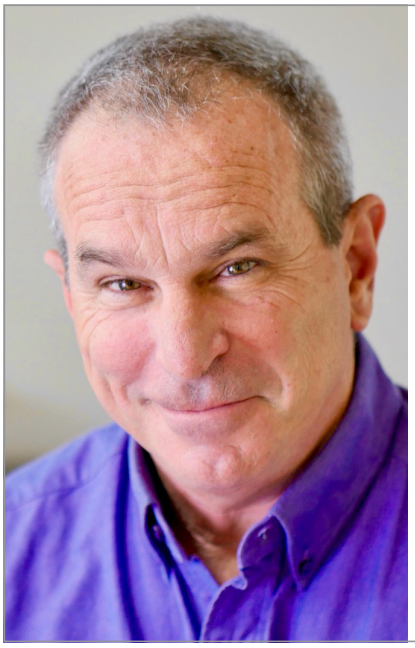
AMERICAN EXPERIMENT

NOT IN OUR BACKYARD

Rural America is fighting back against large-scale renewable energy projects

ROBERT BRYCE • AUTHOR

A REPORT FOR CENTER OF THE AMERICAN EXPERIMENT



Robert Bryce has been writing about energy, power, innovation, and politics for three decades. He's the host of the Power Hungry Podcast and the author of six books including his latest, *A Question of Power: Electricity and the Wealth of Nations*. Bryce is a visiting fellow at the Foundation for Research on Equal Opportunity. He is also an executive producer and co-writer of a new feature-length documentary: *Juice: How Electricity Explains the World*. The film has received rave reviews and is now available on streaming platforms including iTunes, Amazon Prime, and many others. Bryce lives in Austin, Tex., with his wife, Lorin, who is a photographer, art teacher and master potter.

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Executive Summary

Renewable energy is politically popular. Polling data show that about 70 percent of Americans want more wind energy and 80 percent want more solar.[1] Regulators at the local, state, and federal levels have responded to this popularity by passing a myriad of goals, mandates, and subsidies to encourage the development and consumption of wind and solar energy. The Sierra Club claims that "over 170 cities, more than ten counties, and eight states across the U.S. have goals to power their communities with 100% clean, renewable energy."[2]

In addition to their political popularity, a spate of academic studies released over the past few years have claimed that the U.S. can run most or, all, of its economy solely on renewables. No oil, coal, natural gas, or nuclear required. Although renewables are popular among voters and professors at elite universities, they also have several problems, including their intermittency, need for high-voltage transmission lines, and resource intensity. Several analyses, including one done in 2019 by the Natural History Museum in London, have documented the enormous amounts of metals and rare-earth elements that will have to be mined in order to manufacture the vast amounts of solar panels and wind turbines needed for such a large effort.[3]

But the most important — and the most obvious — challenge in converting to a renewables-only economy is commandeering the enormous amounts of land needed to accommodate the staggering amounts of solar and wind generation capacity that will be required to meet domestic energy needs. As longtime consulting electric engineer Lee Cordner summed it up, "Where are you going to put it? How are you going to connect it? And how are you going to pay for it?" This paper addresses those issues.

With regard to how all of those renewables will be paid for, it is clear that mandates and subsidies are driving their deployment. A key finding of this report is that between 2010 and 2029, federal tax incentives for the wind and solar sectors will total $140.3 billion.

In addition to the conflicts over new wind and solar projects, attempting to convert the domestic electric grid will require roughly doubling the amount of high-voltage transmission capacity in the United States.

Federal officials have introduced a spate of energy plans that could require dramatic increases in renewable energy use and untold billions more in federal spending. Among the most famous is the Green New Deal. Introduced in 2019, the plan aims to "mobilize every aspect of American society to 100% clean and renewable energy by 2030."[4] In July 2020, the Biden-Sanders Unity Task Force announced a plan that commits Democrats to eliminate "carbon pollution from power plants by 2035." It continues, "Within five years, we will install 500 million solar panels, including eight million solar roofs and community solar energy systems, and 60,000 made-in-America wind turbines."[5]

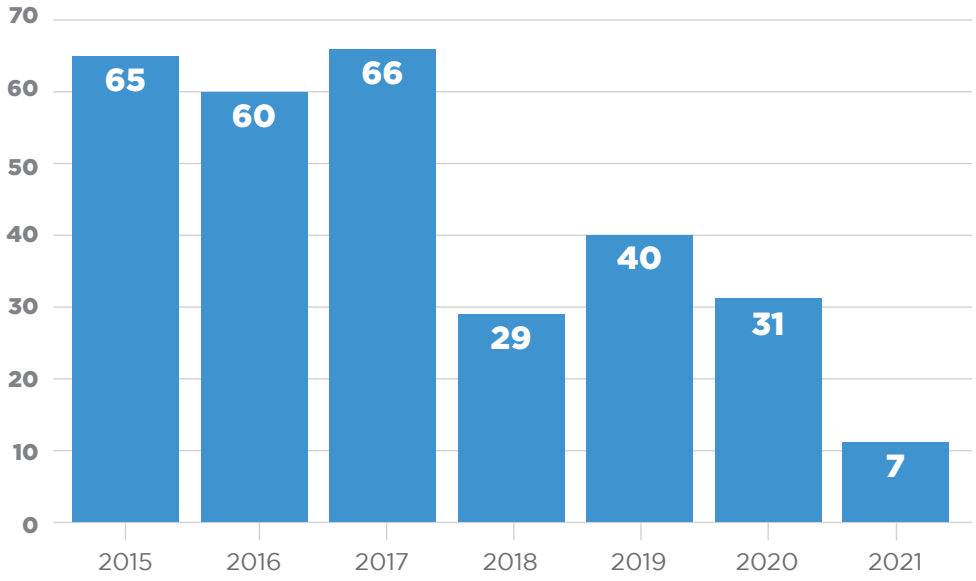
President Joe Biden's "Energy Efficiency and Clean Energy Standard" calls for the deployment of "millions of solar panels — including utility-scale, rooftop and community solar systems — and tens of thousands of wind turbines."[6]

In December 2020, academics at the Andlinger Center for Energy and the Environment at Princeton

FIGURE 1

Rejections or Restrictions of U.S. Wind Projects, 2015-2021

From Maine and Vermont to California and Hawaii, local governments are restricting or rejecting the expansion of wind energy.



SOURCE: MEDIA REPORTS

University released a study that says the U.S. can "reach net-zero emissions of greenhouse gases by 2050 using existing technology and at costs aligned with historical spending on energy." The 300-page report includes several scenarios, all of which require huge increases in wind and solar energy, as well as a massive expansion of high-voltage transmission capacity.[7] One scenario necessitates covering about 228,000 square miles with renewables. That's an area roughly equal to the size of the state of California and Washington *combined*.[8]

Despite the obvious difficulty in acquiring such vast swaths of land, the Princeton study got significant media attention, including a favorable piece in the *New York Times*, which called it "at once optimistic and sobering," adding that the report's conclusions seem "technically feasible and affordable."[9]

Top officials in the Biden administration are also forecasting huge increases in renewables. In March, Energy Secretary Jennifer Granholm said, "We have to add hundreds of gigawatts to the grid over the next four years. It's a huge amount. And there's so little time."[10]

Regardless of which academic, political or economic scenario is considered, it's clear any attempt to convert the entire domestic electric grid — not to mention the entire economy — to run solely on renewables will require covering vast territories with oceans of solar panels and forests of giant wind turbines. Further, that effort will have to occur at the same time that rural politicians and landowners across the U.S. are fighting against the encroachment of large-scale renewable energy projects.

These land-use conflicts are the binding constraint on wind and solar energy expansion and they are slowing or stopping these developments all over the country. Since 2015, according to published media stories, about 300 government entities have moved to reject or restrict wind energy projects (See Figure 1).

Among the recent examples of the backlash against wind energy: On April 7, the planning board in the town of Foster, R.I., voted 5-1 to ban wind turbines. The board took action after hearing from residents of the nearby town of Portsmouth who had turbines built near their homes. According to an April 14 article by Jaquelyn Moorehead, a reporter for *The Valley Breeze* newspaper, the Portsmouth residents warned the board "about their experiences, complaining about constant noise disturbances, vibrations, and loss in home values from turbines in their neighborhood."

The ban in Foster reflects the broader backlash against Big Wind. Objections to large-scale renewable energy projects include concerns about negative health effects from the noise generated by wind turbines, reductions in property values, protection of existing viewsheds, and potential loss of tourism.

These conflicts, seldom covered by major media outlets, provide a stark example of the urban-rural divide. They are also a harbinger of future fights as environmental groups, renewable energy companies, and their allies in state and federal governments continue pushing for dramatic increases in renewable energy, and slashing (or banning) the use of coal, oil, and natural gas.

Land use battles are occurring in states with some of America's most ambitious renewable energy goals. For instance, New York has a 70 percent renewable electricity mandate by 2030, but the backlash in the state has been so widespread that Gov. Andrew Cuomo recently pushed through a measure that allows the state to override local governments when siting energy projects.[11]

Connecting lots of wind and solar to the grid also requires appropriating land for transmission projects. According to the National Renewable Energy Laboratory, converting the domestic electric grid to run on renewables will require roughly doubling the amount of high-voltage transmission capacity in the U.S. At present, the U.S. has about 240,000 miles of high-voltage transmission.[12] Therefore, renewables conversion means adding enough high-voltage transmission lines to circle the Earth about 10 times.[13]

This report provides a review of the many studies that found the noise from wind energy projects can cause health issues. It includes the summary of a 2009 study done by the Minnesota Department of Health, which documented the health complaints lodged against wind projects and recommended further analysis of the turbine-noise issue.

This analysis also marks the launch of the National Renewable Energy Rejection Database. It provides the names of towns and government entities that have rejected or restricted wind projects since 2015. The database will be regularly updated by Center of the American Experiment, and includes links to additional information, such as local newspaper articles or court judgments (americanexperiment.org/windrejectiondatabase).

Finally, this report documents the widespread resistance to the encroachment of large-scale renewable projects by landowners and local governments across rural America. It shows that the enormous amount of land required by renewable energy is already limiting the growth of wind and solar. Of course, other factors, including the incurable intermittency of renewables as well as the massive amounts of materials, including steel, concrete, copper, and rare earth elements, will limit the deployment of wind and solar. But the biggest barrier is the land-use problem. The ferocity and extent of rural land-use conflicts are showing that any attempt to convert the domestic economy to run solely on renewables is destined to fail. ■

Policy Recommendations

Respect the home-rule rights of counties and towns that don't want renewable energy projects in their jurisdictions.

Many local governments have been successful in fending off large-scale renewable projects by enacting measures that limit the height of the projects, as well as their proximity to non-participating landowners, homes, and other structures. They have also enacted noise restrictions. In response, some states are attempting to override local jurisdictions that have passed measures designed to protect local landowners from the encroachment of renewable energy projects. These local laws should be respected.

End the lavish tax incentives given to wind and solar energy: The production tax credit and investment tax credit.

Between 2010 and 2029, federal tax incentives for wind and solar will total $140.3 billion. Those subsidies are encouraging renewable energy developers to push for deployment of projects in rural areas that don't want them. Furthermore, the incentives for wind and solar are far greater, on both an absolute and energy-equivalent basis, than those given to hydrocarbons. The tax credits also distort wholesale power markets and, when combined with renewable energy mandates, result in increased electricity prices for consumers. It is time to end these giveaways.

If reducing carbon dioxide emissions is the goal, policymakers must consider the options that are scalable, affordable, and have small footprints.

There is no viable pathway toward running our economy solely on renewables. Therefore, policymakers must be considering the energy sources that are low- or no-carbon, and are affordable and scalable. That means using more natural gas and nuclear energy.

The negative health impacts of noise from wind turbines can no longer be ignored.

Numerous health studies have found that humans are sensitive to the noise produced by wind turbines. Given those findings, regulators must assure that wind projects are located far enough from homes and businesses to prevent negative health impacts. That means adopting proper setbacks and/or requiring wind energy developers to buy out nearby landowners who are affected by turbine noise.

Introduction

Every form of energy production — solar, nuclear, oil, natural gas, coal, wind, biomass, geothermal — requires real estate.

Over the past decade, environmental activists have seized on the land-use issue to block oil and gas pipelines. In 2014, nearly 400 people were arrested near the White House while protesting against the Keystone XL Pipeline.[14] Since then, the pipeline has continued to face legal opposition and in 2018, a federal judge found that the Trump administration had ignored concerns about climate change and ruled that the federal government had to do a more complete review of the project.[15]

Land-use conflicts are a key issue today and those conflicts are already proving to be the limiting factor in the growth of renewables.

In 2016, climate activists in Massachusetts blocked construction of a five-mile gas pipeline called the West Roxbury Lateral.[16] Climate activist Karenna Gore was one of 23 people who were arrested during the protest. In an op-ed in the *Boston Globe* published a few days after her arrest, Gore said that she was protesting the West Roxbury project "in order to avoid the worst effects of climate change."[17] When the defendants went to trial in March 2018, the judge on their case ruled that they could use the necessity defense. That is, that they had a moral obligation to oppose the project due to the possibility of climate change. The decision allowed the defendants to plead guilty to civil violations rather than face criminal misdemeanor charges.[18]

Also in 2016, a group of protesters temporarily blocked construction on a section of gas pipeline being built in the Hudson River Valley near Verplanck, N.Y. The protesters were opposing the Algonquin Incremental Market project, a pipeline that now transports about 340 million cubic feet of gas per day from Pennsylvania to New England. Despite the protests, the pipeline went into service in late 2016. The Algonquin Incremental Market project was one of the first projects to bring additional gas supplies to New England since 2010.[19] In 2019, a state judge found three of the protesters guilty of trespassing in Verplanck, but let them go free without imposing any punishment.[20]

PHOTO: FIBONACCI BLUE, (WIKIMEDIA.ORG)

In 2016 and early 2017, thousands of protesters gathered near Cannon Ball, N.D., to oppose the Dakota Access pipeline. Those protests got enormous amounts of media coverage, including front-page stories in the *New York Times*. More than 700 climate-change activists and others were arrested during the protest, which claimed that the pipeline, by crossing the traditional lands of the Standing Rock Sioux tribe, was violating the tribe's cultural and spiritual rights.[21]

While the protests against these hydrocarbon projects received widespread coverage in national media outlets, the growing resistance to renewable energy projects has received far less attention. But these conflicts are raging in several states, as well as in Canada and Europe. Ontario has been a hotbed of anti-wind activism. In that Canadian province, 90 towns have declared themselves "unwilling hosts" to wind projects.[22] The anti-wind backlash is also obvious across the Atlantic. In 2010, the European Platform Against Windfarms had about 400 members in 20 countries. By 2021, it had nearly quadrupled in size and counted some 1,600 member organizations in 31 countries.[23]

To be sure, land use is only one of many challenges that will face any effort to convert the economy to run solely on renewables. Large-scale deployment of wind and solar energy — as well as the massive quantities of batteries that will be needed to offset their incurable intermittency — will require gargantuan quantities of cement and steel. It will also demand massive increases in the production of elements like lithium, cobalt, and rare-earth elements like dysprosium, lanthanum, and neodymium — nearly all of which are largely controlled by China. Those limits will become more acute as more renewables are deployed. But it is readily apparent that land-use conflicts are a key issue today and that those conflicts are already limiting the growth of renewables.

Section I of this paper details the main reasons why rural landowners in the United States and other countries are objecting to renewable energy projects.

Section II discusses the vacant-land myth, the idea that there's plenty of empty, unused land in rural America that is ready and waiting to be covered with renewable energy stuff. Variations on this myth have been repeated by academics and prominent media figures to further the claim that massive amounts of renewable energy can be deployed if only the United States had the political will to make it happen. The section explains the physics of renewables and why they require so much land.

Section III details the history of the resistance to wind energy in various states, including Vermont, California, New York, and Minnesota.

Section IV delves into the regulations that are being adopted by rural communities in their effort to slow or stop large-scale wind and solar projects from being built in their regions.

Section V discusses the enormous amount of high-voltage transmission capacity that will be needed to accommodate any effort at moving the country onto renewable energy.

Section VI details the tens of billions of dollars in subsidies that are being given to the wind and solar industries. ■

◀ **PHOTO:** ON JANUARY 20, 2017, SOME 3,000 PEOPLE MARCHED THROUGH MINNEAPOLIS TO PROTEST THE INAUGURATION OF PRESIDENT DONALD TRUMP.

Section I: Why are landowners objecting?

The popular narrative about renewable energy projects, and in particular, wind and solar energy, is that they are "green." This notion stems largely from the fact that wind and solar projects do not emit carbon dioxide. But carbon dioxide emissions are only one issue among many that must be considered when evaluating the environmental impact of energy production. It can be easy for city dwellers to dismiss the opponents of these facilities as just "NIMBYs" — that is, not in my backyard. But rural landowners have plenty of reason for concern. The resistance to the encroachment of large-scale renewable projects generally focuses on several key issues: noise and health impacts, reduction of property values, wildlife mortality, and despoliation of viewsheds.

"Wind turbines can cause sickness, say public health officals."

—WHO13.com, (Des Moines, Iowa), Aug. 12, 2019

Noise and health

For more than a decade, rural landowners have been complaining about the noise produced by wind-energy projects. In 2008, a Missouri man, Charlie Porter, filed a lawsuit against a wind developer after several turbines were built near his home. He claimed the noise from the turbines was causing sleeplessness, anxiety, and dizziness.[24] (Porter later settled the lawsuit for an undisclosed amount of money. In a 2019 phone interview, he told the author of this report that the company that owned the wind project had written him a "big check" and that he was not allowed to discuss the litigation or the amount of the settlement.)

By 2010, rural residents from Texas, Maine, Pennsylvania, Oregon, New York, Minnesota, Wisconsin, Canada, New Zealand, Australia, France, and England had lodged complaints about the noise from wind turbines. The most common complaint was sleep deprivation.[25]

The wind industry's main lobbying group — The American Wind Energy Association, now known as The American Clean Power Association — has long claimed that wind turbines don't produce much noise and that vibrations from the turbines are "too weak to be detected by, or to affect, humans."[26] It has also claimed there is "no link between human health and wind turbine sound."[27] The facts show otherwise. There is plenty of evidence — both scientific and

anecdotal — that shows the audible and inaudible noise produced by the massive turbines can irritate humans, cause sleeplessness, and in some cases, make people sick.[28]

In 2009, a study by the Minnesota Department of Health found that sleeplessness and headaches are the most common complaints about wind farms from nearby residents. The report, which has received only passing mention by Minnesota media outlets, includes several conclusions that have since been corroborated by subsequent studies, including specifically, the problems of sleeplessness and headaches.[29] For that reason — and the fact that noise issues have been central to objections about wind energy siting in the state — the conclusion of the Department of Health's 2009 report deserves full quotation:

> *Wind turbines generate a broad spectrum of low-intensity noise. At typical setback distances higher frequencies are attenuated. In addition, walls and windows of homes attenuate high frequencies, but their effect on low frequencies is limited. Low frequency noise is primarily a problem that may affect some people in their homes, especially at night. It is not generally a problem for businesses, public buildings, or for people outdoors.*
>
> *The most common complaint in various studies of wind turbine effects on people is annoyance or an impact on quality of life. Sleeplessness and headache are the most common health complaints and are highly correlated (but not perfectly correlated) with annoyance complaints. Complaints are more likely when turbines are visible or when shadow flicker occurs. Most available evidence suggests that reported health effects are related to audible low-frequency noise. Complaints appear to rise with increasing outside noise levels above 35 dB. It has been hypothesized that direct activation of the vestibular and autonomic nervous system may be responsible for less common complaints, but evidence is scant.*
>
> *The Minnesota nighttime standard of 50 dB(A) not to be exceeded more than 50% of the time in a given hour, appears to underweight penetration of low frequency noise into dwellings.*[30]

Since 2009, numerous studies have documented the deleterious effect that wind-turbine noise can have on human health and well-being. In 2010, Dr. Michael Nissenbaum, a radiologist in Fort Kent, Maine, surveyed about two dozen residents who live near the Mars Hill wind project in northeastern Maine. His findings: 82 percent of the residents who were living within about 1,100 meters of the wind turbines complained of sleep disturbance. Nissenbaum also surveyed about two dozen people in a control group, all of whom lived at least 6 kilometers away from the turbines. Nissenbaum found that while 82 percent of those living close to the turbines complained about disturbed sleep, only 4 percent of the people in the control group did so.[31] In an interview, Nissenbaum told me that the wind industry is "intentionally neglecting the issue of sleep disturbance."[32]

Depriving humans of sleep can make them sick. Nissenbaum made that point during a press conference in Montpelier, Vermont, in 2010, shortly after he completed his initial survey of the residents at Mars Hill. "Annoyance leads to sleep deprivation and illness as day follows night," Nissenbaum said. The people who suffer from the noise pollution, Nissenbaum added, don't need psychological help, "they need the turbines placed further away from their home."[33] In 2012, Nissenbaum, along with two co-authors, published his findings in the journal ***Noise Health***, which concluded that "the adverse event reports of sleep disturbance and ill health by those living close to industrial wind turbines are supported."[34]

In 2011, in a peer-reviewed article in the ***Bulletin of Science, Technology & Society,*** Carl V. Phillips, a Harvard-trained Ph.D., concluded that there is "overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder type diseases, at a nontrivial rate."[35]

Alec Salt, a research scientist at the Cochlear Fluids Research Laboratory at the Washington University School of Medicine in St. Louis, has written extensively about the health effects of wind energy projects and has concluded that turbine noise "can be hazardous to human health." Salt said the wind industry has "taken the position that if you cannot hear the infrasound, then it cannot affect you...[W]e disagree strongly."[36] In a 2012 paper, Salt and a colleague at Washington University, Jeffery Lichtenhan, concluded that "the physiological effects of low-frequency sounds are more complex than is widely appreciated. Based on this knowledge, we have to be concerned that sounds that are not perceived are clearly transduced by the ear and may still affect people in ways that have yet to be fully understood." Salt and Lichtenhan concluded that infrasound and low-frequency noise can result in "localized endolymphatic hydrops," which is swelling of the inner-ear. That condition can result in dizziness and loss of equilibrium.[37] Those two symptoms are common among people who complain about the noise generated by wind turbines. It appears that low-frequency noise and infrasound affect the body's vestibular system, which aids in balance.

In 2012, Peter Narins, a professor and expert on auditory physiology at the University of California-Los Angeles, published a paper in the journal *Acoustics Today*. In the paper, Narins and his co-author, Annie Chen, a graduate student, found that wind turbines generate "substantial levels of infrasound and low-frequency sound" and therefore, "modifications and regulations to wind farm engineering plans and geographical placements are necessary to minimize community exposure and potential human health risks."[38]

Other studies, from Denmark, Iran, Germany, and Portugal, came to similar conclusions. In 2014, Danish researchers found "that noise from wind turbines increases the risk of annoyance and disturbed sleep in exposed subjects in a dose-response relationship."[39] In 2015, researchers from Iran found that noise from wind turbines "can directly impact on annoyance, sleep and health."[40] In 2017, German researchers concluded that "the construction of wind turbines close to households exerts significant negative external effects on residential well-being," and that those effects are felt by people living within about 4 kilometers of the wind projects.[41] A 2017 study by five Portuguese researchers concluded that "exposure to wind turbine sound significantly impairs individuals' well-being because it strongly affects their decision to spend, or consider spending, resources in retrofitting their houses."[42] Thus, four studies — done by researchers in four different countries — came to the same conclusion: the closer wind turbines are to homes, the more likely it is that the people living in there will have impaired well-being and disturbed sleep.

The preponderance of scientific evidence shows that wind-turbine noise may have serious health impacts on humans.

The wind industry and its allies also claim that there is a "nocebo" effect — implying that the people who are complaining are merely imagining their discomfort and the reasons for their sleeplessness. But if the nocebo effect were so strong, and noise pollution from wind turbines isn't a problem, why have so many people, in so many locations all over the globe, been complaining for so many years, about the noise problem?

In 2018, the World Health Organization issued a report that found there are "serious issues with noise exposure assessment related to wind turbines" and that there is "wide variability in the values and preferences of the population, with particularly strong negative attitudes in populations living in the vicinity of wind turbines."[43]

In 2019, the Board of Public Health in Madison County, Iowa, declared that there is "potential for negative" health effects associated with wind turbines and that "current setbacks are inadequate to protect the public health." The board recommended that all future wind turbines in the county be located 1.5 miles from homes.[44] In December 2020,

the Madison County Board of Supervisors passed an ordinance that effectively bans wind turbines. The measure prohibits installation of wind projects within 1.5 miles of non-participating landowners, limits turbine height to less than 500 feet, and imposes strict noise limits.[45]

A study by researchers at the University of Gothenburg, Sweden, that was published in April 2020, found that wind-turbine noise had a "small but significant effect on dream sleep." The study included 50 participants. About half of them had been living within 1 kilometer of one or more wind turbines for at least a year. The reference group did not live near wind turbines.

The study found that "participants spent an average of 11.1 minutes less in REM (rapid eye movement) sleep, which they entered 16.8 minutes later than during the quiet night. The proportion of time they spent in REM sleep was 18.8% for the night with WTN, compared with 20.6% for the quiet night."[46] The study also found that amplitude modulation, the rhythmic change in noise levels that corresponds to the rotational frequency of turbine blades, was strongest during the night when the atmospheric conditions are "favorable for the propagation of low-frequency noise, such as that emitted by wind turbines." It noted that "a larger number of dwellings could therefore be exposed to wind turbine noise at sound pressure levels relevant for disturbance. Combined with lower nocturnal anthropogenic noise, and lower ambient noise levels due to more stable meteorological conditions, there could be increased audability of wind turbine noise and amplitude modulation at nearby dwellings during the night." In the study's conclusions, it noted that despite relatively low sound-pressure levels, "continuous environmental noise with amplitude modulation may impact sleep."[47]

In summary, there is plenty of evidence that shows wind turbine noise can have serious health impacts on humans. Further, the potential negative health impacts of turbine noise have been known to regulators and policymakers in Minnesota and other states for more than a decade and yet little to no action has been taken to assure the health and safety of the public from this noise pollution.

"Wind turbines hurt property prices, study finds."

—Clean Energy Wire, Jan. 21, 2019

Property values

In 2010, Michael McCann, a Chicago-based real estate appraiser, submitted testimony to members of the county board in Adams County, Ill., which concluded that "residential property values are adversely and measurably impacted by close proximity of industrial-scale wind energy turbines." He continued, "Real estate sale data typically reveals a range of 25 percent to approximately 40 percent of value loss, with some instances of total loss as measured by abandonment and demolition of homes, some bought out by wind energy developers and others exhibiting nearly complete loss of marketability."[48]

In 2013, landowners in the town of Georgia, Vt., contested their property valuation after a wind project was built near their homes. In at least one case, the local taxing authority agreed to reduce the property value from $400,000 to $350,000, or 12.5 percent, because of the noise and visual intrusion of the wind project.[49]

A 2014 study by the London School of Economics looked at more than 1 million sales of properties located close to wind projects over a 12-year period and found that houses located within 1.2 miles of large wind projects saw their values reduced by about 11 percent. The study, by Steve Gibbons, the director of the London School of Economics' Spatial Economics Research Centre, included 150 wind projects in England and Wales. Gibbons summed up the study by saying that "property prices are going up in places" where wind projects are not visible, "and down in the places where they are."[50]

In 2016, two researchers from Aachen University in Germany published a study in the journal ***Energy Economics***, which found that "the asking price for properties whose view was strongly affected by the construction of wind turbines decreased by about 9

to 14 percent. In contrast, properties with a minor or marginal view on the wind turbines experienced no devaluation."[51]

In 2019, a study by the German think tank RWI found that the value of a single-family home "falls by an average of 7 percent when a wind turbine begins operation within 1 kilometer of the property."[52] RWI's analysis was based on the asking prices on more than 2.7 million houses that were posted on the site of Germany's leading online real-estate broker between 2007 and 2015. The drop in property value disappears on homes that are 8 kilometers or more away from the wind turbines. RWI attributed the value reductions to potential noise pollution from the turbines as well as their deleterious aesthetic effect on the countryside. RWI researcher Manuel Frondel said that "wind power may be important for the success of the energy transition but the implications for property owners can be severe in some cases."[53]

In 2019, about 100 residents of Chautauqua County, N.Y., filed a lawsuit against the owners of the recently completed Arkwright Summit Wind Farm. The plaintiffs are claiming that noise from the 78-megawatt facility, which is owned by the Portuguese company EDP Renewables, is disturbing their sleep. They are also claiming it has reduced the value of their homes.[54] The lawsuit claims that the landowners who live near the wind project "who attempt to sell their homes and move away...are often unable to do so because the value of land near turbines plummets."

Other New York residents have also sued because of reduced property values due to the proximity of wind projects. In 2012, about 60 residents of New York's Herkimer County — all of whom lived within a mile of the $200 million Hardscrabble Wind Power Project — sued Iberdrola and a group of other companies because of the noise and disruption caused by the wind project. The plaintiffs contended the companies "failed to adequately assess the effect that the wind turbines would have on neighboring properties including but not limited to, noise creation, significant loss of use and enjoyment of property...diminished property values, destruction of scenic countryside, various forms of trespass and nuisance to neighboring properties, and health concerns, among other effects."[55]

In 2019, a Nebraska man, Kevin Kohmetscher, filed a class action lawsuit against NextEra Energy after the company built a 40-turbine wind project that surrounds his 11-acre property on three sides. The closest turbine was built 1,300 feet from his property line. As reported by the ***Lincoln Journal-Star***, the suit says that since the NextEra project began operating, "Kohmetscher has experienced stress, anxiety, an inability to sleep, headaches, nausea and other physical symptoms, which he says are caused by shadow flicker, noise and other negative effects of the wind turbines." The suit also claims that the wind project has decreased the value of his property and he "will be unable to lease or sell his property for its fair market value prior to installation of the turbines."[56]

Wildlife conservation

The proliferation of wind energy is having a deadly impact on bats and birds and those impacts are being cited by opponents to slow or stop the deployment of wind energy.

A widely cited study published in 2013 by biologist K. Shawn Smallwood estimated that U.S. wind turbines were killing about 888,000 bats and 573,000 birds per year. The bird kills include some 83,000 raptors.[57] That same year, raptor biologists at the U.S. Fish and Wildlife Service published a paper that found the number of eagles being killed annually by wind turbines had increased dramatically, going from two in 2007 to 24 in 2011. During that period, wind turbines killed 85 eagles, including six bald eagles. That figure, according to Joel Pagel, the report's lead author, was "an absolute minimum."[58] In 2007, the U.S. had about 17 gigawatts of installed capacity. By 2011, that figure nearly tripled to about 47 gigawatts.[59] Over that period, the number of documented eagle kills increased by a factor of 12. Killing bald and golden eagles is a federal crime.

Pagel's 2013 study on eagle mortality caused by wind turbines was published a few months after the Fish and Wildlife Service issued a report that

concludes "there are no conservation measures that have been scientifically shown to reduce eagle disturbance and blade-strike mortality at wind projects."[60]

In 2018, ecologists from the Indian Institute of Science in Bangalore studied the effect of wind turbines on wildlife in India's Western Ghats, where wind projects have been operating for two decades. They found that wind projects can act like apex predators. "By reducing the activity of predatory birds in the area, wind turbines effectively create a predation-free environment that causes a cascade of effects on the lower trophic level," it said.[61] The researchers found almost four times as many birds of prey in areas without wind turbines. They also found that areas near the wind projects had far more lizards than those without wind turbines. The study concluded that wind projects have "complex ecological consequences" and that they "have emerging impacts that are greatly underestimated."[62]

"Wind farms can act like apex predators in ecosystems, study finds."

—Yale Environment 360, Nov. 5, 2018

A 2019 study published in ***Science*** found a drastic decline in North American avifauna over the past few decades. Led by Ken Rosenberg of the Cornell Lab of Ornithology, the study evaluated 529 species of birds in the continental U.S. and Canada. It found a "net loss approaching 3 billion birds, or 29% of 1970 abundance." It concluded with this warning: "Our results signal an urgent need to address the ongoing threats of habitat loss, agricultural intensification, coastal disturbance, and ***direct anthropogenic mortality***, (emphasis added) all exacerbated by climate change, to avert continued biodiversity loss and potential collapse of the continental avifauna."[63] Although the Cornell study does not mention wind turbines, the studies by Smallwood, Pagel, and the ecologists at the Indian Institute of Science clearly show that turbines are having a significant and deadly impact on bird populations.

In 2019, opponents of an offshore wind project proposed for Lake Erie filed suit in federal court against the Department of Energy and the U.S. Army Corps of Engineers, claiming that they had failed to comply with the National Environmental Policy Act and Clean Water Act in their evaluation of the Icebreaker Wind project. By ignoring the federal statutes, the plaintiff, the American Bird Conservancy, contends that the agencies are putting numerous bird species at risk. The groups said that the proposed project will "pose substantial collision risks to the enormous numbers of birds that use the area throughout the year, including large concentrations of migrating songbirds" and waterfowl.[64]

Bats are not as popular as birds. But they are essential pollinators and insectivores. In Texas alone, economists have estimated that bats save the state more than $1 billion annually by reducing the need for pesticides.[65]

Several studies have found that the wind industry is having a serious impact on bat populations. In 2015, Merlin Tuttle, one of the world's foremost experts on bats, expressed concern about the effect that wind energy deployment is having on the only flying mammals. Tuttle said, "Anyone familiar with bat population biology is deeply concerned about the impact of wind turbines on the long term viability of a number of bat species." Tuttle, who founded Bat Conservation International, reiterated the point about bats' slow reproductive rates. "We are at great risk of needlessly creating new endangered species," he told me. "We risk losing the benefits of bats to natural systems and agriculture."[66]

In 2016, two scientists from the U.S. Geological Survey, Thomas O'Shea and Paul M. Cryan, published a paper which said that wind turbines were the largest cause of mass bat mortality, and exceed the toll taken by white-nose syndrome, a fungal disease that afflicts bats.[67] In a discussion of the paper, Cryan said that the wind industry's toll on bat populations could have long-term negative effects. "Bats are long-lived and very slow reproducers," he said. "Their populations rely on very high adult survival rates. That means their populations recover from big losses very slowly."[68]

The adverse effect of wind turbines on bat

AMERICAN BALD EAGLES PERCHED IN THE ALASKAN KENAI MOUNTAINS

populations was further confirmed in 2016, when Bird Studies Canada, a conservation group, released a report on wind energy. According to the study, "across Canada, bat fatalities were reported more often than birds, accounting for 75 percent of all carcasses found." The report found that wind turbines in Ontario alone killed about 42,656 bats between May 1 and Oct. 31, 2015, and each wind turbine had killed about 18 bats over that time frame.[69] The bat fatalities in Ontario included several species of rare or endangered bats, such as the little brown bat and northern long-eared bat. The report also found that wind turbines in the province killed 462 raptors over that same six-month period.[70]

In March 2020, K. Shawn Smallwood — whose work on bird mortality was cited above — published a paper that updated his earlier estimates of bat mortality due to wind turbines. Using a new methodology, Smallwood found that wind turbines may have caused "2.22 million bat fatalities across the USA in 2014." He went on to point out that the U.S. now has more than 100,000 megawatts of wind capacity "and bat fatalities likely increased proportionally with this increase in capacity, so long as the pool of vulnerable bats has not diminished. The decline of hoary bats in the Pacific Northwest suggests that the pool of vulnerable bats might be diminishing. It is imperative, therefore, that methods of fatality monitoring improve to more accurately estimate bat fatalities."[71]

Wind-energy promoters have repeatedly attempted to downplay the death toll on avifauna by saying that buildings and cats also kill birds. That may be true. But house cats are not killing golden eagles, bald eagles, and other iconic birds — wind turbines are. Many of those same promoters claim that climate change is a bigger long-term threat to wildlife than are wind turbines. That may or may not be so. But allowing the immediate destruction of wildlife so that they might be saved from future

climate change makes no sense at all.

Viewsheds

Rural residents are objecting to wind projects because they don't want to see the red-blinking lights atop those 50 or 60-story wind turbines, all night, every night, for the rest of their lives. They are also concerned about the issue of shadow flicker, which occurs when the turbine blades reflect or obscure sunlight on nearby homes. Numerous residents have complained about shadow flicker, which causes a strobe-like effect on the sunlight that hits their homes, and how that effect diminishes their enjoyment of their property.[72]

Regulators in Europe have rejected several wind projects due to concerns about viewsheds. In 2015, the British government refused a permit for the 968-megawatt Navitus Bay offshore wind project which was planned to be built in the English Channel near the Isle of Wight.[73] Among the reasons given for rejecting the project, which would have utilized 121 turbines, were its "seascape, landscape and visual impact."[74]

"L.A. County supervisors to ban large wind turbines in unincorporated areas."

—Los Angeles Daily News, July 14, 2015

In Scotland, numerous wind projects have been rejected by planning authorities due to local opposition. In 2015, after several wind projects were rejected, Fergus Ewing, Scotland's minister for business, energy, and tourism, said the plans had been rejected due to "unacceptable landscape and visual impacts in the local areas and these are not outweighed by any wider policy benefit."[75] In 2016, a proposed wind project near Scotland's famous Loch Ness was rejected by local authorities because of its potential impact on tourism.[76]

Similar concerns about viewsheds are being expressed here in the United States. In 2015, the Los Angeles County Board of Supervisors voted unanimously in favor of an ordinance banning large wind turbines in the county's unincorporated areas.[77] (One of the board members was Hilda Solis, who served as U.S. secretary of labor in the Obama administration.[78]) During a hearing on the measure, then-supervisor Michael D. Antonovich said "wind turbines create visual blight." He also said the skyscraper-sized turbines would "contradict the county's rural dark skies ordinance which aims to limit light pollution in areas like Antelope Valley and the Santa Monica Mountains."[79]

That wind turbines are a blight on the landscape — both day and night — is indisputable. And there's no small bit of irony that Los Angeles County politicos banned them in 2015 at about the same time state legislators in Sacramento were passing a law requiring the state's electric utilities to get 50 percent of their power from renewables by 2030.[80]

In 2015, residents of Henderson, N.Y., objected to a proposed wind project that aimed to put a 108-megawatt wind project on Galloo Island in Lake Ontario.[81] The project, proposed by Apex Clean Energy, was snared in controversy because in documents the company filed with the state of New York, it neglected to report that bald eagles have been nesting on Galloo Island.[82] That omission caused an uproar and in early 2019, Apex withdrew its application for the Galloo project.[83] Similar concerns about viewsheds were lodged against a proposed 200-megawatt project called Lighthouse Wind, which aimed to put dozens of turbines on the shores of Lake Ontario. The project was opposed by three upstate counties — Erie, Orleans, and Niagara — as well as the towns of Yates and Somerset.[84] In April 2019, Apex Clean Energy announced it was suspending work on the Lighthouse Wind project.[85]

Wind energy promoters have acknowledged the visual impact of the turbines. In 2018, Anne Reynolds, the executive director of the pro-renewable lobby group Alliance for Clean Energy New York, said, "I personally think the arguments against wind energy are because people don't want to see the turbines."[86] ■

Section II: The vacant land myth and the power density problem

Among the most-enduring claims about wind and solar deployment is that there is plenty of unused, uncared-for land out in flyover country that's ready and waiting to be covered with forests of renewable energy stuff.

This "vacant-land" myth has been around for two centuries. An online history of South Africa notes that the "myths of empty and vacant land were common currency by the mid-1840s," and that the myth was "propagated by European settlers in 19th-century South Africa to support their claims to land" in that country. British settlers claimed that much of the territory they took "had been 'vacant' land at the time of colonization and therefore the British had a right to claim it." The same claims were made during the apartheid era when the government justified the "incredibly unequal distribution of land by claiming that the land in White hands was historically 'empty land', land that had belonged to nobody and therefore could not form part of a homeland."[87]

In 1905, the artist Frederic Remington, who gained renown for his paintings and sculpture of the American West, wrote that he was motivated to visit the western states because "I knew the wild riders and the vacant land were about to vanish forever, and the more I consider the subject, the bigger the forever loomed."[88]

"Renewable energy sources can take up to 1,000 times more space than fossil fuels."

—Phys.org, Aug. 28, 2018

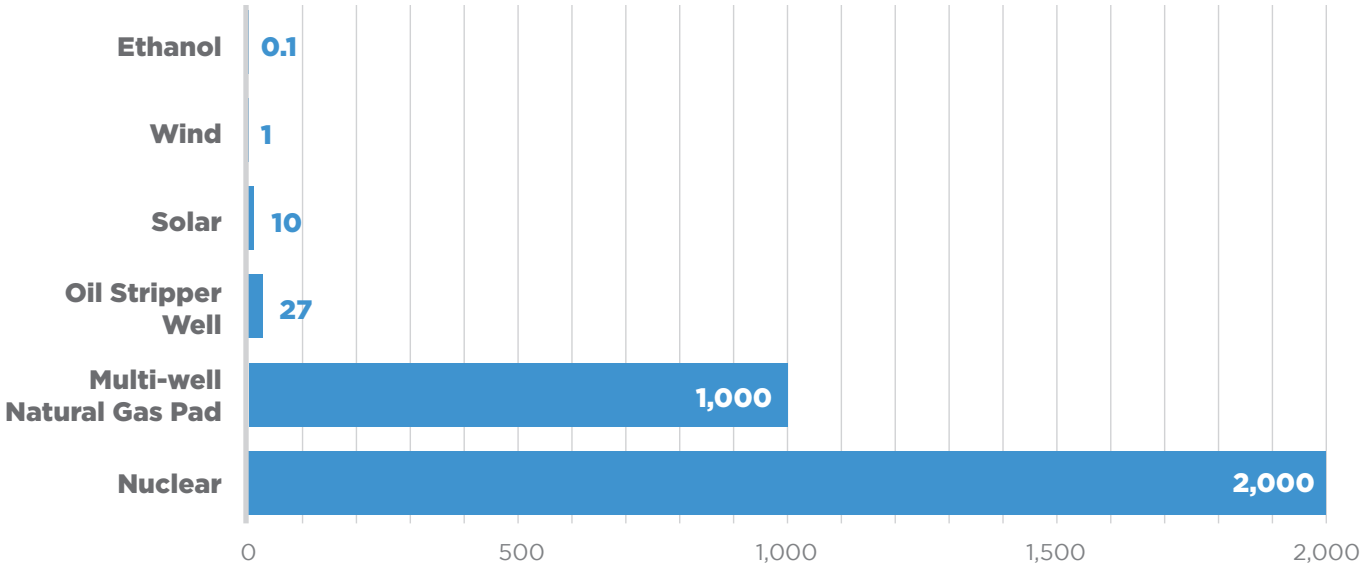
Leading climate activists and academics have repeatedly downplayed or simply ignored the vast amount of land that would be needed to achieve large-scale wind and solar deployment. In 2016, Bill McKibben, the founder of 350.org and one of America's highest-profile climate activists, wrote a cover story for *The New Republic* in which he lauded the work of Stanford University engineering professor Mark Jacobson, who has claimed that the U.S. could convert its entire economy to run solely on wind, solar, and hydropower. In his article, McKibben repeated Jacobson's claim that converting the U.S. to an all-renewable system would only "need about four-tenths of one percent of America's landmass."[89]

But a 2017 analysis of Jacobson's work that was published in the *Proceedings of the National Academy of Sciences* found that the Stanford professor's scheme had understated the amount of land needed *by a factor of 15.* The analysis found that it would

FIGURE 2

Power Density of Various Energy Sources

Power density in watts per square meter (W/m^2)



SOURCES: ENTERGY, LEIDEN UNIVERSITY, BUREAU OF ECONOMIC GEOLOGY, UNIVERSITY OF TEXAS; MILLER AND KEITH, AUTHOR CALCULATIONS

require "nearly 500,000 square kilometers, which is roughly 6 percent of the continental United States and more than 1,500 square meters of land for wind turbines for each American."[90]

A study on renewable energy published in June 2020 by the Goldman School of Public Policy at the University of California at Berkeley, also claimed that the U.S. could completely overhaul its electric grid and do so in short order. Called the "2035 Report" the study claims to provide "a pathway to 90 percent clean electricity in the U.S. by 2035." The report said that "plummeting costs for wind and solar energy have dramatically changed the prospects for rapid, cost-effective expansion of renewable energy" and that battery storage has "become a viable option for cost-effectively" integrating wind and solar into electricity grids. It estimated that for the U.S. to have 90 percent "clean electricity" by 2035, it would need to add about 1,100 gigawatts of new renewable capacity, including 600 gigawatts of wind and about 500 gigawatts of solar capacity.[91] For reference, that amount of capacity, 1.1 terawatts, is roughly equal to the existing installed base of electricity generation, of all types, in the U.S.[92]

The report by the Goldman School makes only passing mention of land use, calling it "an important area for future work," and noted that a discussion of land use could be found in an appendix to the report.[93] But the appendix containing the land-use calculations was not published along with the original report. About three weeks after the original paper was published, the appendix including the land-use information was finally published and the discussion allotted to land use amounted to three paragraphs. The study's authors said that installing the required amount of solar and wind capacity would be "only 0.4% of the area of the continental U.S."[94] The appendix did not mention a single instance of land-use conflicts in California or anywhere else.

A document supporting the Berkeley paper was

published at about the same time by San Francisco-based consulting firm Energy Innovation, which said that wind and solar plants "require significant but manageable land area." It claimed that the amount of land needed for all of the wind and solar capacity amounted to about 28,200 square kilometers, which was "about triple the amount of land currently devoted to golf courses, and equivalent to about half of the land owned by the Department of Defense." It went on to say that "Efforts to engage with private landowners are crucial."[95] The document made no mention of any land-use conflicts in the United States.

Although many academics have minimized the land-use needs of renewables, the problem is fundamentally about physics and the metric of power density, which is a measure of energy flow that can be produced from a given piece of land. As shown in Figure 2, nuclear energy is the most environmentally friendly form of power generation because it requires the least amount of land. The Indian Point Energy Center in Buchanan, N.Y., which is now slated for closure by April 2021, occupies one square kilometer on the banks of the Hudson River. The facility has two reactors that can produce more than 2,000 megawatts of power. Simple math shows that the power density of the Indian Point Energy Center is roughly 2,000 watts per square meter.[96] Natural gas production from modern shale-drilling operations has a power density of about 1,000 watts per square meter.[97] Corn ethanol production, which relies on photosynthesis, has the worst power density: roughly 0.1 watt per square meter.

In 2018, Lee Miller, a postdoctoral fellow at Harvard University, and David Keith, a physics professor at Harvard, published a paper in the journal ***Environmental Research Letters***. They found that the power density of wind energy is about 1 watt per square meter.[98] They also found that solar energy can generate about 10 watts per square meter.[99]

Meeting present-day U.S. electricity consumption, for example, would require 12 percent of the continental U.S. land area for wind.

As Miller explained it to the ***Harvard Gazette***, he and Keith "found that the average power density — meaning the rate of energy generation divided by the encompassing area of the wind plant — was up to 100 times lower than estimates by some leading energy experts." The problem, Miller said, is that most estimates of wind energy's potential ignore "wind shadow" — that is how air flows through a given turbine disrupts the air flowing to turbines downwind of it.[100] The two also found "that while improved wind turbine design and siting have increased capacity factors (and greatly reduced costs) they have not altered power densities." In other words, even as wind turbines have gotten larger — the latest models stand about 800 feet (244 meters) tall — the wind industry has not been able to wring more electric energy out of the kinetic energy of the wind.[101]

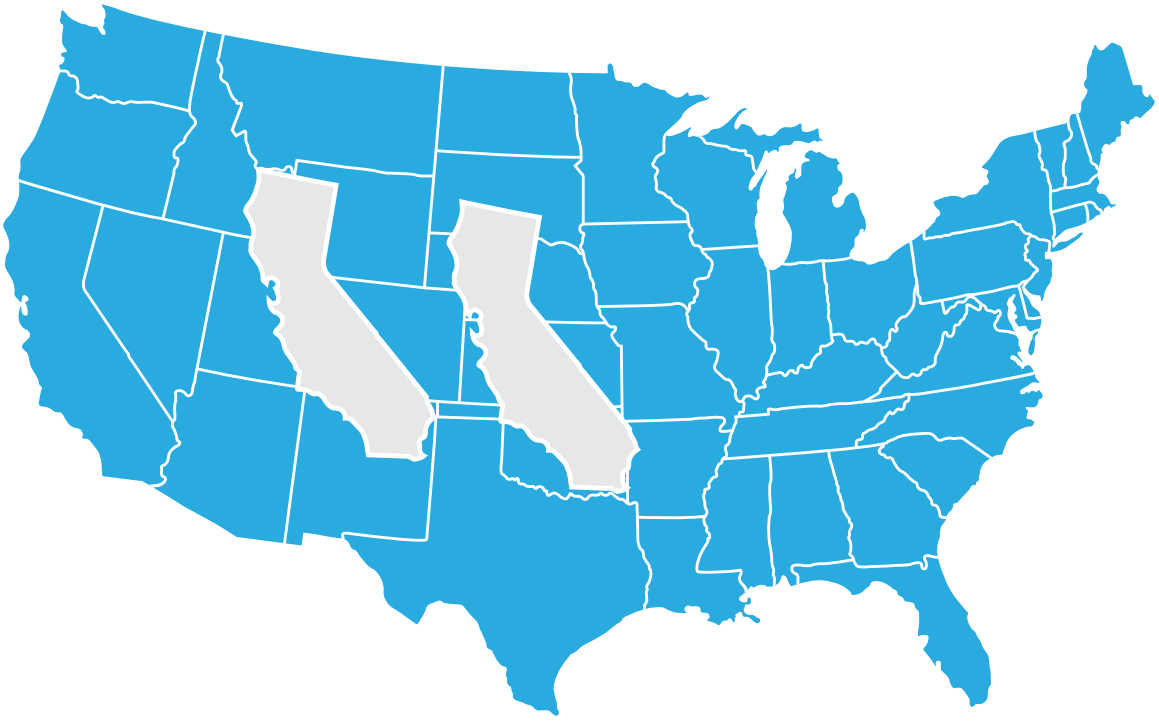
Miller and Keith determined that "meeting present-day U.S. electricity consumption, for example, would require 12 percent of the continental U.S. land area for wind." A bit of math reveals what that 12 percent figure means. The land area of the continental U.S. is about 2.9 million square miles, or 7.6 million square kilometers.[102] Twelve percent of that area would be about 350,000 square miles or 912,000 square kilometers. Therefore, merely meeting America's current electricity needs with wind energy would require a territory more than two times the size of California.

Miller and Keith's 2018 calculations are almost identical to those done by Vaclav Smil, an author, energy analyst, and professor emeritus at the University of Manitoba. In his 2010 book, ***Energy Myths and Realities: Bringing Science to the Energy Policy Debate***, Smil found that "relying on large wind turbines to supply all U.S. electricity demand," would "require installing about 1.8 terawatts of new generating capacity." Accommodating that much wind capacity, Smil explained, "would require 900,000 square kilometers of land — nearly a tenth

FIGURE 3

Two Californias

The land necessary to meet America's current electricity needs with wind energy



SOURCE: AUTHOR CALCULATIONS

of the country's land, or roughly the area of Texas and Kansas combined."[103]

Solar energy has 10 times the power density of wind. Thus, assuming that 900,000 square kilometers of wind turbines would be needed to provide enough electricity to meet domestic needs, it can be further assumed that roughly 90,000 square kilometers of territory would be needed to accomplish the same with solar panels. But even at that size, those panels would still cover a land area nearly as large as Maine. That's a far smaller land area than two Californias, but even assuming that land area is available, the best solar resources are located far from population centers, meaning the U.S. would have to build tens of thousands of miles of new transmission lines. Furthermore, solar energy is not practical in northern locations due to the lack of sun during the winter months, which means that states like Alaska and Maine would either need massive batteries or be connected via long transmission lines to southern states. ■

Section III: The backlash: From Maine to Hawaii (with Minnesota and Iowa in between)

Mandates and targets at the state level are a key driver of the growth in renewables. According to the Lawrence Berkeley National Laboratory, about half of "all the growth in U.S. renewable electricity generation and capacity since 2000" is due to state-level requirements and state mandates that "will require roughly a 50% increase" in domestic renewable electricity generation by 2030.[104] Iowa was the first state to establish a renewable portfolio standard, which requires utilities to obtain a specified percentage of the electricity they sell from renewable sources. About 30 states, as well as the District of Columbia, and three territories have adopted renewable portfolio standards. Hawaii has mandated that its utilities be selling 100 percent renewable electricity by 2045.[105]

"Freedom passes wind turbine ordinance. Town that triggered wave of wind energy regulation gets rule of its own."

—Waldo.VillageSoup.com, (Waldo County, Maine), Nov. 24, 2015

While these mandates are politically popular, they have helped spawn conflicts over project siting and zoning authority. That conflict can be seen in the numbers. Since 2015, nearly 300 government entities in dozens of states have passed measures restricting or rejecting the encroachment of wind energy projects. (A complete list of those restrictions and rejections can be found americanexperiment.org/windrejectiondatabase.)

Solar projects are also facing increased friction. In 2019, the town of Duanesburg, N.Y., imposed a six-month moratorium on new solar projects.[106] Also in 2019, Maryland regulators denied a permit for a solar-energy project proposed for rural Charles County. The project, which was backed by Georgetown University, would have required clear-cutting some 210 acres of trees in a region that has been deemed an "important bird area," meaning it is a rare remnant of large contiguous forest land.[107]

While solar projects are facing more opposition, this report focuses on wind energy for a simple reason: The U.S. derives about three times more energy from wind than it does from solar and the conflicts over wind-energy projects are far more widespread.[108] This section highlights a few of the more notable conflicts and puts particular focus on the ongoing battles in Minnesota.

Maine: In 2010, five people, including some members from the environmental group Earth First! were arrested near Lincoln, Maine, after they blocked a road leading to a construction site for a 60-megawatt wind project on Rollins Mountain. According to the *Portland Press Herald*, one of the protesters carried a sign which read, "Stop the rape of rural Maine."[109]

In 2015, the town of Freedom passed an ordinance that requires "setbacks of 13 times the turbine height for three larger classes of windmills, which translates to close to a mile for a 400-foot industrial wind turbine." The measure passed by a town vote of 32 to 6.[110]

Vermont: The home state of Sen. Bernie Sanders has a mandate that requires the state to be getting 75 percent of its electricity from renewables by 2032.[111] But rural Vermonters have been resisting the encroachment of wind energy projects for years. In 2015, residents of Irasburg (population: 1,077) held a town meeting on a proposed 5-megawatt wind project that was to be built just west of the village.[112] The meeting concluded with a vote. The tally: 274 against and just 9 in favor.[113]

In early 2020, the backers of Dairy Air Wind, the only remaining wind-energy project being developed in Vermont, announced they were pulling the plug on the single-turbine facility, which had been seeking a permit from the state since 2016.[114] In a press release, David Blittersdorf, the CEO of AllEarth Renewables, the company pushing Dairy Air, said his company was giving up on the project because of a "political environment that is hostile to wind energy." He added that in 2012, more than a dozen wind projects were being developed in the state. "Now there are none. This is truly a sad state of affairs for Vermont."[115] On March 24, 2020, the Vermont Public Utilities Commission issued a formal rejection of the Dairy Air project.[116]

North Dakota: In 2016, at the same time that thousands of protesters were gathered near Cannon Ball to oppose the Dakota Access pipeline, Billings County officials rejected a proposed 383-megawatt wind energy project that was to cover some 25,000 acres of land in the county. Chief among the county's concerns was the project's visual impact, including the fact that some of the turbines would have been visible from inside Theodore Roosevelt National Park, a local tourist attraction. During the meeting, Commissioner Jim Arthaud announced that he would vote against the wind project, saying there were "too many impacts to our county and to our citizens in different uses of our economy from ridgeline, to tourism, to being able to see it at the Painted Canyon, to the neighbors that are directly affected by it... I just think the magnitude of this project in our county, the visual impacts it will have on western North Dakota is just more than the county can bear."[117]

Indiana: In 2018, seven communities in Henry County passed resolutions establishing a four-mile buffer zone around their towns. In an article published on Nov. 1, 2018, and titled "County Towns Putting Up Walls Against Wind," Darrel Radford, a reporter for the *New Castle Courier-Times*, wrote that "there's still lots of anti-turbine activity" in the county and that "as many as half" of the incorporated communities in Henry County had passed anti-wind measures.[118]

Pennsylvania: In 2018, the zoning board in Penn Forest Township denied an application by a company called Atlantic Wind that wanted to build more than two dozen turbines on property owned by the Bethlehem Water Authority. A member of the zoning board, Paul Fogal, told a local news outlet, "We just don't feel it is right for the township."[119]

SUING FOR WIND ENERGY

In some parts of the country, the wind industry is so unpopular that it has resorted to litigation as part of an effort to intimidate cash-strapped rural governments into allowing it to build projects.

In 2016, Florida-based NextEra Energy filed a state lawsuit against officials in Clinton County, Mo., after that county passed a ban on wind turbines.[120]

In Indiana, NextEra filed a state lawsuit after officials in Rush County denied a permit for a 22-turbine project the company wanted to build.[121]

In 2017, NextEra Energy filed lawsuits in both state and federal court against the town of Hinton, Okla., population: 3,200. NextEra, the world's biggest wind-energy producer, sued Hinton shortly after town officials approved an ordinance which deemed wind turbines "a public nuisance" and prohibited their installation within two miles of the town's borders.

A few weeks after the company sued Hinton, it also filed suit against two small governments in Michigan — Ellington Township and Almer Township — both of which were opposed to Tuscola III, a 118-megawatt project that aimed to put 55 wind turbines across thousands of acres of rural Tuscola County.

New York: State regulators have mandated that utilities obtain 70 percent of the electricity they sell from renewables by 2030 and to sell 100 percent "clean" electricity a decade later.[122] But opposition to renewable energy projects in rural New York has been so widespread that the state wants to strip local governments of their zoning authority. If the state prevails in this dispute, local governments in New York will not be allowed to enforce regulations regarding noise or setbacks from energy-related infrastructure. That could force local communities to accept wind and solar projects that they do not want. In response to the state's effort, several communities, including Cambria, Yates, and Somerset, passed resolutions declaring themselves "sanctuary towns" against the encroachment of large-scale renewable projects.[123] Niagara and Orleans counties passed similar resolutions.[124]

In mid-2020, the New York State Siting Board, in a unanimous 5-0 decision, voted to approve a proposed 340-megawatt wind project known as Alle-Catt. All five board members were appointed by New York Gov. Andrew Cuomo. The project was opposed by the local towns of Freedom and Farmersville, as well as a local community of conservative Amish known as the Swartzentruber. If the wind project is built, the majority of the turbines will be installed in Allegany and Cattaraugus counties, which are among the poorest counties in New York. Of the 62 counties in New York, the two rank 59th and 58th respectively, in median household income.[125]

California: In 2018, California passed a law that requires the state to obtain at least 60 percent of its electricity from renewables by 2030 and all of its electricity from carbon-free sources by 2045.[126] But achieving those goals will be difficult. In 2019, San Bernadino County, the largest county by land area in the country, passed a measure that effectively bans large renewable energy projects.[127] The regulations prohibit new renewable energy projects if more than half of the energy they will produce is to be exported out of the county. San Bernadino County is home to two of the world's biggest thermal-solar projects, including Ivanpah and Abengoa Mojave.[128]

Building new projects in California is so difficult that the wind industry has nearly given up trying to site any new turbines in the state.[129] In December 2019, the Humboldt County Board of Supervisors rejected plans for a large wind project proposed to be built near the town of Scotia.[130] In March 2020, the Santa Barbara County Board of Supervisors rejected plans that called for 29 wind turbines to be built near the town of Lompoc.[131] The result is a standstill in new wind capacity. Between 2013 and 2020, California added just 86 megawatts of new wind generation capacity.[132]

Minnesota: The Land of 10,000 Lakes has been a popular destination for the wind industry. By mid-2020, the state had more than 4,000 megawatts of installed wind-generation capacity, and the wind industry employed between 2,000 and 3,000 Minnesotans.[133] By 2025, utilities in the state are required to be producing 25 percent of the electricity they sell from renewables and Gov. Tim Walz has proposed the "One Minnesota Path to Clean Energy," which would require the state to be getting all of its electricity from zero-carbon sources by 2050. But the state has also seen fierce opposition from rural residents who are fighting the encroachment of large-scale wind projects.

Meeting present-day U.S. electricity consumption, for example, would require 12 percent of the continental U.S. land area for wind.

In 2010, Dallas-based energy mogul T. Boone Pickens announced plans to build a 50-turbine wind project in Goodhue County. But residents of the county organized to oppose the project and showed that the proposed location near the Mississippi River would have deleterious impacts on bats, eagles and other birds. In 2012, Pickens gave up on the project.[134]

Noise complaints against wind projects have been common in Minnesota. In 2016, the Minnesota Department of Commerce found that noise complaints that had been lodged against the 200-megawatt Bent Tree Wind Farm in Freeborn County were "unresolved and substantial" and may have violated the conditions of the project's permit. A state-sponsored study done on the 122-turbine wind project found that it had repeatedly exceeded state noise standards.[135] In 2017, Freeborn County resident Dave Langrud told the *Minneapolis Star Tribune* that 10 wind turbines had been built within three-quarters of a mile of his home and the closest one was just 1,150 feet away. "We can hear them inside our house — whoosh, whoosh, whoosh. It's hard to fall asleep and you don't get a restful sleep," Langrud said. "When I go out of town, I start catching up on my sleep." Langrud, like many other people who have had turbines built near their homes, said he often got dull headaches due to the noise. Furthermore, his property — including the interior of his house — was affected by shadow flicker, the stroboscopic effect caused by shadows of the rotating turbine blades. "It drives you nuts," Langrud said.[136]

In 2018, Wisconsin Power and Light, the owner of the Bent Tree project, purchased Langrud's home. The company also bought the home belonging to Bernie and Cheryl Hagen, who, like Langrud, had complained for years about the noise coming from the Bent Tree wind project. The terms of the buyout were confidential.

Nearly all of the wind projects in Minnesota are located in counties that are poorer than the statewide average. Freeborn County is among the poorest in the state. According to the U.S. Census Bureau, the median household income in Freeborn County is $52,447, which is about 23% below the Minnesota state average of $68,411.

The county is being targeted for another wind project. Xcel Energy wants to build the 200-megawatt Freeborn Wind Farm, with about 42 turbines slated to be installed in Freeborn County and the rest in Worth County, Iowa.[137] But some 80 percent of the residents in Freeborn County who live in the area to be covered with turbines, have signed a

petition opposing the wind project.[138]

First proposed in 2014, the project has encountered several regulatory challenges. In June 2018, an administrative law judge submitted a recommendation to the Minnesota Public Utilities Commission that the project be denied a permit because the developer could not show that it would meet noise standards set by the Minnesota Pollution Control Agency.[139] Despite the recommendation, the Minnesota Public Utilities Commission upheld the permit. In 2019, the Freeborn County Board of Commissioners voted 4-1 to approve the project.[140] In June 2020, the Association of Freeborn County Landowners (AFCL) sued the Minnesota Public Utilities Commission claiming the permit for the wind project was issued in violation of the Minnesota Environmental Policy Act and some parts of the Power Plant Siting Act.[141]

Faced with resistance to its wind projects in Minnesota, utilities in the state are doing what New York and California are doing: They are getting power from renewable energy projects in other states to help meet their mandates. Most of Minnesota Power's wind energy production comes from North Dakota, where it owns and operates the 496-megawatt Bison Wind Energy Center. The utility also purchases wind energy from the 98-megawatt Oliver County I and II wind projects. Otter Tail Power gets some of its electricity from a 150-megawatt wind project near Edgeley, N.D.[142] Great River Energy is buying electricity from a 100-megawatt wind project in Osceola County, Iowa. It also gets wind energy from the 200-megawatt Emmons-Logan wind project and some 51 megawatts from the Ashtabula II wind project, both of which are in North Dakota.[143]

Xcel Energy, Minnesota's largest utility, has pledged to be producing 80 percent of its electricity from zero-carbon sources by 2030 and to be completely carbon-free by 2050. To do that, it is betting big on the Dakotas. The company is developing some 900 megawatts of wind capacity in South Dakota and 250 megawatts in North Dakota.[144] ■

Section IV: How rural communities are fighting back

Local communities have used various methods to prevent the encroachment of large renewable energy projects. In Minnesota, anti-wind activists have been using a creative solution to block wind projects: They are buying wind rights. In 2016, Minnesota passed a law that made land rights and wind rights distinct and separable.[145] That allowed wind rights to be traded or sold without owning title to the property itself. (Mineral rights in the U.S. have long been traded separately from surface rights.)

In 2017, a group of Minnesotans created a conservation holding company called Wind Locked LLC, which allows members to assign the rights to wind development on their property to the LLC.[146] Landowners who want to block wind projects near their property pay a fee of $2 per acre to Wind Locked, which then assumes control over their wind rights, which are similar to easements. The easements stay in effect for seven years and are automatically renewed for another seven years until the landowner decides to terminate the agreement. The concept behind Wind Locked is straightforward: By pooling the wind rights on a large number of parcels, landowners can prevent new wind projects from being built near their property. By 2020, according to Tracy Zierke, one of the founders of Wind Locked, the group had easements with about 100 landowners that covered about 30,000 acres. Of that acreage, roughly 85 percent of it is in Faribault County. Zierke says that two wind projects that were targeting Faribault County were effectively turned away due to Wind Locked's easements.

While using wind rights to block development may be effective, that tactic appears to be restricted to Minnesota. Anti-wind activists in other states are using a number of other methods to fend off the encroachment of large wind projects.

In 2012, a group of landowners in Benzie County, Mich., determined that a handy way to fend off a large wind project being proposed by Duke Energy was to build a series of helipads. For safety reasons, wind turbines can't be built near heliports. Recognizing that fact, several Benzie County residents proposed building as many as eight licensed public heliports. The tactic paid off and the wind project never got off the ground.[147]

To be clear, building heliports is an unusual tactic. Local communities hoping to fend off renewable energy projects usually rely on regulations that limit noise and turbine height as well as rules requiring minimum setbacks from occupied buildings or non-participating landowners. All of those factors were incorporated in an ordinance passed in 2011 by Riga Township, Mich. Since then, Riga's ordinance

has often been used as a model by other municipalities aiming to restrict the development of wind energy.

The Riga ordinance requires that any wind turbines must be set back from adjacent non-participating properties by a minimum of four times the height of the top of the turbine. Thus, a turbine standing 500 feet in height must be no closer than 2,000 feet from the property line of landowners who haven't leased their property for wind development. If the wind energy developer wants to place a turbine closer than that to a non-participating landowner, they may purchase an easement from the landowner. The measure also requires setbacks from public roads, communication towers, and electricity lines. Those setbacks must be at least 1.5 times the height of the turbine.[148] Furthermore, the turbines are not allowed to produce noise exceeding 45 decibels during the day and 40 decibels at night.[149]

The noise and setback limits appear to be effective. In 2018, the town council in Darlington, Ind., approved an ordinance that limits noise from wind turbines to no more than 38 decibels. In response, a representative of the company developing the project said that such a low decibel level could be "nearly impossible" to accomplish.[150] Since 2015, local governments in Alabama, New York, and Nebraska have passed measures limiting nighttime noise levels from wind turbines at 40 decibels or lower.

Setback ordinances are also common. In 2016, the board of supervisors in Letcher Township, S.D., adopted an ordinance establishing a 1-mile setback for any turbine taller than 75 feet from the nearest residence or non-participating landowner.[151] That same year, the town council in Clayton, N.Y., also passed a measure requiring a one-mile setback from any "structure, roadway, or property line."[152] While the noise and setback regulations on wind energy vary widely, the two metrics have become common in efforts aimed at restricting wind-energy development.

Regulations aimed at restricting solar energy are less common than ones for wind energy. For instance, a 2020 survey of regulations in Michigan found that out of 1,800 local units of government, about 750 had rules regarding utility-scale wind energy projects while less than 300 had regulations on utility-scale solar. Some regulations are aimed at preserving farmland while others treat solar projects as though they were industrial projects. In 2019, Cambria, N.Y., rejected a 100-megawatt solar project that would have covered about 900 acres of the town with solar panels. Cambria Town Supervisor Wright Ellis said the project was rejected because it violated the town's zoning laws on industrial installations.[153]

While regulations aimed at restricting solar energy are less common than those designed to stop wind energy, solar is growing far faster. Between 2008 and 2018, domestic solar production grew by an average of 53 percent per year while wind energy grew by about 14 percent per annum.[154] Given that rapid growth, it is certain that more regulations aimed at restricting solar energy production will be adopted by rural communities in the years ahead. ■

Section V: High-voltage transmission: You can't get there from here

With the obvious exception of rooftop solar systems, electricity generation plants need transmission and distribution lines to carry the energy they produce to customers. Renewable energy projects are particularly dependent on long transmission lines because the best wind, solar, and hydropower resources are in rural areas where electricity use is usually low. Moving the electricity from those remote sites where demand is low to urban areas where demand is high requires long transmission lines, and the more renewable energy capacity gets added to the grid, the more transmission capacity must be built.

Converting the domestic electric grid to run primarily on renewables will require mind-boggling amounts of new transmission capacity to be built. In 2012, the National Renewable Energy Laboratory estimated that if the U.S. were to attempt to derive 90 percent of its electricity from renewable sources, it would have to roughly double its high-voltage transmission capacity.[155] The U.S. now has about 240,000 miles of high-voltage transmission lines.[156]

Put another way, to convert the electric grid to renewables would require adding enough high-voltage transmission to circle the Earth about 10 times.[157] That's a lot of wire.

High-voltage transmission projects are also expensive. The proposed TransWest project, which aims to move wind energy from Wyoming to Las Vegas, is expected to cost about $4 million per mile.[158] In California, the Tehachapi Renewable Transmission Project, which moves electricity from renewable generators in Kern County south to San Bernadino County, cost about $2 billion for a project that spans 173 miles, resulting in a cost of about $11 million per mile.[159]

"New Hampshire rejects Northern Pass transmission line permit."

—Greentech Media, Feb. 1, 2018

One high-voltage transmission project designed to deliver Canadian hydropower to New York, has been discussed for four decades, but has never been built. In 1982, journalist E.J. Dionne published a piece in the *New York Times* in which he wrote that the allure of Canadian hydropower to New Yorkers "seems especially strong."[160] But moving electricity from Canadian dams to consumers in Manhattan would require a 1,000-megawatt high-voltage transmission line extending the entire

north/south length of New York, some 333 miles, and require putting that line down the middle of the Hudson River Valley.

Over the past year or so, New York politicians, including Gov. Andrew Cuomo and New York City Mayor Bill de Blasio, have said they support the construction of the proposed Champlain Hudson Power Express, a $2.2 billion project that could finally make good on the promise of using Canadian hydropower in New York. But the project still has not moved forward.[161]

Residents across the U.S. have engaged in lengthy fights to stop construction of transmission lines through their regions. In Monmouth County, N.J., hundreds of residents fought the proposed Monmouth County Reliability Project, a 10-mile, 230-kilovolt transmission line, which was expected to cost $111 million. In 2018, after a long legal fight, the New Jersey Board of Public Utilities ruled against the project.[162]

In 2017, Iowa enacted a law prohibiting the use of eminent domain for high-voltage transmission lines. The move doomed the Rock Island Clean Line, a 500-mile, $2 billion, high-voltage direct-current transmission line that aimed to carry electricity from Iowa to Illinois.[163] The opposition forced the project's developer, Houston-based Clean Line Energy Partners, to withdraw its application for the project in Iowa.

In early 2018, Clean Line Energy Partners announced it was suspending its years-long effort to build a 720-mile, $2.5 billion transmission line across the state of Arkansas. The Plains & Eastern Clean Line aimed to carry wind energy from Oklahoma to customers in the southern and southeastern U.S. But the project faced fierce opposition in Arkansas where the state's entire Congressional delegation opposed the deal.[164]

Also in 2018, New Hampshire regulators rejected a high-voltage electricity transmission project called Northern Pass Transmission that was to carry power from Quebec hydroelectric facilities to consumers in Massachusetts. But the 192-mile, $1.6 billion project — which was to go through New Hampshire's White Mountains — was vetoed in a unanimous vote by the New Hampshire Site Evaluation Committee.[165]

A similar high-voltage project, the $2.3 billion, 780-mile Grain Belt Express, has been delayed for years by opposition from rural residents in Missouri. First proposed in 2010, the 4,000-megawatt project is designed to move electricity from Kansas to Indiana and other states.[166] But in 2015, the Missouri Public Service Commission blocked the project after concluding the cost to the state's landowners exceeded its benefits.[167] The fight over the project was partially resolved in mid-2018 when the Missouri Supreme Court ruled in favor of the transmission line. But several counties in Missouri must still approve the project and by late 2018, the project had only acquired about 40 of the more than 700 easements it needs from private landowners.[168] In July 2020, a Missouri state appeals court upheld a decision that allowed the sale of the project to Chicago-based Invenergy. But it still must get approval from regulators in Illinois.[169]

In 2019, environmental groups and local governments sued the Wisconsin Public Utility Commission to block construction of a $492 million, 100-mile, high-voltage transmission project called Cardinal-Hickory Creek that is designed to move wind energy to urban areas. They claimed the regulators abused their discretion and violated their own rules when they approved the project.[170] In September 2020, two Wisconsin lawmakers asked the U.S. Fish and Wildlife Service to reexamine the impact of the Cardinal-Hickory Creek project, a portion of which is slated to cut through the Upper Mississippi River National Wildlife and Fish Refuge. Opponents have also pointed out that bald eagles are nesting close to the proposed route of the transmission project.[171]

In June 2020, a federal judge ruled that the U.S. Fish and Wildlife Service hadn't considered all of the impacts of a 225-mile, 345-kilovolt transmission line designed to go through Nebraska's Sandhills. The decision blocked construction on the project, which has been in development for several years.[172]

The battle over high-voltage transmission in Missouri was reignited in February 2021, when the state House of Representatives approved legislation that bans the use of eminent domain for construction of the Grain Belt Express power line project. As reported by the Associated Press, "The aim of the Missouri bill to stop the project's developers, Invenergy Transmission, from pursuing condemnation if landowners won't sell easements, which means allowing a piece of their land to be used for the power line."[173]

As efforts to expand the high-voltage transmission grid continue, these types of land-use conflicts will become more common. Indeed, the conflicts in Wisconsin and Nebraska show that whenever transmission projects attempt to cross state parks, national parks, scenic areas and Native American lands, people and politicians will object.

Given these facts, it is highly unlikely that the U.S. will be able to build enough transmission capacity to convert the electric grid to run solely on renewable sources like wind and solar. ■

Section VI: Follow the money

Subsidies are driving the expansion of wind energy in rural America. First implemented in 1992, the production tax credit was designed to provide a temporary boost to the wind-energy sector. Representatives of the wind industry have repeatedly claimed they no longer need the subsidy. In 2015, the industry agreed to a phase-out by 2019.

That never happened. Instead, just as it has over the past three decades, the wind energy lobby and its allies on Capitol Hill got an extension of the PTC. In all, according to the Congressional Research Service, the wind industry has obtained 13 extensions of the PTC.[174] One extension occurred in May 2020 without a vote by Congress. Instead, the Treasury Department agreed to change the rules governing the timeframe under which projects can qualify for the maximum value of the tax credits.[175]

The repeated extensions have resulted in a windfall. Between 2020 and 2029, according to data published by the Treasury, the wind industry will collect about $33.75 billion in the form of the production tax credit. Over that same time period, thanks to the investment tax credit, the solar industry will collect about $26.9 billion.[176] Those sums come on top of the money already given to the wind and solar sectors. Between 2010 and 2019, those sectors collected some $71 billion in federal subsidies in the form of the production tax credit and the investment tax credit.[177]

"As the father of the first wind-energy tax credit in 1992, I can say that the tax credit was never meant to be permanent."

—Sen. Charles Grassley, (R-Iowa), Dec. 16, 2015

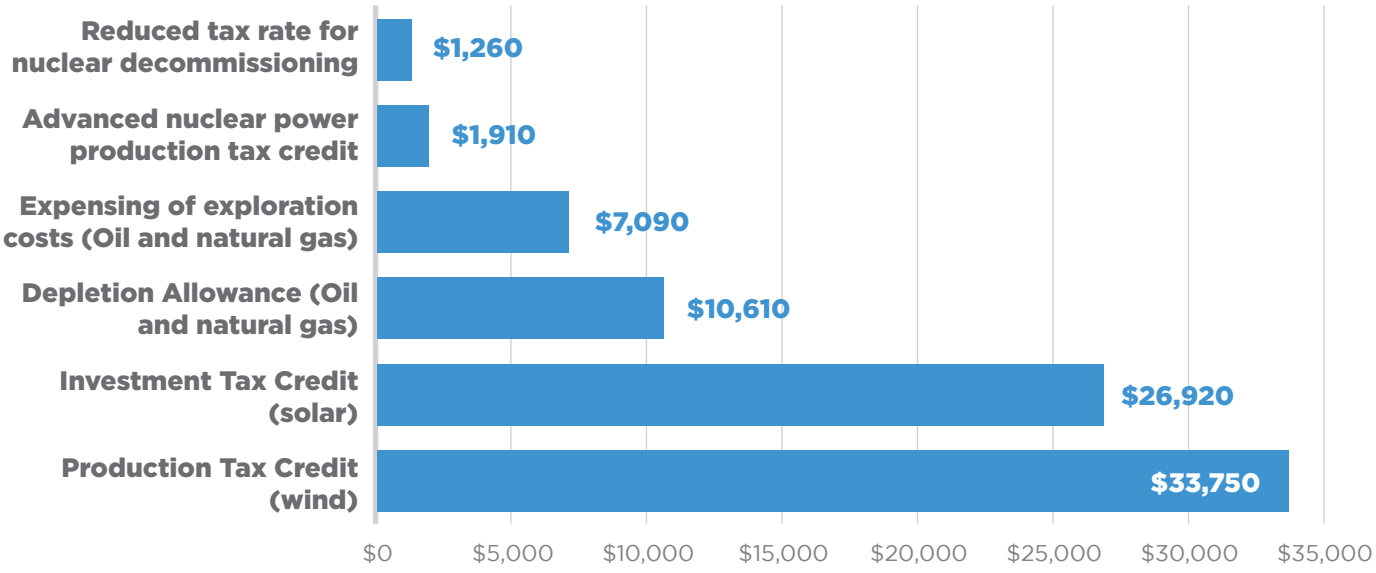
Furthermore, those lucrative tax breaks continue to be extended and those extensions are costing taxpayers billions of dollars. In December 2020, Congress joined and passed two measures: a $1.4 trillion must-pass government spending bill and a $900 billion Covid-relief bill. The 5,593-page bill, the longest piece of legislation ever passed by Congress, included extensions of both the ITC and the PTC. According to the Joint Committee on Taxation, the ITC extension will cost the American treasury another $7 billion between now and 2030. The extension of PTC — like the ITC, once slated to be phased out — will reduce federal tax collections by another $1.7 billion.

Thus, when summing all of the tax breaks

FIGURE 4

Estimated Energy-Related Tax Incentives, 2020-2029

Total incentives (millions of U.S. dollars)



SOURCE: U.S. TREASURY

already granted to the wind and solar sectors and the extensions of them that were passed by Congress last December, we find that between 2010 and 2029, the federal tax incentives for those two industries will total about $140.3 billion.

Renewable energy proponents frequently claim that hydrocarbon producers and the nuclear sector also get favorable tax treatment from the federal government.[178] That is true. But in both absolute terms, and on an energy-equivalent basis, the subsidies given to wind and solar dwarf those given to hydrocarbons and nuclear.

As shown below in Figure 4, the biggest tax incentives related to oil and gas — expensing of exploration costs and the depletion allowance — will total about $18 billion between 2020 and 2029. This decade, in absolute terms, the wind and solar sectors will receive more than three times as much in subsidies as the hydrocarbon sector.

In 2019, the Congressional Research Service found that tax credits for "solar and the production tax credit for wind have increased substantially in recent years." The report shows that in absolute terms, wind and solar energy are getting far more in federal tax incentives than hydrocarbons or nuclear. The CRS's numbers also show that wind and solar are getting vastly more than hydrocarbons or nuclear on an energy-equivalent basis.

The CRS reported that in 2018, the cost of PTC and ITC totaled $9.8 billion while the hydrocarbon sector collected about $3.2 billion. It also found that the tax credits given to the nuclear sector, which produces more than half of America's zero-carbon electricity, totaled about $100 million. While those numbers are instructive, the disparity in subsidies is even more apparent when comparing how much energy they provide to the U.S. economy.

Such a comparison can be done by tabulating the total energy production from each source and dividing that output by the amount of tax credits it receives. To get a common denominator for each energy source, this report relied on energy production data from the BP Statistical Review, which uses exajoules (EJ) as a unit of measure. (For comparison, 1 exajoule is roughly equal to 1 trillion cubic feet of natural gas.) According to BP, in 2018, domestic production of hydrocarbons — coal, oil, and natural gas — totaled about 68 EJ. Nuclear production totaled about 7.6 EJ. Wind output was about 2.46 EJ and solar was about 0.84 EJ.

Those numbers show that the tax incentives given to nuclear and hydrocarbons are dwarfed by those given to the wind and solar sectors. As shown in Figure 5, in 2018, America's nuclear sector received about $13.1 million in tax incentives per EJ while the solar sector soaked up $3.3 billion per EJ — or 253 times the amount given to nuclear. The wind sector got $2 billion per EJ, or about 158 times as much as nuclear. Hydrocarbon producers got tax incentives of about $47 million per EJ, or about four times as much per EJ as the nuclear sector.

In 2018, on an energy-equivalent basis, the solar sector got 253 times as much in federal tax incentives as nuclear energy. The wind industry got 158 times as much as nuclear.

To be clear, these calculations are not comprehensive. They don't count mandates or subsidies that renewables may be getting from state or local governments. Nor do they include tax credits that the nuclear sector is getting in states like New York and Illinois, costs associated with air pollution, or any calculations for the social cost of carbon. What these numbers do show is that the federal tax system has been drastically tilted in favor of two land-hungry sources of electricity generation.

In addition to federal tax incentives, wind energy companies are also getting state money. In 2017, the New York State Energy Research and Development Authority announced that it would award $360 million in subsidies to a handful of proposed renewable energy projects.[179] The biggest share of those handouts will go to wind projects being developed by Florida-based NextEra Energy, the world's biggest renewable energy producer, and Invenergy, a company that is among the world's biggest privately held wind-energy companies.

NYSERDA, which gets most of its funding from surcharges added to New Yorkers' electric bills, will pay about $24.24 for each megawatt-hour produced by wind projects being developed by the two companies.[180] NextEra is developing the 102-megawatt Eight Point Wind Energy Center in Steuben County. In 2019, New York regulators approved the construction of the Eight Point project.[181] Invenergy is developing the Number Three Wind Farm in Lewis County. In addition to the subsidy from NYSERDA, the two companies might qualify for the PTC.

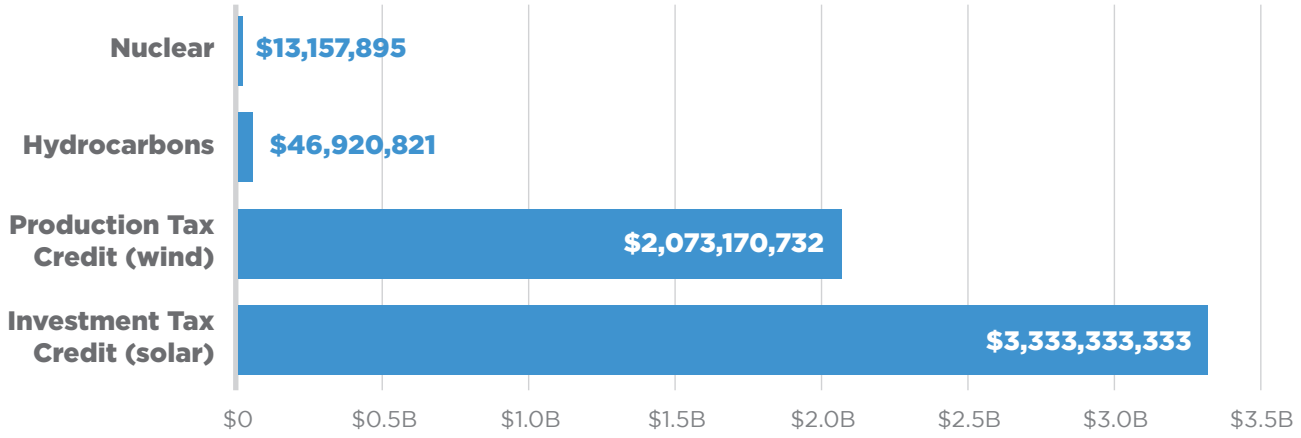
If NextEra and Invenergy complete their projects and they qualify for the full PTC, they could collect about $49.24 per megawatt-hour from the electricity produced by their wind turbines. For comparison, in 2019, according to the New York Independent System Operator, the average wholesale price of electricity in New York was $32.59 per megawatt-hour.[182] Thus, the two wind companies stand to collect about 51 percent more in state and federal subsidies for the energy they produce than the value of that same energy in the wholesale marketplace.

In addition to reducing federal tax revenue, the incentives given to wind and solar are also distorting wholesale power markets and raising costs for consumers. Wind and solar generators do not have to pay fuel costs. But they get lucrative tax incentives. That means that wind and solar generators can, during some time periods, pay to have grid operators take the electricity off of their hands. Known as "negative pricing," this situation works

FIGURE 5

U.S. Energy-Related Tax Incentives, Per Unit of Energy Produced, 2018

Dollars per EJ



SOURCES: CONGRESSIONAL RESEARCH SERVICE, BP, AUTHOR CALCULATIONS

for the renewable producers because they are getting tax favors. But negative pricing undermines the economic viability of traditional generators like nuclear and natural gas plants, which are needed to keep the grid stable and functioning during times that the wind isn't blowing and the sun isn't shining.

The result of these market distortions is higher rates for consumers. That can be seen by looking at California. In 2018, Mark Nelson and Michael Shellenberger of the Berkeley-based think tank, Environmental Progress, released a report which showed that California's electricity rates rose at more than five times the rate of electricity prices in the rest of the U.S. between 2011 and 2017.[183]

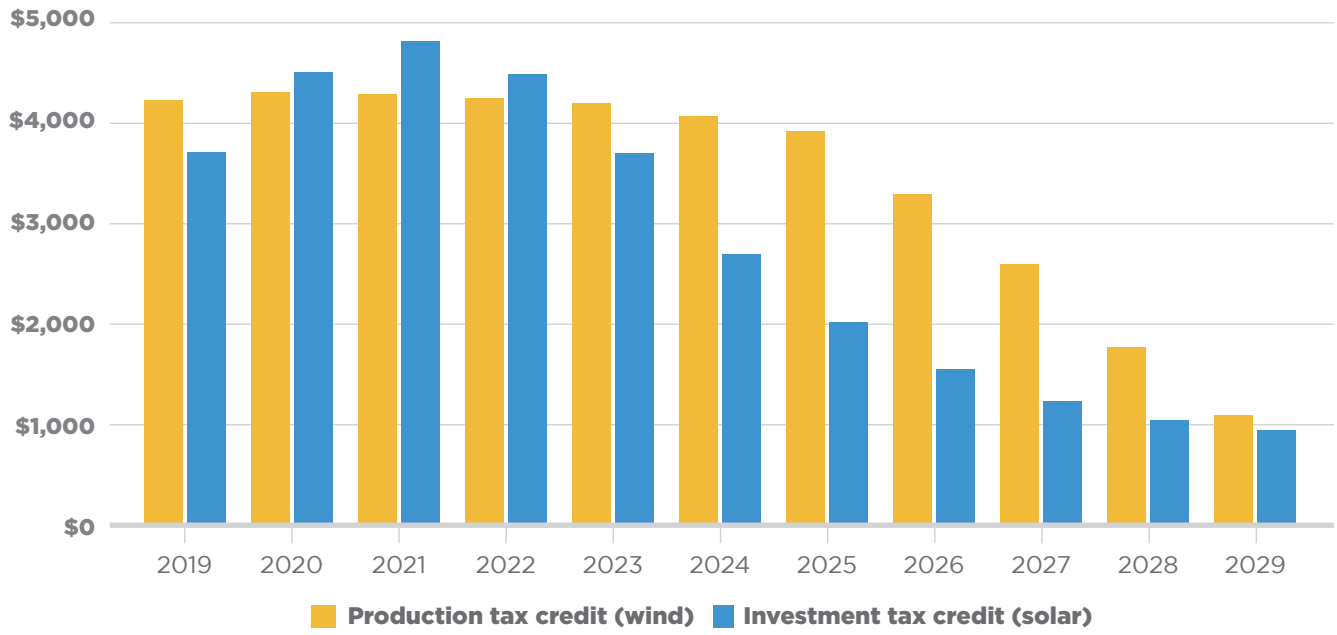
In 2017, Steven F. Hayward and Peter Nelson wrote a report for Center of the American Experiment that analyzed the impact renewable energy mandates have had on Minnesota's ratepayers. They reported that between 1990 and 2009, the "retail price of electricity in Minnesota was, on average, 18.2 percent lower than the national average." But as the state added increasing amounts of wind energy, that price advantage disappeared.

Hayward and Nelson found that if, over the previous seven years, Minnesota had maintained its historic price advantage on electricity, "the state's consumers would have paid nearly $4.4 billion less than what the actual cost of electricity turned out to be." They point to filings made by Xcel Energy in its requests for rate increases. In one document, the utility said that it had been focusing on carbon-free generation and that it had to spend on new generation units and transmission capacity to "deliver this generation to load. These investments were in addition to the capital investments we always need to make in our distribution, transmission and generation assets to help ensure we can safely and reliably serve our customers." The report also says that Xcel had to build new capacity to comply with Minnesota's renewable energy mandates, a cost of some $1.8 billion. All costs were passed on

FIGURE 6

Estimates of Renewable Energy Related Tax Expenditures

For fiscal years 2019-2029, in millions U.S. dollars



SOURCE: MEDIA REPORTS

to ratepayers. Hayward and Nelson concluded that through 2017, the "cost to build out the wind farms currently serving the state's mandate amounts to around $10.6 billion."[184]

A 2019 study done by academics at the University of Chicago also found that renewable energy mandates cost ratepayers: Mandates "raise electricity prices more than previously thought" due to "hidden costs that have typically been ignored." It said the mandates "come at a high cost to consumers and are inefficient in reducing carbon emissions." The report also identified the factors that drive up the cost of power. It found "the intermittent nature of renewables means that backup capacity must be added" and that "by mandating an increase in renewable power, baseload generation is prematurely displaced, and some of the cost is passed to consumers."[185] The study's authors, Michael Greenstone and Ishan Nath, also found that renewables mandates lead to "substantial increases in electricity prices that mirror the program's increasing stringency over time."[186]

In short, renewable energy projects don't save ratepayers money, they make electricity more expensive. They also deprive the federal government of billions of dollars per year in forgone tax revenue. ■

Conclusion

Energy is the lifeblood of the economy. Between 2005 and 2019, thanks to the shale revolution, domestic oil and natural gas production doubled. That surge in output was the largest increase in energy production in world history and turned the U.S. from a large energy importer to a major energy exporter. That surge in energy production was a key driver of the economic growth that the U.S. has enjoyed over the past decade or so.

In 2019, the White House Council on Economic Advisers published a report which said the shale revolution was saving "U.S. consumers $203 billion annually, or $2,500 for a family of four." It continued saying that "nearly 80 percent of the total savings stem from a substantially lower price for natural gas, of which more than half comes from lower electricity prices. Oil accounts for the other roughly 20 percent of the savings."[187] Thus, over the past decade, the domestic drilling sector likely saved American consumers more than $1 trillion.

By contrast, attempting to convert the domestic economy to run solely on renewables will cost consumers many trillions of dollars. In 2019, energy consultancy Wood Mackenzie estimated that "full decarbonization of the U.S. power grid" would cost $4.5 trillion. The firm said that "from a budgetary perspective, the cost is staggering at US$35,000 per household — nearly US$2,000 per year if assuming a 20-year plan."

But Wood Mackenzie's $4.5 trillion estimate only includes the cost of transforming the electric grid. Converting the rest of the domestic economy — including transportation, industry, commercial buildings, and residences — to run solely on renewables will cost many trillions of dollars more and require covering state-sized territories with wind turbines and solar panels. It will also require building tens of thousands of miles of new high-voltage transmission lines.

Paving rural America with renewable energy will cost trillions of dollars, create visual blight on landscapes across the country, kill untold numbers of bats and birds, cause more negative human health impacts, and lead to more economic pain in rural America.

Paving rural America with renewable energy infrastructure won't solve climate change. It will, however, cost trillions of dollars, create visual blight on landscapes across the country, kill untold numbers of bats and birds, cause more negative human health impacts, and lead to more economic pain in rural America.

This paper shows that land-use conflicts will prevent any wholesale effort to convert the domestic economy to renewables. It also shows that Dieter Helm, a professor of energy policy at Oxford University, was correct back in 2012 when he declared that, "Even if we devoted all our resources to current wind and solar technologies, they would not be anything like enough to solve the problem of climate change. There simply is not enough land."[188] ■

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