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Posted Date: 28 August 2025

doi: 10.20944/preprints202508.2067.v1

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Navigating Headwinds in the Green Energy Transition: Explaining Variations in Local-Level Wind Energy Regulations

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Abstract

Promoting economic prosperity, social justice, and ecological sustainability requires rapid decarbonization of our global energy system in favor of renewable sources of energy. Recent news analysis estimates that 15% of counties across the US have banned wind turbines, solar fields, and other green energy developments. We answer two overarching research questions: 1) How do regulations of wind facilities vary at the county level? And 2) what factors appear to explain the variation of local wind regulations? We created a GIS database of energy regulations afor all 105 counties in Kansas, a top state for wind potential and a recent hotbed of local actions. We coupled descriptive statistics, mapping, and regression modeling to describe the variation in local policy approaches and identify factors driving the variation. We find counties using at least five different policy approaches to enable or block wind regulations. Factors driving variation include a combination of infrastructure capacity, demographic characteristics that shape local planning capacity, and the apparent reliance on large farming operations for local economic output, but not partisan voting patterns or underlying wind capacity. Our findings provide vital insights for policymakers at the federal, state, and local levels, as well as provide a foundation for future scholarship on planning for a just energy future.

Keywords: wind power; wind regulation; energy planning; green energy; land use regulation

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1. Introduction

Promoting economic prosperity, social justice, and ecological sustainability requires rapid decarbonization of our global energy system in favor of renewable sources of energy. Our planetary transition to a just and clean energy future unfolds at widely different rates across different government contexts, within and across nations (Harrington, Jacobs, and Lyles, 2024). In the United States (US), the Biden Administration set a target to achieve 100% clean power by 2035 with the broad goal of attaining net zero emissions by 2050 (Denholm et al., 2022). Anticipated transition scenario predicts that wind and solar sources will account for the highest share of all future electricity sources, representing between 60 and 80 percent (Denholm et al., 2022) Recent news analysis, however, estimates that 15% of counties across the US have banned wind turbines, solar fields, and/or other green energy developments (Weise & Bhat, 2024) and a majority of wind developers (80%) and solar developers (67%) identify local land use regulations as the main barrier to green energy installation (Nilson et al., 2023).

This phenomenon of local land use planning powers being used to inhibit, undermine, or otherwise complicate federal or state policy aims raises complicated questions for energy scholars and practitioners alike, questions that have not been robustly investigated to date. Local governments in most states have tremendous leverage to advance or hold back wind and solar projects irrespective of the goals of federal and state governments. Utility-scale wind and solar siting regulations, which involve a local authority dictating the procedures, standards, and conditions that inform how, when, and where wind and solar capacity is installed, are very commonly under the jurisdiction of county governments (Outka 2010, Oteri et al., 2017). Given the location of major belts of wind and solar potential in the Great Plains and Sun Belt (Weise & Bhat, 2024), proposed projects are in areas that tend to be more politically conservative, less comfortable with government regulation of all kinds, and highly protective of private property rights. Together, these contextual factors create a fast-moving, complicated, and oftentimes vexing regulatory environment for green energy advocates and developers seeking to invest in wind and solar facilities (Susskind et al., 2022). They also raise questions of whether counties in greater need of economic development opportunities to help stem decline may be left behind in renewable energy installation.

Nevertheless, few research studies have investigated how local factors influence these regulations. An initial analysis by Lerner, (2022) on these factors modeled the relationship between developers and the counties and how it affects the regulations. However, they only modelled a sample of counties from states. Another study by Winikoff (2022), modelled the economic tradeoffs of adopting these regulations and its role in policy diffusion. In both papers , a gap remains as to the local factors that lead to regulations adopted or not adopted and the type of regulation adopted using a comprehensive current and statewide database.

Our research, which focuses specifically on wind regulations, responds to these challenges. We pose two overarching research questions: 1) How do local regulations of wind facilities vary at the county level? And 2) what factors explain the variation of local wind regulations? Together, the answers to these two questions will provide vital insights for policymakers at the federal, state, and local levels and provide a foundation for future scholarship on what promises to be a multi-decadal process of global consequence: planning for a just energy future. We also expand the scope of policy types by introducing a classification of regulations. These include , Zoning, wind energy ordinance, development agreements, county moratorium and state moratorium. Prior research do not make a distinction in the regulations and models them as zoning regulation yet counites can use different set of policy types to regulate these developments. Moreover, we investigate how social, technical and planning considerations relate to the regulations observed.

To answer these questions, our research began with creating a geospatial information system (GIS) database of the local energy regulations available for all 105 counties in Kansas, a top state for wind potential, and a recent hotbed of local actions that both facilitate and block renewable energy investments. We used this information to answer our descriptive question about the variation in the policy landscape. Then, we coupled the database with secondary data, including internal county factors and broader external factors that may explain the observed patterns of variation.

Next, we review the literature to understand local siting of renewable energy facilities, including the federal and state policy framework, local land use planning, and issues specific to renewable energy. The literature review leads to our conceptual framework, which in turn guides our analysis of factors driving variation in local wind regulations, using multivariate regression modelling. After describing our research design and methods, we present our findings, which make clear that planners and policymakers do, in fact, have levers that can advance or encumber wind transitions. We conclude by highlighting the policy implications of our findings, as well as laying out ideas for future research.

2. Materials and Methods

2.1. The Critical Role of Local Regulation in the Renewables Energy Transition

The United States has set ambitious targets for energy transition across different sectors of the economy. This transition, often referred to as the “green energy” or “clean energy” transition, aims to reduce the consumption of fossil fuels and embrace renewable energy alternatives (Ahmad et al., 2023; Carley & Konisky, 2020; U.S. Department of Energy (DOE), 2023; Wiseman, 2021). Rising energy demands, carbon dioxide emissions, and increasingly negative impacts of climate change necessitate this transition (Atems et al., 2023; Carley & Konisky, 2020; Hafner & Tagliapietra, 2020; IPCC, 2018; Outka, 2012) with utility-scale renewable energy projects playing and even more important role in achieving climate goals (Claus et al., 2021). Wind energy is a key renewable source, with the Great Plains region of the US poised to contribute significantly (Oteri et al., 2017; Weise & Bhat, 2024). To meet the transition goals, it is estimated that the United States needs wind power to grow by 70–145 Gigawatts per year by the end of the decade, which is four times the current annual development trends (U.S. DOE Wind Energy Technology Office, 2024a) (The transition to 100% clean energy promises to yield net benefits far exceeding the associated costs, with benefit-to-cost ratios ranging from 2.2 to 4.8 and total net benefits estimated between $900 billion and $1.3 trillion by 2035 (U.S. Department of Energy, 2023). A renewable energy grid could reduce environmental and health costs by $1.7 trillion and prevent approximately 93,000 premature deaths by 2050 (Abhyankar et al., 2021). Moreover, fossil fuel-based energy systems in the US lose about 67% of energy from production to use, with up to 80% inefficiency in the transportation sector (Lawrence Livermore National Laboratory, 2023; U.S Energy Information Agency, 2022). In contrast, renewables convert energy directly at the source, achieving efficiencies of up to 90%, as seen with electric vehicles using renewable energy (Eyre, 2021). The economic impacts of wind energy developments are significant, especially in rural areas where most of the projects are situated (Shoeib et al., 2021). Local communities benefit economically through lease payments to landowners and increased tax revenues (Claus et al., 2021; Hohl et al., 2023). The ambitious clean energy targets are projected to generate about 500,000 to 1 million jobs per year in the green energy sector alone (Esposito, 2021).). The 'just energy' movements adds the equitable distribution of costs and benefits to the aim of shifting energy sources.

A major constraint to achieving urgent global emissions reduction and generating foreseeable economic and societal benefits from renewable energy is the devolution of land use authority to the local level in the United States, which empowers local governments to enable or block the transition (Brooks & Liscow, 2023; Pierce et al., 2021; Stokes et al., 2023). Zoning and land use control typically lies at the county and municipal level, subjecting transition activities to local regulations that can outright ban renewable energy projects or functionally do so with strict limitations. Scholars have begun to call attention to local ordinances arising from local opposition as a primary cause of delays and cancellation, along with the challenge of connecting a project to the electric grid (Nilson et al., 2023) (Grid integration is an additional challenge, but one that industry experts are optimistic that the sector can solve it (Motkya et al., 2021).). In 2023, about 80% of wind energy developers cited local ordinances, or zoning as the leading cause of their project cancellation (Survey of Utility-Scale Wind and Solar Developers 2023). Approximately 60% cited these regulations as the critical causes of project delays, second only to grid interconnection challenges. Projects were most delayed during the site control and local permission phases, with 62% of respondents anticipating that local siting authorities will increase with community opposition (Nilson et al., 2023). In recent years, the energy transition has slowed down, with a decline in wind energy generation in 2024 for the first time since the 1990s (U.S. Energy Information Administration, 2024b). According the US Energy Information Administration wind generation in 2023 was about 425 Terawatt-hours (TWh) compared to 434 TWh in 2022, representing a decrease of 2.1% (U.S. Energy Information Administration, 2023). This decline was largely observed in the Midwest, including states like Kansas which generated 47% of its total energy from wind in 2022 compared to 46.2% in 2023 (Lawrence Berkeley National Laboratory, 2024).

Yet, few studies offer empirical insights on the local regulatory network underpinning the renewable energy transition, and little attention has been paid to the dynamic and rapidly evolving array of approaches used by local jurisdictions (Abhyankar et al., 2021). At the local level, renewable energy transition initiatives will remain a hotly contested arena of political action, especially given that local ordinance development and implementation are much more accessible to non-experts than state and federal policy. Understanding patterns in wind energy development regulations and factors driving variation in local regulations will help practitioners and scholars design and study policy adjustments to better achieve climate goals.

2.1.1. Local Options for Regulating the Renewable Energy Transition

Local land use regulations, especially zoning ordinances, legally dictate suitable activities for specific land areas (as well as issues like density, design, and infrastructure) and thus have a tremendous influence on renewable energy installations (Bronin, 2008; Hirt, 2007; Lagro, 2005). In theory, these local land use regulations are guided by local comprehensive plans, which offer general guidelines and policy directions for the community, developed through extensive public engagement over a period of one or more years (Berke et al., 2006; Kent, 1964; Lyles & Stevens, 2014). However, in most states with areas of high wind potential, local plans often lack the force of law, if they exist at all. This context reinforces the crucial power of local land use regulations, which can be enacted or modified by local county or municipal commissions in a single meeting, in some cases based on the perspectives of a small number of commissioners.

In contrast to renewable energy production, fossil fuels have historically faced few local regulatory hurdles. Traditional land use categories, like public utility and industrial use, have been used to classify power production activities, such as coal plants, oil refineries, pipelines, and transmission lines (Berke, Godschalk, et al., 2006; Kent, 1964). Yet, given the large size of such facilities and the history of strong federal and state interests to supersede local authority through tools like eminent domain (whether in the name of economic development or national security), local plans and local land use regulation have not played a major role in fossil fuel development, compared to the role they already in play for renewable sources.

Local regulations, as much as they are critical to wind development, exist in a complex regulatory system. Obtaining construction approval for a large-scale wind installation involves a multi-step, intricate process with multiple permits commonly needed for a single project, often from Federal, Tribal, or State authorities (Enterline et al., 2024; Susskind et al., 2022). Wind energy developers typically navigate consent and/or ground lease agreements from the private landowners before any sitting permits or construction can proceed, with other easements and covenants sometimes in play (Criglow & Phiilips, 2022). These agreements or contracts, notably known as Wind Energy Land Agreements (WELA), spell out the terms of use of the property, duration, and payments that will be made to the owner by the developer.

Recently, renewable energy installations such as solar and wind farms have been added and incorporated into existing land uses, often on open land or integrated with agricultural activities (Denholm et al., 2009; Wachs & Engel, 2021). These renewable energy uses can be categorized into resource production, transmission, and storage land uses (Dale et al., 2011; Stevens et al., 2017) (Additional approaches, though uncommon, are proposed for adoption in land use planning to enable cost-effective grid-connected renewable energy development (Lee et al., 2017). These zones possess attributes facilitating cost-effective renewable energy development, such as abundant resources, suitable topography, proximity to infrastructure, high energy demand, and strong developer interest. Another method used for electricity production is power sector planning, which involves market, geographical, policy, and labor factors(Cox et al., 2018).). Again, despite their critical role, county regulations related to wind generation installation remain an understudied aspect of this regulatory framework.

2.1.2. Land Use Approaches to Wind Development

At the broadest level, we conceive of local land use approaches to wind development as enabling or blocking. The former aims at attracting or at least allowing wind installations and the latter aims at prohibiting or limiting wind installations. Enabling and blocking regulations in states with rich wind potential can take one of four primary forms.

First, counties can modify their existing zoning ordinances to include provisions related to wind installations, just as zoning can address a wide array of other land uses like housing, industry, commerce, and education. Not all counties have existing zoning ordinances, particularly in less populous rural counties. Second, counties can adopt a wind-specific zoning regulation, which essentially serves as an addendum to existing zoning (if general zoning exists) or as a use-specific zoning code (where general zoning does not exist). Third, counties can enable wind installations through development agreements. These one-off agreements between a county and a wind developer provide the regulations for a single, specific, proposed project, functioning as a one-time, wind-specific zoning code. Sometimes, these development agreements include payments in lieu of taxes (PILOTs) that include fees and community development grants, which are appealing to county authorities who may be expecting wind developers to fund county development (Brunner & Schwegman, 2022; Claus et al., 2021) (PILOT payments are considered voluntary for renewable energy farms due to property tax exemptions by the state(Kenyon & Langley, 2016) . Some counties also transfer road repair costs to wind farm developers (Mcgraw & Hennessy, 2017). This makes jurisdictions with wind resources more inclined to accept wind energy proposals, especially if they need more financial resources. For example, in Kansas, farmers facing hardships have found lease payments from wind farms helpful (Weise, 2020).). Fourth, the primary tool available to counties to block development is a moratorium, which can prohibit the development of wind installation in perpetuity (i.e., a ban) or prohibit development until wind regulations are enacted as part of the zoning ordinance or as a stand-alone ordinance (i.e., a temporary moratorium) (Eisenson, 2023; Wiseman & Bronin, 2013). Some counties, however, may choose a more complicated path of intentionally (or unintentionally) blocking wind installations by using the specific provisions of the zoning code or wind-specific regulation to greatly limit or even eliminate acceptable sites for wind installations.

The distinction between “blocking” and “enabling” regulations in the context of wind siting is critical for understanding how regulatory frameworks can either hinder or facilitate the development of renewable energy projects. “Blocking” regulations impose stringent restrictions that can prevent the establishment of wind farms, while “enabling” regulations create a supportive environment that encourages development through incentives and streamlined processes. Blocking regulations often arise from environmental concerns, land use conflicts, and community opposition. In the United States, the siting of wind farms is heavily influenced by ecological considerations (Copping et al., 2020) recognizing the need for an ecological risk-based management approach to mitigate potential impacts on wildlife. This type of regulatory framework can cause delays or outright denial of projects, thereby effectively blocking development. Similarly, a systematic review by Spyridonidou & Vagiona (2020) emphasizes that stringent site-selection processes can complicate the approval of wind energy projects, particularly when they are not aligned with local community interests or environmental protection.

On the other hand, enabling regulations are designed to facilitate wind energy development by providing clear guidelines and incentives. For instance, (Tegou et al., 2010) outlines a comprehensive environmental management framework integrating technical, economic, social, and environmental factors to assess wind energy sites. This approach not only aids in identifying suitable locations but also aligns with sustainable development goals, thus enabling projects to proceed more smoothly. Furthermore, the work of Mahdy & Bahaj (2018) illustrates how multi-criteria decision analysis can be employed to identify optimal offshore wind sites, thereby promoting development through informed decision-making processes. Moreover, the integration of Geographic Information Systems (GIS) in site selection, as discussed by Bili & Vagiona (2018) . Gavériaux et al. (2019) exemplified how enabling regulations can leverage technology to enhance the efficiency and effectiveness of wind farm siting. These methodologies allow for a more nuanced understanding of potential sites and balance ecological concerns with the need for renewable energy development.

2.2. Wind-Specific Regulation Characteristics

Wind projects typically consist of wind turbines, access roads, and connections to transmission lines. Wind turbines, typically 50 or 80 meters, with recent (post-2016) models exceeding 100 meters

(Office of Energy Efficiency & Renewable Energy, 2024), generate electricity as the wind's air pressure turns turbine blades. Access roads allow for the construction and maintenance of turbines. Transmission lines enable the transmission of electricity generated by turbines to users of energy. Often, the wind-specific infrastructure can take up only about 10% of the installation space, with a majority of this being the roads for servicing and maintenance (Denholm et al., 2009), meaning the concrete pad for turbines is not the only siting issue of concern (Saunders, 2020). Local regulations of wind installations typically focus on two main features: the spatial context of turbines and the technical features of the turbines themselves.

2.2.1. Spatial Context

A primary set of considerations for local wind regulations involves the spatial context of turbines siting. Setbacks are the core method by which a county can dictate how and to an extent if a renewable energy installation will be installed by requiring a minimum distance between the wind energy conversion system and other features around it a minimum distance between the wind energy conversion system and other features around it, form (Enterline et al., 2024; Winikoff, 2019). As shown in Figure 1, typical features from which turbines are set back include existing structures, property lines, transmission lines, roads, settlements, and other turbine installations. Additionally, within a single project, turbines may be required to have a certain setback from each other, known as tower density. Setback values can significantly affect the viability of a project proposal. Larger setbacks reduce the land available to install the turbines, make it costly to connect to the grid, and reduce the power density output from a wind farm. Some setbacks may have the effect of severely reducing the land available, making the developer cancel the project proposal altogether (Nilson et al., 2023). At the same time, while wind farms require large land areas, the spaces not directly occupied by the turbines or roads to the turbine area are left free for other uses that allow for multiple economically productive activities simultaneously, such as farming and grazing (Stevens et al., 2017), allowing the possibility of multiple economically productive land uses simultaneously.

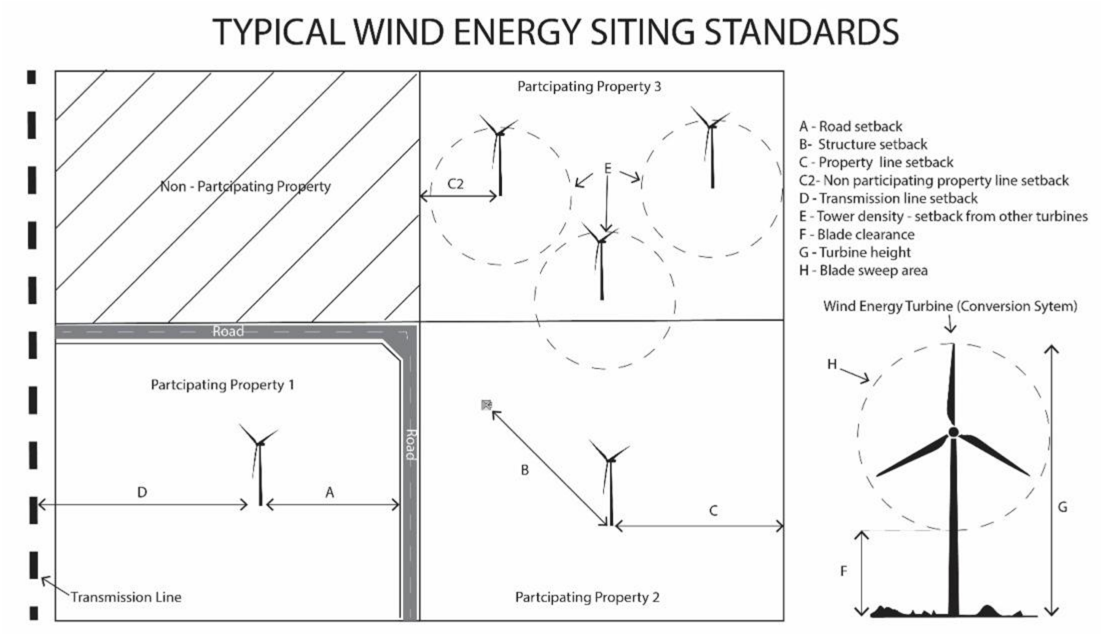

Figure 1. Typical land use siting standards showing setbacks and clearances applicable to Wind Energy Conversion Systems.

2.2.2. Technical Specifications

Counties may also enact land use provisions that are more technical in nature, generally to address issues perceived as nuisances. Negative impacts associated with wind projects may include the shadow flicker resulting from light disrupted by turning blades, noise to the houses within their vicinity (U.S. DOE Wind Energy Technology Office, 2024a; Haac et al., 2022), and reduction of property values (Rampell & Estes, 2023). Height above ground plays a key factor in the wind generation by turbines but also raises local concerns about the degradation of viewsheds and the rural character of communities (Gross, 2020). Height limits may make it more difficult to use this massive resource because taller turbines may capture more energy higher up, where speeds are faster than at lower heights (Lantz et al., 2019; Lopez et al., 2021). Similarly, restricting height could have the unfavorable effect of requiring more turbines to produce the same amount of electricity (U.S. DOE Wind Energy Technology Office, 2024a). According to Hoen et al.(2023) given the existing innovation trends, local governments might mandate greater setbacks to accommodate larger turbines. Nonetheless, bigger turbines might result in a 60% decrease in the amount of land needed, or around 130 turbines per typical wind farm (U.S. DOE Wind Energy Technology Office, 2024a). Collectively, we classify these four areas of technical considerations: 1) height restrictions, 2) minimum blade clearance, 3) shadow flicker conditions, and 4) maximum noise allowances.

2.3. Factors Driving Local Wind Regulation

Next, we examine factors that may help explain local variation in wind regulation, which together form our conceptual model and drive our core research questions. A growing body of studies investigates the success and failures of the green energy transition across a range of issues. These include the impact of renewables on land (Hoen et al., 2023; Mills et al., 2019; Stevens et al., 2017; van de Ven et al., 2021), factors affecting renewable energy generation (Denholm et al., 2009; Hoen et al., 2023; Lopez et al., 2021; Saunders, 2020; van de Ven et al., 2021; Wachs & Engel, 2021), the market trends of the renewable energy (U.S. DOE Wind Energy Technologies Office, 2023b, 2023a; U.S. DOE Wind Energy Technology Office, 2024b), federal and state policies concerning clean energy(Enterline et al., 2024; Outka, 2010; Stokes & Warshaw, 2017), attitudes towards renewable energy(Eisenson, 2023), policy diffusion between counties(Winikoff, 2022) and factors that limit the adoption of renewable energy (Howe et al., 2015; Pierce et al., 202; Susskind et al., 2022).

While some states have established policy targets for renewable energy, counties less commonly set corresponding goals, especially in states with the most wind potential. The regulations counties implement are largely influenced by local dynamics (Brunner & Schwegman, 2022; Stokes et al., 2023; Winikoff, 2019). Few empirical studies examine the interplay of factors leading to different types of regulations adopted by a local government, however. Existing studies typically focus on a single, distinct factor, such as the regulation's environmental considerations, or provide in-depth case studies of the local political context. Winikoff (2022), models economic factors, assuming counties have a target number of turbines and making regulatory trade off to optimize this number. The model also draws data from earlier years (2007, 2008, 2010) to predict or explain regulatory outcomes in 2019. Our study improves on this by controlling for the temporal effects and modeling local factors and their relationship to regulation adopted. On the other hand, Lerner (2022) attempts to model these local factors, primarily the relationship between developer and counites and how it impacts the regulations. However, their data has limitations as they show only 27 counties in Kansas have a regulation while we show is 74 counties. In both cases they also ignore the state moratoria which supersedes the local regulations in their sample.

Data limitations about local regulations across a state or region have long been a challenge in conducting studies that go into the depth of myriad local land use planning issues, such as environmental conservation, mitigation of natural hazards, provision of affordable housing, and adapting to climate change; such data limitations have been a barrier in understanding the green energy transition (Veers et al., 2017). Beyond data limitations, renewable energy is a relatively new area of local policy innovation with substantial prior scholarship.

2.3.1. Federal and State Policy Contexts

In United States federalist system, the Federal government has significant, though not unlimited, power to compel or incentivize state-level action on renewable energy. In turn, states may compel or incentivize local-level action. However, as noted earlier, land use regulation powers essential for renewable energy transitions have typically remained at the local level (Klass & Wilton, 2022), as states typically hesitate to impose land use standards on communities, a phenomenon especially true in the states with high wind potential. Because the empirical dimension of our study focuses on one state at one point in time, Kansas, in 2024, we only briefly reference the federal and state policy context, although future studies that compare county regulations across time or across states should account for these factors (In recent years, the federal government has increasingly sought to incentive wind energy development (Lüthi & Prässler, 2011; Restrepo & Uribe, 2023; Tang, 2018; U.S. DOE Federal Energy Regulatory Commission, 2023). The Infrastructure Investment and Jobs Act of 2021, often known as the Bipartisan Infrastructure Law (BIL), and the Inflation Reduction Act of 2022 (IRA) are the most recent laws that Congress has approved that directly affect renewable energy (Cunningham & Jordan, 2023). Production tax incentives, offering credits for each kilowatt-hour of electricity sold to an unaffiliated party for ten years once the facility is put into service, provide perhaps the biggest incentive for wind installation (U.S. DOE Federal Energy Regulatory Commission, 2023). However, investment incentive credits are provided to wind developers to cover some of the capital input costs at the initial stages of project development and thus may not have much impact on county-level decision-making. Developers also need to submit an environmental assessment statement in accordance with the National Environmental Policy Act (NEPA) to evaluate potential environmental impacts of the proposed project (Braun et al., 2022), while some sites require permits from agencies such as the Bureau of Land Management, Federal Aviation Administration, and U.S. Fish and Wildlife Service often require a permit or specific project specifications (U.S. Federal Aviation Administration, 2023), U.S DOE Federal Energy Regulatory Commission, 2023). At the state level, renewable energy portfolio standards (RPS) establish targets for the percentage of total energy that electric suppliers must derive from renewable sources thus serving as incentives for their development (Wiser, 2004) . The state of Kansas is one of the few states with an expired RPS, which it did after meeting its target of 20% by 2020. All states have utility commissions, and some have regulatory requirements for the development of renewable energy projects, especially on siting or permitting (Enterline et al., 2024). Some states have model regulations that local jurisdictions use to guide the enactment of local regulations. Again, for our purposes, all of these considerations hold constant within Kansas.).

2.3.2. Biophysical Factors

Two main biophysical factors shape local wind installation regulation. Most obviously, the potential for an area to generate enough wind to be economically viable. Wind energy projects are most viable where the wind blows strongly and consistently, whether onshore (i.e., on land) or offshore (i.e., on water and beyond the scope of this study). In the United States, the onshore wind resource is predominantly available in the middle belt of the country, running from North to South (Wachs & Engel, 2021) covering states such as North Dakota, South Dakota, Nebraska, Kansas, Iowa, Oklahoma and Texas. Interrelated is the availability of land, typically in rural areas, sufficient for a concentration of turbines from which energy can be generated and transmitted; that is, production of electricity from wind energy is a land-use-intensive activity (Mai et al., 2021; Stevens et al., 2017; Tegen et al., 2016; Winikoff, 2022). Turbines installed on the ground require considerable space due to safety issues while also maximizing energy generation (Kaza & Curtis, 2014). The National Renewable Energy Lab (NREL) indicates that 30 acres of land is needed to produce 1 megawatt of electricity (Wachs & Engel, 2021) and the US will need land nearly the size of Texas to meet the ambitious goal of net-zero transition by 2050 (The Nature Conservancy, 2023). Thus, the availability of wind potential and available land presents the first set of biophysical challenges to meet the rising demand for wind energy (van de Ven et al., 2021).

 doi:10.20944/preprints202508.2067.v1

A second biophysical factor involves whether wind installations negatively impact other environmental concerns (Pierce et al., 2021; The Nature Conservancy, 2023). A site might have high wind energy potential but also comprise a valuable ecological habitat. Such concern led Kansas in 2011 to create (and in 2020 to reaffirm) a multi-county Tallgrass Heartlands Wind Moratorium area to preserve the "unique prairie ecosystem" (Governor Kelly, 2020). This mirrors concerns about tradeoffs between wind and agriculture in agriculturally productive areas with high wind potential.

2.3.3. Infrastructure Connectivity Factors

New wind projects in high wind potential regions like the Great Plains can be hindered by transmission constraints, limiting the ability to transmit electricity to areas of high demand. Research shows that the availability and proximity of the electricity transmission grid influences where developers choose to site their projects (Eto, 2016; Jenkins et al., 2022; Lee et al., 2017). Developers prefer areas close to the necessary voltage transmission lines connected to utility providers. Due to wind's intermittent power generation and the nature of current, renewable energy power must be converted before being connected to the main grid, which complicates connectivity from a technical and, potentially, a land use standpoint (Moch & Lee, 2022). Thus, for purposes of understanding county regulations, proximity to transmission capacity may be an important influence (Land regulations, local opposition, and right-of-way permit requirements have delayed the construction of renewable energy projects (Reed et al., 2020). In 2020, about 750 GW of renewable energy projects faced setbacks due to transmission limitations, causing concerns from grid developers about underutilization (Moch & Lee, 2022; Rand et al., 2021).).

2.3.4. Community Socio-Economic Characteristics

Myriad social and economic factors shape local planning and land use regulation, with wide variation depending on the composition of the community and whether the planning topic is considered to benefit the community (Logan and Molotch 2007, Brody et al., 2006; Göçmen & LaGro, 2016; Norton et al., 2018; Berke et al., 2014). Typically, places with more college-educated residents, which often are more populous communities, are likely to push for planning that addresses their environmental concerns(Opp & Rugeley, 2014). Community wealth, whether considered in terms of median incomes or home values, can influence local planning by increasing fiscal resources to hire more in-house or consulting planning capacity. Each of these factors has the potential to shape whether and how counties regulate wind projects.

Additionally, economic factors specific to energy generation may influence how a county regulates new wind projects. Many communities with high wind potential may have legacies of fossil fuel production or processing. Fossil fuel extraction often carries local fiscal effects that are valuable to local jurisdictions, whether due to job creation or revenue like property taxes that support schools, roads, and the provision of public services (Raimi et al., 2023). Shifting to renewable energy sources, especially if linked rhetorically or substantively to reductions in fossil fuels, may become a local impediment to wind installation. Likewise, in rural areas, dependence on agricultural production and processing can dominate the local economy. The extent to which major farm interests understand wind installations as complementary or competitive may shape county regulations.

2.3.5. Local Political Context

Local politics is also another factor which has been found to play a role in local green energy planning (Brunner & Schwegman, 2022; Stokes et al., 2023; Winikoff, 2022). Prominent considerations include economic benefits to the community, (Acemoglu et al., 2016; Claus et al., 2021), existence and abundance of renewable energy resources (Mai et al., 2021), political opinions and community attitudes (Hoen et al., 2019; Pierce et al., 2021), state of grid infrastructure (Bohn & Lant, 2009) and environmental considerations (The Nature Conservancy, 2023). Instances of local governments having highly restrictive land-energy regulations, possibly more so than their federal and state

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counterparts, were noted early in the initial years of renewables development (Mcgraw & Hennessy, 2017; Pursley & Wiseman, 2010). Over time, some local officials have strived to ban wind projects, while others have aggressively promoted them (Weise & Bhat, 2024).

Opposition to renewables is in both conservative and liberal areas (Wiseman, 2021). Core values and deeply entrenched policy orientations influence local decision-making at the local level, even if partisan politics are less dominant (Karakislak & Schneider, 2023; Mills et al., 2019). Objections to wind development proposals may extend beyond "NIMBY" (Not in My Backyard) concerns, and often reflect concerns about participation and authority during the decision-making process (Susskind et al., 2022). Evidence suggests that those who object to wind energy in their areas often lack first-hand experience (Weise, 2020). Thus, even if directly impacted landowners have an agreement with a developer to install wind turbines on their property, public participation requirements at the local level permitting stage may result in objections from residents and stall or kill a project (Nelson et al., 2018). A recent case study of the High Banks Wind Project, a large wind project situated in the counties of Republic and Washington in Kansas, suggests that the communities' opposition to wind development was influenced by local mistrust and, to some extent, false and misleading information (Holtz, 2024).

Meanwhile, more liberal areas may more readily accept land use regulation and broadly support the green energy transition but worry about tradeoffs with other local environmental issues like habitat conservation or social issues, like affordable housing. In virtually all contexts, the green energy transition is highly political with local leaders facing intense pressures, up to and including physical threats (Holtz, 2024; Karakislak & Schneider, 2023). Familiarity with renewable energy sources matter as well, as local leaders push for the adoption of ordinances regulating wind in instances where they have interacted more with the developers and have seen neighboring counties adopt them (Lerner, 2022; Thomas et al., 2022). Pierce and colleagues (2021)noted that high social capital was related to fewer turbine installations in the counties in Kansas and posited that this higher social capital is likely used to drum up opposition to renewable projects.

2.3.6. Planning Capacity

Developing appropriate renewable energy siting policy at the county scale requires familiarity, if not expertise, across a broad swath of knowledge applicable to local land use regulations. Prior studies identified the availability of planners during the planning process as a critical component in land use planning in general (Berke et al., 2006; Yu et al., 2021). Planners improve the capacity of local authorities to make sound decisions by providing expertise and information on the issues being addressed (Lyles et al., 2013). Local governments, particularly in rural areas, have been found to be lacking in professional expertise that would enable them to plan for and regulate renewable energy developments effectively (Gross, 2020). Local planners often bear responsibility for reviewing and making recommendations on wind installation proposals for adoption or denial by planning commissions and county commissions, which are often comprised of volunteers and other non-experts (Göçmen & LaGro, 2016). As is true for the general public, a lack of prior experience with wind regulation among planning professionals can complicate drafting, approval, and implementing county regulations (Stanton, 2012). The lack of widespread expertise, as well as basic capacity in smaller counties, may increase the importance of policy diffusion, as neighboring counties enact similar regulations to those surrounding them, especially if those counties have the capacity to draft their own regulations (Winikoff, 2019).

2.4. Conceptual Framework and Research Questions

The literature reviewed above leads us to develop research questions from the conceptual framework (Figure 2):

1) How do regulations of wind facilities vary at the county level?
2) What factors explain the variation across county wind regulations?

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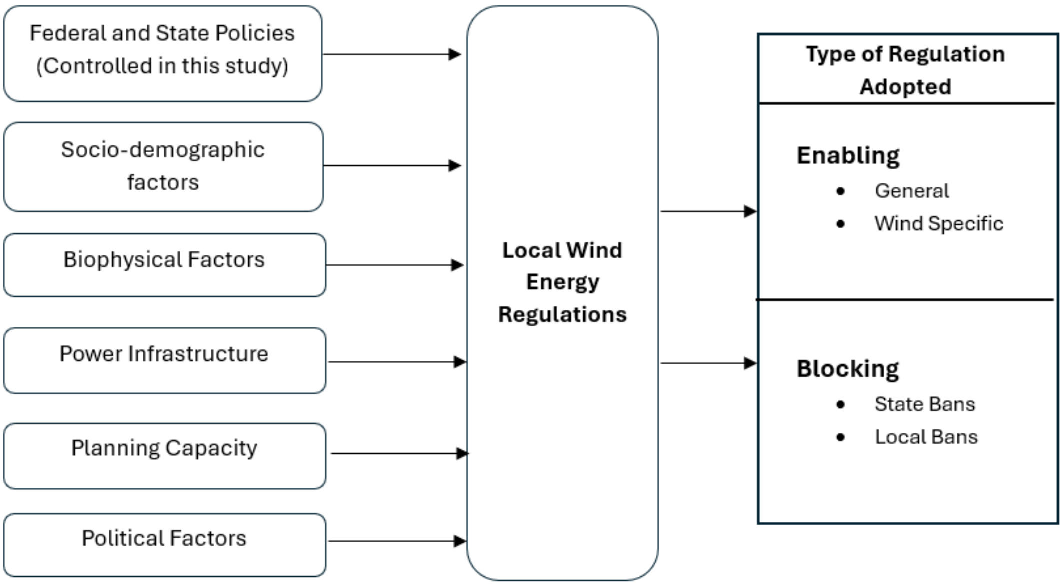

Figure 2. Conceptual framework diagram.2.5.

2.5. Research Design and Methodology

We employ a comparative research design using primary data collection and couple the primary data with secondary data sources in multivariate regression modeling to answer our two questions. The unit of analysis for our study is the county, focusing on the regulations adopted to enable, block, and otherwise shape the installation of wind generation capacity. Collecting county-level regulations and analyzing their contents requires considerable time and effort, and thus we focus on one state with high wind potential and an actively evolving local regulatory context. Our approach allows us to eliminate state planning and energy policy as a confounding factor, while also providing a foundation for future extensions and comparisons across states.

2.5.1. Why Kansas

Kansas is the nation's fourth-largest wind producer and third-largest in terms of share of renewable energy sources (U.S. Energy Information Administration, 2024a). Kansas ranks first in the country in terms of wind energy share of total renewable energy production at 99.4% wind, with solar and other sources comprising the remainder. In recent years, more than 40% of electricity generation in the state has come from wind. Focusing on Kansas thus allows us to understand the role of local regulation in one of the key states for a green energy transition, although it may limit generalizability to states with lower wind potential.

Kansas' land use and energy policy context highlights the importance of local land use regulation, as well as the dynamic and contested nature of the green energy transition. The State of Kansas grants counties and municipalities the authority and autonomy to enact regulations concerning land use within their jurisdictions, under which renewable projects must be approved. Additionally, at the state level, Kansas went from actively supporting renewable sources of energy generation at the state level, such as having a Renewable Portfolio Standard, to a state posture of leaving renewable energy development to the existing market dynamics and local preferences (Stokes, 2020). Stokes charts how a combination of fossil fuel industry lobbying and local resistance to wind installations drove this shift, creating a complicated local policy landscape in which some counties sought economic development benefits associated with wind installations and others sought to block wind installations for a mix of economic, private property rights, and anti-climate change rationales.

2.5.2. Primary Data Collection on County Wind Regulations

Our team visited the government website for each of the 105 counties in Kansas to obtain wind regulations, downloading the relevant documents and web links. In cases where regulations were not obtainable online, we contacted local governments directly to obtain the relevant regulation or affirm that no such regulations had been adopted. Our data was collected and coded between January and July 2024, which establishes August 2024 as the point in time for our analyses.

We coded four main types of regulatory mechanisms being used: incorporation of wind regulation standards in an existing zoning code, a stand-alone wind regulation code, a moratorium on wind installation (ban or temporary), and one-off development agreements between a county and a wind developer for a specific installation project. A fifth category of the regulatory mechanism includes a state-level moratorium on wind installation, the Tallgrass Heartland Wind Moratorium, which covers all or parts of 12 counties for the purpose of "conserve[ing] Kansas' unique prairie ecosystem, vital to native wildlife, tourism, education, and local ranching economies" (Governor Kelly, 2020). We characterize these five types of regulatory approaches as enabling (zoning, wind-specific, and development agreements) or blocking (state and local moratoria). As previously noted, however, the specific features of zoning and wind-specific ordinances can be crafted to functionally ban wind projects, for example by setting such large setback distances that no site in the county could possibly meet the setback requirements. The implication here is that our measurement likely underestimates the extent of local blocking actions. Finally, some counties have taken no action to regulate wind installations to date.

In addition to noting the type of regulatory mechanism, our team read the relevant regulations and coded eleven distinct types of sitting characteristics, covering topics including distance-based setbacks, turbine heights, minimum lot sizes, and more, in line with Figure 1 in the literature review (see Appendix 1 for more detail).

2.5.3. Creating the Kansas Energy Transition Atlas

We created the Kansas Energy Transition Atlas (KETA), a publicly available, web-based Geographic Information Systems platform to provide access to the primary data described above. Additionally, we collected secondary data from federal, state, and non-profit organization sources to enrich the ability of users to explore, understand, and analyze the myriad factors shaping the green energy transition in Kansas. An overview of the data from secondary sources includes the following categories: political factors, such as voting patterns; sociodemographic factors, such as median home values, education levels, and environmental (in)justice indicators; biophysical factors, such as wind potential, oil and gas production, and environmentally sensitive areas; energy infrastructure, particularly transmission lines; and planning capacity, especially the presence or absence of a local planning director. Detailed explanations for how each data set was obtained and converted to be accessible are in the notes (We utilized ArcGIS Pro to convert biophysical data from raster to vector format and then performed pairwise intersection processing using the county feature layer. The resulting intersect layer underwent summary statistics processing to find the sum, mean, median, maximum, and minimum values, which were then spatially joined to the counties layer and exported. The process was similarly applied to oil and gas wells point data and transmission line data to analyze cumulative production and capacity. However, for the transmission layer, the summary statistics were configured to be a function of the length and voltage capacity, so that the highest capacity represented counties with more lines and also higher carrying capacity. This was done to control for instances where a county might have low voltage lines that do not have enough capacity for carrying large amounts of power from wind farms. The KETA provides users the following capabilities: 1) exploring county wind regulations, including specific siting characteristics in the regulations, as well as direct access to the relevant document (pdf or weblink) and contact information for the relevant local agency; 2) generating maps of selected variables (displayed in selectable layers) and overlays, with the user only need to create a map title; and 3) as described below, analysis of quantitative relationships between variables included in the KETA. A detailed user guide helps users navigate the platform, and the team is in the process of complementing the county wind regulation data with data on county solar regulations (a slower-developing policy domain in Kansas).).

2.5.4. Descriptive and Inferential Statistical Methods

Our first research question regarding the patterns of variation in county wind regulation is answered with a combination of descriptive statistics and maps generated from the KETA. We chart and map the following data: a) the presence or absence of any county wind regulation; 2) variation in the regulatory approaches used (zoning, wind ordinance, development agreements, moratoria); and 3) variation in the specific sitting characteristics used to influence wind installations.

Our second research question regarding factors that explain variation in county wind regulation is answered with a series of multivariate regression models. Two main regression models presented in the findings answer our questions, although we ran additional models for the purposes of sensitivity analysis. The first model uses binary logistic regression to explain the presence or absence of any wind regulation (a binary dependent variable with an n of 105 counties), based on a combination of political, sociodemographic, biophysical, power infrastructure, and planning capacity factors (independent variables descriptive statistics in the Appendix). To improve model interpretation and reduce large coefficient values, some variables were rescaled . Median Income and average farm income was divided by 1000, population divided by 1000, cumulative gas and oil production divided by 100,000, area covered by environmentally sensitive land and valuable ecosystem divided by 1,000,000 and transmission potential divided by 1000. The main focus of the analysis was the significance and direction of relationships rather than the absolute magnitude of the coefficients. Thus, the model still retains the validity of inference based on coefficient signs and p-values, as these are unaffected by the linear rescaling.

The second model also uses binary logistic regression to explain whether the type of wind regulations adopted is a blocking or enabling regulation (a binary dependent variable with an n of 74 counties that have taken one of the five approaches), using the same set of independent variables as predictors. Diagnostic measures of model fit are presented along with the model estimates, standard errors, and p-values.

We recognize inherent limitations in a single-state approach with a limited sample size (n=105 counties), which may limit generalizability. Additionally, some factors that may predict local policy adoption, such as aspects of the planning process used to generate the regulations, the idiosyncrasies of local county officials' views toward wind energy, and the strategies of the private wind developers, are beyond our ability to measure at this time. Likewise, our research provides a single-point in-time view of the regulatory environment, which prohibits any tracing of policy evolution over time. Due to the limited number of counties with influential setback regulations, statistical modeling to assess relationships with predictor variables was not feasible. Each of these limitations offers directions for future research.

The interpretation of binary logistic regression results in wind energy regulation studies requires the consideration of both statistical significance and effect sizes. While p-values indicate the presence of relationships between variables, effect sizes reveal the magnitude and practical significance of these relationships, providing an important context for policy applications (Muller & Maclehose, 2014; Smeden et al., 2016). In the context of county-level wind regulation, this understanding goes beyond simply identifying which factors (such as median household income, population, or transmission line proximity) have statistically significant associations with regulatory adoption. Instead, recognizing the impact of sample size can quantify and contextualize the strength of these relationships through measures such as odds ratios, which provide stakeholders with clearer insights into the practical implications of their findings (Fuyama et al., 2021).

When examining the factors that influence whether specific places can adopt enabling or blocking regulations, the integration of effect sizes becomes particularly important for understanding the relative impact of different variables. For instance, while the presence of valuable ecosystems

doi:10.20944/preprints202508.2067.v1

shows statistical significance in predicting blocking regulations, the practical interpretation of this relationship requires an examination of effect magnitudes to understand its policy implications (Copping et al., 2020). This approach aligns with recent methodological advances in environmental policy research that advocate for more nuanced interpretations of logistic regression results (Spyridonidou & Vagiona, 2020). Such an analysis enhances the statistical rigor of the research and provides more actionable insights for policymakers and stakeholders involved in wind energy development.

3. Findings

Our findings answer our two research questions about variations in county wind regulations and factors explaining that variation. As described below, we found that 70% of Kansas counties have wind installation regulations in effect, with clear spatial patterns apparent in our maps. Among those counties, we find wide variation in the types of regulatory approaches being used. However, patterns of spatial variation are more nuanced, as is true for the variation in the specific siting characteristics found in the regulations. Our regression modeling identifies that socioeconomics, infrastructure, and biophysical context are associated with variation in county regulations, but no relationship to political factors and wind-generating potential.

3.1. Presence of Wind Installation Regulations

Out of 105 Kansas counties, 74 have wind regulations in place, which amounts to 70.5% of the total. As shown in Figures 3a and b, the counties with no wind regulations generally align into two spatial groups: a handful of eastern counties, mostly along the border with Missouri. The second cluster is western counties, especially in northwestern Kansas and along the Colorado border.

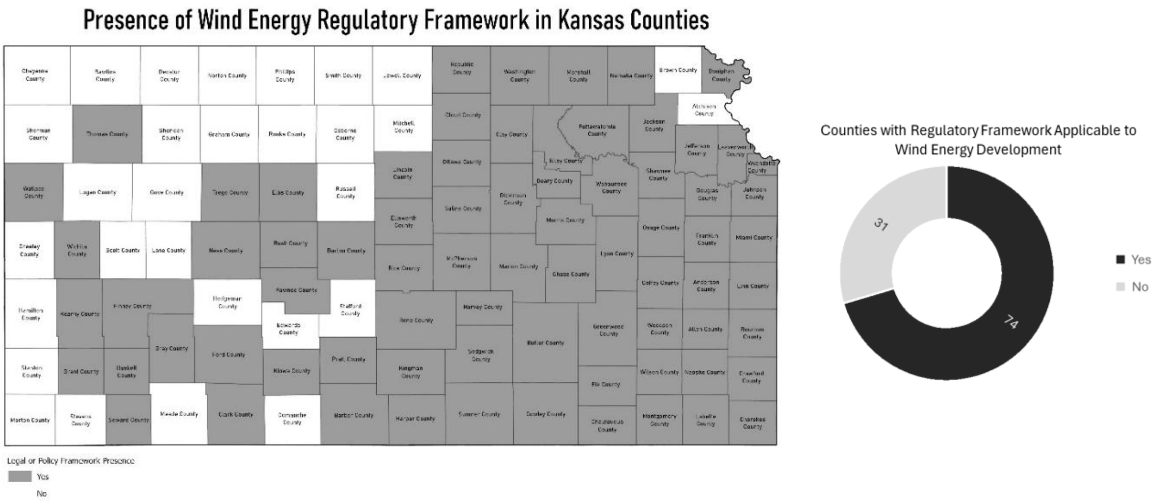

Figure 3. a. Map showing counties with wind energy regulations present. **b**. Chart showing the number of counties with or without wind regulations.

In terms of the types of regulatory approaches taken (Figures 4a and b), we note the wide swath of counties in east-central Kansas subject to the Tallgrass Heartland Wind Moratorium (THWM). These 11 counties comprise 15% of the 74 Kansas counties with some form of wind regulation. Again, this swath of counties prohibits wind installations based on state activity that was initiated in 2011, reaffirmed in 2020, and tends to have bipartisan support. Five additional counties are part of the THWM and also have zoning regulations. The six additional counties with moratoria (8% of the 74 counties) consist of three counties along the I-135 corridor from Wichita to Salina, just west of the THWM swath, as well as Shawnee County, which contains Topeka and is just east of the THWM and two lower population eastern Kansas counties. Together, these counties represent the group we consider to be engaged in blocking actions, a combined 19 counties, which is nearly 20% of the 105 total counties.

In terms of the counties opting for enabling actions, we find zoning regulations to be the dominant approach, with 30 of the 74 counties (40%) embedding wind standards in their existing zoning code. These counties span the state from east to west and north to south, showing no clear clustering. Nineteen counties (26%) rely on one-off development agreements with private wind developers to set standards for installations. Like the counties using zoning, these counties span the state north to south and east to west, with no clear clustering. The three counties with wind-specific regulations (4%) are in southern Kansas but do not border each other. Together, these counties amount to 52 counties (or at most 50% of all Kansas counties) that are taking enabling actions, as some of the zoning and wind-specific ordinances may functionally block wind projects.

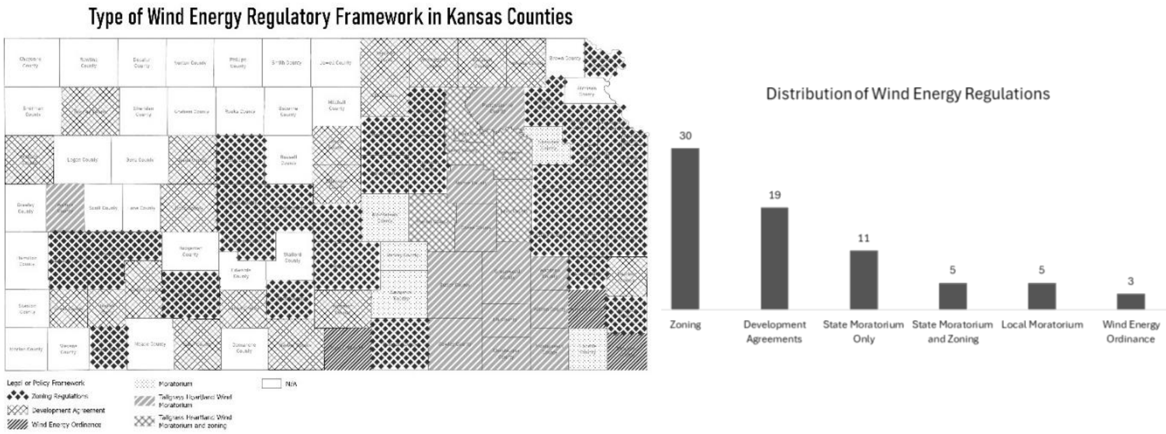

Figure 4. a. Map showing the type of wind energy regulation used by Kansas counties. **b**. Distribution of the types of wind energy regulations in Kansas.

3.2. Characteristics of Wind Installation Regulations

The patterns of specific characteristics of wind installation regulations are even more varied among the 74 counties with regulations in effect (Table 1). More counties focus on spatially oriented characteristics of installations than technical characteristics. For example, environmental considerations – the key factor identified for the THWM – are present in more than half of the counties (41 or 55%), even as minimum lot sizes and minimum distances from settlements are less common. Project size limitations also abound, with road, structure, and property line setbacks used in roughly half of the counties. Nuisance considerations and technical considerations, while present in many counties, are not typical. In terms of spatial distribution, the patterns shown in Figures 5a, b, and c basically reflect the same variation as the zoning and wind-specific regulations, as one-off development agreements do not necessarily set forward-looking policy standards.

Table 1. Characteristics of wind energy regulations.

Category		Planning Standards	Frequency
Technical	Structural Limitation	Height Limits	8
		Minimum Blade Clearance	15
	Nuisance*	Shadow Flicker Conditions	21
		Maximum Sound/Noise level	20
Spatial	Project Size Limitation	Property Line Setback	27
		Road Setback	34
		Structure Setback	32
		Transmission Line Setback	9
		Tower Density	5
	Location Limitation	Minimum Lot Size in Acres	1

Minimum Distance from Settlement in Miles	6
Environmental Consideration	41

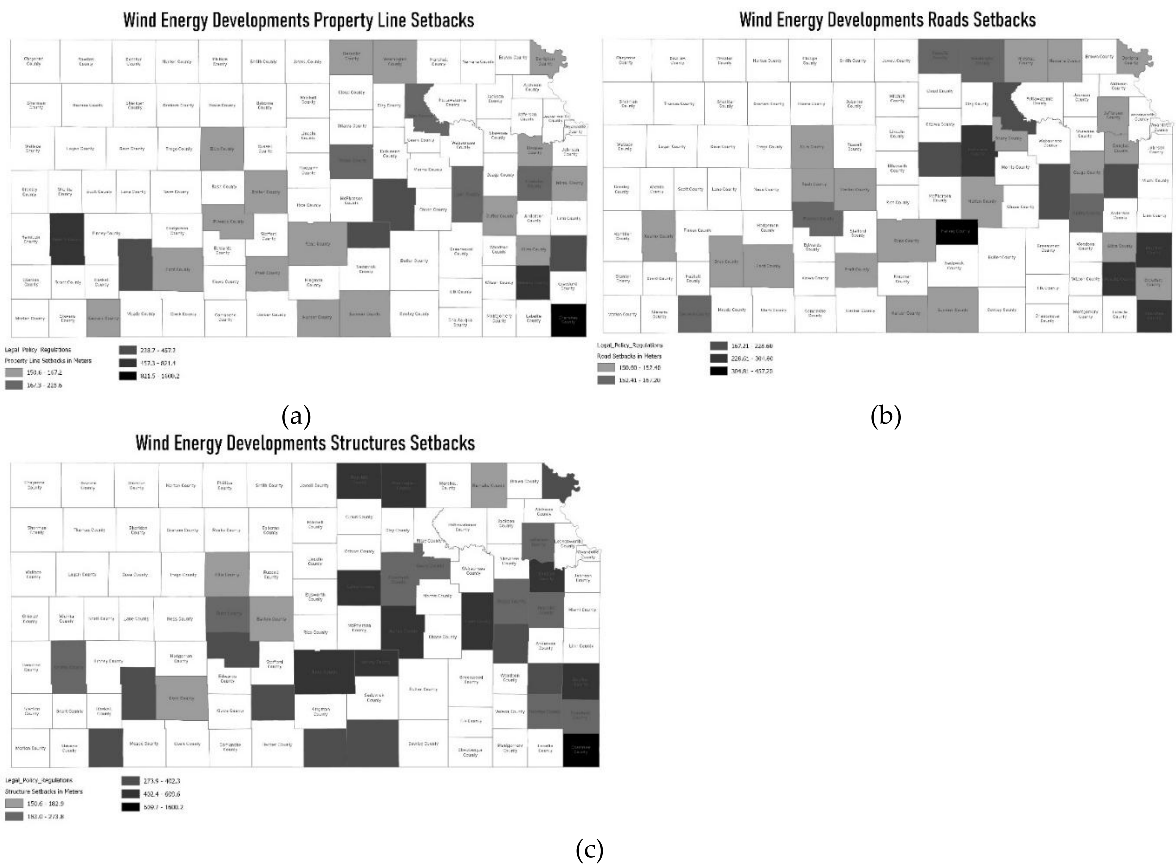

Figure 5. a. Map showing property line setback in meters per county. **b**. Map showing road setback values in meters per county. **c.** Map showing the structure/building setback values in meters per county.

Setback standards exhibit limited variation across most counties. However, a small number (approximately 7 – Cherokee, Harvey, Bourbon, Neosho, Reno, Kearny, Reno) adopt significantly larger setback distances that deviate from the broader pattern. Moreover, only 36 counties have at least one documented setback regulation, further constraining the sample size available for modeling the factors associated with variation in setback strictness.

3.3. Explaining Factors Shaping Wind Installation Regulations

We begin by explaining factors associated with the existence of any wind installation regulation, which 74 counties have in place. Table 2 shows the results of the first logistic regression modeling; the model includes all 105 counties (n) and exhibits strong model performance in terms of pseudo-R-squared, explaining more than half of the variation in the data (0.64).

Table 2. Factors influencing the presence of wind energy regulation.

Variable	estimate	std. error	t-statistic	p.value
(Intercept)	-13.3121	19.1215	-0.6962	0.4863
Population	0.0003	0.0002	1.8896	0.0588
Median Household Income	0.0002	0.0001	2.8449	0.0044
Population 25 and Over with a College Degree	-0.2107	0.1173	-1.7963	0.0724
Republican Voters Percentage	-0.0585	0.1061	-0.5516	0.5812
Oil Production	-0.0005	0.003	-1.6879	0.0914
Gas Production	-0.0055	0.0042	-1.3048	0.1920
Transmission Line Capacity	0.1162	0.0487	2.3846	0.0171

Wind Energy Potential	1.6685	2.0290	0.8223	0.4109
Planners Present	-1.9766	0.9054	-2.1831	0.0290
Urban-Rural Designation	-1.9214	1.7778	-1.0808	0.2798
Average Income Per Farm	-0.0340	0.0133	-2.5509	0.0107

N = 105, Pseudo R^2 = 0.647, Likelihood Ratio Test, P value = 0.00000000187, AUC = 0.856.

The model indicates that median household incomes (p=0.004), proximity to transmission lines (p=0.017), and overall population (p=0.058) are positively associated with a county having some sort of wind regulation. Meanwhile, high average farm income (p=0.010) and the presence of a county planner (p=0.029) are negatively associated with county wind regulations. Notably, partisan voting, fossil fuel production, and wind energy potential are not statistically significantly related to county wind regulation at commonly accepted levels.

The modeling of factors associated with whether a county wind regulation focuses on blocking (moratoria) or enabling (zoning, wind-specific, development agreement) wind installation also exhibits strong model fit (pseudo-R-squared of 0.78). This model includes the 74 counties with some sort of regulation, of which 22 are considered to be blocking, and 52 are considered to be enabling. Median household income (p=0.022) and overall population (p=0.059) are associated with enabling regulations (positive estimates), similar to the adoption of any type of regulation. Again, average farm income (p=0.014) is associated with blocking legislation (negative estimate). However, the main driver of a blocking regulation appears to be the presence of a valuable ecosystem (p=0.008), which fits with the state intervention to create the Tallgrass Heartland Wind Moratorium. Other factors, like fossil fuel production, partisan voting, and proximity to transmission capacity, are not statistically significantly related to blocking or enabling at commonly accepted levels. *(We also analyzed this relationship without the valuable ecosystem variable and found that direction of relationships holds for other variable although with less variables being significant. We replaced the valuable ecosystem variable with key environmental areas for each county and run the model. See Table 3b)*

Table 3. Factors influencing whether a wind regulation leads to blocking or enabling.

Variable	estimate	std. error	t-statistic	p.value
(Intercept)	4.8100	20.0700	0.2400	0.8106
Population	-0.0171	0.0088	-1.9480	0.0514
Median Household Income	0.2690	0.1119	2.4040	0.0162
Population 25 and Over with a College Degree	-0.5132	0.2685	-1.9110	0.0560
Republican Voters Percentage	0.1749	0.1049	1.6680	0.0954
Oil Production	0.0052	0.0027	1.8890	0.0589
Gas Production	0.0012	0.0053	0.2250	0.8218
Transmission Line Capacity	0.0750	0.0640	1.1720	0.2411
Wind Energy Potential	-1.2460	2.5250	-0.4930	0.6217
Valuable Ecosystem	-0.0082	0.0030	-2.7620	0.0058
Planners Present	-4.6990	8.9810	-0.5230	0.6001
Urban-Rural Designation	-3.6740	1.6780	-2.1900	0.0286
Average Income Per Farm	-0.0001	0.0001	-2.3690	0.0178

b. Relationship without the environmental sensitive areas in Kansas replaced with ey environmental areas for each county

Variable	estimate	std. error	t-statistic	p.value
(Intercept)	0.2011	13.7000	0.0150	0.9883
Population	-0.0037	0.0049	-0.7480	0.4544
Median Household Income	0.0794	0.0400	1.9880	0.0468
Population 25 and Over with a College Degree	-0.1473	0.1120	-1.3150	0.1883
Republican Voters Percentage	0.0616	0.0504	1.2220	0.2217
Oil Production	0.0029	0.0024	1.2260	0.2201
Gas Production	0.0060	0.0037	1.6040	0.1088

Transmission Line Capacity	-0.0059	0.0308	-0.1910	0.8484
Wind Energy Potential	-0.2520	1.8460	-0.1370	0.8914
Key Environmental Areas	0.0001	0.0001	-2.5660	0.0103
Planners Present	-1.0130	1.2690	-0.7980	0.4246
Urban-Rural Designation	-1.2940	0.9669	-1.3390	0.1807
Average Income Per Farm	0.0000	0.0001	-1.2400	0.2149

n = 74, Pseudo R^2 = 0.784, Likelihood Ratio Test, P value = 0.000000029041, AUC = 0.877. R^2 = 0.41.

4. Discussion

Our findings provide clear answers to our two research questions, and from the answers, we glean numerous insights of importance for scholarship and practice. First, as expected, our descriptive analysis shows wide variation in the county-level wind regulation landscape. Like many aspects of land use regulation, we see a 'patchwork quilt' of approaches that evidences the centrality of local control when it comes to the use of land in the United States. The variation plays out across three dimensions: whether counties have taken any type of action yet, whether the actions taken are enabling or blocking wind installations, and what array of specific characteristics comprise the regulations. Second, the regression modeling provides robust predictive power for the presence of county wind regulations and whether those regulations tend towards enabling or blocking wind installation. The wide variation in a dynamic policy realm suggests that Kansas is in a tumultuous phase of energy development at the time of this study.

We see two types of counties that have not yet engaged in wind regulation. The smaller group consists of counties along the eastern border with Missouri, which comparatively speaking have less wind potential than much of the rest of Kansas. We discourage others from interpreting these counties as irrelevant, however, as even the lowest wind potential areas of Kansas still have more generation potential than almost any county in the eastern half of the United States. We expect these counties will likely face pressure to adopt regulations in the near future, whether due to proposals for wind facilities from developers or to proactive policy pushes within the county. The larger group of inactive counties (as of August 2024) tend to be in western Kansas, especially along the border with Colorado and in northwestern Kansas. Compared to other counties in western Kansas, the inactive counties tend to have smaller populations, are less wealthy, and are somewhat farther away from the major energy transmission lines.

The results from the associated regression model affirm this dynamic. The indication that the presence of a county planning director is negatively associated with the adoption of regulation is counter-intuitive. Although this finding may be an artifact of variation in planning capacity in the inactive counties, as the eastern counties that are inactive may be likely to have planning staff. Together, these findings point to the question of whether smaller counties farther from transmission lines, which are often in desperate need of economic development opportunities to help stem population decline, may be left behind in the green energy transition? This concern may have even greater import outside of Kansas, in Great Plains counties ranging from the Canadian border in North Dakota and Montana to the Mexican border in Texas and New Mexico.

Interpreting the patterns of enabling and blocking regulations presents a more nuanced narrative. First, in 2011, the state prioritized conserving environmentally sensitive areas by adopting the Tallgrass Heartland Wind Moratorium across the Flint Hills region of Kansas. Other states may also choose to take such action to preserve ecologically sensitive areas, which may reveal deep tensions between local environmental goals, particularly protecting endangered ecosystems and vulnerable species, and national and global environmental goals of expediting the renewable energy transition.

Interpreting local actions to block wind installations also points to place-based context and the need for additional research. Do the actions of counties in the I-135 corridor between Wichita and Salina and in the Topeka area of Shawnee County point to spillover concerns about ecological conservation adjacent to the Flint Hills? Or, perhaps, do the actions of these higher-population counties suggest more of a Not-In-My-Backyard (NIMBY) dynamic among residents on aesthetic grounds? (Two interesting exceptions are Douglas County and Johnson County in eastern Kansas, each with larger populations and wind potential, though lower potential than counties in Western Kansas. For now, the counties have pursued what we measured as enabling regulations, although debate continues as to whether the standards amount to a ban.) Case study research holds the potential to shed light on these nuances, particularly the role of public discourse in planning processes and the specific features of local political climates, given that partisan politics does not appear to be a factor.

Around half of Kansas counties, at most, fall into the group enacting enabling regulations. These counties tend to be more populous and have a higher median income, although we must remember that those tendencies are in reference to the rest of the state, not the nation. The finding that counties with larger average farm incomes are less likely to adopt enabling regulations points to the need for a better understanding of the interaction between agriculture and renewable energy industries. Although our data does not include a temporal dimension, we suspect that future research will show that development agreements often precede the adoption of wind-specific provisions in zoning regulations or stand-alone wind regulations. We also acknowledge that stringent setback regulations may reduce the favorability of certain locations for wind energy development. Future research that develops a detailed stringency index for these regulations, especially for specific standards that directly impact developers would provide a more comprehensive understanding of their implications.

Overall, we see a general pattern that will be interesting to monitor over time. Among the counties not subject to state-level moratoria, less populous counties farther from transmission capacity (northwestern Kansas) or of prime wind generation areas (eastern Kansas) tend not to have taken action yet. At the other end of the spectrum, more populous counties seem to tend toward blocking action. Most Kansas counties are in between these two extremes, largely rural counties that appear to be pursuing enabling legislation, presumably to foster economic growth. Yet, these counties vary widely in the type of regulatory approach – zoning, wind-specific regulation, and development agreements – and in the specific siting characteristics.

Our findings highlights the rapidly evolving and dynamic nature of the green energy transition, overlaid on the United States' longstanding tradition of local land use control. All manner of interested parties in the renewable energy transition seek more clarity and control, although often coming from very different philosophical, economic, and social perspectives. At the very least, the 'patchwork quilt' of regulations requires tremendous effort from interested parties to monitor and engage with varied local processes. This challenge holds true whether one is a county official seeking to develop regulations, energy developers seeking to build a wind project, or residents and advocates seeking to shape local regulations, or influence decision-making on project proposals.

Before concluding, we also feel it is important to iterate that the only state-level intervention in renewable energy siting in Kansas – the THWM – has been a blocking action. That is, to date, the state has not opted to preempt or otherwise limit local land use control over wind energy development. A few states have recently modified the role of local governments in renewable energy siting, raising questions about whether and how and under what circumstances states may intervene on traditional land use regulation for national and global aims.

5. Conclusions

Our research has sought to answer key questions in the rapidly evolving renewable energy transition policy landscape. With Kansas, one of the vanguard wind energy generation states, as our focus, we have examined the variation of local land use policies related to wind development. We assessed factors explaining whether counties have regulations that enable or block wind generation capacity, an issue identified by green energy developers and media outlets as a major barrier to meeting national and global goals to transition away from fossil fuels.

 doi:10.20944/preprints202508.2067.v1

Our findings point to a highly varied local regulatory context in Kansas, with roughly 70% of counties currently regulating wind installation through land use controls. Of those, between ¼ and 1/3 have adopted blocking regulations (or are subject to a state-level moratorium based on environmental rationales). That leaves just 50% of Kansas counties adopting some form of enabling legislation, although the approaches vary widely across including wind provisions in existing regulation, adopting stand-alone wind ordinances, and one-off development agreements. Our regression modeling suggests a non-linear pattern of the least populous and least wealthy counties, especially those farther from transmission capacity, not having yet taken action. Notably, some counties have adopted moratoria, and others are in the midst of contentious policy debates and battles. The broad middle contingent of counties seems poised to facilitate wind installations, although those with larger average farm incomes appear less receptive.

Our study points to implications for states and local governments in areas with high wind capacity, not least because a huge menu of options exists. At the very least, the 'patchwork quilt' of regulations in this 'wild west' landscape poses challenges for all parties interested in clarity, especially those eager for an accelerated green energy transition. We hope the Kansas Energy Transition Atlas, a publicly available, web-based Geographic Information Systems tool, aids all parties to understand this context better. We also hope the KETA and the analyses we present here advance future research into activities in other states, activities over time, and especially place-based factors that so often shape local land use regulations that enable or constrain broad societal goals.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org.

Author Contributions: All authors listed contributed to the conceptualization and implementation of this research project. Author Njuguna led the development of the GIS database and the analysis, as well as the first drafting of the manuscript. Authors Lyles and Outka provided primary collaboration for Njuguna and authors Harrington, Jacobs, and Ahmad all provided secondary collaboration.

Funding: This research was made possible by a grant from the Afred P. Sloan Foundation with authors Ahmad and Harrington as Principal Investigators on the project. (https://sloan.org/grant-detail/g-2022-19313).

Data Availability Statement: All data available at the Kansas Energy Transition Atlas: https://experience.arcgis.com/experience/f37701d386824345951016dc61859057.

Conflicts of Interest: Authors have no conflicts of interests to declare.

References

1. Abhyankar, N., Paliwal, U., McNair, T., Wooley, D., O'boyle, M., & Phadke, A. (2021). *POWERING AMERICA'S CLEAN ECONOMY*.
2. Acemoglu, D., Johnson, S., Kermani, A., Kwak, J., & Mitton, T. (2016). The value of connections in turbulent times: Evidence from the United States. *Journal of Financial Economics*, *121*(2), 368–391. https://doi.org/10.1016/j.jfineco.2015.10.001
3. Ahmad, N., Outka, U., Stokes, D., & Wiseman, H. (2023). Synthesizing Energy Transitions. *Georgia State University Law Review*, *39*(4), 1087–1129. https://readingroom.law.gsu.edu/gsulrAvailableat:https://readingroom.law.gsu.edu/gsulr/vol39/iss4/12
4. Atems, B., Mette, J., Lin, G., & Madraki, G. (2023). Estimating and forecasting the impact of nonrenewable energy prices on US renewable energy consumption. *Energy Policy*, *173*. https://doi.org/10.1016/j.enpol.2022.113374
5. Berke, P., Backhurst, M., Day, M., Ericksen, N., Laurian, L., Crawford, J., & Dixon, J. (2006). What makes plan implementation successful? An evaluation of local plans and implementation practices in New Zealand. *Environment and Planning B: Planning and Design*, *33*(4), 581–600. https://doi.org/10.1068/b31166
6. Berke, P., Godschalk, D. R., Kaiser, E. J., & Rodriguez, D. A. (2006). *Urban Land Use Planning* (5th ed.). University of Illinois Press.

7. Bili, A., & Vagiona, D. G. (2018). Use of multicriteria analysis and GIS for selecting sites for onshore wind farms: the case of Andros Island (Greece). *EUROPEAN JOURNAL OF ENVIRONMENTAL SCIENCES*, *8*(1), 5–13. https://doi.org/10.14712/23361964.2018.2
8. Bohn, C., & Lant, C. (2009). Welcoming the wind? Determinants of wind power development among U.S. States. *Professional Geographer*, *61*(1), 87–100. https://doi.org/10.1080/00330120802580271
9. Braun, T., Curtiss, S., & McMahan, T. (2022). Siting and Permitting Wind Projects. In *The Law of Wind*.
10. Brody, S. D., Carrasco, V., & Highfield, W. (2006). Measuring the adoption of local sprawl: Reduction planning policies in Florida. *Journal of Planning Education and Research*, *25*(3), 294–310. https://doi.org/10.1177/0739456X05280546
11. Bronint, S. C. (2008). The Quiet Revolution Revived: Sustainable Design, Land Use Regulation, and the States. http://ofee.gov/sb/fgbreport.pdf
12. Brooks, L., & Liscow, Z. (2023). Infrastructure Costs. *American Economic Journal: Applied Economics*, *15*(2), 1–30. https://doi.org/10.1257/app.20200398
13. Brunner, E. J., & Schwegman, D. J. (2022). Commercial wind energy installations and local economic development: Evidence from U.S. counties. *Energy Policy*, *165*. https://doi.org/10.1016/j.enpol.2022.112993
14. Burby, R., May, P., Peter, J., Berke, P., Dalton, L., French, S., & Kaiser, E. (1997). *Making Governments Plan: State Experiments in Managing Land Use*. JHU Press.
15. Carley, S., & Konisky, D. M. (2020). The justice and equity implications of the clean energy transition. In *Nature Energy* (Vol. 5, Issue 8, pp. 569–577). Nature Research. https://doi.org/10.1038/s41560-020-0641-6
16. Claus, A., Hagedorn, A. L., & Schulte, A. (2021). ANNUAL ECONOMIC IMPACTS OF KANSAS WIND ENERGY 2020 REPORT.
17. Copping, A. E., Hemery, L. G., Overhus, D. M., Garavelli, L., Freeman, M. C., Whiting, J. M., Gorton, A. M., Farr, H. K., Rose, D. J., & Tugade, L. G. (2020). Potential environmental effects of marine renewable energy development—the state of the science. *Journal of Marine Science and Engineering*, *8*(11), 1–18. https://doi.org/10.3390/jmse8110879
18. Cox, S., Lopez, A., Watson, A., Grue, N., & Leisch, J. E. (2018). *Renewable Energy Data, Analysis, and Decisions: A Guide for Practitioners*. www.nrel.gov/publications.
19. Criglow, C., & Phiilips, S. (2022). Wind Energy Lease Agreements. In *The Law of Wind*.
20. Cunningham, L. J., & Jordan, C. M. (2023). *Renewable Energy and Energy Efficiency Incentives: A Summary of Federal Programs*. https://www.congress.gov/crs-product/R40913
21. Dale, V. H., Efroymson, R. A., & Kline, K. L. (2011). The land use-climate change-energy nexus. *Landscape Ecology*, *26*(6), 755–773. https://doi.org/10.1007/s10980-011-9606-2
22. Denholm, P., Brown, P., Cole, W., Mai, T., Sergi, B., Brown, M., Jadun, P., Ho, J., Mayernik, J., McMillan, C., & Sreenath, R. (2022). *Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035*. www.nrel.gov/publications.
23. Denholm, P., Hand, M., Jackson, M., & Ong, S. (2009). *Land-Use Requirements of Modern Wind Power Plants in the United States*. http://www.osti.gov/bridge
24. Eisenson, M. (2023). Opposition to Renewable Energy Facilities in the United States: Opposition to Renewable Energy Facilities in the. https://scholarship.law.columbia.edu/sabin_climate_change/200/
25. Enterline, S., Valainis, A., & Project, R. A. (2024). Laws in Order: An Inventory of State Renewable Energy Siting Policies.
26. Esposito, D. (2021). STUDIES CONVERGE ON BENEFITS OF A RAPID CLEAN ENERGY TRANSITION.
27. Eto, J. H. (2016). Building Electric Transmission Lines: A Review of Recent Transmission Projects.
28. Eyre, N. (2021). From using heat to using work: reconceptualising the zero carbon energy transition. *Energy Efficiency*, *14*(7). https://doi.org/10.1007/s12053-021-09982-9
29. Fuyama, K., Hagiwara, Y., & Matsuyama, Y. (2021). A simulation study of regression approaches for estimating risk ratios in the presence of multiple confounders. *Emerging Themes in Epidemiology*, *18*(1). https://doi.org/10.1186/s12982-021-00107-2
30. Gavériaux, L., Laverrière, G., Wang, T., Maslov, N., & Claramunt, C. (2019). GIS-based multi-criteria analysis for offshore wind turbine deployment in Hong Kong. *Annals of GIS*, *25*(3), 207–218. https://doi.org/10.1080/19475683.2019.1618393

31. Göçmen, Z. A., & LaGro, J. A. (2016). Assessing local planning capacity to promote environmentally sustainable residential development. *Journal of Environmental Planning and Management*, *59*(8), 1513–1535. https://doi.org/10.1080/09640568.2015.1080673
32. Governor Kelly. (2020). Governor Kelly Reaffirms Tallgrass Heartland Wind Moratorium - Governor of the State of Kansas.
33. Gross, S. (2020). *RENEWABLES, LAND USE, AND LOCAL OPPOSITION IN THE UNITED STATES EXECUTIVE SUMMARY*. https://www.brookings.edu/wp-content/uploads/2020/01/FP_20200113_renewables_land_use_local_opposition_gross.pdf
34. Hafner, M., & Tagliapietra, S. (2020). *The Geopolitics of the Global Energy Transition*. http://www.springer.com/series/8874
35. Hirt, S. (2007). The devil is in the definitions: Contrasting American and German approaches to zoning. *Journal of the American Planning Association*, *73*(4), 436–450. https://doi.org/10.1080/01944360708978524
36. Hoen, B., Darlow, R., Haac, R., Rand, J., & Kaliski, K. (2023). Effects of land-based wind turbine upsizing on community sound levels and power and energy density. *Applied Energy*, *338*. https://doi.org/10.1016/j.apenergy.2023.120856
37. Hoen, B., Firestone, J., Rand, J., Elliot, D., Hübner, G., Pohl, J., Wiser, R., Lantz, E., Haac, T. R., & Kaliski, K. (2019). Attitudes of U.S. Wind Turbine Neighbors: Analysis of a Nationwide Survey. *Energy Policy*, *134*. https://doi.org/10.1016/j.enpol.2019.110981
38. Hohl, C., Lo Prete, C., Radhakrishnan, A., & Webster, M. (2023). Intraday markets, wind integration and uplift payments in a regional U.S. power system. *Energy Policy*, *175*. https://doi.org/10.1016/j.enpol.2023.113503
39. Holtz, M. (2024). Winds of Change: Rural Kansas and the Clean-Energy Transition.
40. Howe, P. D., Mildenberger, M., Marlon, J. R., & Leiserowitz, A. (2015). Geographic variation in opinions on climate change at state and local scales in the USA. *Nature Climate Change*, *5*(6), 596–603. https://doi.org/10.1038/nclimate2583
41. IPCC. (2018). IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In *Global Warming of 1.5°C* (pp. 1–24). Cambridge University Press. https://doi.org/10.1017/9781009157940.001
42. Jenkins, J. D., Farbes, J., Jones, R., Patankar, N., & Schivley, G. (2022). *Electricity Transmission is Key to Unlock the Full Potential of the Inflation Reduction Act*. Zenodo. https://doi.org/10.5281/zenodo.7106176
43. Karakislak, I., & Schneider, N. (2023). The mayor said so? The impact of local political figures and social norms on local responses to wind energy projects. *Energy Policy*, *176*. https://doi.org/10.1016/j.enpol.2023.113509
44. Kaza, N., & Curtis, M. P. (2014). The Land Use Energy Connection. *Journal of Planning Literature*, 1–16.
45. Kent, T. (1964). *The Urban General Plan*. Chandler Publishing Company,.
46. Kenyon, D. A., & Langley, A. H. (2016). NONPROFIT PILOTS (PAYMENTS IN LIEU OF TAXES).
47. Klass, A. B., & Wilton, R. (2022). Local Power. *Vanderbilt Law Review*, *75*. https://scholarship.law.vanderbilt.edu/vlr/vol75/iss1/2/
48. Lagro, J. A. (2005). LAND-USE CLASSIFICATION.
49. Lantz, E., Roberts, O., Nunemaker, J., Demeo, E., Dykes, K., & Scott, G. (2019). *Increasing Wind Turbine Tower Heights: Opportunities and Challenges*. www.nrel.gov/publications.
50. Lawrence Berkeley National Laboratory. (2024). *LAND-BASED WIND MARKET REPORT 2024 EDITION*. https://emp.lbl.gov/sites/default/files/2024-08/Land-Based%20Wind%20Market%20Report_2024%20Edition.pdf
51. Lawrence Livermore National Laboratory. (2023). *Estimated U.S energy consumption in 2022: 100.3 Quads Energy Flow Chart*. https://flowcharts.llnl.gov/
52. Lee, N., Flores-Espino, F., & Hurlbut, D. (2017). RENEWABLE ENERGY ZONE (REZ) TRANSMISSION PLANNING PROCESS: A GUIDEBOOK FOR PRACTITIONERS.

 doi:10.20944/preprints202508.2067.v1

53. Lerner, M. (2022). Local power: Understanding the adoption and design of county wind energy regulation. *Review of Policy Research*, *39*(2). https://doi.org/10.1111/ropr.12447
54. Lopez, A., Mai, T., Lantz, E., Harrison-Atlas, D., Williams, T., & Maclaurin, G. (2021). Land use and turbine technology influences on wind potential in the United States. *Energy*, *223*. https://doi.org/10.1016/j.energy.2021.120044
55. Lüthi, S., & Prässler, T. (2011). Analyzing policy support instruments and regulatory risk factors for wind energy deployment-A developers' perspective. *Energy Policy*, *39*(9), 4876–4892. https://doi.org/10.1016/j.enpol.2011.06.029
56. Lyles, W., Berke, P., & Smith, G. (2013). Do planners matter? Examining factors driving incorporation of land use approaches into hazard mitigation plans. *Journal of Environmental Planning and Management*, *57*(5), 792–811.
57. Lyles, W., & Stevens, M. (2014). Plan Quality Evaluation 1994–2012: Growth and Contributions, Limitations, and New Directions. *Journal of Planning Education and Research*, *34*(4), 433–450. https://doi.org/10.1177/0739456X14549752
58. Mahdy, M., & Bahaj, A. B. S. (2018). Multi criteria decision analysis for offshore wind energy potential in Egypt. *Renewable Energy*, *118*, 278–289. https://doi.org/10.1016/j.renene.2017.11.021
59. Mai, T., Lopez, A., Mowers, M., & Lantz, E. (2021). Interactions of wind energy project siting, wind resource potential, and the evolution of the U.S. power system. *Energy*, *223*. https://doi.org/10.1016/j.energy.2021.119998
60. Mcgraw, M., & Hennessy, R. (2017). *Rush to attract wind turbine investors leaves Kansas school districts shortchanged Why you can trust Investigate Midwest*. https://investigatemidwest.org/2017/12/04/rush-to-attract-wind-turbine-investors-leaves-kansas-school-districts-shortchanged/
61. Mills, S. B., Bessette, D., & Smith, H. (2019). Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. *Land Use Policy*, *82*, 754–762. https://doi.org/10.1016/j.landusepol.2019.01.010
62. Moch, J. M., & Lee, H. (2022). The Challenges of Decarbonizing the U.S. Electric Grid by 2035.
63. Motkya, M., Thomson, J., Plechowski, M., Rizzo, C., & Sanborn, S. (2021). *Renewable transition Separating perception from reality*.
64. Muller, C. J., & Maclehose, R. F. (2014). Estimating predicted probabilities from logistic regression: Different methods correspond to different target populations. *International Journal of Epidemiology*, *43*(3), 962–970. https://doi.org/10.1093/ije/dyu029
65. Nelson, H. T., Swanson, B., & Cain, N. L. (2018). Close and Connected: The Effects of Proximity and Social Ties on Citizen Opposition to Electricity Transmission Lines. *Environment and Behavior*, *50*(5), 567–596. https://doi.org/10.1177/0013916517708598
66. Nilson, R., Hoen, B., & Rand, J. (2023). *Survey of Utility-Scale Wind and Solar Developers Report*. https://emp.lbl.gov/publications/survey-utility-scale-wind-and-solar
67. Office of Energy Efficiency & Renewable Energy. (2024, August 21). *Wind Turbines: the Bigger, the Better*. U.S DOE. https://www.energy.gov/eere/articles/wind-turbines-bigger-better
68. Oteri, F., Baranowski, R., Baring-Gould, I., & Tegen, S. (2017). *2017 State of Wind Development in the United States by Region*. https://www.nrel.gov/docs/fy18osti/70738.pdf.
69. Outka, U. (2010). Siting Renewable Energy: Land Use and Regulatory Context. *Ecology Law Quarterly*, *Vol 37*, 1041–1106. http://www.dsireusa.org
70. Outka, U. (2012). Environmental Justice Issues in Sustainable Development: Environmental Justice in the Renewable Energy Transition. In *Journal of Environmental and Sustainability Law* (Vol. 19). https://scholarship.law.missouri.edu/jeslhttps://scholarship.law.missouri.edu/jesl/vol19/iss1/5
71. Pierce, J. C., Krause, R. M., Hofmeyer, S. L., & Johnson, B. J. (2021). Explanations for wind turbine installations: Local and global environmental concerns in the central corridor of the United States? *Energies*, *14*(18). https://doi.org/10.3390/en14185830
72. Pursley, G. B., & Wiseman, H. J. (2010). *Local Energy*. http://ssrn.com/abstract=1567585https://ssrn.com/abstract=1567585Electroniccopyavailableat:https://ssrn.com/abstract=1567585

73. Raimi, D., Grubert, E., Higdon, J., Metcalf, G., Pesek, S., & Singh, D. (2023). The Fiscal Implications of the US Transition Away from Fossil Fuels. *Review of Environmental Economics and Policy*, *17*(2), 295–315. https://doi.org/10.1086/725250
74. Rampell, C., & Estes, D. (2023). *Battles over wind farms divide rural communities*. https://www.pbs.org/newshour/show/battles-over-wind-farms-divide-rural-communities
75. Rand, J., Bolinger, M., Wiser, R., & Jeong, S. (2021). *Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2020*. https://emp.lbl.gov/publications/queued-characteristics-power-plants
76. Reed, L., Dworkin, M., Vaishnav, P., & Morgan, M. G. (2020). Expanding Transmission Capacity: Examples of Regulatory Paths for Five Alternative Strategies. *Electricity Journal*, *33*(6). https://doi.org/10.1016/j.tej.2020.106770
77. Restrepo, N., & Uribe, J. M. (2023). Cash flow investment, external funding and the energy transition: Evidence from large US energy firms. *Energy Policy*, *181*. https://doi.org/10.1016/j.enpol.2023.113720
78. Saunders, P. (2020). Land Use Requirements of Solar and Wind Power Generation: Understanding a Decade of Academic Research. https://www.researchgate.net/publication/345638945
79. Shoeib, E. A. H., Hamin Infield, E., & Renski, H. C. (2021). Measuring the impacts of wind energy projects on U.S. rural counties' community services and cost of living. *Energy Policy*, *153*. https://doi.org/10.1016/j.enpol.2021.112279
80. Spyridonidou, S., & Vagiona, D. G. (2020). Spatial energy planning of offshore wind farms in Greece using GIS and a hybrid MCDM methodological approach. *Euro-Mediterranean Journal for Environmental Integration*, *5*(2), 24. https://doi.org/10.1007/s41207-020-00161-3
81. Stanton, T. (2012). Wind Energy and Wind Parks zoning.
82. Stevens, L., Anderson, B., Cowan, C., Colton, K., & Johnson, D. (2017). *THE FOOTPRINT OF ENERGY: LAND USE OF U.S. ELECTRICITY PRODUCTION*. https://www.eia.gov/electricity/
83. Stokes, L. (2020). *Short Circuiting Policy*. Oxford University Press.
84. Stokes, L., Franzblau, E. I., Lovering ID, J. R., & Miljanich, C. (2023). Prevalence and predictors of wind energy opposition in North America. *Sustainability Science*, *120*(40). https://doi.org/10.1073/pnas
85. Stokes, L., & Warshaw, C. (2017). Renewable energy policy design and framing influence public support in the United States. *Nature Energy*, *2*(8). https://doi.org/10.1038/NENERGY.2017.107
86. Susan M. Opp, J. L. O. J. R., & Rugeley, C. R. (2014). Explaining the Adoption and Implementation of Local Environmental Policies in the United States. *Journal of Urban Affairs*, *36*(5), 854–875. https://doi.org/10.1111/juaf.12072
87. Susskind, L., Chun, J., Gant, A., Hodgkins, C., Cohen, J., & Lohmar, S. (2022). Sources of opposition to renewable energy projects in the United States. *Energy Policy*, *165*. https://doi.org/10.1016/j.enpol.2022.112922
88. Tang, T. (2018). Explaining technological change in the US wind industry: Energy policies, technological learning, and collaboration. *Energy Policy*, *120*, 197–212. https://doi.org/10.1016/j.enpol.2018.05.016
89. Tegen, S., Lantz, E., Mai, T., Heimiller, D., Hand, M., & Ibanez, E. (2016). *An Initial Evaluation of Siting Considerations on Current and Future Wind Deployment*. www.nrel.gov/publications.
90. Tegou, L. I., Polatidis, H., & Haralambopoulos, D. A. (2010). Environmental management framework for wind farm siting: Methodology and case study. *Journal of Environmental Management*, *91*(11), 2134–2147. https://doi.org/10.1016/j.jenvman.2010.05.010
91. The Nature Conservancy. (2023). *Power of Place*.
92. Thomas, M., DeCillia, B., Santos, J. B., & Thorlakson, L. (2022). Great expectations: Public opinion about energy transition. *Energy Policy*, *162*. https://doi.org/10.1016/j.enpol.2022.112777
93. U.S. Department of Energy (DOE). (2023). *On The Path to 100% Clean Electricity*. https://www.energy.gov/policy/articles/path-100-clean-electricity
94. U.S DOE Federal Energy Regulatory Commission. (2023). *Explainer on the Interconnection Final Rule*. https://www.ferc.gov/explainer-interconnection-final-rule
95. U.S. DOE Federal Energy Regulatory Commission. (2023). FEDERAL ENERGY REGULATORY COMMISSION Office of Energy Policy and Innovation A Handbook for Energy Market Basics Energy Primer.

96. U.S. DOE Wind Energy Technologies Office. (2023a). *Distributed Wind Market Report: 2023 Edition*. http://www.ntis.gov/about/form.aspx
97. U.S. DOE Wind Energy Technologies Office. (2023b). *Land-Based Wind Market Report: 2023 Edition*. http://www.osti.gov
98. U.S. DOE Wind Energy Technology Office. (2024a). *Wind Farms of the Future Will Be More Powerful and Quieter*. https://www.energy.gov/eere/wind/articles/wind-farms-future-will-be-more-powerful-and-quieter
99. U.S. DOE Wind Energy Technology Office. (2024b). *WINDExchange_ Production Tax Credit and Investment Tax Credit for Wind Energy*. https://windexchange.energy.gov/projects/tax-credits
100. U.S. Energy Information Administration. (2023, December 27). *Wind explained Electricity generation from wind*.
101. U.S. Energy Information Administration. (2024a). *Kansas State Energy Profile Kansas Quick Facts*. https://www.eia.gov/state/print.cfm?sid=KS
102. U.S. Energy Information Administration. (2024b). *Wind generation declined in 2023 for the first time since the 1990s*. https://www.eia.gov/todayinenergy/detail.php?id=61943
103. U.S Energy Information Agency. (2022). *U.S Energy Consumption by Sector*. https://www.eia.gov/totalenergy/data/monthly/pdf/sec2_n.pdf#page=5.45
104. U.S. Federal Aviation Administration. (2023, October 19). *Wind Turbine FAQs*. https://oeaaa.faa.gov/oeaaa/external/content/instructions.jsp
105. van de Ven, D. J., Capellan-Peréz, I., Arto, I., Cazcarro, I., de Castro, C., Patel, P., & Gonzalez-Eguino, M. (2021). The potential land requirements and related land use change emissions of solar energy. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-82042-5
106. Van Smeden, M., De Groot, J. A. H., Moons, K. G. M., Collins, G. S., Altman, D. G., Eijkemans, M. J. C., & Reitsma, J. B. (2016). No rationale for 1 variable per 10 events criterion for binary logistic regression analysis. *BMC Medical Research Methodology*, *16*(1), 1–12. https://doi.org/10.1186/s12874-016-0267-3
107. Veers, P., Dykes, K., Baranowski, R., Bay, C., Bortolotti, P., Doubrawa, P., MacDonald, S., Rooney, S., Bottasso, C. L., Fleming, P., Ellen Haupt, S., Hale, A., Hein, C., & Robertson, A. (2017). *GRAND CHALLENGES REVISITED IEA Wind TCP Task 11 Technical Report Wind Energy Research Needs for a Global Energy Transition*.
108. Wachs, E., & Engel, B. (2021). Land use for United States power generation: A critical review of existing metrics with suggestions for going forward. In *Renewable and Sustainable Energy Reviews* (Vol. 143). Elsevier Ltd. https://doi.org/10.1016/j.rser.2021.110911
109. Weise, E. (2020). *Wind energy can help American farmers earn money, avoid bankruptcy*. https://www.usatoday.com/story/news/nation/2020/02/16/wind-energy-can-help-american-farmers-earn-money-avoid-bankruptcy/4695670002/
110. Weise, E., & Bhat, S. (2024, February 4). Across America, clean energy plants are being banned faster than they're being built. *USA Today*. https://www.usatoday.com/story/news/investigations/2024/02/04/us-counties-ban-renewable-energy-plants/71841063007/
111. Winikoff, J. B. (2022). Learning by Regulating: The Evolution of Wind Energy Zoning Laws *. *The Journal of Law and Economics*, *65*(51), S223–S262. https://doi.org/10.1086/718912
112. Wiseman, H. J. (2021). Localizing the Green Energy Revolution. *Emory Law Journal Online*, *70*. https://scholarlycommons.law.emory.edu/elj-online/40/
113. Wiser, R. H. (2004). Environmental Energy Technologies Division • Energy Analysis Department Renewables Portfolio Standards: What Are We Learning?