Incorporating Health and Equity Metrics into the Otter Tail Power 2023 Supplemental Integrated Resource Plan

Prepared by PSE Healthy Energy on Behalf of Fresh Energy, Minnesota Center for Environmental Advocacy, Clean Grid Alliance, and Sierra Club

September 2023

Bringing science to energy policy

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Acknowledgements

We would like to thank Amelia Vohs, Isabel Ricker, Stephanie Fitzgerald, and the others who provided input, suggestions, and feedback on our analysis. Any errors or omissions remain our own.

Funding

This report was funded by Fresh Energy and Minnesota Center for Environmental Advocacy.

About PSE Healthy Energy

PSE Healthy Energy (PSE) is a scientific research institute generating energy and climate solutions that protect public health and the environment. PSE provides expertise in public health, environmental science, and engineering and brings science to energy policy through actionable research, communications, and advising. Visit us at psehealthyenergy.org and follow us on X at @PhySciEng.

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About the Authors

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Executive Summary

The Otter Tail Power Company (Otter Tail or OTP) supplies electricity to communities across Minnesota, North Dakota, and South Dakota. In a revision to a previously submitted integrated resource plan, the utility recently submitted a Supplemental Plan, outlining an updated mix of resources it hopes to use to reliably meet demand between 2023-2037.

In this report, we provide an analysis of the Supplemental Plan to determine its implications for climate change, public health, equity, and energy affordability. As part of this analysis, we examine the distribution of the plan's potential impacts on vulnerable populations, such as those experiencing high energy cost burdens or historic cumulative environmental burdens, to determine which communities may experience disproportionate risk.

$PM_{2.5}$-Related Health Impacts

OTP's Supplemental Plan proposes operating two coal plants, Coyote and Big Stone, until 2040 and 2046, respectively. Based on our analysis, closing the Coyote plant by 2028—as originally proposed in the Integrated Resources Plan—would avoid approximately 17-40 mortalities attributable to OTP each year from 2029-2040, saving a total of 479 lives over that time span. Further, emissions from Coyote disproportionately impact Native people, who experience 2.6 $PM_{2.5}$-related mortalities from Coyote's emissions for every one mortality in the overall population. Exiting Big Stone by 2030 would save another 17 lives per year, and reduced use of both plants would yield significant benefits to the surrounding soil and groundwater. OTP should consider measures to add utility-scale and distributed energy storage, which may enable it to retire some of its aging oil-fired peaking plants and reduce its need for backup LNG storage at its Astoria facility.

Energy Affordability

Annual energy bills for OTP's customers in Minnesota are roughly 20 percent higher than the average for Minnesota, with 35 percent of OTP's customers paying more than six percent of income for their energy bills. This results in an annual sum of approximately $10 million in bill assistance needed to pay down electricity bills to affordable thresholds for all of OTP's roughly 50,000 customers in Minnesota. Upcoming federal funding paired with utility programs can instead make costly home retrofits that reduce bills available for low-income customers while also benefiting the grid. We estimate an average bill savings potential of $1,000 per year for low-income OTP's customers. While OTP's proposed demand-side efficiency programs and forecasted energy savings[1] are on par with some of the most successful utilities, more can be done to reduce energy-burdened households' energy bills. We recommend that OTP should report energy affordability metrics and their predicted evolution under the Plan from its programs. Furthermore, distributed solar, community solar, and electrification may all help reduce energy bills for low-income households, but OTP has minimal deployment of these technologies in its territory. We recommend more fully incorporating distributed solar resources, as well as energy storage and electrification, into planning. This can be done by modeling high electrification sensitivities along with demand-side resources in its next resource plan.

By considering cleaner resources for energy supply and demand management while also rapidly moving away from coal, OTP has the potential to reduce annual energy bills for low-income households by an average of $1,000 while improving public health across the entire region.

[1] Otter Tail Power Company. 2024-2026 Energy Conservation and Optimization Triennial Plan. Docket No. E017/CIP-23-94.

1. Introduction

The Otter Tail Power Company (Otter Tail or OTP) supplies electricity to communities across Minnesota, North Dakota, and South Dakota. It submitted an initial integrated resource plan in 2021, covering the periods 2022-2036, to the utility commissions across these three states, demonstrating how it planned to meet energy and reliability needs. This plan was subsequently revised and re-filed in 2023 as a supplemental resource plan covering 2023-2037. The revised plan was intended to allow Otter Tail to reflect changes to the MISO resource adequacy construct and capacity accreditation methodology, new Inflation Reduction Act incentives, and other changing conditions.[2]

OTP's Plan lays out its roadmap for electricity generation additions and retirements to reliably meet projected demand across its territory. In addition to energy, however, these decisions hold implications for climate change, public health, equity, and energy affordability. These impacts and benefits—and the distribution of these impacts and benefits—hold particular weight for populations facing high energy cost burdens, those with historic cumulative environmental burdens, and others that experience disproportionate impacts from existing energy infrastructure. Here, we analyze the public health, affordability, and equity dimensions of OTP's Plan, including a specific focus on its coal units.

To meet customer demand, OTP currently relies on two coal facilities that it owns a partial interest in—Big Stone Plant and Coyote Station—as well as two gas peakers (Solway and Astoria), two oil peakers (Jamestown and Lake Preston), a mix of renewable energy resources, and imports from Midcontinent Independent System Operator (MISO). OTP's Preferred Plan originally included the withdrawal of its interest in the Coyote coal plant by the end of 2028, but the Supplemental Plan now continues to rely on Coyote indefinitely unless a major upgrade investment in the facility is required. The OTP's Supplemental Plan also adds some solar and wind capacity and proposes adding liquified natural gas (LNG) storage capability at the Astoria Station combustion turbine plant.

Fossil fuel combustion at power plants produces both greenhouse gases and health-damaging air pollutants, the latter of which have public health impacts that can extend far downwind and across state borders. Emissions from coal plants include carbon dioxide (CO_2), fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_x), sulfur dioxide (SO_2), mercury, and volatile organic compounds (VOCs), among others. The magnitude of public health impacts associated with coal plant operations varies with fuel type, emission controls at each facility,

[2] Otter Tail Power Company (2021). Application for Resource Plan Approval, 2022-2026. Docket No. E017/RP-21-339.

the location of the facility, atmospheric conditions, and the characteristics of exposed populations. These pollutants can either have direct health impacts (e.g., $PM_{2.5}$, NO_x) and/or can react chemically in the atmosphere to form pollutants that have health impacts. For example, NO_x and SO_2 may react chemically in the atmosphere to form secondary $PM_{2.5}$, and NO_x may react with VOCs to produce ozone. Exposure to these pollutants is associated with a wide range of cardiovascular and respiratory health impacts, including asthma attacks, heart attacks, and premature death.[3] While power plant air pollutant emissions can affect populations living many miles away, health impacts *per capita* tend to be highest for populations living near and downwind from these facilities. Several studies have associated living near power plants with adverse health outcomes such as asthma[4] and premature births.[5]

In addition to air pollution from power plant stacks, populations living near power plants may be exposed to pollution along other pathways, such as through the contamination of water from on-site disposal of coal ash in impoundments, facility accidents, diesel emissions from heavy-duty trucks, and equipment associated with facility operations. Some of the health impacts associated with power plant operations, such as exposure to $PM_{2.5}$, can be modeled using standard approaches developed in the academic literature and utilized by the U.S. Environmental Protection Agency (EPA); the health impacts of other pathways, such as groundwater or soil pollution, are more challenging to model, due in part to lack of sufficient data. However, analyzing the demographics of nearby populations can provide insight into who is most likely to be exposed to these environmental health hazards and risks and whether these populations who are exposed may be particularly vulnerable to such exposures due to socioeconomic and environmental health factors, such as age, underlying health conditions, and high cumulative environmental burdens. Reducing emissions from these plants may therefore hold public health implications for both nearby populations and across a broad regional area.

In addition to public health, the resources used to meet electricity demand have implications for energy affordability. Access to energy is essential for daily existence in modern society and is critical for maintaining public health, individual well-being, and economic growth. In the utility sector, the costs of investments are typically passed onto consumers. Any unnecessary

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[3] Murray, C. J., Aravkin, A. Y., Zheng, P., Abbafati, C., Abbas, K. M., Abbasi-Kangevari, M., ... & Borzouei, S. (2020). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *396*(10258), 1223-1249.
[4] Casey, Joan A., et al. Improved Asthma Outcomes Observed in the Vicinity of Coal Power Plant Retirement, Retrofit and Conversion to Natural Gas. *Nature Energy* 5.5 (2020): 398-408.
[5] Casey, Joan A., et al. Increase in Fertility Following Coal and Oil Power Plant Retirements in California. *Environmental Health* 17.1 (2018): 1-10.

investments may result in increases in energy bills, which may increase stress on customers with high energy cost burdens—that is, the fraction of household income spent on energy. Demand-side resources such as energy efficiency can help reduce energy cost burdens and increase affordability. The incorporation of such resources into integrated resource planning, even though rates and specific programs may be detailed in other proceedings, can help ensure these resources are available to provide benefits for all customers.

In this analysis, we look at the public health, demographic, and affordability dimensions of Otter Tail's supplemental resource plan. In the following sections, we first introduce our methodology (**Section 2**); then, we describe our results, i.e., the demographics of populations living near OTP's power plants, the projected public health impacts of power plant operations under OTP's Preferred Plan, and an assessment of equitable access to energy and energy affordability (**Section 3**); and finally, we provide our key findings (**Section 4)**.

2. Methodology

2.1. Equity Screening and Demographics

We analyzed populations living within three miles of each of the fossil-fuel power plants (Coyote, Big Stone, and Astoria) using the EPA's EJSCREEN 2.0 tool.[6] EJSCREEN reports total population as well as seven socioeconomic measures (people of color, low income, unemployment, linguistically isolated, less than high school education, under age five, over age 64) and thirteen pollution measures ($PM_{2.5}$, ozone, diesel PM, air toxics cancer risk, air toxics respiratory index, air toxics releases, traffic proximity, lead paint, and proximity to facilities including superfund sites, risk management plan facilities, hazardous waste sites, underground storage tanks, and wastewater discharge sites). In our analysis, we looked at the indicators of the population living within a three-mile radius of each plant compared to the rest of the state in order to identify whether nearby populations are more vulnerable or face more cumulative burdens than other residents.

2.2. Power Plant Health Impact Modeling

We used data from the U.S. Environmental Protection Agency (EPA)'s National Emissions Inventory (NEI)[7] to calculate emissions rates (tons per megawatt-hour [MWh]) of five pollutants (NO_x, SO_2, CO_2, $PM_{2.5}$, and VOCs) for the two Otter Tail coal plants: Coyote and Big Stone. We used 2020 emissions data from NEI for Coyote and Big Stone, and 2020 coal

[6] U.S. Environmental Protection Agency. (2022). EJScreen: Environmental Justice Screening and Mapping Tool.
[7] US Environmental Protection Agency. (2023). 2020 National Emissions Inventory (NEI) Data.

electricity generation data for these two facilities from the U.S. Energy Information Administration (EIA).[8] The emissions (in tons) for each pollutant were divided by the generation (in MWh) to create an emissions factor (in tons/MWh) for each plant. These emissions factors were then multiplied by forecasted electricity generation provided by the Energy Futures Group for each plant to project annual emissions for 2023-2046.

To model the $PM_{2.5}$-related health impacts of each of Otter Tail's power plants, we used two reduced-form models. The EPA's COBRA model, which is widely used to calculate public health impacts from point and area sources of primary and secondary $PM_{2.5}$,[9] was used to calculate health impacts associated with Otter Tail's Preferred Plan. The model's inputs include emissions of primary $PM_{2.5}$ and $PM_{2.5}$ precursors (e.g., NO_x, SO_2, and VOCs) (in tons), as well as facility characteristics (like stack height) and location (state and county). COBRA calculates how emissions, primary $PM_{2.5}$ and $PM_{2.5}$ precursors, impact ambient (i.e., outdoor) $PM_{2.5}$ concentrations, and uses epidemiological concentration-response functions to calculate the $PM_{2.5}$-related public health impacts associated with changes in ambient $PM_{2.5}$. For some health endpoints (such as mortalities and nonfatal heart attacks), COBRA uses two different concentration-response functions, resulting in low and high health incidence estimates. COBRA reports health endpoints both by the number of incidences (e.g. asthma exacerbations, hospital admissions) and in monetary impacts (in 2017 US dollars), which are calculated by assigning a monetary value to each health outcome. Total health benefits (or costs) are calculated by summing values for each health endpoint. COBRA reports the impacts of $PM_{2.5}$ on a county level over the contiguous United States.[10] COBRA results indicate that counties near and downwind of emitting facilities tend to have the greatest health impacts.

The second model, InMAP, is a peer-reviewed model that calculates how changes in emissions of $PM_{2.5}$ and $PM_{2.5}$ precursors affect atmospheric $PM_{2.5}$ concentrations and health outcomes, using a similar approach to COBRA.[11] We use InMAP in addition to COBRA because it offers greater spatial granularity (up to 1km grid) as well as built-in racial demographic information, enabling us to assess which populations may see the greatest health impacts or benefits from a change in power plant operations. InMAP and COBRA use different underlying atmospheric chemistry models, different concentration-response functions, and different underlying demographic information (InMAP is somewhat older, meaning its estimates of total health impacts are likely lower). COBRA provides both a "low" and a "high" $PM_{2.5}$-related mortality estimate based on two different epidemiological models, and InMAP's results more closely

[8] US Energy Information Administration. (2020). Electricity Data Browser.
[9] List of publications that cite COBRA
[10] U.S. Environmental Protection Agency. CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA).
[11] Tessum, C. W., Hill, J. D., & Marshall, J. D. (2017). InMAP: A Model for Air Pollution Interventions. *PloS One*, 12(4), e0176131.

model the "low" results due to similarities in the underlying epidemiological models used. As a result, the total health impacts associated with each model do not perfectly match. However, used together, COBRA provides an understanding of the scale of public health impacts associated with Otter Tail's power plants, while InMAP provides spatial resolution to those impacts that we cannot achieve using COBRA.

2.3. Power Plant Environmental Health Hazards

To understand additional environmental health hazards associated with power plant operation, we looked at a mix of data related to toxic releases, groundwater monitoring wells, and historic violations at Otter Tail's coal plants. We looked up historic measurements of heavy metal concentrations in groundwater wells near the coal facilities, Coyote and Big Stone, using the Ashtracker database.[12] These measurements were taken between 2010 and 2017. We further looked up toxic releases and historic violations at these facilities using the EPA's Toxic Release Inventory (TRI) facility search tool.[13] This tool reports both on-site and off-site toxic releases and associated health hazards. We used the EPA's Enforcement and Compliance History Online (ECHO) tool to evaluate information on facility violations.[14]

2.4. Energy Affordability and Energy Access

To better understand concerns related to energy affordability and energy access, we first modeled energy cost burdens across Otter Tail territory. Since energy bills are not publicly available due to privacy concerns, we used models to estimate the energy cost burden and the energy affordability gap in each census tract. The "energy affordability gap" refers to the amount of money that would be required to ensure all households' bills do not exceed six percent of gross household income—a commonly accepted threshold for affordability. To do so, we used a multistep process and various models built upon publicly available survey data.

We summarize the energy bill modeling methodology here, but more details are available in previous reports.[15] First, we use integer programming methods in order to sample households from the 2015-2019 American Community Survey (ACS) microdata[16] that agree with the ACS tallies of households at the census tract scale. These are aligned along a variety of housing and demographic dimensions relevant to energy use and household incomes, including but

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[12] Environmental Integrity Project. (2023). Ashtracker.
[13] U.S. Environmental Protection Agency. (2021). Toxic Release Inventory (TRI) Program.
[14] U.S Environmental Protection Agency. (2023). Enforcement and Compliance History Online.
[15] Arjun Makhijani, Yunus Kinkhabwala, Jessie Jaeger, Kelsey Bilsback, Lee Ann Hill, Laurel Peltier, Boris Lukanov, Elena Krieger. (2023). Energy Affordability in Maryland.
[16] U.S. Census Bureau. (2023). 2015-2019 American Community Survey 5-year Public Use Microdata Samples.

not limited to, the fuel used for space heating, household income, type of home, and tenure (ownership status of home).

Second, we used models to estimate the square footage of the simulated homes from the first step using data from the American Housing Survey (AHS)[17] and the type of fuel used for water heating and fractions of fuel used for appliances using data from the 2015 Residential Energy Consumption Survey (RECS).[18] Third, we developed a random forest model that predicts energy use by fuel type and end-use based on the 2015 RECS survey data. We used this model, alongside climate data, to estimate the energy use for the simulated households. We assume that all electrically heated homes are driven by resistance heating and inefficient heat pumps based on the statistically insignificant number of central heat pump homes reported by the 2020 RECS survey.[19]

Lastly, we geospatially assign local rates for natural gas, as reported to the EIA,[20] to households in order to calculate the amount spent for each energy end-use. We randomly chose households from the census tracts that intersect with OTP's service area such that the total number of customers and their total electricity consumption matched the values reported to the EIA in 2021.

Using this simulated dataset of energy bills and household demographics, including income, it becomes possible to estimate the energy cost burdens and affordability gaps for each household as well as how various home interventions can reduce energy affordability metrics. To do so, we simply calculate the percent of income spent on energy. If that percentage is greater than six percent, we calculate the dollar amount paid beyond six percent of income. Furthermore, this disaggregated dataset allows for the aggregation of households along various dimensions in order to calculate affordability statistics for custom groups such as low-income households that rent their homes.

[17] U.S. Census Bureau. (2023). 2015-2019 American Community Survey 5-year data. Retrieved from IPUMS NHGIS, University of Minnesota.
[18] U.S. Energy Information Administration. 2015 Residential Energy Consumption Survey.
[19] U.S. Energy Information Administration. 2020 Residential Energy Consumption Survey.
[20] Electricity and natural gas prices are calculated by dividing reported residential sales by revenue as reported in forms EIA-861 and EIA-176 respectively.

3. Findings

3.1. Equity Screening and Demographics Near Power Plants

Populations living nearest to power plants face higher *per capita* health risks from air pollutant emissions than populations further away, and may also be exposed to additional health hazards through pollution in soil and groundwater. For example, on-site coal ash impoundments can lead to heavy metal contamination of nearby groundwater, posing a particular risk to those who use wells for drinking water. On-site heavy-duty equipment and trucks going to and from facilities may also contribute to environmental health exposures for these populations. Certain populations, such as those with high cumulative socioeconomic, health, or environmental burdens, may be particularly vulnerable to these exposures. Therefore, we analyze the populations living near each power plant to identify potential underlying risk factors in these populations.

We analyzed populations living within a three-mile radius of the Coyote, Big Stone, Astoria, Lake Preston, Jamestown, and Solway power plants. All except Jamestown are located in relatively rural areas or near small towns: 131, 950, 240, 611, 14,648, and 546 people live within three miles of each plant, respectively. We also looked at EJScreen socioeconomic and environmental indicators in these regions compared to the rest of the state, namely compared to North Dakota for Coyote and Jamestown; Minnesota for Solway; and South Dakota for Big Stone, Astoria, and Lake Preston.

The Coyote facility is located in a rural area of North Dakota near Beulah, supplied by a nearby coal mine. The nearby population does not have any particularly high EJScreen demographic indicators (e.g., percent of low-income populations) when compared to the rest of the state. The area does rank highly for various environmental pollutant exposures and sites, including 96th percentile for wastewater discharge, 89th percentile for air toxics cancer risk, 75th percentile for air toxics respiratory risk, and 87th percentile for ozone. The coal plant and nearby mine are likely contributing to relatively high cumulative environmental burdens in the area.

The Big Stone power plant near Big Stone, South Dakota, sits right on the Minnesota border. The 950 people living within three miles have a larger share of elderly people (94th percentile) and those without a high school education (86th percentile) than the rest of the state. The area ranks in the 95th percentile for $PM_{2.5}$, 96th percentile for air toxics cancer risk, and 75th percentile for air toxics respiratory risk, suggesting that this region also may have high cumulative environmental burdens, particularly for air quality.

Astoria Station, also located in a relatively rural area of South Dakota, has 240 people living within three miles. This population does not have any demographic indicators that rank highly compared to the rest of the state, but the region ranks in the 82nd percentile for $PM_{2.5}$, 75th percentile for air toxics, and 82nd percentile for lead paint exposure. These metrics suggest that it may be worth evaluating the plant in the context of cumulative environmental burdens on nearby populations.

Jamestown is an oil peaker plant that came online in 1976 in Jamestown, North Dakota. Of all of Otter Tail's facilities, it has the most people living within three miles. This population does not rank above the 75th percentile for any demographic indicators but ranks in the 96th percentile for proximity to facilities with risk management plans, 89th percentile for air toxics cancer risk, and 75th percentile for air toxics respiratory risk.

Lake Preston is an oil peaker that came online in 1978 in Lake Preston, South Dakota. It ranks above the 85th percentile for the over-64 population, 79th percentile for lead paint presence, and 75th percentile for air toxics respiratory risk.

Solway is a 2003 combustion turbine plant that runs primarily on natural gas with fuel oil backup near Solway, Minnesota. 546 people live within three miles of the facility and they rank in the 76th percentile for low-income populations.

Collectively, the populations nearest Otter Tail's plants rank relatively low on demographic indicators except for the over-64 population (who may be particularly vulnerable to air pollution), and the low-income population near Solway, yet many of the plants run the risk of adding to cumulative environmental burdens that nearby residents face.

3.2. Power Plant Health Impact Modeling

3.2.1. Baseline 2020 Coal Plant Air Pollutant Emissions

As described above, we used 2020 emissions data from the National Emissions Inventory (NEI) and 2020 electricity generation from the Energy Information Administration (EIA) to establish each plant's historical emissions and to calculate emission factors for each facility. We report both the *total* emissions and the *rate* of emissions in **Table 1** and **Table 2**, respectively. For both plants, we report total emissions, even though Otter Tail only owns portions of each plant.

Table 1. 2020 annual coal power plant emissions and electricity generation. Emissions for both plants are reported for *total* generation, although we note that Otter Tail only owns portions of each.

Plant Name	Primary Fuel	Generation	Carbon Dioxide (CO_2)	Nitrogen Oxides (NO_x)	Sulfur Dioxide (SO_2)	Particulate Matter ($PM_{2.5}$)	Volatile Organic Compounds (VOCs)
		MWh	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Coyote	Coal	2,380,100	2,910,800	5,884	11,975	453	68.9
Big Stone	Coal	1,648,200	2,076,700	785	664	23.2	62.8

Table 2. 2020 annual average coal power plant emissions rates.

Plant Name	Generation	Carbon Dioxide (CO_2)	Nitrogen Oxides (NO_x)	Sulfur Dioxide (SO_2)	Particulate Matter ($PM_{2.5}$)	Volatile Organic Compounds (VOCs)
	MWh	*Tons/MWh*	*Lbs/MWh*	*Lbs/MWh*	*Lbs/MWh*	*Lbs/MWh*
Coyote	2,380,100	1.22	4.94	10.06	0.38	0.06
Big Stone	1,648,200	1.26	0.95	0.81	0.03	0.08

In 2020, Coyote emitted significantly more NO_x, SO_2, and $PM_{2.5}$ than Big Stone—nearly 20 times more for SO_2 and $PM_{2.5}$—even though it generated only 44 percent more electricity in the same time frame. **Table 2** illustrates why: Coyote emits significantly more of these pollutants for every MWh of electricity generation. It burns lignite coal, which is the lowest grade of coal and has the lowest energy content per unit of mass, requiring more coal to be burned to generate the same amount of electricity as hard coal, such as anthracite or subbituminous (the latter of which is used in Big Stone). Lignite also tends to have higher amounts of sulfur and ash content than other types of coal, meaning that it also leads to more pollution per MWh generated than harder coals.[21] These two facilities may also have different emissions controls installed.

[21] Health and Environmental Alliance. (2018). Lignite Coal - health effects and recommendations from the health sector.

3.2.2. Coal Power Plant Baseline Health Impacts

We estimate $PM_{2.5}$-related health impacts associated with Otter Tail's 2023 generation, i.e., health impacts that can be ascribed to Otter Tail's share of operation, in
Table 3. Using COBRA, we estimate that Coyote contributes 39 $PM_{2.5}$-related mortalities in 2023, compared to approximately 3 $PM_{2.5}$-related mortalities for Big Stone the same year. These figures only account for Otter Tail's share of generation at each plant (35 percent ownership share for Coyote and 54 percent ownership share for Big Stone). We note that these values are in line with the Clean Air Task Force's *Toll from Coal* project, which estimates 68 and 4 premature mortalities in 2019 from the *total* generation of Coyote and Big Stone, respectively.[22]

Table 3. Estimated annual 2023 coal power plant $PM_{2.5}$-related health impacts. Health impacts are for a single year and estimated based on 2020 emission factors and Otter Tail Power's share of 2023 generation from each plant as estimated in Otter Tail Power's Supplemental Resource Plan and modeled in COBRA.[23]

Plant Name	**Otter Tail Share of Generation** (MWh)	**Mortality** (high est.)	**Upper Respiratory Symptoms**	**Respiratory Hospital Admits**	**Nonfatal Heart Attacks** (high est.)	**Infant Mortality**	**Total Health Impacts ($)**[24]
Coyote	1,099,200	38.7	402.3	4.2	17.6	0.09	429,358,700
Big Stone	1,707,300	2.9	30.5	0.3	1.3	0.007	33,565,100

3.2.3. Scenario-Based Coal Plant Health Impacts

Otter Tail originally proposed to withdraw from ownership of Coyote Station at the end of 2028 and to continue operations at Big Stone through 2046. The Supplemental Plan revises this plan to keep the Coyote Station online until 2040 unless major unexpected infrastructure investments are required, but still continues Big Stone operations through 2046. The Clean Energy Organizations (CEO) recommend that Otter Tail withdraw from Coyote at the end of 2028 and begin planning for a withdrawal from Big Stone at the end of 2030.

[22] Clean Air Task Force (2021). Toll from Coal.
[23] Coyote impacts only reflect the portion of power contracted for by Otter Tail, which we calculated by assigning emissions to Otter Tail based on the projected MWh of generation in the Preferred Plan and CEO Alternative Plan scenarios.
[24] Dollar values of health impacts are based on COBRA's 2017 US dollar value. Adjusted for inflation, these impacts are likely valued higher in 2023.

In **Table 4,** we provide the cumulative $PM_{2.5}$-related health impacts of the Coyote and Big Stone separately for these scenarios. Our modeling shows that Otter Tail's revised Supplemental Plan is associated with 710 premature mortalities between 2023-2046. We estimate that cumulative mortalities between 2023 and 2040 associated with Otter Tail's share of Coyote would fall from 675 to 215 if Otter Tail exited Coyote in 2028 rather than 2040—avoiding 461 $PM_{2.5}$-related premature mortalities and over $5.2 billion[25] in health damages. Additionally, under the CEO Preferred Plan, where Otter Tail exits Big Stone in 2030 instead of 2046, would avoid an additional 18 $PM_{2.5}$-related mortalities and save up to $186 million. In total, the CEO Preferred Plan, which exits Coyote in 2028 (rather than 2040) and Big Stone in 2030 (rather than 2046), would avoid 478 $PM_{2.5}$-related premature mortalities and save approximately $5.4 billion in health damages between 2023-2046.

Table 4. Cumulative coal power plant $PM_{2.5}$-related health impacts in each scenario. Health impacts are modeled in COBRA. The "2028 Plan" scenario refers to the plan where OTP exits Coyote in 2028, and the "2040 Plan" scenario refers to the plan where OTP Coyote exits Coyote in 2040. (There is only a small difference in the operation of Big Stone between the two scenarios.) The "CEO Preferred Plan" refers to the scenario in which OTP exits Coyote in 2028 and Big Stone in 2030. (The health impacts of Coyote in the CEO Preferred Plan are the same as in the "2028 Plan" scenario.)

Plant Name (Modeled Years)	Scenario	Mortality (high est.)	Upper Respiratory Symptoms	Respiratory Hospital Admits	Nonfatal Heart Attacks (high est.)	Total Health Impacts ($)
Coyote (2023-2028)	**2028 Plan (CEO Preferred Plan)**	215	2,299	24.3	100.6	2,417,448,600
Coyote (2023-2040)	**2040 Plan**	675	7,105	76.9	313.7	7,674,237,700
Big Stone (2023 - 2046)	**2028 Plan**	36	376	4.2	16.9	410,846,000
Big Stone (2023 - 2046)	**2040 Plan**	35	369	4.1	16.5	400,377,700
Big Stone (2023-2030)	**CEO Preferred Plan**	17	172	1.9	7.7	185,903,300

[25] Health impact dollar values based on 2017 valuation, and are likely valued higher in 2023.

The magnitude of these health savings are shown in **Figure 1**, represented in both dollar savings (top) as well as mortality impacts (bottom). Health impacts ($) are calculated within COBRA and reflect, in part, COBRA's dollar valuation for the Value of a Statistical Life (roughly $10 million for a healthy life in 2017 dollars).

Figure 1: Total health impacts (top) and mortality (bottom) by power plant for Otter Tail's coal plants. See Table 4 caption for a description of the scenarios.

While Otter Tail does consider some externality values within its assessment, these are limited and do not reflect the scale of environmental and social costs of its fossil fuel plants. Namely, Otter Tail only assigns an externality cost value to the CO_2 emissions from power plants in Minnesota, of which it only has one (Solway), and does not assign an externality cost value to criteria pollutants from power plants 200 miles or more from the Minnesota border, which excludes Coyote. While these values may reflect specified reporting requirements for each state, they paint an incomplete picture of the environmental and social costs of OTP's resource decisions. Further, Otter Tail's externality values do not fully address the impacts of OTP's decisions within Minnesota because of the long-distance transport of air pollutants, as we illustrate in the next section.

3.2.4. Spatial Distribution of Coal Plant Health Impacts

We used InMAP to evaluate the *distribution* of health impacts associated with the operation of Coyote and Big Stone. **Figure 2** maps the total health impacts of Coyote (top) and Big Stone (bottom) in dollars. The impacts from both extend across multiple states, in particular downwind to the east of each facility. Impacts are particularly high in population centers since a larger number of people are exposed to the polluted air.

Figure 2. Annual total $PM_{2.5}$ public health impacts of each of Otter Tail Power's coal plants. Values are given in 2017 dollars. The location of each plant is shown as a red dot. Health impacts were only evaluated in the contiguous U.S. Grid cells outside of the U.S. are shown as zero. Maps are from InMAP model runs using estimated emissions for 2023 (**Section 2.2**) and include only mortality as a health outcome and do not include a discount rate in the economic valuation.

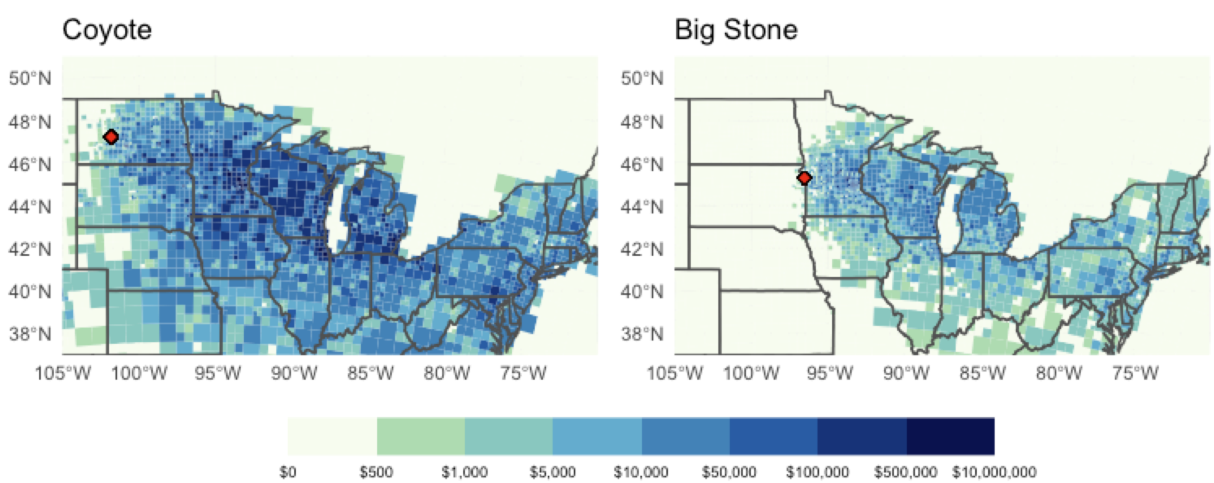
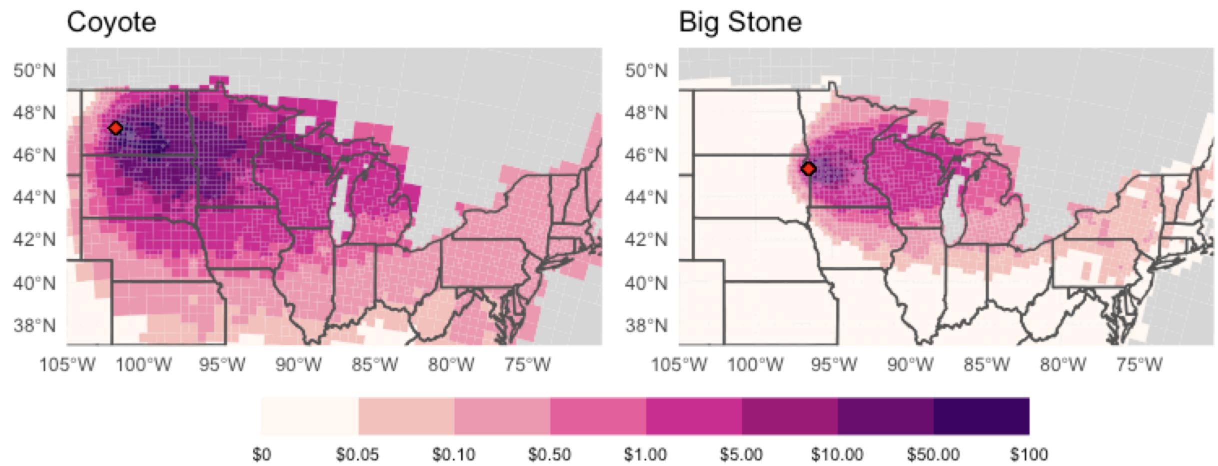


Figure 3 maps the *per capita* health impacts of each plant. While total impacts tend to be more concentrated in population centers, as noted, the *per capita* impacts are highest near to the emitting facility. These maps show the disproportionate impacts of these plants on nearby populations, even though the total number of people living in close proximity to each facility is low.

Figure 3. Annual per capita $PM_{2.5}$ public health impacts of Big Stone and Coyote. Values are given in 2017 dollars per person. The location of each plant is shown as a red dot. Health impacts were only evaluated in the contiguous U.S. Grid cells. Cells outside of the U.S. are shaded in gray. Maps are from InMAP model runs using estimated emissions for 2023 (**Section 2.2**). The analysis only included mortality as a health outcome and did not include a discount rate in the economic valuation.



In **Table 5**, we provide the per-capita health impacts by race and ethnicity. Both plants impact White and Native populations more than the overall population, and, in particular, Coyote emissions lead to 2.6 times more $PM_{2.5}$-related mortalities for Native populations than for the overall population.

Table 5. Annual per capita coal plant health impacts by race and ethnicity. Data are from InMAP model runs and use estimated emissions for 2023 (**Section 2.2**). The analysis included only mortality as a health outcome and did not include a discount rate in the economic valuation (in 2017 dollars).

Plant Name	**Black** *$/100 people*	**Latino** *$/100 people*	**Native** *$/100 people*	**Asian** *$/100 people*	**White** *$/100 people*	**Overall** *$/100 people*
Coyote	17.5	12.4	93.7	20.1	47	36
Big Stone	5.8	3.9	12.4	8.5	15	11.5

3.2.5. Power Plant Environmental Health Hazards

It can be difficult to assess the public health impacts of certain environmental health exposures due to limitations such as lack of data and complex modeling requirements.

Instead, we characterize these environmental health hazards based on available data. In this section, we look at groundwater monitoring near coal ash impoundments and power plant regulatory violations as indicators of potential environmental health risks to nearby communities.

Measurements of heavy metals at groundwater monitoring wells near the coal ash impoundments at the Big Stone power plant from 2016 to 2017 showed exceedances of federal advisory levels at all 15 wells. The pollutant exceedances include arsenic, boron, cobalt, lead, lithium, molybdenum, radium, and sulfate.[26] The facility released between 314,000 and 650,000 pounds of toxic chemicals on site each year from 2017-2021, largely on land. The EPA gives the highest risk-screening environmental score (RSEI) to its disposal of barium compounds.[27] Measurements of heavy metals at the groundwater monitoring wells at Coyote found that 24 out of 25 wells reported exceedances of federal advisory levels between 2010 and 2017. These included exceedances for sulfate, manganese, lithium, cobalt, selenium, boron, arsenic, nitrate, and lead.[28] Coyote released 619,000-1,455,000 pounds of toxic chemicals on site per year between 2017 and 2021, almost entirely on land. EPA reports RSEI scores much higher than for Big Stone, and these are largely associated with mercury (developmental and neurological impacts), arsenic (cancer, cardiovascular, neurological, and other impacts), and chromium compounds (cancer, gastrointestinal, hematological, and respiratory impacts).[29] These releases and groundwater exceedances may pose potential risks to nearby communities through soil and groundwater contamination. While early retirement of these plants would reduce on-site pollutant disposal, the existing waste levels suggest the need for careful monitoring and cleanup after facility retirement as well.

Coyote Station had two-quarters of noncompliance with the Clean Water Act in the last twelve quarters. Its compliance with the Resource Conservation and Recovery Act (RCRA) has not been recorded since 1993.[30] Big Stone power plant reports three Clean Air Act violations in the last twelve quarters, and none of RCRA, which also has not been monitored since 2002.[31] Astoria reports no violations.[32]

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[26] Environmental Integrity Project (2023). Ashtracker: Big Stone Plant.
[27] U.S. Environmental Protection Agency. (2023, July 25). Toxics Release Inventory.
[28] Environmental Integrity Project (2023). Ashtracker: Coyote Station.
[29] U.S. Environmental Protection Agency. (2023, July 25). Toxics Release Inventory.
[30] U.S. Environmental Protection Agency. (2023). Enforcement and Compliance History Online: Otter Tail Power Co Coyote Station.
[31] U.S. Environmental Protection Agency. (2023). Enforcement and Compliance History Online: Big Stone Power Plant - Otter Tail Power.
[32] U.S. Environmental Protection Agency. (2023). Enforcement and Compliance History Online: Otter Tail Power Company - Astoria Station.

3.2.6. Peaker Plants

OTP relies on a number of peaker facilities, including a number of very old oil-burning plants, to meet its peak demand. Within the Supplemental Plan, OTP is proposing to add five days of on-site LNG storage to its 245 MW Astoria peaking power plant. The company states LNG storage would improve reliability by adding security to the plant's fuel supply during potential disruptions, and could be used as a cost-saving measure during periods of high gas prices.

In Table 3-8, OTP compares the reliability of different resource options, including fossil fuel facilities and solar and wind, but it omits another option: adding energy storage to the Astoria site. We do not have sufficient data to know exactly what peak demand needs look like (e.g. duration and frequency) in Otter Tail territory, but it would behoove Otter Tail to model the addition of battery storage at the Astoria site for increased energy security and reliability. A second alternative would be to aggregate distributed energy storage throughout the communities where it supplies electricity, which could help meet peak needs while also enabling resilience at individual homes, community centers, critical facilities, and businesses in the case of an outage. Such storage would be flexible and enable different uses in the future (e.g., incorporating additional renewable resources and providing additional capacity value moving forward), which may be of particular value as cooling needs increase in a warming climate.

Currently, OTP plans to retire Jamestown and Lake Preston by 2033. It is worth exploring energy storage (utility-scale or distributed), as well as renewables, demand response, and other clean portfolio resources, as options for replacing these aging, high-emission, and inefficient plants. An example of this kind of replacement can be seen in Oakland, California, where an aging oil peaker recently retired and is being replaced with 36 MW of on-site storage, taking advantage of existing transmission and interconnections;[33] and an additional 500 kW of solar and storage capacity distributed in the surrounding community.[34]

Using oil as a fuel is typically considered both expensive and environmentally unfriendly. The health-damaging air pollutant emissions are higher for fuel oil than for gas, potentially adding a health risk to nearby communities. According to Figure 20 (Appendix F), Lake Preston and Jameston have heat rates at a maximum of 15,300-16,567 Btu/kWh, which is not only much less efficient than most gas-fired plants but also higher than the 2021 average for oil-fired

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[33] Power Technology. (2021, September 3). Vistra Energy-Oakland Power Plant - Battery Energy STorage System, US.

[34] Sunrun. (2019). Sunrun Solar and Battery Systems to Help Replace Retiring Oakland Power Plant.

plants of 11,223 Btu/kWh.[35] These plants also have higher variable operation and maintenance costs than the other OTP fossil fuel generators.

3.3. Measurements of Energy Affordability

Currently, energy costs are a persistent financial burden for low-income communities across the country. Energy affordability is increasingly viewed as a major equity concern by both policymakers and energy equity advocates.[36] Survey results from 2017 suggest that nearly a third of U.S. households struggle to pay their utility bills, and one in seven received a disconnection notice.[37] To investigate how to reduce these inequities due to high energy bills, we first estimate energy bills and quantify the financial strain they put on budgets for households across the OTP territory in Minnesota.[38]

Energy affordability is typically evaluated by calculating *energy cost burdens*: the percentage of household income spent on residential electricity and fuel use. Energy cost burdens in excess of six percent are typically considered high. The magnitude of affordability challenges can also be measured with the associated *energy affordability gap*: the total amount each household pays beyond six percent of their income. Furthermore, we estimate the *electricity affordability gap,* which only accounts for electricity costs. This gap uses the same six percent threshold for electrically heated homes but assumes a three percent threshold for fossil-fuel-heated homes, as electricity costs are typically around half of such household's total energy bills. These metrics have been shown to be a key indicator of energy insecurity[39] and thus help to identify households that experience undue financial burden due to their energy bills.

Low-income households tend to spend a larger fraction of their income on energy bills compared to other income groups because household incomes vary more widely than household energy consumption. This is true even though low-income households consume less energy per household on average.[40]

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[35] U.S. Energy Information Administration. (2023). Table 8.1 Average Operating Heat Rate for Selected Energy Sources.
[36] Drehobl A. and Ross L. Lifting the High Energy Burden in America's Largest Cities: How Energy Efficiency Can Improve Low Income and Underserved Communities. *American Council for an Energy-Efficient Economy (ACEEE). 2016.*
[37] U.S. Energy Information Administration. One in Three U.S. Households Faces a Challenge in Meeting Energy Needs. *Today in Energy,* September 19, 2018.
[38] We have adapted parts of this section from our report: Lukanov et al. (2022). Pathways to Energy Affordability in Colorado. *PSE Healthy Energy.*
[39] Hernández D. (2013). Energy Insecurity: A Framework for Understanding Energy, the Built Environment, and Health Among Vulnerable Populations in the Context of Climate Change. *American Journal of Public Health*, *103*(4), e32–e34.
[40] Krieger, E., Lukanov, B. et al. (2020). Equity-Focused Climate Strategies for Colorado: Socioeconomic and Environmental Health Dimensions of Decarbonization. *PSE Healthy Energy.*

A detailed analysis of existing energy cost burdens is thus important for identifying populations who may struggle to pay their energy bills and for developing policy strategies to improve affordability. To estimate the intersection of energy bills we use models based on geographic, demographic, housing-related, and climate variables to estimate energy use in a simulated portfolio of residential buildings across the Otter Tail Minnesota service area, as described in **Section 2**.

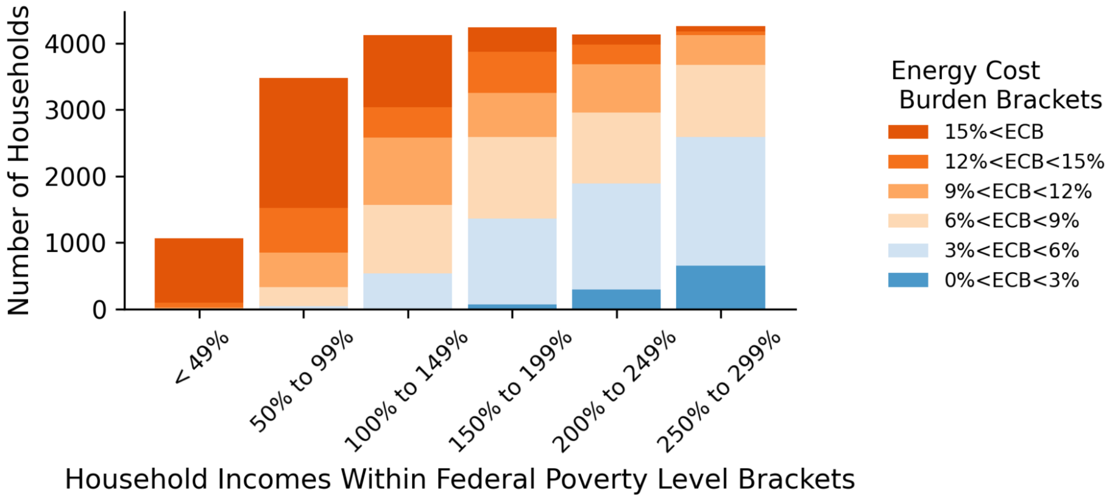
Here, we investigate the energy affordability metrics in relationship to geography, income, housing type, demographics, and other key variables. These factors provide insights into what kinds of policies and programs may help alleviate energy cost burdens, and where they might be most useful.

3.3.1. Energy Cost Burden Analysis Within the Otter Tail Territory in Minnesota

Households served by Otter Tail Power in Minnesota are more energy burdened on average than the rest of Minnesota. Roughly 35 percent of Otter Tail's customers are energy burdened compared to 25 percent of all customers in Minnesota. As we show below, this is due to multiple factors, including a greater reliance on expensive heating fuels, more single-family homes, and a colder climate. Factors such as these drive average annual household energy costs in Otter Tail to approximately $3,000, roughly 20 percent higher than the $2,500 average for Minnesota overall.

Within Minnesota, Otter Tail Power served approximately 50,000 residential customers. Of those, we estimate approximately 18,000 (36 percent) are energy-burdened, with cost burdens greater than six percent. Roughly 11,000 (60 percent) of those cost-burdened households earn incomes less than twice the Federal Poverty Level (FPL). **Figure 4** breaks down the distributions of energy cost-burdened households within income brackets defined by the FPL. Nearly all households earning less than the FPL are beyond the six percent threshold, and most households between one and two times the FPL are also beyond the six percent threshold, but to a lesser degree.

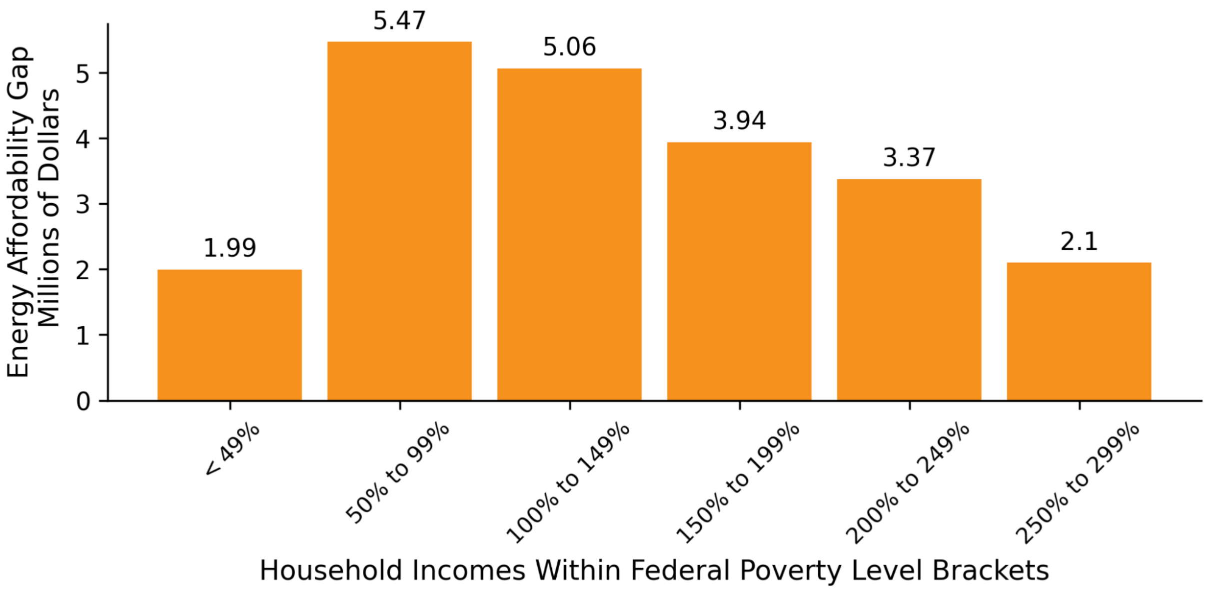
Figure 4. Energy cost burden distributions by income group.



The cumulative energy affordability gap metric for these same income brackets is shown in **Figure 5**. As expected, the gap decreases in higher-income groups because burdens are not as high. We estimate that the total energy affordability gap for Otter Tail's Minnesota customer base is roughly $26 million. This sum is the same as the bill assistance that would be required to pay all energy bills down to the six percent affordability threshold and far exceeds the amount available from such programs. For example, the largest source of funding for bill assistance is the Low Income Home Energy Assistance Program (LIHEAP) which allocated $128 million for all of Minnesota in 2023.[41] This amount divided equally across all Minnesota households is just $3 million for OTP's Minnesota customers, approximately 11 percent of the bill assistance needed in 2021.

[41] U.S Department of Health and Human Services. LIHEAP First Funding Release of FY 2023.

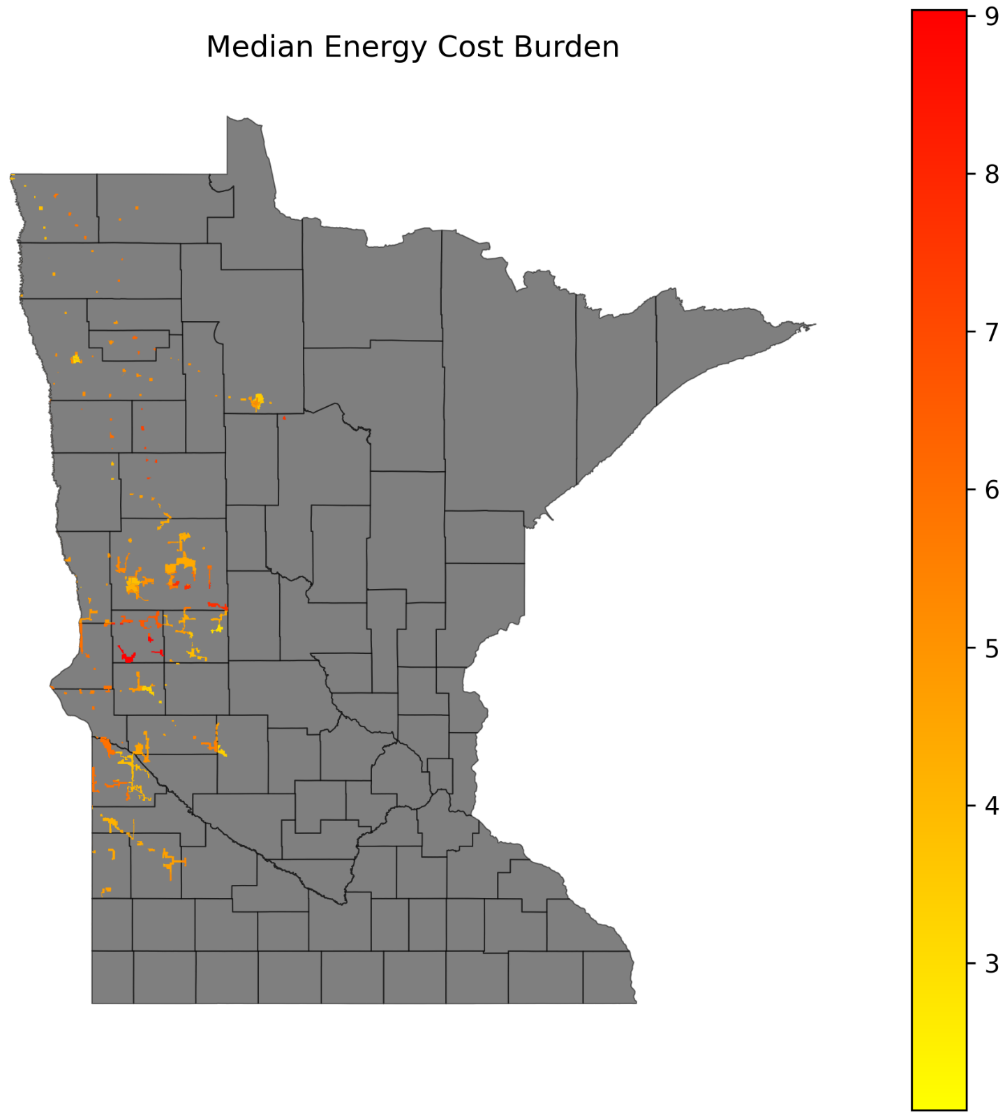
Figure 5. Total energy affordability gap for Otter Tail Minnesota by income group.



We additionally report the electricity affordability gap for OTP Minnesota customers of $10 million. While the *total* affordability gap is more relevant to household incomes, the *electricity* affordability gap represents only electricity costs and thus is more directly relevant to electric utility decision-making.

These burdened households are not distributed equally across the Otter Tail Minnesota service area. Certain areas have the highest median cost burdens, as shown in the map of cost burdens at the tract scale in **Figure 6**.

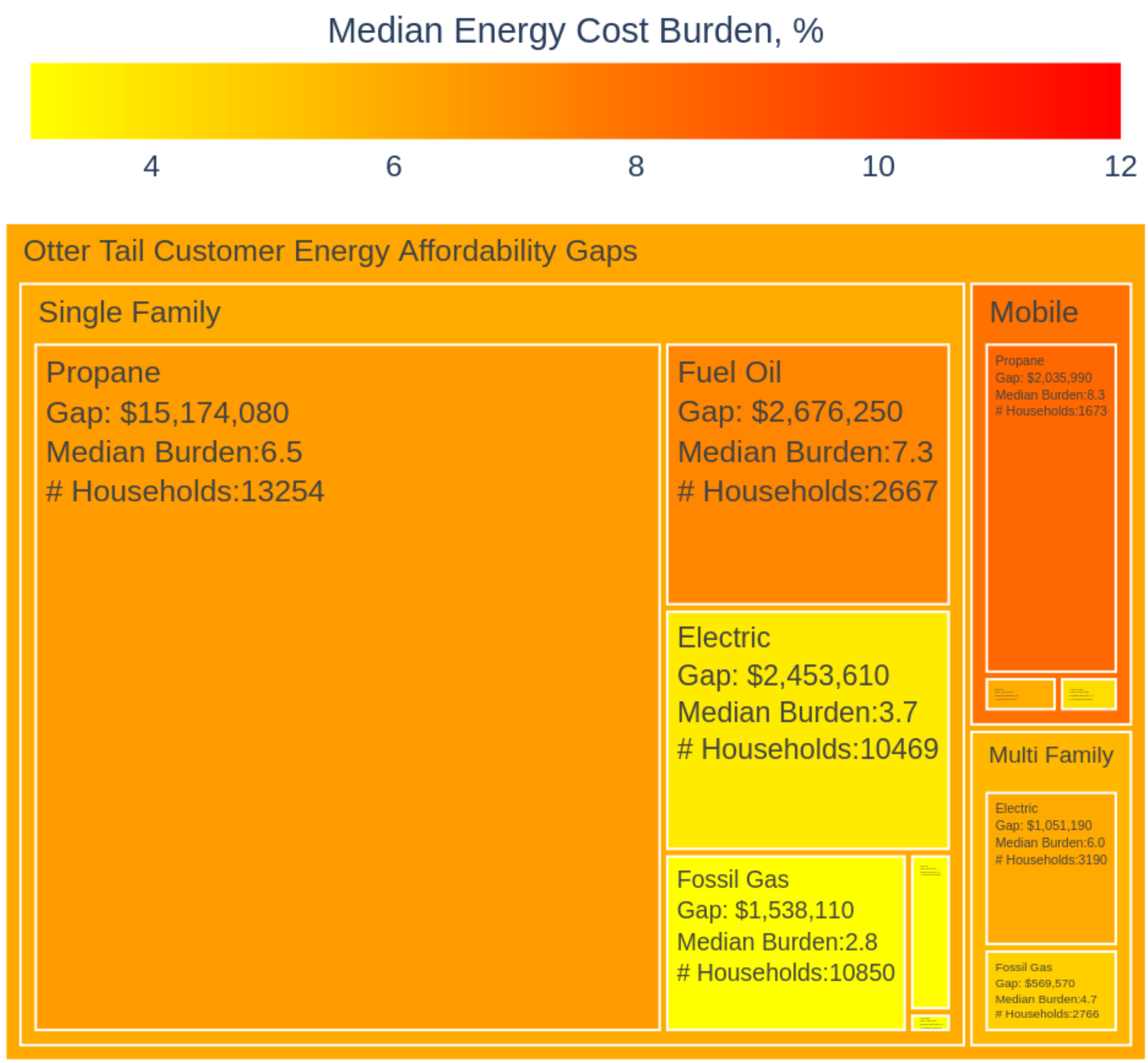
Figure 6. Median energy cost burdens in Otter Tail's Minnesota service territory.



3.3.2. Affordability Dependence on Home Attributes

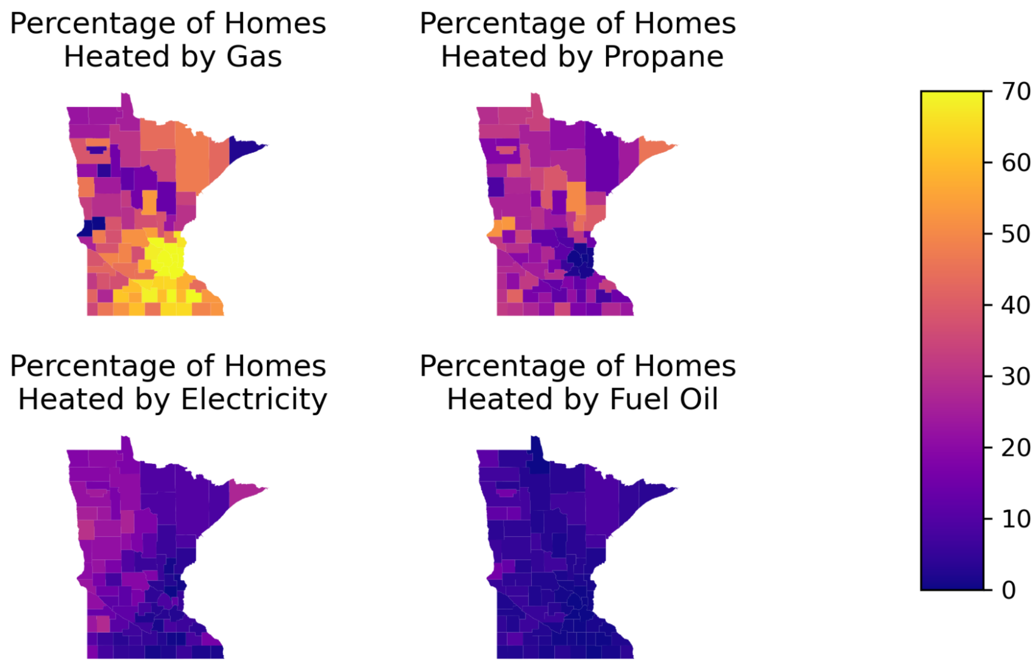
Two of the strongest indicators for unaffordable energy bills are the type of home and the type of fuel used to heat the home. Shown in **Figure 7** are the total energy affordability gaps and energy burdens broken down by home type and the fuel used for space heating. The areas of the rectangles are proportional to the cumulative energy affordability gap for households in that category, and the color shadings represent their median cost burden. As an example, we see that propane-heated single-family homes have the greatest cumulative gap of roughly $15 million because there are many such households within Otter Tail's service territory and because they have a high median cost burden of over six percent, as shown by their red-orange color.

Figure 7. Total Energy Affordability Gap within subsets of households.



The fuel used for space heating has an outsized contribution to energy cost since roughly half of an average household's annual energy bill in Otter Tail service territory is due to space heating. The fuel used for space heating also correlates with other end uses in the home, such as water heating. The average prices of electricity, fuel oil, propane, and natural gas in OTP's Minnesota service area in 2021 were 34, 23, 22, and 9.1 dollars per million BTU, respectively. **Figure 8** shows the percentages of homes in Minnesota that rely on each of these heating fuels. Through comparison with **Figure 7**, we see that Otter Tail customers live in areas with greater reliance on fuel oil, propane, or resistive electric heating and have higher cost burdens.

Figure 8. Map of fuel used for space heating in Minnesota.



We additionally note that home ownership status should be an essential consideration for programs aimed at reducing home energy bills, as most renter-occupied homes suffer from the split incentive problem in which tenants are responsible for energy bills while landlords are responsible for home improvements. The majority (72 percent) of OTP's customers in Minnesota live in owner-occupied housing. However, for low- and moderate-income households, the proportion of home ownership drops to approximately half. Thus, to effectively serve low- and moderate-income households, energy affordability programs must be designed to address both owner and renter-occupied homes.

3.3.3. Potential for Bill and Energy Savings for Low-Income Households

While energy bill assistance can help alleviate energy poverty in the short term, the most sustainable approach to reducing cost burdens is by reducing energy bills. Here, we will consider potential and ongoing approaches pursued by OTP regarding weatherization, appliance efficiency, heat pumps, distributed solar, and demand response. These programs can play an important role in resource planning through their impact on load and peak demand forecasting. The Minnesota Public Utilities Commission has recently recognized the benefits of modeling "bundles" of energy efficiency and distributed energy resources as selectable resources in capacity expansion modeling, which can allow planners to evaluate to what extent demand-side resources can reduce the need for new peaking power plants, for example.[42]

3.3.3.1. Weatherization and Efficiency

We estimate approximately 45 percent of household energy bills in the OTP's Minnesota territory are driven by heating, with another five percent spent on cooling. Data from the EPA estimates weatherization through sealing and insulating homes saves households, on average, 15 percent of their heating and cooling bills.[43] We calculate that OTP's low- and moderate-income customers in Minnesota spend approximately $1,500 on heating, which translates to weatherization, providing annual average savings for households of $225. In addition to these annual bill savings, a Department of Energy report[44] studying the Weatherization Assistance Program estimates the one-time "total health and household-related benefits for each unit is $14,148." In addition to weatherization, appliances such as refrigerators and water heaters can be made more efficient.

Fortunately, OTP provides upfront rebates for many of these upgrades. Alongside upcoming grants from the Inflation Reduction Act, we expect the vast majority of the improvements will be subsidized for low-income households. The HEEHRA program provides one hundred percent rebates for efficient electrification of up to $14,000 for households with less than 80 percent of the area median income and fifty percent rebates for those with incomes between 80 and 150 of the area median income.[45] These investments will help guarantee that households making such investments will get to keep most or all of the resulting bill savings in addition to offsetting the need to replace old technologies. The challenge, then, is to ensure that low-income households are aware of these benefits and that pathways exist for those who rent their homes to also gain access to these upgrades.

3.3.3.2. Cold Weather Heat Pumps

A rapidly growing technology is the use of cold-weather (or "cold-climate") heat pumps. According to the 2020 RECS survey, there are statistically insignificant numbers of homes

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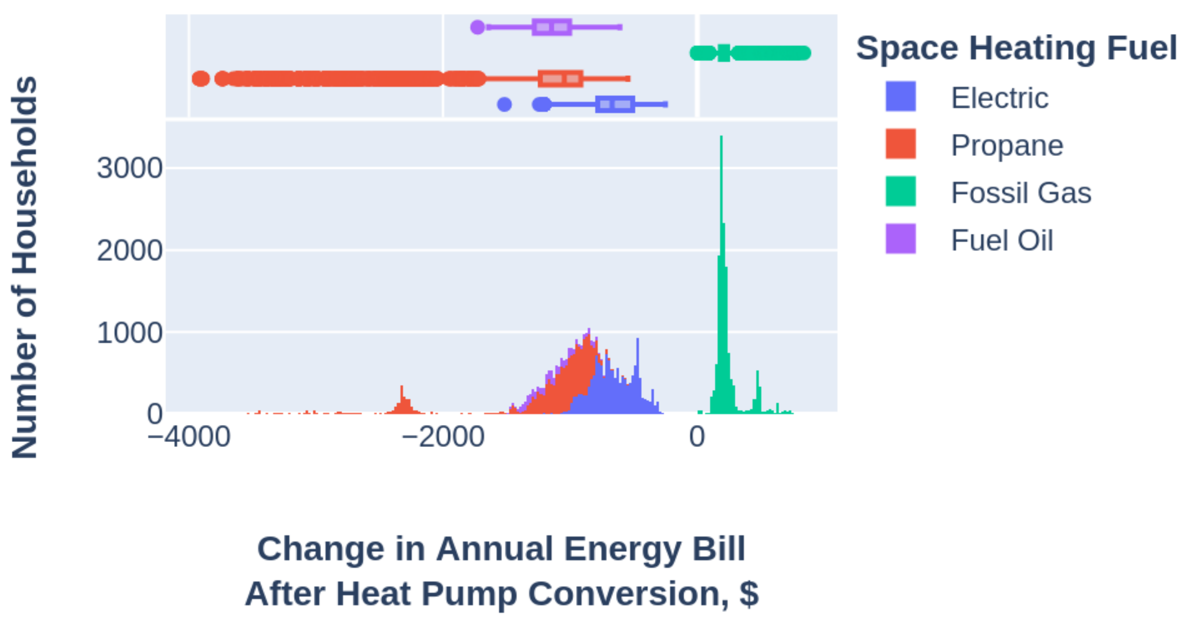
[42] Minnesota PUC, Order Approving Plan with Modifications and Establishing Requirements for Future Filings, April 15, 2022, Docket No. E002/RP-19-368
[43] Energy Star. (2023). Methodology for Estimated Energy Savings.
[44] U.S. Department of Energy. (2018). Weatherization Assistance Program Fact Sheet.
[45] Rewiring America. (2023). High-Efficiency Electric Home Rebate Act (HEEHRA) summary.

using efficient cold-weather heat pumps in Minnesota.[46] However, heat pumps are becoming more common nationwide, including in cold climates, as supported by that same survey. We assume conversion to a cold-weather heat pump results in average annual heating energy savings of 66 percent when replacing thermal heating sources and 60 percent when replacing resistive heating, which corresponds to a heat pump heating seasonal performance factor (HSPF2) of 8.5 and to efficiencies of 85 percent and 100 percent for thermal and electric resistive heating respectively.[47] Under these assumptions, we see annual energy bills for electric-, fuel oil-, and propane-heated homes decreasing by $650, $1,100, and $1,200 while natural gas-heated homes increase energy bills by $200, as shown in **Figure 9**. The amount saved is dependent on the price of fuels[48] and how much a home consumed previously. For example, homes heated by resistive electric heating tend to be smaller and thus save less overall despite saving more proportionally. Many homes may see a greater bill decrease if their current technology is old and inefficient, if they use a dual fuel system, or if an inefficient air conditioner is being replaced, as these effects were not included in this calculation.

Figure 9: Changes in annual energy bill after heat pump conversion. Negative values represent bill savings.



[46] U.S. Energy Information Administration. (March, 2023). 2020 Residential Energy Consumption Survey.
[47] These assumptions are roughly in line with those of the State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs. (2023).
[48] As mentioned above, we use energy prices from 2021 of $34, $23, $22, and $9 per MMBTU for electricity, fuel oil, propane, and natural gas respectively.

In addition to reducing heating bills, heat pumps are also used for cooling. Roughly 94 percent of Minnesotans currently use air-conditioning.[49] Homes whose air conditioning is upgraded to efficient heat pumps will, on average, also decrease cooling bills as modern inverter-based heat pumps are more efficient than the vast majority of air-conditioning units currently in use. Moreover, if homes switch from window AC units to a central heat pump system, they will be eligible to participate in cooling demand response programs, which would provide OTP with more summer peak shaving capacity while also providing bill savings to customers.

The Minnesota Energy Conservation and Optimization (ECO) Act[50] sets a limit of 0.35 percent for utility spending on energy fuel switching programs such as conversions to heat pumps. OTP's ECO Plan[51] aims to nearly maximize that spending cap at 87 percent. However, they allocate just 32 percent of that spending towards residential heat pumps, with the remainder used for commercial buildings and EV charging. Increased spending on heat pump conversions for the low-income households that are most burdened by heating bills due to expensive fuels such as propane would have greater improvements in energy affordability.

We further note that electrification can provide health benefits. The electrification of household appliances located within living spaces, such as gas stoves and ovens, can also eliminate combustion-related emissions that contribute to poor indoor air quality and increased health risks. Studies have shown that the 1-hr national ambient air quality standard for NO_2 (100 ppb) can be exceeded within minutes of gas stove usage, particularly in small kitchens with poor ventilation.[52,53] Leakage from gas stoves and ovens not in use can also result in concentrations of benzene (a known carcinogen) exceeding the California EPA 8-hour and chronic reference exposure level and, in some cases, comparable to tobacco smoke.[54] Roughly one-eighth of childhood asthma in the United States may be attributable to the use of gas stoves.[55]

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[49] U.S. Energy Information Administration. (March, 2023). 2020 Residential Energy Consumption Survey.
[50] Minn. Laws Ch. 29, § 2 (2021).
[51]Otter Tail Power Company. 2024-2026 Energy Conservation and Optimization Triennial Plan. Docket No. E017/CIP-23-94
[52] Lebel, E. D., Finnegan, C. J., Ouyang, Z., & Jackson, R. B. (2022). Methane and NO x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes. Environmental Science & Technology, 56(4), 2529–2539.
[53] Singer, B. C., Pass, R. Z., Delp, W. W., Lorenzetti, D. M., & Maddalena, R. L. (2017). Pollutant concentrations and emission rates from natural gas cooking burners without and with range hood exhaust in nine California homes. Building and Environment, 122, 215–229.
[54] Lebel, E. D., Michanowicz, D. R., Bilsback, K. R., Hill, L. L., Goldman, J. S. W., Domen, J. K., Jaeger, J. M., Ruiz, A., & Shonkoff, S. B. C. (2022). Composition, Emissions, and Air Quality Impacts of Hazardous Air Pollutants in Unburned Natural Gas from Residential Stoves in California. Environmental Science & Technology.
[55] Gruenwald, T., Seals, B. A., Knibbs, L. D., & Hosgood, H. D. (2023). Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States. International Journal of Environmental Research and Public Health, 20(1), Article 1.

3.3.3.3. Demand Response

Demand response programs can be an excellent way for households to reduce their energy bills while also helping the grid. OTP's Energy Control program allows the utility to temporarily switch off appliances and turn down HVAC equipment in participating premises during times of peak demand. According to OTP, customers enrolled in residential energy control pay a rate that's about 25 percent lower than standard.[56] This is an excellent amount of savings and a program that can benefit all stakeholders. Enrollment into these programs may be more difficult for low-income households as they rent their homes or may not be aware of the existence or benefits of such programs. For example, some programs require the installation of hardware into a home, which is more difficult for a renter-occupied household. As such, outreach is needed to ensure that energy-cost-burdened households are able to enroll in these demand response programs.

3.3.3.4. Distributed Solar

The last resource we consider to reduce energy bills is rooftop or community solar. Community solar is useful for households that do not own their own rooftops but wish to experience the benefits of owning solar. Unlike energy efficiency and demand response, where rebates and programs are readily available, OTP does not have significant options or uptake of distributed solar. However, there are models for community-oriented solar in the region. For example, a community solar project in Duluth is experimenting with building solar for financial assistance for low-income households and a future resilience center that will provide energy even in cases of disasters or outages.[57] Community solar helps to reduce power bills. The Department of Energy aims to increase the percentage bill savings of community solar from 10 percent to 20 percent, and a low-income community solar pilot in Illinois guarantees bill savings of 50 percent for low-income customers.[58] Moreover, time-of-use rates already exist for Otter Tail, with higher rates in the daytime when solar is the strongest, which can increase bill savings with solar. With the continued decrease in costs of solar, developing solar programs for lower-income and/or energy-burdened households may be a viable pathway to decrease energy bills.

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[56] Otter Tail Power Company. (September, 2023). Residential Demand Control.
[57] Clean Energy States Alliance (2023). Strengthening a Minnesota Community with Solar and Resilience.
[58] Energy News Network. (August, 2023). Department of Energy looks to Illinois to lead on low-income community solar.

3.3.4. Implications of Energy Cost Burden Interventions for the Preferred Plan

The interventions described above can serve to reduce energy poverty within OTP's service territory. For some households, we estimate that the energy interventions described above could provide annual bill savings of over $1,500 every year, with an average savings of $1,000 per year for currently cost-burdened customers who have not performed these bill-reducing measures. For context, nationwide, about 35 percent of all households would struggle to pay an unexpected $400 bill, less than half the average potential bill savings that could typically be achieved.[59] Some of these affordability measures are already reflected in the Plan, but not others. We discuss each resource in reference to OTP below:

- **Energy Efficiency:** Otter Tail has a strong record of energy efficiency programs and, in its most recent Conservation Improvement Program triennial plan, proposes an energy savings goal of 3.0 percent of annual sales.[60] Prioritizing energy efficiency investments in low-income households would have significant affordability benefits. However, the level of residential savings varies significantly by state. In Minnesota, residential customers account for 22 percent of demand but actually receive 32 percent of incremental annual savings (Schedule 6, Part A). North Dakota residential households are 35 percent of the load, but we cannot find the percentage of efficiency savings for residential customers. In South Dakota, residential customers are 25 percent of the load (Schedule 4 Part A) but only receive 8 percent of incremental annual efficiency savings, suggesting that there is significant room to expand residential energy efficiency programs and achieve an even higher reduction in the percent of retail sales saved per year.

- **Demand Response:** Otter Tail has similarly deployed demand response across its customer classes, including residential. The current scale in Minnesota—16,745 enrolled residential customers—is slightly lower than the number of energy-burdened customers in the territory. Expanding its proven demand response programs to more of these low-income customers would increase the affordability benefits of these programs, and expand the demand-side capacity savings available. It would be especially impactful if the diverse demand response offerings accompany conversions to heat pump space heating. We recommend reporting the number of demand

[59] Board of Governors of the Federal Reserve System. (June, 2022). Economic Well-Being of U.S. Households in 2020 - May 2021.
[60] Otter Tail Power Company. (2023). 2024-2026 Energy Conservation and Optimization Triennial Plan. Docket No. E017/CIP-23-94.

response participants who are low-income to help ensure equitable access to these bill-reducing programs.

- **Distributed Solar:** Unlike efficiency and demand response, the number of residential net-metered customers in Otter Tail territory is negligible as of 2020: 24 total net-metered customers in its Minnesota territory, one in North Dakota (for wind), and one in South Dakota (also for wind).[61] Expanding distributed solar resources used in the Preferred Plan—including providing discounted virtually net-metered community solar—could help reduce energy cost burdens for low-income households. Coupling distributed solar with storage can provide additional resilience benefits for communities in the case of an outage—and help reduce peak demand.

- **Electrification:** Many of Otter Tail's Minnesota customers rely on expensive methods for heating their homes, contributing to high energy cost burdens. Electrification of these systems with efficient cold-climate air or ground source heat pumps can help reduce energy cost burdens, and Otter Tail is proposing to expand its incentives for heat pumps and other building electrification measures. This potential for electrification should be incorporated into Otter Tail's demand projections to ensure it will meet the electricity needs of these customers. Likewise, electrification programs should be coordinated with rate design and demand response offerings to ensure that Otter Tail can meet load growth in the most cost-effective way possible. We furthermore recommend that limited financial assistance in electrification be concentrated in the most energy-cost-burdened homes.

4. Key Findings

- **Coyote Station:** Otter Tail's 2028 withdrawal of ownership from the Coyote Station coal plant would avoid approximately 17-40 $PM_{2.5}$-related mortalities attributable to Otter Tail's energy production each year from 2029-2040. Emissions from Coyote disproportionately impact Native people, who experience 2.6 $PM_{2.5}$-related mortalities for every one mortality in the overall population. In comparison to this plan, the CEO Preferred Plan withdraws from Coyote twelve years earlier (2028) and ramps down the operation of Coyote before then—a scenario which reduces mortality impacts by an estimated 461 lives and mitigates a total of $5.2 billion dollars in health impacts. A 2028 withdrawal from Coyote would likely have benefits for Native people living downwind from the Coyote plant and reduce potential water and soil contamination for nearby communities.

[61] Schedule 7, part A.

- **Big Stone:** The continued operation of Big Stone from 2022-2046 is associated with 36 $PM_{2.5}$-related premature mortalities and $410 million in total health impacts. The 2030 exit of this facility, as outlined in the CEO Preferred Plan, would reduce total mortality impacts to 17 and total health impacts to $186 million due to improved air quality from 2030 onward.
- **Demand-Side Resources:** Otter Tail's proposed demand-side efficiency programs and forecasted energy savings are on par with some of the most successful utilities, and hold the potential to help reduce energy cost burdens as described above. However, in certain territories, such as South Dakota, the company should focus more of its efficiency efforts on residential programs. Furthermore, distributed solar, community solar, and electrification may all help reduce energy cost burdens, but Otter Tail has minimal deployment of these technologies in its territory. We recommend incorporating distributed solar resources, as well energy storage and electrification, more fully into planning. This can be done by modeling high electrification sensitivities and modeling bundles or portfolios of demand-side resources in its next resource plan. These resources may also help enable the retirement of the Otter Tails' aging oil-fired peaker plants and provide additional energy reliability in lieu of building up backup LNG storage at the Astoria facility.
- **Energy Affordability:** More than a third of OTP's customers in Minnesota struggle to pay their energy bills with energy cost burdens greater than six percent. This is due to energy bills that are, on average, 20 percent higher than the rest of Minnesota, leading to a need for $26 million in annual energy bill assistance for these customers, with $10 million needed for electricity bills alone, far less than the amount currently available through programs such as LIHEAP. Through demand-side investments for low-income Otter Tail customers, we estimate total annual household energy bills could be reduced by an average of $1000. As such, we recommend that OTP report their own estimates of these affordability metrics using customer data and model how programs aimed at low-income customers will bring down both the total and electric energy affordability gap.