Permitting, Litigation Risk, and Energy Infrastructure Investment*

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Abstract

Legal risks arising from the permitting process may deter infrastructure development, but their magnitude and mechanisms are unclear. Using novel litigation data on environmental and land-use permits, I study this question in the context of renewable energy infrastructure. I find that litigation influences market entry through two pathways. Directly, a history of litigation deters renewable market entry by 4 percent at the mean entry rate through perceived risk, while legal precedent encourages entry by 9 percent by clarifying legal standards. Indirectly, through regulatory agency responses, litigation extends permit review timelines by 21 days on average and by 206 days following negative rulings, while legal precedent mitigates these delays. The informational clarity created by legal precedent generates non-rival, non-excludable spillovers, resembling a public good. Because developers bear private litigation costs while the benefits of clearer standards are shared market-wide, economic theory predicts underinvestment in legal precedent. I develop a structural model to quantify permitting costs and assess the extent of this underinvestment. The model estimates average permitting costs of $5.5 million, or 14 percent of expected project net profits. Counterfactual simulations show that a legal fee shifting scheme would increase market entry by 6.1 percent, compared to 3.4 percent from permitting cost reductions. Internalizing the externalities of legal precedent may accelerate renewable deployment more effectively than administrative reforms alone.

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1 Introduction

Capital investment in public infrastructure is fundamental to long-term economic growth and productivity (Munnell 1992, Granados & Topalova 2014). Before breaking ground, many infrastructure projects must navigate a permitting process that ensures environmental compliance, protects public resources, and authorizes appropriate land use. In the United States, however, permitting is often slow, bureaucratic, and fragmented, delaying critical infrastructure investments (Brooks & Liscow 2023). Such permitting challenges are particularly salient for renewable energy infrastructure. This creates a "green versus green" tension, in which environmental safeguards designed to protect ecosystems can inadvertently slow or block infrastructure essential for decarbonization.

One important but underexplored source of friction in the permitting process is litigation. Lawsuits have become an increasingly common tool for stakeholders seeking to block such projects. These legal challenges can shape developers' expectations and affect their investment decisions by imposing direct costs, such as legal fees and delays, and through informational spillovers that heighten perceived risk. This intersection of permitting and litigation raises important economic questions about how legal uncertainty affects entry decisions, investment behavior, and the overall pace of renewable energy deployment.

Understanding legal challenges in the permitting of renewable energy infrastructure has gained urgency given the sharp rise in electricity demand. Driven by electrification, artificial intelligence, and the resurgence of domestic manufacturing, U.S. electricity use is projected to increase by 15.8 percent by 2029 (Walton 2024).[1] Meeting this demand will require timely capacity expansions, with a growing share expected to come from renewable sources such as wind and solar, which accounted for 17 percent of U.S. generation in 2024 (*Electric Power Monthly - Energy Information Administration* 2025). However, compared with fossil fuel infrastructure, renewable projects operate under more ambiguous regulatory frameworks and face greater exposure to legal challenges because utility-scale renewables typically require large parcels of land and rely on relatively new and often unclear legal frameworks (Sercy & Cavert 2024, Bennon & Wilson 2023).

Litigation and permitting obstacles have drawn growing attention from policymakers and industry leaders concerned about regulatory barriers to investment.[2] There

[1] The North American Electric Reliability Corporation has warned that more than half of North America may face elevated risks of electricity shortfalls within the next decade (North American Electric Reliability Corporation 2024).

[2] Since the 1970s, when national permitting regimes were introduced, the United States has experienced persistent slowdowns in productivity growth (Gordon 2017), while infrastructure costs have risen to approximately three times those of other high-income countries (Transit Costs Project 2024). Although this correlation does not imply causation, the timing and magnitude of these trends help

is now bipartisan agreement that permitting reform is a priority (U.S. Congress 2024, Orler et al. 2024), with the U.S. Chamber of Commerce calling the process "broken" (U.S. Chamber of Commerce 2025). Recent studies echo this concern, finding that legal barriers, often amplified by local opposition, continue to be a key bottleneck in the permitting process (Bauer et al. 2024). Such local opposition typically arises from nearby communities, local governments, or interest groups that challenge projects over land use, perceived environmental and property value concerns, or visual and noise impacts.

How do legal challenges affect renewable development? Empirical analysis remains limited due to data constraints. To address the research gap, I collect a new dataset with national coverage of litigation related to all types of environmental and land-use permits for energy projects on previously undeveloped sites (greenfields), including both renewable energy facilities and transmission infrastructure.[3] These litigation data are supplemented with permitting data for one type of permit captured in the litigation dataset: the Clean Water Act (CWA) Section 404 permit. The Section 404 permit is commonly required for renewable energy projects located near navigable waters, wetlands, or other natural resources regulated under the CWA. I obtain nationwide application records for this permit through Freedom of Information Act (FOIA) requests. I supplement these data with information on electricity market entry from the grid connection process, as well as data on electricity market conditions, regulatory stringency, and county-level characteristics across the United States. Throughout this paper, I define market entry as a developer's entry into the grid connection process, by an application to join the interconnection "queue."

Using this new dataset, I provide evidence on how litigation over environmental and land-use permits shapes renewable energy development through two contrasting informational channels that affect both developers and permitting agencies. First, litigation signals legal risk, informing actors of the likelihood of future challenges over permit issuance. Second, legal precedents reduce ambiguity by clarifying legal standards and providing regulatory guidance. Legal precedents are judicial rulings that establish authoritative interpretations of the law for future cases with similar facts. [4]

explain why permitting has drawn widespread attention and discussion.

[3]Transmission projects are included because, like renewable energy developments, they often require extensive greenfield land and face similar permitting challenges. As such, litigation involving transmission projects can provide valuable information about the broader legal environment that renewable energy developers are likely to encounter.

[4]Legal precedents typically arise from "appellate courts" or "higher courts." I use the term "lower court" or "trial court" to describe a court where a dispute is initially heard. In the U.S., this could be federal district court or state trial court. A lower court's decision is typically not considered controlling or binding precedent. An intermediate court hears appeals from the "lower court." The highest court in a jurisdiction, such as the U.S. Supreme Court, hears appeals from intermediate courts. I use the terms "appellate court" and "higher court" to refer to a court that provides precedent, whether that court is intermediate or the highest in a jurisdiction.

I first show direct evidence of how these channels impact developers' market entry decisions. Developers consider a history of litigation in a location to assess their likelihood of facing similar disputes. I find that a history of litigation reduces future entry by 4 percent at the mean entry rate, a deterrence effect consistent with developers avoiding locations with elevated legal risk. Conversely, legal precedent encourages entry by 9 percent at the mean entry rate, reflecting developers' preference for locations with greater legal clarity.

On the regulatory side, I examine how these channels shape agency practices, creating an indirect pathway through which litigation history impacts developers. While agencies cannot control which projects seek permits, they can adjust their permitting practices based on litigation patterns within their jurisdiction. Past litigation signals heightened legal risk, prompting agencies to adopt more cautious procedures. Using Clean Water Act permits as a case study, I find that additional litigation cases lengthen review timelines by an average of 21 days (a 25 percent increase), while a history of negative rulings extends timelines by 206 days (a 250 percent increase). Negative rulings refer to court decisions in which a permit is deemed invalid or requires further verification or review. Agencies also impose extra procedural burdens, such as a higher likelihood of issuing permits with added conditions. Because renewable energy development is highly time-sensitive, with project timelines directly affecting eligibility for policy incentives, financing conditions, and electricity grid access, these regulatory slowdowns can significantly hinder project development. Legal precedent, however, provides clearer guidance that tempers agencies' risk-averse behavior and enables more consistent permitting decisions. Even when rulings are negative, precedent mitigates their impact by reducing uncertainty. The results show that when legal precedent interacts with negative rulings, review timelines shorten by about 220 days, and other procedural burdens are eased.

Legal precedent is an informational public good. Higher court legal proceedings can establish legal precedent that clarifies permitting standards and reduces uncertainty for future projects. This informational and institutional clarity generates non-rival, non-excludable spillovers across the market. Because parties directly involved in litigation bear the costs of higher court legal proceedings while the benefits are shared broadly [5], economic theory predicts underinvestment in legal precedent. Consistent with this prediction, only 35 percent of developers with unfavorable lower court rulings pursue appeals, despite a 45 percent appellate success rate.

Next, I develop a structural model of energy project development that incorporates litigation risk arising from the permitting process. The model serves three purposes. First, the model corrects for selection into the observed litigation sample. This issue

[5] Courts are publicly provided, but it is reasonable to assume that the cost to the public of funding courts is fixed over the short to medium term.

arises primarily in state courts, where trial court records are incomplete; cases generally enter the dataset only when they are appealed to state appellate courts. This correction helps address potential bias from unobserved factors correlated with both litigation outcomes and project decisions. Second, I estimate the monetary value of permitting costs that developers face when deciding whether to enter the market. Finally, I evaluate counterfactual scenarios and their effects on renewable energy deployment. Through the counterfactual analysis, I also quantify the value of legal precedent that individual developers do not internalize in their private decision-making.

I estimate the structural model using the simulated method of moments (SMM). Identification draws on variation across legal environments, permitting conditions, markets, and county characteristics. Differences in project entry across locations with varying exposure to legal risk, permitting backlogs, and profitability identify parameters governing entry decisions, while variation in appellate participation and outcomes across legal settings informs parameters of the appeal stage. Correlations in unobserved factors across stages are addressed using exclusion restrictions that shift one decision margin without affecting others. In particular, historical transmission infrastructure density influences entry but not lower-court litigation or appeals, lower-court caseloads affect lower-court litigation risk but not entry or appeal payoffs, and appellate caseloads impact the probability of appeal conditional on lower-court litigation. These exclusion restrictions provide the exogenous variation necessary to separately identify correlated unobservables across decision stages.

The model estimates reveal several patterns. First, permitting costs are modest for most projects but substantial for some. Conditional on entering the market and having a positive net profit, the median permitting cost is approximately \$4.4 million. These costs are right-skewed: the mean is \$5.5 million, while at the 90th percentile they reach \$8.8 million. To put these figures into perspective, relative to project net profit, permitting costs represent 6 percent at the median, 14 percent on average, and more than 40 percent for the most burdened projects at the 90th percentile. Second, a history of litigation raise permitting costs by about \$0.67 million, while legal precedent reduces costs by about \$0.26 million. Administrative backlog in obtaining general permits increases costs by about \$0.10 million, and local zoning regulations impose the single largest burden at \$2.29 million. Third, the model reveals moderate but economically meaningful correlation in unobserved factors across decision stages. The correlation between entry and lower-court litigation exposure is 0.73, while the correlation between lower-court litigation and higher appellate court proceedings is 0.44. These correlations confirm that selection into litigation is non-random and underscore the importance of explicitly modeling this selection process when estimating the effects of legal and regulatory barriers.

I use the model to conduct a comparative static analysis that isolates the informational value of legal precedent. This exercise simulates a legal environment in which each county attains its maximum observed level of precedent over the sample period, approximating an institutional setting with greater legal clarity. The results show that project entry increases by 2.6 percent relative to the baseline, indicating that enhanced legal clarity alone yields modest gains.

I then use the model to evaluate two categories of counterfactual policies. The first category addresses the market failure arising from underinvestment in legal proceedings that generate precedent. This is simulated through a fee-shifting provision and a legal insurance scheme that reduce developers' private litigation costs and encourage greater investment in legal clarity, which provides social value. The second category examines administrative permitting reforms that lower permitting costs through streamlined review processes. The counterfactual results show that a 20 percent fee-shifting scheme, which allows projects involved in litigation to recover their appeal costs, increases project entry by 6.1 percent. This effect is substantially larger than the 1.6 percent increase under a legal-insurance scheme, which achieves a similar reduction in expected litigation costs after accounting for an upfront premium fee. In comparison, administrative reforms such as streamlining the permitting process, modeled as a 20 percent reduction in permitting costs, yield a 3.4 percent increase in project entry. These findings suggest that policies designed to internalize the positive externalities of legal precedent, such as legal fee-shifting provisions, offer greater potential for accelerating renewable deployment than administrative streamlining alone.

Related Literature

First, this paper contributes to the growing body of economic research on barriers to energy infrastructure development by focusing on the permitting process, which has been rarely studied in the economics literature. I provide the first causal empirical analysis of litigation risk within the permitting process. A broad consensus holds that inefficiencies in transmission planning, grid connection (interconnection queue), and permitting constitute major obstacles to integrating new generation capacity into the electric grid (The White House 2023). Recent work has examined how these institutional frictions constrain infrastructure expansion: Davis et al. (2023) and DeLosa III et al. (2024) highlight the effects of regulatory complexity and logistical constraints in transmission planning, while Johnston et al. (2023, 2025) document the delays and costs associated with interconnection queues.

Second, this paper identifies legal disputes arising from the permitting process as an underexplored factor influencing renewable energy market entry. In doing so, I contribute to literature examining how land-use regulation, environmental policy, and local opposition shape firms' entry decisions. Prior research shows that zoning and land-use restrictions can create entry barriers and distort competition across sectors (Bunting 2021, Suzuki 2013). In the renewable energy context, setback requirements reduce land availability, regulatory leniency varies with local political preferences, and community opposition can raise costs and discourage entry (Lopez et al. 2023, Huang & Kahn 2024, Jarvis 2021).

Third, this paper engages with the literature on litigation-induced hold-ups, which documents how legal challenges generate delays and cost overruns in infrastructure projects. I contribute by quantifying the deterrent effect of permitting-related litigation and estimating permitting costs that incorporate litigation-induced regulatory burdens. Prior research shows that litigation arising from regulatory challenges and local opposition increases infrastructure costs and delays project completion (Gordon & Schleicher 2015, Brooks & Liscow 2023, Zambrano 2023). These effects largely stem from prolonged permitting timelines and additional administrative burdens (Liscow 2024, Bennon et al. 2023). Renewable energy projects are particularly vulnerable, as legal disputes create regulatory uncertainty (Brown & Escobar 2007, Bennon & Wilson 2023).

Lastly, this paper contributes to the literature that conceptualizes legal precedent as a public good. I provide the first empirical evidence of legal precedent's informational value in renewable energy industry, showing that precedent facilitates market entry and generates public value beyond individual litigants' interests. The economic analysis of legal precedent and legal uncertainty provides foundational insights into litigation mechanisms. Landes & Posner (1998) conceptualize precedent as a public good, arguing that precedent creation constitutes an investment by litigants that reduces uncertainty for future parties. Subsequent work highlights that legal uncertainty itself drives litigation: when standards are ambiguous, disputes are more likely to arise, while adjudication resolves uncertainty by producing precedent (Dari-Mattiacci & Deffains 2007, Dari-Mattiacci et al. 2011, Alexander 2025). This feedback loop between legal ambiguity, litigation incentives, and legal clarification is particularly salient in emerging policy domains such as renewable energy permitting, where legal frameworks continue to evolve.

The remainder of the paper is organized as follows. Section 2 provides an overview of the legal framework for renewable energy permitting in the United States. Section 3 describes the data and summarizes descriptive statistics. Section 4 presents reduced-form evidence on how litigation history affects renewable energy development and elicits regulatory responses. Section 5 introduces a structural model of project entry and legal engagement that incorporates litigation risk and externalities. Section 6 presents the identification strategy, estimation approach, and results. Section 7 presents counterfactual simulations, and Section 8 concludes.

2 Legal Framework for Renewable Energy Permitting in the United States

Permitting is a central step in developing utility-scale renewable energy projects. Before financing and construction, developers must obtain land-use and environmental permits and secure interconnection agreements for grid access (American Wind Energy Association 2020, Gillam 2023). These processes often proceed in parallel, and the full timeline from market entry to commercial operation averages roughly five years (Rand et al. 2024), with permitting occupying much of the pre-construction phase. Appendix 1 provides additional detail on the U.S. permitting system. Permitting oversight prevents environmental harm and ensures alignment with land management objectives. However, because permit decisions can be challenged in court, permitting often becomes a focal point for legal disputes, typically driven by local community opposition.

2.1 Fragmented Regulation and Legal Ambiguity

Renewable energy projects face greater legal uncertainty and regulatory fragmentation than most other industries, including fossil fuel development (Reed et al. 2021). Utility-scale wind and solar facilities are typically greenfield projects requiring extensive use of undeveloped land, which can trigger overlapping federal, state, and local permitting requirements with limited coordination. Federal statutes such as the National Environmental Policy Act, the Clean Water Act, and Endangered Species Act each govern separate aspects of environmental review, while states assess projects based on need determinations and environmental impacts, and local governments impose additional zoning and environmental requirements. However, no single agency oversees or coordinates these layers of approval. This regulatory patchwork creates numerous procedural points where opponents can challenge permits, compounded by the lack of standardized permitting frameworks for renewable energy.

The contrast with fossil fuel development is evident in permitting trends. Between 2010 and 2018, clean energy projects accounted for 60 percent of NEPA Environmental Impact Statements compared to 24 percent for fossil fuels (Mackenzie 2025). Moreover, fossil fuel operations benefit from more established regulatory pathways, including categorical exclusions under the 2005 Energy Policy Act that allow oil and gas drilling permits without site-specific environmental analysis (U.S. Government Accountability Office 2009). These mature regulatory systems provide fossil fuel developers and agencies with clearer guidance and greater legal certainty than the evolving frameworks governing renewable energy.

2.2 Reactive and Contested Local Zoning Regimes

Renewable energy projects face a more unstable local regulatory environment that heightens litigation risk. Unlike established industries with settled zoning frameworks, wind and solar projects often confront ordinances adopted or amended in response to specific proposals (Eisenson 2023). This reactive approach creates legal vulnerability, as local governments frequently revise setbacks, height limits, noise standards, and land-use rules, sometimes applying changes to projects already underway. Such mid-stream revisions invite lawsuits alleging procedural defects, conflicts with state law, or violations of vested rights. Because these rules are often newly enacted or frequently revised, they lack legal precedent, increasing the likelihood of challenges and reducing predictability.

At the local zoning level, the contrast with fossil fuel development is stark. Fossil fuel projects often benefit from state preemption, which insulates them from local opposition and creates a more predictable legal environment. For example, California vests exclusive certification authority for thermal power plants of 50 MW or more in the Energy Commission, in lieu of local permits (California Energy Commission n.d.). In Wisconsin, issuance of a Public Service Commission Certificate of Public Convenience and Necessity withdraws municipal authority over matters the Commission addressed or could have addressed (Wisconsin State Legislature 2023).

2.3 Heightened Litigation Risk for Renewable Energy

Fragmented permitting authority, evolving local ordinances, and the absence of categorical exclusions combine to increase litigation exposure for renewable energy projects. At the federal level, available data confirm that renewable energy projects experience substantially higher litigation rates than fossil fuel developments. For example, under NEPA review, 64 percent of solar projects and 38 percent of wind projects were litigated, compared to 0 percent for gas and coal plants (Bennon & Wilson 2023). Comparable litigation statistics for the local level are not available in current research, but the reactive nature of local zoning for wind and solar strongly suggests a volatile legal environment similar to that seen at the federal level. These disparities reflect both the procedural complexity of permitting and the greater legal ambiguity of renewable-specific regulatory frameworks, which remain less standardized than those for fossil fuel infrastructure.

3 Data

This project draws on a newly collected litigation dataset, as well as permitting, energy market, regulatory, and county-level demographic and economic data.

3.1 Litigation Data

I construct a novel dataset of legal cases involving greenfield energy infrastructure that contested or defended environmental or land-use permits prior to June 2024. These legal disputes primarily involve conflicts between energy developers, regulatory agencies, and other public or private stakeholders. Such disputes typically manifest in two forms: challenges to approved permits, where public interest groups or local residents are the plaintiffs, while energy developers and government agencies are defendants; and challenges to permit denials or delays, where developers are the plaintiffs challenging adverse regulatory decisions, with government agencies as defendants. Examples of these litigation cases are shown in Appendix A.2.

I identified relevant cases through searches in two legal databases widely used by legal scholars: Westlaw and LexisNexis. I applied a string-based search algorithm to systematically detect litigation that met this study's criteria, with the specific search strings detailed in the Appendix A.3 and Appendix A.4. In addition, to capture federal cases that the initial searches might have missed, I supplemented the dataset with records from the Public Access to Court Electronic Records (PACER) system.

The newly collected dataset provides coverage across the federal and state court systems, as illustrated in Figure 1, though with varying comprehensiveness by court level. In the federal system, I capture nearly all relevant litigation with written records, since federal court records are systematically maintained and accessible through platforms such as PACER and legal databases.[6] As a result, it is unlikely that relevant federal cases are missing from the dataset. State court coverage is strong for higher appellate and supreme courts, which typically provide public access to decisions and maintain consistent records. In contrast, lower state trial court coverage is more limited due to substantial variation in record-keeping practices and restricted public access. In each empirical section that follows, I discuss the potential biases introduced by this sampling limitation. In my structural model, I explicitly model selection into my observed litigation data.

[6] PACER is the official electronic access system for the United States federal courts. It provides searchable access to docket entries, case metadata, and filings from district, appellate, and bankruptcy courts. Although some cases may be sealed for reasons such as national security or privacy, such restrictions generally do not apply to the land use and environmental permitting litigation analyzed in this study. I use PACER in conjunction with Westlaw and LexisNexis to identify and verify federal cases, including cases that may be incomplete or partially represented in Westlaw or LexisNexis. For this category of civil litigation, coverage during the 2000 to 2024 period is effectively complete.

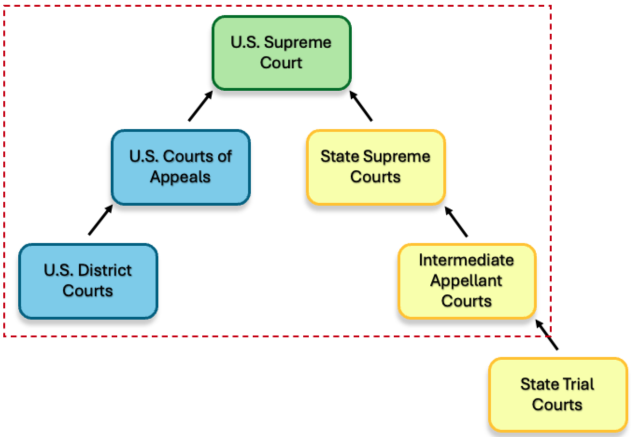

Figure 1: Level system hierarchy

Note: Litigation data from courts within the red dashed triangle are largely comprehensive, as these courts systematically publish records. This includes federal courts: U.S. supreme court (green), U.S. courts of appeals and U.S. district courts (blue) and part of the state courts: state supreme courts and state intermediate appellant courts (yellow). In contrast, data from state trial courts (yellow, outside the triangle) reflect a selective sample of publicly posted cases.

Within this coverage framework, the dataset encompasses 1,009 unique court cases. For each case, I collected detailed information on legal attributes, including court level, statutes invoked, parties involved, requested relief, court decisions, injunctive relief granted, and the case timeline. I also constructed a variable indicating whether a decision qualifies as legal precedent. To identify such cases, I employed a dual-verification approach using both legal databases. A case is classified as legal precedent if Westlaw designates it as precedential and LexisNexis indicates public publication (enabling citation by future cases). This conservative approach ensures that only cases with recognized legal authority are classified as precedent-setting. Additionally, I recorded project characteristics for the infrastructure projects involved in each case, including project name, developer, fuel type, capacity, and geographic location.

These litigation cases are filed across various courts under different statutes. Figure 2 illustrates the distribution of cases by court level and applicable statute type, demonstrating the institutional diversity of greenfield energy disputes within the judicial system. Wind-related litigation is prevalent in both federal and state court, whereas solar-related litigation is more often governed by state or local statutes and heard in state courts.

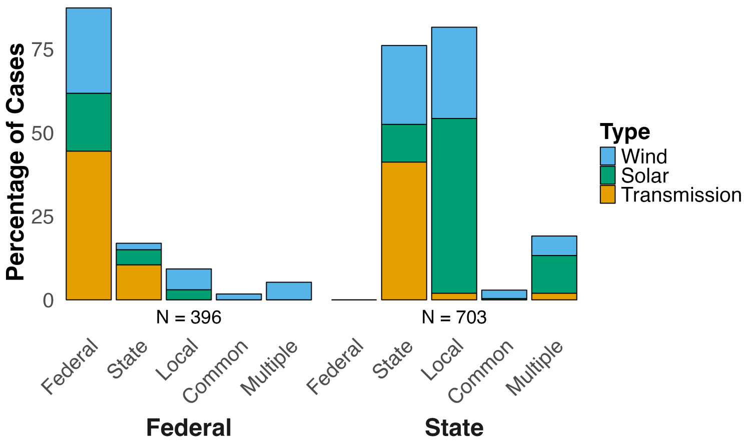

Figure 2: Court and Statute Level by Project Type

Note: Distribution of legal cases by court system (federal vs. state) and the type of statute cited (federal, state, local, common law, or multiple). The left panel reports cases filed in federal courts, while the right panel reports those in state courts. Each bar is color-coded by project type: blue for wind, green for solar, and orange for transmission. The figure highlights that wind-related and transmission-related litigation are prevalent in both federal and state court, whereas solar-related litigation is more often governed by state or local statutes and heard in state courts.

The data demonstrates both spatial and temporal variation in permit-related litigation cases. Figure 3 demonstrates that litigation is not simply concentrated in regions with the highest levels of renewable energy development. Instead, renewable energy litigation exhibits geographic clustering, with distinct regional hotspots that do not necessarily correspond to areas of greatest wind or solar resource potential or project density. This spatial pattern suggests that litigation risk is likely shaped by factors beyond project concentration. Plausible additional factors include regional differences in regulatory frameworks, institutional capacity, local opposition intensity, and legal culture. This geographic heterogeneity has important implications for renewable energy investment decisions and market efficiency. Temporally, figure 4 reveals distinct litigation patterns across project types. Wind energy projects have faced the most consistent legal challenges, with notable increases around 2009, peaking in 2016, and rising sharply again in 2023. Solar litigation showed a steep rise beginning in 2011, followed by steady growth.

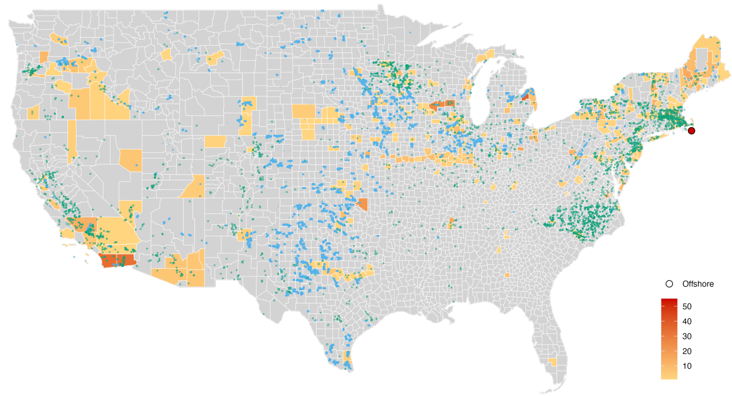

Figure 3: Geographic Distribution of Renewable Energy Litigation

Note: Geographic distribution of legal cases related to clean energy projects across the continental United States. Color intensity indicates the number of cases per county, with darker shades representing higher concentrations of legal activity. Blue dots denote operational wind farms, while green dots represent operational solar farms.

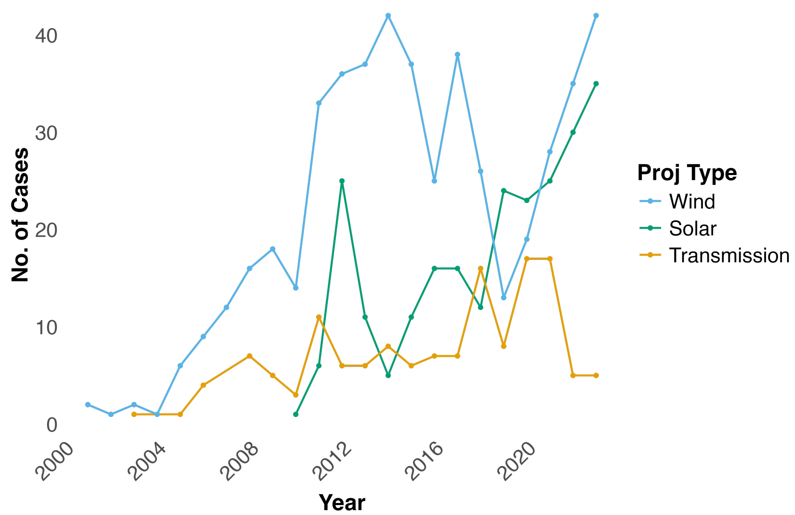

Figure 4: Time Series of Renewable Energy Litigation

Note: The lines display number of legal cases related to renewable energy projects while the shaded areas show number of projects enter operation from 2000 to 2023, categorized by project type: wind, solar, and transmission. Wind energy projects have faced the most consistent legal challenges, with notable increases around 2009, peaking in 2016, and rising sharply again in 2023. Solar litigation showed a steep rise beginning in 2011 followed by steady growth, while transmission-related cases remain less frequent and more stable.

3.2 Permitting Data

Among the various permitting processes required for utility-scale energy infrastructure and included in my litigation dataset, Clean Water Act (CWA) Section 404 permits, administered by the U.S. Army Corps of Engineers (USACE), provide the most transparent data for investigating how regulatory agencies respond to litigation threats. I use CWA Section 404 permits as a case study to examine agency behavior.

CWA Section 404 permits are commonly required for renewable energy projects near navigable waters, wetlands, or other resources under the CWA.[7] As one of the most widely used federal permitting programs, with general permits covering tens of thousands of activities annually, Section 404 offers exceptional advantages for empirical analysis. USACE maintains detailed, standardized records of applications and decisions across all offices. While Section 404 represents only one component of the broader permitting framework, its procedural similarities to other federal and state processes and its transparent documentation make it a strong empirical lens, suggesting that these findings may extend beyond the CWA context.

The primary data source is the USACE Operation and Maintenance (ORM) permit decisions database, which tracks permit applications and outcomes across all USACE offices. Through FOIA requests to USACE Headquarters, I obtained national permitting data from 2010 to 2022 for greenfield energy projects. The dataset includes permit type, final outcome (issued, denied, or withdrawn), review timeline, geographic identifiers, and project description. To extract additional project characteristics, I applied text analysis to the project description field, identifying project type, infrastructure category, references to emergency use and right-of-way alignment, and whether the project served a core or supplementary infrastructure role.

Of the permit applications, 98 percent are general permits (national general permits, regional general permits, and programmatic general permits), which are designed to authorize activities with minimal environmental impact through pre-established approval processes. In contrast, the remaining applications required individual permits (standard permits and letters of permission), which involve comprehensive project-specific environmental review and more extensive regulatory scrutiny. Figure 5 maps the geographic distribution of permitting applications in the dataset by project type, illustrating the nationwide coverage of CWA Section 404 activities for energy projects.

[7] No official report documents what share of renewable energy projects require Section 404 permits. I cannot calculate this exact statistic because I cannot merge the Clean Water Act permit data with specific energy projects that entered the market. However, from 2010 to 2020, there were 5,447 Section 404 applications submitted by wind and solar projects, while 15,543 projects entered the grid interconnection process during the same period.

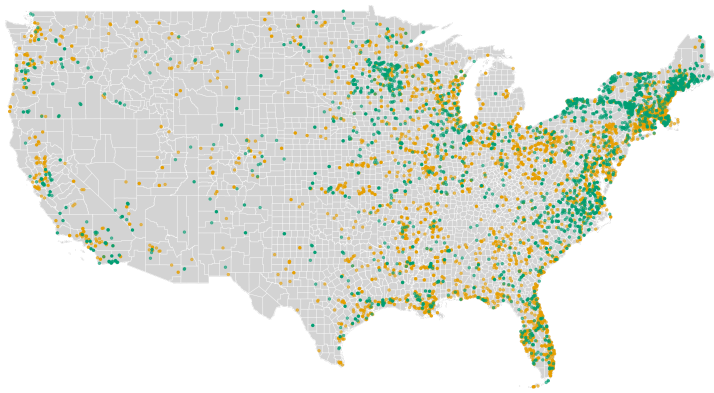

Figure 5: Geographic Distribution of CWA 404 Permit Applications

Note: Geographic distribution of Clean Water Act (CWA) Section 404 permit applications submitted from 2010 to 2022 across the continental United States, by project type. Green dots denote generators (wind and solar), and yellow dots denote transmission applications.

3.3 Energy Market Data

This project also draws on interconnection queue data compiled by Lawrence Berkeley National Laboratory to analyze renewable energy market entry behavior (Rand et al. 2024). The data track energy projects as they apply to connect to the electricity grid. Queue entry represents one of the earliest formal steps in project development and serves as a strong institutional signal of market entry intent. Developers typically submit interconnection requests before initiating the permitting process, making the queue a reliable proxy for early-stage investment decisions that can be analyzed in relation to litigation exposure. The dataset includes detailed information on interconnection dates, project characteristics such as fuel type, capacity, and queue status, and the transmission owner operating the electric grid to which each project aims to connect. County-level summary statistics for this dataset are presented in Table 1.

Table 1: Summary Statistics of Market (Interconnection) Entry

Variable	Mean	Variable	Mean
Project Status - Complete	0.075	Fuel - Solar	0.830
Project Status - Active	0.434	Fuel - Wind	0.170
Project Status - Withdrawn	0.491	Capacity(MW)	139.269

I also draw on other energy market data to calculate net profit for potential entrants in my structural model. I detail these data in Appendix A.8 when discussing profit construction.

3.4 Other Data

This project further incorporates data on regulatory stringency, county-level demographic and economic conditions, and court system caseloads. To capture local regulatory environments, I use zoning ordinance data from the National Renewable Energy Laboratory, which document state and local siting rules for wind and solar projects and proxy permitting burdens at the local level (Lopez et al. 2022*b*,*a*). To measure geographic variation in federal permitting exposure, I use the dataset from Greenhill et al. (2024), which provides spatial estimates of jurisdictional water regulated under the Clean Water Act over time and across presidential administrations.

I also include county-level demographic and economic variables that may influence both project siting and litigation activity. These controls capture population size, income levels, political composition, and economic dependence on different type of industries. In addition, I include the share of land in each county under federal ownership, since projects on or near federal land face distinct permitting requirements. Together, these variables account for underlying regulatory, socioeconomic, and political conditions that shape both permitting practices and the likelihood of legal disputes.

Finally, I include measures of court system caseloads at both the lower trial court level and the higher appellate court level (Gibson et al. 2024).

4 Reduced-Form Evidence

This section provides reduced-form evidence on how litigation over environmental and land-use permits shapes renewable energy development through two contrasting informational channels that affect developers directly and indirectly: litigation signals legal risk while legal precedent reduces legal ambiguity.

4.1 Litigation Deters, Legal Precedent Encourages Renewable Entry

In this subsection, I examine how litigation history directly shapes renewable energy developers' market entry decisions at the county level. The analysis focuses on entry into the grid connection process, one of the earliest formal steps in project development and a strong institutional signal of market intent. Developers may respond to litigation history because past legal challenges signal risk and increased development costs that could threaten project viability and returns on investment.

I test three hypotheses within this framework. First, counties with a history of permitting-related litigation are less likely to attract new renewable energy projects. Second, litigation with negative court outcomes (at either the lower or higher court level) discourages future entry more than litigation with neutral or favorable outcomes. Third, legal precedent established through judicial rulings facilitates future entry.

I conduct the analysis using a county-month panel and employ the following regression:

$$entry_{it} = \beta\, \boldsymbol{litigation}_{it} + \delta\, \boldsymbol{C}_{it} + \gamma \boldsymbol{E}_i + \alpha_i + \lambda_t + \varepsilon_{it}, \tag{1}$$

where $entry_{it}$ is defined as the occurrence of a new project entering the grid connection process in county i in period t.[8]

The key independent variable, $\boldsymbol{litigation}_{it}$, is a vector capturing litigation history at two geographic layers to reflect distinct channels of legal influence. Four measures are constructed at the county level: total cases filed within the same county, cases with negative rulings for developers, county-level legal precedent, and interaction terms between precedent and negative outcomes. These measures capture localized legal friction that directly signals risk to developers considering entry in that specific county. One measure is constructed at the jurisdictional level and captures legal precedent established by higher appellate courts. Legal precedent has binding authority across all counties within the court's jurisdiction, reflecting the primary channel through which higher-court rulings shape developer expectations. All litigation variables are measured using a one-quarter lag: for each month, the litigation variables reflect cumulative legal activity up to the end of the previous quarter. This lag structure ensures that the legal environment precedes entry decisions, reducing concerns about simultaneity. Moreover, the litigation history measures cases initiated in earlier periods, typically by external parties such as project opponents or other developers already active in the market, rather than by developers entering in the current period. This provides quasi-exogenous variation in legal exposure.

The vector of controls, $\boldsymbol{C}_{it}$, includes time-varying county-level covariates that address potential confounding factors driving both litigation exposure and entry decisions. First, I control for grid conditions and market fundamentals through the number and aggregate capacity (in megawatts) of energy projects with higher priority in the interconnection queue, which capture transmission constraints and unobserved location-specific advantages. Second, I control for regulatory stringency through the presence of local ordinances and federal statutory jurisdiction (e.g., CWA jurisdiction),

[8] I model entry as a binary outcome rather than a count of entries for two reasons. First, most county-month observations record zero entries, so a binary specification avoids excessive zeros and sparsity that could destabilize estimation. Second, there could be spikes in the number of entries in certain months that reflect interconnection queue deadlines set by transmission owners, which lead projects to bunch within the same period.

which proxy for permitting burden and administrative hurdles that could both trigger litigation and independently deter entry.

The specification also includes time-invariant county-level economic and demographic characteristics, $\boldsymbol{E}_i$, which may correlate with both litigation propensity and investment attractiveness. These include population, median household income, political composition, major industry specialization, and the share of federal land. Together, these variables account for local economic conditions and stakeholder composition that shape the regulatory environment and developers' site selection. $\boldsymbol{E}_i$ also includes county-specific wind and solar resource potential, which reflects natural resource endowments and controls for the underlying economic viability of renewable projects.

I also include transmission provider fixed effects, α_i, to control for time-invariant differences across electric service territories, including utility-specific interconnection procedures and regulatory environments. Year fixed effects, λ_t, account for common temporal shocks such as changes in federal policy and technology costs.

The analysis examines how temporal and spatial variation in litigation exposure influences developers' market entry decisions. Figure 6 presents the point estimates with confidence intervals from my preferred specification. The estimation tables for the main independent variables as well as the control variables are provided in Appendix A.5 and Appendix A.6. Summary statistics are shown in Table 2.

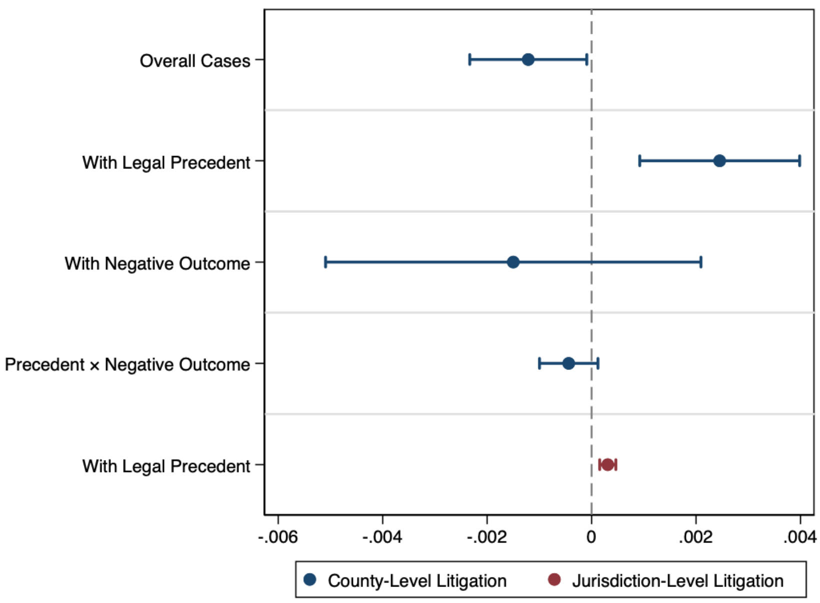

Figure 6: Coefficients for the entry analysis

Note: Coefficients estimated from equation (1), preferred specification (Appendix 5, column 4), which includes the full litigation vector, all control variables, queue-year fixed effects, and transmission provider fixed effects. Standard errors clustered at the county level.

Table 2: Summary Statistics for the Entry Analysis

Variable	Mean	Std. Dev
Future Project Entry	0.03	0.17
County General Litigation	0.16	0.93
County Litigation with Precedent	0.06	0.47
County Litigation with Neg Outcome	0.02	0.20
Jurisdiction Litigation with Precedent	1.24	3.52
No. of Higher Queued Projects	9.62	76.76
Size of Higher Queued Projects (MW)	1,018	6,994
Has Local Zoning Ordinance	0.24	0.42
Clean Water Act Jurisdiction	0.28	0.25
Wind Resource Potential	6.69	0.77
Solar Resource Potential	4.50	0.49
County Population	113,455	360,951
County Median Household Income	65,514	16,096
Political Composition - Democrat	0.36	0.15
High Farming Concentration County	0.14	0.34
Share of Federal Land	7.53	16.91

The sample includes monthly observations from 2,245 counties between 2010 and 2023, covering 35 transmission providers. Future Project Entry is a binary variable indicating whether a new project enters the interconnection queue in a given month. County general litigation is the cumulative number of past cases related to renewable energy projects seeking permits. County litigation with precedent captures cumulative exposure to cases in the county that resulted in precedent-setting decisions. County litigation with negative outcome reflects cumulative exposure to cases where courts ruled against a renewable project. Jurisdiction litigation with precedent measures cumulative exposure to precedent-setting cases within the broader legal jurisdiction. Number and size of higher queued projects (in MW) proxy for grid conditions, reflecting the number and total capacity of projects that entered the interconnection queue in the past year. Has local zoning ordinance is a binary variable indicating the presence of a wind or solar ordinance, used as a proxy for regulatory stringency. Clean Water Act jurisdiction indicates the probability that a project in the county is subject to CWA regulation and also serves as a proxy for regulatory stringency. Wind and solar resource potential represent county-level annual averages of natural resource availability. County population, median household income, political composition - democrat, a binary indicator for high farming concentration capture local economic and demographic conditions. Share of Federal Land measures the proportion of county land under federal ownership.

The history of county-specific litigation significantly affects entry outcomes. Total litigation cases reduce the likelihood of entry by 4 percent at the mean entry rate, indicating that developers actively respond to local legal risks. However, legal precedent within a county not only eliminates this deterrent effect but also reverses it: legal precedent increases entry by 9 percent at the mean entry rate, suggesting legal precedent clarifies ambiguity and reduce legal uncertainty. The effects of specific case outcomes (cases with negative rulings) and their interactions with precedent status are imprecisely estimated. This suggests that developers may place less weight on whether prior projects won or lost than on broader patterns of legal precedent and overall litigation exposure.

Legal precedent at the jurisdictional level has a positive but more modest effect on market entry. Jurisdictional precedent increases entry by about 1 percent at the mean entry rate, substantially smaller than the 9 percent county-level effect. This indicates that developers prioritize highly localized legal factors when making investment decisions. These findings align with insights from industry interviews with developers and attorneys, who frequently noted that local legal context is a key consideration alongside broader economic and market factors. Together, these findings indicate that legal precedent produces meaningful positive spillovers for future renewable energy development.

A limitation of this analysis is the incomplete coverage of state trial court litigation, which introduces measurement error in the independent variables of interest. This likely attenuates the estimated deterrent effect of litigation on entry but does not affect the estimated positive effect of legal precedent, since precedent is fully observed through higher appellate court records. If missing cases are not systematically related to outcomes favoring either party, the measured variance in litigation exposure is smaller than the true variance, biasing the coefficient toward zero and understating the deterrent effect. If missing cases reflect decisive losses for developers who choose not to appeal, my data underclassifies hostile legal environments, again biasing the deterrent effect toward zero; conversely, if missing cases reflect developer victories that do not generate appeals, the observed negative relationship could overstate the true deterrent effect. However, this limitation may not substantially affect the analysis because many renewable energy developers likely do not observe most trial court cases when evaluating potential entry locations, as trial court cases are typically not publicly visible or easily accessible unless developers already have projects in the jurisdiction and possess local knowledge. Thus, the incomplete coverage in my dataset likely mirror developers' actual information sets when evaluating potential entry locations.

4.2 Regulatory Response to Litigation History

In this subsection, I investigate an indirect pathway that contributes to the pattern identified in the above analysis: how permitting agencies respond to litigation history in ways that subsequently affect developers' entry decisions. Regulatory agencies can become involved in legal disputes regardless of their permit decisions, as environmental groups may sue over approvals while developers may litigate denials. This dual legal vulnerability incentivizes agencies to adapt their permitting practices in response to perceived litigation risk. I test whether a history of permitting-related litigation leads agencies to impose longer review timelines and stricter procedural requirements on subsequent permit applications.

This analysis focuses on Clean Water Act Section 404 permits as a case study. The analysis concentrates on federal court litigation because Section 404 permits fall under federal agency jurisdiction and are governed by federal statute, making federal court legal activity more likely than state court litigation to directly influence USACE's permitting practices. This focus on federal courts also minimizes concerns about bias from incomplete data coverage.

The analysis uses permit-level cross-sectional data and estimates the following specification:

$$\text{permit\_complexity}_i = \beta\, \boldsymbol{litigation}_i + \delta\, \boldsymbol{C}_i + \alpha_i + \varepsilon_i \tag{2}$$

To capture different dimensions of permitting complexity, I estimate this specification separately using two distinct $\textit{permit\_complexity}_i$ outcomes. The first is permit issuance time, defined as the number of days between permit submission and final decision. The second is extra conditions, which indicate whether the permit involved more extensive issuance requirements or required procedural adjustments during the permitting process. Each outcome reflects a distinct procedural burden.

In these specifications, the key independent variable, $\boldsymbol{litigation}_i$, is a vector measuring historical exposure to permitting-related litigation relevant to permit application i. As in the entry analysis, the vector captures multiple dimensions of litigation history, but the construction differs in scope and timing. The litigation vector here is constructed using a defined lookback period prior to the submission date of each application.Specifically, it includes cases heard in federal court within the agency's jurisdiction during the one year preceding the application, measured up to one quarter before submission to avoid simultaneity. This one-quarter lag matches the entry analysis. However, the one-year lookback window is shorter because regulatory agencies may respond more to recent litigation activity, whereas renewable energy developers consider longer legal histories when making entry decisions, as indicated by industry interviews. As a robustness check, I also test alternative lookback windows of three quarters and five quarters.

The control vector, $\boldsymbol{C}_i$, includes rich permit-level characteristics such as permit type, infrastructure category, equipment type, emergency status, existing right-of-way designation, whether it is supplemental infrastructure, and the number of pending applications at submission time, which proxies for contemporaneous agency workload.

The specification includes fixed effects for USACE office, and submission year to control for persistent differences in office practices, local procedural requirements, and temporal variation.

The analysis exploits cross-sectional variation in historical litigation exposure. The identification strategy benefits from several institutional features that support causal interpretation. The institutional setting provides clear temporal ordering, where permit applications precede litigation, and litigation is initiated by external parties rather than agencies themselves. While agencies can be parties to litigation, which may introduce endogeneity concerns, office-level fixed effects absorb time-invariant differences in agency practices that might systematically attract litigation. The analysis also controls for observable project characteristics and contemporaneous workload measures that capture variation in permitting complexity unrelated to litigation history. Together, these institutional features and controls support a causal interpretation of how legal challenges influence regulatory behavior.

Regression point estimates with confidence intervals are reported in Figure 7. The corresponding estimate tables for the main independent variables are provided in Appendix A.7. Robustness checks using different time windows are reported in Appendix A.8. Summary statistics are presented in Table 3.

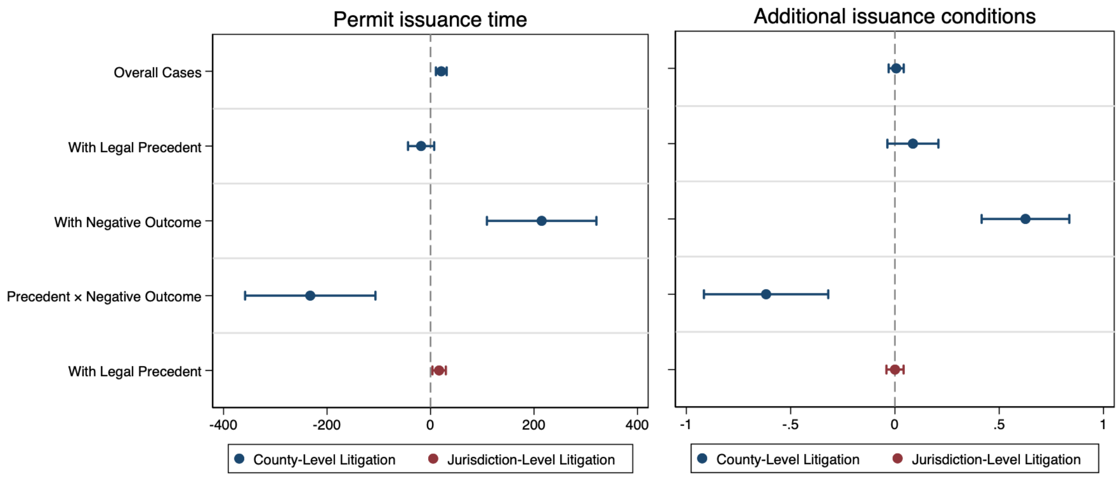

Figure 7: Coefficients for the Permitting Regulatory Response Analysis

Note: This figure presents coefficient estimates from equation (2). The left panel reports results where the dependent variable is permit issuance time measured in days. The right panel reports results where the dependent variable is a binary indicator for requiring additional issuance conditions. Both specifications include the full litigation vector measured using a 1-year lookback period. Standard errors are clustered at the county level.

Table 3: Summary Statistics for the Permit Complicity Analysis

Variable	Mean	Std. Dev
Permit Issuance Date	87.77	113.30
Application Processing Time	37.99	74.75
External Coordination	1.413	1.420
Extra Condition	0.616	0.486
County General Litigation (prior 2 yrs)	0.203	0.617
County Litigation with Precedent (prior 2 yrs)	0.073	0.331
County Litigation with Neg Outcome (prior 2 yrs)	0.020	0.145
Jurisdiction Litigation with Precedent (prior 2 yrs)	0.752	0.719
Total Application Awaiting	150.4	166.5
General Application Awaiting	164.5	179.3
Individual Application Awaiting	1.538	1.698
Existing Right-of-way	0.128	0.335
Emergency Project	0.007	0.083
Supplemental Project	0.050	0.219
Permit Type - LOP	0.003	0.055
Permit Type - NWP	0.647	0.478
Permit Type - PGP	0.016	0.125
Permit Type - RGP	0.323	0.468
Permit Type - SP	0.011	0.104
Project Type - Generator	0.275	0.446
Project Type - Transmission	0.725	0.446
Infrastructure - Cable	0.620	0.485
Infrastructure - Structure	0.076	0.264
Infrastructure - Substation	0.004	0.063
Infrastructure - Multiple	0.300	0.458

The sample includes Clean Water Act (CWA) Section 404 permit applications submitted between 2010 and 2023 to 38 U.S. Army Corps of Engineers (USACE) offices. The table reports summary statistics for the dependent variables used in the analysis. Permit Issuance Time measures the number of days from submission to permit decision, and Application Processing Time captures the days until the application is marked complete. External Coordination counts the number of external agencies consulted by USACE, while Extra Condition is a binary indicator for whether the permit required special conditions or procedural changes. County-level litigation variables reflect the cumulative number of renewable energy permitting cases over the prior two years, including total cases, precedent-setting cases, and cases with unfavorable rulings for developers. Jurisdiction-level precedent captures cumulative appellate rulings within the broader legal jurisdiction during the same period. Total Application Awaiting, General Application Awaiting, and Individual Application Awaiting measure the number of pending applications in the same USACE office at the time of submission. Existing Right-of-Way indicates whether the project involves an existing right-of-way. Emergency Project and Supplemental Project identify applications classified as emergencies or as amendments to earlier submissions. Permit Type reflects the share of applications by permit category, Project Type by project purpose (such as generation or transmission), and Infrastructure by infrastructure type.

I find that a history of litigation leads to slower permitting timelines, with delays becoming substantially larger following negative court rulings, while legal precedent can offset these effects. Historical exposure to permitting-related litigation increases timelines by approximately 21 days, representing about 25 percent relative to the sample mean. The impact becomes substantially larger when litigation includes negative outcomes for the permitting agency: negative outcomes increase timelines by 206 days, nearly a 250 percent increase relative to the mean. This dramatic effect reflects agencies responding with heightened caution to negative rulings. Importantly, the interaction between negative outcomes and legal precedent reduces timelines by 220 days, suggesting that precedent clarifies legal standards and mitigates risk-averse behavior in high-risk contexts. By contrast, jurisdiction-level precedent is not statistically significant, suggesting that localized litigation experiences are more salient in shaping agency behavior.

Litigation with negative court rulings increases the likelihood that permits are processed with additional conditions, but legal precedent mitigates these burdens. Overall litigation exposure and legal precedent alone are not significantly associated with extra conditions. However, litigation involving negative outcomes for developers substantially increases the likelihood of burdensome permit terms: each such case raises the probability of additional conditions by 0.60, nearly doubling the baseline rate. This suggests that agencies become more risk-averse following unfavorable rulings, adopting additional procedural safeguards to avoid legal scrutiny. Importantly, the interaction between precedent-setting cases and negative outcomes reduces the likelihood of extra conditions by 0.53. This indicates that, when a negative ruling establishes legal precedent, agencies impose fewer additional requirements, as precedent helps limit defensive permitting practices.

The specific independent variables driving regulatory responses differ from those explaining the entry patterns in section 4.1, but convey a similar message: litigation signals risk and deters entry, while precedent alleviates this deterrence. The key distinction lies in decision-making constraints and informational relevance. Developers can choose whether to enter based on signals of legal risk and legal clarity, responding to overall litigation activity and the presence of precedent. Case outcomes hold limited informational value: both positive and negative rulings reveal what factors attract scrutiny. Agencies face different constraints because they cannot choose the projects for which applications are submitted, and must process all applications under statutory mandates. Negative rulings are costly, in that they invalidate existing practices, while non-negative outcomes merely confirm procedural adequacy. This explains why negative rulings prompt substantial procedural adjustments and why legal precedent becomes particularly valuable in these contexts.

These patterns of heightened caution are consistent with my interviews with regulatory officials and observations from think tanks. Agencies respond to litigation through two channels. First, direct involvement in litigation prompts “litigation proofing” by modifying review processes to strengthen permit defensibility (Mackenzie et al. 2023). Second, agencies respond to broader litigation risk from cases not directly targeting them, driven by legal vulnerability and reputational concerns. This includes preemptively aligning procedures with more defensible standards after other agencies lose cases using similar methodologies, adjusting practices to comply with legal precedents that may bind the agency or shape judicial expectations, and adapting to stakeholder attitudes hardened by observing lawsuits against federal permits. These defensive regulatory behaviors likely focus on minimizing exposure rather than considering how such responses might alter the broader legal environment.

While this analysis focuses on CWA Section 404 permits, the insights likely generalize to other federal permitting regimes, with some caveats. First, CWA permits may have narrower geographic coverage than other permitting programs. Second, CWA permit procedures are relatively standardized, particularly given the widespread use of nationwide permits that streamline approval. This procedural uniformity may limit variation in agency responses compared to permitting frameworks involving more complex, project-specific reviews. While core mechanisms such as regulatory caution in response to litigation risk likely apply across permitting contexts, the magnitude and manifestation of these effects may vary in settings with greater procedural heterogeneity or broader spatial scope.

4.3 An Externality: Developers Likely Under-Invest in Legal Precedent

Legal precedent has the defining characteristics of a public good. It is largely non-excludable: once established, other developers can rely on it without compensating the developer that engages in appellate court proceedings to create it. It is non-rivalrous: one developer’s use does not diminish its availability to others. Legal precedent clarifies legal standards and reduces uncertainty for all future market participants. Because these benefits spill over to the broader market, the developer who bears the litigation costs captures only a fraction of the total value. Standard public economics predicts underinvestment by developers relative to the socially optimal level.

Patterns in the litigation data are consistent with this underinvestment logic. In the federal court sample, where coverage is most complete, only 35 percent of developers who receive unfavorable lower-court rulings pursue further legal proceedings at the appellate courts. This is relatively low in light of the fact that appellate courts rule in favor of developers roughly 45 percent of the time – nearly even odds. These figures suggest that most developers forgo appeals despite reasonable prospects of success. The most plausible explanation lies in the cost-benefit calculus facing individual developers.

In permitting disputes involving renewable projects, litigation risk is often procedural rather than substantive. More than 75 percent of observed cases place developers in a defensive posture, requiring them to protect already-approved permits. Opponents frequently request injunctions, with 47 percent of defensive cases in federal court seeking to halt construction during litigation, exploiting the fact that renewable projects are highly sensitive to timing. Even when the final ruling favors the developer, delays can raise financing costs, trigger contractual penalties, or cause the loss of tax incentives (Wiser et al. 2023, Bolinger et al. 2023). These pressures make prolonging litigation costly and risky for developers.

As a result, the private gains from legal proceedings may often be outweighed by the direct costs, prolonged uncertainty, and financing risks, while much of the potential benefit accrues to other market participants. In theory, this mismatch between who bears the costs and who enjoys the benefits creates incentives that result in underinvestment in socially valuable legal precedent.

5 A Structural Model of Entry and Legal Engagement

I next develop a structural model of energy project development that incorporates litigation risk from the permitting process. The model accomplishes three objectives. First, it accounts for selection into the observed litigation data, by explicitly modeling which developers' cases advance to appellate courts, mitigating bias from unobserved factors correlated with litigation outcomes and market entry. Second, the model quantifies permitting costs in dollar terms, providing estimates of the financial burden developers face when evaluating market entry. Third, I use the model to simulate counterfactual policy scenarios and assess their impact on renewable energy deployment.

I model project development as a two-stage process in which energy developers make sequential, discrete decisions. In the first stage, potential developers decide simultaneously whether to enter the market by submitting a grid connection request and initiating the permitting process. Permit outcomes and lower-court litigation are then realized. Developers then enter the second stage, where those whose projects are contested decide whether to appeal in higher courts.

The model is defined at the county-year level, which I treat as a distinct local development market c. A finite set of potential projects indexed by $i \in \{1, \dots, I_n\}$ make entry decisions and, conditional on being involved in permit litigation, make legal proceedings decisions at the appellate court level to maximize expected profits. The game is static and features complete information over market fundamentals, with idiosyncratic private shocks entering each stage.

The model imposes several assumptions on developer behavior. First, developers are short-lived and make entry decisions based on contemporaneous fundamentals. They do not accelerate or delay entry in response to anticipated future changes in permitting delays or legal risks. This assumption is reasonable given that shifts in legal precedent and permitting policy typically occur slowly relative to the timescale of entry decisions. Second, developers take the legal and permitting environment as fixed at the time of entry, treating institutional risks and permitting backlogs as given within the model period. This reflects the limited ability of individual firms to influence broader regulatory or judicial conditions in the short run.

5.1 Market Fundamentals and Information Structure

At the beginning of each time period, all developers observe a vector of common knowledge $\boldsymbol{S_c} = (\boldsymbol{L_c}, \boldsymbol{D_c}, \boldsymbol{M_c}, \boldsymbol{C_c})$, which summarizes institutional and economic conditions relevant for energy project development:

- $\boldsymbol{L_c}$: legal environment, capturing the number of past cases, the presence of precedent-setting court rulings, the outcomes of past litigation, and caseloads at lower (trial) courts and higher (appellate) courts with jurisdiction over the county;

- $\boldsymbol{D_c}$: permitting environment, capturing the number of existing permit applications of various types currently queued at the lead permitting agency and awaiting decisions, reflecting administrative backlog;

- $\boldsymbol{M_c}$: electricity market conditions, reflecting the expected revenue opportunity per megawatt of developed capacity. This includes wholesale electricity prices, power purchase agreements, electricity demand forecasts, and other county-level factors that determine project profitability;

- $\boldsymbol{C_c}$: county characteristics, capturing demographic, economic, political, and infrastructure factors that may influence project entry, including population size, median household income, political alignment, local zoning and ordinance requirements, and electricity grid congestion.

Each project also observes its own project-specific characteristic x_i, including fuel type(wind or solar) and capacity.

5.2 Selection Mechanism and Correlated Unobservables

A key challenge in modeling market entry and subsequent legal engagement is the selective nature of observed legal disputes. The projects that appear in my litigation data represent a non-random subset of all potential market participants, determined by unobserved characteristics such as financial resources, legal sophistication, project quality, and risk tolerance. These unobserved factors likely influence multiple stages of the development process simultaneously.

Failure to account for this selection would lead to biased estimates of both litigation risk and the costs of legal proceedings. For instance, if developers with deeper financial resources are both more likely to enter competitive markets and more likely to pursue costly appellate litigation when challenged, then the appellate sample will systematically over-represent well-capitalized firms. Similarly, if developers who enter the market possess systematically different risk tolerance or project quality than those who stay out, then permitting cost estimates derived from the observed entrant sample would generate misleading counterfactual predictions about how policy changes might affect overall market participation.

To address this selection problem, I model the joint determination of entry, lower-court litigation exposure, and appellate legal proceedings through correlated unobservables. Each developer i in market c draws a vector of private Type I extreme value shocks:

$$\boldsymbol{\varepsilon}_i = \left(\varepsilon_i^{\text{entr}}, \varepsilon_i^{\text{lit}}, \varepsilon_i^{\text{appeal}}\right)$$

These shocks govern heterogeneity in entry decisions, litigation exposure, and appeal decisions, respectively. While each shock follows an extreme value distribution to preserve the logit structure, the key modeling feature is allowing these shocks to be correlated across decision stages. The correlation structure is governed by three parameters: ρ_{EL}, which captures the dependence between entry and litigation exposure, reflecting how developer characteristics might simultaneously influence market participation and legal vulnerability; ρ_{LA}, which measures the correlation between litigation exposure and appeal propensities, capturing how factors such as legal capacity affect both the likelihood of litigation and the decision to pursue appeals; and ρ_{EA}, which captures direct correlation between entry and appeal decisions. The specific implementation of this correlation structure is detailed in the estimation section.

5.3 Stage 1: Entry and Permitting

At the start of each period, each potential developer simultaneously decides whether to enter the market and to initiate the permitting process by formally choosing $e_i \in \{0, 1\}$, where $e_i = 1$ denotes entry. Entry requires incurring a fixed cost C_E, which represents the upfront investment necessary to prepare and submit a grid connection request and begin navigating the permitting process.

Developers also face a permitting cost, C_i^{permit}, which reflects the burden of navigating the permitting process. This cost has several components. The first component captures the permitting burden associated with litigation risk and is represented by the legal environment, $\mathbf{L}_{\boldsymbol{c}}$. As motivated in the empirical section, litigation risk imposes costs through two channels: a direct effect, where the threat of litigation increases perceived project risk, and an indirect effect, where regulatory agencies respond to litigation exposure by adopting more cautious permitting procedures. The second component reflects institutional costs independent of litigation risk and is captured by the permitting environment, $\mathbf{D}_{\text{c}}$. These include permitting agency workload, staffing constraints, and general administrative backlog, which vary across locations and over time. The third component captures project-level variation from county-level siting characteristics, C_c. Together, these components define the total permitting cost faced by a developer:

$$C_i^{\text{perm}} = \alpha_0 + \underbrace{\alpha_L' \mathbf{L}_c}_{\text{legal cost}} + \underbrace{\alpha_D' \mathbf{D}_c}_{\text{institutional cost}} + \alpha_c' \mathbf{C}_c, \tag{3}$$

where $\boldsymbol{\alpha}$ capture how permitting costs vary with the legal environment, permitting environment, and county characteristics, respectively. In this model, every entrant eventually obtains a permit.[9] The cost described above is incurred once.

Conditional on receiving a permit, projects may be subject to litigation risk. The probability that a permitting project is litigated is given by:

$$\Pr\left(L_i = 1 \mid e_i = 1\right) = \Lambda\left(\beta_0 + \beta_L' \mathbf{L}_c + \beta_x' \mathbf{x}_i + \beta_C' \mathbf{C}_c + \varepsilon_i^{\text{lit}}\right), \tag{4}$$

where $\Lambda(\cdot)$ denotes the logistic cumulative distribution function, and the probability depends on the $\mathbf{L}_c$, $\mathbf{x}_i$, $\mathbf{C}_c$ and the unobserved litigation shock $\varepsilon_i^{\text{lit}}$.

The expected profit from a successful project is based on project-specific characteristics, market conditions, and local county conditions: $\pi_i = \theta_\pi \cdot \text{NPV}_i\left(\mathbf{M}_c, \mathbf{x}_i, \mathbf{C}_c\right)$, where θ_π is a scaling parameter. The construction of π_i will be discussed in the estimation section below.

A developer's expected payoff conditional on entry then can be expressed as:

$$V_i\left(S_c, x_i\right) = \left(1 - \Pr\left(L_i = 1 \mid e_i = 1\right)\right)\left(\pi_i - C_i^{\text{permit}}\right)\kappa^{\text{comp}} + \Pr\left(L_i = 1 \mid e_i = 1\right) W_i^{\text{lit}}, \tag{5}$$

where:

[9]Data on CWA Section 404 permits show that 92 percent of permit applications are ultimately granted, though permits may come with delays or additional conditions that developers must follow and comply with.

- W_i^{lit} denotes the payoff from appellate court legal proceedings, defined in below subsection;
- κ^{comp} is exogenous shocks that terminate the project while in the grid connection process.

Each developer enters if the net expected value exceeds its private entry shock:

$$V_i\left(\mathrm{~S}_c, \mathbf{x}_i\right)-C_E \geq \varepsilon_i^{\text{entr}}$$

This yields the logit entry probability:

$$\operatorname{Pr}\left(e_i=1\right)=\frac{\exp \left(V_i\left(\mathrm{~S}_c, \mathbf{x}_i\right)-C_E\right)}{1+\exp \left(V_i\left(\mathrm{~S}_c, \mathbf{x}_i\right)-C_E\right)}$$

5.4 Stage 2: Litigation, Appellate Legal Proceedings, and Precedent Formation

Conditional on experiencing a litigation shock at the lower courts, developers choose whether to engage in legal proceedings at the appellate courts, $a_i \in\{0,1\}$, by paying an upfront appeal cost C_A. If the developer appeals, it wins the case (receives a favorable ruling) with probability p^{win} . This probability depends on $\boldsymbol{L_c}$ and $\boldsymbol{z_i}$, which is case-specific legal characteristics:

$$p_i^{\text{win}}=\Lambda\left(\gamma_0+\gamma_L^{\prime} \mathbf{L}_c+\gamma_z^{\prime} \mathbf{z}_i\right) . \tag{6}$$

Not all appellate decisions generate precedent. The legal system may designate an appealed case as precedent-setting based on its characteristics, independent of the ruling outcome. A binding precedent will be set after appeal with probability:

$$\psi_i=\Lambda\left(\psi_0+\psi_L^{\prime} \mathbf{L}_c+\psi_z^{\prime} \mathbf{z}_i\right) \tag{7}$$

The net return to successful appellate proceedings reflects project revenues and exogenous shocks that may terminate projects at the grid connection process, similar to shocks at the entry stage. The private latent payoff from engaging in appellate court proceedings is given by:

$$U_i^{\text{appeal}}=p^{\text{win}}\left[\pi_i-C_i^{\text{permit}}\right] \kappa^{\text{comp}}, \tag{8}$$

which yields the appeal probability:

$$\Pr\left(a_i = 1 \mid L_i = 1\right) = \frac{\exp\left(U_i^{\text{appeal}} - C_A\right)}{1 + \exp\left(U_i^{\text{appeal}} - C_A\right)}, \tag{9}$$

The expected continuation value conditional on litigation is:

$$W_i^{\text{lit}} = \Pr\left(a_i = 1 \mid L_i = 1\right) \lambda_i \zeta, \tag{10}$$

where:

$$\lambda_i \equiv p_i^{\text{win}} \left[\pi_i - C_i^{\text{permit}}\right] \kappa^{\text{comp}} - C_A, \tag{11}$$

and ζ is the discounted continuation value of legal proceedings at the appellate court.

5.5 Legal Precedent as An Externality

A legal precedent generates externalities for future entrants by clarifying the legal environment. Specifically, one precedent shifts the permitting and lower-court litigation probability by marginal amounts $\delta_\alpha > 0$ and $\delta_\beta > 0$, respectively. Let $\bar{p}^{\text{lit}}$ denote the baseline probability of litigation for future projects, $\bar{\Pi}^{\text{fut}}$ the expected project surplus conditional on successful completion, and N^{fut} the expected size of the next cohort of potential entrants. The resulting social surplus generated by a single precedent is given by:

$$\Omega = \left[\delta_\alpha \left(1 - \bar{p}^{\text{lit}}\right) + \delta_\beta \bar{p}^{\text{lit}}\right] \kappa^{\text{comp}} \bar{\Pi}^{\text{fut}} N^{\text{fut}}.$$

For project i, the external benefit of its appellate engagement is given by:

$$\Omega_i = \lambda_i \Omega,$$

where $\lambda_i \in [0, 1]$ reflects the project-specific weight or likelihood that project i 's appeal creates binding precedent.

Developers do not internalize Ω_i when choosing a_i. However, the project's social continuation value is:

$$W_i^{\text{lit,soc}} = P_i^{\text{appeal}} \left(\lambda_i + \Omega_i\right).$$

6 Identification and Estimation

This section describes how I recover the structural parameters of the model and discusses the sources of identifying variation. The estimation procedure involves three stages. First, I calibrate two parameters using external data sources, collectively denoted $\Theta_{\text{calibration}}$. Second, I estimate 10 parameters outside the full structural model using a probit specification, collectively denoted Θ_{probit} . Third, I jointly estimate the remaining 23 structural parameters using the simulated method of moments (SMM) within the full model, collectively denoted Θ_{SMM}.

6.1 Calibration and Probit Estimation

I calibrate parameters directly from data and estimate a subset of parameters outside the full structural model via a probit specification. These parameters are collected as below and summarized in Table 4

$$\Theta_{\text{calibrate}} = \left[ct^{lit}, \kappa^{\text{comp}}\right],$$
$$\Theta_{\text{probit}} = [\boldsymbol{\psi}],$$

where $\boldsymbol{\psi}$ is a vector of 10 parameters

First, I calibrate the count of lower court cases ct^{lit}, which is used to derive the probability of lower court litigation p_i^{lit} in the model simulations below. This calibration is necessary because I do not directly observe all trial court cases in the state court system. As discussed in the Data section, state trial courts' inconsistent record-keeping and limited public access prevent comprehensive data collection. To address this limitation, I exploit the systematic documentation in the federal court system, where both trial and appellate cases are comprehensively recorded. Using federal court data, I calculate the ratio of appellate cases to trial cases, which equals 0.25 . I then apply this ratio to state appellate court data to impute the number of state trial-level cases, assuming similar litigation patterns between trial and appellate courts across federal and state systems. Finally, I distribute the imputed trial cases across years using the empirical lag distribution between trial and appellate filings observed in the data. Specifically, I assign weights of $0.39, 0.39, 0.16$, and 0.06 to time lags of $0-1, 1-2, 2-3$, and $3-4$ years, respectively.

Second, I calibrate a project withdrawal shock $\kappa \in [0,1]$, which captures the probability that a project exits the grid connection process for reasons inherent to the interconnection system. The withdrawal rate is treated as an exogenous shock reflecting systematic features of the queue, such as evolving connection cost estimates. Withdrawal rates are calculated for each transmission provider–year pair using all projects applying to connect from 2010 to 2024. This calibration allows the model to capture grid-related sources of project failure that are external to developers' market entry decisions.

Finally, I estimate a probit model, outside the main structural framework, to capture the probability that appellate litigation results in the formation of legal precedent.

Estimating this model separately allows a richer specification that incorporates detailed court-level and case-specific legal characteristics without adding computational complexity to the full structural model. I estimate a parsimonious model guided by institutional knowledge of which factors are most relevant to precedent formation but also provide a comprehensive specification that includes all available legal covariates. The parsimonious specification is incorporated into the structural model to balance tractability and interpretability, while the full results are reported in Appendix 9 for completeness. Importantly, although developers make decisions about market entry and whether to pursue appeals, they do not influence whether an appellate ruling establishes precedent once litigation has reached the higher court. The formation of precedent is driven by institutional legal factors, not by the characteristics or actions of the project itself. The separate estimation of the precedent formation model preserves internal consistency: precedent influences developers' forward-looking expectations, and arises through their appeal decisions, but conditional on appeal, it is determined exogenously by judicial rulings. This approach maintains a clear separation between project behavior and institutional legal outcomes.

Table 4: Parameters Estimated Outside the Model

Parameter	Symbol	Granularity	Value
Lower court litigation count	ct^{lit}	State - Year	[0,1]
Exogenous withdrawal shock	κ	TO - Year	[0,1]
Legal precedent marginal probability effect			
- Overall Litigation Case	ψ_{L1}	Constant	-0.01
- Case with Negative Outcomes	ψ_{L2}	Constant	0.02
- Case with Legal Precedent	ψ_{L3}	Constant	0.01
- Appellate court	ψ_{z1}	Constant	0.34
- High court	ψ_{z2}	Constant	0.57
- Multiple motions	ψ_{z3}	Constant	0.13
- Decision affirmed	ψ_{z4}	Constant	0.08
- Decision remanded	ψ_{z5}	Constant	0.24
- Decision summary judgment	ψ_{z6}	Constant	0.28
- Relief against authority	ψ_{z7}	Constant	-0.23

The first two parameters are calibrated. The remaining parameters are estimated using a parsimonious probit regression. The lower-court litigation counts vary at the state-year level. The exogenous withdrawal shocks vary at the transmission-owner (TO)–year level.

6.2 Simulation

I estimate the remaining structural parameters jointly using the Simulated Method of Moments (SMM), and discuss the sources of variation that identify them. These parameters are collected as follows:

$$\Theta_{\text{SMM}} = [\ \underbrace{C_E, \boldsymbol{\alpha}, \theta_\pi}_{\text{Entry / Permit}}\ ,\ \underbrace{C_A, \zeta, \boldsymbol{\gamma}, \psi_0}_{\text{Appeal/Precedent}}\ ,\ \underbrace{\rho_{EL}, \rho_{LA}}_{\text{Selection Corr}}\ ],$$

where $\boldsymbol{\alpha}$ is a vector of 12 parameters and $\boldsymbol{\gamma}$ is a vector of 4 parameters.

6.2.1 Entry Stage

The simulation procedure for the entry stage generates potential developers' decisions through a forward-looking discrete choice framework that incorporates both permitting costs and expected continuation values from potential future litigation against the project.

The simulation begins by generating a pool of potential entrants. For each county-year, I set the number of potential entrants equal to the maximum number of actual entrants ever observed in that county over the sample period. Each potential project inherits the observed county-year characteristics, including the legal environment, permitting conditions, electricity market variables, and other county-level attributes. Project-specific characteristics such as fuel type and capacity are drawn from the county-year empirical distribution through bootstrap sampling, or from the county-level distribution over the full period when no entrants are observed in that year.

Entry decisions follow a discrete choice framework with forward-looking considerations. Each potential project evaluates its expected profit against multiple cost components (entry cost, permitting cost, and the probability of facing a litigation shock) as well as the expected continuation value from subsequent legal proceedings. To incorporate these expectations, I employ a two-stage computational approach. First, using backward induction from the current parameter estimates, I compute the expected continuation value from potential appellate engagement beyond the lower court stage, such as appealing a negative lower court decision to higher courts. These continuation values reflect both the probability of prevailing on appeal and the associated project payoff, conditional on winning a lawsuit and achieving grid connection. Second, with these continuation values established, I simulate entry decisions forward using a logit framework. Each potential project evaluates its expected profit (calculated as $\pi_i = \theta_\pi \cdot \text{NPV}_i\left(\mathbf{M}_c, \mathbf{x}_i, \mathbf{C}_c\right)$, where $\mathbf{M}_c$ is the electricity market conditions, $\mathbf{x}_i$ is the project characteristics, and $\mathbf{C}_c$ is the county characteristics) against costs, using the methodology detailed in Appendix A.10. Projects enter when their simulated entry probability exceeds the drawn entry shock. As discussed in the Model section, these entry shocks may be correlated with litigation and appeal shocks; I discuss this correlation structure in section 6.2.4.

The identification of entry-stage parameters relies on variation in market entry patterns across different local environments, permitting conditions, and project profitability levels. The entry cost parameter C_E is identified from the overall level of entry across markets, because it shifts the fundamental threshold for market participation. The permitting cost parameters ($\alpha_0, \alpha_L, \alpha_D, \alpha_C$) are identified by comparing entry frequencies across bins of the legal environment, permitting backlog, and county characteristics, respectively. These comparisons isolate how different regulatory and institutional conditions raise or lower the effective costs of navigating the permitting process, distinct from the baseline entry costs that all projects face. The profit scaling parameter θ_π is identified from how entry rates respond to variation in calculated project profitability. Because project-level net present values are computed using observed market fundamentals and project characteristics, this parameter governs the sensitivity of entry decisions to financial returns relative to regulatory and legal costs. Additional identification leverage comes from variation across the instrumental shifters of historical transmission infrastructure density z_1 and lower-court caseload z_2, which provide exogenous shifts in expected continuation values and litigation risk exposure. I will discuss these shifters in more detail in section 6.2.4.

6.2.2 Litigation Shock

Conditional on entry, some projects are exposed to litigation in lower courts. As discussed earlier, the number of litigated projects, ct^{lit}, is calibrated externally to provide a state-by-year target count. During simulation, I draw from the pool of entrants within each state-year to exactly match the calibrated count. When the calibrated count exceeds available entrants, I adjust the target and redistribute the shortfall across other years within the same state. I determine which specific entrants face litigation through a probabilistic assignment mechanism corresponding to $\Pr(L_i = 1 \mid e_i)$ in the model. Each project's litigation exposure follows a logistic index based on observable litigation shifters z_2. This selection uses an exponential race approach [10]that ensures both exact count matching and selection heterogeneity across projects. The

[10]The exponential race approach is used to assign which projects face litigation when a fixed number of cases must be selected within each state-year. Each entrant is given a random "clock" that ticks faster for projects with a higher litigation propensity, meaning a higher probability of being litigated given its litigation shifters z_2. These shifters summarize factors that influence litigation likelihood but are not directly estimated in the model. The propensities are modeled through a logistic index and then shifted by a common adjustment so that the total number of litigated cases exactly matches the calibrated target. Projects whose clocks go off first are selected, ensuring both the correct overall count and realistic variation across entrants.

assignment mechanism is purely computational, distributing the predetermined litigation incidence across the heterogeneous population of entrants without estimating structural litigation probabilities.

6.2.3 Appellate Stage

Projects that experience a litigation shock may choose to engage in further legal proceeding at the appellate court if the expected net benefits from higher-court engagement justify the effort. For projects facing lower-court litigation, I model the appeal decision within a logistic framework. The latent payoff of appealing is given by the expected net payoff: developers weigh the probability-weighted return from a favorable ruling against the fixed cost of appellate proceeding and the risk of project termination during the legal process. A project appeals when this expected utility exceeds its idiosyncratic appeal shock, an unobserved random term capturing project-specific variation in appeal propensity. The next subsection details how I allow the appeal shock to be correlated with shocks from the entry and lower-court litigation stages.

For projects proceeding to appeal, I simulate both case outcomes and legal precedent formation. The probability of prevailing on appeal depends on legal environment characteristics through the win probability function, while legal precedent formation follows the separately estimated probit specification described in section 6.1. These simulated outcomes feed back into the continuation values used in the initial entry decisions, creating consistency between forward-looking entry behavior and realized appellate returns. The simulation captures both the direct returns to individual developers from successful appeals and the broader institutional consequences through precedent creation, though developers do not internalize the latter when making private appeal decisions.

The identification of appeal-stage parameters relies on variation in appellate engagement patterns and outcomes across different legal and institutional environments. The appeal cost parameter C_A is identified from overall appeal frequencies and how these vary across bins of lower-court caseload z_2, appellate caseload z_3, and legal environment. Because higher court backlog and legal complexity affect the expected burden of appellate litigation, variation in appeal rates across these conditions reveals the magnitude of costs that deter marginal cases from escalation. The win probability parameters (γ_0, γ_L) are identified from observed success rates among appealed cases, particularly their variation across different legal environment bins. This identification assumes that, conditional on the decision to appeal, case outcomes reflect both the underlying legal merits and the institutional context, with stronger legal environments systematically affecting the probability of developer success. The baseline precedent formation probability ψ_0 is identified from the overall frequency with which appealed cases produce legal precedent, leveraging the institutional variation in when courts choose to establish binding precedents independent of case outcomes.

6.2.4 Correlated Unobservable

I begin by discussing how I model selection and estimate correlations across decision stages. The observed lower-court litigation and appellate cases in my data represent a selective subset of all potential projects, shaped by unobserved developer characteristics such as financial resources, legal sophistication, and risk tolerance. These unobserved factors likely influence multiple stages. While lower-court litigation counts are predetermined through calibration, the selection of which specific projects enter, face lower-court litigation, and pursue further legal proceedings in the appellate courts is driven by these correlated unobserved factors.

I model the latent shocks governing entry, lower-court litigation exposure, and appellate decisions jointly by assuming they follow a trivariate normal distribution:

$$\left(\nu_i^{\text{entry}}\ \nu_i^{\text{lit}}\ \nu_i^{\text{appeal}}\right) \sim \mathcal{N}\left(\mathbf{0}, \mathbf{\Sigma}\right)$$

where $\mathbf{\Sigma}$ is a 3×3 correlation matrix with unit variances and correlation parameters:

$$\mathbf{\Sigma} = \begin{pmatrix} 1 & \rho_{EL} & \rho_{EA} \\ \rho_{EL} & 1 & \rho_{LA} \\ \rho_{EA} & \rho_{LA} & 1 \end{pmatrix}$$

The correlation parameter ρ_{EL} captures the dependence between unobserved factors affecting entry decisions and lower-court litigation exposure, reflecting how developer sophistication might simultaneously influence market participation and legal vulnerability. The parameter ρ_{LA} measures the correlation between lower-court litigation and appeal propensities, capturing how factors such as legal capacity or case strength affect both the likelihood of being targeted for litigation and the decision to escalate disputes to higher courts. The parameter ρ_{EA} captures direct correlation between entry and appeal decisions. I normalize $\rho_{EA} = 0$, assuming that, conditional on litigation exposure, the direct correlation between entry and appeal shocks is negligible. The correlated normal draws are then transformed to uniform random variables: $u_i^j = \Phi\left(\nu_i^j\right)$ for $j \in \{$ entry, lit, appeal $\}$, where $\Phi(\cdot)$ is the standard normal cumulative distribution function. These correlated uniform draws are incorporated directly into the logit choice probabilities, ensuring that the composition of litigated and appealed cases differs systematically from the broader population in ways consistent with selection on unobservables.

The identification of these correlation parameters relies on stage-specific instrumental variables that shift one decision margin while being excluded from others, combined with the parametric structure of the error distribution. I exploit three sources of exogenous variation: historical transmission infrastructure density z_1, lower court caseload z_2, and appellate court caseload z_3. Historical transmission infrastructure density z_1, measured from transmission lines constructed nearly two decades before the sample period, reflects long-term siting fundamentals rather than current local conditions. It affects the entry by improving access to the grid. However, it does not influence litigation or appeals, which respond to current project characteristics and local opposition. The lower court caseload z_2 is a measure of court backlog that shifts litigation probability by lengthening the duration of the case processing times. While developers may anticipate litigation risk when making entry decisions, the exclusion restriction is that, conditional on profitability, variation in z_2 affects only the litigation margin and not the entry payoff or the decision to appeal. Similarly, appellate court caseload z_3 shifts appeal probability conditional on litigation by affecting expected processing times, but does not directly influence entry or litigation margins.

The conceptual argument for identification is as follows. ρ_{EL} is identified from variation in entry across lower court caseload z_2 bins conditional on historical transmission infrastructure density z_1. Because z_2 shifts only litigation, any systematic differences in entry rates across z_2 bins must come from correlated unobservables that influence both developers' entry decisions and the likelihood of litigation. ρ_{LA} is identified from variation in appeal counts across z_2 bins conditional on litigation. Moments measuring the probability of appeal, conditional on litigation and binned by z_2, reveal whether projects that enter litigation are systematically more or less likely to escalate to appeal. Because z_2 affects only the litigation stage, differences in appeals across these bins reflect the composition of litigated projects and therefore the correlation between litigation and appeal errors. ρ_{EA} is identified from variation in entry rates across bins z_3. Because entry decisions incorporate the continuation value of possible appeals in the model, systematic differences in entry across z_3 after controlling for z_1 and z_2 reveal correlation between unobserved entry and appeal shocks.

These correlation parameters, along with the other structural parameters, are estimated jointly through the simulated method of moments.

6.3 Moments Matching

I target $K = 40$ empirical moments by matching simulated moments to their empirical counterparts. I denote these empirical moments as $M = [M_1, M_2, \ldots, M_K]$, constructed from the observed data. For each candidate parameter vector Θ, I construct the corresponding simulated moments $M(\Theta) = [M(\Theta)_1, M(\Theta)_2, \ldots, M(\Theta)_K]$.These moments consist primarily of observation counts.

The SMM estimator then minimizes the weighted sum of squared percentage deviations:

$$\hat{\Theta} = \arg\min_{\Theta} g(\Theta)' W g(\Theta),$$

where W is the optimal weighting matrix. I construct W as the inverse of the variance-covariance matrix of the empirical moments, $W = \hat{\Omega}^{-1}$, where $\hat{\Omega}$ is the variance-covariance matrix of the empirical moments estimated through 200 bootstrap replications of the data. This weighting scheme is asymptotically efficient under standard regularity conditions. Minimization of the objective function proceeds via a genetic algorithm.

To construct standard errors for the parameter estimates, I apply the asymptotic distribution of the SMM estimator:

$$\sqrt{S}\left(\hat{\Theta} - \Theta_0\right) \xrightarrow{d} \mathcal{N}\left(0, \left(G'WG\right)^{-1} G'W\Omega WG \left(G'WG\right)^{-1}\right),$$

where S denotes the number of observations, G is the Jacobian matrix of simulated moments with respect to the $K = 23$ parameters evaluated at $\hat{\Theta}$, and Ω is again the variance-covariance matrix of the empirical moments. I compute G numerically using finite differences.

6.4 Estimation Results and Model Fit

Table 5 presents the parameter estimates alongside the empirical moments used for identification. I now interpret the economic meaning of the estimated parameters. The fixed entry cost is moderate in magnitude ($C_E = 0.500$, in millions of dollars) and precisely estimated. As expected, entry is also responsive to project profitability, with $\theta_\pi = 0.077$, confirming that projects with higher net present values are significantly more likely to proceed.

Permitting costs, measured in millions of dollars, are influenced by the legal environment, which emerges as an important determinant in my model. A higher overall volume of litigation raises effective permitting costs ($\alpha_{L1} = 0.672$), suggesting that developers anticipate additional burdens in counties with greater legal uncertainty. In contrast, the cumulative incidence of negative litigation outcomes exerts a more modest effect ($\alpha_{L2} = 0.089$). Notably, precedent-setting litigation reduces permitting costs ($\alpha_{L3} = -0.258$), which aligns with the expectation that legal precedent simultaneously clarifies the legal environment.

Second, I find an asymmetry in how administrative backlog affects permitting costs across permit types. Higher administrative backlog in individual permits is estimated to lower permitting costs ($\alpha_{D1} = -0.138$), while backlog in general permits increases permitting costs ($\alpha_{D2} = 0.097$). This counterintuitive pattern can be explained by the nature of projects requiring each permit type. Individual permits typically govern larger, more complex developments pursued by better-capitalized and more experienced developers. Such developers can deploy substantial legal and technical resources to navigate permitting delays, effectively reducing their permitting costs even when individual permit queues lengthen. In contrast, general permits cover routine, standardized projects; backlog in this category reflects systemic institutional weaknesses that elevate costs across all developers, regardless of their resources.

Third, county-level characteristics also shape permitting costs. Specifically, the estimated effect of zoning ordinances is both substantial and statistically meaningful: the presence of local zoning regulations increases permitting costs considerably ($\alpha_{C6} = 2.285$), underscoring the central role of local land-use governance. This result is consistent with empirical evidence that many permitting challenges and legal disputes originate from local opposition, highlighting how local political and regulatory environments can act as binding constraints on project development.

Overall, the model predicts that permitting costs are economically meaningful and highly skewed among projects that enter and have positive net present value. As displayed in Figure 8, the median permitting cost is about \$4.4 million, with a mean of \$5.5 million and a 90th percentile of nearly \$8.8 million. Expressed relative to profits, these costs represent 6 percent at the median, 14 percent on average, and more than 40 percent for projects in the upper tail of the distribution. This pattern suggests that, while most projects face permitting expenses that are moderate relative to returns, a nontrivial share confront permitting burdens large enough to significantly erode profitability. The long right tail of the distribution highlights the uneven impact of legal and institutional frictions, with some developers bearing disproportionately high permitting costs.

Next, I focus on parameters that predict developers' behaviors in the legal proceeding. The direct cost of appeal is modest ($C_A = 0.536$, in millions of dollars). The sensitivity to expected appellate value is substantial ($\zeta_v = 0.841$), suggesting that developers weigh continuation carefully against expected gains.

Finally, the model estimates relatively strong correlation of unobserved shocks across decision stages. The raw parameters are $\rho_{EL} = 0.922$ and $\rho_{LA} = 0.764$, which correspond to correlations of 0.726 and 0.441, respectively, implying that unobserved factors influencing entry are strongly related to lower-court litigation risk, while the connection between lower-court litigation and appeal decisions is positive but more modest.

Having estimated the model, I also evaluate its overall performance. Table 6 displays my model's performance in fitting its target moments. The model achieves a generally close fit to the data across a wide range of targeted moments. At the aggregate level, predicted entry (16,395) is roughly 5 percent higher than observed entry (15,570), predicted appeals (253) are about 1 percent higher than observed appeals

(250), and predicted legal precedent formation matches exactly. However, predicted appeal wins (147) are about 15 percent lower than the observed number (177), reflecting some difficulty in matching appellate outcomes. This discrepancy arises because the current model does not model appellate outcomes as a function of specific characteristics of the legal case.

Table 5: Parameters Esimtated Via SMM

Parameter	Value	Std. Err.	Target Moments
C_E	0.500	0.021	Overall entry
α_{L1}	0.672	0.337	Entry by overall litigation cases bins
α_{L2}	0.089	0.277	Entry by negative-outcome litigation bins
α_{L3}	-0.258	0.050	Entry by legal precedent-setting litigation bins
α_{D1}	-0.138	0.061	Entry by individual permits backlog bins
α_{D2}	0.097	0.029	Entry by general permits backlog bins
α_{C1}	-0.329	0.322	Entry by county population bins
α_{C2}	0.942	1.521	Entry by county median income bins
α_{C3}	6.184	4.299	Entry by county share of democrats bins
α_{C4}	-0.699	1.690	Entry by No. of higher queued project bins
α_{C5}	-1.450	1.384	Entry by size of higher queued project(in MW) bins
α_{C6}	2.285	1.150	Entry by county local zoning ordinance bins
α_0	3.664	16.445	Entry in baseline bins
θ_π	0.077	0.021	Entry by project profit (NPV) bins
C_A	0.536	0.002	Overall appeal among litigated
ζ_v	0.841	0.238	Entry sensitivity to expected appeal value
γ_{L1}	8.531	4.333	Appeal win rate by overall litigation cases bins
γ_{L2}	0.994	0.945	Appeal win rate by negative-outcome litigation bins
γ_{L3}	-0.713	0.660	Appeal win rate by legal precedent-setting litigation bins
γ_0	-4.977	0.107	Overall appeal win rate
ψ_0	0.062	9.012	Overall precedent rate among appeals
ρ_{EL}	0.922	0.245	Entry variation across lower-court caseload bins
ρ_{LA}	0.764	0.204	Appeal variation across lower-court caseload bins

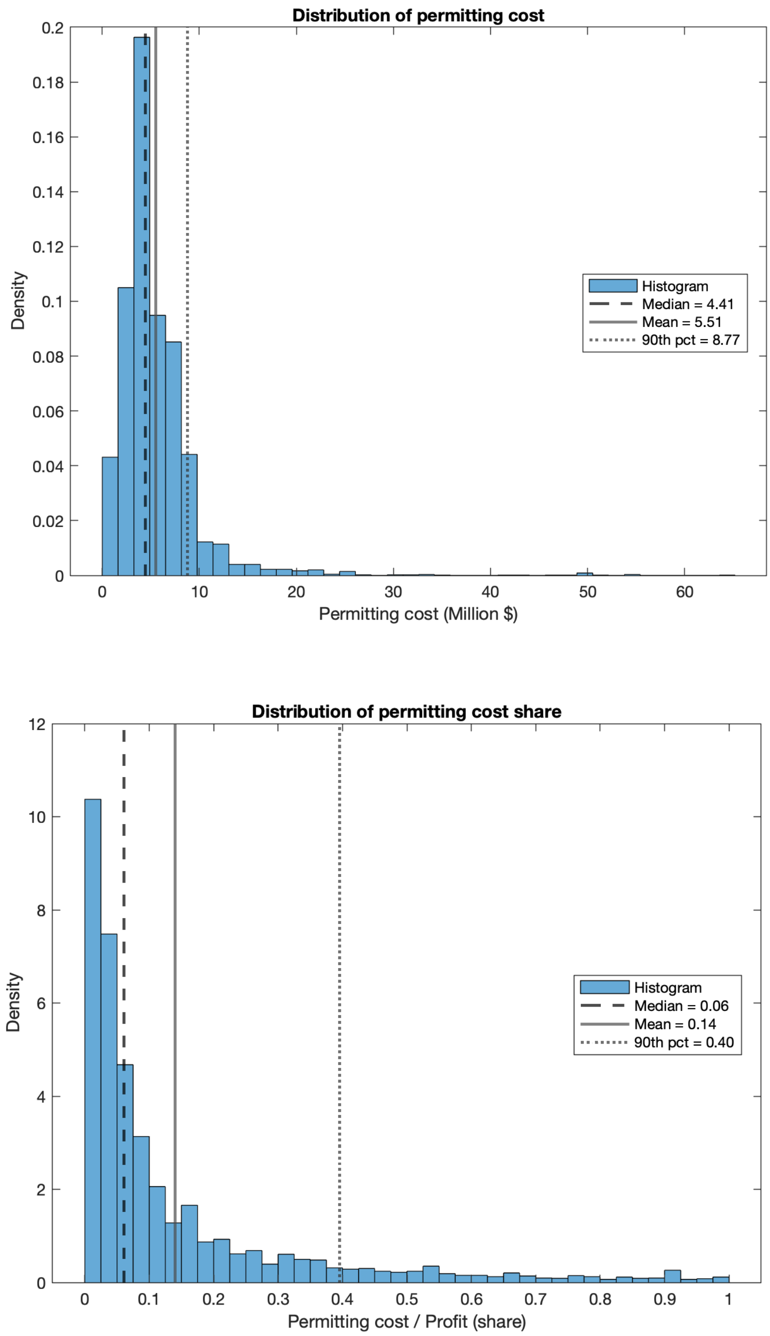

Figure 8: Distribution of Permitting Costs and Cost Shares of Net Profit.

Note: The top panel shows the distribution of permitting costs estimated from the structural model, measured in millions of dollars. The bottom panel shows permitting costs as a share of net profit.

Table 6: Model Fit

Moment	Data (ct.)	Model (ct.)
Overall entry	15570	16395
Entry by overall litigation exposure (L1) high bin	2217	2248
Entry by negative-outcome litigation (L2) high bin	631	602
Entry by legal precedent-setting litigation (L3) high bin	9676	9686
Entry by individual-permit congestion (D1) mid bin	5430	5705
Entry by individual-permit congestion (D1) high bin	4874	4774
Entry by general-permit congestion (D2) mid bin	5954	6169
Entry by general-permit congestion (D2) high bin	4914	4493
Entry by county population (C1) mid bin	5504	5502
Entry by county population (C1) high bin	5383	5260
Entry by county median income (C2) mid bin	5349	5531
Entry by county median income (C2) high bin	5009	5412
Entry by county share of democrats (C3) mid bin	5009	5472
Entry by county share of democrats (C3) high bin	5138	5563
Entry by No. of higher queued project (C4) mid bin	5720	5278
Entry by No. of higher queued project (C4) high bin	6129	6022
Entry by size of higher queued project(in MW) (C5) mid bin	4605	5252
Entry by size of higher queued project(in MW) (C6) mid bin	7098	6083
Entry by county local zoning ordinance (C6) high bin	4769	4794
Entry by historical grid access (z1) mid bin	5130	5171
Entry by historical grid access (z1) high bin	5704	5433
Entry by lower-court caseload (z2) mid bin	4383	4014
Entry by lower-court caseload (z2) high bin	3531	3601
Entry by project profit NPV mid bin)	6115	5021
Entry by project profit NPV high bin)	7253	6891
Overall appeals among litigated	250	253
Appeal by overall litigation exposure (L1) high bin	200	175
Appeal by negative-outcome litigation (L2) high bin	67	41
Appeal by legal precedent-setting litigation (L3) high bin	188	213
Appeal by project profit NPV mid bin	93	91
Appeal by project profit NPV high bin	109	131
Appeal by lower-court caseload (z2) mid bin	75	97
Appeal by lower-court caseload (z2) high bin	57	37
Appeal by appellate caseload (z3) mid bin	13	23
Appeal by appellate caseload (z3) high bin	4	2
Overall appeal win rate	177	147
Appeal win rate by overall litigation exposure (L1) high bin)	139	147
Appeal win rate by negative-outcome litigation (L2) high bin)	21	30
Appeal win rate by legal precedent-setting litigation (L3) high bin)	134	127
Overall legal precedent formation	157	157

7 Counterfactual Analysis

Next, I use the estimated structural model to conduct a comparative static analysis and evaluate two categories of counterfactual scenarios. These exercises illustrate how institutional and policy changes can reshape renewable energy project entry. Figure 9 summarizes the results.

The comparative static analysis quantifies the informational value of legal precedent. The first category of counterfactual scenarios addresses the externality arising from underinvestment in legal precedent, a market failure driven by its public-good nature. Policies in this category aim to internalize the social value of legal precedent by making legal proceedings easier for developers to pursue. The second category focuses on permitting reforms that directly reduce the administrative burden and delay of obtaining regulatory approval.

7.1 Comparative Static: A Maximal Legal Precedent Scenario

I begin with a comparative static that isolates the informational value of legal precedent by simulating a legal environment in which each county attains its maximum observed level of precedent over the sample period. This counterfactual serves an analytical purpose and is designed to capture how a more fully developed body of judicial interpretation would influence project entry, holding constant all other economic and institutional conditions. Conceptually, it represents an environment where the legal information that ultimately emerged through litigation is available from the outset, reflecting an earlier realization of the informational public good. In doing so, it identifies the upper bound of project entry attributable solely to legal clarity, abstracting from the behavioral responses associated with specific policy interventions examined in subsequent counterfactuals.

Under the maximal precedent scenario, the total number of project entries over the sample period rises to 16,818, compared with 16,395 in the factual data, corresponding to an increase of 2.6 percent relative to the baseline. This result quantifies the informational value of legal precedent in isolation. When all jurisdictions are assumed to have access to the complete body of judicial precedent observed at the end of the study period, developers operate in a more predictable and transparent legal environment. The resulting increase in entry underscores the role of clear legal interpretation as an enabling institutional condition for private investment, rather than as a direct financial or policy intervention.

7.2 Counterfactuals Targeting Economic Externalities

Legal precedent provides clarity to the legal environment for renewable energy permitting and development. However, precedent creation is likely socially inefficient: developers bear the full cost of legal proceedings while the informational benefits of court rulings are shared across all future market participants. This misalignment can lead to private incentives to pursue precedent-setting litigation to fall below the social optimum. To evaluate the implications of this externality, I simulate two counterfactual scenarios that modify the cost of legal proceedings.

7.2.1 Legal Fee-Shifting Scheme

A natural policy intervention to address the economic inefficiency would be to provide mechanisms that facilitate legal proceedings for developers, thereby incentivizing them to internalize the public-good nature of legal precedent. One such intervention is a legal fee-shifting provision, under which courts award litigation costs, including reasonable attorney and expert witness fees, to prevailing parties in citizen suits. Although such a provision currently exist in a few environmental statutes, such as the Clean Air Act, they remain largely unavailable to project developers challenged under other legal frameworks that govern permitting disputes. Extending fee-shifting provisions to additional legal statutes governing renewable energy development represents a feasible policy reform that could better align private incentives with the social value of precedent creation.

In this framework, a fee-shifting provision effectively lowers developers' expected cost of pursuing legal proceedings because the potential recovery of legal expenses increases the expected payoff from continuing a case. This mechanism is represented in the model through a reduction in the appeal cost parameter C_A. In the counterfactual simulation, I decrease C_A by 5 to 40 percent to capture the effect of partial reimbursement of litigation expenses under an expanded fee-shifting policy. The lower C_A increases the continuation value of legal proceedings in the entry value function and raises the likelihood that higher courts issue rulings clarifying future permitting standards. Under a 20 percent reduction in C_A, project entry increases to 17,388, approximately 6.1 percent above the baseline.

7.2.2 Legal Protection Insurance Scheme

This counterfactual considers a legal protection insurance, an indemnity product that protects against legal process costs by reimbursing policyholders' costs of pursuing or defending legal action. Through upfront premiums, developers could offset potential litigation costs, with coverage typically including legal fees, lawyer costs, and sometimes opponents' costs if the insured party loses.

While renewable energy projects already rely heavily on risk-transfer instruments, existing insurance coverage focuses on construction or operational risks: construction liability, property damage, operation interruption, equipment breakdown, and professional liability. Coverage for legal expenses during early-stage development remains rare. Europe has more established legal protection insurance market (*RIAD* 2017). In contrast it remains limited in scope in the United States, where the market is characterized by alternative arrangements such as prepaid legal plans or liability coverage (ARAG 2017, Ramsey Solutions 2024). [11] The scarcity of such coverage for renewable developers likely reflects both the difficulty of pricing heterogeneous regulatory risk and limited actuarial experience in this domain.

In this counterfactual, I represent a hypothetical insurance arrangement in which developers pay a fixed premium that reduces the expected legal proceeding cost C_A by the same proportion as in the fee-shifting scenario while adding an upfront premium cost. This exercise should be viewed as a thought experiment, since market data on pricing for legal protection insurance are scarce, and such products remain limited in availability within the United States. In practice, the premium would likely depend on project visibility, as more prominent projects can attract greater legal scrutiny and thus higher expected legal costs. Because no standard pricing benchmarks available, I proxy the premium using the project's expected net profit.[12] This structure transforms uncertain ex-post reimbursement into predictable ex-ante coverage, lowering the expected variance of litigation costs. By stabilizing legal risk exposure, the policy changes the expected value of pursuing precedent-generating legal proceedings. The simulation indicates that project entry rises by 1.6 percent after accounting for the premium and a 20 percent coverage reduction in C_A, a smaller effect compared with fee-shifting.

7.3 Counterfactual Targeting the Permitting Process

The second category of counterfactual shifts from considering economic inefficiencies in the legal process to examining outcomes that could arise from potential administrative reforms aimed at modernizing and expediting permitting procedures. The counterfactual evaluates the effect of lower permitting costs, which conceptually correspond to reduced procedural and regulatory barriers, on energy infrastructure development.

[11] Unlike legal protection insurance, which reimburses a policyholder's own costs of pursuing or defending legal action, liability insurance protects against third-party claims for damages, while prepaid legal plans provide limited access to legal advice through subscription arrangements. Even professional liability insurance, which does cover some legal costs, only addresses those arising from negligence claims.

[12] For example, if the developer purchases insurance covering 20 percent of litigation costs, the premium is set at one over K of that share, or approximately $20/K$ of project net profit. In the main analysis show in Figure 9, I set $K = 15$, and Appendix 11 shows results varying K between 10 and 20.

7.3.1 Streamlining the Permitting Process and Reducing Costs

This counterfactual explores a hypothetical environment where permitting procedures are streamlined, leading to lower costs of obtaining project approval. Streamlining typically entails shorter review timelines, fewer agency interactions, and simplified documentation requirements, all of which reduce the time and administrative effort developers must expend to secure permits. It can also reduce potential focal points for legal challenges, lowering the likelihood of litigation. Moreover, regulatory agencies may respond with fewer procedural delays and less cautious review if the legal environment is less contentious, further diminishing the administrative delay and burden on developers, as suggested by the reduced-form analysis.

For renewable projects, such reductions in permitting time are particularly consequential because delays can substantially increase financing and compliance costs. Extended review periods raise interest expenses on construction loans, trigger penalties under power purchase agreements, and in some cases cause developers to miss deadlines for production or investment tax credits. By limiting these sources of delay, permitting reform effectively lowers the total cost of project completion and mitigates the risk of financial losses associated with regulatory uncertainty. The analysis speaks directly to ongoing policy debates at both federal and state levels, where efforts to expand energy infrastructure increasingly focus on accelerating project approvals and reducing compliance costs.

To simulate this scenario, I model a reduction in the permitting cost parameter C^{perm} by increments of 5 to 40 percent. A 20 percent reduction in C^{perm} results in 16,946 total entries, a 3.4 percent increase relative to the baseline level of 16,395 entries, indicating that even moderate improvements in administrative efficiency can meaningfully accelerate renewable investment.

7.4 Discussion

The comparative static analysis highlights the informational value of legal precedent, which increases project entry by 2.6 percent, indicating that enhanced legal clarity alone yields modest gains compared with the effects observed in other policy simulations.

All other policy counterfactual simulations increase project entry relative to the baseline, though their magnitudes vary substantially. When all scenarios are evaluated under a 20 percent reduction in their respective cost parameters, the difference in impact becomes clear. Lowering litigation costs through fee-shifting provisions produces the largest effect, increasing entry by approximately 6.1 percent. The legal protection insurance scenario, which achieves a similar reduction in expected litigation costs after accounting for the premium, generates a smaller 1.6 percent increase. In comparison, administrative reforms such as streamlining the permitting process, modeled as a 20 percent reduction in permitting costs, yields a 3.4 percent increase in project entry.

These results indicate that policies that directly lower private costs by addressing the underlying economic inefficiency of underinvestment in legal precedent are more effective at stimulating new market entry than administrative interventions that streamline the permitting process alone.

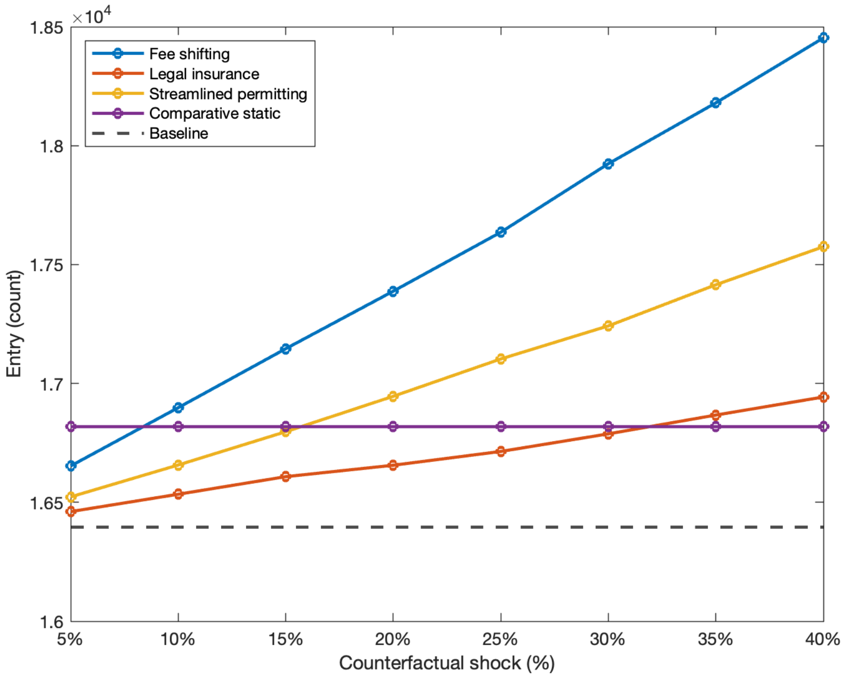

Figure 9: Market Entry Counts by Counterfactual Scenarios

Note: This figure plots the number of market entries across different counterfactual scenarios. The y-axis shows the entry counts, the x-axis shows the magnitude of the counterfactual change, and colors distinguish between scenario types.

8 Conclusion

This paper uses novel litigation data to study how legal risks arising from the permitting process affect market entry of renewable energy projects. Project entry decisions are impacted through two pathways. The direct pathway shapes developer expectations: historical litigation signals legal risk and deters market entry, while legal precedent clarifies legal standards and encourages entry. The indirect pathway operates through how regulatory agencies respond: litigation exposure prompts agencies to extend permit review timelines and adopt more cautious practices, while legal precedent mitigates these burdens.

Legal precedent generates informational clarity that is non-rival and non-excludable, providing benefits for all subsequent projects. Yet the costs of creating this clarity fall on individual developers who pursue legal proceedings at higher courts, while the benefits extend broadly across the market. This imbalance between private costs and shared gains likely results in underinvestment in precedent, as predicted by economic theory. Consistent with this prediction, despite relatively high appellate success rates, most developers with unfavorable lower-court rulings do not pursue further legal proceedings in my data

I estimate permitting costs and study policy counterfactuals using a structural model that accounts for selection into litigation. The model reveals that permitting costs are modest for most projects but substantial for some. I compare two types of policy interventions: those that address the market failure in precedent formation by reducing litigation costs, such as fee-shifting provisions and legal insurance, and permitting administrative reforms that lower permitting costs through streamlined review processes. Policies that directly target litigation costs and address the economic inefficiency generate the largest increases in renewable project entry. In particular, the fee-shifting counterfactual outperforms administrative reform by correcting the coordination failure in which individual developers underinvest in legal proceedings despite high social returns to precedent creation.

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A Appendix

A.1 Renewable Energy Permitting in the United States

Permitting serves as a critical regulatory gateway that determines whether and how renewable energy projects can proceed to development. This system operates across federal, state, and local levels, with each jurisdiction wielding authority to approve, condition, or deny projects. The permitting process is consequential because it directly controls access to land and resources and establishes binding operational parameters.

In principle, this multilayered framework is designed to balance infrastructure development with environmental protection and land-use planning. Environmental statutes are designed to prevent or mitigate ecological harm and protect sensitive habitats, while land-use regulations safeguard local priorities, preserve compatible land uses, and guide long-term spatial development. Together, these mechanisms seek to ensure that renewable energy projects advance both environmental and planning objectives.

In practice, industry experience points to two key challenges. The first is procedural complexity and exposure to legal challenge. Renewable projects often require review under multiple statutes and agencies, creating numerous points where disputes can arise. Stakeholders such as community groups, landowners, and environmental organizations may litigate to contest approvals on procedural or substantive grounds, even after permits are granted. A recent survey by Bauer et al. (2024) ranked litigation driven by community opposition among the top three obstacles to utility-scale renewable deployment. Yet systematic evidence on the frequency, nature, and consequences of permitting-related litigation remains limited.

The second challenge is administrative delay from overlapping jurisdictions. Projects requiring multiple permits must satisfy numerous and sometimes conflicting agency requirements, making reviews complex and time-consuming. Reports by the U.S. Chamber of Commerce (USCC n.d.) and the Government Accountability Office (GAO n.d.) document cases where jurisdictional overlap substantially lengthened project timelines. Industry data indicate that utility-scale solar installations can take up to six years from planning to completion, with about 80 percent of that time devoted to planning and permitting rather than construction (SEIA n.d.). Despite widespread recognition of these delays, little empirical evidence exists on their underlying causes.

Overall, the permitting framework remains central to balancing development with environmental and land-use goals, but its complexity creates multiple points where progress can stall.

A.2 Litigation Case Examples

***Ten Residents of Mass. v. Cape Wind Assocs., LLC**, 2010 Mass. Super. LEXIS 3161, 2010 WL 11813795 (Superior Court of Massachusetts, At Barnstable February 18, 2010, Decided)*

Ten Massachusetts residents, the Alliance to Protect Nantucket Sound, and the Town of Barnstable brought suit against Cape Wind Associates and the Massachusetts Office of Coastal Zone Management (MCZM). The case involved Cape Wind's proposal to build a 130-turbine, 440-foot-tall offshore wind farm on Horseshoe Shoal in Nantucket Sound, covering roughly 25 square miles. MCZM had issued federal consistency concurrences under the Coastal Zone Management Act, agreeing that Cape Wind's federal permits were consistent with the state's coastal management program. Plaintiffs argued that MCZM acted improperly by concurring before other state permits and historic-site reviews were finished, and by failing to follow referral requirements to the Cape Cod Commission. They sought to block or overturn the concurrences through injunctions, mandamus, judicial review, certiorari, and declaratory judgment. The court rejected these claims, holding that MCZM's concurrence was a discretionary and advisory step in the federal permitting process, not a permit itself, and therefore not subject to judicial review. All claims were dismissed.

***In re Ehlebracht v. Crowned Ridge Wind, LLC**, 2022 SD 46, 978 N.W.2d 741, 2022 S.D. LEXIS 88, 2022 WL 3097464 (Supreme Court of South Dakota August 3, 2022, Opinion Filed)*

Two neighboring landowners, joined in an administrative appeal with other residents, challenged the South Dakota Public Utilities Commission's decision granting Crowned Ridge Wind II, LLC a state siting and construction permit for a large wind farm (about 132 turbines, 300.6 MW) in Codington, Grant, and Deuel Counties. They argued the project would violate "applicable laws and rules" (pointing to changes in a Grant County noise ordinance and alleged shortcomings in solid-waste/decommissioning plans) and would impair health, safety, and welfare. The South Dakota Supreme Court affirmed that Crowned Ridge met its burden: the project will comply with applicable laws, provided a sufficient forecast of impacts on solid-waste management with a decommissioning plan, and the evidence showed no substantial impairment to health, safety, or welfare. Accordingly, the Court affirmed the PUC's determination that Crowned Ridge met its burden on all statutory criteria and upheld issuance of the state construction permit.

***Dan's Mt. Windforce, LLC v. Shaw**, 2022 Md. App. LEXIS 280, 2022 WL 1115005 (Court of Special Appeals of Maryland April 14, 2022, Filed)*

A developer called Dan's Mountain WindForce, LLC has sought to construct a windfarm on Dan's Mountain in Allegany County, Maryland. The developer pursed different state approvals over time: a 2016 application for a Certificate of Public Convenience and Necessity (CPCN) for a roughly 59.5-MW project, which the Maryland Public Service Commission (PSC) denied, and later a 2020 request for a CPCN exemption for a smaller wind-powered generating station, which the PSC granted. Opponents argued that the PSC's 2016 denial precluded the 2020 exemption under res judicata and collateral estoppel. The appellate court rejected that argument, explaining that a CPCN and a CPCN exemption involve different statutory standards and issues: a CPCN is a comprehensive, PSC-controlled siting approval, while an exemption is a streamlined determination that largely defers substantive siting and permitting to local government. Because the claims and issues were not identical, preclusion did not apply; there was substantial evidence supporting the exemption and the PSC adequately explained its decision. The court reversed the circuit court and reinstated the PSC's approval of the CPCN exemption.

Atl. Wind, LLC v. Zoning Hearing Bd. of Penn Forest Twp.*, 2022 Pa. Commw. Unpub. LEXIS 18, 272 A.3d 994, 2022 WL 108437 (Commonwealth Court of PennsylvaniaJanuary 12, 2022, Filed)*

Developer Atlantic Wind, LLC sought a special exception to construct a 28-turbine wind project on land leased from the Bethlehem Authority in Penn Forest Township. The Zoning Hearing Board denied the application on three grounds: (1) the project would constitute a prohibited second principal use on land already dedicated to the Authority's potable water mission, (2) Atlantic Wind failed to prove compliance with the ordinance's 45 dBA noise limit, and (3) the proposed permanent meteorological tower was not a permitted accessory use. On appeal, the Commonwealth Court reversed the first and third grounds, holding that no valid prior principal use had been approved and vacated the noise ruling for further fact-finding. The case was thus reversed in part, vacated in part, and remanded.

A.3 Search Keywords Used for Legal Database Queries

Direct Keywords

Wind energy permit; Solar energy permit; Transmission line permit

Indirect Keywords: X + Y

X: Technology Terms	**Y: Legal/Regulatory Terms**
Wind farm	**General Terms:**
Wind turbine	Certificate of public
Wind project	Conditional use permit
Wind energy	Permit
Solar farm	Right of way
Solar panel	Right-of-way
Solar project	Special use permit
Solar energy	
Electric transmission	**Local Zoning Terms:**
	Local land use planning act
	Ordinance
	Zoning
	Federal Statute Terms:
	Administrative protection act
	Bald and golden eagle protection act
	Clean water act
	Coastal barrier resources act
	Comprehensive environmental response, compensation, and liability act
	Eagle act
	Endangered species act
	Energy facilities site location act
	Energy policy and conservation act
	Federal land policy and management act
	Historic preservation act
	Marine mammal protection act
	Migratory bird treaty act
	National environmental policy act
	National forest management act
	National historic preservation act
	Outer continental shelf lands act
	Public utility environmental standards act
	Resource conservation and recovery act
	Safe drinking water act
	Steens Mountain Cooperative Management and protection act of 2000
	Wilderness Act
	State Statute Terms:
	Please refer to table *State Statute Terms (Y Terms Continued)*

A.4 State-Specific Statute Terms (Y Terms Continued)

State	State Statute Terms
General	State environmental quality review act
Arkansas	Arkansas clean water act; Arkansas endangered, threatened, and non-game species preservation; Arkansas protected wetlands and streams; Arkansas river basin compact; Arkansas wetlands mitigation bank act
California	California clean water act; California coastal act; California endangered species act; California environmental quality act; Porter-cologne water quality control act; McAteer-petris act; Wetlands protection act; Suisan marsh protection act
Colorado	Lower Colorado river multi-species conservation program act
Connecticut	Connecticut environmental policy act; Connecticut river valley flood control compact; Connecticut threatened and endangered species; Connecticut water discharge permit regulations; Connecticut water quality standards; The Connecticut environmental protection act
Delaware	Delaware surface water quality standards
District of Columbia	District of Columbia environmental policy act of 1989
Illinois	Illinois administrative code: water regulations; Illinois endangered species protection act; The great lakes compact; Wetlands and Illinois state waters protection
Indiana	Indiana clean water act; Indiana environmental policy act; Indiana non-game and endangered species conservation act; Indiana protection of streams and wetlands
Iowa	Chapter 481B of the code of Iowa; Endangered plants and wildlife; Iowa administrative code: water quality standards; Iowa code section 314.24 - natural and historic preservation; Wetlands, streams, and other waters regulation in Iowa
Kansas	Kansas surface water quality control standards; Kansas state preservation law
Kentucky	Kentucky conservation and state development fish and wildlife resource; Kentucky floodplain protection
Louisiana	Louisiana administrative code 76: IX.105,115 and 117: natural and scenic river systems; Louisiana coastal resources program; Louisiana wetlands and streams protection
Maine	Maine mandatory shoreline zoning act; Maine site location of development act; Maine stormwater management law; Maine wetlands protection; Maine's endangered species act
Maryland	Code of Maryland regulations 26.08.02 anti degradation of tire II waters; Code of Maryland regulations 26.23 non tidal wetlands and waterways; Maryland environmental policy act; Maryland forests conversation act; Maryland state protected species; Maryland wetlands protection act; Non-game and endangered species conservation act
Massachusetts	Massachusetts endangered species act; Massachusetts environmental policy act; Massachusetts wetlands protection act
Michigan	Michigan environmental protection act; Michigan natural resources and environmental protection act; Michigan state wetlands protection; The Great Lakes compact
Minnesota	Minnesota endangered and threatened species law; Minnesota environmental policy act; Minnesota environmental regulations; Minnesota environmental rights act
Mississippi	Mississippi nonage and endangered species conservation act; Mississippi surface and groundwater use regulations; Mississippi surface water quality standards
Missouri	Missouri clean water law; Missouri soil and water conservation districts law
Montana	Montana environmental policy act; Montana major facility siting act; Montana natural streambed and land preservation act

State	State Statute Terms
Nebraska	Nebraska non-game and endangered species conservation act; Nebraska surface water quality standards
New Hampshire	New Hampshire alteration of terrain; New Hampshire shoreline water quality protection act; The New Hampshire wetlands act
New Jersey	New Jersey coastal area facility review act; New Jersey endangered and non-game species conservation act of 1973; New Jersey executive order 215; New Jersey freshwater wetlands protection act; New Jersey register of historic places act of 1970; New Jersey soil erosion and sediment control act
New Mexico	New Mexico cultural properties act; New Mexico water quality act; New Mexico wildlife conservation act
New York	Article 78 proceedings; New York City environmental quality review; New York climate leadership and community protection act; New York environmental quality review act; New York protection of waters regulatory program
North Carolina	North Carolina archaeological resource protection act; North Carolina environmental policy act; North Carolina surface water and wetland standards
North Dakota	North Dakota century code 55-02-07; North Dakota century code 55-03-01; North Dakota century code 61-04-02; North Dakota sovereign lands
Ohio	Ohio revised code section 1531.25; Ohio river valley water sanitation commission
Oklahoma	Oklahoma ground water law
Pennsylvania	Pennsylvania clean streams law; Pennsylvania environmental rights amendment; Pennsylvania wild resource conservation act
Rhode Island	Rhode Island endangered species of animals and plants; Rhode Island freshwater wetlands act; Rhode Island water quality regulations
South Dakota	South Dakota endangered and threatened species; South Dakota environmental policy act; South Dakota preservation of historic sites; South Dakota surface water quality
Tennessee	Tennessee ephemeral streams; Tennessee water quality control act; Tennessee wetlands definition
Texas	Texas ephemeral streams; Texas parks and wildlife code; Texas endangered species protections
Virginia	Virginia code 10.1-10.1188; Virginia environmental impact report procedure; Virginia water protection permit
Vermont	Vermont endangered and threatened species rule; Vermont preservation in act 250; Vermont water supply rule; Vermont water quality standards; Vermont wetlands and water protection
West Virginia	West Virginia erosion and sediment control best management Manual; West Virginia wetlands and water protection; West Virginia water quality standards
Wisconsin	Wisconsin act 395; Wisconsin environmental policy act; Wisconsin wetlands permitting
Wyoming	Bear river compact; Water quality rules and regulations: Wyoming surface water quality standards; Wyoming environmental quality act; Wyoming wetlands act

A.5 Impact of Litigation on Future Entry

	(1)	(2)	(3)	(4)
Litigation at County				
... Overall Cases	-0.0002	-0.0013**	-0.0001	-0.0012*
	(0.0004)	(0.0007)	(0.0005)	(0.0007)
... With Precedential		0.0021**		0.0025***
		(0.0009)		(0.0009)
... With Negative Outcome			-0.0012	-0.0015
			(0.0018)	(0.0022)
... With Precedential X With Negative Outcome				-0.0004
				(0.0003)
Litigation at Legal Jurisdiction				
... With Precedential		0.0003***		0.0003***
		(0.0001)		(0.0001)
Queue Year FE	X	X	X	X
Transmission Provider FE	X	X	X	X
Mean of dependent var.	0.0307	0.0307	0.0307	0.0307
N	375,984	375,984	375,984	375,984
R2	0.73	0.73	0.73	0.73

$* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

The sample period spans 2010 to 2023 and includes all counties that experienced renewable project entry at any point during this time. The dependent variable is a binary indicator for whether a county saw renewable project entry in a given month. Four independent variables are measured at the county level: total litigation cases, cases that established legal precedent, cases with negative rulings for developers, and an interaction term between precedent-setting and negative rulings. One independent variable is measured at the jurisdiction level, capturing cases that established legal precedent. All specifications control for the number of higher-queue projects, the capacity of higher-queue projects (MW), population, and median household income, all measured in logs. They also control for wind resource potential, solar resource potential, Clean Water Act jurisdiction, political composition, whether the county has high farming concentration, and the share of federal land. Standard errors are reported in parentheses and clustered by county.

A.6 Impact of Litigation on Future Entry (Control Variables)

No. of Higher Queue	-0.0992***	-0.0993***	-0.0992***	-0.0992***
	(0.0075)	(0.0075)	(0.0075)	(0.0075)
Capacity of Higher Queue (MW)	0.1292***	0.1292***	0.1291***	0.1292***
	(0.0040)	(0.0040)	(0.0040)	(0.0040)
Wind Resource Potential	0.0021***	0.0020***	0.0021***	0.0020***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Solar Resource Potential	0.0051***	0.0055***	0.0050***	0.0054***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)
Zoning Ordinance	0.0024***	0.0025***	0.0024***	0.0025***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Clean Water Act Jurisdiction	-0.0025	-0.0025	-0.0025	-0.0025
	(0.0016)	(0.0016)	(0.0016)	(0.0016)
Population	-0.0024***	-0.0024***	-0.0024***	-0.0025***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Median Household Income	-0.0082***	-0.0080***	-0.0082***	-0.0079***
	(0.0018)	(0.0018)	(0.0018)	(0.0018)
Political Composition - Democrat	-0.0121***	-0.0121***	-0.0121***	-0.0121***
	(0.0021)	(0.0021)	(0.0021)	(0.0021)
High Farming Concentration	-0.0040***	-0.0040***	-0.0040***	-0.0040***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)
Share of Federal Land	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Queue Year FE	X	X	X	X
Transmission Provider FE	X	X	X	X
Mean of dependent var.	0.0307	0.0307	0.0307	0.0307
N	375,984	375,984	375,984	375,984
R2	0.73	0.73	0.73	0.73

A.7 Impact of Litigation on Regulatory Practices

Dep Var	Permit Issuance Time	Extra Condition
Litigation at County		
... Overall Cases	20.9092***	0.0173
	(6.5957)	(0.0223)
... With Legal Precedent	-4.3389	0.0302
	(18.9724)	(0.0687)
... With Negative Outcome	206.2693***	0.6029***
	(68.6935)	(0.1258)
... With Precedential X With Negative Outcome	-220.6718***	-0.5293***
	(78.8516)	(0.1536)
Litigation at Legal Jurisdiction		
... With Legal Precedent	9.6577	-0.0204
	(8.3819)	(0.0222)
Application Year FE	X	X
USACE Office FE	X	X
Mean of dependent var.	85.05	0.62
N	5,475	5,475
R2	0.55	0.63

$* \ p < 0.1$, $** \ p < 0.05$, $*** \ p < 0.01$.

The sample spans 2010 to 2023 and includes greenfield energy project applications for Section 404 permits under the Clean Water Act. The analysis examines two dependent variables: Permit Issuance Time (days between application submission and permitting decision) and Extra Conditions (a binary indicator for whether the permit required special conditions or procedural changes). Key independent variables are measured cumulatively over the previous year and include three county-level measures (total litigation cases, precedent-setting cases, and cases with negative rulings for developers) and one jurisdiction-level measure (precedent-setting litigation). All specifications control for pending permit applications in the same USACE district (overall, general, and individual), right-of-way use, emergency status, supplemental status, permit type, facility type (generation or transmission), and infrastructure type. Standard errors in parentheses; clustered by county.

A.8 Impact of Litigation on Regulatory Practices Robustness

Dep Var	Permit Issuance Time	Extra Condition
Litigation at County (past 3 qrts)		
... Overall Cases	20.8359***	0.0062
	(6.3086)	(0.0220)
... With Legal Precedent	-18.2090	0.0863
	(15.3235)	(0.0743)
... With Negative Outcome	214.8423***	0.6262***
	(64.1908)	(0.1275)
... With Precedential X With Negative Outcome	-232.4397***	-0.6177***
	(76.4211)	(0.1808)
Litigation at Legal Jurisdiction (past 3 qrts)		
... With Legal Precedent	16.6492**	0.0006
	(7.8719)	(0.0250)
Litigation at County (past 5 qrts)		
... Overall Cases	20.4866***	0.0287
	(7.1364)	(0.0241)
... With Legal Precedent	-1.6373	0.0029
	(14.5510)	(0.0538)
... With Negative Outcome	185.0052**	0.5467***
	(53.9945)	(0.1202)
... With Precedential X With Negative Outcome	-177.5314**	-0.4070***
	(79.4248)	(0.1533)
Litigation at Legal Jurisdiction (past 5 qrts)		
... With Legal Precedent	7.1480	-0.0296
	(10.2689)	(0.0231)
Application Year FE	X	X
USACE Office FE	X	X
Mean of dependent var.	85.05	0.62
N	5,475	5,475

A.9 Legal Precedent Formation Marginal Probability Effect

Variables	Coef	Std. Err.
Overall Litigation Cases	-0.005	0.004
Litigation With Negative Outcome	0.009	0.018
Litigation With Legal Precedent	0.009***	0.003
Appellate Court	0.32***	0.050
High Court	0.56***	0.052
Federal Statute	-0.043	0.097
State Statute	-0.050	0.102
Local Statute	-0.032	0.090
Multiple Statutes	-0.011	0.110
Multiple Motions	0.127***	0.034
Wind Project	0.035	0.054
Solar Project	-0.075	0.055
Decision		
... Affirmed	0.087*	0.047
... Remanded	0.206***	0.050
... Summary Judgment	0.290***	0.072
... Neutral Change	0.072	0.046
... Deny	-0.026	0.064
... Dismissed	0.008	0.083
Relief		
... Request	-0.062	0.075
... Against Auth	0.225***	0.037
... Seek Damage	-0.002	0.102
... Judicial Review	0.046	0.157
... Injunction	-0.032	0.044
... Against Zoning	0.068	0.113
... Seek Hearing	-0.099	0.112

The sample includes 703 litigation cases heard in higher courts that had the potential to establish legal precedent. The reported values are marginal effects from a probit regression. Standard errors are clustered at the county level.

A.10 Net Profit Approximation for Potential Entrants

In order to simulate project entry, I construct a measure of net profit for each potential renewable energy entrant. Net profit is defined as the present value of revenues, net of operating and capital costs, over the project's expected lifetime, which I assume to be 25 years in line with industry standards. This measure provides a project-level indicator of financial viability that links technology, location, and market conditions to entry decisions in the model.

To estimate net profits for potential entrants, I compile data from multiple sources. Project characteristics, including technology type (wind or solar) and nameplate capacity (MW), are assigned through bootstrap sampling from the pool of actual entrants within the same county–year, or from the state–year pool if the number of actual entrants is smaller than the maximum number of potential entrants specified in the simulation.

Spot market electricity prices are obtained from the Renewables and Wholesale Electricity Prices (ReWEP) Tool (Millstein et al. 2025), which reports hourly locational marginal prices across U.S. markets. I calculate peak-hour average spot prices from these data. To address missing observations, I regress observed spot prices on electricity resale price from wholesale market from EIA Form 923, controlling for state and year fixed effects, and use the fitted values to impute unavailable prices at the market-year level. Power purchase agreement (PPA) prices are drawn from Berkeley Lab's Utility-Scale Solar, 2024 Edition (Seel et al. 2024) and Land-Based Wind Market Report, 2024 Edition (Wiser et al. 2023), which provide ISO-level and regional annual averages. To capture project-level generation, I use annual state-level capacity factors from the EIA State Energy Data System and curtailment rates from the same Berkeley Lab reports. Finally, investment and operating costs are taken from the EIA's Cost and Performance Characteristics of New Generating Technologies, which reports technology- and year- specific estimates of capital expenditures (CapEx) and fixed operations and maintenance (O&M) costs.

Given these inputs, I calculate expected annual generation for project i as:

$$Q_i = \mathrm{MW}_i \times \mathrm{CF}_i \times (1 - \text{ Curtail }_i) \times 8,760,$$

where MW_i denotes project capacity, CF_i the state-level technology specific capacity factor, and Curtail, the annual curtailment rate. The effective price received per MWh is constructed as the sum of the average peak-hour wholesale price and the region-specific PPA price, both of which are estimated at the ISO or regional level and then matched to potential entrants at the county level. Annual revenues are given by

$$R_i = Q_i \times \left(P_i^{\text{wholesale }} + P_i^{\text{ppa}}\right).$$

Subtracting fixed O&M costs yields annual net revenue. These flows are discounted at a real interest rate $r = 0.05$ over a 25-year lifetime, such that the project's net present value is

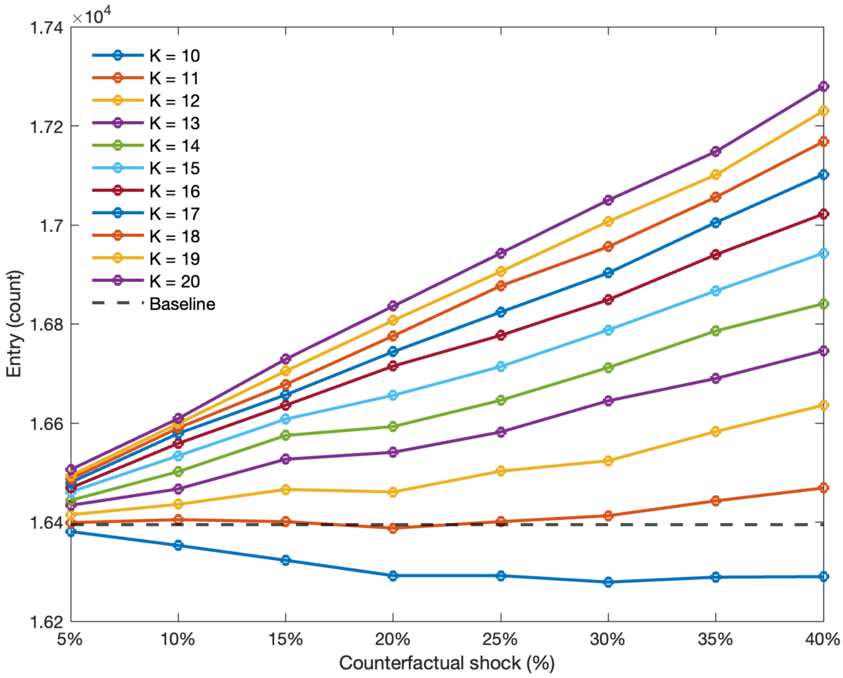
$$NPV_i = \left(R_i - C_i^{0\&\mathrm{M}}\right) \times \frac{1-(1+r)^{-25}}{r}.$$

Finally, net profit is obtained by subtracting upfront capital investment costs:

$$\pi_i = NPV_i - F_i,$$

where F_i denotes the technology-specific capital expenditure. For presentation, π_i is scaled to millions of dollars.

A.11 Counterfactual: Legal Insurance with Alternative Premium Levels



Note: Project entry under the Legal Insurance counterfactual with varying premium rates. Higher X correspond to lower upfront premiums. For example, if the developer purchases insurance covering 20 percent of litigation costs (x-axis is 20), the premium is set at one over K of that share, or approximately 20/K of project net profit.