NISKANEN CENTER

SITING, LEASING, AND PERMITTING OF CLEAN ENERGY INFRASTRUCTURE IN THE UNITED STATES

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The Niskanen Center is a 501(c)3 issue advocacy organization that works to change public policy through direct engagement in the policymaking process.

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Executive summary

Across the U.S., market demand for clean energy is healthy. While a variety of short-term headwinds can dampen quarterly or annual market growth, long-term outlooks remain strong. Utilities continue to add large-scale renewable energy to cut power costs for customers, diversify energy mixes, and meet state public policy goals.[1] Corporate buyers are pursuing 100 percent clean energy commitments and reduced operating expenses.[2] Cities and counties are targeting economic development, public health, and decarbonization as well.[3] Private and public sectors have mobilized impressively to meet demand, innovating to improve performance and cut costs, and successfully bringing an abundance of new clean power supply online.

Yet the ongoing expansion of clean energy supply cannot be sustained unless outdated government regulations and processes are improved. In particular, the siting, leasing, and permitting stages of clean energy infrastructure development are increasingly presenting obstacles to private firms developing electric generation and transmission, even as demand accelerates.[4]

The Niskanen Center undertook research to better understand the existing regulatory structure and to identify opportunities to reduce inefficient and counterproductive regulations. Our primary focus is the federal level, aligning with the nation-wide geographic scope of the obstacles to clean energy expansion. We reviewed research by think tanks, reporting by journalists, and agency rulemakings and programs related to siting, leasing, and permitting regulations for five illustrative types of clean energy infrastructure: onshore wind, solar photovoltaics, electric transmission,[5] offshore wind, and geothermal. These examples encompass commercially mature and nascent technologies, siting needs ranging from land-based to ocean-based and above-ground versus below-ground resources, and linear and non-linear infrastructure. Albeit non-comprehensive, this clean technology selection provides a broad look into regulatory bottlenecks that emerge for different types of energy resources. In many cases, we also made use of a comparative lens that viewed clean energy infrastructure side by side with traditional, widely deployed fossil fuel infrastructure - for example, comparing geothermal well drilling with oil and gas production, and comparing electric transmission lines with natural gas pipelines.

This white paper documents our findings and recommends regulatory improvements that would support continued robust market growth in clean energy infrastructure. Our findings and recommendations come in two categories:

1. Specific insights related to particular types of clean energy infrastructure, such as solar PV or geothermal; and

1. Galen Barbose, *U.S. Renewables Portfolio Standards 2021 Status Update: Early Release* (Lawrence Berkeley National Laboratory, February 2021), at 16-20; Elesia Fasching, "Wind, solar, and batteries increasingly account for more new U.S. power capacity additions," U.S. Energy Information Administration, March 2023.

2. American Clean Power Association, "Clean Energy Powers American Business," ACPA, 2022, at 1.

3. Tatsatom Gonçalves and Yuning Liu, "How U.S. Cities and Counties Are Getting Renewable Energy," World Resources Institute, June 2020; American Council for an Energy Efficient Economy, "Scorecard: Leading U.S. Cities Grow Clean Energy Efforts but Many More Lag Far Behind," ACEEE, October 2020.

4. Rayan Sud and Sanjay Patnaik, "*How does permitting for clean energy infrastructure work?*" Brookings Institution, September 28, 2022.

5. Notably, electric transmission can carry energy from clean generation, fossil fuel generation, or a mix, depending on location within the transmission network, including in relation to load and generation locations. We include transmission as a clean infrastructure type in recognition of the crucial role of its expansion in enabling high penetration levels of clean generation technologies such as wind and solar on power grids, as discussed further in the report.

2. Overarching takeaways drawn from the broad research scope that apply more generally to multiple existing clean infrastructure types, and potentially to future technologies as well.

The specific insights by clean energy type are summarized below in Table ES-1, with detailed explanations included in the main body of the paper. The overarching takeaways, in brief, are as follows (more detailed descriptions appear in the Conclusions section):

- Fossil fuel infrastructure comparisons are frequently useful for identifying proven strategies for successful buildout of energy projects.
- These proven infrastructure deployment strategies can be systematically utilized to develop federal policy and agency rulemakings related to clean energy infrastructure, with due caution for maintaining strong community and environmental safeguards.
- Regulatory coordination is essential for reducing clean energy development siting, leasing, and permitting obstacles:
    - Strengthened coordination is needed across federal permitting agencies with overlapping jurisdictional authority;
    - Strengthened coordination is needed among federal, state, and local agencies;
    - Regulatory processes must incorporate a heavy emphasis on early, meaningful, and ongoing community engagement;
    - Government capacity limitations must be addressed, including recognizing and intentionally resolving resource development tradeoffs between fossil and clean energy sources;
    - Clean energy should be explicitly prioritized through an all-of-government approach.
- Clean generation depends on transmission infrastructure that itself is stymied by inefficient approval processes; unlocking expanded clean energy development requires us to reform and coordinate both of these complex systems.

Future work could build on this research by considering additional regulatory elements, more clean energy technologies and infrastructure types, and potentially additional fossil fuel or other infrastructure regulatory regimes that may offer instructive comparisons.

Table ES-1: Specific policy responses to further responsible development by clean energy type

Solar and onshore wind - siting
1. Incentivize favorable local siting ordinances.
2. Foster community engagement by providing resources and imposing developer requirements.
3. Require a community benefits agreement.
4. Implement a state-level “fair share” approach.
Solar and onshore wind - leasing
1. Expand Bureau of Land Management solar Designated Leasing Areas and designate wind Designated Leasing Areas.
2. Add a Bureau of Land Management Preferred Land Area category.
3. Bring solar and wind rental rates more in line with those for oil and gas.
4. Adopt an internally consistent approach to energy production payments.
5. Discontinue BLM leasing of public land for specific energy development where there is low potential for that energy resource.
Solar and onshore wind - permitting
1. Rebalance the categorical exclusion framework to encompass low-impact renewable development activities.
2. Encourage early stakeholder participation in the permitting process.
3. Expand the successful use of programmatic Environmental Impact Statements for solar and wind.
4. Evaluate success of BLM Renewable Energy Coordination Office for solar and wind.
Transmission
1. Establish federal interstate siting authority via the Federal Energy Regulatory Commission for transmission infrastructure.
2. Require minimum transfer capacity between regions.
3. Evaluate reuse and expansion of existing transmission corridors and potential of building adjacent to highways and railways.
4. Enact policies and regulations that support government agency capacity and coordination for permitting activities.
5. Foster community engagement, create community benefit agreements, and incentivize favorable local siting ordinances.
6. Support transmission planning efforts for coordinated infrastructure expansion.
Offshore wind
1. Increase funding for Bureau of Ocean Energy Management to aid in implementing permitting reforms.
2. Establish offshore grid regulations under FERC.
3. Create a framework for addressing community engagement and compensation.
4. Support transmission planning and cost allocation reforms.
5. Repeal the linkage between leasing of offshore wind and offshore fossil fuel drilling.
6. Create a dedicated statutory title for offshore wind.
Geothermal
1. Evaluate categorical exclusions for geothermal.
2. Open a centralized BLM permitting office for geothermal energy.
3. Identify geothermal leasing priority zones and update the geothermal programmatic Environmental Impact Statement.
4. Foster community engagement and stakeholder participation in the permitting process.

Introduction

Market demand for clean energy is healthy across the United States. While a variety of short-term headwinds can pose challenges and temporarily slow market growth, long-term outlooks remain strong. Utilities, corporate buyers, and communities are driving adoption of wind and solar technologies,[6] which have tripled as a share of U.S. electricity generation over the last decade.[7] Yet government regulations need improvement to ensure new clean-energy generation and transmission projects keep up with market demand.

This white paper examines those regulations and how they impact an illustrative range of clean energy infrastructure types. Additionally, we compare federal regulations governing fossil-fuel and clean-energy infrastructure to gain further perspective on challenges and opportunities for clean energy deployment. We offer recommendations for how regulatory paradigms can be modernized to accommodate new technologies that are in high demand and have the potential to meet numerous energy policy goals, including cost savings, reliability enhancements, economic development, energy security, and health and environmental gains.

Siting, leasing, and permitting

Project development and deployment for clean energy infrastructure is a multifaceted process that includes engineering design, procurement, financing, siting, acquisition of land rights, permitting, construction, and operations.[8] For leading clean energy technologies, such as solar photovoltaics (PV)[9] and onshore wind turbines, considerable market growth in installed capacity and in planned projects has revealed bottlenecks to ongoing deployment, including in the siting, leasing, and permitting stages of project development.[10] Thus, while the engineering, procurement, and construction (EPC) stages of project development and project financing have overall remained strong, regulatory processes need to adapt to keep pace.

All energy infrastructure projects undergo some form of siting and permitting impacted by government regulations. Depending on the project, land rights may be obtained via a private property transaction, the exercise of eminent domain authority, or a government process determined by agency actions and regulations (for example, leasing federal land). Generally, the collective purpose of siting, leasing, and permitting processes and their associated regulations is to identify a viable location for energy project development and authorize construction on that site, in a manner that captures potential project benefits and avoids, offsets and/or compensates negative impacts to communities and the environment.[11]

6. Galen Barbose, *U.S. Renewables Portfolio Standards 2021 Status Update: Early Release* (Lawrence Berkeley National Laboratory, February 2021), at 16-20; American Clean Power Association, "Clean Energy Powers American Business," ACPA, 2022, at 1; Tatsatom Gonçalves and Yuning Liu, "How U.S. Cities and Counties Are Getting Renewable Energy," World Resources Institute, June 2020; American Council for an Energy Efficient Economy, "*Scorecard: Leading U.S. Cities Grow Clean Energy Efforts but Many More Lag Far Behind*," ACEEE, October 2020.

7. Tyler Hodge, "New renewable power plants are reducing U.S. electricity generation from natural gas," U.S. Energy Information Administration, January 18, 2022.

8. See, e.g., Scott Gillam, "A Detailed Guide to the Solar Project Development Process," PFNexus, May 10, 2023.

9. Solar PV is one of three basic types of solar energy technology. PV directly converts sunlight into electricity. In contrast, concentrating solar power uses heat from sunlight to drive turbines, and solar heating and cooling technologies use heat from sunlight to heat water or provide air conditioning for buildings. See Solar Energy Industries Association, "Solar Energy Technologies: Solutions for Today's Energy Needs," SEIA, April 2018.

10. Rayan Sud and Sanjay Patnaik, "How does permitting for clean energy infrastructure work?" Brookings Institution, September 28, 2022.

11. DOE Office of Energy Efficiency & Renewable Energy, "Siting of Large-Scale Renewable Energy Projects," accessed Jan. 25, 2024.

Siting refers to the process of finding and deciding on a location for energy infrastructure. It must be a place where energy resources are available; land is obtainable for purchase or lease; and local, county, state, or federal rules do not proscribe or significantly restrict energy development.

Leasing refers to the renting of land for energy development. In the west, the Bureau of Land Management (BLM) manages vast swathes of acreage, so energy developers often find themselves leasing from BLM. In all parts of the country, developers can also purchase or lease private lands — a lucrative proposition for a farmer leasing land for solar development and charging up to $2,000/acre per year.[12] Further, land access can involve subsurface rights in addition to surface rights in some cases, such as geothermal, and these can have different owners.

In addition to purchasing or leasing a viable site, energy developers must obtain one or more permits as part of the project development process. Multiple local, state, and federal authorities may issue or require permits, and timelines for permitting processes vary from months to years.

Illustrative clean energy infrastructure

Low-carbon electricity can be produced by a wide variety of energy sources and technologies. In the U.S., large amounts of onshore wind and solar PV capacity have been installed in the last two decades, and the commercial maturity and cost-competitiveness of these resources have led decision-makers to feature continued expansion of wind and solar in long-term energy plans.

Numerous other clean energy technologies are expected to have significant roles alongside onshore wind and solar. For example, electric transmission is essential for tying distant renewable energy generation facilities into existing grid networks connected to population centers. Offshore wind offers a closer geographic match with coastal cities responsible for a large proportion of electricity demand. Geothermal is a clean energy resource that is capable of generating in a more "round the clock" manner than wind and solar. While offshore wind and geothermal are currently not as cost-competitive as onshore wind and solar, ongoing technology development and deployment have the potential to drive costs down and enable larger volumes of these resources to be harnessed in the coming decades.

Additional examples of potentially important low-carbon resources include infrastructure for carbon capture and sequestration; green hydrogen production, distribution, and combustion; various types of battery storage; advanced nuclear; hydro; and biomass. And ongoing technological development may bring still more low-carbon sources into commercial development, such as wave energy and additional storage technologies. While this paper does not directly address these additional technology and fuel types, many of the takeaways we found may apply to them as well.

This paper examines onshore wind, solar PV, offshore wind, geothermal, and electric transmission infrastructure in order to survey an illustrative range of clean energy sources and technologies. Taken together, this selection of infrastructure types includes (i) both commercially mature and nascent technologies, (ii) siting needs ranging from land-based to ocean-based and above-ground versus below-ground resources, and (iii) linear and non-linear infrastructure. Albeit non-comprehensive, this clean technology selection provides a broad look into existing regulatory structures for different types of energy

12. YSG Solar, "Solar farm land lease rates," YSG Solar, October 2020.

resources. The range of challenges and opportunities we identify here also provides insight into what types of barriers and responses may emerge for other technologies that begin to experience substantial market growth in the future.

Fossil fuel comparisons

The existing regulatory process often favors fossil fuels over low-carbon energy options. For example, interstate natural gas pipelines benefit from federal eminent domain authority, as interstate gas infrastructure is approved at the federal level. Conversely, the siting and permitting of interstate transmission lines must obtain certain authorizations one state at a time — for this infrastructure, there is no interstate eminent domain authority to obtain needed land. The federal government in recent decades has approved interstate natural gas pipelines comparatively quickly — 18 months on average, which is less than half the average permitting time for interstate transmission[13], though some have asserted that pipeline review times have risen this decade.[14] Further, the Federal Energy Regulatory Commission (FERC) from 1999 to 2019 approved over 99 percent of the proposed pipeline projects before it.[15] At the leasing level, BLM offers artificially low rental rates for oil and gas development but not for wind and solar, as detailed in the main body of the paper. And in a permitting example, oil and gas extraction projects enjoy permitting exemptions that geothermal, wind, and solar do not – including, in many cases, from provisions of the National Environmental Policy Act (NEPA).[16]

This paper utilizes fossil fuel infrastructure regulations as a lens for viewing clean energy siting, leasing, and permitting processes. While we might reasonably expect regulatory regimes for different energy resources to vary according to the unique attributes of each resource, fossil fuel infrastructure comparisons nevertheless provide instructive context for evaluating efficiencies and whether clean energy regulations are appropriately designed given market demand, energy policy objectives, and their environmental and community impacts. Further, fossil fuel regulatory frameworks that are highly favorable towards infrastructure development can provide models for clean energy regulatory approaches that may be adapted to fit resource characteristics and policy goals. Importantly, fossil infrastructure practices have also led to deep community harms.[17] Thus, any lessons learned from fossil infrastructure deployment must also adjust problematic elements to ensure that clean energy expansion maintains strong community and environmental safeguards.

Roadmap

The remainder of the paper proceeds as follows. Four core sections address five clean energy infrastructure types in turn (one section simultaneously addresses two energy types, for reasons described below). The four core sections are: solar and onshore wind, transmission, offshore wind, and geothermal. Each core section includes subsections that specifically address siting, leasing, and/or permitting challenges. The subsections also frame these challenges in comparison to analogous fossil fuel infrastructure where

13. Liza Reed, *Transmission Stalled: Siting Challenges for Interregional Transmission* (Niskanen Center, April 14, 2021), at 9.

14. Paul Parfomak, *Interstate Natural Gas Pipeline Siting: FERC Policy and Issues for Congress*, (Congressional Research Service, June 9, 2022), at 14.

15. Claire Hill, "Rethinking FERC's Approach to Natural Gas Pipeline Approvals," The Regulatory Review, 21 December 2022.

16. Brian Steed, "NEPA Efficiencies for Oil and Gas Development," Bureau of Land Management, Information Bulletin no. 2018-061, June 6, 2018.

17. See for example, Liza Reed, *Transmission Stalled: Siting Challenges for Interregional Transmission* (Niskanen Center, April 14 2021) at 9-10.

our research uncovered meaningful comparisons. Each core section also includes policy responses: potential regulatory changes that would support clean energy infrastructure deployment. Finally, we offer concluding remarks, including an integration of our findings across the four core sections into general takeaways.

This paper draws on research by think tanks, reporting by journalists, and agency rulemakings and programs; given the breadth of the subject matter, rather than attempting a summary of this previous work here, the main body of the report includes extensive descriptions and citations of the wide-ranging work we draw on. To our knowledge, the broad exploration we undertook —- spanning siting, leasing, and permitting across onshore wind, solar PV, offshore wind, geothermal, and electric transmission, and also comparing regulatory approaches to analogous fossil infrastructure —- is unique.

Rather than attempting to comprehensively assess each of these three regulatory areas across five clean energy infrastructure types while comparing them to fossil fuel regulations, we draw on available sources to highlight a sample of major regulatory issues for each clean infrastructure type along with readily comparable fossil infrastructure regulatory treatment.

Solar and onshore wind

Solar PV and onshore wind are the leading renewable resources worldwide and in the U.S. for new capacity additions, having reached commercial maturity, low cost, and widespread deployment, while still retaining tremendous volumes of untapped potential.[18] While there are many important differences between wind and solar, for the purposes of this paper we consider them in tandem because they share advanced commercial maturity and abundant additional potential, and because they face similar needs for regulatory improvement within the realms of siting, leasing, and permitting.

Siting solar and onshore wind

Siting challenges have recently become a significant barrier to solar and wind energy deployment. In many states, siting decisions are made by local county commissions or zoning boards. While investment in wind and solar is growing fast and will continue to accelerate with implementation of the Inflation Reduction Act, many counties are adopting stringent or prohibitive wind and solar development ordinances. Columbia University's Sabin Center for Climate Change Law has identified 228 local ordinances across 35 states that restrict the siting of renewable energy projects, mostly solar and wind.[19]

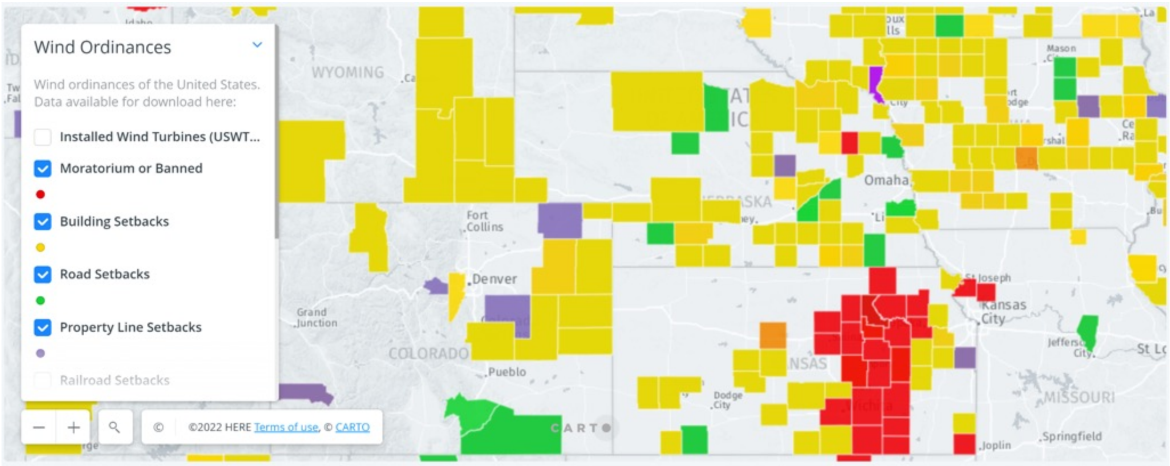
For example, Figure 1 depicts counties where a local ordinance limits wind development or bans it altogether. As discussed further below, reasons for resistance to renewables include but are not limited to: concerns that renewable development will reduce property values, conflict among landowners regarding who will and will not benefit from renewable development, and concerns around environmental degradation.[20]

18. Joseph DeCarolis and Angelina LaRose, *Annual Energy Outlook*, (U.S. Energy Information Administration, March 16, 2023), at 14; Florian Heineke et al., "Renewable-energy development in a net-zero world," McKinsey, October 2022.

19. Matthew Eisenson, "Report Finds 228 Local Restrictions Against Siting Wind, Solar, and Other Renewables, as Well as 293 Contested Projects," Columbia Law School, May 2023.

20. Samantha Gross, *Renewables, Land Use, and Local Opposition in the United States* (Brookings Institution, January 2020).

Figure 1: Sample of local ordinances limiting wind development in the U.S.



Source: NREL.[21] Cutaway of some midwestern states with counties that have enacted a wind energy-restrictive ordinance of some kind

Iowa, for example, has enormous wind energy potential. Princeton University's Net-Zero America Project identified 76 percent of the state as a possible wind Candidate Project Area (CPA), representing 299 GW of total capacity potential,[22] which is more capacity than all currently installed wind and solar in the entire country.[23] But local permitting ordinances have ruled out 49-52 percent of total CPAs, and analysis from ClearPath projects that 70-77 percent of total CPAs could be unavailable in the future due to local ordinances.[24] ClearPath further notes that many other Midwestern states with high wind potential are adding restrictive ordinances.[25]

Solar siting encounters challenges, too. However, the scope of public resistance has been smaller up to this point, due to the comparatively low visibility of solar farms. Still, the number of county-level bans on solar projects is rising. For example, in Ohio, 10 out of the state's 88 counties have recently banned large-scale solar development.[26] A recent NREL study found 839 U.S. ordinances that could impact utility-scale solar development.[27]

Areas with high wind or solar potential often cross county lines, so one county with a prohibitive rule can pose significant barriers even when others are more open. Additionally, counties can change ordinances, including after a project commences development. Overall, swathes of high-potential areas for wind and solar are unavailable for renewable energy project development, and it is an increasingly expensive endeavor to navigate the complex maze of county-level requirements.

21. National Renewable Energy Laboratory, "Wind Energy Siting Regulation and Zoning Ordinances," U.S. Department of Energy, 2022.

22. Casey Kelly et al., "Hawkeye State Headwinds," ClearPath and LucidCatalyst, July 14, 2022.

23. Center for Sustainable Systems, "U.S. Renewable Energy Factsheet," University of Michigan, pub. no. CSS03-12, September 2022.

24. Kelly et al., "Hawkeye State Headwinds."

25. *Ibid*.

26. Jake Zuckerman, "Ten Ohio Counties ban wind, solar projects under new state law," Ohio Capital Journal, August 23, 2022.

27. Emma Penrod, "'Setback' ordinances could cut U.S. wind potential by 87%, solar by 38%: NREL," Utility Dive, August 10, 2023.

Community land use concerns

Residents may oppose wind and solar development for various reasons.[28] Concerns about land value and environmental impacts are two of the most common causes of community opposition. For example, utility-scale wind turbines in the United States are hundreds of feet tall; a 2020 Brookings report notes, "Residents are concerned about noise and shadow flicker, potential declines in property values, and bird kills, and many believe that wind turbines are an eyesore."[29] Another concern that residents sometimes have is that wind or solar will displace local agricultural land uses.[30]

The relative land intensity of wind and solar generation creates various challenges across the development process, particularly regarding siting. Wind and solar require more space than fossil fuels.[31] Location near residential areas and resident concerns about aesthetics and safety create siting challenges for renewables, especially wind. At the same time, there are opportunities for overlapping land uses within wind and solar farms — for example, agricultural land uses within the portions of renewable energy sites that are not directly occupied by the energy infrastructure itself, such as between wind turbine towers.[32]

Wind[33] and solar[34] resource maps illustrate the concentration of wind potential in the Great Plains, the Midwest, and Texas, while solar potential is most outstanding in the Southern states. Recent research has noted that some counties being sought out for wind and solar development have not historically hosted large-scale energy development.[35] Community opposition may be more likely in these areas than in communities more accustomed to hosting energy infrastructure.

Supporting infrastructure

As indicated by the resource maps shown in Figure 2 (next page), the best areas for wind and solar development are often in regions with lighter electric loads and limited high-capacity transmission infrastructure for delivering power to distant load centers.

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28. Lawrence Susskind et al., "Sources of opposition to renewable energy projects in the United States" Energy Policy 165 (2022): 112922.

29. Gross, *Renewables, Land Use, and Local Opposition in the United States*.

30. Alison Knezevich, "Proposed solar energy developments draw opposition over loss of farmland," The Washington Post, Jan 19, 2019.

31. Gross, *Renewables, Land Use, and Local Opposition in the United States*.

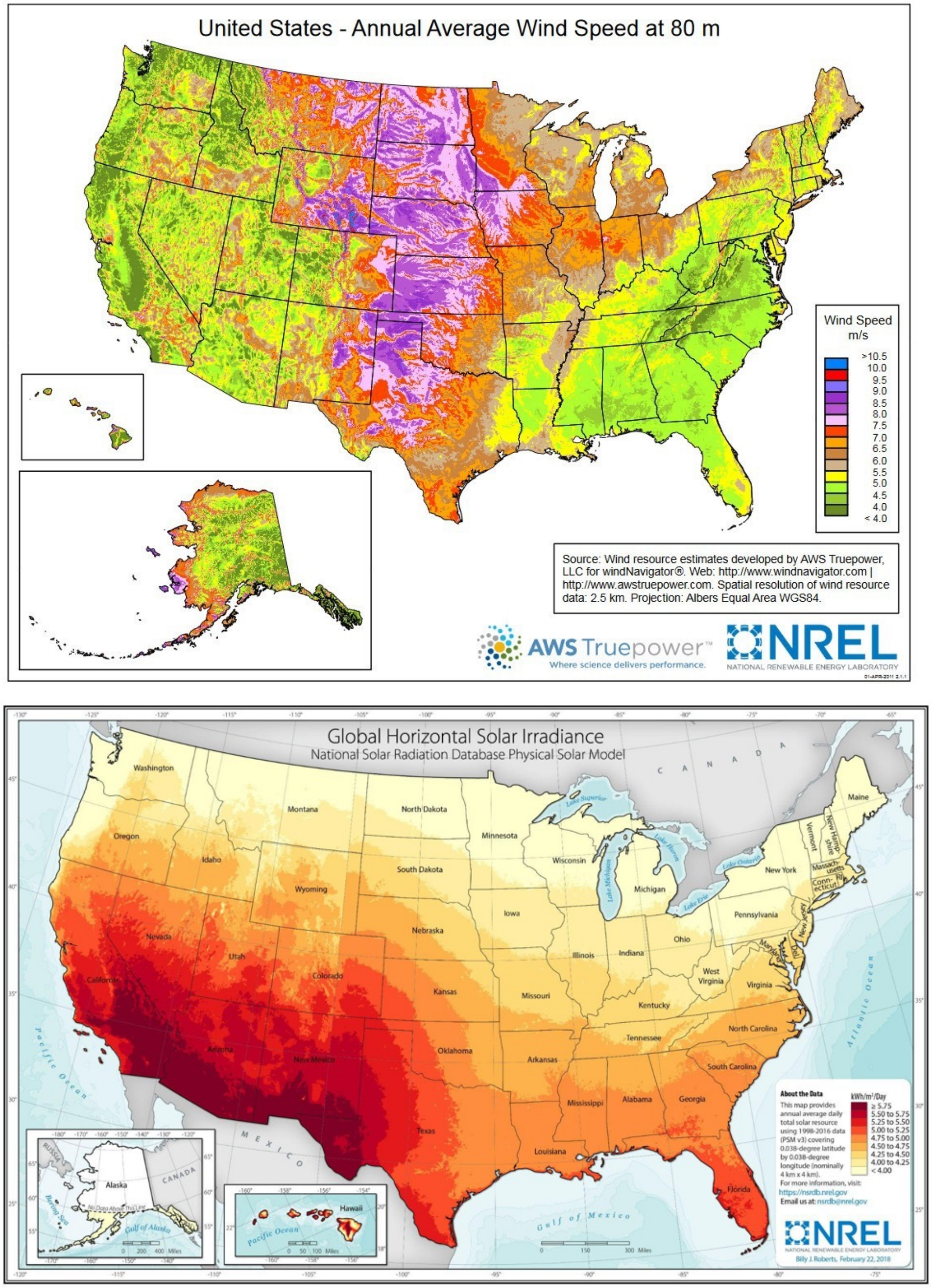
32. Bryn Huxley-Reicher, "How much land will a renewable energy system use?," Frontier Group, November 2022.

33. National Renewable Energy Laboratory, "Land-based wind resource map at 80m hub height," U.S. Department of Energy, April 2011.

34. National Renewable Energy Laboratory, "Solar irradiance map," U.S. Department of Energy, , February 2018.

35. Gross, *Renewables, Land Use, and Local Opposition in the United States*.

Figure 2: U.S. onshore wind and solar PV resource potential



Source: NREL.[36],[37]

36. NREL, "Land-based wind resource map at 80m hub height."

37. NREL, "Solar irradiance map."

The lack of available transmission capacity remains a significant barrier to renewable deployment.[38] Wait times for interconnection are rising: the typical duration from connection request to commercial operation rose from 2.1 years for projects built in 2000-2010 to 3.7 years for those constructed in 2011-2021.[39] More than 1,400 gigawatts (GW) of electric generation and storage capacity are waiting in line to plug into the transmission network.[40]

As discussed further below in the Transmission section, electric transmission faces its own concerns, which show how inefficient infrastructure development can compound barriers to successful clean energy deployment.

Policy responses

Incentivize favorable local siting ordinances.
Federal and state policymakers could offer incentives to places that welcome wind and solar development. Federal carrots could include federal aid for local outreach to communities with high wind or solar potential, technical assistance to county zoning boards, or support for regional universities' clean energy extension programs. This response could also account for and seek to mitigate the challenges of resource potentials crossing county lines and of local ordinances changing in the midst of a project's development.

For example, the Department of Energy (DOE) recently launched the R-STEP program (Renewable Energy Siting through Technical Engagement and Planning), which "seeks to expand the decision-making capacity and expertise of state and local governments around large-scale renewable energy planning, siting, and permitting" and intends to award five to seven states with grants of $1-2 million each.[41]

Foster community engagement by providing resources and imposing developer requirements.
According to a 2020 Brookings report, "Positive attitudes toward projects were correlated with residents being compensated for the projects' impacts and their perception that the planning process was fair. On the other hand, projects that begin in secret and developers that are seen as aggressive or misleading toward community members foster opposition and mistrust."[42] DOE research is uncovering new insights on the drivers of community concerns and ways to address them and achieve "community-centered" renewable energy development.[43]

State and federal lawmakers could provide resources and requirements for developers to engage with communities early and often. Resources could include easily accessible mapping information, like that

38. DOE Office of Policy, "Queued Up...But in Need of Transmission," U.S. Department of Energy, DOE/OP-0015, April 2022; Solar Energy Industries Association, "Transmission," accessed August 28, 2023..

39. Joseph Rand et al., *Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection as of the End of 2021* (Lawrence Berkeley National Lab, April 2022).

40. Joe Rand, "Record amounts of zero-carbon electricity generation and storage now seeking grid interconnection," Lawrence Berkeley National Lab, April 13, 2022.

41. DOE Office of Energy Efficiency and Renewable Energy, "Renewable Energy Siting through Technical Engagement and Planning," DOE, accessed August 31, 2023.

42. Gross, *Renewables, Land Use, and Local Opposition in the United States*.

43. Doug Bessette et al., *Community-Centered Solar Development Case Study Interviews* (Lawrence Berkeley National Laboratory, June 2023).

provided in Oregon,[44] and sponsorship of community outreach liaisons as practiced in Hawaii,[45] to assist developers and community members in understanding siting considerations and opportunities early in the process. Oregon's Renewable Energy Siting Assessment project created a centralized data repository and public mapping tool, in addition to diagrams of the siting process and a state renewable energy assessment. By making extensive use of stakeholder feedback in the development of these resources, the state energy office and partners were able to incorporate user recommendations and make a substantial network of interested parties aware of the resources. Hawaii's Clean Energy Wayfinders program trains recruits from target communities in outreach and engagement to provide low- to moderate-income households and underserved communities with information on programs for energy bill assistance, home energy upgrades, and clean energy workforce development opportunities. This helps establish channels of communication and trust that strengthen collaboration and decision-making for siting energy projects in Hawaiian communities. Other publicly available mapping and information resources could further benefit community engagement — for example, the Nature Conservancy's Site Renewables Right map[46] provides land use and wildlife data to inform conservation and biodiversity discussions. Requirements could mandate developers to show they engaged with the community as a prerequisite for permitting approval.

Encourage a community benefits agreement.

Another way to engage the community is through a community benefits agreement (CBA), which DOE defines as "an agreement signed by community benefit groups and a developer, identifying the community benefits a developer agrees to deliver, in return for community support of the project."[47] State policymakers or regulators could encourage developers to employ CBAs as part of applications to receive siting approval. The state could provide a model CBA, with suggested benefits such as an amount per megawatt (MW) generated to be put in a community fund or distributed to a particular county. The state could also provide technical assistance to counties and communities to negotiate CBAs, which a trusted community organization or NGO could administer. This practice would support residential benefits from solar and wind development within their communities. Easily available information on national and regional CBA best practices, trends, and market rates for land leases and other provisions would support communities in realizing the full potential of these agreements, further bolstering community receptiveness and confidence in hosting energy projects.

Implement a state-level "fair share" approach.

Some states have chosen to consolidate siting authority for renewable energy projects at the state level.[48] This is an approach that continues to expand, most recently in Michigan,[49] as a solution for enabling renewable energy development. For others, state politics may warrant continued local siting authority. A state law that utilizes a federalism model by setting broad goals and allowing counties to pursue them could strike a balance between state and local preferences.

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44. Oregon Renewable Siting Assessment Project (ORESA) https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=renewable.

45. Clean Energy Wayfinders https://energy.hawaii.gov/get-engaged/clean-energy-wayfinders/.

46. The Nature Conservancy, "Site Renewables Right," May 5, 2022.

47. U.S. Department of Energy, *Guide to Advancing Opportunities for Community Benefits through Energy Project Development* (DOE Office of Minority Business & Economic Development, August 1, 2017).

48. Hannah Wiseman, "Balancing Renewable Energy Goals with Community Interests," University of Pennsylvania Kleinman Center for Energy Policy, May 20, 2020.

49. Kelly House, "Michigan Senate votes to override local decisions on wind, solar energy," Bridge Michigan, November 8, 2023.

One such approach could be a "Fair Share Plan,"[50] modeled on fair share affordable housing programs, that requires each local jurisdiction to contribute towards the state's overall renewable energy generation goals according to its renewable potential. Such a plan would start with a state renewable development goal. Then, the state would allocate a proportionate share of that goal to each local jurisdiction — municipality, region, city, or county — based on each jurisdiction's "fair share" of the total energy potential. Each locality would need to develop that much renewable energy by a certain date or pay another locality to develop additional renewables beyond its allocated amount. Importantly, localities may differ in the amount of renewable energy that can be cost-competitively developed within their borders. Fair share allocations, credit trading parameters, and other program design elements would need to account for these differences and in particular protect vulnerable communities — including from losing out to wealthier areas on the flexibility provisions of the policy. Ensuring local government capacity to evaluate options and make informed decisions within a fair share program is critical. Compared to state-level siting authority, potential trade-offs of the fair share approach include the possibility that some areas of highest renewable resource potential are left under-utilized, and the possibility of undermining some economies of scale by fragmenting buildout in disparate areas.

This approach strikes a balance between state and local control, enabling state authorities to spur equitable renewable development while allowing municipalities to set rules around the growth of renewable projects according to their unique area characteristics. Fair share also offers an opportunity for a more coordinated state and local approach, rather than the existing procedures where either the state or local government has the siting power or both require distinct permits.[51] Moreover, this approach could boost public acceptance of renewable energy development in areas whose residents feel they host more than their fair share of projects.

Leasing solar and onshore wind

The federal government owns vast swathes of land, much of which is in the western half of the country. Given that these lands overlap with areas of high solar and wind resources, federal leasing could open large amounts of solar and wind generating capacity. Yet relatively little solar and wind has been developed on public land thus far. Here we explore challenges and opportunities related to federal land leasing for clean infrastructure development. We focus on the Bureau of Land Management because it administers the largest portion of federal lands, and BLM lands have high potential for solar PV and onshore wind development.

Multiple stages within the BLM leasing process create barriers for solar and wind. First, BLM determines which lands are available to lease for which purposes. The acreage available for solar and wind development has been limited, and also competes with oil and gas leasing. Second, BLM establishes rental rates and other charges levied on lessees, and the costs of leasing for solar and wind projects may have deterred businesses from siting on public land. In this section, we examine both issues.

Limited land areas available for solar and onshore wind

The Bureau of Land Management manages 245 million surface acres of federal land in the West. More

50. Jazz Tomassetti, "We're All in This Together," *Journal of Land Use & Environmental Law* 32, no. 1 (2016): 193-230.

51. Jaclyn Kahn and Laura Shields, "Brief State Approaches to Wind Facility Siting," National Conference of State Legislatures, September 2, 2020.

than 100 million acres of BLM land have potential for wind or solar development.[52] Wind and solar projects gain access to BLM land through the BLM leasing process, which consists of three main steps:

1. BLM determines which lands are available to lease.
2. BLM holds a lease sale – typically a competitive auction — and leases rights to a parcel of public land to the highest bidder.
3. The leasing period begins and BLM collects rental, royalty, and capacity fees, depending on the energy infrastructure being developed.

BLM's oil and gas bidding system[53] has historically allowed anyone to nominate a parcel of land for auction at no cost, though the Inflation Reduction Act of 2022 raised the nomination fee to $5/acre.[54] BLM chooses a subset of nominated lands and offers them for lease. However, lessees are not required to develop the federal land they lease.[55]

At present, public lands leasing through BLM is dominated by the oil and gas industry, which enjoys preferred access to the nomination process and better leasing terms. Oil and gas companies lease land under the BLM process and then invest in a variety of exploration activities with the goal of finding and producing oil and gas. Because the presence of oil and gas on a given parcel of land is uncertain, more land access increases the odds a company will find fossil fuels. More often than not, a given exploratory well does not find fossil fuel. An industry perspective from ExxonMobil offered an analogy for finding productive wells: "In some ways, it's like buying raffle tickets at a school function – sure, you have a chance of winning the prize with one ticket, but your chances are greater the more tickets you buy."[56] For example, a Government Accountability Office review found that only 7 percent of fiscal year 2003 to 2009 10-year leases produced oil and gas during the primary term.[57]

The large amounts of land the oil and gas industry ties up with these long-shot bets come with an equally large opportunity cost in terms of national energy production.[58] An analysis by the Center for American Progress overlaid geographic areas having low oil and gas potential with areas having renewable resource potential and found extensive overlap, concluding that lands occupied by oil and gas leases could be utilized for clean energy development.[59] In addition, the industry's voluminous nominations (Figure 3) have the effect of forcing an under-resourced BLM to spend a large amount of time and resources processing low-potential oil and gas nominations, which further bottlenecks renewables' already-fraught leasing process.[60]

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52. Jenny Rowland-Shea and Zainab Mirza, "The Oil Industry's Grip on Public Lands and Waters May be Slowing Progress Towards Energy Independence," Center for American Progress, July 19, 2022.

53. Bureau of Land Management, "Parcel Nominations," accessed August 31, 2023.

54. Bureau of Land Management, "Impacts of the Inflation Reduction Act of 2022 (Pub. L. No. 117-169) to the Oil and Natural Gas Leasing Program," November 21, 2022.

55. Mark DeSantis, "Oil and Gas Companies Gain by Stockpiling America's Federal Land," Center for American Progress, August 2018.

56. Ken Cohen, "*Let's lose the 'use it or lose it' rhetoric*," ExxonMobil, March 2011.

57. U.S. Government Accountability Office, *Oil and Gas: Onshore Competitive and Noncompetitive Lease Revenues* (GAO-21-138, November 2020), at 15.

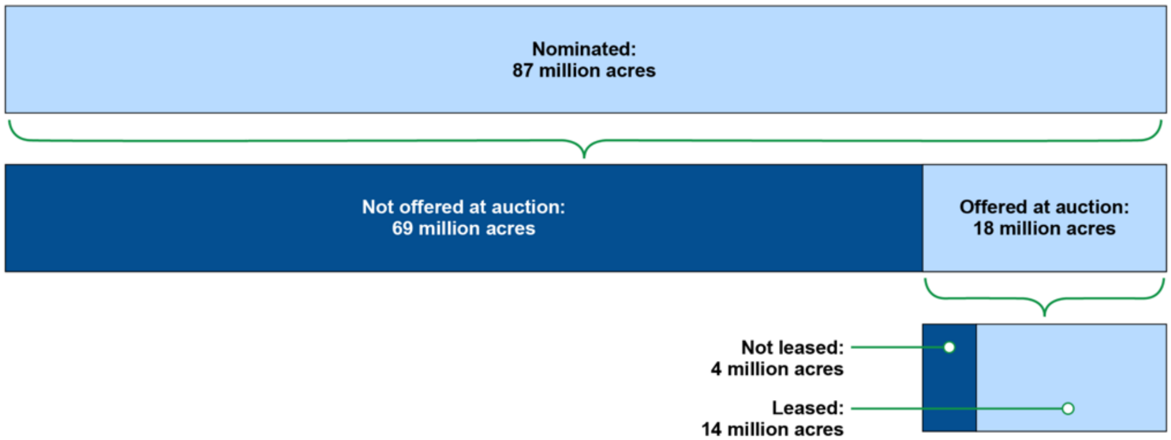
58. Kate Kelly et al., "Backroom Deals," Center for American Progress, May 23, 2019.

59. Rowland-Shea and Mirza, "The Oil Industry's Grip."

60. Chandra Rosenthal, "Building a Better BLM," Public Employees for Environmental Responsibility, June 15, 2022.

Oil and gas also enjoys built-in advantages over wind and solar energy in the standard BLM process. Within solar variance areas (public lands potentially available for solar projects under the BLM leasing process) that have low fossil fuel potential, oil and gas companies are able to nominate land at $5/acre compared to $15/acre for the low-carbon, higher-potential solar resource.[61]

Figure 3: BLM acreage nominated, offered for lease, and leased for federal onshore oil and gas development (2009-2019)



Source: GAO analysis of BLM data[62]

Critically, BLM has not historically considered potential conflicts with other resources — including renewables — when approving oil and gas leasing nominations. Despite the ready availability of data on energy development potential, the BLM offers leases to the fossil fuel industry without first evaluating this potential.[63]

Table 1: Share of BLM land with wind or solar potential that has low oil or gas potential

	Solar	Wind
	Share with low oil or gas potential	Share with low oil or gas potential
Colorado	47%	36%
Montana	0	74%
Nevada	81%	83%
New Mexico	64%	62%
Utah	90%	72%
Wyoming	0	68%
Total	77%	72%

Source: Center for American Progress[64]

61. Rowland-Shea and Mirza, "The Oil Industry's Grip"; Peter Daniels, "Siting Renewable Energy on Public Lands: Existing Regulations and Recommendations," Harvard Law School, May 13, 2021, at 5.

62. U.S. Government Accountability Office, *Oil and Gas Leasing: BLM Should Update its Guidance and Review its Fees* GAO-22-103968, November 2021.

63. Rowland-Shea and Mirza, "The Oil Industry's Grip."

64. *Ibid.*

Of note, a November 2021 Department of the Interior report recommended specific reforms to the BLM's oil and gas leasing process, including that "as an overarching policy, BLM should ensure that oil and gas are not prioritized over other land uses, consistent with BLM's mandate of multiple-use."[65] This is a promising development, but the BLM can exercise discretion when making leasing decisions, so it remains uncertain whether this recommendation will make a real difference in practice.

BLM's leasing system does provide for special designations that prioritize high-potential resources within appropriate geographic areas, yet these designations are underutilized for wind and solar.

Only a tiny sliver of BLM lands grant priority status to wind and solar development by way of such "Designated Leasing Areas" (DLAs): BLM designated just 870,000 acres for solar energy,[66] and *none* have been established for wind.[67] In other words, of 245 million acres managed by BLM, less than one million prioritize wind or solar.

DLAs offer several opportunities to renewable developers. Within DLAs, the fee for nominating a land parcel for auction is $5/acre – equivalent to the new fee for oil and gas developers. Further, part of the designation process for DLAs includes creating a programmatic environmental impact statement (PEIS). As a result, once a developer is awarded a lease through competitive bidding, the NEPA process is expedited because typically site-specific analysis is limited.[68]

The relatively small percentage of high-potential BLM land that has received DLA designation may be explained by the designation's requirements. For example, per the BLM's 2012 solar energy plan, to receive a DLA designation, proposed Solar Energy Zones (SEZs) must "(1) be large areas suitable for solar development, (2) be where solar development is economically and technically feasible, (3) have good potential access to transmission systems, and (4) have generally low resource conflict."[69]

Thus, the percentage of BLM land where renewable development receives any degree of prioritization is fractional compared to oil and gas. This may help explain why many solar developers have resorted to siting projects on private land.[70]

Charges levied on lessees

Rental rates, royalties, and capacity charges are another barrier for solar and wind developers considering a public-land lease.

As discussed in more detail below, acreage rent for renewables is more variable and can be higher than rents for oil and gas. Oil and gas companies enjoy rates predictably fixed by statute, while renewable

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65. U.S. Department of Interior, *Report on the Federal Oil and Gas Leasing Program* (Department of Interior, November 2021).

66. Bureau of Land Management, "Solar Energy," accessed August 28, 2023.

67. Peter Daniels, "Siting Renewable Energy on Public Lands: Existing Regulations and Recommendations," Harvard Law School, 13 May 2021.

68. *Ibid.*

69. Bureau of Land Management, "Approved Resource Management Plan Amendments/Record of Decision (ROD) for Solar Energy Development in Six Southwestern States," October 2012.

70. Solar Energy Industries Association, "Land Use & Solar Development," accessed August 28, 2023.

developers must navigate higher rates periodically adjusted by executive action and agency discretion.

As noted above, to date most solar projects are sited on private land.[71] High public land rental rates may have contributed to this trend.

Oil and gas companies pay rent until a lease is in production. Up until the passage of the Inflation Reduction Act, those rates started at just $1.50/acre, increasing to $2/acre after five years. The IRA raised them to $3/acre for the first two years, $5/acre for lease years three through eight and $15/acre afterward.[72] These rates are fixed by statute and are the same regardless of location.

Meanwhile, rental rates on BLM land for solar are generally higher and vary by state – often dramatically. Across all western states, solar power projects have historically paid several times higher rental rates than oil and gas, and they are still higher in most cases, even after recent increases. Rates range from $8.09/acre on the low end (New Mexico) to $75.13/acre on the high end (California).[73] Rental rates for wind projects are lower, ranging from $0.81/acre (New Mexico) to $7.51/acre (California). That's now more on par with the new oil and gas rates. The variation in state-level rental rates is the product of a complicated BLM methodology that uses land value estimates originally published in 2008 as its base, and also includes several adjustment factors. [74]

Recent actions illustrate that BLM intends to enable renewable energy leases. For example, a BLM manual text adjustment from May 2022 reduced rent and fee amounts for solar and wind projects in order to encourage project development on public lands.[75] Whether the specific rates and charges currently in place reduce barriers far enough to make a difference in the market is unclear. BLM should continue to monitor renewable energy leasing activity, as well as considering the methodological basis for deriving the rates.

Further, for oil and gas leases, developers only need to pay rent until production begins, at which point they pay royalty rates from drilling profits but no rent.[76] The royalty rate for oil leases remained at 12.5 percent for almost a century. In 2022, rates increased to 16.67 percent.[77]

Meanwhile, solar (and sometimes wind) developers pay higher rental rates and must continue paying them after generation begins. It's worth noting that these rental rates include a de facto royalty – a so-called "Rate of Return" factored into the original rent calculation. In addition, wind and solar developers also pay a capacity fee. Due to a recent move from the Biden administration, that fee has been cut down to $2,000/MW for all renewables projects from a previous rate of $2,172/MW for solar and $3,802/MW for wind.[78]

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71. *Ibid*.

72. Bureau of Land Management, "Impacts of the Inflation Reduction Act of 2022 (Pub. L. No. 117-169) to the Oil and Natural Gas Leasing Program," November 21, 2022.

73. Bureau of Land Management, "Rent and Fee Reductions for Solar and Wind Energy Development Authorizations," May 26, 2022.

74. Bureau of Land Management, "Wind Energy Rental Policy," June 13, 2011.

75. Bureau of Land Management, "Rent and Fee Reductions for Solar and Wind Energy Development Authorizations," May 26, 2022.

76. Legal Information Institute, "43 CFR § 3103.2-2 - Annual rental payments."

77. Bureau of Land Management, "Impacts of the Inflation Reduction Act of 2022 (Pub. L. No. 117-169) to the Oil and Natural Gas Leasing Program," November 21, 2022.

78. Bureau of Land Management, "Rent and Fee Reductions for Solar and Wind Energy Development Authorizations," May 26, 2022.

Newly proposed BLM rules further reduce the fees for wind and solar development on federal land.[79] Under this proposal, once a facility is operational, only the higher of the rental fee and capacity fee would be charged to the project, rather than both. The capacity fee would be based on 20 percent of the regional wholesale electricity rate and a 7 percent rate of return.[80] Conceptually these changes would move renewable energy treatment closer to that of oil and gas leases (in the sense of paying only one fee at a time both before and after operation begins), and the fees paid by renewable energy facilities would be lower than under current regulations.

Policy responses

Expand BLM solar DLAs and designate wind DLAs.

The BLM could significantly increase the opportunity for renewable development on public land by naming additional DLAs, including by issuing its first DLAs for wind energy. DLAs allow for the express prioritization of renewable energy infrastructure and provide several important economic and developmental benefits. There are likely tens of millions of acres of BLM land with high potential for wind or solar that are not DLAs. Absent designation, BLM is effectively restricting solar and wind development while remaining open to unproductive oil and gas leases. Officially designating them would allow for a better use of the diverse energy potential on federal lands.

Add a BLM Preferred Land Area category.

The criteria for DLAs are somewhat restrictive, as discussed above, making it difficult for BLM to move quickly to expand DLAs. But it is difficult or impossible to develop wind or solar on any BLM land that is not DLA. BLM could create an intermediate category with easier-to-meet criteria than DLAs — a Preferred Land Area (PLA) — and preferable treatment for solar and wind compared to other land. This could be a relatively quick interim step to give more parity to solar and wind development while BLM works towards creating more DLAs.

Bring solar and wind rental rates more in line with those for oil and gas.

As noted, the federal government recently increased royalty and rental rates for oil and gas, helping to level the playing field. However, solar rates are still higher and more variable, as are some wind rates. Adjustments to bring the renewable energy rates significantly more in line with those for oil and gas would help reduce this barrier. An easy fix would be to treat them the same, giving solar and wind the identical flat fee of $3.00/acre for the first two years, $5.00/acre for lease years three through eight, and $15.00/acre after that.

Adopt an internally consistent approach to energy production payments.

BLM should maintain a consistent approach in terms of charging either rent or production fees for energy development. As it stands, BLM takes an either/or approach to oil and gas but charges both for wind and solar. Just as oil and gas stop paying rent once they start paying royalty fees on production, wind and solar should stop paying rent once they begin paying capacity rates on production. BLM's 2023 proposed rule takes a step in this direction. Alternatively, agency objectives to not play favorites could be achieved by continuing to charge rent to oil and gas after production begins, in addition to royalties.

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79. Akielly Hu, "The feds move to speed up development of wind and solar on public land," Grist, June 2023.

80. Bureau of Land Management, "Rights-of-Way, Leasing, and Operations for Renewable Energy, Proposed Rule," DOI, June 2023, at 114.

Discontinue BLM leasing of public land for specific energy development where there is low potential for that energy resource.

Prioritizing oil and gas leasing on federal lands with low oil and gas potential but high potential for other energy uses contradicts the BLM's principle of "balanced and diverse resource use."[81] When this prioritization locks up land with high wind or solar potential, it hinders the clean energy development crucial to American decarbonization. New criteria used by the Biden administration have taken some low-potential areas off the table for oil and gas leasing. Still, more durable reform, ideally in the form of legislation, is necessary for the longer term.[82]

To this end, the recently proposed End Speculative Oil and Gas Leasing Act of 2021 would prevent BLM from leasing federal land with low potential for oil and gas development.[83] Such a ban could free up unproductive federal land for energy development. To avoid unequal treatment of different energy sources, future legislation should aim to prevent BLM from leasing federal land for *any* energy development where there is low potential for that energy source. For example, BLM should also not lease low solar potential land to solar developers.

Permitting solar and onshore wind

Every major infrastructure project built with federal funds must undergo the permitting process, a series of reviews and authorizations laid out by federal environmental law. Permitting has undeniably produced profound environmental and community benefits. An Earthjustice synopsis of NEPA achievements notes that the law has "saved lives, preserved community integrity, protected endangered species and public land and saved billions of dollars," and states further that it "has often been the first and last line of defense against government mismanagement and industry abuse."[84]

Nonetheless, an inefficient permitting process has slowed down clean energy deployment. Major infrastructure projects must produce Environmental Impact Statements (EISs) and/or Environmental Assessments (EAs) per NEPA. The process averages four years and $4.2 million to complete.[85] Additionally, projects often need to acquire permits from half a dozen different federal agencies — each with its process — and can be held up or shut down by lawsuits over agency omissions.[86]

Notably, the permitting process has an outsize impact on renewables. For example, one 2021 R Street Institute report found that:

> Of the Department of Energy's active NEPA projects requiring either an environmental assessment or the more intensive environmental impact statement , 42 percent were related to either clean energy, transmission or environmental conservation, while only 15 percent were related to fossil fuel.[87] Similarly, for the Bureau of Land Management, 24 percent of active EISs were

81. Bureau of Land Management, "Public Land Statistics 2020," June 2021.

82. Department of the Interior, "Department of the Interior Announces Steps to Increase Clean Energy Development on Public Lands," June 1, 2022.

83. Sen. Catherine Cortez-Masto, "S.607 – End Speculative Oil and Gas Leasing Act of 2021," March 4, 2021.

84. Earthjustice, "The People's Environmental Law: National Environmental Policy Act." Earthjustice, January 2023.

85. DJ Gribbin, "Environmental permitting might block Biden's clean energy targets," Brookings Institution, May 13, 2021.

86. Mario Loyola, "Renewable Energy? Where's Your Permit?," Wall Street Journal, August 31, 2022.

87. Philip Rossetti, "Addressing NEPA-Related Infrastructure Delays," R Street Institute, July 2021.

for renewable energy projects, and only 13 percent were for fossil fuels.

With hundreds of billions of dollars primed to enter the clean energy sector over the next decade, improving the permitting process will be crucial to speeding up the pace of clean energy deployment. A Brookings Institute report noted that "permitting projects of this magnitude will be highly improbable if hundreds of massive projects have to plod through the current permitting system."[88]

Under Section 390 of the 2005 Energy Policy Act, oil and gas drilling is afforded a "Categorical Exclusion" from NEPA, meaning that the BLM and the U.S. Forest Service (USFS) can issue drilling permits without site-specific environmental analysis.[89] This exemption eliminates years and millions of dollars worth of agency review. Renewable projects do not benefit from such exemptions. It is one of the reasons that only 0.3 percent of oil and gas projects under BLM jurisdiction require an EIS, compared to 12 percent of renewable projects.[90]

Indeed, a 2020 U.S. GAO report argues that categorical exclusions played a leading role in reducing BLM review times for oil and gas permits to fewer than 100 days.[91] From 2006 through 2008, BLM permitting actions made use of categorical exclusions for at least 28 percent of oil and gas well applications across the country.[92] That number could be higher as the Energy Policy Act does not require BLM field offices to disclose their decisions publicly. Per a Vermont Journal of Environmental Law report by Mark Capone and John Ruple, "Because Section 390 [categorical exclusions] offer a relatively quick method for permitting individual wells, there is an incentive to use Section 390 whenever possible, and to avoid larger-scale development plans."[93]

The provision of categorical exclusions for drilling operations runs contrary to the very concept of NEPA. The NEPA website states, "A categorical exclusion is a class of actions that a Federal agency has determined [...] do not individually or cumulatively have a significant effect on the human environment."[94] Oil and gas are major emitters of carbon when burned and thus significantly impact the human environment, in addition to the sizeable externalities they pose for human and community health. Clean energy infrastructure such as wind and solar, in contrast, produces no air emissions and does not pose a threat of spills or leaks. Thus there is potential to judiciously utilize categorical exclusions for wind and solar in a way that protects the environment as appropriate under NEPA while reducing barriers to clean energy development.

A promising recent development is the BLM's recent creation of Renewable Energy Coordination Offices (RECOs),[95] which are intended to "implement improved coordination among agencies, help avoid and

88. DJ Gribbin, "Environmental permitting might block."

89. Government Accountability Office, "Energy Policy Act of 2005: Greater Accountability Needed to Address Concerns with Categorical Exclusions for Oil and Gas Development Under Section 390 of the Act," September 16, 2009.

90. Philip Rossetti, "The Environmental Case for Improving NEPA," R Street Institute, July 7, 2021.

91. Government Accountability Office, *Oil and Gas Permitting: Actions Needed to Improve BLM's Review Process and Data System*, GAO-20-329, March 2020.

92. Mark Capone and John C. Ruple, "NEPA and the Energy Policy Act of 2005 Statutory Categorical Exclusions: What Are the Environmental Costs of Expedited Oil and Gas Development?" *Vermont Journal of Environmental Law* 18 (2017): 372-399.

93. *Ibid*.

94. Council on Environmental Quality, "Categorical Exclusions," accessed August 31, 2023.

95. Bureau of Land Management, "Information Bulletin No. 2022-040," BLM, May 2022.

resolve potential conflicts and bottlenecks, identify best practices, accelerate information sharing, and promote efficient and timely reviews to support smart agency decision-making." These offices are newly formed, and federal permitting for renewable energy remains complex.[96] Ongoing evaluation of the success of the RECOs in enabling appropriate wind and solar projects will be important moving forward.

Policy responses

Rebalance the categorical exclusion framework to encompass low-impact renewable development activities.

Agencies should consider categorical exclusions for low-impact renewable energy development. Existing categorical exclusions for oil and gas drilling activities[97] are one reference point, though of course resource-specific considerations are essential. Further, as discussed above, environmental permitting processes bring fundamental protections and societal benefits, and any categorical exclusions implemented must be thoroughly vetted and justified for streamlining permitting without compromising community protections.

Encourage early stakeholder participation in the permitting process.

A Center for American Progress survey of clean energy permitting case studies, including for a large solar PV facility, concluded: "By engaging with stakeholders early and often, both inside and outside the NEPA process, major infrastructure projects may avoid common delays in permitting, ensure timely project completion, and mitigate risks of litigation."[98] Encouraging active participation from community members and local stakeholders during the permitting process is a crucial means of realizing the community and environmental protection goals of permitting while also avoiding the conflicts that can compromise timely permitting completion.

Expand the successful use of programmatic EISs for solar and wind.

A programmatic EIS performs a generalized environmental review, "studying the effects of a broad type of project in a large area."[99] The generalized review avoids duplicative work across many essentially similar projects, while still allowing for narrower, supplemental EIS work where warranted by project specifics. In early 2024,[100] the Interior Department published a draft report of its utility-scale solar programmatic EIS which, pending finalization, could reduce requirements for permitting solar on public lands in Western states.

Evaluate success of BLM Renewable Energy Coordination Office for solar and wind.

The new BLM RECOs have strong potential to enhance BLM's efficiency in permitting renewable resources. Assessing the success of these offices in their intended purpose will ensure timely gains in permitting processes, identify areas for improvement, and help adapt offices to evolving clean energy markets.

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96. Reid Persing, "Five Tips for Permitting Solar Energy Projects on BLM Land," SWCA, May 2023.

97. United States Forest Service, "Energy Policy Act of 2005, Use of Section 390 Categorical Exclusions for Oil and Gas," USFS Washington Office, June 9, 2010.

98. Edward Boling and Kerensa Gimre, "NEPA Permitting Process Crucial to Renewable Infrastructure Project Success," Center for American Progress, September 7, 2023.

99. Rayan Sud et al., *How to Reform Federal Permitting to Accelerate Clean Energy Infrastructure* (Brookings Institution, February 2023).

100. U.S. Bureau of Land Management, "Notice of Availability of the Draft Programmatic Environmental Impact Statement for Utility-Scale Solar Energy Development and Notice of Public Meetings," DOI, January 2024.

Transmission

Perhaps just as important to the United States' clean energy growth as any individual energy source is its ability to move clean energy across the country. To meet clean energy demand, the United States may have to triple its electric transmission capacity by 2050.[101] Instead of speeding up to meet this challenge, transmission line buildout is slowing down. From 2012 to 2016, an annual average of 2,000 miles of lines were built, but from 2017 to 2021, the yearly average dropped to just 700 miles.[102] Unlike the other clean energy infrastructure examined in this paper, electric transmission lines are linear infrastructure, which poses unique regulatory issues.

Transmission planning, siting, and permitting functions in the United States are fractured between federal, Tribal, regional, state, and local entities.[103] Many entities involved can only focus on considerations within their jurisdiction, with no authority or guidance to account for benefits that cross borders. These decentralized and siloed processes make planning, financing, and building interstate transmission lines challenging, resulting in lengthy permitting processes. These challenges apply to both inter-regional and intra-regional lines that cross state borders.

Siting and permitting electric transmission lines

The Federal Energy Regulatory Commission (FERC) has established planning requirements for transmission lines,[104] but each region complies by developing its own planning process designed by the regional planning entities — that is, utilities, a regional transmission organization (RTO), or an independent system operator, depending on the region. Interregional planning has suffered from inconsistent planning parameters across regions and lack of consensus on cost sharing.[105] Lines financed by private developers, "merchant transmission," do not have to participate in the regional planning process but are subject to the same inefficient interconnection process that has become snarled in recent years, with long wait times.[106] Establishing even a broad conceptual siting route for an inter-regional transmission line, along with consensus across regions that there is a need to build a line, has thus been challenging. As a consequence, across the U.S., inter-regional transfer capacity is limited (Figure 4).

101. DOE Office of Policy, "Queued Up...But in Need of Transmission," DOE, DOE/OP-0015, April 2022.

102. Jeff St. John, "The U.S. has more clean energy projects than the grid can handle," Canary Media, 20 April 2022.

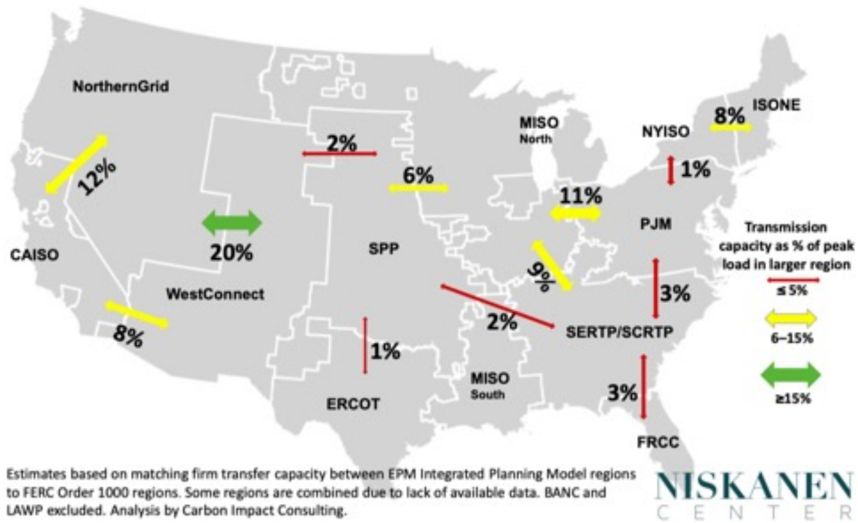
103. Liza Reed et al., *How Are We Going To Build All That Clean Energy Infrastructure?* (Niskanen Center, August 2021).

104. Joseph Eto, *Planning Electric Transmission Lines: A Review of Recent Regional Transmission Plans* (Lawrence Berkeley National Lab, LBNL-1006331, September 2016).

105. Reed et al., *How Are We Going To Build All That Clean Energy Infrastructure?*, at 10-11.

106. Joe Rand. "Grid connection requests grow by 40% in 2022 as clean energy surges, despite backlogs and uncertainty," Lawrence Berkeley National Lab, April 2023.

Figure 4: Estimated inter-regional transfer capacity as a percentage of regional peak demand



There's also a mismatch in the identification of "need" between the state permitting processes and the utility or regional planning realm: due to jurisdictional limits, state permitting processes may focus on economic needs and benefits to the individual state, while utilities focus on the function of their assets, which may cross state lines. RTOs and ISOs consider the overall electrical system under their purview, which can span many states. A regulator's determination of how a line serves an individual state's needs can significantly delay a transmission project that was found to benefit the utility or overall RTO system, such as occurred with the Independence Energy Connection project in the PJM region.[107] In another PJM example, after state regulators rejected the PATH project's application, denying siting approval, PJM updated its studies and found the need for the line had moved several years back, after which the line was canceled.[108] Yet, ultimately, siting the line as originally proposed by PJM or in a modified form may have brought more benefits to the system than terminating it. Thus, much like the challenges that hamper inter-regional transmission projects, siloed processes across jurisdictions can undermine siting and permitting of intra-regional lines that span multiple states.

Zooming in further to more route-specific decisions, transmission projects must be approved at the state and local levels to receive a permit to begin construction, and projects impacting federal land or receiving federal financial support undergo NEPA review. Local jurisdictions each have their own siting and zoning processes that may include examining various environmental and social impacts of the particular path of a transmission line. State processes also vary but usually have an application for a "certificate of public necessity and convenience," or permit to construct, with an accompanying environmental review. Any project that involves federal financing, traverses federal land, or impacts habitats and historic sites protected by the Endangered Species Act and National Historic Preservation Act, respectively, requires review under NEPA. Oftentimes multiple federal agencies must review a project, and the unique mission, organizational practices, and competencies of each agency can create federal

107. Marvin Richards Jr, "Pa. court upholds regulator's denial of Transource transmission project," S&P Global, May 10, 2022.

108. Joseph Eto, *Building Electric Transmission Lines: A Review of Recent Transmission Projects*, (Lawrence Berkeley National Laboratory, LBNL-1006330, September 2016), at 20-21.

coordination challenges.[109] Each of these processes adds procedural hurdles[110] and can result in the cancellation of a transmission line – notably if any state or locality does not support the line.

The linear nature of electric transmission results in project footprints that cross many types of property within many jurisdictions, any one of which (and often multiple of which) can present challenges. Thus, considering the full spectrum of inter-regional, intra-regional, state, Tribal, local, and federal permitting hurdles, it is unsurprising that large transmission lines have suffered major delays, when developers attempt projects at all.

Comparison to natural gas pipelines

Natural gas pipelines are subject to a markedly different, preferential regulatory regime, and this has enabled widespread buildout of major interstate gas pipeline infrastructure across the U.S. Specifically, gas pipelines benefit from a federal siting and eminent domain authority, allowing most pipeline development to bypass state-level siting barriers. Lessons learned from gas pipeline deployment can guide consideration of extending similar authority to transmission infrastructure.

The 1938 passage of the Natural Gas Act established a federal siting authority for interstate natural gas pipelines. With this authority, FERC has permitted hundreds of thousands of miles of interstate pipelines over the last 80 years, including more than 13,000 new miles in the previous 25 years alone.[111] The eminent domain authority conferred by FERC to pipeline developers under the Natural Gas Act is truly extraordinary, empowering the developer to secure property rights for the pipeline if negotiation with landowners fails, and preempting any state or local siting decision that conflicts with the FERC permit.[112] This is in stark contrast to electric transmission lines, which must acquire permits state by state and county by county, as described above, whereby any one jurisdiction with an objection to the line can be fatal to the project. Importantly, the successful pipeline deployment outcomes under the Natural Gas Act must be viewed with recognition of the serious community harms that have occurred under the Natural Gas Act's federal siting authority. Consideration of a similar authority for electric transmission must heed the lessons learned from federal pipeline siting.[113]

Attempts have been made to provide for a degree of federal siting authority for interstate electric transmission. The Energy Policy Act of 2005 in theory created a limited federal siting authority with potential to overcome some of the challenges described here. The Act gave FERC "backstop" siting authority under certain conditions: first, the line must be sited in a "national interest electric transmission corridor" (NIETC) designated by DOE; second, one of several pathways must be triggered: (i) lack of state authority to consider interstate benefits, (ii) project proponent does not serve end-use customers in the state, or (iii) a state must have "withheld approval" for the line.[114] If FERC used its backstop authority, the

109. When multiple federal agencies must review a project, a lead agency is named to supervise the review. Joint lead agencies can also be named. See U.S. Environmental Protection Agency, "What is the National Environmental Policy Act?," accessed February 16, 2024.

110. Joseph Eto, *Building Electric Transmission Lines*.

111. Liza Reed and David Bookbinder, "An all-of-the-above approach for permitting energy infrastructure," The Hill, 24 August 2022.

112. Paul Parfomak, *Interstate Natural Gas Pipelines: Process and Timing of FERC Permit Application Review* (Congressional Research Service, January 16, 2015) at 5-6.

113. Liza Reed, *Transmission Stalled: Siting Challenges for Interregional Transmission* (Niskanen Center, April 14 2021), at 9-10.

114. Pamela Anderson & Jane Rueger, "FERC Proposes To Update Its Backstop Siting Authority for Electric Transmission Facilities," Perkins Coie, January 23, 2023.

developer gained the right to acquire private (but not state-owned) lands through eminent domain. But court decisions (*Piedmont Environmental Council v. FERC* in 2009, and *California Wilderness Coalition v. Dept. of Energy* in 2011) limited even this minimal federal authority, and it has never been used.[115]

In 2021, Congress attempted to revive federal backstop authority via an amendment responding to the above court decisions as part of the bipartisan Infrastructure, Investment, and Jobs Act (IIJA).[116] The amended statute provides that FERC can issue a backstop siting permit when a state (i) has not made a determination within one year, (ii) has conditioned approval in such a way as to undermine project feasibility or congestion impacts, or (iii) has denied the application.[117] In December 2023, DOE released final guidance on its revised process to designate NIETC corridors, an update to federal rules related to the backstop authority.[118] As of 2024, FERC has yet to issue a rulemaking related to the Notice of Proposed Rulemaking it published in 2022[119] on implementing the amended backstop authority.[120] Whether FERC will attempt to use backstop authority again remains to be seen, and it is unclear whether it will survive legal challenges.

While backstop siting could provide a pathway for certain transmission lines meeting the statutory requirements in NIETCs to get federal siting and permitting approval, it is still an additional regulatory process that must be navigated. And this federal option is not universally available — projects are only eligible in areas the Department of Energy determines need transmission.

Finally, it is worth noting that while gas pipelines and transmission lines have similar linear footprints, gas pipelines are typically buried, and transmission lines are usually above ground, which can lead to certain permitting obstacles for transmission that pipelines do not face (by the same token, burying fossil infrastructure has unique issues as well, such as potential soil and water contamination). For example, transmission developers must find ways of avoiding or reducing impacts on bird populations.[121] Transmission lines' visual impact on the landscape can also increase public opposition.[122] One promising pathway for mitigating some of these concerns is re-using existing transmission corridors, implementing grid-enhancing technologies for extant infrastructure, or co-locating transmission lines in other existing rights of way.[123] Another critical component for building local support is strong community engagement.[124]

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115. Liza Reed, *Transmission Stalled: Siting Challenges for Interregional Transmission* (Niskanen Center, April 14 2021).

116. Federal Energy Regulatory Commission, "Explainer on the Notice of Proposed Rulemaking Regarding Applications for Permits to Site Interstate Electric Transmission Facilities," FERC, December 15, 2022.

117. Anderson & Rueger, "FERC Proposes To Update Its Backstop Siting Authority."

118. Department of Energy, "Guidance on Implementing Section 216(a) of the Federal Power Act to Designate National Interest Electric Transmission Corridors," Grid Deployment Office, December 2023.

119. Federal Energy Regulatory Commission, "Applications for Permits to Site Interstate Electric Transmission Facilities," FERC, Docket RM22-7-000, December 15, 2022.

120. John Decker et al. "The Federal Government's High-Wire Act: Setting FERC Up to Employ its Transmission Siting Backstop Authority," Vinson & Elkins LLP, June 6, 2023.

121. Bureau of Land Management, "Policy Guidance For Processing Right-Of-Way Applications For High-Voltage Electric Transmission Lines," BLM, November 18, 2016; Brooke L Bateman, Gary Moody, Jennifer Fuller, et al., "Birds and Transmission: Building the Grid Birds Need", National Audubon Society, August 2023.

122. Joshua Rhodes et al., "Renewable Electrolysis in Texas: Pipelines versus Power Lines," University of Texas, August 2021.

123. Darren Goode, "NextGen Highways Secures Funding To Expand Siting Of Electric Transmission In Public Rights-of-Way," NextGen Highways, 9 January 2023.

124. Americans for a Clean Energy Grid, "Recommended Siting Practices For Electric Transmission Developers," ACEG, 13 February 2023.

Despite the critical importance of transmission expansion for enabling growth of clean energy technologies,[125] this essential infrastructure faces numerous challenges that have severely limited the construction of a stronger and more resilient grid. Policy solutions could turn these circumstances around and unlock transmission growth that would in turn unlock further clean energy generation expansion.

Policy responses

Establish federal interstate siting authority via FERC for transmission infrastructure.
Interstate transmission siting authority, potentially housed at FERC, would create a clear, single authority, remove duplicative processes, and speed up timelines. Laws like the SITE Act would establish this authority while ensuring fair treatment of affected landowners and impacted communities.[126]

Require minimum transfer capacity between regions.
Congress could require regional planning authorities to maintain a minimum level of interregional transmission capacity to boost grid reliability and resource competition. Such a requirement would not solve the underlying planning, siting, and permitting challenges that interregional transmission line projects face, but it would prioritize siting and permitting of high-value interregional connections, as well as creating urgency and motivation for state and regional bodies to find ways of addressing the barriers within their control.

Evaluate reuse and expansion of existing transmission corridors and potential of building adjacent to highways and railways.
Reusing and expanding existing transmission corridors – rather than applying for new rights of way – would potentially reduce siting challenges and speed up transmission system capacity growth. Federal coordination and research activities could support evaluation of possibilities to proactively upgrade the capacity of existing transmission lines, and to use existing highway and rail rights of way for electric transmission siting.

Enact policies and regulations that support government agency capacity and coordination for permitting activities.
The large number and complexity of permitting activities needed for high-voltage transmission requires adequate staffing, budget, digital infrastructure, and coordination among agencies to efficiently process applications and resolve permitting challenges. The multitude of agency tasks required in DOE's proposed CITAP[127] is a good illustration of this need.

Foster community engagement, create community benefit agreements, and incentivize favorable local siting ordinances.
Meaningful community engagement is essential to successful transmission expansion, and recommended practices have been identified[128] and can be supported through policy and regulatory means. As with

125. DOE Office of Policy, "Queued Up…But in Need of Transmission," DOE, DOE/OP-0015, April 2022; Solar Energy Industries Association, "Transmission," accessed August 28, 2023.

126. Sen. Whitehouse, "S.2651 - SITE Act," 5 August 2021.

127. Grid Deployment Office, "Coordinated Interagency Transmission Authorizations and Permits Program," U.S. Department of Energy, accessed November 14, 2023.

128. Americans for a Clean Energy Grid, "Recommended Siting Practices For Electric Transmission Developers."

renewable energy projects, established benefits for community members may encourage community interest in hosting transmission lines. The Inflation Reduction Act funds local communities in order to support them in siting and permitting transmission lines.[129] Voluntary, strategic co-location is another proposed approach for building rural landowner and community support for hosting new transmission infrastructure, whereby broadband or other infrastructure desirable to the community is co-located as part of a "meet in the middle" partnership with developers.[130]

Support transmission planning efforts for coordinated infrastructure expansion.

The existing, siloed utility and RTO/ISO planning processes are too limited in their capacity to identify priority interstate and interregional transmission connections that would reduce customer costs, improve market access, increase clean energy generation, and improve reliability and resilience. These oversights in turn limit the volume of potential transmission projects that move into the siting and permitting phases of project development and ultimately achieve construction and operation. The DOE's Transmission Needs Study[131] and National Transmission Planning Study[132] are examples of current agency efforts that could make important contributions to national-level transmission buildout by studying grid expansion from a national perspective. Federal and state policies and actions that support improved, transparent transmission planning and coordination among states and regions would boost the volume of valuable transmission projects that enter the siting and permitting processes, promote a coordinated infrastructure buildout, and contribute to the public record of project benefits and costs to transparently inform siting and permitting activities.

Offshore wind

Offshore wind is a rapidly developing renewable technology with enormous potential. According to Department of Energy figures, offshore wind in U.S. waters could generate 7,203 TWh per year of net technical energy,[133] twice the 2016 national electricity demand.[134] It also offers a strong match with customer demand, both in terms of generating during periods of higher electricity demand [135] and in terms of geographical proximity to population centers.[136]

Offshore wind costs were once prohibitive but, as with other renewables, have fallen significantly, with prices dropping by as much as 80 percent in recent decades.[137] So far, the U.S. has only built 42 MW of offshore wind capacity, falling behind Europe and China, which have built 14,600 MW[138] and 26,000

129. Department of Energy, "Grid Deployment Office Launches Transmission Siting and Economic Development Grants Program with $760 Million Inflation Reduction Act Investment," DOE, 13 January 2023.

130. Robin Allen, "Accelerate the U.S. high-capacity transmission build-out with voluntary, strategic co-location," Utility Dive, 13 June 2023.

131. Grid Deployment Office, "National Transmission Needs Study," DOE, accessed November 1, 2023.

132. *Ibid*.

133. Patrick Gilman et al., *National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States* (US Department of Energy and U.S. Department of Interior, September 9, 2016).

134. Walt Musial et al., *2016 Offshore Wind Energy Resource Assessment for the United States* (National Renewable Energy Laboratory, NREL/TP-5000-66599, 2016).

135. Gilman et al., *National Offshore Wind Strategy*.

136. Robert Zullo, "For offshore wind aspirations to become reality, transmission hurdles must be cleared," Oregon Capital Chronicle, October 17, 2022.

137. Ivan Penn, "Offshore Wind Farms Show What Biden's Climate Plan Is Up Against," The New York Times, 7 June 2021.

138. European Commission, "Offshore renewable energy," 2021.

MW, respectively.[139] Thus, while offshore wind is deployed at a large scale in other countries and in that sense is not a nascent technology, it has not been installed in substantial amounts in the U.S. Offshore wind is additionally unique within the clean energy infrastructure we consider in this paper in that it is not a land-based technology.

President Biden has outlined a goal of approving 16 offshore wind projects by 2025 with the eventual aim of generating 30 GW of power from offshore wind by 2030.[140] Such capacity could power 10 million homes.[141] Despite these ambitious objectives, in the administration's first two years in office, only two projects were approved.[142] Moreover, shifting financial expectations and supply chain bottlenecks have recently plagued the project pipeline and undermined the feasibility of the 30 GW goal by 2030.[143]

Siting offshore wind

As with other renewables, siting is a barrier to developing utility-scale offshore wind projects.[144] Because wind farms are near mainland areas, they must contend with complex ocean planning regulations. Finding an optimal location with minimal procedural obstacles can prove challenging. Shipping routes, marine sanctuaries, fisheries, Tribal lands, ocean preservation areas, protected habitats, and military training zones must be avoided.

Other complications can arise depending on the technical specifications of the turbines. For example, wind farms within shallow waters are often closer to shore and can embed monopile foundations in the seabed. These must then contend with more stringent zoning restrictions and environmental impact assessments. Wind farms close to the shore also exacerbate visibility concerns from the mainland, which may lead to opposition from residents or businesses.[145]

On the other hand, turbines sited in deepwater holdings can be more costly and require longer transmission lines to connect to the mainland, distorting additional seafloor acreages. Leasing areas where the continental shelf rapidly drops below 200 feet, as it does for much of the Pacific coast, require new and untested floating wind technology.[146] European companies like Ørsted and Equinor, whose experience with these issues has already helped to drive development in U.S. waters, can provide models of best practices.[147] Yet deepwater siting challenges may still emerge, particularly as the U.S. takes its initial steps with these technologies.

Notably, the Bureau of Ocean Energy Management (BOEM) has established regional offices for managing offshore oil development, located in the Gulf of Mexico and Alaska where much offshore oil

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139. David Vetter, "China Built More Offshore Wind In 2021 Than Every Other Country Built In 5 Years," Forbes, 26 January 2022.

140. The White House, "Fact Sheet: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs," March 29, 2021.

141. Heather Richards, "Offshore wind in 2022: Billions in bids and new confidence," E&E News, 23 December 2022.

142. *Ibid*.

143. Nichola Groom, "Biden's offshore wind target slipping out of reach as projects struggle," Reuters, September 15, 2023.

144. Angie Kaufman and Alicia Moulton, "Siting isn't simple for offshore wind," EFI Foundation, August 9, 2022.

145. Robert Sullivan et al., "Offshore Wind Turbine Visibility and Visual Impact Threshold Distances," *Environmental Practice* (February 2013).

146. Kaufman and Moulton, "Siting isn't simple for offshore wind."

147. Scott Carpenter, "Offshore Wind Companies Are Racing To Develop America's East Coast. First They Must Appease The Fishermen," Forbes, 16 June 2020.

production occurs. Regional offshore wind offices could greatly facilitate ongoing project monitoring and community engagement, with each office specializing in the particular marine environment, wind technologies, and community issues within its area.[148]

Additionally, effective planning and siting of offshore wind demand longer-term strategic thinking and interregional communication. Strategic planning will be essential for interconnecting to the onshore grid the total capacity of offshore wind that will be built in the coming decades. Although offshore wind will require fewer miles of transmission than most onshore wind projects, it nonetheless will necessitate the buildout of new transmission on the ocean floor and along beach crossings. This will produce a web of siting and permitting questions that will need to be addressed.

Interregional and forward-thinking planning will allow grid operators to keep costs down and minimize expenses. Instead of single radial lines that run from each wind farm to the mainland, experts advise proactive planning that creates a meshed or networked grid connection.[149] This would consist of a central hub or series of hubs integrated off the mainland, all sharing a single major tie to an interconnection point that could handle the high volume of bulk power. A singular connection – rather than many transmission lines repeatedly crossing beachheads – would prove far more cost-effective and limit environmental disturbances.

Leasing offshore wind

The federal leasing process for offshore wind developers is relatively new and therefore far less established than the offshore leasing process for other energy sources. While offshore wind leases issued to date represent a significant amount of power generation potential, only a small fraction of this is operating or under construction today. Achieving substantial buildout of America's vast offshore wind resources will require a high-functioning, coordinated leasing process that is able to award leases in a timely manner while maintaining community and environmental protections.

BOEM issued its first offshore wind lease in 2009.[150] The offshore wind leasing process begins when a state expresses interest in offshore wind leasing and works with BOEM to identify a potential area. Alternatively, a developer can submit an unsolicited application directly to BOEM.[151] Next, BOEM must release a Federal Register notice or 'Request for Interest' to determine interest and gather public comment.[152] If there is interest, BOEM will analyze the location and any competing concerns. If wind development is appropriate, BOEM will designate it as a Wind Energy Area (WEA). Environmental evaluation under NEPA occurs as part of the WEA identification process. Those areas that generate competitive interest are auctioned through competitive commercial leases. In this circumstance, BOEM conducts environmental reviews and consultations before finally holding the lease auction. The timeline to advance from a site assessment to a successful sale and construction is still highly variable due to the small number of projects that have reached completion. Nonetheless, regulators aim to establish a

148. Ted Boling et al., *From Policy to Power* (Ocean Conservancy, Washington, D.C., 2022), at 28.

149. Johannes Pfeifenberger et al., *The Benefit and Urgency of Planned Offshore Transmission* (Brattle, January 24, 2023).

150. Laura Comay and Corrie Clarke, *U.S. Offshore Wind Energy Development: Overview and Issues for the 118th Congress* (Congressional Research Service, September 13, 2023), at 5.

151. Gilman et al., *National Offshore Wind Strategy*.

152. *Ibid*.

transparent and streamlined process to assuage developer concerns regarding uncertain timetables.[153]

In contrast, the National Outer Continental Shelf (OCS) Oil and Gas Leasing Program[154] has a program structure[155] and Department of Interior (DOI) staff built and iterated on since the 1980s. The program has leased large acreages that produce significant quantities of fossil fuels; for example, in 2020 OCS production accounted for 16 percent of all U.S. oil production.[156] The Interior Department is exploring using BOEM's five-year oil and gas leasing planning cycle as a model for offshore wind.[157] The typical oil and gas leasing process takes eight months, from the initial request for information to the eventual issuance of leases.[158]

As of May 31, 2022, BOEM had leased offshore areas with 40,083 MW of generation potential, but only 974 MW were operating or under construction. For context, state-specific studies have shown a need of around 200,000 MW of offshore wind by 2050, and a national modeling study has projected a need of up to 460,000 MW.[159] During the Biden administration, BOEM has already held several lease sales, and plans for more are in the works (Figure 5). Deep-water lease areas in the Gulf of Maine and along the Pacific Coast would also open up plots to new floating wind technologies that are not limited by a physical connection to the ocean floor and are thus capable of generating energy at much greater distances from the coastline.

Winning bids have averaged around $5,906/acre over the past decade, and payment is directed in full to BOEM.[160] Notably, offshore oil and gas bids average $47/acre.[161] The large discrepancy in leasing payments across industries could be examined to understand its drivers and to evaluate the potential for reducing this financial hurdle for offshore wind developers while maintaining a reasonable leasing revenue from projects. This is especially significant in light of the financial struggles offshore wind developers have faced recently, which have threatened project financials and drained developer interest in the August 2023 Gulf of Mexico lease sale.[162]

One difference between leasing and auction processes for offshore industries arises from the need for transmission and interconnection of offshore generation. As the Federal government's leasing procedure currently stands, auctions occur separately from affiliated permitting processes for transmission and interconnection approvals.

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153. *Ibid*., at vii.

154. Laura Comay and Adam Vann, *Five-Year Offshore Oil and Gas Leasing Program: History and Background* (Congressional Research Service, September 14, 2022).

155. Bureau of Ocean Energy Management, "OCS Oil and Gas Leasing, Exploration, and Development Process," accessed October 2023.

156. Department of the Interior, *Report on the Federal Oil and Gas Leasing Program* (DOI, November 2021).

157. Heather Richards, "Interior proposes 5-year schedule for offshore wind sales," E&E News, 12 January 2023.

158. Bureau of Ocean Energy Management, "OCS Oil and Gas Leasing, Exploration, and Development Process," accessed October 2023.

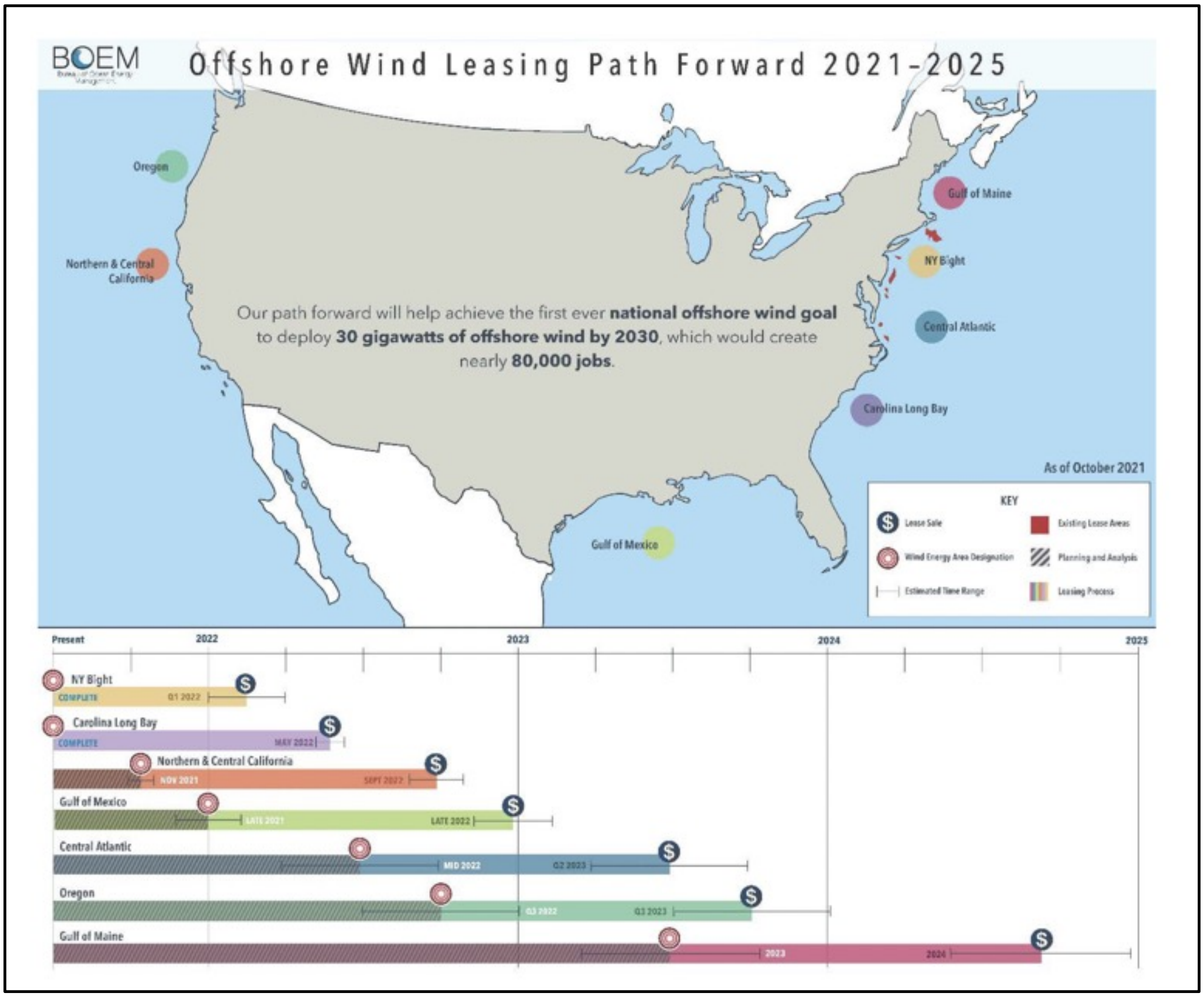
159. Pfeifenberger et al., *The Benefit and Urgency of Planned Offshore Transmission*.

160. Michael Freeman, "Offshore Wind Can Lower Energy Prices and Beat Out Oil and Gas," Center for American Progress, September 23, 2022.

161. *Ibid*.

162. Groom, "*Biden's offshore wind target slipping out of reach*."

Figure 5: BOEM's plans for offshore wind leasing



Source: BOEM[163]

Potential lessees face uncertainty regarding where generated energy will come onshore, what regional grid operator it will be regulated by, and potential permitting or siting difficulties regarding transmission and interconnection. Furthermore, these isolated leasing processes make interregional planning more challenging as participants are only sometimes aware of who is bidding on neighboring leases, thus reducing developers' ability to coordinate. The siloed nature of offshore lease auctions, regional transmission planning, and state-by-state procurement of generation capacity prevent broad cooperation and strategic planning.

Finally the IRA includes language that allows new offshore wind leases only when offshore oil and gas drilling leases accompany them.[164] Ultimately this serves as an additional constraint that has the potential to artificially slow down offshore wind development.

163. Walter Musial et al., *Offshore Wind Market Report: 2022 Edition* (DOE Office of Energy Efficiency and Renewable Energy, 2022), at 22.

164. Laura Smith Morton et al. "The Inflation Reduction Act's Impact on Offshore Wind Leasing," Perkins Coie, August 2022.

Permitting offshore wind

Permitting also poses obstacles to the efficient buildout of offshore wind at scale. Of the 40,000 MW of offshore wind power currently planned or in construction, over half are stuck in the permitting stage.[165] As with all renewable development, offshore wind projects must apply for permits from federal and state agencies for both the turbines themselves and the state and federal waters that transmission cabling connects to — not to mention building beach crossings and interconnections. The Army Corps of Engineers is designated as the federal agency responsible for assessing NEPA reviews under the Clean Water Act and Rivers and Harbor Act.[166]

Offshore wind permitting has many areas for improvement. A wide variety of habitats and ecosystems are present across the offshore acreage with high wind development potential. Biological and oceanographic data must be collected and assessed as part of reviews under NEPA, the Marine Mammal Protection Act, and the Endangered Species Act. As a result, multiple federal agencies are often involved for the range of reviews that must be completed. There are a variety of actions that BOEM could take to address these requirements and improve the permitting regulatory process, which we discuss below.[167]

Notably, compared to offshore oil and gas production, offshore wind projects pose little risk of the types of spills and leaks that have caused billions of dollars of damage to the environment, local communities, public health, and tourism.[168] Further, wind energy produces very low lifecycle greenhouse gas emissions.[169] Policymakers and agencies must consider these environmental and community advantages of offshore wind as part of overall offshore energy permitting regulations design.

The process of approving interconnection requests for offshore wind currently is not coordinated within a larger offshore transmission plan. Approving individual projects one at a time means that transmission for wind is often bound up with leases for individual wind projects, complicating interregional planning and coordination. The result is slower, more expensive construction. And unlike with onshore transmission, DOE does not define national interest corridors for offshore wind transmission. Such a designation could alleviate some of the uncertainties wind developers must navigate before starting a project.

Policy responses

The IRA earmarked $100 million for further studies to support planning and modeling the buildout of the offshore wind industry.[170] While these funds and the Biden administration's commitment to accelerating approval of offshore wind projects have the potential to advance development of this clean energy infrastructure type, further policy actions are needed to systematize the regulatory process.

165. Musial et al., *Offshore Wind Market Report: 2022 Edition*.

166. Nate McKenzie and Monica Maher, *Offshore Wind Energy Strategies* (DOE Office of Energy Efficiency and Renewable Energy, January 2022).

167. Boling et al., *From Policy to Power*, at 16-22.

168. Jonathan Ramseur, *Oil Spills: Background and Governance* (Congressional Research Service, September 9, 2017) at 8-11.

169. National Renewable Energy Laboratory, "Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update," NREL, 2021.

170. Laura Comay et al., "Offshore Wind Provisions in the Inflation Reduction Act," Congressional Research Service, 29 September 2022.

Increase funding for the BOEM to aid in implementing offshore wind permitting processes.
BOEM should be allocated additional funding to keep pace with demand from the energy industry.[171] This expanded funding could support a variety of ideas that have been suggested for the permitting process, including making permitting data publicly available, using adaptive management practices within the environmental review and mitigation process, developing programmatic environmental assessments when suitable, and enhancing governmental coordination and harmonization across participating review agencies.[172]

Establish offshore grid regulations under FERC.
In the coming years, federal agencies and regulatory bodies need to develop and establish a clear regulatory framework and determine best practices for transmission development for offshore wind, cost allocation for coastal interties, ocean planning, and leasing procedures.[173] FERC should release guidance and rulemaking on relevant issues so that grid planners can construct offshore energy markets that support a resilient and cost-effective grid.

Create a framework for addressing community engagement and compensation.
As offshore wind grows, increasing numbers of affected communities have raised concerns about how their lands, recreation areas, sacred sites, businesses, and livelihoods will be affected. As with other renewables and transmission infrastructure, there is a strong need to determine and implement the most effective engagement practices to bring communities into planning processes through meaningful outreach. Built-in recommendations for community benefits agreements, contracts, or credits for locals whose livelihoods may be impacted by ocean developments should be considered. Regional BOEM offices, analogous to those existing for offshore oil, could further advance this objective.

Relatedly, creating an Offshore Renewable Energy Compensation Fund could help address the losses fishermen, property owners, and other stakeholders may experience due to offshore wind development.[174] Additionally, outreach and respect for sovereignty should be a priority in engaging and including Tribal Nations whose rights to fishing, preservation, ownership, and recreation have long been sidelined or trespassed on without regard for historic treaties and agreements.[175]

Support transmission planning and cost allocation reforms.
In April 2022, FERC released a Notice of Proposed Rulemaking that, if finalized, would represent significant progress in establishing standards for transmission planning.[176] The rule could prompt RTOs/ISOs and other stakeholders to approach the buildout of offshore wind farms with future development in mind and encourage the adoption of offshore meshed grids instead of a piecemeal approach constructing radial lines for each project. Increasing federal coordination for offshore wind transmission is crucial for this new industry, which relies heavily on interconnecting to the grid and coastal load centers.[177]

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171. Heather Richards, "Offshore wind in 2022: Billions in bids and new confidence," E&E News, 23 December 2022.

172. Boling et al., *From Policy to Power*, at 16-22.

173. Johannes Pfeifenberger et al., *The Benefit and Urgency of Planned Offshore Transmission* (Brattle, January 24, 2023).

174. Lamar Johnson, "Lawmakers announce offshore wind reform plans," E&E Daily, 23 December 2022.

175. Heather Richards, "Interior sale may shape offshore wind's future on West Coast," E&E News, 12 December 2022.

176. Federal Energy Regulatory Commission, "RM21-17-000 Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection," FERC, April 21, 2022.

177. Pfeifenberger et al., *The Benefit and Urgency of Planned Offshore Transmission*.

Repeal the linkage between leasing of offshore wind and offshore fossil fuel drilling.
The IRA requirements tying offshore wind and offshore oil and gas leasing should be repealed. These requirements could create an unnecessary bottleneck for offshore wind development in the event that offshore oil and gas leasing activity is deemed unwarranted. The possibility that offshore wind development could be frozen for an uncertain amount of time itself is likely to have a chilling effect on investment and development activities.

Create a dedicated statutory title for offshore wind.
The Energy Policy Act of 2005 created the first legal authorities related to offshore wind, but these were styled as additions to the existing statutory provisions for offshore oil and gas. Establishing a separate title for offshore wind would be an opportunity to better capture the unique needs and best practices for this important clean energy resource.[178]

Geothermal

Geothermal energy is an often-overlooked clean energy source. Only 3.7 GW of capacity is currently deployed in the U.S.[179] However, effective reforms to the geothermal regulatory process and improvements in geothermal technology could lead to an increase of up to 60 GW of geothermal capacity in the U.S. by 2050, which would generate a projected 8.5 percent of U.S. electricity in that year.[180] For context, the American utility-scale solar sector consists of 74 GW of capacity today.[181] Geothermal also has three crucial advantages when compared with wind and solar energy:

- It can function as a baseload power source.
- It can ramp up on demand.
- It has a significantly smaller land footprint than wind and solar.

On the other hand, a similarity among geothermal, wind, and solar is the challenges all three face in developing projects. The regulatory imbalance between clean energy and fossil fuels is perhaps most striking with geothermal energy, as geothermal drilling technology is quite similar to oil and gas drilling technology but faces a markedly different regulatory process.

The Bureau of Land Management is a critical regulatory player for geothermal deployment. Extensive overlap exists between areas of high conventional geothermal potential[182] and BLM-administered lands[183] in the western U.S. About two-thirds of current geothermal capacity is on public lands, mostly administered by BLM.[184] This two-thirds existing capacity share tracks the estimated 63 percent share

178. Ted Boling et al., From Policy to Power (Ocean Conservancy, Washington, D.C., 2022) at 29.

179. Jody Robins et al., *2021 U.S. Geothermal Power Production and District Heating Market Report* (NREL, 2021).

180. Susan Hamm et al., *GeoVision: Harnessing the Heat Beneath Our Feet* (U.S. Department of Energy, 2019), at 66-68.

181. Elesia Fasching, "Wind, solar, and batteries increasingly account for more new U.S. power capacity additions," U.S. Energy Information Administration, Today in Energy, March 6, 2023.

182. National Renewable Energy Laboratory, "Geothermal Resources of the United States," NREL, February 2018.

183. Department of Interior, "Bureau of Land Management: National Conservation Lands," BLM, 2021.

184. Jody Robins et al., *2021 U.S. Geothermal Power Production and District Heating Market Report* (NREL, 2021).

of overall U.S. geothermal resources that are located on public land.[185] Given that geothermal potential is so concentrated on federal lands, this paper focuses on leasing and permitting, and not geothermal siting. The enhanced geothermal systems (EGS) that could be enabled with technology improvements would expand the geographic potential of geothermal to the entire U.S.[186]

Leasing and permitting geothermal

Much as for wind and solar, a Center for American Progress analysis[187] found little overlap between lands suitable for oil and gas and those good for geothermal – 84 percent of BLM's favorable geothermal land has low oil and gas potential (see Table 2). Yet, rather than being prioritized for geothermal, those lands are still open to oil and gas leasing. The result is that large amounts of land with geothermal potential can be leased by oil and gas companies and effectively made unavailable for geothermal development, even when the land has low fossil fuel potential. While the nature of this regulatory treatment is the same as discussed previously for wind and solar, the magnitude of the impact is higher for geothermal given that a larger portion of the resource potential is on federal land, and given the relatively limited market size for the technology, which lacks the commercial volume and momentum of the wind and solar sectors.

Table 2: Share of BLM lands with geothermal favorability that have low oil or gas potential

Colorado	74%
Montana	87%
Nevada	89%
New Mexico	89%
Utah	86%
Wyoming	12%
Total	84%

Source: Center for American Progress[188]

Land access is recognized by the Energy Department's Geothermal Technology Office as a challenge with significant impacts on geothermal energy development.[189] An element unique to geothermal among the infrastructure types reviewed in this paper is the issue of "split estate" reviews. This occurs when project development involves multiple landowners, or when multiple federal agencies review because there are different owners of the surface and subsurface estate. Findings from a GeoVision Barriers Analysis illustrate how the complexity of such reviews can prolong project development timelines: "The average time for the 11 projects with Forest Service and BLM jurisdiction took 60 days longer to complete than the 28 projects completed solely by the BLM."[190]

185. Aaron Levine and Katherine Young, *Efforts to Streamline Permitting of Geothermal Projects in the United States* (National Renewable Energy Laboratory, 2018).

186. Hamm et al., *GeoVision*, at 19.

187. Jenny Rowland-Shea and Zainab Mirza, "The Oil Industry's Grip on Public Lands and Waters May be Slowing Progress Towards Energy Independence," Center for American Progress, 19 July 2022.

188. *Ibid*.

189. Sean Porse et al. *Geothermal Technologies Office Multi-Year Program Plan FY 2022-2026* (U.S. Department of Energy, 2022), at 39.

190. Katherine Young et al., *GeoVision Analysis Supporting Task Force Report: Barriers—An Analysis of Non-Technical Barriers to Geothermal Deployment and Potential Improvement Scenarios* (National Renewable Energy Laboratory. NREL/PR-6A20-71641, 2019), at 31.

In addition to leasing hurdles, geothermal also faces permitting challenges. Geothermal energy development on BLM land can require multiple Environmental Assessments under NEPA, and some projects must undergo an Environmental Impact Statement for the power plant. The complete development timeline for geothermal currently averages seven to 10 years. Multiple stages of the geothermal development process can each trigger a NEPA review, in some cases with data collected at one stage being required for the next stage's permit application.[191] Sequencing dependencies like these create permitting bottlenecks and slow down project development timelines.

Further slowing geothermal deployment is the lack of a centralized BLM geothermal permitting office. This absence may hinder development of staff expertise and longevity, as well as coordination of permitting practices, data, and digital tools across state offices. Renewable Energy Coordination Offices, authorized in the Energy Act of 2020, could make a difference, but their long-term impact is unclear.

Meanwhile, oil and gas development benefits from numerous categorical exclusions passed in the 2005 Energy Policy Act.[192] Categorical exclusions, as discussed above in the wind and solar section, significantly reduce oil and gas review times and overall development costs. Geothermal energy development is unique among clean energy sources in how similar it is to oil and gas development. Geothermal relies on similar equipment and workforces as oil and gas.[193] Geothermal also has a small land footprint, using much less land per capacity than solar, wind, and even coal.[194] Thus, there is no obvious reason why oil and gas should receive categorical exclusions that geothermal does not.

Notably, the original draft of the Energy Policy Act of 2005 *did* include categorical exclusions for geothermal — but those provisions did not make it into the final version.[195]

Moreover, as recognized in the Energy Departments GeoVision report — which quantitatively assessed geothermal potential and explored how to overcome deployment barriers — geothermal projects face a hurdle in the "lack of awareness and acceptance" of the technology.[196] Compared to relatively widely deployed wind and solar infrastructure, geothermal installations are rare. In part, their small land footprint and inconspicuous profile further contribute to lack of public awareness. While geothermal's low visibility holds promise in helping community acceptance, it poses an awareness challenge at the same time. The DOE Geothermal Technologies Office notes that stakeholders who are aware of the technology can have concerns around "perceived risk of induced seismicity, volcanic hazards, and water use and contamination."[197] Effective permitting processes engage host communities to ensure their concerns are understood and appropriately incorporated into the review. Geothermal permitting should make use of stakeholder engagement, data access, and other best practices for responsible energy infrastructure development, as with the other clean infrastructure types discussed in this paper.

191. Levine and Young, *Efforts to Streamline Permitting of Geothermal Projects*..

192. United States Forest Service, "Energy Policy Act of 2005, Use of Section 390 Categorical Exclusions for Oil and Gas," USFS Washington Office, June 9, 2010.

193. Morgan Smith, Oil and Gas Technology and Geothermal Energy Development (Congressional Research Service, January 2023).

194. DOE, "Geothermal Basics," Geothermal Technologies Office, accessed September 1, 2023.

195. Sen. Mike Lee, "Geothermal Innovation Act," July 29, 2021.

196. Susan Hamm et al., *GeoVision*..

197. Porse et al. *Geothermal Technologies Office Multi-Year Program Plan FY 2022-2026*.

In sum, similarly to other clean energy infrastructure discussed in this paper, geothermal faces opportunities to improve and update current regulations so as to avoid undermining ongoing development and commercialization. Regardless of how similar they may be with traditional fossil resource approaches, non-traditional technologies like geothermal will not benefit from those similarities in terms of regulatory treatment without proactive consideration and a targeted effort to improve regulations for the technology in question.

Policy responses

Evaluate categorical exclusions for geothermal.

Given the technology and resource development similarities between geothermal and oil and gas, categorical exclusions implemented for oil and gas should be evaluated for geothermal. This includes, for example, exploration activities.[198] In addition, categorical exclusions should be considered for other geothermal project development actions, such as geothermal pilot projects. Improving regulations to facilitate small-scale, next-generation geothermal projects could help usher in critical breakthroughs in geothermal technology.

Open a centralized BLM permitting office for geothermal energy.

States such as Hawaii and Alaska have opened such offices, and found they can speed permitting timelines.[199] A centralized office at BLM could coordinate timelines, facilitate data sharing, and identify areas for reducing duplicative environmental review work. It could also assist with thorny issues that geothermal faces but other clean energy technologies do not, such as split estate permitting. Such a permitting office should have staff experienced with geothermal energy development. Alternatively, the BLM's recently established Renewable Energy Coordination Office could fulfill these goals for geothermal energy.

Identify geothermal leasing priority zones and update the geothermal Programmatic Environmental Impact Statement.

Solar DLAs offer important advantages within the BLM leasing process, and this type of priority area applied to geothermal could similarly be used to reduce hurdles to leasing for geothermal development. Additionally, the BLM's current geothermal PEIS was released in 2008,[200] indicating an opportunity to update the analysis to account for new data and technology development, while considering today's environment of accelerating clean energy demand. Beyond the direct benefits of these actions, developers would have more certainty about their investments under a regime where geothermal priority areas are available and a more recent PEIS is in place.

Foster community engagement and stakeholder participation in the permitting process.

Much like the other clean energy infrastructure types discussed above, meaningful community engagement is vital to successful development of geothermal energy projects.[201] Involving communities early

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198. A ClearPath report notes that "NREL estimates that a combination of expanding [categorical exclusions] for geothermal exploration and centralized federal and state permitting would ultimately cut the total development timeline for geothermal in half and allow an additional 7GW of development by 2050, a 116 percent increase over business as usual in 2050. Future developments in EGS could accelerate this even further." See Spencer Nelson, "Regulatory Reform Could Unlock Gigawatts of Zero-Emission Geothermal," ClearPath, May 2019.

199. Levine and Young, Efforts to Streamline Permitting of Geothermal Projects).

200. Bureau of Land Management, "Geothermal Energy," accessed September 1, 2023.

201. Porse et al., *Geothermal Technologies Office Multi-Year Program Plan FY 2022-2026*.

and often can head off and resolve conflicts, promote public acceptance, and identify community goals and values that are essential to address as part of infrastructure deployment efforts.

Conclusion

In this paper, we spotlight a variety of siting, leasing, and permitting challenges for a range of clean energy infrastructure. In addition to highlighting specific regulatory reforms, we have collected numerous potential policy responses that would help overcome these obstacles and thereby facilitate clean energy supply growth to meet the robust market demand evident across the U.S. and meet climate targets.

We recognize several overarching takeaways that emerge from the broad scope of this research, which encompassed several key stages of project development, five clean energy infrastructure types, and comparisons to fossil fuel infrastructure regulations. These takeaways could further inform policymaking related to the infrastructure types reviewed here, and also may inform policies applicable to emerging clean technologies and infrastructure.

First, the nation's decades of experience deploying fossil energy infrastructure offers numerous insights and evidence as to regulatory approaches that enable successful and widespread buildout of energy projects. We can and should apply these lessons to aid in clean energy infrastructure buildout, while at the same time learning from their failures. For example, siting authorities that are able to holistically consider interstate projects, as with natural gas pipelines, can unlock considerable project development activity. Another example is the use of NEPA categorical exclusions to streamline permitting timelines. As policymakers and agency administrators search for ways to improve the regulatory regime for clean energy, fossil infrastructure practices should be a primary resource. Caution should be exercised in order to successfully expedite clean energy while maintaining community and environmental safeguards.

Second, mechanisms for coordination are key to improving regulatory treatment of clean energy. Federal, state, and local regulations must align such that siting and permitting do not become obstacles to beneficial clean energy projects, and community engagement and benefits should feature heavily in these alignments. The many federal agencies involved in siting, leasing, and permitting must communicate effectively among themselves to coordinate and align their reviews. And federal agencies should seek to minimize constraints on clean energy created by competition for limited agency resources. Land leasing for multiple clean energy types is a notable example of this issue. Sufficient government capacity should be provided to meet energy development needs, and any capacity limitations should be recognized and addressed intentionally to reasonably resolve resource development trade-offs between fossil and clean energy sources. Moreover, clean energy should be prioritized through a whole-of-government approach. This would mean addressing staffing and other agency capacity elements, and proactively coordinating the various government activities required for clean energy infrastructure development while maintaining appropriate environmental, community, and cultural protections.

Third, transmission expansion is necessary to bring the electricity from clean energy sources to consumers. Transmission also requires improving existing siting and permitting processes. The compounding nature of these regulatory requirements potentially also applies to emerging infrastructure types such as hydrogen and CO2 capture. Expanding clean energy development hinges on recognizing and addressing this uniquely complex challenge.

Policymakers and administrative agencies can apply both the infrastructure-specific policy responses and the overarching takeaways from this research to further promote clean energy infrastructure development. Future work could build on these insights by considering additional regulatory elements, more clean energy technologies and infrastructure types, and additional fossil or other infrastructure regulatory regimes that may offer instructive comparisons.