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Health Impacts of Coal Plant Retirement: Lessons from a Health Impact Assessment of the New Madrid Power Plant in Southeastern Missouri

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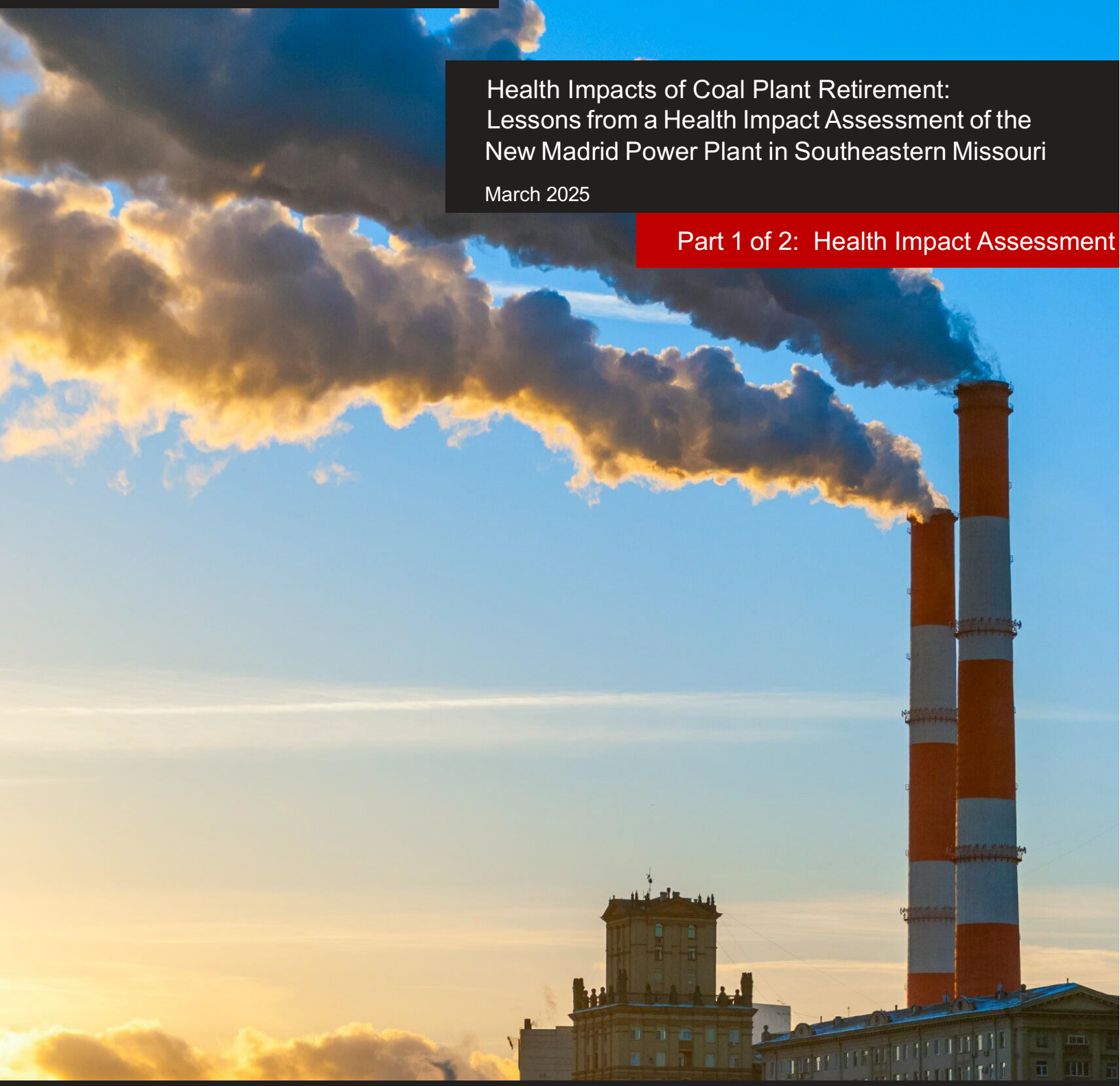
Part 1 of 2: Health Impact Assessment



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The Renewable Energy Transition in Rural America: A Policy & Action Lab (Fall 2024)

Health Impacts of Coal Plant Retirement:

Lessons from a Health Impact Assessment of the New Madrid Power Plant in Southeastern Missouri (Part 1 of two-part research HIA)

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Foreword

This two-part report is the result of a ten-week graduate-level course in Fall 2024, guided and funded by Stanford Law School, the Stanford University Center for Human and Planetary Health, and Stanford Medical School. The course, "Renewable Energy Transition in Rural America" (Law 809U / EBS 291 / PEDS 289), was led by Professor Lisa Patel (Medical School) and Professor Deborah Sivas (Law School), with support from Lecturer Luciana Herman (Law School), Education Adviser Katie Vogelheim (Human and Planetary Health), and Special Adviser in Public Health Kate Hoppe (Medical Society Consortium & CivicPoint Consulting).[1]

The first part of the report is a comprehensive health impact assessment for the New Madrid power plant. The second part of the report describes policy recommendations to shift the production of New Madrid power from fossil fuel to clean energy.

Importantly, the contents of this two-part report are student-produced and do not feature direct research by Stanford University faculty or staff. Furthermore, the research was conducted in Fall 2024, under Biden administration policies prior to the change in federal administrations.

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[1] The course description for "Rural Energy Transition in Rural America" (EBS 291, LAW 809U, PEDS 289) can be accessed at: Renewable Energy Transition in Rural America (809U) - Practicums 2024-2025 - Stanford Law School and is shown in Stanford Explore Courses at https://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&q=PEDS+289.

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Executive Summary

Project Overview

The Magnitude 7 Metals (Mag 7) aluminum plant was once a significant employer in Missouri's New Madrid County and contributed nearly one-third of national primary aluminum production. In January 2024, the plant closed. The community is interested in reviving aluminum production but has concerns about the potential health impacts of the Mag 7 smelter relying on electrical power generated by the New Madrid coal power plant, which has historically supplied the aluminum smelter's energy. To assess the potential health and economic impacts of closing the coal power plant and replacing its energy generation with clean power, Renew Missouri, a non-profit organization focused on advancing clean and affordable energy solutions across the state, has partnered with Stanford University Human and Planetary Health Action Lab and the Stanford Law & Policy Lab to conduct this Health Impact Assessment (HIA) with accompanying policy recommendations (Appendix A) and a mapping tool. The research partnership took place as a policy practicum, "Renewable Energy Transition in Rural America" (EBS 291/LAW 809U/PEDS 289) in Fall 2024.[1]

Findings

This HIA finds significant health and economic costs associated with the New Madrid Coal Plant. Under current operating conditions, the plant is responsible for nearly all (98%) of the county's nitrous oxide emissions, 89% of nitrogen oxides, and 88% of carbon dioxide emissions. Its significant sulfur oxide emissions also exceed national standards by 400%, making the county the only one in Missouri to be out of compliance with EPA requirements. This air pollution has

[1] The course description for "Policy Practicum: Rural Energy Transition in Rural America" (EBS 291, LAW 809U, PEDS 289) can be accessed at https://law.stanford.edu/education/only-at-sls/law-policy-lab/practicums-2024-2025/renewable-energy-transition-in-rural-america-809u/ and is shown in Stanford University Explore Courses at https://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&q=PEDS+289. The mapping tool url is available via PolicyMap.com: https://www.policymap.com/embed/widget/117/4D2AFE10710D41918F180775F0A353F2.

considerable effects on human health and is estimated to lead to nearly 100 deaths per year in the region.

In large part because of the plant's emissions, New Madrid County is the second worst of 115 Missouri counties in terms of deleterious human health outcomes. Residents have higher rates of respiratory and cardiovascular problems than the rest of the state. For example, 11.24% of residents have asthma in comparison to 9.4% of the state's overall population, and 40% have high blood pressure while the rate is 35.1% statewide. Chronic obstructive pulmonary disease affects 12.3% of locals and only 8.5% of the state's population. The estimated costs of these and other health challenges total approximately $731 million each year. Combined with other social costs of air pollution, the plant's economic toll is estimated at $1.68 billion annually. The impacts of this pollution are felt beyond Missouri; in fact, real mortality impacts are being felt by communities in neighboring states such as Illinois, Tennessee, Ohio, and Indiana, as detailed in Table 4.

The economic and health benefits of renewable energy are well established. However, the transition to renewables can sometimes pose socioeconomic risks for local workforces. Closing the New Madrid Power Plant would impact approximately 180 employees, many of whom earn above the county median income and have access to health benefits. Closure would mean the loss of those jobs and accompanying health benefits. Part of our analysis focuses on how to support the community economically through the transition to renewable energy production.

HIA Recommendations

1. Decommission New Madrid power plant and replace it with a renewable energy facility

Based on the HIA described in this report, we recommend the full decommissioning of the New Madrid Coal-Fired Power Plant. In its place, we recommend transitioning to renewable energy sources to power the Mag 7 aluminum production facility. Our results indicate significant health and economic benefits of this transition, primarily because of reduced air pollution.

2. Develop support programs for displaced workers, including healthcare coverage

To address short- and long-term economic needs during the transition, we propose support programs for displaced workers, including job training. It will also be important to ensure

continued healthcare access during this transition given the community's high rates of chronic health conditions. We recommend developing programs to fill coverage gaps, thereby ensuring that affected workers and their families maintain access to healthcare.

3. Proactively attract wind and solar industries

We also recommend that county and local governments and the rural electric co-op proactively attract new energy generation industries like wind and solar that create local jobs with competitive wages and benefits. Once established, such renewable energy facilities could not only support the Mag 7 aluminum production plant but also provide low-cost electricity to businesses and citizens throughout the county.

4. Track the health and economic effects of the transition

Finally, we outline a monitoring system that could be used to track health and economic indicators and assess progress toward goals. This system should particularly focus on monitoring respiratory and cardiovascular health among vulnerable populations, including children and seniors.

Together, these actions would secure the personal health and economic well-being of New Madrid County residents during a transition for the production of energy, shifting away from traditional fossil fuel refining to renewable sources, which, in turn, could then power the reopening of the Mag 7 aluminum production plant.

1. Introduction

The Magnitude 7 Metals (Mag 7) plant, located in New Madrid County, once accounted for approximately 30% of the nation's primary aluminum production.[2] It is the largest of the six active aluminum smelters in the U.S. However, in January 2024, Mag 7 ceased operations. In addition to impacting national aluminum supply, the closure of operations resulted in a decreased demand for energy county-wide. The closure led to the subsequent loss of 400 jobs and other adverse effects on the local economy.[3] The community has expressed interest in resuming operations of the Mag 7 aluminum smelter, but its former power source, the New Madrid Coal Plant, could pose health and economic risks if it re-opens in full under current operating conditions.

Before its closure, the Mag 7 aluminum smelter required a constant energy supply that made it the state's largest single consumer of energy.[4] The smelter was fed by the New Madrid coal-fired power plant.[5] The energy was not cheap. Estimates place the annual energy bill at $55 million.[6] The coal plant is also noncompliant with national environmental laws, and the upgrades necessary to bring the plant into compliance are expected to be costly. Finding the coal plant in violation of

[2] "U.S. Aluminum Market Roiled by Closure of Major Smelter." *OilPrice.com*, February 21, 2024. https://oilprice.com/Metals/Commodities/US-Aluminum-Market-Roiled-by-Closure-of-Major-Smelter.html.
[3] Hindle, Ryleigh. "Southeast Missouri Aluminum Smelter Curtailment Poses Challenges for Local Economy, National Industry." *Missouri Business Alert*, March 18, 2024. https://www.missouribusinessalert.com/economy/southeast-missouri-aluminum-smelter-curtailment-poses-challenges-for-local-economy-national-industry/article_f0a57dec-e484-11ee-bd7a-b726c0965617.html.
[4] Plautz, Jason. "Aluminum Shortage Threatens US Clean Energy Plans." *E&E News*, March 13, 2024. https://www.eenews.net/articles/aluminum-shortage-threatens-us-clean-energy-plans/.
[5] Home, Andy. "Column: Another US Primary Aluminum Smelter Bites the Dust." *Reuters*, January 28, 2024. https://www.reuters.com/markets/europe/another-us-primary-aluminium-smelter-bites-dust-2024-01-26/.
[6] "Magnitude 7 Aluminium Smelter in Missouri Mulling over Closure." *Fastmarkets*, December 22, 2023. https://www.fastmarkets.com/insights/magnitude-7-aluminium-smelter-in-missouri-mulling-over-closure/.

its Good Neighbor Rule for excessive sulfur dioxide (SO_2) emissions, the EPA required changes to operating conditions.[7,8] Retrofit technology alone is calculated to cost upwards of $116 million.[9]

In addition to impending mounting costs, the New Madrid coal refinery raises environmental health concerns. In addition to emitting SO_2 at levels considered unsafe by the EPA, the plant contributes significant nitrogen oxides (NO_x) and particulate matter ($PM_{2.5}$) pollutants, which are harmful to human health.[10] Concerned about these health impacts, Renew Missouri, a non-profit organization focused on advancing clean and affordable energy solutions across the state, partnered with Stanford Law School's Policy Lab and Stanford University's Human & Planetary Health Action Labs to conduct this Health Impact Assessment (HIA) and accompanying policy recommendations (Appendix A) with a mapping tool.[11] This assessment aims to evaluate the potential health effects of transitioning the power supply for future aluminum production from the existing New Madrid coal plant to renewable energy sources. This assessment assumes the economic importance of the Mag 7 aluminum production plant and does not investigate its environmental impact or advocate closing it down. This HIA focuses exclusively on the effects of transitioning the power source for the Mag 7 plant from coal to renewable energy.

2. Health Impact Assessment: Overview and Methodology

A Health Impact Assessment (HIA) is a research method for systematically evaluating the health effects of proposed projects or policies. HIA findings can help decision-makers and communities

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[7] Kite, Allison. "Sierra Club Calls on EPA to Enforce Coal Plant Rules, Highlighting Missouri Facilities." *Missouri Independent*, May 25, 2023. https://missouriindependent.com/2023/05/25/sierra-club-calls-on-epa-to-enforce-coal-plant-rules-highlighting-missouri-facilities/.

[8] Environmental Protection Agency. "Air Plan Partial Approval and Partial Disapproval; Missouri; Regional Haze." *Federal Register*, July 3, 2024. https://www.federalregister.gov/documents/2024/07/03/2024-14612/air-plan-partial-approval-and-partial-disapproval-missouri-regional-haze.

[9] NRECA Associated Electric Cooperative Inc. "Summary of Associated Electric's Statement of Harm Regarding the EPA Power Plant Rule." *Electric Cooperative Newsroom*. Accessed December 13, 2024. https://www.electric.coop/epa-power-plant-rule-aeci-statement-of-harm.

[10] Environmental Protection Agency. "Air Plan Partial Approval and Partial Disapproval; Missouri; Regional Haze." *Federal Register*, July 3, 2024. https://www.federalregister.gov/documents/2024/07/03/2024-14612/air-plan-partial-approval-and-partial-disapproval-missouri-regional-haze.

[11] Stanford Law School Law & Policy Lab, https://law.stanford.edu/education/only-at-sls/law-policy-lab/; Stanford University Human & Planetary Health Action Labs, https://hph.stanford.edu/human-and-planetary-health-education/human-and-planetary-health-action-labs.

understand how the choices they make may affect community health. By revealing potential health impacts, an HIA can provide evidence-based recommendations to maximize health benefits while mitigating risks.[12]

After screening to determine that an HIA would be a useful tool, we established assessment parameters in the scoping phase—identifying health effects and determining the breadth and depth of our analysis. We grounded our methodology in discussions with key stakeholders and experts and in relevant sources of data. We focused our research on state and county health data sources, including interviews with state and county health experts. We also examined data at the federal level to compare health data in other regions that had shifted from coal-fired to renewable energy sources. Next, we formulated our research questions to align with an assessment phase that documents potential outcomes for the New Madrid Power Plant. In formulating our research questions, we collected data on community demographics to understand community health baseline conditions. We also collected and analyzed data on environmental contaminants known to negatively impact human health, such as NO_x, SO_x, $PM_{2.5}$, PM_{10}, and hazardous air pollutants.

This baseline assessment was complemented with data mapping, pulling together geospatial datasets such as the CDC Environmental Justice Index, Energy Communities designation data, power plant locations, National Ambient Air Quality Standards (NAAQS) noncompliance records, and renewable energy potential assessments for solar, wind, and geothermal sources, which we compiled into a user-friendly and publicly accessible tool.[13] We then examined the types and directions of health effects, their distribution across community subpopulations, their probabilities, and the quality of evidence supporting our predictions. Our assessment includes health and economic effects, drawing on secondary literature review and modeling to establish impact pathways and likelihood of outcomes.

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[12] Centers for Disease Control and Prevention. "Health Impact Assessment Resources." *CDC Environmental Public Health Tracking*, February 14, 2024, https://www.cdc.gov/environmental-health-tracking/php/communications-resources/hia-resources.html.

[13] See our Stanford Rural Energy Transition Renew Missouri Mapping Tool, https://stanford.maps.arcgis.com/apps/instant/basic/index.html?appid=566b248da7254253ae1192550404a100. The tool provides targeted data based on the Center for Disease Control Environmental Justice Index. It allows comparison of different EJ factors across the Missouri and Kentucky regions.

While we were interested in health impacts broadly, we paid special attention to addressing health inequities, drawing on economic analysis and environmental justice considerations. Our final deliverables include this HIA (with policy recommendations and actionable steps for implementation) and a mapping tool to assess the distribution of health risks.[14]

3. Case Study Findings

Baseline Assessment of Health and Demographics

New Madrid County has a total population of around 16,300 people.[15] Notably, the county has a relatively greater population of children under 18 and elders over 65, compared to the state, and a greater percentage of people living in poverty. 13.8% of people in the county are without health insurance, which is a significant discrepancy from Missouri's overall uninsured rate of 7.5% (see Table 1).

Table 1. Community Demographics and Context

Demographic (2022)	New Madrid County	Missouri
Population Total	16,300	6,196,156
White	76.1%	61.6%
Black or African American	12.2%	12.4%
People under 18	24%	22%

[14] Stanford Rural Energy Transition Mapping Tool, https://stanford.maps.arcgis.com/apps/instant/basic/index.html?appid=566b248da7254253ae1192550404a100.
[15] "Explore Census Data." Accessed December 12, 2024. https://data.census.gov/profile/New_Madrid_County,_Missouri?g=050XX00US29143.

People over 65	19.4%	17%
Percent Living in Poverty	17.3%	12.0%
Without Health Insurance	13.8%	7.5%
Bachelor's Degree or Equiv	13.0%	33.2%

Associated Electric Cooperative Incorporated's (AECI) New Madrid Power Plant is one of the three largest employers in New Madrid County with 180 employees—about 2% of the county's overall workforce. Besides the coal power plant, the other two primary employers in the county are in the manufacturing industry, which also demand significant energy from the New Madrid Power Plant.[16] Carlisle Construction employs 220 people and manufactures building supplies, such as roofing. SRG Global is the largest employer in the county with 440 employees and makes automotive parts. The county is also home to the annual Bootheel Rodeo,[17] which is one of the top 40 rodeos in the nation and is organized by the Sikeston Junior Chamber of Commerce, a group of young professionals striving to boost economic activity in the region.

Community Economic and Health Impacts

Retiring the New Madrid Power Plant would likely result in lost jobs for the current plant workforce. There is strong evidence that employment status can have significant and varied impacts on health. As of October 2024, New Madrid County's unemployment rate is 4.3%, and the civilian labor force consists of 8,069 people.[18,19]

[16] Source: email from Sarah Ezell, 18 November 2024, Economic Development at Sikeston Chamber Commerce, Economic Development, and Tourism, https://www.sikeston.net/.
[17] Sikeston Rodeo. "Being a Sikeston Jaycee Means Putting the Community Before Yourself." Accessed December 12, 2024. https://sikestonrodeo.com/about/.
[18] "Unemployment Rate in New Madrid County, MO," November 27, 2024. https://fred.stlouisfed.org/series/MONEURN.
[19] "Civilian Labor Force in New Madrid County, MO." Accessed December 12, 2024. https://alfred.stlouisfed.org/series?seid=MONELFN.

The plant currently employs around 180 people, providing them with income and benefits, including health insurance.[20] Assuming that every employee is a resident of the county means that the coal plant employs around 2 percent of the county's workforce.

13.8% of people in New Madrid County do not have health insurance—closing the plant would likely increase the number of uninsured residents.[21] In 2022, the local median household average income in New Madrid County was $44,092, compared to a national median of $80,610 in 2023.[22,23] Wage data for the New Madrid Power plant was not accessible, but data from the Bureau of Labor Statistics shows that power plant operator income in central Missouri has a mean wage of $72,440, well above the New Madrid county average.[24]

Notably, the New Madrid Power Plant Unit 1 was owned by the City of New Madrid (CNM) and operated by AECI until 2018, when AECI completed its purchase of the unit from the city.[25] For 9 years prior, AECI paid CNM $5,000,000 per year through a purchase option agreement. These payments ceased with the finalization of AECI's purchase of the plant. In October of 2023, CNM terminated a power purchase contract with AECI that had begun in 1968 and transitioned to the Midcontinent Independent System Operator (MISO) market.[26] City Administrator Aaron Griffin cited reasoning that "the city no longer receives a discount on power costs and can no longer sell any excess power it was allotted by AECI." It is unclear where CNM directed this prior revenue stream, such as towards social services that support health, but AECI currently does not provide monetary contributions to the county in the form of payments in lieu of taxes (PILOT) or any other forms that would cease with the retirement of the plant.

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[20] AECI. "New Madrid Power Plant." Accessed December 12, 2024. https://www.aeci.org/resources/reliable-coal/new-madrid/.
[21] "Explore Census Data." Accessed December 12, 2024. https://data.census.gov/profile/New_Madrid_County,_Missouri?g=050XX00US29143.
[22] "Explore Census Data." Accessed December 12, 2024. https://data.census.gov/profile/New_Madrid_County,_Missouri?g=050XX00US29143#income-and-poverty.
[23] Bureau, US Census. "Income in the United States: 2023." Census.gov. Accessed December 12, 2024. https://www.census.gov/library/publications/2024/demo/p60-282.html.
[24] Bureau of Labor Statistics. "Power Plant Operators." Accessed December 12, 2024. https://www.bls.gov/oes/current/oes518013.htm.
[25] "Notes to Consolidated Financial Statements." Associated Electric Cooperative, n.d. page 16 https://www.aeci.org/media/5138/2019-annual-report-plus-cover-fact-book-audited-statement-single-pgs.pdf.
[26] Democrat, Jill Bock/Standard. "After More than 50 Years, New Madrid Ends Electrical Purchasing Deal with AECI." Sikeston Standard Democrat, August 16, 2023. https://standard-democrat.com/story/3006269.html.

Unemployment is correlated with several health outcomes, including heart attacks, reduced physical activity, and poor mental health.[27,28,29] Unemployment and related loss of income can also lead to increased rates of homelessness.[30] Children in households with insufficient family income are also at risk for health impacts related to lack of access to care, nutrition, and education.[31]

Air Quality and Health Impacts

The New Madrid Power Plant significantly contributes to Missouri air pollution, with emissions exceeding national and regional standards. The plant emits 12,033 tons of SO_2 per year, with design values exceeding the NAAQS by 400%.[32] Missouri ranks fifth in emitters for EPA Region 7 (which includes Iowa, Kansas, Missouri, Nebraska, and 9 tribal nations) for SO_2. Within Missouri, the New Madrid Power Plant is the largest producer of SO_2, with over 91,000 tons/year.[33] The power plant also emits 18,227 tons of NO_x per year,[34] ranking Missouri first in the country

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[27] Dupre, Matthew E., Linda K. George, Guangya Liu, and Eric D. Peterson. "The Cumulative Effect of Unemployment on Risks for Acute Myocardial Infarction." *Archives of Internal Medicine* 172, no. 22 (December 10, 2012): 1731–37. https://doi.org/10.1001/2013.jamainternmed.447.

[28] Colman, Gregory, and Dhaval Dave. "Exercise, Physical Activity, and Exertion over the Business Cycle." *Social Science & Medicine (1982)* 93 (September 2013): 11–20. https://doi.org/10.1016/j.socscimed.2013.05.032.

[29] Flint, Ellen, Mel Bartley, Nicola Shelton, and Amanda Sacker. "Do Labour Market Status Transitions Predict Changes in Psychological Well-Being?" *Journal of Epidemiology and Community Health* 67, no. 9 (September 2013): 796–802. https://doi.org/10.1136/jech-2013-202425.

[30] Burke, Colin, Erin E. Johnson, Claire Bourgault, Matthew Borgia, and Thomas P. O'Toole. "Losing Work: Regional Unemployment and Its Effect on Homeless Demographic Characteristics, Needs, and Health Care." *Journal of Health Care for the Poor and Underserved* 24, no. 3 (August 2013): 1391–1402. https://doi.org/10.1353/hpu.2013.0150.

[31] Aber, J. L., N. G. Bennett, D. C. Conley, and J. Li. "The Effects of Poverty on Child Health and Development." *Annual Review of Public Health* 18 (1997): 463–83. https://doi.org/10.1146/annurev.publhealth.18.1.463.

[32] Missouri Department of Natural Resources, Division of Environmental Quality. *2023 Revision of the State Implementation Plan for the New Madrid County Nonattainment Area Plan for the 2010 Sulfur Dioxide Standard.* Adopted April 27, 2023. State government publication. Accessed May 18, 2023. https://archive.org/details/2023NewMadridSIPRev.

[33] Missouri Department of Natural Resources. "Missouri Air Monitoring Network Assessment". June 26, 2020. 2020 Missouri Air Monitoring Network Assessment | Missouri Department of Natural Resources

[34] Mansouri, Kavahn. "Midwest Coal-Fired Power Plants Are Among the Country's Worst Polluters, but They Don't Break EPA Rules." *Nebraska Public Media*, Midwest Newsroom Investigative Reporter. Accessed December 13, 2024. https://nebraskapublicmedia.org/en/news/news-articles/midwest-coal-fired-power-plants-are-among-the-countrys-worst-polluters-but-they-dont-break-epa-rules/#:~:text=The%20New%20Madrid%20Power%20Plant,about%2014%2C000%20tons%20in%202019.&text=Associated%20Electric%20Cooperative%20Inc.

and first in EPA Region 7.[35] CO_2 emissions from the plant are 6,197,074 tons per year, ranking Missouri ninth in EPA Region 7 for emissions, with coal plants among the highest emitters in the country.[36]

The coal plant's contribution to air pollution in the county is stark and significant and plays a major role in harmful emissions. In 2020, the plant was responsible for an overwhelming 98% of the county's total nitrous oxide emissions and 89% of nitrogen oxides, highlighting its outsized impact on these air pollutants. It also accounted for 88% of the county's carbon dioxide emissions, revealing its contribution to greenhouse gases. Sulfur dioxide levels were heavily influenced, as well, with 79% attributed to the plant. While the coal plant's contributions to particulate matter were smaller in comparison, they were still notable, comprising 17% of the primary $PM_{2.5}$ and 6% of PM_{10} emissions. Additionally, the plant contributed 8% to the county's total carbon monoxide emissions. This data illustrates the plant's dominant role in local air quality degradation, with potential implications for public health and environmental policy.[37]

New Madrid County is the only county in Missouri to be noncompliant for any NAAQS, specifically for SO_x. The health impact of air pollutants in the county is more severe compared to the overall state of Missouri. The county experiences 4,440 work loss days per year due to air pollution-related health issues. Specifically, several health conditions have a higher prevalence in New Madrid County compared to the state average, including asthma (11.24% vs. 9.4%), high blood pressure (40% vs. 35.1%), chronic obstructive pulmonary disease (12.3% vs. 8.5%), cognitive disability (19.4% vs. 16%), and low birth weight infants (11.3% vs. 9.12%). Air toxics cancer prevalence in New Madrid is 7.4%, but no data is provided for Missouri. The Environmental Justice Index indicates that New Madrid has 0.9 highly severe cumulative impacts of air pollution compared to 90% of other tracts in Missouri. Overall, New Madrid County ranks at the bottom in terms of health, placing 113 out of the 115 counties in Missouri.[38]

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[35] "Missouri Air Quality Index (AQI) and USA Air Pollution." IQAir. Accessed October 8, 2024. https://www.iqair.cn/cn-en/usa/missouri.

[36] Mansouri. Supra, note 34.

[37] Mansouri. Supra, note 34.

[38] University of Wisconsin Population Health Institute. *2022 State Report Missouri: County Health Rankings 2022.* University of Wisconsin School of Medicine and Public Health, 2022.

Plant Retirements and Health Impacts

A study by Yu et al. (2023) assessed the health impacts of improved air quality after the shutdown of the Shenango, Inc. coke plant in Pittsburgh, Pennsylvania, in January 2016. There were statistically significant reductions in emergency department (ED) visits and hospitalizations observed at both 1 week and 3 years post closure. A 42% drop in cardiovascular ED visits from the pre-closure mean were observed after one week. Emergency visits decreased, as well as inpatient cardiovascular hospitalizations. The study concluded that the change in outcomes resulted primarily from a decrease in sulfate and arsenic concentration in $PM_{2.5}$ due to the decline of coal dust.[39] The relative contribution of a point source, such as a generating plant, is an important factor. Chen et al. (2023) observed no statistically significant reductions in cardiovascular hospitalizations when quantifying $PM_{2.5}$ effects on cardiorespiratory hospitalizations during 11 coal and oil facility retirements in California between 2006 and 2013. The Chen study collected data 26 weeks before retirement and 4 weeks after retirement.[40] The report concluded that the absence of an effect on cardiorespiratory hospitalizations likely resulted from the effects of existing air pollution requirements which regulated the relatively low contribution of the plant's emissions to the overall $PM_{2.5}$.

Children are especially sensitive to air quality. Komisarow et al. (2021) found that "emergency department visits for asthma-related conditions among 0- to 4-year-old children decreased by 12% in zip codes near the 3 closed coal-fired power plants in the 5 years following the closures, relative to rates in zip codes farther away during the same period."[41] These findings add another data point to a strong body of evidence linking air emissions with asthma in children.

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[39] Yu, Wuyue, and George D Thurston. 2023. "An Interrupted Time Series Analysis of the Cardiovascular Health Benefits of a Coal Coking Operation Closure." Environmental Research Health 1 (4): 045002–2. https://doi.org/10.1088/2752-5309/ace4ea.

[40] Chen, Chen, Sindana D Ilango, Lucas Henneman, Joan A Casey, and Tarik Benmarhnia. 2023. "The Local Impacts of Coal and Oil Power Plant Retirements on Air Pollution and Cardiorespiratory Health in California: An Application of Generalized Synthetic Control Method." Environmental Research 226 (June): 115626–26. https://doi.org/10.1016/j.envres.2023.115626.

[41] Komisarow, Sarah, and Emily L. Pakhtigian. 2021. "The Effect of Coal-Fired Power Plant Closures on Emergency Department Visits for Asthma-Related Conditions among 0- to 4-Year-Old Children in Chicago, 2009–2017." American Journal of Public Health 111 (5): 881–89. https://doi.org/10.2105/ajph.2021.306155.

Estimating Costs of Health Impacts

Utilizing different sources, it is possible to estimate the economic impact of adverse health impacts associated with air pollution from the New Madrid Coal Plant.

Table 2. Economic Quantification of Health Impacts from the New Madrid Plant

Health Outcomes	Cases Per Year	Cost in Dollars
Deaths	90	$731,410,714
Hospital Admissions	10	$4,897,058
Asthma ED Visits	19	$2,307,494
Asthma Attacks	939	$377,381
Heart Attacks	40	$1,032,300
Work Loss Days	4440	$712,378

*ABT Associates estimated costs per health outcome

Heo et al. (2016) created the Estimating Air Pollution Social Impact Using Regression (EASIUR) model to calculate the public health costs associated with specific components of air pollution, including SO_2, NO_x, and $PM_{2.5}$ from a point source.[42] While health impacts are acutely felt by those experiencing them, there is a real economic cost for the surrounding community, as well—in millions of dollars per year.

Table 3. Economic Quantification of Air Emissions from the New Madrid Plant

Component	Tons Per Year (2020)	Cost in Dollars	Cost per MWh
Sulfur Dioxide (SO_2)	12,033	$1,189,762,834	$182
Nitrous Oxides (NO_x)	18,227	$393,391,961	$60
$PM_{2.5}$	Not Reported for Site	NA	NA

*The pollutants were assumed to be airborne at 300m given the approximate ejection height of emissions from the plant chimney.

[42] Heo, Jinhyok, Peter J. Adams, and H. Oliver Gao. 2016. "Reduced-Form Modeling of Public Health Impacts of Inorganic PM 2.5 and Precursor Emissions." Atmospheric Environment 137 (July): 80–89. https://doi.org/10.1016/j.atmosenv.2016.04.026.

Plant Retirements and Mortality Impacts

Fan et al. (2020) studied the effects of 5 coal-fired power plant closures in Georgia, North Carolina, Ohio, and Tennessee on the mortality of adults older than 65. They found coal plant retirement decreased monthly mortality by 15 per 100,000. Using an instrumental variable approach, they also found that the reductions of $PM_{2.5}$ significantly decreased monthly age-adjusted mortality by 7.17 people per 100,000. They also studied the difference in mortality outcomes between sexes, finding that the impact of $PM_{2.5}$ concentrations on male mortality rates is greater than that for females. A 1 $\mu g/m^3$ reduction in monthly $PM_{2.5}$ concentration corresponded to 9.9 fewer deaths per 100,000 among males compared to 5.5 per 100,000 among females.[43]

Air pollution impacts can often be felt far from the point source, as Henneman et al. (2023) found in a study quantifying the deaths associated with air pollution from any given coal-fired power plant in the United States.[44] As shown below, Missouri sees the 5th most deaths associated with the air pollution from the New Madrid coal-fired power plant.

Table 4. Economic Quantification of Mortality Impacts Across State Borders

State	Deaths Per Year	Cost in Dollars	Cost per MWh
Illinois	92	$874,002,891	$134
Tennessee	90	$855,002,828	$131
Ohio	84	$798,002,639	$122
Indiana	74	$703,002,325	$108
Missouri	64	$608,002,011	$93

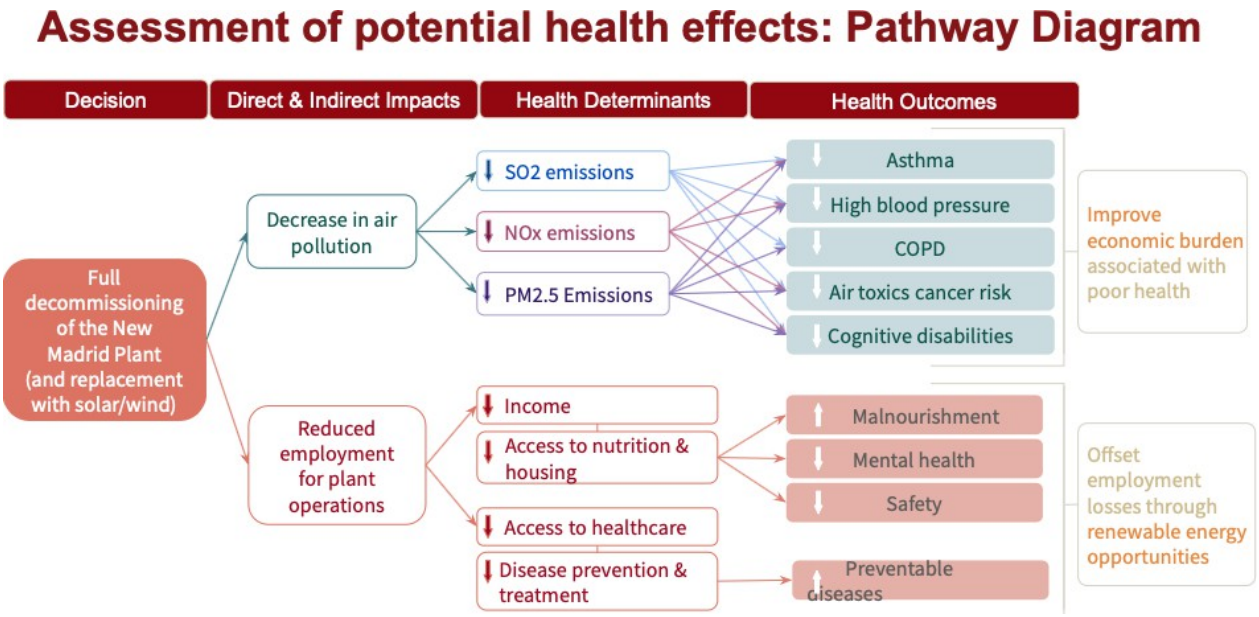
[43] Fan, Maoyong, and Yi Wang. 2020. "The Impact of $PM_{2.5}$ on Mortality in Older Adults: Evidence from Retirement of Coal-Fired Power Plants in the United States." Environmental Health 19 (1). https://doi.org/10.1186/s12940-020-00573-2.

[44] Henneman, Lucas, Christine Choirat, Irene C Dedoussi, Francesca Dominici, Jessica Roberts, and Corwin Zigler. 2023. "Mortality Risk from United States Coal Electricity Generation." Science 382 (6673): 941–46. https://doi.org/10.1126/science.adf4915.

The pathway diagram illustrates the potential health effects of the decision to fully decommission the New Madrid Plant and replace it with solar/wind energy. The decision to decommission the plant directly leads to two key trade-offs: decreased air pollution and reduced employment due to shuttered plant operations.

Impact Pathway Diagram

Figure 1. [Pathway Diagram of Health Outcomes]



Reducing air pollution results in lower emissions of SO_2, NO_x, and $PM_{2.5}$. These changes in health determinants have cascading effects on health outcomes. Specifically, reduced SO_2, NO_x, and $PM_{2.5}$ emissions lower the risk of asthma, high blood pressure, chronic obstructive pulmonary disease (COPD), air toxics cancer risk, and cognitive disabilities.

Conversely, the closure of the New Madrid Power Plant would likely result in job losses for the current workforce of around 180 people, which can negatively impact social determinants of health, such as income, access to nutrition and housing, access to healthcare, and disease prevention and treatment. Among these declines, reduced access to nutrition and housing contributes to a series of adverse health outcomes, including malnourishment, worsening mental

health, and reduced safety. Moreover, reduced access to disease prevention and treatment will increase preventable diseases' prevalence.

These adverse effects could be offset by creating new employment opportunities in the renewable energy sector. Moreover, the transition to clean energy also improves the economic burden that is associated with poor health outcomes. Improved health enables workers to work energetically and consistently, with fewer work hours lost to absences for health reasons. The reduction in air pollution-related health issues can lower healthcare costs by reducing the number of visits to healthcare providers, including ER visits, and by reducing reliance on prescription therapies such as inhalers, steroids, or medications for hypertension.

In conclusion, the pathway diagram demonstrates that the decision to fully decommission the New Madrid Plant and replace it with solar/wind energy can lead to a cascade of positive impacts on health determinants and outcomes. By reducing air pollution, improving socioeconomic conditions, and creating new employment opportunities in the renewable energy sector, this transition can significantly enhance public health and well-being in New Madrid County and the surrounding regions.

Impact Matrix

Table 5. Impact Matrix Summarizing the Two Scenarios and Associated Impacts

Scenario	Direction, Extent, Severity	Likelihood	Who is Impacted	Quality of Evidence
Continued Operation of New Madrid, Continued Release of Air Pollutants	⇧⇧⇧⇧	Likely	Residents of New Madrid, especially those with preexisting health conditions like asthma & heart disease. Specifically the elderly and children are at high risk. Residents in surrounding states - Illinois, Tennessee, Ohio, & Indiana - are also affected.	****
Retirement of the New Madrid Coal Plant and	⇩⇩⇩⇩	Possible	Residents of New Madrid, especially those with preexisting health conditions, elderly, and children. Residents of surrounding	***

Elimination of Air Pollutants			states like Illinois, Tennessee, Ohio, & Indiana.	

⇧⇧⇧⇧ Emissions going up and *negative* impact on many across broad context
⇩⇩⇩⇩ Emissions going down and *positive* impact on many across broad context
**** many studies with very strong evidence
*** good number of studies with compelling evidence

The key takeaway, which is grounded in secondary community information, leads us to believe that the current status quo of power plant operation as-is will likely continue. This means the health impacts outlined in this paper will continue to be deleterious to the community, the state, and neighboring states. Children and those 65 or older would be most acutely impacted by asthma, heart attacks, and overall increased mortality resulting from the air pollutants associated with coal emissions.

4. Key Takeaways and Recommendations

Our Health Impact Assessment (HIA) reveals significant health risks of continuing the operation of the New Madrid Power Plant not only to local residents but also to neighboring communities across state borders. The facility's emissions contribute to elevated rates of respiratory illness, cardiovascular disease, and premature mortality. While all residents are at risk of these health conditions, vulnerable populations, like children and the elderly, are at even higher risk.

We find that the health costs of operating the New Madrid Power Plant under business as usual exceed $1.68 billion and are driven primarily by the impacts of air pollution on human health. Included in this estimate are direct healthcare expenses and broader health-relevant societal impacts, such as lost productivity and premature mortality. The plant's sulfur dioxide emissions, which exceed the EPA's National Ambient Air Quality Standards by 400%, affect Missouri residents and communities in Illinois, Tennessee, Ohio, and Indiana, making this an interstate public health concern.

Despite the adverse health impacts of operating the power plant, its closure could pose economic hardship for its ~180 employees, who depend on their jobs for income and health benefits. To

transition away from coal generation, we consider how best to support affected workers and their families.

Primary Recommendations

We recommend a full decommissioning of the New Madrid Power Plant and a transition to renewable energy. The transition plan should support affected workers and community members. In particular, we emphasize:

1. Workforce Development and Economic Support

A workforce transition program is necessary immediately to support existing and prospective energy workers to transition into clean energy jobs. In addition to focusing on retraining workers to move into the renewable energy sector and other expanding clean energy industries, we recommend wage support to help maintain economic stability for families affected by the transition. Collaborating with local educational institutions will be key to providing tailored training programs that align with future job opportunities and are easily accessible to residents..

2. Healthcare Access Protection

Transitional health insurance should be set up for affected workers and their families to ease the transition. This program must consider the community's higher-than-average rates of chronic conditions and offer continuous access to necessary medical care. Such a program could be implemented through workforce development programs, offering trainees access to healthcare under an apprenticeship structure.

3. Economic Development Initiatives

Local and state authorities should make concerted efforts to attract renewable energy developers to the area, leveraging existing transmission infrastructure and the current workforce's skillsets. The community might consider partnering with companies such as Insitu Energy, which works with coal communities to maximize the value of transitioning to new energy sources and industries. The New Madrid plant sits at a unique interconnection point on the electric grid between subregions within the Midcontinent Independent System Operator that is highly attractive to large industry, as well as renewable developers. Economic development initiatives should aim to bring

in industries that can offer wages and benefits similar to those provided by the coal plant and give special consideration to industries that promote long-term economic growth and stability in the region.

4. Environmental Monitoring and Health Surveillance

Local leaders and new industries should establish a monitoring system to track improvements in air quality and related health outcomes following the plant's closure. This system should regularly assess respiratory and cardiovascular health indicators, focusing on vulnerable populations. The findings should be publicly shared to maintain transparency and accountability throughout the transition.

5. Community Services

Additional "wrap-around" social support systems are necessary to assist families during the transition. These services could include career counseling, financial planning assistance, and mental health support to help address the psychological effects of job displacement and community changes.

6. Stable Phase-Out

We suggest a phased approach to closing the plant over a period of a few years, allowing for thorough planning and implementation of transition programs. The timeline could include:

- Immediate start of workforce development programs and healthcare transition planning.
- A six-month period to set up monitoring systems and community support services.
- Gradual reductions in plant operations synchronized with the development of alternative power sources.
- Final decommissioning to coincide with the completion of worker transition programs.

Implementing these recommendations will require collaboration among various stakeholders, including local governments, state agencies, industry partners, and community organizations. Structured, accessible opportunities for these discussions should be decided upon ahead of time and posted publicly. Finally, regular evaluations of progress, with adjustments based on

community feedback, will be essential for ensuring a successful transition that supports public health and economic stability in New Madrid County.

5. Next Steps in the Research

The transition of energy sources from legacy fossil sources to new, less carbon intensive sources inherently requires tradeoffs. This report provides qualitative and quantitative assessment of the health impacts of the New Madrid power plant's continued operation. This report acknowledges the acute impact to individuals whose livelihoods currently depend on the plant. We recommend further research on how best to transition the economic livelihoods of coal plant workers. It is unlikely that you can copy and paste the exact programs from other communities, but across the multitude of coal communities already transitioning their employment bases, there are approaches to be avoided as well as replicated.

In this report, we show that developers believe that the New Madrid area is ripe for both industrial development and renewable energy development due to its access to high-capacity interconnection infrastructure. Further research could quantify that opportunity. As the nation looks to reshore manufacturing and industrial processes, the Southeast region is already experiencing an increase in economic development. New Madrid may find opportunities to benefit from this rising tide.

6. Conclusion

This report highlights many lesser-known complexities in the energy transition with a focus on often hidden health impacts of legacy fossil fuel energy systems. The report reveals the positive health outcomes likely associated with the transition to renewable energy.

This Health Impact Assessment has underscored the profound and multifaceted consequences of continuing operations at the New Madrid Power Plant. While the plant provides employment and economic stability for its workforce, its significant contributions to air pollution exacerbate severe health disparities locally and beyond, highlighting the need for action.

Decommissioning the coal plant and transitioning to renewable energy offers a clear pathway to improving public health and environmental outcomes. However, this transition must be approached with care to minimize the socioeconomic disruptions it might cause. Supporting affected workers through targeted programs—such as job training, wage replacement, and healthcare access—will be essential to ensuring that the benefits of clean energy extend to all community members.

Moreover, the findings reinforce the importance of engaging with populations, such as children, the elderly, and those living in poverty or without health insurance, who bear the disproportionate burden of environmental degradation. Through thoughtful planning, real stakeholder collaboration, and transparent monitoring of health and economic indicators, New Madrid County can mitigate the adverse impacts of the energy transition, maintain operation of the Mag 7 aluminum smelter, and also position itself to benefit from new economic development opportunities.

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