Mandatory Emissions Reductions

for Climate Mitigation in the Power Sector

New Jersey, Delaware, and Minnesota case studies

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The **Environmental Justice Health Alliance for Chemical Policy Reform (EJHA)** is a national network of grassroots environmental and economic justice organizations and advocates. This network represents communities that are disproportionately impacted by toxic chemicals from legacy contamination and ongoing exposure to polluting facilities and health-harming chemicals in household products. EJHA, in its strategic partnership with the **Coming Clean** network, supports a just transition toward safer chemicals and a pollution-free economy that leaves no community or worker behind. In line with the **Louisville Charter for Safer Chemicals**, an emerging, central initiative in EJHA's work to transform the chemical sector is to expand the concept of mandatory emissions reductions to include toxic chemicals.

The **Center for Earth, Energy & Democracy (CEED)** works in collaboration with grassroots communities, policymakers, and researchers to conduct research and provide community education on climate, energy, and the environment. CEED provides tools and information for communities and policymakers in an effort to create just climate and environmental policy.

The **New Jersey Environmental Justice Alliance (NJEJA)** is an alliance of New Jersey–based organizations and individuals working together to identify, prevent, and reduce or eliminate environmental injustices that exist in communities of color and low-income communities. NJEJA will support community efforts to remediate and rebuild impacted neighborhoods, using the community's vision of improvement, through education, advocacy, review and promulgation of public policies and training, as well as through organizing and technical assistance.

Report designed by Drake Reed and Tian-Tian He and edited by Elise Marton

I. EXECUTIVE SUMMARY

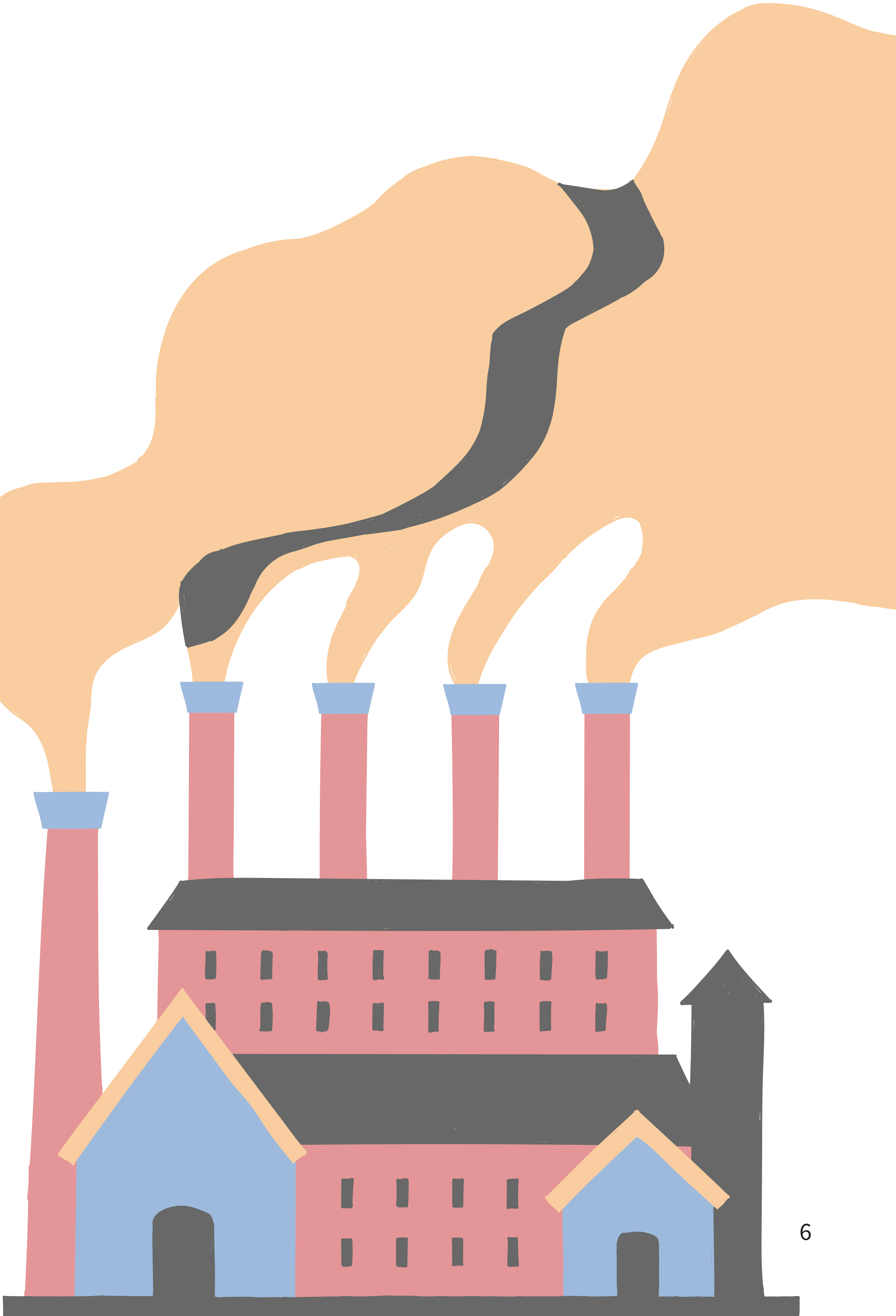
Across the United States, fossil fuel infrastructure emits toxic air pollution and planet-warming greenhouse gases that drive climate change. Environmental justice (EJ) communities bear the brunt of both, living on the front lines of impacts from climate change while also suffering the localized environmental health harms caused by fossil fuel facilities in their vicinity. Despite these disproportionate impacts, climate mitigation policies remain focused on reducing carbon dioxide (CO_2) emissions without attention to the health-harming co-pollutants from the power sector. A just and equitable climate mitigation policy, however, makes the elimination of the sector's outsize and inequitable impact on low-income communities and communities of color an explicit goal. From an environmental justice perspective, climate change mitigation measures, whether they use a technology-based standard, a greenhouse gas (GHG) target, or a market-based or other mechanism, should explicitly incorporate mandatory emissions reductions (MER) of health-harming co-pollutants in EJ communities.

This report lays out the justification and framework for an MER policy in the U.S. power sector. The essential steps of our framework are to identify power plants located in EJ communities, decide on the specific type of MER policy to apply, and finally, examine additional factors—such as measures of cumulative burden or vulnerability—that can inform which power plants should be prioritized for MER soonest or to the greatest extent. We offer several variants of an MER policy, with the ideal option being the closure of fossil fuel–fired power plants in EJ communities and a concomitant transition to renewable energy to maintain safe and reliable electricity generation.

To understand how the selection and prioritization of plants for MER might work in practice, we applied our framework to three states, New Jersey, Delaware, and Minnesota. We adopted a definition of "environmental justice community" based on quantitative thresholds for People of Color, those with limited English proficiency, and low-income populations, in line with recommendations of EJ advocates and the classification used in New Jersey's 2020 landmark environmental justice law (A2212/S232). Once plants in EJ communities were identified, additional factors that reflect environmental burden, such as cancer risk and respiratory hazard related to toxic air pollution, as well as the emissions profiles of the plants, were incorporated as an illustrative, second layer of analysis for prioritizing plants and the most impacted EJ areas.

Throughout the development and application of our framework, the research team relied on the input and collaboration of key stakeholders representing EJ communities in the three case study states. These EJ partners played a crucial role in ground-truthing the set of plants that were identified and prioritized for an MER policy, which was important given the occasional gaps in data and the inherent limitations of relying on strict quantitative thresholds for definitional purposes.

Overall, the New Jersey, Delaware, and Minnesota case studies underscore the disproportionate siting of power plants in environmental justice communities. In all three states, there is an inequitable overrepresentation of People of Color in the fence-line populations residing near power plants, emphasizing the importance of considering race when developing strategies for the sector. As more attention, policy, and investment are directed toward a just energy transition, this work aims to highlight the need for, and to advance a path forward for, mandatory emissions reductions in power sector climate mitigation efforts.



II. INTRODUCTION

The climate crisis and air pollution are inextricably linked to each other and to environmental injustice, but few climate mitigation policies in the United States address them in a comprehensive manner. There is widespread recognition that low-income, Black, Indigenous, and communities of color are on the front lines of climate impacts and that existing environmental burdens will be exacerbated in these same communities due to climate change.[1] Despite these disproportionate impacts, climate policies are focused largely on carbon emissions without explicit goals to mitigate the differential impacts faced by environmental justice (EJ) communities. State and local governments, and increasingly the federal government, have introduced policy interventions designed to mitigate climate change through various mechanisms, primarily programs that target greenhouse gas (GHG) emissions reductions or investments in renewable energy technologies, yet equity and justice objectives are often an afterthought in policy development. Most often equity considerations are discussed in the context of potential investments in EJ communities in the form of renewable energy, energy efficiency, or energy rebate programs.[2] EJ communities throughout the United States and abroad are demanding that justice and equity issues be addressed more explicitly through the reduction of disproportionate pollution at the source.[3]

The sources of climate change are often concentrated in EJ communities even though these communities are the least consumptive and least responsible for driving the climate crisis.[4] One example of this injustice is the documented concentration of dirty industries including fossil fuel power plants and infrastructure in EJ communities. Power plants contribute to and exacerbate the cumulative and unequal exposure to co-pollutants and adverse health impacts in EJ communities.[5] Co-pollutants, such as particulate matter, sulfur dioxide, and nitrogen oxides, are localized pollutants detrimental to human health, whereas carbon pollution, or GHGs, are global pollutants that cause climate change. EJ communities are bearing the brunt of both climate change impacts and localized health impacts from poor air quality.[6]

While these climate policies seek to reduce GHG emissions, they rarely, if ever, target or track the location-specific reduction of GHG emissions, and they neglect co-pollutants or simply assume that a concomitant reduction in co-pollutants will occur.

Climate mitigation policies are among the most urgent and politically viable pathways to realize EJ gains in the form of co-pollutant mitigation. There are a variety of climate mitigation policies in place across the country, such as California's Global Warming Solutions Act of 2006 (AB32) and the Regional Greenhouse Gas Initiative (RGGI) in the Northeast, which are both carbon trading programs. Additionally, there are sector-specific clean energy programs such as the Renewable Portfolio Standard, which regulates power sector emissions, and energy efficiency programs like the federal Weatherization Assistance Program. While these climate policies seek to reduce GHG emissions, they rarely, if ever, target or track the location-specific reduction of GHG emissions, and they neglect co-pollutants or simply assume that a concomitant reduction in co-pollutants will occur. In fact, some carbon-trading programs can result in no emissions reductions in EJ communities or, in the worst-case scenario, an emissions increase.[7] However, there is now a unique window of opportunity to address these challenges and target disproportionate burdens, given the movement to develop federal climate mitigation policies for the power sector under the Biden-Harris administration.

For at least a decade and a half, many in the EJ grassroots movement have advanced the idea that climate change mitigation policy for the power sector should be used to address disproportionate pollution loads in EJ communities. This policy has come to be known as mandatory emissions reductions (MER).

The beginnings of the MER policy were developed in discussions within the EJ community in the early 2000s when the Regional Greenhouse Gas Initiative was created and the Waxman-Markey carbon trading bill was being prepared for introduction in Congress. When the Clean Power Plan was developed during the Obama administration, EJ advocates stated that, from an EJ perspective, climate change mitigation policy would ideally maximize reductions of GHG co-pollutants while achieving a GHG emissions reduction goal. More important, it would also require emissions reductions by power plants located in EJ communities and whose emissions detrimentally affected EJ communities. Since the EJ movement was not aware of any climate change mitigation policy that intentionally maximized co-pollutant reductions, it was also stated that a next-best version of this policy would mandate only the reduction of GHG emissions by power plants that affected EJ communities.[8]

RGGI, AB32, and Waxman-Markey were market-based carbon trading programs and not only provided the context for, but perhaps also unintentionally constrained thinking on, the boundaries of an EJ climate change policy such as MER. Now there is a different context for a MER policy. Current popular climate mitigation policies have evolved into more technological and fuel-based approaches that can be risky for communities with fossil fuel infrastructure. These technologies include carbon capture and sequestration (CCS) and hydrogen mixing that will extend the life of power plants.[9] EJ communities with power plants are vulnerable to risky CCS technology and policy that has no planned mechanism to reduce emissions of harmful co-pollutants in those communities. It is imperative that federal, state, and local strategies used to reduce CO_2 emissions also reduce co-pollutants in EJ communities and not allow co-pollutant emissions to increase or even remain at existing levels in these areas.

As climate mitigation strategies and technologies evolve, so too must we evolve the proposed MER policy in order to address any negative aspects of these strategies that are forced on EJ communities, as well as to free it from any constraints placed on it by the previous political and policy context in which it was developed.

This study examines how climate mitigation policies that target GHG reductions should be leveraged to address existing inequalities in the form of co-pollutant emissions reductions from power plants in EJ communities. It proposes using mandatory emissions reductions (MER) policy to address climate and health-harming air pollution simultaneously.

- The ideal, most protective approach would mandate the closure of all fossil fuel–fired power plants in EJ communities and the transition to renewable energy to maintain safe and reliable electricity generation. This option will end emissions of power plant GHGs and co-pollutants in these areas.

- The next-best approach would require plants in EJ communities to reduce CO_2 and co-pollutant emissions simultaneously (irrespective of the carbon reduction goal or technology) using strategies that can achieve the greatest substantial reduction of co-pollutants. These strategies should not use carbon capture and utilization/sequestration, hydrogen mixing, or any other technology that increases localized burden in EJ communities.

- The least protective policy would require plants in EJ communities to achieve reductions in CO_2 without carbon capture and utilization/sequestration, hydrogen mixing, or any other technology that could contribute to localized pollution burdens. This policy assumes that a reduction in CO_2 would achieve a reduction in co-pollutants without any requirement for co-pollutants, and therefore is the least protective policy.

Identifying and Prioritizing Power Plants for MER

To select plants for MER, stakeholders would begin by identifying which plants are located in EJ communities. This is the primary factor for deciding which power plants should be forced to reduce emissions. Other factors such as co-pollutant emissions and disproportionate environmental and health burdens could be considered when deciding which plants should reduce emissions first, or when prioritizing plants for further reductions. The sidebar below shows the potential framework to identify and prioritize plants for MER.

MER Framework

1. Identify plants located in EJ communities

We recommend that an MER policy start by identifying power plants located in EJ communities. There are different methods for doing this. While there is no universal definition of an "environmental justice community," our review of national, state, and local definitions used in EJ policies and programs reveals that most definitions incorporate indicators and thresholds relating to racial composition and socioeconomic status, to capture low-income communities and communities of color.[10] Thus, for this mandatory emissions policy proposal, we applied a set of disjunctive thresholds for race, limited English proficiency, and income to determine whether the area surrounding a given plant would be considered an environmental justice community. We also conducted ground-truthing with local EJ groups to determine whether any additional plants should also be included as targets of an MER policy.

2. Identify MER policy to use

The Ideal, Most Protective Policy

Mandate the closure of all fossil fuel–fired power plants in EJ communities and transition to renewable energy to maintain safe and reliable electricity generation. This option will end emissions of power plant GHGs and co-pollutants in these areas.

The Next-Best Policy

Require plants in EJ communities to reduce CO_2 and co-pollutant emissions simultaneously (irrespective of the carbon reduction goal or technology) using strategies that can achieve the greatest substantial reduction of co-pollutants. These strategies should not use carbon capture and utilization/sequestration, hydrogen mixing, or any other technology that increases localized burden in EJ communities.

The Least Protective Policy

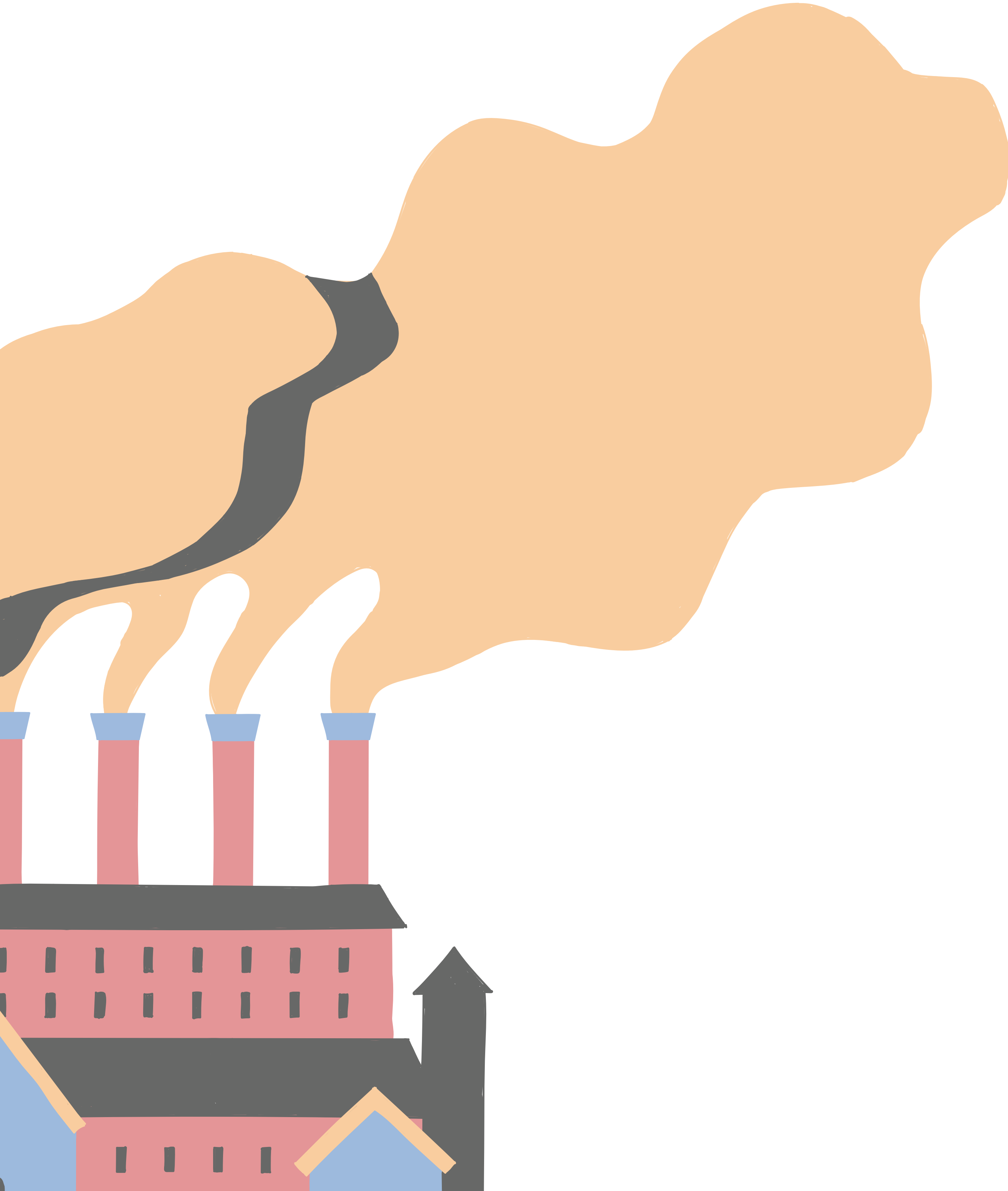
Require plants in EJ communities to achieve reductions in CO_2 without carbon capture and utilization/sequestration, hydrogen mixing, or any other technology that could contribute to localized pollution burdens. This policy assumes that a reduction in CO_2 would achieve a reduction in co-pollutants without any requirement for co-pollutants, and therefore is the least protective policy.

3. In the implementation of MER, consider other variables to help prioritize plants for the earliest application of the MER policy or for additional reductions.

Such variables could include:

- Plants with relatively high co-pollutant emissions (e.g., fine particulate matter, nitrous oxides, sulfur dioxide)
- Plants in areas with a high level of cumulative burden, using indicators such as traffic proximity and volume, air toxics respiratory hazard index, and air toxics cancer risk, among others
- Plants located in areas with high population density

This paper provides insight into the considerations and potential mechanisms for identifying power plants for MER policies. To understand the implications of MER in practice, we examin the location of power plants in New Jersey, Delaware, and Minnesota in relation to EJ communities. For each case study, we explore ways states can prioritize the application of MER to specific power plants within EJ communities based on a variety of factors. These factors include (1) some measure of the cumulative environmental burden already present in the plant's surrounding community, (2) the amount of CO_2 and co-pollutant emissions for each facility, and (3) other relevant factors raised with the input of local EJ stakeholders.[11]



III. BACKGROUND

The typical rebuttal to the adoption of MER in climate policies is that co-pollutants are already regulated under the Clean Air Act (CAA). However, this has been insufficient in protecting communities.[12] Climate mitigation policy should be used not only to fight climate change but also to address the disproportionate pollution found in EJ communities. A mandatory emissions reduction approach to climate mitigation policies provides a critical opportunity to address equity and climate justice more explicitly. Through MER, it is possible to reduce both GHG emissions and co-pollutants in a more targeted and intentional manner in EJ communities, thereby improving public health and addressing the climate crisis simultaneously. This approach ensures that communities most impacted by the fossil fuel industry will receive direct benefits from the energy transition.

Co-pollutants From Power Plants

Even small contributions of pollution to an already overburdened area can be problematic. Power plants, relative to other individual stationary sources, emit large amounts of health-harming air pollutants including sulfur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOCs), and hazardous air pollutants (HAPs).[13] Fine particulate matter ($PM_{2.5}$) is especially harmful to human health, as it has been linked to premature death, cardiovascular and pulmonary diseases, and asthma and is particularly concerning for EJ communities because they are disproportionately exposed to PM from a variety of local sources.[14] According to the World Health Organization (WHO), $PM_{2.5}$ has health impacts even at low concentrations, and no safe threshold has been identified. Therefore, WHO 2005 guidelines suggest attempting to achieve the lowest concentrations of PM possible.[15]

People with asthma are particularly sensitive to SO_2 emissions, which can make it difficult to breathe. High concentrations of SO_2 in the air can cause the formation of sulfur oxides (SOx), which can lead to particulate matter pollution.[16]
Research drawing on advanced statistical methods for causal identification has linked SO_2 from coal plants to adverse health outcomes.[17] NOx contributes to the production of smog and can lead to respiratory problems such as asthma symptoms, coughs, pulmonary disease, and chronic lung disease.[18] For this study, NOx, SO_2, and $PM_{2.5}$ power plant emissions were selected for analysis on the basis of data availability and their potential to exacerbate localized pollution and health impacts.

Consideration of co-pollutants is important in understanding how power plants are contributing to cumulative impacts, especially in EJ communities.

Consideration of co-pollutants is important in understanding how power plants are contributing to cumulative impacts, especially in EJ communities. Studies have shown a pattern of disproportionate siting of unwanted land uses associated with heightened amounts of pollution in EJ communities.[19] Current regulatory practices do not take into account these cumulative burdens when permitting and conducting other regulatory responsibilities, thereby leaving these communities under-protected.[20] EJ advocates have long suggested that chemical-by-chemical and source-specific assessments of environmental hazards do not reflect the multiple environmental and social stressors that harm the health of EJ communities.[21] Fossil fuel–fired power plants located in EJ communities are contributing to the overall pollution burden in these areas.

Some argue that mandating reductions for CO_2 will be sufficient to bring about co-pollutant reductions, citing research that has found that in the power sector, there is a positive relationship between CO_2 and co-pollutants.[22] However, prioritizing CO_2 reduction is not enough; we need to simultaneously prioritize co-pollutant reductions.

This is especially true in light of technologies like carbon capture and sequestration (CCS)—also called carbon capture, utilization, and storage (CCUS)—and hydrogen mixing, which are focused on "managing" carbon dioxide and are being heavily promoted through various federal policies and investments.[23] There is increasing concern that carbon capture and the combustion of hydrogen-blended fuel may in fact increase emissions of certain co-pollutants, like NOx, while supposedly having a smaller carbon footprint.[24] If power plants begin introducing CCS technology or hydrogen mixing, there is a risk that the correlation between CO_2 and co-pollutant emissions may change. In the context of a neighborhood with multiple sources of pollution, even small contributions to pollution are a problem, and therefore power plants in these areas should be prioritized for MER without the use of carbon capture and hydrogen mixing technologies.

Equity Implications of Existing Cap-and-Trade Climate Mitigation Policies

Market-based mechanisms such as carbon cap-and-trade have been a signature climate mitigation policy promoted by state and federal agencies and many national environmental organizations. Climate mitigation policies that rely on these mechanisms to reduce greenhouse gases have been the subject of debate by EJ scholars and advocates. One of the primary critiques is that they do not guarantee the reduction of co-pollutant emissions with localized health impacts specifically in EJ areas that are already facing cumulative and disproportionate burdens.[25]

The Clean Power Plan (CPP) policy released in 2015 under the Obama administration was modeled around a cap-and-trade system whereby states would target the electricity-generating sector for carbon reductions using a combination of system-wide caps and the issuance of tradable allowances. Similar carbon markets already exist in California as well as in the Northeast under the Regional Greenhouse Gas Initiative (RGGI). These climate policies are typically agnostic about the location of CO_2 emissions reductions and thus ignore the localized impact of co-pollutant emissions associated with power plants. In theory, cap-and-trade programs allow the market to determine where emissions reductions can happen most efficiently. Thus, some facilities may increase or maintain their current emissions of CO_2 by buying allowances or offsets, which can also maintain or increase criteria air pollution at the source in the host EJ community.[26]

Market-based policies like the CPP or RGGI are driven primarily by a concern for achieving market efficiency in efforts to gradually drive down overall CO_2 emissions at the lowest cost. This type of system is markedly different from a regulatory approach that would require mandatory reductions in the emissions of CO_2 and other air pollutants. Market-based climate mitigation policies are often not conducive to prioritizing equity considerations because these considerations may require additional costs or less flexibility in the approach to reducing CO_2 from particular plants.

Proponents of market-based approaches often cite the Montreal Protocol, which specifically targeted chlorofluorocarbons (CFCs) and was cost effective and successful in reducing CFC pollution.[27] Carbon dioxide, however, is ubiquitous and deeply entrenched in the global economy. The ultimate goal of many EJ advocates is not only to decarbonize the power sector but to dramatically transform it into a more just and democratic system of power production, transmission, and consumption. This will require not only driving down all emissions from the power sector (co-pollutants and GHGs) but also rethinking the energy sector altogether.[28]

Climate mitigation policies present a unique opportunity to address legacy air pollution at the source in EJ communities, driving down concentrations of co-pollutants while also supporting the reduction of GHG emissions and larger goals of transforming the overall power sector.

IV. METHODS

This study explores the application of a proposed mandatory emissions policy to the power sectors of three states: New Jersey, Delaware, and Minnesota. We selected these states on the basis of our access to available data regarding power plant emissions, familiarity with state laws and policies, and partnerships with in-state EJ organizations with an interest in advancing mandatory emissions reduction policy.[29]

Inclusion Criterion for Power Plants

This study uses the Regional Greenhouse Gas Initiative (RGGI) criterion for selecting a subset of plants in all three states for analysis.[30] RGGI-qualifying power plants are those that have a generating capacity of 25 MW or greater. New Jersey and Delaware are members of RGGI; therefore the study included power plants regulated under that trading scheme. Minnesota does not have a cap-and-trade or carbon pricing program, so the study applied the same RGGI capacity threshold to the state's plants for inclusion. For New Jersey, a list of RGGI-qualifying plants was obtained from the state open data source. For Delaware and Minnesota, plants were identified using the U.S. Energy Information Administration's (EIA) database.[31] Based on our inclusion criterion, the study identified 73 power plants across the three states, with 33 plants in New Jersey, 10 in Delaware, and 30 in Minnesota.[32]

Demographic Analysis and Identification of Plants Located in EJ Communities

Power plant facilities generally occupy a large parcel of land. Because our methodology represented power plants as point features, the research team used satellite imagery to ensure that the location of the point representing a power plant and its emissions was placed close to or on top of a power plant smokestack rather than in a random part of the parcel of land. Plants were first verified against high-resolution satellite imagery within QGIS via the "QMS plugin" in order to ensure power plant points maintained "stack level" precision.[33] Plant points not positioned at stack locations within a plant parcel were rectified, a necessary condition for accurate proximity analysis. Once rectified, three-mile proximity buffers were developed for each plant.[34]

Each three-mile buffer area around the plant was considered the plant's "community" for purposes of this study.[35] To determine whether the plant's community would be considered an environmental justice community, we adopted a set of disjunctive criteria thresholds based on three demographic indicators: percentage of People of Color (POC), percentage of low-income households, and percentage of households with limited English proficiency. A plant was considered to be located in an environmental justice community if its host community met any one (or more) of the thresholds we established for each indicator.

EJ Community Threshold Criteria

The indicators and thresholds applied in this study to qualify a community as an environmental justice community were based on those used in the landmark environmental justice law passed in New Jersey in 2020, NJ S232.[36] This law defines "overburdened communities" as those census block groups where 35 percent of households are low-income (i.e., with an income below or equal to twice the federal poverty level), or 40 percent of residents identify as People of Color (all individuals except those who list their race as non-Hispanic white alone), or at least 40 percent of households are linguistically isolated (no one age 14 and older speaks English "very well"). Because Delaware and Minnesota have state averages for income similar to New Jersey's, income thresholds were set at the same level (35 percent). For POC and linguistic isolation, this analysis used the New Jersey thresholds for Delaware because of their similar state averages, but the analysis set Minnesota's thresholds for POC and linguistic isolation at 20 percent and 12 percent, respectively, closer to the state's own (lower) averages. EJ community threshold definitions for all three states are shown in Table 1.

Table 1: EJ Thresholds for New Jersey, Delaware, and Minnesota

State	**POC Threshold** (all individuals except those who list their race as white alone and not Hispanic)	**Income Threshold** (household at or below 200% of the federal poverty line)	**Linguistic Isolation Threshold** (households with limited English proficiency, in which no one age 14 and older speaks English "very well")
New Jersey	40%	35%	40%
Delaware	40%	35%	40%
Minnesota	20%	35%	12%

As mentioned above, plants were considered to be located in EJ communities if their host community (the three-mile buffer area surrounding the plant) met the threshold for any one of the three socio-demographic characteristics listed above. Data for the socio-demographic characteristics were obtained from the 2019 version of the U.S. Environmental Protection Agency's (EPA) EJScreen dataset, available at the census block group level.[37] Given that the three-mile areas often cut across census block group boundaries rather than containing them in their entirety, a method known as geographic apportionment was used to estimate the demographics of "cut" block group pieces.[38] The overall demographics of each three-mile community area were then estimated from the demographics of the pieces it contained, and the above thresholds were applied to determine whether the community qualified as an environmental justice community.

Based on the thresholds and indicators above, 28 (85 percent) of plants in New Jersey were located in EJ communities, 10 (100 percent) of plants in Delaware were located in EJ communities, and 9 (30 percent) of plants in Minnesota were located in EJ communities. Overall, of the 73 plants across all three states with a capacity of 25 MW or greater, 47 (64 percent) were located in EJ communities.

For each state, we also analyzed the number and characteristics of individuals living within three miles of a power plant. EJScreen 2019 data were used for this purpose. In instances where a power plant's three-mile radius overlapped with another power plant's three-mile radius, the QGIS "dissolve" function was used to ensure that populations were not double-counted. Mapping of "urban areas" utilized urban area shapefiles from the U.S. Census, which determines urban areas on the basis of population density. The research team used 2019 urban area data.[39]

A Note About Methodology for Selecting Plants in EJ Communities

In this study, we considered the three-mile area surrounding a given plant as the relevant community area and applied a set of disjunctive thresholds for the percentage of People of Color, the percentage of linguistically isolated households, and the percentage of low-income households to determine whether it would be considered an environmental justice community. An alternative method for identifying plants located in EJ communities is to assess whether any one of the census tracts or census block groups within the three-mile radius of a plant meets the threshold for being considered an environmental justice community. This approach could result in identifying a slightly different set of plants as located in EJ communities and could be more protective of communities in situations where averaging out the demographics across a three-mile catchment areas loses sight of smaller vulnerable communities.

With respect to the thresholds and indicators used to define an EJ community, we have selected one specific set of thresholds and indicators based on state-specific socio-demographic characteristics. This choice does not explicitly account for the presence or concentration of environmental or health stressors or social vulnerability that may make a community more susceptible or vulnerable to pollution impacts. A variety of other possible indicators could be used to define an EJ community. However, the study team chose to focus on race and income as these factors have been shown to be important predictors of environmental inequality and are recommended by the Equitable and Just National Climate Platform.[40] In any event, we recommend ground-truthing indicators, thresholds, and final plant selection with local EJ communities, as each context is unique and requires its own consideration.

CO_2 and Co-pollutant Emissions Profiles for Plants

For each plant meeting the capacity inclusion criterion (25 MW or greater), annual emissions data were obtained for three criteria air pollutants, nitrogen oxides (NOx), sulfur dioxide (SO_2), and fine particulate matter ($PM_{2.5}$), as well as carbon dioxide (CO_2). The study sought to collect the most recent publicly available data, and data sources varied by state. In Minnesota, $PM_{2.5}$ data from 2018 were obtained through the Minnesota Pollution Control Agency, and in New Jersey, $PM_{2.5}$ data for 2018 were collected through the New Jersey Department of Environmental Protection.[41] $PM_{2.5}$ data for Delaware were not publicly available, and therefore the EPA's ECHO (Enforcement and Compliance History Online) database was the source of $PM_{2.5}$ data for this state. The most recent $PM_{2.5}$ data in ECHO were for 2017.[42] Annual emissions totals for NOx, SO_2, and CO_2 were obtained from the EIA for 2018.[43]

The rate of emissions was calculated for each of the plants with available $PM_{2.5}$ data as pounds of $PM_{2.5}$ per megawatt-hour based on the generation capacity for each plant (data not shown, but available upon request). This rate was also calculated for CO_2 emissions.

Power plants in each state for which PM data were missing were excluded from the PM analysis. In New Jersey 2 of 33 plants were excluded; in Delaware 2 of 10 were excluded, and in Minnesota 1 power plant out of 30 was excluded from the PM analysis.[44]

Understanding Burden Around Each Power Plant

We wanted to contextualize the conditions in the locations where power plants are located and provide a potential indicator of burden or disproportionate impacts within each power plant catchment area. To this end, we analyzed EPA's EJScreen indicators of (1) air toxics cancer risk, (2) air toxics respiratory hazard, and (3) traffic proximity and volume.[45]

Definitions and data sources for each indicator are as follows:[46]

1. Air toxics cancer risk is the estimated lifetime cancer risk from inhalation of analyzed carcinogens in ambient outdoor air, as calculated by the 2014 EPA National Air Toxics Assessment (NATA). The indicator is calculated at the census tract level, and the tract-level value is assigned to each of the census block groups (CBGs) contained within the tract.

2. Air toxics respiratory hazard is the respiratory hazard from analyzed carcinogens in ambient outdoor air, as calculated by the 2014 EPA NATA. A hazard index is derived from summing chronic, non-cancer hazard quotients for individual air toxics that cause similar adverse health effects. The value calculated at the census tract level is assigned to each block group contained within it.

3. Traffic proximity and volume is the count of vehicles (average annual daily traffic) on major roads within 500 meters, divided by the distance in meters, calculated from 2017 U.S. Department of Transportation traffic data.

Three custom "analysis area" geographies were established, one for each state. The analysis area for a given state consisted of the CBGs within the state plus all CBGs in bordering states that fall, wholly or partially, within three miles of the state's boundary.

For each of the three indicators, we averaged the individual CBG burden values in every CBG partially or wholly contained within the three-mile buffer area around a power plant. This resulted in each power plant having an average value for cancer risk, respiratory hazard, and traffic. The plant's average values were compared with all the CBGs within the custom analysis area of its respective state. The average value was considered a "high burden" if it was in the 75th percentile or above relative to all the CBGs in the analysis area.

Finally, to complement this analysis, a series of burden maps was also developed to show the power plant locations and the percentile rank of each CBG for each burden indicator in each of the three states.

Collaborative Project Process

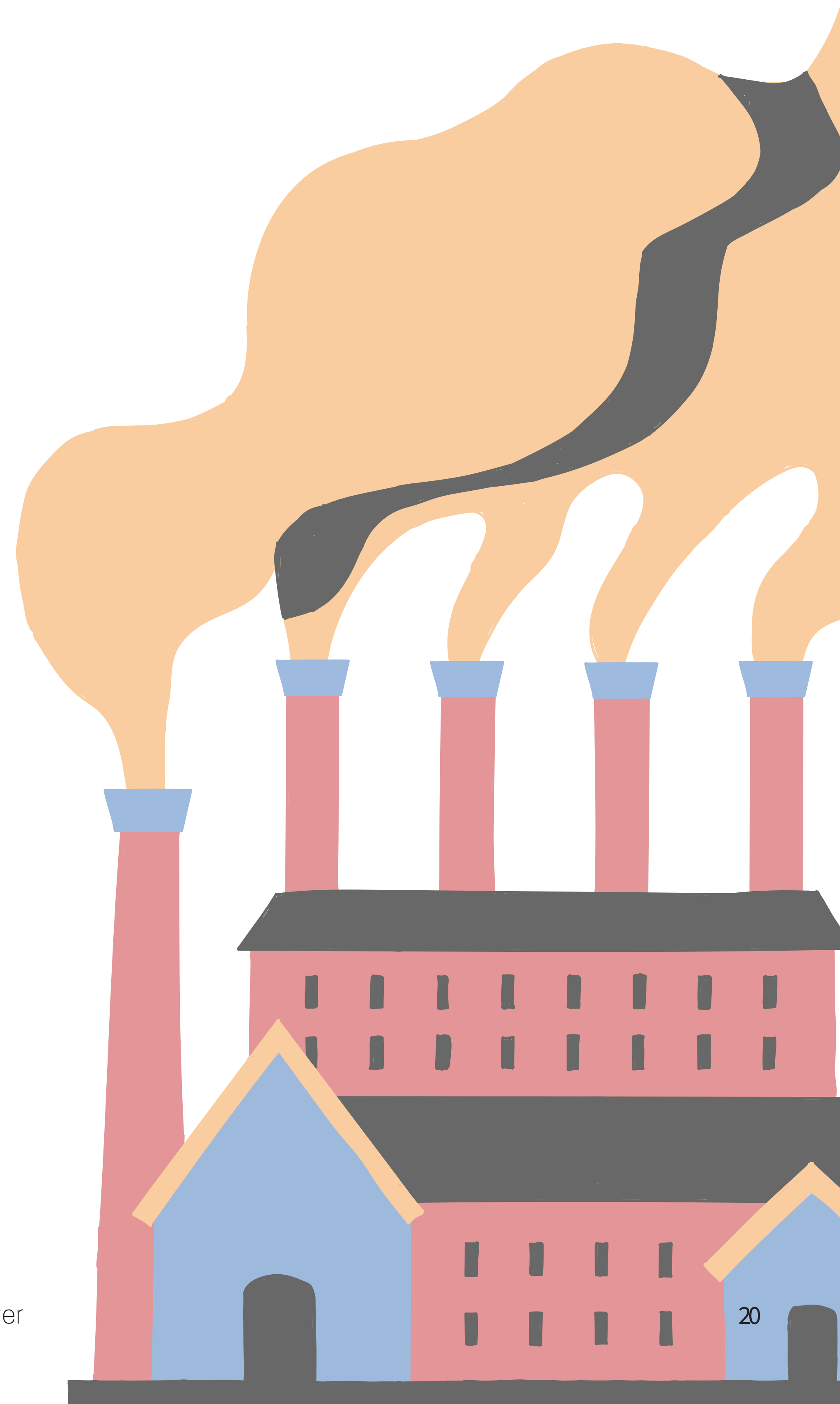
The scope of this study and the accompanying analysis were developed with input and involvement of key stakeholders representing EJ communities in the three case study states. This iterative process of gathering feedback during each phase of the project contributed to the study's overall direction, methodology, and specific focus areas. For example, the original list of power plants obtained from state and national databases was cross-checked with state EJ representatives to ensure accuracy and comprehensiveness. Additionally, the thresholds and characteristics used to define an EJ community were based on definitions advanced by EJ movement leaders (through the New Jersey environmental justice law and the Equitable and Just National Climate Platform). State EJ stakeholders also had the opportunity to provide feedback on the final list of plants identified as being located within EJ communities and therefore recommended as targets of an MER policy.

Study Limitations

The data that we used for $PM_{2.5}$, NOx, and SO_2 emissions were from 2017 and 2018, representing the most up-to-date emissions data available at the time we conducted our study. We also used EJScreen 2019, which itself draws on the U.S. Census's five-year estimates for the period 2013 to 2017. Application of an MER policy going forward would benefit from using more recent data and could consider other hazardous air pollutants beyond the three we examined.

We took the emissions data at face value, as it was beyond the scope of this study to address possible deficiencies in monitoring or issues with self-reported data. Additionally, we limited our burden analysis to three specific indicators. Since we conducted this study, new tools (including a newer version of U.S. EPA's EJScreen) have been introduced that better capture cumulative impacts. Future applications of the MER framework could draw on these tools to inform plant prioritization.

Finally, our proposed definition of an EJ community was based on quantitative thresholds and therefore drew distinctions between locations right below and right above the thresholds that may in fact be very similar. To help mitigate the arbitrariness of a strict numerical cutoff, we introduced ground-truthing into our methodology to help ensure that plants that should have been included for MER were not left out.



V. NEW JERSEY

Natural gas makes up the majority of New Jersey's utility-scale electricity generation.[47] Beginning in the mid-1990s, New Jersey began building more natural gas–fired power plants and shutting down many coal plants.[48] This analysis looked at the 33 RGGI-qualifying plants in the state, all but five of which are natural gas–fired. Many of these new plants, built in the mid 1990s or later, were sited in communities whose residents are predominantly People of Color, often near major transportation and industrial corridors (see Table 2). Although many tout natural gas plants as cleaner than coal-fired plants, they still produce significant absolute amounts of air pollution that can contribute to public health impacts, particularly for overburdened and EJ communities.

New Jersey was an original participant in the RGGI program that began in 2009. However, in 2012, then governor Chris Christie withdrew the state from the program. In 2019, Governor Phil Murphy directed the state to rejoin RGGI.[49] EJ organizations in New Jersey have objected to the state's participation in the RGGI program, citing concerns about the absence of equity goals and inattention to co-pollutant reductions in EJ communities. Currently, New Jersey's RGGI-enabling legislation does not ensure emissions reductions of co-pollutants in EJ communities.[50]

In September 2020, Governor Murphy signed into law the landmark EJ bill S232.[51] This bill represents a precedent-setting approach to tackling EJ and cumulative impacts because it is the first of any adopted state or federal legislation to include an explicit mandate to deny permits for certain polluting facilities in EJ communities on the basis of cumulative impacts. Covered facilities include new fossil fuel–fired power plants. Existing power plants are also subject to the law under the renewals and expansions provision, whereby permit renewals and permits for expansion will be subject to conditions that can help mitigate direct and indirect contributions to stressors in overburdened communities. The law denotes the communities to be protected as "overburdened communities" and defines them as census block groups that meet certain thresholds for race, income, and limited English proficiency. Extensive community input went into the designation of the law's thresholds, which we adopted as our thresholds to identify EJ communities in our analysis.

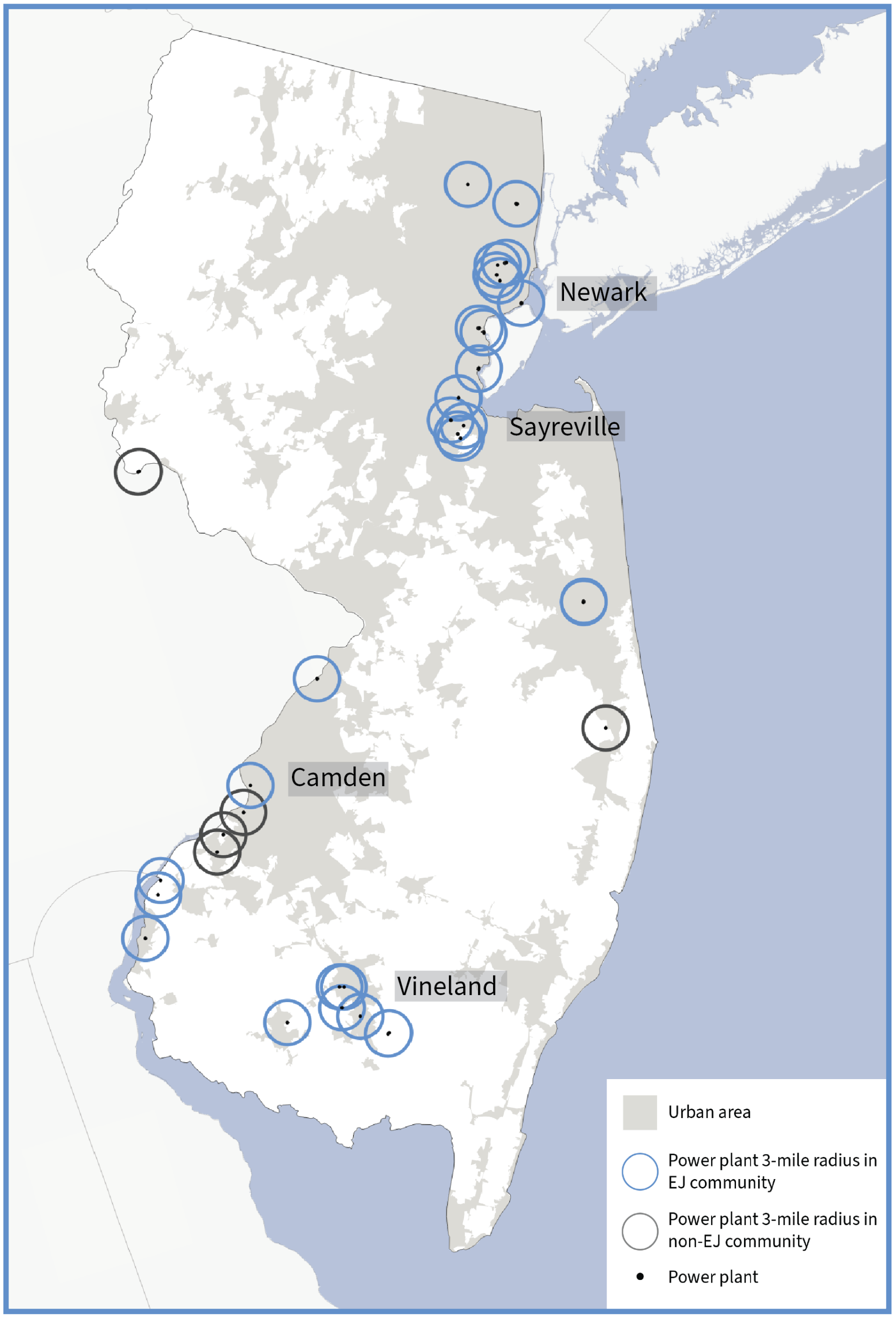
Results

New Jersey has 33 power plants that are regulated under RGGI (see Table 2).[52] The largest is the Linden Generating Station, with a nameplate capacity of 1,740 MW, and the smallest is West Station, an old diesel oil plant built in the 1970s with a nameplate capacity of 27 MW. The average capacity for RGGI-qualifying plants in the state is 405 MW.

Of the 33 power plants, 28 (85 percent) are located in an EJ community, based on the demographics of their three-mile surrounding areas and our EJ community thresholds (see Map 1). According to the EIA, 11 power plants were constructed in New Jersey between 2000 and 2018, and 10 of them are in EJ communities. Some cities host multiple plants. For example, there are three plants in Newark, four in Vineland, and three in Sayreville, all of which are EJ communities.

Across the state, 1.9 million people live within three miles of at least one of the 33 RGGI-qualifying plants. Of these people, 36 percent are low-income and 63 percent are People of Color. When compared with the state averages of 22 percent and 29 percent, respectively, we see that People of Color and low-income individuals are overrepresented and disproportionately burdened by these power plant emissions.

Map 1: New Jersey RGGI-Qualifying Power Plants and Proximity to EJ Communities



Particulate Matter Emissions

Two RGGI-qualifying plants, Clayville and Lakewood, did not have 2018 $PM_{2.5}$ data. For the 31 RGGI-qualifying plants with available 2018 PM data, $PM_{2.5}$ total annual emissions range from 60 pounds to 181,740 pounds with a mean of 35,071 pounds.[53] Of the 10 highest emitters of $PM_{2.5}$, 9 are located in EJ communities. The highest emitters of $PM_{2.5}$ are concentrated in the Northeast corridor of New Jersey and tend to be located in the most densely populated areas of the state. Table 2 shows New Jersey's RGGI-qualifying power plants in order of $PM_{2.5}$ emissions with each plant's location, fuel source, capacity, co-pollutant emissions, and CO_2 emissions, as well as surrounding demographics.

The yellow line in Table 2 marks New Jersey's top 10 $PM_{2.5}$ emitters. Sixty-four percent of the 635,144 people living within a three-mile radius of these top emitters are People of Color, and 32 percent are low-income. The Linden Cogeneration Facility, located in the city of Linden in Union County, emitted the highest amount of $PM_{2.5}$ pollution at nearly 182,000 pounds in 2018. The facility was built in 1992 and generated 5,546,963 MWh of electricity in 2018. Despite not being the oldest or largest plant in New Jersey, it still emitted the most $PM_{2.5}$. Residents within three miles of this facility are mostly People of Color (80 percent), and 40 percent are low-income.[54] The next-highest emitter of $PM_{2.5}$ is the Bergen Generating Station located in Bergen County, which emitted more than 170,000 pounds of $PM_{2.5}$ in 2018, exposing nearly 121,000 people within a three-mile radius, of whom 64 percent were People of Color and 28 percent were low-income.

Sixty-four percent of the 635,144 people living within a three-mile radius of these top emitters are People of Color, and 32 percent are low-income.

Four of New Jersey's five non-EJ plants, Forked River, Mickleton, Gilbert, and Eagle Point, are among the state's oldest plants, coming online between 1974 and 1990. Generally, these older plants have a higher rate of $PM_{2.5}$ emissions, indicating that they are less efficient than newer plants. However, they also have the lowest generation, likely because many are located in more rural areas and service fewer people. Within three miles of the five non-EJ plants, there are 73,456 people, 15 percent of whom are People of Color and 22 percent of whom are low-income.

Table 2: New Jersey RGGI-Qualifying Power Plants in Order of $PM_{2.5}$ Emissions (Pounds) in 2018*

Power Plant	City	Fuel Source	Year On-line	Capacity (MW)	$PM_{2.5}$ Emissions (lbs.) 2018	SO_2 Emissions (lbs.) 2018	NOx Emissions (lbs.) 2018	Total Co-pollutants ($PM_{2.5}$+NOx+ SO_2) (lbs.)	CO_2 Emissions (lbs.) 2018	Total Persons Within 3-Mile Radius	% Low-Income	% People of Color
Linden Cogeneration Facility	Linden	NG	1992	974	181,740	276,640	13,091,240	13,549,620	6,209,864,100	111,111	39.70	80.15
Bergen	Ridgefield	NG	1959	1,401	170,500	195,540	1,857,780	2,223,820	3,572,991,820	120,937	27.57	64.13
Red Oak Power, LLC	Sayreville	NG	2002	821	109,660	17,500	8,169,680	8,296,840	3,569,982,280	40,694	20.98	42.52
Linden Generating Station	Linden	NG	1995	1,740	106,840	191,480	10,005,760	10,304,080	4,603,621,780	94,643	37.20	74.81
Bayonne Energy Center	Bayonne	NG	2012	644	63,620	102,220	2,730,820	2,896,660	950,575,260	105,810	36.36	61.47
Sewaren Generating Station	Sewaren	NG	2018	610	61,988	8,300	3,869,700	3,939,988	1,689,607,080	79,130	22.50	52.62
Carneys Point	Carneys Point	C	1994	285	55,636	1,876,540	1,211,500	3,143,676	2,050,191,540	9,057	39.03	40.46
Newark Energy Center	Newark	NG	2015	735	55,320	18,020	8,257,180	8,330,520	3,611,491,260	120,003	40.90	75.82
West Deptford Energy Station	West Deptford	NG	2014	755	52,560	15,940	1,115,320	1,183,820	3,223,354,060	15,511	23.09	20.20
Woodbridge Energy Center	Woodbridge Township	NG	2015	773	49,960	19,120	8,543,160	8,612,240	3,834,655,380	63,525	27.75	68.92
Logan Generating Plant	Swedesboro	C	1994	242	39,560	806,760	301,960	1,148,280	1,370,201,300	8,474	39.95	33.52
North Jersey Energy Associates	Sayreville	NG	1991	430	33,920	3,480	1,621,080	1,658,480	677,374,720	45,579	20.10	40.50
Ocean Peaking Power	Lakewood	NG	2003	383	24,300	1,580	860,040	885,920	325,492,440	47,869	40.35	24.38
Cumberland Energy Center	Millville	NG	1990	231	23,700	38,620	727,500	789,820	248,863,960	3,442	40.60	40.73
Kearny Generating Station	Kearny	NG	2001	605	10,480	1,780	972,640	984,900	357,352,360	168,413	37.72	76.84
Eagle Point Power Generation	Westville	NG	1990	252	7,560	2,640	1,236,280	1,246,480	532,083,040	33,303	29.49	25.40
Sherman Avenue	Vineland	DO	1991	113	7,060	8,800	271,680	287,540	95,947,980	14,612	46.57	64.18

Burlington Generating Station	Burlington	NG	2000	242	5,940	44,340	236,000	286,280	63,978,740	44,692	28.52	45.49
Howard M. Down	Vineland	NG	2012	68	5,660	5,220	268,100	278,980	96,741,460	25,139	42.45	64.65
Pedricktown Co-generation Plant	Pedrick-town	NG	1992	140	5,480	4,700	103,800	113,980	50,795,380	4,916	36.59	36.10
Newark Bay Cogen	Newark	NG	1993	152	4,560	160	78,860	83,580	35,238,760	129,674	41.72	78.44
Carll's Corner Energy Center	Upper Deerfield Township	NG	1973	84	2,420	7,740	77,440	87,600	24,551,140	15,883	48.44	70.41
Camden Plant Holding	Camden	NG	1993	173	2,100	260	112,460	114,820	53,075,740	138,756	41.03	50.51
Sayreville	Sayreville	NG	1972	212	1,900	11,620	42,500	56,020	8,660,080	35,201	21.55	46.39
EFS Parlin Holdings, LLC	Parlin	NG	1991	135	1,620	100	47,120	48,840	21,592,780	38,522	19.58	42.14
Mickleton Energy Center	Gibbstown	NG	1974	71	940	40	25,820	26,800	9,543,980	13,391	20.41	19.51
Forked River Power	Forked River	DO	1974	77	740	240	35,620	95,800	13,165,900	12,707	19.01	7.99
Gilbert Generating Station	Milford	NG	1989	512	740	16,560	78,500	36,600	20,194,420	3,016	16.71	2.98
West Station	Vineland	DO	1972	27	400	5,000	16,140	21,540	2,927,580	22,713	43.27	67.25
Elmwood Park Power - LLC	Elmwood Park	NG	1989	90	240	20	9,560	9,820	4,218,280	182,454	42.40	69.39
Essex	Newark	NG	1990	94	60	140	7,100	7,300	2,547,000	133,922	39.88	74.48
Clayville	Vineland	NG	2015	73	No Data	500	272,640	No Data	101,140,060	16,422	40.75	47.63
Lakewood	Lakewood	NG	1994	237	No Data	60,340	1,652,920	No Data	750,289,300	46,397	40.21	24.37

* Blue shading of a row denotes a power plant sited in an EJ community, and white shading indicates a power plant in a non-EJ community. The yellow line marks the 10 highest emitters of $PM_{2.5}$. In the "Fuel Source" column, NG refers to natural gas, C refers to coal, and DO refers to diesel oil.

Nitrogen Oxides and Power Plant Emissions

All of the 10 highest emitters of NOx pollution, according to 2018 U.S. EIA data, are in EJ communities (Table 2). NOx emissions for the 33 plants ranged from 7,100 pounds to 13,091,240 pounds in 2018. Thirty-three percent of the 793,250 people living within three miles of the 10 highest emitters of NOx are low-income and 63 percent are People of Color.

Power Plant Emissions in the Context of Cumulative Burdens in New Jersey

As described in the Methods section, an average value for each indicator was calculated for each power plant using all the CBGs partially or wholly contained within its three-mile radius. These average values were compared with the values across the CBGs in the New Jersey analysis area and were designated as "high burden" if they were in the 75th percentile or higher.

Fourteen of the 33 power plants have at least one high burden indicator, and all but one of these 14 are located in an EJ community (Table 3). Four of the 33 power plants are located in areas with high burdens for all three indicators. All of these plants are located in EJ communities. These results reflect the fact that power plant host communities that face high underlying burden also tend to be EJ communities. Maps 2, 3, and 4 display the locations of the power plants against the burden indicators. The maps show the high burdens faced by power plant host communities in the Northeast corridor and the southwest area of the state.

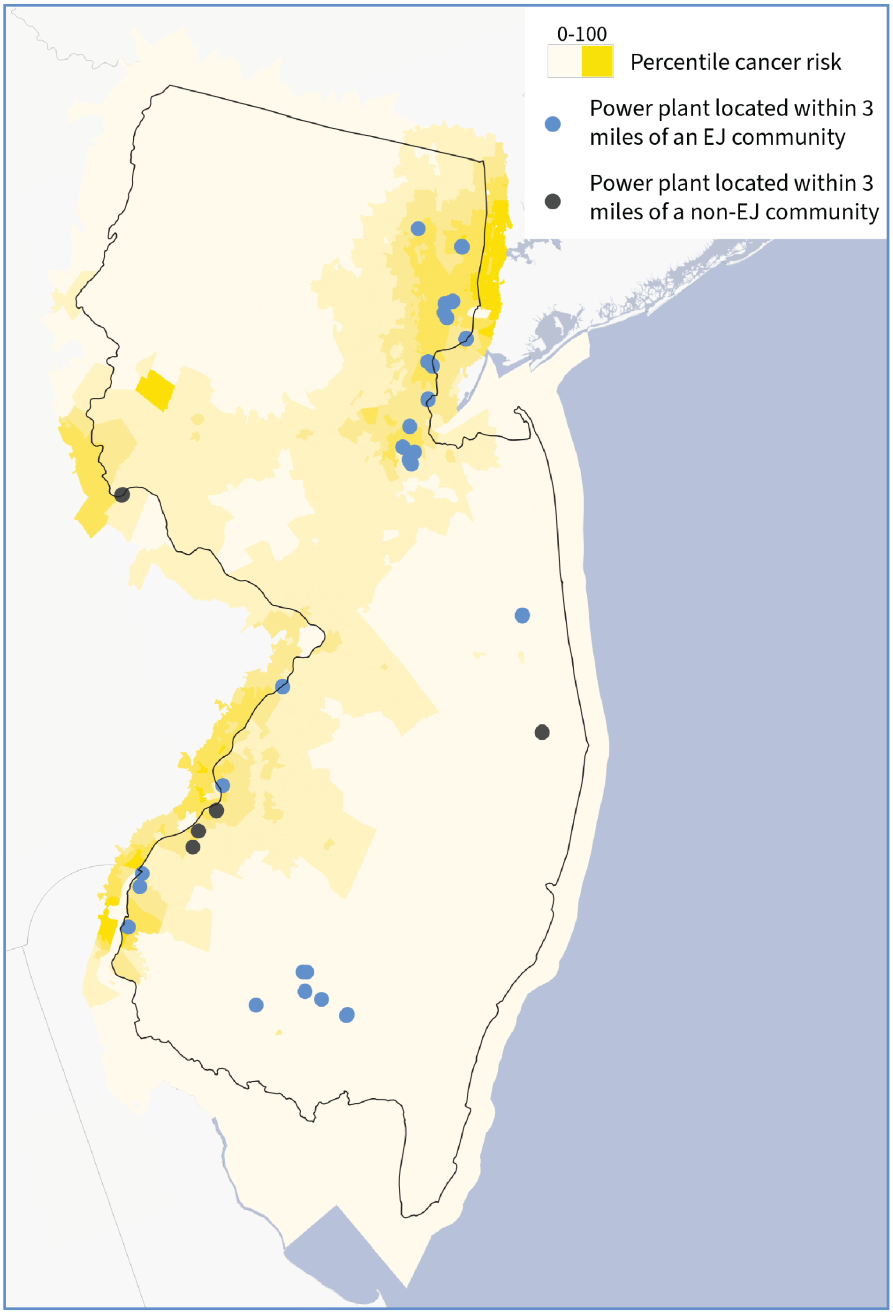
In New Jersey, an industrial corridor runs from the northeast to the southwest following the New Jersey Turnpike, and the high riskscape exemplifies the extent to which power plant host communities along this corridor are overburdened by pollution.

Table 3: Plants With High Burden Indicators Relative to the Analysis Area*

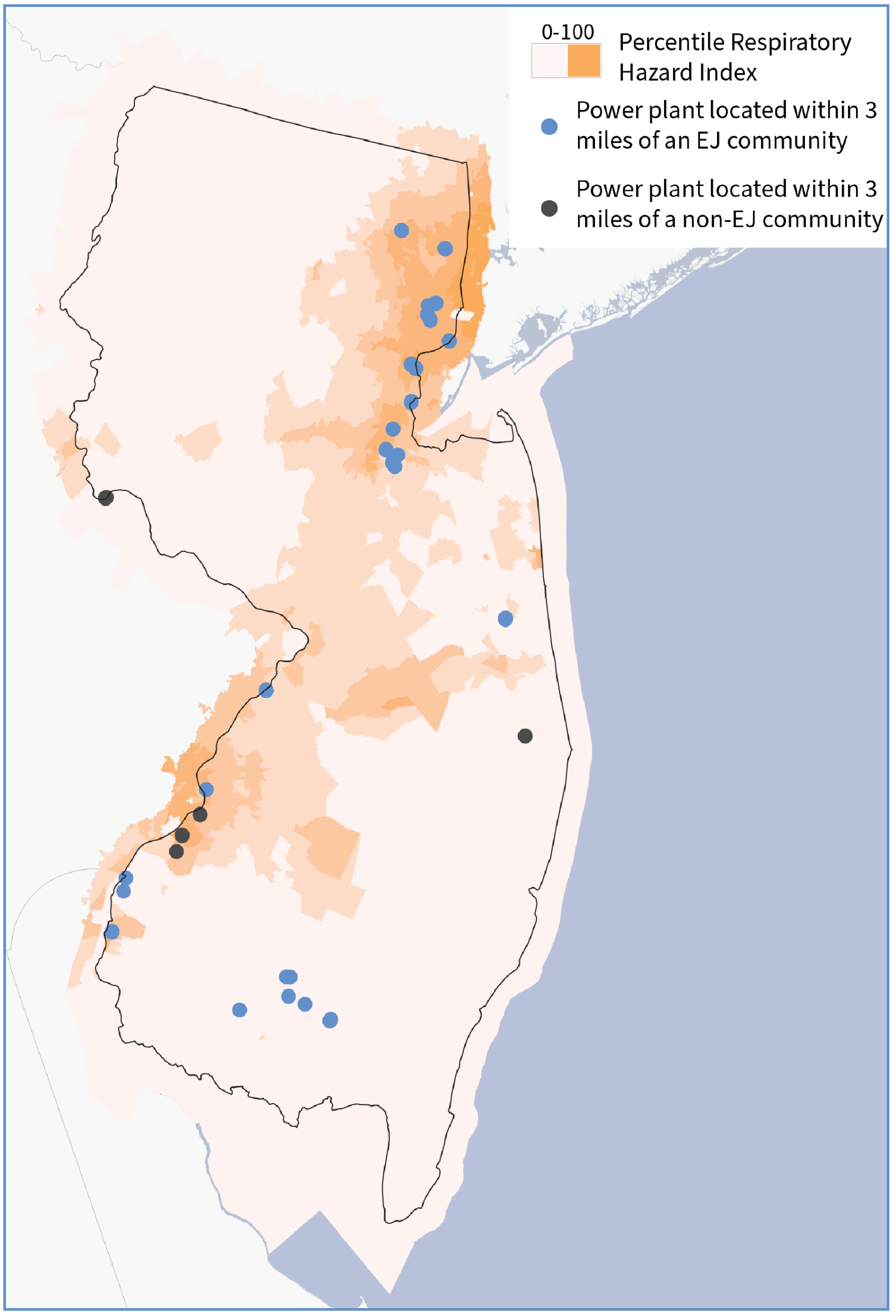
High burden for one indicator	High burden for two indicators	High burden for three indicators
Carneys Point **Bayonne Energy Center** **Elmwood Park Power LLC** Eagle Point Power Generation **Woodbridge Energy Center**	**Essex** **Newark Bay Cogen** **Logan Generating Plant** **Linden Cogeneration Facility** **Newark Energy Center**	**Bergen** **Linden Generating Station** **Camden Plant Holding** **Kearny Generating Station**

* Plants highlighted in blue are located in EJ communities.

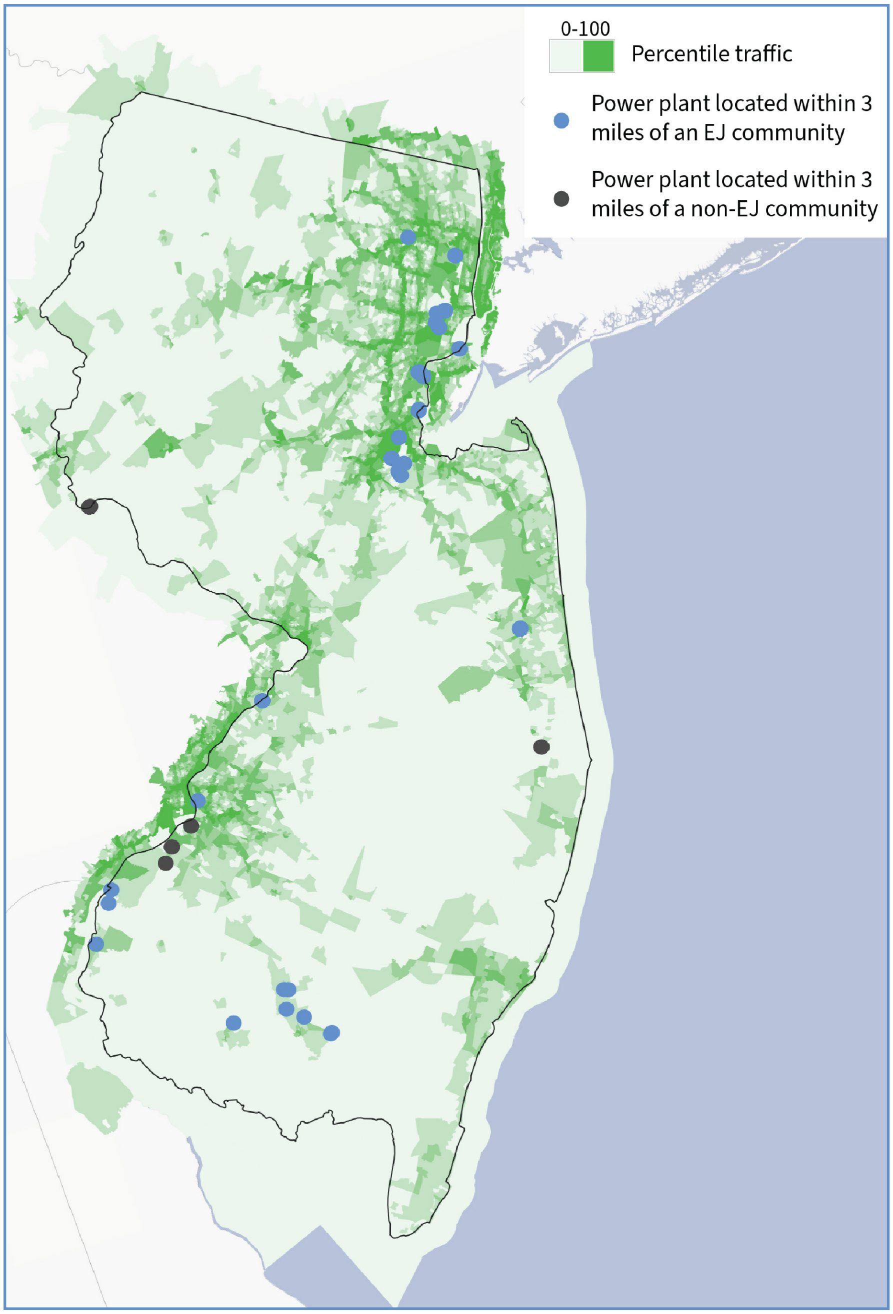
Map 2: Air Toxics Cancer Risk and RGGI-Qualifying Power Plant Locations, New Jersey Analysis Area



Map 3: Air Toxics Respiratory Hazard and RGGI-Qualifying Power Plant Locations, New Jersey Analysis Area



Map 4: Traffic and RGGI-Qualifying Power Plant Locations, New Jersey Analysis Area



Summary

Our analysis highlights 28 power plants of at least 25 MW capacity located in EJ communities in New Jersey. Their environmental justice host communities, where 1.8 million people live, would benefit from emissions reductions at these plants. Prioritizing which plants among these should be targeted for the earliest and/or deepest reductions could be useful, given the large number of plants. As discussed in our Introduction, the criteria for prioritization are: (1) indicators of the host communities' existing cumulative burdens, (2) the profile of emissions for each facility, and (3) other relevant factors raised by local EJ stakeholders.

Following this framework, Table 4 shows the identification and prioritization of plants for MER in New Jersey. For instance, the Linden Generating Station was identified as a plant with high co-pollutant emissions and is located in an area with high relative burden. It is also the largest natural gas plant in the state, with a nameplate capacity of 1,740 MW, and almost 100,000 people live within its three-mile radius, 75 percent of whom are People of Color. Thus, this plant stands out as a good candidate for the earliest and most robust application of an MER policy.

Table 4: Identification and Prioritization of Plants for MER in New Jersey

PLANT *IDENTIFICATION* FOR MER	
Plants located in EJ communities	
Bayonne Energy Center	Linden Cogeneration Facility
Bergen	Linden Generating Station
Burlington Generating Station	Logan Generating Plant
Camden Plant Holding	Newark Bay Cogen
Carll's Corner Energy Center	Newark Energy Center
Carneys Point	North Jersey Energy Associates
Clayville	Ocean Peaking Power
Cumberland Energy Center	Pedricktown Cogeneration Plant
EFS Parlin Holdings, LLC	Red Oak Power, LLC
Elmwood Park Power LLC	Sayreville
Essex	Sewaren Generating Station
Howard M. Down	Sherman Avenue
Kearny Generating Station	West Station
Lakewood	Woodbridge Energy Center
PLANT *PRIORITIZATION* FOR MER	
Top five emitters of total co-pollutants examined	
1. Linden Cogeneration	4. Newark Energy Center
2. Linden Generating Station	5. Red Oak Power, LLC.
3. Woodbridge Energy Center	
Plants in areas with high relative burden for all three burden indicators	
Bergen	Kearny Generating Station
Camden Plant Holding	Linden Generating Station

VI. DELAWARE

Delaware has 10 RGGI-qualifying power plants and produces the smallest amount of energy of any state in the country. The state's total energy consumption is the third lowest in the United States, partly due to its small population.[55] Yet it still used 70 times more energy than it produced in 2020.[56] Most of the plants are natural gas-powered because of a shift away from coal plants in the last decade.[57] Between 2010 and 2021, the proportion of generated electricity attributed to coal fell from 46 percent to 7 percent, while natural gas increased from 51 percent to 86 percent.[58] Hay Road, a natural gas plant in Wilmington, has the highest generating capacity in the state, at 1,100 MW. Christiana, a petroleum plant also in Wilmington, has the smallest at 52 MW capacity.

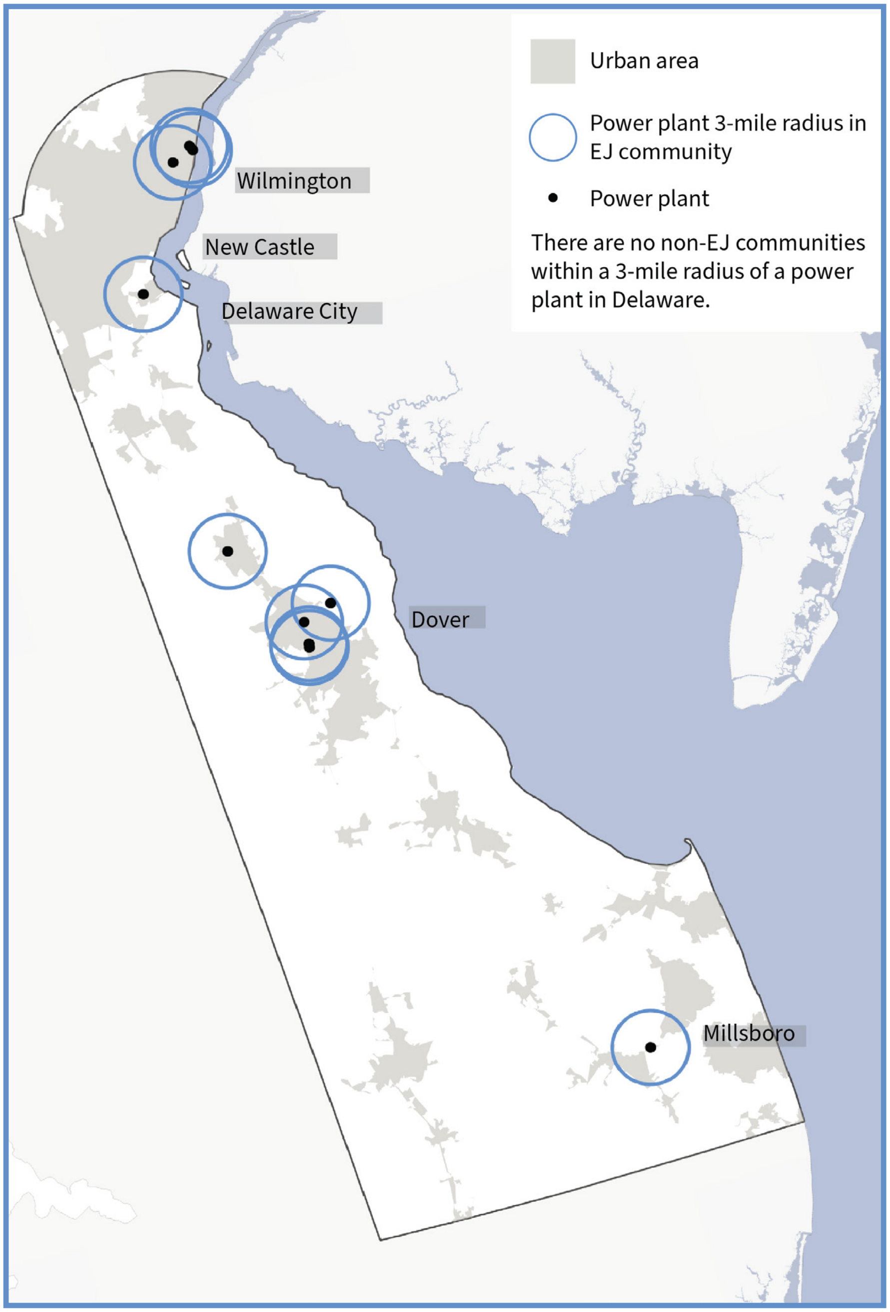
Delaware was an original signatory of RGGI and has since touted its GHG emissions reductions as a result of the program.[59] Delaware's CO_2 emissions from the electric power sector decreased from 6.4 million metric tons in 2005 to 1.8 million metric tons in 2021, representing a decrease of a little over 70 percent.[60] The state's transition from coal to natural gas has been a major factor in reducing its CO_2 emissions during this time.[61,62]

Results

All 10 of the RGGI-regulated power plants in the state are located in EJ communities (see Map 5). Approximately 213,000 people, or 21 percent of the population of the state, live within three miles of one or more RGGI-qualifying power plants. The demographic composition of this fence-line population is 35 percent low-income and 55 percent People of Color, exceeding the state averages of 27 percent and 40 percent, respectively.[63] Thus, low-income people and People of Color are disproportionately impacted by the pollution burden from these power plants. Some cities host multiple plants. For example, there are three plants in Wilmington and four in Dover, which are the two largest cities in the state. These two areas are densely populated and also have large concentrations of industry and transportation infrastructure. Dover, in particular, has a high concentration of manufacturing facilities.

The demographic composition of this fence-line population is 35 percent low-income and 55 percent People of Color, exceeding the state averages of 27 percent and 40 percent, respectively.

Map 5: Delaware RGGI-Qualifying Power Plants and Proximity to EJ Communities



Particulate Matter Emissions

At the time of analysis, $PM_{2.5}$ data was available for 2017 for 8 of the 10 RGGI-qualifying plants. Emissions ranged from 15 pounds to 150,695 pounds, with a mean of 27,584 pounds and a median of 1,363 pounds. All of the five highest emitters of $PM_{2.5}$ are located in EJ communities. Table 5 lists the power plants in Delaware with capacities of 25 MW or greater in order of 2017 $PM_{2.5}$ emissions.

The largest emitter of $PM_{2.5}$ is Edge Moor natural gas–fired power plant located in Wilmington, in New Castle County, which emitted 150,695 pounds in 2017. Edge Moor is located in a relatively densely populated and diverse part of the state. Of the 65,244 people living within three miles of Edge Moor, 69 percent are People of Color and 43 percent are low-income. Overall, power plants emitting the most $PM_{2.5}$ are concentrated in densely populated areas, especially in northern Delaware. The second-highest emitter of $PM_{2.5}$ is Indian River Generating Station, located in Dagsboro, which emitted approximately 63,527 pounds in 2017. This is unsurprising, since it is the only coal-fired RGGI-qualifying power plant in the state. The three-mile radius surrounding the plant is the least populated relative to the areas around the other power plants, with a population of 8,514; however, 36 percent of this population is low-income, exceeding the state average by 9 percentage points.

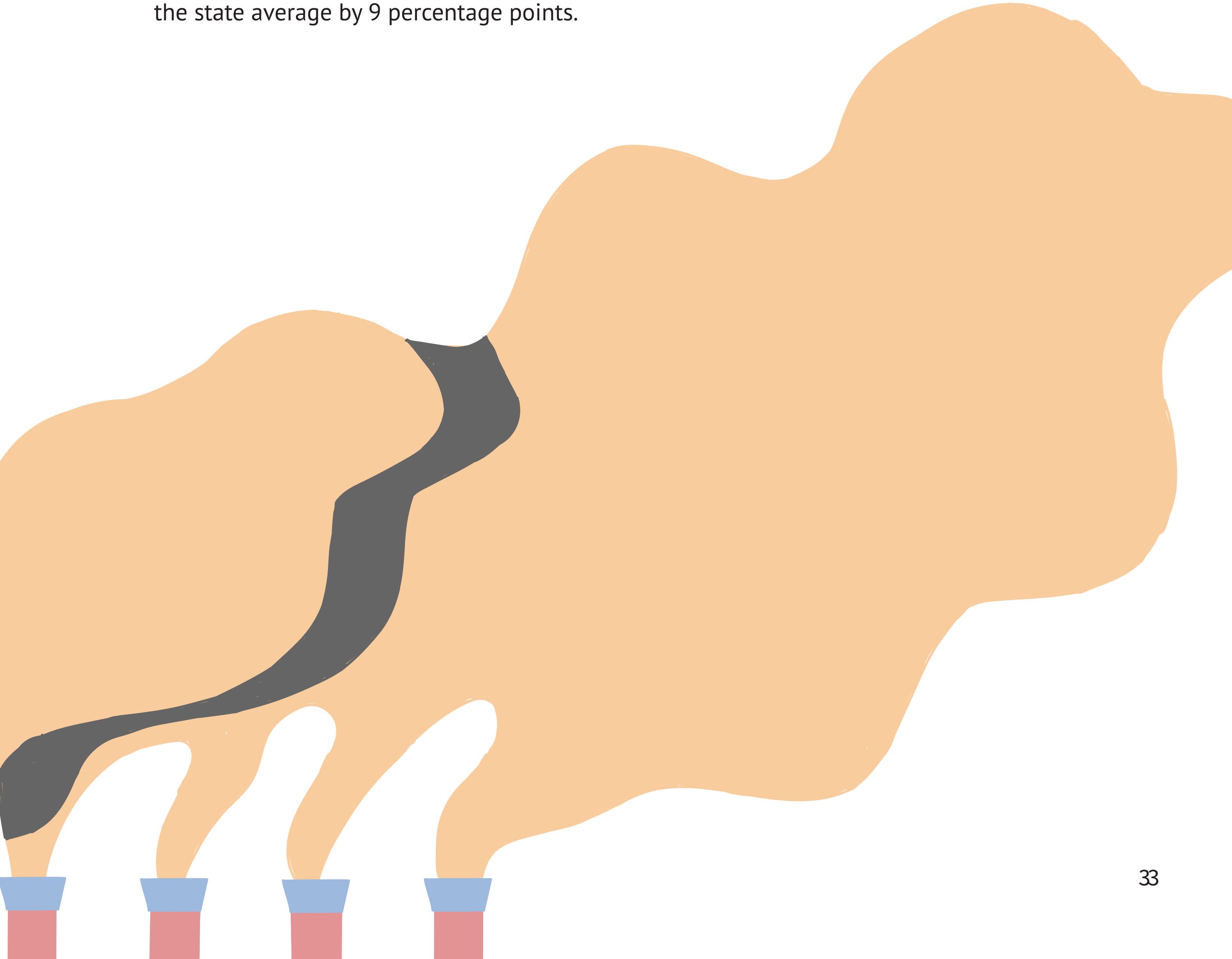


Table 5: Delaware's RGGI Power Plants in Order of $PM_{2.5}$ Emissions (Pounds) in 2017*

Power Plant	City	Fuel Source	Year Online	Capacity (MW)	$PM_{2.5}$ Emissions (lbs.) 2017	SO_2 Emissions (lbs.) 2018	NOX Emissions (lbs.) 2018	Total Co-Pollutants ($PM_{2.5}$+NOX+SO_2) (lbs.)	CO_2 Emissions (lbs.) 2017	Total Persons Within 3-Mile Radius	% Low-Income	% People of Color
Edge Moor	Wilmington	NG, PL	1954	710.3	150,695	379,429	597,067	1,127,192	464,050,380	65,244	43.26	69.38
Indian River Generating Station	Dagsboro	C, PL	1967	464.1	63,537	626,325	418,111	1,107,973	908,900,560	8,514	36.43	31.17
NRG Energy Center Dover	Dover	NG	1985	118	3,521	7,212	221,572	232,305	95,302,040	41,497	31.76	50.66
Warren F. Sam Beasley Generation Station	Smyrna	NG	2002	96	2,598	19,612	155176	177,386	45,471,280	23,772	28.58	40.16
Christiana	Wilmington	PL	1973	52	127	7,424	23,960	31,510	4,395,160	98,091	44.51	68.43
McKee Run	Dover	NG	1975	113.6	115	12,059	52,933	65,106	40,341,160	36,037	32.33	52.20
Delaware City Power Plant	Delaware City	NG	1956	324	65	12,006	3,918,541	3,930,612	1,418,624,000	21,055	16.29	50.78
Van Sant Station	Dover	NG	1991	45.1	15	5,060	40,647	45,722	12,023,900	41,349	31.69	49.39
Garrison Energy Center LLC	Dover	NG	2015	361	No Data	24,652	2,505,014	>2,529,666	1,119,699,080	21,833	36.70	57.42
Hay Road	Wilmington	NG	1989	1,193	No Data	259,586	6,125,877	>6,385,463	2,725,779,780	72,077	42.35	66.85

* Blue shading of a row denotes a power plant sited in an EJ community. (All Delaware power plants were sited in EJ communities.) In the "Fuel Source" column, NG refers to natural gas, C refers to coal, and PL refers to petroleum liquids.

Nitrogen Oxides Emissions

For the 10 RGGI-qualifying power plants in Delaware, NOx annual emissions, as reported in the EIA database, ranged from 23,960 pounds to 6,125,877 pounds in 2018, with an average of 1,405,890 pounds. The power plant with the largest emissions of NOx was the Hay Road plant in Wilmington. This natural gas–fired power plant emitted more than six million pounds of NOx in 2018. The surrounding three-mile radius is home to 72,077 people, 42 percent of whom are low-income and 67 percent of whom are People of Color.

Power Plant Emissions in the Context of Cumulative Impacts in Delaware

As described in the Methods section, an average value for each indicator was calculated for each power plant using all the CBGs partially or wholly contained within its three-mile radius. These average values were compared with the values across the CBGs in the Delaware analysis area and designated as "high burden" if they were in the 75th percentile or higher.

Table 6 shows the power plants in communities with high burden indicators. This provides some context about the level of underlying cumulative burden in the plants' host communities. The table indicates that 3 out of the 10 power plants are located in areas with high burden for air toxics cancer risk, air toxics respiratory hazard, and traffic.

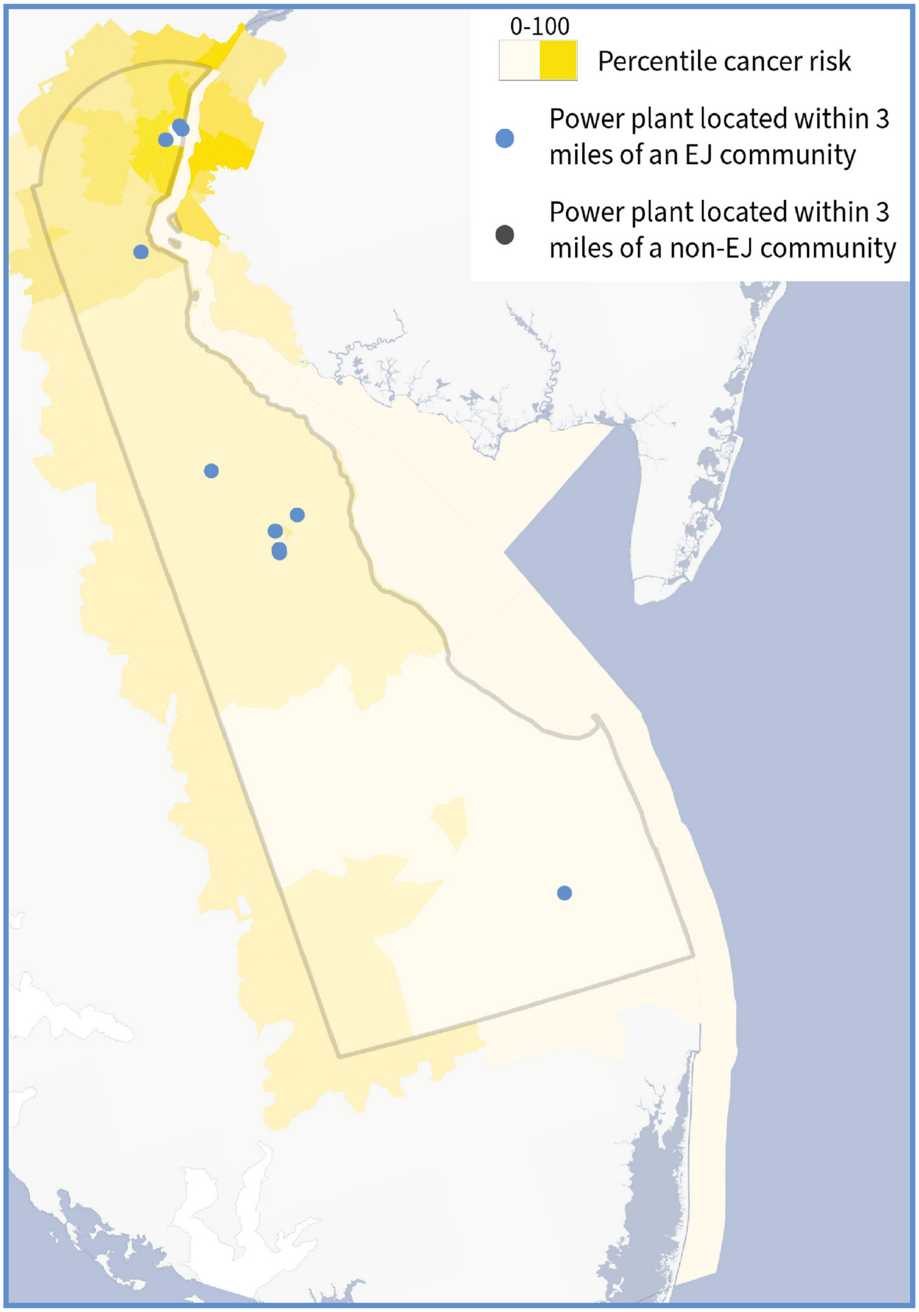
Table 6: Plants With High Burden Indicators Relative to the Analysis Area*

High burden for one indicator	High burden for two indicators	High burden for three indicators
None	None	**Edge Moor** **Christiana** **Hay Road**

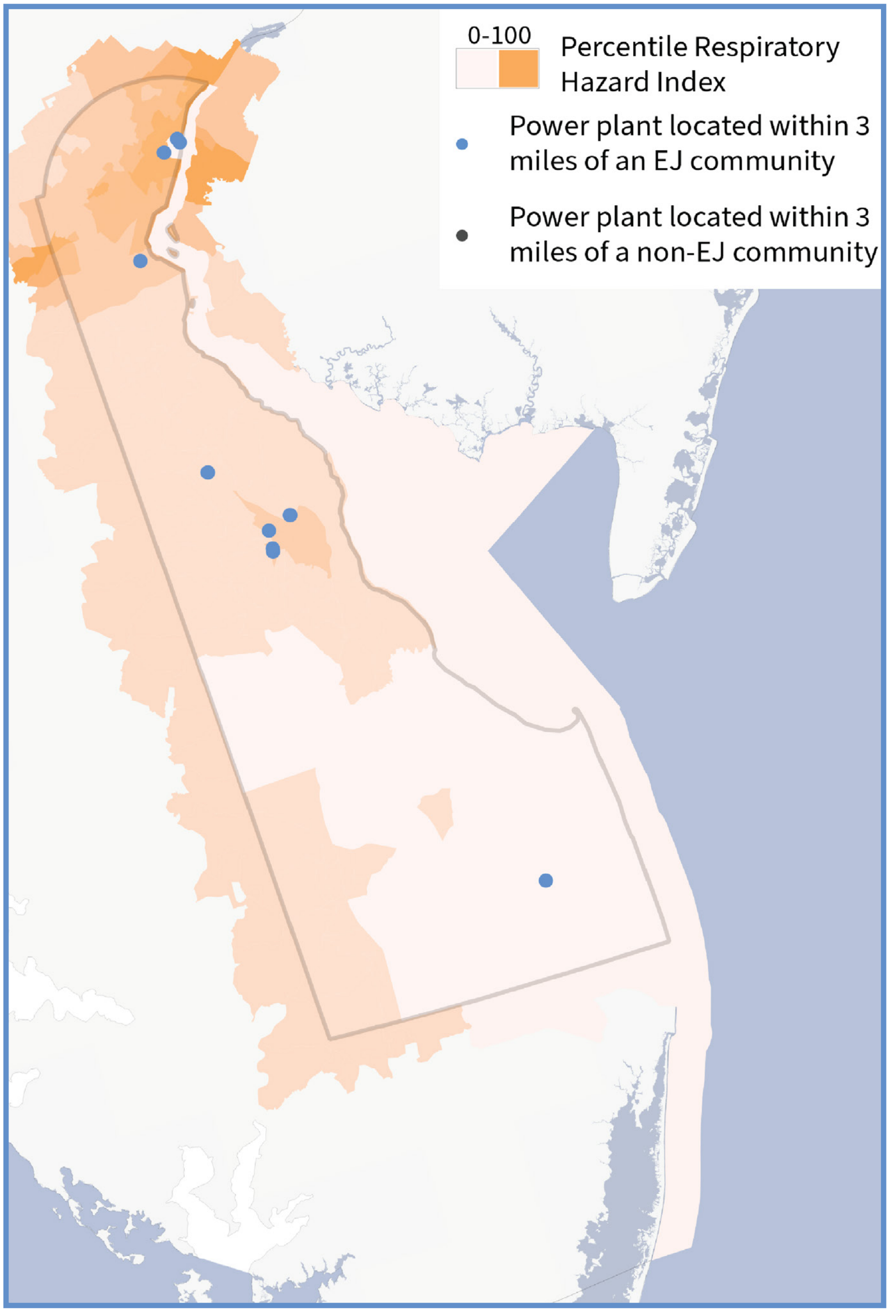
* Plants highlighted in blue are located in EJ communities.

All three of these plants are also located in EJ communities.
Maps 6, 7, and 8 show the locations of power plants and burden indicators. Consistently across the three indicators, the northeastern part of Delaware faces greater burdens. The power plants in this area include Edge Moor, Hay Road, Christiana, and Delaware City. This area of the state is also more industrialized and close to transportation and other infrastructure. The host communities located around plants in central Delaware near Dover also face relatively high burdens compared with the rest of the state.

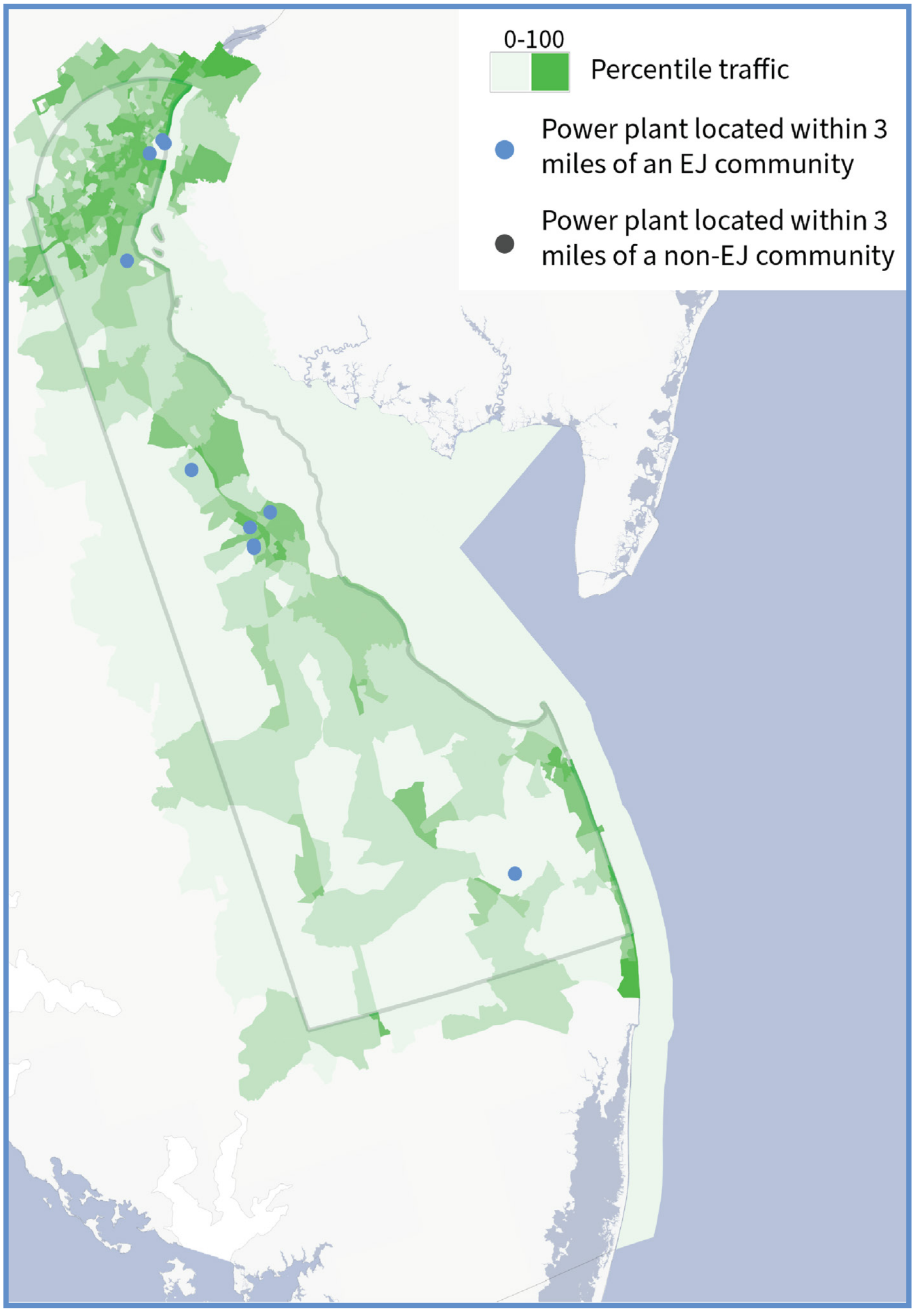
Map 6: Air Toxics Cancer Risk and RGGI-Qualifying Power Plant Locations, Delaware Analysis Area



Map 7: Respiratory Hazard and RGGI-Qualifying Power Plant Locations, Delaware Analysis Area



Map 8: Traffic and RGGI-Qualifying Power Plant Locations, Delaware Analysis Area



Summary

Our analysis found that all 10 power plants of at least 25 MW capacity in Delaware are located in EJ communities and would be recommended for MER. Following the identification of plants in EJ communities, we applied our framework for prioritization by considering the amount of co-pollutant emissions and indicators of burden in the host communities (see Table 7).

It is important to note that the Hay Road and Garrison Energy Center plants are among the top three emitters of total co-pollutants (i.e., aggregate amounts of $PM_{2.5}$, NOx, and SO_2), even without having available $PM_{2.5}$ data.

While we recommend that an MER policy be applied to all the power plants located in EJ communities, Edge Moor and Hay Road stand out as particularly good candidates for the earliest and most vigorous application of MER, given their emissions profiles and the high burdens faced by their host communities.

Table 7: Identification and Prioritization of Plants for MER in Delaware

PLANT *IDENTIFICATION* FOR MER	
Plants located in EJ communities Indian River Generating Station Edge Moor NRG Energy Center Dover Warren F. Sam Beasley Generation Station Christiana McKee Run Delaware City Power Plant Van Sant Station Garrison Energy Center LLC Hay Road	
PLANT *PRIORITIZATION* FOR MER	
Top five emitters of total co-pollutants examined	
1. Hay Road 2. Delaware City Power Plant 3. Garrison Energy Center	4. Edge Moor 5. Indian River Generating Station
Plants in areas with high relative burden for all three burden indicators	
Edge Moor Christiana	Hay Road

VII. MINNESOTA

Minnesota has 30 power plants with 25 MW or greater capacity and has an energy profile markedly different from those of New Jersey and Delaware. The state has a much larger share of non-hydroelectric renewable electricity generation than do New Jersey and Delaware; however, this includes some polluting energy sources such as biomass.[64] According to the EIA, "In 2020, renewables accounted for 29% of in-state electricity net generation, nuclear power supplied 26%, coal fueled 25%, and natural gas contributed 20%."[65] Compared with New Jersey (8 percent) and Delaware (7 percent), renewables account for a much greater share of electricity in Minnesota.[66]

About 25 percent of utility-scale electricity in Minnesota came from coal plants in 2020, down from 53 percent in 2011.[67] There are seven coal-fired power plants in Minnesota (two of them are mixed-fuel sources). Minnesota has plans to phase out coal-fired power plants and largely replace them with natural gas plants.[68] The Sherburne County coal plant in Becker is slated to close all three of its coal generators by 2030 and replace them with a solar megafarm.[69] Nevertheless, the state is much more reliant on coal than New Jersey and Delaware.

Minnesota is also demographically distinct among the case study states, with a lower proportion of People of Color than New Jersey and Delaware and with power plants located in less densely populated areas of the state. Statewide, 21 percent of the total population are People of Color and 22 percent are low-income.[70] Power plants are also much more evenly dispersed throughout the state, distinct from the concentration of plants in New Jersey's and Delaware's industrial corridors.

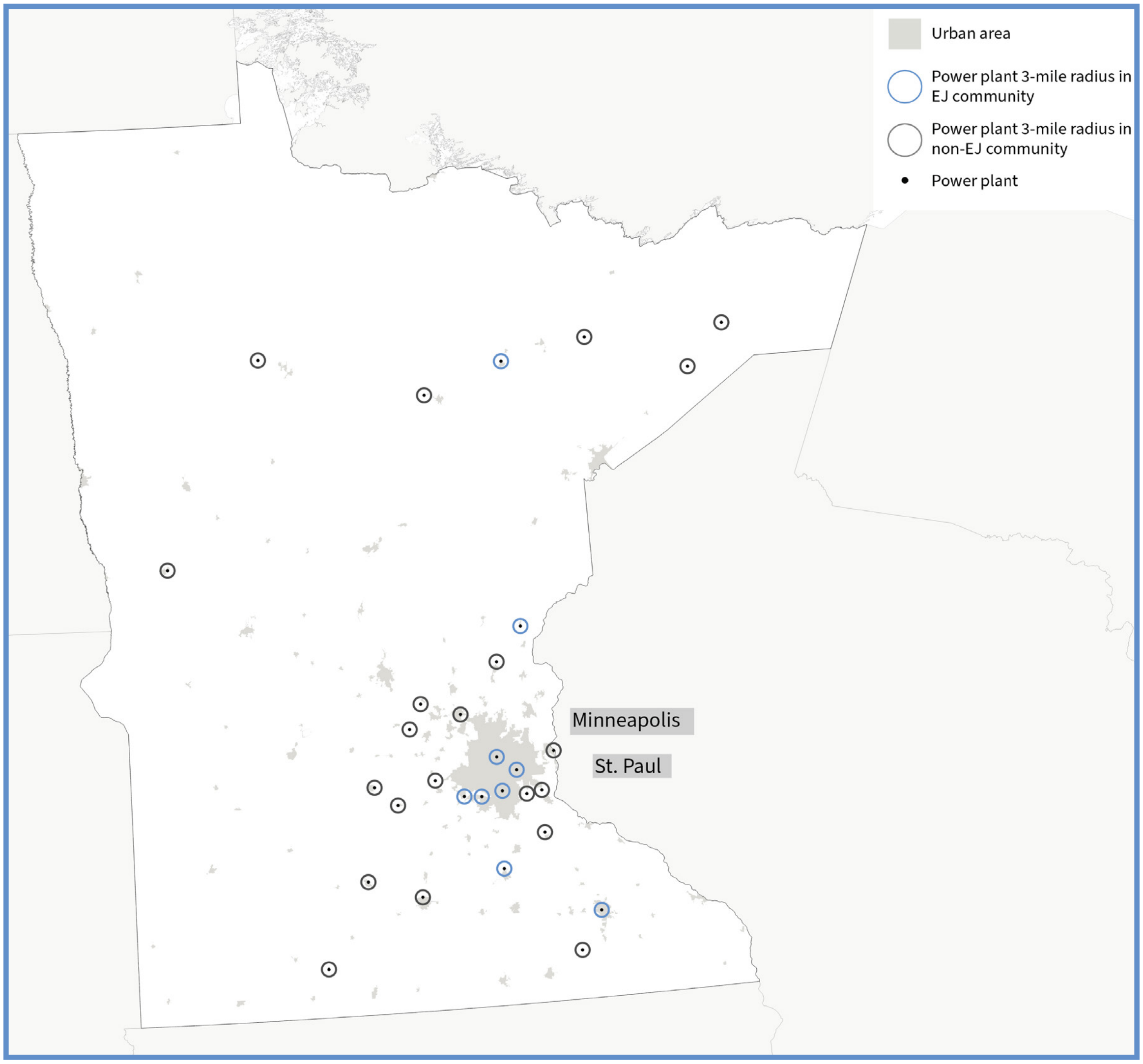
Power plant emissions contribute to both local and regional air quality conditions, particularly those from coal-fired power plants, which are generally dirtier in terms of co-pollutant emissions. The Minnesota Pollution Control Agency's most recent bi-yearly air quality report notes that while Minnesota is meeting federal standards for air pollution, disparities in air quality across the state exist along racial and income lines.[71] The report also notes that areas of environmental justice concern are particularly vulnerable to air pollution impacts because of existing health and socioeconomic burdens.[72] The report highlights that while the retirement of coal plants is helping to improve air quality, pollution is still being produced by a variety of plants including natural gas–fired power plants.[73]

Results

Of the 30 power plants with 25 MW capacity or greater in the state, 9 plants, or 30 percent, are located in an EJ community (see Map 9).[74] Eight new power plants have been constructed in Minnesota since 2000, all of which are natural gas-fired plants with a generation range of 549 to 2,294,775 MWh in 2018.[75] Three of these plants are located in EJ communities.[76]

Our analysis also found that 690,169 people (12% of the total population) live within a three-mile radius of the 30 plants, of whom 31 percent are low-income and 30 precent are People of Color, indicating that the plants are disproportionately sited near People of Color and low-income population in Minnesota.

Map 9: Minnesota Power Plants and Proximity to EJ Communities



Particulate Matter Emissions

Twenty-nine of the 30 power plants had available $PM_{2.5}$ data for 2018. The 2018 $PM_{2.5}$ emissions ranged from 17 pounds to more than 1 million pounds, with a mean of 98,311 pounds. Of the 10 power plants with the total highest emissions of $PM_{2.5}$, 4 are located in EJ communities.

While the plants emitting the most $PM_{2.5}$ tend to be outside of urban areas, there is a clustering of power plants in Minnesota's southeastern region around Minneapolis and St. Paul, where there is a higher population density and more EJ communities are located. Table 8 lists the power plants in Minnesota with capacities of 25 MW or greater in order of 2018 $PM_{2.5}$ emissions.

Table 8: Minnesota's Power Plants 25 MW or Greater, in Order of $PM_{2.5}$ Emissions (Pounds) in 2018*

Power Plant	City	Fuel Source	Year On-line	Capacity (MW)	$PM_{2.5}$ Emissions (lbs.) 2018	SO_2 Emissions (lbs.) 2018	NOX Emissions (lbs.) 2018	Total Co-pollutants ($PM_{2.5}$+NOX+SO_2) (lbs.)	CO_2 Emissions (lbs.) 2018	Total Persons Within 3-Mile Radius	% Low-Income	% People of Color
Sherburne County	Becker	C	1976	2,469.30	1,118,000	13,740,041	17,960,877	32,818,919	27,816,107,980	3,880	14.83	6.12
Silver Bay Power	Silver Bay	C	1955	131.6	714,000	2,380,860	2,174,407	5,269,267	1,079,695,060	1,145	28.58	5.88
Clay Boswell	Cohasset	C, PL	1973	923.3	638,000	7,167,686	7,065,972	14,871,659	16,420,327,000	1,629	27.99	5.77
Allen S. King	Oak Park Heights	C	1958	598.4	296,000	2,890,753	3,830,007	7,016,760	5,666,428,580	21,778	17.39	12.81
Hibbing	Hibbing	C	1965	35.9	28,000	748,282	609,977	1,386,259	274,563,160	12,487	44.22	7.07
Cannon Falls	Cannon Falls	NG	2008	346.8	18,000	19,606	427,751	465,357	154,012,020	4,215	22.93	4.48
Black Dog	Burnsville	NG	1954	562.8	12,000	4,278	775,136	791,414	910,445,880	67,491	23.92	32.09
Riverside	St. Paul	NG	1987	644	6,000	9,035	4,216,351	4,897,097	1,892,740,480	141,125	38.11	42.16
High Bridge	Minneapolis	NG	2008	585.9	6,000	10,365	4,880,732	4,231,386	2,181,474,920	157,016	41.74	47.78
Mankato Energy Center	Mankato	NG	2006	530	6,000	10,291	943,758	960,049	428,430,720	24,913	31.97	11.47
LSP-Cottage Grove LP	Cottage Grove	NG	1997	283.5	2,000	1,599	94,069	97,668	338,527,080	17,302	12.74	17.43
Glencoe	Glencoe	PL	1957	39.5	2,000	451	5,449	7,900	272,040	5,973	34.56	14.44
Faribault Energy Park	Faribault	NG	2005	334.5	966	6,021	1,202,019	1,209,005	559,749,440	9,016	36.56	23.29
Syl Laskin	Hoyt Lakes	NG	1953	116	715	140	24,456	25,311	25,616,040	1,230	26.83	2.22
Lakefield Junction	Trimont	NG, PL	2001	537.8	673	1,366	604,568	606,607	215,502,420	169	16.58	4.62
Pleasant Valley (MN)	Dexter	NG	2001	467.8	627	7,350	379,963	387,941	131,704,360	481	17.31	2.83
Blue Lake	Shakopee	PL, NG	1974	559.4	514	4,940	358,056	363,510	135,142,140	33,439	10.77	22.55
Cambridge CT	Cambridge	PL, NG	1978	194.2	272	1,626	225,625	227,524	79,783,060	6,298	30.68	7.30
Solway CT	Solway	NG, PL	2003	51.3	265	517	225,932	226,715	82,662,480	376	27.62	8.63
Inver Hills	Inver Grove Heights	NG, PL	1972	284.4	250	6,905	100,925	108,079	34,506,460	6,861	13.23	15.40
Elk River**	Elk River	NG	s2009**	239.3	242	508,740	1,648,380	2,157,362	423,497,320	20,449	19.08	9.68
Cascade Creek	Rochester	NG	1975	84.9	173	764	120,079	121,016	42,524,120	72,185	27.44	23.06
New Ulm	New Ulm	NG, PL	1957	78.5	112	746	78,935	79,793	32,546,800	11,872	22.46	6.71
Hutchinson Plant #2	Hutchinson	NG	1994	90.5	86	135	62,853	63,073	28,456,540	13,071	22.91	6.66

St. Bonifacius	St. Boni-facius	PL	1978	61.2	40	2,434	7,855	10,329	1,409,840	4,805	11.12	3.42
Taconite Harbor Energy Center	Schroeder	C	1957	168	31	No Data	No Data	No Data	No Data	27	21.26	4.18
Maple Lake	Maple Lake	PL	1978	25	27	1,651	5,329	7,007	956,120	3,477	20.11	3.76
Minnesota River	Chaska	NG	2001	49	18	3	1,877	1,898	714,280	32,925	18.59	21.14
Rock Lake CT	Pine City	PL	1978	25.0	17	1,048	3,382	4,447	606,940	3,128	40.31	6.84
Hoot Lake	Fergus Falls	C, PL	1959	130.7	No Data	4,125,554	997,969	No Data	1,295,875,100	11,404	27.41	7.03

* Blue shading of a row denotes a power plant sited in an EJ community, and white shading of a row indicates a power plant in a non-EJ community. The yellow line marks the 10 highest emitters of PM2.5. In the "Fuel Source" column, NG refers to natural gas, C refers to coal, and PL refers to petroleum liquids.

** Elk River was originally a municipal solid waste plant opening in 1951. In 2009 it became the natural gas plant that it is today.

For the 10 power plants with the highest $PM_{2.5}$ emissions, 36 percent of the 435,679 people living within three miles are low-income and 37 percent are People of Color, meaning that these plants are disproportionately sited near the state's low-income and POC populations. The Sherburne County facility, a coal-fired plant located in Becker, emitted the most $PM_{2.5}$, 1,118,000 pounds, in 2018. The Sherburne County facility generated 12,477,637 MWh of electricity in 2018 and is currently Minnesota's largest power plant. Although it was built in 1976, it is not the state's oldest, as several other plants were built in the mid to late 1950s. Not surprisingly, many of the highest $PM_{2.5}$ emitters are coal-fired plants.

Of the nine power plants located in EJ areas, the second- and third-highest emitters of $PM_{2.5}$ are natural gas plants with similar capacity: Black Dog in Burnsville, Riverside in St. Paul, and Highbridge in Minneapolis. They produced significantly more emissions than other power plants in EJ areas, aside from the Hibbing coal plant. The Black Dog facility emitted 12,000 pounds of $PM_{2.5}$; Riverside and Highbridge emitted 6,000 pounds each in 2018.

Nitrogen Oxides Emissions

NOx emissions for the 30 plants ranged from 1,877 pounds to 17,960,877 pounds in 2018. Three of the 10 highest emitters of NOx pollution are in EJ communities. The 10 plants with the highest NOx emissions have a combined population within a three-mile radius of 392,356, of which 36 percent are low-income, exceeding the state average of 27 percent, and 37 percent are People of Color, almost meeting the state average of 40 percent.

Power Plant Emissions in the Context of Cumulative Impacts in Minnesota

As described in the Methods section, an average value for each indicator was calculated for each power plant using all the CBGs partially or wholly contained within its three-mile radius. These average values were compared with the values across the CBGs in the Minnesota analysis area and designated as "high burden" if they were in the 75th percentile or higher.

Table 9 shows the power plants whose host communities faced high burdens. All but one of the plants located in areas with high burden for all three indicators are sited in EJ communities.

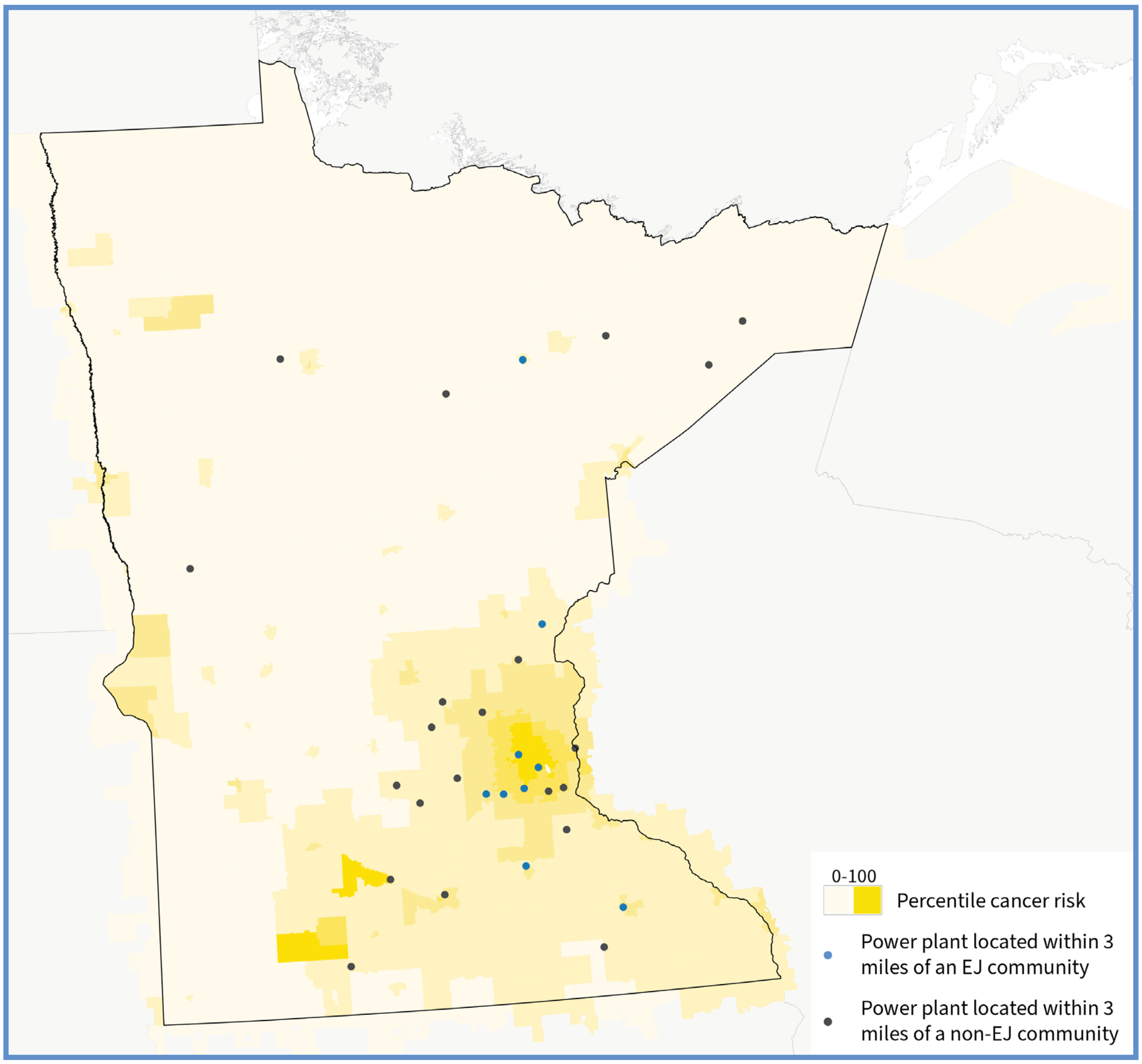
Maps 10, 11, and 12 show that most Minnesota power plants are in the southeastern part of the state, which has high burdens as indicated by air toxics cancer risk, air toxics respiratory hazard, and traffic. The Twin Cities are located in this region, where there is also a more diverse population and higher population density compared with the rest of the state. Power plants in this area (including Riverside and High Bridge) contribute to cumulative impacts, as the communities are burdened by unequal rates of air pollution–related health issues.[77]

Table 9: Plants With High Burden Indicators Relative to the Analysis Area*

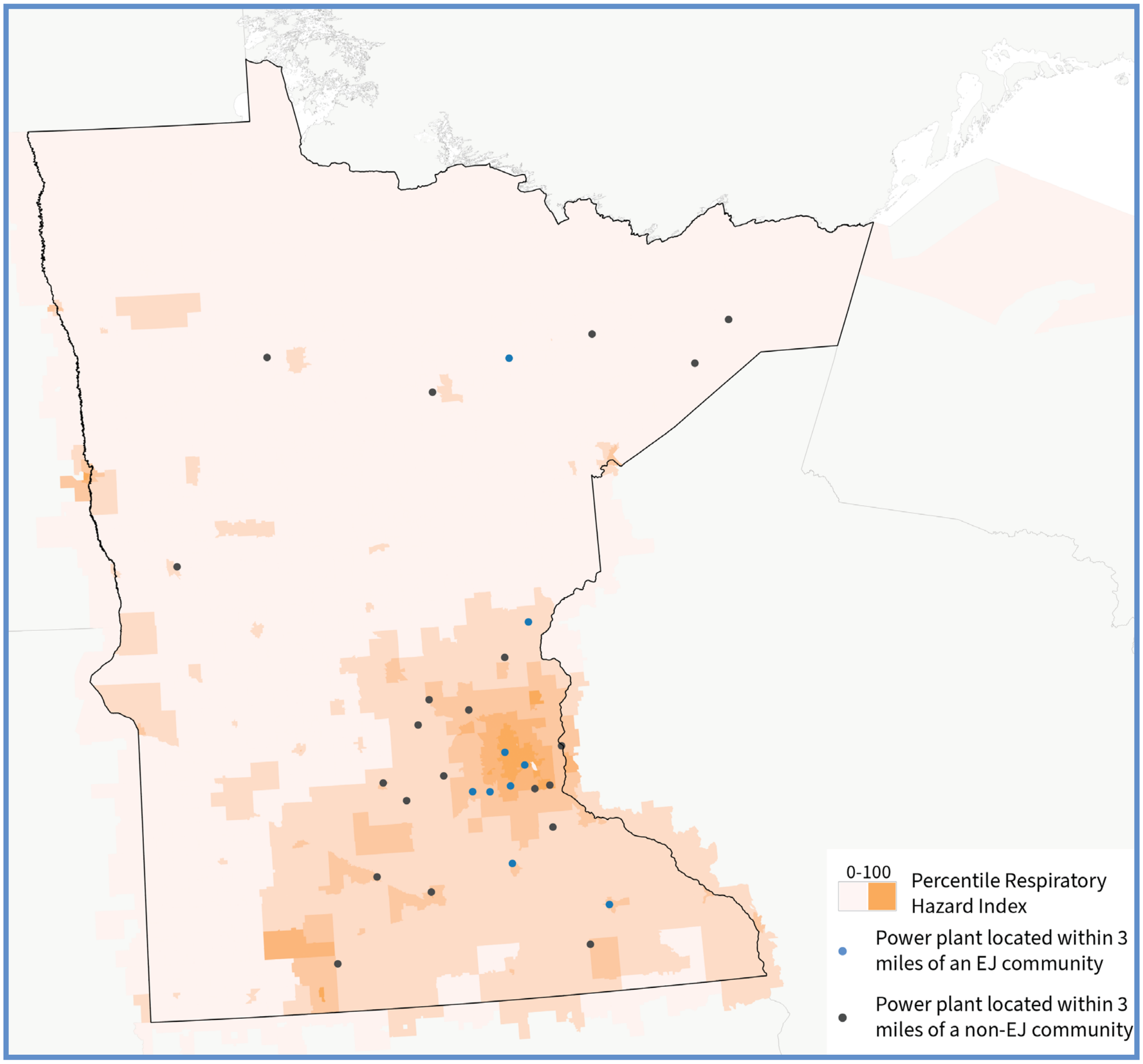
High burden for one indicator	High burden for two indicators	High burden for three indicators
Mankato Energy Center **Minnesota River** **Cascade Creek** Elk River	New Ulm Inver Hill LSP-Cottage Grove LP **Blue Lake**	**High Bridge** **Riverside** **Black Dog** Allen S. King

* Plants highlighted in blue are located in EJ communities.

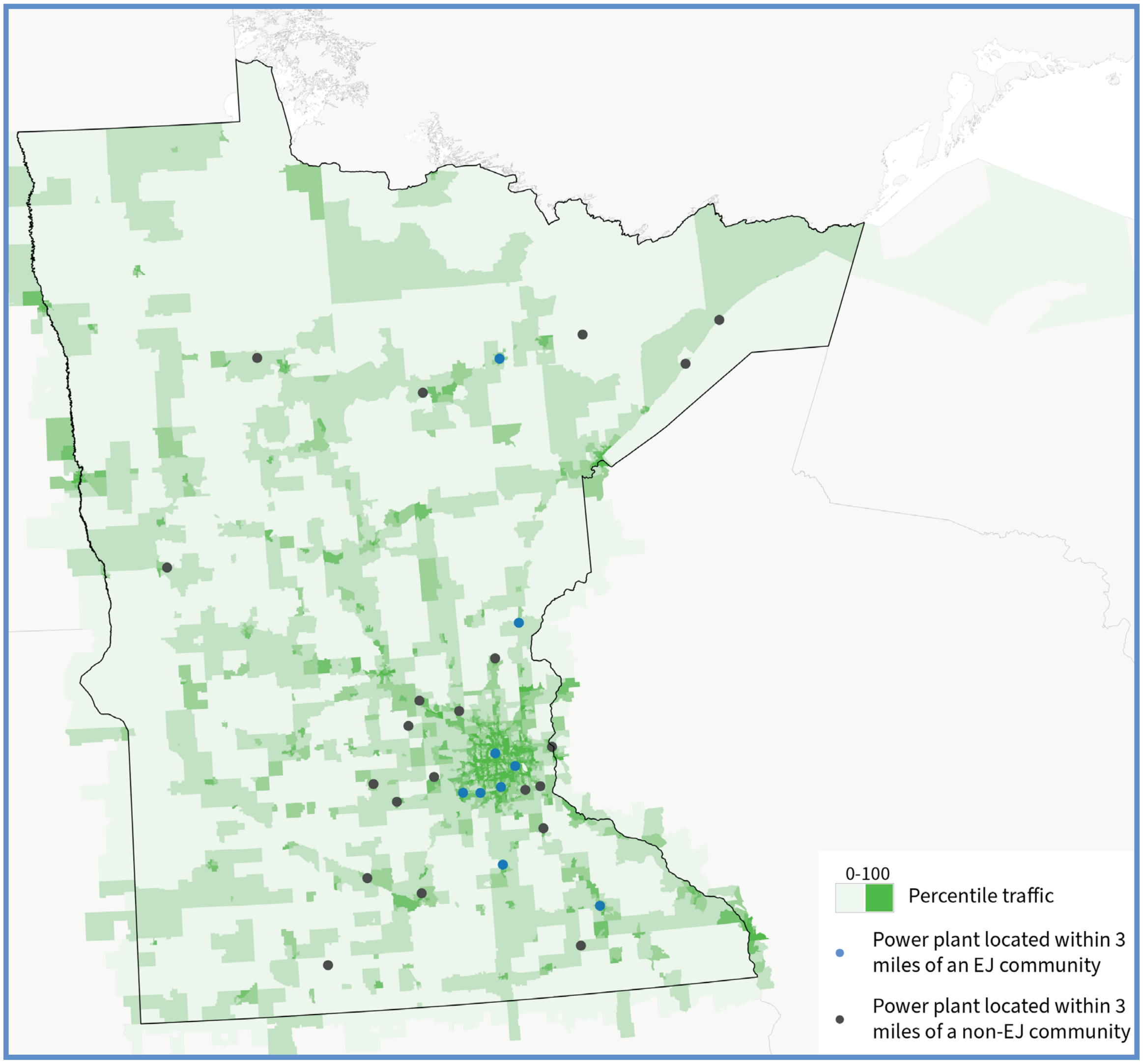
Map 10: Air Toxics Cancer Risk and Power Plant Locations, Minnesota Analysis Area



Map 11: Respiratory Hazard and Power Plant Locations, Minnesota Analysis Area



Map 12: Traffic and Power Plants, Minnesota Analysis Area



Summary

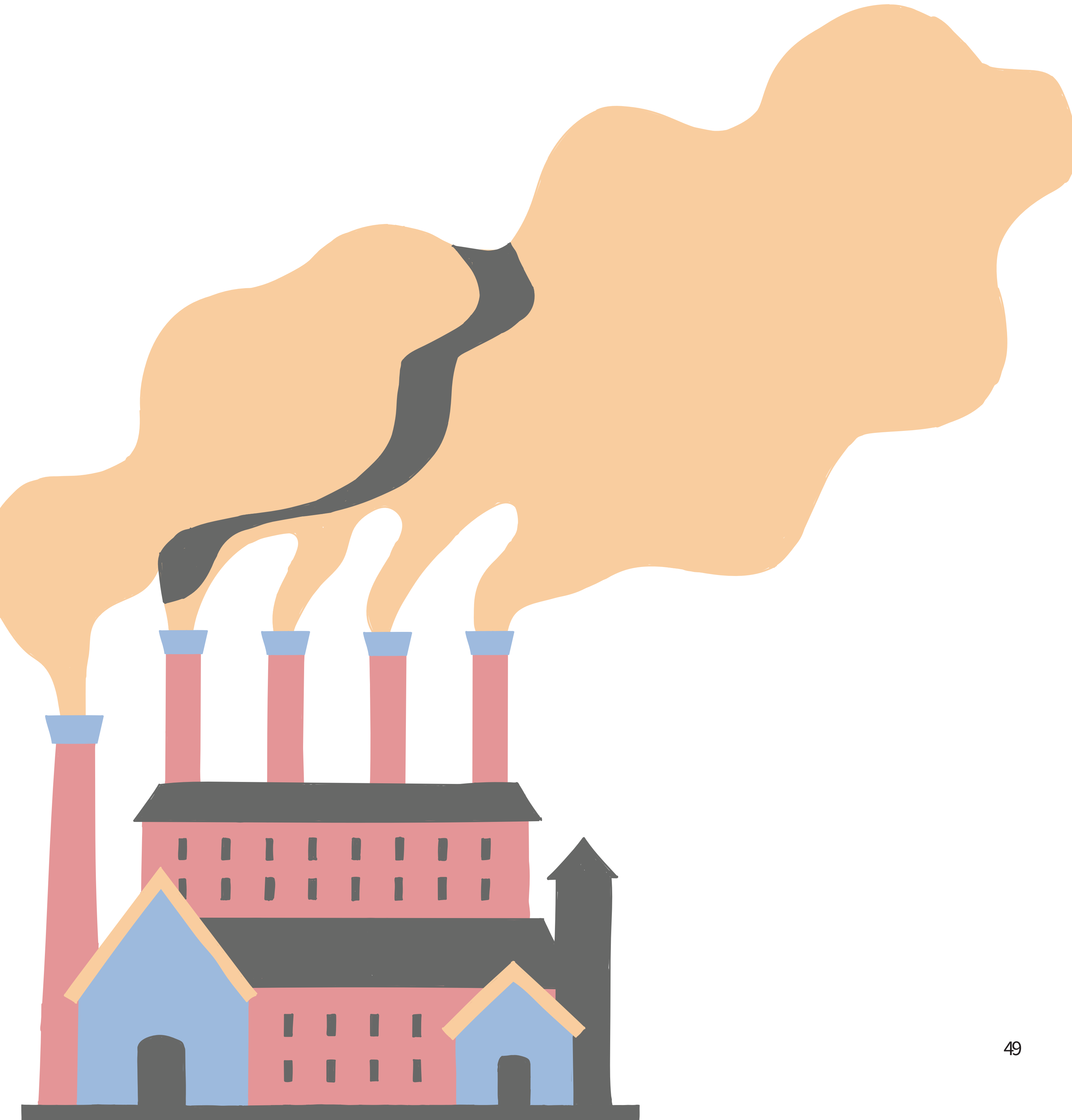
Although most power plants of at least 25 MW capacity in Minnesota are located in non-EJ areas, those sited in EJ communities impact more densely populated areas. There are more than half a million people living within a three-mile radius of the nine power plants in EJ communities, whereas there are only 166,380 people living within a three-mile radius of the remaining 21 power plants in non-EJ areas. Moreover, the percentage of People of Color living within a three-mile radius of the 30 power plants exceeds the state average by about 10 percentage points, indicating that People of Color are disproportionately impacted by power plant pollution, even if the majority of the state's plants are not located in EJ communities. The proportion of low-income people living within a three-mile radius of a power plant in the state also exceeds the state average, by nine percentage points.

After identifying which plants were in EJ communities, we applied our framework to demonstrate how these plants could be prioritized for MER by considering emissions profiles and indicators of burden in the host community (Table 10).

Table 10: Identification and Prioritization of Plants for MER in Minnesota

PLANT *IDENTIFICATION* FOR MER	
<u>Plants located in EJ communities</u>	
Hibbing Black Dog High Bridge Riverside Farobault Energy Park	Blue Lake Cascade Creek Minnesota River Rock Lake CT
PLANT *PRIORITIZATION* FOR MER	
<u>Top five emitters of total co-pollutants examined</u> 1. Riverside 2. High Bridge 3. Hibbing 4. Fairbault Energy Park 5. Black Dog Note: The top four co-pollutant emitters in Minnesota are not located in EJ communities. However, since the policy targets plants located in EJ communities, we have listed the five highest emitters that are located in EJ communities.	
<u>Plants in areas with high relative burden for all three burden indicators</u>	
High Bridge Riverside	Black Dog

An MER policy should be applied to all the power plants located in EJ communities. If policymakers and community members want to stagger emissions reductions across plants over a defined time period, they could start with plants in communities with relatively high environmental burdens or high overall air pollutant emissions. Riverside, High Bridge, and Black Dog stand out as particularly good candidates for the earliest and most vigorous application of MER, given their emissions profiles and the high burdens faced by their host communities. However, given that only 9 of the 30 power plants in Minnesota are in EJ communities, there doesn't seem to be much need or reason to prioritize.



VIII. DISCUSSION AND RECOMMENDATIONS

Despite a transition from coal-fired to natural gas–fired power plants, emissions from the power sector continue to contribute to air pollution in EJ communities in all three states examined for this report. This study shows that the majority of power plants in New Jersey (85 percent) and Delaware (100 percent) are located in EJ communities and that 30 percent of Minnesota's power plants are located in EJ communities. High emitters of co-pollutants in all three states disproportionately impact People of Color and low-income populations. It is imperative that climate policies prioritize the protection of communities dealing with the legacy of air pollution deriving from the fossil fuel industry.

All three states follow the national trend in a transition from coal to natural gas generation in the power sector, with many new natural gas plants built in the last two decades. Although natural gas plants tend to run more efficiently than coal plants, our results show that natural gas plants can still leave EJ areas extremely vulnerable—or render them even more vulnerable than before. In particular, in Minnesota, half of the 14 plants that have been built or upgraded (e.g., with the addition of a new electrical generating unit) since 2000 are located in EJ areas.[78] Disparities persist in New Jersey, where 10 of the 11 natural gas plants built since 2000 are located in EJ communities. In Delaware, the two plants built or upgraded since 2000 are both in EJ communities. The persisting, and in some cases worsening, concentration of plants in EJ areas underscores the importance of targeting these plants for mandatory emissions reductions.

As it currently stands, People of Color were overrepresented (above the state average) in all three states in terms of the population living within a three-mile radius of a power plant.

As it currently stands, People of Color are overrepresented (above the state average) in all three states in terms of the population living within a three-mile radius of a power plant. This finding suggests that race is a key factor associated with proximity to a power plant and should be considered when developing climate mitigation strategies.

Climate policies for the power sector that mandate GHG reductions should be leveraged to address existing inequalities in pollution burdens. This is particularly important in the current political context of significant federal investments and incentives for the use of carbon capture and hydrogen-mixing technologies. As these technologies are added on to existing and new power plants, it is imperative that EJ communities not be forced to endure the impacts of prolonged fossil fuel infrastructure or the risks of these new technologies.

As this paper has outlined, a mandatory emissions reduction policy for the power sector should be used to address climate and health-harming air pollution simultaneously. The best approach to protect EJ communities would be the mandated closure of all fossil fuel–fired power plants in EJ communities with a simultaneous transition to renewable energy (solar, wind, geothermal) to ensure reliable electricity generation. This is the safest way to transition the sector to a carbon-free future.

During the transition to renewables, state or federal governments could require plants in EJ communities to reduce GHGs and co-pollutants simultaneously using strategies that can safely achieve the reduction of both. These strategies should not contribute to environmental burdens.

As a last resort, the least ideal MER policy would be to mandate GHG emissions reductions in EJ communities specifically with the assumption that co-pollutant emissions would also decrease. This least protective option would require monitoring and tracking to ensure an actual reduction of co-pollutants. It would have to occur without using carbon capture or hydrogen-mixing technologies, given the air co-pollutant and other environmental burdens caused by those technologies.

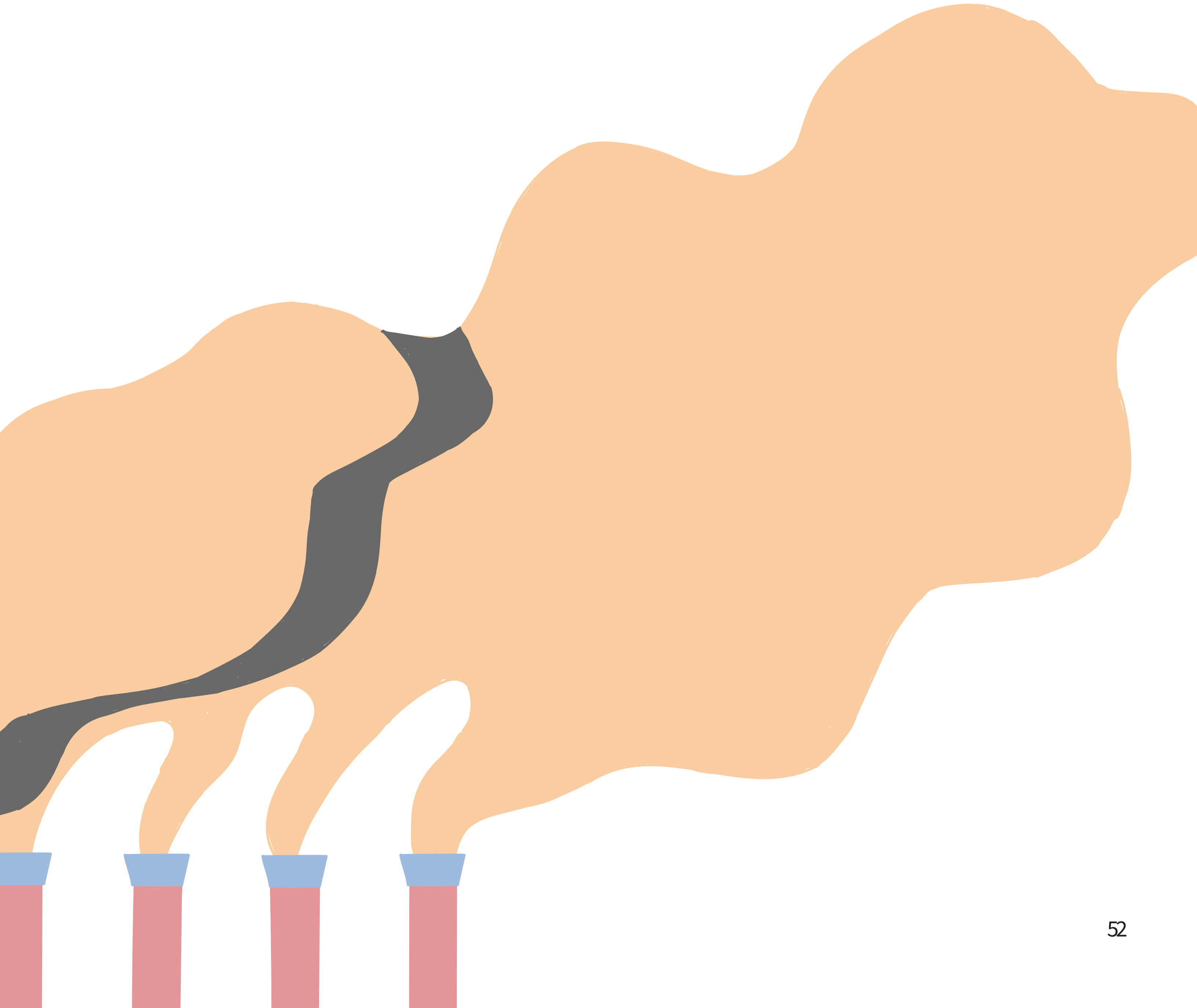
The incorporation of indicators of burden to inform the prioritization of plants for MER was motivated by the fact that cumulative impacts are exacerbated when power plants are sited in EJ communities, which experience pollution from multiple sources. To get a better understanding of the context of cumulative impacts in power plant host communities, this study looked at three indicators of underlying burden: air toxics cancer risk, air toxics respiratory hazard, and traffic. If cumulative burden is to be used as a way to prioritize among plants targeted for MER, we would recommend that policymakers and agencies consider additional indicators besides the three used here, along with the best available tools that have emerged for capturing cumulative impacts.

Policy design should take into account the local context in making these decisions. Perhaps most crucial to prioritizing power plants for MER is the consideration of local, community-based input. Communities can identify or ground-truth the impacts of power plants and additional factors relevant to prioritizing plants (e.g., historical legacy, political or economic conditions, health concerns, opportunities for co-benefits, etc.). This input is invaluable in the development and implementation of any mandatory emissions reduction policy.

An MER policy for the power sector could and should be established in coordination with other policies to address environmental justice comprehensively. For example, adopting a cumulative impacts policy in the permitting context would be important to prevent disproportionate burdens caused by a range of polluting infrastructure. An MER-type policy could also be developed and applied to other sectors known to harm environmental justice communities, such as the chemical sector. These combinations of policy alternatives have not yet been attempted in any state to date and could be the subject of future work.

IX. CONCLUSION

Our study presents a framework for identifying and prioritizing power plants for mandatory emissions reductions and applies this framework to three example states—Minnesota, New Jersey, and Delaware. The methodology used for this study can be applied to examine patterns of power plant siting in relation to overburdened EJ communities in other states. Currently, there is a unique window of opportunity to promulgate strong, equity-based policies that can address both the climate crisis and the legacy of environmental injustice. Mandatory emissions reduction policies can be one avenue for pursuing these interrelated goals.



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4. Benjamin Goldstein, Dimitrios Gounaridis, and Joshua P. Newell, "The Carbon Footprint of Household Energy Use in the United States," *Proceedings of the National Academy of Sciences* 117, no. 32 (August 11, 2020): 19122–30, https://doi.org/10.1073/pnas.1922205117; Rachel Morello-Frosch and Osagie K. Obasogie, "The Climate Gap and the Color Line: Racial Health Inequities and Climate Change," *New England Journal of Medicine* 388, no. 10 (March 9, 2023): 943–49, https://doi.org/10.1056/NEJMsb2213250.

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7. According to Lara Cushing et al., under AB32 between 2013 and 2014 more emissions offset credits were used than the total reduction in allowable GHG emissions—signaling that AB32 is not leading to emissions reductions. Furthermore, the study found that "40 (61 percent) of these high-emitting facilities reported increases in their localized GHG emissions in 2013–14 relative to 2011–12, versus 51 percent of facilities overall. Neighborhoods near the top-emitting facilities that increased emissions had higher proportions of People of Color than neighborhoods near top-emitting facilities that decreased their emissions." Lara J. Cushing et al., "A Preliminary Environmental Equity Assessment of California's Cap-and-Trade Program," University of California at Berkeley, University of Southern California, San Francisco State University, and Occidental College, September 2016, https://dornsife.usc.edu/assets/sites/242/docs/Climate_Equity_Brief_CA_Cap_and_Trade_Sept2016_FINAL2.pdf; Lara Cushing et al., "Carbon Trading, Co-Pollutants, and Environmental Equity: Evidence From California's Cap-and-Trade Program (2011–2015)," ed. Jonathan Patz, *PLOS Medicine* 15, no. 7 (July 10, 2018): e1002604, https://doi.org/10.1371/journal.pmed.1002604; Manuel Pastor et al., "Up in the Air: Revisiting Equity Dimensions of California's Cap-and-Trade System," USC Dornsife Equity Research Institute, February 2022, https://dornsife.usc.edu/assets/sites/1411/docs/CAP_and_TRADE_Updated_2020_v02152022_FINAL.pdf.

8. Sheats, "Achieving Emissions Reductions."

9. Carbon capture and sequestration (CCS) refers to the process of removing and storing carbon dioxide emissions from fossil fuel facilities. There has been a recent shift toward investment in this technology, which is being touted as a climate solution but ultimately extends the life of the fossil fuel industry and poses new risks to the communities that would host storage of the emissions. "Carbon Capture," Hoodwinked in the Hothouse, June 25, 2021, https://climatefalsesolutions.org/carbon-capture/ . Hydrogen is promoted as a clean energy source; however, alone, it does not produce energy. Energy is used to separate hydrogen from other substances it is stored in, largely dirty sources. Once produced, hydrogen is put into a fuel cell, similar to a battery. The handling of hydrogen is extremely risky, and in gas form it is invisible even when on fire. Hydrogen is only as clean as the source of energy used to obtain the electricity. Energy Justice Network, "Hydrogen and Fuel Cells," accessed May 2023, http://www.energyjustice.net/hydrogen.

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11. In this study, air toxics cancer risk, air toxics respiratory hazard, and traffic proximity and volume were used to measure cumulative environmental burdens. However, there are many other ways to capture cumulative burden. For example, a policymaker could aggregate layers contained in screening tools such as the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool, https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5, or the U.S. Environmental Protection Agency's EJScreen, https://www.epa.gov/ejscreen.

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25. Indigenous Environmental Network and Climate Justice Alliance, "Carbon Pricing: A Critical Perspective for Community Resistance," October 2017, https://www.ienearth.org/wp-content/uploads/2017/11/Carbon-Pricing-A-Critical-Perspective-for-Community-Resistance-Online-Version.pdf.

26. Carbon offsets indirectly mitigate emissions. A plant can meet reduction requirements by purchasing offsets at another plant that is more efficient or by purchasing out-of-state offsets that are considered a "sink" for carbon, like forests. Alice Kaswan, "Reconciling Justice and Efficiency: Integrating Environmental Justice Into Domestic Cap-and-Trade Programs for Controlling Greenhouse Gases," in *The Ethics of Global Climate Change*, ed. Denis G. Arnold, 1st ed. (Cambridge, UK: Cambridge University Press, 2011), 232–54, https://doi.org/10.1017/CBO9780511732294.012.

27. Greg Whitesides, "Learning From Success: Lessons in Science and Diplomacy From the Montreal Protocol," *Science & Diplomacy*, August 10, 2020, https://www.sciencediplomacy.org/article/2020/learning-success-lessons-in-science-and-diplomacy-montreal-protocol.

28. Food and Water Watch, "Cap and Trade: More Pollution for the Poor and People of Color," November 2019, https://foodandwaterwatch.org/wp-content/uploads/2021/04/ib_1911_rggicaptradeej-web.pdf.

29. Co-pollutant emissions data were obtained primarily from the U.S. Energy Information Administration (hereinafter EIA); this includes SO_2, CO_2, and NOX for all three states. PM emissions data were obtained from New Jersey's Department of Environmental Protection database, from the Minnesota Pollution Control Agency (MCPA) for plants in Minnesota, and from the EIA for plants in Delaware (researchers were unable to obtain PM data from a state source in Delaware).

30. The Regional Greenhouse Gas Initiative (RGGI) is a multistate program designed to reduce carbon emissions in the electricity-generating sector through a regional cap-and-trade program. There are currently 11 states participating in RGGI. Participating states sell CO_2 allowances through auctions and use the proceeds to invest in energy efficiency, renewable energy, and other programs designed to benefit consumers. Delaware has been a member of RGGI since its inception in 2009. New Jersey rejoined RGGI in January 2020 after dropping out of the program for six years, and the program is currently in its 2023-2025 strategic plan. New Jersey's Carbon Dioxide Budget Trading Rule established the mechanisms for rejoining RGGI and set a cap of 18 million tons of carbon dioxide in 2020 for the state's electricity generation sector. State of New Jersey Governor Phil Murphy, "Governor Murphy Announces Adoption of Rules Returning New Jersey to Regional Greenhouse Gas Initiative," 2019, https://nj.gov/governor/news/news/562019/approved/20190617a.shtml. EJ advocates in New Jersey led efforts that were initially aimed at halting the state's reentry into the program. When those efforts were unsuccessful, the state's EJ community attempted to ensure the state's RGGI plan incorporated equity considerations for communities most affected by the energy sector. They advocated for the adoption of an MER mechanism for the power plants located in EJ communities; however, as of January 2023 this type of policy had not been adopted.

31. New Jersey Geographic Information Network, "Power Plants (RGGI EGU) in New Jersey," database, n.d.,https://njogis-newjersey.opendata.arcgis.com/datasets/njdep::power-plants-rggi-egu-in-new-jersey/about; EIA, "Form EIA-860 Detailed Data With Previous Form Data (EIA-860A/860B)," database, 2018, https://www.eia.gov/electricity/data/eia860/.

32. This is just one way to identify power plants. An alternative method, such as California's, identifies polluting facilities to be part of the climate mitigation program by their yearly CO_2 emissions. Center for Climate and Energy Solutions, "California Cap and Trade," n.d., https://www.c2es.org/content/california-cap-and-trade/.

33. QGIS is an open-source desktop geographic information system. See QGIS, "QGIS—The Leading Open Source Desktop GIS," n.d., https://www.qgis.org/en/site/about/index.html.

34. A three-mile radius is consistent with environmental justice literature and studies, including the "EJ Screening Report for the Clean Power Plan." These key demographics and information about nearby power plants may help identify a community's potential vulnerability to environmental concerns. EPA, "EJ Screening Report for the Clean Power Plan," n.d., https://archive.epa.gov/epa/cleanpowerplan/ej-screening-report-clean-power-plan.html.

35. We recognize that an area as large as a three-mile buffer region might in fact contain multiple communities, especially in densely populated areas. However, we use the term *community* here for conciseness and ease of reference.

36. Senate and General Assembly of the State of New Jersey, S232, ch. 92, https://njeja.org/wp-content/uploads/2021/08/ej-bill.pdf.

37. EPA, "EJScreen: Environmental Justice Screening and Mapping Tool," last updated June 26, 2023, https://www.epa.gov/ejscreen.

38. See, generally, Esri, ArcGIS Pro, "Understand Data Apportionment," n.d., https://pro.arcgis.com/en/pro-app/latest/help/analysis/business-analyst/data-apportionment-and-layers.htm. For our study, we conducted apportionment based simply on spatial area without the use of census block points.

39. U.S. Census Bureau, "Cartographic Boundary Files," 2019, https://www.census.gov/geographies/mapping-files/time-series/geo/cartographic-boundary.html.

40. Equitable and Just National Climate Platform, "Approaches to Defining Environmental Justice Community for Mandatory Emissions Reduction Policy," September 2021.

41. Minnesota Pollution Control Agency, Data Services, "Criteria Pollutant Data Explorer," Tableau Software, n.d., https://public.tableau.com/views/CriteriaPollutantDataExplorer/CriteriaPollutantDataExplorer?%3Adisplay_static_image=y&%3AbootstrapWhenNotified=true&%3Aembed=true&%3Alanguage=en-US&:embed=y&:showVizHome=n&:apiID=host0#navType=0&navSrc=Parse; New Jersey Department of Environmental Protection, "NJDEP Emissions Statement Annual Report," 2018.

42. EPA Enforcement and Compliance History Online (ECHO), "Facility Search—Enforcement and Compliance Data," database, n.d., https://echo.epa.gov/facilities/facility-search?srch=adv.

43. EIA, "Electricity: Emissions by Plant and by Region," database, 2018, https://www.eia.gov/electricity/data/emissions/.

44. We obtained 2017 $PM_{2.5}$ emissions data from the EPA's ECHO. Data for 2018 emissions of $PM_{2.5}$ were not available from EIA or ECHO. Hay Road and Garrison power plants in Delaware did not have 2017 emissions data available in ECHO. Clayville and Lakewood power plants in New Jersey, and Hoot Lake power plant in Minnesota, were missing data.

45. As mentioned above, there are many other data sources that could be used to assess disproportionate burden and cumulative impacts, such as the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool and additional indicators from EPA's EJScreen. See note 11. See also Lam et al., *Seeing the Whole*.

46. For more detail on each indicator, see EPA, "Technical Information About EJScreen," last updated January 30, 2023, https://www.epa.gov/ejscreen/technical-information-about-ejscreen.

47. EIA, "New Jersey State Profile and Energy Estimates, Profile Overview," n.d., https://www.eia.gov/state/?sid=NJ.

48. EIA, "Form EIA-860."

49. NJ.gov, "Governor Murphy Announces Adoption of Rules Returning New Jersey to Regional Greenhouse Gas Initiative," June 17, 2019, https://www.nj.gov/governor/news/news/562019/20190617a.shtml.

50. Environmental Protection: Air Quality, Energy, and Sustainability, "Adopted New Rules: N.J.A.C. 7:27D," Pub. L. No. N.J.A.C. 7:27D (2019), https://www.nj.gov/dep/aqes/docs/rggi-gwsf-adoption-20190617.pdf.

51. New Jersey S232 (2020–2021) Regular Session, Pub. L. No. 232 (2020), https://legiscan.com/NJ/text/S232/id/2213004.

52. The list of power plants was obtained from New Jersey Geographic Information Network, "Power Plants (RGGI EGU) in New Jersey." Power plants with a capacity of 25 megawatts or greater qualify for the RGGI program. Regional Greenhouse Gas Initiative, "Elements of RGGI," accessed August 13, 2019, https://www.rggi.org/program-overview-and-design/elements.

53. $PM_{2.5}$ emissions data were obtained from the New Jersey Department of Environmental Protection. At the time of the analysis, the most recent available data were from 2018, and the Lakewood and Clayville power plants were missing data.

54. Janice E. Nolen et al., *State of the Air 2019*, 2019, American Lung Association, https://www.congress.gov/116/meeting/house/110157/documents/HHRG-116-GO28-20191029-SD006.pdf.

55. EIA, "Delaware State Profile and Energy Estimates: Profile Data," June 15, 2023, https://www.eia.gov/state/data.php?sid=DE.

56. EIA, "U.S. States, State Profiles and Energy Estimates: Rankings—Total Energy Production, 2020 (Trillion Btu)," 2020, https://www.eia.gov/state/rankings/#/series/101; EIA, "Delaware State Profile and Energy Estimates."

57. Ibid.

58. Ibid.

59. Delaware.gov, "Governor Carney's Statement on Regional Greenhouse Gas Initiative (RGGI) Announcement on Emission Reductions," *Delaware News* (blog), August 2017, https://news.delaware.gov/2017/08/23/governor-carneys-statement-regional-greenhouse-gas-initiative-rggi-announcement-emission-reductions/.

60. EIA, "Energy-Related CO_2 Emission Data Tables," accessed 2021, https://www.eia.gov/environment/emissions/state/.

61. Juan Declet-Barreto and Andrew A. Rosenberg, "Environmental Justice and Power Plant Emissions in the Regional Greenhouse Gas Initiative States," *PLOS ONE* 17, no. 7 (July 20, 2022), https://doi.org/10.1371/journal.pone.0271026.

62. Ibid.

63. U.S. Census Bureau, "U.S. Census Bureau QuickFacts: Delaware," accessed May 2020, https://www.census.gov/quickfacts/fact/table/DE/PST045222.

64. Biomass (such as wood, agricultural, and crop residues) can be used for the production of landfill gas in municipal solid waste (MSW) incinerators and in biomass/wood power plants to produce energy. MSW incineration produces health-harming pollutants such as heavy metals like lead and mercury, as well as other hazardous air pollutants. National Research Council, *Waste Incineration and Public Health* (Washington, D.C.: National Academies Press, 2000). The combustion of biomass produces greenhouse gases and criteria air pollutants such as CO_2, NOX, SO_2, VOCs, and $PM_{2.5}$. Jonathan J. Buonocore et al., "A Decade of the US Energy Mix Transitioning Away From Coal: Historical Reconstruction of the Reductions in the Public Health Burden of Energy," *Environmental Research Letters* 16, no. 5 (2021): 054030, https://iopscience.iop.org/article/10.1088/1748-9326/abe74c.

65. EIA, "Minnesota State Profile and Energy Estimates: Profile Analysis," last updated July 21, 2022, https://www.eia.gov/state/analysis.php?sid=MN.

66. EIA, "New Jersey State Profile"; EIA, "Delaware State Profile."

67. EIA, "Minnesota State Profile."

68. The Hoot Lake coal-fired power plant in Fergus Falls, Minnesota, closed in 2021. Otter Tail Power Company, "Hoot Lake Plant Retires," June 2021, https://www.otpco.com/newsroom/posts/hoot-lake-plant-retires/; Elizabeth Dunbar, "Minnesota's Departure From Coal Will Mean More Natural Gas and Nuclear," *MPR News*, May 2019, https://www.mprnews.org/story/2019/05/28/minnesota-energy-pie-transition.

69. Kirsti Marohn, "In Becker, Little Shock Over News of Coal Plant's Early Demise," *MPR News*, May 28, 2019, https://www.mprnews.org/story/2019/05/28/becker-absorbs-news-of-sherco-coal-plant-early-closure; Mike Hughlett, "State Energy Watchdogs Say Xcel's Megasolar Project Is Too Pricey," *Star Tribune,* June 4, 2022, https://www.startribune.com/state-energy-watchdogs-say-xcels-megasolar-project-is-too-pricey/600179208/.

70. U.S. Census Bureau, "U.S. Census Bureau QuickFacts: Minnesota," accessed 2020, https://www.census.gov/quickfacts/MN.

71. Maggie Wenger, Aneka Swanson, and Hassan Bouchareb, *The Air We Breathe: The State of Minnesota's Air Quality in 2020*, Minnesota Pollution Control Agency, 2021,

https://www.pca.state.mn.us/sites/default/files/lraq-2sy21.pdf.

72. Ibid.

73. Ibid.

74. In Minnesota, a block group was categorized as an EJ community if 35 percent of households were low-income or at least 20 percent of individuals identified as People of Color, similar to the state average. The study used linguistic isolation at an 11.9 percent threshold to match the state average, but it did not result in any change to the identification of EJ communities in Minnesota.

75. Year of operation was obtained from the U.S's Energy Information Administration. EIA, "Electricity - Form EIA-860 Detailed Data With Previous Form Data (EIA-860A/860B)," 2018, https://www.eia.gov/electricity/data/eia860/.

76. Faribault Energy meets the EJ threshold for income and POC; Highbridge meets the EJ threshold for income and POC; and Minnesota River meets the EJ threshold for POC only.

77. Minnesota Department of Health, "Life and Breath: Twin Cities Metro Area," updated 2022, https:/data.web.health.state.mn.us/documents/20147/0/LIFE+and+BREATH+III+METRO+BRIEF-FINAL.pdf/708c1326-4d48-d2a0-64e6-6ae7f6e2995f.

78. The research team gathered upgrades data but did not include these data in the report. It is available upon request.