The Social Lifecycle Impacts of Power Plant Siting in the Historical United States

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Abstract

This paper examines the relative contributions of siting decisions and post-siting demographic shifts to current disparities in exposure to polluting fossil-fuel plants in the United States. Our analysis leverages newly digitized data on power plant siting and operations from 1900-2020, combined with spatially resolved demographics and population data from the U.S Census. We find little evidence that fossil-fuel plants were disproportionately sited in counties with higher Black population shares on average. However, event study estimates indicate that Black population share grows in the decades after the first fossil-fuel plant is built in a county, with average increases in Black population share of 5 percentage points in the 50-70 years after first siting. These long-run demographic shifts are driven by counties that first hosted a fossil-fuel plant between 1900-1949. We close by exploring how these long-run demographic shifts were shaped by the Great Migration, differential sorting in response to pollution, and other factors. Our findings highlight that the equity implications of siting long-lived infrastructure can differ dramatically depending on the time span considered.

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1 Introduction

Environmental justice considerations have risen to the forefront of policy discussions over the location of long-lived infrastructure. These discussions have centered on ensuring equitable siting of planned infrastructure, but rarely account for its long-run general equilibrium consequences such as residential sorting and discriminatory steering (Christensen and Timmins, 2022). Relatively little work has focused on estimating the "social lifecycle" impacts of long-lived infrastructure such as power plants precisely because these effects can take many decades to manifest.

This paper examines the relative contributions of siting decisions and post-siting demographic shifts to current disparities in exposure to polluting fossil-fuel plants in the United States. To investigate this, we combine newly digitized data on power plant siting and operations from 1900-2020 (Clay et al., 2025) with spatially resolved demographic data from the U.S Census. This extended time horizon allows us to assess how demographics evolve over several decades after power plants are built. We focus on the U.S power sector since this sector remains one of the largest contributors to local air pollution and its impacts are felt disproportionately by minority and low-income individuals (Tessum et al., 2021; Hernandez-Cortes, Meng and Weber, 2023; Cushing et al., 2023).

We begin by estimating a series of cross-sectional regressions to study how historical plant siting decisions were influenced by underlying county demographic and economic characteristics. We then estimate event-study models to assess the evolving impacts of fossil-fuel power plant openings on county demographics in the decades following first siting. Since the timing of treatment is staggered and the effects are likely to be heterogeneous across plant vintages, we estimate these effects using the difference-in-differences methodology developed by Callaway and Sant'Anna (2021).

We have two main findings. First, we find little evidence that power plants were disproportionately sited in counties with higher Black population shares. The cross-sectional results suggest that counties with higher Black population share in the prior decade were not significantly more likely to receive their first fossil-fuel power plant, except in the 1980s and 1990s. Even for the 1980s and 1990s, a one standard deviation increase in Black population share corresponded to an increase in the probability of a plant siting of about 2 percentage points. Instead, siting decisions appear to have been influenced primarily by factors related to local electricity demand and power plant operating costs. In particular, power plants were disproportionately sited in counties that were more populous, had larger employment shares in manufacturing, and enjoyed better access to coal.[1]

A Oaxaca-Blinder decomposition highlights that Black population shares were higher in areas that were also more suited for the siting of power plants based on other observed siting determinants (e.g., population, manufacturing employment share, and railroad mileage). In most decades, the share of the overall difference in siting across counties with high versus low Black population shares unexplained by the other siting determinants suggests a bias *against* siting in counties with high Black population shares. The two exceptions are the 1970s and 1980s, when the bias was positive. We speculate that one potential mechanism underlying the positive bias in these decades may be changing perceptions of the health effects of air pollution following Earth Day and the passage of the 1970 Clean Air Act. These cross-sectional comparisons suggest that current disparities in exposure to power plants do not stem from inequities in initial siting decisions.

Second, we find that fossil-fuel power plant openings led to long-run increases in county Black population shares. We estimate average increases in county Black population share of up to 5 percentage points in the *50-70 years* after the first fossil-fuel plant in the county was built. These demographic shifts took many decades to materialize. Indeed, three decades post-opening, we estimate that Black population shares had increased by less than one percentage point.

We find that these longer-run demographic shifts were driven entirely by counties first hosting a fossil fuel power plant before 1950. These early cohorts of counties experienced sustained increases in capacity both through expansion of existing plants and the construction of new plants. In contrast, we find no economically or statistically significant impacts of power plant siting on demographics among counties receiving their first fossil-fuel plant after 1950.

The longer-run demographic responses to early power plant openings likely reflect a number of interrelated mechanisms including the Great Migration and local sorting within and across county boundaries based on air pollution and other factors. Between 1910 and 1970, millions of African Americans moved from the South to northern cities. These population inflows resulted in large outflows of White people from city centers to outlying suburbs and neighboring counties, particularly in the 1940-1970 period (Shertzer and Walsh, 2019; Baum-Snow, 2007; Boustan, 2010). These outflows likely reflect both sorting due to air pollution from power plants and other industrial activity as well as sorting due to other factors such as crime, school quality, and racial animus.

[1] Morehouse and Rubin (2021) documents the restrictive geographic, political, and regulatory constraints facing electric utilities deciding where to build coal-fired power plants.

These findings have important implications for environmental and infrastructure policies, particularly in the context of environmental justice. First, they underscore that the equity implications of long-lived infrastructure investments can vary greatly depending on the time horizon considered. To ensure equitable outcomes, it is essential to account for the full social lifecycle of these investments—both in terms of their long-run costs and benefits and the communities affected. This long-term perspective can inform strategies such as the joint-siting of compensatory projects or court-mandated settlements to offset negative impacts on disadvantaged communities (Campa and Muehlenbachs, 2024). Policymakers, however, face significant challenges in addressing intertemporal distributional concerns. Economists have proposed different approaches, including reporting inequality metrics, disaggregating impacts by subgroup (Banzhaf, 2023), and applying equity weights (Mansur and Sheriff, 2021; Burlile and Maniloff, 2024). Valuing demographic shifts far in the future involves normative judgments and assumptions about discounting, but recent evidence suggests that individuals apply relatively low discount rates to long-term outcomes (Giglio, Maggiori and Stroebel, 2015), supporting the importance of considering these effects in forward-looking infrastructure decisions.

The results also highlight that geographic mobility can lead to inequitable outcomes even when plants are not inequitably sited. To the extent that pollution and other disamenities are capitalized into housing prices, residential sorting after infrastructure siting is likely to lead to socioeconomic-based disparities in exposure to the disamenities from this infrastructure.

This paper contributes to the literature examining disparities in residential proximity to polluting facilities (Banzhaf, Ma and Timmins, 2019*b*; Cain et al., 2023). Existing research has found that minority populations live closer to highly polluting facilities (Wolverton, 2009; Tanaka, 2024; Cassidy, Hill and Ma, 2022) and face higher pollution concentration levels than White populations (Currie, Voorheis and Walker, 2023; Colmer et al., 2020). While average pollution levels and pollution disparities have decreased in recent decades, differences in pollution exposure across groups still remain (Tessum et al., 2021). Our study contributes to this existing literature on current pollution disparities by examining whether polluting fossil-fuel power plants were disproportionately sited in counties with high Black population shares and by quantifying the long-run demographics that occurred after plant siting.

Our paper also contributes to the literature exploring potential mechanisms behind current environmental disparities (Banzhaf, Ma and Timmins, 2019*a*). One important question concerns whether current pollution disparities arise from discriminatory siting (Wolverton, 2009) and zoning (Shertzer, Twinam and Walsh, 2016) or from residential sorting (Banzhaf and Walsh, 2013; Depro, Timmins and O'neil, 2015; Shertzer and Walsh, 2019) and discriminatory steering after siting (Christensen and Timmins, 2022; Christensen, Sarmiento-Barbieri and Timmins, 2022). Our study contributes to this literature by providing evidence that, in the case of fossil-fuel power plants, long-run demographic shifts after siting likely played a much larger role in current disparities in power plant exposure than inequity in initial siting decisions.

However, a key caveat is that our analyses are at the county-level, and so our event study results solely capture *across-county* sorting in response to changes in amenities such as air quality. Previous research has documented meaningful *within-county* differential sorting and steering by race, income, and/or class in response to pollution shocks. Examples from historical settings include Heblich, Trew and Zylberberg (2021) for England and Banzhaf, Mathews and Walsh (2024) for Pittsburgh. Research focused on more recent time periods in the United States include Depro, Timmins and O'neil (2015); Christensen and Timmins (2022); Christensen, Sarmiento-Barbieri and Timmins (2022). Since we do not capture within-county sorting, our county-level event study analyses likely under-estimate the full demographic shifts over the decades following power plant siting.

The paper proceeds as follows. Section 2 discusses disparities in pollution exposure, historical expansion of the electricity grid, and the siting of power plants during different historical periods. Section 3 describes the data utilized. Sections 4 and 5 present the methodology and findings, respectively. Finally, Section 6 provides concluding remarks and discusses policy implications.

2 Background

2.1 Expansion of the Electricity Grid

Electricity generation from coal power plants rose dramatically over the course of the twentieth century. In 1900, power plants generated less than 2 TWh (2 billion kWh); in 1950, they generated more than 200 TWh; in 2000, they generated more than 3,000 TWh per year (U.S. Census Bureau, 2006). Figure 1 shows the growth in national total generation over time. The rise in generation was driven by an increase in demand for electricity, both for industrial use and residential services.

To meet this increasing demand, hundreds of new power plants and thousands of miles of transmission lines were built over the century. Figure 2 shows fossil fuel power plant siting over time. Initially, power plants were primarily located in urban industrial areas, but over time, fossil-fuel plants were located throughout the United States. Appendix Figure A.1 shows the expansion of the transmission infrastructure.

2.2 Siting of Power Plants

The siting of coal-fired power plants has evolved over time in response to changes in technology, economic and environmental considerations, and regulation. In the early and mid-twentieth century, constraints on electricity transmission meant that generation occurred near the source of demand. In 1929, transmission losses accounted for 15 percent of total U.S. electricity generation (Electrical World, 1930). A study by the Twentieth Century Fund Power Committee (1948), entitled *Electric Power and Government Policy: A Survey of the Relations Between the Government and Electric Power Industry* found: "[S]team plants are usually located near the larger markets because it is generally cheaper to transport coal than to generate electricity at the mines ... Recent reductions in the quantity of coal consumed per generated kilowatt hour have strengthened the tendency to transport coal rather than electricity (p. 17)." As of 1960, only a few mine mouth electricity plants had been developed (Joskow, 1985).

Despite the constraints on electricity transmission in the early 20th century, cost factors still played an important role in power siting decisions. Indeed, Lovell (1941) argued that "the relatively high cost of transporting enormous quantities of water used in condensers of large steam prime movers... [requires that] the location must be such that the water supply be ample and cool. A very slight difference in the temperature of condensing water makes so marked a difference in the performance of a steam turbine that a change of location of many thousand of feet, or even a few miles, may easily justify the greater electric-transmission expense involved (p. 272)." Similarly, because coal accounted for more than 70 percent of power plant operating costs, utilities had a strong incentive choose locations that limited freight costs.[2]

The expansion of high voltage electricity transmission in the late 1950s and 1960s meant that power plants were increasingly less constrained to co-locate near sources of urban demand. As a result, location decisions were more heavily influenced by factors related to operating costs, such as optimal water temperature for cooling and access to coal. The Federal Power Commission (1961) reported that the Federal Power Commission's Coordinated Nation Power Survey was developing "an orderly long range plant to meet the anticipated loads of 1980 and subsequent years in the most economical manner is giving top consideration to the large highly efficient units located as close to fuel sources as possible and the coordination of the many systems through Extra High Voltage Transmission (p. v.)." Consistent with this, many mine mouth electricity plants were developed in the 1960s and 1970s (Joskow, 1985).

[2]Of the total power plant coal costs, 61 percent went to freight and 39 to coal operators (Lovell, 1941).

In his survey of power plant siting, Hamilton (1979) argues that siting of power plants largely focused on site suitability and not on issues of water or air pollution up to the early 1960s. An important early event on the water side was Consolidated Edison's 1962 announcement that it planned to build the Storm King pumped hydroelectric plant in the Hudson Highlands (Lifset, 2014). In a lecture quoted in the *New York Times* (Revkin, April 14, 2015), Lifset argued: "While in 1962 the larger public might be characterized as indifferent or mildly impressed with the engineering feat of a pumped-storage hydroelectric plant, by the late 1960s, the tide of opinion had begun to turn and a new conventional wisdom began to emerge. This new narrative held that the benefits of a plant at Storm King were outweighed by the environmental costs." The tide had turned both on aesthetic issues and on the issue of fish kills, which were prevalent at many power plants and were anticipated to be important for Storm King.

Around the same time, environmental concerns about fossil fuel power plants, particularly coal-fired plants, were growing. The 1970 Clean Air Act (CAA) is the focus of a large literature. Clay et al. (2025) highlight that it was the culmination of a series of pieces of legislation aimed at reducing air pollution. In particular, the 1963 CAA was the first piece of legislation that authorized federal control of air pollution. While it resulted in minimal enforcement, it served as a strong signal of impending federal air pollution regulation. Clay et al. (2025) present a range of evidence suggesting that electric utilities made anticipatory investments in air pollution control following the passage of the 1963 CAA. Air pollution issues reinforced the increasing tendency towards siting plants in rural areas.

The historical siting of fossil fuel power plants had important consequences for the long-term health and well-being of local populations. Local investments in electricity infrastructure contributed to growth in the manufacturing and agricultural sectors through the mid-20th century (Kline and Moretti, 2014; Kitchens and Fishback, 2015; Lewis and Severnini, 2020). Proximity to coal-fired power plants was also an important determinant of household electricity access, with important benefits to household health and women's economic opportunities (Lewis, 2018; Vidart, 2024). Through the early-20th century, coal-fired power plant openings led to increases in local housing prices, suggesting that the perceived gains from electricity access outweighed the costs associated higher local pollution levels (Clay, Lewis and Severnini, 2022). To the extent that Whiter communities were able to lobby for a plant to be built, early discriminatory siting may actually have *counteracted* Black-White disparities in air pollution exposure from coal-fired power plants.

Over time, however, the local benefits from coal-fired generation diminished, as the development of an interconnected electricity grid meant that localities were less reliant on local sources of generation (Severnini, 2023). Coal-fired power plants remained a major contributor to local water and air pollution (Lifset, 2014; Clay, Lewis and Severnini, 2022). By mid-20th century, coal-fired power plants were viewed as a local disamenity, as reflected in their negative impact on local housing prices (Clay, Lewis and Severnini, 2022). As a result, discriminatory siting of coal-fired power plants in this era may have reinforced Black-White disparities in air pollution exposure. Moreover, to the extent that coal-fired plants were increasingly viewed as a local disamenity, longer run residential sorting may have exacerbated Black-White disparities in exposure to coal-fired power plants, regardless of when the plant was actually built.

2.3 Disproportionate Exposure to Pollution

Environmental justice research has shown that polluting facilities are disproportionately located near minority communities and that these communities experience higher pollution exposure than White populations (Banzhaf, Ma and Timmins, 2019*b*; Colmer et al., 2020; Currie, Voorheis and Walker, 2023). Some studies have found that air pollution disparities have decreased in the last few decades. For instance, Colmer et al. (2020) find that the difference between the 90th and 10th percentiles in $PM_{2.5}$ pollution exposure fell from 15.7 $\mu g/m^3$ in 1981 to 4.2 $\mu g/m^3$ in 2016. Currie, Voorheis and Walker (2023) find that the mean Black-White disparity in pollution exposure fell from $1.5 \mu g/m^3$ in 2000 to $0.5 \mu g/m^3$ in 2015. Changes in fuel mix and environmental regulations in the power sector explain a meaningful share of these decreases in disparities (Hernandez-Cortes, Meng and Weber, 2023). Due to data limitations, most of these studies use relatively recent pollution data to understand the evolution of disparities.

Understanding the historical evolution of demographics following power plant siting allows us to explore the determinants behind existing disparities. For example, some studies have suggested that discrimination in the placement of power plants is associated with current pollution disparities (Cushing et al., 2023). Given that power plants, especially those fueled with coal, are a significant source of air pollution emissions (Clay, Lewis and Severnini, 2022), historical siting of coal-fired power plants may have contributed to long-run racial disparities in air pollution exposure and might continue to be a driver of existing disparities.[3]

[3] Other studies have shown that minority populations are more likely to live closer to power plants (Tanaka, 2024), other high polluting facilities such as TRI sites (Wolverton, 2009), refineries, hazardous waste facilities (Cassidy, Hill and Ma, 2022), and solid waste disposal facilities (Ho, 2023).

2.4 The Social Life Cycle Assessment

The Social Life Cycle Assessment (S-LCA) is a methodological framework used to evaluate the social and socio-economic impacts of systems or products throughout their entire life cycle, from raw material extraction to disposal. Unlike environmental Life Cycle Assessment (LCA), which primarily focuses on biophysical environmental indicators, S-LCA centers on human dimensions—such as labor rights, community wellbeing, and equity. The United Nations Environment Programme has been instrumental in advancing this framework through its *Guidelines for Social Life Cycle Assessment of Products and Organizations* (UNEP, 2009, 2020).

S-LCA assesses impacts across several stakeholder categories, including local communities, workers, consumers, and society at large. These categories are further evaluated through specific subcategories, such as environmental pollution, public health, fair wages, child labor, access to resources, and the preservation of cultural heritage.

To demonstrate how S-LCA can be applied, consider the hypothetical siting of a coal-fired power plant in Pennsylvania in the 1950s. An S-LCA of this project would analyze upstream labor conditions in coal mining, such as unsafe working conditions and the prevalence of black lung disease among miners – issues well-documented in historical accounts. The assessment would also explore impacts on local communities, such as forced relocations, land loss, and environmental degradation, which disproportionately affected lower-income populations. During the plant's operational phase, the analysis would evaluate both local employment effects and the broader impacts on air quality and public health, particularly among marginalized populations living near the facility.

Downstream, the S-LCA would examine the region's long-term economic dependency on a single polluting industry, which stifles economic diversification and creates vulnerabilities. The post-use phase would consider the social legacy of the plant, including diminished trust in institutions, intergenerational poverty, and environmental injustice, highlighting how S-LCA extends beyond immediate impacts to address long-term societal wellbeing.

S-LCA thus provides a comprehensive approach to uncovering the hidden social costs of energy transitions, offering a tool to assess equity over time and across space. This is especially relevant in historical evaluations of energy infrastructure, such as coal-fired power plants in the United States, where environmental justice concerns often preceded formal recognition of these issues. In this study, we will focus on the evolution in demographics following the siting of fossil-fuel power plants, specifically examining the long-term consequences on the racial composition of the counties where these plants are located.

3 Data

The analysis combines newly-digitized data on power plant investment and operations with spatially-resolved demographic data from the U.S Census. In addition, we collect data on the potential determinants of power plant siting over time, such as population, transmission infrastructure, location of coal production, economic activity, and railroads. This allows us to ascertain the potential role played by pre-existing demographics in addition to these other siting determinants.

Power plants: We begin with data on generating unit capacity and initial year of operation from eGrid (1996-2020). However, these data may not contain generating units that retired prior to 1995. Consequently, we supplement the eGrid database with newly-digitized data on the universe of fossil-fuel-fired power plants from 1938-1994 (Clay et al., 2025). This dataset includes the year built, latitude/longitude coordinates, and the following variables for each year of operation: production capacity, electricity output, and quantities of coal, oil, and natural gas burned. Our newly digitized dataset allows us to include plants which retired prior to 1995, primarily those built early in our 1900-2020 sample period. Figure 2 presents the spatial distribution of power plants by decade of siting.

The historical reporting requirements for power plants evolved over time, reflecting changes in the scope and scale of plants covered. In 1948, the Commission stopped requiring detailed information from plants with capacities under 2.5 megawatts. By 1966, reporting for plants with capacities between 10 and 25 megawatts was no longer required in sufficient detail, and new plants under 25 megawatts were excluded from detailed reporting. By 1979, the reporting exemptions expanded further, as electric utilities were no longer required to report detailed data for steam-electric plants under 25 megawatts or gas-turbine plants under 10 megawatts. These adjustments reflect increases in the size of new capacity investment over time and a shift in the focus of regulatory oversight to larger plants.

Demographic characteristics: We use information on total population by race at the county level for the 1900-2000 period from the "Historical Demographic, Economic and Social Data: The United States, 1790-2002 (ICPSR 2896)" and harmonized IPUMS data for 2010 and 2020 (Manson, 2020).

Siting characteristics: We use county-level data on geographic and economic variables to analyze potential determinants of the siting of fossil-fuel power plants. First, as mentioned previously, we obtain data on decadal county-level population. Especially early in our sample period when electricity transmission capacity was limited, proximity to electricity demand centers may have been a key determinant of power plant siting decisions.

Given the importance of transmission infrastructure for the development of power plants (e.g., Wolak (2015); Ryan (2021)), we digitized data on historical transmission power lines for 1923, 1935, 1949, and 1962 from various historical sources (U.S. Geological Survey, 1923; Federal Power Commission, 1935, 1951, 1963). The data shows transmission lines of different voltages for these years.[4]

Appendix Figure A.1 plots maps of the transmission lines with the highest voltage level: above 150kV in 1923, 220kV in 1935, 220kV in 1949, and above 188kV in 1965. This figure documents the significant rollout of high-voltage transmission lines between 1923-1965, particularly between 1949 and 1965. Appendix Figure A.1 documents that electric utilities largely could not transmit electricity to consumers far from the plant site early in our sample period.

Similarly, research has shown that expansions in coal power plant capacity have been concentrated in areas with existing manufacturing industries (Clay, Lewis and Severnini, 2022). To account for this, we obtained the share of manufacturing employment from 1900 to 2010 at the county level from ICPSR 2896.

Coal-fired power plants may also be more likely to be sited near coal mines (Joskow, 1985). To assess the importance of proximity to coal production, we draw on data on decadal county-level coal production from the "Local Economic Impacts of Coal Mining in the United States 1870 to 1970" repository on ICPSR (Matheis, 2016). For 1983-2020, we supplement this with annual county-level data on coal production from the Annual Coal Report published by the Energy Information Administration.[5] From these data, we construct an indicator for whether the county produced coal in the previous decade. For example, this indicator would be equal to one for county c in decade $t = 1950$ if and only if there was any coal production in the county between 1940-1949.

Finally, the majority of coal is transported from coal mine to power plant via rail (Preonas, 2024). To ascertain the importance of proximity to railroads to coal plant siting decisions, we utilize data on railroads built as of 1911 (Donaldson and Hornbeck, 2016). As noted in Donaldson and Hornbeck (2016), the bulk of railroad mileage was already built as of 1900, so this cross-sectional historical measure of railroad mileage across the United States likely captures the variation relevant even for coal-fired power plants built later in our sample period.

[4]Available data on voltages vary by year. For 1923, the voltages were 11-44kV, 44-66kV, 66-150kV, and 150kV or more. For 1935 and 1949, the voltages were less than 66kV, 66-110kV, and 220 or more kV. For 1962, the voltages were 22-57kV, 58-79kV, 80-188kV, and 189 or more kV.

[5]We impute annual total coal production in 1970 as the average of annual total coal production in 1960 and 1980.

Summary statistics: Tables A.1-A.4 present summary statistics of the key variables utilized in our analysis. We present averages and standard deviations separately for each "cohort" of counties. Summary statistics for the same decade are also presented for the "never-treated" counties, those that never received a fossil-fuel power plant during our sample period.

These summary statistics tables document key differences in population, railroad mileage, and other variables across first-treated and never-treated counties. For all siting decades, average population levels are substantially higher in first-treated counties compared to never-treated counties, and these differences are statistically significant. Mileage of low-voltage transmission in the county is positively associated with first siting throughout our sample period, but becomes more important among counties first treated from the 1970s on. Finally, Black population share and first siting are negatively correlated among counties first treated early in the sample, but average Black population share is larger among counties first treated in the 1970s-1990s relative to never-treated counties.

An important caveat is that Tables A.1-A.4 document simple average differences in siting determinants. The average difference in Black population share across first-treated and never-treated counties in a given decade, for example, may stem from differences in population, manufacturing employment share, and other siting determinants. In the following section, we discuss our methodology to ascertain the relative importance of each of these variables in power plant siting decisions.

4 Methods

4.1 Siting determinants

In this section, we describe the methodology used to explore the determinants of whether a county first receives a fossil-fuel power plant in the decade. This allows us to assess whether Black population share played a role in initial siting decisions.

The dependent variable $T_{i,t}$ in these cross-sectional comparisons is equal to one if county i first has a fossil-fuel power plant as of decade t and is zero otherwise. For example, a county that first receives a fossil-fuel plant in 1945 would part of the 1950s "cohort" (so $T_{i,1950} = 1$ while $T_{i,1940} = 0$). We keep only observations corresponding either to: (1) never-treated counties (i.e., $T_{i,t} = 0$ for all decades between 1900-2020), or (2) counties in the first decade that they were treated (i.e., the observation where $T_{i,t} = 1$ is kept while all other observations for the county are dropped).

Using this sample, we estimate binary logistic regression specifications that result in the following probabilities:

$$Prob[T_{i,r,t} = 1] = \frac{exp(\delta_{r,t} + \theta_t \text{Black Pop. Share}_{i,t-1} + X_{i,t-1}\beta_t)}{1 + exp(\delta_{r,t} + \theta_t \text{Black Pop. Share}_{i,t-1} + X_{i,t-1}\beta_t)} \tag{1}$$

where r indexes the census region where county i is located. All specifications include census-region-by-decade fixed effects, $\delta_{r,t}$.

The impacts of lagged Black population share on the probability of first siting is captured by θ_t, with other siting determinants included in $X_{i,t-1}$. These determinants include: total county population, share of employment in manufacturing, and an indicator for whether the county produced coal – all for the previous decade; railroad mileage as of 1911, and one-decade lags based on measurements in 1923, 1935, 1949, and 1962 of an indicator for the presence of low-voltage transmission in the county as well as distance to high-voltage transmission. For example, considering a county in $t = 1950$, the estimating equation would include Black population share, population, manufacturing employment share, and an indicator for coal production, all in 1940, as well as railroad mileage in 1911, and transmission variables based on the 1935 digitized maps.

4.2 Event study framework

This section discusses the event study framework used to estimate the impacts of power plant siting on county-level demographics. Our primary dependent variable is county-level Black population share in each decade. In our setting, a county is considered treated as of the first decade after it received its first fossil-fuel power plant. For example, if a county first received a fossil-fuel power plant in 1945, then it is considered treated for every decade on or after 1950 (i.e., the "event decade" is 1950, which we will term its "cohort").

To illustrate the intuition behind the event study methodology, consider the average Black population share in 1990 across counties that are first treated as of 1950: $\overline{Y_{i,1990}}^{1950}$. A simple estimate of the treatment effect for the 1950 cohort of counties in the year 1990 might compare the average outcome in 1990 for these counties, $\overline{Y_{i,1990}}^{1950}$, to the average outcome across the same set of counties in 1940 (i.e., the decade before these counties are first treated):

$$\overline{Y_{i,1990}}^{1950} - \overline{Y_{i,1940}}^{1950}$$

However, this pre- versus post- comparison may stem from unrelated changes over time—such as national changes in economic and social conditions—rather than the power plant siting in the 1940s. For this reason, we consider the "difference-in-differences" estimate, comparing

$\overline{Y_{i,1990}}^{1950} - \overline{Y_{i,1940}}^{1950}$ to the same average difference for "never-treated" counties that never received a fossil fuel plant during our sample period:

$$[\overline{Y_{i,1990}}^{1950} - \overline{Y_{i,1940}}^{1950}] - [\overline{Y_{i,1990}}^{NT} - \overline{Y_{i,1940}}^{NT}] \quad (2)$$

Though Equation (2) focuses only on the 1950 cohort in the year 1990, similar comparisons can be made for other cohorts and years. For example, generalizing Equation (2) to consider differences for each cohort c four decades after the cohort is first treated relative to the same difference for never-treated counties:

$$[\overline{Y_{i,c+40}}^{c} - \overline{Y_{i,c-10}}^{c}] - [\overline{Y_{i,c+40}}^{NT} - \overline{Y_{i,c-10}}^{NT}]$$

After these comparisons are calculated for each cohort, we can take a weighted average across cohorts to ascertain the average effect on treated counties of being four decades from first treatment. We can similarly calculate weighted averages to ascertain the average effects on treated counties for other decades from first treatment (e.g., three or five decades after treatment rather than four decades as in the example).

Equation (2) illustrates the assumptions required to interpret estimates from this methodology as causal. First, the parallel trends assumption requires that average Black population share in the decades following first power plant siting would have trended the same across treated and never-treated counties in the absence of the plant being sited. Second, the no-anticipation assumption requires that Black population shares in treated counties in the decades prior to first siting are not influenced by the siting. Finally, the stable unit treatment value assumption requires that never-treated counties are unaffected by plant siting in the treated counties.

Formally, we estimate this event study specification using the staggered difference-in-differences methodology developed by Callaway and Sant'Anna (2021). This methodology accommodates arbitrary heterogeneity in treatment effects when estimating the average treatment effects on the treated when the timing of treatment is staggered. In our application, we only use never-treated counties as controls and all pre-treatment and post-treatment effects are normalized relative to the decade before first treatment. We include county fixed effects and decade fixed effects in all specifications. Standard errors are clustered by county. Appendix B provides a formal discussion of the Callaway and Sant'Anna (2021) methodology, and the potential pitfalls of a simple regression approach to estimating event study specifications.

5 Results

5.1 Initial siting determinants

We first examine whether fossil-fuel power plants are disproportionately sited in counties with higher Black population share. To do so, as discussed in Section 4.1, we estimate the effect of county-level Black population share at the beginning of the decade on the likelihood of first receiving a fossil-fuel power plant in the decade, controlling for other siting determinants. Other siting determinants include: total county population; the share of county employment in manufacturing; mileage of railroads in the county as of 1911; whether coal production occurred in the county; whether lower-voltage transmission (less than 66 kV) was present in the county; and distance from the county centroid to the nearest high-voltage transmission line (greater than 150 kV). Other than railroads, which are measured as of 1911, each of these determinants is lagged relative to the decade of siting (e.g., we include population in 1940 when considering the probability of first siting between 1940-1949). We estimate separate binary logistic regression models for each decade. The resulting average marginal effects documenting the change in the probability of first siting associated with changes in each siting determinant are reported in Appendix Tables A.5 and A.6.

Figure 3 presents the estimated average marginal effects documenting how changes in each of four siting determinants affects the probability of first siting in each decade. Panel A of Figure 3 indicates that, controlling for other siting determinants, the average impacts of lagged Black population share on probability of first siting are small and not statistically significant for counties first receiving a fossil fuel plant prior to 1940. The lack of an effect of Black population share on siting among early cohorts is consistent with the available historical evidence, which emphasizes the importance of other factors such as proximity to electricity demand from residents and manufacturing facilities.

Panel A of Figure 3 also indicates that, controlling for other siting determinants, increases in lagged Black population share correspond to slight increases in the propensity to receive a first power plant among counties first treated between 1980-1999. This small positive effect may reflect increased awareness of air pollution as a disamenity following the passage of the 1970 Clean Air Act and its amendments in 1977 and 1990, combined with the economic and political powerlessness of minority communities that makes them the "path of least resistance" for locally undesirable land uses (Roberts, 1998)—where affluent communities' ability to oppose such facilities ("Not In My Backyard"–NIMBY) effectively shifts burdens onto less powerful minority neighborhoods ("Place in Minorities' Backyard"–PIMBY), often accompanied by weaker enforcement and greater environmental risks in these areas.

Panels B-D of Figure 3 show that, across most siting cohorts, lagged population, share of employment in manufacturing, and railroad mileage are positively correlated with the probability of a county getting its first power plant. Panels B and C suggest that locating power plants around areas with high residential or manufacturing electricity demand played a key role in siting decisions. Panel D highlights that proximity to railroads also played an important role in power plant siting decisions, likely because the majority of input coal is transported from mine to power plant by rail (Preonas, 2024).

To further investigate these differences, Table 1 presents a Oaxaca-Blinder decomposition. Specifically, separately for each decade, we decompose the difference in the probability of first siting a power plant between counties with above- versus below-average Black population shares into a portion that can be explained by the other siting determinants and a portion that is unexplained. Prior to performing this decomposition, we residualize both the outcome and explanatory variables by census region fixed effects. This mirrors the cross-sectional analysis discussed above, which controls for census region fixed effects.

The explained component is consistently positive across most decades, indicating that observed siting determinants tended to favor siting in counties with above average Black population shares. This suggests that, once regional patterns are accounted for, such counties possessed more favorable attributes – such as greater industrial activity, larger population, or more developed infrastructure – that were associated with power plant placement. In contrast, the unexplained component is negative in all but two decades, implying that counties with higher Black population shares were less likely to receive their first power plant than would be expected based on observables alone. The two exceptions were in the 1970s and 1980s, when the unexplained portion of the overall difference was positive. The reasons for the positive unexplained portion in these years is unclear. We speculate that this pattern may partly reflect growing public awareness of the health effects of air pollution following Earth Day and the passage of the 1970 Clean Air Act. This may have had an interactive effect with the persistent economic and political power differences between minority communities and other communities, which makes them the "path of least resistance" for locally undesirable land uses (Roberts, 1998). As affluent communities mobilize to block such facilities through the NIMBY phenomenon, developers and policymakers often shift their focus to less organized, less politically influential neighborhoods.

5.2 Event study findings

Figure 4 presents event study estimates from the Callaway and Sant'Anna (2021) methodology of the effects of the first fossil-fuel power plant being built in a county on Black population share in the preceding and following decades. All reported effects are relative to the decade prior to first plant opening in the county (i.e., the decade prior to first plant siting serves as the reference decade). We utilize only counties that never received fossil-fuel power plants during our 1900-2020 sample period as controls. Standard errors are clustered by county.

Prior to first siting, the estimated pre-treatment effects are small and not statistically significant. Aggregating across cohorts, this suggests parallel trends in demographics in the decades leading up to the siting of the first plant in the county. The most striking post-treatment effects are seen 30-70 years after the first plant is built. Namely, we estimate a sizable and growing increase in Black population share, from a roughly 3 percentage point increase 3 decades out to a 10 percentage point increase 7 decades out.

Figures 5 and A.2 present the cohort-specific estimated event study effects for power plants sited between 1900-1959 and 1960-2020 respectively. The estimated effects by cohort indicate that post-treatment increases in Black population share are driven primarily by fossil fuel plants built prior to 1949. The largest estimated post-treatment effects are for the 1900-1909 and 1910-1919 cohorts, which have point estimates above 5 percentage points after 5 decades and 10 percentage points after 10 decades. The next three cohorts – 1920-1929, 1930-1939, and 1940-1949 – exhibit a roughly 3 percentage point increase after 5 decades. The last cohort in the graph, 1950-1959, indicates a roughly 1 percentage point increase in Black population share after 5 decades.

These figures also make clear that the pre-treatment event study estimates aggregated across cohorts in Figure 4 stem primarily from counties receiving fossil-fuel plants after 1940. For post-1940 cohorts, the pre-treatment estimated effects are largely flat and not statistically significant. However, the pre-treatment event study estimates for counties first treated between 1920-1939 exhibit a slight pre-trend, statistically significant at the 5% or 10% levels in most cases.

5.3 Mechanisms

Why are Black population shares increasing in counties with power plants, particularly in counties with power plants sited before 1949? In this section, we discuss the potential roles played by the Great Migration and residential re-sorting in response to power plant siting. Since the largest effects on Black population share were for the two earliest cohorts of counties to receive a first power plant (i.e., counties first receiving a fossil-fuel plant in the 1900s or 1910s), the discussion of potential mechanisms will focus on these counties. Appendix Table A.1 indicates that these counties were populous and manufacturing oriented at the time of siting. Many of these early cohort counties remain more populous in 2020 compared to later cohort counties.

The Great Migration of African Americans to northern cities likely played a significant role in the rising share of Black population in early treated counties. These early cohort counties were attracting Black workers. Figure 6 shows changes in Black population share in cities for 1910-1940 and 1940-1970. Black workers moved to Northern cities for economic opportunity. The available evidence suggests that the economic benefits were large (Boustan, 2009; Collins and Wanamaker, 2014; Clay and Schmick, 2020).[6]

Panel (a) of Figure 7 documents that increases in county-level change in percentile ranking of Black population share from 1910 to 1940 (i.e., the first wave of the Great Migration) corresponds to increases in total fossil-fuel capacity between 1910 and 1940. Panel (b) documents a similar strong positive relationship between changes in Black population share between 1940-1970 (i.e., the second wave of the Great Migration) and fossil-fuel capacity between 1940-1970.[7] This is suggestive that the shifts in demographics induced by the first and second waves of the Great Migration exacerbated the current pollution disparities from fossil-fuel generating capacity documented in Hernandez-Cortes, Meng and Weber (2023).

Power plant openings may have also induced ex-post residential sorting. The local disamenity associated with the pollution emissions from burning fossil fuels may have contributed to socioeconomic-based sorting (Davis, 2011), as lower income households are pushed towards more affordable homes in heavily polluted areas (Clay, Lewis and Severnini, 2022). These patterns may have been reinforced by underlying racial differences in employment and occupational outcomes. For example, to the extent that African Americans were disproportionately employed in sectors that benefited from local coal-fired generation, this may have generated within and across county sorting on the basis of economic opportunity.

Figure 8 shows that early treated cohorts of counties experienced sustained increases in fossil-fuel electricity generating capacity throughout our sample period. As a result, the 1900-1909 cohort had by far the highest average capacity from all fossil-fuel sources in 2020 and the 1910-1919 cohort had the second highest average capacity throughout much of the period and

[6] Other aspects of the migration, such as segregation, crime and increased mortality were less favorable (Black et al., 2015; Derenoncourt, 2022).

[7] Figure A.3 examines this same relationship between 1940-1970 when restricting the sample to only counties that already had a power plant as of 1940, but experienced an expansion in capacity, finding a similar pattern. Between 1910-1940, only a few counties in our data experienced expansion of existing capacity.

the third highest average capacity overall in 2020, after the 1920-1929 cohort. This increase in fossil-fuel generating capacity over time among early cohort counties suggests that the post-treatment event study estimates for these counties may be driven by capacity expansions, but are unlikely to stem from plant retirements.[8]

This expansion of fossil-fuel capacity among early treated cohorts likely came with increased pollution emissions. Consistent with this, Panel (a) of Figure 9 shows that early cohorts of counties were much more likely than later cohorts to be in nonattainment with the National Ambient Air Quality Standards in 1972.[9] Counties in nonattainment in 1972 had significantly higher air pollution levels at the time of the designation than attainment counties and likely exhibited high pollution levels in the years prior to 1972.[10]

At the same time, nonattainment counties also experienced demographic shifts that might have changed which populations were exposed to pollution. For instance, Panel (b) of Figure 9 shows that the total share of Black population living in counties classified as nonattainment in 1972 increased from 20% in 1900 to nearly 70% after 1970. In contrast, the share of White population living in counties out of attainment in 1972 remained relatively constant during the same period. These demographic changes likely contribute to the current pollution disparities experienced by Black populations.

Residential sorting in response to fossil-fuel-fired plant openings is likely to have emerged gradually over the course of the 20th century. Despite high levels of urban air pollution throughout the early 20th century, widespread public concerns regarding air pollution did not emerge until the post-1950 era, following several high profile events such as the 1947 Donora Smog and the 1952 London Smog (Clay, Lewis and Severnini, 2022; Clay et al., 2025). Similarly, industrial reorganization in response to changes in local generating infrastructure is a process that likely emerged gradually over a period of several decades.

Sorting in response to local disamenities from power plants may have been compounded by White households moving from central cities to suburbs. This "White flight" was in response to a range of urban disamenities, including crime, pollution, low quality schools, and living in proximity to specific racial and ethnic groups (Shertzer and Walsh, 2019; Baum-Snow, 2007;

[8]Figure A.4 presents event study estimates of the *first* capacity expansion in a county on Black population share, using as controls counties with fossil-fuel plants that never experienced a capacity expansion during the sample period. This figure indicates that the first capacity expansion did not have a sizable effect on Black population share, suggesting that our primary event study estimates are driven by first siting rather than subsequent capacity expansions.

[9]For the years 1972-1977, we use the attainment status designations specified in Greenstone (2002).

[10]Appendix Figure A.5 depicts similar trends when examining $PM_{2.5}$ concentrations in 1980 by siting cohort. Counties that received their first power plant between 1900-1919 had higher $PM_{2.5}$concentration levels in 1980 than any other cohort.

Boustan, 2010; Derenoncourt, 2022). These moves occurred both within and across county boundaries.

6 Concluding Remarks

Our analysis has two main findings. First, the cross-sectional analysis indicates that counties with higher lagged Black population share were not substantially more likely to receive a first fossil-fuel power plant. Thus, current disparities in exposure to power plants do not stem from inequities in initial siting decisions. Second, we estimate increases in average Black population share of up to 5 percentage points in the *50-70 years* after the first fossil-fuel plant in the county was built. Our post-treatment event-study effects are driven by counties that first received a fossil-fuel plant before 1949.

These findings highlight that the equity implications of long-lived infrastructure can differ dramatically depending on the time span considered. In our setting, demographics shift slowly in the decades following the first siting of a fossil-fuel plant, highlighting the need to consider the equity implications of siting over the full lifespan of the power plant. This long-run shift in demographics is a key contributor to the current disparities in pollution exposure from power plants.

Our findings also underscore the importance of considering the social lifecycle of infrastructure projects, especially those with long-lasting effects such as fossil-fuel plants. While these projects may promise short-term economic or energy benefits (Clay, Lewis and Severnini, 2024), their long-term implications often extend far beyond immediate gains. In particular, the demographic shifts observed in counties that first hosted a fossil-fuel plant between 1900-1949 suggest that infrastructure decisions made in the past continue to shape local communities in ways that are not always apparent in the short term.

This dynamic highlights a critical aspect of infrastructure planning: the need to account for the potentially longer-term benefits and costs, particularly in terms of social equity. In the case of fossil-fuel plants, the immediate positive impacts of job creation or energy access may be overshadowed by the persistent environmental and health burdens that disproportionately affect marginalized communities. These externalities, which accumulate over time, can exacerbate existing inequalities and contribute to current disparities in pollution exposure. Thus, lifecycle analyses of infrastructure projects must not only evaluate their direct immediate benefits but also anticipate the broader, often delayed, costs they impose on vulnerable populations.

Moreover, the persistence of these disparities points to the necessity of incorporating a long-term perspective into infrastructure policy and siting decisions. Policymakers should be mindful of how early infrastructure investments, particularly those with lasting environmental impacts, may continue to shape the social fabric of communities for generations. By integrating considerations of equity and environmental justice into the planning and evaluation of infrastructure projects, policymakers can better balance short-term gains with long-term sustainability, ensuring that the benefits of development are more equitably distributed across all communities.

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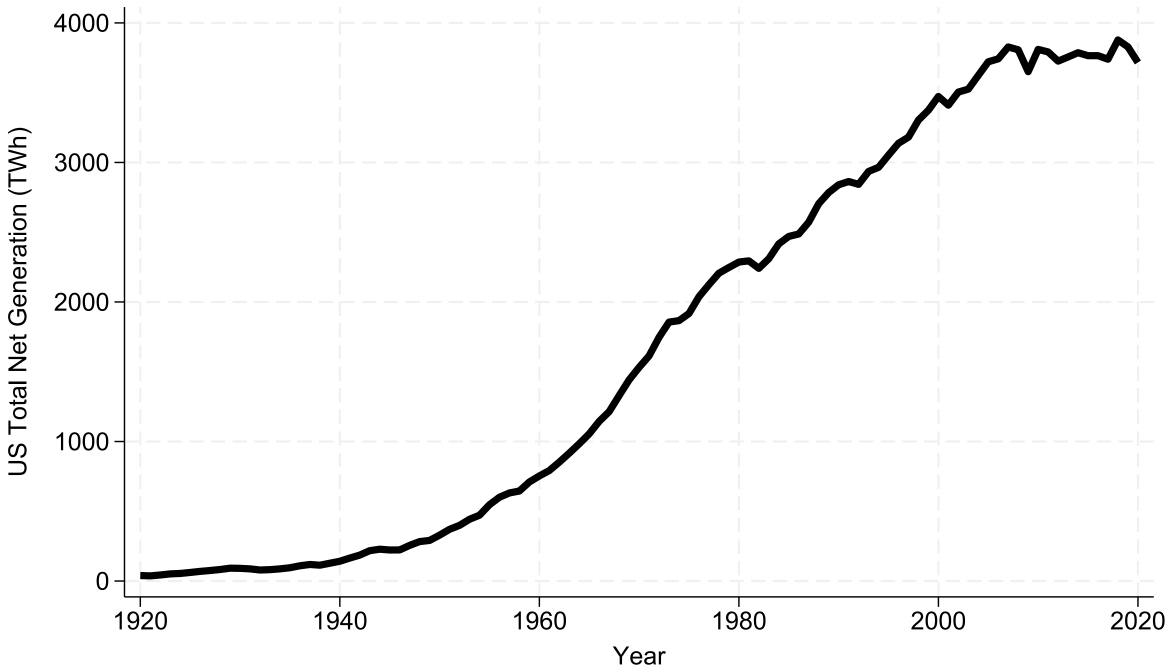
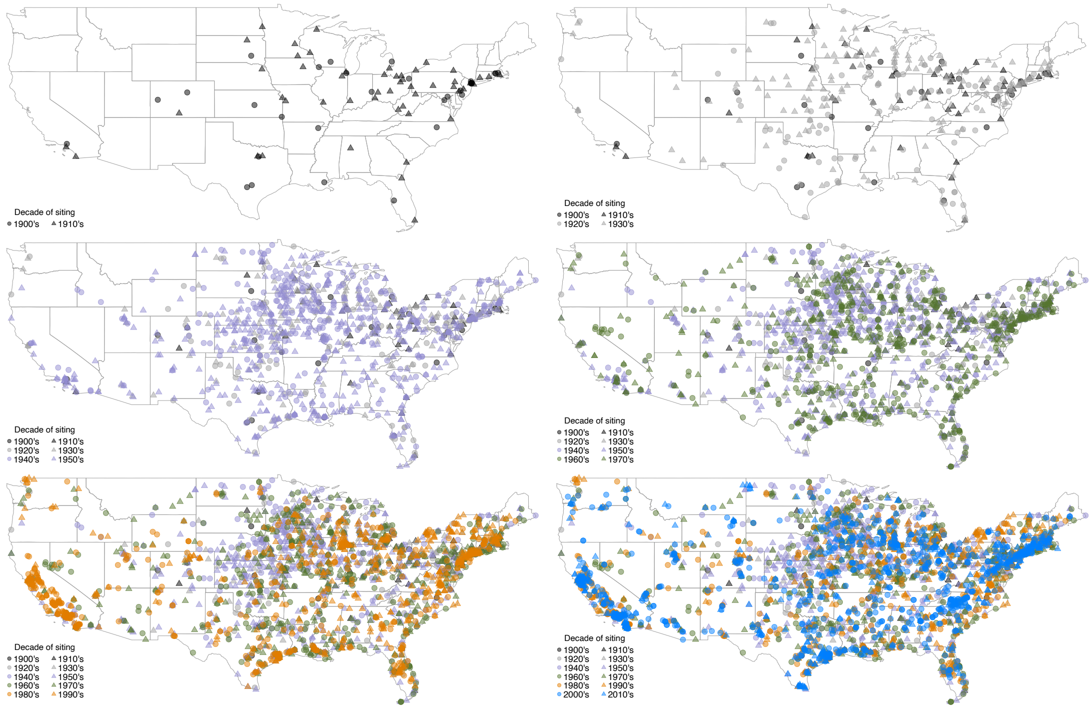
Figures and Tables

Figure 1: Annual U.S. Total Net Electricity Production



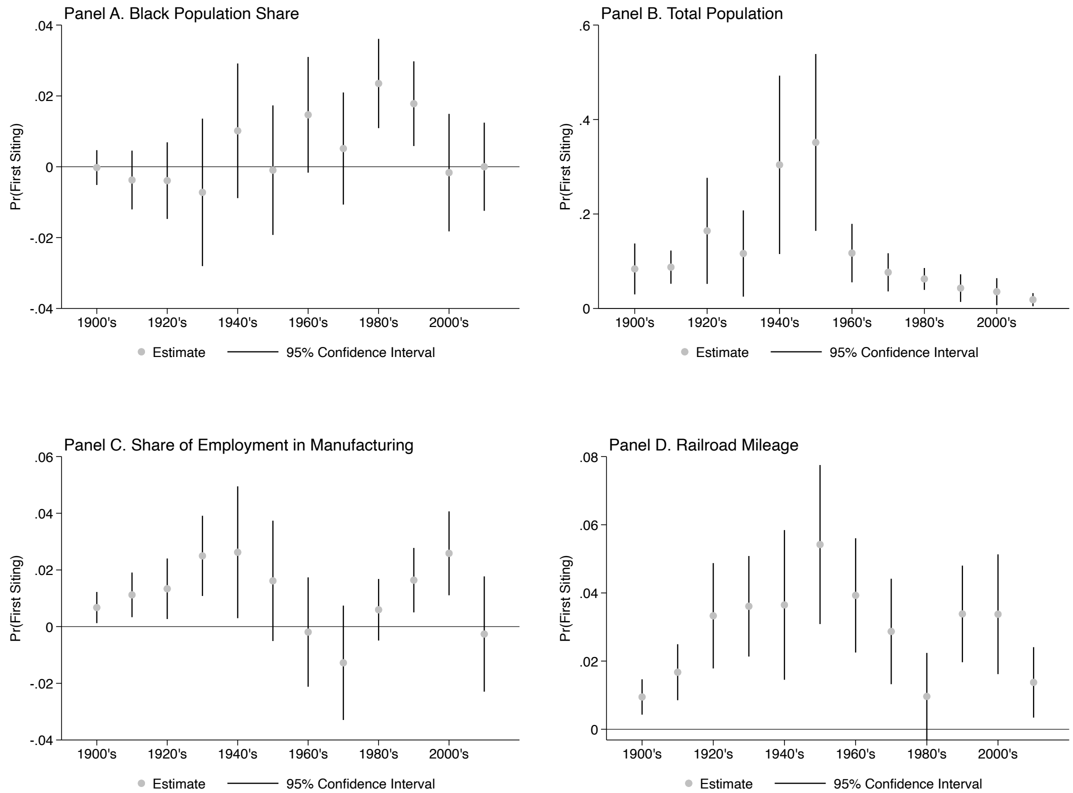
Notes: This figure reports total net electricity generation across the United States. For the period 1920-1990, we utilize data from Table Db218-227 from the Historical Statistics of the United States on U.S total net generation only from electric utilities. For the period 1990-2020, we utilize data from the Energy Information Administration's (EIA's) historical state data on "Net Generation by State by Type of Producer by Energy Source." For the period 1990-2020, we include total net generation both from electric utilities and independent power producers (IPPs), noting that IPPs produced a very small share of total net generation prior to 1998 (e.g., 1.1% in 1990).

Figure 2: First Power Plant Siting by Decade



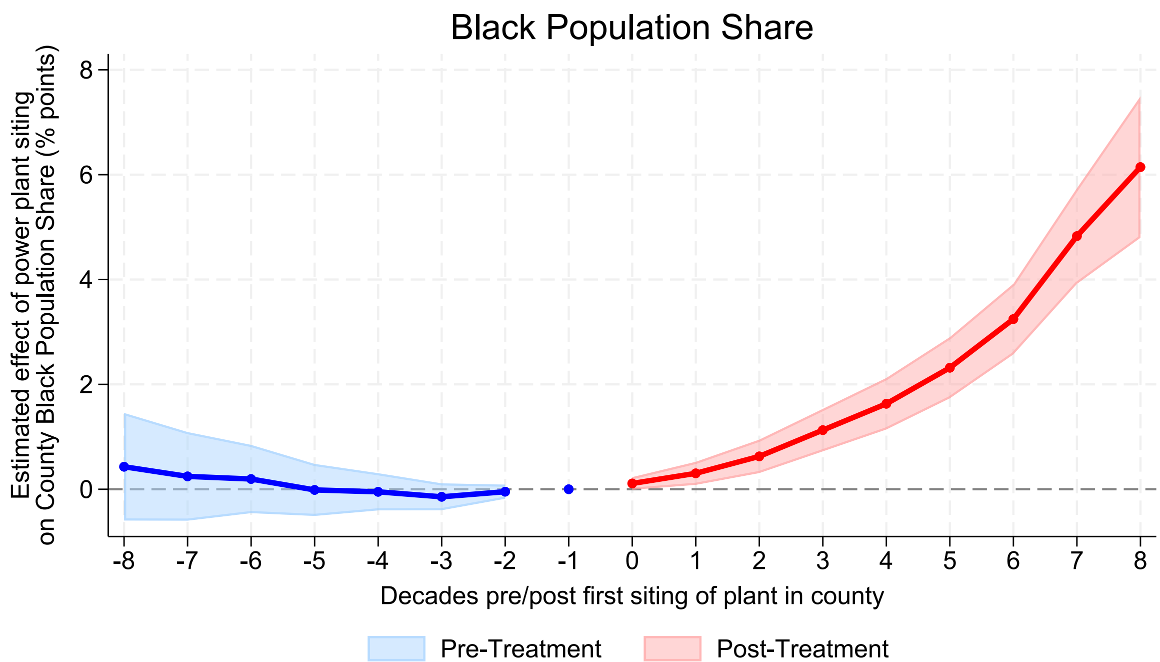
Notes: This figure presents the location of fossil-fuel power plants in the United States by the decade of first siting.

Figure 3: Effects of Siting Determinants on Probability of First Power Plant Siting



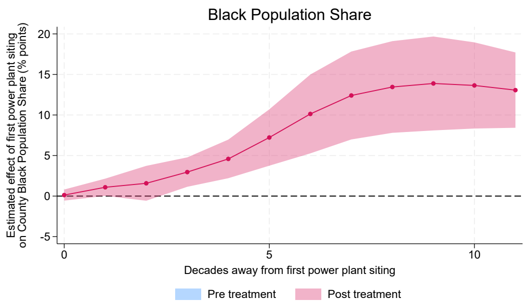
Notes: This figure presents, for each decade between the 1900's and 2010's, the estimated impact of four key siting determinants on the probability that a county receives its first fossil fuel power plant in a specific decade. Panel A depicts the one-decade lagged Black population share, Panel B depicts the one-decade lagged county population, Panel C depicts the one-decade lagged share of county employment in manufacturing, and Panel D depicts the mileage of railroads in the county as of 1911. Only never-treated counties and counties first treated in the specified decade are included in the estimating sample. Effects are estimated using separate binary logistic regressions for each decade, with marginal effects of a one standard deviation change reported. All specifications include census-region fixed effects and the following siting determinants: Black population share, population, share of employment in manufacturing, an indicator for whether the county produced coal, an indicator for the presences of low-voltage transmission in the county, and distance to high-voltage transmission – all lagged – as well as railroad mileage in 1911. Full results are reported in Tables A.5 and A.6.

Figure 4: Impacts of First Power Plant Siting on Black Population Share

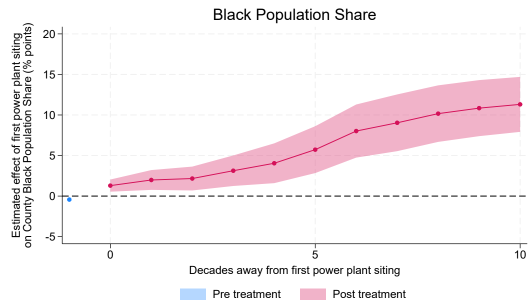


Notes: This figure plots event study estimates and 95% confidence intervals of the impacts of the first fossil-fuel plant being built in a county on Black population share. We estimate these event studies using the methodology from Callaway and Sant'Anna (2021), considering only never-treated counties as controls. All reported effects are relative to the decade prior to first plant (i.e., the decade prior to the first plant being built in the county serves as the reference decade). 95% confidence intervals are based on standard errors are clustered by county. As a point of reference, the population-weighted average Black population share across counties that ever received a fossil-fuel power plant during our sample period ranges from roughly 8%-13% across sample years.

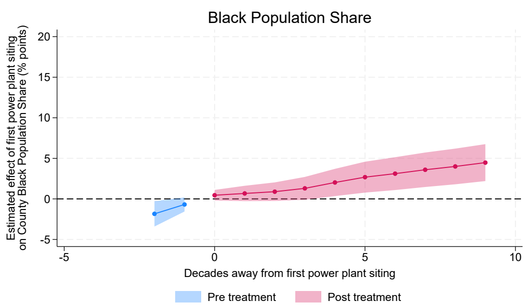
Figure 5: Cohort-Specific Effects of First Power Plant Siting on Black Population Share (1900-1959)



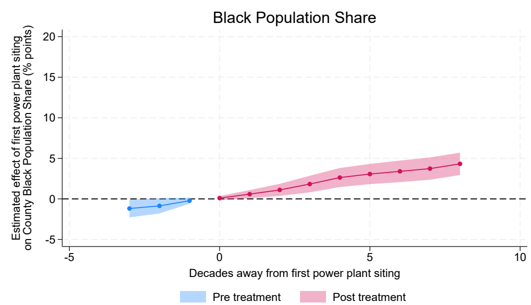
(a) 1900-1909 cohort



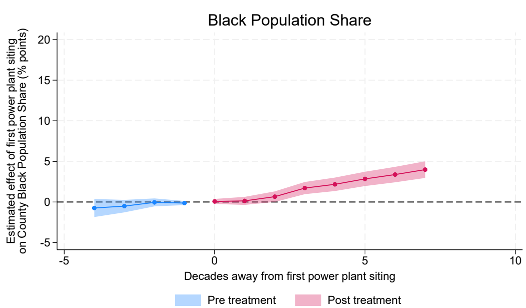
(b) 1910-1919 cohort



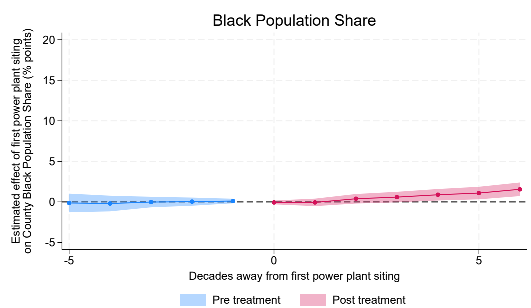
(c) 1920-1929 cohort



(d) 1930-1939 cohort



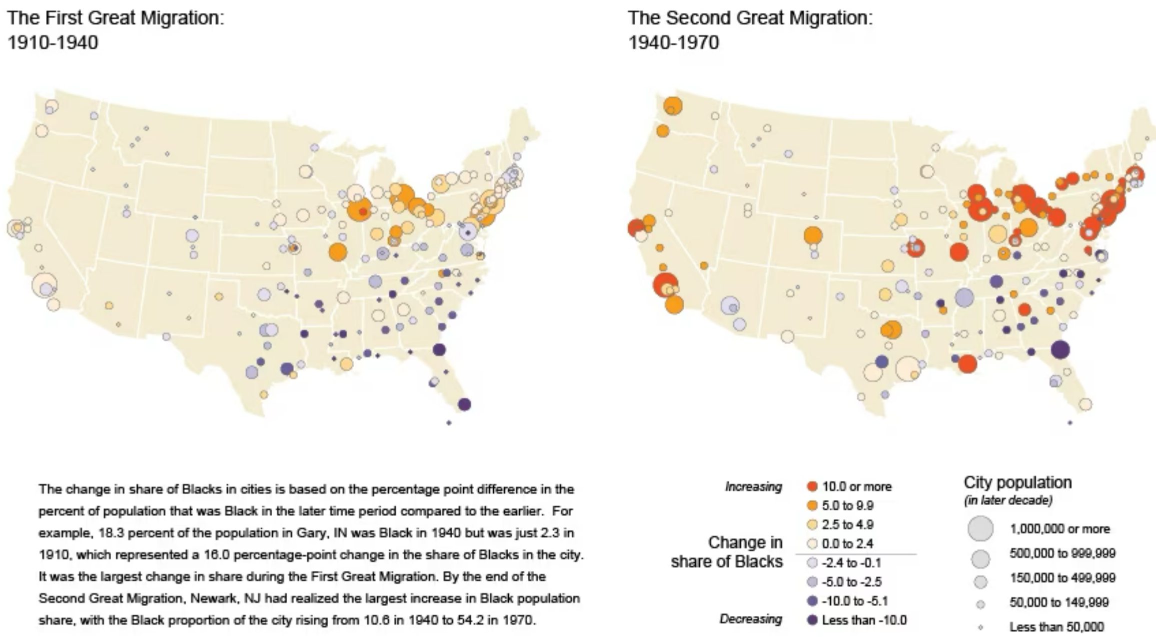
(e) 1940-1949 cohort



(f) 1950-1959 cohort

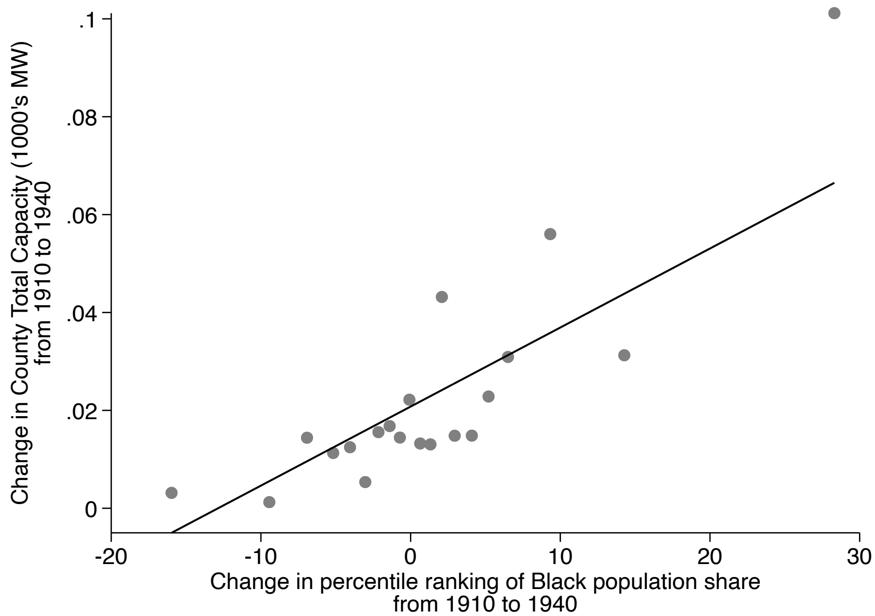
Notes: This figure plots event study estimates and 95% confidence intervals of the impacts of the first fossil-fuel plant being built in a county on Black population share. We estimate these event studies using the methodology from Callaway and Sant'Anna (2021), considering never-treated as controls. All reported effects are relative to the decade prior to first plant (i.e., the decade prior to the first plant being built in the county serves as the reference decade). Each panel documents the event study estimates and 95% confidence intervals for a given cohort (e.g., panel (a) reports the estimated effects for counties first hosting a plant between 1900-1909). 95% confidence intervals are based on standard errors are clustered by county. As a point of reference, the population-weighted average Black population share across counties that ever received a fossil-fuel power plant during our sample period ranges from roughly 8%-13% across sample years.

Figure 6: First and Second Great Migrations

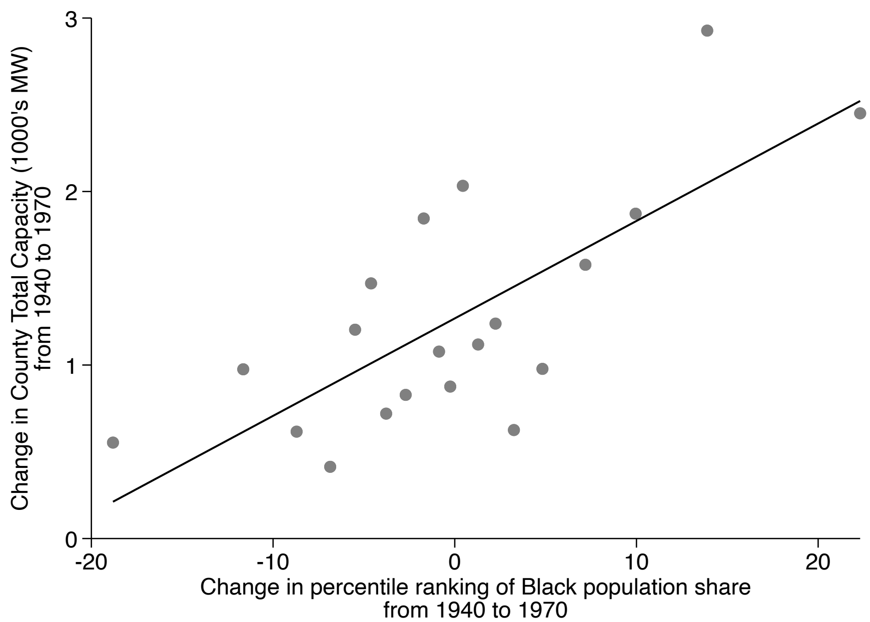


Notes: These figures document changes in the shares of African-Americans during the first and second waves of the Great Migration. These figures are from U.S. Census (2012).

Figure 7: Changes in Power Plant Capacity and Black Population Share



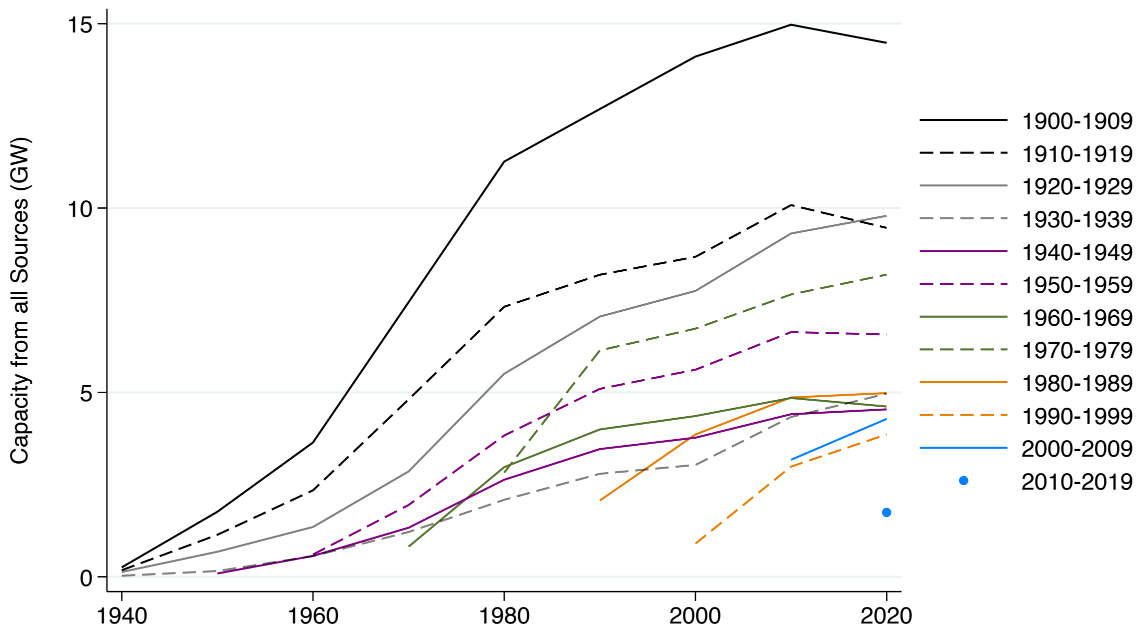
(a) Total Capacity from 1910-1940



(b) Total Capacity from 1940-1970

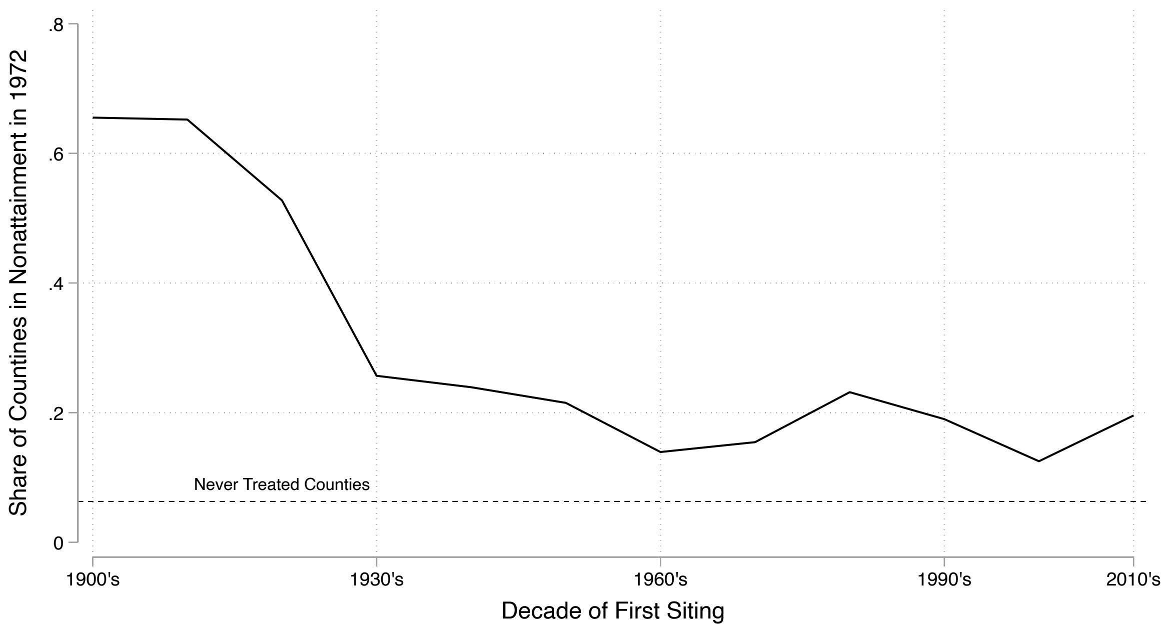
Notes: This figure presents binned scatter plots of county-level changes in power plant generating capacity on changes in the percentile ranking of counties by share of Black population. Two time periods are considered: changes from 1910 to 1940 in Panel A, and from 1940 to 1970 in Panel B, corresponding to the first and second waves of the Great Migration. Here, we allow change in capacity to be driven both by plant openings as well as by capacity expansions at existing plants. In Appendix Figure A.3, we restrict the sample to only include capacity expansions at existing plants, finding very similar trends between 1940-1970. As of 1910, there were only 27 counties with power plants in our data, almost none of which saw expansions by 1940. We thus omit the corresponding figure on capacity expansion at existing plants between 1910-1940 from Appendix Figure A.3.

Figure 8: County Average Power Plant Capacity by Decade of First Siting

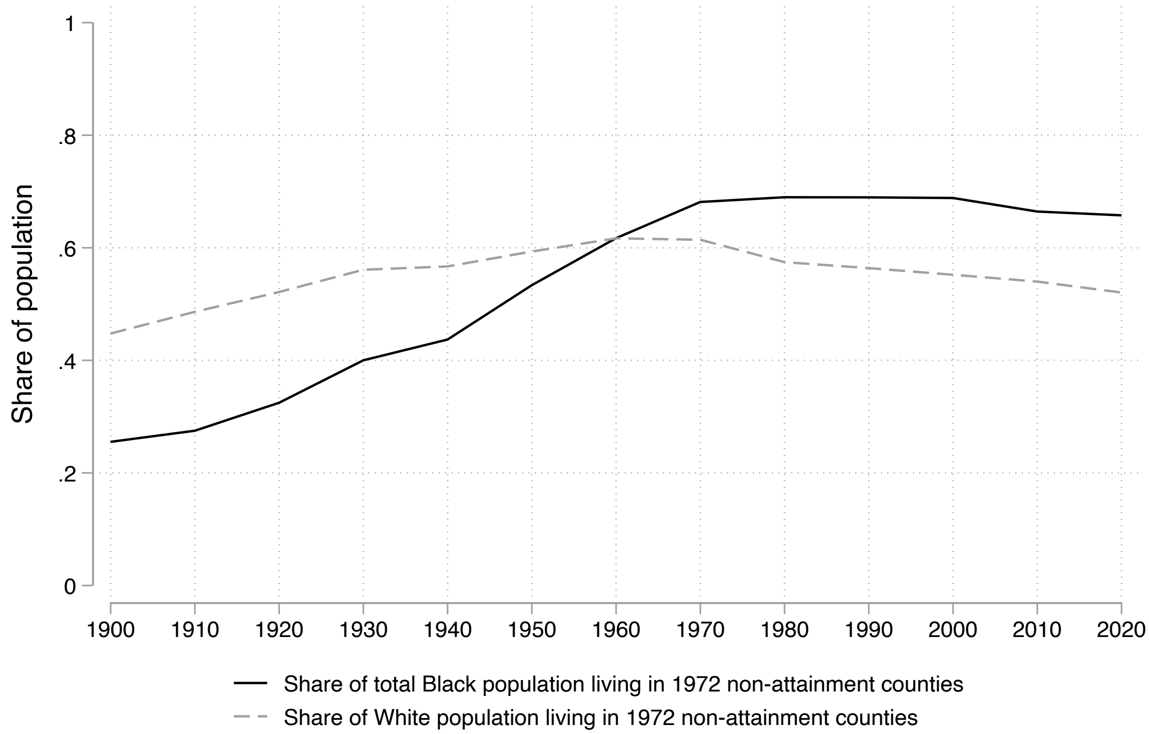


Notes: This figure depicts the evolution of county average power plant capacity over time, separately for each set of counties grouped by decade of first power plant siting. While power-plant location data is available prior to 1940, capacity data are generally unavailable prior to 1940. Consequently, we plot county average power plant capacity beginning in 1940.

Figure 9: Counties and Population in Nonattainment in 1972



(a) Share of counties out of attainment in 1972 by decade of first siting



(b) Shares of Black and White population living in counties that were out of attainment as of 1972

Notes: Panel (a) of this figure plots the share of counties in nonattainment as of 1972, by decade of first siting. As a point of comparison, the share of nonattainment for counties without a fossil-fuel plant siting in our sample period is included as a dashed horizontal line. Panel (b) plots the shares of Black population and White population living in counties in nonattainment as of 1972. The numerator is the U.S. total group-specific population living in 1972 nonattainment counties while the denominator is U.S. total group-specific population.

Table 1: Oaxaca-Blinder Decomposition of Difference in Probability of First Siting in Counties with Above and Below the Mean Black Population Share

	(1)	(2)	(3)	(4)	(5)	(6)
	1900's	1910's	1920's	1930's	1940's	1950's
Panel A. 1900's - 1950's						
Difference	0.013	0.004	0.008	−0.014	−0.024	−0.008
Explained	0.028	0.041	0.025	0.006	0.025	0.033
Unexplained	−0.015	−0.036	−0.017	−0.02	−0.049	−0.041
Panel B. 1960's - 2010's	1960's	1970's	1980's	1990's	2000's	2010's
Difference	0.007	0.019	0.024	0.053	0.022	0.009
Explained	0.018	−0.001	−0.046	0.084	0.107	0.068
Unexplained	−0.01	0.021	0.069	−0.031	−0.085	−0.059

Notes: This table presents, for each decade between the 1900's through the 2010's, the difference in the probability that counties above the mean Black population share in that decade received their first fossil fuel power plant, relative to counties below the mean. It then presents the portion of this difference that is explained by the other siting determinants considered in Tables A.5 and A.6, as well as the unexplained portion.

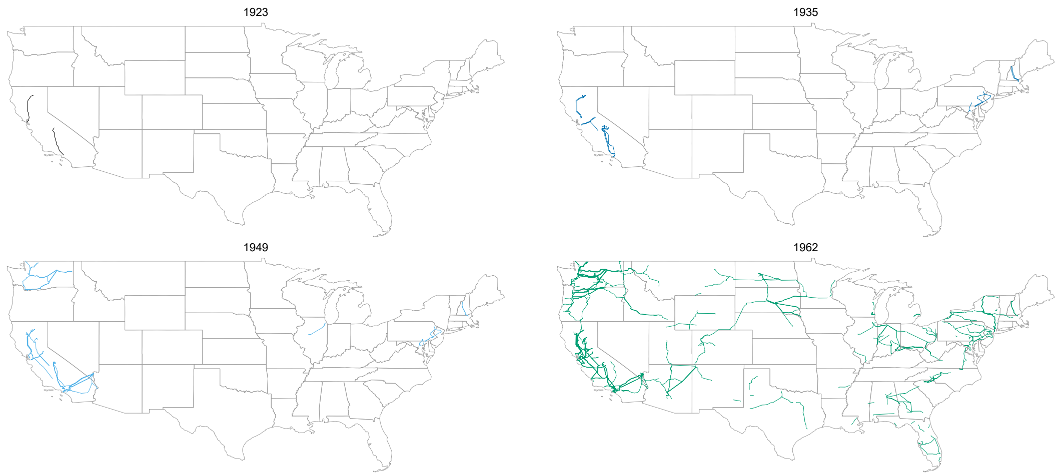
A Appendix

This Appendix includes additional tables and figures, listed below and referenced in the text.

Figures

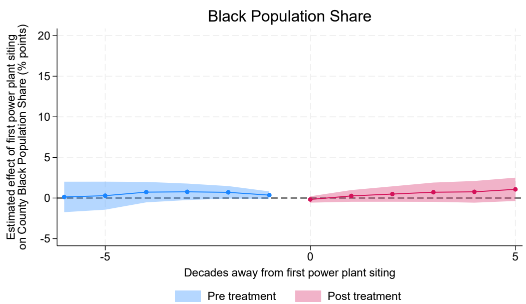
Tables

Figure A.1: Transmission Lines

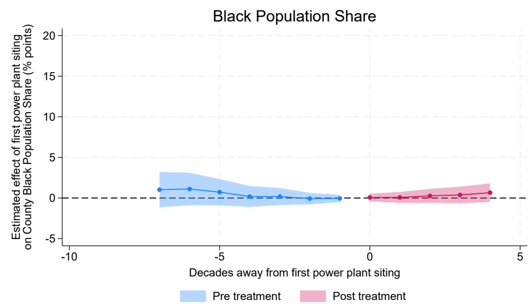


Notes: This figure shows transmission lines with the highest voltage level: above 150kV in 1923, 220kV in 1935, 220kV in 1949, and above 188kV in 1965.

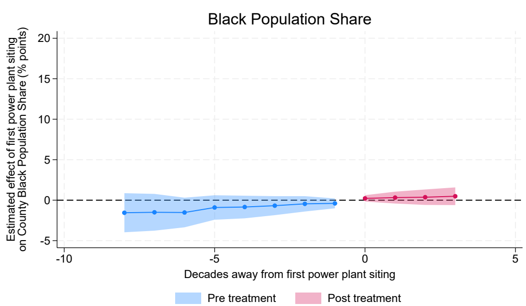
Figure A.2: Cohort-specific Effects of First Power Plant Siting on Black Population Share (1960-2020)



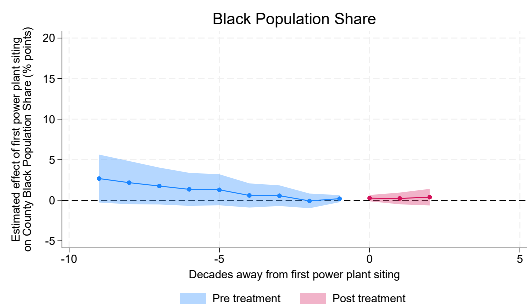
(a) 1960-1969 cohort



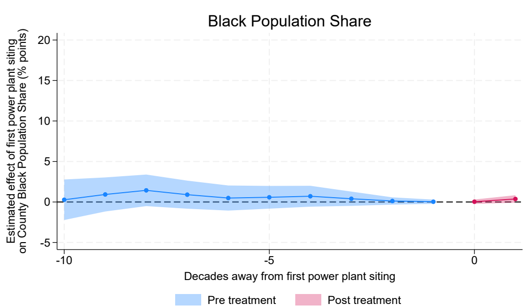
(b) 1970-1979 cohort



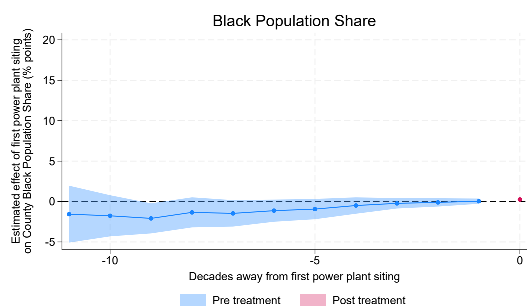
(c) 1980-1989 cohort



(d) 1990-1999 cohort



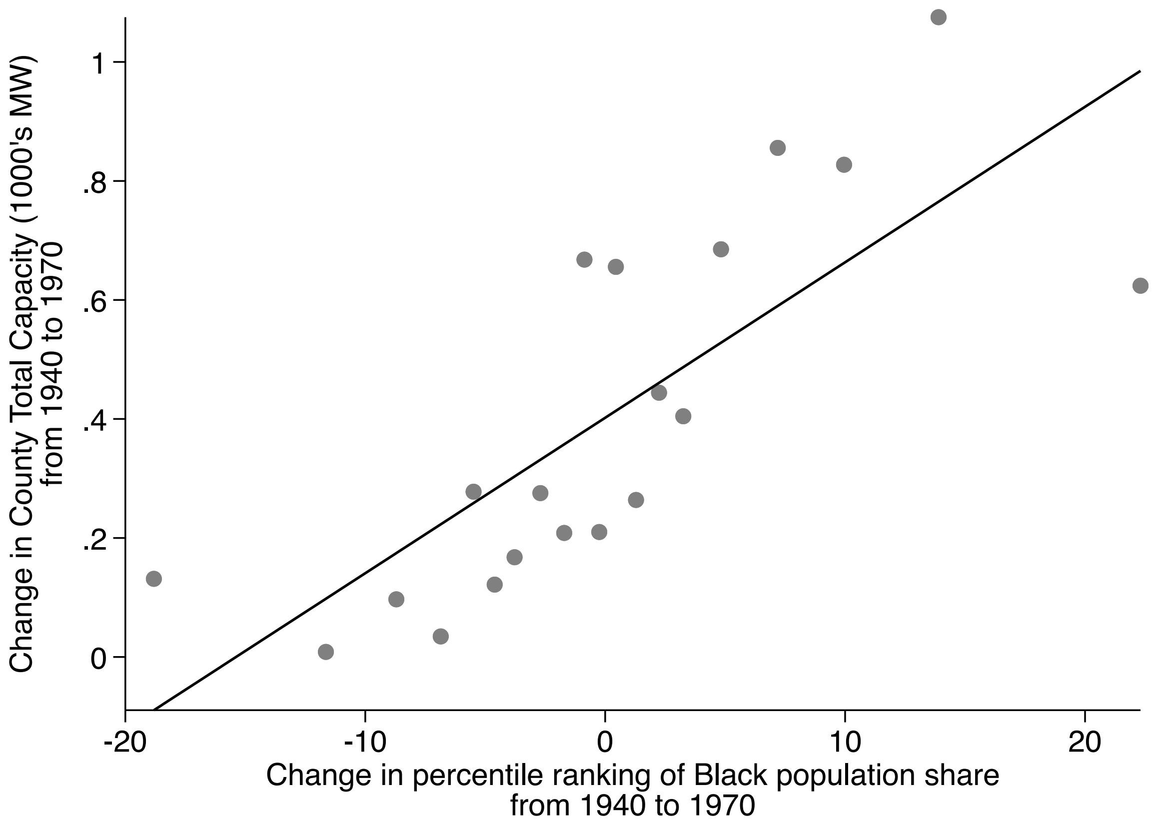
(e) 2000-2009 cohort



(f) 2010-2019 cohort

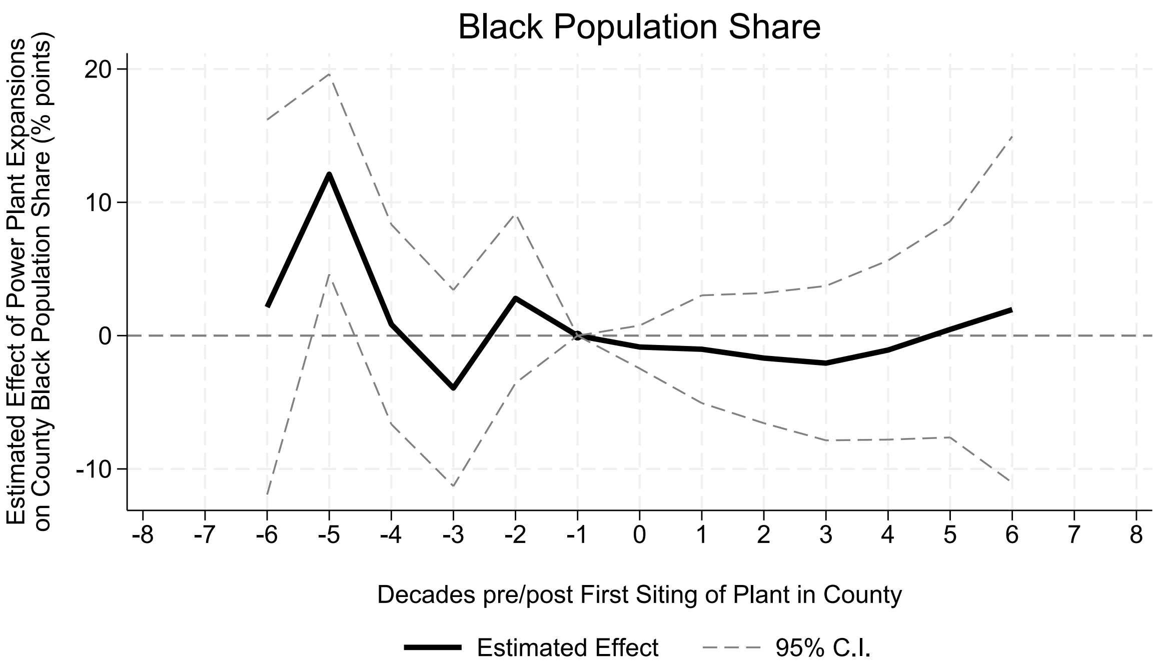
Notes: This figure plots event study estimates and 95% confidence intervals of the impacts of the first fossil-fuel plant being built in a county on Black population share. We estimate these event studies using the methodology from Callaway and Sant'Anna (2021), considering never-treated as controls. All reported effects are relative to the decade prior to first plant (i.e., the decade prior to the first plant being built in the county serves as the reference decade). Each panel documents the event study estimates and 95% confidence intervals for a given cohort (e.g., panel (a) reports the estimated effects for counties first hosting a plant between 1960-1969). 95% confidence intervals are based on standard errors are clustered by county. As a point of reference, the population-weighted average Black population share across counties that ever received a fossil-fuel power plant during our sample period ranges from roughly 8%-13% across sample years.

Figure A.3: Changes in Power Plant Capacity and Black Population Share (Expansions Only)



Notes: This figure presents binned scatter plots of county-level changes in power plant generating capacity (expansions only) on changes in the percentile ranking of counties by share of Black population. Very few counties had active power plants before 1910. Thus for examining the impact of expanding capacity we examine only 1940 to 1970, corresponding to the second wave of the Great Migration. Panel A presents all generating capacity, while Panel B includes only coal-fired capacity.

Figure A.4: Impact of First Power Plant Capacity Expansion on Black Population Share



Notes: This figure plots event study estimates and 95% confidence intervals of the impacts of the first fossil-fuel capacity expansion in a county on Black population share. These event studies consider only county/decades with fossil-fuel capacity, and a capacity expansion is defined to be capacity in decade t in the county being at least 40% higher than capacity in decade $t-1$ in the county. The "event" is the first capacity expansion experienced by the county. We estimate these event studies using the methodology from Callaway and Sant'Anna (2021), considering only never-treated counties as controls (i.e., counties that have fossil-fuel capacity but never experienced a capacity expansion). All reported effects are relative to the decade prior to first capacity expansion (i.e., the decade prior to the first capacity expansion in the county serves as the reference decade). 95% confidence intervals are based on standard errors are clustered by county.

Figure A.5: Average PM2.5 Concentration in 1980 by Cohort of First Siting

Notes: This figure presents the average $PM_{2.5}$ concentration level in 1980, by decade of first siting.

Table A.1: Summary Statistics of First Siting and Siting Determinants: 1900's – 1920's

	Treated Counties		Control Counties		Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	Std. Error
Panel A. 1900's						
County Black Population Share (%)	8.03	13.42	14.13	21.79	−6.1	4.21
County Population (1,000's)	319.51	569.86	15.26	12.3	304.25	14.77
County Employment in Manufacturing (%)	8.61	7.34	2.04	3.25	6.57	0.65
Railroads (mileage, 100's)	1.52	1.38	0.57	0.45	0.95	0.09
Coal Producing County	0.15	0.36	0.08	0.27	0.07	0.05
Low-voltage Transmission in County	0.04	0.19	0	0.07	0.04	0.01
Distance to High-voltage Transmission (100 miles)	17.43	6.29	15.39	5.37	2.04	1.05
Obs	27		1474			
Panel B. 1910's						
County Black Population Share (%)	5.97	11.97	13.57	21.48	−7.6	3.22
County Population (1,000's)	140.63	162.46	16.96	14	123.67	4.68
County Employment in Manufacturing (%)	9.57	6.29	2.33	3.31	7.24	0.52
Railroads (mileage, 100's)	1.55	0.72	0.57	0.45	0.98	0.07
Coal Producing County	0.24	0.43	0.09	0.29	0.15	0.04
Low-voltage Transmission in County	0.04	0.21	0	0.07	0.04	0.01
Distance to High-voltage Transmission (100 miles)	18.64	4.59	15.39	5.37	3.25	0.81
Obs	45		1474			
Panel C. 1920's						
County Black Population Share (%)	9.03	14.98	12.63	20.36	−3.6	2.3
County Population (1,000's)	118.14	178.61	17.7	16.45	100.44	4.97
County Employment in Manufacturing (%)	7.63	6.46	2.65	3.99	4.98	0.47
Railroads (mileage, 100's)	1.42	0.87	0.57	0.45	0.85	0.05
Coal Producing County	0.19	0.39	0.08	0.28	0.11	0.03
Low-voltage Transmission in County	0.04	0.19	0	0.07	0.04	0.01
Distance to High-voltage Transmission (100 miles)	16.05	5.63	15.39	5.37	0.66	0.61
Obs	81		1474			

Notes: This table presents, for each decade between the 1900's through the 1920's, the mean and standard deviation of the considered siting determinants. Recall that determinants are lagged by one decade; e.g., for the 1920's determinants reflect the 1910 values. Values are reported separately for treated counties – those that received their first power plant siting the in the decade, and control counties – those that never received a power plant siting. Finally, differences in means and the standard error of the difference are reported in the final two columns.

Table A.2: Summary Statistics of First Siting and Siting Determinants: 1930's – 1950's

	Treated Counties		Control Counties		Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	Std. Error
Panel D. 1930's						
County Black Population Share (%)	4.67	11.68	12	19.37	−7.33	1.9
County Population (1,000's)	68.93	139.55	18.68	19.6	50.25	4.09
County Employment in Manufacturing (%)	4.98	6.31	2.33	3.56	2.65	0.38
Railroads (mileage, 100's)	1.18	0.91	0.57	0.45	0.61	0.05
Coal Producing County	0.12	0.33	0.09	0.29	0.03	0.03
Low-voltage Transmission in County	0.04	0.19	0	0.07	0.04	0.01
Distance to High-voltage Transmission (100 miles)	15.29	5.28	15.39	5.37	−0.1	0.54
Obs	107		1474			
Panel E. 1940's						
County Black Population Share (%)	6.71	14.57	11.54	18.95	−4.83	1.4
County Population (1,000's)	44.13	54.77	19.71	21.13	24.42	2.07
County Employment in Manufacturing (%)	3.4	3.82	2.11	3.27	1.29	0.25
Railroads (mileage, 100's)	0.97	0.58	0.57	0.45	0.4	0.04
Coal Producing County	0.11	0.32	0.11	0.32	0	0.02
Low-voltage Transmission in County	0.11	0.31	0.03	0.18	0.08	0.02
Distance to High-voltage Transmission (100 miles)	6.83	3.35	6.4	3.25	0.43	0.25
Obs	197		1474			
Panel F. 1950's						
County Black Population Share (%)	8.24	13.85	10.92	18.13	−2.68	1.19
County Population (1,000's)	47.55	70.52	20.59	25.93	26.96	2.45
County Employment in Manufacturing (%)	4.69	5.07	3.36	4.23	1.33	0.3
Railroads (mileage, 100's)	0.92	0.69	0.57	0.45	0.35	0.03
Coal Producing County	0.16	0.37	0.12	0.32	0.04	0.02
Low-voltage Transmission in County	0.09	0.29	0.05	0.22	0.04	0.02
Distance to High-voltage Transmission (100 miles)	3.9	2.33	3.8	2.22	0.1	0.15
Obs	254		1474			

Notes: This table presents, for each decade between the 1930's through the 1950's, the mean and standard deviation of the considered siting determinants. Recall that determinants are lagged by one decade; e.g., for the 1920's determinants reflect the 1910 values. Values are reported separately for treated counties – those that received their first power plant siting the in the decade, and control counties – those that never received a power plant siting. Finally, differences in means and the standard error of the difference are reported in the final two columns.

Table A.3: Summary Statistics of First Siting and Siting Determinants: 1960's – 1980's

	Treated Counties		Control Counties		Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	Std. Error
Panel G. 1960's						
County Black Population Share (%)	9.81	16.89	10.7	17.66	−0.89	1.51
County Population (1,000's)	52.33	89.49	21.97	32.51	30.36	3.53
County Employment in Manufacturing (%)	4.83	4.55	4.01	4.18	0.82	0.36
Railroads (mileage, 100's)	0.92	0.68	0.57	0.45	0.35	0.04
Coal Producing County	0.14	0.35	0.09	0.29	0.05	0.03
Low-voltage Transmission in County	0.09	0.29	0.05	0.22	0.04	0.02
Distance to High-voltage Transmission (100 miles)	3.34	2.35	3.8	2.22	−0.46	0.19
Obs	150		1474			
Panel H. 1970's						
County Black Population Share (%)	10	14.91	9.96	16.2	0.04	1.55
County Population (1,000's)	63.06	125.78	23.93	39.48	39.13	4.91
County Employment in Manufacturing (%)	6.08	3.17	6.19	3.22	−0.11	0.31
Railroads (mileage, 100's)	0.86	0.62	0.57	0.45	0.29	0.04
Coal Producing County	0.07	0.25	0.08	0.27	−0.01	0.03
Low-voltage Transmission in County	0.49	0.5	0.33	0.47	0.16	0.05
Distance to High-voltage Transmission (100 miles)	0.55	0.58	0.65	0.54	−0.1	0.05
Obs	116		1474			
Panel I. 1980's						
County Black Population Share (%)	11.97	17.18	9.05	15.45	2.92	1.7
County Population (1,000's)	119.99	199.64	27.96	45.27	92.03	7.06
County Employment in Manufacturing (%)	8.8	4.49	8.38	5.22	0.42	0.57
Railroads (mileage, 100's)	0.88	0.49	0.57	0.45	0.31	0.05
Coal Producing County	0.11	0.32	0.08	0.27	0.03	0.03
Low-voltage Transmission in County	0.6	0.49	0.33	0.47	0.27	0.05
Distance to High-voltage Transmission (100 miles)	0.48	0.48	0.65	0.54	−0.17	0.06
Obs	89		1474			

Notes: This table presents, for each decade between the 1960's through the 1980's, the mean and standard deviation of the considered siting determinants. Recall that determinants are lagged by one decade; e.g., for the 1920's determinants reflect the 1910 values. Values are reported separately for treated counties – those that received their first power plant siting the in the decade, and control counties – those that never received a power plant siting. Finally, differences in means and the standard error of the difference are reported in the final two columns.

Table A.4: Summary Statistics of First Siting and Siting Determinants: 1990's – 2010's

	Treated Counties		Control Counties		Difference	
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	Std. Error
Panel J. 1990's						
County Black Population Share (%)	13.78	16.58	8.91	15.29	4.87	1.64
County Population (1,000's)	84	102.1	30.1	51.77	53.9	5.96
County Employment in Manufacturing (%)	10.1	4.57	8.28	5.12	1.82	0.54
Railroads (mileage, 100's)	0.96	0.66	0.57	0.45	0.39	0.05
Coal Producing County	0.05	0.23	0.08	0.27	−0.03	0.03
Low-voltage Transmission in County	0.55	0.5	0.33	0.47	0.22	0.05
Distance to High-voltage Transmission (100 miles)	0.4	0.45	0.65	0.54	−0.25	0.06
Obs	94		1474			
Panel K. 2000's						
County Black Population Share (%)	8.72	12.6	8.97	15.34	−0.25	1.42
County Population (1,000's)	64.27	76.03	34.58	61.07	29.69	5.85
County Employment in Manufacturing (%)	8.6	4.46	7.29	4.39	1.31	0.41
Railroads (mileage, 100's)	0.8	0.44	0.57	0.45	0.23	0.04
Coal Producing County	0.08	0.27	0.07	0.25	0.01	0.02
Low-voltage Transmission in County	0.49	0.5	0.33	0.47	0.16	0.04
Distance to High-voltage Transmission (100 miles)	0.52	0.49	0.65	0.54	−0.13	0.05
Obs	123		1474			
Panel L. 2010's						
County Black Population Share (%)	8.22	13.89	8.94	15.23	−0.72	2.38
County Population (1,000's)	117.98	184.09	38.1	69.15	79.88	11.68
County Employment in Manufacturing (%)	1.52	2.57	0.5	1.65	1.02	0.26
Railroads (mileage, 100's)	0.96	0.64	0.57	0.45	0.39	0.07
Coal Producing County	0.1	0.3	0.06	0.24	0.04	0.04
Low-voltage Transmission in County	0.48	0.51	0.33	0.47	0.15	0.07
Distance to High-voltage Transmission (100 miles)	0.42	0.37	0.65	0.54	−0.23	0.08
Obs	42		1474			

Notes: This table presents, for each decade between the 1990's through the 2010's, the mean and standard deviation of the considered siting determinants. Recall that determinants are lagged by one decade; e.g., for the 1920's determinants reflect the 1910 values. Values are reported separately for treated counties – those that received their first power plant siting the in the decade, and control counties – those that never received a power plant siting. Finally, differences in means and the standard error of the difference are reported in the final two columns.

Table A.5: Siting Determinants by Cohort: 1900's – 1950's

	(1) 1900's	(2) 1910's	(3) 1920's	(4) 1930's	(5) 1940's	(6) 1950's
County Black Population (%)	-0.001	-0.022	-0.023	-0.042	0.059	-0.006
	(0.015)	(0.024)	(0.032)	(0.061)	(0.056)	(0.054)
County Population (millions)	0.397**	0.415***	0.780**	0.552*	1.443**	1.668***
	(0.130)	(0.085)	(0.272)	(0.221)	(0.457)	(0.453)
County Employment in Manufacturing (%)	0.136*	0.226**	0.270*	0.504***	0.530*	0.326
	(0.057)	(0.081)	(0.110)	(0.146)	(0.240)	(0.219)
Railroads (mileage, 100s)	0.015***	0.027***	0.053***	0.057***	0.058**	0.086***
	(0.004)	(0.007)	(0.013)	(0.012)	(0.018)	(0.019)
Coal Producing County	0.005	0.011	0.021	-0.013	-0.032	0.053*
	(0.009)	(0.009)	(0.014)	(0.020)	(0.027)	(0.026)
Low-voltage Transmission in County	-0.020	0.021	0.009	0.030	0.051	0.014
	(0.012)	(0.014)	(0.033)	(0.046)	(0.034)	(0.035)
Distance to High-voltage Transmission (100 miles)	-0.002	-0.001	-0.004	-0.006*	0.008*	0.023***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.005)
Obs	1,501	1,519	1,555	1,581	1,671	1,728
Census Region FE	YES	YES	YES	YES	YES	YES

Notes: This table presents, for each decade between the 1900's and 1950's, the estimated impact of black population share and other potential siting determinants within a county in the prior decade on the probability that the county receives its first fossil fuel power plant in the current decade. Only never-treated counties and counties treated in the current decade are included in the estimating sample. Effects are estimated using a binomial logit regression, with marginal effects reported. Estimated models include census-region fixed effects.

Table A.6: Siting Determinants by Cohort: 1960's – 2010's

	(1) 1960's	(2) 1970's	(3) 1980's	(4) 1990's	(5) 2000's	(6) 2010's
County Black Population (%)	0.085	0.030	0.136***	0.103**	-0.010	0.000
	(0.048)	(0.047)	(0.037)	(0.035)	(0.049)	(0.037)
County Population (millions)	0.557***	0.363***	0.297***	0.205**	0.169*	0.088**
	(0.150)	(0.098)	(0.056)	(0.071)	(0.069)	(0.033)
County Employment in Manufacturing (%)	-0.039	-0.258	0.120	0.331**	0.523***	-0.053
	(0.199)	(0.208)	(0.112)	(0.117)	(0.153)	(0.210)
Railroads (mileage, 100s)	0.063***	0.046***	0.015	0.054***	0.054***	0.022**
	(0.014)	(0.013)	(0.010)	(0.012)	(0.014)	(0.008)
Coal Producing County	0.036	-0.008	0.038*	-0.022	0.010	0.004
	(0.023)	(0.027)	(0.019)	(0.025)	(0.025)	(0.014)
Low-voltage Transmission in County	-0.004	0.018	0.026*	0.029*	0.028	-0.001
	(0.030)	(0.015)	(0.013)	(0.013)	(0.015)	(0.010)
Distance to High-voltage Transmission (100 miles)	0.003	-0.015	0.003	-0.041*	-0.021	-0.018*
	(0.004)	(0.014)	(0.011)	(0.017)	(0.014)	(0.009)
Obs	1,624	1,590	1,563	1,568	1,597	1,516
Census Region FE	YES	YES	YES	YES	YES	YES

Notes: This table presents, for each decade between the 1960's and 2010's, the estimated impact of black population share and other potential siting determinants within a county in the prior decade on the probability that the county receives its first fossil fuel power plant in the current decade. Only never-treated counties and counties treated in the current decade are included in the estimating sample. Effects are estimated using a binomial logit regression, with marginal effects reported. Estimated models include census-region fixed effects.

B Further details on Callaway-Sant'Anna methodology

In Callaway and Sant'Anna (2021), the cohort-time average treatment effect on the treated ($ATT(c,t)$) is a key component of their methodology: $ATT(c,t) = E[Y_{i,t}(c) - Y_{i,t}(\infty)|C_i = c]$, which represents the average treatment effect at time t for the cohort first treated in decade c. $ATT(1950, 1990)$, for instance, would measure the average treatment effect in 1990 for counties that first received a fossil-fuel power plant as of 1950. For clarity, we use a county-decade panel covering the years 1900-2020. A county is defined as treated in every decade following the first decade in which it receives a fossil-fuel power plant. For example, if a county receives its first fossil-fuel power plant in 1945, it is considered first treated in 1950 and remains treated in all subsequent decades. Our primary dependent variable is Black population share.

Under staggered versions of the parallel trends and no anticipation assumptions, $ATT(c,t)$ can be identified by comparing the expected change in outcomes for cohort c between periods $c-1$ and t to that of a comparison group C_{comp} that has never been treated. Formally, for all $c' \in C_{comp}$:

$$ATT(c,t) = E[Y_{i,t} - Y_{i,c-1}|C_i = c] - E[Y_{i,t} - Y_{i,c-1}|C_i \in C_{comp}]. \quad (3)$$

The corresponding estimator replaces expectations with their sample analogs:

$$\widehat{ATT}(c,t) = \frac{1}{N_c} \sum_{i:C_i=c} [Y_{i,t} - Y_{i,c-1}] - \frac{1}{N_{C_{comp}}} \sum_{i:C_i \in C_{comp}} [Y_{i,t} - Y_{i,c-1}], \quad (4)$$

where the comparison group in our case includes only never-treated units ($C_{comp} = \{\infty\}$).

When there are many treatment cohorts and periods, reporting all $\widehat{ATT}(c,t)$ estimates may be cumbersome, and individual estimates may be imprecise. However, the method naturally extends to estimating weighted averages of $ATT(c,t)$, which help summarize treatment effects over time. One such parameter of interest, which we adopt, is an "event-study" measure that represents the weighted average treatment effect m decades from first siting across different cohorts:

$$ATT_m = \sum_c w_c ATT(c, c+m), \quad (5)$$

where the weights w_c are assigned to ensure equal weighting across cohorts or to reflect their relative frequencies in the treated population.

The key distinction between the methodology specified in Callaway and Sant'Anna (2021) and traditional "two-way fixed effects" estimates of the difference-in-differences effect is that the latter includes comparisons in which counties that are already treated are utilized as "controls" (i.e. the role played by never-treated counties in Equation 2). The event study estimates from the methodology specified in Callaway and Sant'Anna (2021) do not include such comparisons.