessed Mar. 16, 2021. Available at: https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_use_ng.html&sid=US

36 US Energy Information Administration. "Natural Gas Gross Withdrawals and Production." Accessed Mar. 16, 2021. Available at: https://www.eia.gov/dnav/ng/NG_PROD_SUM_DC_SNM_MMCF_A.htm

37 US Energy Information Administration. "Petroleum and Other Liquids." Accessed Mar. 16, 2021. Available at: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPNM2&f=M

FIGURE 1. Cross-sector primary emissions of carbon dioxide, methane, and select criteria air pollutants by fuel type, 2017.[38,39] Industrial criteria air pollutant emissions include fuel- and non-fuel emissions from stationary point sources, from nonroad mobile sources serving industrial activity, as well as from non-point sources associated with oil and gas exploration, drilling, extraction, and transport to central processing facilities.[40] Fugitive methane is as reported in the New Mexico Greenhouse Gas Emissions Inventory and Forecast.[41] The variation in co-pollutant emissions indicates that the reduction of greenhouse gases from different sectors will have different impacts on criteria air pollutant reductions. These relative emissions have already changed significantly since 2017. For example, as of 2019, power sector SO_x and NO_x had dropped more than half due to a drop in coal generation, and estimated industrial emissions had grown due to a 90 percent increase in oil production and 40 percent increase in gas production.



38 Coal generation fell 20 percent between 2017 and 2019, somewhat reducing coal-related emissions in recent years.

39 Data sources: internal modeling and US Environmental Protection Agency, "National Emissions Inventory (NEI)" (2017), available at: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei; US Energy Information Administration, "Energy-Related CO_2 Emission Data Tables," available at: https://www.eia.gov/environment/emissions/state/; US Energy Information Administration, "Emissions by Plant and by Region," available at: https://www.eia.gov/electricity/data/emissions/

40 NEI emissions estimates for industrial nonpoint sources may be underestimates, as a result of underreporting of pipeline emissions between wellheads and gas processing facilities, as well as the existence of above-average high-emitting oil and gas sites (Grant, John *et al*. U.S. National Oil and Gas Emission Inventory Improvements. (2017)).

41 Energy+Environmental Economics. New Mexico Greenhouse Gas Emissions Inventory and Forecast (2020).

The sectors in **Figure 1** capture the majority of the state's energy consumption and associated emissions and categorize them in a way that is pertinent to the structure of decarbonization policies. We use this sectoral framework throughout this report. It is important to note the wide variability in pollutant emissions by sector and fuel type, illustrating that reductions in carbon dioxide emissions can achieve very different co-pollutant reduction benefits depending upon the sector.

Low-income households, communities of color, and other socio-demographically vulnerable communities across the country disproportionately live near fossil fuel infrastructure and are exposed to an outsize share of its pollution. Studies have shown, for example, that communities of color are disproportionately exposed to air pollution,[42] including from fossil fuel sources like transportation,[43] and that socioeconomically burdened communities are more likely to live near fossil fuel infrastructure, such as power plants.[44,45] Living near facilities such as power plants is associated with adverse health effects such as respiratory disease[46] and adverse birth outcomes.[47,48] Additionally, some vulnerable populations, such as young children, the elderly, and those with pre-existing medical conditions, are particularly sensitive to health impacts from environmental pollution.[49] Decarbonization efforts, such as power plant retirements, have the potential to reduce fossil fuel co-pollutant exposures and health impacts for these communities and populations.[50]

Energy Cost Burdens and Clean Energy Access

Residential and vehicle energy use can contribute to high utility and fuel bills, which weigh particularly heavily on lower-income households. Lower-income households tend to pay less (in total magnitude) for energy than higher-income households, but also tend to live in less efficient homes, drive less efficient vehicles, and spend a larger fraction of their paycheck on energy use. For example, the American Council for an Energy Efficient Economy estimates that low-income households (<200 percent of the federal poverty line) across the Mountain West, including New Mexico, spend a median of 6.9 percent of their income on residential energy bills, as compared to 2.9 percent for the average household.[51] These burdens are likely even higher in New Mexico, which has the highest poverty rate in the region at 18.2 percent.[52] Moreover, low-income households may struggle to pay fluctuating bills, face the risk of utility shutoffs, and otherwise struggle with energy insecurity,

42 Tessum, Christopher W., *et al.* Inequity in Consumption of Goods and Services Adds to Racial–Ethnic Disparities in Air Pollution Exposure. *Proceedings of the National Academy of Sciences* 116.13 (2019): 6001-6006.

43 Clark, Lara P., Dylan B. Millet, and Julian D. Marshall. Changes in Transportation-Related Air Pollution Exposures by Race-Ethnicity and Socioeconomic Status: Outdoor Nitrogen Dioxide in the United States in 2000 and 2010. *Environmental Health Perspectives* 125.9 (2017): 097012.

44 Krieger, Elena M., Joan A. Casey, and Seth BC Shonkoff. A Framework for Siting and Dispatch of Emerging Energy Resources to Realize Environmental and Health Benefits: Case Study on Peaker Power Plant Displacement. *Energy Policy* 96 (2016): 302-313.

45 US Environmental Protection Agency., "EJ Screening Report for the Clean Power Plan," US Environmental Protection Agency, Tech. Rep. Docket: EPA–HQ–OAR–2013–0602, (2015).

46 Liu, Xiaopeng, Lawrence Lessner, and David O. Carpenter. Association Between Residential Proximity to Fuel-Fired Power Plants and Hospitalization Rate for Respiratory Diseases. *Environmental Health Perspectives* 120.6 (2012): 807-810.

47 Ha, Sandie, *et al*. Associations Between Residential Proximity to Power Plants and Adverse Birth Outcomes. *American Journal of Epidemiology* 182.3 (2015): 215-224.

48 Casey, Joan A., *et al*. Retirements of Coal and Oil Power Plants in California: Association with Reduced Preterm Birth Among Populations Nearby. *American Journal of Epidemiology* 187.8 (2018): 1586-1594.

49 Pope III, C. Arden, and Douglas W. Dockery. Health Effects of Fine Particulate Air Pollution: Lines that Connect. *Journal of the Air & Waste Management Association* 56.6 (2006): 709-742.

50 Martenies, Sheena E., *et al*. Health and Environmental Justice Implications of Retiring Two Coal-Fired Power Plants in the Southern Front Range Region of Colorado. *GeoHealth* 3.9 (2019): 266-283.

51 Drehobl, Ariel and Lauren Ross. Lifting the High energy cost burden in America's Cities: How Energy Efficiency Can Improve Low-Income and Underserved Communities. *American Council for an Energy Efficient Economy,* (2016).

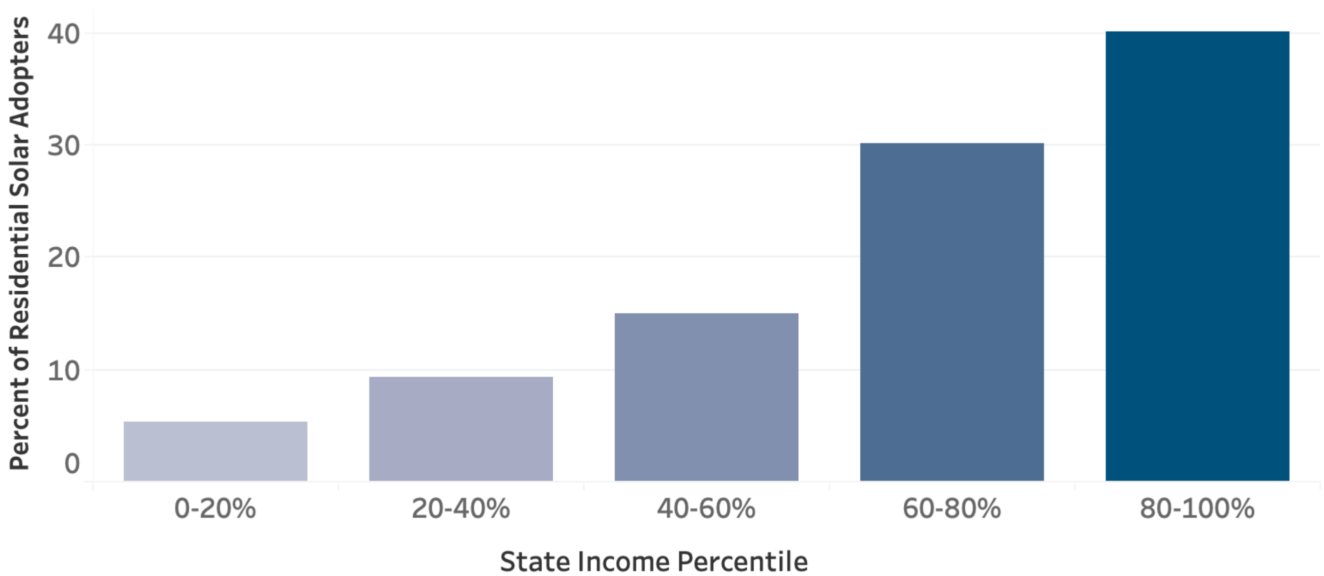
52 US Census Bureau. "2019 Poverty Rate in the United States." (2020). Available at: https://www.census.gov/library/visualizations/interactive/2019-poverty-rate.html

which can exacerbate underlying health conditions[53] and reduce resilience to climate extremes.

Certain clean energy interventions can help alleviate energy cost burdens. Residential efficiency and weatherization measures, for example, can reduce electric bills and the need for heating and cooling. Rooftop solar or community solar can provide long-term economic savings and stable electric bills. Unfortunately, low-income households and people of color often face barriers to adoption for these kinds of technologies. Some technologies, such as air source heat pumps, solar panels, or electric vehicles, are capital-intensive. They may be cheaper over the lifetime of the equipment, but lower-income households often lack access to capital, financing, or credit that makes these investments accessible. Many of these households, including those that are linguistically-isolated, may lack access to information that energy-saving technologies are available. As many people of color and low-income families live in rental apartments, their ability to replace appliances or adopt efficiency measures in their homes is limited. This barrier is termed the split incentive problem, wherein renters pay utility bills but landlords own energy sources and appliances and have limited incentives to invest in efficiency measures. In addition, some clean energy measures—such as energy efficiency—may reduce average bills but increase electricity rates (that is, the cost of electricity per kilowatt-hour consumed). While average energy bills may go down, those households which do not adopt energy-savings measures may face higher bills. Due to the aforementioned barriers, low-income households are at particular risk for such bill increases.

The impact of these kinds of barriers is reflected in rooftop solar adoption rates across New Mexico. **Figure 2** shows solar adoption rates by income bracket in 2018. The wealthiest 20 percent of households adopted rooftop solar at eight times the rate of the lowest-income 20 percent of households.

FIGURE 2. Residential adoption by New Mexico state income percentiles in 2018.[54] The highest-income 20 percent of households were responsible for 40 percent of solar installations, as compared to 5 percent of solar installations among the 20 percent lowest-income households.



53 Hernández, Diana, and Stephen Bird. Energy Burden and the Need for Integrated Low-Income Housing and Energy Policy. *Poverty & Public Policy* 2.4 (2010): 5-25.

54 Data source: Berkeley Lab. "Solar Demographics Tool" (2020). Available at: https://emp.lbl.gov/solar-demographics-tool

1.3 Approach

In this assessment, we examine current energy pollution and cost burdens and socioeconomic and racial disparities across the New Mexico population and how different approaches to decarbonization may increase or decrease these burdens. We relied on a variety of publicly available datasets to evaluate the types, magnitudes, and spatial distributions of energy infrastructure and environmental pollutants, as well as the distribution of costs and benefits across New Mexico's population. To inform our technical analyses, we also conducted extensive statewide outreach with various nongovernmental organizations, advocacy groups, and other community organizations. This outreach enabled us to identify key topics, concerns, and priorities. Our analysis is meant to provide an initial screen of pollution and energy cost burdens and identify policy levers to intervene and approaches to integrate energy and environmental equity into decarbonization research and policy efforts moving forward. The development and implementation of energy and environmental equity-focused policies should include extensive engagement and outreach to affected communities to help identify concerns and barriers, and develop policies and implementation strategies reflecting community needs and priorities.

We first mapped existing fossil fuel infrastructure and energy-related pollutant emissions across the commercial, residential, transportation, industrial, and power sectors, and analyzed the demographics of nearby populations. Next, we estimated average baseline residential and transportation energy cost burdens for households across the state. We projected pollutant emissions and energy consumption data from baseline year 2017 to year 2050 for each of Evolved Energy's four decarbonization scenarios (see below) to assess impacts on pollution and energy bills across different segments of New Mexico's population.

Decarbonization Scenarios

Evolved Energy Research developed cost-optimized decarbonization pathways using a combination of two energy system analysis platforms: EnergyPATHWAYS, a bottom-up energy sector model which calculates future energy demand; and the Regional Investment and Operations (RIO) platform, which optimizes costs while ensuring demand is reliably met. Together, these models estimate future energy use, appliance and vehicle turnover, electricity generation and demand, greenhouse gas emissions, and costs from 2020-2050. In Evolved Energy's models and throughout our accompanying analysis, estimated energy consumption and greenhouse gas and criteria air pollutant emissions in the year 2020 do not reflect the impacts of COVID-19 on energy production and use. Evolved Energy Research assessed five scenarios, including a reference "business-as-usual" scenario and four additional scenarios ensuring each state achieves its climate targets. These scenarios are outlined in **Table 2**. For a full description of Evolved Energy Research's scenarios, as well as underlying models, assumptions and inputs, please see the accompanying report by Evolved Energy Research, GridLab, Natural Resources Defense Council (NRDC), and Sierra Club.[55]

55 Evolved Energy, GridLab, NRDC, and Sierra Club. Climate Action in New Mexico *(Full Report Forthcoming)*. (2021).

TABLE 2. Description of decarbonization scenarios.

Scenario	Description
Reference	State implements no new climate policies and does not achieve greenhouse gas targets.
Core	A cost-optimized decarbonization pathway in which the state achieves its greenhouse gas targets and net-zero greenhouse emissions from the energy system and industrial sectors by 2050, relying primarily on near-term decarbonization of the power sector and retirement of coal plants, combined with building efficiency, electrification of transportation and buildings, and fuel replacement in industry.
Low Demand	Energy demand is lower than in the Core scenario due to lower vehicle miles traveled (e.g. due to public transit or behavioral changes) and more energy efficiency in buildings.
Fossil Free	Current state greenhouse gas targets are surpassed, the state achieves net-zero greenhouse gas emissions across the economy (not just energy systems) by 2050 and fossil fuel production, extraction, and use is eliminated across the country by 2050.
Slow Coal Retirement	Decarbonization of the power sector lags behind the Core scenario, requiring more rapid adoption of energy efficiency and electrification measures across the building and transportation sectors to ensure 2030 climate targets are met.

Integrating Health and Energy Equity Analysis

Our initial environmental and energy cost burden analysis provides a baseline to identify areas where clean energy adoption and emissions reductions might be particularly valuable to reduce air pollution or energy cost burdens in socioeconomically or environmentally overburdened communities. To create this baseline, we aggregated public datasets reporting fossil fuel emissions from power plants and industrial facilities, estimated transportation emissions from highway vehicle counts and standard vehicle emission factors, and conducted a regression analysis based on household characteristics to estimate residential fuel use on a census tract level. In addition to calculating emissions, we estimated household energy cost burdens based on these fuel consumption estimates.

Assessments of cumulative environmental burdens and socioeconomic vulnerabilities can help identify populations for whom interventions to reduce pollution may be particularly beneficial.[56] California uses an environmental justice screening tool, CalEnviroScreen 3.0,[57] to identify disadvantaged communities and develop incentives to increase clean energy access and reduce pollution burdens for these populations. The US Environmental Protection Agency has also developed an environmental justice screening tool, EJSCREEN, to identify similar highly polluted and vulnerable communities nationwide.[58] To identify New Mexican communities that may be particularly vulnerable to energy and environmental inequities, we developed a Demographic Index for New Mexico census tracts, which combines measures on income, education, linguistic isolation, and very young, elderly, and racial minority populations (see **Technical Appendix: Methods**). We then used this index to assess where socioeconomically

56 Sadd, James L., *et al.* Playing It Safe: Assessing Cumulative Impact and Social Vulnerability through an Environmental Justice Screening Method in the South Coast Air Basin, California. *International Journal of Environmental Research and Public Health* 8.5 (2011): 1441-1459.

57 California Office of Environmental Health Hazard Assessment. CalEnviroScreen. Accessed Mar. 2021. Available at: https://oehha.ca.gov/calenviroscreen

58 US Environmental Protection Agency. EJSCREEN. Accessed Apr. 2021. Available at: https://www.epa.gov/ejscreen

overburdened communities are also exposed to high environmental pollution or have high energy cost burdens.

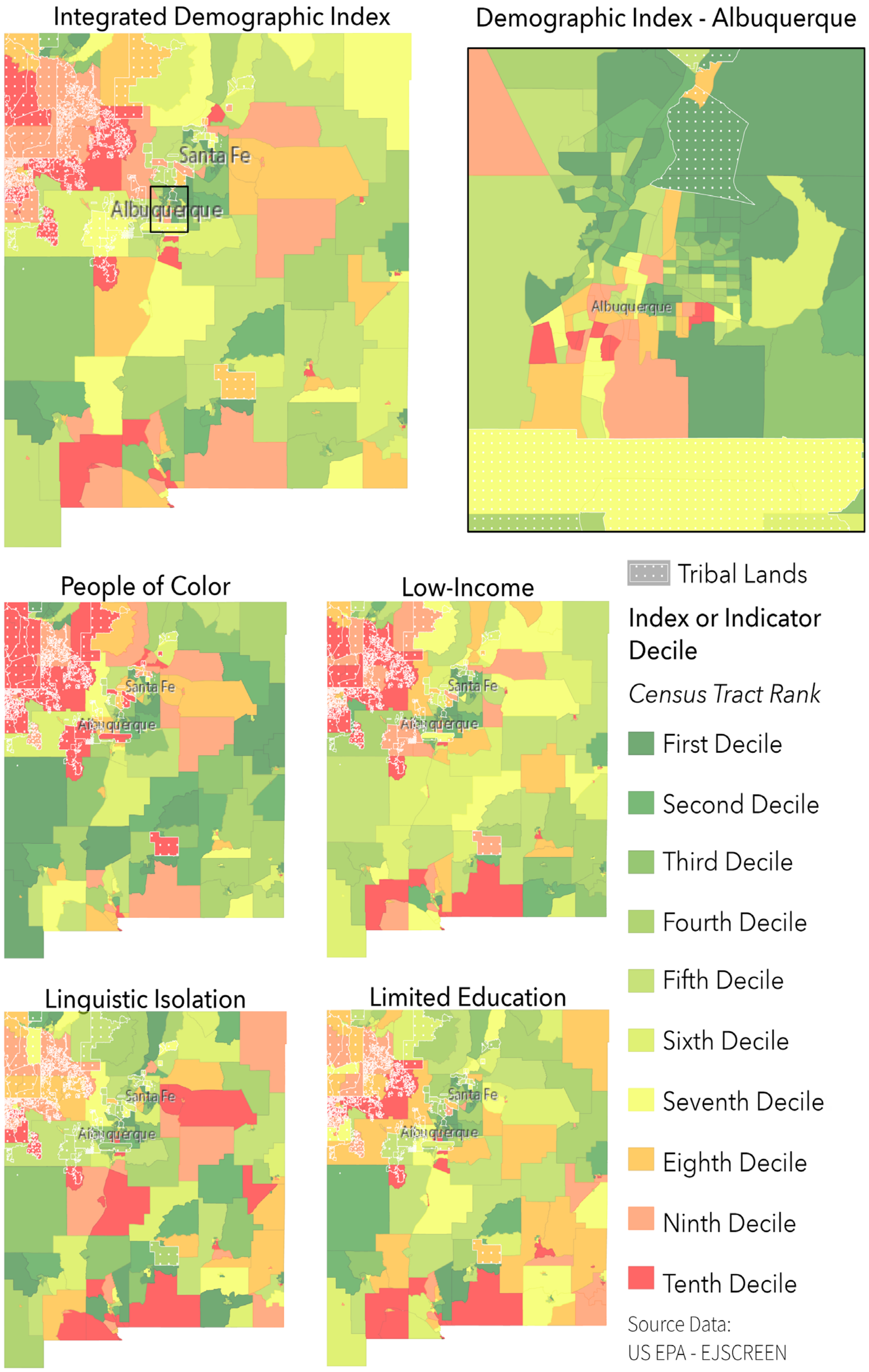
In **Figure 3**, we show this Demographic Index for New Mexico, along with four of the six socioeconomic and demographic indicators used to calculate the Index. This map reflects a mix of sociodemographically vulnerable populations, in both urban and rural communities. In the following sections, we use demographic and socioeconomic indicators to explore relationships between specific pollutant sources (e.g. on-road vehicles) and population characteristics across New Mexico. Regions on and near the Navajo Nation, as well as along the southern border with Mexico, rank high on the Demographic Index, indicating greater social and economic vulnerability. Additionally, a closer look at the Albuquerque metropolitan area reveals a number of vulnerable neighborhoods, notably in the southwestern part of the city.

The combined demographic indicators underlying our Demographic Index metric only reflect those variables that are included in the US Environmental Protection Agency's EJSCREEN tool. Additional measures, such as underlying health conditions (e.g. asthma rates or preterm births) are not included in these indices but may be valuable for identifying populations sensitive to pollution.[59] We therefore include additional indicators within some of our analyses below, including climate indicators (e.g. wildfire and heat day risks), and environmental indicators (e.g. federal ozone nonattainment areas). These additional metrics provide more specific insight into the types of vulnerabilities and environmental burdens faced across the state. Our analysis provides an initial screen for polluted and otherwise environmentally vulnerable communities, however direct community engagement can help identify additional environmental concerns and socioeconomic burdens not available within our datasets.

By overlaying fossil fuel pollution and energy use data with the demographic and socioeconomic indicators above, we identified certain regions where communities live near numerous sources of environmental pollution, and other communities (some overlapping) where household adoption of clean energy and transportation technologies may help provide economic and resilience benefits. We projected these baseline estimates across decarbonization scenarios and modeled where benefits might accrue—and we identified potential risks where carbon-only decarbonization policies might actually lead to negative externalities such as economic impacts on socioeconomically vulnerable households. We combined these baseline and decarbonization modeling results in a discussion of policy options for New Mexico to incorporate health, environment, and energy equity into its decarbonization planning.

59 We also separately assessed the cumulative environmental metrics included in EJSCREEN, but found these data to be heavily limited by the data types included in the dataset. We decided instead to primarily assess pollution from the data we aggregated and modeled across sectors.

FIGURE 3. Integrated Demographic Index for New Mexico and Albuquerque, and individual statewide demographic indicators. In the Demographic Index, neighborhoods that are orange or red have a higher share of combined low-income, racial minority, limited educational attainment, linguistically isolated, elderly, and very young populations than other census tracts.



2. Results

2.1 Overview of Findings

Across New Mexico, we find that decarbonization has the potential to improve public health, reduce energy cost burdens, and expand access to clean, reliable energy. However, our analysis suggests that these co-benefits may not accrue evenly across the state and that disparities in fossil fuel-associated air pollution and economic impacts may be exacerbated with a decarbonization strategy focused exclusively on greenhouse gas emissions.

New Mexico faces two broad challenges as it decarbonizes and adopts clean energy resources statewide.[60] To tackle fossil fuel pollution, it must transform the oil and gas sector and heavy duty transportation (e.g. heavy duty trucks), which dominate greenhouse gas and health-damaging air pollutant emissions across the state. Simultaneously, it must identify and implement strategies to deliver clean energy to socio-demographically vulnerable and economically disadvantaged communities. These communities are responsible for only a fraction of the state's greenhouse gas emissions, but would greatly benefit from utility bill savings, access to electricity for those off the grid, resilience in the face of a changing climate, and reduced indoor air pollution. A suite of technologies could be strategically deployed to prioritize benefits for these vulnerable groups while helping New Mexico to meet its climate targets, including energy efficiency, electrification, solar, energy storage, vehicle electrification, and free electrified public transit. Reducing greenhouse gas emissions, especially from the transportation and oil and gas sectors, can help reduce air pollution, but the full potential of a clean energy transition to achieve economic and environmental equity will not be achieved without a targeted focus on reducing barriers to clean energy access for underserved communities statewide.

One of the key themes that emerges from our analysis is that the bulk of both greenhouse gas and health-damaging air pollutant emissions across the state are associated with activities that provide services *outside* of New Mexico. Greenhouse gas emissions per capita in New Mexico are more than twice the national average, largely due to the state's emissions-intensive oil and gas industry.[61] The oil and gas sector is responsible for more than half of the state's greenhouse gas emissions and a significant share of NO_x, SO_x, and $PM_{2.5}$ emissions, but primarily produces fossil fuels for export. As noted earlier, New Mexico's consumption is equivalent to only a sixth of the natural gas and a seventh of the oil it produces. The majority of coal-fired electricity generated in-state—from the Four Corners plant on the Navajo Nation—is exported to Arizona. As a "bridge state," New Mexico also bears the brunt of air pollution generated by interstate traffic. Roughly 60 percent of on-road vehicle NO_x and $PM_{2.5}$ emissions come from heavy-duty truck traffic—85 percent of which occurs on east-west interstates as trucks simply pass through New Mexico.[62] Pollution associated with the oil and gas industry has the highest cumulative impact on those living near oil production in the San Juan Basin in the northwest (also home to the state's remaining coal power plants) and the Permian Basin in the southeast, while transportation pollution most heavily burdens those living near urban interstates.[63] **Figure 4** shows

60 Interconnected with both of these challenges is the need to train and adapt the workforce in tandem with this energy transition which will be addressed in a forthcoming companion report.

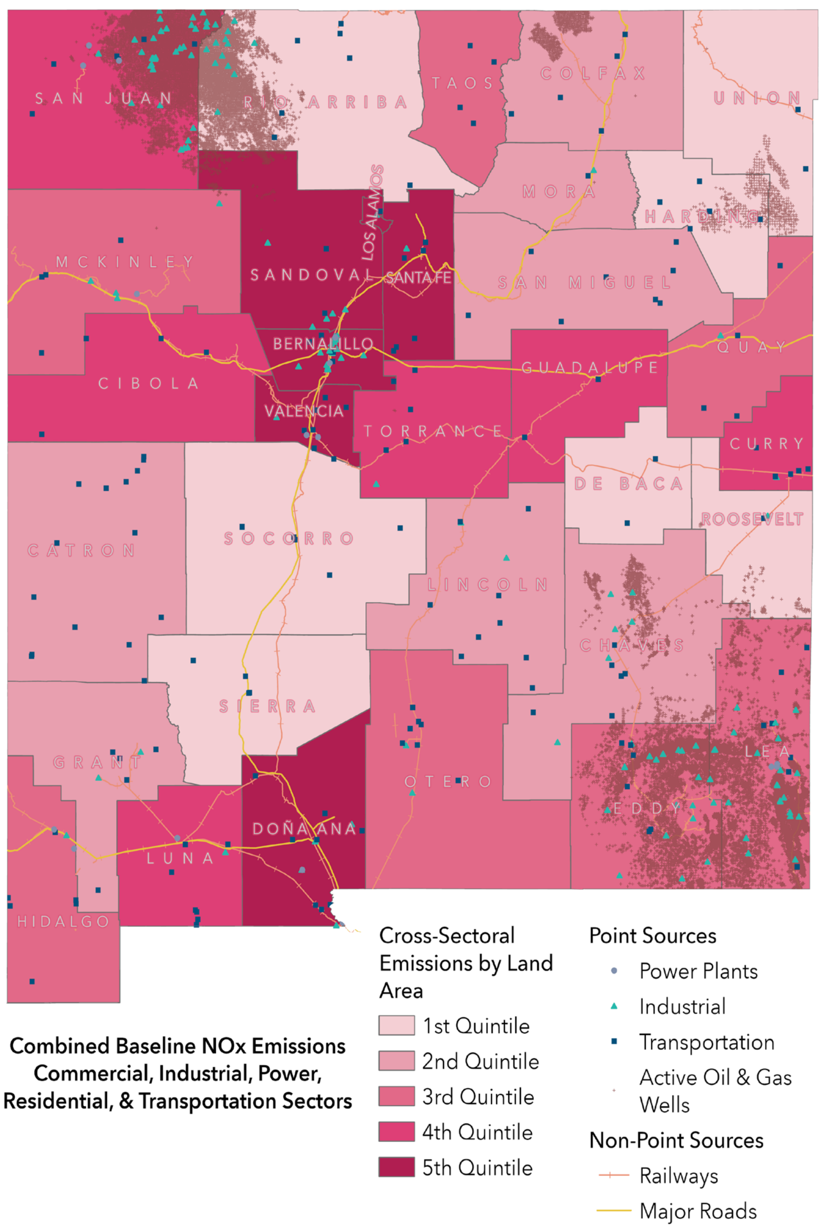
61 Tabor, Laura *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

62 New Mexico Department of Transportation. New Mexico 2030 Statewide Multimodal Transportation Plan. Dec. 2009.

63 Throughout the report, "urban" refers to combined US Census Bureau metropolitan and micropolitan statistical areas, while "rural" refers to all census tracts excluded from these categories.

cumulative NO_x emissions across all sectors, as well as the locations of oil and gas wells, from which pollution may have doubled in recent years in line with soaring oil production levels. Decarbonization and pollution reduction will require a concerted focus on these sectors, including measures to electrify heavy duty trucks and to reduce methane leakage associated with oil and gas infrastructure, and in the long term to phase out oil and gas production entirely and remediate polluted sites. Some of the long-term emission impacts may depend on regional decisions beyond New Mexico's borders; interstate truck emissions, as well as export-driven oil and gas production, will likely depend in part on regional and national decarbonization goals. Given the disproportionate health and environmental impacts these activities have on residents of New Mexico however, the state may benefit from proactively collaborating with neighboring states on decarbonization policies.

FIGURE 4. Cumulative NO_x emissions from electricity generation, buildings, transportation, and industry in 2017. Given the limited available data for oil and gas wells, we map their locations as a proxy for the spatial distribution of their emissions. Transportation point sources include freight terminals, airports, and similar fixed points in the transportation system.



To develop strategies that help reduce economic and environmental disparities for communities and households across the state, we identified populations facing inequitable environmental and economic burdens from the existing fossil fuel energy system as well as those facing elevated risks from climate change. In some parts of the state—notably in tribal areas such as the Navajo Nation—some households have no electricity whatsoever. Other populations, particularly those in rural areas, populations of color, and low-income populations, pay disproportionate shares of their income towards utility bills. Solar, building electrification, efficiency, and battery storage can all help reduce these energy cost burdens, and when replacing natural gas or wood can reduce in-home emissions of air pollutants. Wood, in particular, may contribute to high indoor particulate matter emissions for rural populations and Native American populations. In buildings, the electrification of natural gas appliances will help reduce indoor air pollution, but lower-income and renter households are less likely than wealthier households and homeowners to see these benefits in the near term due to the clean energy adoption barriers. Policies targeted at providing clean energy for these underserved households may be particularly valuable.

Regions throughout the state, especially near Las Cruces, Roswell, and Carlsbad, will face increased extreme heat days, drought, and wildfires in the next few decades as the climate warms. These regions may particularly benefit from clean energy technologies like efficiency measures to reduce energy cost burdens and improve grid reliability during peak demand and solar panels with battery storage (solar+storage) to provide emergency backup power in the face of increasingly frequent extreme weather events.

Without explicit policies, clean energy access may lag behind in environmentally and socioeconomically overburdened communities, excluding them from bill savings and potentially leaving them to shoulder the cost of maintaining an aging fossil infrastructure in the coming decades. As the state decarbonizes, it will have to ensure that legacy fossil fuel infrastructure is carefully remediated, particularly in socio-demographically vulnerable and environmentally overburdened communities. This infrastructure includes, but is not limited to, coal power plants, coal ash impoundments, and coal mines on and near tribal lands in the northwest, gas plants, orphaned and abandoned oil and gas wells, and associated oil and gas production infrastructure, especially in the northwest and southeast portions of the state.

We walk through these findings in detail in the following sections. We first discuss our findings for each individual sector and then address cross-sector themes for clean energy access, emission reductions, and resilience.

2.2 Transportation

2.2.1 Overview

New Mexico's transportation sector—including light-duty passenger and commercial vehicles, buses, medium-duty and heavy-duty trucks, aviation, rail, and other transport-related nonroad vehicles—is the second-largest energy consumer in the state,[64] accounting for more than four-fifths of statewide petroleum use.[65] Energy use by the transportation sector is notably high relative to New Mexico's population, consuming more energy per capita than the transportation sectors of three-quarters of states nationwide.[66] Transportation also contributes a sizeable fraction of statewide air emissions, accounting for nearly 14 percent of statewide greenhouse gas emissions in 2018[67] and 30 percent of statewide NO_x emissions. In addition to the ground-level ozone and secondary particulate matter formed by reactions of NO_x in the atmosphere, transportation also contributes nearly a quarter of primary $PM_{2.5}$ emissions statewide. A disproportionate share of on-road vehicle NO_x and particulate matter emissions are from heavy-duty and medium-duty trucks (over 75 percent), both because they are more emissions-intensive than light-duty vehicles and because they make up a particularly large fraction (18 percent) of total vehicle miles traveled in New Mexico—double the nationwide average.[68,69] Along with truck emissions, pollution from cars and buses can occur in population-dense urban areas at ground-level, contributing to pollution hotspots and harming the health of nearby communities.

Decarbonization of the transportation sector is primarily driven by vehicle electrification, which reduces vehicle pollution in addition to greenhouse gas emissions. While we find that on-road vehicle tailpipe emissions are almost entirely eliminated by 2050, ground-level emissions from transportation-related sites such as airports may continue to pose health risks to adjacent communities even as the rest of the sector decarbonizes. Moreover, low-income households, which include a disproportionate share of populations of color and those with low educational attainment, spend a large portion of their income on vehicle fuel. These households may face barriers to adopting fuel-efficient electric vehicles, such as high up-front costs and lack of access to charging infrastructure. Health and energy equity-focused decarbonization policies can help accelerate vehicle turnover in highly polluted areas, reduce barriers to adoption, and reduce vehicle use altogether by expanding access to public transit and facilitating active, transit-friendly built environments.

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64 US Energy Information Administration. "New Mexico Energy Consumption by End-Use sector, 2018." Accessed Jan. 2021. Available at: https://www.eia.gov/state/?sid=NM#tabs-2.

65 US Energy Information Administration. "New Mexico: State Profile and Energy Estimates" (2020). Accessed Jan. 2021. Available at: https://www.eia.gov/state/analysis.php?sid=NM.

66 *Ibid.*

67 Tabor, Laura *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

68 Throughout our analysis, "medium-duty trucks" refer to single-unit trucks and "heavy-duty trucks" refer to combination-unit trucks.

69 US Federal Highway Administration. "Highway Statistics 2018: Table VM-1." Accessed Jan. 2021. Available at: https://www.fhwa.dot.gov/policyinformation/statistics/2018/vm1.cfm

2.2.2 Fuel Consumption and Vehicle Travel

Fuel consumption by New Mexico's transportation sector is dominated by gasoline (52 percent), and diesel (44 percent) in the baseline year 2017, and gradually switches to electricity and liquid hydrogen by 2050 under the Core and Low Demand scenarios (**Figure 5**). On-road vehicles consume the vast majority of fuel used by the transportation sector (95 percent), largely due to heavy fuel usage by light-duty and heavy-duty trucks. Under the modeled decarbonization scenarios, electricity and liquid hydrogen make up the majority of total transportation fuel use by 2050 (50 percent and 30 percent, respectively), but petroleum products like gasoline, diesel, and jet fuel still make up almost 20 percent of projected fuel use (Core Scenario, **Figure 5**).[70] Because electric vehicle motors are more efficient than conventional motors,[71] total fuel consumption declines even as total vehicle miles traveled increases in the Core scenario. While jet fuel makes up a relatively small fraction of total fuel use across transportation subsectors in 2017 (3 percent), use of this fuel type increases in all of the decarbonization scenarios, including in the Low Demand case. Aviation poses an ongoing challenge in terms of emission reductions due to the current lack of technological options for replacing jet fuel.

As shown in **Figure 6**, passenger vehicle and truck miles decrease significantly in the Low Demand scenario compared to projected travel in the Reference and Core scenarios. The Low Demand scenario maximizes public health co-benefits by replacing automobile trips with public transit and active transit such as walking and cycling, which are associated with myriad health and economic benefits.[72,73] If strategically designed with energy equity considerations in mind, this scenario could improve transit access for low-income households while reducing total pollutant emissions. Urban and rural public transit would need to be greatly expanded to achieve the Low Demand scenario in New Mexico, however, in addition to policies incentivizing alternative modes of transportation. While on-road vehicle travel declines in the Low Demand scenario, airline, freight rail, and passenger rail travel still increase. As airports emit significant amounts of health-damaging criteria air pollutants, the projected increase in airline travel in all decarbonization scenarios could exacerbate emissions burdens for communities living in close proximity to New Mexico's airports. The largest airport in New Mexico, Albuquerque International Sunport, as well as several other airports in the state, are located in census tracts that rank above 75 percent of other census tracts on the Demographic Index, suggesting that lingering ground-level aviation emissions may continue to impact vulnerable populations even as the state decarbonizes.

70 Figures throughout this section of the report display the Reference, Core, and Low Demand scenarios and omit the Slow Coal Retirement and Fossil Free scenarios for readability.

71 US Department of Energy. "All-Electric Vehicles." Accessed Nov. 2020. Available at: https://www.fueleconomy.gov/feg/evtech.shtml.

72 US Department of Transportation. "Integrate Health and Transportation Planning." Available at https://www.transportation.gov/mission/health/Integrate-Health-and-Transportation-Planning.

73 Giles-Corti, Billie, *et al*. The Co-Benefits for Health of Investing in Active Transportation. *New South Wales Public Health Bulletin* 21.6 (2010): 122-127.

FIGURE 5. Transportation sector fuel consumption by fuel type from 2017-2050. Fuel consumption across all transportation sectors—including aviation, passenger and freight rail, on-road vehicles, shipping, recreational boats, and military vehicles— is dominated by gasoline (52 percent) and diesel (44 percent) in 2017 and gradually switches to electricity and liquid hydrogen by 2050 under the Core and Low Demand scenarios. The dip in fuel use in the Reference scenario is due to increased fuel efficiency and low levels of electric vehicle adoption, followed by an overall increase in travel and associated fuel demand. Because electric vehicle motors are more energy efficient than internal combustion engines, total energy consumption (MMBtu) declines even as total vehicle miles traveled increases in the Core scenario.

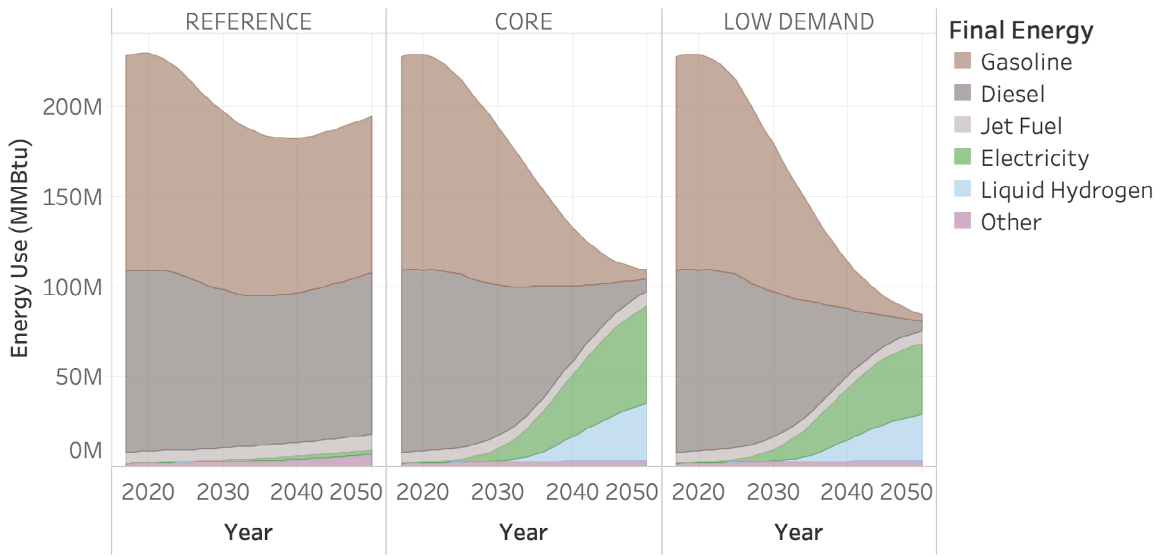
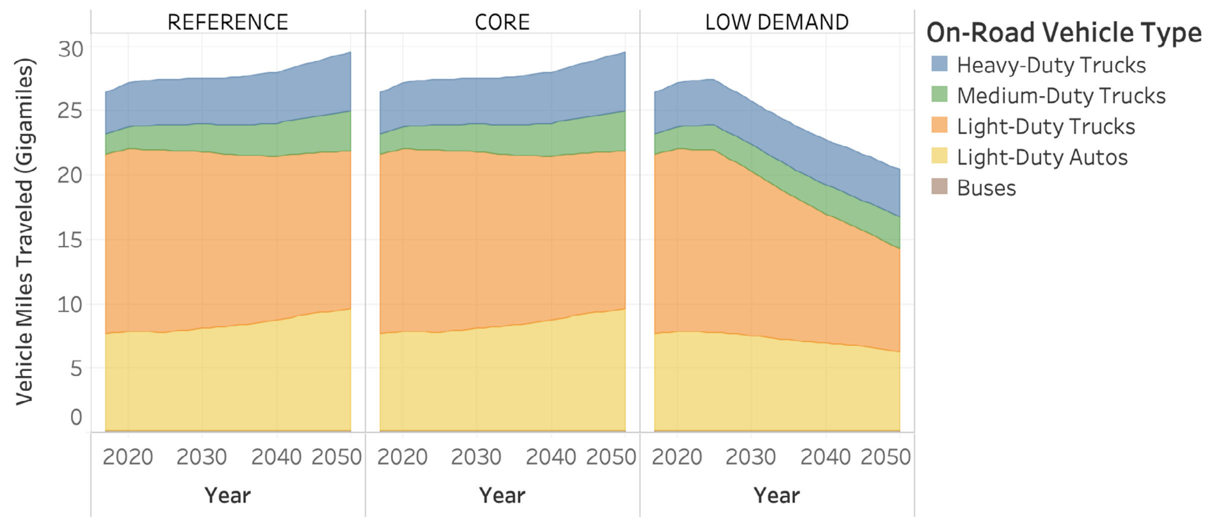


FIGURE 6. Vehicle miles traveled by on-road vehicle type in New Mexico, 2017-2050. Vehicle miles traveled in light-duty passenger cars and light-duty trucks dominate on-road vehicle travel. Vehicle miles traveled in light-duty passenger cars, medium-duty trucks, and heavy-duty trucks grow in both the Reference and Core scenarios. Only the Low Demand scenario reduces overall vehicle travel compared to the Reference case.

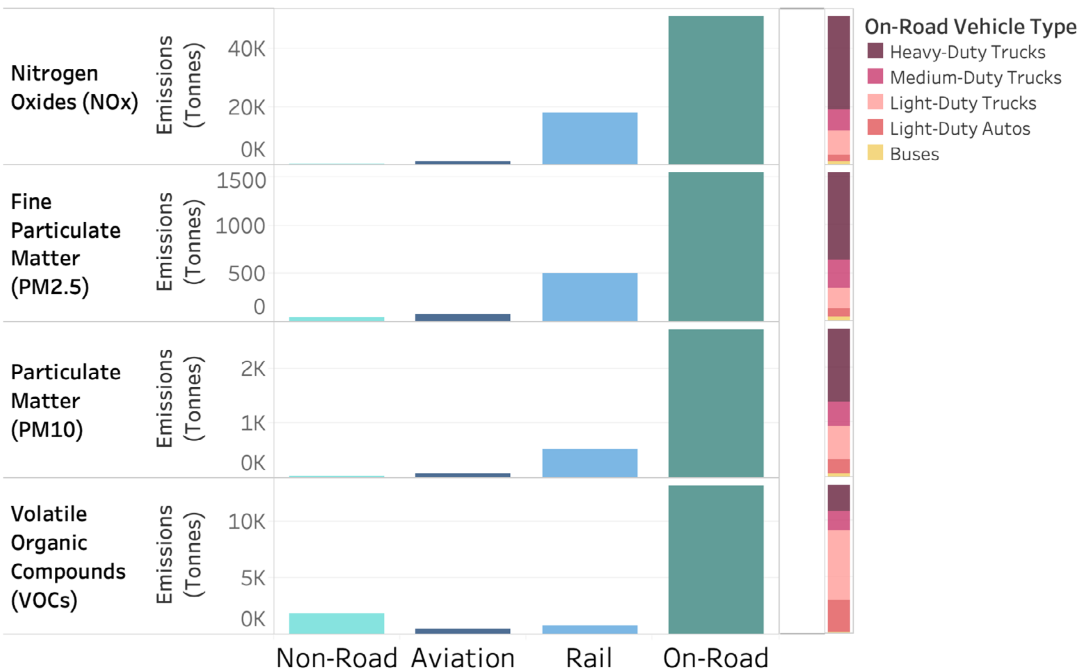


2.2.3 Transportation Sector Emissions

Transportation is a significant source of air pollution across the country, emitting various criteria air pollutants and air toxics that contribute to poor air quality and negatively impact human health. Notable smog-forming and health-damaging pollutants from this sector include NO_x, SO_x, VOCs, and particulate matter, as well as air toxics such as benzene, formaldehyde, and diesel particulate matter.[74] Transportation is a leading source of NO_x emissions, accounting for over half of total NO_x emissions in the US.[75]

On-road mobile sources, including light-duty vehicles, buses, and medium-duty and heavy-duty trucks, contribute the largest share of transportation-related ground-level NO_x, VOC, PM_{10}, and $PM_{2.5}$ emissions in New Mexico (**Figure 7**). Rail, which is predominantly used for freight transport in New Mexico (60 percent of which is coal by weight),[76] is the second-highest emitter of transportation-related NO_x and particulate matter emissions due to the use of diesel fuel.[77] Non-road mobile sources in **Figure 7** include only those that transport people or goods, such as recreational marine vessels, golf carts, and snowmobiles, but exclude those used for industrial activity, such as construction equipment. Because the majority of these sources are fueled by gasoline, they are the second-highest emitters of VOCs but contribute minimal amounts of other criteria air pollutants.

FIGURE 7. 2017 transportation sector criteria air pollutant emissions in New Mexico.[78] In New Mexico, on-road vehicles contribute the largest share of transportation-related ground-level NO_x, VOC, PM_{10}, and $PM_{2.5}$ emissions. Heavy-duty and medium-duty trucks, which are largely diesel-powered, dominate $PM_{2.5}$, PM_{10}, and NO_x emissions. Light-duty passenger vehicles and light-duty trucks, which primarily use gasoline, dominate emissions of VOCs.



74 US Environmental Protection Agency. "Smog, Soot, and Other Air Pollution from Transportation." Accessed Mar. 2021. Available at: https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-local-air-pollution.

75 *Ibid.*

76 New Mexico Department of Transportation. New Mexico State Rail Plan. (2014).

77 Nunno, Richard. "Electrification of U.S. Railways: Pie in the Sky, or Realistic Goal?" *Environmental and Energy Study Institute*. May 2018. Available at: https://www.eesi.org/articles/view/electrification-of-u.s.-railways-pie-in-the-sky-or-realistic-goal

78 Aviation, non-road, and rail emissions are from the 2017 National Emissions Inventory (NEI). We include only non-road sources used for the transport of people or goods. On-road vehicle emission estimates are derived from our own analysis, but verified against NEI values to ensure they are reasonable estimates (see **Technical Appendix: Methods**).

In the subsequent analysis, we focus primarily on on-road mobile sources due to their large share of transportation-related criteria air pollutant emissions and the availability of spatially granular data for these sources. We estimate on-road vehicle emissions by combining highway vehicle counts with emission factors (grams of pollutant emitted per mile) by vehicle type and fuel (see **Technical Appendix: Methods**). We find that while light-duty vehicles, including passenger cars and light-duty trucks, account for the vast majority of on-road vehicle miles traveled (as shown in **Figure 6**), heavy-duty trucks contribute disproportionately to total NO_x and particulate matter emissions due to the higher emission rates of these pollutants associated with diesel fuel combustion. The breakdown of on-road criteria air pollutant emissions by vehicle type in 2017, depicted in **Figure 7**, shows the disproportionate contribution of heavy-duty trucks to $PM_{2.5}$, PM_{10}, and NO_x emissions relative to their share of total vehicle miles traveled.

2.2.4 On-Road Vehicles: Baseline Emissions

Rural and urban areas differ significantly in terms of transportation characteristics and associated criteria air pollutant emissions. Heavy-duty trucks make up a greater fraction of total vehicle miles traveled in rural areas and along urban interstates, while light-duty vehicles make up a greater fraction of vehicle miles traveled in urban areas. Because heavy-duty and light-duty vehicles are not distributed evenly across road segments, the amount and composition of primary pollutant emissions from on-road vehicles vary throughout the state. We estimate vehicle emissions for specific road segments throughout the state based on the composition of traffic by vehicle type. Combining census tract-level emission estimates with demographic data allows us to analyze where traffic pollution is most concentrated in New Mexico, and which segments of the population are disproportionately exposed to this pollution.[79]

In the following analysis, we focus on primary $PM_{2.5}$ emissions from vehicles—which have a well-documented positive correlation with local health impacts[80]—to analyze local exposure risk to air pollution from on-road mobile sources. We normalize emissions estimates by census tract land area (tonnes emitted per square mile) to compare air pollution exposure risk between populations living in census tracts of varying size. We refer to area-normalized emission estimates as *emissions density* throughout this report, using this metric as a proxy for exposure risk to air pollution from transportation.

Analyzing vehicle emissions by census tract, we find that Black, Asian American, and Hispanic communities are exposed to disproportionately high levels of vehicle pollution in New Mexico (**Figure 8**).[81] These groups are underrepresented in the 20 percent of census tracts with the lowest density of $PM_{2.5}$ emissions from on-road vehicles, and overrepresented in the 20 percent of census tracts with the highest density of $PM_{2.5}$ emissions, relative to their proportion of the statewide population. This trend cannot be explained by the fact that Black and Asian American populations primarily live in urban areas in New Mexico, where traffic emissions are more highly concentrated.[82] Even within metropolitan areas in New Mexico, we find a statistically significant positive correlation between vehicle $PM_{2.5}$ emissions density and the population fraction that is Black or Asian American (**Figure 9**). We also find a positive correlation between vehicle emissions and urban multiracial populations, as well as those categorized as “Other Race” by the US Census Bureau, however the trend for these racial groups is not as prominent as it is for Black, Asian American, and Hispanic populations in New Mexico.

Our findings align with previous research on inequitable exposure to traffic density between racial groups. A nationwide study using a similar geographically-based approach found that New Mexico is among the ten states with the strongest correlation between traffic density at the census tract-level and the population

79 While the distribution of primary pollutant emissions can provide an initial screening of areas with particularly high levels of local emissions, it is important to note that primary pollutant emissions do not necessarily correspond to local air pollutant levels. Secondary pollutants such as ozone can form downwind of emissions sources, contributing to health-damaging air pollution in regions far from the initial source of primary pollutants.

80 Loomis, Dana *et. al*. IARC Evaluation of the Carcinogenicity of Outdoor Air Pollution. *The Lancet Oncology* 14 (2013):1262–1263.

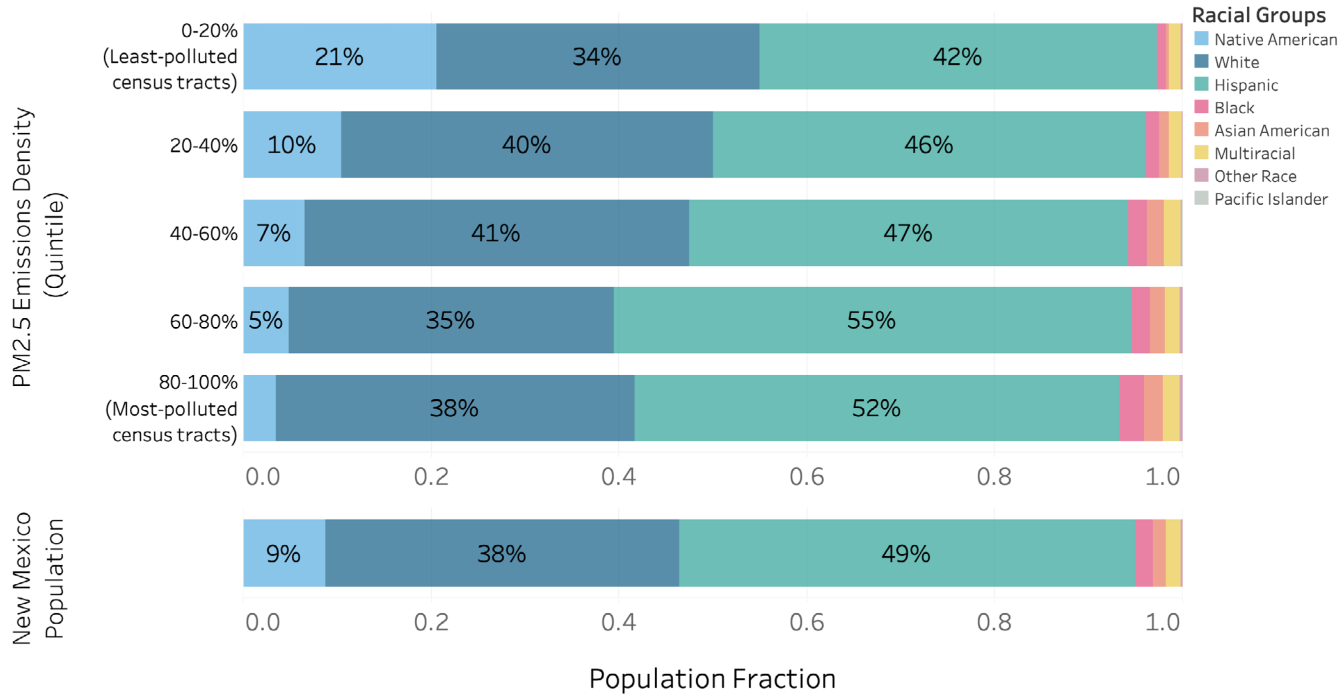
81 The terms “Black” and “Asian American” here refer to non-Hispanic Black and non-Hispanic Asian American populations. The term “Hispanic’’ refers to all populations identifying as Hispanic, including those who also identify with other racial groups.

82 Rural areas refer to all census tracts that are not designated as metropolitan statistical areas by the US Census Bureau. This includes micropolitan statistical areas (at least one urban cluster of at least 10,000 but less than 50,000 population), as well as census tracts that are neither metropolitan or micropolitan.

fraction that is Black.[83] A more recent study authored by the Union of Concerned Scientists found that across the country, Asian American, Black, Hispanic, and multiracial populations were exposed to higher levels of $PM_{2.5}$ emissions from on-road vehicles than the national average, while White and Native American populations were exposed to lower than average levels of vehicle pollution.[84]

In contrast to analyzing by race, there are no clear trends between income level and vehicle emissions in New Mexico. We do not find a strong correlation between traffic-related criteria air pollutant emissions and median household income or low income population fraction. Because we used state-average emissions factors to estimate tract-level emissions from on-road vehicles, our methodology may underestimate emissions in low-income census tracts, where households tend to drive older vehicles with higher criteria air pollutant emission factors (assuming local residents comprise a meaningful proportion of vehicle miles traveled within any given tract).[85] Further research is needed to analyze the relationship between average vehicle age and local vehicle pollution.

FIGURE 8. Exposure to $PM_{2.5}$ emissions from on-road vehicles in New Mexico by race in 2017. Asian American, Black, and Hispanic populations are underrepresented in the 20 percent of census tracts with the lowest levels of vehicular $PM_{2.5}$ emissions and are overrepresented in the 20 percent of census tracts with the highest levels of vehicular $PM_{2.5}$ emissions, relative to their proportion of the statewide population (lowest bar). Native American populations have disproportionately low exposure to $PM_{2.5}$ emissions, reflecting their concentration in rural areas where vehicle emissions are lower per unit land area.

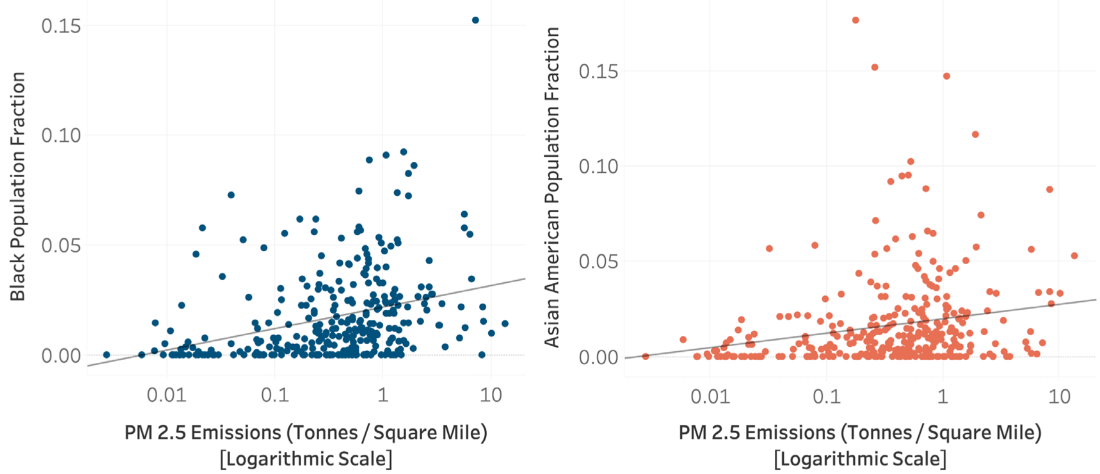


83 Tian, Nancy, Jianping Xue, and Timothy M. Barzyk. Evaluating Socioeconomic and Racial Differences in Traffic-Related Metrics in the United States Using a GIS Approach. *Journal of Exposure Science & Environmental Epidemiology* 23.2 (2013): 215-222.

84 Reichmuth, David. "Air Pollution from Cars, Trucks, and Buses in the US: Everyone is Exposed, But the Burdens are not Equally Shared." *Union of Concerned Scientists*. Oct. 2019. Available at: https://blog.ucsusa.org/dave-reichmuth/air-pollution-from-cars-trucks-and-buses-in-the-u-s-everyone-is-exposed-but-the-burdens-are-not-equally-shared.

85 US Energy Information Administration. "U.S. Households Are Holding on to Their Vehicles Longer." Dec. 2018. Available at: https://www.eia.gov/todayinenergy/detail.php?id=36914.

FIGURE 9. 2017 $PM_{2.5}$ emissions density (tonnes / square mile) from on-road vehicles and Black and Asian American population fractions in New Mexico metropolitan areas. In urban areas in New Mexico, there is a statistically significant positive correlation between $PM_{2.5}$ emissions density from on-road vehicles and the population fraction that is Black (left) or Asian American (right). Each dot represents a census tract within a US Census Bureau-defined metropolitan area, which includes Albuquerque, Santa Fe, Las Cruces, and Farmington and represents roughly 65 percent of the statewide population.[86]



Heavy-duty and medium-duty trucks are responsible for the vast majority of vehicle pollution in New Mexico, contributing over 75 percent of NO_x and $PM_{2.5}$ emissions. This is both due to the fact that they make up 18 percent of vehicle miles traveled in New Mexico—double the nationwide average—and because they emit more pollution per mile than light-duty vehicles. Trucks make up a disproportionate fraction of vehicle travel in part because New Mexico serves as a "bridge state" for long-distance freight transport—roughly 85 percent of trucks on I-10 and I-40 are just passing through the state.[87] Truck travel is also growing at a faster pace than total vehicle travel in New Mexico, particularly along the freight corridors of I-10 and I-40 and in oil and gas regions in the southeast and northwest parts of New Mexico.[88]

Interstate freight trucking highlights an overarching environmental equity issue evident throughout our report—much of the pollution that New Mexicans shoulder is generated from economic activities that primarily provide goods and services out-of-state.

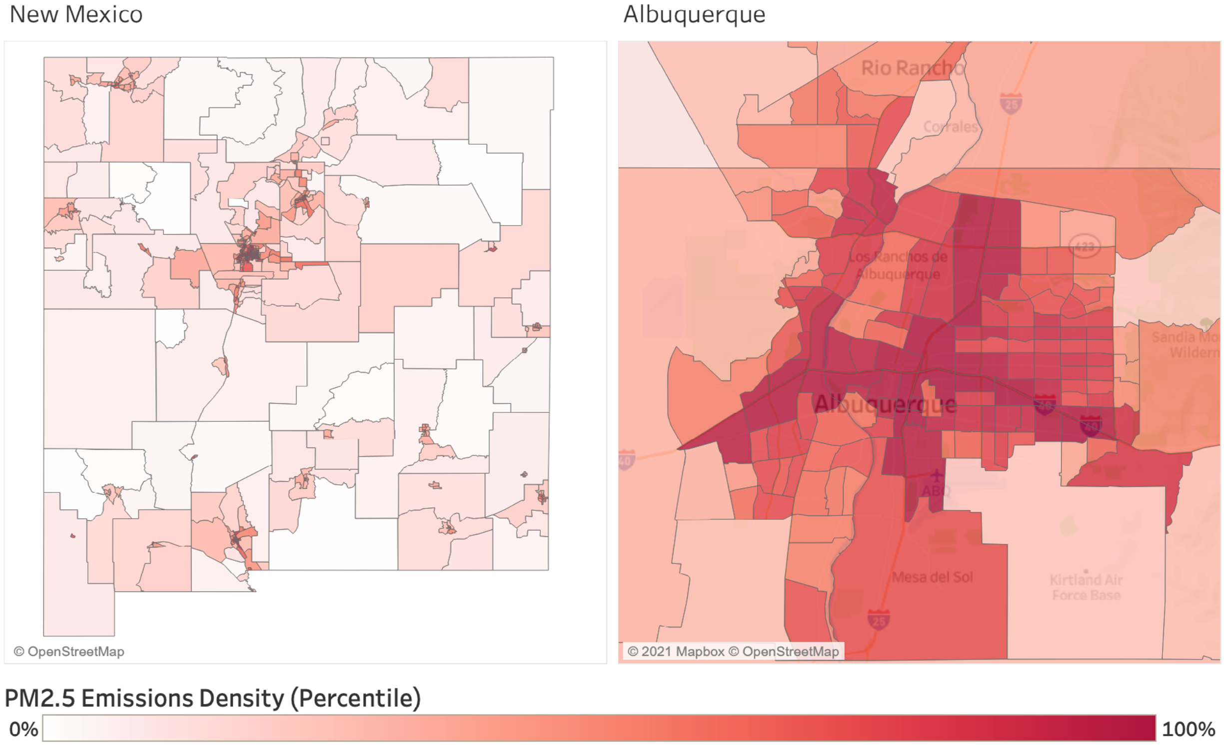
Interstate 40, for example, which serves as a main corridor for interstate truck travel, crosses through the middle of Albuquerque. As evident in **Figure 10**, truck pollution is most dense in urban areas of New Mexico, particularly along urban interstate corridors like I-40. The inequitable emissions burden that New Mexicans face as a result of interstate trucking is more pronounced for certain racial groups. In line with the trends we see for total vehicle pollution, discussed above, Black, Asian American, and Hispanic populations in New Mexico are disproportionately exposed to $PM_{2.5}$ emissions from trucks. These groups are underrepresented in the 20 percent of census tracts with the lowest level of truck pollution and overrepresented in the 20 percent of census tracts with the highest level of truck pollution, relative to their statewide population fraction. Tackling emissions from trucking—particularly interstate freight transport—is therefore not only critical to decarbonizing the transportation sector in New Mexico, but is also key to improving environmental equity outcomes in the state.

86 Manson, Steven, et al. . US Census Bureau American Community Survey 2014-18 5-Year Dataset. IPUMS National Historical Geographic Information System: Version 15.0.(2020). Accessed July 2020. Available at: http://doi.org/10.18128/D050.V15.0.

87 New Mexico Department of Transportation. New Mexico 2030 Statewide Multimodal Transportation Plan (2009).

88 New Mexico Department of Transportation. New Mexico Freight Plan: Moving Freight Forward, through 2040 (2015).

FIGURE 10. Census tract percentile ranking by density of $PM_{2.5}$ emissions from heavy-duty and medium-duty trucks in 2017, statewide and in Albuquerque. Truck pollution is most dense in urban areas, particularly along urban interstate and highway corridors. Black, Asian American, and Hispanic populations in New Mexico are disproportionately exposed to pollution from trucks.



2.2.5 On-Road Vehicles: Projected Emissions

Electrification of on-road vehicles in each of the decarbonization scenarios reduces criteria air pollutant emissions significantly compared to the Reference case, although these impacts are largely seen after 2025 (**Figure 11**). Between 2020-2025, the sharp decline in criteria air pollutant emissions in both the Reference and decarbonization scenarios is largely driven by the retirement of old, high-emitting vehicles with outdated pollution control technologies (**Figure 11**).

While NO_x and VOC reach near-zero emissions by 2050 in all four decarbonization scenarios, a substantial portion of $PM_{2.5}$ and PM_{10} emissions remain, with the greatest reductions of these pollutants occurring in the Low Demand scenario (**Figure 11**). Electric vehicles still contribute non-exhaust $PM_{2.5}$ and PM_{10} emissions through tire and brake wear (**Figure 12**), which are reflected in the emission factors we use.[89,90] While electric vehicles use regenerative braking, which may reduce particulate matter emissions from brake wear, they are also heavier than conventional vehicles on average, which may increase particulate matter

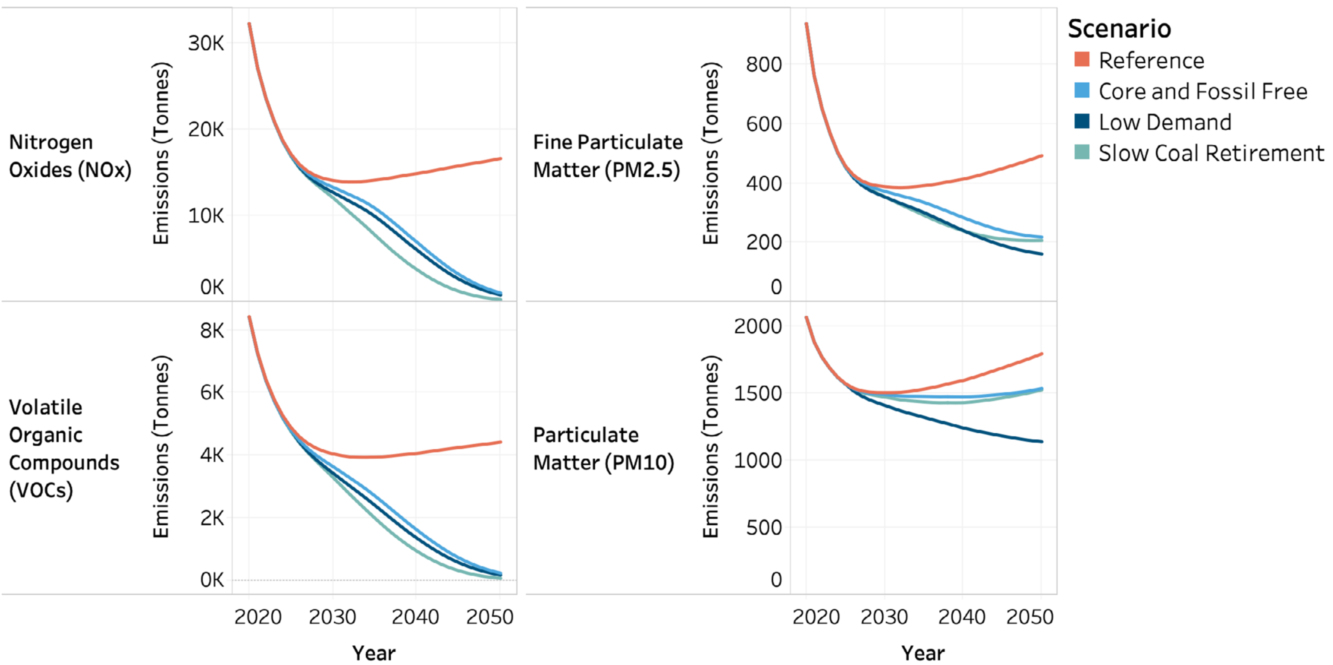
89 Working Party on Integrating Environmental and Economic Policies, Organisation for Economic Co-operation and Development (OECD). Non-Exhaust Emissions from Road Transport: Causes, Consequences and Policy Responses (2020).

90 Argonne National Laboratory. "Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool" (2019). Accessed July 2020. Available at: https://greet.es.anl.gov/afleet.

emissions from tire wear.[91] Conventional and alternative fuel vehicles also produce PM_{10} emissions through the resuspension of dust and other particulate matter on road surfaces, although these non-exhaust emissions are not reflected in our emission estimates. While outside of the scope of our analysis, road surface PM_{10} emissions may be of particular relevance to rural communities in New Mexico living in close proximity to unpaved roads.

Incorporating measures from the Low Demand scenario into other decarbonization pathways, such as investment in public transit and the reduction of vehicle travel, would help to reduce residual $PM_{2.5}$ and PM_{10} emissions along urban interstate corridors, where the density of vehicle emissions remains the highest in 2050.

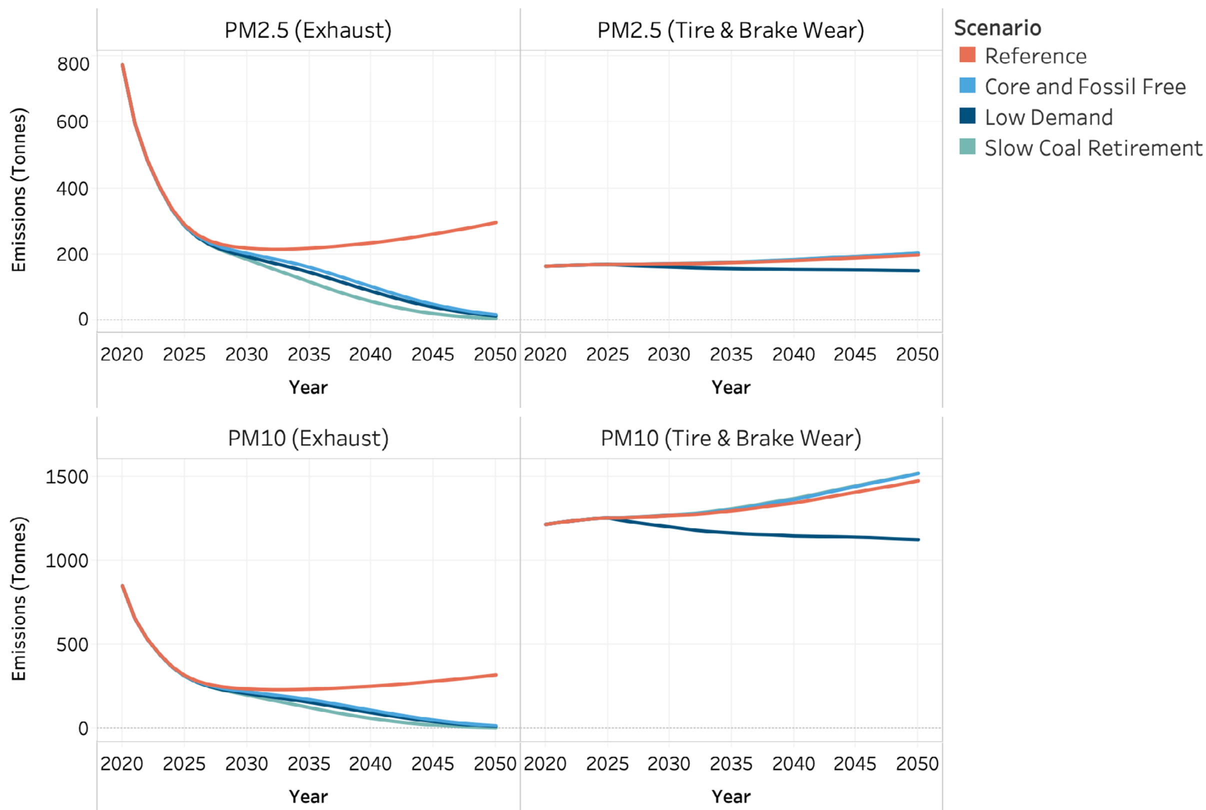
FIGURE 11. Air pollutant emission reductions by scenario, 2020-2050.[92] Unlike the other pollutants, PM_{10} emissions do not decrease substantially from 2020-2050 in the Core, Fossil Free, and Slow Coal Retirement scenarios due to an increase in total vehicle miles traveled and a corresponding increase in emissions from tire and brake wear. The Low Demand scenario achieves the greatest $PM_{2.5}$ and PM_{10} emission reductions, underscoring the public health benefits of reduced vehicle travel.



91 Beddows, David C.S. and Roy M. Harrison. PM_{10} and $PM_{2.5}$ Emission Factors for Non-Exhaust Particles from Road Vehicles: Dependence upon Vehicle Mass and Implications for Battery Electric Vehicles. *Atmospheric Environment, 244: 117886* (2021).

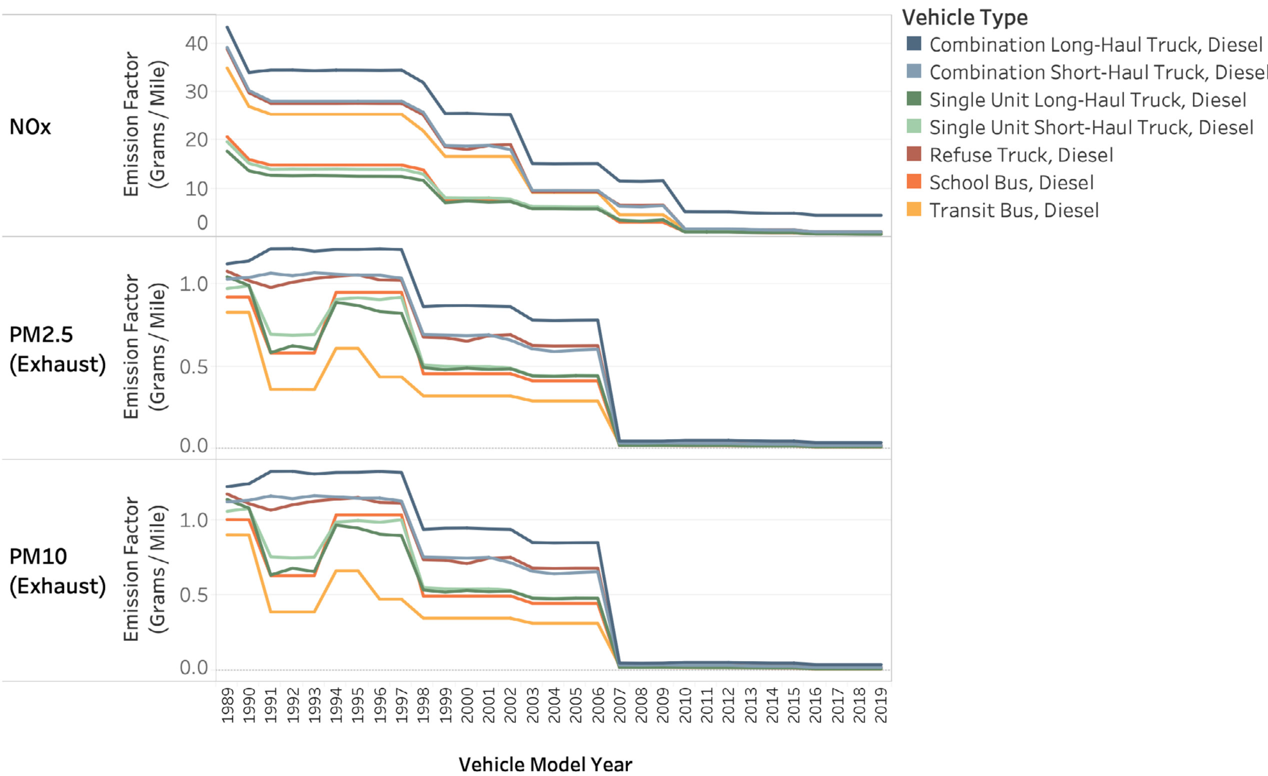
92 Modeled emissions in the year 2020 do not reflect the impacts of COVID-19 on travel patterns and associated changes in fossil fuel use within the transportation sector.

FIGURE 12. $PM_{2.5}$ and PM_{10} exhaust and non-exhaust emissions by scenario, 2020-2050. While all decarbonization scenarios eliminate exhaust emissions of $PM_{2.5}$ and PM_{10}, only the Low Demand scenario reduces non-exhaust emissions of $PM_{2.5}$ and PM_{10} by 2050. Because vehicle PM_{10} emissions are largely due to tire and brake wear rather than exhaust, increased vehicle travel across scenarios from 2020-2050 results in a smaller reduction in PM_{10} emissions across scenarios compared to other pollutants.



Across pollutants, older vehicles have higher emission rates than newer vehicles because of different technological constraints and regulations in place at the time they were manufactured (**Figure 13**). Retiring older vehicles is therefore critical to reducing vehicle pollution in the near-term. While vehicle electrification is necessary to reach near-zero greenhouse gas and criteria air pollutant emissions by 2050, our findings suggest that prioritizing the retirement of older vehicles is critical to significantly reduce vehicle pollution over the next decade. **Figure 14** illustrates two very different emission trajectories New Mexico's transportation sector could take as it decarbonizes, depending on whether older vehicles retire first or remain on the road until vehicle fleets are fully electrified. Prioritizing the retirement of older heavy-duty and medium-duty trucks in particular would maximize the reduction of near-term vehicle pollution, as trucks are projected to electrify more slowly than light-duty vehicles over the next decade and older truck models have high emission rates of $PM_{2.5}$, PM_{10}, and NO_x (**Figure 13**).

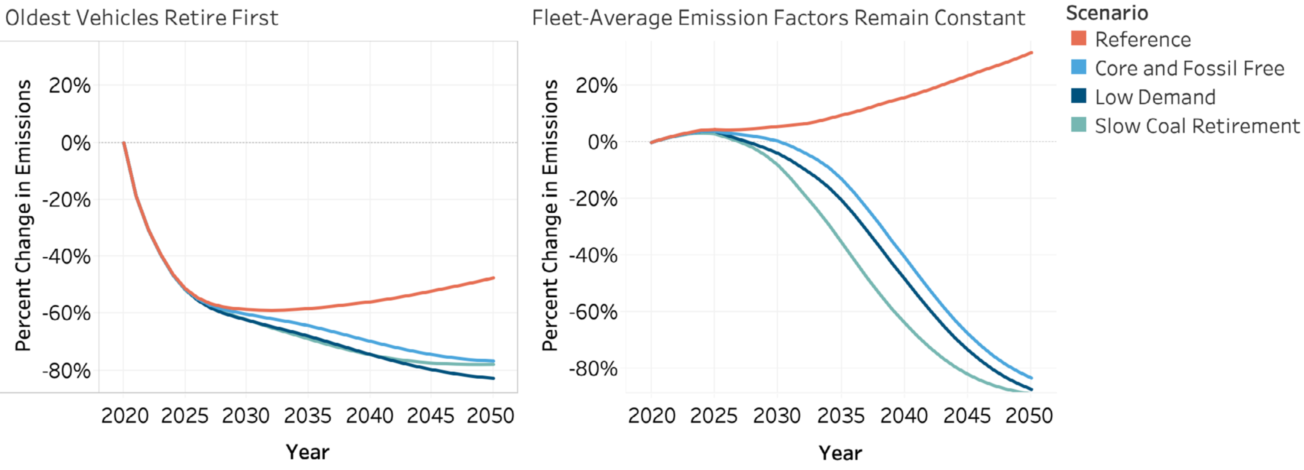
FIGURE 13. New Mexico heavy-duty and medium-duty diesel vehicle emission factors by model year.[93] The substantial decline in vehicle emission factors (grams emitted per mile) over the last several decades underscores the need to retire older vehicles first in order to achieve maximal emission reductions in the coming decade.



Mapping the emission trajectories depicted above at the census-tract level allows us to see which population segments would be most impacted by each path. Because heavy-duty and light-duty vehicles make up different proportions of total vehicle miles traveled in different parts of the state, and each vehicle class reduces pollution at a different rate, certain regions see more aggressive emission reductions than others throughout the decarbonization timeline. Whether or not the retirement of older vehicles is prioritized affects where emission reductions are greatest in the near-term.

93 We accessed EPA MOVES 2014a emission factors through the Argonne National Laboratory's 2019 AFLEET tool. The sharp reduction in heavy-duty and medium-duty vehicle $PM_{2.5}$ and PM_{10} emission factors from model year 2006 to model year 2007 reflects the adoption of an EPA rulemaking in 2001 (66 FR 5002, January 18, 2001) requiring all on-road diesel heavy-duty vehicles, starting with the 2007 model year, to use a diesel particulate filter. The rulemaking also required a phased-in adoption of NO_x exhaust control technology from 2007-2010. We are unaware of an explanation for the dip in EPA MOVES emission factors from 1990-1994 for several vehicle types.

FIGURE 14. Projected vehicle $PM_{2.5}$ emissions, if older vehicles retire first (left) or remain on the road until vehicle electrification is complete (right). The discrepancy between these two emission trajectories emphasizes the significant impact that retiring old vehicles, particularly trucks, has on vehicle emission reductions. In the left figure, we assume that the oldest internal combustion engine vehicles are continually replaced by newer, less-polluting internal combustion engine vehicles throughout decarbonization. In the right figure, we assume that fleet-average emission factors for internal combustion engine vehicles remain constant over time,[94] modeling only the emission reductions achieved through fuel switching and vehicle electrification.

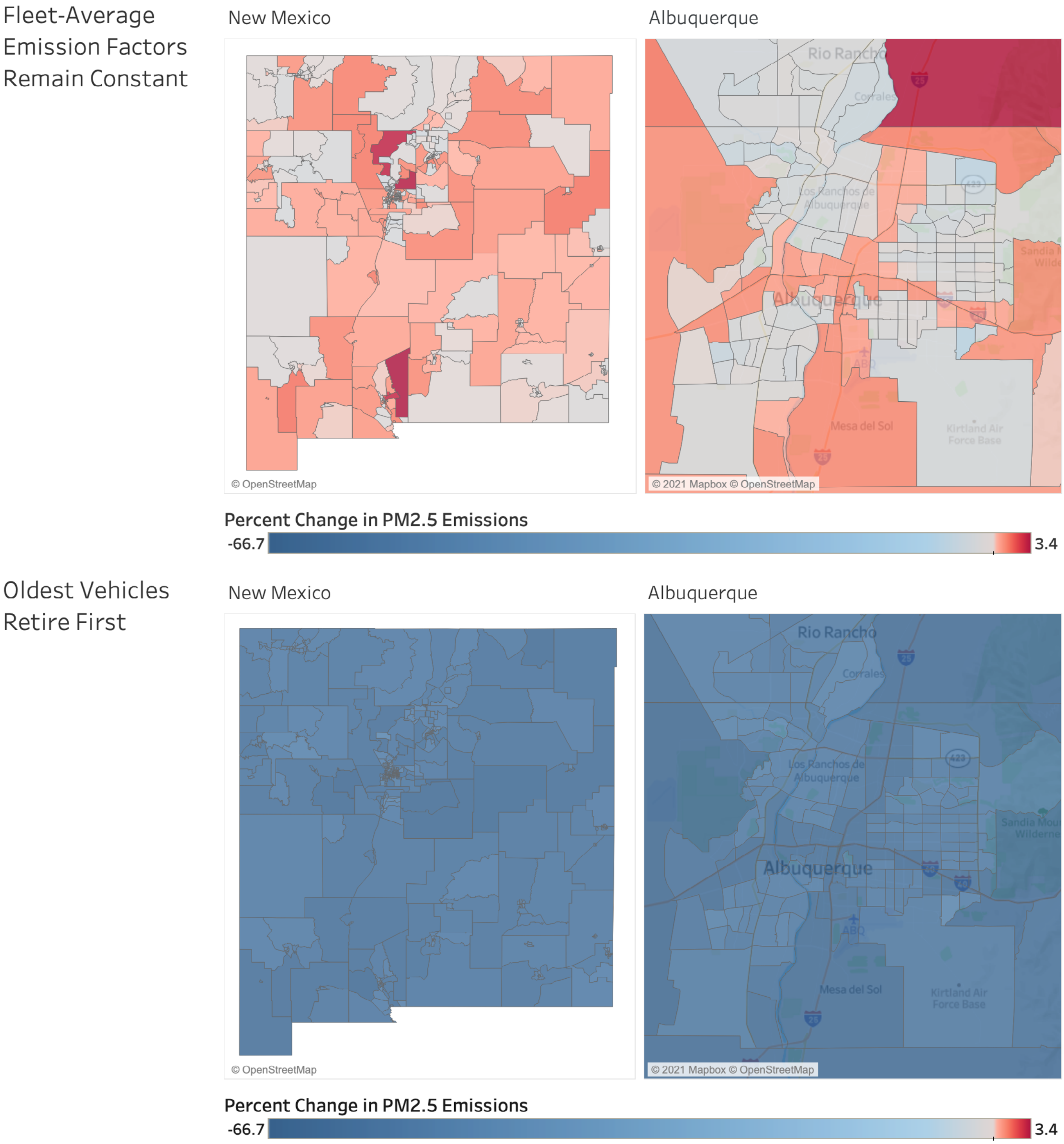


If we assume that older, conventional fuel vehicles remain on the road until vehicles are fully electrified, census tracts in close proximity to trucking routes see slower emission reduction rates from 2020-2030 in the Core scenario (**Figure 15**, top panel). Some census tracts in rural areas and along urban interstate corridors, where heavy-duty and medium-duty trucks make up a greater fraction of vehicle miles traveled, even see an increase in emissions over the next decade. This is because heavy-duty and medium-duty trucks electrify more slowly than light-duty vehicles, while still seeing an increase in vehicle miles traveled over this period.

If we assume that older, high-emitting conventional fuel vehicles retire first, however, census tracts in close proximity to trucking routes see more aggressive emission reductions than other areas from 2020-2030 in the Core scenario (**Figure 15**, bottom panel). Retiring older heavy-duty and medium-duty trucks has an outsized impact on emission reductions, because these vehicle types have seen particularly sharp declines in PM_{10}, $PM_{2.5}$ and NO_x emission factors over the last several decades.

94 Fleet-average emission factors are calculated by weighting emission factors for each model year using the EPA MOVES 2014a default vehicle age distribution for each vehicle type in analysis year 2019.

FIGURE 15. Modeled percent change in on-road vehicle $PM_{2.5}$ emissions by census tract from 2020-2030 in the Core scenario under different vehicle retirement scenarios. Under the assumption that fleet-average emission factors for internal combustion engine vehicles remain constant over time, the Core scenario results in an increase in $PM_{2.5}$ emissions along trucking routes from 2020-2030 due to increased vehicle travel and associated emissions (top). Under the assumption that, in addition to vehicle electrification, the oldest internal combustion engine vehicles are continually replaced by newer, less-polluting internal combustion engines throughout decarbonization, the Core scenario results in emission reductions everywhere in the state by 2030, with more aggressive emission reductions along trucking routes (bottom). The contrast between these two trajectories emphasizes the significant impact that retiring old trucks has on environmental equity outcomes.



The two different emission reduction trajectories depicted in **Figure 15** illustrate that the prioritized retirement of older, high-emitting vehicles holds implications for environmental equity outcomes. As discussed in **Section 2.3.4**, Black, Asian American, and Hispanic populations in New Mexico are disproportionately exposed to truck pollution. If older, high-emitting heavy-duty and medium-duty trucks remain on the road, census tracts adjacent to interstates in New Mexico's rural and urban areas could see slower rates of PM_{10}, $PM_{2.5}$ and NO_x emission reductions compared to other areas in the coming decade. This outcome risks widening existing environmental inequities over the next decade, particularly for New Mexican communities of color. Incentivizing the retirement of highly-polluting older vehicles, by contrast, could help to achieve greater emission reductions in these areas in the near-term, lowering emissions burdens for communities of color.

In addition to retiring older truck models first, prioritizing electric vehicle charging infrastructure for heavy duty trucks along interstate corridors, rerouting heavy-duty and medium-duty trucks to less populated areas, and addressing bus and truck idling in urban areas could help to reduce vehicle emissions where they are highest.

2.2.6 Household Vehicle Fuel Cost Burdens

Although higher-income households drive more than lower-income households on average, lower-income households tend to spend a greater fraction of their income on vehicle fuel (**Figure 16**). Importantly, our vehicle fuel cost burden estimates do not include public transit costs or the costs of vehicle ownership and maintenance, the latter of which are far higher than annual vehicle fuel costs on average.[95] The inclusion of these costs in our estimates would result in much higher average transportation cost burdens for households across income levels. For reference, the Center for Neighborhood Technology estimates that a regional typical household[96] in Albuquerque spends roughly 24 percent of their annual income on transportation costs, when accounting for vehicle ownership and maintenance costs, fuel costs, and public transit costs.[97] By analyzing only the transportation cost burden imposed on households by vehicle fuel costs, our findings are limited in scope. Still, our conclusions point to an equity consideration relevant to the reduction of carbon emissions from household travel. Because higher-income households drive more and consume more vehicle fuel on average,[98] and therefore likely contribute more to transportation-related carbon emissions, policies designed solely to reduce carbon emissions from household vehicle travel may fail to address the transportation-related financial burden faced by lower-income households.

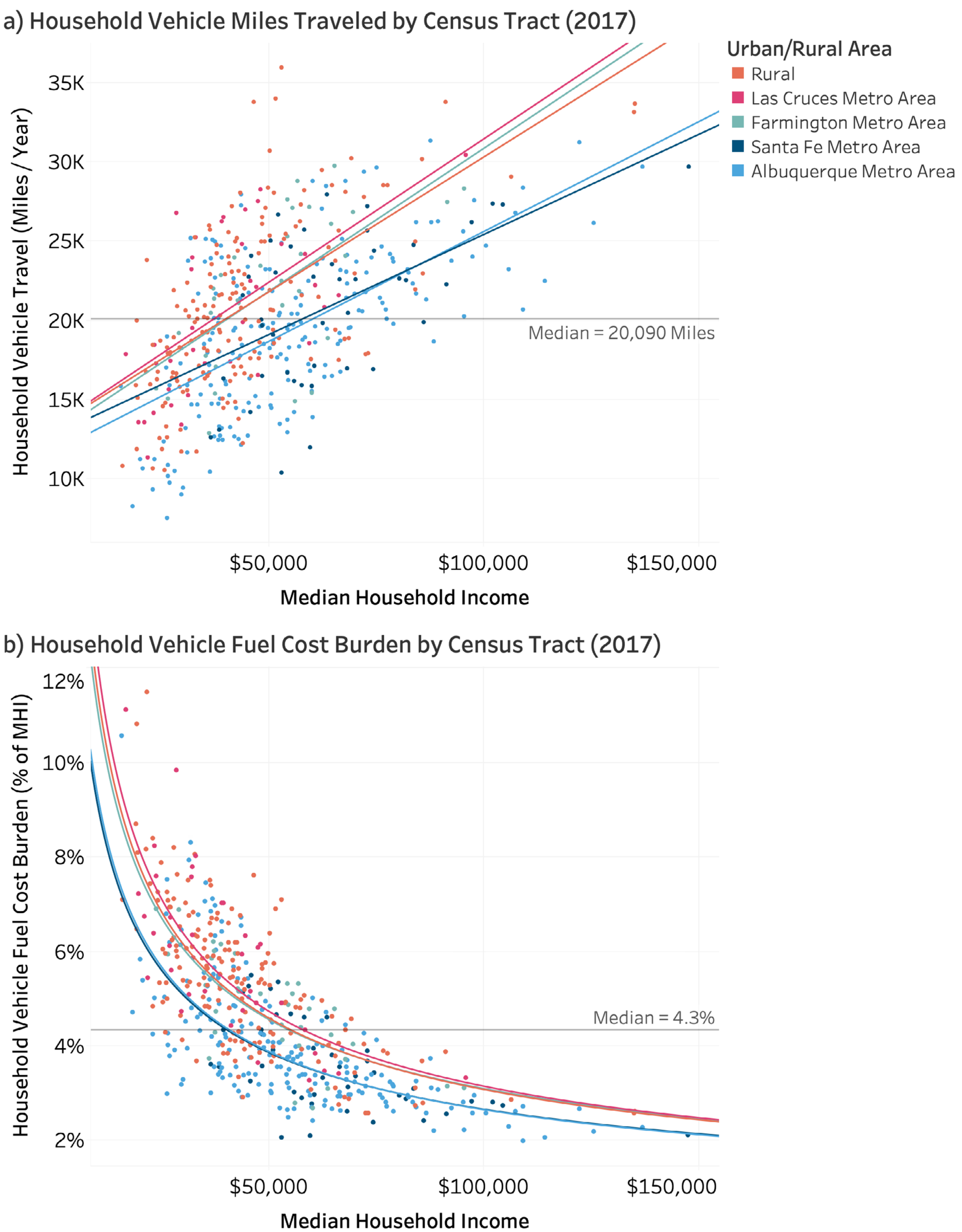
95 Center for Neighborhood Technology. "Housing and Transportation (H+T®) Affordability Index." Accessed Dec. 2020. Available at: https://htaindex.cnt.org/.

96 According to the Center for Neighborhood Technology, a *Regional Typical Household* in Albuquerque, NM has the following characteristics: Income: $48,495, Commuters: 1.08, Household Size: 2.59.

97 Center for Neighborhood Technology. "Housing and Transportation (H+T®) Affordability Index." Accessed Dec. 2020. Available at: https://htaindex.cnt.org/.

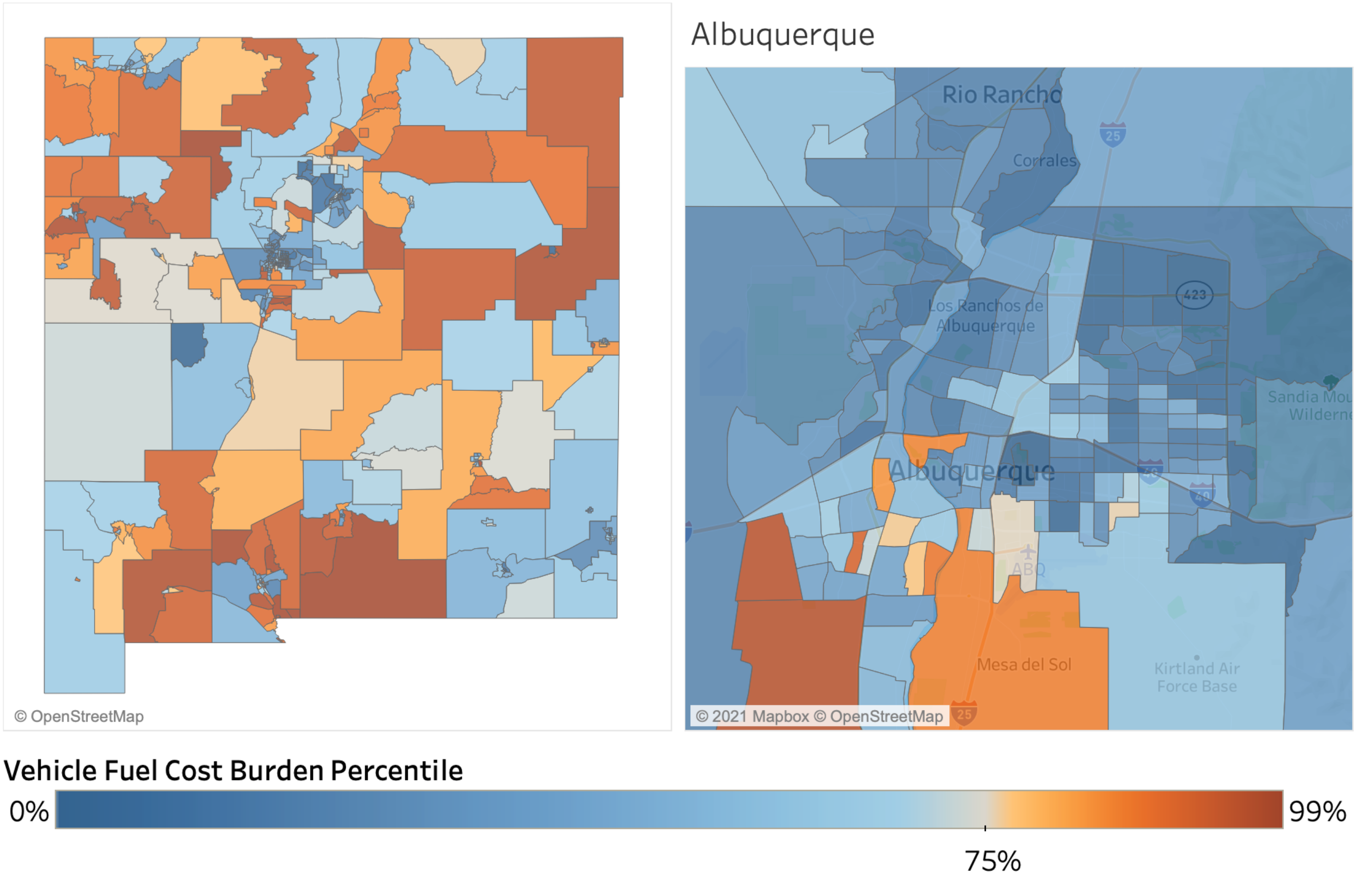
98 US Energy Information Administration. "Household Spending on Gasoline and Public Transit Varies by Region, Income," Apr. 2015. Available at: https://www.eia.gov/todayinenergy/detail.php?id=20772.

FIGURE 16. a) Average annual household vehicle miles traveled and b) average vehicle fuel cost burden by median household income. Lower-income households drive less than higher-income households on average, but spend a greater fraction of their annual income on vehicle fuel. Those households living in rural areas, Las Cruces, and Farmington have slightly higher vehicle fuel cost burdens on average than those households living in Albuquerque and Santa Fe due to longer average driving distances and lower average household incomes in those areas.



Vehicle fuel cost burdens are slightly higher on average for households living in rural areas, Las Cruces, and Farmington than for households living in Albuquerque and Santa Fe, due to longer average driving distances and lower average household income levels. In certain areas of the Albuquerque metropolitan area, however, particularly in census tracts that are majority people of color and low-income, vehicle fuel cost burdens are higher than 75 percent of census tracts statewide (**Figure 17**). Urban and rural areas with high vehicle fuel cost burdens may benefit from programs targeted at low-income households such as free, electrified public transit, financing for electric vehicles, and investment in public electric vehicle charging infrastructure.

FIGURE 17. Vehicle fuel cost burden percentile by census tract, statewide and in Albuquerque. While households in rural areas, Las Cruces, and Farmington have slightly higher vehicle fuel cost burdens on average than households living in Albuquerque and Santa Fe, certain census tracts within the Albuquerque metropolitan region have fuel cost burdens higher than 75 percent of census tracts statewide. Expanding free, electrified public transit, subsidizing electric vehicle adoption, and building out public electric vehicle charging infrastructure in these areas may help to reduce financial burdens incurred by household vehicle travel.



2.2.7 Electric Vehicle Adoption

Throughout our analysis, we assume that vehicle electrification occurs uniformly across the state, meaning that the electric vehicle adoption rates vary by vehicle class but not by geographic location. In reality, electric vehicle adoption rates across the country tend to be higher among consumers who have more formal education, have higher incomes, and own single-family homes.[99] As New Mexico's transportation sector decarbonizes, low-income households, communities of color, linguistically-isolated households, and households with lower educational attainment risk facing disproportionately low electric vehicle adoption rates in the coming decade, if adoption trends follow similar trends to those we see for residential rooftop solar.[100,101] These households may be excluded from the financial and health benefits associated with vehicle electrification in the near-term, unless the cost of electric vehicles declines substantially and policies are implemented to reduce barriers to electric vehicle access.

Higher-income households drive more and consume more vehicle fuel on average,[102] and therefore likely contribute more CO_2 emissions from vehicle travel than lower-income households. Lower-income households tend to drive older vehicles,[103] however, which on average emit more pollution per mile traveled compared to newer vehicles. Vehicle electrification may therefore have the potential to achieve higher criteria air pollutant emission reduction benefits per vehicle mile traveled for lower-income households.

Primary barriers to widespread electric vehicle adoption include but are not limited to up-front cost, vehicle travel range, and access to charging infrastructure.[104] As the cost of electric vehicles declines and vehicle travel range continues to improve, access to public charging infrastructure may become a key localized barrier to electric vehicle adoption over the next decade.[105] Public charging infrastructure is particularly critical for renters, who may lack access to private home chargers. As with energy efficiency improvements in buildings, the installation of private residential chargers suffers from the split-incentive problem, in which landlords are not incentivized to pay for home upgrades that primarily result in savings for their tenants.

Based on data from the US Department of Energy's Alternative Fuel Data Center, there are currently about 16 public electric vehicle charging outlets per 100,000 people in New Mexico.[106,107] For comparison, the rate of public charging outlets per 100,000 people in the US ranges from 4.8 in Alaska to 105.3 in Vermont.[108] As New Mexico expands public charging infrastructure, ensuring that infrastructure is equitably distributed rather than concentrated in areas with high early adoption rates will be critical to facilitating access among households with historically low levels of electric vehicle adoption. Households in many rural areas, including on tribal reservations—where there are currently only three charging stations total—have particularly high vehicle fuel cost burdens and high Demographic Index rankings compared to the rest of the state. Households in these areas would likely benefit from the financial savings associated with electric vehicle adoption and accessible charging infrastructure (**Figure 18**).

99 Hsu, Chih-Wei and Kevin Fingerman. Public Electric Vehicle Charger Access Disparities Across Race and Income in California. *Transport Policy* 100 (2021): 59-67.

100 Lukanov, Boris R., and Elena M. Krieger. Distributed Solar and Environmental Justice: Exploring the Demographic and Socio-Economic Trends of Residential PV Adoption in California. *Energy Policy* 134 (2019): 110935.

101 Sunter, D.A., *et al*. Disparities in Rooftop Photovoltaics Deployment in the United States by Race and Ethnicity. *Nature Sustainability* 2.1 (2019): 71-76.

102 US Energy Information Administration. "Household spending on gasoline and public transit varies by region, income," Apr. 2015. Available at: https://www.eia.gov/todayinenergy/detail.php?id=20772#.

103 US Energy Information Administration. "U.S. Households Are Holding on to Their Vehicles Longer," Aug. 2018. Available at: https://www.eia.gov/todayinenergy/detail.php?id=36914.

104 *Ibid.*

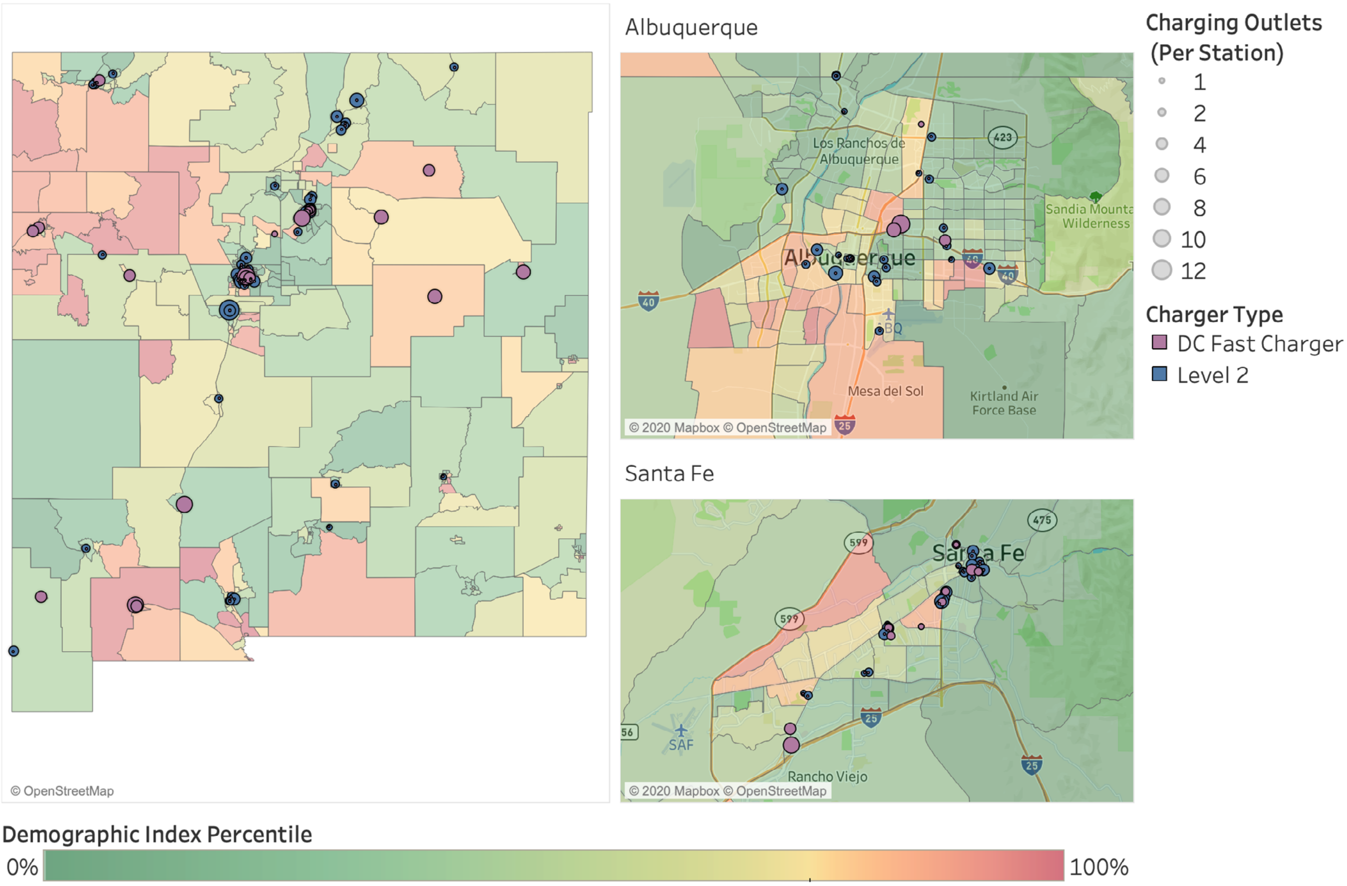
105 *Ibid*.

106 Includes Level 2 and DC Fast Charging outlets, excludes Level 1 charging outlets. Uses 2019 US Census Bureau population estimate for New Mexico: 2,096,829.

107 US Department of Energy Alternative Fuels Data Center. "Alternative Fueling Station Locator." Accessed Dec. 2020. Available at: https://afdc.energy.gov/stations#/find/nearest?country=US.

108 Brown, A., *et al.* Electric Vehicle Charging Infrastructure Trends from the Alternative Fueling Station Locator: First Quarter 2020. *National Renewable Energy Laboratory* (2020).

FIGURE 18. Public electric vehicle charging stations and demographic index in New Mexico.[109,110] Each dot represents an electric vehicle charging station, while the bubble size reflects the number of charging outlets, known as electric vehicle supply equipment (EVSE), per station. Ensuring that charging infrastructure is equitably distributed rather than concentrated in areas with high early adoption rates will be critical to facilitating access among households with historically low levels of electric vehicle adoption in New Mexico.



109 US Department of Energy Alternative Fuels Data Center. "Alternative Fueling Station Locator." Accessed Nov. 2020. Available at: https://afdc.energy.gov/stations#/analyze?region=US-NV&country=US&fuel=ELEC&ev_levels=all

110 The map includes AC Level 2 (240v) and DC fast charging outlets, the latter of which provides electric vehicles with a higher travel range per unit of time charging.

2.3 Buildings

Residential fuel use across New Mexico creates both indoor and outdoor air pollution, and when combined with electricity use can contribute to burdensome utility bills, particularly for low-income households and populations of color. Electrification of natural gas and propane appliances, as well as whole-building efficiency measures, can save energy, reduce bills, and improve indoor air quality. However, these benefits may accrue unevenly and even exacerbate energy cost burdens if policies do not prioritize clean energy adoption among households with high energy cost burdens.

We used a regression model based on geographic, demographic, housing-related, and climatic variables to estimate census tract-level fuel use in residential buildings (see **Technical Appendix: Methods**). Our emissions analysis includes the most commonly combusted residential fuels in New Mexico: natural gas, propane, and wood. Our consumer energy utility bill analysis also includes electricity. Electricity generation and upstream methane emissions are omitted from the residential sector emissions analysis as these emissions are accounted for in the power and industrial sectors. Electricity use is, however, included in the residential building cost analysis to get a full picture of household energy bills. A small fraction of New Mexico households use less common fuels, such as fuel oil. Although these fuels are excluded from this analysis, they should be included when planning residential decarbonization policies.

2.3.1 Baseline Residential Emissions and Demographics

Despite the state's climate extremes, New Mexico has among the lowest per capita residential energy consumption in the country.[111] Fuel use in residential buildings accounts for only three[112] percent of New Mexico's CO_2 emissions and one percent of the state's NO_x emissions, but almost a third of primary $PM_{2.5}$ emissions, largely due to residential wood burning. NO_x also contributes to the secondary formation of particulate matter and ozone. While these emissions contribute in part to statewide ambient air quality impacts, in-home fuel combustion is of particular concern for indoor air quality. Like ambient air pollution, indoor air pollution is associated with adverse respiratory and cardiovascular health outcomes. Furthermore, the average American spends roughly 90 percent of their time indoors,[113] further emphasising the importance of indoor air quality from a public health perspective.[114]

Natural gas combustion can contribute to significant in-home emissions of carbon monoxide, NO_x, $PM_{2.5}$, and formaldehyde.[115,116,117] Leakage of unburned natural gas from appliances, in addition to releasing methane, may also result in increased exposure to known human carcinogens including benzene and other VOCs.[118] There is a lack of research on the magnitude of exposure to health-damaging air pollutants and associated health impacts due to incomplete combustion and natural gas leakage, although this topic is of growing interest in the scientific field.

111 US Energy Information Administration. "New Mexico - State Energy Profile." Accessed Jan. 15, 2021. Available at: https://www.eia.gov/state/analysis.php?sid=NM

112 NM Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations. (2020).

113 Klepeis, Neil E., *et al*. The National Human Activity Pattern Survey (NHAPS): A Resource for Assessing Exposure to Environmental Pollutants. *Journal of Exposure Science & Environmental Epidemiology* 11.3 (2001): 231-252.

114 US Environmental Protection Agency. "Indoor Air Quality." Accessed Apr. 2021. Available at: https://www.epa.gov/report-environment/indoor-air-quality#health

115 Seals, Brady and Andee Krasner. Health Effects from Gas Stove Pollution. *Rocky Mountain Institute* (2020).

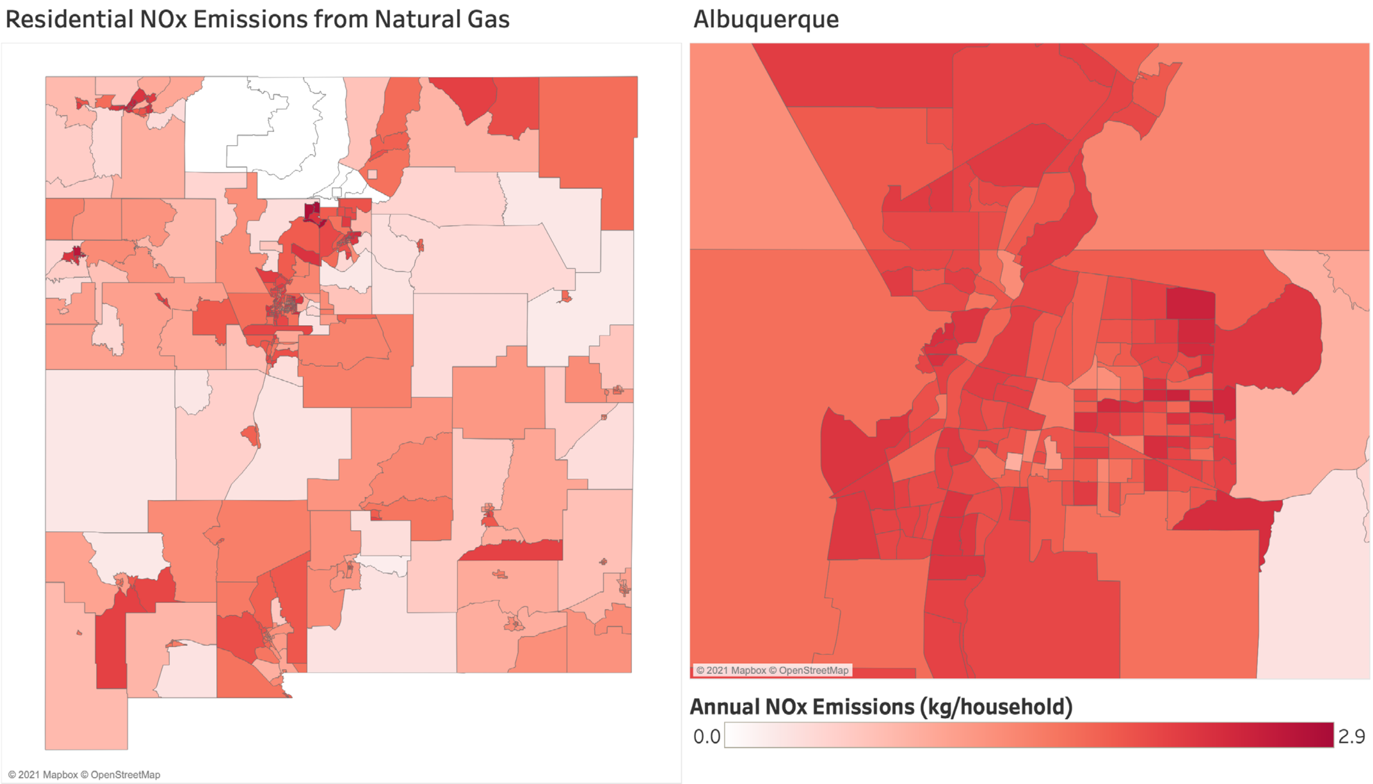
116 Mullen, Nasim A., *et al*. Results of the California Healthy Homes Indoor Air Quality Study of 2011–2013: Impact of Natural Gas Appliances on Air Pollutant Concentrations. *Indoor Air* 26.2 (2016): 231-245.

117 Logue, Jennifer M., *et al*. Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California. *Environmental Health Perspectives* 122.1 (2014): 43-50.

118 Burger, Jessica L., *et al.* Composition of the C_{6+} Fraction of Natural Gas by Multiple Porous Layer Open Tubular Capillaries Maintained at Low Temperatures. *Energy Fuels* 30.3 (2016): 2119-2126.

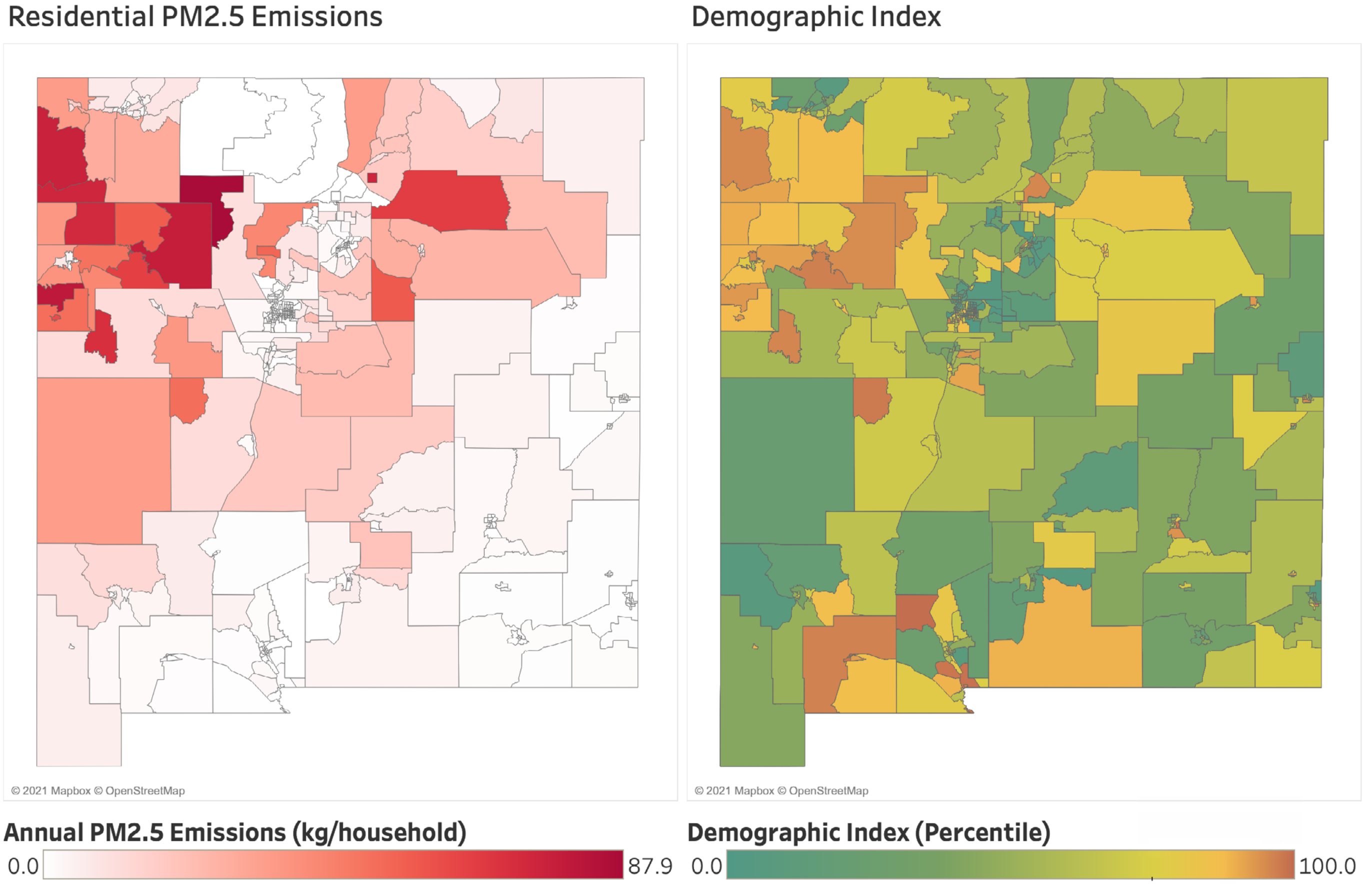
In 2017, natural gas comprised the majority of New Mexico's in-home energy use at 73 percent of non-electric residential energy consumption. It also produced the majority of end-use CO_2 emissions (63 percent). Reducing residential greenhouse gas emissions therefore requires reducing natural gas use in buildings. Propane, which emits a similar suite of co-pollutants to natural gas and may be targeted by a similar set of fuel switching policies, accounted for roughly nine percent of consumption and ten percent of residential CO_2 emissions. Wood, often used in different geographic and socioeconomic contexts compared to natural gas and propane, comprised 18 percent of consumption and 28 percent of residential CO_2 emissions. In addition to emitting CO_2, wood emits a disproportionate amount of health-damaging $PM_{2.5}$ relative to its energy content. A residential decarbonization strategy which seeks to maximize public health co-benefits must therefore be inclusive of wood-burning households.

FIGURE 19. Average NO_x household emissions in New Mexico (left) and the Albuquerque area (right) by census tract. NO_x emissions from natural gas are highest in urban and suburban areas, however, almost all areas, including rural, have some NO_x emissions associated with natural gas use.



Although natural gas accounts for the majority of residential carbon emissions in New Mexico, its use is clustered in urban and suburban areas (**Figure 19**).[119] The lack of natural gas distribution systems in rural areas means that many rural homes rely on propane and wood for home heating. The latter emits nearly thirty times as much $PM_{2.5}$ as natural gas annually (2,900 tonnes vs. 100 tonnes) despite providing about a quarter as much residential energy statewide, though it is largely constrained to rural regions and tribal areas in the northwestern part of the state (**Figure 20**). These communities also score higher on the integrated Demographic Index, as shown in **Figure 20**, indicating that they have a larger proportion of combined low-income, racial minority, low educational attainment, linguistically isolated, elderly and very young populations compared to other census tracts in New Mexico. Using 2019 American Community Survey data, we found that about 50,000 households in New Mexico currently use wood as their primary heat source—this constitutes roughly 6.5 percent of New Mexican households, compared to approximately 1.8 percent of US households. Decarbonization efforts focused solely on natural gas will therefore risk leaving significant residential $PM_{2.5}$ emissions across rural parts of the state that are already experiencing significant socio-economic burdens.

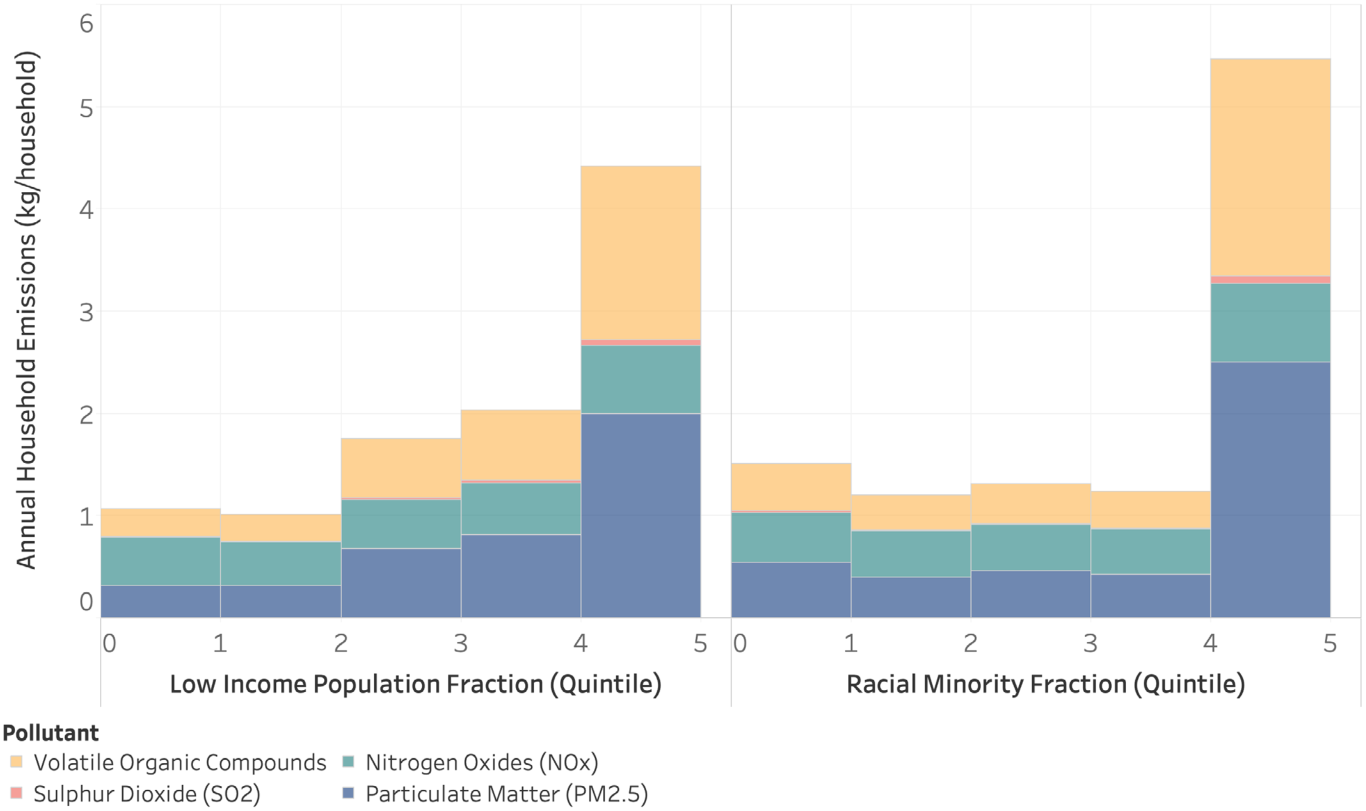
FIGURE 20. Average $PM_{2.5}$ household emissions (left) and integrated Demographic Index (right) by census tract. $PM_{2.5}$ emissions from wood are highest in rural regions and in tribal areas in the northwestern part of the state. In the Demographic Index, orange/red neighborhoods have a higher share of combined low-income, racial minority, low educational attainment, linguistically isolated, elderly, and very young populations compared to other census tracts in New Mexico.



119 US Department of Homeland Security. “Natural Gas Service Territories.” Sept. 2017. Accessed Oct. 2020. Available at: https://hifld-geoplatform.opendata.arcgis.com/datasets/natural-gas-service-territories

Low-income communities and communities of color experience by far the highest average household emissions (**Figure 21**), mainly due to reliance on wood in rural areas. Wood emits significantly more $PM_{2.5}$ and VOCs per unit of energy generated compared to other common home-heating fuels. Nearly one in two households in majority Native American areas use wood as their primary heating fuel.

FIGURE 21. New Mexico residential air pollution emissions and demographics. Average annual household air pollutant emissions are significantly higher in census tracts where a higher fraction of the population are low-income and people of color. Census tracts are grouped into quintiles based on the fraction of racial minority and low-income populations in each census tract.

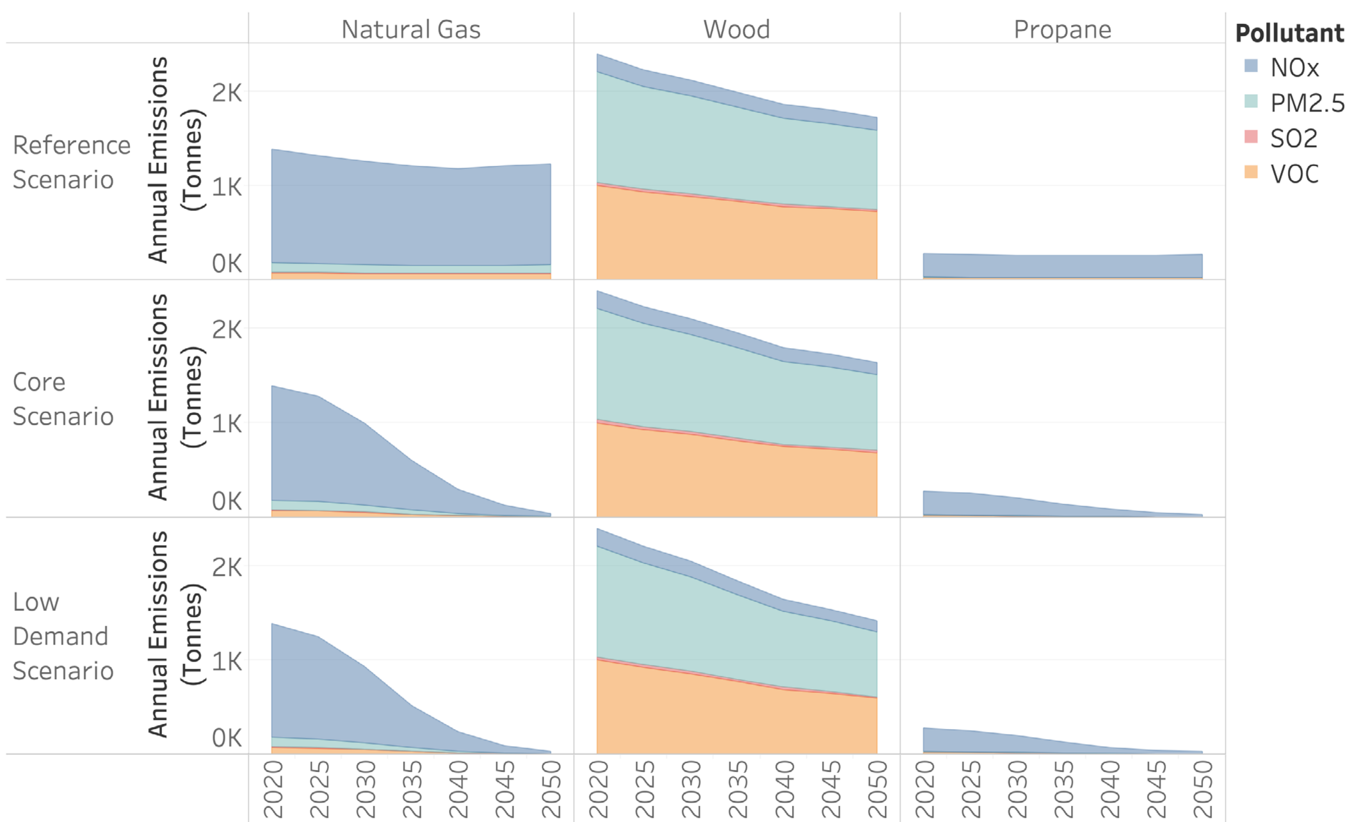


2.3.2 Projected Residential Emissions

Our modeled emission projections under the decarbonization scenarios reveal the possibility of continued $PM_{2.5}$ emissions across rural parts of the state. **Figure 22** compares projected emissions for the Reference scenario to emissions under the Core and Low Demand scenarios. Other scenarios are omitted from the figure for readability, though they show similar patterns to those depicted. For both decarbonization scenarios shown, natural gas-related emissions begin declining nearly immediately, with a more rapid decline starting in 2030, and reaching near-zero levels by 2050. $PM_{2.5}$, SO_2, and VOC emissions from natural gas start at lower levels compared to emissions from wood, and reach near-zero levels by 2050. Only a small quantity of NO_x emissions remain by 2050. Similar patterns exist for propane, though propane is responsible for a much smaller portion of overall emissions at baseline than wood and natural gas, making the magnitude of emission reductions lower for this fuel.

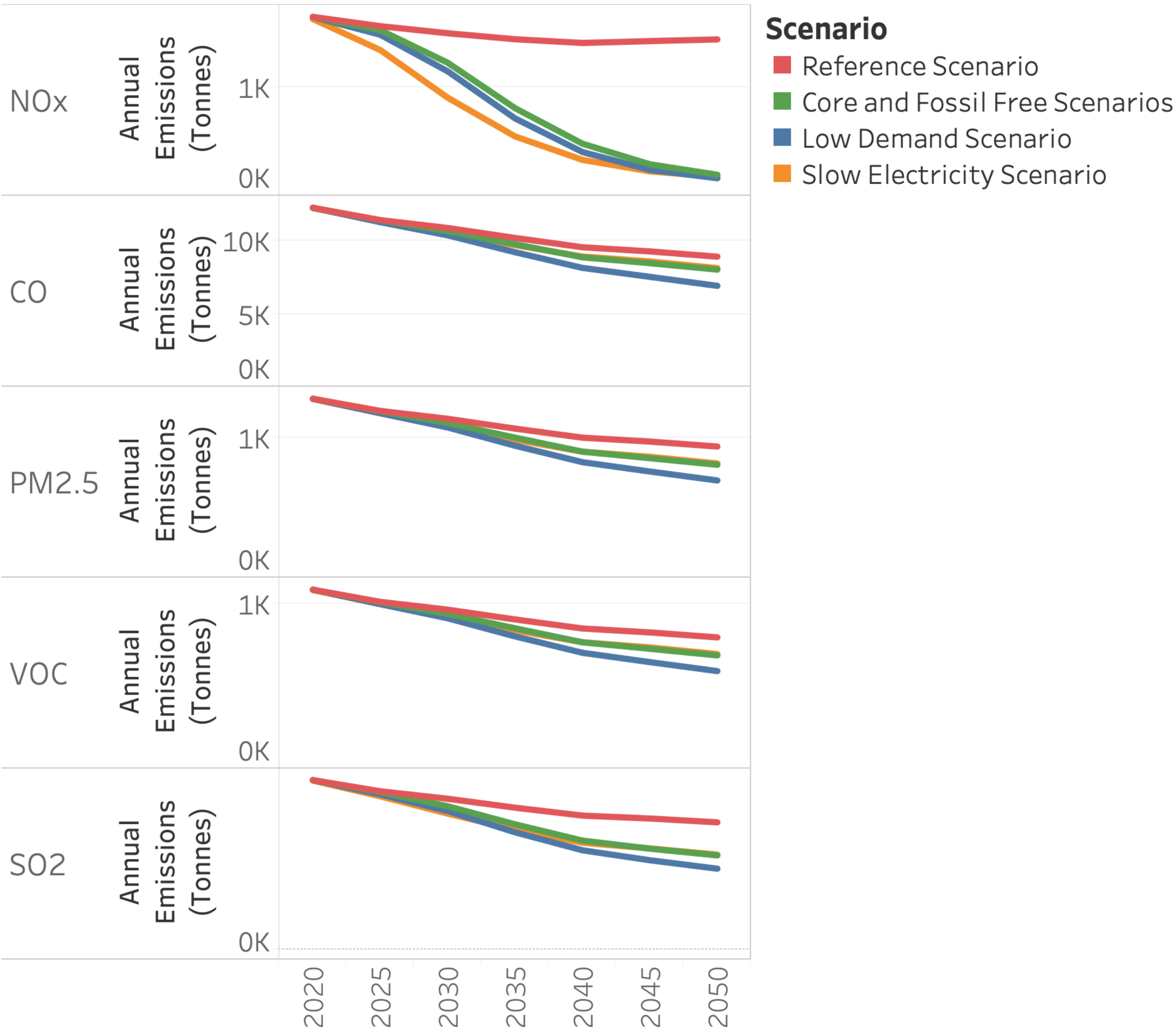
In contrast to natural gas and propane, wood use and resultant emissions decrease only slightly by 2050. This is due to Evolved Energy's energy system modeling assumption that from a decarbonization standpoint, natural gas and propane appliances are the primary targets for fuel switching. $PM_{2.5}$ and VOCs are the major constituents of wood-related air pollution and remain high through all projected years, though some SO_2 and NO_x are emitted as well. The high emission rates of wood and continued emissions across scenarios suggest that, without targeted efforts to reduce wood-related emissions, rural regions of New Mexico with high baseline wood use may continue to contribute relatively high emissions of health-damaging air pollutants such as $PM_{2.5}$.

FIGURE 22. Air pollutant emission projections by residential fuel type for three decarbonization scenarios. Due to uneven fuel switching, propane and natural gas-associated emissions decline substantially by 2050 while biomass-related emissions (wood) remain high.



Due to uneven fuel switching across scenarios and different air pollutant emission factors for each fuel, residential air pollutant emissions of each criteria air pollutant could grow increasingly uneven moving forward (**Figure 23**). Residential NO_x emissions are almost entirely eliminated in all decarbonization scenarios due to complete electrification of natural gas and propane home heating by 2050. The Slow Electricity scenario is particularly efficient in reducing residential NO_x emissions due to accelerated electrification of natural gas and propane home heating to compensate for a slower clean energy transition in the power sector for this scenario. Emissions of other criteria air pollutants, such as $PM_{2.5}$, SO_2, VOCs and CO, however, remain relatively high in 2050 due to continued reliance on wood for home heating. The Low Demand scenario projections show the largest overall reduction in criteria air pollutant emissions due to increased adoption of energy efficiency measures and lower overall household energy use in this scenario. All of these findings suggest it may be valuable to incorporate considerations for replacing in-home wood use into energy transition strategies.

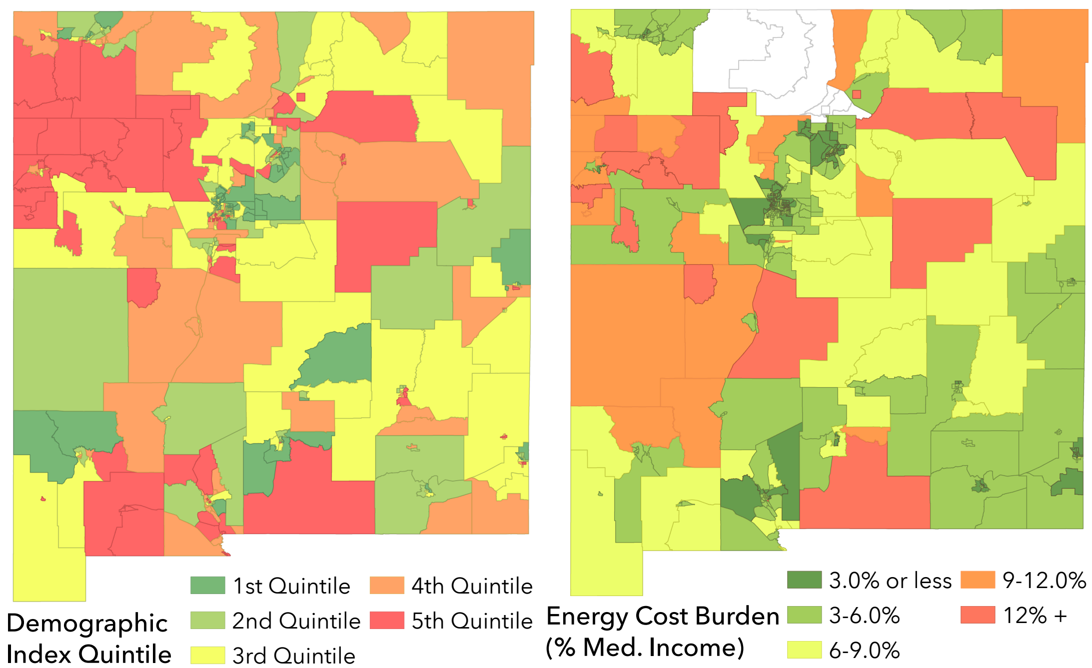
FIGURE 23. Air pollutant emission projections by decarbonization scenario. Long-term residential sector emissions of NO_x, $PM_{2.5}$, SO_2, CO and VOCs are scenario- and pollutant-dependent, with some scenarios (e.g. Low Demand) achieving lower criteria air pollutant emissions than others.



2.3.3 Household Energy Cost Burdens

The spatial distribution of residential energy cost burdens in New Mexico generally follow geographic trends in demographic vulnerability. **Figure 24** compares the Demographic Index (left) and average household energy cost burden (right) by census tract in New Mexico. Several of the most cost burdened census tracts are in rural parts of the state and on tribal lands.

FIGURE 24. Demographic Index and average household energy cost burden. In the Demographic Index, orange/red neighborhoods have a comparatively high share of low-income, racial minority, limited education, linguistically isolated, elderly, and child populations. In the energy burden map, yellow/orange neighborhoods have high and red neighborhoods have very high average energy cost burdens.



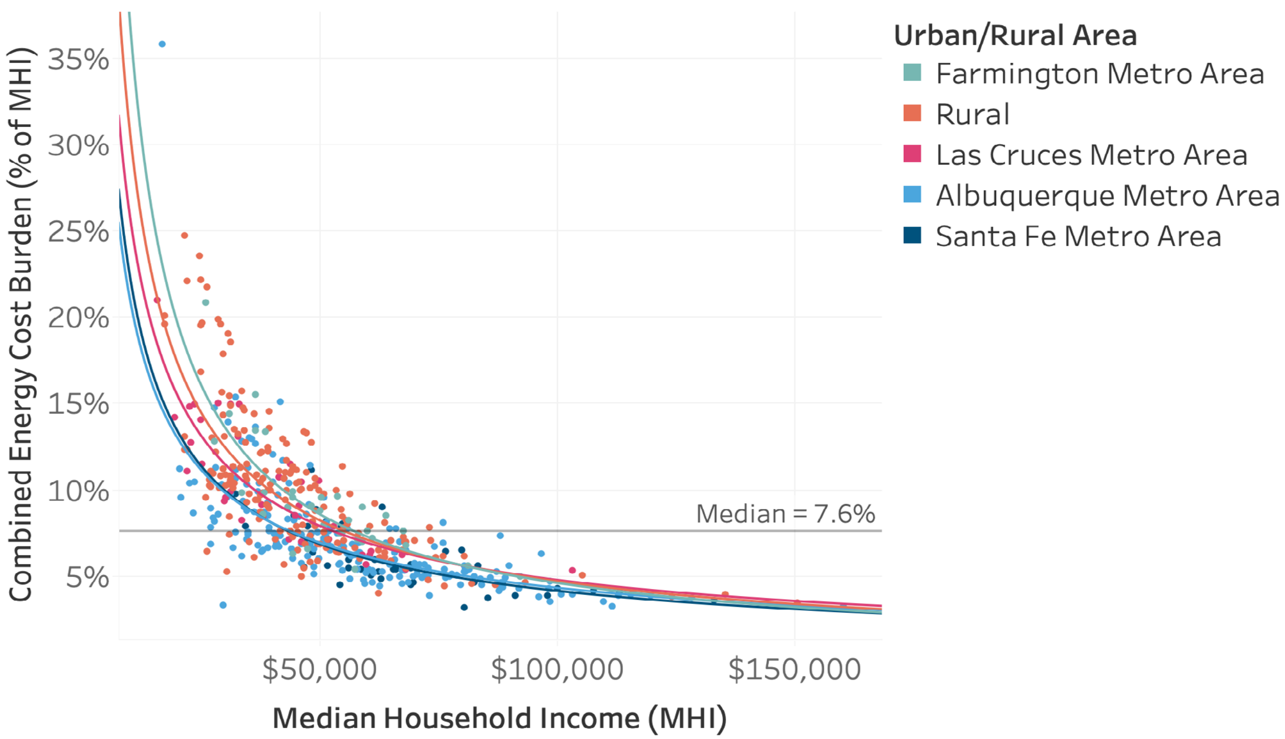
Similar to household vehicle fuel cost burdens, residential energy cost burdens are inversely correlated with household income. **Figure 25** shows that on average, households in the lowest income census tracts spend an appreciably higher percentage of their annual income on energy bills: the maximum residential energy cost burden per census tract is 27 percent, while the median of all census tracts in New Mexico is 3.6 percent.[120] At the same time, household income is positively correlated with energy consumption, with higher income households consuming more energy on average and more natural gas as a fraction of total energy use (**Figure 26**). Energy cost burdens tend to be higher in rural areas in part due to average household income levels, but also due to factors such as fuel type. These broader rural and metro area trends are based

120 These values reflect estimated *average* energy cost burdens by census tracts. Some individual households within these tracts may have significantly higher energy cost burdens, and some will be lower.

on average values, meaning there may be households within these areas with substantially higher energy burdens than their neighbors.

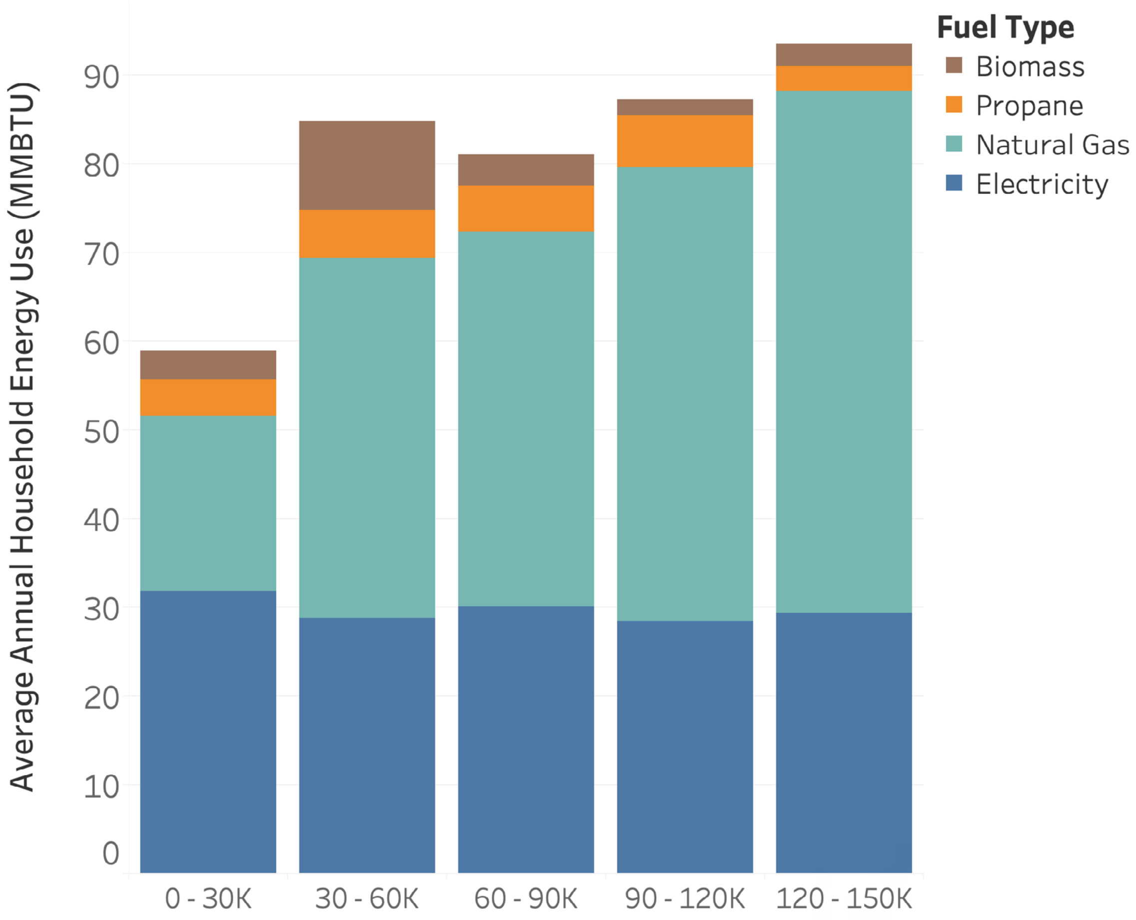
Based on our findings, policy strategies to reduce per-household energy consumption may maximize economic and public health co-benefits if tailored towards low-income households. Conversely, strategies which primarily target households with large carbon footprints and do not explicitly target populations with the highest energy cost burdens may disproportionately benefit the least economically vulnerable households and exacerbate existing socioeconomic disparities. Carbon reduction and energy cost burden mitigation goals do not have to be mutually exclusive, and it is critical for policies to be structured in ways that achieve both objectives.

FIGURE 25. Census tract average household energy cost burden.[121] Lower income households tend to spend a much greater proportion of their income on energy bills. Rural areas generally have higher



121 Rural areas refer to all census tracts that are not designated as metropolitan statistical areas by the US Census Bureau. This includes micropolitan statistical areas (at least one urban cluster of at least 10,000 but less than 50,000 population), as well as census tracts that are neither metropolitan or micropolitan.

FIGURE 26. Census tract average household energy use and median household income. Higher income households use more energy on average. Decarbonization strategies that solely focus on greenhouse gas emissions reductions may therefore exacerbate existing socioeconomic inequities.



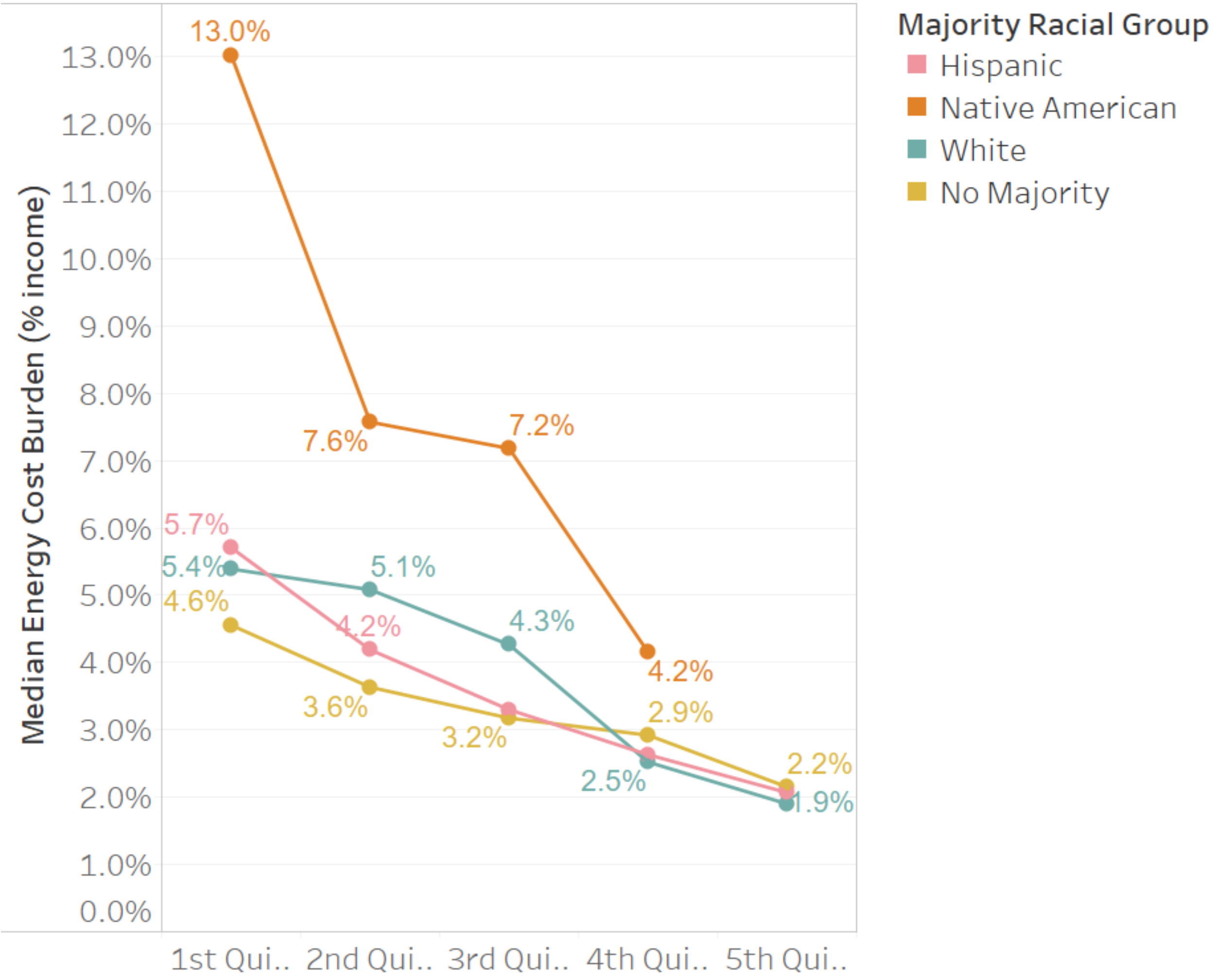
2.3.4 Energy Cost Burdens and Demographics

In addition to varying by income, energy cost burdens vary by community racial composition and other demographic characteristics. Native American communities have the highest average energy cost burdens of any racial group statewide (**Figure 27**). Though these communities are often lower income than White communities, energy burden disparities were observed across income quintiles, with even the highest earning Native American communities experiencing higher average burdens than White and Hispanic communities in the same income bracket.

Additionally, electricity access on tribal lands lags behind that of New Mexico and the United States. This phenomenon is particularly well-known within the Navajo Nation, where up to 15 percent of households lack access to electricity altogether, comprising roughly 75 percent of non-electrified homes in the United

States.[122,123] Data on the exact extent and location of this problem are not widely available due to the dispersed nature of housing and infrastructure on the sprawling tribal lands within New Mexico—though proxy data generally verify the need to expand electricity access. For example, a 2011 Navajo Housing Authority survey found that 80 percent of homes on Navajo land are served by an electric utility, as compared with 98 percent of homes in the United States.[124] Efforts that expand clean energy access on tribal lands, such as deployment of community and rooftop solar, may therefore expand electricity access to new areas as well as providing bill relief and decarbonizing homes that are already on the grid. Expanded funding for such endeavors may be particularly impactful due to the often prohibitively high cost of connecting rural households to the grid.[125]

FIGURE 27. 2018 Energy cost burdens by income and race. Census tract energy burdens decrease with increasing median income regardless of majority racial group, though majority Native American communities have substantially higher energy cost burdens on average across income quintiles. Averages are not calculated for 5th quintile Native American households due to lack of data.



122 Personal communication with New Mexico-based community groups, 2020.

123 American Public Power Association. "Light Up the Navajo Nation." Accessed Feb. 2021. Available at: https://www.publicpower.org/LightUpNavajo

124 Navajo Housing Authority. Phase II Housing Needs Assessment and Demographic Analysis (2011).

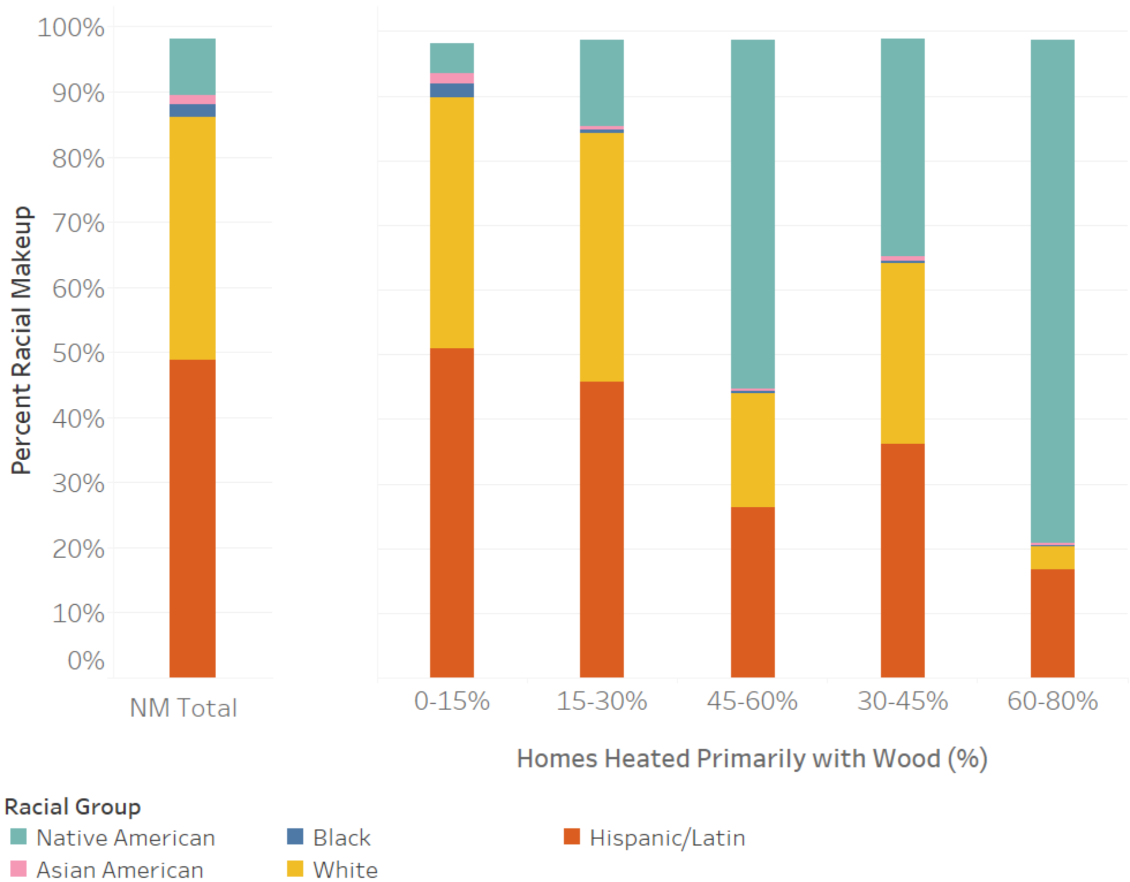
125 Morales, Laurel. "For Many Navajos, Getting Hooked Up to the Power Grid Can be Life-Changing." *National Public Radio,* May 2019. Available at: https://www.npr.org/sections/health-shots/2019/05/29/726615238/for-many-navajos-getting-hooked-up-to-the-power-grid-can-be-life-changing

The above broadly discusses trends by racial groups. Environmental and social vulnerability, however, may also vary by community characteristics within groups. Although Native American communities are compared above to Hispanic communities without accounting for intra-group demographic differences, there is significant variability within Hispanic neighborhoods. **Figure 28** shows that within neighborhoods with majority Hispanic residents, areas with a greater concentration of immigrants have higher average energy cost burdens despite similar per-household energy use. Various indicators of socioeconomic vulnerability also tend to increase as the immigrant population fraction increases, such as lower average incomes and educational attainment. Hispanic immigrant communities may therefore benefit from clean energy investments that lead to significant residential energy bill savings, but they may also be overlooked if they are more broadly grouped in with racially similar communities. It is therefore important to take a nuanced approach to assessing social vulnerability that holistically considers barriers to clean energy access.

FIGURE 28. Energy cost burdens and demographic indicators by nativity in majority Hispanic neighborhoods. In majority Hispanic neighborhoods with larger foreign-born populations, energy cost burdens tend to be higher despite similar energy usage (shown in million British thermal units). Indicators of socioeconomic vulnerability such as educational attainment and household income tend to be lower in immigrant communities.

Electricity constitutes a substantial portion of residential energy consumption and the majority of residential energy spending for most New Mexican households in 2020. By 2050, electricity's share of per-household use and expenditures will grow due to electrification efforts aimed at curtailing in-home use of fossil fuels like natural gas and propane. Consequently, many households and regions will benefit from reduced exposure to health-damaging co-pollutants emitted by indoor combustion of these fuels.[126] As discussed in **Section 2.3.1** however, many probable decarbonization strategies fail to deliver these same benefits to wood-burning households. This omission risks exacerbating sociodemographic inequities due to the generally higher socioeconomic status of communities using gas (**Figure 26**) and the disproportionate reliance on wood in New Mexico's tribal communities (**Figure 29**). Developing strategies to expand these health benefits to populations with lower rates of gas use may therefore alleviate potential health inequities. At the same time, electrification efforts aimed at underserved populations should be accompanied by bill-relief efforts to ensure that replacement of less expensive fuels such as wood does not increase cost burdens for already over burdened households.

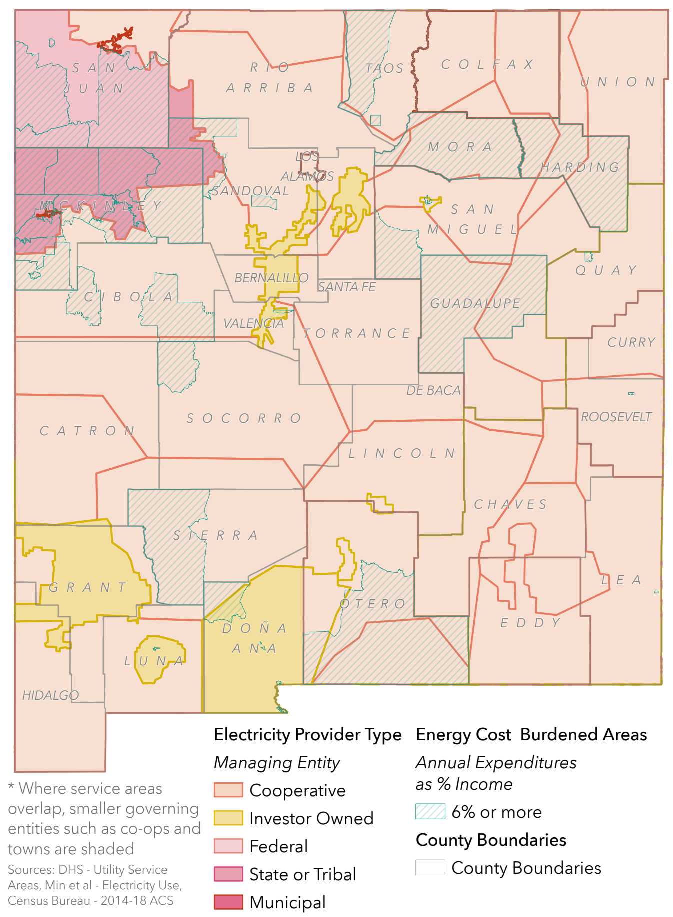
FIGURE 29. Racial composition in wood burning communities. New Mexico's most wood-reliant areas are disproportionately Native American. The most extensively wood-burning communities are 97 percent Native American, compared to 9 percent of the state overall.



126 Yifang Zhu *et al.* Effects of Residential Gas Appliances on Indoor and Outdoor Air Quality and Public Health in California. UCLA Fielding School of Public Health. April 2020.

These trends suggest that fuel switching efforts and efficiency measures in wood-burning communities, especially in tribal areas, are important for environmental and cultural equity purposes. Increased electrification efforts, however, should be undertaken in a manner that minimizes energy cost burdens for communities already struggling to pay their energy bills. Increased reliance on electricity may present new economic challenges due to its higher cost, particularly for rural New Mexicans who source their electricity from one of the state's many small electric cooperatives. While larger electricity providers may levy additional fees or bill increases on higher-earning households to raise subsidies for bill-burdened households, smaller rural cooperatives may have an insufficient quantity of high-earning customers to take on similar initiatives. Large areas of New Mexico are at least partially served by cooperative electricity providers (**Figure 30**). Furthermore, the state's electric cooperatives charge residential customers more than 20 percent more per kilowatt-hour, on average, than do the municipal or investor-owned utilities, which could contribute to even higher energy cost burdens in these territories.[127] It is therefore important to adopt policies that assure that bill relief is available to the most cost-burdened households served by these smaller, local providers.

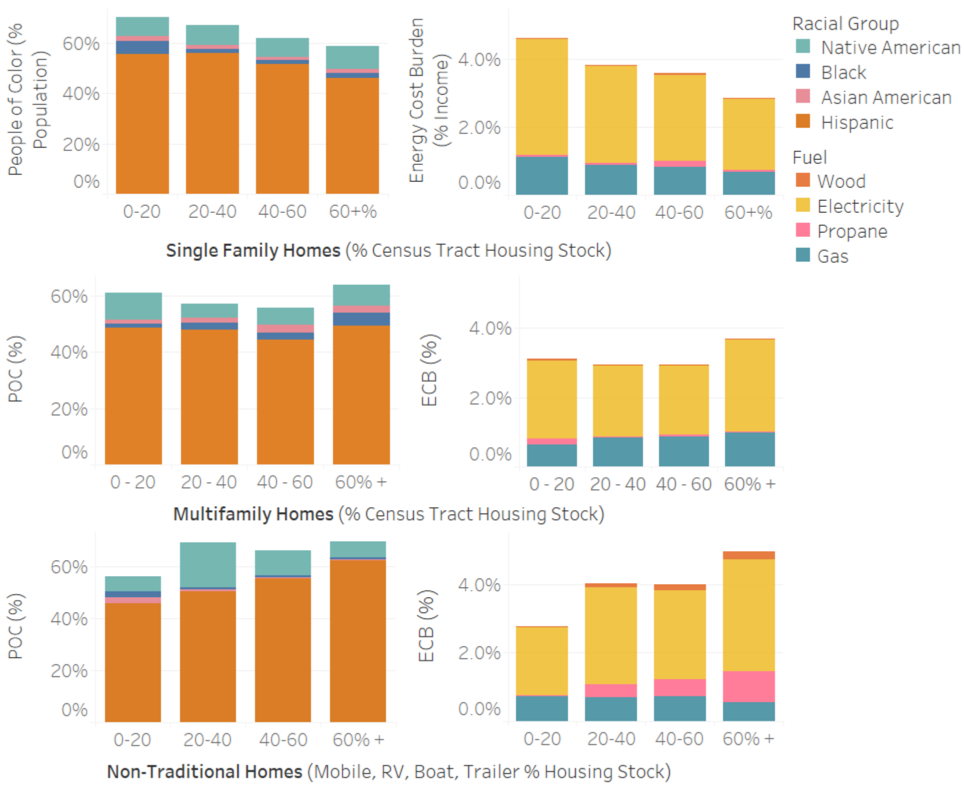
FIGURE 30. Electric retail service areas and energy cost burdens. Large portions of the state, particularly in rural areas, are served by small electric cooperatives which may charge higher rates than larger utilities and lack funds to subsidize their most energy burdened customers.



127 $0.146/kWh for electric cooperatives as compared to $0.120/kWh and $0.121/kWh at investor-owned and municipal utilities, respectively, as of 2019. US Energy Information. "Annual Electric Power Industry Report, Form EIA-861 detailed data file," (2020). Available at: https://www.eia.gov/electricity/data/eia861

As the State establishes policies to increase clean energy access for low-income populations, communities of color, and other energy cost-burdened groups, it is also important to devise strategies that account for differences in housing stock and fuel type among groups. Clean energy policies that are only open to or disproportionately benefit single-family homeowners risk directing outsize benefits to socioeconomically- and demographically-advantaged groups. As an example, **Figure 31** illustrates this point by comparing occupants of single family homes with those of multifamily homes and non-traditional housing units such as RVs, vans, and boats. Though many clean energy policy contexts favor single family homeowners, energy cost burdens tend to decrease as single family homes' share of neighborhood housing stock increases. Moreover, White New Mexicans are more likely to live in single family homes than New Mexicans of color. Decarbonizing multi-family and non-traditional housing units through community solar deployment, electrification of propane and wood, and other measures designed for these types of homes can help promote more equitable outcomes. This is just one illustrative example of how equity outcomes may be improved by considering various housing situations. Policies should be designed to target households with non-traditional or substandard[128] housing situations, occupants of multi-family apartment buildings, renters, and others beyond single-family homeowners to assure that disproportionately wealthy homeowners are not the only ones who benefit from residential decarbonization.

FIGURE 31. Demographics, housing type, and energy cost burdens. Single-family home occupants tend to be disproportionately White and have lower average cost burdens. Decarbonization policy should be designed to include occupants of different housing and fuel types to avoid disproportionate benefits for economically and demographically advantaged groups.



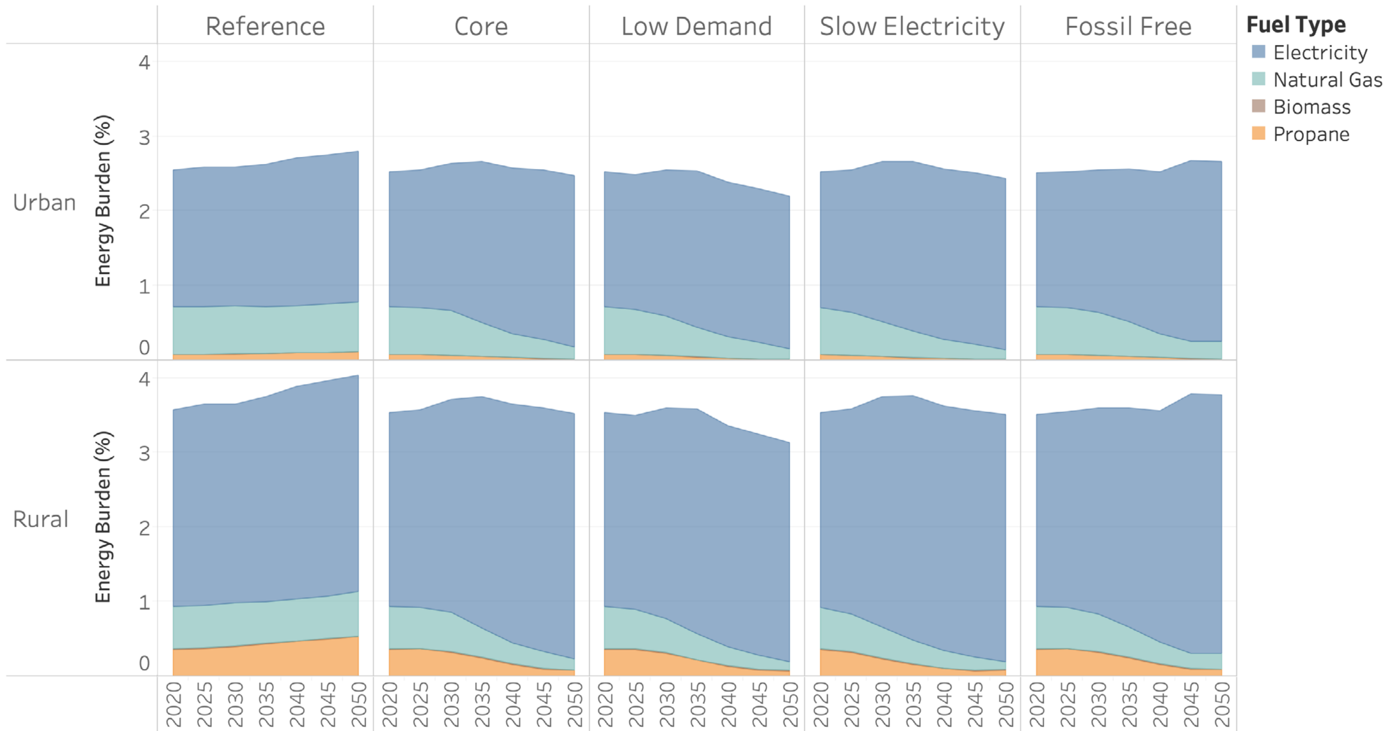
128 Census data suggest a high proportion of homes in some tribal lands lack access to complete plumbing facilities (e.g. running water) relative to the rest of the United States.

2.3.5 Projected Household Energy Cost Burdens

Although residential fossil fuel-focused decarbonization strategies generally result in greater emission reductions in urban areas compared to rural areas, we project that energy cost burdens will decrease slightly more in rural areas on average (**Figure 32**). This is largely due to the gradual curtailment of propane use in rural areas and replacement with electric heating. While residential electricity rates are projected to increase under decarbonization scenarios, overall residential energy use per household is projected to decrease due to the higher efficiency of electric heat pumps and the implementation of other energy-saving measures. Thus, the gradual curtailment of natural gas use in urban areas and propane use in rural areas and their replacement with electric heating does not lead to increased energy cost burden. Our analysis of energy cost burden reflects median values for each census tract and focuses on broad geographic patterns, though individual households may face higher energy cost burdens.

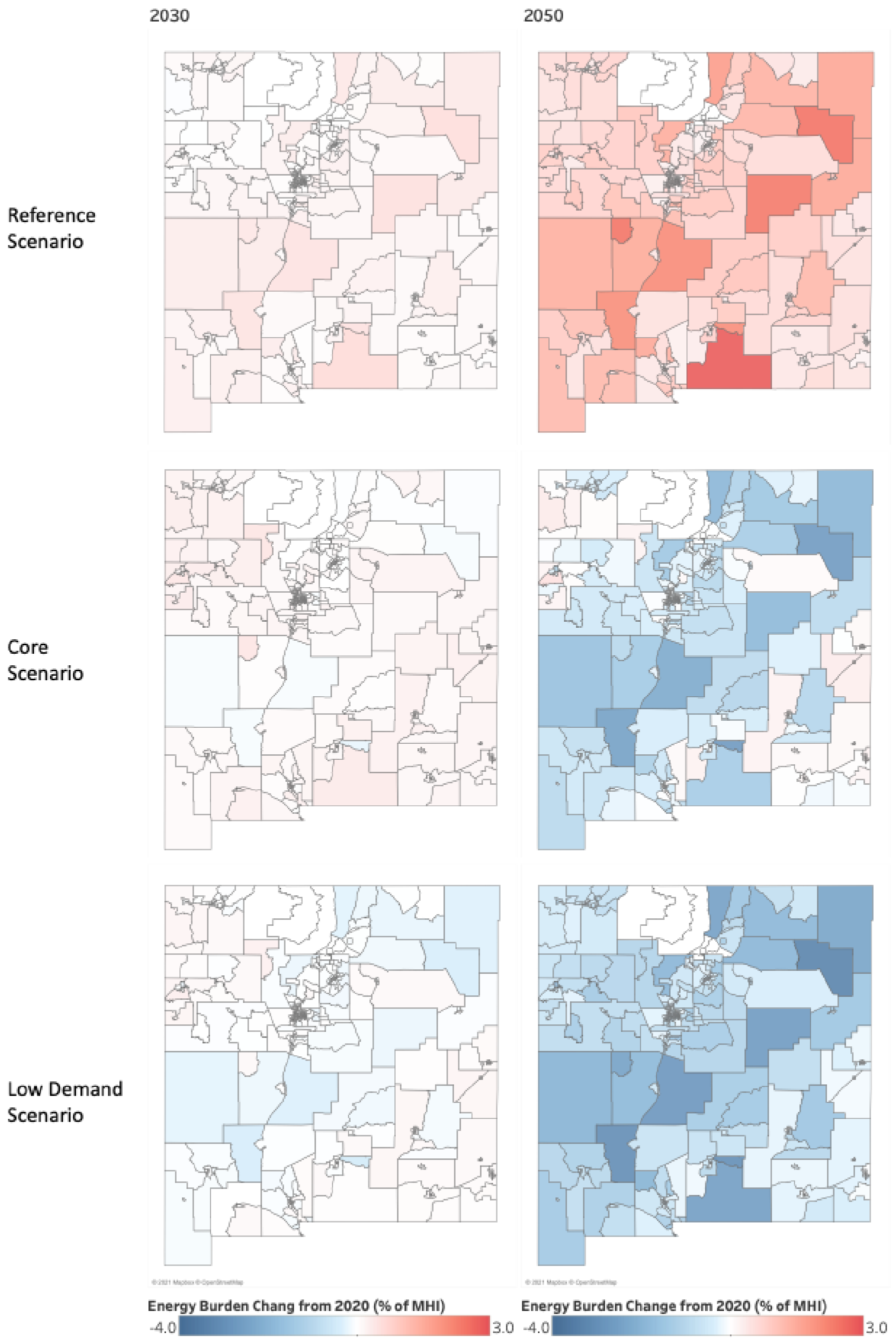
Rural households experience a slight decrease in average energy cost burden mainly under the Core, Low Demand, and Slow Electricity scenarios. The Low Demand scenario results in the largest decrease in energy cost burden, and urban energy cost burdens also decrease on average—making this scenario the most beneficial overall for reducing energy cost burdens.

FIGURE 32. Percent change in projected energy cost burden by scenario for urban and rural areas. Rural areas tend to have the largest decreases in energy cost burden across scenarios, though urban and suburban areas also experience decreases under certain scenarios.



Energy cost burdens are not projected to decrease evenly across rural areas in New Mexico. Due to different rates of fuel switching across scenarios and geographical variability of fuel types at baseline, the spatial distribution of residential energy cost burdens could grow increasingly uneven moving forward (**Figure 33**). In the Reference case, we project energy cost burdens to increase throughout the state and particularly in some rural areas. Core scenario projections, on the other hand, show a decrease in residential energy cost burdens in most rural areas by 2050, even though we see a slight increase in the medium term. The decrease in rural energy cost burdens under the Core scenario, however, is not evenly distributed across the state, and we note that a modest increase is projected in the northwestern and southeastern parts of the state by 2050. In contrast, this uneven change in residential energy cost burdens is largely eliminated under the Low Demand scenario, where we see a decrease in energy cost burdens throughout the state by 2050. Some rural areas experience a slight increase in the medium term (2030) even under the Low Demand scenario.

FIGURE 33. Change in projected energy cost burden by census tract as a percent of median household income.



We did not attempt to identify varying effects on energy cost burdens between different racial groups based on projected values from Evolved's modeled decarbonization scenarios due to the complexity of projecting demographic shifts and future racial composition by census tract. The analysis above assumes relatively equal clean energy adoption rates among demographic groups. Given historic adoption rates throughout the United States, however, this may be an invalid assumption, creating the possibility of higher cost burdens for communities of color if they adopt clean energy technologies at lower rates than White populations (see **Section 2.3.6** below). Targeted policies that provide bill relief for communities of color and increase access to clean energy technologies such as distributed solar and efficiency upgrades may therefore result in more equitable outcomes by bringing the two groups' energy burdens closer to parity.

2.3.6 Projected Energy Bill Impacts

In the context of energy cost burden and bill impacts, it is important to consider possible outliers. Models for each scenario assume that a certain percentage of households are included in decarbonization efforts and adopt some combination of clean energy technologies such as electrification and efficiency measures, leaving the remaining households with less efficient appliances and with pollutant-emitting fuel sources such as natural gas.

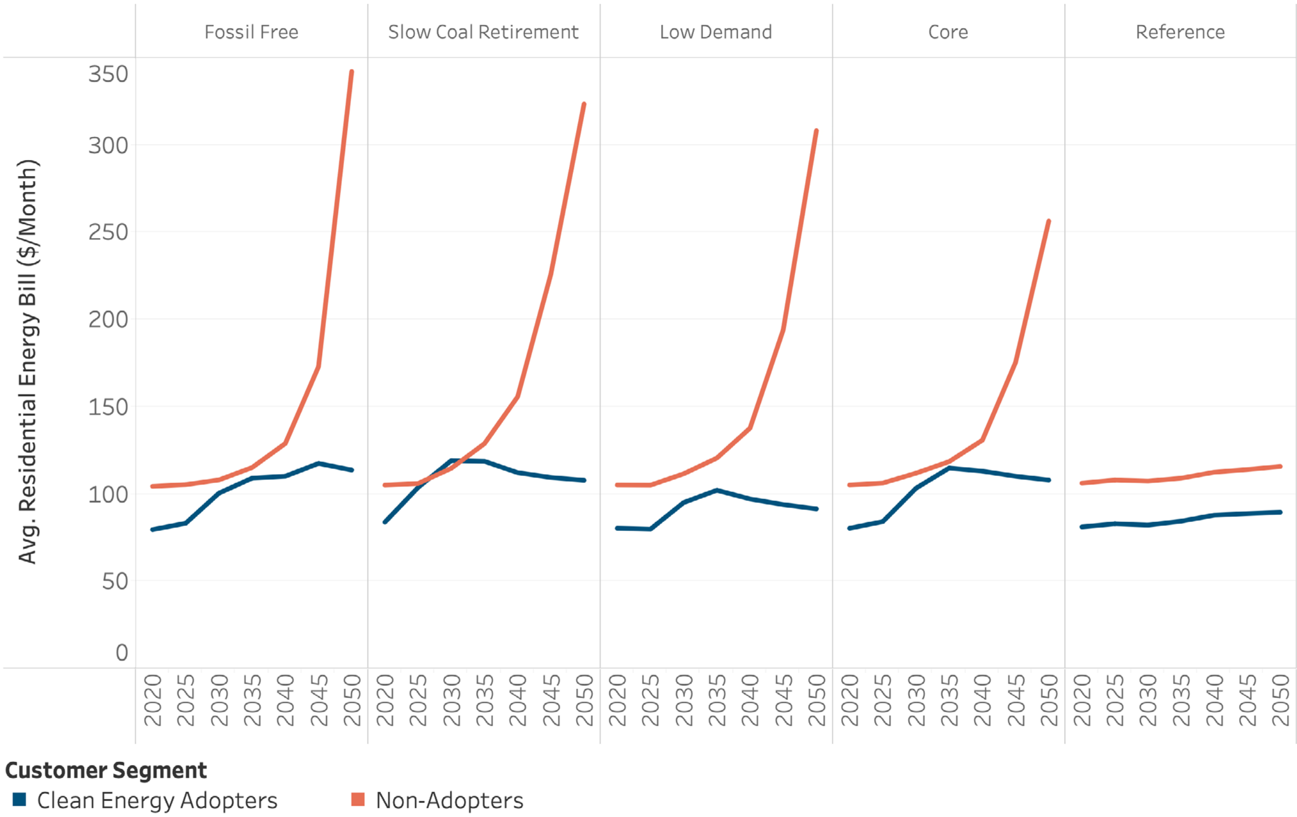
Natural gas use is largely phased out across the state according to a timeline which varies by scenario, but some households continue using natural gas past 2040 even as other homes transition most of their residential energy consumption to electricity. Assuming that households that continue to use gas are located throughout the state and the entire gas distribution system must remain in-place to avoid energy disruption to these homes, the cost of maintaining fossil fuel distribution systems will remain relatively fixed and will need to be distributed among fewer and fewer users.

Figure 34 illustrates how distributing these costs among fewer households has the potential to lead to significant energy bill increases for households that do not transition to clean energy technologies. Monthly bills are consistently higher for non-adopters than adopters over time, but the gap between the two groups varies between 2020 and 2050. For all scenarios, non-adopters' bills are only moderately higher than those of clean energy adopters until roughly 2035-2040, at which time they increase dramatically to cover the cost of maintaining remnant gas infrastructure. This trend is particularly true of the Fossil Free, Slow Coal Retirement and Low Demand scenarios, where non-adopting households could see their energy bills increase by as much as 350%. Though projected energy bill increases are highest for non-adopting households under the Fossil Free and Slow Coal Retirement scenarios, all scenarios yield some monthly bill increase relative to the Reference Scenario by 2050, including for clean energy adopters. This increase is smallest for clean energy adopters under the Low Demand Scenario, where energy bills remain relatively flat in the long term due to a higher rate of implementation of energy efficiency measures.

This analysis raises important questions about the future of the gas distribution system post 2040 and how to prepare in the coming decades to maximize economic co-benefits and minimize adverse energy bill impacts to socioeconomically vulnerable groups in the 2040-2050 timeframe. Our findings underscore the importance of policy interventions that provide energy bill protections for low-income households and make clean energy technologies accessible to households with high baseline energy cost burdens, both of which may be disproportionately impacted by potential energy bill increases.

In addition, our findings suggest that infrastructure maintenance may become challenging for gas utilities past 2040 as demand and revenue decrease in the decarbonization scenarios. A residential gas distribution system will be difficult to maintain if: a) costs are passed onto fewer and fewer remaining customers, in which case fuel switching may happen even faster than assumed in our model due to economic pressures on consumers post 2040; or b) if gas utilities have to absorb these costs to keep their remaining customers. Therefore, a managed and geographically targeted phase-out of the gas distribution system from one region to the next (one region entirely phased out at a time) may have to be considered to mitigate some of these potential impacts by gradually reducing fixed maintenance costs.

FIGURE 34. Change in monthly aggregate energy bills for electricity plus in-home natural gas for clean energy adopters of electrification and efficiency measures versus non-adopters over time. Households that do not adopt clean energy technologies may face skyrocketing utility bills by mid-century, particularly under the Fossil Free and Slow Coal Retirement scenarios.



2.3.7 Climate Resilience and Targeted Deployment of Distributed Energy Resources

Clean energy deployment among certain population subsets may be particularly beneficial to reduce energy cost burdens and provide climate resilience. Rooftop or community solar, for example, can provide bill stability and economic savings for low-income households, especially if paired with energy efficiency measures. Approximately 1.5 gigawatts of solar capacity would be required to completely match the 2030 energy needs of very low-income (below Federal poverty line) households. This number increases to roughly 3.7 gigawatts for low-income (below twice the Federal poverty line) households.[129]

Similar focused deployment strategies are possible to target different populations in a way that maximizes economic, public health, and community resilience benefits. The Core decarbonization scenario projects approximately 1.7 gigawatts of total solar capacity across the state by 2030, 0.8 gigawatts of which are rooftop solar. **Table 3** shows approximately what portion of this would be required to completely meet 2030 energy needs for various groups. The populations shown may particularly benefit from clean energy due to social, geographic, and health-based vulnerabilities. Though this table is not comprehensive, it illustrates

129 In this analysis, "very low-income" households are households below the federal poverty line. "Low-income" households are households below double the federal poverty line.

that focusing on vulnerable populations during clean energy deployment may maximize the co-benefits of decarbonization. Policymakers may therefore wish to consider co-benefits when balancing deployment of distributed energy resources versus utility-scale solar projects and developing financing mechanisms and adoption incentives.

Rural households, for example, and people who rely on electricity for medical needs may particularly benefit from solar + storage systems, which can provide backup during grid outages. Urban apartment dwellers can benefit from the bill stability of community solar programs. Low-income households living in areas with many extreme heat days—projected to increase, particularly in places like Las Cruces and Carlsbad (**Figure 35**)—may face trade-offs between affording their electric bills and risking heat- and air pollution-related health complications (e.g. heat stroke,[130] cardiovascular and respiratory episodes).[131] Affordable, reliable access to air conditioning and air filtration may help mitigate such outcomes.[132,133] Low-income households in or downwind of high fire risk areas may similarly benefit from improved access to air filtration and reliability during natural disasters. Solar + storage systems and microgrids can serve as resilience hubs and help meet cooling, cell phone charging, air filtration, and evacuation needs at locations such as schools and community centers, as well as providing resilience to key facilities such as hospitals and fire stations.

Though there are many populations which may benefit from increased energy reliability and affordability in the face of a changing climate, households that altogether lack access to electricity potentially stand to benefit the most from clean energy adoption. Thousands of households across rural New Mexico—particularly within tribal lands—are not connected to the grid (see **Section 2.4.5**). Lack of access to refrigeration for food and medication, inability to pump water, and other challenges are accordingly a fixture of everyday life for many New Mexicans; and may become particularly acute challenges to community resilience in light of increasing weather extremes and more frequent disasters. Pairing grid connection efforts with clean energy deployment efforts can therefore improve the daily lives of thousands of New Mexicans as well as improving resilience. This would require a relatively small portion of projected 2030 solar capacity—with just 2.5 percent of projected rooftop capacity meeting the energy needs of households without electricity in the Navajo Nation, for example. Policies providing accessible clean energy resources to communities without electricity connection may therefore prove particularly high-yield for maximizing public health and resilience co-benefits.

130 Wu *et al.* Emergency Department Visits for Heat Stroke in the United States, 2009 and 2010. *Injury Epidemiology* 1.1 (2014): 8.

131 Barnett, A. G., *et al.* Cold and Heat Waves in the United States. *Environmental Research* 112 (2012): 218-224.

132 Ostro *et al.* The Effects of Temperature and Use of Air Conditioning on Hospitalizations. *American Journal of Epidemiology* 172.9 (2010): 1053-1061.

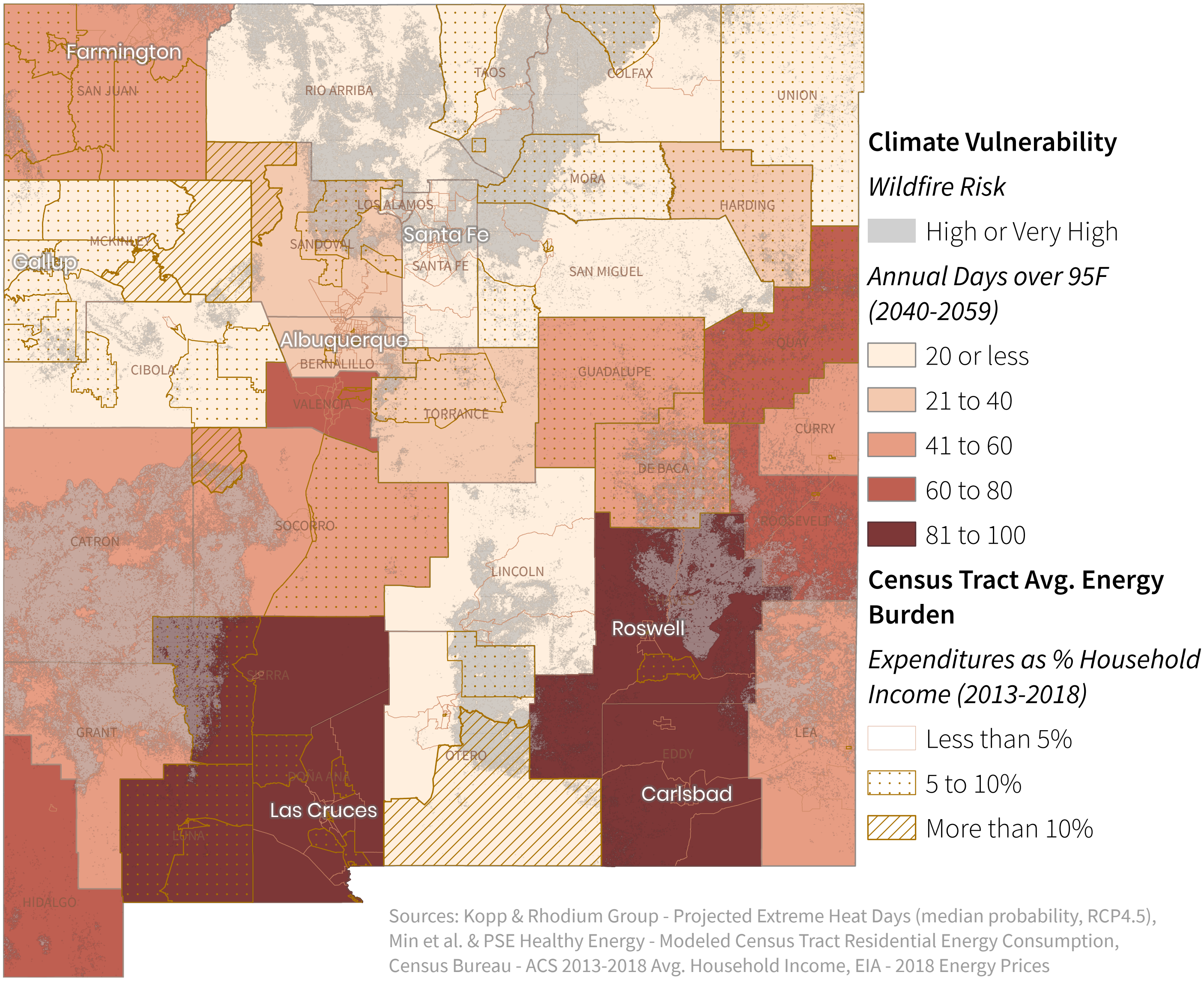
133 Pascal, Mathilde, *et al.* "Extreme Heat and Acute Air Pollution Episodes: a Need for Joint Public Health Warnings?." *Atmospheric Environment* (2021): 118249.

TABLE 3. Approximate solar capacity required to meet demand for a subset of vulnerable groups by 2030 under the Core Scenario. Developing policies to maximize distributed clean energy adoption among climate-vulnerable New Mexicans may maximize public health and resilience co-benefits while consuming a relatively small portion of available resources.

Population Subset	Number of Households	Solar Required to Meet Projected 2030 Electricity Needs (Core Scenario)		
		Total GW	% of Total Solar in 2030 (1.7 GW)	% of Rooftop Solar in 2030 (0.8 GW)
Total New Mexico Households	780,000	4.5	265%	560%
Base Demographic & Geographic Groups				
Very Low-Income Households (below Federal poverty line)	156,500	0.8 GW	47%	100%
Low-Income Households (below 2x Federal poverty level)	330,600	1.7 GW	100%	212%
Rural Households	56,000	0.3 GW	18%	38%
Projected Extreme Heat County Households (90th percentile annual days over 95˚F)	70,000	0.2 GW	12%	38%
Projected High Heat County Households (75th percentile annual days over 95˚F)	200,500	0.9 GW	53%	113%
Electricity-dependent Medicare Beneficiaries	41,300	0.2 GW	12%	25%
Households within Tribal Lands	35,000	0.2 GW	12%	25%
Households in Navajo Nation	17,700	0.1 GW	6%	13%
Combination Demographic & Geographic Groups				
Low-Income, Rural Households	29,000	0.2 GW	12%	20%
Medical Baseline Customers in Heat Counties (50th percentile annual days over 95˚F)	14,600	0.1 GW	6%	13%
Low-Income Households in Heat Counties (50th percentile annual days over 95F)	87,000	0.5 GW	30%	63%
Households in Navajo Nation without Electricity Access*	2,700	0.02 GW	1%	2.5%

**Assumes 15 percent of households lack reliable access to electricity based on conversations with community groups.*

FIGURE 35. Projected extreme heat days and average household energy cost burdens. Portions of New Mexico may experience frequent extreme heat days by mid-century, particularly in the southern portion of the state. A warming climate may exacerbate energy cost burdens due to increasing air conditioning needs.



Sources: Kopp & Rhodium Group - Projected Extreme Heat Days (median probability, RCP4.5), Min et al. & PSE Healthy Energy - Modeled Census Tract Residential Energy Consumption, Census Bureau - ACS 2013-2018 Avg. Household Income, EIA - 2018 Energy Prices

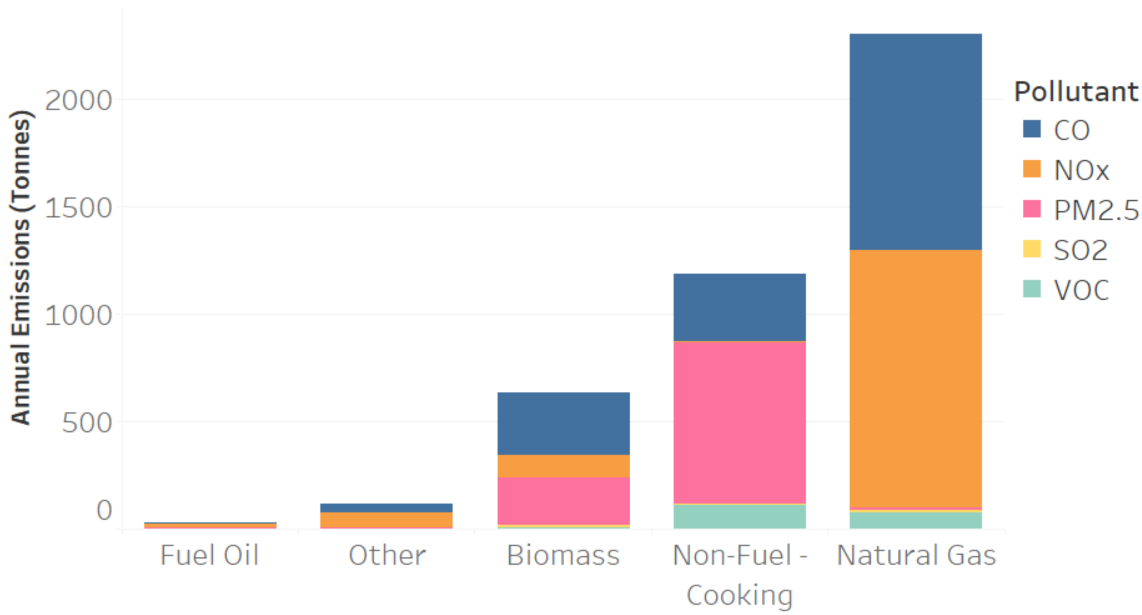
2.3.8 Commercial Buildings

According to the US Energy Information Administration, the commercial sector accounted for 4.1 megatonnes of CO_2 emissions in New Mexico in 2017.[134] We were unable to locate or derive commercial emissions data at finer spatial resolution than the county level, which we obtained from the National Emissions Inventory (NEI).[135] Lack of spatially granular commercial data does not preclude further decarbonization efforts, but presents difficulties in ensuring decarbonization policy is designed to maximize health, economic, and equity co-benefits where they are most needed. There is accordingly a strong need for more rigorous reporting and characterization of commercial emissions data.

The NEI dataset characterizes non-point sources of commercial emission. Of the fuels burned by non-point sources in the NEI dataset, natural gas produces the most criteria air pollutant emissions statewide (**Figure 36**).

Emissions also result from burning fossil fuels such as gasoline, distillate, propane, and biomass, though to a lesser extent. Without census-tract or facility-level data, it is not feasible to ascertain the distribution of these fuels across geographic space and commercial facility types. The only industry with emissions characterized in the dataset is commercial cooking. However, many of these emissions come from the act of cooking itself,[136] which results in emissions of pollutants such as $PM_{2.5}$ and VOCs due to the chemical processes that occur during cooking, as opposed to fuel burning for the purposes of cooking. Based on the available data, the state should initiate fuel switching initiatives to replace use of natural gas, gasoline, propane, and other emitting fuels with clean electricity in the commercial sector. Moreover, the State may be better able to develop targeted policy initiatives with more detailed information and data collection efforts are warranted.

FIGURE 36. Commercial sector criteria pollutant emissions (2017). "Other" includes gasoline and propane. Data are limited, though commercial use of natural gas, gasoline, propane, and distillate emit criteria air pollutants and precursors. Electrification can reduce fuel use and associated emissions. More data will help develop well-targeted decarbonization strategies for the commercial sector.



134 US Energy Information Administration. "2017 State Energy-Related Carbon Dioxide Emissions by Sector." May 20, 2020. Available at: https://www.eia.gov/environment/emissions/state/

135 The National Emissions Inventory reports state commercial sector emissions but is incomplete.

136 US Environmental Protection Agency. "Commercial Cooking NEMO FINAL_4-2 update." Accessed Oct. 2020. Available at: http://newftp.epa.gov/air/nei/2017/doc/supporting_data/nonpoint/

2.4 **Industrial Sector**

2.4.1 Overview

New Mexico's industrial sector—dominated by oil and gas production—is the state's largest energy consumer[137] and is responsible for the majority of greenhouse gas emissions and a significant share of criteria air pollutant emissions across the state (**Figure 1**). Because energy-related industrial greenhouse gas emissions in New Mexico are almost entirely attributed to fossil fuel production (97 percent), reducing fossil fuel use at non-oil and gas industrial facilities will only eliminate a small fraction (3 percent) of these emissions.[138] Reducing combustion-related emissions at oil and gas facilities through fuel switching and energy efficiency measures, as well as reducing non-combustion fugitive emissions from oil and gas infrastructure, will therefore be critical to decarbonizing the industrial sector in New Mexico. Full mitigation will require phasing out oil and gas production entirely and remediating polluted sites.

Determining the extent to which criteria air pollutant emissions will be reduced through decarbonization measures such as electrification is difficult due to limited emissions data across New Mexico's industrial sector. While data are available on carbon emissions from fossil fuel use across the industrial sector, facility-level data on criteria pollutant emissions from industrial point sources do not distinguish between combustion and non-combustion emissions for various fuel types. Without this attribution, we cannot reasonably estimate what fraction of criteria air pollutant emissions from industrial point sources will be reduced through decarbonization measures, which primarily address combustion processes through electrification, energy efficiency, and the replacement of fossil fuels with biofuels and synthetic fuels.

Estimates of emissions from distributed industrial sources across the state—such as oil and gas wells and associated infrastructure—are only available at the county level and are likely underestimates.[139] Without sufficient spatial granularity, we cannot thoroughly assess the environmental equity and health impacts of these distributed sources, even though they are known to produce criteria air pollutants and other health-damaging air pollutants. Within these data limitations, we analyze the distribution of criteria air pollutant emissions from stationary industrial point sources across population segments, but are limited to a proximity analysis for distributed sources, mapping populations living near oil and gas wells (as a proxy for oil and gas development operations more generally).[140] Given the lack of facility-level data on criteria air pollutant emissions from fuel combustion and spatially granular emissions data for distributed sources, we can only describe potential health and environmental equity implications of industrial decarbonization in broad strokes.

137 US Energy Information Administration. "New Mexico: State Profile and Energy Estimates" 2020. Accessed Jan. 2021. Available at: https://www.eia.gov/state/analysis.php?sid=NM.

138 Energy+Environmental Economics. New Mexico Greenhouse Gas Emissions Inventory and Forecast (2020).

139 National Emissions Inventory (NEI) emissions estimates for industrial nonpoint sources may be underestimates as a result of underreporting of pipeline emissions between wellheads and gas processing facilities, as well as the existence of above-average high-emitting oil and gas sites (Grant, John *et al*. "U.S. National Oil and Gas Emission Inventory Improvements." (2017)).

140 Czolowski, Eliza D., *et al.* Towards Consistent Methodology to Quantify Populations in Proximity to Oil and Gas Development: A National Spatial Analysis and Review. *Environmental Health Perspectives* 125.8 (2017): 086004.

2.4.2 Oil and Gas Sector

New Mexico is the third largest oil producing state[141] and eighth largest natural gas producing state[142] in the country. Accounting for about 1 percent of total greenhouse-gas emissions in the US,[143] the oil and gas sector in New Mexico employs over 100,000 people and contributes a significant portion of the state's budget.[144] While fossil fuel combustion at oil and gas facilities is responsible for a portion of greenhouse gas and health-damaging air pollutant emissions—providing an opportunity to reduce such emissions through electrification—a majority of emissions from these facilities are emitted through non-combustion processes. The phase-out of oil and gas production will therefore be required to meaningfully reduce total sectoral emissions in the coming decades to both meet state climate targets and protect public health. Infrastructural investments and clean energy job creation in regions with a large oil and gas presence may help facilitate managed decline and a just transition by assuring that communities which economically rely on the fossil fuel industry are included in a decarbonized economy.

Oil and gas facilities are largely centered in the San Juan Basin in the northwest and the Permian Basin in the southeast of New Mexico, and include roughly 50,000 active oil and gas wells,[145] four interstate crude oil pipelines, nine major natural gas pipeline operators, 24 gas processing plants, two refineries, and a broad network of support infrastructure including compressor stations and distribution pipelines (**Figure 37**).[146] A large share of greenhouse gas emissions from the state's oil and gas infrastructure comes from methane, a potent greenhouse gas with 87-times the global warming potential of CO_2 over a 20-year time period. Methane may be emitted intentionally (e.g., during venting or blowdowns) or unintentionally (e.g., from leaking infrastructure) (See **Box 1**). While measures can be taken to reduce fugitive methane emissions, the phase-out of oil and gas production can reduce them entirely along with various health-damaging air pollutants that are co-produced from oil and gas reservoirs (e.g., benzene, toluene, ethylbenzene, and xylene, together referred to as BTEX). Benzene, for example, is listed by the EPA as a hazardous air pollutant, is a known human carcinogen, and is toxic to human development, the immune system, and blood.[147]

141 US Energy Information Administration. "New Mexico: State Profile and Energy Estimates" 2020. Accessed Jan. 2021. Available at: https://www.eia.gov/state/analysis.php?sid=NM.

142 US Energy Information Administration. "Natural Gas Gross Withdrawals and Production" 2020. Accessed Jan 2021. Available at: https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGW_mmcf_m.htm.

143 "Joe Biden's Climate-Friendly Energy Revolution." *The Economist*. Feb. 20, 2021. Available at: https://www.economist.com/briefing/2021/02/20/joe-bidens-climate-friendly-energy-revolution.

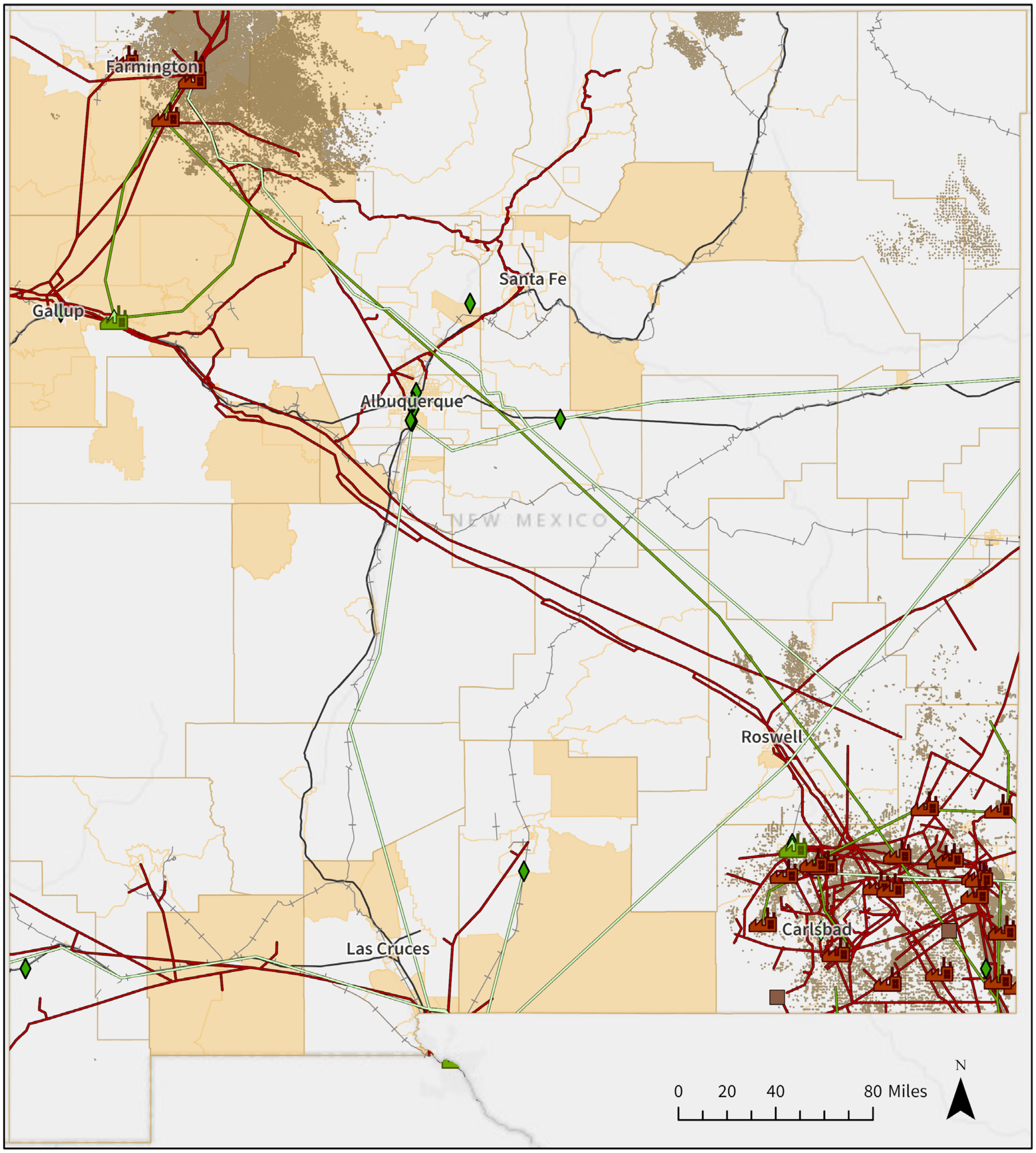
144 Hedden, Adrian. "Before COVID-19, Oil and Gas' Drove Economy in New Mexico, Struggles to Continue in 2021." *Carlsbad Current-Argus*. Oct. 14, 2020. Available at: https://www.currentargus.com/story/news/local/2020/10/14/before-covid-19-oil-and-gas-drove-economy-new-mexico/5972582002/.

145 Enverus DrillingInfo. "Production." Accessed Feb. 2021.

146 US Energy Information Administration. "U.S. Energy Mapping System." Accessed Jan. 2021. Available at: https://www.eia.gov/state/?sid=NM.

147 Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary.

FIGURE 37. New Mexico oil and gas production, transmission, and processing. Oil and gas extraction and processing infrastructure is concentrated in the San Juan Basin in northwestern New Mexico and the Permian basin in the southeast. In the northwest, oil and gas infrastructure is located in areas with particularly high fractions of low income households relative to the state average.



New Mexico Oil & Gas Infrastructure

Extraction & Production
- Petroleum Refineries
- Natural Gas Plants
- Active Oil & Gas Wells

Transport and Storage
- Crude Rail Terminals
- Underground Natural Gas Storage
- Petroleum Product Terminals
- Petroleum Product Pipelines
- Crude Oil Pipelines
- Natural Gas Pipelines
- Railroads
- Major Roads

Low Income Census Tracts

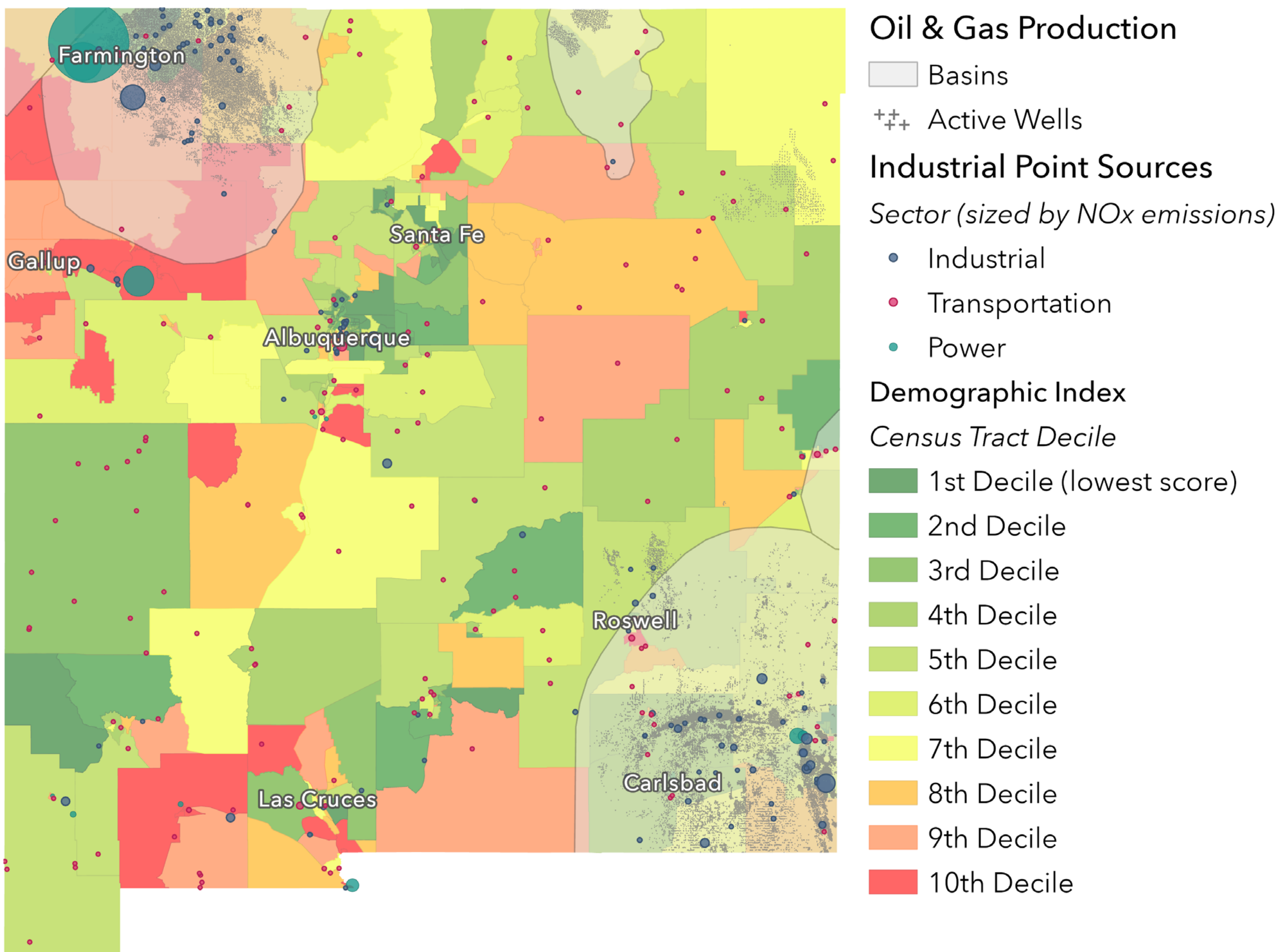
% Low-Income Residents
- 1st - 4th Quintile
- 5th Quintile (most low income residents)

Date: September 3, 2020 | Source Data: U.S. Energy Information Administration Energy Mapping System - Petroleum Refineries, Petroleum Product Terminals, Crude Rail Terminals, Petroleum Product Pipelines, Crude Oil Pipelines, U.S. Census Bureau - TIGER/LINE Railroads & Major Roads, DrillingInfo - Active Oil and Gas Wells

Oil and gas production and processing facilities are responsible for the vast majority of criteria air pollutant emissions from industrial point sources in New Mexico, emitting roughly 90 percent of NO_x emissions, 99 percent of SO_2 emissions, and 63 percent of $PM_{2.5}$ emissions,[148] in addition to hazardous air pollutants such as benzene, toluene, ethyl benzene, and xylene. The health co-benefits of decarbonizing New Mexico's industrial sector are therefore heavily dependent not only on the replacement of fossil fuel use at industrial sites (with measures such as electrification or renewable hydrogen), but even more importantly on the future of oil and gas development across the state.

Figure 39 depicts power plants and oil and gas development facilities—the highest emitters of NO_x—clustered in the northwestern San Juan Basin, where census tracts have high Demographic Index rankings, as well as in the southeastern Permian Basin.

FIGURE 38. Point source NO_x emissions and Demographic Index. Point sources are located throughout the state; though certain sources, such as industrial facilities and oil and gas wells, are heavily clustered in the San Juan and Permian Basins. Failure to address spatially clustered polluting facilities risks leaving disproportionate residual pollution burdens in environmentally overburdened communities.



148 Oil and gas sector emissions are based on the National Emissions Inventory (NEI) 2017 dataset, and are likely underestimates due to the difficulty of characterizing criteria and hazardous air pollutant emissions from the oil and gas sector.

Analyzing the demographic characteristics of communities living near industrial point sources, we find that $PM_{2.5}$, NO_x, and SO_2 emissions are higher per unit area on average in census tracts with racial minority percentile rankings between 50 and 70 percent (**Figure 39**). Industrial point sources that emit $PM_{2.5}$, NO_x, and SO_2 are highly concentrated in the state, located in roughly 8 percent of New Mexico's census tracts. The high average emissions densities in certain decile brackets in **Figure 39** are therefore driven by a small subset of census tracts where these facilities are concentrated. $PM_{2.5}$ and NO_x emissions in these census tracts are primarily from oil and gas facilities, including the Navajo Refinery in the city of Artesia, which is predominantly Hispanic, and natural gas extraction and processing facilities in an area of Bloomfield that is disproportionately Native American. Manufacturing facilities in Albuquerque also contribute to the high average emissions density in communities of color, with several facilities located in census tracts where Hispanic, Asian American, and Black populations are overrepresented. The high average density of SO_2 emissions in the 60-70 percent decile bracket is due to the San Juan River Gas Plant, a natural gas processing facility located about ten miles west of Farmington in a census tract that is majority Native American. The New Mexico Environment Department found the San Juan River Gas Plant to be in violation of allowable emission limits from October 2016 to November 2018, with numerous excess emissions events amounting to over 1.6 million pounds of excess health-damaging air pollutants, including SO_2, NO_x, VOCs, carbon monoxide, and hydrogen sulfide.[149] This incident is indicative of a broader trend among oil and gas facilities in New Mexico, many of which have violated air pollution regulations over the last several years.[150]

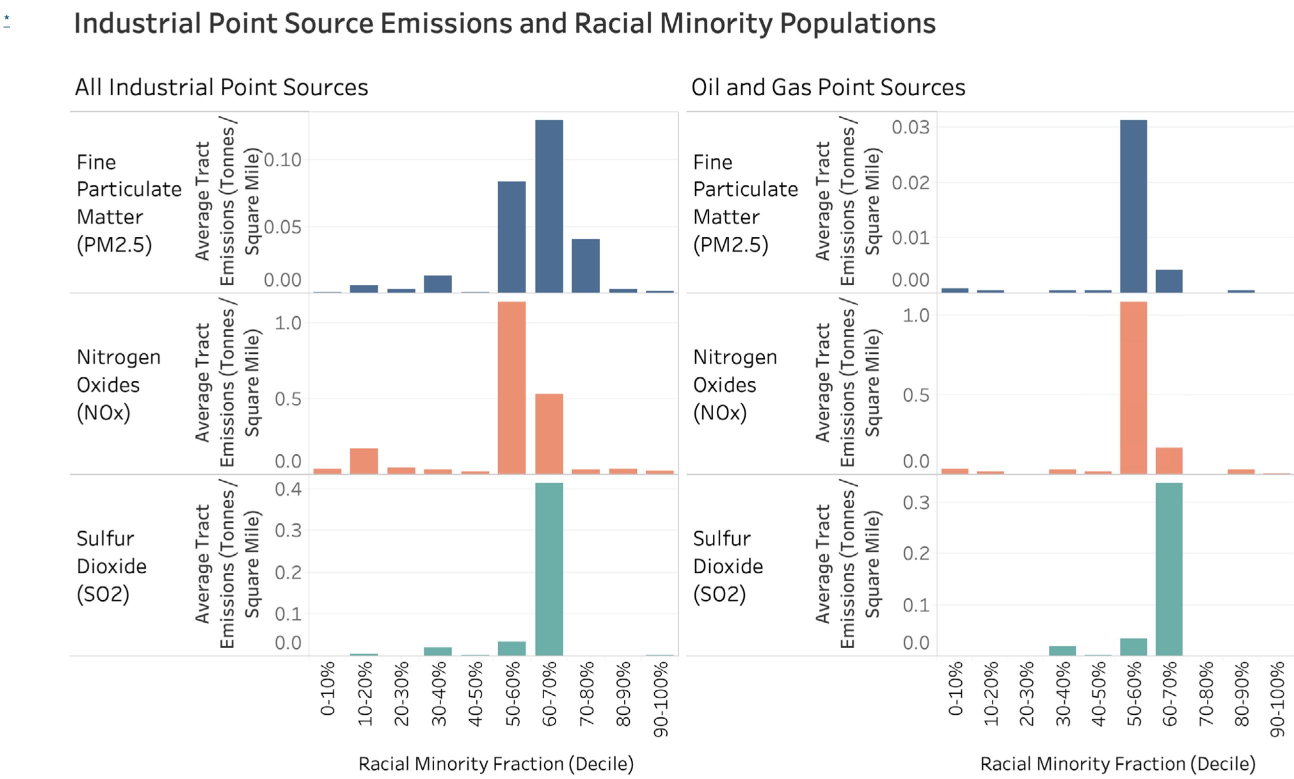
We find a similar demographic trend for the subset of industrial point source emissions associated with oil and gas infrastructure. Emissions of $PM_{2.5}$, NO_x, and SO_2 from these facilities—including natural gas processing plants and compressor stations, petroleum refineries, and other large, stationary sources associated with fossil fuel production, refining, storage, and transport—are also most dense on average in census tracts with racial minority percentile rankings between 50 and 70 percent (**Figure 39**).[151] Oil and gas facilities that emit $PM_{2.5}$, NO_x, and SO_2 are concentrated in only 6 percent of New Mexico's census tracts. The high average emission densities in certain decile brackets in **Figure 39** are therefore driven by a small subset of census tracts. The high average density of oil and gas-related $PM_{2.5}$ and NO_x emissions in the 50-60 percentile decile bracket is primarily due to natural gas processing plants and compressor stations in Bloomfield and Hobbs, where the population fraction that is Native American (Bloomfield) and Hispanic (Hobbs) is higher than the state average. The high average density of SO_2 emissions in the 60-70 percent decile bracket is due to the San Juan River Gas Plant, discussed above.

149 Secretary of the Environment, State of New Mexico. Environmental Protection Division of the New Mexico Environment Department v. CCI San Juan LLC, San Juan River Gas Plant (NO. AQB CCI-1252-1801-R2) (2020).

150 Hedden, Adrian. "New Mexico Fines DCP Operating Co., Energy Transfer Partners $7 Million for Air Pollution." *Carlsbad Current-Argus,* Sep. 2020. Available at: https://www.currentargus.com/story/news/local/2020/09/02/new-mexico-fines-oil-and-gas-companies-air-pollution-regulations/5684672002/.

151 Analysis excludes distributed sources such as oil and gas wells, for which we have limited emissions data.

FIGURE 39. Industrial point source $PM_{2.5}$, NO_x, and SO_2 emissions and racial minority population fraction, for all industrial point sources (left) and for oil and gas facilities (right). Industrial point source emissions are more dense on average in census tracts with racial minority percentile rankings between 50 percent and 70 percent. This is also true for the subset of point sources that are oil and gas related. The rightmost bar represents the 10 percent of census tracts with the highest population proportion of racial minorities, while the leftmost bar represents the 10 percent of census tracts with the lowest population proportion of racial minorities.



BOX 1

Emissions of Methane and Health Damaging Air Pollutants From Oil and Gas Production

According to New Mexico's recent climate strategy,[152] oil and gas production is responsible for 53 percent of the state's greenhouse gas emissions. Methane, a potent greenhouse gas, accounts for more than half of these oil and gas sector emissions, making up 35 percent of New Mexico's total greenhouse gas emissions in the state's 2018 inventory.[153] While formidable, these 2018 values are likely an underestimate of current greenhouse gas emissions from oil and gas, in large part due to skyrocketing oil and gas production levels. Moreover, the oil and gas sector emits numerous health-damaging air pollutants in addition to greenhouse gases, both directly from production wells and infrastructure, and from fossil fuel combustion powering oil and gas production and processing. New Mexico plans to take steps in the near term to reduce methane emissions, but full mitigation of the climate and health impacts of this sector will require a phase-out of oil and gas production and remediation and monitoring of polluted sites.

Methane

Methane, the primary constituent in natural gas, is released throughout the entire natural gas system (Ingraffea, 2011, Brandt *et al.* 2014, Alvarez *et al.,* 2018). Methane has 28 times the global warming potential of CO_2 on a 100-year timescale (36 times when including secondary climate responses), and 87 times the potency of CO_2 on a 20-year timescale. Methane leakage plagues oil and gas production across the United States, leaking at an estimated average rate of 1.9 percent of gross gas production during production, gathering, and processing, and 2.3 percent of gross gas production when considering the entire supply chain (Alvarez *et al.,* 2018). However, atmospheric measurements of methane concentrations above the Delaware sub-basin in the Permian, which is largely located in New Mexico, find that methane leakage rates in this region are double the national average at 4.1 percent (Zhang *et al*. 2020). Methane leaks occur at numerous sources. Natural gas-powered pneumatic devices, used to control gas and liquid flows, release methane as a part of normal operation and are one of the largest sources of methane from the industry.[154] Associated gas from oil production is often vented or flared (burned), but these flares frequently malfunction and release gas directly to the atmosphere. A recent analysis of the Permian found that during four weeks in 2020, at any time approximately five percent of flares were unlit—meaning the methane was directly released—and another five percent were malfunctioning.[155] Additional methane leaks occur throughout the system, including from valves and other equipment and from abandoned and orphaned wells. Methane is emitted from oil tanks, condensate tanks, produced water tanks, completions and workovers, gathering stations, pipelines, processing plants, and transmission, storage, and distribution systems (Alvarez *et al.* 2018).

The State of New Mexico greenhouse gas inventory estimates that the oil and gas sector released 1.26 million metric tons of methane in 2018. However, by 2020, emissions were likely even higher for multiple reasons. First, oil production increased by 51 percent between 2018 and 2020,[156] and gas production increased by 32 percent[157] over the same period, in spite of drops in production during the first months of the COVID-19 pandemic. Assuming that methane emissions grow in line with production, methane leakage and production-related fossil fuel combustion may have increased by 30-50 percent between 2018 and 2020. Second, the inventory is based on bottom-up estimates from the Western Regional Air Partnership (WRAP) inventory. However, bottom-up inventories—which sum up estimated emissions factors for individual components, like valves, across the oil and gas system—typically

152 Tabor, Laura *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

153 *Ibid.*

154 US Environmental Protection Agency. Options for Reducing Methane Emissions from Pneumatic Devices in the Natural Gas Industry (2006).

155 Environmental Defense Fund. "Through Turbulent Year, EDF Data Show Permian Oil and Gas Operators Consistently Failed to Keep Flares Lit." Feb. 10, 2021. Available at: https://www.edf.org/media/through-turbulent-year-edf-data-show-permian-oil-and-gas-operators-consistently-failed-keep

156 US Energy Information Administration. "Petroleum and Other Liquids." Accessed Mar. 16, 2021. Available at: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPNM2&f=M

157 US Energy Information Administration. "Natural Gas Gross Withdrawals and Production." Accessed Mar. 16, 2021. Available at: https://www.eia.gov/dnav/ng/NG_PROD_SUM_DC_SNM_MMCF_A.htmhttps://www.eia.gov/dnav/ng/NG_PROD_SUM_DC_SNM_MMCF_A.htm

find lower total methane emissions than studies that measure real atmospheric concentrations of methane above productive basins (e.g. as done by Zhang *et al.,* 2020). These higher atmospheric concentrations may be due in part to super-emitters—a small fraction of wells, valves, compressor stations, and other components that are thought to be the source of a large fraction of total methane emissions—which are poorly characterized by bottom-up emission inventories. Based on the findings from Zhang *et al.,* the State of New Mexico's inventory estimates may therefore be low. Finally, the timeframe used by the state inventory to evaluate the climate impact of methane likely undervalues its potency. The state inventory uses a global warming potential of 28. However, the global warming potential of methane inclusive of climate feedbacks—36—is 29 percent higher than the value of 28 used in the inventory. More importantly, methane's 20-year global warming potential is three times higher than its 100-year global warming potential, meaning it has significantly higher climate impacts in the near term than reflected in the inventory. Collectively, the growth in production, high atmospheric concentrations of methane above the Permian, and high near-term climate impact of methane indicate that the need to reduce oil and gas sector greenhouse gas emissions, and methane in particular, is of even greater urgency than the state's climate report suggests.

Health-Damaging Air Pollutants

Oil and gas production also emits numerous health-damaging air pollutants.[158] Some of these, such as NO_x, CO, and $PM_{2.5}$, are produced in large part from diesel and gas combustion used to provide energy to produce steam, power trucks, or drive production and processing equipment, as well as from associated gas[159] flared on site. Other pollutants, such as non-methane volatile organic compounds, including benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX), frequently leak alongside fugitive methane. BTEX are considered hazardous air pollutants and carcinogens in and of themselves, and also react with NO_x to form regional ozone, which is associated with cardiovascular and respiratory health impacts such as asthma attacks. Recent work from EDF suggests that oil and gas production in New Mexico releases more than 337,500 metric tons of VOCs annually.[160] Nationwide, the increase in ozone concentrations due to oil and gas production are greatest above the Permian Basin in Texas and New Mexico.[161]

Mitigation

Specific steps can be taken to help reduce the emissions of greenhouse gases and air pollutants from oil and gas production and to protect the health of nearby populations. These include such measures as:

- Replace fossil fuel combustion (typically diesel and gas) with cleaner sources of electricity generation, such as renewable energy, reducing emissions of CO_2, NO_x, $PM_{2.5}$, and SOx;
- Create and enforce setback requirements for production wells and processing facilities to put space between these sources and hospitals, schools, and homes;
- Replace pneumatic controllers with low-bleed and no-bleed controllers, reducing emissions of methane and VOCs;
- Increase routine monitoring for fugitive methane leaks and deploy higher density air monitoring to better characterize and mitigate pollutant emissions;
- Employ VOC controls at oil and condensate tanks;
- Limit gas flaring, including by requiring green completions to capture associated gas (that is, capturing the first flow of gas produced upon completing a well rather than flaring or venting it);[162]
- Phase out all oil and gas production and properly remediate polluted sites.

The most effective and only complete measure to reduce these emissions is to phase out oil and gas production itself. Once this phase-out has occurred, many markers of the industry will be left behind: facilities, oil and gas wells, and other sites. Funding will be required to remediate brownfields, plug orphaned and abandoned wells, and monitor sites for residual leaks and emissions.

158 Congressional Research Service. Methane and Other Air Pollution Issues in Natural Gas Systems, R42986 (2020).

159 Associated gas is natural gas found in oil-producing wells.

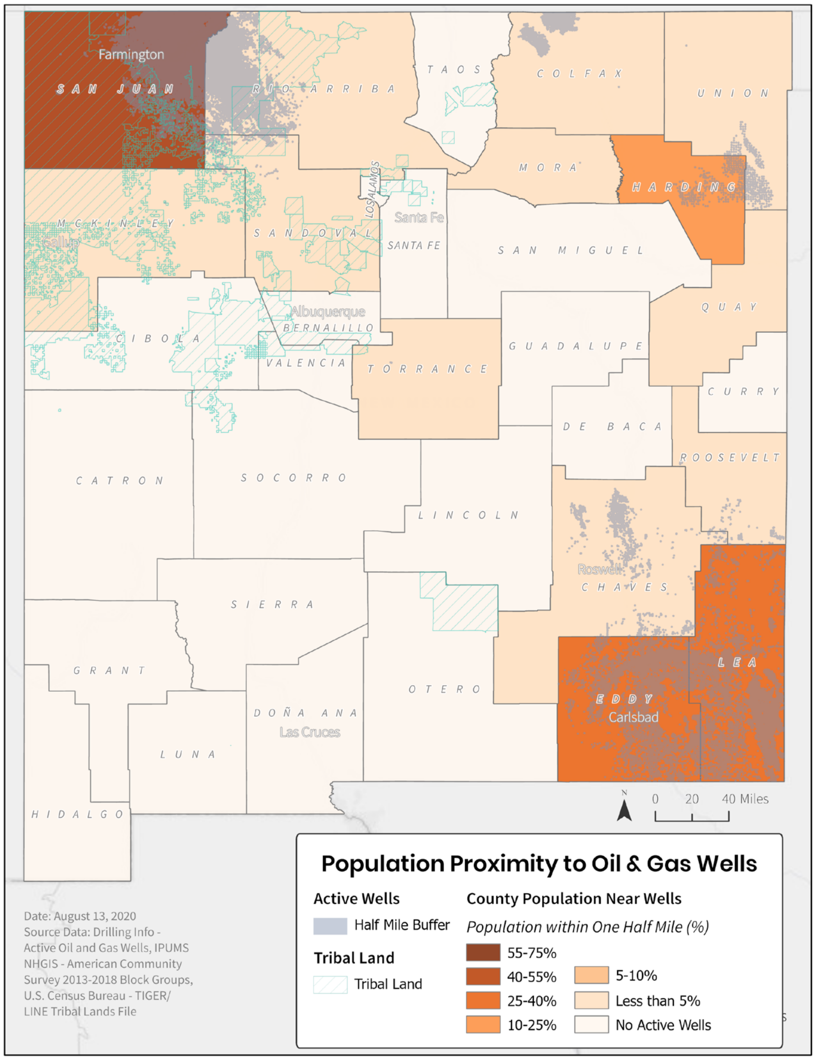
160 Environmental Defense Fund. "New Analysis Reveals Persistent Methane Problem." Nov. 2020. Available at: http://edf.org/nm-oil-gas/

161 Pozzer, Andrea *et al*. Impact of US Oil and Natural Gas Emission Increases on Surface Ozone Is Most Pronounced in the Central United States. *Environmental Science & Technology* 54.19 (2020): 12423-12433.

162 Grant, John, *et al*. Revised Final Report: 2028 Future Year Oil and Gas Emission Inventory for WESTAR-WRAP States - Scenario #1: Continuation of Historical Trends. *Ramboll for Western Regional Air Partnership.* (2020).

Although robust emissions data are unavailable for oil and gas wells, population proximity analysis serves as a rough proxy for evaluating potential health burdens associated with oil and gas extraction in New Mexico. We find that roughly 6.5 percent of New Mexicans (135,000 people) live within a half mile of an active well, predominantly in San Juan, Eddy, and Lea Counties, shown in **Figure 40**. New Mexicans living in the regions most heavily impacted by oil and gas production may be exposed to oil and gas-associated pollutants in their air and water, some of which are associated with adverse respiratory, reproductive, and hematological (blood-related) health outcomes.[163,164,165,166] Should oil and gas production continue as-is or increase moving forward, these exposures may persist.

FIGURE 40. Populations living within half a mile of active oil and gas wells. Statewide, 6.5 percent of New Mexicans (135,000 people) live within a half mile of an active well, predominantly in San Juan, Eddy, and Lea Counties. Ongoing oil and gas production and/or failure to properly plug wells may lead to continued exposures to health hazards.



163 Johnston, Jill E. *et al.* Impact of Upstream Oil Extraction and Environmental Public Health: A Review of the Evidence. *Science of the Total Environment* 657 (2019): 187-199.

164 Balise, Victoria D., *et al.* Systematic Review of the Association Between Oil and Natural Gas Extraction Processes and Human Reproduction. *Fertility and Sterility* 106.4 (2016): 795-819.

165 American Public Health Association. The Environmental and Occupational Health Impacts of Unconventional Oil and Gas Industry (2018).

166 Willis, Mary, *et al.* Natural Gas Development, Flaring Practices and Paediatric Asthma Hospitalizations in Texas. *International Journal of Epidemiology* (2020).

The future of industrial greenhouse gas and co-pollutant emissions in New Mexico depends largely on whether oil and gas production and processing are phased out. In all modeled scenarios, production declines to 75 percent of current levels by 2030. In the Fossil Free scenario, all production declines to zero in 2050, whereas in the other scenarios production remains at 25 percent of current 2020 levels in 2050. As seen in **Figure 40**, oil and gas wells are concentrated in the San Juan basin in Northwestern New Mexico and the Permian basin in the Southeast. If these fields are still producing in 2050, or if well sites are not sufficiently remediated after production is phased out, associated pollution in these regions will remain even as the rest of the state reduces pollution from fossil fuel use.

A number of measures can help minimize the health hazards, risks, and impacts of oil and gas development in the coming decades. In the near term, measures such as setback requirements can act as a factor of safety to help reduce population exposures to health-damaging pollutants and other stressors from oil and gas infrastructure. Ongoing regulations to measure and reduce methane leakage, sources of which often emit health-damaging, non-methane VOCs, can help reduce risks of exposures to these pollutants in addition to the climate forcing of methane. Increased monitoring to better characterize methane and methane co-pollutant emissions statewide will enable more focused regulations and enhanced enforcement. As oil and gas development declines, monitoring and upkeep will be required to ensure the safety of aging infrastructure, including the careful monitoring of idle, abandoned, and orphaned wells.[167] Finally, set-aside funds and bonding requirements for remediating fossil fuel brownfields, including proper plugging and abandonment of surface and subsurface oil and gas infrastructure, can help ensure the safe transition of these areas into new land uses.

167 Kang, Mary, *et al.* Direct Measurements of Methane Emissions from Abandoned Oil and Gas Wells in Pennsylvania. *Proceedings of the National Academy of Sciences* 111.51 (2014): 18173-18177.

2.5 **Electricity Generation**

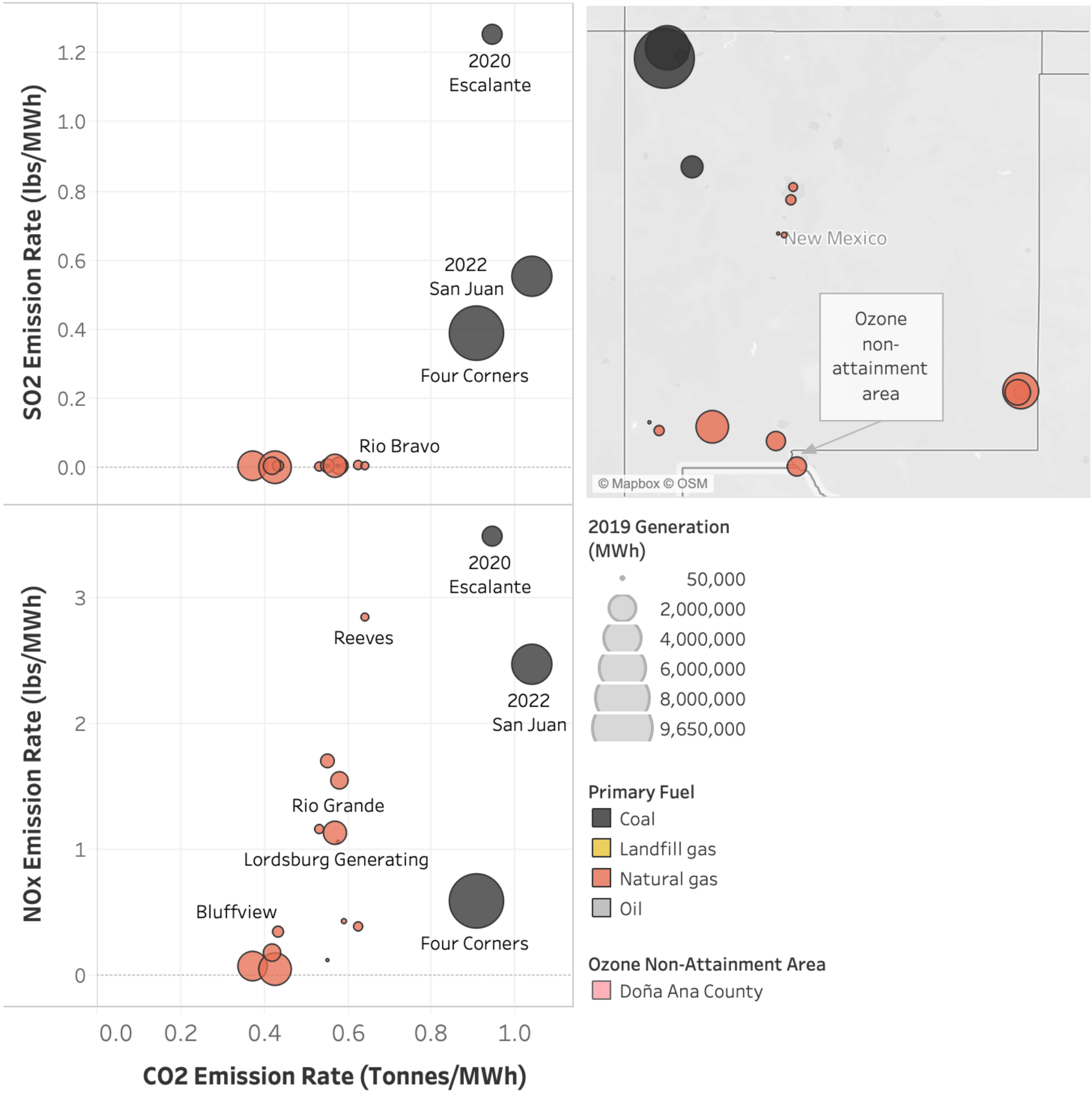
New Mexico currently has 25 natural gas, coal, oil, and biofuel power plants—facilities reliant on fuels which release greenhouse gases and criteria air pollutants when combusted. Of the plants that could be confirmed as operational, one burns primarily landfill gas, two burn oil, three burn coal, and 19 burn natural gas, although many of these facilities can burn multiple fuels. While the state only has three coal facilities, they generated more electricity than all of the gas-powered plants combined in 2019. Altogether, coal generated 42 percent of in-state electricity in 2019, gas generated 34 percent, wind supplied 20 percent, and solar another four percent. New Mexico exports roughly 30 percent of the electricity it produces, and is projected to continue to export electricity as it continues its transition towards renewable energy.

In 2020, New Mexico had three operational coal plants (Escalante, San Juan, and Four Corners[168]) and three coal mines (Navajo, San Juan, and El Segundo), all of which are located on or near tribal lands in the northwest corner of the state. Escalante was retired at the end of 2020, and the San Juan plant is slated to close by 2022 and to be replaced with a mix of renewable energy and energy storage. These closures will have significant environmental health benefits: as seen in **Figure 41**, all of the coal plants had high emissions of health-damaging co-pollutants, such as NO_x and SO_2, which, in addition to exerting their own health effects, can oxidize in the atmosphere and react with other compounds to form secondary particulate matter and ozone. Coal plants also produce other pollutants, including primary particulate matter and mercury. The health impacts of these pollutants are typically highest per capita near the plants but their impacts can stretch for hundreds of kilometers downwind.[169] While Escalante generated the least electricity of the three plants, it had the highest rate of NO_x and SO_2 emissions for every megawatt-hour of electricity generated. Displacing electricity from this plant with a cleaner alternative will have the greatest impact on pollutant emission reductions per megawatt-hour. The retirement of Escalante and San Juan alone will reduce power sector NOx emissions by 59 percent and SO2 emissions by 54 percent from 2019 levels.

168 The State of New Mexico does not include Four Corners in its emissions inventory because it is located outside state jurisdiction in the Navajo Nation and much of the power is exported to Arizona. However, even if electricity is exported, the pollution impacts of this plant are centered in New Mexico.

169 Levy, Jonathan I., Lisa K. Baxter, and Joel Schwartz. Uncertainty and Variability in Health-Related Damages from Coal-Fired Power Plants in the United States. *Risk Analysis: An International Journal* 29.7 (2009): 1000-1014.

FIGURE 41. Power plant emission rates of CO_2, NO_x, and SO_2 in 2019. Bubble size reflects the total electricity generated by that plant in 2019. Date labels indicate plants with planned retirement dates. Some plants show much higher emission rates than others for every megawatt-hour (MWh) of electricity generated.



In addition to air pollution, coal plants can contribute to water and soil contamination. Escalante disposed of its coal ash—the residual waste from burning coal—in a landfill, and nearby groundwater monitoring wells have exceeded federal advisory levels for lithium, molybdenum, sulfate, arsenic, and lead. Four Corners disposes of coal ash in an unlined surface impoundment, and nearby groundwater measurements exceed federal standards for numerous pollutants, including arsenic, lead, cadmium, and chromium among others.[170] These heavy metals can damage the function of the brain, kidneys, lungs, liver, and blood. In the long term, some are known carcinogens.

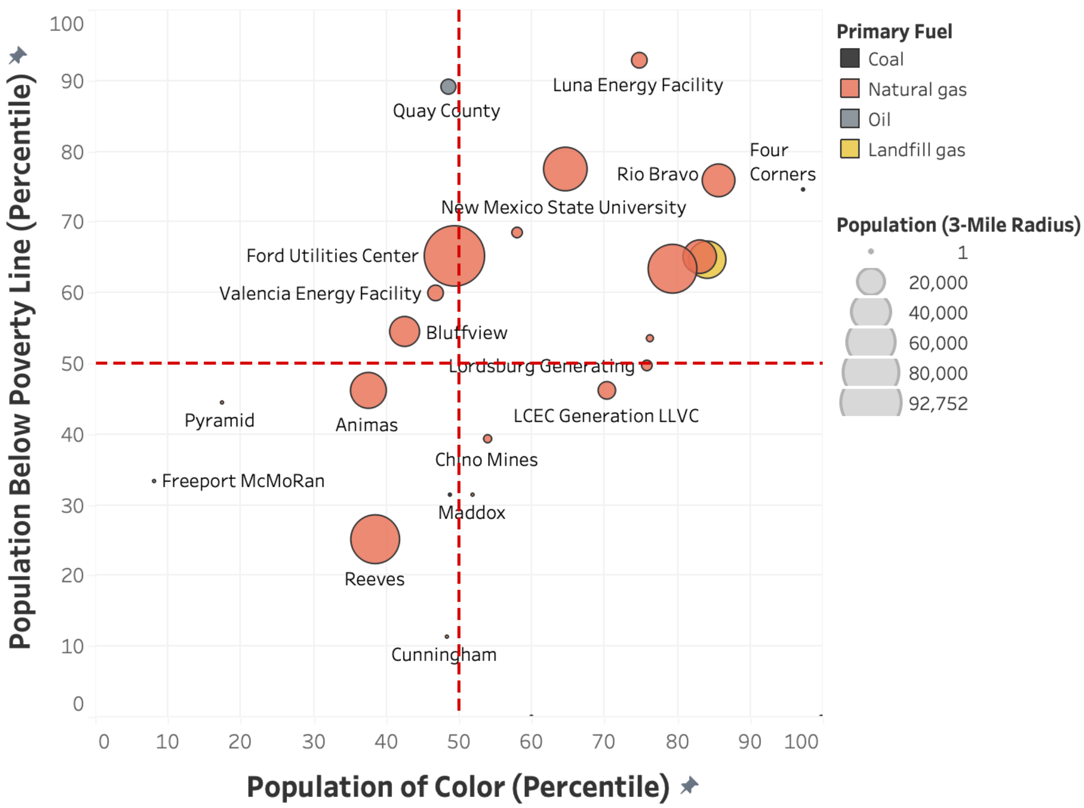
Natural gas plants have much lower rates of SO_2 emissions for every megawatt-hour generated than coal plants, but their NO_x emission rates can be quite high. The Reeves Generating Station, for example, did

170 Environmental Integrity Project. "Ashtracker." Accessed Jan. 30, 2021. Available at: https://ashtracker.org/

not generate much electricity in total, but had a higher emission rate of NO_x for every megawatt-hour generated than two of the three coal plants. Other gas plants are located in environmentally vulnerable areas. For example, the Rio Grande power plant is located on the border of Texas in an area considered out of attainment for federal ozone standards, and also had the second-highest total emissions of NO_x—an ozone precursor—compared to the rest of New Mexico gas plants in 2019.

While health impacts are not limited to the populations closest to power plants, living next to power plants is associated with adverse health outcomes, such as respiratory disease-related hospitalizations[171] and adverse birth outcomes.[172,173] We therefore analyzed the demographics of populations living within a three-mile radius of New Mexico's power plants.[174] In **Figure 42**, we plot power plants by the demographics of those living within a three-mile radius. While many of the state's power plants are located in rural areas, those in urban areas are disproportionately located in low-income communities, and many of these are also communities of color. Of the 13 plants with more than 5,000 people living within three miles, 10 have a larger share of low-income populations than the state median. These urban plants primarily combust natural gas, which produce NO_x, a precursor to both ozone and particulate matter formation.

FIGURE 42. Demographics of populations living within a three-mile radius of New Mexico power plants. Many of the facilities are in rural areas (reflected by small bubbles), but the more urban plants (those represented by larger bubbles) are disproportionately located in the state's low-income communities.



171 Liu, Xiaopeng, Lawrence Lessner, and David O. Carpenter. Association Between Residential Proximity to Fuel-Fired Power Plants and Hospitalization Rate for Respiratory Diseases. *Environmental Health Perspectives* 120.6 (2012): 807-810.

172 Ha, Sandie, *et al.* Associations Between Residential Proximity to Power Plants and Adverse Birth Outcomes. *American Journal of Epidemiology* 182.3 (2015): 215-224.

173 Casey, Joan A., *et al.* Retirements of Coal and Oil Power Plants in California: Association with Reduced Preterm Birth Among Populations Nearby. *American Journal of Epidemiology* 187.8 (2018): 1586-1594.

174 While the health impacts of power plants are not constrained to a three-mile radius around a plant, this radius was used by the US Environmental Protection Agency as a proxy for evaluating environmental justice dimensions of power plant locations. See: EPA, "EJ Screening Report for the Clean Power Plan," US Environmental Protection Agency, Tech. Rep.Docket: EPA–HQ–OAR–2013–0602, (2015).

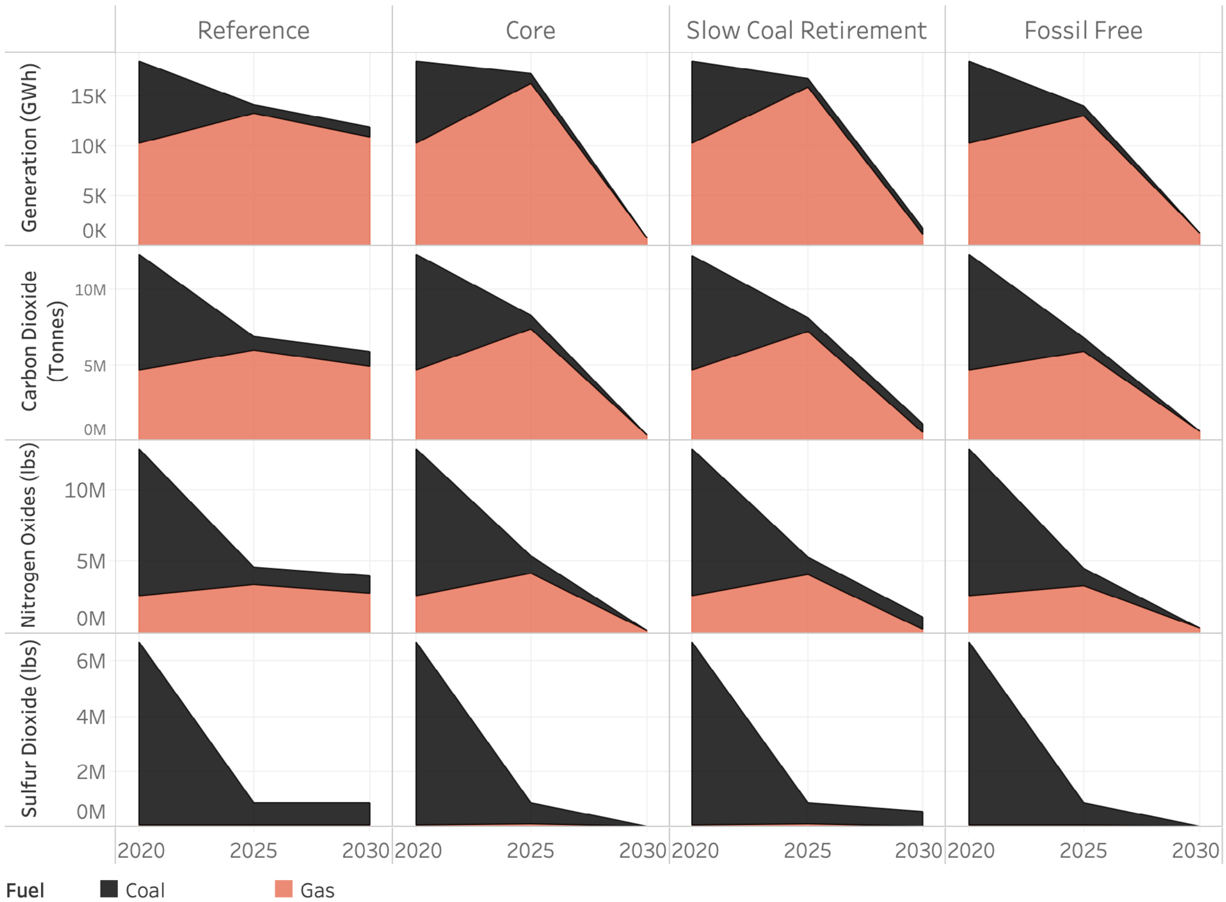
The transition to renewable energy yields two primary opportunities for environmental and social equity benefits: reduction of total health-damaging air pollutants from power plants, and the prioritized retirement of facilities in communities overburdened with environmental pollution. However, the realization of these benefits depends on the transition pathway itself. The modeled decarbonization pathways prioritize the retirement of coal plants, but leave some power plants in place to burn either natural gas, synthetic fuels, biofuels, or hydrogen. While these plants are expected to operate infrequently to help meet peak demand—as shown in **Figure 7**, total NO_x emissions fall 98 percent in the Core scenario between 2020 and 2030—they will continue to generate some electricity, and therefore may still produce NO_x emissions, particularly to meet cooling loads on hot summer days when ozone is already high. Indeed, if hydrogen fuel combustion replaces these facilities, they will still release NO_x, even though CO_2 emissions will be eliminated, and biomass combustion releases a wide variety of health-damaging pollutants including particulate matter. Without clear policy directives to help determine which plants are being used for these reliability needs, the State runs a risk of leaving gas or hydrogen plants disproportionately in urban, low-income communities and communities of color. Current energy storage technologies may be able to replace some of these gas plants in the near term. In the long term, developments in long-duration energy storage may render ongoing combustion capacity unnecessary altogether and eliminate these concerns.[175]

Rapid decarbonization of New Mexico's power sector is central to achieving the state's 2030 climate goals. In **Figure 43** we show the electricity generation (MWh) and total emissions of CO_2, NO_x, and SO_2 for the Reference (business-as-usual), Core, Slow Coal Retirement, and Fossil Free decarbonization scenarios from 2020-2030. The Low Demand scenario looks similar to the Fossil Free scenario for the power sector during this time frame. All of the decarbonization scenarios (see **Table 2**) require coal electricity generation to drop by nearly 90 percent by 2025, and coal is eliminated by 2030 in all but the Slow Coal Retirement scenario. Notably, even the Reference scenario projects coal generation to decline precipitously by 2025, largely due to the planned retirement of the San Juan Generating Station and recent Escalante retirement, as noted. The Slow Coal Retirement Scenario continues to have lingering emissions through 2030, whereas the other scenarios almost entirely eliminate SO_2 and greatly reduce NO_x. Notably, the models also suggest that fossil electricity generation in 2025 may actually be higher than in the Reference scenario, largely due to an increase in natural gas to meet demand for electricity exports, except in the Fossil Free scenario where all nearby states are assumed to be phasing out fossil fuels.

By 2050, the Core scenario permits natural gas combustion at a number of facilities for reliability purposes—in contrast to the Fossil Free scenario, where this gas is replaced with carbon-neutral fuels.

175 Dowling, Jacqueline A., *et al.* Role of Long-Duration Energy Storage in Variable Renewable Electricity Systems. *Joule* 4.9 (2020): 1907-1928.

FIGURE 43. Fossil fuel electricity generation, CO_2, SO_2 and NO_x emissions from 2020-2030 for the Reference, Core, Slow Coal Retirement, and Fossil Free scenarios. The Low Demand scenario (not shown) is similar to Fossil Free. SO_2 and NO_x emissions are highest in 2030 in the Slow Coal Retirement scenario, although greatly reduced overall. The Fossil Free Scenario has lower 2025 CO_2 and NO_x emissions than Core and Slow Coal Retirement, which increase due to higher demand for exports in these scenarios.



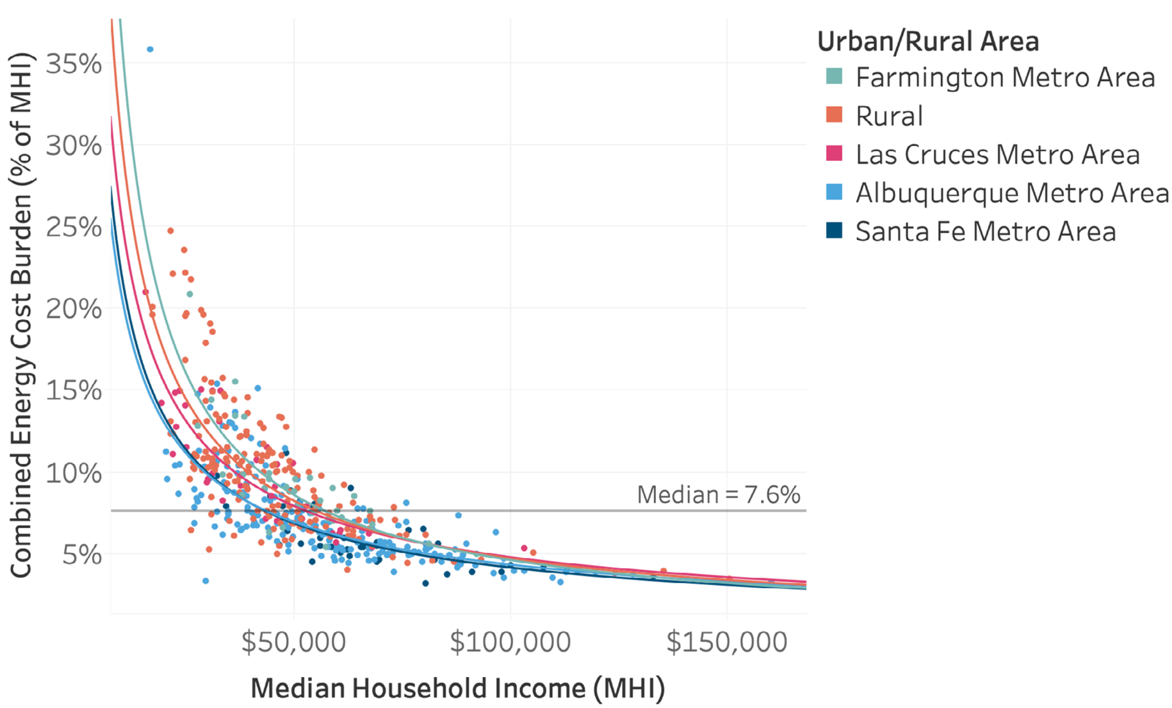
2.6 **Cross-Sectoral Themes**

In the previous sections, we analyze existing pollution, energy cost burdens, and decarbonization pathways on a sectoral basis. Below, we address the intersection of these sectors: combined energy cost, environmental and socioeconomic burdens, opportunities to reduce cumulative pollution from multiple sources, and the trade-offs between each pathway that result from prioritizing decarbonization in some sectors before others.

2.6.1 Combined Energy Cost Burdens

While household CO_2 emissions tend to be higher for census tracts with higher median incomes, energy cost burdens are highest for households in census tracts with the lowest median incomes. These energy bills are even more burdensome when considered in combination across sectors. **Figure 44** shows combined utility bill and vehicle fuel burdens for average households in each census tract by median household income. While the median combined household energy cost burden is 7.6 percent of household income, some census tracts have combined average energy cost burdens as high as 35 percent. On average, rural households and households in Farmington and Las Cruces face slightly higher energy cost burdens than households in Santa Fe and Albuquerque, in part due to lower average household incomes, longer average driving distances, and harsher climates. Individual households within each census tract, of course, may spend an even greater fraction of their annual income on vehicle fuel, heating their homes, and powering their appliances.

FIGURE 44: Average combined residential energy and vehicle fuel cost burden and median household income by census tract. On average, low-income households spend a greater fraction of their annual income on residential heating, household appliances, and vehicle fuel. Rural households and households in Farmington and Las Cruces have slightly higher combined energy cost burdens on average than households in Santa Fe and Albuquerque, in part due to lower average household incomes, longer average driving distances, and a harsher climate.



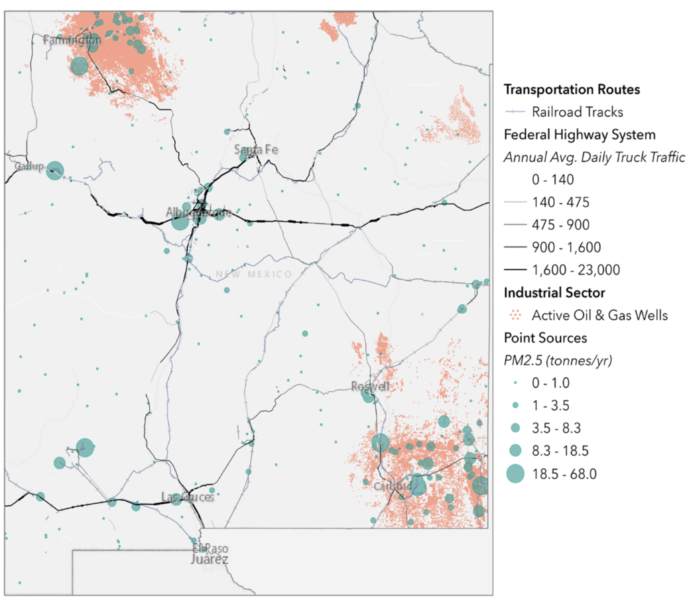
2.6.2 Transportation and Industry

While we analyzed the transportation and industrial sectors separately in our report, their activities are inextricably linked on the ground in New Mexico, with more industrial portions of the state often experiencing heavy trucking traffic (**Figure 45**). Heavy-duty trucking, which is primarily used to transport freight and serve industrial facilities, accounts for the majority of vehicle $PM_{2.5}$ and NO_x emissions in the state. Increased industrial activity, particularly within truck-dependent industries like oil and gas, therefore has a significant impact on transportation-related pollution.

In addition to health risks posed by trucking-related air pollution, the rapid expansion of oil and gas development in the Permian Basin over the last five years has brought an influx of heavy-duty trucks and tankers to Southeastern New Mexico, likely contributing to a doubling of roadway fatalities in Eddy and Lea counties from 2016-2018.[176] Increased truck traffic in these areas are compounding pre-existing risks associated with road safety in New Mexico. From 2002-2012, the commercial motor vehicle fatality rate in New Mexico was 37 percent higher than the national rate on average.[177] Truck safety issues are particularly prevalent in rural areas along emerging non-interstate truck corridors, many of which do not meet the same safety design standards as interstates.[178] According to the New Mexico Department of Transportation, heavy-duty trucks in rural areas often use dirt roads, travel at speeds that pose safety risks, and cause congestion issues that limit community access to local roads.[179] These impacts highlight additional health and safety risks posed by industry-driven trucking growth in New Mexico's rural communities.

As the state evaluates decarbonization pathways for the industrial and transportation sectors, it may want to consider opportunities to minimize cross-sectoral cumulative health impacts, particularly for rural oil and gas communities and those living adjacent to interstates. Improving safety standards on rural emerging truck corridors, electrifying heavy-duty trucks to reduce pollution in oil and gas communities, and ensuring that communities have access to local roads could lessen the negative impacts of these industries in the near-term as oil and gas development is phased out to meet New Mexico's climate goals.

FIGURE 45. Industrial and transportation hotspots. Point sources pictured include those associated with the transportation or industrial sectors (power sector not pictured). Industrial facilities and oil and gas wells tend to be clustered near major roadways and railroad rights-of-way; and interstate routes tend to experience the most truck traffic. Though treated separately in this analysis, industrial activity may influence transportation and associated emissions.



176 Reed Jr., Ollie. "Surviving 285: Oil and Gas Boom Wreaks Havoc on Southeast NM Highways." *Albuquerque Journal.* Mar. 2, 2019. Available at: https://www.abqjournal.com/1287467/surviving-285-oil-and-gas-boom-wreaks-havoc-on-southeast-nm-highways.html

177 New Mexico Department of Transportation. New Mexico Freight Plan: Moving Freight Forward, through 2040. (2015).

178 *Ibid.*

179 *Ibid.*

2.6.3 Resource Extraction—Cleanup and Transition Opportunities

Much of New Mexico's economic activity and rural job opportunity has long centered around extractive industries. Some key resources in the state's extractive economy have included uranium, coal, oil, and gas. Uranium mining in New Mexico originally revolved around fueling the Cold War-era nuclear arms race and has since ceased—though renewed conversations around nuclear power create the possibility of expanded activity, with two newly permitted operations in recent years.[180] Coal mining has been present in the state since the 1800s and, although declining, continues in the San Juan Basin today.[181] Oil and gas remains a prominent industry, though production must be phased out to meet climate goals. The boom-and-bust cycle of resource extraction and the industry's environmental and health impacts (discussed in **Section 2.4.2** for oil and gas and below for uranium) underscore the necessity of policy mechanisms to hold industry accountable for the safe closure and clean up of mines, wells, and associated infrastructure, as well as opportunity at hand as the State and the Nation pivot towards renewable energy.

New Mexico is well-positioned to create long-term jobs due to its abundant solar and wind resources; though it is critical to minimize environmental and health impacts and maximize benefits to New Mexicans, especially those who historically had limited economic opportunity outside of extractive contexts.

As the United States developed nuclear weapons in the mid-1900s, mines rapidly proliferated in the Grants Uranium District in the San Juan Basin.[182] Many ceased operations with little to no regulatory oversight, leaving abandoned or inadequately cleaned mines polluting surface water, groundwater, soil, and air.[183] Though uranium created temporary economic opportunity, its extraction, processing, and disposal created lasting environmental and health effects—especially on tribal lands, including those of the Navajo, Laguna Pueblo, Mescalero Apache, and others.[184] Miners have suffered increased death rates, especially due to diseases such as lung cancer.[185,186] Studies have also identified potential community exposure to uranium and hazardous co-occurring metals through water and food[187,188,189] and associated health effects including kidney damage, hypertension, and adverse birth outcomes.[190,191] Production largely ceased decades ago, but most mines were abandoned without cleanup, and obtaining funding can involve complex regulatory enforcement

180 US Energy Information Administration. "New Mexico" February 20, 2020. Accessed Feb. 2021. Available at: https://www.eia.gov/state/analysis.php?sid=NM

181 *Ibid.*

182 McLemore, Virginia T. "Uranium Resources in New Mexico." New Mexico Bureau of Geology & Mineral Resources. Jan. 2020. Accessed Feb. 2021. Available at: https://geoinfo.nmt.edu/resources/uranium/nmresources.html

183 McLemore, Virginia T, *et al.* Uranium Resources in the Grants Uranium District, New Mexico: An Update. *New Mexico Geological Society Guidebook. [64th Field Conference]. Geology of Route.* (2013). Vol. 66.

184 Moore-Nall, Anita. The Legacy of Uranium Development On or Near Indian Reservations and Health Implications Rekindling Public Awareness. *Geosciences* 5.1 (2015): 15-29.

185 JM Samet, *et al.* Lung Cancer Mortality and Exposure to Radon Progeny in a Cohort of New Mexico Underground Uranium Miners. *Health Physics*. (1991) Dec; 61(6):745-752.

186 Frank Gilliland *et al.* Uranium Mining and Lung Cancer Among Navajo Men in New Mexico and Arizona, 1969 to 1993. *Journal of Occupational and Environmental Medicine.* (2000). Vol. 42(3): 278-283.

187 Hakonson-Hayes, Audrey C., P. R. Fresquez, and F. W. Whicker. Assessing Potential Risks from Exposure to Natural Uranium in Well Water. *Journal of Environmental Radioactivity* 59.1 (2002): 29-40.

188 Samuel-Nakamura, Christine, Wendie A. Robbins, and Felicia S. Hodge. Uranium and Associated Heavy Metals in *Ovis aries* in a Mining Impacted Area in Northwestern New Mexico. *International Journal of Environmental Research and Public Health* 14.8 (2017): 848.

189 Ingram, Jani C., *et al.* Uranium and Arsenic Unregulated Water Issues on Navajo Lands. *Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films* 38.3 (2020): 031003.

190 Limson Zamora M., *et al.* Chronic Ingestion of Uranium in Drinking Water: a Study of Kidney Bioeffects in Humans. *Toxicological Sciences* 43.1 (1998): 68-77.

191 Arnold, Carrie. Once Upon a Mine: The Legacy of Uranium on the Navajo Nation. (2014): A44-A49.

and litigation.[192,193] As such, hundreds of mines requiring cleanup remain on New Mexico's tribal lands.[194,195,196,197]

New Mexico's relatively short-lived uranium industry and its lasting pollution and health impacts exemplify the importance of accountability for polluting industries and safe, long-term jobs for communities which have historically relied on resource extraction. This is particularly important as the State looks toward a decarbonized future where oil and gas production is phased out. There are roughly 50,000 active, 50,000 abandoned, and 17,000 inactive oil and gas wells across the state.[198] Hundreds of inactive wells have no financially solvent entity responsible for them, making them their closure the State's responsibility, and many more are at risk of also becoming orphaned.[199] As the industry's active footprint shrinks due to decarbonization efforts and market forces, it is critical to ensure regulatory mechanisms provide accountability for funding and implementing safe site cleanup. This will help prevent ongoing leakage of methane as well as health-harming air and water pollutants, and may help prevent other hazards associated with improperly abandoned wells such as explosions.[200] Failure to provide such accountability mechanisms risks leaving communities to continue shouldering the burden of oil and gas-related pollution, even after production and associated economic benefits and employment opportunities end.

Ensuring safe site closure for oil and gas wells, as well as other defunct resource extraction sites such as coal and uranium mines, is a key first step to address environmental inequities for communities bearing the brunt of industrial pollution. To address social inequities for these communities, which may heavily rely on disappearing jobs, it is important to establish policy mechanisms which incentivize creation of clean energy jobs in legacy resource extraction areas. Though a larger portion of employment in New Mexico depends on resource extraction than in most western states,[201] there is currently a large opportunity to grow the renewable energy industry and associated jobs. New Mexico is well-positioned to be a national leader in renewable energy—virtually the entire state's solar potential ranks above the national average (**Figure 46**) and six of ten counties in the country with the highest solar potential are in New Mexico.[202] In addition to the large majority of the state having strong solar potential, much of the state also has potential for wind energy development. Utilizing areas which were previously the site of resource extraction for wind and solar projects may provide jobs for potentially underemployed populations with proper community engagement and buy-in. Additionally, this strategy may encourage development of already environmentally degraded areas, avoiding new development which may compromise key ecological resources.[203]

192 US Environmental Protection Agency. Abandoned Uranium Mine Settlements on or near the Navajo Nation (2020).

193 American College of Environmental Lawyers. "Deal or No Deal? - Partial Dismissal of CERCLA Claims Against United States and Tribal Entities." May 19, 2016. Accessed Feb. 2021. Available at: http://www.acoel.org/post/2016/05/19/Deal-or-no-Deal-Partial-Dismissal-of-CERCLA-Claims-Against-United-States-and-Tribal-Entities.aspx

194 US Department of Energy. Defense-Related Uranium Mines Prioritization Topic Report. (2014).

195 Arnold, Carrie. Once Upon a Mine: The Legacy of Uranium on the Navajo Nation. (2014): A44-A49.

196 US Environmental Protection Agency. "Navajo Nation: Cleaning Up Abandoned Uranium Mines." Accessed Feb. 2021. Available at: https://www.epa.gov/navajo-nation-uranium-cleanup/abandoned-mines-cleanup

197 US Environmental Protection Agency. "Jackpile-Paguate Uranium Mine Laguna Pueblo, NM." Accessed Feb. 2021. Available at: https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0607033#bkground

198 Enverus DrillingInfo. "Production." Accessed Feb. 2021.

199 NM Political Report. "With Oil's Future Uncertain, Orphaned Wells on Public Lands Could Become a Big Problem for New Mexico." July 11, 2020. Available at: https://nmpoliticalreport.com/2020/07/11/with-oils-future-uncertain-orphaned-wells-on-public-lands-could-become-a-big-problem-for-new-mexico/

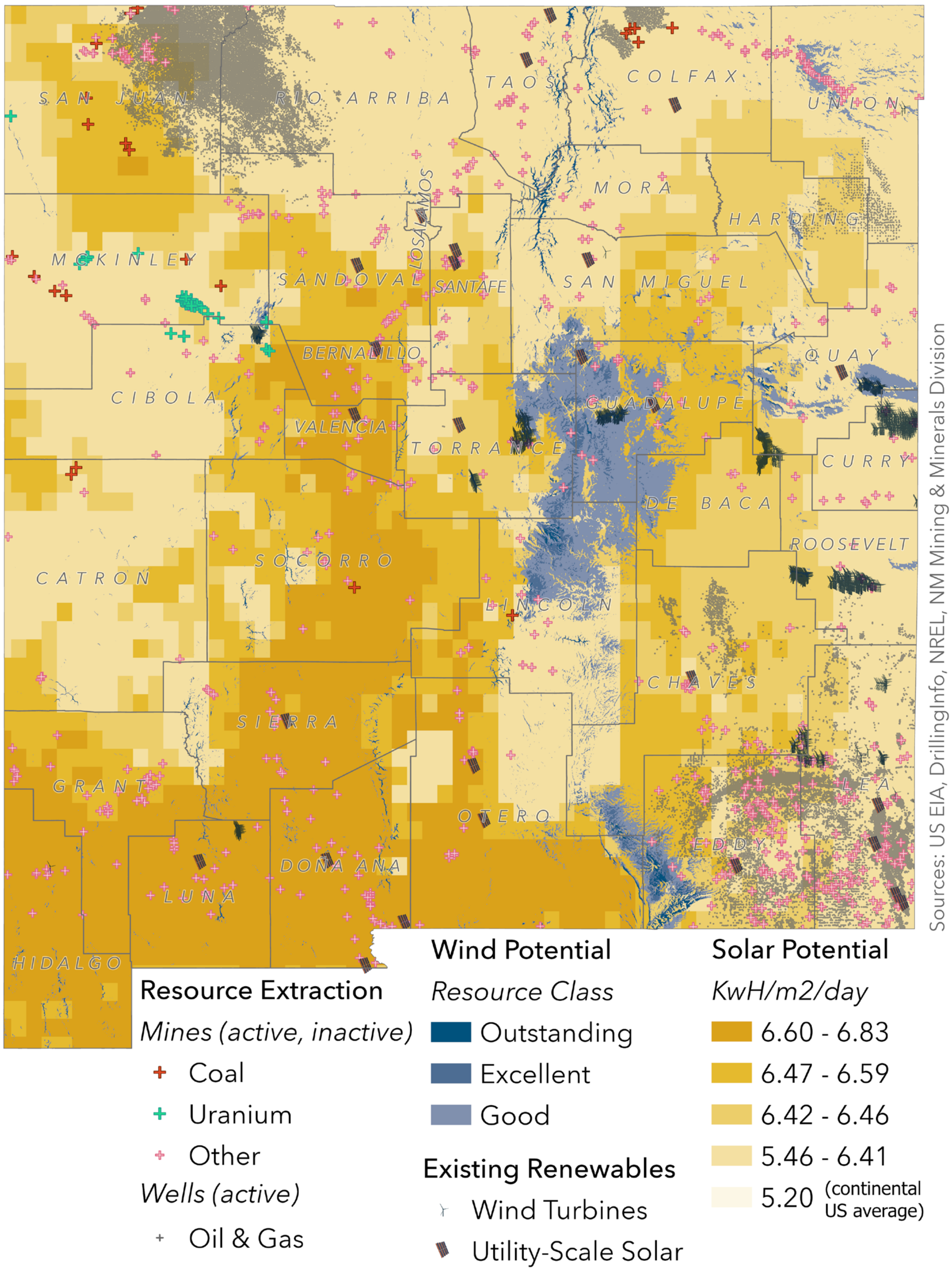
200 PEW Trusts. "Why 'Orphan' Oil and Gas Wells Are a Growing Problem for States." July 9, 2018. Available at: https://www.pewtrusts.org/en/research-and-analysis/blogs/stateline/2018/07/09/why-orphan-oil-and-gas-wells-are-a-growing-problem-for-states

201 New Mexico Department of Workforce Solutions. Industry Spotlight: Mining, Quarrying, and Oil and Gas Extraction (2013).

202 Brookings Institute. "How Renewable Energy Jobs Can Uplift Fossil Fuel Communities and Remake Climate Politics." Feb. 23, 2021. Available at: https://www.brookings.edu/research/how-renewable-energy-jobs-can-uplift-fossil-fuel-communities-and-remake-climate-politics/?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiosgenerate&stream=top

203 National Renewable Energy Laboratory. Solar Development on Contaminated and Disturbed Lands. (2013)

FIGURE 46. Renewable energy opportunities and legacy extractive industries. As demand shifts from petroleum resources to renewable energy, the State must assure that legacy infrastructure such as mines and wells are safely closed and cleaned up without undue burden on nearby communities or taxpayers. Simultaneously, there is an opportunity to create long-term renewable energy jobs in regions which have historically been economically dependent on polluting industries. Both imperatives are critical to achieving an equitable energy transition.



2.6.4 Urban Greening and High-Density Air Monitoring

Cross-sectoral NO_x and $PM_{2.5}$ emissions are most dense in New Mexico's metropolitan counties (**Figure 4**). While we are not able to analyze cross-sectoral emissions at the census-tract level due to data availability constraints, we find that vehicle pollution in particular is most dense in urban areas and disproportionately burdens Black, Asian American, and Hispanic populations. In addition to reducing emissions through decarbonization measures, other initiatives such as urban greening have the potential to reduce pollution and bring other public health benefits to these areas. Disparities in green cover, green spaces, and trees, among other factors, have been found to contribute to variation in surface temperature within cities.[204] In addition to mitigating the urban heat island effect, green vegetation can play a valuable role in removing pollutants such as ozone and particulate matter from urban environments,[205] and have been associated with improved mental and physical health outcomes. Unfortunately, there is a lack of high-density air monitoring to capture neighborhood-to-neighborhood variations in atmospheric pollutant concentrations. Neighborhoods with high cumulative emissions may benefit from a set of cross-sectoral intervention policies, from subsidized tree planting to the re-routing of heavy-duty trucks away from these areas. High-density air monitoring at the community level could help guide and evaluate the effectiveness of such policies.

2.6.5 Comparing Decarbonization Pathways

Along with clear climate benefits, all statewide decarbonization strategies explored in this report yield overlapping air quality and human health co-benefits, such as overall reductions in criteria pollutant emissions. These findings are outlined in each section above. However, the underlying strategies in each decarbonization scenario also lead to certain unique outcomes. In **Table 4**, we summarize some of the unique impacts and benefits of each decarbonization pathway.

The trade-offs between scenarios tend to fall into two main categories: (1) impacts on bills and energy cost burdens, and (2) impacts on type and location of pollutant emission reductions. Two key decisions emerge:

- **Does oil and gas production decline by 2030 and cease by 2050?** In contrast to the other scenarios, the Fossil Free scenario assumes all fossil fuel production is eliminated by 2050. While even this scenario will require maintenance, inspections, and remediation of retired fossil fuel infrastructure, it is the only scenario in which populations living near oil and gas production and infrastructure may nearly eliminate their risks of exposure to associated health-damaging criteria air pollutants, non-methane VOCs, and hazardous air pollutants, along with other forms of pollution such as soil and water pollution. The Fossil Free scenario requires greater investments in renewable energy facilities and other technologies (e.g., electric hydrogen and synthetic fuels) to ensure that fossil fuels can be fully replaced.
- **Are broad efforts taken to reduce energy demand?** The Low Demand scenario achieves the greatest emissions reductions by 2030 and lowest utility bills overall, and increases public transit and active transit options, which can particularly benefit low-income households and increase public health co-benefits. However, this scenario hinges on widespread efforts to increase building efficiency and expand public transportation. These actions require multi-agency coordination, significant municipal planning with community feedback mechanisms, and sufficient up-front capital expenditures, but yield longer term economic and environmental health benefits.

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204 Plumer, Brad and Nadja Popvich. "How Decades of Racist Housing Policy Left Neighborhoods Sweltering." *The New York Times,* Aug. 24, 2020. Available at: https://www.nytimes.com/interactive/2020/08/24/climate/racism-redlining-cities-global-warming.html

205 Nowak, David J., Daniel E. Crane, and Jack C. Stevens. Air Pollution Removal by Urban Trees and Shrubs in the United States. *Urban Forestry & Urban Greening* 4.3-4 (2006): 115-123.

TABLE 4. Unique outcomes from each decarbonization scenario.

Scenario	Unique outcomes
Reference	Energy demand is projected to increase with population growth across all sectors, along with greenhouse gas and health-damaging air pollutant emissions in most sectors. Oil and gas production continues at current rates.
Core	Rapid greenhouse gas and criteria air pollutant emission reductions from the power sector, as well as sustained emission reductions in all other sectors. Slight increase in residential criteria air pollutant emissions in some rural communities due to continued use of wood in home heating.
Slow Coal Retirement	Persistent emissions from fossil fuel power plants through 2030, notably SO_2. Slightly greater near-term criteria air pollutant reductions in other sectors. Higher average residential energy bills.
Low Demand	Greatest near-term criteria air pollutant emission reductions. Greatest particulate matter emission reductions from the transportation sector. Increased access to public transit. Greatest overall reduction in energy cost burdens. Lowest overall utility energy bills.
Fossil Free	Greatest long-term greenhouse gas and criteria air pollutant emission reductions. Phase out of oil and gas production; opportunity to eliminate all fossil fuel infrastructure and associated health hazards. Higher average residential energy bills (though these bills do not include the social benefits associated with greater reductions in carbon dioxide and criteria air pollutants).

Policy Discussion

Our analysis highlights the need to further integrate health, environment, and energy equity considerations into New Mexico's deep decarbonization planning. A wide portfolio of policy options is available to support a combined approach to achieving climate and energy equity goals. Below, we first briefly review the existing electricity market to understand New Mexico's unique landscape. Next, we review a select number of existing climate and energy policies in New Mexico from an environmental- and energy-equity lens. We then discuss the policy implications of our analysis for each sector in conjunction with those existing policies, or if none exist, identify where new policy might be valuable.[206] Finally, we describe additional data collection and research needs that can enable the State to create data-driven energy equity policies and measure their effectiveness moving forward.

3.1 Electricity Market Landscape

The existing electricity market landscape in New Mexico influences the ability of regulators, legislators, and consumers to use policy and market levers to decarbonize the state. We therefore begin with a brief overview of New Mexico's current electricity market from a renewable energy and consumer protection perspective. This overview provides important context for how potential decarbonization initiatives will interact with some of the market's key stakeholders, including utilities and consumers.

New Mexico's renewable portfolio standard (RPS)[207] was originally established under the Renewable Energy Act[208] and Rule 572[209] for investor-owned utilities and expanded to include rural electric cooperatives.[210] The RPS was last legislatively updated in 2019 by SB 489, which required the State reach a target of 100 percent renewable energy-derived electricity[211] by 2045.[212]

The Public Regulation Commission, which regulates the telecommunications, transportation, and utility industries in New Mexico, is the regulatory body responsible for ensuring that New Mexico's RPS is met. In 2020, a constitutional amendment was passed to shrink the Commission from five elected commissioners to three appointed ones.[213] This shift was undertaken with the goal of limiting regional political resistance or opposition to the RPS and in favor of state-wide ratepayer benefits.[214]

Electricity producers within the state include investor-owned utilities, electric cooperatives, and municipal or publicly-owned utilities.[215] Investor-owned utilities

206 We offer two levels of suggestions in this section: **bolded** recommendations are our direct recommendations to the stakeholders involved in and impacted by the State's decarbonization policies; they are standalone with supporting text. *Italicized* suggestions are found within the text and emphasize indirect recommendations we think are important to highlight, but that did not rise to the level of broader and more substantial bolded recommendations.

207 New Mexico Public Regulation Commission. "Utility - Renewable Energy." Accessed Jan. 2021. Available at: http://www.nmprc.state.nm.us/utilities/renewable-energy.html#gsc.tab=0.

208 New Mexico Public Regulation Commission. "Utility - Renewable Energy: Renewable Energy Act: Ch. 62, Art. 16 NMSA 1978 (2007)." Accessed Jan. 2021. Available at: http://www.nmprc.state.nm.us/utilities/renewable-energy-act/index.html#gsc.tab=0.

209 New Mexico Public Regulation Commission. NMAC: Title 17, Chapter 9, Part 572.

210 New Mexico Public Regulation Commission. "Utility - Renewable Energy." Accessed Jan. 2021. Available at: http://www.nmprc.state.nm.us/utilities/renewable-energy.html#gsc.tab=0.

211 This target applies to public utilities, however rural electric cooperatives and municipalities have a different target deadline of achieving the standard by 2050.

212 New Mexico State, Legislature. Senate Bill 5 (2019). *New Mexico State Legislature*.

213 New Mexico Secretary of State. "Official Results: 2020 General, November 3, 2020, Constitutional Amendment 1." Accessed Jan. 2021. Available at: https://electionresults.sos.state.nm.us/resultsSW.aspx?type=SW&map=CTY.

214 Patel, Sonal. "2020 Voters Cement Nevada's 50% RPS, Shakeup of Energy Oversight in New Mexico." *Power Magazine.* Nov. 5, 2020. Available at: https://www.powermag.com/2020-voters-cement-nevadas-50-rps-shakeup-of-energy-oversight-in-new-mexico/.

215 Depending on the locality and which electricity producers are considered, some utilities may operate in specific utility service areas that are designed to protect territory or service a specific demographic population.

include El Paso Electric, Southwestern Public Service Company (a subsidiary of Xcel Energy), and Public Service Company of New Mexico (PNM, the largest of the three), collectively serving nearly 70 percent of in-state customers. Twenty electric cooperatives, mostly rural, account for 22 percent of in-state customers. They source electricity primarily through the cooperative Tri-State Generation and Transmission Association, which is joining the Southwest Power Pool[216] emerging 2021 Western Energy Imbalance Service (WEIS) market,[217,218] and supplement with electricity from Xcel Energy. Public utilities, which are inclusive of municipal-, tribal-, and military-owned entities, account for the remaining in-state customer base. Electric utility service areas cover multiple regions, regardless of electricity provider, and are used to help balance reliability and access.[219,220] Additionally, some areas of eastern New Mexico participate in other electricity markets, such as the Southwest Power Pool, and most of the state participates in regional markets such as the Western Interconnection. These regional markets are governed by the Federal Energy Regulatory Commission (FERC) and are responsible for ensuring reliable power, transmission infrastructure, and wholesale market price stability.[221]

The electricity market in New Mexico is regulated (i.e. not open), with utilities facing little competition to catalyze lower electricity retail rates or facilitate the expansion of renewable energy and/or battery storage. A previously stalled push for restructuring the market to allow competition for electricity generation among retail customers by unbundling generation from transmission and distribution infrastructures,[222] was partially revitalized in the 2005 Efficient Use of Energy Act. The Act provided utilities with a cost recovery mechanism to implement load management and efficiency programs, allowing utilities to still profit while stabilizing and lowering consumer demand. To further incentivize energy efficiency at utilities, New Mexico implemented 2019's HB291,[223] which amended the Efficient Use of Energy Act, by encouraging electricity decoupling, which financially separates utility-owned generation from infrastructure costs by pricing each component individually and not as a bundle. Decoupling incentivizes energy efficiency adoption, as costs for infrastructure can be repaid, and made profitable, regardless if more or less energy is consumed by ratepayers.[224,225]

In-state electric generation in New Mexico is primarily fossil fuel-derived. Utility-scale solar makes up the majority of current renewable generation,[226] however, geothermal and wind energy production are on the rise.[227] New Mexico is also a major exporter of energy—predominantly in the form of oil, gas, and

216 The full list of Southwest Power Pool market participants, of which two New Mexico investor owned utilities participate, is listed here.

217 Tri-State. "Three Regional Utilities Announce Decision to Join Southwest Power Pool Market." Sep. 9, 2019. Available at: https://tristate.coop/three-regional-utilities-announce-decision-join-southwest-power-pool-market.

218 Southwest Power Pool. "SPP's Role in Western Reliability Continues to Grow with Addition of New Customers in Four States." Sept. 1, 2020. Available at: https://spp.org/newsroom/press-releases/spp-s-role-in-western-reliability-continues-to-grow-with-addition-of-new-customers-in-four-states/.

219 US Environmental Protection Agency and US Department of Energy. Energy Efficiency and Electric Infrastructure in the State of New Mexico (2015).

220 Dreaming New Mexico: A Bioneers Collaborative Project. "Can we dream of a human organization that effectively harvests, produces, transports, and uses low-carbon sources of energy?" Accessed Jan. 2021. Available at: https://dreamingnewmexico.bioneers.org/energy/governance/.

221 Federal Energy Regulatory Commission. "Electric Power Markets: National Overview." Accessed Nov. 2020. Available at: www.ferc.gov/industries-data/market-assessments/electric-power-markets.

222 US Environmental Protection Agency and US Department of Energy. Energy Efficiency and Electric Infrastructure in the State of New Mexico (2015).

223 New Mexico State, Legislature. House Bill 291 (2019). *New Mexico State Legislature*.

224 EnerKnol. "New Mexico Governor Signs Efficiency Bill Decoupling Energy Use From Utility Revenue." *Hart Energy*. Apr. 8, 2019. Available at: https://www.hartenergy.com/news/new-mexico-governor-signs-efficiency-bill-decoupling-energy-use-utility-revenue-179005#:~:text=The%20Efficient%20Use%20of%20Energy,efficiency%20and%20load%20management%20programs.

225 Morehouse, Catherine. "New Mexico Efficiency Bill Ensures Utilities Don't Take Hit From Lower Energy Use." *Utility Dive*. Apr. 5, 2019. Available at: https://www.utilitydive.com/news/new-mexico-efficiency-bill-ensures-utilities-dont-take-hit-from-lower-ener/552110/.

226 US Energy Information Administration. "Electricity Data Browser." Accessed Nov. 2020. Available at: www.eia.gov/electricity/data/browser/#/.

227 New Mexico Economic Development Department. "Sustainable & Green Energy." Accessed Jan. 2021. Available at: https://gonm.biz/why-new-mexico/key-industries/energy-natural-resources/.

electricity—making the financial impact of reducing these exports an economic concern if not rapidly replaced with renewables.

Presently, growth in New Mexico's oil and gas production is largely driven by exports, whereas renewable generation predominantly stays in-state,[228] but efforts are underway to enable the export of renewable electricity generation. To keep pace with the renewable energy expansion, the New Mexico Renewable Energy Transmission Authority (NMRETA) was legislatively created in 2007 to plan, finance, and develop transmission and energy storage infrastructure to further the economic growth of renewables across the state, and allow for greater access and ability to export renewable electricity.[229,230] The June 2020 Renewable Energy Transmission and Storage Study by NMRETA elaborately plans out how to get new transmission projects funded and deployed, but omits any community engagement in the ownership mechanism, planning, siting, funding, and maintenance of such projects, outside of notifying affected Tribal communities.[231,232]

The largest investor-owned utility in the state, PNM,[233,234,235] services over half a million consumers[236] and is a regional monopoly, severely limiting choice in electricity provider and generation sources.[237] To protect consumers, the Public Regulation Commission secures a basic utility "Bill of Rights," protecting consumers from inadequate service or abusive[238] billing practices, and ensuring continued service during severe illness or life endangerment.[239] However, many consumers have limited access to renewable sources without the approval of PNM. In 2017, PNM supported the passage of SB210: the Consumer Protection for Distributed Generation Act.[240] This bill was supposed to help protect consumers from manipulative solar installation companies, but opponents argued that PNM was acting in its own best interest by adding unnecessary and time-consuming barriers for residential rooftop solar installation, thus maintaining reliance on PNM's generation.[241] In the next section, we discuss how PNM programs and incentives fall under the Energy Transition Act and how benefits are distributed.

Many of New Mexico's legislative and administrative policies, regional compacts, and local initiatives surrounding decarbonization have focused on alleviating financial burdens for electricity consumers while providing renewable energy and energy efficiency options. In the next section, we consider this existing policy framework as it relates to environmental and socioeconomic equity potential.

228 Ladislaw, Sarah, *et al.* New Mexico's Energy Future. *Center for Strategic & International Studies* (2018).

229 Busch, Robert. New Mexico Oversight Committee. *New Mexico Renewable Energy Transmission Authority* (2018).

230 New Mexico Renewable Energy Transmission Authority. "About." Accessed Jan. 2021. Available at: https://nmreta.com/about/.

231 ICF. New Mexico Renewable Energy Transmission and Storage Study. *New Mexico Renewable Energy Transmission Authority* (2020).

232 To ensure a more just transition, community impact analysis with direct input from the impacted communities is needed during the technical feasibility stage of planning.

233 PNM Resources announced in October 2020 the merger with Avangrid, which would help increase the renewable energy portfolio of PNM and re-evaluate the ownership interests in the Four Corners power plant. This has led to some skepticism of the planned closure of coal plants, with the Navajo Transitional Energy Company trying to secure PNM's share interest in Four Corners and extend the life of the coal mine. While beyond the scope of this study, the full implications of the Four Corners shareholder interest sale and how the Navajo Nation itself will be impacted, are not yet determined but should be closely evaluated for pollution and energy accessibility.

234 PNM News. AVANGRID and PNM Resources to Combine in Strategic Merger Transaction (2020).

235 Feaster, Seth and Karl Cates. "As Utility Company Exits Four Corners Power Plant, NTEC Seeks to Keep It Open." *IEEFA*. Oct. 22, 2020. Available at: https://ieefa.org/ieefa-u-s-as-utility-company-exits-four-corners-power-plant-ntec-seeks-proxy-buyer-to-keep-it-afloat/.

236 PNM. "About PNM." Accessed Jan. 2021. Available at: https://www.pnm.com/about-pnm.

237 Chamberlain, Kendra. "Suit Alleges ETA a 'Deregulation Law' for PNM." *NM Political Report.* Aug. 28, 2019. Available at: https://nmpoliticalreport.com/2019/08/28/suit-alleges-eta-a-deregulation-law-for-pnm/.

238 Can include overly frequent, administratively cumbersome to pay, or other practices that can financially or time-wise cause undue and unnecessary harm to a retail ratepayer.

239 New Mexico Public Regulation Commission. Utility Consumer's Bill of Rights. Accessed Jan. 2021.

240 New Mexico State, Legislature. Senate Bill 210 (2017). *New Mexico State Legislature*.

241 Moss, Rebecca. "Transparency or Bureaucracy? Solar Bill Stirs Contention." *Sante Fe New Mexican.* Apr. 11, 2018. Available at: https://www.santafenewmexican.com/news/local_news/transparency-or-bureaucracy-solar-bill-stirs-contention/article_8d1df7c2-ea01-5fde-9831-321d1669c710.html.

3.2 Existing Environmental and Energy Equity Policy Overview

Below, we briefly review some of New Mexico's relevant existing policies to frame the broader landscape for policies intersecting climate justice and energy equity.[242] This review informs some of our proposed initiatives and recommendations that aim to address inequities across multiple sectors. We find that New Mexico has implemented measures to reduce burdens on a few defined disproportionately impacted communities, specifically targeting the coal mining and fossil fuel workforce. However, the enforcement components of these policies and further evaluation of other disproportionately impacted communities—such as people of color, tribal nations, and those with limited educational attainment—are limited.

The State of New Mexico is a leading oil and gas producer and exporter of electricity. The energy industry is an economic juggernaut—it accounts for nearly nine percent of all employment in the state and finances a third of the state's General Fund.[243,244] It is also heavily dependent on carbon-based energy production, to the detriment of local communities' and workers' health.[245,246,247] Thus in 2015, New Mexico overhauled its outdated energy policy and outlook plan (last updated in 1991) to reflect a moderate shift away from carbon-intensive activities such as oil production and coal mining and towards a more renewable energy economy, but with heavy emphasis on natural gas as a "cleaner" fossil fuel. This effort resulted in the 2015 Energy Policy & Implementation Plan,[248] a broad framework for expanding and updating New Mexico's energy industry across energy resources (renewable- and fossil-based), private companies, and research-focused institutions (e.g. universities and national laboratories). The primary twelve recommendations of the plan focus on:

1. Promoting all forms of energy, not just renewables,
2. Increasing natural gas in industrial and manufacturing operations,
3. Evaluating new energy markets and research,
4. Streamlining intrastate, interstate, and federal energy regulations for existing energy and renewable energy,
5. Expanding transmission infrastructure,
6. Expanding energy efficiency,
7. Using scientific evidence to guide environmental, public health, and safety perceptions,
8. Energy production water reductions,[249]
9. Publicly providing energy sector data,
10. Energy workforce training, and
11. Reviewing and renewing the energy policy frequently.

Only some of these recommendations pertain to the expansion of renewables in New Mexico, and several de-emphasize legacy health impacts or make subjective the legacy health, environmental, and socioeconomic

242 The State of New Mexico has numerous policies related to environmental public health, climate change, and renewable energy, however, here we focus specifically on the intersection with energy equity and climate justice.

243 New Mexico Legislative Finance Committee. Finance Facts: Oil and Natural Gas Production (2018).

244 Peach, James, and Starbuck, C. The Economic Impact of Coal Mining in New Mexico. *US Department of Energy* (2009).

245 Chamberlain, Kendra. Climate Change, Oil & Gas Emissions a Bad Mix for New Mexico Air Quality. *NM Political Report.* Apr. 23, 2020. Available at: https://nmpoliticalreport.com/2020/04/23/report-climate-change-oil-gas-emissions-a-bad-mix-for-new-mexico-air-quality/.

246 Moss, Rebecca. "7% of New Mexicans Exposed to Oil, Gas Production Pollutants." *Sante Fe New Mexican.* Oct. 13, 2017. Available at: https://www.santafenewmexican.com/news/health_and_science/report-7-of-new-mexicans-exposed-to-oil-gas-production-pollutants/article_e82ddfcc-9dd7-54af-a887-65304f61449d.html.

247 Environmental Defense Fund. "New Mexico's Oil and Gas Methane Problem Persists, Proposed Rules Need Improvement to Protect State's Health and Climate." Nov. 20, 2020. Available at: https://www.edf.org/media/new-data-new-mexicos-oil-and-gas-methane-problem-persists-proposed-rules-need-improvement.

248 New Mexico Energy, Minerals and Natural Resources Department. New Mexico Energy Policy & Implementation Plan (2015).

249 Includes produced water and water used in energy production.

inequities[250] related to fossil fuel production in the state. There is no focus on social equity: ownership of energy projects is not economically equitable among stakeholders nor are negative outcomes for energy development and deployment. While the Plan does have some community feedback through listening sessions, community feedback in general is not consistently and enforceably required nor easy to navigate for constituents.

The state's Energy, Minerals and Natural Resources Department (EMNRD) applied for US Department of Energy funding to implement the 2015 Energy Policy & Implementation Plan after initial efforts proved unsuccessful due to lack of clear strategies for implementation.[251] This support and additional funding led to the development of the 2018 Energy Roadmap,[252] an actionable framework to deploy the strategies of energy development through (1) education and workforce, (2) energy efficiency, (3) economic diversification, (4) transportation, and (5) transmission and natural gas expansion.[253] From an environmental and health perspective, the inclusion and expansion of natural gas as a primary fuel, even in rural communities, creates cause for concern from local communities and health advocates[254,255] because gas production releases non-methane VOCs and other health-damaging air pollutants alongside methane.[256,257] The Roadmap was developed with substantial input from a steering committee of over 70 energy stakeholders, representing a variety of interested parties including multiple industries, non-profits, trade associations, tribal representation (notably the Navajo Nation and Navajo Tribal Utility Authority), community and advocacy organizations, think tanks and policy organizations, government agencies, and private sector contributors. This level of stakeholder inclusiveness is a positive step towards ensuring representation from constituencies with economic ties to the success of an expanded energy industry. However, the stakeholder engagement did not extend to other impacted communities, such as smaller grassroots nonprofits, economically disadvantaged communities, linguistically isolated communities, or those communities with low or no access to reliable electricity.

The Energy Transition Act (ETA) of 2019[258] brought clean energy to the forefront in New Mexico policy, requiring 100 percent zero carbon energy by 2045 for investor-owned utilities (2050 for rural cooperatives). The ETA also provides workforce training and development for former mine and coal workers along with funding to support transitioning to renewable energy technologies particularly in the hard-hit regions of San Juan County and Four Corners.[259] The ETA created three new funds to spur clean energy growth, support worker retraining,

250 These inequities are often de-emphasized, omitted, or misinterpreted to be negative "perceptions" of those experiencing them, instead of the lived and learned experiences of those populations. This is where data analysis can aid in understanding through quantifying these experiences. Referencing when data sets are inaccurate, missing, or non-existent is necessary to gain a more comprehensive understanding of why some of these inequities continue to be perpetuated.

251 New Mexico Energy, Minerals and Natural Resources Department. "New Mexico Energy Roadmap Project 2017 - 2027." Accessed Jan. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/energyroadmap.html.

252 New Mexico Energy, Minerals and Natural Resources Department: Energy Conservation and Management Division. New Mexico Energy Roadmap (2018).

253 New Mexico Energy, Minerals and Natural Resources Department: Energy Conservation and Management Division. New Mexico Energy Roadmap (2018).

254 Barbee, Jeffrey. "Life Around New Mexico's Gas Wells: How Fracking Is Turning the Air Foul." *The Guardian.* Aug. 14, 2015. Available at: https://www.theguardian.com/environment/2015/aug/14/new-mexicos-gas-wells-fracking-air-pollution.

255 Fleischman, Lesley and Molly Dunton. Country Living Dirty Air: Oil & Gas Pollution in Rural America. *Clean Air Task Force; Earthworks* (2018).

256 Environmental Defense Fund. "New Mexico's Oil and Gas Methane Problem Persists, Proposed Rules Need Improvement to Protect State's Health and Climate." Nov. 20, 2020. Available at: https://www.edf.org/media/new-data-new-mexicos-oil-and-gas-methane-problem-persists-proposed-rules-need-improvement.

257 Fleischman *et al.* Gasping for Breath: An Analysis of the Health Effects from Ozone Pollution from the Oil and Gas Industry. *Clean Air Task Force* (2016).

258 New Mexico State, Legislature. Senate Bill 489 (2019). *New Mexico State Legislature*.

259 Nájera, Maria. "The Energy Transition Act Makes New Mexico a National Leader in Clean Energy." *Western Resource Advocates.* Mar. 7, 2019. Available at: https://www.google.com/url?q=https://westernresourceadvocates.org/blog/the-energy-transition-act-will-make-new-mexico-a-national-leader-in-clean-energy/&sa=D&source=editors&ust=1618360082973000&usg=AOvVaw3-KDIEbz8UCU-EYQx4eiWiK.

and protect against displacement.[260] One of those funds is the development assistance fund, aimed to help affected[261] local economies transition away from fossil fuels.[262] In addition to providing funding mechanisms, the ETA makes the economic development department responsible for creating an economic diversification plan to assist affected communities. Public planning will include at least three public meetings in the affected community for monetary spending guidance, but does not specify any required input from the affected community to be used by the Department.[263] The Department of Workforce Solutions is responsible for creating a displaced worker development plan and while workforce recommendations are beyond the scope of this study, a 2020 workforce development study analyzes the need for clean energy job training for new workers and transitioning for those workers impacted by fossil fuel facility closures.[264]

The drafting of the ETA received widespread support from a variety of large-scale stakeholders, including government agencies, environmental organizations, labor unions, and clean energy advocates, including local, community-based organizations,[265,266] but received opposition from a few smaller, local organizations and residents who urged for stronger local community engagement, particularly from numerous tribal organizations,[267] and greater financial accountability for PNM's facility retirements[268] to ensure existing social and health equity issues in the energy landscape are not further exacerbated.[269] Longstanding health impacts from prior PNM operations would not be immediately remediated, and the cost to close fossil-fueled facilities like the San Juan Generating Station, a coal-fired plant slated to close in 2022, will ultimately be paid by ratepayers through financial instruments allowed under the ETA instead of the utility.[270,271,272] This cost shift to ratepayers opens up the potential need for ratepayer protections for populations already facing high energy cost burdens.

Tribal land and nations are a substantial portion of land in New Mexico. The state ranks third for the most tribal land in the US, with 23 federally recognized tribes residing in the state.[273] However, few tribes were consulted in the drafting phase of the ETA. Implementation of the law through community engagement with numerous tribes is missing and guidelines for structure and frequency of community advisory groups is lacking. Given the historic siting

260 Foehringer Merchant, Emma. "New Mexico's 100% Clean Energy Law Praised for Worker Retraining, but Community Concerns Remain." *Greentech Media*. Mar. 29, 2019. Available at: https://www.greentechmedia.com/articles/read/new-mexico-100-clean-energy-law-community-concerns.

261 Affected community includes a New Mexico county within 100 miles of a closed electricity producer, where such a closure resulted in at least 40 displaced workers.

262 New Mexico State, Legislature. Senate Bill 489 (2019). *New Mexico State Legislature*.

263 *Ibid.*

264 New Mexico Department of Workforce Solutions. New Mexico Clean Energy Workforce Development Study (2020).

265 *Ibid.*

266 New Mexico Indian Affairs Department. "Energy Transition Act (ETA)." Accessed Jan. 2021. Available at: https://www.iad.state.nm.us/policy-and-legislation/energy-transition-act/.

267 Indigenous Peoples of the Southwest & Allies. Open Letter to Governor Michelle L. Grisham: No Just Transition without Indigenous Consultation.

268 PNM owns the San Juan Generating Station and the Four Corners Plant.

269 Madeson, Frances. "New Mexico Law Gives Private Utilities Unchecked Power Over Shift to Renewables." *Truthout*. Aug. 27, 2019. Available at: https://truthout.org/articles/new-mexico-law-gives-private-utilities-unchecked-power-over-shift-to-renewables/.

270 *Ibid.*

271 Bryan, Susan M. "Court Filing Targets New Mexico's Energy Transition Law." *Associated Press.* Aug. 19, 2020. Available at: https://apnews.com/article/f9c8a21d98abf6e934b318ad9c928b80.

272 Fischmann, Steve. "Changes Needed in New Mexico's Energy Transition Act." *KRWG Public Media.* Jan. 4, 2021. Available at: https://www.krwg.org/post/changes-needed-new-mexicos-energy-transition-act.

273 US Energy Information Administration. "New Mexico State Energy Profile." Accessed Feb. 2020. Available at: https://www.eia.gov/state/analysis.php?sid=NM.

of fossil fuel infrastructure such as gas wells (and leases)[274] and coal mines and power plants, the potential impact to tribes for such a law is substantial.[275] *Appointing a representative committee, composed of all tribal nations within the state, may help assure more equitable implementation of the ETA. As the ETA's funds are distributed to create the programs needed for the transition from fossil fuels to clean energy, we recommend representation in fund allocation and fund distribution. This should include populations with historically high energy cost burdens, low electricity access rates, and/or low clean energy transportation options (including electric vehicle adoption rates). According to our analyses, these populations include, but are not limited to, tribal nations, people of color (especially Native American and immigrant communities), and low- and middle-income New Mexicans.*

Our findings can provide additional insight into the various ways the ETA and other clean energy efforts across New Mexico can, and should, incorporate environmental and energy equity considerations, as outlined in the next section.

3.3 Key Themes and Policy Implications by Sector

Our findings across sectors reveal multiple opportunities for deep decarbonization in New Mexico to simultaneously address environmental, socioeconomic, public health, and energy equity disparities. Building upon these key themes, we use our findings to inform and shape our policy recommendations through an energy and environmental equity lens, by sector and across sectors. We do not address the full scope of potential climate policies here, nor impacts—positive or negative—on the energy workforce. Instead, our analysis focuses on energy equity- and health-related climate policies.

In every sector evaluated in this study, the full engagement of local and impacted communities (i.e. representative and enforceable decision-making power) emerged as a recurring and vital theme. Current legislative and regulatory processes could improve stakeholder participation through genuine, meaningful community engagement and participation, including but not limited to outreach during the design and planning stages of policy development, and community feedback mechanisms that directly impact decision making and implementation. Improvements to community engagement should include:

1. Outreach to local residents and businesses near sources of high pollutant emissions, including:
    a. Transportation hubs such as interstate corridors and bus yards,
    b. Oil and gas infrastructure,
    c. Mining facilities, and
    d. Other industrial point sources;
2. The provision of educational materials in local languages that explain how communities may benefit from (e.g. utility bill reductions, health improvements, etc.) and can access (e.g. how to apply for subsidies and financing) electrification and decarbonization measures;
3. Increased opportunities for binding community feedback as decarbonization efforts are developed, particularly in tribal communities, moderate- to low-income neighborhoods, and communities of color; and
4. Community involvement in the ownership of decision-making processes through working groups or committees focused on how decarbonization efforts are rolled out, which communities should be prioritized, and how the benefits and costs of decarbonization should be allocated.[276]

New Mexico has a plethora of renewable energy- and climate change-focused initiatives and policies at local, regional, and state levels. While it is beyond the scope of this study to comprehensively evaluate them all, we aim to review those that might be enhanced, modified, or otherwise updated to incorporate a social and energy equity lens. Specifically, multiple

274 Foehringer Merchant, Emma. "New Mexico's 100% Clean Energy Law Praised for Worker Retraining, but Community Concerns Remain." *Greentech Media*. Mar. 29, 2019. Available at: https://www.greentechmedia.com/articles/read/new-mexico-100-clean-energy-law-community-concerns.

275 While the ETA focuses on coal, the fossil fuel industry in New Mexico is heavily serviced by, and located in or around, tribal communities. The impact of the ETA is therefore substantial to these populations.

276 These considerations also include workforce development, such as job retraining for workers in the fossil fuel industry, which will be addressed in a forthcoming partner report.

state agencies are responsible for the development and implementation of these policy initiatives, including New Mexico's Department of Transportation, Environment Department, and Energy, Minerals, and Natural Resources Department. These agencies work in partnership with other state agencies and private sector stakeholders that focus on providing energy efficiency, accessibility and funding support, and demographically-targeted population assistance.[277,278] Due to their broad coverage, we briefly outline a limited selection of these programs next, along with some local initiatives, and then provide recommendations on how they might be updated or expanded, based on our findings.

3.3.1 **Transportation**

New Mexico's transportation sector is the second-largest emitter of greenhouse gases in the state, after the oil and gas industry.[279] To increase the adoption of electric vehicles and expand their associated health and economic benefits to all populations, policies should be aimed at alleviating barriers to access for underserved communities. This can be achieved largely through the expansion of targeted financing mechanisms and community engagement. Community input should guide electric vehicle charging infrastructure investments as well as measures that facilitate alternative modes of personal transportation, such as public transit, biking or walking, and carpooling.[280]

Additional investments in community infrastructure measures that reduce vehicle demand by supporting active transportation options, such as biking or walking, could help reduce pollution burdens in urban areas and improve public health through increased physical activity. Achieving sociodemographic, environmental equity, and public health benefits across the transportation sector requires a suite of approaches that address existing pollution—including from medium- and heavy-duty vehicles—and provide affordable, electrified public transit and electric vehicle financing for moderate- and lower-income households and small trucking operators.

Recommendation 1: Design upfront financial incentives to support adoption of electric passenger vehicles in low-adoption rate communities, such as populations of color and low-income communities who experience disproportionally high vehicle fuel-related cost burdens. Incorporate community input to guide electric vehicle charging infrastructure investments, which can facilitate electric vehicle adoption among households facing access barriers.

To incentivize electric vehicle adoption, New Mexico is partnering with public and private stakeholders to substantially expand fueling infrastructure for alternative and electric vehicles. Governor Lujan-Grisham issued Executive Order 2019-003 to create an

277 New Mexico Interagency Climate Change Task Force. "New Mexico Climate Change Action." Accessed Feb. 2021. Available at: https://www.climateaction.state.nm.us/state-climate-action.html.

278 New Mexico Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations (2020).

279 *Ibid.*

280 The NM Department of Transportation's Highway Operations division has a Civil Rights Bureau, focused on the roll out of federal protections required of the department, including but not limited to civil rights, Americans with Disabilities Act compliance, working with disadvantaged businesses, affirmative action, and training requirements. While the latest report (2015 NMAA) provides data on the department's workforce by demographic indicators such as sex, race, job, and other pertinent activities and attributes, more is needed to correct inequities found within the data.

Interagency Climate Change Task Force[281,282] tasked with evaluating low- or zero-emission vehicles for use to meet climate targets and collaboration with RETA on renewable energy transmission infrastructure pathways, among other tasks.[283]

New Mexico has also strategically located electric vehicle chargers along heavily trafficked corridors, making travel in the state more electric vehicle-friendly. However, there is also an opportunity to improve economic equity as charging infrastructure is updated or created. From our findings (see **Figure 22**), the majority of public charging stations in New Mexico are located in metropolitan areas. Only three public charging stations (eight charging outlets total) are located on tribal lands. Ensuring that public charging infrastructure is accessible to rural residents, particularly in northwestern New Mexico[284]—where populations are majority people of color, majority low-income, and have high concentrations of tribal nations[285]—could help the State reach households with high vehicle fuel cost burdens and who may face barriers to electric vehicle adoption.

Ownership of these charging stations is currently left to the utilities via House Bill 521,[286] which requires more electric charging stations in low-income and underserved areas, as well as in private businesses, municipalities, and other entities with financial resources for installation and maintenance.[287,288] *While there are free options to charge vehicles sponsored by automakers and businesses,[289] they are rare and limited in number and reach. The costs to access a charging station in addition to the unrestricted price of the electricity itself[290] may be prohibitive for widespread use as infrastructure owners can set the prices charged. To benefit more low-income households and communities of color, New Mexico can incentivize ownership and operations of these stations by the local community. This can be achieved by expanding on the models used by homeowners association-owned and cooperative-owned charging stations,[291,292] which provide examples of small-scale local ownership that may be modified to provide for more inclusive community ownership. Where this is not possible, the State should work towards more reliable accessibility to stations and price stabilization.*

While cooperatives are technically owned by the communities they serve, in general, rural cooperative boards and committees are predominantly White. This leaves racially diverse rural populations without decision-making authority over how the clean energy transition will occur, over what timeframe, at what financial cost, and at what gain for member

281 The Task Force has nine interagency teams, with four focused on reducing greenhouse gas emissions: (a) clean and efficient electricity and buildings, (b) transportation decarbonization, (c) state leadership, and (d) industrial and oil and gas sector emissions, and five focused on adaptation and resilience: (a) economic transition, (b) natural working lands, (c) sustainable infrastructure and planning, (d) emergency management, health, and resilience, and (e) cultural heritage.

282 New Mexico Interagency Climate Change Task Force. "Interagency Climate Change Task Force." Accessed Feb. 2021. Available at: https://www.climateaction.state.nm.us/task-force.html.

283 New Mexico, Executive Office of the Governor. Executive Order 2019-003: Executive Order on Addressing Climate Change and Energy Waste Prevention (2019).

284 The southwest and other areas throughout the state may also have high concentrations of populations that lack access to electricity, and may have demographic characteristics that rank individually or cumulatively higher on our Demographic Index.

285 Some tribal nations, rural populations, and communities of color may lack direct access to reliable and affordable electricity. First, installing sufficient electricity infrastructure to these areas to support home electriciation needs is necessary and then electric charging infrastructure can be built to further support electric vehicle adoption.

286 New Mexico State, Legislature. House Bill 521 (2019). *New Mexico State Legislature*.

287 Romero, Leah. "New Mexico Shifting from Slow to Fast Lane for Electric Vehicles. *Las Cruces Sun News*. Dec. 14, 2019. Available at: https://www.lcsun-news.com/story/news/local/new-mexico/2019/12/14/new-mexico-shifting-slow-fast-lane-electric-vehicles/2639727001/.

288 New Mexico Energy, Mineral, and Natural Resources Department. "Electricity." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/CleanFuelsandEfficientTransportation/electricity.html.

289 Electric Power Research Institute. Consumer Guide to Electric Vehicle Charging (2019).

290 Messer, Colin and Amy Miller. Electric Vehicle Infrastructure Checklist for Government, Community and Business Leaders. *Land of Enchantment Clean Cities Coalition* (2020).

291 US Department of Energy. A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects (2014).

292 Kelly, Erin. "Co-ops Create Electric Vehicle Charging Network in Upper Midwest". *NRECA*. Jan. 14, 2021. Available at: https://www.electric.coop/co-ops-create-electric-vehicle-charging-network-in-upper-midwest.

owners.[293,294,295] *Accordingly, state and local policy makers should encourage cooperative boards and committees to be representative of customer communities.*

Though we did not find data on electric vehicle ownership by income specific to New Mexico, electric vehicles are typically purchased by higher-income households across the country.[296] A study focused on the California electric vehicle buyers market shows that electric vehicles are disproportionately purchased by non-Hispanic White populations, even when adjusted for income, which may hold true in New Mexico as well based on national trends.[297]

Common existing incentives,[298] such as tax credits or post-purchase rebates for electric vehicle adoption, benefit those with higher income tax burdens and fail to address socioeconomic barriers to vehicle electrification faced by communities of color and lower- to moderate-income New Mexicans. *Upfront financing and subsidies to encourage electric vehicle adoption for communities of color, tribal communities, and lower- to moderate-income communities are needed to ensure that electrification is more accessible to these populations.* Additional financing measures can include point-of-sale rebates, low-interest loans for low- and moderate-income customers, and additional rebates for trading in inefficient older vehicles for cleaner models. Policies that facilitate the secondary market for electric vehicles may also help increase affordability.

As vehicles are electrified, the accompanying public charging infrastructure will need to keep pace. The Land of Enchantment Clean Cities Coalition—sponsored and funded by the US Department of Transportation—serves as a strategic partner and technical resource for local government, community, and business leaders building charging infrastructure. This coalition is establishing an alternative fuels and electric vehicle corridor for intra- and interstate travel, allowing for one barrier to infrastructure inaccessibility to be partially addressed.[299,300] The 2019 passage of House Bill 521[301] allowed for a more structured and compulsory approach to increasing charging infrastructure by (1) requiring investor-owned utilities to create transportation electrification plans, which were due by the beginning of this year, and (2) allowing resellers of electricity for fuel purposes to not be categorized as a utility, reducing regulatory constraints for charging operators. Private, public, and government programs such as these should be funded and expanded, with a focus on areas with high household vehicle fuel cost burdens, dense vehicle pollution, and large numbers of renters, multifamily building tenants, low-income households, people of color, and/or linguistically-isolated households, to ensure these regions do not lag behind in adoption (current stations are shown in **Figure 22**).

As New Mexico continues to expand intrastate charging infrastructure, expansion of infrastructure to support interstate travel is also advisable as interstate commerce is necessary for state-wide economic stability. Interstate electric vehicle travel will help New Mexicans, and surrounding neighboring states, by expanding air quality benefits and clean transportation options to more people. Collaborative multi-state approaches to decarbonization are one effective way to realize the benefits of electrification. The Electric Vehicle Plan for the West (named the *Regional Electric Vehicle West Plan* by its signatories) is a memorandum of understanding between New Mexico and seven other western states. The memorandum serves as an example of how a multistate effort can further electric vehicle adoption by making it more convenient and accessible to drive

293 Yanez, Miguel, *et al.* Equitable Beneficial Electrification for Rural Electric Cooperatives. *Environmental and Energy Study Institute* (2019).

294 Ross, Lauren, *et al.* The High Cost of Energy in Rural America: Household Energy Burdens and Opportunities for Energy Efficiency. *Energy Efficiency for All, American Council for an Energy-Efficient Economy* (2018).

295 Labor Neighbor Research and Training Center and ACORN International. The Rural Power Project: A Research & Advocacy Report (2016).

296 Slowik, Peter and Michael Nicholas. Expanding Access to Electric Mobility in the United States. The International Council on Clean Transportation (2017).

297 Muehlegger, Erich and David Rapson. Understanding the Distributional Impacts of Vehicle Policy: Who Buys New and Used Alternative Vehicles?. *National Center for Sustainable Transportation Research Report* (2018).

298 At the federal, state, or local levels.

299 Clean Cities Coalition. "About." Accessed Feb. 2021. Available at: https://www.loecleancities.org/electric.

300 New Mexico Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations (2020).

301 New Mexico State, Legislature. House Bill 521 (2019). *New Mexico State Legislature*.

an electric vehicle across multiple states by providing a corridor with sufficient charging infrastructure.[302] As noted in the non-binding agreement, strategic deployment of vehicle charging infrastructure, especially along urban interstate corridors and paired with beneficial vehicle charging rate design, are needed to facilitate electric vehicle adoption within the trucking industry.

Recommendation 2: Accelerate medium- and heavy-duty truck electrification and emission reductions by (1) prioritizing the retirement of old, high-emitting heavy-duty and medium-duty trucks, (2) providing sufficient financial incentives for small businesses to convert their trucks, (3) rerouting trucks away from dense, urban areas with high cumulative environmental burdens, (4) limiting diesel truck idling, and (5) creating enforceable in-state targets to divert more freight trucking to rail and to support interstate trucking electrification goals.

Within the decarbonization modeling scenarios, passenger vehicles are electrified at a faster rate than trucks. Policies are needed to help accelerate the electrification of medium-duty and heavy-duty trucks and trailers, which are responsible for a disproportionately high fraction of vehicle NO_x and $PM_{2.5}$ emissions relative to their fraction of vehicle miles traveled. In New Mexico, 85 percent of truck traffic on I-40 and I-10 is passing through the state.[303] This makes multi-state initiatives with enforceable in-state targets key to the facilitation of truck electrification. These initiatives can help reduce pollution along urban interstate corridors in particular, where emissions from on-road vehicles are most dense.

Given the prevalence of interstate freight trucking in New Mexico, designing policies to divert freight transport to rail could significantly improve energy efficiency, reduce air pollution, and reduce roadway fatalities associated with freight transport in New Mexico. Although rail is more fuel-efficient than trucking, achieving a rate of 156-512 ton-miles/gallon compared to 68-133 ton-miles/gallon,[304] continued use of diesel fuel by new and existing rail lines would risk burdening adjacent communities with lingering air pollution. Electrifying new and existing rail lines would maximize the energy efficiency gains of switching from trucks to rail, reduce noise pollution, and reduce emissions of greenhouse gases and pollutants including soot, volatile organic compounds, nitrogen oxides, and sulfur oxides.[305] Rail would also improve road safety. Freight rail causes one-eighth of the fatalities caused by freight trucking per ton-mile.[306] While analyzing the spatial and environmental equity impacts of expanded rail freight transport was outside the scope of this report, we encourage the State to seek community input in all stages of rail planning and development to ensure land use and environmental impacts are equitable.

In addition to accelerating truck electrification and diverting freight transport to rail, New Mexico could significantly reduce near-term trucking pollution by implementing policies that incentivize the retirement of older heavy-duty and medium-duty trucks. Given that Black, Asian American, and Hispanic communities in New Mexico are disproportionately exposed to trucking pollution, this strategy could also help the State advance climate equity objectives over the next decade. To accelerate this transition, New Mexico should consider applying for federal funding through the EPA's Diesel Emissions Reduction Act,[307] which provides financial incentives for truck owners to replace high-emitting older vehicles. To maximize emissions benefits, the EPA recommends retiring the oldest trucks with the highest annual mileage first, and replacing them with models from 2014 or after.[308]

302 National Associate of State Energy Officials. Regional Electric Vehicle Plan for the West (2019).

303 New Mexico Department of Transportation. New Mexico 2030 Statewide Multimodal Transportation Plan (2009).

304 Federal Railroad Administration. Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors (2009).

305 *Ibid.*

306 Nunno, Richard. "Electrification of U.S. Railways: Pie in the Sky, or Realistic Goal?" *Environmental and Energy Study Institute.* May 30, 2018. Available at: https://www.eesi.org/articles/view/electrification-of-u.s.-railways-pie-in-the-sky-or-realistic-goal#:~:text=Though%20trains%20are%20more%20efficient,the%20energy%20to%20the%20wheels.

307 US Environmental Protection Agency. "Learn About Impacts of Diesel Exhaust and the Diesel Emissions Reduction Act (DERA)." Accessed Mar. 2021. Available at: https://www.epa.gov/dera/learn-about-impacts-diesel-exhaust-and-diesel-emissions-reduction-act-dera.

308 US Environmental Protection Agency. "Drayage Truck Best Practices to Improve Air Quality." Accessed Mar. 2021. Available at: https://www.epa.gov/ports-initiative/drayage-truck-best-practices-improve-air-quality#age.

A multi-state approach may also prove useful to target the trucking sector. One example of such an effort is the *Pledge to Develop Action Plan to Eradicate Toxic Diesel Emissions by 2050*. The pledge establishes a shared target between 15 states and Washington D.C. for 30 percent of new medium- and heavy-duty vehicle sales to be zero emission by 2030, increasing to include all new vehicles in the medium- and heavy-duty weight class by 2050.[309,310,311] While this joint memorandum is a first step, neither the 2050 target nor the intermediary 2030 target are binding. More aggressive policies, such as California's Advanced Clean Trucks rules, which require truck manufacturers to produce and make available for sale zero-emission vehicles,[312] could be used to ensure emission reductions are achieved in the near term.

Private electrification efforts can also be further developed to expand conversion. In 2020 for example, the New Mexico Environment Department awarded $4.6 million in funding from the Volkswagen Settlement Fund (also known as the Diesel Emission Mitigation Fund) to 43 projects across New Mexico for alternative fuel solid waste vehicles, electric and alternative fuel school buses, and electric transit buses.[313] Approximately $1.9 million went to projects in Bernalillo, McKinley, Santa Fe, and Torrance counties.[314] Of these, McKinley has a high average concentration of sociodemographically vulnerable populations on a countywide basis, based on several indicators in our Demographic Index. All of these counties have some areas with high concentrations of low-income populations.

While large fleet owners and operators may be able to absorb some or the majority of the costs of converting their fossil-fueled fleets into electric vehicles, smaller fleets and independent truckers may not be able to do so without additional financial support.[315, 316] Small owner-operator truckers are typically micro enterprises owned or leased by a single person[317] and access to capital to improve or buy new equipment or vehicles is severely limited. Any effort to electrify the trucking industry will need to incorporate upfront financing mechanisms for these small and micro enterprises.[318] For example, the Volkswagen Settlement Fund could have prioritized these smaller owner-operators. In decarbonization scenarios, small and independent fleets that continue operating non-electrified trucks may be further financially disadvantaged. Unless policy intervention is implemented, these businesses will likely be required to purchase more expensive zero-carbon fuels to comply with the 2050 climate goals.

Other efforts to mitigate truck pollution, such as rerouting trucks to less populated areas and limiting idling at checkpoints, weigh stations, and in residential neighborhoods, could reduce air pollution and be rapidly implemented. Currently, New Mexico does not have limitations on idling,[319] though commercial vehicles are allowed increased load limits if they use an idle reduction technology.[320] Mitigating the cumulative pollution impacts of trucking pollution, which may include ground-level ozone precursors, near industrial and oil and gas facilities is also important. Idling limits should be designed with feedback from truckers, as

309 California Air Resources Board. Multi-State Medium- and Heavy-Duty Zero Emissions Vehicle Memorandum of Understanding (2020).

310 Northeast States for Coordinated Air Use Management. 15 States and the District of Columbia Join Forces to Accelerate Bus and Truck Electrification. Pledge to Develop an Action Plan to Eradicate Toxic Diesel Emissions by 2050 (2020).

311 New Mexico is not currently a signatory for this pledge.

312 California Air Resources Board. "Advanced Clean Trucks." Accessed Oct. 2020. Available at: https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/about.

313 New Mexico Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations (2020).

314 Ibid.

315 Leung, Jessica and Janet Peace. Insights on Electric Trucks for Retailers and Trucking Companies. *Center for Climate and Energy Solutions* (2020).

316 Romero, Ezra David. "California Electric Trucks Standard is First of Its Kind; Pandemic Leads Trucking Industry to Question Its Viability." *Capital Public Radio*. Apr. 3, 2020. Available at: https://www.capradio.org/articles/2020/04/30/california-electric-trucks-standard-is-first-of-its-kind-pandemic-leads-trucking-industry-to-question-its-viability/.

317 Owner-Operator Independent Drivers Association. "OOIDA." Accessed Dec. 2020. Available at: https://www.ooida.com/.

318 Satterfield, Charles and Nick Nigro. Assessing Financial Barriers to Adoption of Electric Trucks. *Atlas Public Policy* (2020).

319 US Department of Energy. "Clean Cities IdleBase: Database of Idling Regulations." Accessed Feb. 2021. Available at: https://www.google.com/url?q=https://cleancities.energy.gov/files/docs/idlebox_idlebase_database.xlsx&sa=D&source=editors&ust=1618427453237000&usg=AOvVaw1mO0yDlj1GDqMLfaZVhubq.

320 Nm. Code Ann. § 66-7-410 (1978).

auxiliary equipment for heating and cooling during cold or hot days is often directly powered by vehicle idling; alternative and electrified ways to power auxiliary equipment may prove to be a useful compromise. Additional measures that replace aging and inefficient trucks should also be considered to address legacy environmental and sociodemographic disparities in electric truck adoption, ownership, and access. However, further investigation is needed to ensure that these measures do not unduly burden small and micro trucking owner/operator enterprises, or fail to benefit communities with disproportionately high cumulative pollution.

The Land of Enchantment Clean Cities and the New Mexico Electric Grid Modernization[321] programs should be leveraged when citing new electric charging stations to account for current and future trucking routes and pollution levels. The Energy Grid Modernization Roadmap[322,323] could specifically help to alleviate infrastructure inequities[324] found in electricity distribution and transmission networks as it is broadly designed to incorporate numerous approaches to consumer engagement,[325] distributed energy resources, and electricity generation planning and benefits. However, as evidenced by the lack of social- and energy-equity focused discussion at the 2019 New Mexico Grid Modernization Retreat,[326] more focus on energy equity outcomes, particularly in trucking electrification and charging infrastructure, is needed.[327]

New charging infrastructure for trucks should not financially overburden communities already dealing with existing environmental and socioeconomic disparities. Instead, economic incentives should be provided to accelerate electrification through local infrastructure ownership, job creation, and revenue generation in impacted communities. This infrastructure build-out must be coupled with the safe retirement of existing petroleum-based fueling stations through government- and fossil fuel company-financed dismantling, and soil and water remediation programs. Retired gas stations, for example, are classified as petroleum brownfields and improper cleanup can contaminate soil and groundwater, and threaten the health of adjacent communities.[328] *Cleanup and reinvestment of abandoned gas stations and other petroleum-contaminated properties into clean energy sites could increase local tax bases, promote job growth, and provide greater amenities for the community if structured in a social and economically equitable manner.*

Recommendation 3: Coordinate efforts by local, regional, and state governments—with outreach to local communities—to expand electrified low- or zero-fare public transit, where appropriate, to reduce transportation-related pollution and overall vehicle travel while improving transit access for mobility-limited households.

New Mexico has taken several initial steps towards electrifying and expanding the transit portion of the transportation sector over the years, including planning and funding active transportation options such as biking or walking,[329] promoting multimodal

321 New Mexico Energy, Minerals, and Natural Resources Department. “Electric Grid Modernization.” Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/GridModernization/GMAG.html.

322 *Ibid.*

323 New Mexico State Legislature. House Bill 233 (2020). *New Mexico State Legislature*.

324 Location and siting, ownership, and accessibility of infrastructure.

325 The roadmap is scheduled to be released later in 2021, and it remains unclear how much community members and other stakeholders will be engaged in the drafting and final implementation of the roadmap.

326 National Governors Association. “New Mexico Grid Modernization Retreat.” Dec. 12, 2019. Available at: https://www.nga.org/center/meetings/new-mexico-grid-modernization-retreat/.

327 The 2019 New Mexico Grid Modernization Retreat was sponsored by the National Association of Governors, which competitively selected four states with governor-designated teams to promote grid modernization. The New Mexico retreat included multiple presentations from academia and private interests to “examine[d] how to reach the targets in the Act with a modernized grid in the most affordable, reliable, and equitable way.” However, it is unclear how robust further discussions of equitable outcomes were, as no additional mention of equity exists in the remaining presentations.

328 US Environmental Protection Agency. “Petroleum Brownfields.” Accessed Mar. 2021. Available at: https://www.epa.gov/ust/petroleum-brownfields.

329 New Mexico Department of Transportation, Multimodal Planning and Programs Bureau. Active Transportation and Recreational Programs (2017).

transportation,[330] and electrifying public and school transportation.[331] Additional city planning to support active transit options can yield further individual and public health benefits. Public transit build-out is a core component of the Low Demand decarbonization scenario, which yields the greatest emission reductions and lowest net cost. However, the design of this scenario should be community-guided and should include an implementation plan to ensure communities are not displaced or otherwise negatively affected.[332]

In addition to providing community-wide benefits, affordable electric public transportation particularly benefits communities of color and low-income households, which have historically lagged behind in electric vehicle adoption and have the lowest access to any kind of vehicle.[333] For example, the Multimodal Planning and Programs Bureau[334] has several programs to promote less carbon-intensive transportation options. Programs such as the Bicycle, Pedestrian, and Equestrian Program, and the Transportation Alternatives Program could be expanded in scope to include equitable planning and community participation.

New Mexico has used federal funding to procure a limited number of electric buses for regional transit districts[335] and cities,[336] yet the need to pair alternative transportation with a reduction in single-passenger vehicle miles traveled[337] is widely acknowledged. With no large-scale implementation plan for alternative and electrified transit options in place, the State has ample room to coordinate statewide planning and funding efforts. In urban contexts where public transportation is currently limited or unavailable, electrified fleets should be prioritized for deployment. Where transit is already available, current fossil fuel-reliant fleets could be phased out and replaced with electric school and transit buses, prioritizing aging fleets and those operating along highly polluted routes. A potential initiative New Mexico may consider looking to as a model is the Innovative Clean Transit rule from California, which supports transitioning all public buses to zero-emission technology.[338]

Expanded public transit infrastructure, such as mass transit trains, electric Rapid Ride[339] or high-speed buses, and electric trains,[340] could help alleviate congestion and pollution burdens in urban areas and increase transit access in rural and underserved communities. To navigate the financial and logistical challenges of expanding public transit infrastructure to serve New Mexico's low-density rural population, the state could apply for funding and technical assistance through the Federal Transit Administration's Rural Transit

330 New Mexico Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations (2020).

331 These steps can be further expanded upon, with additional funding sources and outreach a central theme.

332 The negative effects of public transit expansion can expand beyond displacement and gentrification, and may include for example, undesired changes in community character, accessibility, and cultural and heritage preservation or practice. This list is not exhaustive, and if public transit expansion is done with significant community-input to lead the direction, scope, and scale of the build-out, then the potential positive impacts from public transit such as localized mobility, economic diversification, and health, could mitigate or outweigh adverse reactions.

333 Hsu, Chih-Wei and Kevin Fingerman. Public Electric Vehicle Charger Access Disparities Across Race and Income in California. *Transport Policy* 100 (2021): 59-67.

334 New Mexico Department of Transportation. "Multimodal Planning and Programs Bureau." Accessed Feb. 2021. Available at: https://dot.state.nm.us/content/nmdot/en/planning.html.

335 Wyland, Scott. "North Central Regional Transit District to receive nearly $3 million for green bus program." *Santa Fe New Mexican*. Jun. 4, 2020. Available at: https://www.santafenewmexican.com/news/local_news/north-central-regional-transit-district-to-receive-nearly-3-million-for-green-bus-program/article_7cf937e6-a5b6-11ea-9ea2-73de102d5422.html.

336 City of Albuquerque. "City Bringing First Electric Buses to Albuquerque." Accessed Feb. 2021. Available at: https://www.cabq.gov/transit/news/city-bringing-first-electric-buses-to-albuquerque.

337 New Mexico Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations (2020).

338 California Air Resources Board. "Innovative Clean Transit Regulation Fact Sheet." Accessed Oct. 2020. Available at: https://ww2.arb.ca.gov/resources/fact-sheets/innovative-clean-transit-ict-regulation-fact-sheet.

339 Albuquerque-based express bus service.

340 New Mexico has a long history of using fossil fueled high speed rail for passenger and freight loads, spanning intra- and interstate. Multiple local public transportation agencies could evaluate and electrify their fleets as a part of decarbonization efforts.

Assistance Program.[341] Public transportation may even be considered a utility in its own right, as it is an essential provider of public goods and its broad accessibility is needed for fuller economic participation.[342, 343] However, investments should be informed by community feedback, and should include community-driven solutions for public transit implementation, supporting accessibility and affordability, while limiting the negative impacts of displacement and gentrification.[344, 345, 346] To continue moving the state towards more accessible electrified transit options, coordination is required between state, regional, and local government agencies and communities throughout the state.

3.3.2 Residential Buildings

Our findings for the residential sector, public data sources, and analyses indicate that socioeconomically and demographically vulnerable communities—including low-income communities, communities of color (particularly Native American communities), and the renting population[347]—lag in access to clean energy technologies.[348, 349] This leads to the inequitable distribution of clean energy benefits (e.g. utility bill savings and reduction of indoor air pollution[350]) away from these communities. In addition, air pollution from buildings—notably particulate matter ($PM_{2.5}$) and NO_x—is not distributed evenly across the state and can vary dramatically by community and fuel type, including substantial contributions from wood in rural areas and on tribal lands (see **Figures 19** and **20**).

Meanwhile, residential energy cost burdens tend to be highest for low-income neighborhoods and for some communities of color across income levels. Native American communities were found to have the highest burden, as shown in **Figures 25** and **27,** even though energy consumption tends to be largest for higher-income neighborhoods (as shown in **Figure 26**). Additionally, we see that despite similar energy usage to others, energy cost burdens tend to be higher in neighborhoods with majority Hispanic populations that have larger fractions of foreign-born residents (**Figure 28**). Policies aimed solely at reducing greenhouse gas emissions may not alleviate New Mexico's disproportionate residential energy cost burdens nor reduce building pollutant emissions, particularly from burning wood fuel. Complementary policies will be needed to ensure that tribal nations, low-income

341 Federal Transit Administration. "Rural Transportation Assistance Program - 5311(b)(3)." Accessed Apr. 2021, Available at: https://cms7.fta.dot.gov/funding/grants/rural-transportation-assistance-program-5311b3.

342 Templeton, Carter. "Transportation as Utility." *The Eno Center for Transportation.* Mar. 26, 2013. Available at: https://www.enotrans.org/article/transportation-as-utility/#:~:text=%E2%80%9CTransportation%20is%20a%20utility%2C%20essential,natural%20gas%2C%20telephone%2C%20etc.

343 Stomberg, Joseph. "The Real Reason American Public Transportation is Such a Disaster." *Vox.* Aug. 10, 2015. Available at: https://www.vox.com/2015/8/10/9118199/public-transportation-subway-buses.

344 Padeiro, Miguel, *et al*. Transit-Oriented Development and Gentrification: a Systematic Review. *Transport Reviews* 30 (2019): 733-754.

345 Turrentine, Jeff. "When Public Transportation Leads to Gentrification." *NRDC,* June 1, 2018. Available at: https://www.nrdc.org/onearth/when-public-transportation-leads-gentrification.

346 Chapple, Karen and Miriam Zuk. Chapter 4 - Transit-Oriented Displacement: the Role of Transit Access in the Housing Market. *Transportation, Land Use, and Environmental Planning* (2020): 55-79.

347 There was only a modest correlation in the Las Cruces area to show renters had an impact, however we believe from our analysis of other states, renter data trends show that typically renters are underserved and a split incentive problem likely exists.

348 Lukanov, Boris R., and Elena M. Krieger. Distributed Solar and Environmental Justice: Exploring the Demographic and Socio-Economic Trends of Residential PV Adoption in California. *Energy Policy* 134 (2019): 110935.

349 Sunter, Deborah, *et al*. Disparities in Rooftop Photovoltaics Deployment in the United States by Race and Ethnicity. *Nature Sustainability* 2.1 (2019): 71-76.

350 Particulate air pollution is of specific concern in New Mexico, as natural gas use is generally higher in less socioeconomically vulnerable communities according to our analysis.

households, communities of color, and rural populations have access to, and benefit equitably from, clean energy technologies.

Weatherization programs offer cost savings through demand reduction and can be implemented at scale. There already are weatherization programs that focus solely on lower income households, such as the Energy$mart Weatherization Assistance Program.[351,352] Multifamily and single-family homes are eligible, but owners, not tenants, are responsible for implementing weatherization measures; tenants are eligible to apply but must secure written landlord authorization for property improvements.[353] *However, as our findings suggest, using only income to identify underserved households might miss other populations with disproportionately high energy cost burdens. Furthermore, limiting program reach to mostly owners may fail to create financial benefits for renters.*

Programs focused only or primarily on homeowners can exacerbate wealth disparities. By increasing home values, these programs benefit some homeowners but can have displacing effects on lower- and fixed-income homeowners and the renting population at large. While New Mexico has a lower renting population compared to the national average,[354] tenants can be more vulnerable to rent increases caused by increasing property values. *Expanding program accessibility to otherwise eligible residents who do not own their homes could provide clean energy benefits to tenants and landlords alike.*

Unlike the residential sector, the commercial sector lacks granular spatial and emissions data and we were unable to conduct a detailed analysis of commercial buildings. However, New Mexico already implements a number of targeted renewable energy and energy efficiency programs and initiatives in the commercial sector; we outline a select few below. New Mexico can further these programs and implement robust data collection efforts to decarbonize this sector efficiently and with more economically and environmentally equitable outcomes.

Recommendation 1: Ensure equitable access to the economic and health benefits of energy efficiency, distributed energy resources, and electrification, beyond home- and landowners.

Targeted incentives, financing, and outreach can help reduce barriers to clean energy adoption for underserved households, including those who struggle with high energy cost burdens. In general, building decarbonization should include:

1. Easily accessible funding mechanisms for financially disadvantaged communities, including upfront financing;
2. Building efficiency measures that reduce overall energy demand and prioritize communities facing higher energy costs due to inefficient electric equipment in drafty or poorly insulated buildings;
3. Educational outreach to communities addressing the benefits of—and personal, linguistic, or cultural barriers to—clean energy technologies; and
4. Evaluation and removal of the social barriers that low-income communities and communities of color face to adopting these measures.

Community feedback on building decarbonization efforts can be delivered in numerous forms, including but not limited to forums and workshops, committees for program and project approval, and in advisory capacities throughout program development and implementation.

New Mexico's residential and commercial building energy codes are required to follow the 2018 International Energy Conservation Code for building efficiency standards.[355] This framework prioritizes energy efficiency in new and recently renovated buildings, saving money for beneficiaries of compliance.[356] *There is an opportunity to further the mission of the program, which currently focuses on homeowners, homebuilders,*

351 New Mexico Mortgage Finance Authority. NM Energy$mart Weatherization Assistance Program (2018).

352 This program is for homeowners and property owners, and is administered through the quasi-government organization (Mortgage Finance Authority) via regional non profit housing authorities who specialize in their respective service areas.

353 US Department of Energy. Weatherization Assistance Program State Plan/Master File Worksheet for New Mexico (2018).

354 US Census Bureau. "New Mexico QuickFacts." Accessed Apr. 2021. Available at: https://www.census.gov/quickfacts/fact/table/NM,US/PST045219.

355 The most current edition of the codes is from 2018, and codes are updated by the IECC directly.

356 US Department of Energy. "Building Energy Codes Program: New Mexico." Accessed Feb. 2021. Available at: https://www.energycodes.gov/adoption/states/new-mexico.

and State agencies, by (1) regularly updating to the latest version of code,[357] *and (2) expanding accessibility and financing assistance to populations that are traditionally marginalized from the benefits of energy efficiency, including but not limited to tenants, populations of color, and moderate- to low-income populations.*

Currently, most residential energy efficiency measures that are not income-related are administered by regulated utilities. Measures that are income-selective are run by the public utilities commission or a state-wide government agency directly.[358] To ensure wide decarbonization participation of households facing multiple market barriers, additional market-oriented mechanisms could be implemented. One option is to encourage utility bill-financed energy efficiency upgrades through budget billing (average payment plans) programs.[359] This approach evenly spreads the cost of upgrades over time, allowing the utility consumer to have consistent, predictable pricing. Similar, but distinct to budget billing, is participation in a Property Assessed Clean Energy program.[360] Such programs allow homeowners to finance renewable energy via lien-backed bonds on their home, removing up-front costs and stabilizing the repayment plan.[361] Another option is to participate in a percentage of income payment plan, which would cap the amount of income spent on electricity utility bills. These payment plans can be tailored to any population with disproportionately high energy cost burdens, such as communities of color and low-income populations. While our study looked at income and racial minority demographic indicators, it is likely that other indicators should be evaluated as well to assess both energy cost overburdens and participation in a percentage of income payment plan program. A third option is to allow third-party energy service companies to finance the cost of electrification and efficiency efforts and pass on the benefits from the energy savings. The service company can guarantee the utility consumer a flat rate for a specified period of time, which allows utility consumers financial access to larger, more expensive upgrades they otherwise could not afford through budget billing. In this approach, policy provisions will be needed to protect household interests. This can be achieved by mandating rate-stabilizing contracts with the third-party energy service companies during the electrification upgrade payback period, and by providing additional incentives for the service companies to encourage deep building retrofits and full electrification.

As building efficiency and electrification measures are widely adopted, community engagement should inform the balance between creating financial incentives for private residential property owners and securing housing affordability and stability for tenants. At a minimum, decarbonization policies should be paired with affordable rent and anti-displacement provisions. Providing commercial and residential landlords with capital for upgrades through publicly-funded mechanisms, such as grants, can alleviate pressure to increase tenant rents, without undue burden on landlords. Grants should include provisions to prevent program abuse, and measure how capital upgrades are implemented. It is important to protect both small landlords and tenants from bearing more than their share of the work to transition to a clean energy economy.

Recommendation 2: Plan for a gradual, geographically targeted phase-out of the natural gas distribution system, with targeted rate-stabilization for non- or late-adopters of electrification and utility bill subsidies for populations with high energy cost burdens.

As demonstrated in **Figure 34**, households that are unable to participate in the adoption of clean energy technologies risk facing escalating utility bills to cover the costs of an aging gas distribution system in transition. As electrification progresses, it is important to strategically target the legacy fossil fuel infrastructure phase-out from one region to the next (i.e. pruning infrastructure) and balance utility bill rates throughout the state. Any phased approach should include sociodemographic equity considerations, such

357 International Code Council. “Energy Efficiency and Carbon Reduction.” Accessed Feb. 2021. Available at: https://www.iccsafe.org/advocacy/energy-efficiency-and-carbon-reduction/.

358 New Mexico Public Regulation Commission. “Utility - Energy Efficiency.” Accessed Feb. 2021. Available at: http://www.nmprc.state.nm.us/utilities/energy-efficiency.html#gsc.tab=0.

359 The investor-owned utilities, El Paso Electric and PNM, do offer this type of billing arrangement.

360 This program has limited current use in the residential market.

361 New Mexico Energy, Mineral and Natural Resources Department. “Property Assessed Clean Energy Bond Financing.” Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ecmd/CleanEnergyTaxIncentives/PACE.html.

as income and race, when determining regions and populations to prioritize for building electrification. As our findings show, these factors have a disproportionate effect on energy cost burdens and must therefore be directly addressed to account for existing environmental health burdens and historical inequity in access to clean energy technology, among other factors.

This approach will avoid service disruptions, eliminate long-term maintenance costs, and minimize expensive retrofits and upgrades during the transition. It also provides the additional benefit of removing safety hazards associated with aging natural gas distribution infrastructure. Our findings further underscore the importance of policy interventions that provide utility bill protections and make clean energy technologies accessible to households with high baseline energy cost burdens during this transition. A more equitable approach would require that non-adopters are not left behind shouldering the full cost of stranded assets, and that economically vulnerable and demographically underserved communities are among the first to transition off of the soon-to-be-retired fossil fuel system.

Recommendation 3: Consider focused deployment strategies for distributed energy resources to maximize public health and climate resilience benefits, including an expansion of residential and community solar and energy storage systems.

Utility-scale projects are perceived by many to be the most cost-effective per megawatt-hour generated (excluding necessary but typically deferred transmission-related investments). However, distributed resources may be more cost-effective in certain regions—particularly for populations with no electricity access—and also confer additional benefits to New Mexicans that should be considered but are not captured by solely weighing costs and generation capacity. Clean energy deployment in certain population subsets can be particularly beneficial for reducing energy cost and pollution burdens, improving climate resilience, and maximizing public health benefits. Policymakers should therefore consider how to maximize these co-benefits when weighing the deployment of distributed energy resources such as solar (e.g. community, rooftop, etc.), energy storage, microgrids, and energy efficiency measures as compared to utility-scale projects.

Rural households, individuals who rely on electricity for medical needs, low-income households, households of color, and households in climate vulnerable areas (e.g. high wildfire risk, high number of extreme heat days, etc.) may face trade-offs between affording their electric bills and risking climate-related health complications or potentially life-threatening power shut offs during or in anticipation of natural disaster events (e.g. wildfires). For example, New Mexico is preparing for year-round wildfire seasons[362] with consideration of 2021 House Bill 57,[363] which would help alleviate liability and restrictions on prescribed burns for residential properties if passed.[364] Climate vulnerable households would benefit from improved access to reliable and affordable electricity through technologies such as home solar + storage systems to ensure that air conditioning, air filtration, medical devices, and other important in-home necessities are resilient to climate-related events.

Our calculations in **Table 3** provide illustrative examples of how New Mexico may leverage distributed energy deployment to maximize public health and resilience co-benefits. For example, our results show that the projected electricity needs of all medical baseline customers[365] in heat-vulnerable counties could be covered by 2030 if 13 percent of all rooftop solar installations were allocated to these households (as projected under the Core decarbonization scenario). Similarly, projected electricity needs could be covered by 2030 for all Tribal land[366] households if 25 percent of all rooftop solar installations were allocated to these

362 Wyland, Scott. "New Mexico Officials Adjusting to Year-Round Wildfire Seasons." *Santa Fe New Mexican.* Jan. 31, 2021. Available at: https://www.santafenewmexican.com/news/local_news/new-mexico-officials-adjusting-to-year-round-wildfire-seasons/article_628f4266-60bd-11eb-b950-2794115ee792.html.

363 New Mexico State, Legislature. House Bill 57 (2021). *New Mexico State Legislature*.

364 Attanasio, Cedar. "With Wildfire Risk Up, New Mexico Supports Controlled Burns." *The Associated Press*. Feb. 11, 2021. Available at: https://apnews.com/article/fires-new-mexico-controlled-burns-71a061774962e25a67839d0a1970111b.

365 "Medical baseline customers" refer to Medicare beneficiaries who rely on electricity for medical purposes.

366 The Navajo Nation is included in this projection, accounting for 13 of the 25 percent requirement.

households.[367] The projected electricity needs of all low-income rural households could be covered by 2030 if 20 percent of all rooftop solar installations were allocated to these households, even under the assumption that distributed solar resources comprise a relative minority of 2030 solar installations. Solar + storage and microgrids at community sites such as schools and community centers can also provide resilience hubs where community members can access air conditioning and ventilation, refrigerate medicines, charge cell phones, and otherwise gather in emergencies.

Future household energy needs should be evaluated beyond their potential climate impacts, to include cost-effectiveness and resiliency. As a hypothetical example, replacing an existing natural gas heating system with an air source heat pump might not meet existing incentive cost-effectiveness requirements, but if a household needs to add air conditioning as the summers grow increasingly hot, an air source heat pump may be significantly more cost effective than replacing an existing heating system and adding a new HVAC system. Similarly, a solar + storage system might be more expensive than the existing grid supply of electricity, but might be more cost competitive if a customer[368] is considering the alternative of adding a diesel generator for backup. For heating or cooling spaces, a geothermal (i.e. ground source) heat pump is another alternative to natural gas.[369,370] Current incentive structures and cost-effectiveness provisions may have to be updated, or new ones created, to reflect combined decarbonization and climate resilience goals. As the State and local governments develop plans and policies for climate resilience,[371,372,373,374,375,376] revising these incentive structures accordingly, and incorporating an equity lens[377,378] may be needed to maximize climate mitigation and adaptation strategies for all.

Recommendation 4: Those without reliable access to electricity, particularly in rural or tribal nation areas, should be prioritized and targeted for clean energy adoption.

Electricity access is not equitably distributed throughout New Mexico. While data[379] on the exact extent and location of the problem are limited, available data strongly suggest that tribal areas lag behind the rest of the state and the nation in connection to the grid (see **Section 2.3.4)**, with as many as 15 percent of households in the Navajo Nation lacking access to electricity. There is a need for the clean energy transition to focus on and correct the shortcomings of existing energy infrastructure where it exists for these populations. Distributed energy resources such as solar power, coupled with resilience-focused technologies like battery storage, can provide safe, reliable, and cost effective clean energy sources for Tribal nations and rural communities lacking access to the grid. Distributed energy resources, in addition to utility-scale

367 Increased uptake among this population can be facilitated through targeted funding mechanisms and community deployment initiatives.

368 This assumes the customer has current, reliable electricity access. A solar + storage system may also be more cost competitive to provide electricity to those without current access, however, the technical and logistical variations of how to provide that access were beyond the scope of this study.

369 Gellerman, Bruce. "How a Climate Change Nonprofit Got Eversource Thinking About a Geothermal Future." *WBUR*. Jan. 13, 2020. Available at: https://www.wbur.org/earthwhile/2020/01/13/heat-eversource-geothermal-energy-climate-change.

370 Roberts, David. "The Earth Itself Could Provide Carbon-Free Heat for Buildings." *Vox*. Nov. 13, 2020. Available at: https://www.vox.com/energy-and-environment/2020/11/13/21537801/climate-change-renewable-energy-geothermal-heat-gshp-district-heating.

371 New Mexico Energy, Minerals, and Natural Resources Department. "Government Lead by Example: Executive Order Implementation." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/GovernmentLeadByExample/GovLeadEOImplementation.html.

372 New Mexico Interagency Climate Change Task Force. New Mexico Climate Strategy: 2020 Progress and Recommendations (2020).

373 Horger, Terry *et al.* City of Albuquerque Climate Action Plan. *New Mexico Climate Action Task Force* (2009).

374 City of Albuquerque. "Sustainability: Climate Action Plan." Accessed Feb. 2021. Available at: http://www.cabq.gov/sustainability/climate-action-plan/climate-action-plan.

375 City of Sante Fe. "Sustainability." Accessed Feb. 2021. Available at: https://www.santafenm.gov/sustainable_santa_fe.

376 Sustainable Sante Fe Commission. Sustainable Sante Fe: 25-Year Plan (2018).

377 *Ibid.*

378 Crowder Jr. *et al.* An Equity Profile of Albuquerque. *PolicyLink and USC Program for Environmental and Regional Equity* (2018).

379 US Department of Energy Office of Indian Energy Policy and Programs. Strengthening Tribal Communities, Sustaining Future Generations (2017).

and community-scale renewable generation, should be supported by publicly-funded financing mechanisms that tailor solutions for historically underserved and underrepresented communities so that they can have full and reliable access to clean electricity.

Recommendation 5: Prioritize early electrification of buildings using unconventional or alternative fuels (e.g. fuel oil, propane, wood, etc.) to reduce energy cost burdens and improve health outcomes in rural areas.

Although alternative fuels such as wood and propane are infrequently used in homes compared to electricity and natural gas[380], both provide good targets for near-term electrification. This is especially true of wood, which is more heavily relied upon by New Mexicans than by residents of neighboring states. Propane is comparatively expensive, and wood is responsible for a large fraction of New Mexico's residential particulate matter emissions, but is not replaced in solely carbon-focused decarbonization scenarios. Specifically targeting buildings that burn propane can help reduce high energy cost burdens. Targeting buildings that burn either propane or wood (or often both) can improve ambient and indoor air quality, potentially reducing pollution burdens in rural areas and improving health.

However, electrification of wood heating is not always the most cost-effective option given the low out of pocket cost of wood, and there are social and cultural ties to burning wood beyond heating purposes. As conveyed in **Figure 29**, the use of wood is highest among Tribal nations in New Mexico, and may be of cultural and spiritual significance. To balance home heating and cultural preferences, direct consultation with the impacted communities should be extensively held and alternative measures considered. One option to maintain wood burning while reducing pollution is to replace aging, conventional, and EPA-certified wood stoves with wood pellet stoves, which have significantly lower particulate matter and VOC emission rates. Because energy efficiency measures may limit outdoor and indoor air exchanges and increase indoor air quality risks, proper air ventilation systems should be considered when weatherizing buildings with high indoor emissions.[381]

Though propane and wood are the most common unconventional residential fuels, and are accordingly highlighted in our analysis and recommendations, a small number of New Mexican households rely on other fuels such as coal and fuel oil to heat their homes. Like propane and wood-using households, electrifying these homes should also be a key component of decarbonization policy to maximize public health co-benefits.

Recommendation 6: Expand commercial sector programs to provide more socioeconomically equitable outcomes by requiring cost-savings from decarbonization measures be split between stakeholders (landlords, owners, developers, tenants, and the surrounding local community).

To incentivize new residential[382] and commercial building construction and existing building renovations to meet green building standards, New Mexico's Energy, Mineral, and Natural Resources Department uses the Sustainable Building Tax Credit Program.[383] The program provides state tax credits to the builder, up to $6.50 per square foot for buildings up to 2,000 square feet, for projects which use either the LEED (Silver or greater) or Build Green NM rating systems criteria. These two systems rate buildings based on a set of environmentally sustainable design, construction, and operation criteria.[384, 385] Additionally, State-owned buildings have requirements for LEED silver certification when newly constructed or

380 Rural communities may commonly use alternative fuels, though the aggregated amount of alternative fuel use may be low compared to traditional fossil fuels.

381 Underhill, Lindsay J. *et al.* Simulation of Indoor and Outdoor Air Quality and Health Impacts Following Installation of Energy-Efficient Retrofits in a Multifamily Housing Unit. *Building and Environment* (2020): 170.

382 For brevity and conciseness, the residential program is summarized with the commercial program in this study.

383 New Mexico Energy, Mineral, and Natural Resources Department. "Sustainable Building Tax Credit Program." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ecmd/CleanEnergyTaxIncentives/SBTC.html.

384 *Ibid.*

385 Build Green NM. "Certification Process." Accessed Feb. 2021. Available at: http://www.buildgreennm.com/certification-process/.

recently renovated.[386] *While some social equity metrics are included in these industry standards, the whole of these standards focus on environmental sustainability, and additional social equity-focused standards could be adopted. Furthermore, direct social equity metrics requiring commercial or residential tenants receive a portion of the tax credit through lease concessions or tenant improvements could further economic equity.*

As with all the other economic sectors, community input, feedback, and representation mechanisms must be considered broadly across commercial real estate stakeholders such as commercial building owners, building management and operators, building tenants (owners, employees, and contractors), and residents that live in or near mixed use commercial spaces. While commercial building tenants may want to electrify their operations based on consumer market preferences, they have limited-to-no control over the commercial building shell and building systems, limiting overall building efficiency and indoor air pollution control. *As commercial facilities are upgraded for energy efficiency, ventilation systems should also be upgraded to allow for higher quality indoor air, particularly when the space is used for cooking or other particulate-emitting processes.*

Recommendation 7: Expand renewable energy and energy efficiency programs to ensure historically pollution- and socio-demographically-overburdened populations beyond low-income communities, such as populations of color, tribal nations, and tenants, benefit from commercial sector cost-savings.

New Mexico has used renewable energy certificates to incentivize residential and small business solar installation and usage, with the program administered by the investor-owned utilities, such as the Public Service Company of New Mexico,[387] (the largest investor-owned utility in the state) El Paso Electric,[388] and Xcel Energy (Southwestern Public Service).[389] This approach, combined with net metering,[390,391] allows solar to continue to grow in New Mexico, however only in some communities are these renewable energy benefits being realized. Social barriers to clean energy access exacerbate financial inequities for affected populations.[392] *Therefore, we recommend that any solar energy incentive programs, including the renewable energy certification program, include easier access to and up-front financing for those populations that experience higher energy cost burdens and may lack access to affordable, clean energy.*

Similar to the residential version, the Commercial Property Assessed Clean Energy[393] program allows commercial buildings to stabilize renewable energy upgrades and energy efficiency costs over time through lien-backed bonds. The Clean Energy Performance Financing[394] program uses performance contracting for energy improvements in New Mexico public facilities (e.g. schools, county, and tribal governments). Instead of front-loading the capital expenses of these upgrades and retrofits, the program allows lower cost, steady payments over time. The lower costs are predetermined from calculating the energy cost savings from utility or operational expenses, which are then contractually repaid over time for the upgrades and retrofits. This leaves capital budgets intact and guarantees savings.

386 US Department of Energy. "Building Energy Codes Program: New Mexico." Accessed Feb. 2021. Available at: https://www.energycodes.gov/adoption/states/new-mexico.

387 Public Service Company of New Mexico. "PNM Customer Solar Energy Program." Accessed Feb. 2021. Available at: https://www.pnm.com/solar.

388 El Paso Electric. "New Mexico - Interconnection of Facilities Less Than 10kW." Accessed Feb. 2021. Available at: https://www.epelectric.com/renewables-tech/distributed-generation/new-mexico-interconnection-of-facilities-less-than-10-kw.

389 Xcel Energy. "Renewable Energy Options - Business." Accessed Feb. 2021. Available at: https://www.xcelenergy.com/programs_and_rebates/business_programs_and_rebates/renewable_energy_options_business.

390 Database of State Incentives for Renewables & Efficiency. "Net Metering: Program Overview for New Mexico." Accessed Feb. 2021. Available at: https://programs.dsireusa.org/system/program/detail/284.

391 El Paso Electric. "Distributed Generation." Accessed Feb. 2021. Available at: https://www.epelectric.com/renewables-tech/distributed-generation.

392 Our data analysis focuses on residential buildings for this conclusion, and while commercial buildings likely also have various social and economic inequities, our analysis did not cover commercial spaces in this level of detail.

393 US Department of Energy Office of Energy Efficiency & Renewable Energy. "Commercial PACE Working Group." Accessed Feb. 2021. Available at: https://www.energy.gov/eere/slsc/commercial-pace-working-group.

394 New Mexico Energy, Minerals and Natural Resources Department. "Clean Energy Performance Financing." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/CleanEnergyPerformanceFinancing/cleanenergyperformancefinancing.html.

Improvement qualification criteria are flexible and broad, based on the needs and assessment of the government facility, and may include anything from HVAC upgrades to irrigation systems. Audits identify specific energy saving strategies for that government entity, in order to inform the subsequent financial mechanism to contractually lock in those savings. A pre-selected Energy Service Company (ESCO) performs the audits for the project owner under the supervision of a third-party reviewer assigned by the New Mexico Energy, Minerals, and Natural Resources Department.[395, 396]

We recommend the state's Energy, Minerals, and Natural Resources Department, who currently oversees third-party ESCOs and reviewers, to consider social and economic equity criteria in their selection process. Economic equity criteria should include, but not be limited to, traditionally underrepresented or underfinanced small businesses, such as those with racial- or gender-minority ownership. Since ESCOs and reviewers can potentially have a job-generating impact on the local economy, further analysis is needed to evaluate workforce opportunities and limits of using this third-party auditing system from a social and economic equity lens. Our study does not cover workforce equity. However, a future companion study will consider how workforce and ownership of contractors may further broaden the economic benefits of deep decarbonization.

Additional community feedback

Based on the discussions we held with community organizations, we also recommend (1) support for electrification of mobile homes and buildings, allowing better utility cost stabilization and (2) further community feedback considerations for large-scale projects. As our findings in **Figure 31** show, housing type varies across demographic and socioeconomic groups. For mobile homes located on rented land, mobile homeowners pay park owners for their utilities in general, as separate metering is uncommon.[397] Given the aging of mobile home parks, many park landowners charge maintenance, retrofitting, and upgrade fees to homeowners to bring the homes to current aesthetic and safety standards, creating a large potential expense for homeowners. Coupling electrification efforts with energy equity provisions like homeowner and tenant cost-sharing could be encouraged by modification to existing legislative policies (e.g. the Mobile Home Park Act,[398] or the Energy Transition Act) or creation of new policies. Currently there is little incentive for park owners to electrify as utility charges are paid directly by, or reimbursable by the mobile homeowner.[399]

Additionally, a balance of social equity needs for the primary three land ownership types (Bureau of Land Management, Tribal land, and Trust-owned or private land) within New Mexico is appropriate. For example, the US Bureau of Land Management works with New Mexico to perform environmental impact assessments under NEPA[400] for large-scale projects. The State should require residential and commercial facility permitting agencies to review and use community input received during this process, particularly from historically excluded communities, prior to project approval. The State should also work with Federal agencies to make the NEPA process and other public comment processes more accessible to under-resourced communities, which may face technology, language, legal, and other barriers to the process. While some entities may already consider community input, a state-wide approach may be beneficial. Based on our discussions with community organizations, a holistic process should include input from all property stakeholders, including but not limited to renters, property owners, and property managers.

395 New Mexico Energy, Minerals and Natural Resources Department. "Clean Energy Performance Financing." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/CleanEnergyPerformanceFinancing/cleanenergyperformancefinancing.html.

396 New Mexico Energy, Minerals and Natural Resources Department. "Energy Savings Performance Contracting for New Mexico Public Facilities." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/CleanEnergyPerformanceFinancing/documents/ESPCinNM_000.pdf.

397 In rural New Mexico, many homeowners may already own the land. We did not have access to data delineating absolute numbers of mobile homeowners that did or did not own their land, but do suggest future research evaluate the extent of this for effective policy benefits to all mobile homeowners.

398 State of New Mexico. Mobile Home Park Act (1983).

399 *Ibid.*

400 Bureau of Land Management. "New Mexico Planning and NEPA." *US Department of the Interior.* Accessed Dec. 2020. Available at: https://www.blm.gov/programs/planning-and-nepa/plans-in-development/new-mexico.

3.3.3 Industrial

Available data on criteria air pollutant emissions from industrial point sources do not adequately distinguish between combustion and non-combustion emissions at the facility-level, making it difficult to identify energy consumption-specific industrial criteria air pollutant emissions. Additionally, data on distributed industrial emissions, such as fugitive emissions (i.e. unintentional emission leaks) from oil and gas transmission infrastructure, are only available at the county-level and likely underestimates. Due to these limited data, our recommendations are broad, but are a starting point for decarbonization efforts. We address oil and gas-related emissions independently in addition to industry emissions as a whole.

Recommendation 1: Minimize the public health impacts of oil and gas development on those who live, work, and play near infrastructure by (1) implementing increased setback distances between oil and gas infrastructure and hospitals, schools, and homes and (2) fully phasing out in-state oil and gas production and processing.

The future trajectory of oil and gas production and processing in New Mexico has one of the largest impacts on projected pollution burdens in 2050, and may derail policy decarbonization targets if not phased out. While decarbonization across New Mexico will eliminate the majority of existing fossil fuel emissions by 2050, ongoing oil and gas production—modeled at 25 percent of current 2020 levels in all but the Fossil Free scenario—will continue to pose health risks to workers and nearby communities. A decarbonization framework that eliminates oil and gas production by 2050, if not before, would greatly reduce these risks. In the coming decades, additional measures can help mitigate public health concerns.

Population exposure to oil- and gas-associated air pollution and non-chemical stressors (e.g., noise and light pollution) can be reduced through the implementation of increased setback distance requirements, which prohibit drilling within a fixed distance of where populations live, work, play, and learn.[401] Additional financial reserves, such as bonding requirements put forward by oil and gas operators, should be required to ensure proper plugging and abandoning of oil and gas wells and other surface and subsurface infrastructure when they are no longer being used to avoid climate, health, and environmental damages.

Recommendation 2: Reduce fugitive emissions of methane and co-pollutants associated with oil and gas production by deploying best available emission control and monitoring technologies as soon as possible.

Methane makes up more than half of oil and gas sector greenhouse emissions in New Mexico, accounting for 35 percent of total statewide greenhouse gas emissions in the 2018 inventory.[402] As stated in our findings (see **Box 1**), methane emissions are likely even higher than these estimates, primarily because oil and gas production in New Mexico has grown significantly over the last several years. In addition to the climate implications of fugitive methane emissions, they indicate a public health issue, as numerous health-damaging air pollutants are emitted alongside methane from oil and gas production wells and infrastructure. Effectively tracking methane emissions is critical, given methane's outsized contribution to total statewide greenhouse gas emissions and associated emissions of health-damaging air pollutants. The state must invest in better monitoring and emission control technologies to reduce unintended and intended methane and non-methane VOC emissions from oil and gas infrastructure.

Ongoing monitoring efforts for methane, VOCs, and other pollutants can help to identify unintended emission leaks from oil and gas infrastructure and can inform regulatory efforts to reduce pollution and

401 Rules on setback requirements in New Mexico have varied in scope and impact throughout the state, however, newer proposed setback rules should restrict population exposure to oil- and gas-associated health hazards.

402 Tabor, Laura, *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

hold facility operators and owners accountable.[403] Specifically, the state could increase routine monitoring of oil and gas infrastructure for fugitive methane leaks and deploy higher density air monitoring in oil and gas regions to better characterize and mitigate pollutant emissions. Air monitoring efforts should consider the episodic nature of emissions from oil and gas sites and utilize limits of detection below health-based guidance values to allow for assessment of acute and chronic non-cancer health risk and cancer risks.

In addition to increased monitoring, the state could require emission control technologies to be deployed at oil and gas facilities. For example, replacing pneumatic controllers with low-bleed and no-bleed controllers and employing VOC controls at oil and condensate tanks would help reduce methane and VOC emissions. The state could also reduce gas flaring, a process that releases methane, by requiring that oil and gas well operators conduct “green” completions to capture associated gas. In other words, this would require production well operators to capture the first flow of gas produced upon completing a well rather than intentionally flaring or venting it into the atmosphere.[404]

We did not analyze the spatial distribution of methane and co-pollutant emissions from oil and gas infrastructure due to inadequate data, and are therefore unable to draw detailed conclusions about the environmental equity and sociodemographic aspects of the emission reduction mechanisms discussed above. However, given the disproportionately high average density of $PM_{2.5}$, NO_x, and SO_x emissions from oil and gas point sources in communities of color (**Figure 31**), as well as the clustering of oil and gas facilities in certain regions of the state with high Demographic Index rankings (**Figure 30**), it is likely that reducing methane and co-pollutant emissions from oil and gas infrastructure could help to alleviate emissions burdens in socio-demographically vulnerable communities in New Mexico.

Recommendation 3: Prioritize energy efficiency and decarbonization of fuel use at energy-intensive industrial facilities–particularly upstream and midstream oil and gas infrastructure.

Industrial decarbonization efforts should include incentives and financing for energy efficiency measures and fuel switching to renewable hydrogen and electricity, particularly for energy-intensive oil and gas facilities in areas with high cumulative criteria pollutant emissions and near socioeconomically overburdened communities and sensitive populations. Fossil fuel combustion at oil and gas facilities—primarily at upstream and midstream facilities—accounts for almost half of energy-related[405] industrial greenhouse gas emissions (44 percent), and almost all of combustion-related[406] industrial greenhouse gas emissions (93 percent).[407] Oil and gas facilities are disproportionately located in communities of color in New Mexico and emit health-damaging air pollutants such as NO_x, $PM_{2.5}$, and SO_x alongside greenhouse gas emissions (**Figure 31**). Replacing diesel and gas use with clean energy sources and implementing aggressive energy efficiency measures at these facilities would reduce emissions of CO_2, NO_x, $PM_{2.5}$, and SO_x. Prioritizing fuel switching and energy efficiency measures at oil and gas facilities in the San Juan Basin in particular, where census tracts rank highly on our Demographic Index and where a large fraction of the population is Native American, may help to alleviate existing racial disparities in the distribution of industrial air pollution. Community feedback mechanisms may also help to identify regions and facilities of concern to prioritize for fuel switching, energy efficiency, and other pollution reduction measures.

403 Although water quality is outside the scope of this report, we note that it may be valuable for water quality testing and transparent reporting to be expanded to cover waste water from point source polluters, and require ground and surface water quality testing around, under, and near waste disposal sites.

404 Grant, John, *et al*. Revised Final Report: 2028 Future Year Oil and Gas Emission Inventory for WESTAR-WRAP States - Scenario #1: Continuation of Historical Trends. *Ramboll for Western Regional Air Partnership* (2020).

405 Energy-related greenhouse gas emissions refer to emissions from fossil fuel combustion at all industrial facilities, as well as non-combustion emissions from oil, gas, and coal infrastructure.

406 Combustion-related greenhouse gas emissions refer to emissions from fossil fuel combustion at all industrial facilities, including oil/gas and non-oil/gas facilities.

407 Energy+Environmental Economics. New Mexico Greenhouse Gas Emissions Inventory and Forecast (2020).

Recommendation 4: Electrify mobile sources serving industrial facilities, including heavy-duty and medium-duty trucks, non-road industrial equipment, and transit modes for commuting workers to industrial sites (e.g. buses, carpooling vans, etc.).

The growth of oil and gas development in the northwestern San Juan basin and southeastern Permian basin are contributing to an increase in heavy-duty truck traffic in these rural areas of New Mexico.[408] Increased air pollution from oil and gas production and processing combined with an increase in trucking pollution risks exacerbating cumulative environmental burdens in these areas. Aggressively electrifying mobile sources associated with industrial activity—including non-road (off-road) equipment, heavy-duty and medium-duty trucks, and commuting vehicles such as buses and vans for commuting workers—could help reduce cross-sectoral emissions in the near-term before oil and gas development is phased out.

Recommendation 5: Fund and prioritize site remediation and reclamation for retired industrial facilities, particularly mining and manufacturing sites, and oil, gas, and coal infrastructure.

Industrial activities in New Mexico have brought economic benefits and employment to the state, but mining, manufacturing,[409] and fossil fuel infrastructure in particular have left a sizable and negative environmental and social impact on local communities. As New Mexico phases out carbon-intensive industries in order to meet its climate goals, requiring site owners to properly remediate polluted sites will be critical to preventing long-term environmental damage and minimizing public health hazards. Developing a prioritization framework for site remediation based on climate, public health, and groundwater risks may help the state to maximize environmental and health benefits.

While environmental damage can occur from upstream, midstream, and downstream oil and gas infrastructure, production wells and underground storage tanks in particular pose significant risks to the environment.[410] Underground storage tanks, which store crude oil and refined petroleum products, can leak due to corrosion of underground walls. Leaking petroleum products can damage surrounding soil, contaminate groundwater, and in some cases, cause underground fires or explosions.[411] In 2020, the EPA granted the New Mexico Environment Department $553,238 to assist the clean up of underground storage tank leaks throughout the state and the remediation of surrounding areas impacted by leaks. As the EPA Leaking UST Trust Fund is funded by motor fuel sale taxes,[412] New Mexico may need to seek alternative funding and policy mechanisms to adequately enforce remediation requirements for site owners and operators over the next several decades if nationwide motor fuel sales decline due to fuel switching and vehicle electrification.

When oil and gas production wells are not properly plugged, they can continue to release methane and other health-damaging air pollutants and contaminate local water resources long after production ends.[413] To avoid bearing the costs of plugging future abandoned and "orphaned" wells—wells that do not have a known owner responsible for financing site remediation—New Mexico could require site owners to provide up-front bonds that cover the entire cost of well plugging and site remediation before they obtain permitting for a new well.[414] The state may also consider developing a framework to prioritize plugging existing abandoned and orphaned wells based on their climate, public health, and groundwater risks. For example, a prioritization

408 New Mexico Department of Transportation. New Mexico Freight Plan: Moving Freight Forward, through 2040 (2015).

409 Manufacturing facilities were voiced as polluted sites of particular concern in our discussions with community-based organizations in New Mexico. New Mexico has substantial manufacturing in the electronic and aerospace industries, however quantifying the environmental equity impacts of these broader industries was beyond the scope of this study.

410 Raimi, Daniel. Environmental Remediation and Infrastructure Policies Supporting Workers and Communities in Transition. *Resources for the Future and Environmental Defense Fund* (2020).

411 US Environmental Protection Agency. "EPA Awards N.M. Over $553,000 To Maintain An Effective Underground Storage Tank Program." Jul. 16, 2020. Available at: https://www.epa.gov/newsreleases/epa-awards-nm-over-553000-maintain-effective-underground-storage-tank-program.

412 Raimi, Daniel. Environmental Remediation and Infrastructure Policies Supporting Workers and Communities in Transition. *Resources for the Future and Environmental Defense Fund* (2020).

413 *Ibid.*

414 Greenpeace. Remediation of Orphan Oil & Gas Wells in COVID-19 Stimulus (2020).

framework might consider the proximity of a well to nearby populations as one measure of its public health risk and the age of the well as an indicator of potential groundwater contamination and fugitive emissions. Utilizing fugitive emission monitoring would allow for the prioritization of specific wells based on their climate and health risks. As oil and gas production is phased out, the state could facilitate a just transition for fossil fuel workers by implementing policies incentivizing the employment of fossil fuel workers in the remediation of remaining production wells.[415]

With regards to mining infrastructure, the New Mexico Mining Act[416] initiated regulatory oversight for mineral mining activities, including permitting, siting, and reclamation. Through commission-led environmental impact assessments and review processes, projects are evaluated for environmental damage, and once retired or abandoned, mines are supposed to go through an environment-focused reclamation program[417] to restore the environmental media post-mining operations.

However coal mines are excluded from the Mining Act, and while other programs focus on reclamation and remediation efforts for some hard rock and mineral mining, coal mines on tribal lands or reservations are typically excluded.[418] According to the Department of Interior's Office of Surface Mining, Reclamation, and Enforcement (OSMRE), the Navajo Nation hosts 1,235 abandoned coal mines—about three-quarters of abandoned coal mines on tribal lands throughout the US[419]—while the rest of New Mexico hosts 453 sites. While the Navajo Nation spans several states, cleaning up the sites located on Navajo land in New Mexico may require coordination between the state and tribal governments. Uranium mining also lacks thorough cleanup efforts, resulting in numerous superfund sites,[420] particularly located in pollution overburdened areas. More robust remediation programs for legacy mining infrastructure in New Mexico would help to reduce the environmental and public health risks associated with abandoned coal and uranium mines.

3.3.4 **Electricity Generation**

Our power sector analysis yields two key next steps for policymakers from a climate, environmental health, and environmental- and sociodemographic-equity perspective: first, develop policy mechanisms to ensure the remaining coal and natural gas plants are phased out responsibly without adversely affecting pollution-overburdened communities and while reducing negative health impacts to those communities; and second, ensure that renewable energy adoption more equitably benefits communities across socioeconomic strata. New policy initiatives should prioritize communities that are already disproportionately burdened by environmental pollution and health and socioeconomic inequities. Coal generation is largely being phased out already, but these trends must continue to yield the highest health co-benefits. Below, we provide the key policy recommendations that have emerged from the technical findings and conclusions in this report.

Recommendation 1: Rapidly retire New Mexico's remaining coal plants, including Four Corners; although the electricity from this plant is largely

415 Raimi, Daniel. Environmental Remediation and Infrastructure Policies Supporting Workers and Communities in Transition. *Resources for the Future and Environmental Defense Fund* (2020).

416 State of New Mexico. Mining Act (1993).

417 New Mexico Energy, Minerals, and Natural Resources Department. "Mining Act Reclamation Program." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/MMD/MARP/marpmainpage.html.

418 New Mexico Energy, Minerals, and Natural Resources Department. "Mining and Minerals Division." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/MMD/.

419 Raimi, Daniel. Environmental Remediation and Infrastructure Policies Supporting Workers and Communities in Transition. *Resources for the Future and Environmental Defense Fund* (2020).

420 US Environmental Protection Agency, Region 6 Superfund Division. The Legacy of Abandoned Uranium Mines in the Grants Mineral Belt, New Mexico (2011).

exported from the state, air pollution from this plant still impacts residents. Remediate polluted coal plant, waste disposal, and mine sites.

New Mexico's two remaining coal-fired power plants, and associated coal mines, are disproportionately located in or near rural, tribal communities in the northwestern part of the state. The San Juan Generating Station, which burns coal, is scheduled to close in 2022. PNM plans to divest from its share of the other coal plant, Four Corners, but the state of New Mexico itself does not count most emissions from the plant towards its greenhouse gas budget because it is largely owned by entities outside the state and most of its electricity is exported. This exclusion is problematic from a health standpoint, however, because the highest particulate matter and sulfur dioxide emissions come from coal plants and these emissions have *local* impacts. Furthermore, the Four Corners plant disposes of coal ash in an unlined surface impoundment and nearby groundwater measurements have shown high pollutant concentrations. Prioritizing immediate coal plant closure is imperative from a health standpoint to alleviate air and water pollution, particularly given the location of these plants in areas that rank highly on our Demographic Index (**Figure 3**). Once retired, facility dismantling and soil and water remediation should be funded by the utility companies with oversight by the government, and not left to the local communities or New Mexico's taxpayers. Additionally, local communities should be consulted on how and when to dismantle the facilities in order to minimize personal and work disruption, and how the remediated land is used.

Various stakeholders from within the Four Corner and San Juan regions of New Mexico have differing viewpoints on permanently closing the coal plants, and how an economically sound and just transition could occur. The Four Corners plant, which is expected to stay online through the decade, is owned by Arizona Public Service Co. (majority stakeholder), Public Service Company of New Mexico (which is actively moving to divest in the plant), the Salt River Project, Tucson Electric Power, and the Navajo Nation.[421] The San Juan Generating Station, majority owned by Public Service Company of New Mexico, has a more definitive closure path and will be replaced with solar and energy storage.[422] Some stakeholders want to implement carbon capture at the plant to permanently delay its closure, including the City of Farmington, the US Department of Energy,[423] and capture technology company Enchant Energy, arguing that keeping the plant open will keep more jobs and provide more revenues to the government.[424,425] Others oppose the use of carbon capture technology to extend the useful life of the San Juan Generating station and want Four Corners to decommission and retire immediately, citing environmental and economic concerns for the region.[426,427] *Any job loss in the region can have a compounding effect on regional quality of life and economic mobility, but must be weighed against the economic and health consequences of keeping coal-fired power plants online,*[428] *particularly in socio-demographically vulnerable communities. While a workforce analysis is beyond the scope of this study, fossil*

421 The Nation owns various energy projects, and operates the Navajo Transitional Energy Company (owns the coal mine). The Navajo Tribal Utility Authority operates a multi-utility enterprise. It is beyond the scope of this study to evaluate the effectiveness, equitable benefits and economic outcomes of the Nation's business holding and operations. However, any coal related closures must consider the Nations, and other stakeholders, vested interest in the local community's workers who are predominantly impacted.

422 Proctor, Darrell. "Solar Farms Would Replace New Mexico Coal-Fired Plants." *Power Magazine*. Nov. 26, 2020. Available at: https://www.powermag.com/solar-farms-would-replace-new-mexico-coal-fired-plants/.

423 The US DOE funded a study performed by Management Information Services, which included a clause to convey that the views may or may not be the official stance of the US government.

424 Proctor, Darrell. "Solar Farms Would Replace New Mexico Coal-Fired Plants." *Power Magazine*. Nov. 26, 2020. Available at: https://www.powermag.com/solar-farms-would-replace-new-mexico-coal-fired-plants/.

425 Management Information Services, Inc. Use of the San Juan Generating Station to Develop Metrics to Compare Coal Fueled Power Plant Jobs Impacts to Those of Renewables. *US Department of Energy* (2020).

426 San Juan Citizens Alliance. "San Juan Generating Station." Accessed Feb. 2021. Available at: https://www.sanjuancitizens.org/san-juan-generating-station-sjgs.

427 San Juan Citizens Alliance. "Four Corners Power Plant." Accessed Feb. 2021. Available at: https://www.sanjuancitizens.org/four-corners-power-plant-navajo-mine.

428 Fossil-fuel electricity generation should be phased out to maximize public health and environmental benefits. To ensure a socially just transition, the process for phasing out that industry needs to be informed by the community.

fuel-based energy should be phased out in a manner that balances regional job growth[429] *and wage retention with pollution reduction co-benefits in pollution overburdened communities.*

Recommendation 2: Ensure that any gas power plants left online for reliability are (1) not disproportionately located in socioeconomically disadvantaged communities with high cumulative environmental burdens and (2) phased out with priority given to pollution-overburdened neighborhoods.

In the Core scenario some natural gas plants remain online for reliability for decades. Over this time, these plants will continue to burn natural gas, or in some cases hydrogen, which can also produce co-pollutants like NO_x. NO_x and other co-pollutants emitted by these facilities, such as VOCs and HAPs, can adversely impact public health in nearby communities and at a regional level when they react to form ozone.[430] While the state's natural gas plants are scattered throughout the state, this strategy of using as for reliability risks leaving some facilities operational in urban areas with high concentrations of low-income residents. For example, the aging Rio Grande plant is located in an urban ozone nonattainment region near the Texas border with a disproportionate share of low-income and households of color nearby (**Figure 41**). While rapid renewable energy adoption, coupled with energy efficiency measures, can reduce the vast majority of power sector air pollution, natural gas plants still run a risk of operating to meet peak demand on hot summer days when ozone concentrations are already elevated.

As an alternative, New Mexico should prioritize replacing these natural gas plants by incentivizing energy storage and other clean energy alternatives to meet local reliability and peak demand needs. Even in the Fossil Free scenario, plants intended to help meet peak demand may burn biogas or hydrogen in lieu of natural gas, and similar precautions must be taken to limit criteria air pollutant emissions from these facilities, as co-pollutants may still be emitted from this fuel switching. To address these risks as these facilities are operationally phased out, agencies with jurisdiction could limit the annual capacity factor (i.e. ratio of actual electricity generated over the nameplate or maximum generation capacity) or limit the annual and/or seasonal mass of criteria air pollutants allowed to be emitted. In addition, retirement or infrequent use of these facilities poses a risk that they will become stranded assets or fully abandoned by their owners. These assets could pose environmental and health hazards to nearby communities and create uncertainty regarding who will bear the financial costs of decommissioning and remediating these sites.

Recommendation 3: Ensure equitable economic benefits from utility-scale and distributed renewable energy and efficiency adoption.

In addition to pollution reduction, renewable energy growth can provide tax benefits and job creation. Furthermore, distributed energy resources such as rooftop solar and efficiency can contribute to resilience and economic benefits, which we discuss in the buildings policy section below. On the utility and community scale, the State of New Mexico should work with marginalized communities to develop strategies for new renewable generation technologies to provide tax revenue and workforce development opportunities.[431]

The Energy Transition Act addresses some procedural, workforce, and economic participatory inequities for local communities affected by the clean energy transition to renewables. The Act requires affected communities[432] participate in the Community Advisory Committee, which includes tribal nations, pueblos, and other cultural or economic population groups.[433] Apprenticeship programs established under law target diverse participation from those who are currently

429 An expansion of workforce training could focus on retraining current workers in the fossil-fuel industry to other industries, including renewable energy and bringing new workers into the renewable energy sector via vocational and college training coursework and apprenticeships.

430 Alvarez, Ramón A. and Elizabeth Paranhos. Air Pollution Issues Associated with Natural Gas and Oil Operations. *Air & Waste Management Association* (2012).

431 Workforce development is beyond the scope of this report but will be forthcoming in a companion report in 2021.

432 The Energy Transition Act defines an affected community as one "...within one hundred miles of a New Mexico facility producing electricity that closes, resulting in at least forty displaced workers…"

433 New Mexico Indian Affairs Department. "Energy Transition Act." Accessed Jan. 2021. Available at: https://www.iad.state.nm.us/policy-and-legislation/energy-transition-act/.

underrepresented in the industry and the Workforce Solutions Department will partner with community and trade colleges to develop appropriate curriculum for new technicians.[434,435] However, feedback from local communities and community organizations varies as to how the Energy Transition Act will implement local ratepayer feedback into creating more equitable economic outcomes.

The Energy Transition Act does not require that affected communities be prioritized for or obtain a share of the new investment's ownership or financial returns as transition to renewable energy technologies from coal-fired generation occurs. Indeed the same utilities that own coal-generated energy may financially benefit from the Energy Transition Act and leave distributed energy opportunities limited or disincentivized compared to utility-scale generation.[436,437] For example, with San Juan Generating Station closing, the path to a just transition for local communities is not entirely clear. Many communities want more than participation in the planning process—they want to diversify their income and economic outlook by building and holding equity in those projects as well.[438]

Community-owned, investor-owned, government-owned, and individually-owned assets all inherently benefit different communities, which may or may not financially benefit the local community the technology is sited in, suggesting the need for multiple ownership and funding mechanisms for renewable generation with preference towards an ownership mix. These factors should play a role in the State's considerations for renewable energy financing and incentives.

Financial incentives that are split between stakeholders can help limit competing interests, encourage a variety of energy efficient solutions, and lead to more socioeconomically equitable outcomes. Recent initiatives focus on providing financial assistance to single entities owning assets. For example, local governments benefit from the 2020 Industrial Revenue Bond Act, allowing electricity transmission projects to receive specialized financing options through bond obligations.[439] Distributed solar-focused projects benefit from tax credits through 2020 Senate Bill 29,[440] available for home-owning residents and business property owners. Additional incentive measures for energy generators are available for large-scale projects,[441] and while workforce or other job training may be included,[442] a broader and more in-depth analysis of how social or economic equity is being considered or measured is warranted.

Additional community feedback

Our discussions with community organizations highlighted the need for more formal mechanisms establishing ownership opportunities for communities where clean energy transition projects will be sited. Additionally, more workforce engagement and retraining programs are needed in communities that will experience coal plant closures over the coming years. While workforce development is beyond this study's scope, such retraining could include collaboration between various sector stakeholders (e.g. clean energy

434 *Ibid.*

435 New Mexico Department of Workforce Solutions. "Energy Transition Act Committee." Accessed Feb. 2021. Available at: https://www.dws.state.nm.us/ETA.

436 New Mexico Indian Affairs Department. "Energy Transition Act." Accessed Jan. 2021. Available at: https://www.iad.state.nm.us/policy-and-legislation/energy-transition-act/.

437 Misbrener, Kelsey. "In New Mexico, Making Solar Policy That Benefits All Sectors Requires a Multi-Pronged Approach." *Solar Power World.* Oct. 29, 2020. Available at: https://www.solarpowerworldonline.com/2020/10/new-mexico-solar-policy-benefits-all-sectors-a-multi-pronged-approach/.

438 Chamberlain, Kendra. "New Mexico Is Leading the Nation': Renewables Set to Replace Coal-Fired San Juan Generating Station." *New Mexico Political Report.* Jul. 30, 2020. Available at: https://nmpoliticalreport.com/2020/07/30/new-mexico-is-leading-the-nation-renewables-set-to-replace-coal-fired-san-juan-generating-station/.

439 Tabor, Laura, *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

440 New Mexico State, Legislature. Senate Bill 29 (2020). *New Mexico State Legislature*.

441 New Mexico Energy, Minerals & Natural Resources Department. Economic Analysis of the New Mexico Renewable Energy Production Tax Credit (2015).

442 We selectively cover workforce policies that are already included in the clean energy transition and related to the broader policies and recommendations we analyzed, however we did not conduct a comprehensive workforce review and a further, separate workforce companion study is forthcoming.

industry, infrastructure financing entities, communities where target industries are currently located, tribal nations impacted, and communities downstream of target industries), regional or state authorities (e.g. New Mexico Department of Workforce Solutions, New Mexico Economic Development Department, and the New Mexico Energy, Minerals, and Natural Resources Department), and educational institutions (e.g. post-secondary).

3.3.5 **Cross Sector**

Our study reveals several themes across sectors and socioeconomic indicators, including energy cost burdens by income, cumulative emissions across sector, and energy inaccessibility and financing hurdles. There are numerous programs (full- and pilot-scale) and initiatives that have already been completed or are no longer accepting applications that relate to renewable energy and energy efficiency. We acknowledge that these policies and programs[443,444] have existed in New Mexico, some over decades, and that our recommendations may coincide with the resurrection of some of these programs to further the clean energy transition within the state.

Recommendation 1: Continue programs, with appropriate funding, that offer cross-sector benefits and collaboration.

In New Mexico, many projects and partnerships are funded through a combination of legislatively-created funding within the state and a US Department of Energy State Energy Program grant. This funding provides a broad range of opportunities to adopt renewable energy and energy efficiency measures while reducing energy waste.[445,446] Projects span across the transportation, residential, commercial, education, and electricity generation sectors, and include funding mechanisms for other programs previously mentioned. *Ensuring these programs continue to receive funding, while they are updated with specific social equity targets informed by community engagement, can help alleviate some of the inequitable impacts of a transitional period.*

For example, funding was allocated to install and operate multiple charging stations, study existing policies for energy efficiency and savings, and create electrification strategies for the transportation sector.[447] A multi-agency approach led by the General Services Department[448] will use these funds to upgrade government facilities in the capital of Sante Fe and will include battery storage in State-owned buildings, as well as efficiency measures such as lighting, HVAC, and control systems retrofits.[449] Transportation and built environment projects have included sector decarbonization through electric vehicle charging stations, electric vehicle deployment

443 Tabor, Laura, *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

444 New Mexico Energy, Minerals, and Natural Resources Department. "Government Lead by Example: Executive Order Implementation." Accessed Feb. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/GovernmentLeadByExample/GovLeadEOImplementation.html.

445 US Department of Energy Office of Energy Efficiency & Renewable Energy. "State Energy Program." Accessed Nov. 2020. Available at: https://www.energy.gov/eere/wipo/state-energy-program.

446 Tabor, Laura, *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

447 Tabor, Laura, *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

448 A non-exhaustive list of other agencies helping to improve building efficiency and energy savings include the Department of Military Affairs, Department of Public Safety, Department of Workforce Solutions, Department of Transportation, and the Energy, Minerals, and Natural Resources Department. Additional agencies and partnerships can be found at the Interagency Climate Change Task Force website.

449 Tabor, Laura, *et al.* New Mexico Climate Strategy: 2020 Progress and Recommendations. *New Mexico Interagency Climate Change Task Force* (2020).

(public transit buses, and light-, medium-, and heavy-duty vehicles), vehicle miles traveled reductions, and partnerships with researchers to estimate, evaluate, and project greenhouse gas emissions and tax revenue impacts.[450,451] The Energy, Minerals, and Natural Resources Department, with technical assistance from the University of New Mexico and New Mexico State University, is conducting energy audits to find energy efficiency opportunities and increase system resiliency and accessibility; and local governments have used energy audits to help reduce energy use and conserve water in wastewater treatment facilities, which service multiple sectors.[452,453] *Further funding towards renewable energy program adoption, particularly in solar and battery storage, and increasing capacity and accessibility in off-grid, remote, rural, or recreational areas is necessary to bring more New Mexicans into an affordable, accessible clean energy economy.*[454, 455]

Recommendation 2: Incentivize residential efficiency measures and electric vehicle adoption among households in underserved, underrepresented communities or with high combined energy and fuel cost burdens.

Combined residential energy and vehicle fuel costs as a fraction of household income generally increase when household income decreases. This is true even though higher-income and White households tend to consume more energy and drive more on average. Socioeconomic status and racial background are therefore important determinants of energy and fuel burden. Improved access to bill-reducing clean energy technology such as efficiency measures, community solar (particularly with virtual net metering[456]), and electric vehicles may help reduce energy burdens for traditionally marginalized households.

Based on our findings, low-income populations and communities of color are correlated with high vehicle fuel cost burden. Therefore, these households should be targeted for clean energy adoption to maximize economic co-benefits; however, demographic indicators correlated with energy burden may vary geographically (**Figure 24**). Additionally, resilience and public health may be improved by targeting populations vulnerable to natural disasters (e.g. linguistically isolated communities), historic barriers to reliable and clean energy access (e.g. tribal communities), and populations with high pollution burdens (e.g. communities of color). Policy initiatives such as upfront financing options, rebates, and subsidies for clean energy adoption, among others, may reduce existing sociodemographic and geographic barriers to access. Residential electricity rates may also have to be restructured to ensure that electrification efforts, both for appliances and vehicles, do not shift consumers into a higher-cost electricity tier and inadvertently cause a disproportionate increase in electricity bills.

Recommendation 3: Prioritize pollution reduction measures—such as electrification, fuel switching, and brownfield remediation—in communities facing high cumulative environmental burdens across sectors; increase environmental data collection efforts to help identify these hotspots.

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450 *Ibid.*

451 New Mexico Department of Transportation. Request for Proposals: On-Call Planning Climate Change Services (2021).

452 New Mexico Energy, Minerals, and Natural Resources Department. Annual Report (2018).

453 US Department of Energy Office of Energy Efficiency & Renewable Energy. "Weatherization and Intergovernmental Programs Office Project Map - New Mexico." Accessed Mar. 2021. Available at: https://www.energy.gov/eere/wipo/downloads/weatherization-and-intergovernmental-programs-office-project-map-new-mexico.

454 US Department of Energy Office of Energy Efficiency & Renewable Energy. "Weatherization and Intergovernmental Programs Office Project Map - New Mexico." Accessed Mar. 2021. Available at: https://www.energy.gov/eere/wipo/downloads/weatherization-and-intergovernmental-programs-office-project-map-new-mexico.

455 New Mexico Energy, Minerals and Natural Resources Department. "New Mexico Energy Roadmap Project 2017 - 2027." Accessed Jan. 2021. Available at: http://www.emnrd.state.nm.us/ECMD/energyroadmap.html.

456 Community solar with virtual net metering lets customers receive utility bill credits for using solar that is located off-site, which is particularly beneficial for multi-family and other residential building configurations that do not have the space or ownership rights to make permanent solar installations. This community solar approach has been shown to be beneficial for fixed and reduced utility rates (typically below the retail utility rate), which stabilizes more affordable electricity access for populations that are rate sensitive, or those who have limited ability to make permanent energy efficiency upgrades such as tenants. For more information, see the nonpassed 2017 Community Solar Gardens Act, infographic, and newly introduced Senate Memorial 63's Community Solar Working Group.

Energy pollution burdens, shown in **Figures 9** and **21**, reflect how racialized policy practices and income inequality are associated with pollution burdens. There are several ways to address these pollution burden inequities. One measure is to better characterize pollution hotspots[457] by increasing environmental monitoring in regions of concern, and to conduct dispersion modeling of pollution reduction measures to identify high-impact emission reduction strategies. Though this report focuses on air quality, monitoring efforts should include various environmental media: air, water, soil, and other environmental indicators as appropriate, and characterize their cumulative health impacts wherever possible. A second is to ensure facilities are regularly inspected and regulatory standards enforced. A third is to prioritize, with community guidance, the replacement of remaining power generation (inclusive of small diesel generators) in hotspot areas with energy storage and/or renewables. A fourth is to target cross-sector pollutant reduction measures such as electrification of heavy-duty equipment at industrial facilities, electrification of trucks doing short-distance trips in industrial areas, re-routing trucks away from more residential areas, anti-idling truck regulations,[458] and to continue to build out electric vehicle charging infrastructure. Additional cross-sector measures may include brownfield remediation and neighborhood greening efforts, such as tree planting, which can have substantial benefits for local community environmental conditions.

Recommendation 4: Consider the distinct characteristics of rural and urban areas when designing decarbonization and energy equity policies.

Policies to address the clean energy transition must consider populations in both urban and rural areas. As our Demographic Index reveals, populations in both regions can have higher shares of traditionally marginalized communities (low-income, people of color, limited educational attainment, linguistically isolated, elderly, and very young populations). In both regions, energy cost burdens skew higher for lower income populations, and those with lower income tend to have higher concentrations of populations of color and immigrant populations. In urban cores, moderate- to lower-income neighborhoods are more racially diverse and have disproportionately higher energy burdens and pollution emission burdens, relative to the rest of their respective metropolitan area, further perpetuating the negative externalities from racially motivated redlining in housing and historic exclusionary practices in employment, education, and job training for communities of color.[459] We also find that many of these communities face high cumulative environmental burdens from existing fossil fuel infrastructure and transportation emissions, which are modeled to take longer to electrify than other sectors.

Our findings reveal that some rural communities, and in particular tribal communities (even with limited accessible data), face multiple challenges, including the persistence of $PM_{2.5}$ pollution indoors from wood burning, persistent exposure to pollutants associated with mining production, and higher risks of the compounding effects of extreme heat days, wildfire risk, and higher energy cost burdens, as shown in **Figure 35**. Tribal communities that are moderate- to low-income also face inconsistent access to energy, or no connectivity at all.

Recommendation 5: Restructure clean energy financing mechanisms to enable equitable access to capital among economically vulnerable communities.

Lack of access to capital is a large hindrance for clean energy technology adoption among pollution overburdened and racially- and socioeconomically-underserved populations. To avoid inequitable clean energy adoption rates similar to those of rooftop solar, which skew heavily towards higher-income and White

457 Our study does not define hotspots for New Mexico, as the prioritization of these areas needs to be defined by in-state stakeholders and must include community members. However, our analysis does lend insight to some metrics that can be used to guide how to narrow down these geographical regions.

458 Anti-idling regulations should only be implemented with the input and consideration of the truckers that are responsible for implementation. Regulations that are unnecessarily onerous or do not provide for the reasonable air-conditioning requirements that truck drivers depend on, such as heating and cooling during extreme weather, should be avoided. When air conditioning or other auxiliary equipment operation is needed for the safety and health of the truck driver, alternative fueled or renewable fueled power sources should be made available.

459 Hunt, Jerome. A State-by-State Examination of Nondiscrimination Laws and Policies. *Center for American Progress Action Fund* (2012).

populations based on national trends,[460] assessment should be taken to identify New Mexicans who lack access to financial capital or experience non-financial barriers to clean energy. Inequities in clean energy access can be reduced, in part, through renewable energy, efficiency, and electrification financing mechanisms supporting underrepresented and underserved households—such as point-of-purchase rebates and low- or no-interest loans—rather than relying on tax incentives and post-purchase rebates.

Broader measures to support equitable access to clean energy and its economic benefits, which may already be underway in local communities in New Mexico, should also include, at-large:

- Financing education to advance or transition non-graduates, new-graduates, and non-energy career professionals into clean energy careers;
- Research funding to identify and address financial and non-financial barriers to clean energy access for historically marginalized communities, particularly communities of color, who face higher average financial burdens than White communities regardless of income status;
- Direct reimbursement and stipend funding for participants of the community engagement process to ensure no adverse financial impacts of participation;[461]
- Continued and greatly expanded public infrastructure investments for electric vehicle charging stations, conversion/retrofitting of current fueling stations, and electric grid upgrades to support distributed energy resources;
- Financial incentives for communities of color and underserved populations to access clean energy technologies, encompassing the sector-specific recommendations described earlier;
- Support for businesses repurposing, recycling, or dismantling renewable energy technologies used in the clean energy transition for safe disposal at end-of-life, coupled with financing for transitioning current fossil fuel-focused companies that perform end-of-life services to the new opportunities in the clean energy economy.

Financing mechanisms and related efforts should be accompanied by further workforce development, for which a detailed analysis is beyond the scope of this study. However, a key consideration should include skilled job training in clean energy fields focused on current fossil fuel industry workers.

460 Sunter, Deborah, *et al.* Disparities in Rooftop Photovoltaics Deployment in the United States by Race and Ethnicity. *Nature Sustainability* 2.1 (2019): 71-76.

461 Typically, community members and organizations are asked to participate in community engagement processes with government and non-government organizations, without direct financial assistance or compensation for their time, expertise, and efforts. This encourages financial inequities between those who are compensated to work for the companies, investors, government, and non-government organizations working in the clean energy transition, and those who are not compensated but expected or asked to participate. Direct payments to community members is a way to correct this financial inequity.

3.4 Recommendations for Future Research and Data Needs

3.4.1 Data Collection Needs Moving Forward

Much of our analysis is based on models and estimates due to lack of granular pollution, emission, and energy use data. Data collection in the areas below would be valuable in better identifying communities and sectors for energy investments and pollution reduction, setting health-protecting regulations, enabling better enforcement, and creating a baseline upon which to measure success. With the exception of some data that should be aggregated to protect individual privacy, these data should be publicly available, easily accessible, transparent, and regularly updated.

Cross-Sector

Air Quality

1. High-density ambient air monitoring, particularly in potential pollution hotspots.
2. Fenceline air monitors at power plants and industrial facilities, including for hazardous air pollutants such as benzene, toluene, ethylbenzene, and xylene.
3. Indoor air monitoring and exposure assessment characterizing concentrations of and exposure to pollutants associated with in-home fossil fuel and biomass use.

Electricity Access

1. Historical and contemporary electricity accessibility and reliability data within the state, by census tract. This should be updated regularly, broken down by sociodemographic indicators, and include community surveys or other self-reporting mechanisms to more broadly capture all populations.
2. Electricity access data for tribal populations.
3. Reliability data by utility provider and consumer.
4. Adoption rates and availability of capital financing for distributed electricity resources (i.e. solar, energy storage, etc.) specific to New Mexico.

Transportation

1. Data on electric vehicle adoption is only available by county in New Mexico. Data at a more spatially granular level, as is provided for a number of other states through the Atlas Public Policy EV Hub, would allow for analysis of the socioeconomic and demographic characteristics of electric vehicle adoption.
2. National Emissions Inventory (NEI) data on nonroad mobile source emissions are only available at the county-level. Data at a more spatially granular level would allow for public health and equity analysis of these sources.
3. Accessible data on vehicle idling times, particularly for medium-duty and heavy-duty trucks in New Mexico, would allow for more accurate on-road vehicle emission estimates.

Power

1. Primary particulate matter emissions measured hourly (rather than estimated) and covering all facilities.
2. Current and regularly updated data on the ownership for fossil fuel facilities and clean energy facilities, along with sociodemographic breakdown of ownership, board, and leadership positions.

Residential Buildings

1. Household-level energy use and burden data, aggregated at the census tract or block group level to protect privacy while allowing some spatially refined analysis.
2. Energy efficiency and solar adoption rates by household, again summarized for individual household privacy.
3. Gas distribution line and service area data. Given the public safety hazards inherent in natural gas distribution and the potential for these hazards to increase if systems are not retired properly, it is important to know the exact alignment of distribution systems and who is responsible for their maintenance in any given area.

Commercial Buildings

1. Spatially detailed emissions data (e.g. city or county level) collected and maintained by the government.
2. Fuel-use emissions reporting requirements categorized by commercial use (e.g. retail, hotels, salons, casinos, etc.) and occupancy.
3. Fuel-use emissions reporting requirements based on building type (e.g. Class A, B, or C[462]), and location in accordance with a standards organization such as NAIOP[463] or CoStar.[464]

Industry

1. While the NEI provides criteria air pollutant emissions data for industrial point sources, the data do not adequately distinguish between combustion and non-combustion emissions at the facility-level. More detailed facility-level emissions data would allow for analysis of the impact of decarbonization on the spatial distribution of industrial emissions.
2. Data on emissions from oil and gas production and processing is limited, and would benefit from not only the regular monitoring of methane leakage, venting, and flaring, but also improved characterization of health-damaging air pollutant emissions.

462 Commercial building classifications vary by organization and other external factors. In general, Class A represents the highest grade or quality available, as compared to Class B, C, etc.

463 Originally founded as the National Association for Industrial and Office Parks, this trade and standards organization currently operates as the Commercial Real Estate Development Association.

464 CoStar. CoStar Building Rating System.

3.4.2 Recommendations for Research

Baseline Environmental Justice Screening Data

We created a Demographic Index, reliant on EJSCREEN indicators, to identify socioeconomically burdened populations across New Mexico. However, it may be valuable for the state to design its own environmental justice screening tool using indicators which reflect New Mexico's priorities and needs to support vulnerable and environmentally overburdened populations. In addition to identifying a suite of socioeconomic indicators deemed pertinent by New Mexico stakeholders, this tool could incorporate additional indicators such as health measures (e.g. asthma rates) and environmental burdens (e.g. pesticide concentrations). Input from a broad range of stakeholders, including scientists, community organizations, and others, can provide valuable insights into the design of such a screening tool. The resulting tool may be useful for designing and measuring the efficacy of energy and climate policy and could be applied to policy decisions more broadly.

Health Impacts Analyses

Our analysis here focuses primarily on current pollutant *emissions* and changes in emissions under different decarbonization scenarios in order to determine whether or not there are inequities in pollution burdens and to identify potential strategies to alleviate those burdens. However, we did not model the health *impacts* of these emissions. The trends we have identified suggest there are likely disparities in the health impacts, in addition to the pollutant emissions, of fossil fuel infrastructure and pollution mitigation pathways; these findings highlight the need to model air pollution dispersion and health impacts to ensure that proposed state decarbonization policies achieve greater health benefits for communities across New Mexico, and particularly in communities burdened by a disproportionate share of pollution. For example, Fann *et al.* (2011) illustrate strategies to maximize health benefits and reduce inequality in pollution burdens by focusing on multi-pollutant reductions in vulnerable communities.[465] Our initial screen may highlight sectors and regions where a detailed health impact analysis, of both the current system and of clean energy policy strategies, may be valuable. These include both indoor and outdoor air quality analyses, such as quantitative research on exposures to indoor air pollution from natural gas leakage, to better characterize health risks associated with residential natural gas use.

Managed Retirement of Infrastructure

We see a significant risk of inequitable bill impacts moving forward for households that do not electrify. One strategy to limit these impacts would be selective "pruning" of the natural gas infrastructure, effectively electrifying entire neighborhoods at a time and retiring the gas distribution lines to reduce upkeep costs. It would be valuable to analyze the gas loads and strategies that would allow for such a transition to minimize infrastructure upkeep costs. During this transition period, publicly funded financial mechanisms can be used to stabilize ratepayer bills and reduce them for low-income customers.

Barriers to Clean Energy Adoption

Current trends suggest that solar, storage, efficiency, and electric vehicles are inequitably distributed across New Mexico. To mitigate these inequities moving forward, the state should collect higher-granularity data on existing adoption rates and analyze these in relation to existing demographic distributions in order to set a reliable baseline. The state should conduct a study to identify specific barriers facing underserved populations, including outreach to these communities, to design effective policies. Ongoing data collection will allow for comparison to baseline adoption levels and provide opportunities to revise policies as needed.

465 Fann, Neal, *et al.* Maximizing Health Benefits and Minimizing Inequality: Incorporating Local-Scale Data in the Design and Evaluation of Air Quality Policies. *Risk Analysis: An International Journal* 31.6 (2011): 908-922.

4. Technical Appendix: Methods

4.1 Overview of Methods

We used a three-step process to identify priority areas for the State of New Mexico to build energy equity and co-pollutant reduction benefits into its decarbonization strategy. First, we approximated sectoral greenhouse gas and criteria pollutant emissions at fine spatial resolution. To do so, we applied emissions factors to energy production and consumption data obtained using processes detailed in the sector-specific methods below. Next, we joined these data with demographic data from the US Census Bureau. This enabled us to characterize the state's existing energy equity landscape—accounting for such considerations as clean energy access, bill burdens, and proximity to pollution, among others. We then integrated our findings from the first two steps with Evolved Energy Research's model results to illustrate how various decarbonization pathways may be implemented in a manner which maximizes social and environmental co-benefits. Throughout this process, we held multiple listening sessions and interviews with New Mexico community organizations to understand the unique energy equity and social equity priorities of local communities. Methodologies and source data used at each step are discussed in greater detail below.

4.2 Sectoral Energy Equity and Emissions Mapping

4.2.1 Baseline Demographic and Environmental Indicators

We analyzed population characteristics and cumulative environmental burdens across New Mexico using a mix of data aggregated from the US Census and from the US Environmental Protection Agency's environmental justice screening tool EJSCREEN.[466] EJSCREEN includes census block group information on a set of demographic indicators, including:[467]

Demographic Indicators

1. **Populations of color:** Population fraction that is not non-Hispanic White;
2. **Low-income:** Population in households below double the federal poverty level;
3. **Linguistic isolation:** Population living in households where no one over the age of 14 speaks English as a primary language and all adults speak English less than "very well;"
4. **Educational attainment:** Fraction of adults aged 25 and over, with less than high school education;
5. **Children:** Population fraction under age five;
6. **Elderly:** Population fraction over 64.

466 US Environmental Protection Agency. "EJSCREEN: Environmental Justice Screening and Mapping tool." Available at: www.epa.gov/ejscreen

467 Descriptions and data years for EJSCREEN indicators are provided in the "Technical Documentation for EJSCREEN." Available at: www.epa.gov/ejscreen/technical-documentation-ejscreen

Census tract-level values were calculated for each indicator using the population-weighted average of the block group values in each tract. The indicator value for each census tract was then compared to the remaining census tracts statewide and assigned a percentile value.

To identify populations which are uniquely vulnerable to this pollution due to cumulative socioeconomic burdens, we created a Demographic Index to reflect a combination of demographic indicators. The raw value for the Demographic Index was calculated by averaging the percentiles for each of the above demographic indicators. This raw value was then assigned a statewide percentile by comparing census tracts across the state, and the percentile value used as the Demographic Index score.

This index is necessarily limited by the data available within EJSCREEN. We therefore also assess some of our data in the context of additional environmental and socioeconomic indicators not available in EJSCREEN. These include the following, reflecting additional environmental burdens, climate vulnerabilities, and health vulnerabilities:

1. **Non-attainment areas:** Regions that exceed federal air quality standards (in this case, average 8-hour ozone concentrations) in the US Environmental Protection Agency's Green Book.[468]
2. **Wildfire risk zones:** Regions facing high wildfire risk.[469]
3. **Projected extreme heat days:** Number of days projected to exceed 95˚ F given a moderate carbon emissions scenario in the 2020-2039 timeframe.[470]

We used these indicators to assess both their combined and individual relationships with energy burdens and cumulative environmental burdens from the fossil fuel industry, as described below. These indicators are meant to help characterize both cumulative burdens and vulnerabilities, but are not necessarily complete, and the state may choose to include additional indicators (e.g. health measures such as low birthweight births and environmental exposure metrics such as proximity to pesticide application) for decision-making purposes.

4.2.2 Power Sector

We aggregated power plants from the US Energy Information Administration's Form 860[471] and selected a subset of 25 facilities burning fossil fuels (including natural gas, petroleum liquids, and coal) and/or biofuels (including landfill gas and wood), seven of which were deemed likely idle or closed. We cross-checked and updated facility locations using satellite view on Google Maps.[472]

We subsequently characterized populations in close proximity to New Mexico's power plants by calculating population characteristics within a one-mile and three-mile radius of each plant. We used 2010 Census Block data[473] for population weighting and 2014-2018 Census Block Group data[474] to obtain underlying population characteristics, such as population size, percent of residents under two times the Federal poverty line, and percent non-white residents. Our methods are modeled after the Environmental Protection Agency's EJSCREEN population weighting methods, which are described in the tool's technical documentation.[475]

468 US Environmental Protection Agency. "New Mexico 8-hour Ozone Nonattainment Areas (2015 Standard)." Available at: https://www3.epa.gov/airquality/greenbook/nm8_2015.html

469 USDA Wildfire Hazard Potential. Available at: https://www.firelab.org/project/wildfire-hazard-potential

470 Rasumussen et al. *Probability-weighted ensembles of U.S. County-level climate projections for climate risk analysis*. 2016.

471 US Energy Information Administration. "Form EIA-860 (2018)." 2020. Available at: www.eia.gov/electricity/data/eia860

472 Google. "Maps." 2020. Available at: www.google.com/maps

473 US Census Bureau. "TIGER/Line FTP Archive: TIGER2010BLKPOPHU." June 2011. Available at: www2.census.gov/geo/tiger/TIGER2010BLKPOPHU/

474 US Census Bureau. "TIGER/Line FTP Archive: 2018 ACS." April 2020. Available at: www2.census.gov/geo/tiger/TIGER_DP/2018ACS/

475 US Environmental Protection Agency. "EJSCREEN Technical Documentation." September 2019. Available at: www.epa.gov/sites/production/files/2017-09/documents/2017_ejscreen_technical_document.pdf

We used the US Environmental Protection Agency Air Markets Program Database[476] for 2019 to calculate baseline emission data, including total CO_2, SO_2, and NO_x emissions and rates of emissions per megawatt-hour of electricity generation. This database omits some small and infrequently used power plants. We cross-checked the generation and emissions for these small facilities for 2018, which are estimated by the US Energy Information Administration,[477] and determined they account for a minimal portion of in-state fossil fuel and biomass-consuming power generation. The *estimated* emission rates of NO_x and SO_2 from some of these facilities seemed anomalously high. We therefore included these facilities (which may be small but often burn high-emission fuels like diesel) in our analysis of populations near power plants, but only included the data for plants for which we have *measured* emissions in our analysis of electricity transition pathways.

We used the emission rates calculated above to estimate the average emissions of each power sector generation scenario developed by Evolved. We next calculated how much emission benefit could be obtained by prioritizing the retirement of plants with the highest co-pollutant emission rates. We ranked the plants by emission rates, and assumed that the highest-emission plants would be retired first (including the highest SO_2 emission rates for coal plants and the highest NO_x emission rates for natural gas plants). Using this prioritization, we compared end-point (e.g. 2030) and cumulative emissions from each scenario with and without prioritizing retirement of higher polluting facilities.

4.2.3 Transportation

On-Road Mobile Source Emissions

Using the Federal Highway Administration's 2018 Highway Performance Monitoring System (HPMS) dataset, we multiplied annual average daily traffic by road segment length to obtain daily vehicle miles traveled (VMT) for each road segment. The New Mexico Department of Transportation was able to provide a more granular VMT breakdown than is required by the HPMS, including a breakdown of VMT by FHWA vehicle class, road type (including local roads), and rural/urban designation. We aggregated VMT from each FHWA vehicle class into the HPMS vehicle categories: (1) motorcycles, (2) light-duty passenger cars, (3) light-duty trucks, (4) buses, (5) single-unit heavy-duty trucks, and (6) combination-unit heavy-duty trucks.

We created a 250-foot buffer around each road segment in the HPMS dataset and proportionally allocated VMT to overlapping census tracts based on area of overlap. We subsequently aggregated VMT across road segments within each census tract to estimate total VMT for each census tract. This procedure was carried out for each HPMS vehicle category to enable later application of emissions factors.

To estimate criteria air pollutant emissions in each census tract, we used EPA MOVES 2014a state-specific emission factors for carbon monoxide, NO_x, $PM_{2.5}$, PM_{10}, and VOCs, which are provided for each vehicle model year. Estimating current and future vehicle emissions is highly dependent on the assumed vehicle age distribution of each vehicle type (ex. the fraction of passenger cars that are 10 years old) as well as the allocation of vehicle miles traveled by vehicle vintage (ex. annual miles driven by the average 10-year-old passenger car). We used Evolved's assumed allocation of VMT by vehicle vintage for each analysis year to calculate a fleet-average emission factor for each MOVES vehicle source type and fuel type (gasoline and diesel) in each year. Rather than predict future emission factors for vehicle model years 2020-2050, we used 2019 emission factors for the equivalent vehicle type for future years. Due to missing emission factors for gasoline-powered long-haul single-unit heavy-duty trucks, we used emission factors for gasoline-powered short-haul single-unit heavy-duty trucks for that MOVES vehicle source type. For alternative fuel vehicle types used in Evolved's model, we used emission factors from Argonne National Laboratory's 2019 AFLEET tool.

We applied emission factors (grams/mile) to statewide VMT for each vehicle category, mapping the MOVES vehicle source types to their corresponding HPMS vehicle categories. When multiple MOVES vehicle source types mapped to one HPMS vehicle category (e.g. buses), we averaged the emission factors across MOVES vehicle source types within the corresponding HPMS vehicle category.

476 US Environmental Protection Agency. "Air Markets Program Data." 2020. Available at: https://ampd.epa.gov/ampd/

477 US Energy Information Administration. "Emissions by plant and by region." 2020. Available at: www.eia.gov/electricity/data/emissions/

We assigned a weight to each census tract based on its fraction of statewide VMT for each vehicle category. We then allocated emissions by pollutant and HPMS vehicle category to each census tract by multiplying the tract's assigned weight by the statewide emissions from that HPMS vehicle category.

To analyze criteria air pollutant emissions over time for each decarbonization scenario, we used the Evolved model's projected changes in VMT and fuel switching for each vehicle category. We assumed the relative contribution of each census tract to statewide VMT per vehicle category remained the same from 2017-2050 despite changes to overall statewide VMT. We also assumed that fuel switching occurred uniformly (geographically) across the vehicle fleet for each vehicle category.

Vehicle Fuel Cost Burden

To estimate the fraction of vehicle miles traveled that is household-generated (i.e. not from commerce), we took the national sum of household travel from the 2017 National Household Travel Survey and divided it by the national sum of light-duty vehicle miles traveled from the 2017 Federal Highway Administration HPMS dataset. We applied the resulting household travel fraction of light-duty vehicle miles traveled of approximately 73 percent to Evolved Energy's projected statewide light-duty vehicle miles traveled for every year from 2017-2050 to project annual household-generated vehicle miles traveled. We attributed this resulting statewide estimate solely to passenger cars and light-duty passenger trucks, excluding light-duty commercial trucks. We excluded motorcycles, as Evolved does not estimate vehicle miles traveled for this vehicle class. We then derived the fuel use for household-generated light-duty vehicle travel, using Evolved's fuel use estimates for passenger cars and light passenger trucks.

To allocate household travel fuel use to each census tract, we used the Bureau of Transportation Statistics 2017 Local Area Transportation Characteristics for Households data on average household weekday travel by census tract. We multiplied the average household weekday travel by the count of households with vehicles in each census tract to estimate aggregated household weekday travel for each census tract. We then assigned a weight to each census tract based on its proportional contribution to total statewide household weekday travel. We then multiplied each census tract's weight by the statewide household travel light-duty vehicle fuel use estimated above to estimate household travel fuel use for each census tract.

To estimate household fuel costs associated with vehicle travel in 2017, we multiplied tract-level aggregated household fuel use by fuel costs, using the EIA's 2017 New Mexico transportation fuel price data by fuel type. We used Evolved's 2020 fuel cost estimates for electricity, liquid hydrogen, and residual fuel oil, which were not available from the EIA for 2017. We then divided the total tract-level fuel costs by the number of households in each census tract to estimate vehicle fuel cost for the average household in each census tract. We divided this by median household income from the American Community Survey 5-year 2015-2019 dataset to estimate annual vehicle cost fuel burden as a fraction of income for the average household in each census tract.

Electric Vehicle Charging Stations

We used data from the Department of Energy's Alternative Fuels Data Center to visualize the location of public electric vehicle charging stations and the density of electric vehicle supply equipment (EVSE), or charging outlets, in New Mexico. We include AC Level 2 and DC fast charging stations.

4.2.4 Residential

Residential energy consumption data are not readily available at geographic scales conducive to spatial or demographic analysis—though reliable statewide estimates by fuel type are available from the Energy Information Administration.[478] We accordingly built a regression model to develop weights which apportion statewide residential energy consumption to individual census tracts based on a variety of geographic, climatic, housing-related and demographic variables.

Our model uses previously developed methods[479,480] to estimate each tract's relative contribution to statewide residential electricity, natural gas, propane, and wood consumption. Predictive variables for each census tract were extracted from the 2015 Residential Energy Consumption Survey[481] and the 2014-2018 American Community Survey[482] to estimate fuel-specific energy consumption for the average household in each census tract. We used this output, supplemented with additional electricity and natural gas data (provided by the authors of Min *et al.* 2010 and updated with more current predictors),[483] and the number of households in each tract to develop a weighting factor for each tract's share of statewide energy consumption.

We then applied this weighting factor to the Energy Information Administration's statewide consumption estimates to approximate each tract's residential energy consumption by fuel. These weighted values were used as baseline census tract energy consumption estimates. Similarly, we applied these weighting factors to projected consumption estimates under each Evolved scenario to estimate future census tract-level residential energy consumption along each modeled decarbonization pathway. This methodology assumes the distribution of energy consumption amongst census tracts stays constant, and does not account for any changes to its spatial distribution between different scenarios. We subsequently multiplied all tract-level energy consumption estimates by emission factors[484] to identify priority areas for greenhouse gas reductions, populations and geographic regions likely to use more heavily polluting fuels, and possible changes in the distribution of residential emissions for different decarbonization pathways.

Residential Energy Cost Burden

To characterize baseline residential energy cost burdens, we multiplied our census tract-level energy consumption estimates by 2018 Energy Information Administration New Mexico prices by fuel.[485] We used the same methodology to project energy cost burdens with 2030 tract-level consumption estimates and scenario price projections from the Evolved model. Average household energy cost burden was then calculated for each census tract by dividing estimated energy expenditures by household income.

Residential Bill Impacts

To illustrate the impacts of fuel switching and energy efficiency measures on household energy bills, we used Evolved projections for residential fuel consumption, residential fuel prices, and residential clean energy adoption rates to calculate the average increase in household electricity use under each Evolved scenario relative to the Reference case. We then attributed the electricity use increase to the fraction of adopting households only, resulting in higher electricity bills for

478 US Energy Information Administration. "State Energy Data System." Available at: https://www.eia.gov/state/seds/

479 Min, Jihoon, Zeke Hausfather, and Qi Feng Lin. A High-Resolution Statistical Model of Residential Energy End Use Characteristics for the United States. *Journal of Industrial Ecology* 14.5 (2010): 791-807.

480 Jones, Christopher, and Daniel M. Kammen. Spatial Distribution of US Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density *Environmental Science & Technology* 48.2 (2014): 895-902.

481 US Energy Information Administration. "Residential Energy Consumption Survey 2015." Available at: https://www.eia.gov/consumption/residential/data/2015/

482 US Census Bureau. "TIGER/Line FTP Archive: 2018 ACS." April 2020.

483 Min, Jihoon, Zeke Hausfather, and Qi Feng Lin. A High-Resolution Statistical Model of Residential Energy End Use Characteristics for the United States. *Journal of Industrial Ecology* 14.5 (2010): 791-807.

484 California Air Resources Board, "Residential Emissions Factors". Available at: https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-residential-fuel-combustion; Environmental Protection Agency "Residential Emission Factors". Available at: https://www3.epa.gov/ttn/chief/ap42/ch01/index.html

485 US Energy Information Administration. "Residential Sector Energy Price and Expenditure Estimates, 1970-2018, New Mexico." (2020). Available at: https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_prices/res/pr_res_NM.html&sid=NM

those households but eliminating their natural gas bills. Conversely, non-electrifying households were assumed to have the same average electricity and natural gas consumption as in the Reference scenario.

The Evolved model assumes different electrification rates for different residential end-uses. We used the projected electrification rates for space heating as a proxy for all electrification measures with the assumption that they happen simultaneously to simplify our calculations. Because the Low Demand, Core, and Fossil Free scenarios all have identical residential end-use electrification rates in the Evolved model, we also incorporated the rate of residential building shell retrofits to distinguish the Low Demand scenario, which has higher rates of energy efficiency upgrades, from the other scenarios. The goal of the outlined approach to calculating residential bill impacts was to provide an illustrative apples-to-apples comparison between clean-energy-adopter and non-adopter bills, and between the different scenarios based on projected fuel consumption, fuel prices, and adoption rates, all other things being equal.

Residential Solar Deployment

We applied the weights calculated as described in **Section 4.2.4** to statewide 2030 residential energy consumption estimates for Evolved's Core scenario. We additionally developed census tract population weights by dividing each tract's baseline number of people and households by statewide totals. We multiplied these weights by 2030 values from the Evolved model to get tract-level demographic projections.

We joined our tract-level energy and population projections with data describing potential high-priority populations for residential solar deployment. Populations identified as high-priority include those who may derive additional resilience, economic, and/or health benefits from rooftop solar deployment, such as residents of counties with a high number of projected mid-century heat days,[486] households with income below the Federal poverty line,[487] rural households,[488] and households with at least one person dependent on electricity for medical reasons.[489]

We used our demographic and consumption projections and a 0.18 average capacity factor for distributed solar in New Mexico to estimate the solar capacity needed to match target populations' residential energy needs by 2030. We compared these numbers to the 2030 total solar and rooftop solar projections underlying Evolved's model outputs to gauge whether additional solar deployment or redistribution of solar resources (i.e. residential instead of commercial) might be considered to maximize co-benefits.

4.2.5 Commercial

To our knowledge, the most spatially granular commercial emissions data available to the public are delivered at the county level in the NEI.[490] Methods to derive more spatially detailed emissions data are not readily available for the commercial sector due to a lack of geographic and descriptive data such as those used to derive weighting factors for the transportation and residential sectors. As such, our analysis of the commercial sector and cross-sectoral analyses integrating commercial data are limited to the county level. Furthermore, our commercial analyses are limited due to data quality issues in the NEI commercial dataset which lead us to conclude that these data are incomplete.

4.2.6 Industrial

To evaluate current industrial criteria air pollutant emissions, we drew from the NEI 2017 point source dataset, excluding power plants and transportation-related point sources (airports, railyards), and the NEI

486 Rasmussen, D. J.; Meinshausen, Malte; Kopp, Robert E. "Probability-Weighted Ensembles of U.S. County-Level Climate Projections for Climate Risk Analysis." Rutgers University Libraries. 2016. Available at: https://rucore.libraries.rutgers.edu/rutgers-lib/51860/#package

487 US Census Bureau. "TIGER/Line FTP Archive: 2018 ACS." *Ibid.*

488 US Census Bureau. "TIGER/Line FTP Archive: 2018 ACS." *Ibid.*

489 US Department of Health and Human Services. "HHS emPOWER Map 3.0." Accessed Sept. 2020. Available at: https://empowermap.hhs.gov/

490 US Environmental Protection Agency. "National Emissions Inventory 2017 - Nonpoint Sources." Available at: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

industrial nonpoint source dataset, including only those distributed sources associated with the oil and gas sector. While the NEI nonpoint source dataset specifies which nonpoint sources are associated with oil and gas production, emissions are estimated at the county level and the locations of distributed sources are not provided.

While the NEI point source dataset provides criteria air pollutant emissions by industrial facility, it does not provide emission factors or EPA source classification codes for these facilities. Without emission factors, we were unable to project criteria air pollutant emissions over time based on Evolved's projected changes in fuel consumption and production quantities for various industrial subsectors.

We analyzed the demographic characteristics of communities near industrial point source emissions in the baseline year by assigning facilities to census tracts based on their latitude and longitude in the NEI dataset. We then used demographic data from the EPA EJSCREEN dataset to analyze the distribution of industrial point source emissions across census tract demographic indicators, such as low-income population fraction, people of color population fraction, and overall demographic index.

Despite the potential for significant emissions and associations with adverse health outcomes,[491,492,493] oil and gas wells are only included at the county-level in the NEI nonpoint dataset and are likely underestimates.[494] To our knowledge, no comprehensive datasets characterizing these emissions are available. A growing body of research has worked around this data gap by using where people live as a proxy for population exposure to oil and gas production-related health hazards.[495] We accordingly used spatial data from Enverus' DrillingInfo database for all active wells in New Mexico[496] and 2014-2018 Census block group data[497] to calculate the number of New Mexicans living near oil and gas wells in 2020. We allocated residents based on the area-based proportion of overlap between each block group and a half-mile buffer around wells. Though this methodology does not characterize oil and gas production-related emissions, it provides a rough assessment of baseline health hazards—which enables discussion of the potential for ongoing hazards under various decarbonization pathways.

4.2.7 Cross-Sectoral Data

In addition to analyzing the health, equity, and environmental implications of decarbonizing each individual sector, we sought to characterize economy-wide patterns by conducting cross-sectoral analyses. We joined the commercial, industrial, power, residential, and transportation data discussed in **Sections 2.2** to **2.6** above at the county level. Analyses at finer spatial resolution, such as the census tract level, was considered but omitted due to the lack of readily available commercial data below the county level and due to the complex nature of pollutant dispersion from point sources, such as power plants and industrial facilities, which is outside the scope of this report.

Aggregate, cross-sector datasets were used to analyze patterns such as overall baseline pollution distribution and household energy (residential) and fuel (transportation) burdens. Additional datasets pertinent to pollution and demographics were integrated into these analyses to provide further context. These include spatial data detailing the distribution of ambient air pollutant non-attainment areas.[498]

491 McKenzie *et al.* Childhood Hematologic Cancer and Residential Proximity to Oil and Gas Development. *PloS one* 12.2 (2017): e0170423.

492 Tran, Kathy V., *et al.* Residential Proximity to Oil and Gas Development and Birth Outcomes in California: A Retrospective Cohort Study of 2006–2015 Births. *Environmental Health Perspectives* 128.6 (2020): 067001.

493 Hays, Jake, Michael McCawley, and Seth BC Shonkoff. Public Health Implications of Environmental Noise Associated with Unconventional Oil and Gas Development. *Science of the Total Environment* 580 (2017): 448-456.

494 Grant, John *et al*. U.S. National Oil and Gas Emission Inventory Improvements. (2017)

495 Czolowski, Eliza D., *et al.* Towards Consistent Methodology to Quantify Populations in Proximity to Oil and Gas Development: A National Spatial Analysis and Review. *Environmental Health Perspectives* 125.8 (2017): 086004.

496 Enverus. "Active Oil and Gas Wells." Accessed July 2020 from: https://www.enverus.com/

497 Manson *et al.* "IPUMS National Historical Geographic Information System: Version 15.0 [dataset]." 2020. Available at: https://data2.nhgis.org/main

498 US Environmental Protection Agency. "Green Book GIS Download." May 30, 2020. Available at: https://www.epa.gov/green-book/green-book-gis-download

4.3 **Community Organization Outreach for Equity Considerations**

We conducted multiple virtual listening and interview sessions with various New Mexico organizations throughout 2020 in order to understand their policy, energy equity, and social equity concerns and priorities. Some covered topics included local community priorities regarding:

- Public health and policy priorities related to energy;
- Pollution sources and nearby communities;
- Economic impacts and job creation, stagnation, or decline;
- Local, community input and accountability of projects to communities;
- Access and funding to demand-side energy use reduction efforts, such as appliance efficiency; and
- Access and funding to electrification efforts in transportation and housing.

From these discussions, we compiled a list of focus areas and case studies that were incorporated into the technical analysis performed in this study.