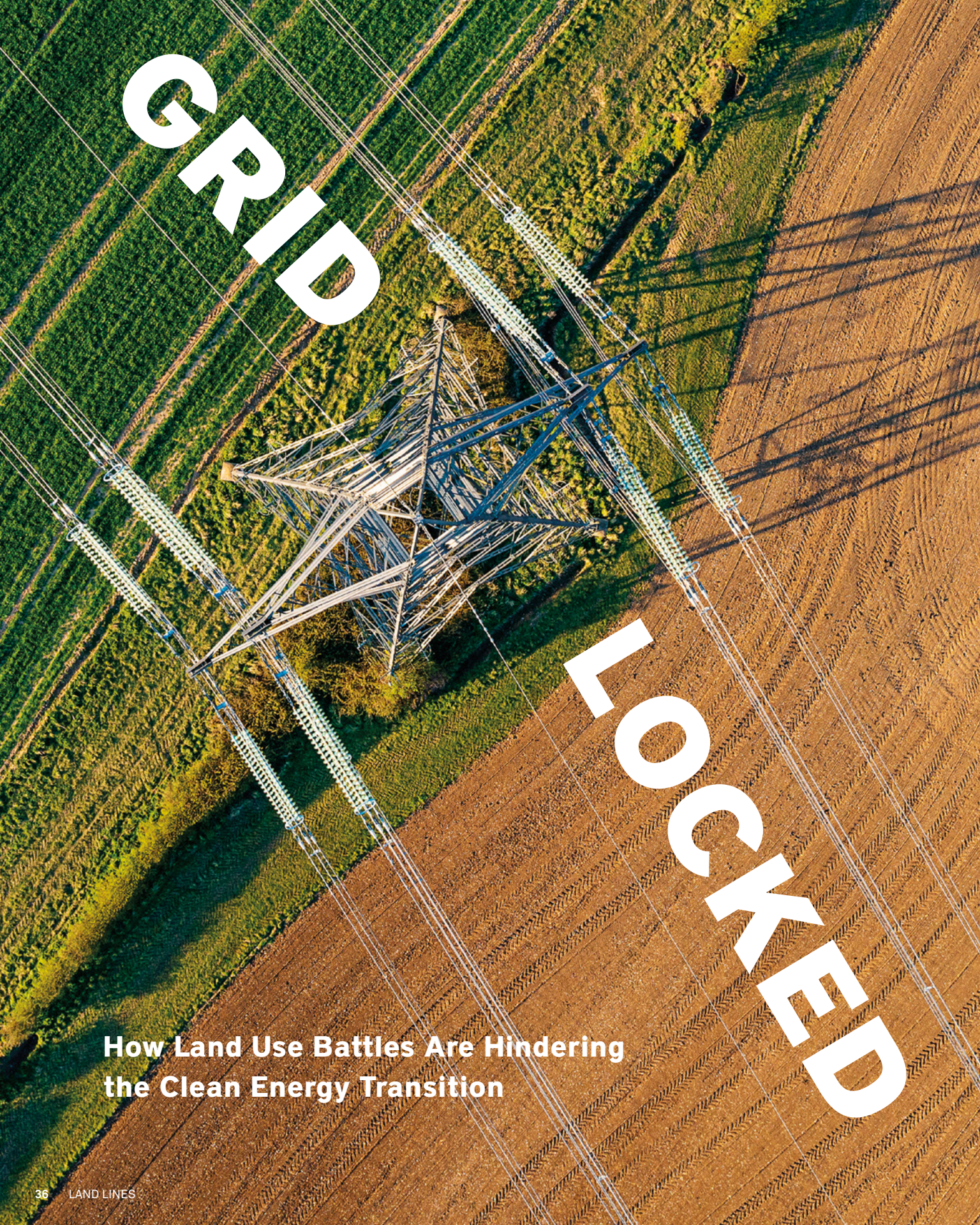


GRID LOCKED

How Land Use Battles Are Hindering the Clean Energy Transition

By Anthony Flint

ONE EMERGING CONSENSUS to combat climate change is increasingly clear: electrify everything, and make that power come from renewable sources, like wind, solar, and hydro power. Removing fossil fuels from electricity generation can be surprisingly smooth, as clean power facilities have rapidly become more cost-efficient. Renewables are currently 20 percent of US power generation and steadily growing.

But there's a sprawling and daunting land use task that is necessary to make that clean energy transition happen: not only the siting of solar arrays and wind farms, but the construction and improvement of transmission lines and substations and pipelines, across thousands of acres of land.

Researchers at Princeton University have estimated that if manufacturing capacity for turbines and photovoltaics continues to ratchet up as it has been for the last several years, up to 400,000 square miles will be needed in the US to harvest wind energy alone (Larson et al. 2020). That means much more visible renewable energy infrastructure on hilltops, in suburban neighborhoods, and in what may feel like people's backyards.

Battles over the siting of wind and solar installations, and opposition to the key upgrades and expansion of the grid that will allow clean power to plug in, are occurring on a state-by-state basis, in the absence of federal authority or oversight. In many cases, renewable energy facilities have been cleared through the permitting process to start operating, but remain in limbo because they can't plug in to the existing, antiquated grid.

A crazy quilt of local land use regulations—including bylaws restricting solar fields and wind farms—has amplified the voices of opposition from neighbors and organized groups, including, in what many climate advocates consider a profound irony of the times, some environmental organizations.

In addition, land use conflicts are hindering another critical component of the clean energy transition—the mining of metals such as lithium to make high-capacity rechargeable batteries, for electric vehicles and storing power from renewable sources when the sun doesn't shine or the wind doesn't blow (see sidebar page 39).

Those targeting net-zero emissions by mid-century hoped for a high-level wave of renewable energy that would transform the way everyone gets their power. Instead, there are standoffs and bottlenecks, at the state and local level, as the execution of this extraordinary transition gets bogged down, literally, on the ground.

"I would agree things aren't going well right now—though I would suggest that we also have way more shots on goal than in previous years, so there are more stories of projects getting blocked because there are just more project proposals," said Sarah Banas Mills, senior project manager at the Graham Sustainability Institute and lecturer at the School for Environment and Sustainability, University of Michigan.

Those targeting net-zero emissions by mid-century hoped for a high-level wave of renewable energy that would transform the way everyone gets their power. Instead, the execution of this extraordinary transition is getting bogged down on the ground.

Credit: Justin Paget via DigitalVision/Getty Images.

As frustration mounts at what many see as a fumbling of the ball at a key moment in the fight against climate change, Mills, who has been tracking battles over renewable energy all over the US and coauthored a paper on the topic (Bessette and Mills 2021), says a more nuanced analysis is required about each and every site, now that installations are ramping up. Wind projects in places with more people or higher scenic amenities are more likely to be opposed; neighbors may also be more likely to balk at large solar arrays on farmland, which many clean energy advocates thought would be an easier sell.

"Renewables present one of the biggest economic opportunities rural communities have seen in decades," she said. "But with all opportunities, there are trade-offs. That we have so many communities saying no suggests to me that in many places communities are finding that the positives—economic benefits—don't outweigh the negatives. Changes may need to be made to project characteristics, like size, location within the community, and distribution of economic benefits . . . to get more communities to 'yes.'"

Construction of power lines in the Maricopa County town of Cashion, Arizona, in 1934. Credit: Arizona State Library, Archives and Public Records, History and Archives Division, Phoenix, #98-3250.

IT WASN'T always this way. In the past, there was little to no veto power exercised at the local level, as industrialization advanced and critical infrastructure was deemed necessary, whether canals, railroads, and telegraph lines in the 19th century, or the interstate highway system in the 1950s.

A common thread for infrastructure is the intensive use of land, which is necessary to complete networks and distribute benefits across large expanses. This was especially true in the development of the grid. Power plants were built at whatever location was required, whether near a coal mine or on a river. Then, a decentralized but highly connected system of substations, transformers, and transmission and distribution lines got the power to the end user—homes and businesses. The flow of power is from point to point and as it happens, since large amounts of electricity are not stored; the power is used as it is produced, and vice versa.

Although the construction, organization, and regulation of the grid started out in a patchwork state-by-state and regional framework, the federal government established oversight with the Federal Power Act of 1920, which Congress passed to coordinate the development of hydroelectric projects such as the Hoover Dam. Major new agencies like the Tennessee Valley Authority, established in 1933, helped create a sense of intention and purpose; bringing electricity to rural areas was part of a national mobilization in economic development during the Great Depression (and, also intentionally, a fountainhead of jobs). Among other federal agencies, what is now known as the Federal Energy Regulatory Commission (FERC) took the lead in managing power generation and the grid, although generally oversight of utilities, and the prices they charge in particular, remains a state responsibility.

In terms of the extraordinary accomplishment of the grid, the ultimate result of planning and coordination is the familiar landscape of today: 160,000 miles of high-voltage power lines draped on shiny metal stanchions up to 200 feet tall,

A worker at the Albemarle lithium mine in Chile's Atacama Desert. Credit: AP Photo/Rodrigo Abd.

MUCH ADO ABOUT MINING

Another critical land use dimension of the clean energy transition is the mining of metals used for batteries for electric vehicles and general power storage, including lithium, cobalt, copper, nickel, niobium, and graphite. The World Bank estimates that over 3 billion tons of minerals and metals will be needed by 2050 to meet the clean energy storage and deployment goals in the 2015 Paris Agreement—a production increase of 500 percent.

With these minerals in such high demand, regions like Latin America, which controls two-thirds of the global supply of lithium, are under tremendous pressure to allow mining as a new source of economic development. But the mining process is dangerous, hugely disruptive to the environment, and often occurs within Indigenous territories.

The resource-rich countries where the minerals are, primarily in the Global South, are home to extensive biodiversity and uniquely vulnerable to the impacts of climate change, said Claudia Dobles Camargo, former First Lady of Costa Rica, where open-air mining is banned. Honduras and El Salvador have also banned the practice. "We cannot just transition from one type of energy to clean energy without taking into consideration that this could become a new extractivism," she said.

Beyond the developing world, any move to extract these clean-power minerals seems to become instantaneously contentious. When a Maine couple discovered large lithium deposits on their property, they were surprised that neighbors didn't celebrate the potential contribution to the clean energy transition—but rather demanded state regulators prevent any kind of mining operation at all.

Technology may come to the rescue, in the form of more sustainable lithium mining techniques involving microbes, seawater, and brine. Lithium can also be recycled from old batteries, a process dubbed "urban mining." And researchers at MIT and elsewhere are working on new kinds of batteries, such as metal-air devices using aluminum, zinc, or iron, all of which are abundantly available, that would obviate the need for lithium altogether.

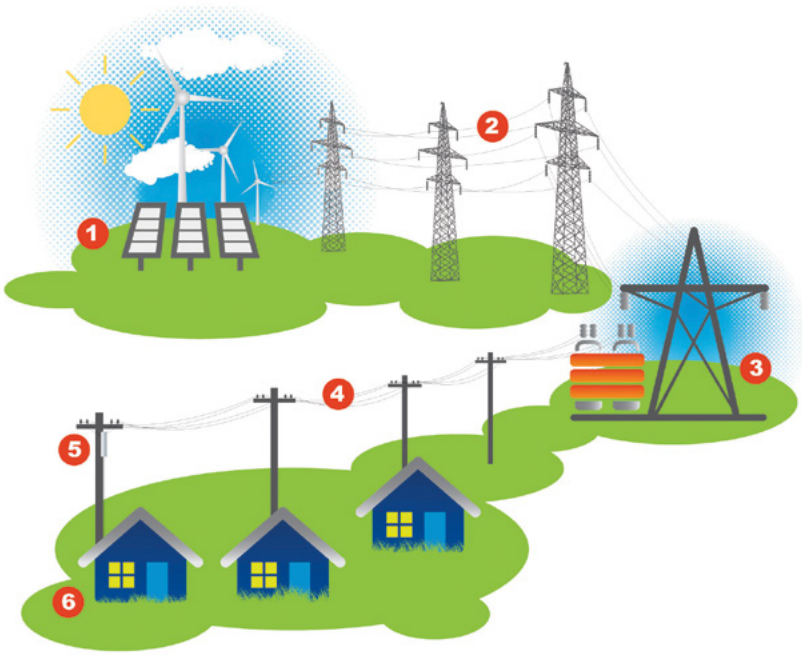
Another approach to minimize damage and land use conflicts: reduce demand for batteries for electric vehicles by driving less—a higher bar, to be sure, for societies just getting used to the concept of alternatives to fossil fuel.

A report by a team led by Providence College professor Thea Riofrancos found that the United States "can achieve zero emissions transportation while limiting the amount of lithium mining necessary by reducing the car dependence of the transportation system, decreasing the size of electric vehicle batteries, and maximizing lithium recycling" (Riofrancos et al. 2023).

"Reordering the US transportation system through policy and spending shifts to prioritize public and active transit while reducing car dependency," the report says, "can also ensure transit equity, protect ecosystems, respect Indigenous rights, and meet the demands of global justice."

HOW ELECTRICITY IS DELIVERED TO HOMES

1. Electricity generated
2. Electricity transmitted over high-voltage lines
3. Voltage reduced at substation
4. Power distributed through lower-voltage lines
5. Voltage further reduced by overhead transformer
6. Electricity delivered



Credit: PPL Electric Utilities.

with forest and brush cleared away underneath, crisscrossing the countryside, whisking electricity generated by 7,300 power plants to nearly 150 million customers across the US, according to the US Energy Information Administration. The North American grid—three grids, technically, called the Eastern, Western, and Texas Interconnect—is completed by millions of miles of low-voltage power lines and distribution transformers (EIA 2016).

To date, most electricity is produced using conventional sources such as natural gas, oil, coal, and nuclear. But at least 20 percent of the nation's power is now generated by renewable energy facilities—wind, solar, hydroelectric, biomass, geothermal—and that proportion is growing, as coal-fired power plants, for example, are steadily phased out. Over the past decade, 290 coal-fired plants were decommissioned in the US, leaving 224 in operation.

The Biden administration has pledged to eliminate fossil fuels as a form of energy generation in the US by 2035, setting the goal of 80 percent carbon-free electricity by 2030. Wind, solar, and hydroelectric power have been the fastest-growing segment of the energy sector, and will be further fueled by some $370 billion in funding under the Inflation Reduction Act. Wind and solar projects, steadily improving in their technology and efficiency, are ready to roll.

But therein lies the current land use challenge—not only in the siting of renewable energy installations, but also in the all-important upgrade to the grid to carry and distribute all that clean power. On both fronts, the development of renewable energy has been stymied in recent years.

At least 20 percent of our power is generated by renewable energy facilities—wind, solar, hydroelectric, biomass, geothermal—and that proportion is growing.

Opposition to offshore wind farms, notably the Cape Wind project off Cape Cod, was perhaps the first and most infamous example of affluent homeowners objecting to clean energy infrastructure because they claimed it spoiled the view. But wind farms on land, whether atop ridges or on farmland, have also ignited fierce opposition, even in remote areas.

In Northern California, Shasta County supervisors rejected a proposal by Connect Wind/Fountain Wind for 48 turbines on rural land after hearing concerns about impacts on wildlife habitat, Indigenous lands, and even whether the turbines would interfere with fighting wildfires from the air. A local ordinance passed shortly afterward banning large wind projects outright. The California Energy Commission is allowing the developers a second chance under a provision of Assembly Bill 205, which can override local veto power over clean energy projects.

In Iowa, a judge ordered developers to dismantle three 450-foot turbines on farmland after neighboring landowners complained about the noise the turbines made. The victorious opponents, who successfully argued that the zoning board shouldn't have issued the permits, hope their battle "will empower other rural landowners and small towns to take on wind," according to the *Des Moines Register* (Eller 2018).

A typical concern as well is the danger posed by wind turbines to birds—although pesticides, buildings, and housecats kill many times more birds than the slowly rotating blades, and clean-tech researchers, using artificial intelligence, have come up with ways to keep birds away anyway.

Solar installations have not fared much better. While more than 2,500 solar farms are up and running in the United States, solar projects are increasingly encountering blockades, in Indiana, Ohio, Virginia, and elsewhere. Neighbors often get in an uproar when they see how large, visible, and land-intensive some of the solar arrays are, describing them in alarming fashion, as in one battle over a Midwest proposal, as filling up thousands of football fields with shiny, deep blue panels.

Solar installation in western Massachusetts. Credit: Jerry Monkman/EcoPhotography.

Researchers in a 2021 Michigan study found that despite readily acknowledged benefits such as economic development, tax payments, and compensation for the landowner and community, "projects have increasingly faced local resistance . . . [due to] aesthetics, noise, and negative impacts to rural and Tribal culture, values, and community energy sovereignty, along with . . . risk to wildlife, productive farmland, biodiversity, and human health" (Crawford, Bessette, and Mills 2022). Additional perceived risks included lowered home and property values, increased electricity rates, impacts to tourism, and the toxicity of materials used in construction and operation, the study says.

A team at MIT studied 53 American renewable energy projects that were paused, delayed, or canceled between 2008 and 2021 in 28 states because of local opposition. The researchers identified seven common drivers of conflict: environmental impact; financial viability; quality of public engagement; Tribal rights; health and safety concerns; and concerns related to land and property values (Susskind et al. 2022).

"We found overwhelming evidence to suggest that federal, state, and local regulators need to rethink the design and operation of their facility siting processes," the researchers conclude. "A fast and fair transition to renewable energy will not be achieved in the US if policymakers and energy developers do not anticipate and respond proactively to the full array of sources of local opposition."

High-profile standoffs have the effect of scaring off partners worried about bad publicity. In Queensland, Australia, the tech company Apple withdrew from an agreement to buy power from a proposed 80-turbine wind farm on nearly 2,000 acres, a project the World Wildlife Fund (WWF) had criticized for threatening koalas, wallabies, and red goshawks. A WWF spokesperson applauded the move, saying it demonstrated "leadership and a commitment to renewables that are good for climate and nature."

Opposition to transmission lines and the upgrades and expansion of the grid that are necessary to handle new clean power has been perhaps the most strenuous of all—leaving renewable energy installations that have already been built or permitted to remain in limbo, an untenable scenario for green-tech companies and investors.

A four-year legal battle over a 145-mile transmission line that would carry hydroelectric power from Quebec to Massachusetts has been representative of the bare-knuckle brawling over land use. Conservation groups said the pipeline threatened wilderness areas in Maine, where most of the line would be constructed, prompting a statewide vote against the project, though it had already been permitted. A judge recently ruled that construction could resume.

Protesters rally against a transmission line that will cut through Maine to bring hydropower from Quebec to Massachusetts. Credit: AP Photo/Robert F. Bukaty.

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Proponents complained that the opposition had been financed and motivated by a rival natural gas utility seeking to block competition. Joseph Curtatone, president of the Northeast Clean Energy Council, said he hoped the court decision "marks an end to the self-interested, corporate-funded attempts to sabotage this project." Building the project as planned, he said, would remove more than 3 million metric tons of carbon annually and provide $200 million in desperately needed upgrades to the electric grid.

"This is essential work in our effort to electrify everything in order to avoid the worst effects of climate change. Without grid upgrades we can't deliver power to heat pumps and electric vehicles. These are the kinds of big leaps we need to take after decades of minimal progress on climate action," he said. "If we're fighting tooth-and-nail over removing 3 million tons of CO_2 with lower-cost energy, we're never going to reach net zero."

In the book *Superpower*, the author Russell Gold chronicled the ultimately futile attempt by Houston businessman Michael Skelly to get approval for a transmission line to connect wind farms in Oklahoma to the grid in Tennessee, which became emblematic of community opposition paired with politics (Gold 2020). But the same problem keeps recurring. It took 18 years before a 732-mile transmission line was approved by federal authorities to carry clean power from the proposed 700-turbine TransWest wind farm on ranchland in Wyoming to homes and businesses in California. The interstate project required multiple approvals under the National Environmental Protection Act (NEPA), with detailed examination of impacts on flora and fauna, including the sagebrush grouse.

The objections to green infrastructure have evoked past battles over endangered species, sacred sites, and otherwise culturally valuable land. The Greenlink West project, a 470-mile transmission line through Nevada, is under fire because it might disturb woolly mammoth tusk fossils.

Pads have been cleared for wind turbines at Wyoming's Overland Trail Ranch, which straddles the Continental Divide. Credit: Robert Gauthier/ *Los Angeles Times*.

The irony is not lost on many that environmental laws passed in the 1970s to combat rampant pollution are now being used to fight renewable energy projects that will curb climate change. Environmental litigation is threatening a wide range of environmentally advantageous initiatives across the country, from dense housing to bike lanes to congestion pricing.

"I'm an environmentalist, which means I've got some practice in saying no. It's what we do," wrote Bill McKibben in an essay for *Mother Jones* titled, "Yes in Our Backyards" (McKibben 2023). McKibben's decades of activism include successfully fighting the Keystone XL fossil-fuel pipeline. "But we're at a hinge moment now, when solving our biggest problems—environmental but also social—means we need to say yes to some things. . . . One way may be to back up a little and think of the slightly longer term."

Without any sense of a grand plan or rationale, and environmentalists divided—one camp saying impacts on the environment must always be considered, the other that there will be no functioning wildlife habitats or thriving species if climate change isn't curtailed—renewable energy projects are increasingly being viewed as what Harvard professor Alan Altshuler called LULUs: "locally unwanted land uses," like prisons or landfills.

A solar installer in Lowell, Massachusetts. Credit: Jerry Monkman/EcoPhotography.

AN ARRAY of solutions for overcoming this impasse has emerged recently, including legislation introduced just this year.

At least three steps are needed to adequately and effectively deploy clean energy infrastructure, says Patrick Welch, an analyst in the climate strategies group at the Lincoln Institute of Land Policy: federal-level permitting reform, local regulatory changes, and more strategic and creative planning.

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"In many instances, there are genuine issues regarding the proposed siting of new solar, wind, and hydro projects—whether that is related to stormwater runoff issues, other impacts on important ecosystems, or new land grabs on Indigenous lands," Welch said. "We need to be more strategic and creative. Things like co-locating solar on parking lots and rooftops or interstate rights of way, rather than clearcutting forests, are good solutions."

The Nature Conservancy's Site Renewables Right initiative, which identifies suitable sites for wind and solar energy in the central United States by mapping factors including environmental impact and agricultural production, is a good example of trying to find workable solutions, he said; another is Baltimore County's study on solar siting, which identified nearly 34,000 acres of potential optimal solar sites on rooftops, parking lots, and degraded lands (Minnemeyer and Wiggans 2020).

But even with more appropriate siting, Welch said, permitting and local land use regulations can get in the way. "Both sides of the aisle have known for decades that NEPA and the associated permitting spiderwebs are responsible for long, unnecessary delays. Now, the climate crisis has

A worker inspects Bonneville Power Administration lines in Oregon in the 1970s. Credit: James L. Amos via Image Bank Unreleased/Getty Images.

brought new urgency to that conversation. Local regulations must allow for the appropriate siting of renewable energy infrastructure, too."

Federal coordination—harkening back to the more intentional establishment of infrastructure in the first half of the 20th century—has seemed to many the obvious first step. This spring, US Senator Sheldon Whitehouse (D-RI) and US Representative Mike Quigley (D-IL) introduced the Streamlining Interstate Transmission of Electricity (SITE) Act, which would establish a new federal siting authority at the Federal Energy Regulatory Commission to ease the process of constructing long-range, high-voltage transmission lines.

"If we don't build more long-range transmission lines, much of the low-cost clean energy that is coming online will simply not be able to get to the homes and businesses that need it," Whitehouse said when unveiling the bill. The goal is better reliability, an upgrade of the nation's creaky grid infrastructure, and lower emissions while "responsibly balancing local needs and preferences," he said.

There is action at the state and regional scale as well. After criticism that state regulatory authorities have been dragging their feet on the clean energy transition, Massachusetts Governor Maura Healey appointed climate-savvy commissioners to the state Department of Public Utilities, and established two new commissions, one to review clean energy siting and permitting, and another to coordinate offshore wind development.

In Washington State, Governor Jay Inslee recently signed a bill requiring longer-term planning by utilities and allowing bigger transmission projects to go through the state's streamlined siting process. The Bonneville Power Administration (BPA), which manages hydropower from 31 federal dams in the Northwest, has proposed some upgrades to its system, which, if completed, will help increase transmission capacity.

The electricity market is structured differently in the Pacific Northwest than in California and other states, making coordination and planning that much more difficult, said Emily

Moore, director of the Climate and Energy program at the Sightline Institute. Washington and Oregon have assertive climate action plans to shift to clean energy, but even if all utilities agreed to switch tomorrow, the grid couldn't support the load, she said, so hundreds of wind and solar projects are languishing.

"In an ideal world, we would have clarity on how much more transmission is needed . . . and where it would go, so we could then start building it before it is too late," she said. "But planning, at least in our region, is largely reactive, not proactive. Changing that here will require new levels of coordination between BPA, individual utilities, regulators, and policymakers."

When renewable energy projects or transmission lines are first rolled out to the public, developers would do well to practice better stakeholder engagement, said Josh Hohn, a principle at the urban design firm Stantec. He urges project leaders to help people visualize what's actually being proposed "before imaginations run wild."

BUILDING CONSENSUS about clean energy infrastructure is especially challenging in part because the land use issues are so local, but tie back to the global problem of climate change, requiring conceptualizing priorities in sometimes counterintuitive ways. For example, it seems outrageous to clear trees to make way for solar panels. But according to one forest ecologist, doing so actually reduces carbon emissions more after a period of time than leaving the trees in place (Canham 2021).

Technology is also advancing so rapidly, the land use dimension of clean energy could become less onerous. Geothermal drills require less land, though are akin to the oil rigs that have dotted the landscape since the turn of the last century. Batteries are getting better, allowing clean power to be stored. And there is the notion of the mega-solar project, consolidating arrays all in one or two large, out-of-the-way locations, like a corner of the Sahara desert. By one calculation, solar panels on a single parcel of 43,000 square miles—1.2 percent of the Sahara—could power the entire world (Moalem 2016).

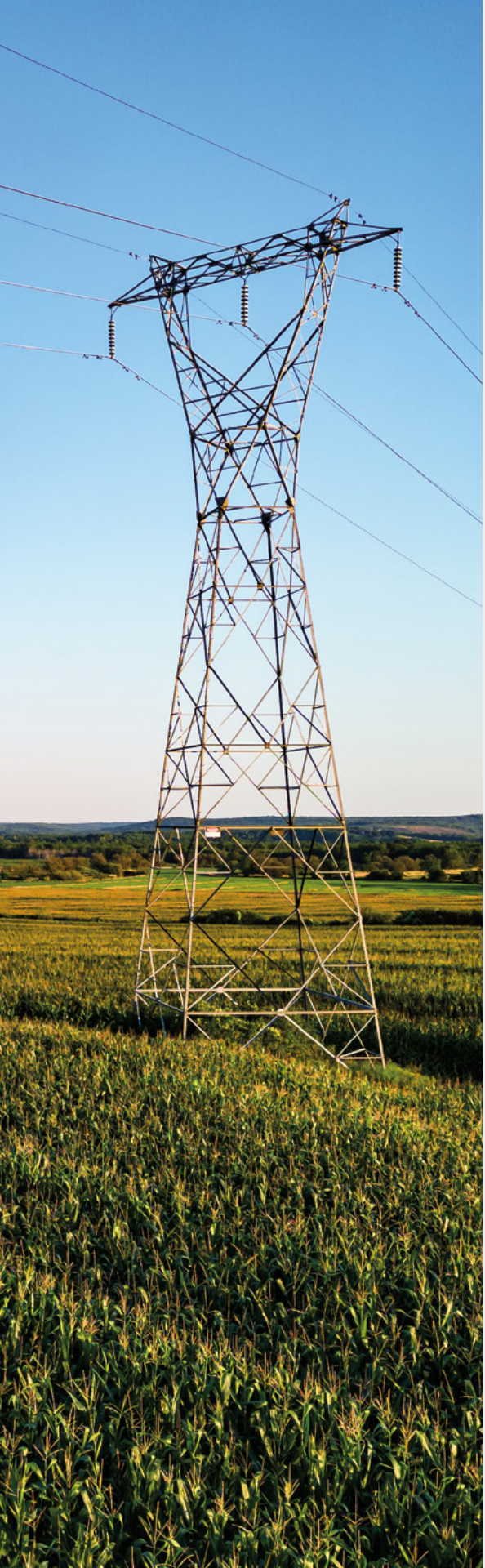
At a more conceptual level, McKibben—who founded the organization Third Act to recruit aging Boomers concerned about climate change—called for a change in mindset when looking at clean energy infrastructure. Instead of viewing it as unsightly, he suggests, we could appreciate how it's helping the planet wean off fossil fuels, and has great economic returns as well. "It's a different kind of beauty," he said in an interview, though he acknowledged people are used to judging landscapes by more conventional measures.

Whether such reconceptualization can happen remains to be seen. But the public's relationship with land has clearly become a key element of the clean energy transition. Above all, this is a moment for thoughtful land policy, with the future of the planet hanging in the balance, said the Lincoln Institute's Patrick Welch.

The public's relationship with land has clearly become a key element of the clean energy transition. Above all, this is a moment for thoughtful land policy, with the future of the planet hanging in the balance.

"Given the scale and urgency needed for this massive rollout of new infrastructure, there is a significant risk that we do it in a way that leads to serious unintended consequences," Welch said. "So we need to be mindful and strategic—but not to the point of inaction." □

Anthony Flint is a senior fellow at the Lincoln Institute of Land Policy, host of the *Land Matters* podcast, and a contributing editor to *Land Lines*.



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