Political Implications of 'Green' Infrastructure in One's 'Backyard': The Green Party's Catch 22?

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Abstract

A clean environment is a public good, with the benefits shared by all. While most individuals can agree on the need to implement green policies, we argue that the cost-benefit calculation is quite different depending on where one lives. Those individuals living in places where green infrastructure is infeasible, such as cities, can advocate for green technologies knowing that the chance of having to bear the cost of infrastructure in their 'backyard' is low. We test how the building of wind turbines and solar farms changes one's political preferences in the German state of Baden-Württemberg. We use a difference-in-difference design based on whether one's area is designated for potential infrastructure in the future. We show that when the burden of 'green' infrastructure falls on voters, wind turbines or solar farms in one's 'backyard', these local authorities vote less for the Green Party. Additionally, using individual level data from SOEP, we find that it is those individuals who previously voted Green who are the most likely to desert their party in the face of green infrastructure, rather than disincentivising potential 'switchers'. We argue that this has profound implications for the move to 'net zero'. Green parties face a Catch-22 situation, the very policies that draw their support create a backlash when implemented.

1. Introduction

The salience of environmental politics and parties has dramatically increased over recent years. A consequence of the well documented scientific evidence of climate change (IPCC 2022), and a societal move towards post-materialistic attitudes (Inglehart 1971). The crux of the issue with tackling climate change is that for the major national polluters there are few immediate benefits from policy change. The benefits of a cleaner environment are predominantly reaped by future generations and those individuals living in lesser developed countries who are most geographically exposed. Thus, there is a well-known global collective action issue (Dietz, Ostrom, and Stern 2003; Ostrom 1990; Stokes 2016).

Similarly, within countries the 'cost' of the green transition and the associated journey to 'net zero' are not distributed equally. The burden often falls on lower socio-economic groups, more deprived areas, and smaller towns and villages (Arndt, Halikiopoulou, and Vrakopoulos 2022; Frondel, Sommer, and Vance 2015; Markkanen and Anger-Kraavi 2019). Rural areas suffer with the transition to green technologies given the lack of access to public transport and the high initial costs involved in the transformation. The latter is particularly salient as society moves to electric vehicles and the required widespread installation of changing points. Moreover, these locations are more likely to house green energy producing infrastructure, notably wind turbines and solar farms. The costs range from economic, such as less tourism and lower local house prices, to the impact on standards of living through noise pollution, destruction of wildlife, and aesthetic displeasure. In short, there is a huge benefit to be brought from 'green' policies, but it is shared by a vast number of people across places and generations. In contrast, the cost is borne by the few, and we know from a variety of literatures that this can often resort to a 'Not in my back yard' (NIMBY) response (see O'Grady, 2020).

On a wider and more dramatic scale, the 2018 'Gilets Jaunes' (Yellow Vests) protests highlights the potential for a mass response when a part of the electorate perceives a disproportionate burden from the green transition (Mehleb, Kallis, and Zografos 2021). In the wake of a hike in fuel prices, partly a result of a planned increase in carbon tax and a decision to strip tax advantages for diesel, tens, if not hundreds, of thousands of protestors filled the streets. The actions included legitimate

protests, blockades, and, on several occasions, protests spilled over to riots. Based on a protestor's quote in Le Monde (Rérolle 2018), for many individuals it was difficult to square the elite's preoccupation with "talking about the end of the world" when many are struggling to make it to "the end of the month" (M. Martin and Islar 2021).

Given this context, we argue that in economically developed states we have seen a 'rational' aggregate increase in environmentally friendly attitudes. As post-materialistic attitudes dominate, individuals tend to focus on cultural issues such as the environment. Moreover, for many individuals that live in cities, there are limited prospects of being directly impacted by environmental infrastructure in one's backyard. It is both inefficient and impractical to place renewable energy sources such as wind turbines or solar farms in the city. Those living in rural locations may already be less 'green', due to a compositional effect, whereby those with higher educational and occupational status, and thus post-materialistic attitudes are attracted to cities. However, crucially, policies designed for the aggregate environmental 'good' often have a negative distributional consequence for groups in society who have already 'lost-out' from processes linked to the transition to the knowledge economy. These policies tend to fall disproportionately on those in rural areas, and individuals in rural areas are more likely to oppose climate change policies (Arndt, Halikiopoulou, and Vrakopoulos 2022). We identify a specific example, when green infrastructure such as wind turbines and solar farms are built in one's district. We expect those voters affected to turn away from the Green Party. More generally, we argue that forming political coalitions for the green transition will be tough without compensating those groups who bear the cost. The Green Party themselves are left with somewhat of a Catch-22 situation; the very policies that draw their support create a backlash when implemented.

In our empirics, we use the case study of the German state of Baden-Württemberg (BW), to investigate how the imposition of 'green' infrastructure affects voting preferences. BW is a 'green' state, the Green Party won 32% of the votes in the latest state elections in 2021 and was the largest party. We exploit the publication of designated areas for wind turbine and solar farms via an internet portal (LUBW and Umweltministerium Baden-Württemberg)[1]. We use a difference-in-

[1] The Energieatlas was published online on 13 November 2015, but the potential analysis was only added in 2018 for solar and 2019 for wind.

difference model to show that when a local authority (Gemeinde) includes a significant area that is designated as a potential site for future wind turbines or solar farms, those local authorities tend to vote less for the Green Party. Our second step is to combine the regional 'green' infrastructure treatment and individual-level panel data from the *German Socio-Economic Panel* (SOEP). In areas that are designated as potential green infrastructure sites, existing Green Party supporters are significantly more likely to desert the Green Party than their non-affected peers. We find no evidence that those individuals who supported other parties in 2018, were any less likely to switch to the Green Party if they were in a potential wind turbine or solar farm area.

Our contribution is four-fold. First, we add to a small but growing literature illustrating the effects of environmental infrastructure on political attitudes. However, there is conflicting evidence. Existing work shows that voters 'blame' incumbents for wind turbines in their backyard (Stokes 2016), contributes to electoral polarisation through increases to both the Green Party vote and support for the AfD (Otteni and Weisskircher 2021), and substantially decrease Green Party voting (Germeshausen, Heim, and Wagner 2021). Our findings in BW contrast with Otteni and Weisskircher (2021), whereby the potential for turbines reduces Green Party support, which arguably may be considered the incumbent. Second, we show that the effects are broader than just wind turbines and apply equally to solar farms. Third, we nuance previous studies by showing that it is existing Green Party supporters who are the most likely to remove their support. Fourth, whilst our empirics focus on wind turbines and solar farms, our argument is much broader, we attempt to show how the political feasibility of a green transition depends crucially on maintaining the support of those bearing the cost.

The paper is structured as follows. The next section describes the rise of green values and green policies in the quest to achieve 'net zero', and how there are distributional consequences to such policies. Following that we develop our expectations for voters' political response when they experience the costs of the green transition. Next, we describe the context of Baden-Württemberg, our data, and empirical strategy. Section 7 outlines the findings. We conclude with a discussion of the implications.

2. The distributional consequences of 'net zero'

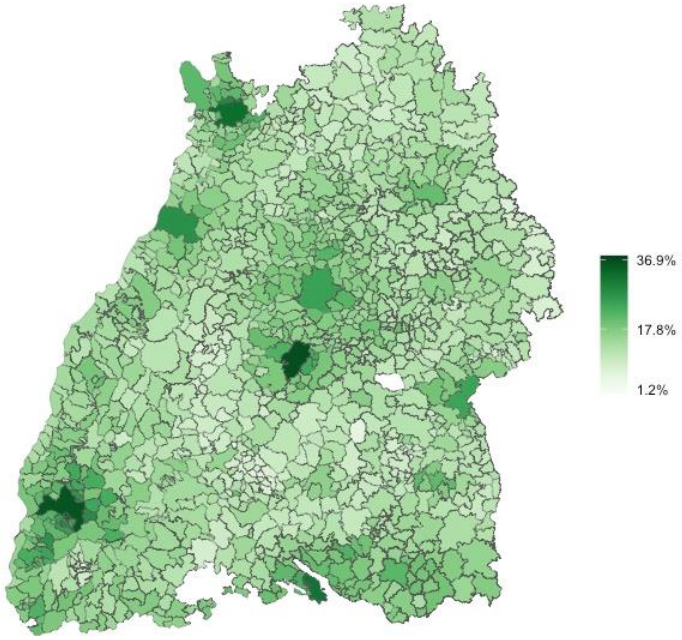
Across Europe, and in particular our country of study, Germany, 'Green' parties have seen a dramatic increase in popularity over the past 40 years. In the most recent German federal elections in 2021, the Greens received 14% of the votes cast and were the third largest party.[2] It is somewhat of a steep ascent from the 1980 election, when they only received 1% of votes. The increase in the 'green' vote is often ascribed to an increasing wealthy population where there is an institutional structure that allows for mobilisation of an electorate with environmentally friendly attitudes (Grant and Tilley 2019). In advanced capitalist democracies, many individuals now have a level of income that sustains their material needs. Their attitudes and electoral priorities thus shift to post-materialistic issues such as gender roles, sexuality rights, and most relevantly for our paper environmentalism (Inglehart 1971). This is supported by evidence from Abou-Chadi and Hix (2021), as they show the highly educated have shifted their support away from mainstream parties to the 'greens' across Europe. However, these pro-environment attitudes are most likely to be relevant at the ballot box when institutions are permissive. Most notably proportional representation and decentralization (Grant and Tilley 2019). Both criteria apply to Germany.

Within countries there is a large divergence of Green Party support. As already noted, in the most recent 2021 Länder (State) elections in BW, 32.6% of votes were for the Green Party. By contrast in the Saarland only 4.9% of the electorate voted Green.[3] Within BW there was a divide between the urban and rural districts. The distribution of Green Party votes in the federal and state elections are shown below (Figure 1). The areas with the relatively highest Green Party vote share, the darker shading in Figure 1, include the university cities/towns (Freiburg, Tübingen, Heidelberg, Konstanz) and most of the major cities (Stuttgart, Karlsruhe, Ulm).

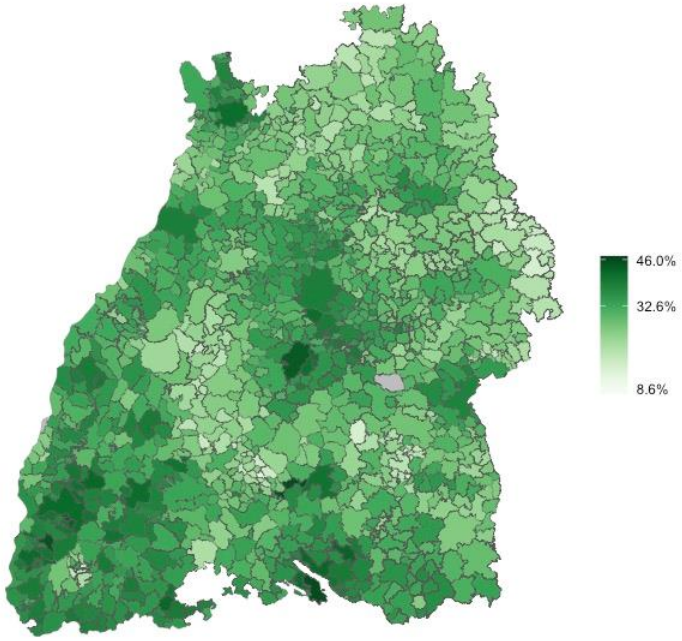
Figure 1: Green Party support by local authority in 2021 Federal and State elections

[2] Based on Constituency votes.
[3] The most recent Länder election in Saarland was 2022.

Green Party - Federal Election 2021



Green Party - BW State Election 2021



We argue that there are three drivers for urban areas tending to have the greatest support for the Green Party. First, there is the compositional effect (Huijsmans et al. 2021). Those voters in urban areas are more likely to be highly educated, be in high status professional occupations, and earn

more. These are factors that we know tend to be associated with more post-materialistic attitudes (Inglehart 1997). Second, we anticipate there is an independent effect of 'place', those people in cosmopolitan areas are likely to promote and reinforce pro-environmental attitudes in those around them. The role of social networks is important, as 'green' views are not only encouraged but expected in friendship circles and in the workplace (Abrams, Iversen, and Soskice 2011; Nordbrandt 2021).

Most relevantly for our thesis, those voters in rural areas face potential costs during the 'green' transformation. There can be health costs[4], for example, Merkel's government decided to decommission nuclear power as there was increased fear of a potential disaster following the Fukushima Daiichi nuclear disaster in 2011[5]. Less dramatically, having 'green' infrastructure in one's vicinity can lead to decreased life satisfaction. Wind turbines, many would argue, are aesthetically displeasing, are noisy, and block out sunlight (Onakpoya et al. 2015). Solar farms, although potentially less intrusive, can reflect light and impact scenic views (The Economist 2021). Both may be destructive to local wildlife and forests (Măntoiu et al. 2020). In turn, there may be a knock-on effect on house prices. Dröes and Koster (2021) show how having a wind turbine within 2km reduces one's house value by 2%, and for large wind turbines of greater than 150m, the effect is as much as 5%. In the same study, having a solar farm in one's vicinity reduces house prices by 2-3% but only if it is very local, within 1km. Decreasing house prices is particularly likely to impact homeowners' attitudes, but we also know that there is a potential for a wider geotropic as house prices shape perceptions of local economic conditions (Adler and Ansell 2020). Similarly, 'green' infrastructure may impact local industry. Many tourists are attracted to the countryside in BW, which includes the Black Forest region, by the uninterrupted natural beauty, and there is the potential that wind turbines and solar farms may deter visitors (Broekel and Alfken 2015).

These 'costs' are likely borne by those in rural districts. There is not the required space or wind in most city locations. It is further plausible that those individuals chose to live in a rural environment to enjoy the idyllic peace and quiet that this very infrastructure may prevent. However, between

[4] Of course, there is much debate whether these health risks are meaningful, but the perception of potential health costs is what is relevant to our argument

[5] Announced on 30th May 2011

rural districts the placing of green infrastructure is seemingly random. In theory, individuals may choose not to live in particularly windy or sunny spots given the fear of wind turbines or solar farms being placed there in the future – although this seems unlikely. Thus, we can then detect whether having new wind turbines in one's local district changes political preferences.

Whilst our research design is based specifically on the effect of wind turbines and solar farms, our argument is much broader. We understand the construction of green energy producing infrastructure as just one example of the cost of the green transition. In the case of wind turbines and solar farms, the cost is unequally spatially distributed. In many, but not all, cases the burden tends to fall more on the rural community. One could also think about the move to electronic vehicles. There will be costs in terms of new car purchases, increased fuel prices, and potentially charging infrastructure. Rural communities rely more heavily on cars than individuals in cities where public transportation is more convenient. That is not to say those living in cities do not face pressures, through congestion charges, low emission zones, or outright driving bans. Thus, our argument is linked to the rural-urban divide but is wider. The burden of the 'green' transition affects some groups more heavily than others (Breetz, Mildenberger, and Stokes 2018; Stokes 2016), thus support for such policies will depend, to a degree, on how much of the burden one expects to take.

It may also be that those individuals who tend to bear the cost of environmentally friendly policy are those who have lost out through other structural changes in the political economy. Those individuals from lower socio-economic positions are more likely to live in rural communities (Maxwell 2019; Valero 2021), which are more exposed to 'net zero' policies. Once again, we refer to the Gilets Jaune where the hiked fuel price was the instigator for protest, but the underlying issue was a perception of societal unfairness. A theme which is repeated in the literature on populism, where a key causal explanation is that of 'losing out' in the face of structural change (e.g. Colantone and Stanig, 2018; Gidron and Hall, 2020; McNeil and Haberstroh, 2022).

3. How do voters react to bearing the cost?

Individuals in Germany have a clear case to associate the prevalence of 'green' infrastructure with the Green Party (see also Germeshausen, Heim and Wagner, 2021 or Otteni and Weisskircher, 2021). To take a brief excerpt from The Green Party's federal election manifesto, they promise "An accelerated exit from coal and to guarantee ongoing energy security a massive expansion of renewable energy sources with an energy market design oriented after solar and wind is required" (Bündnis 90 / Die Grünen, 2021: 21) [authors' translation]. For further historical details on the Green Party's support for renewable energy, and the empirical relationship between Green Party voters and support for renewable energy see Otteni and Weisskircher (2021).

Where we differ from Otteni and Weisskircher (2021), and instead draw more closely on the NIMBYism literature, is that we expect when individuals bear the cost of infrastructure, they will be less likely to support the Green Party. The classic examples are when voters are overall in favour of a policy proposal, such as infrastructure or housing, if it is 'not in their [my] backyard'. In relation to housebuilding, there tends to be a consensus that there is a lack of affordable housing, yet individuals do not want new housing stock in their immediate locality. This may be a function of impact on house valuations (Hankinson 2018; Marble and Nall 2021). Yet, it may also be a willingness to preserve existing ways of life and a reluctance to experience the unknown of rapid changes (O'Grady 2020). While most individuals would be broadly supportive of the policies required to transition to renewable energies and achieve 'net zero' (YouGov 2020), we would still expect them to behave like NIMBYists, that is they rationally do not want to pay the associated costs whilst they are ok to free ride. Radtke, Saßmannshausen and Bohn (2021) find in a representative study about attitudes towards wind turbines in NRW, that the expansion is met with great approval, roughly a third (30.3%) is opposed to a wind turbine in their own district.

Our expectations are in-line with Gaikwad, Genovese and Tingley (2022), whereby they think of 4 groups of voters: 1) policy threatened – those threatened by job losses because of decarbonisation policy, in their case living in coal communities, 2) climate change threatened e.g., living in coastal communities, 3) neither climate change or policy threatened, 4) cross-pressured, exposed to both climate and policy change. They use a survey experiment which asks individuals how they believe revenues from a hypothetical climate energy tax should be spent. The general population with neither exposure is mostly in favour of green energy infrastructure and a widespread rebate. The

policy threatened group expects direct compensation, whereas the group who are climate exposed have a higher tendency to support spending on climate adaptation. This is analogous to our thinking, in our case the general population prefers green infrastructure, although we do not test it, we would expect those areas that are particularly vulnerable to be especially pro green infrastructure. However, those areas that are policy threatened through lower life satisfaction and lower asset prices will be against the policy.

Our study adds to this debate, despite several studies there is no consensus in this 'NIMBYism' field. To briefly summarise, Otteni and Weisskircher (2021) find in Germany that a construction of a wind turbine polarises the electorate through increasing both AfD and Green Party voting. Contrastingly, Germeshausen, Heim and Wagner (2021) find a large magnitude decrease in Green Party support, approximately 17 percent, when a wind turbine is constructed close to one's residence, albeit this effect falls away quickly with distance to the wind turbine. Stokes (2016) shows in a study in Canada that wind turbines are one's vicinity cause a decrease in support for the incumbent party. This is also relevant for BW as in many local authorities Green Party politicians are the incumbent. We delve further into interaction effects with the Greens as the incumbent in the supplementary material[6]. Regarding solar panels, Umit (2021) shows that individuals who install panels on their roof do not change their political attitudes using longitudinal data from Germany, Switzerland, and the UK.

There is also literature focusing on the local and individual effects of other types of infrastructure. Again, there is surprisingly little consensus. Some cases find a NIMBYist type reaction, for example regarding power plants (Ansolabehere and Konisky 2009), and prisons (R. Martin and Myers 2005). A similar individual incentive logic works as workers in industries that are higher pollutants are less supportive of global climate cooperation (Arndt, Halikiopoulou, and Vrakopoulos 2022; Bechtel, Genovese, and Scheve 2019), as are individuals who live in areas reliant on such industries (Gaikwad, Genovese and Tingley, 2022). Other work shows a neutral to potentially even positive effect, which seems most prominent when the infrastructure is already

[6] The Christian Democratic Union (CDU) has been the junior coalition partner during the last two legislative periods. We only treat those electoral districts as having an incumbent where the green party won the majority of the votes.

there. For example, evidence from New Mexico (Jenkins-Smith et al. 2011) and restarting nuclear power plants in Japan (Uji, Prakash, and Song 2021) post the Fukushima disaster, shows individuals do not act in a NIMBYist way post construction, potentially because of existing local jobs.

Those living in the proximity of wind- and solar-farms do not just bear the outlined costs but could potentially also benefit from the green infrastructure. In Germany, there is no clear regulation or guideline for states and communes from the federal level, but there have been discussions around how to compensate affected communities. The suggestions range from communes receiving a share of the profits to a 'Windbürgergeld' ("wind-citizen-money"), i.e. direct payments to affected citizens (Die Zeit 2020). The state government of Schleswig-Holstein passed new legislation in 2016 that forces investors to offer shares to anyone living within 5km of the new development in order to give them the opportunity to benefit from the investment (Die Zeit 2020). However, in BW no regulations exist yet. Without regulations in place, compensation is not mandatory and it is up to the contractual parties (local authority and developer) to decide if the projects are accompanied by any compensatory measures.

Hypothesis 1) In districts that are designated future potential wind turbine (solar farm) sites, the support for the Green Party will decrease.

Next, we theorise as to who it is that will cause a decrease in Green Party support in those areas potentially destined for green infrastructure. There are two potential sets of 'deserters'. First, the classic NIMBYists, those Green Party supporters who in theory were happy to support green infrastructure until it appeared in their direct vicinity. That is individuals who supported the Green Party in previous elections but will no longer, as they blame the Green Party for the direct costs they must now bear. These voters may switch back to the mainstream parties, such as the CDU, SPD, and FDP; or alternatively stage a protest vote for the anti-system left, Die Linke, or the anti-system right, the Alternative für Deutschland (AfD). Second, we know that the Green Party support has been increasing over time. Thus, we may not see the same added support as in other areas where wind turbines or solar farms are not being built. That is, 'switchers' from other parties may be put off by the proponents of green infrastructure.

Unsurprisingly, Green voters are not a homogeneous group. While they are united in their concern for the environment, they also tend to be younger and more likely to be graduates compared to the rest of the population which translates into higher concentrations of Green Party voters in cities, particularly university cities (Abou-Chadi and Hix, 2021). Yet, individuals are drawn to the party for different reasons and hold different views on what the party should prioritize. These different voter camps are also represented within the party's own fault lines, such as the conflict between "Fundis" (fundamentalists) and "Realos" (realists). However, more relevant for the topic of green infrastructure expansion, the Green party is facing a dilemma when it comes to the overlap between two of its core-aims, namely, Klimaschutz ('climate protection'), focusing on how to prevent climate change, and Naturschutz ('nature protection'), focusing on protecting biodiversity. Party supporters are split when it comes to which protection should take the driver's seat. Emblematic for the resistance of those green supporters who favour Naturschutz has been the 'red kite'. Legislation to protect red kites is referred to frequently to prevent new wind turbines, because these birds of prey are looking to the ground while flying, they are potential rotor victims (Goetz, 2019). More generally, sceptics of the expansion of green infrastructure are concerned about the accompanying destruction of living space of animals and plants. For example, solar farms require vast free spaces. Given the disappointment and frustration that those who prioritize Naturschutz over Klimaschutz could feel with the Green party, if their concerns are not addressed, they may desert the party.

That means former supporters might desert the party due to the general NIMBY logic or because they do not feel as if the party is representing their priorities anymore if a wind turbine is built in their vicinity. This could lead former green supporters to either abstain or switch their party preference. If this hypothesis is supported, it proves a real dilemma for the Green Party. The very policies that are core to their existence drive away some of their supporters when implemented in their backyard.

Hypothesis 2) The decrease in Green Party voting in areas designated for wind turbines (solar farms) can be attributed to NIMBYist deserters, i.e., previous supporters.

Over the last years the Green Party has gained more support in both, state and federal elections across Germany and Baden-Württemberg in particular. A decrease in Green Party voting is thus not necessarily just driven by deserters, but also possibly by a lack of gained support in areas with new potential green infrastructure relative to unaffected areas. The expansion of green infrastructure can lead individuals to continue to support other parties instead. This could be due to the NIMBY logic or because of the heightened awareness around the potential effect of green infrastructure on the natural world that activists are trying to create to gather resistance.

Hypothesis 3) The decrease in Green Party voting in areas designated for wind turbines (solar farms) can be attributed to the lack of added support.

4. Regulatory Context and Baden-Württemberg

The planning and construction of new wind turbines is regulated across the different levels of government in Germany. The federal level sets general framework rules, which the state further defines via their own planning regulations and goals. The planning regions within a state have further say on designation of areas, and communes have their own planning committees that take final decisions. However, federal and state regulations decide the majority of the legislative framework. In addition to the planning regulations, the federal and state level set out the aims that should be achieved in terms of renewable energy expansion. If these aims are not met, they tend to increase pressure by, for example, implementing law changes.

From the federal level, onshore wind investors will have to get prior approval for their projects under the Federal Immission Control Act (*Bundes-Immissionsschutzgesetzes* or *BlmSchG*), the federal law regulating the harmful effects of air pollution, noise, vibration, and similar phenomena. Onshore wind is further restricted to specified 'grid congestion zones' where high inputs of renewable electricity cannot be accepted because of network congestion. These areas are to be identified by the Federal Network Agency.

At the state level, the major legislation is the state planning act (*Landesplanungsgesetz* or *LplG*) which defines, for example, the distance of green infrastructure to residential areas. In Baden-

Württemberg, the minimum distance between a wind turbine and a residential area must be 700m. This regulation was the preferred option of the Green party, whereas the CDU would have preferred 1000m which became the federal guidance in 2021. In addition, the state law sets out specific clarifications which usually become part of the LpIG such as how to harmonize biodiversity and animal protection laws with the renewable energy expansion.

Baden-Württemberg is the third largest German state by area and population, with over 11.1 million residents (Federal State Office of Germany). It has a high mean income both absolutely and relative to Germany as a whole. In 2018 the average available income per citizen in Germany was €22,899, this figure was €24,892 for BW, only Bavaria (€25,309) and Hamburg (€25,029) have a higher average income per person (Regionalatlas Deutschland).

Special about the Greens in Baden-Württemberg has been the early success of the party not just in the big and university cities, but also in more rural areas. The Greens jumped the five percent hurdle in all but two of 70 electoral districts at the party's first state election in 1980 (LpB BW 2022). Traditionally the CDU has been the largest party, until the 2016 state election when the Green Party took this mantle.

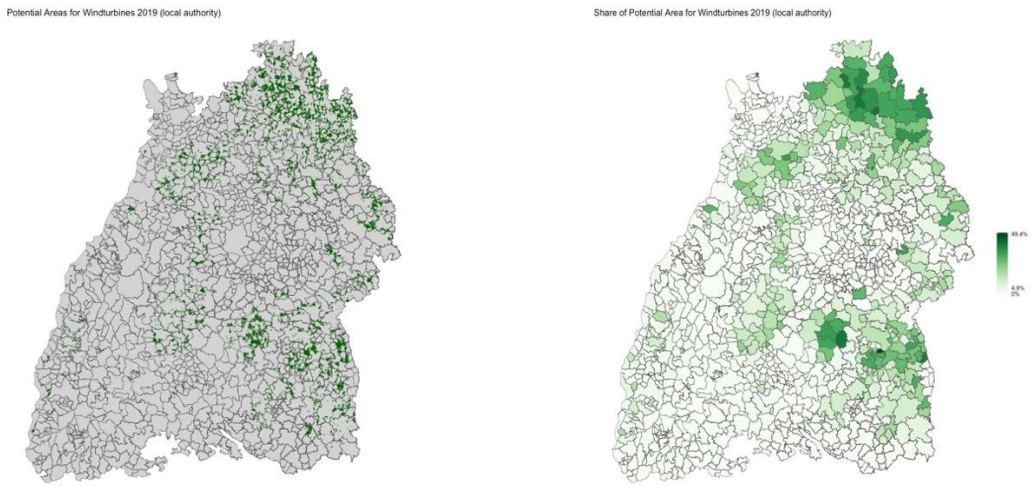
Given its size, diversity, and strength of the Green Party across urban and rural areas, Baden-Württemberg is a good case to study the effects of the introduction of green infrastructure on voters. During the period we study, Baden-Württemberg had a coalition government between the Green Party and Christian Democrats. Given that Germany is a federal system with a multilevel governance system, voters might not always attribute policy decisions to the correct level of governance. The overlap between the CDU in the federal as well as State government will help us to test if we are seeing an incumbent effect as well. The manifested strength of the Green party in the state is also beneficial as the Greens can be considered a mainstream party here, whereas in other parts of Germany the party has only recently experienced a considerable upswing in support which might not be stable and could distort the individual level analysis.

5. Data

We make use of data published by the Landesanstalt für Umwelt Baden-Württemberg (LUBW) which, according to the 'Umweltverwaltungsgesetzes' from 2015, allows access to specific environmental data and digital maps based on evaluation and measurement data from the LUBW as well as the information association of communal and state environmental agencies. This data can be accessed via an interactive online platform called Umwelt Daten und Karten Online (UDO).

To assess the potential of a wind turbine being placed in a local authority we use a dataset that was compiled as part of a state-wide report into potential geographic areas for future wind turbines[7]. Potential future areas were based on wind-speeds and other criteria which formed part of the Windatlas Baden-Württmeberg 2019 (including exclusionary criteria such as proximity to an environmentally protected area or specific infrastructure) which became part of the Energieatlas. Part of this data includes a variable that indicates the size of the area (in hectares) within a local authority. We combine the potential area size with local authority area data from the Statistisches Landesamt Baden-Württemberg to calculate the share of local authority area which has been deemed to be a potential location for future wind turbines. Figure 2 highlights the areas which are potential future wind turbine sites, and the proportion of each local authority that is potentially exposed.

Figure 2: Potential wind turbine sites in Baden-Württemberg



[7] The report also considers 'limited potential' areas

The designated potential areas in the Windatlas are the best predictor of a future wind turbine site due to the natural restrictions, i.e. wind potential, as well as regulatory ones, e.g. distance to residential areas or natural protection areas. The impact on the development of wind farms is shown in a case study by Reusswig et al. (2016) where the official wind potential analysis triggered discussions around the development of a wind park.

We use data from the 2019 Windatlas, which is the updated version of a previous 2011 report. In 2011 Germany had decided its exit from nuclear energy and the Green Party in BW entered the first Green Party led state government. One of the Green Party's priorities was to start planning for the expansion of renewable energy. The 2011 Windatlas was the first official assessment of wind potential throughout the state which should help to identify areas for potential wind turbines. We use the updated 2019 version of the report as our treatment because of important changes to regulations and laws that followed the initial Windatlas in 2011 and saw important changes to the assessment of areas for wind turbines (see appendix for further details).

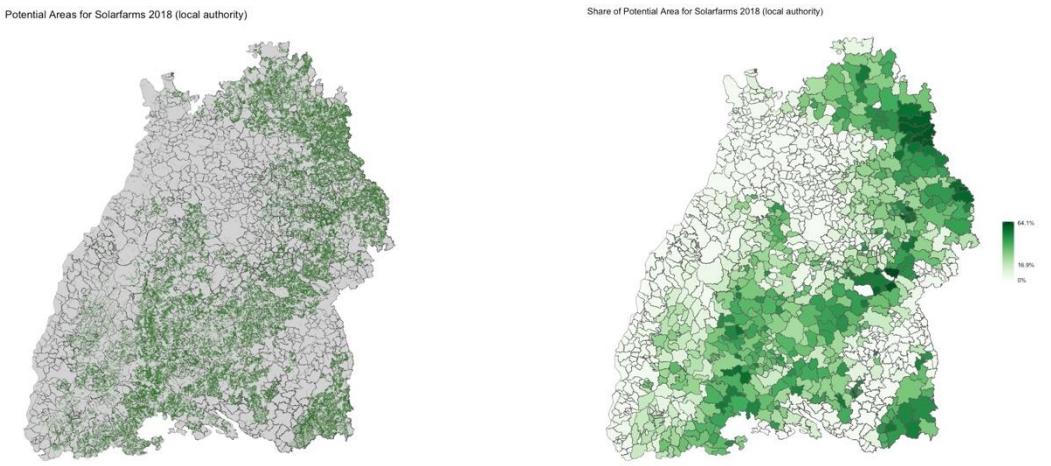
Given the magnitude of changes, both in terms of suitable areas (designated potential areas roughly doubled) and legislative reforms (specifically Windenergieerlass 2012; Umweltverwaltungsgesetz 2015; animal protection 2015; noise protection 2017; EEG reforms in 2014 and 2017) that followed the initial assessment of wind potential in the 2011 report, we believe that the updated 2019 Windatlas version is better suited. In addition, the 2019 report takes new technological advances into account that allows for the building of wind turbines in less windy areas as well. This is particularly important in Baden-Württemberg which has relatively low wind potential compared to the more northern regions in Germany. To manifest the role of the new Windatlas in planning, the state published a note on the use of the Windatlas 2019 in July 2019 stating that the Windatlas calculations can be used as evidence to fulfil the planning efficiency requirement for new wind turbines, taking into consideration the new changes in law and practice.

Another contributing factor to choose the 2019 version is the change in salience around the topic of renewable energy expansion (the so called Energiewende). Salience for the topic greatly increased since the first 2011 report. In 2013 the Baden-Württemberg Parliament passed the 'Klimaschutzgesetz' which defined concrete emission reduction goals (90% reduction by 2050

compared to 1990 base line) emphasising the need for future expansion of renewable energy. On a wider scale the Paris Climate accords in 2016 and a federal debate around renewable energy in 2016/2017 linked to the EEG reform led to an increased salience of the topic nationwide (google trends) and likely increase the awareness of and attention to the expansion of renewable energies further. The switch from seeing renewables as a potential option in communes to increasingly a necessity is most clearly outlined in the new coalition contracts of the federal and state governments in Germany and BW from 2021. According to the federal government 2% of Germany's landmass should be reserved for onshore wind turbines and the so-called repowering, that is the replacement of old wind turbines through newer ones should be made easier and faster. The state government sees 2% of its landmass as the goal for onshore wind farms and solar farms, as well as the aim of building 1000 new wind turbines by the end of the legislative period (by 2021 BW had a total of 751 active wind turbines). Because of the increasing interest in the renewable energy expansion, regional media and newspapers widely reported on the new version of the windatlas and major law changes, including the permission for free space solar farms (see below) raising awareness and interest further.

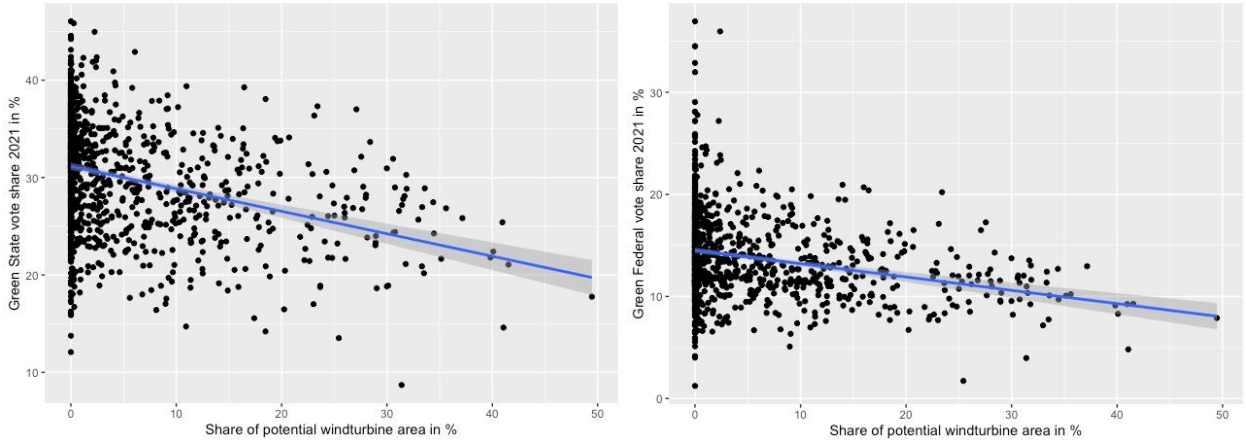
Similarly, we use data around potential areas for solar farms, which is also published by the LUBW and as part of the Energieatlas. Unlike for wind, a solar potential analysis was first published in 2018 based on a law which was passed in 2017 (FFÖ-VO based on the EEG 2017) which extended the possibility of building solar farms in open spaces for the first time as these areas were considered restricted areas previously. We are only using data for solar farms in Freiflächen (open spaces), i.e. this does not include solar panels on roofs of commercial or residential buildings. The potential areas are calculated according to criteria such as type of area, size of area, as well as average slope. Figure 3 maps potential solar farm sites in Baden-Württemberg.

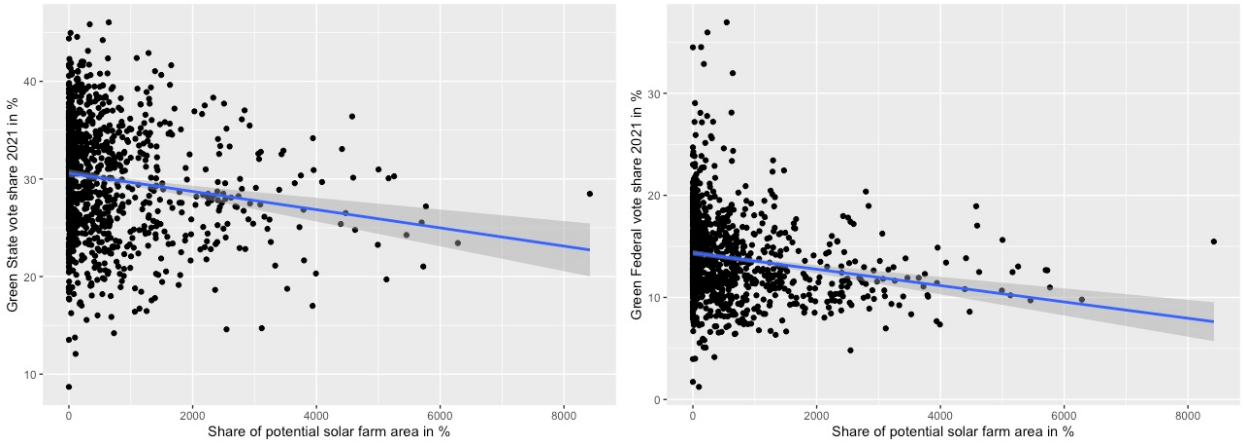
Figure 3: Potential solar farm sites in Baden-Württemberg



We combine the environmental data with federal and state election results from the Regionalstatistik which is published by the Statistische Ämter des Bundes und der Länder, and the Statistische Landesamt Baden-Württemberg. The election results are disaggregated to the local authority level. For federal elections, we base our analysis on Party List votes. We exclude mail voters because they cannot all be accurately linked to their local authority. We show pre-trends from previous elections (Figure 5). Our analysis is based on federal elections in September 2017 (pre-treatment) and Septermber 2021 (post-treatment). For state elections, we use the pre-treatment as elections in March 2016 and the post-treatment as elections in March 2021. To give context of the distribution of Green Party votes and potential area designated to wind turbines for the 1,011 local authorities see Figure 4.

Figure 4: Share of area designated potential for wind turbines (top) or solarfarm (bottom) against Green Party state (left) or federal (right) election vote share in 2021 by local authority





For the individual level analysis, we use the German Socioeconomic Panel (SOEP). SOEP is a nationally representative longitudinal dataset. We use data from Waves 35 (2018) and 37 (2020) for the wind turbine analysis. For the equivalent analysis on solar farms, we use the pre-treatment data from Wave 34 (2017) because the treatment is in 2018. We include only those individuals for which we can track through both waves. We then link these individuals to the district[8] in which they reside, and accordingly whether that has been designated as a potential wind turbine site. Our dependent variable is based on the party which one supports. We remove respondents from our analysis with missing responses via listwise deletion.

6. Empirical Strategy

Our approach exploits the exogenous timing and naming of sites that are potentially cited for wind turbines or solar farms in the future. We use a difference in difference (DiD) identification strategy to exploit the fact that only a proportion of the districts in BW are 'treated' (see Figure 2 and Figure 3). For the analysis on solar farms, the treatment is in 2018. In the first section of our empirics, our unit of analysis is the local authority (Gemeinde). We then exploit the panel nature of the data as shown in equation 1). Our dependent variable, Y_{it}, is the vote share within a local authority, *i*, for the Green Party, at time *t*. We regress Y_{it}, on district and time fixed effects, γ_i and δ_t respectively, to account for time-invariant characteristics of the local authority and any changes over time. We provide two sets of models, with and without time-varying controls, $X_{it,}$ at local authority level.

[8] We use a larger spatial unit, 'district', for the individual analysis due to data constraints with SOEP.

We are restricted to these controls given the contemporary nature of the data; the state and federal elections were only last year (2021). We include population and population density (in the supplementary materials we include a time-varying control for number of turbines in the local authority)[9]. The local authority fixed-effect absorbs any time-invariant factors. Finally, τW_{it} estimates the impact of being in an area which has been designated for 'green' infrastructure. We measure this with respect to wind turbines and solar farms.

Our results consider three specifications at the local authority level[10], 1) the area has more than the median local authority potential sites designated for wind turbines (solar farms), 2) the area has more than the mean designated for wind turbines (solar farms), and 3) the district is in the top quartile of potential wind sites (solar farms)[11]. We only show the 'mean' analysis in the main results, the other specifications are available in the supplementary material but are substantively similar. This analysis is completed separately for federal and state elections. We also provide a supplementary analysis which considers the number of wind turbines that potentially could be built rather than the area. These values are obviously correlated but not identical. Results are substantively similar.

Equation 1

$$Y_{it} = \alpha + \tau W_{it} + \gamma_i + \delta_t + \beta X_{it} + \varepsilon_{it}$$

A causal interpretation of a difference-in-difference design relies upon the assumption that the non-treated districts represent a good counterfactual for those areas that are treated through being designated a potential wind or solar site. We show these parallel trends in Figure 5 for the pre-treatment period. The parallel trends assumption holds well for both state and federal elections. Second, we are assuming there are no time-varying confounding variables between the pre-treatment and post-treatment periods. We address any concerns that we are capturing a further

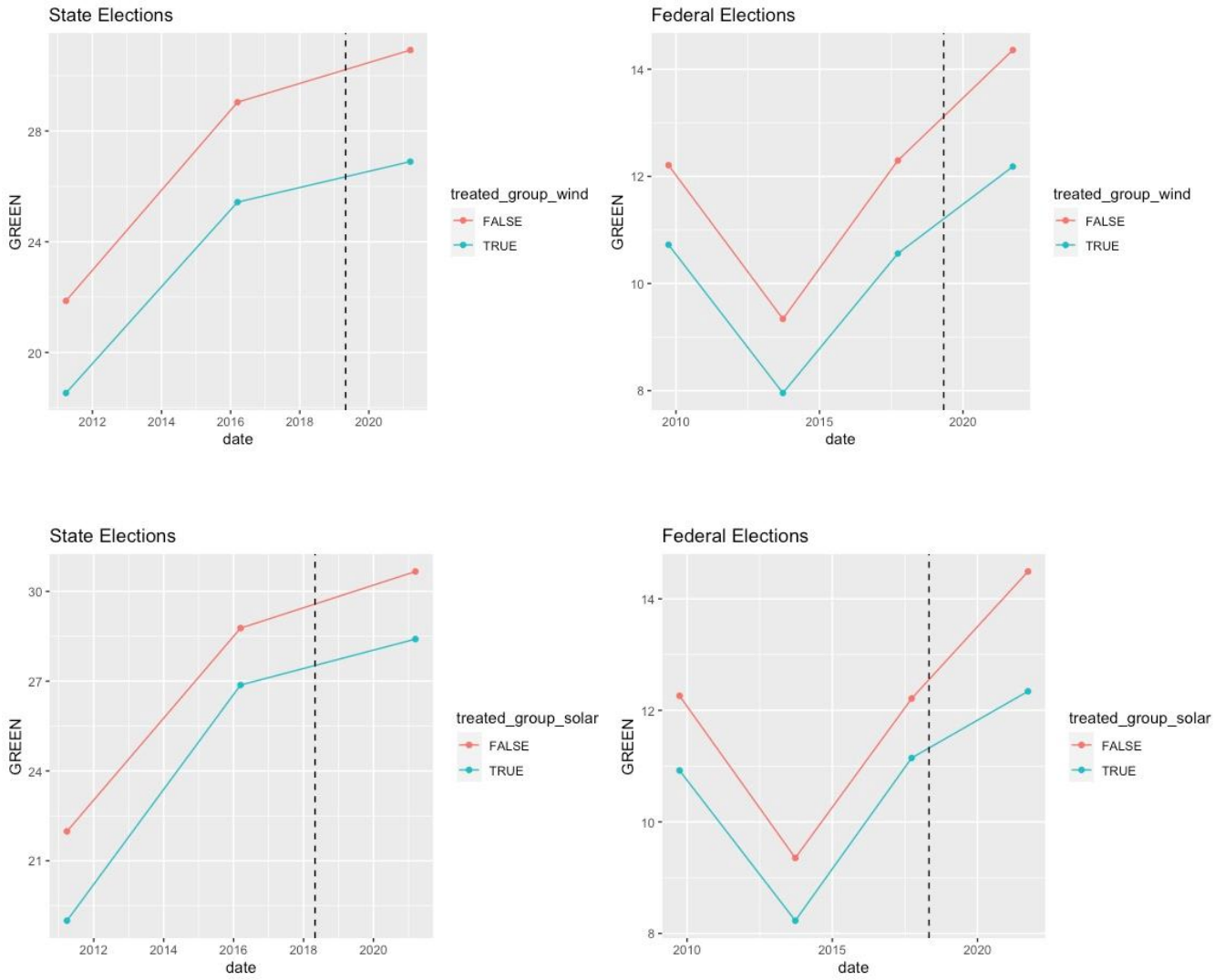
[9] We do not include this in our main results as this is essentially what we are trying to capture, the response to green infrastructure. However, results remain robust to their inclusion.

[10] We also provide in a specification in the appendix whereby local authorities are 'double treated', that is designated as potential wind and solar sites.

[11] Medians and means calculated by excluding zeroes I.e. those local authorities without any land designated as potential for wind turbines (solar farms)

divide between urban and rural voters, rather than a 'green' transition effect per se, in the robustness section. Moreover, we include the vector X_{it} to control for time-varying variables as described above.

Figure 5: Parallel trends for wind and solar: left: Green Party state election results by local authority; right: Green Party federal elections by local authority



We then merge our individual level data from SOEP, which is linked to the respondents' district of residence.[12] In line with the previous analysis, we use a difference-in-difference regression, with a linear probability model (Equation 2). We dichotomise the dependent variable, Y_{it}, the party one

[12] Residence is based on where one lives in 2020. We provide analysis for only those individuals who have not moved to alleviate any sorting concerns.

supports, as 'Green Party' and any other party. Now i refers to an individual at time t. We include individual fixed effects, θ_i, to account for any time-invariant individual characteristics, and again δ_t captures time fixed effects. In the main regression we do not include a vector of time-varying characteristics but do so in supplementary analysis, X_{it}. We are interested in the effect of the 'wind' and 'solar' treatment by an individual's party preference pre-treatment. To do so we introduce the interaction term μW_{it} * $2018P_i$ where $2018P_i$ refers to an individual's 2018 party support preference. Whilst we are not able to introduce individual time-invariant variables directly to the regression, because they are absorbed by the individual fixed effect, we can still use this variable to capture how the 'treatment' varies by group.

Equation 2

$$Y_{it} = \alpha + \tau W_{it} + \mu W_{it} * 2018P_i + \theta_i + \delta_t + \beta X_{it} + \varepsilon_{it}$$

7. Findings

7.1 Local authority level analysis

The first analysis uses the unit of analysis as the local authority (Gemeinde). Our results are split by federal elections (Table 1) and state elections (Table 2).

In all our models, at both state and federal level, there is a negative effect on Green party vote share as a result of being designated as potentially suitable for wind farms. There is a –0.44 percentage point effect on Green Party votes for federal elections and a –0.42 percentage point effect for state elections. In federal elections, based on models with and without time-varying controls, the effect is significant at all convention statistical thresholds. Whilst the magnitude of this effect is less than 1 percentage point, one must place this in the context of the Green Party achieving 14.8% in the 2021 federal election. Moreover, these effects are based purely on the announcement of a potential wind farm. The news of potential windfarms may not be well spread, and it may well be that any effect would be magnified if a wind farm appeared in one's area.

In the state election models, the magnitude of the effects is similar to that of the federal elections. That said, when we include our time-varying controls, population and population density, the coefficients lose their statistical significance.

There is a similar pattern for solar farms. If anything, the effect seems larger in magnitude for federal elections. Being 'treated' through being a potential solar farm site decreases the Green Party vote share by 1.08 percentage points (with no controls). In state elections, the effect loses its significance but is of a similar magnitude to the wind turbine treatment, -0.36 percentage points.

Table 1: Effect of wind and solar treatment on Green Party vote share at federal elections by Local Authority

	Wind turbines		Solar farms	
Treatment	-0.438 ***	-0.368 ***	-1.083 ***	-0.982 ***
	(0.136)	(0.135)	(0 .133)	(0.136)
Time-varying controls	N	Y	N	Y
Local authorities	1101	1101	1101	1101
Observations	2202	2202	2202	2202
*** p<0.01, ** p<0.05, * p<0.1				

Table 2: Effect of wind and solar treatment on Green Party vote share at state elections by Local Authority

	Wind turbines		Solar farms	
Treatment	-0.418 *	-0.282	-0.359	-0.188
	(0.240)	(0.242)	(0.234)	(0.239)
Time-varying controls	N	Y	N	Y
Local authorities	1101	1101	1101	1101
Observations	2202	2202	2202	2202
*** p<0.01, ** p<0.05, * p<0.1				

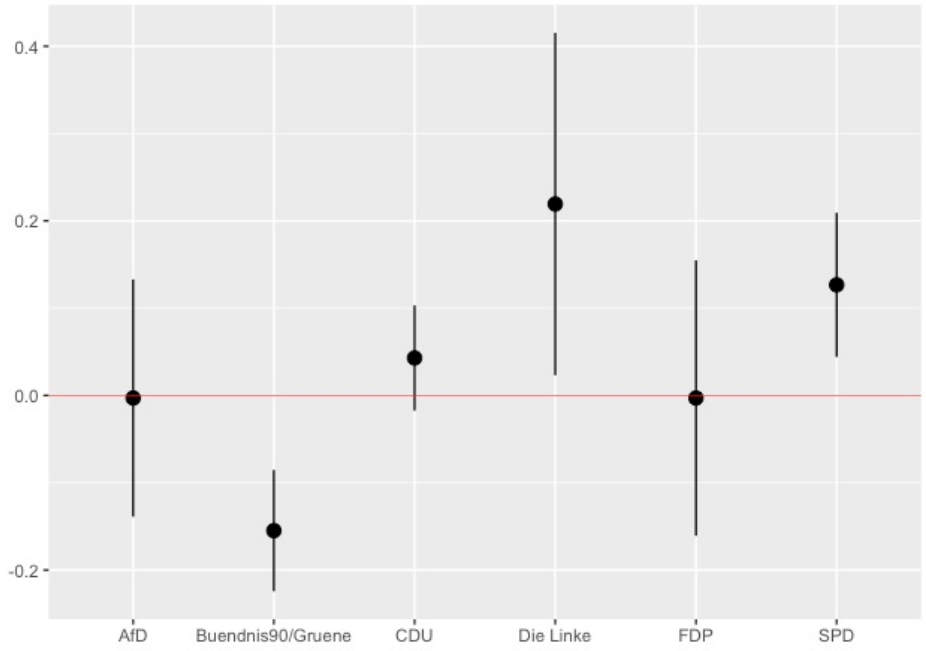
7.2 Individual level

We summarise our individual level analysis in Figure 6 and Figure 7. The effect of being treated, having one's district (Kreis) designated as potentially suitable for windfarms, for 2018 Green Party supporters was to decrease their tendency to vote for the Green Party compared to those non-treated 2018 Green Party supporters. This effect was statistically significant at all conventional thresholds and the point estimate large in magnitude, 14.8 percentage points [95% confidence interval, -0.20, -0.097].

Contrastingly, those 2018 SPD and Die Linke supporters who were treated were more likely to switch to the Green than their non-treated peers. We can only speculate as to why these voters may act in this way. It may be that those individuals already on the centre-left, or left, of politics are persuaded by the 'green' vote when they see the potential for action and change.

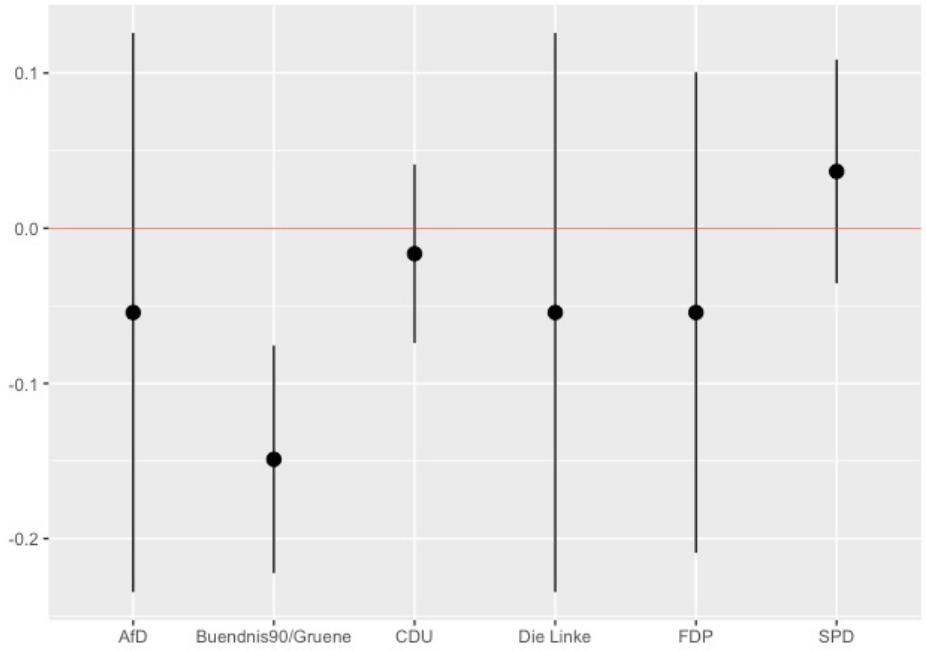
We observe similar results for those areas designated as potential solar sites. 2017 Green supporters are significantly more likely to desert the Green Party when in a treated area. This effect is of a similar magnitude to the 'wind' model, 13.2 percentage points. For the case of solar, we see no effect of treatment on any other 2017 supporter base.

Figure 6: Effects of wind 'treatment' on probability of Green Party 2020 support, based on 2018 party preference



Note: Bars are 95% confidence intervals

Figure 7: Effects of solar 'treatment' on probability of Green Party 2020 support, based on 2017 party preference



Note: Bars are 95% confidence intervals

8. Robustness

8.1 Urban-rural

One concern may be that we are simply capturing an increasing divergence between rural and urban locations between elections. Empirically, we replicate the aggregate level data and remove the nine local authority districts that are city districts (Stadtkreise). The results are available in the supplementary materials and are substantively similar to our main analysis. Thus, we show that our findings are robust to a potentially confounding time-varying district level effect. Whilst we show that our results hold to this critique, theoretically we agree with this point, and it underpins our broader argument. We believe that a growing cleavage between urban and rural districts is inevitable because the burden of the 'green' transition will be borne to a greater extent by those living in the countryside. Our example of wind turbines and solar farms is meant to provide a concrete example of such a 'cost', often without compensation, but for many individuals in rural locations this could be just one of many potential negative implications. That is not to say that rural locations will not benefit from the 'green' transition, but the benefits are often widely diffused across location and generations.

9. Discussion

Our evidence shows that in BW being exposed to 'green' infrastructure through potential wind turbines or solar farms decreases the vote share for the Green Party. This supports hypothesis 1). At the individual level, we complement this finding by showing that those existing Green Party supporters are the ones withdrawing their support, rather than deterring new supporters. That is, we find support for hypothesis 2) and not hypothesis 3). The research design has allowed us to follow individuals who are exposed to a plausibly exogenous shock, the potential for green infrastructure in their backyard.

Whilst we think we make a direct contribution towards the evidence regarding political attitudes and green energy infrastructure (e.g. Stokes, 2016; Germeshausen, Heim and Wagner, 2021; Otteni and Weisskircher, 2021; Umit, 2021), we aim to use this case study to examine a much broader phenomenon. If, and despite some recent breakthrough such as the Paris Accord this remains a

large if, globally nations can coordinate to mitigate collective action and free-rider problems, there remains a national coordination issue. Each country needs to build political coalitions in favour of moves towards 'green' policies and 'green' infrastructure. Inevitably, such decisions have distributional consequences. We have examined two examples of green infrastructure, which have direct consequences in terms of individuals' asset values and living standards. We see this as the tip of the iceberg, the choices and funding required over the coming decades will dwarf the consequences of wind turbines and solar farms.

Moreover, we identify a trap for the Green Party in Germany and green parties more broadly. Their core reason for being is 'green' policy. However, some of those voters, who are presumably attracted by this message, turn away when such a policy is implemented. It could be argued that our case is unique, we have chosen a 'green' state within a country with an established Green party, which has permissive institutions (Grant and Tilley 2019). Yet, these are choices that mainstream parties across countries will need to make to comply with their international commitments over the coming years. The broader question is whether mainstream parties will bow to the pressure of those affected or push through with the transition to net zero. If they do the latter, how can they maintain a broad coalition? This requires further research on how to compensate the 'losers' from the green transition. For example, some of the latest research suggests that bundling climate change policy with economic and social policy can increase support (Bergquist, Mildenberger, and Stokes 2020). In this case there is a broader cost for those voters, for example in cities, who previously were broadly unaffected. When this cost is more broadly shared, do these voters remain in support of 'green' policy?

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Appendix

Law and regulatory changes after 2011

The years following the initial report can be called a transition period with law and regulatory changes to prepare a more certain regulatory environment for the expansion of renewable energy at the federal and state level. A first important change in BW state law happened in 2012 with the so called Windenergieerlass (2012) which ended the black & white designation of potential areas for new wind turbines as part of the 2003 state planning act. Whereas certain areas were excluded from building new wind turbines in the old act, they could now be potential areas if there are 'no concerns of public interest'. Such concerns include for example biodiversity or Immissionsschutz (quality of life). Further clarifications of what counts as legitimate concerns followed (e.g. a 2013 clarification which aimed at conditionally allowing new wind turbines in Landschaftsschutzgebieten (naturally protected areas)).

The 2011 Windatlas and 2012 Windenergieerlass were the cornerstone for the state planning regions to start adjusting the designation of areas and gave communes a better idea of if the planning of different renewable energy infrastructure would become a future option for them. The process, especially for the planning regions turned out to be quite lengthy, not least because of further law changes that followed at the federal and state level (e.g. the Rhein-Neckar Metropolregion plan was only finalised in 2019).

Federal law changes to the EEG (Erneuerbare Energien Gesetz) became effective in 2014 and 2017. While 2014 aimed at integrating renewable energy into the marketplace by changing the profitability calculations for new wind turbines (directly sold in the market + premium on price from state). The 2017 reform can be called a paradigm shift by introducing a tender procedure for energy prices from most renewable energy by limiting the supply, i.e. amount of new renewable energy that is fed into the grid per year (and not vice versa as previously). [this applies to on and offshore wind turbines of a certain size, freestanding solar farms, biomass power plants]. The 2017 change is crucial for the expansion of different types of renewables, as the market was disincentivised from focusing too much on one technology and diversify the installation of a diversity of renewables. More clarifying state legislation and policy notes were passed in 2015 (in

regard to animal protection and wind turbine planning) and 2017 (noise protection and wind turbines).

Effect of 'Double Treatment', by both wind and solar, on Green Party vote share in Federal elections

	No Controls		With Controls	
Wind and Solar Treatment	-1.076	***	-0.955	***
	(0.176)		(0.184)	
Time-dummy	Y		Y	
Time-varying controls	N		Y	
Local authorities	760		760	
Observations	1520		1520	

Note: We exclude local authorities where there was just a 'single' treatment, i.e. just wind or just solar.

	No Controls		With Controls	
Wind and Solar Treatment	-0.764	***	-0.625	***
	(0.167)		(0.172)	
Time-dummy	Y		Y	
Time-varying controls	N		Y	
Local authorities	1101		1101	
Observations	2202		2202	

Note: Here we include non-treated as those local authorities with no treatment or just a single solar or wind treatment

Effects of treatment (wind or solar) on party support, including individual level time varying control

	Mean Wind		Mean Solar	
Treatment # AfD	0.007		-0.049	
	(0.069)		(0.091)	
Treatment # Bündins 90 / Die Grünen	-0.153	***	-0.149	***
	(0.035)		(0.037)	
Treatment # CDU	0.046		-0.017	
	(0.031)		(0.029)	
Treatment # Die Linke	0.237	**	-0.059	
	(0.099)		(0.091)	
Treatment # FDP	0.000		-0.029	
	(0.079)		(0.079)	
Treatment # SPD	0.132	***	0.035	
	(0.042)		(0.036)	
Time-varying control	Y		Y	
Individuals	961		854	
Observations	1,922		1,708	

Note: our time varying control is ‘Erwerbsstatus’ (labour market and occupational status)

Effect of green treatment on Green Party support in rural districts only

State Elections

Wind

	Median wind turbines		Mean wind turbines		Upper quartile wind turbines	
Wind Treatment	-0.367 *	-0.275	-0.412 *	-0.282	-0.234 **	-0.101
	(0.219)	(0.221)	(0.240)	(0.242)	(0.285)	(0.287)
Time-varying controls	N	Y	N	Y	N	Y
Local authorities	1092	1092	1092	1092	1092	1092
Observations	2184	2184	2184	2184	2184	2184

Solar

	Median solar		Mean solar		Upper quartile solar			
Solar Treatment	-0.089	0.065	-0.352	-0.186	-0.735 ***	-0.556 **		
	(0.211)	(0.215)	(0.235)	(0.239)	(0.264)	(0.269)		
Time-varying controls	N	Y	N	Y	N	Y		
Local authorities	1092	1092	1092	1092	1092	1092		
Observations	2184	2184	2184	2184	2184	2184		

Federal

Wind

	Median wind turbines		Mean wind turbines		Upper quartile wind			
Wind Treatment	-0.311 ***	-0.291 **	-0.380 ***	-0.328 **	-0.348 **	-0.285 **		
	(0.125)	(0.125)	(0.135)	(0.133)	(0.146)	(0.145)		
Time-varying controls	N	Y	N	Y	N	Y		
Local authorities	1092	1092	1092	1092	1092	1092		
Observations	2184	2184	2184	2184	2184	2184		

Solar

	Median solar		Mean solar		Upper quartile solar			
Solar Treatment	-0.889 ***	-0.831 ***	-1.022 ***	-0.938 ***	-1.232 ***	-1.144 ***		
	(0.125)	(0.127)	(0 .132)	(0.134)	(0.137)	(0.139)		
Time-varying controls	N	Y	N	Y	N	Y		
Local authorities	1092	1092	1092	1092	1092	1092		
Observations	2184	2184	2184	2184	2184	2184		

Effect of green treatment on Green Party support, Number of turbines rather than area as the measure

State

	No controls		With controls	
Wind Treatment	-0.222		-0.073	
	(0.234)		(0.241)	
Time-varying controls	N		Y	
Local authorities	1101		1101	
Observations	2202		2202	

Federal

	No controls		With controls	
Wind Treatment	-0.317	**	-0.349	**
	(0.145)		(0.137)	
Time-varying controls	N		Y	
Local authorities	1101		1101	
Observations	2202		2202	

Effect of green treatment on Green Party support, median and upper quartile specification

State

	Median wind			UQ wind	
Wind Treatment	-0.374	*	-0.271	-0.240	-0.101
	(0.219)		(0.220)	(0.284)	(0.287)
Time-varying controls	N		Y	N	Y
Local authorities	1101		1101	1101	1101
Observations	2202		2202	2202	2202

	Median solar		UQ solar	
Solar Treatment	-0.099	0.064	-0.741 ***	-0.558 **
	(0.210)	(0.215)	(0.263)	(0.269)
Time-varying controls	N	Y	N	Y

Local authorities	1101		1101		1101		1101	
Observations	2202		2202		2202		2202	

Federal

	Median wind				UQ wind			
Wind Treatment	-0.377	***	-0.335	***	-0.401	***	-0.322	**
	(0.127)		(0.126)		(0.147)		(0.147)	
Time-varying controls	N		Y		N		Y	
Local authorities	1101		1101		1101		1101	
Observations	2202		2202		2202		2202	

	Median solar				UQ solar			
Solar Treatment	-0.964	***	-0.883	***	-1.287	***	-1.186	***
	(0.127)		(0.130)		(0 .138)		(0.141)	
Time-varying controls	N		Y		N		Y	
Local authorities	1101		1101		1101		1101	
Observations	2202		2202		2202		2202	

Effect of wind treatment on Green Party support, including umber of newly built turbines control

	Wind	
Treatment	-0.35	***
	(0.135)	
Population	0.001	***
	(0.0004)	
Population Density	1.354	
	(1.118)	
Active wind turbines	-0.082	
	(0.059)	
Time Dummy	Y	
Local authorities	1101	
Groups	2202	

Note: here we only consider new turbines built and working between 2018-2020 and federal elections.

Effect of treatment on Green Party support, including incumbent interaction

	Wind	Solar
Treatment	-0.429	-0.252
	(0.291)	(0.295)
Treatment # No Green incumbent	-0.049	0.28
	(0.413)	(0.394)
Time Dummy	Y	Y
Local authorities	1100	1100
Observations	2200	2200

Note: we test for state elections and Green Party directly elected incumbents only, local authority 'Mannheim' is excluded because it contains two state electoral districts with two different party incumbents.