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Electoral Backlash against Climate Policy: A Natural Experiment on Retrospective Voting and Local Resistance to Public Policy

Leah C. Stokes University of California, Santa Barbara

Abstract: *Retrospective voting studies typically examine policies where the public has common interests. By contrast, climate policy has broad public support but concentrated opposition in communities where costs are imposed. This spatial distribution of weak supporters and strong local opponents mirrors opposition to other policies with diffuse public benefits and concentrated local costs. I use a natural experiment to investigate whether citizens living in proximity to wind energy projects retrospectively punished an incumbent government because of its climate policy. Using both fixed effects and instrumental variable estimators, I identify electoral losses for the incumbent party ranging from 4 to 10%, with the effect persisting 3 km from wind turbines. There is also evidence that voters are informed, only punishing the government responsible for the policy. I conclude that the spatial distribution of citizens' policy preferences can affect democratic accountability through 'spatially distorted signalling', which can exacerbate political barriers to addressing climate change.*

Replication Materials: The data, code, and any additional materials required to replicate all analyses in this article are available on the *American Journal of Political Science* Dataverse within the Harvard Dataverse Network, at: http://dx.doi.org/10.7910/DVN/SDUGCC.

Democratic accountability depends on voters' ability to retrospectively evaluate public policy (Fiorina 1981; Key 1966; Page and Shapiro 1992). If citizens are able to connect policy to politicians' actions during elections, then politicians should have an incentive to align policy with the public's preferences, enhancing welfare and democratic accountability (Erikson, Wright, and McIver 1993; Stimson, MacKuen, and Erikson 1995; Wlezien 1995). To date, studies have found some evidence of retrospective voting largely by examining cases where citizens have common interests, such as economic performance (Anderson 2007; Healy and Malhotra 2013). However, less attention has been paid to retrospective voting on public policies that divide citizens' preferences. Politicians are less likely to propose and enact policies with concentrated costs and diffuse public benefits (Arnold 1992; Olson 1965). What is less appreciated is that when policies are enacted that concentrate costs spatially, policy losers can use electoral institutions to amplify their voice. Since voters cast their ballots where they live, spatially concentrated opponents can send a clear signal to politicians if they retrospectively punish the government. Crucially, this dynamic can lead to an accountability failure: If there is a concentrated, local opposition and a diffuse, supportive public, the government may receive a signal to adjust a policy that the majority supports. I refer to this dynamic as 'spatially distorted signalling.'

Climate policy is one area where costs are imposed on specific communities, causing citizens' policy preferences to be spatially distributed. For this reason, studying climate policy can provide insights into retrospective voting when preferences are divided. Climate change requires societies to transform their electricity system away from fossil fuels, such as coal and natural gas, toward low-carbon technologies, including wind and

Leah C. Stokes is Assistant Professor, Department of Political Science, University of California, Santa Barbara, Mail Code 9420, Santa Barbara CA, 93106 (stokes@polsci.ucsb.edu).

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solar power (Caldeira, Jain, and Hoffert 2003). Public opinion polls consistently show majority support for addressing climate change and building renewable energy infrastructure in advanced democracies (Aldy, Kotchen, and Leiserowitz 2012; Ansolabehere and Konisky 2014; Lachapelle, Borick, and Rabe 2012). However, citizens living near divisive facilities, such as wind turbines, often resist these projects. Similarly, carbon-dependent communities, such as coal mining areas, will lose from climate policy. Consequently, transforming the electricity system to address climate change entails a distributional dilemma: Although the benefits are global, the negative effects associated with the solution—renewable energy infrastructure in people's backyards or job losses in fossil fuel–dependent communities—are local. This article examines whether spatially concentrated citizens punish the government because of a climate policy's local cost imposed through wind energy projects.

Energy and environmental policy are not common domains for studying retrospective voting, in part due to an assumption that these issues may not be salient during political campaigns. However, the public has shaped energy policy through elections for over a century, beginning with referenda in the 1890s (Hirsh 1999). This trend continued with ballot initiatives, spanning a 1935 vote in Redondo Beach, California, that banned oil development (Smith 2002) to recent climate policy votes in California, Michigan, and Colorado during the 2000s. Similarly, in communities affected by energy infrastructure, climate policy can mobilize citizens. Many individuals believe that wind energy projects create local negative externalities, including lowered house prices and noise, alongside environmental, aesthetic, and perceived health impacts. When residents mount opposition against local projects, they are often characterized as NIMBYs—people who say, "Not In My Back Yard" to new infrastructure (Michaud, Carlisle, and Smith 2008; Rabe 1994; van der Horst 2007).[1] Resistance to locally divisive projects with diffuse public benefits is not unique to energy infrastructure. The same pattern is found when governments site airports, housing projects, roads, subways, hospitals, jails, and waste facilities (Aldrich 2008). However, causally determining whether citizens punish incumbent governments for controversial facilities is difficult due to selection bias in project location and insufficient survey data (Smith 2002). By contrast, the design of a recent climate policy provides a natural experiment that can be used to test whether citizens retrospectively punish governments for policies with concentrated local costs and diffuse public benefits.

In 2009, the Liberal government in Ontario, Canada, expanded its ambitious climate policy, passing the Green Energy Act. This policy allowed corporations, communities, and individuals to build wind turbines and other renewable energy projects throughout the province, signing long-term contracts with the government to sell their energy (Stokes 2013; Yatchew and Baziliauskas 2011). After implementation, support for the policy was divided spatially. In 2010, wind energy remained extremely popular in Ontario, with 90% of respondents in a representative poll supporting wind energy in their region.[2] However, the policy also led over 50 anti-wind groups to mobilize against the incumbent Liberal Party across the province, staging protests outside campaign events, posting signs, and unsuccessfully attempting to block projects (Stokes 2013). In the fall 2011 election, the incumbent Liberal Party government lost its majority in the provincial legislature by one seat. The media attributed this loss to popular dissatisfaction in rural areas with the climate policy, which was a major issue during the campaign.[3] After the election, the government responded to local anti-wind opponents by modifying the policy, placing a de facto moratorium on new wind turbines.

The policy design meant that between 2006 and 2011 developers were able to build wind projects where they were able to secure land. Since the policy provided a significant return on investment, companies acted quickly to develop projects in locations with the best wind resources to maximize their profits. The policy's design eliminated communities' ability to select into or out of receiving wind energy infrastructure by taking away local planning authority. Further, private actors, not the government, chose project locations. The Ontario case thus offers two strategies to identify the causal effect of local wind projects on voting behavior. First, exploiting the fact that there was no selection bias in wind energy project siting decisions allows for causal estimation with fixed effects. Second, to the degree that wind resources are orthogonal to political geography, wind speed can be used as an instrument for turbine location, offering a complementary identification strategy.

Using this natural experiment, this study investigates whether Ontario citizens retrospectively punished the incumbent government for nearby wind turbines. Through an original panel data set that locates all proposed and operational wind turbines, merged with voting and census

[1] In practice, citizens may not only be thinking about their own self-interest when they resist projects, but may also generally oppose putting infrastructure in anyone's backyard. Citizens may also be opposed to the process surrounding siting decisions, object to the impacts projects have on ecosystems, or have other concerns.

[2] Ipsos Reid poll, June 25–30 2010.

[3] See, for example, Spears (2011) and Warren (2013).

data at the precinct level, I use a variety of estimators to examine differences in incumbent vote share and turnout in precincts with and without wind turbines. For precincts with a proposed or operational turbine, the vote share for the governing party declined by 4–10% compared to similar precincts without a turbine. I demonstrate the effect with both fixed effects and instrumental variable estimators, and the results are robust to many alternative specifications. Further, using a measure of distance to turbines, I directly estimate the geographic scale of NIMBY effects: The effect persists in precincts 3 km away from proposed and operational turbines. Taken together, these results suggest 6,050 votes were lost in the 2011 provincial election due to citizens' dissatisfaction with wind turbines. Most of this shift in votes came from existing voters changing their votes, rather than from new voters being mobilized. To test whether citizens' behaviors were informed, I also check whether the same citizens punished the same party nationally over the same time period, despite the fact that the national Liberal Party had no jurisdiction over the climate policy. I find little vote share loss at the national level, suggesting citizens were informed: They only punished the level of government responsible for the climate policy.

More broadly, the article provides insight into political accountability when citizens' policy preferences are divided across space, with implications for other kinds of policy. To whom is the government accountable: mobilized local opponents or the quiet but largely supportive public? The article's findings pose two key problems for democratic governance and accountability. First, I demonstrate that a small group of spatially concentrated citizens with intensely held preferences are able to create incentives for politicians to abandon policy, bucking the preferences of 90% of the public. This asymmetry in mobilization can cause spatially distorted signalling, creating incentives for public policy to reflect a vocal and local minority, rather than the diffuse majority's preferences. Second, even if the policy remains stable, projects may simply be relocated to another community's backyard with lower political mobilization, less wealth, and lower social capital, creating clear equity problems for accountability to local opponents. This dynamic raises further questions about who benefits from accountability if individuals and communities with greater resources are more likely to mobilize and express their preferences to the government. Substantively, the article also highlights important but under appreciated mass politics associated with addressing climate change, given the spatial distribution of winners and losers.

The Distributional Politics of Climate Policy and Divisive Facilities

Although climate change is often viewed as a global collective action problem (Ostrom 2010; Stern 2006), it is also a distributional challenge with implications for domestic politics. Most research on domestic climate change politics has examined interest groups in carbon-intensive industries with concentrated stakes in status quo technologies. For example, representatives from U.S. congressional districts with emissions-intensive industries are less likely to support climate legislation (Cragg et al. 2013). Climate policies may also redistribute benefits to renewable energy companies through subsidies (Aklin and Urpelainen 2013; Urpelainen 2012). Less attention has been paid to the distributional politics associated with public support for climate policy (Aldy, Kotchen, and Leiserowitz 2012; Bechtel and Scheve 2013). A small literature focuses on public perceptions of renewable energy given higher costs (Ansolabehere and Konisky 2014). However, climate policy also imposes costs on communities through job losses and negative externalities from divisive renewable energy infrastructure. The political ramifications of these climate policy costs are less appreciated.

Like other divisive facilities, energy infrastructure typically imposes concentrated, local costs on proximate communities, even as these projects provide benefits to society broadly (Ansolabehere and Konisky 2009; Boudet and Ortolano 2010). Thus, when asked about energy policy, people are concerned about the local rather than the global impacts (Ansolabehere and Konisky 2014). For citizens, the local negative impacts from energy infrastructure are immediate, personal, and visible, whereas the global climate consequences are in the future and harder to understand (Krohn and Damborg 1999). This means that people are more likely to mobilize against an energy development in their backyard—whether a wind turbine or nuclear power plant—than mobilize to support climate policy broadly. In the case of fossil fuel infrastructure such as pipelines and power plants, there are both local and global pollutants. Here, local citizens' interests are aligned with addressing climate change. However, with renewable energy, local citizens' interests often run counter to climate policy. Further, both wind and solar energy need more land area than conventional electricity sources (Carley 2009). Consequently, these technologies will be distributed across the landscape, exacerbating the political challenge of addressing climate change.

These patterns of local resistance and spatially distorted signalling are not limited to energy infrastructure or climate policy. Communities also commonly resist other divisive facilities with diffuse public benefits and concentrated local costs, including airports, subways, roads, housing projects, trailer parks, and jails (Clingermayer 1994; Rabe 1994). These locally unwanted projects fall into two categories: those that have potentially harmful environmental and health impacts for the local community, and those that do not (Schively 2007). Energy projects generally fall into the former category. But with renewable energy, particularly wind projects, harmful health impacts are not supported by peer-reviewed, scientific studies (Bolin et al. 2011; Crichton et al. 2014). Despite increasing demand for divisive facilities due to consumption and population growth, locally contentious projects remain difficult to site, with governments largely relying on coercion (Aldrich 2008).

What are the political effects when divisive facilities are forced on communities? Politicians may worry about siting public bads in their district, but it is less clear whether citizens are able to connect their discontent with nearby divisive facilities to government policy and punish incumbents at the ballot box. There are two broad views on the relationship between citizens' public policy perceptions and vote choice. One view holds that voters are myopic and following elites' lead with little knowledge or interest in specific policies (Achen and Bartels 2004; Bartels 1996; Campbell et al. 1960; Converse 1964; Lenz 2012; Zaller 1992). From this perspective, we should not expect citizens to understand public policy enough to punish the government for an unwanted climate policy or nearby divisive facility. A second view argues that the public, in aggregate, holds policy knowledge, demonstrates retrospective voting, and exhibits lasting electoral responsiveness to policy (Bechtel and Hainmueller 2011; Erikson and Stoker 2011; Fiorina 1981; Grogger and Weatherford 1995; Johnson, Brace, and Arceneaux 2005; Key 1966; Lupia 1994; Page and Shapiro 1992). Accordingly, it is conceivable that citizens could understand public policy and punish the government for imposing costs on their communities.

Studying the political consequences of local resistance to divisive facilities has proven difficult. National public opinion surveys do not include enough respondents living near projects to examine whether nearby citizens' beliefs differ from those living farther away (Smith 2002). When there is sufficient data, selection bias in project location may make places with and without projects incomparable. Large energy infrastructure, such as coal or nuclear plants, are often strategically placed in communities with more minorities, who are poorer or have lower social capital (Aldrich 2008; Mohai, Pellow, and Roberts 2009). Finally, many studies rely on mail-in surveys, case studies, interviews, or newspaper data (Baxter, Morzaria, and Hirsch 2013; McAdam and Boudet 2012; Warren et al. 2005). While these studies are able to identify dynamics surrounding political mobilization, they are less able to estimate the extent of resistance to projects.

As a consequence of these identification challenges, research on local resistance to energy infrastructure has produced divergent estimates (Wolsink 2007). Some researchers find little resistance related to proximity (Wolsink 2000), others find that nearby communities are more supportive (Michaud, Carlisle, and Smith 2008; Baxter, Morzaria, and Hirsch 2013; Krohn and Damborg 1999), and still others find proximity is associated with lower support for projects, including wind turbines (Jacquet 2012; Swofford and Slattery 2010). It is also not clear whether people oppose divisive facilities for short periods of time and come to accept their presence in the community once built (Devine-Wright 2005; van der Horst 2007; Wolsink 2007), or whether discontent and political mobilization continue after projects are operational.

This article overcomes these identifications challenges through a natural experiment that effectively assigned divisive facilities to communities based on an exogenous factor. This policy allows for an examination of whether citizens living in proximity to divisive facilities disproportionately punished the government in a subsequent election. Further, the number of projects developed in this case creates a large enough sample size to facilitate statistical inference. As a result, Ontario's climate policy provides an improved empirical setting to examine whether citizens punish incumbents for placing controversial infrastructure in their backyards.

Ontario's Climate and Renewable Energy Policy

In Ontario's 2003 election, the centrist Liberal Party ran on a platform to phase out coal. At the time, coal accounted for around one-fifth of the electricity mix, making this policy proposal a significant commitment to addressing climate change. After they won the election, the Liberals enjoyed majority control of government for eight years. During this period, the Liberals enacted a "feed-in tariff" (FIT) policy to promote wind energy development. This policy aimed to facilitate the coal phase-out, reduce greenhouse gas emissions, and create jobs in the province.

Feed-in tariffs are a climate policy that focuses on subsidizing new, low-carbon technologies, rather than imposing costs on existing fossil fuel technologies. A FIT sets a price per unit of energy, given a certain technology (i.e., wind), and offers long-term contracts to private-sector project developers. FITs are used to drive investment in new and more expensive technologies, particularly renewable energy, including wind, solar, and geothermal (Mitchell, Bauknecht, and Connor 2006). The idea is to create investor certainty to increase renewable energy projects, and reduce prices through innovation. FITs have been used extensively in Germany, the United Kingdom, Spain, and over 80 other jurisdictions worldwide.

In 2006, the Liberal government passed a small-scale FIT policy. In 2009, they expanded this policy through the Green Energy Act. Crucially, this law preempted much of the Planning Act, removing decision-making authority from local communities. Similarly to a prominent hydraulic fracturing law in Pennsylvania, the law took away local jurisdiction to approve or reject projects (Hill and Knott 2010; Malin 2014). As a result, communities could neither select into nor out of receiving a wind project. This decision was made because of concerns that local anti-wind activists would block projects through municipal governments. As the former Premier, the head of government for Ontario, stated:

> To leave decision making, about setbacks for example, to the local authorities would be to effectively keep the [renewable energy] sector out of Ontario....[I]t would have driven a stake through the heart of the FIT program before it even got out the door. The local politics are just so difficult to manage. So the [Mayor] says, "It would be good for me and for the municipal finances, but I can understand the neighbours don't need that hassle; we'll just tell them to go elsewhere." And then word gets out that Ontario is not really serious. Because the proponent says, "We've been sent to seven different municipalities so far and we can't get in because local opposition has mounted and it's just not possible." So to be realistic about these things, what you've got to do is have a single, province-wide standard. (Dalton McGuinty, Premier of Ontario [2003-2013], personal communication, December 6, 2013)

Since the FIT price was set based on estimated project costs plus a significant return on investment, many companies acted quickly to develop projects. From 2006 to 2012, project proponents were able to build wind turbines wherever they were able to secure land, often by signing agreements with farmers and other land owners. After 2009, municipalities were not able to block proposals if local citizens disapproved of the proposed infrastructure. Only one project was stopped or canceled between 2006 and 2012, and this was because of financing rather than local opposition.[4] Ultimately, government efforts to promote wind energy through the FIT were successful: Despite widespread protests, Ontario signed around 5,500 megawatts of wind energy contracts by 2011, equivalent to building around 10 coal plants or five nuclear reactors.

During a fall 2011 election, the incumbent Liberal government lost its majority in the provincial legislature by one seat, a loss the media attributed to popular dissatisfaction with the wind turbines. This judgment was reasonable: By the 2011 election, every district with a wind turbine had at least one anti-wind group. These groups engaged actively with the political process, staging protests outside Liberal Party campaign events and posting signs throughout their communities. They also successfully encouraged 78 municipalities to pass resolutions against wind turbines, even though such resolutions had no legal effect. Media coverage of wind protests in Ontario also grew between 2003 and 2011, suggesting significant political mobilization. As one columnist summarized: "Massive corporate wind farms have been built in rural communities against their wishes ... Ten of the 18 seats lost in 2011 were in rural [districts] targeted by anti-wind coalitions. They made the election a referendum about halting wind farm development and restoring local decision-making in their communities" (Warren 2013). The Liberals' two rival parties, the center-right Progressive Conservatives and the left-wing New Democrats, both committed to eliminating the FIT policy if elected. As a result, there was a sharp and well-publicized difference between the policy commitments of the incumbent Liberal Party and its political opponents.[5] Thus, citizens faced a clear choice at the polls: Support the incumbents and their climate policy, or vote for an opposition party opposed to the climate policy.

Data, Research Design, and Methodology

This article uses a natural experiment to identify the causal effect of proximity to wind energy projects on voting behavior. Natural experiments depend on exogeneity of treatment assignment to ensure that the average treatment effect estimate is unbiased. In this case, evidence suggests that communities were not able to select into or out of receiving a wind project. The policy took away local

[4] A moratorium on offshore wind projects was put in place during this period, affecting two projects. However, these projects are outside the scope of this study, which examines only onshore turbines.

[5] See the supporting information (SI) for more qualitative evidence of wind project resistance.

planning authority; consequently, communities could not block projects. It is also unlikely that communities were able to select into receiving a turbine. Since the policy offered a flat rate to project developers, developers would make the greatest profit from building projects on sites with the highest wind resources. For these reasons, I argue that wind project treatment assignment to communities in Ontario from 2006 through mid-2013 was plausibly exogenous to political boundaries: Wind farms were proposed and built where wind resources were strongest, and wind resources are conditionally orthogonal to the political preferences of voters.[6]

In addition, this article uses two strategies to identify the causal effect of proximity to wind energy developments on voting behavior: fixed effects estimators and instrumental variable estimators. These two estimators are complementary in that they rely on different assumptions to identify the same causal effect. The fact that both estimation strategies provide similar results provides additional certainty that observed changes in political behavior can be causally attributed to nearby wind energy developments.

Fixed effects estimators rely on variation within a given political unit over time to identify causal effects. Fixed effects estimators do not thus rely on the presence of cross-sectional, as-if random assignment of turbines to precincts. Instead, the main identification assumption is parallel trends in the treated units' potential outcomes, absent treatment, and the control units. By contrast, the instrumental variable estimator uses a cross-sectional approach to compare different units. Wind speed cubed is the instrument used to predict turbine placement. This second approach is a robustness check on the fixed effects specifications, because it addresses any selection bias in wind turbine location. With this broad overview of the identification strategy, the specific data, research design, and methodology can be introduced in greater detail.

Data

In Ontario, the main political unit is a provincial electoral district, also called a riding. Each district elects a provincial representative. To ensure plausible control units, a subset of Ontario's districts where we could reasonably expect wind turbines to be developed was created by excluding all districts without any wind energy proposals. Consequently, the sample includes 26 districts where wind projects were proposed or operational, out of 107 total districts, or just over a quarter of the province's total land area (see Figure 1). In this way, major cities, such as Toronto, are excluded from the data since these are implausible locations for wind projects. Ontario districts are made up of precincts that have an average of 350 voters.[7] The unit of analysis for this study is the precinct, where electors cast their vote for their provincial representative at a nearby polling place. All 6,186 precincts within these 26 districts are included in the data set, providing both treated and control units. At this political scale, data are available for the 2003, 2007, and 2011 elections.

There were some changes in the number and size of precincts between 2003, 2007, and 2011. As a result, the panel relies on matching 2007 precincts with the 2003 and 2011 precincts that have the largest overlapping area. Ultimately, these boundary changes were small and administrative, and did not affect a district's electorate, but rather created minor alterations in where individual citizens cast their vote.[8] National elections data are also available over a similar time period at the precinct level. Three national elections were used because they correspond most closely to the provincial elections: 2004, 2008, and 2011. With the national data, the same approach was used to match each federal precinct to a 2007 provincial precinct.[9]

Census data are important for assessing pretreatment balance and to allow the models to include controls for potential time-varying confounders. Census data from Statistics Canada are available in 2001, 2006, and 2010 at the dissemination area. With an average of 640 people, a dissemination area is around twice the size of a precinct. Dissemination areas do not track precinct boundaries. For this reason, each precinct's census data were estimated using a geographically weighted sum.[10]

[6]Although individual landowners could resist a wind project, this is not relevant to this analysis since treatment assignment is measured at the community (precinct) level. Further, there is no evidence that individual resistance was able to block wind projects across a community.

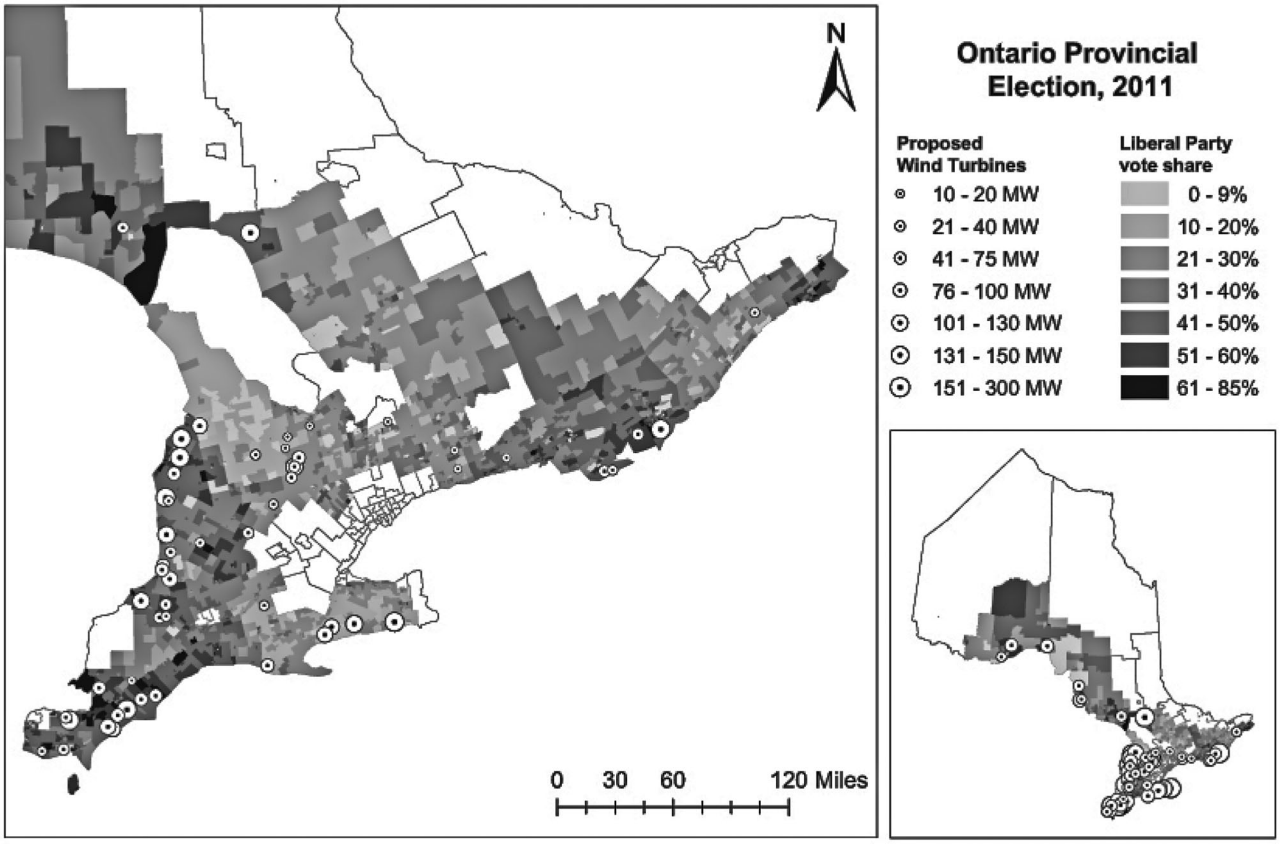
[7]Elections Ontario calls precincts "polling divisions." Precincts in the sample area vary from 4 to 1,722 electors.

[8]See the SI.

[9]In 114 cases, federal data was missing for turnout or liberal vote share. These cases were set at the mean level of each variable for that year. In a few cases where turnout was greater than 100%, due to errors in official data, turnout was set to 100%.

[10]For each precinct, overlapping census dissemination areas were identified. The census values for each precinct were estimated by weighting the sum of each variable based on the amount of overlap between the precinct and each dissemination area. This approach assumes that census variables are evenly distributed across space. This is a plausible assumption, particularly for variables that do not appear infrequently, because the census units are small. This approach was validated at the municipal level, where original census data are available, with very similar results compared to the actual census data. Some census data were censored by Statistics Canada. When more than 25% geographically of the census data in a precinct was censored, that variable was set to NA. When less than 25% of the data was censored, the missing area for that covariate was set at the mean level for that precinct.

FIGURE 1 Governing Party's Vote Share in 2011, by Precinct in 26 Districts, and Proposed Wind Projects, by Scale of Project



Note: The map also shows the districts excluded from the sample in white.

This approach introduces minor measurement error into the panel's census covariates.

Treatment Variable and Instrument

This study uses original panel data on wind energy projects in Ontario. A wind project is defined as any onshore wind turbine development proposed or operational in the province before the 2011 election with a size greater than 10 megawatts. This size is used in the FIT program to distinguish between macro-contracts (industrial-scale facilities) and micro-contracts. Data were gathered using the Ontario Power Authority's (OPA) website of active wind projects and the Independent Electricity System Operator's list of wind projects pending grid connection.[11] These lists were supplemented with public project descriptions from project developers that show each project's location, technology, and timeline. Information was collected for 65 industrial-scale wind projects across the province, totaling 2,753 proposed or operational turbines. Figure 1 shows a map of the wind turbine data overlaid with the provincial, precinct-level Liberal vote share in 2011. This map demonstrates that wind projects are geographically clustered, likely because of wind resource availability and electricity grid infrastructure, but that they are located in districts with both high and low levels of support for the incumbent party.

All turbines were geolocated and assigned to a precinct.[12] Each turbine was also classified as proposed or operational before the 2007 and 2011 elections. From these data, two binary treatment variables were

[11] I assume that if the project is not listed in the OPA's list of projects with a FIT contract, the project is not considered proposed to communities at a given moment in time.

[12] For four projects, only a highly bounded geographic region for the project was shown in project description documents. In these cases, the turbines were randomly placed within the project's boundaries. If this approach affects treatment assignment, it would tend to increase the area coded as treated since it caused all precincts within the project's geographic boundaries to be coded as treated. Given precincts' small size, this approach should not result in miscoding.

constructed. The first identifies each precinct that had an active proposal or an operational turbine within its boundaries. The second identifies each precinct with an operational wind turbine within its boundaries. There were 184 precincts that were treated with a proposal and 52 with an operational turbine by 2011, out of 6,186 precincts. In addition, each precinct was classified in terms of its distance to the nearest turbine in 1 km increments.

Wind speed is theoretically orthogonal to precinct boundaries but predicts the placement of wind turbine locations. As a robustness check, wind power, which is approximately wind speed in meters per second to the third power, was used as an instrumental variable for turbine location. Wind power data were collected from Land Information Ontario, which provides these data for wind developers. These data give the wind resource strength throughout the province at a 100 m^2 spatial resolution. The average wind power resources for each precinct were calculated through a spatial merge.

Fixed Effects Models

The average first empirical strategy relies on a panel data set analyzed using fixed effects estimators. The core model includes both unit-specific fixed effects at the precinct level and time-period fixed effects for each election year. This basic specification is given by

$$Y_{it} = \alpha_0 + \gamma_i + \delta_t + \alpha D_{it} + \epsilon_{it}, \quad (1)$$

where Y_{it} is the vote share for the Liberal Party, or the voter turnout, in precinct i in time t; α_0 is the intercept; γ_i is the precinct fixed effect; δ_t is the election year fixed effect; and αD_{it} is the treatment effect of a turbine being proposed or operational within that precinct's boundaries. This approach, which uses precincts as the unit of analysis, gives equal weight to every precinct in the 26 districts with at least one wind turbine proposal. These models assume that $Cov(\epsilon_{it}, D_{it}) = 0$.

The main threat to causal inference using fixed effects estimators is time-varying confounders—variables that change differentially in the treated and control groups. Thus, for the average treatment effect (ATE) to be interpreted causally, the parallel trends assumption must hold. To provide evidence to support the parallel trends assumption, the mean level of the outcome variable by year is plotted below, showing parallel trends pretreatment (see Figure 2). Also, census data are included to control for observable potential time-varying confounders. Alternate specifications subset or reweight the data, and some models include precinct linear time trends. If the parallel trends assumption holds, even in the absence of perfect covariate balance between the treated and control units, the effect is identified.

Instrumental Variable Model

Although qualitative evidence suggests that treatment assignment was orthogonal to political boundaries, as a robustness check the effect can also be estimated using wind power, which is approximately wind speed to the third power, as an instrument to directly address endogeneity concerns. This empirical strategy uses a cross-section of the 2011 data rather than the panel used above because the instrument, wind power, does not vary over time. Only turbine proposals were used in this model because the timing of specific wind turbines becoming operational is unrelated to wind power, and instead a function of the initial proposal date. In addition, these data do not include precincts that were already treated prior to the 2007 election, defined as being within 3 km of a proposal, nor precincts that are missing wind data because they are too small. The effect is estimated using two-stage least squares regression:

$$\text{First stage}: D_{it} = \pi_0 + \delta_i + \pi_1 Z_i + \gamma^\top X_i + \epsilon_i. \quad (2)$$

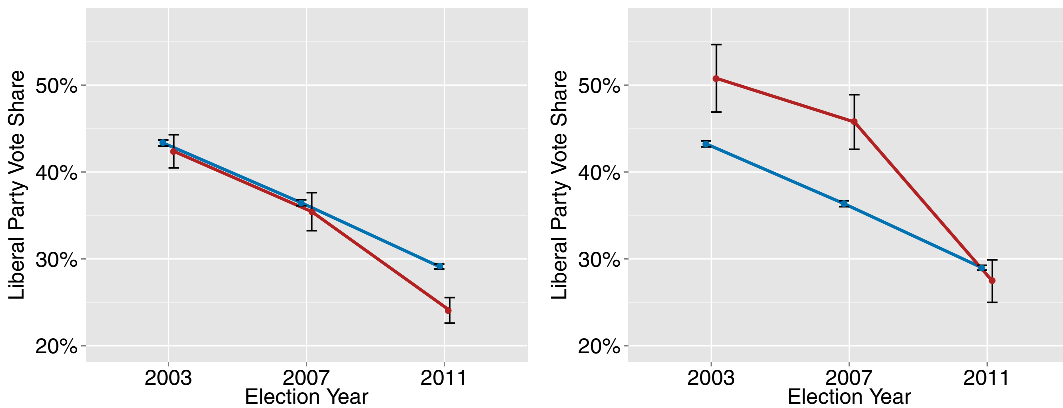
$$\text{Second stage}: Y_i = \alpha_0 + \delta_i + \alpha_1 D_{it} + \theta^\top X_i + \eta_i. \quad (3)$$

D_{it} is the treatment variable, predicted by Z_i, the average wind power (log) in that unit, along with a district fixed effect, δ_i, and covariates, X_i. In the second stage, Y_i is the change in the Liberal Party vote share in that precinct between the 2007 and 2011 elections, which is predicted by the reduced form of the first stage and the same district fixed effects and covariates. Using the change in vote share allows the model to incorporate how the precincts are varying over time and is equivalent to including a precinct fixed effect.

This model relies on the following assumptions: ignorability ($Cov[\epsilon_i, Z_i] = 0$), the exclusion restriction ($Cov[\eta_i, Z_i] = 0$), relevance ($\pi_1 \neq 0$), and monotonicity ($\pi \geq 0$ or $\pi \leq 0$ for all i). While most of these assumptions are not directly testable, the Results section and SI provide evidence for why they are plausible in this case. Unlike the fixed effects approach, this estimation strategy relies on the assumption that wind speed varies as-if randomly. It also assumes that wind speed influences the location of wind turbines.

Using matching to preprocess the data before using an instrumental variable estimator may strengthen the instrument and correct for biases from confounders if the instrument departs from as-if random assignment (Keele and Morgan 2013). To improve the balance in

FIGURE 2 Trends in the Governing Party's Vote Share



Note: The average governing Liberal Party's vote share in treated (red/black) and control (blue/grey) precincts with proposed (left) or operational (right) wind turbines, for each provincial election between 2003 to 2011. The error bars show 95% confidence intervals. (Printed version shown in black and gray, online version shown in red and blue.)

the sample, Mahalanobis distance matching was first used to pair each treated unit with a control unit based on observable characteristics. The data were balanced on four variables: the average home price pretreatment in 2006 (log), the population with a university degree (%), median income (log), and population density (log). These variables were chosen because they predict the outcome variable; thus, controlling for them should work against finding an effect. These matched pairs were then put into the instrumental variable regression with flexible geographic controls to compare the change in vote share in nearby places with and without a proposed turbine. Geographic controls, in both the first and second stage, included longitude, latitude, both variables squared, and their interaction. Since many projects are near the Great Lakes, due to wind resources, the model also controls for distance to these lakes and this variable squared.

Results

This article examines whether people living near wind turbines voted against the incumbent provincial government to punish them for a climate policy creating incentives for wind infrastructure in their community. This analysis consistently finds an effect size of around −4% to 8% for proposed wind turbines and −7% to 10% for operational wind turbines on the governing party's vote share. Figure 2 shows the trend in the governing party's vote share over time. Given the slopes before the majority of units were treated, between 2007 and 2011, the parallel trends assumption necessary for inference using fixed effects estimators is likely plausible. For proposals, there is excellent balance without matching on the outcome variable between treated and control units pretreatment, in 2003.

Fixed Effects Models

The average treatment effect of having a proposed or operational wind turbine within a precinct on the governing party's vote share is first estimated using fixed effects estimators with election year and precinct fixed effects (see Table 1). The government's vote share went down by 4% in precincts with a proposal for a turbine and 10% in precincts with an operational turbine, with both point estimates statistically significant.[13] However, through examining balance tables, it is clear that towns within these 26 districts, where turbines could not plausibly be placed, are still in the sample as control units. This likely makes the control and treatment units somewhat incomparable. As a result, the balance on pretreatment observable census data for treated and control units in 2003 is poor on all covariates; still, the pretreatment dependent variable is notably well balanced for places with and without proposed turbines.

Second, in an attempt to achieve better balance on the covariates across the treated and control units, the data were subset to rural areas with a population density of 400 people per square kilometer or fewer in 2007,

[13]These results are also robust to precinct linear time trends being included in the model, with the operational treatment variable significant at the standard .05 p-value level and the proposal treatment variable significant at the .10 p-value level.

TABLE 1 Effects of Wind Turbines on Incumbent Party Vote Share in Precincts

	All Precincts (ATE)	All Precincts (ATE)	Rural Precincts (ATE)	Rural Precincts (ATE)	Balanced Precincts (ATT)	Balanced Precincts (ATT)
			Turbine Proposal			
Proposed Turbine	−0.042***	−0.039***	−0.048***	−0.046***	−0.050***	−0.050***
(Treatment)	(0.009)	(0.009)	(0.009)	(0.009)	(0.011)	(0.011)
Population with		0.084***		0.055*		−0.069
University Degree (%)		(0.018)		(0.024)		(0.078)
Population Density		0.006***		0.007***		0.002
(log)		(0.001)		(0.001)		(0.004)
Unemployment Rate		0.001*		0.000		0.001
		(0.000)		(0.000)		(0.002)
Median Income (log)		0.013†		0.008		0.022
		(0.007)		(0.009)		(0.022)
Immigrant		0.074**		0.084*		0.047
Population (%)		(0.027)		(0.038)		(0.084)
N Treated	184	184	184	184	184	184
N Control	6002	6002	2985	2985	6002	6002
Fixed Effects	Y	Y	Y	Y	Y	Y
			Turbine Operational			
Operational Turbine	−0.093***	−0.092***	−0.099***	−0.098***	−0.084***	−0.080***
(Treatment)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)
Population with		0.084***		0.057*		0.136
University Degree (%)		(0.018)		(0.024)		(0.102)
Population Density		0.006***		0.007***		0.007
(log)		(0.001)		(0.001)		(0.004)
Unemployment Rate		0.001*		0.000		−0.001
		(0.000)		(0.000)		(0.002)
Median Income (log)		0.013†		0.008		0.006
		(0.007)		(0.009)		(0.035)
Immigrant		0.075**		0.088*		−0.028
Population (%)		(0.027)		(0.038)		(0.082)
N Treated	52	52	52	52	52	52
N Control	6134	6134	3117	3117	6134	6134
Fixed Effects	Y	Y	Y	Y	Y	Y

Note: Robust standard errors, clustered at precinct level. Intercepts are not reported.
†p<.10; *p<.05; **p<.01; ***p<.001.

corresponding to Statistics Canada's definition. Since all of the treated units are rural, none are dropped. For both the proposal and operational treatment variables, the models using the rural precincts subset return a very similar point estimate as when the data includes all precincts as control units. Namely, these rural models find a an average 5% decline in precincts with a proposed turbine and a 10% decline in precincts with an operating turbine in support for the governing provincial Liberal Party.

Third, I used entropy balancing, a form of preprocessing that reweights each unit based on its covariates so that the treated and control groups have the same moments, for example, the mean and variance. Like matching, entropy balancing attempts to achieve better balance between treated and control units on observable covariates to reduce model dependence (Hainmueller 2012). Using the 2003 pretreatment data, the data were weighted on population in the precinct (log), population density (log), median income (log), average home value (log), unemployment rate, percentage housing ownership, percentage of people with a university degree, percentage of immigrants, and each term squared. To avoid dropping data, units missing covariate information were assigned the mean level for that variable for that year.[14] As Table 1 shows, the average treatment effect on the treated (ATT) results from using entropy balancing are very similar to the results using the full sample and the rural subset.[15]

All three models were also run including census covariates as controls, to address potential time-varying confounders. Covariates included population with a university degree, average home value, population density, the unemployment rate, and median income. As Table 1 shows, including these covariates does not substantially change the results. Together, these convergent results suggest that there was a statistically significant and substantive decline in the governing Liberal Party's vote share because of proposed and operational turbines. Operational turbines appear to provoke the ire of a greater proportion of the population than proposals, likely because they are now visible, and, therefore, more of the community knows about the development and its impacts.

How Large Is the Backyard?

To examine how far the effect persists over space, I also examined whether vote share declines occur in precincts near turbines. This approach also addresses concerns that the treatment effect may be biased towards zero because of spillovers to nearby precincts. Spillovers are likely because people can see turbines for several kilometers. Further, Ontario regulations had a requirement for turbines to be set back a minimum of 550 to 1,500 meters from homes, suggesting that wind turbines' perceived negative effects persist for some distance.

Figure 3 shows the average treatment effect within precincts grouped into 1 km increments away from proposed or operational turbines. These buffers can be visualized as 1 km-wide rings, with the turbine at the center; for each group, the buffer moves 1 km further out. If the 1 km buffer touches any part of a precinct, it enters into that group for distance from a proposed or operational turbine. Each treated unit only enters into one group, so that the group of precincts 2 km away from the turbines does not include precincts 1 km away from the turbines. Further, when estimating the effect for each group, the sample excludes units less than 6 km away from the turbines as control, to eliminate spillovers when estimating each group's treatment effect.

The point estimate for each treated group was calculated using fixed effects estimators, with time period and unit-specific fixed effects, and the standard errors were clustered at the precinct level. The error bars in Figure 3 show 95% confidence intervals, which are large in part because the sample size for each group is quite small (43–199 treated units). For both proposed and operational wind turbines, vote share declines can be detected in precincts up to 3 km away from the turbines. At 4 and 5 km away from the turbines, the effects are essentially indistinguishable from zero.

These results suggest that people voting in precincts that are several kilometers away from projects may still perceive negative effects on their communities. Further, it suggests a higher upper bound on the estimate of the government's loss in votes, since defining treatment as voting in a precinct within 3 km of a proposed or operational turbine increases the treated group's size. From a theoretical perspective, the detectable decline in vote share as a function of distance suggests the NIMBY effect is related to proximity to unwanted infrastructure. The effect is also similar to another study, which found effects within 1–5 km away from wind projects, although it only examined variation in 5 km increments (Warren et al. 2005).

Instrumental Variable Model

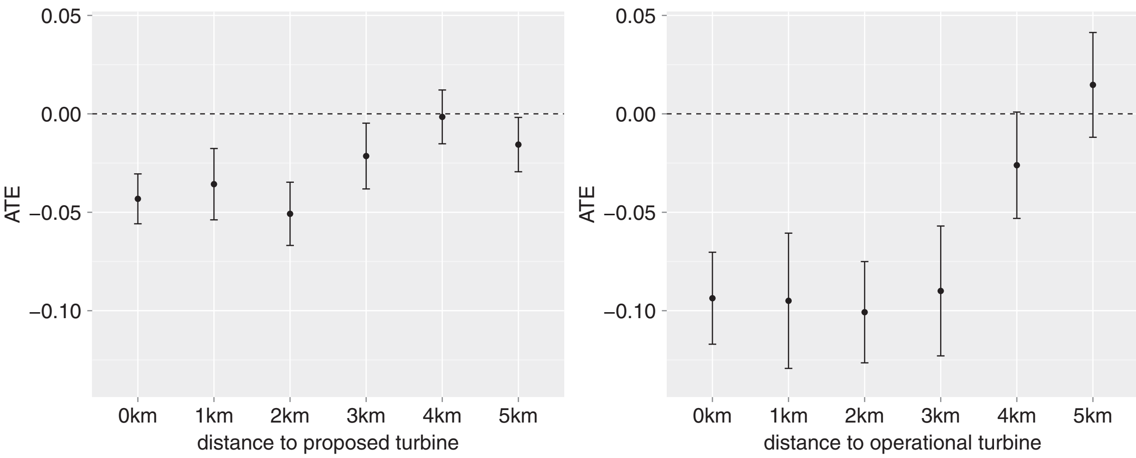
The following model uses wind power as an instrument for wind turbine proposals. This estimation strategy relies on cross-sectional matched pairs from 2011 because wind speed does not vary over time, precluding the use of the panel. Here, the outcome variable is the change in the governing party's vote share in that precinct in 2011 compared to 2007, in effect a precinct fixed effect. Given the preceding section's results on how far the effect persists, these models examine all precincts within 3 km of a proposed turbine.

As Table 2 shows, wind turbine location is highly predicted by wind power. Using flexible geographic controls and a district fixed effect, these models suggest that the vote share decline was 8% in places with a turbine proposal. This effect is robust to including more controls

[14] This should not affect the results, since only 1–4% of the data are missing for each census variable, and, indeed, running entropy balancing with these units dropped leads to similar results.

[15] While it is not reported here, Mahalanobis distance matching was also used and resulted in similar estimates for places with proposed turbines. The operational turbine treatment effect was estimated to be smaller, at around 5%.

FIGURE 3 Estimates of the Decline in the Liberal Party Vote Share Using Fixed Effects Estimators



Note: Each group represents precincts that are a given distance from treatment, from 0 km (in precinct) to 5 km away from a proposed or operational turbine.

TABLE 2 Wind Power as an Instrument for Turbines' Effect on Change in Governing Party's Vote Share, 2007 to 2011

	First Stage	Second Stage
Average Wind Power (log)	0.760***	
	(0.092)	
Proposed Turbine within 3 km of Precinct, 2011		−0.077**
		(0.026)
N Treated	354	354
N Control	354	354
District Fixed Effects	Y	Y
Other Geographic Controls	Y	Y
F-statistic on Instrument	68	

Note: Significant at † p<.10; * p<.05; ** p<.01; *** p<.001.

and using different specifications. Compared to the previous estimates for votes within 3 km of a proposed turbine, this slightly higher effect is plausible, given a potential downward bias on the fixed effects estimates due to measurement error caused by the data only being available at the aggregate, precinct level. Importantly, this same specification does not return significant results if the Liberal vote share in 2003, pretreatment, is used as the outcome variable. This robustness check suggests the relationship is not a spurious correlation between wind resources and political boundaries.[16]

[16]The SI provides further information on balance and robustness checks.

Mobilization versus Vote Swings

Thus far, we have seen strong evidence that wind turbines led to decline in support for the incumbent party. However, this evidence does not tell us whether the opposition came from existing Liberal Party voters switching their votes, or from new voters drawn to the polls as a result of the issue. It is possible that organized anti-wind groups were able to mobilize nonvoters to vote against the government because of proposed and operational wind turbines. By 2011, there were over 50 active anti-wind groups in the province, who posted signs across communities that explicitly connected Liberal Party policy to the wind projects. Did these groups bring new voters to the polls, who otherwise would not have voted, or did they convince previous Liberal supporters to change their votes?

Examining precincts with and without turbine proposals suggests that these groups were able to mobilize some new voters to go to the polls. As Table 3 shows, in precincts with an active proposal, voter turnout went up by 2%. Given that turnout was 49% across the province in the 2011 election, this change represents a substantively large increase. This increase in turnout accounts for about half of the fixed effects estimate of the change in the government's vote share due to wind turbine proposals (5%). Considering that this result holds for places up to 3 km away from a turbine proposal, it suggests communities were mobilized against proposals and that this mobilization accounted for some of the change in the government's vote share.

TABLE 3 Effect of Wind Turbine Status on Voter Turnout

	Proposal in Precinct	Proposal within 3 km	Operational in Precinct	Operational within 3 km
Voter Turnout	0.024***	0.016***	0.019	0.016†
	(0.007)	(0.004)	(0.015)	(0.009)
N Treated	184	492	52	145
N Control	6002	5694	6134	6041
Fixed Effects	Y	Y	Y	Y

Note: Robust standard errors, clustered at precinct level.
†p<.10; *p<.05; **p<.01; ***p<.001.

TABLE 4 Effect of Wind Turbine Status on Federal Liberal Party

	Proposal in Precinct	Proposal within 3 km	Operational in Precinct	Operational within 3 km
Federal Liberal Party Vote Share	−0.009	−0.013*	−0.023	−0.023**
	(0.010)	(0.005)	(0.018)	(0.009)
N Treated	184	492	52	145
N Control	6002	5694	6134	6041
Fixed Effects	Y	Y	Y	Y

Note: Robust standard errors, clustered at federal precinct level.
†p<.10; * p<.05; ** p<.01; *** p<.001

However, in places with an operational turbine, turnout effects were not statistically significant, although the lack of significance may be attributable in part to the smaller treated group for precincts with an operational turbine. Nevertheless, the turnout effect compared to the overall estimated change in the government's vote share (10%) suggests that the majority of the decline in places with an operational wind turbine occurred through existing voters changing their vote to punish the government for unwanted infrastructure, rather than through anti-wind groups mobilizing new voters. Together, these results suggest that, while mobilization of new voters occurred, most of the effect is likely attributable to existing voters changing their votes to punish the incumbent government.

Informed Backlash? National Election Results

While the provincial election results demonstrate that citizens living near wind projects punished the governing Liberal Party, we might also want to know whether voters were informed. On the one hand, their behavior appears to be based on policy knowledge, since the provincial Liberal Party enacted the policy and citizens living near unwanted wind infrastructure punished them at the polls. However, citizens could have simultaneously punished other politicians despite their lack of control over the policy. Ontario municipal elections are nonpartisan; however, we can examine whether the federal Liberal Party was also punished for wind energy developments. If citizens also punished the federal Liberal Party, we could interpret this as uninformed behavior.

Using the same estimator in Equation (1), I examine the federal election results over the same time period. The outcome variable is the federal Liberal Party's vote share, the treatment variable is whether there is a proposed or operational turbine in the precinct, and both unit and time period fixed effects are included in the model. As Table 4 shows, the presence of a proposed or operational turbine in a precinct does not lead to a statistically significant decline in the federal Liberal Party's vote share. However, when the sample is expanded to include precincts within 3 km of a wind turbine, the effect is statistically significant and the point estimate is stable at a 1% decline for precincts with a proposed turbine and 2% for precincts with an operational turbine.[17] However, note that the magnitude of the effect is about one-quarter the size of the effect in the provincial models. This suggests

[17] Although the results are not reported here, when census controls are included in these national models, the results are stable.

that while a portion of citizens may have indiscriminately punished both the provincial and federal parties, most citizens discriminated and only punished the level of government responsible for the policy. This result suggests voters were largely informed about the climate policy.

Conclusion

Using a natural experiment, I demonstrate that voters pay attention to climate policy and can retrospectively punish incumbent governments for nearby facilities they perceive as harming their communities. Taking the point estimates across all models, wind turbine proposals were associated with a 5% decline and operational wind turbines with a 10% decline in the incumbent provincial government's vote share. Across all models, the results remain negative and statistically significant, suggesting the null hypothesis—that there was no change in incumbent support as a consequence of nearby wind turbines—is unlikely. Further, the results provide evidence for the NIMBY hypothesis: Proximity to infrastructure leads local communities to oppose developments. Unlike previous research, an effect was found after projects became operational, suggesting communities may continue to mobilize after divisive facilities are built. This result is intuitive: When projects become operational, more citizens know about the project and experience its impacts. Finally, voters were informed, generally punishing the provincial Liberals but not their federal counterparts over the same time period.

Substantively, using the average point estimates and the average voter turnout per precinct, these results suggest the Liberal government lost around 6,050 votes during the 2011 election.[18] This means that wind turbines may not have changed any individual district's outcome, causing the government to lose its majority. Further, the public at large remained overwhelmingly supportive of the policy. A 2010 poll found more than 85% of Ontarians agreed that their local government should encourage wind developments, that they would support wind energy in their community, and that wind turbines have less health impacts than other energy technologies. Yet, the retrospective punishment that occurred in communities within 3 km of a turbine sent the government a spatially distorted signal. Supporters and opponents' spatial distribution and their asymmetry in mobilization meant that the government was able to hear policy opponents' preferences more clearly than policy supporters. Likely as a result of anti-wind opponents mobilizing and punishing them at the polls in the 2011 election, the Liberal government froze the wind policy in 2012.

More generally, this case is a reminder of the importance of examining a more diverse set of policy areas in political behavior and retrospective voting research. Examining a policy area that creates divided preferences allows for an exploration of retrospective voting dynamics when preferences are divided, resulting in spatially distorted signalling. Some retrospective voting research has examined policies that divided citizens' preferences, for example, Erikson and Stoker's (2011) study of the Vietnam draft lottery. However, my study examined a case of retrospective voting wherein preferences were divided based on geography. This pattern mirrors other types of beneficial but locally opposed facilities, such as housing projects, airports, and waste incinerators. If this study is replicated with other kinds of divisive facilities or public policies with spatially concentrated impacts, close attention to treatment assignment and potential selection bias in host communities will be essential. Future research could also examine the consequences of spatially divided benefits, and whether spatially distorted signalling can occur in those cases.

When the government responds to locally bounded opposition with policy changes, despite majority support, this can create a democratic accountability failure. Further normative concerns are raised because vocal opponents to local divisive projects tend to be white, older, more educated, wealthier, and more likely to vote (Mansfield, Van Houtven, and Huber 2001; Walsh, Warland, and Smith 1997). Since these individuals will be more likely to mobilize to oppose projects, this raises questions about the local community's preferences. Communities with higher wealth and social capital, and fewer minorities, are also more likely to oppose divisive projects (Aldrich 2008; Mohai, Pellow, and Roberts 2009). If projects are simply moved to poorer or minority communities when local resistance occurs, there are clear equity concerns with accountability to local opponents. More broadly, future work could examine potential failures in democratic accountability when small-scale but spatially concentrated electoral groups are mobilized in support of public policy.

Addressing climate change will require sustained political support on the part of both politicians and the public (Schenk and Stokes 2013). Climate policy will impose costs on the public, whether through unwanted renewable energy in Ontario citizens' backyards or job losses in West

[18] We do not know how many people in other political districts (i.e., urban districts) voted for the Liberal Party because they passed the climate policy; I have no way to measure that effect with this approach. However, the hypothesis is that only nearby communities are likely to change their vote because of this policy.

Virginian coal communities. The challenge will be maintaining stable climate policy in the face of intense opposition from local opponents, even while a diffuse majority supports the policy. As renewable energy facilities are sited in communities' backyards around the world, opposition to specific projects is likely. Similar to locating other kinds of divisive facilities, policy makers may need to engage citizens more during project development to build trust, address concerns about fairness, and, if necessary, require revenue-sharing provisions to build support (Boudet and Ortolano 2010; Rabe 1994; Warren and McFadyen 2010). Future research could empirically examine variation in policy design to see whether the way the government structures the process or compensates the community quells local opposition to divisive facilities. Experimenting with policy designs that lead to greater political acceptance of renewable energy will be crucial to minimizing political barriers to effectively addressing climate change.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher’s website:

· Qualitative evidence of wind project resistance
· Polling precinct boundary shifts
· Balance checks for fixed effects models
· Robustness checks for instrumental variable model