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84

Is NIMBYism Standing in the Way of the Clean Energy Transition?

Stephen Jarvis

A radical overhaul of the global energy system is underway as cleaner renewable sources replace fossil fuels. The scale of this transformation raises an important question: Where exactly are all these new solar panels and wind turbines going to go? In many countries, the process for deciding the sites for new projects is very localized, creating a risk that opposition from nearby residents outweighs the need to tackle climate change and ensure energy security. New evidence shows that fragmented local planning decisions have potentially increased the cost of the UK's deployment of wind power by £8–23 billion. Reforming planning processes and ensuring that local residents share in the benefits of renewable energy will be critical to safeguarding countries' ability to meet their clean energy goals.

Stephen Jarvis is an Assistant Professor of Environmental Economics at the Department of Geography & Environment at the London School of Economics and Political Science.

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"The International Energy Agency forecasts that the installed renewable electricity capacity worldwide will increase four-fold by 2050."

Introduction

A radical overhaul of the global energy system is underway as cleaner renewable sources replace fossil fuels. These changes are primarily driven by efforts to tackle climate change but are increasingly being thought of in energy security terms. Under a business-as-usual scenario, the International Energy Agency forecasts that the installed renewable electricity capacity worldwide will increase four-fold by 2050, from 3,000GW to 12,000GW.[1] In a Net Zero emissions scenario, the required growth will more than double again, reaching a whopping 27,000GW of installed capacity by 2050, mostly from solar and wind power.[2] The scale of this transformation raises an important question: Where exactly are all these new solar panels and wind turbines going to go?

Local opposition to new infrastructure development is not a recent phenomenon, and renewable energy is no exception. The objections raised are many, ranging from the environmental impacts on natural habitats and wildlife, visual intrusion, noise, reduced property values, concerns about the fairness of the process, even political attitudes.[3] A critical task for researchers and policymakers alike is to understand the nature of these concerns and weigh them against the clear societal benefits of a cleaner, more sustainable energy system. To that end, there is still much work to be done to identify the most promising policy solutions that can best ensure that cleaner energy production benefits everyone, including the residents living near where it is produced.

The current research seeks to tackle these questions on several fronts, including my own recent paper titled "The Economic Costs of NIMBYism: Evidence from Renewable Energy Projects."[4] In this policy brief, I cover some of my main findings, survey the broader literature on this topic, and look ahead to future challenges.

The Local Impacts of Renewable Energy

Debates about the siting of new infrastructure projects have a long history. In fact, the growing emphasis on ensuring a "just transition" is underpinned by the environmental justice movement, which can trace its origins back to protests against the siting of landfills near predominantly Black communities in the southern United States.[5] However, contestations about the siting of undesirable facilities are not just a story of disadvantaged communities suffering unequal burdens. They are also a story of wealthier and more politically powerful communities successfully resisting development in their neighborhoods. This process has given rise to concerns about the widely recognized Not In My Back Yard (NIMBY) phenomenon. While people may support renewable energy in principle, they often oppose it once a project is proposed near where they live.

THE EVIDENCE FROM CHANGES IN PROPERTY VALUES

One important way to quantify these local impacts is by examining the way the construction of a new renewable energy project affects nearby property values. Property values matter not just because they might be a direct reason for local residents to oppose a project—they can also indirectly tell us something about the value people place on keeping their area free of large turbines and solar arrays. One important way to quantify these local impacts is by examining how the construction of a

1. IEA (2021).
2. IEA (2021).
3. Carley et al. (2020).
4. Jarvis (2021).
5. Banzhaf, Ma, and Timmins (2019); Carley and Konisky (2020).

new renewable energy project affects nearby property values. Examining changes in property values in this way has already been applied to more conventional energy projects, such as fossil fuel power plants.[6] Subsequently, a number of studies have looked at wind projects, with most finding negative effects on residential property values in a range of countries, including the US, UK, Germany, Denmark, and the Netherlands.[7] Building on this prior work, my analysis finds that the average wind project in the UK led to a roughly 4–5% reduction in residential property values at distances of 2km. These effects decline as the distance to the project increases and have largely reached zero beyond 4km.

However, we might expect the impact of a new wind project to be more complex than this. In particular, it likely depends a lot on the features of the surrounding area. Adding wind turbines to a previously pristine rural landscape with unspoiled views might have a much more significant impact than placing them in a more industrial area or in one where there are already plenty of wind turbines. To explore this in more detail, I used geospatial analysis to determine which properties had direct line-of-sight to any new turbines. I also separated out the effects for wealthier, less deprived areas and evaluated how the impacts vary based on the cumulative number of turbines already installed nearby. As expected, the large majority of any adverse impact on property values is concentrated in wealthier, less deprived areas that have direct line-of-sight to a new wind project. The effects I found also tend to decrease if more capacity is already concentrated in a given area, suggesting that the first turbine is much more "costly" than the tenth or the hundredth.

Understanding which residents are likely to be most substantially affected by each additional project that is built has important implications, both from an economic standpoint and when considering where political opposition to these projects may be most concentrated. Interestingly, by incorporating information on proposed but abandoned projects, I was also able to see what happened in areas that successfully managed to resist the deployment of a nearby wind farm. Here, I find new evidence that these areas saw an increase in their property values. This result points to a premium for regions that remain undisturbed by wind power deployment.

It is noteworthy that most local opposition appears to be focused on wind projects, especially in Europe. Solar projects, in contrast, have tended to be less controversial. Similarly, I find no clear evidence of an effect on residential property values from solar projects in the UK. The two other studies that have examined solar projects found minor negative effects in the Netherlands and the US, although the evidence was fairly weak, and any effect was confined to distances of less than 1km.[8] The lack of a clear impact from solar projects certainly seems consistent with the fact that solar projects tend to be much less visually intrusive than wind turbines. They also do not create some of the other adverse impacts associated with wind power, such as noise or wildlife loss. However, it remains to be seen whether local impacts will become more pronounced as solar projects grow in size and scope. If recent media reports are to be believed, there is already anecdotal evidence that this is happening.[9]

PUTTING PROPERTY VALUES IN CONTEXT

What then are we to make of these impacts on local property values? First, it is important to state that changes to nearby residential property values cannot reasonably be expected to capture all of the complex local impacts these projects create, economic and otherwise. Effects on other property types remain unclear. My examination of impacts on commercial property rents did not uncover any significant effects, although a more extensive study in this area would be welcome. It seems plausible that certain commercial sectors, such as tourism, could be acutely affected in ways that are challenging to identify when using more aggregated data.

Second, one of the local stakeholders that stands to benefit from the arrival of renewable energy is local landowners. For instance, one study on Germany found that generous wind power subsidies led to widespread increases in the value of agricultural land that appeared well-suited to siting new wind turbines.[10] How much this can offset the opposition of nearby residents has yet to be examined in detail, but it seems plausible that allowing local residents to share in some of the economic rents that landowners receive, such as through higher taxes, could help align the interests of these different local stakeholders.

Third, there may also be wider effects on the local economy in ways that are not easily captured by residential property values. Possible results could include stimulating new employment in construction and engineering or reducing employment in adversely affected

6. Davis (2011).
7. Lang, Opaluch, and Sfinarolakis (2014); Hoen and Atkinson-Palombo (2016); Gibbons (2015); Sunak and Madlener (2016); Dröes and Koster (2016); Jensen et al. (2018); Dröes and Koster (2020).
8. Dröes and Koster (2020); Gaur and Lang (2020).
9. The Economist (2021).
10. Hann and Simmler (2018).

sectors, such as tourism. In general, the consensus appears to be that renewable energy projects create relatively few long-term local jobs. Beyond the initial construction phase, the ongoing operation of wind and solar projects is not significantly labor-intensive, so direct impacts on local employment are likely to be muted.[11] In my own analysis of changes to local employment, I also found no apparent effect, although a critical challenge here is always the lack of sufficiently granular data. There is a broader "green jobs" debate about the employment provided by the clean energy sector and whether this is actually a compelling economic argument for promoting renewable energy.[12] Nevertheless, even if the shift to greener energy sources does stimulate greater upstream employment, those jobs are not likely to be located in the areas near wind or solar farms and so have little bearing on the opposition of local residents.

Fourth, some of the most vociferous opposition to renewable energy projects has come from conservation groups concerned with their impacts on natural habitats and wildlife. In California, for instance, wind farms have been tied to the deaths of various birds of prey such as golden eagles, and large solar power projects have been opposed on the grounds that they disturb the habitat of the endangered desert tortoise. The extent of these impacts and how much they can be mitigated is hotly contested.[13] Whatever the case, it seems fairly straightforward that nearby property values will not capture these ecological impacts. For example, changes in land values could give a misleading impression, reflecting the costs of limiting future development opportunities rather than the wider social benefits of preserving critical sources of biodiversity.[14]

Therefore, looking beyond the effect on nearby residential households is a crucial area for further study. At best, the effects on residential property values can provide us with a rough quantitative measure of the economic impacts nearby residents might experience. If the primary local impacts are the visual and noise dissemination experienced by nearby residents, then residential property value changes might measure the total local economic effects of interest fairly well. However, even if that does lead us to conclude that the local external effects of wind farms are negative, it is vital to keep in mind that the existence of any negative effects does not necessarily undermine the urgent case for continuing to deploy renewable energy technologies at scale. After all, virtually any large infrastructure project will create winners and losers, often reflected by changes in property values. If the wider benefits of wind and solar projects continue to be large enough, then the case for proceeding will remain compelling. It is to this issue that I now turn.

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Economic Consequences of the NIMBY Problem

Understanding the local economic impacts of renewable energy projects is undoubtedly important. Of greater value, however, is understanding the political and economic consequences of the opposition that these local economic impacts create. Are local impacts large or small in aggregate? How big are the problems created by opposition from nearby residents? Does the way local opposition shapes the planning process risk slowing the clean energy transition or distorting investment in ways that significantly increase its cost?

THE POLITICAL BACKDROP

In terms of the political consequences, several studies have provided evidence that wind farms have a range of political implications for their local area. For example, Germeshausen, Heim, and Wagner show that new wind turbines in Germany lower local residents' interest in clean electricity tariffs and reduce voting levels for "green" politicians.[15] This finding largely confirms earlier evidence from Canada having suggested that voters who oppose wind power punish the politicians they view as responsible at the polls.[16] A natural reaction from political representatives is to bend to the will of their constituents and resist new projects, with evidence from the US highlighting the spread of new restrictive zoning regulations.[17] The level of local control over the planning process and the extent of explicit land-use policies, such as designated or excluded areas, has also been shown to shape wind power deployment in countries such as Germany and Sweden.[18]

I, too, find evidence that local politicians and planning officials are noticeably responsive to the impacts of these projects on nearby residents. The vast majority of planning decisions in the UK are decided by local county officials, with an oversight role for the national government in the case of particularly significant projects or where developers appeal a decision. In many ways, this mirrors the planning processes seen in other developed countries. Unlike other countries, though, the UK compiles a database of all these planning decisions for renewable energy projects,

11. Costa and Veiga (2019).
12. Borenstein (2012).
13. Agha et al. (2020).
14. Auffhammer et al. (2020).
15. Germeshausen, Heim, and Wagner (2021).
16. Stokes (2016).
17. Winikoff (2019).
18. Lauf et al. (2020).

Table 1: Summary Statistics on Renewable Energy Project Planning Outcomes in the United Kingdom.

	Solar	Wind
Number of Projects	1,675	1,775
Total Capacity (MW)	13,737	58,618
Average Capacity (MW)	8.2	33.0
Length of Planning Process to Initial Decision (days)	143	545
Length of Planning Process to Final Decision (days)	184	643
Initial Decision Approval Rate	0.724	0.391
Share of Projects Subject to National Authority Decision	0.001	0.128
National Authority Initial Decision Approval Rate	1.000	0.648
Local Authority Initial Decision Approval Rate	0.723	0.353
Share of Projects Appealed	0.123	0.230
Appeal Success Rate	0.461	0.460
Final Decision Approval Rate	0.779	0.490

Notes: This table contains summary statistics for all wind and solar energy projects in the UK with a capacity of 1 MW or greater submitted for planning approval since 1990. It excludes projects that were under review at the time of writing. Projects can be subject to approval by either a local or national planning authority. The planning authority makes an initial decision to either approve or refuse the project. Projects may then be appealed, in which case the final decision may differ from the initial decision. Data is sourced from the UK's Renewable Energy Planning Database.

allowing researchers to see both those that were built and the ones that failed. Table 1 presents summary statistics from the projects in the UK's Renewable Energy Planning Database.

Looking at the planning data for the UK, it is immediately apparent that wind projects have a much tougher time than solar projects. Not only do wind projects take three to four times longer than solar projects to receive a decision on their planning applications, but the subsequent decision is also much more likely to be "no." Less than half of the wind projects proposed in the UK since the 1990s actually received local planning approval. By contrast, more than three-quarters of the solar projects proposed were approved.

COUNTING THE COST OF MISALLOCATED INVESTMENT

That local officials pay attention to the interests of their constituents is hardly surprising. However, the problem this policy creates is that what may seem optimal for a given local area can, in the aggregate, create harmful outcomes for society as a whole. Importantly, whether local opposition imposes high social costs due to insufficient or misallocated investment remains unclear.

Nevertheless, research on housing development in the United States has shown that local planning restrictions have indeed been costly, leading to chronic underinvestment in important locations such as San Francisco or New York City.[19] These planning restrictions have been consistently linked to NIMBY attitudes, and one analysis estimates that the resulting misallocation of resources actually lowered aggregate economic growth in the US by 36% in the latter half of the twentieth century.[20] At present, we know very little about what the comparable economic drag might be in the area of large infrastructure deployment, including renewable energy projects.

To tackle these questions, I conducted an exhaustive valuation exercise to estimate the full range of lifetime costs and benefits associated with over 3,000 utility-scale wind and solar projects that have been proposed in the UK. Following government guidelines for valuing renewable energy projects, in each case, I estimate the capital costs of building the project; the ongoing operation and maintenance costs, including transmission costs that vary by location; the amount of electricity produced based on the technology installed and local meteorological conditions, valued according to market prices; the value of any carbon emissions or local pollution abated from displacing fossil fuel gener-

19. Glaeser and Gyourko (2018).
20. Hsieh and Moretti (2019).

ation; and the learning-by-doing benefits that early projects have created for future ones. All of these costs and benefits are integral to any net present value calculation for a new project. The last key piece of the puzzle that I add is to compare these more comprehensive social costs and benefits to the aggregate local costs created by each project, as measured by changes in residential property values.

Armed with these measures of the various costs and benefits of many renewable energy projects, it is possible to see just how effectively the planning process weighs these different factors. As expected, the evidence suggests that local planning officials are particularly responsive to the local costs that wind projects impose in their local area through reductions in property values. For every additional £10 million in local property value costs that a wind project creates, the chance of getting approved by local planning officials decreases by 3%. By comparison, similar changes in the wider social costs and benefits from wind projects do not appear to significantly affect the chance of getting approved.

The misalignment between local and wider social incentives risks creating a situation where not enough wind power will be built, or wind projects will be built in less impactful locations. The obvious NIMBY concern here is that there will be a bias toward shifting wind development to more remote locations on the grounds that they are less likely to annoy local residents, even if those projects are more costly overall. That more remote projects might be more costly seems perfectly plausible, not least because they require more power lines to be built to transport the power back to the urban centers where demand is concentrated. In support of this argument, an analysis from Germany has already demonstrated a clear tradeoff between siting wind power to minimize the costs of electricity (paid by everyone) versus minimizing the cost of local disamenities (paid by nearby residents).[21] A similar analysis of wind power in Norway highlights this same tradeoff and notes the importance of considering the local disamenities created by new power lines. Clearly, there is a risk of placing too much emphasis on avoiding costs to local residents when such actions will raise the overall cost of climate change mitigation for everyone.

Interestingly, the prevalence of local control over planning decisions also increases the likelihood that costly siting decisions might be made for a completely different reason—poor regional coordination between counties. In the UK, at least, it seems that all counties feel subject to some degree of pressure to allow at least a modicum of renewable energy to be built in their area. Of the counties that received multiple wind project applications, more than four out of five approved at least one project. This finding probably reflects a political reality that counties have to be seen to be doing something to tackle climate change. The national planning guidelines support this notion by emphasizing the need for all localities to do their part to support renewable energy. The desire to "share the burden" of renewable deployment is understandable, but it potentially puts pressure on all counties to approve at least a few projects, even in areas where it makes little sense to site wind power.

At the same time, local counties are keen to avoid siting too many renewable energy projects in their area. In fact, explicit provisions in the national planning guidelines in the UK pay particular attention to cumulative effects whenever multiple projects have been proposed in the same area. Again, this seems understandable but risks discouraging the concentrated deployment of capacity in areas where the benefits would be greatest. Thus, while counties might be paying particular attention to weighing the local impacts of the wind projects proposed in their area, a distinct lack of collaborative thinking has been devoted toward how best to spread deployment across different regions and counties. This situation is almost certainly not unique to the UK, and many other developed countries have employed a highly decentralized approach to siting renewable energy projects.

To try to quantify the costs created by these various planning inefficiencies, I estimated the potential savings from switching from the set of projects that have been built in the UK to an optimal set of proposed projects that could have been built instead. Using the UK's unique planning database, it was possible to find numerous highly beneficial projects that never got built, as well as many highly costly projects that were still allowed to go ahead. Overall, I found that the fragmented and localized nature of the planning process has potentially increased the cost of the UK's deployment of wind power by as much as £8–23 billion, or 10–29%. These costs do not just fall on a small number of local residents but are spread across all households through higher energy bills and taxes.

21. Lehmann, Reutter, and Tafarte (2021).

"In Sweden, for example, the government has been considering removing the veto that local municipalities hold over wind farms."

Policy Solutions for a Just Transition

Given the scale of the potential costs from an inefficient rollout of renewable energy, it is critical to understand which policy solutions offer the best hope of winning local support. Many countries and regions have adopted different approaches to renewable energy siting, and two solutions offer real promise. The first entails reforming the planning process to improve regional coordination and lessen the supremacy of local political interests. The second involves increasing the local financial benefits of renewable energy projects through higher tax revenues, compensation payments, and even direct ownership.

Reforming Local Political Control

The siting of any new infrastructure project is, at some level, a political decision. Concentrated local concerns about ruined views and noisy turbines often conflict with the diffuse social gains derived from combating environmental issues like climate change and air pollution. If the political process that governs the siting of these projects is highly localized, then it is unsurprising that the private local interests often win out over the public social good. Therefore, an obvious solution is to shift more control over siting decisions to regional or national policymakers.

There are various paths to rolling back the dominance of local control over renewable energy siting decisions. Policymakers could consider setting stricter rules for local planning officials to follow by reforming national planning guidelines. National planning officials could also take a more prominent and direct role by lowering the threshold for projects to be moved to national jurisdiction or streamlining the appeal process. In Sweden, for example, the government has been considering removing the veto that local municipalities hold over wind farms. The main risk with all these solutions is that shifting too much control out of local hands could backfire if it results in residents believing that their concerns are not being heeded. For instance, Norway proposed plans in 2019 to concentrate wind deployment in certain designated areas. This decision was met with widespread opposition from residents of the affected municipalities and was subsequently abandoned. Navigating the politics of planning at the local and national levels remains fraught, and reform will not be easy.

One way to mitigate concerns about an explicit loss of local political control is increasing community engagement. There is extensive survey-based evidence that, in many instances, local residents oppose renewable energy projects because of concerns about the fairness of the development process.[22] Opposition is often expressed in terms of concern for the wider community or dislike of developers as corporate outsiders.[23] Probably the simplest actions developers and policymakers can take to overcome these concerns is to engage earlier and more actively with local stakeholders.

A separate underappreciated issue raised by the prevalence of local decision-making in this context is a lack of coordination. My analysis of the UK indicates that the observed misallocation in renewable energy siting is not just a result of NIMBYism, where localities refuse projects to defend private interests. Another countervailing driver appears to be the inefficient spreading of capacity over many areas, rather than concentrating it in the most productive ones. The desire to share the burden of renewable deployment is understandable. However, it potentially puts pressure on all local planners to approve at least a few projects, even in suboptimal areas, while at the same time giving them latitude to resist the concentrated deployment of capacity in the most beneficial locations. Therefore, finding ways to better coordinate deployment at the regional or national level could yield tangible benefits.

Direct Payments and Local Ownership

Perhaps the most obvious solution to local opposition from an economic standpoint is to ensure that local residents receive more of the financial benefits created by a new project. Probably the most direct way to achieve this is greater local ownership. However, a key issue here is scalability. At present, community-owned capacity represents a tiny fraction of renewable electricity generation in most countries. In many cases, it seems unlikely that local communities can deploy the financial and technical resources that larger private companies employ to roll out renewable energy at the scale and pace required. A less stringent version of this would give local residents a stake in any nearby projects. This approach is widespread in Denmark, where it has been a requirement that new wind farms must be at least 20% community-owned since 2011.

Rather than outright ownership, higher tax revenues and direct payments from developers also have the potential to produce the same kind of result. Concerns have been raised in the past about the effectiveness of direct

22. Hoen et al. (2019).
23. Bell et al. (2013).

"The patchwork of policies and political processes tasked with delivering this transition is increasingly out of date."

payments to combat NIMBYism,[24] but there is some evidence that residents who receive compensation are less likely to oppose wind projects.[25] Modeling studies for both Germany and Norway suggest that a scheme of local compensation and taxation offers real promise in aligning local and broader societal incentives.[26]

Furthermore, there is some recent evidence that enhancements to local tax revenues can work. In Germany, the profits from wind farms are subject to commercial taxation by local municipalities. Historically, those taxes were levied based on the location of a firm's labor force. Given that wind farms have virtually no local ongoing employment once the construction phase ends, they produced almost no increase in tax revenues for the municipality in which they were sited. In 2009, reforms were introduced to ensure that more of the revenues went to the local municipality by instead basing the distribution on the value of a firm's capital assets. Germeshausen, Heim, and Wagner study this change and find that each additional wind turbine has provided an annual boost to local municipality revenues of more than €10,000.[27] The authors then show that these revenues actually help offset various measures of local opposition to wind power.[28]

In the UK context, similar steps have been taken since 2016 to ensure that more of the business tax revenues generated by renewable energy projects stay in the local area. The provision of direct local community payments has also been a growing trend as more developers establish so-called "community benefits funds." Currently, these are voluntary; thus, they can vary significantly in prevalence, size, and structure. Figure 1 gives a sense of the range of payouts that projects in Scotland have provided. Increasingly, those payouts are meeting a £5,000/MW/yr target set by the Scottish government, which is similar in magnitude to the German local tax revenues mentioned earlier. However, there is still a widespread difference in the level of funding offered and who actually stands to benefit from that funding. As such, it could be desirable to consider mandating a certain level of local compensation, especially where there are concerns that less politically powerful communities are at risk of being left behind.

The targeting of funding is also highly inconsistent. The vast majority of projects provide grants to local community organizations, while direct payments to individual residents, such as a discount on their electricity bills, are much less common. In principle, these have the potential to do a better job of accounting for the varying impacts that different residents experience, such as compensation for differences in proximity or direct line-of-sight. How best to target payments is an important area for further study.

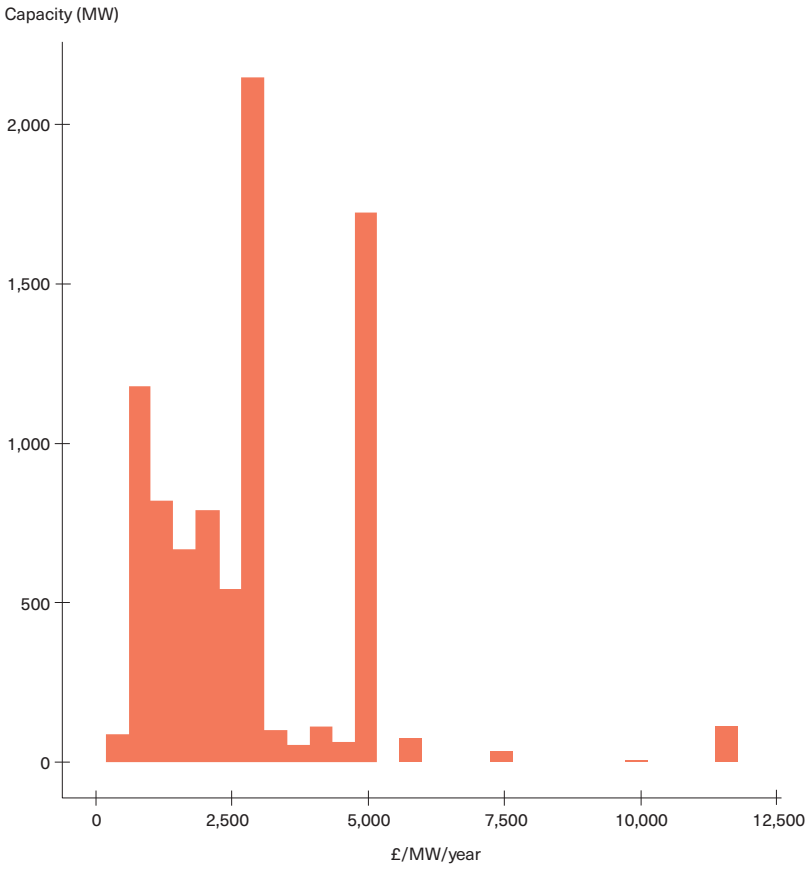
Concluding Remarks

The large-scale deployment of renewable energy envisaged by policymakers worldwide will require an unprecedented transformation of the energy system. Relevant decisions will have wide-ranging and long-term impacts on many regions that have never previously been exposed to any form of industrial development. There is now growing evidence that the patchwork of policies and political processes tasked with delivering this transition is increasingly out of date. It appears that even the capacity that has been added to date could have been built at a significantly lower cost if the siting process functioned more efficiently. To remedy this, a core focus must be ensuring that renewable energy development benefits everyone, including the residents living in the areas where it will be produced. Many of the policy solutions necessary to do this have already been attempted in some form or other.

A critical task faced by researchers and policymakers is understanding which options offer the best chance of success. Reforms to the fragmented planning process are long overdue in many places where local interests frequently override the compelling social case for renewable energy deployment. Early evidence also points to the importance of increasing the local economic benefits created by renewable energy projects through some combination of local ownership, direct payments, and higher tax revenues. These changes can go a long way to speeding up the coming clean energy transition.

24. Frey, Oberholzer-Gee, and Eichenberger (1996).
25. Hoen et al. (2019).
26. Grimsrud et al. (2021); Lehmann, Reutter, and Tafarte (2021).
27. Germeshausen, Heim, and Wagner (2021).
28. Germeshausen, Heim, and Wagner (2021).

Figure 1: Wind Farm Community Benefit Funds in Scotland.



Notes: This figure shows the value of the local community payments made by wind project developers in Scotland. Values are given in £ per megawatt per year. Data is sourced from Scotland's Renewable Energy Community Benefits Register.

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