HAWKEYE STATE HEADWINDS

A Case Study of Local Opposition and Siting Challenges for Large Scale Wind Development in Iowa

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CLEARPATH

LUCID CATALYST



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***ClearPath** conducted all downscaling geospatial analysis, report writing, and policy review.*



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ABOUT CLEARPATH AND LUCIDCATALYST

ClearPath *develops and advances policies that accelerate breakthrough innovations to reduce emissions in the energy and industrial sectors. An entrepreneurial, strategic nonprofit, ClearPath 501(c)(3) collaborates with public and private sector stakeholders to enable private-sector deployment of critical clean energy technologies.*

LucidCatalyst *is a highly specialized international consultancy offering thought leadership, strategy development, and techno-economic expertise. LucidCatalyst focuses on decarbonization, universal access to clean modern energy, alternative energy, and clean tech consulting.*

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DISCLAIMER

Reviewers and discussants were not asked to concur with the judgments or opinions in this report. All remaining errors are the authors' responsibility alone.

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OVERVIEW

Scale and Pace of Wind Deployment for Net-Zero is 3 to 17 Times 2020 Capacity

- Iowa, a national leader in wind energy with a history of supportive policies, is projected to continue playing a pivotal role in decarbonization.
- Across four of Princeton's Net-Zero America Project pathways to net-zero by 2050, Iowa is projected to have:
  - **35 to 199 GW** of new installed capacity
  - **0.1-0.4%** of total direct land impacts and **12-53%** of total indirect land impacts in Iowa

49% of Candidate Project Areas Are Ruled Out by State and Local Policies

- The **prevalence** and **stringency** of wind ordinances are increasing across the U.S., with numerous states, particularly in the Midwest, having some level of local siting authority and adopting prohibitive ordinances for wind development.
- Iowa is no exception, with **all nine of its moratoriums, temporary and indefinite, having been enacted in the past three years.**

No Room for More Wind Without New Transmission; Most Face Opposition

- **Little to no available capacity in Iowa to add wind energy without expanding transmission.**
- New transmission proposals are declining; more than 60% of 345 kV lines have faced opposition.
- Long infrastructure development timelines and interconnection queue wait times also imperil the ability to build cleaner and faster.

Regulatory Reform and Tech Neutrality Are Essential

- We need to balance community concerns and attitudes toward wind development with accelerated permitting timelines for all clean energy technologies and infrastructure.
- Net-zero is still possible, but a technology-neutral approach that is not overly reliant on any one technology and reuses existing infrastructure may be most effective.

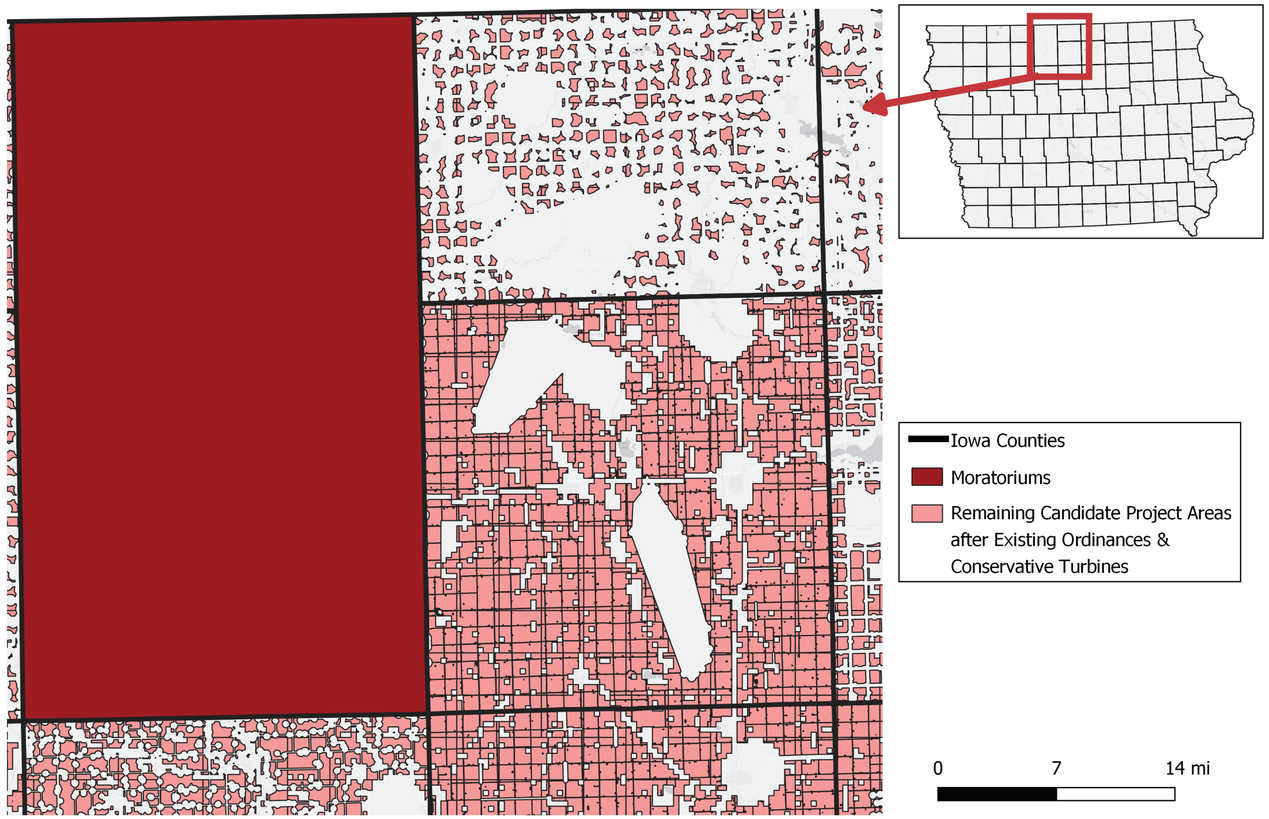
PROCESS IN BRIEF: SPATIAL DOWNSCALING ANALYSIS OF WIND SITING LIMITS

Princeton University's Net-Zero America Project (NZAP), an optimization modelling study, projected five technological pathways to achieve a net-zero economy by 2050.

We conduct a spatially explicit downscaling analysis of NZAP projected onshore wind deployment in Iowa to quantify the impact that local siting regulations, not included in NZAP or other leading energy system modelling studies, could have on the feasibility of achieving the pace and scale of deployments.

We catalogued all county-level wind ordinances and used GIS to calculate the reduction in land availability for overall wind potential and specific technological pathways.

We considered four scenarios, including current ordinances, a future with ordinances in all counties, and both current and future wind turbine technology.



SOURCE: NZAP (2021); IOWA DNR (2020); CLEARPATH IOWA WIND ORDINANCE DATABASE

EXAMPLE OF REMAINING CANDIDATE PROJECT AREAS (CPAs) BASED ON CURRENT ORDINANCES IN THREE COUNTIES

OVERVIEW OF METHODOLOGY

DOWNSCALING ANALYSIS OF NET-ZERO WIND DEPLOYMENT IN IOWA

PRINCETON NZAP

Princeton University's Net-Zero America Project developed spatially explicit pathways to achieve a net-zero economy by 2050.

WIND ORDINANCE

We documented and applied county-level siting regulations on wind development to NZAP-identified Candidate Project Areas and technological pathways.

ADVANCEMENTS IN WIND TURBINES

We assessed the impact of increasing wind turbine size on the availability of land and its concomitant relationship to capacity and generation potential.

IMPLICATIONS FOR NET-ZERO?

NZAP RENEWABLE ENERGY SITING ANALYSIS

CANDIDATE PROJECT AREAS (CPAs)

Potential renewable deployment sites are passed through a land use screening process that employs over 60 GIS layers representing “techno-economic, geological, and environmental land use exclusions”[1] for the Base Land Use Assumptions.

The resulting Candidate Project Areas (CPAs) are characterized by location-specific resource quality — such as wind speed, capital cost, and transmission cost — and then selected by a macro-energy systems optimization model to meet specific wind energy supply levels while minimizing energy costs.

While the technological pathway maps demonstrate one possible projection of least-cost wind development, none utilize the total available land identified as CPAs.

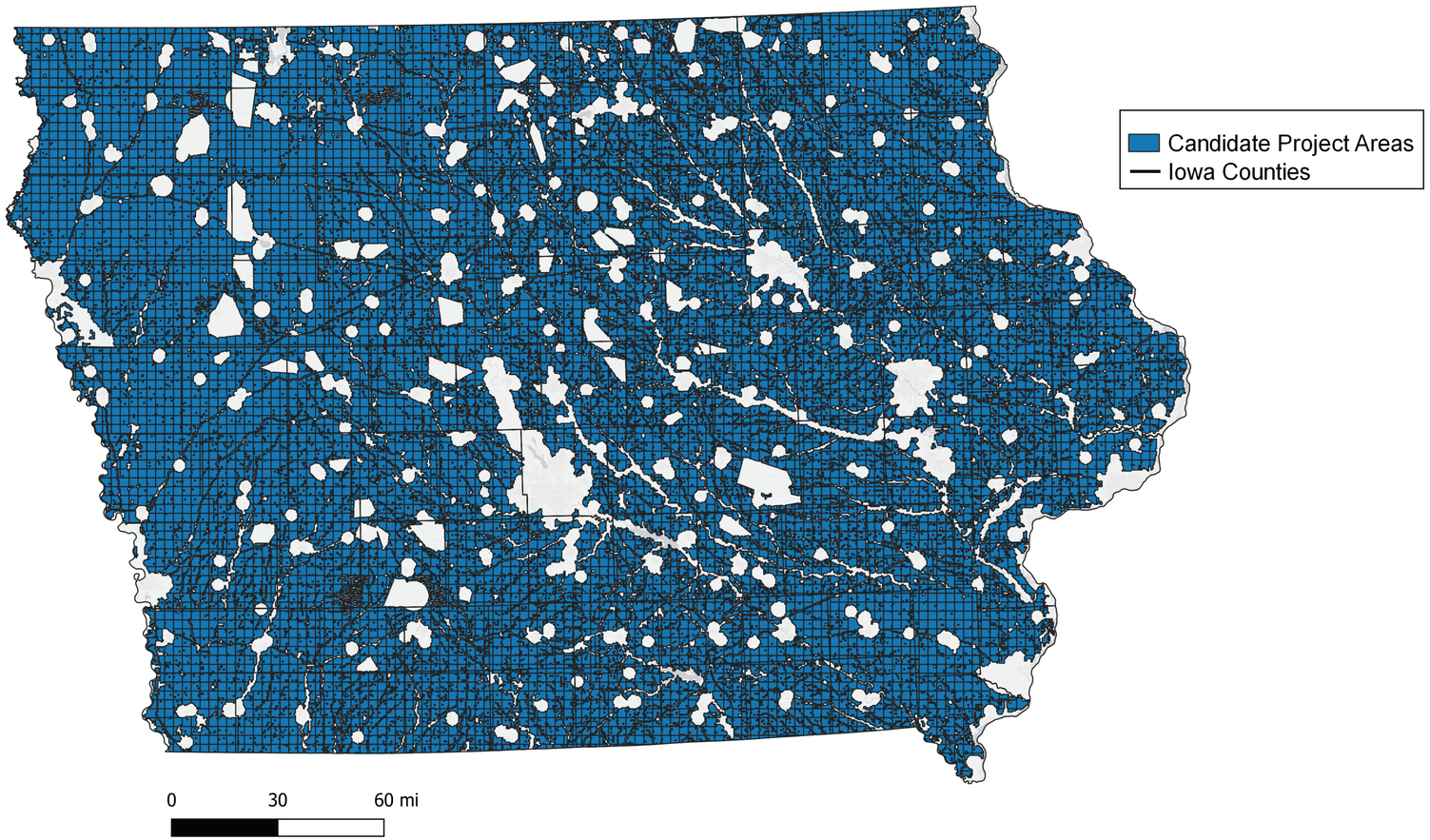
Additional restrictions aimed at preserving intact landscapes and farmland were applied for the Constrained Land Use Assumptions but are not reflected in the CPA data displayed in this study.

TECHNOLOGICAL PATHWAYS TO NET-ZERO

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RE+ BLUA →	High end-use electrification and supply-side constraints of 100% renewable energy supplies with no new nuclear or geological CO_2 sequestration allowed, no land use change for biomass supply, and no fossil fuel use by 2050. Base Land Use Assumptions (BLUA)

IOWA HAS LARGE, CHEAP WIND POTENTIAL

IOWA CANDIDATE PROJECT AREAS FROM PRINCETON'S NET-ZERO AMERICA PROJECT



SOURCE: NZAP (2021); IOWA DNR (2020)

Iowa is the second- or third-largest state for installed wind capacity by 2050, according to NZAP.

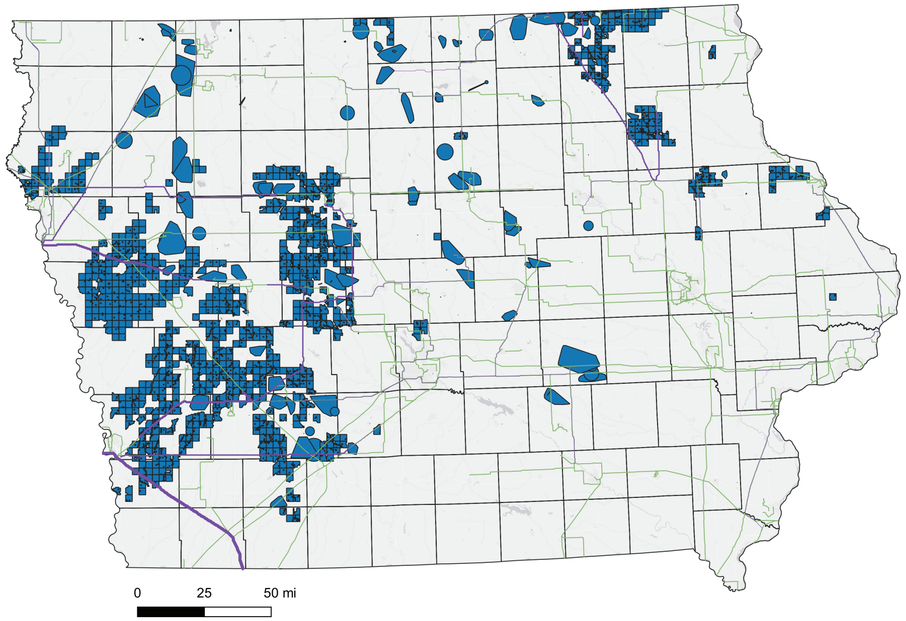
CPAs represent potential wind development areas that passed NZAP's land use screening process.

76% of land in Iowa is identified as CPAs.

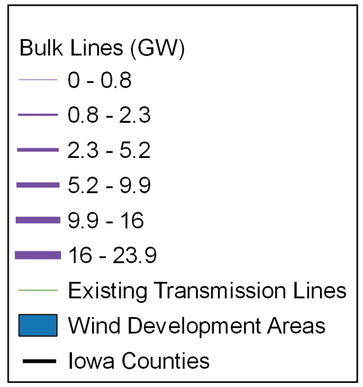
Iowa has 299 GW total capacity potential, with some of the highest capacity factors in the country.

NET-ZERO WIND PROJECTIONS FOR IOWA VARY WIDELY

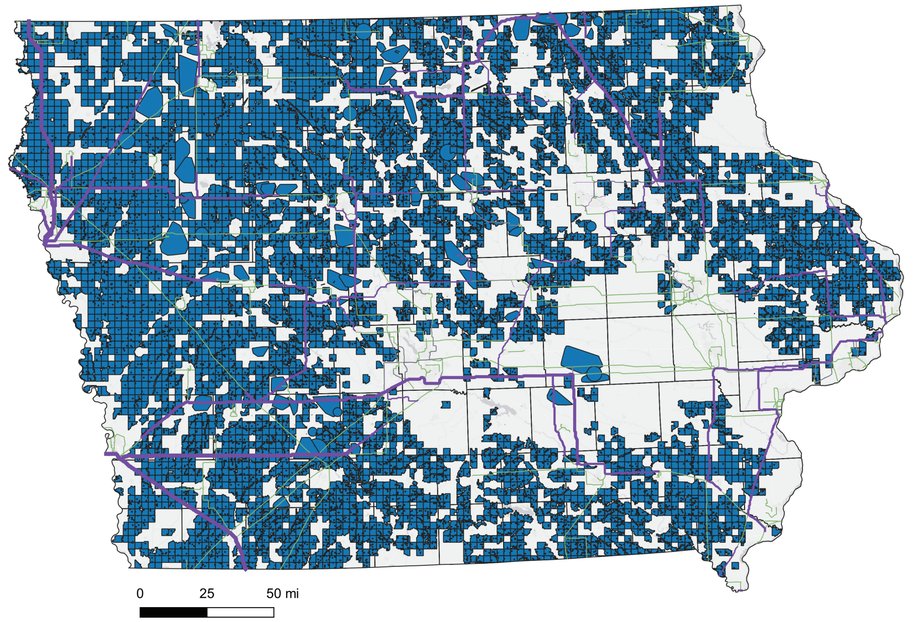
RENEWABLE CONSTRAINED AND BASE LAND USE ASSUMPTIONS PATHWAY



SOURCE: NZAP (2021); IOWA DNR (2020); HIFLD (2022)



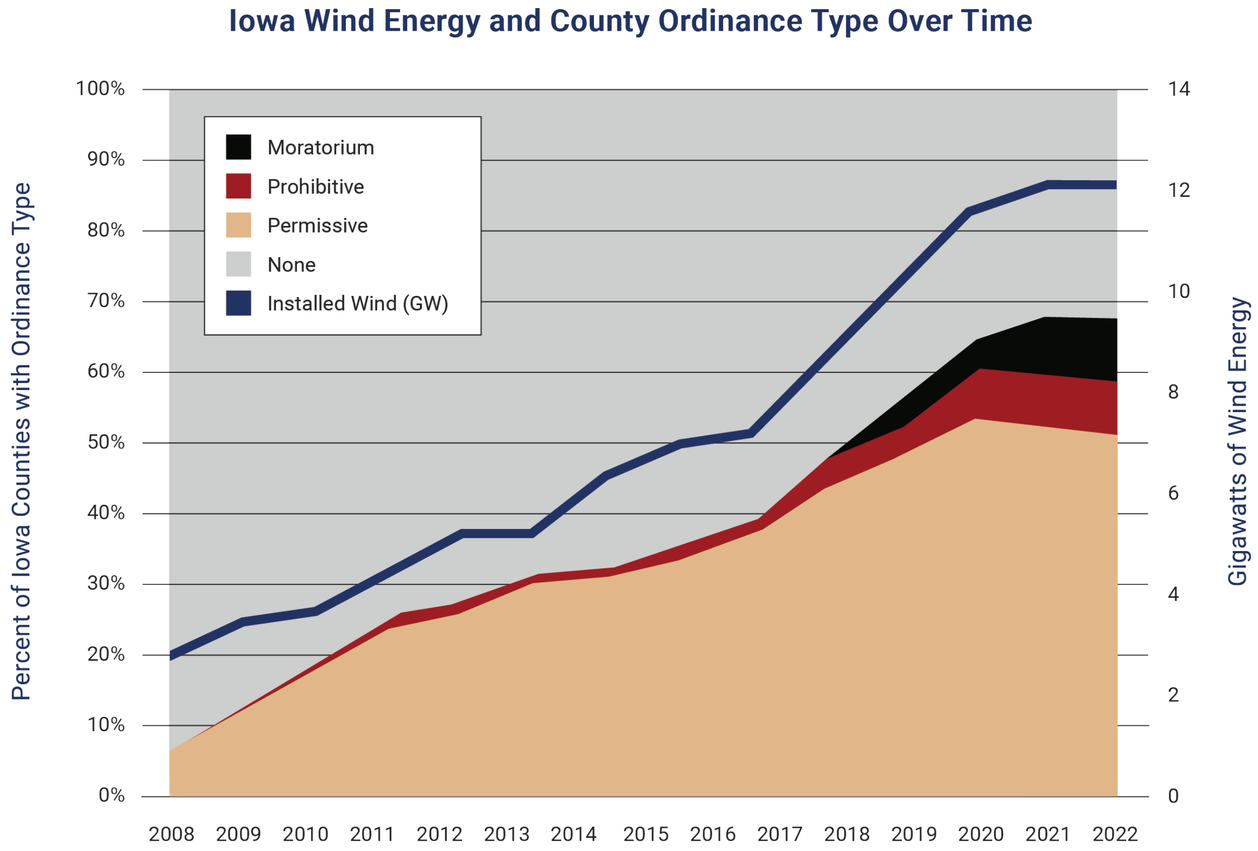
100% RENEWABLE AND BASE LAND USE ASSUMPTIONS PATHWAY



SOURCE: NZAP (2021); IOWA DNR (2020); HIFLD (2022)

- Iowa's total wind energy capacity under 2050 Princeton's proposed net-zero pathways ranges from 46 GW (left) to 210 GW (right).
- Total land impacts range from 0.1-0.4% for direct and 12-53% for indirect.
- The wide range reflects various constraints on resource mix and demand. In the Renewable Constrained pathway, the annual additions of wind and solar are limited to historical maximums. The 100% Renewable pathway features renewables exclusively: no CCS or new nuclear is allowed, while fossil fuels are eliminated by 2050.

ORDINANCE STRINGENCY HAS INCREASED WITH DEVELOPMENT



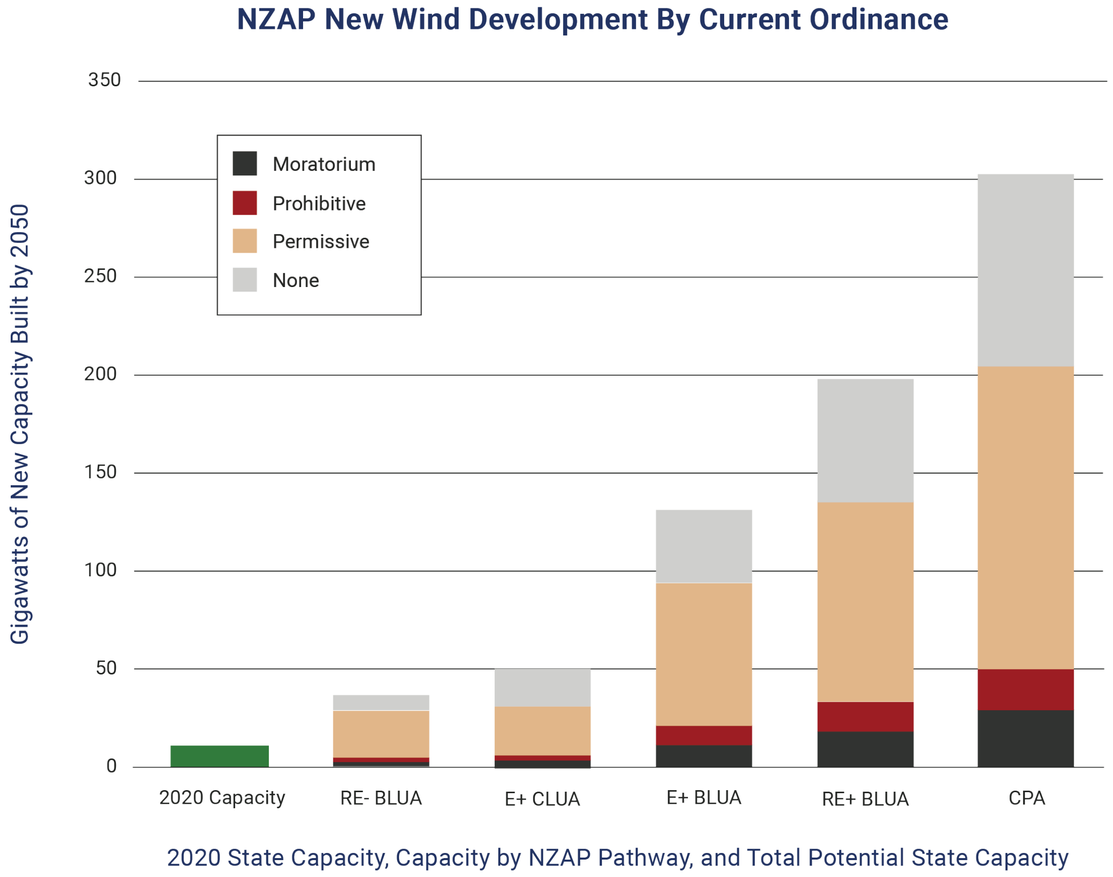
SOURCES: EIA FORM-860 DATA (FEBRUARY 2022); NZAP (2021); CLEARPATH IOWA WIND ORDINANCE DATABASE

Permissive ordinances can provide useful development guidelines that innately limit development in areas with many roads and buildings.

Ordinances that prohibit or severely limit the cost-effective development of wind farms have **become increasingly prevalent** as deployment has boomed across the state.

Counties can change ordinances at any time, creating uncertainty for developers. Some counties have changed permissive ordinances to prohibitive ordinances or moratoriums during development. Other counties adopt temporary moratoriums while they update or create wind ordinances, which can be permissive.

EXISTING ORDINANCES THREATEN FUTURE DEVELOPMENT



2020 State Capacity, Capacity by NZAP Pathway, and Total Potential State Capacity

SOURCES: EIA FORM-860 DATA (FEBRUARY 2022); NZAP (2021); CLEARPATH IOWA WIND ORDINANCE DATABASE

In Iowa, **3-17 times the total 2020 wind capacity** is projected to be built by 2050 under four net-zero pathways.

CPA bar shows the GW of potential capacity identified in counties with permissive or no ordinances. Because no net-zero pathway utilizes all CPAs, there is flexibility to re-site wind.

The degree of flexibility will be constrained by setback requirements not accounted for in this chart.

BENEFITS OF WIND TO IOWANS

OPPORTUNITY COST OF WIND DEVELOPMENT

Counties that adopt moratoriums or prohibitive ordinances forgo direct benefits in the form of revenue streams and employment opportunities during construction and operation, and indirect benefits such as local economic growth, lower electricity rates, and less air pollution.

PUBLIC HEALTH

- Nearly **60,000 metric tons of avoided air pollutant emissions** in 2021 from solar and wind in state.[2]
- **~$3 billion to $7.2 billion** in health benefits from avoided emissions.[2]

ECONOMIC & JOB GROWTH

- **3,953** Iowans directly employed in the wind industry in 2020.[3]
- **53** companies in wind industry supply chain located in Iowa.[4]
- **$19 billion** in capital investment.[5]

CONSUMER SAVINGS

- Current electricity rates are **below the national average,** and wind is the state's cheapest new source of electricity without incentives.[6]

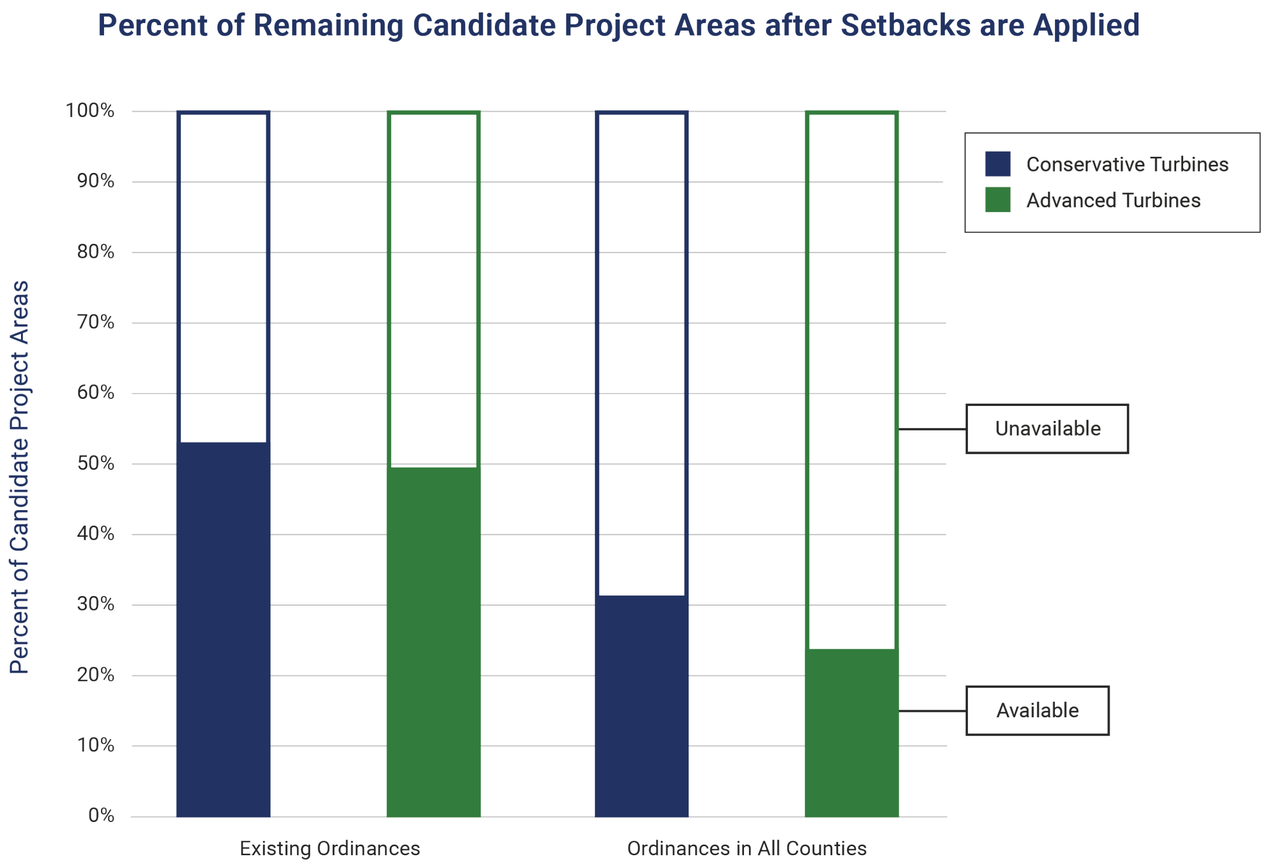
REVENUE FOR PUBLIC SERVICES AND INFRASTRUCTURE

- **$57.2 million** in state and local tax revenue in 2021 from clean power projects.[2]
- Supports schools, hospitals, roads, emergency services, and other services and infrastructure.

ADDITIONAL SOURCE OF INCOME FOR LANDOWNERS

- **$68.2 million** in lease payments to landowners from clean power projects in 2021.[2]
- Small direct footprint of wind turbines enables other land uses, such as agriculture and grazing.

ORDINANCES GREATLY REDUCE TOTAL DEVELOPABLE AREA



49-52% of total CPAs are unavailable under Existing Ordinances.

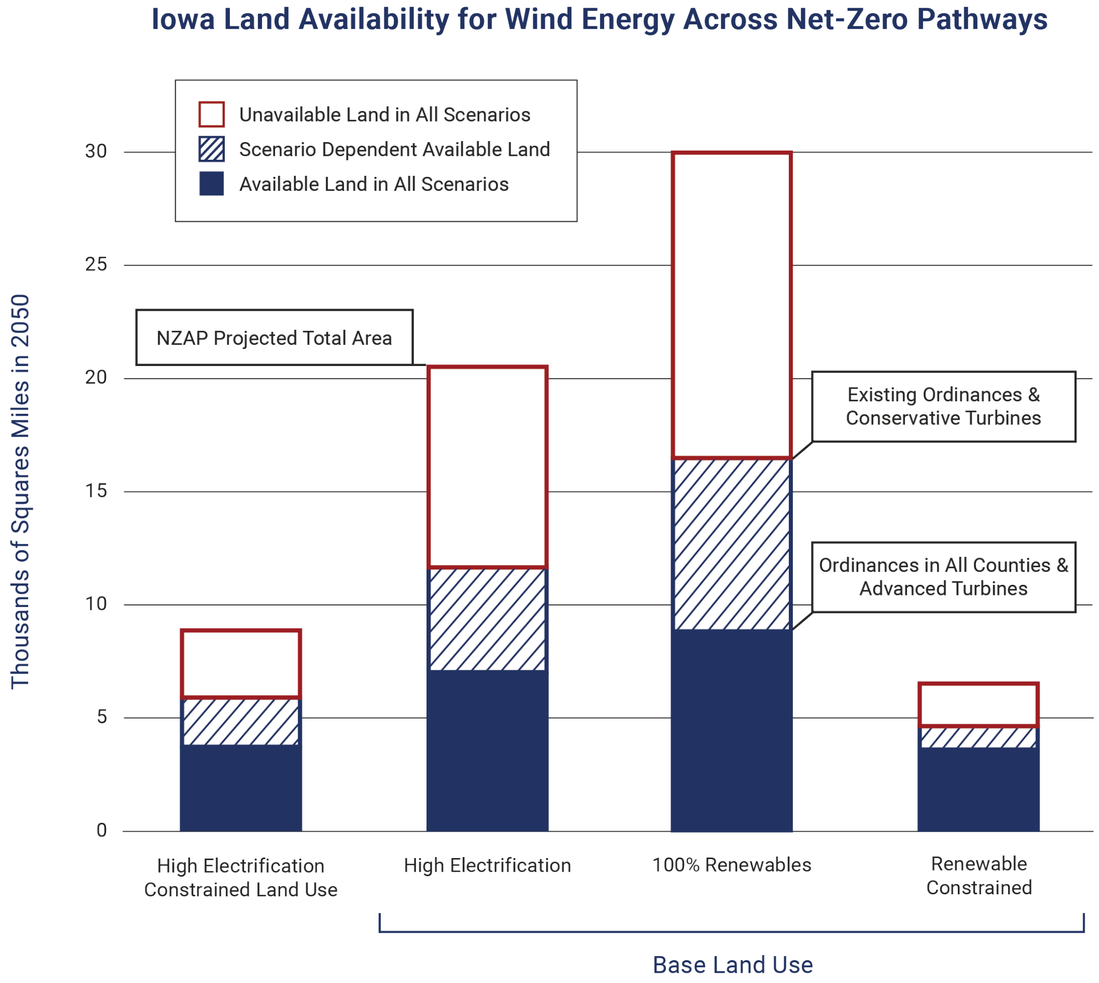
70-77% of total CPAs are unavailable under Ordinances in All Counties (scenario assumes that counties without ordinances adopt permissive setback requirements).

The increasing prevalence and stringency of ordinances in areas with the best wind resources may lead to even greater reductions in potential wind capacity.

The ability to offset capacity losses through larger turbines with higher production is unclear.

- Larger turbines have greater setbacks and require greater spacing between turbines, further constraining land availability.
- Many counties have adopted height limits that would prevent the adoption of these advanced technologies, indicating that increased size may result in more opposition.

AVAILABLE LAND FALLS SHORT OF NZAP TARGETS



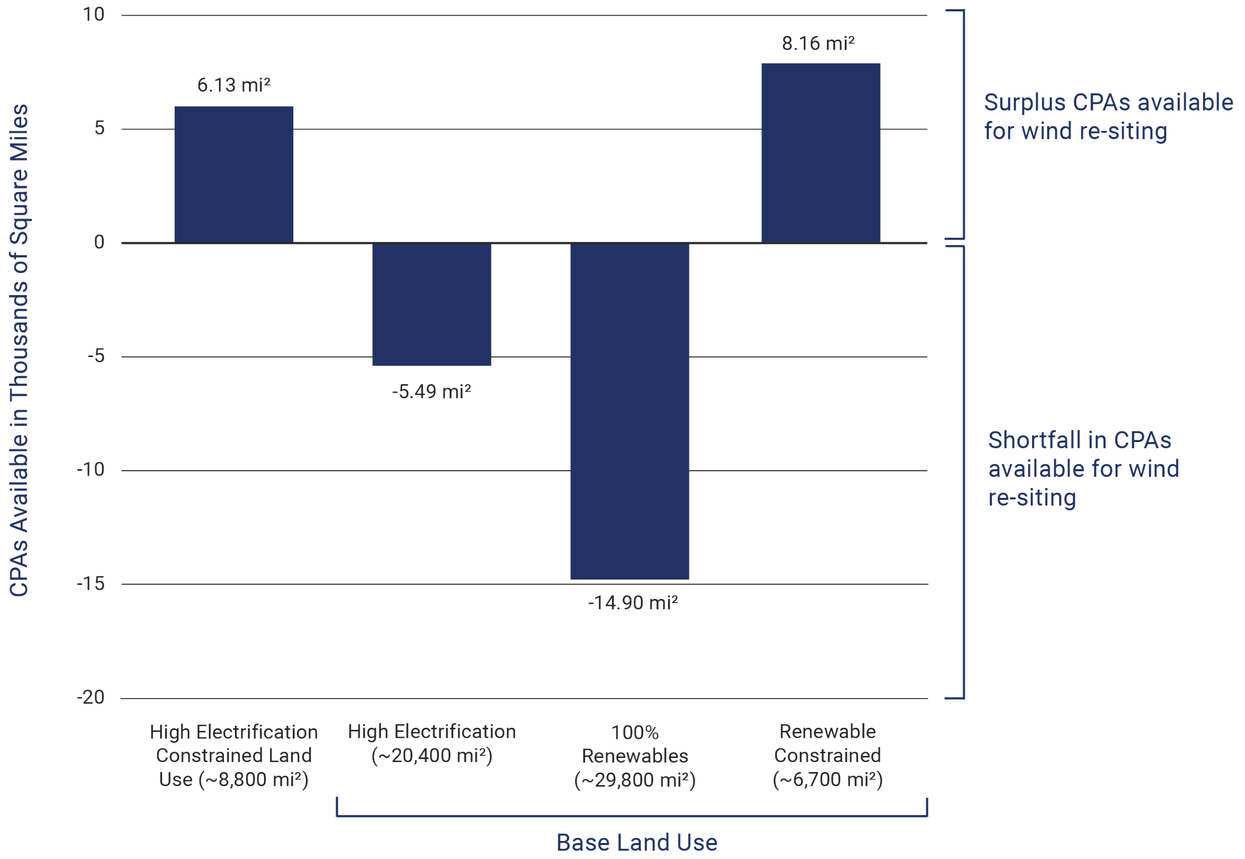
The least-cost siting projections for each net-zero pathway are not feasible under any ordinance or turbine-size scenario we assessed.

The interplay between the highly variable and unpredictable landscape of local regulations and the dynamism of turbine technology demonstrates the importance of considering local siting-derived land use constraints in net-zero planning.

Land with existing and planned wind development is included in these figures.

RE-SITING IS POSSIBLE, BUT NOT IN ALL PATHWAYS

Available Land in Iowa to Re-site Wind Turbines Across Net-Zero Pathways, Assuming Ordinances in All Counties and Conservative Turbines



Even if specific sites are unavailable due to setbacks, it may be possible to re-site wind farms elsewhere in the state to achieve net-zero deployment levels.

Constrained Renewables is the most plausible net-zero pathway, with the most alternative land available for in-state wind siting in each scenario we assessed.

Reaching the deployment targets for a **100% Renewable net-zero pathway is infeasible** in every ordinance and turbine scenario we assessed.

The High Electrification net-zero pathway plausibility depends on the land use and scenario. There is enough land for re-siting with existing ordinances, but if new ordinances are adopted, that would no longer be possible.

TRANSMISSION AND INTERCONNECTION FINDINGS

- Across Iowa, there is minimal, if any, available transmission capacity, and proposals for new high-voltage transmission lines have trended down over the past decade.

- Eminent domain has been required to secure rights-of-way on nearly half of all high-voltage transmission line projects since 2009 (about two-thirds of all 345 kV projects).

- Public opposition to transmission projects has been consistently high; **every project proposed in the last five years has faced opposition.**

- Wait times for generation projects in MISO's interconnection queue (the list of transmission and generation projects in the process of connecting to the electric grid) have increased steadily over the past few years. These findings are consistent with escalating wait times in other ISOs across the country.

- At the federal level, the Federal Energy Regulatory Commission is prioritizing reforms for interconnection queue procedures and agreements in addition to regional and interregional transmission planning and cost-allocation procedures. Despite the procedural improvements that may manifest from these proposed rulemakings, the development and siting of high-voltage lines and generation resources still require several layers of state and local approvals.

- Ultimately, transmission and interconnection delays could limit wind energy growth just as much as, or even more than, local turbine siting.

POLICY RECOMMENDATIONS

MAINTAIN NET-ZERO OPTIONALITY

- Diversified, technology-inclusive net-zero portfolios had greater feasibility than the 100% Renewable pathway when county-level siting regulations were considered.
- Massively scaling up wind energy in a short time period will be extraordinarily difficult. Any clean energy or climate policy should be as tech-neutral as possible.

TAILOR POLICY TO SUPPORTIVE COMMUNITIES

- Counties should be able to access federal aid or technical assistance if they enact permissive ordinances for clean energy development. Another option would be to seed energy extension programs at local universities.
- To balance community autonomy and decarbonization goals, it is essential to understand and acknowledge individual and community concerns, proactively provide resources and tools for communities and decision-makers, and for developers to implement best practices with respect to procedural and distributive fairness.

REIMAGINE EXISTING INFRASTRUCTURE

- Large-scale infrastructure siting across vast swaths of land will be incredibly difficult and will likely worsen over time. Reducing emissions while avoiding greenfield construction — by reusing assets and relying on non-wire transmission alternatives — is essential.
- This includes repurposing existing generation with nuclear or CCUS, optimizing existing transmission lines, repurposing gas pipelines for H_2 or CO_2, and using federal land or rights-of-way.

1
EXECUTIVE SUMMARY

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PURPOSE & BACKGROUND

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DOWNSCALING METHODOLOGY

4
DOWNSCALING RESULTS

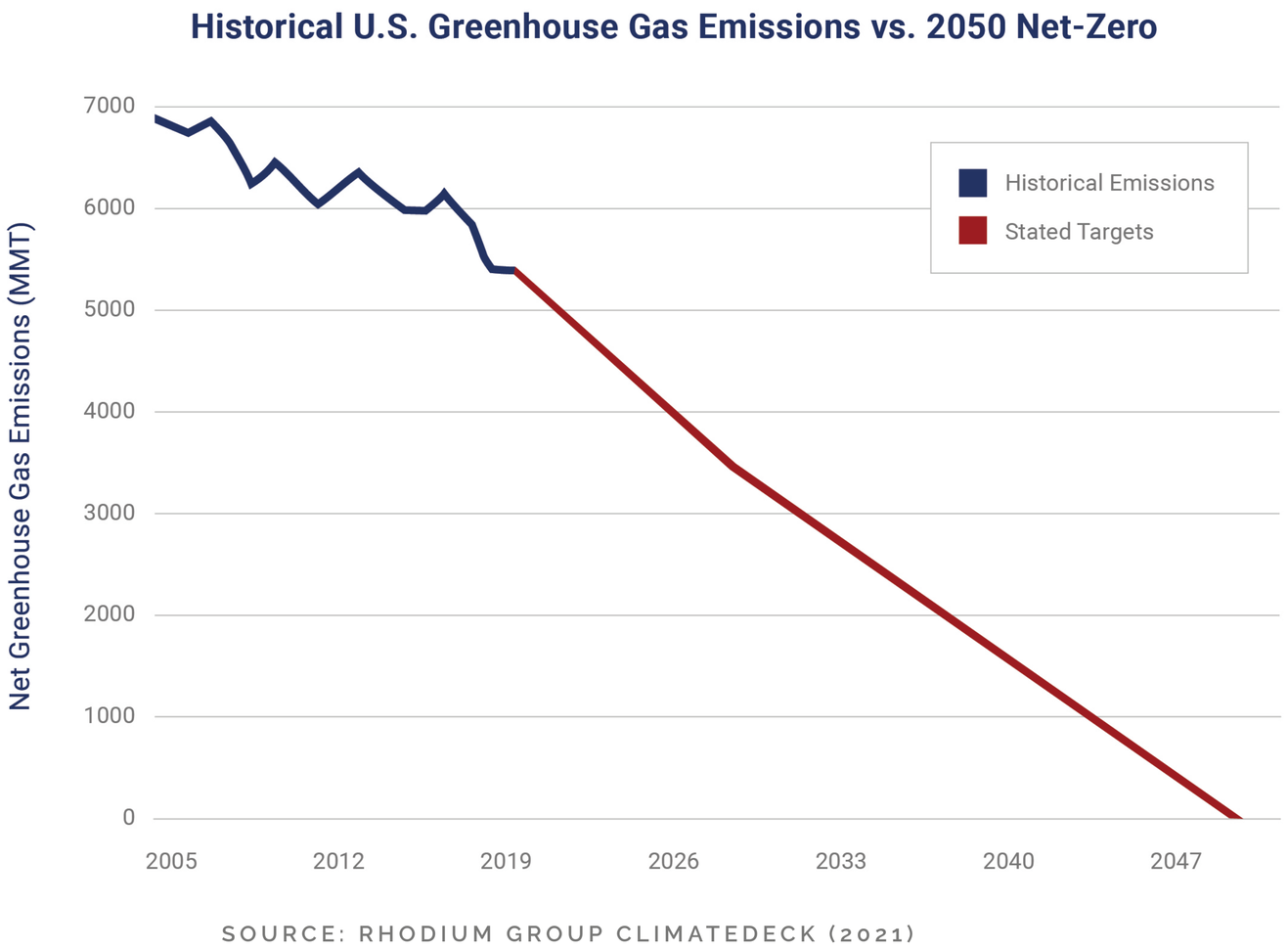
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RECOMMENDATIONS AND CONCLUSION

GOAL IS NET-ZERO BY 2050



SOURCE: RHODIUM GROUP CLIMATEDECK (2021)

The Intergovernmental Panel on Climate Change (IPCC) has identified the unequivocal need to achieve net-zero greenhouse gas emissions between 2050 and 2070 to avoid significant climate change impacts.[7]

Understanding the feasibility of various emissions reduction pathways early is critical to charting a path to net-zero by 2050.

National net-zero emissions targets ultimately need to translate into steel in the ground, and models must be tested for feasibility

PURPOSE OF STUDY

- Wind energy is consistently predicted to be one of the cheapest sources of electricity in the future.
- A growing wave of local and state opposition to wind development threatens the ability to deploy wind generation, particularly in areas with the best wind resources.
- Transmission capacity constraints, lengthy development timelines, and interconnection queue wait times also imperil the ability to build cleaner and faster.
- Analyzing the confluence of the cheapest energy resource with local policy can identify key policy concerns for future clean energy deployment.
- This report is a case study of one state predicted to play a pivotal role in national decarbonization targets, with the aim to better understand:
    - The impact of current and potential local policies on long-term decarbonization.
    - Trends and drivers in local and state opposition to wind development.
    - The impact of transmission infrastructure build-out and generator interconnection processes on the rapid deployment of wind generation.

PRINCETON'S NET-ZERO AMERICA PROJECT (NZAP)



Study of five different technological pathways to reach economy-wide net-zero by 2050 target.

Found that deploying large amounts of wind generation in resource-rich locations, commonly in the Midwest, and transporting the electricity via new transmission infrastructure to load centers will be one of the most cost-effective methods for decarbonization.

- Onshore wind is the largest source of renewable energy across all five technological pathways, representing 8.1% to 31.8% of total energy supply, and 14.2% to 52.0% of total electricity generation in the U.S. by 2050.[8]

Developed a least-cost renewable siting methodology, which accounts for land use constraint assumptions to downscale energy infrastructure deployments that attain net-zero emission targets within each technological pathway.

NZAP RENEWABLE ENERGY SITING ANALYSIS

CANDIDATE PROJECT AREAS (CPAs)

Potential renewable deployment sites are passed through a land use screening process that employs over 60 GIS layers representing "techno-economic, geological, and environmental land use exclusions"[1] for the Base Land Use Assumptions.

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WHAT IS A WIND ORDINANCE?

Laws passed by sub-national governments, such as counties in Iowa, that define the parameters wind turbines and farms must meet to be approved and built.

PURPOSE

To enable cost-effective wind development while protecting the interests and safety of participating landowners, non-participating landowners, and members of the community.[9]

COMMON COMPONENTS

- Application and approval requirements
- Construction and decommissioning guidelines
- Safety
- Setbacks and other technology-specific requirements

SETBACKS AND TECHNOLOGY REQUIREMENTS EXPLAINED

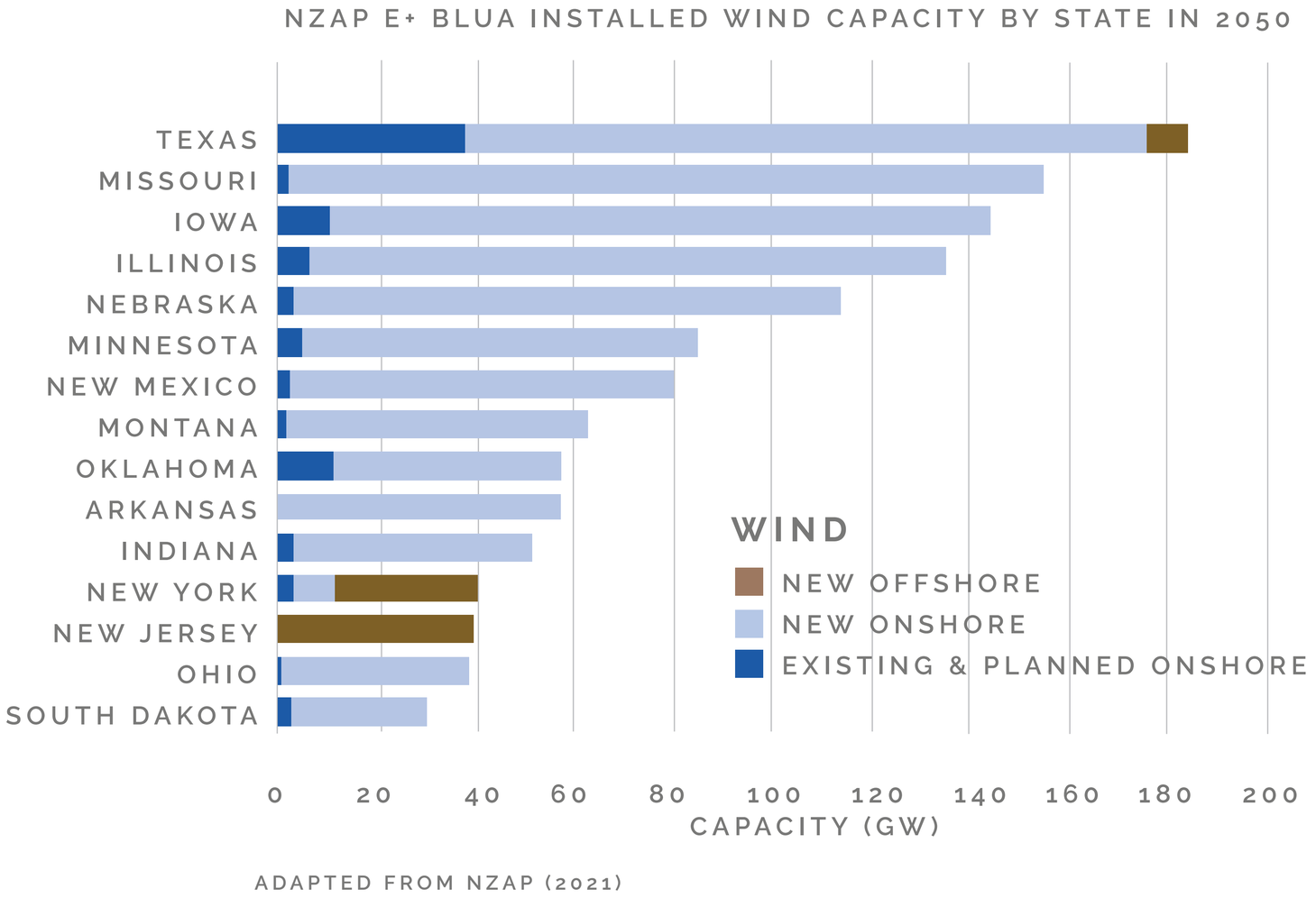
SETBACKS

- Establish the minimum distance between turbines and roads, property lines, or structures.
- For structures, setbacks are typically a **standard distance** (ex. 1,250 ft).
- For roads, setbacks are typically a **multiplier of total turbine height** (ex. 110%), defined as the sum of hub height and rotor radius.

TECHNOLOGY STANDARDS

- Can include limitations on
  - **Turbine height**
  - **Shadow flicker:** the number of hours per year that the shadow cast from the turbine and its rotating blades falls on buildings
  - **Noise level:** as measured in A-weighted decibels (dBA), recorded at a particular distance from a wind farm

WHY IOWA?

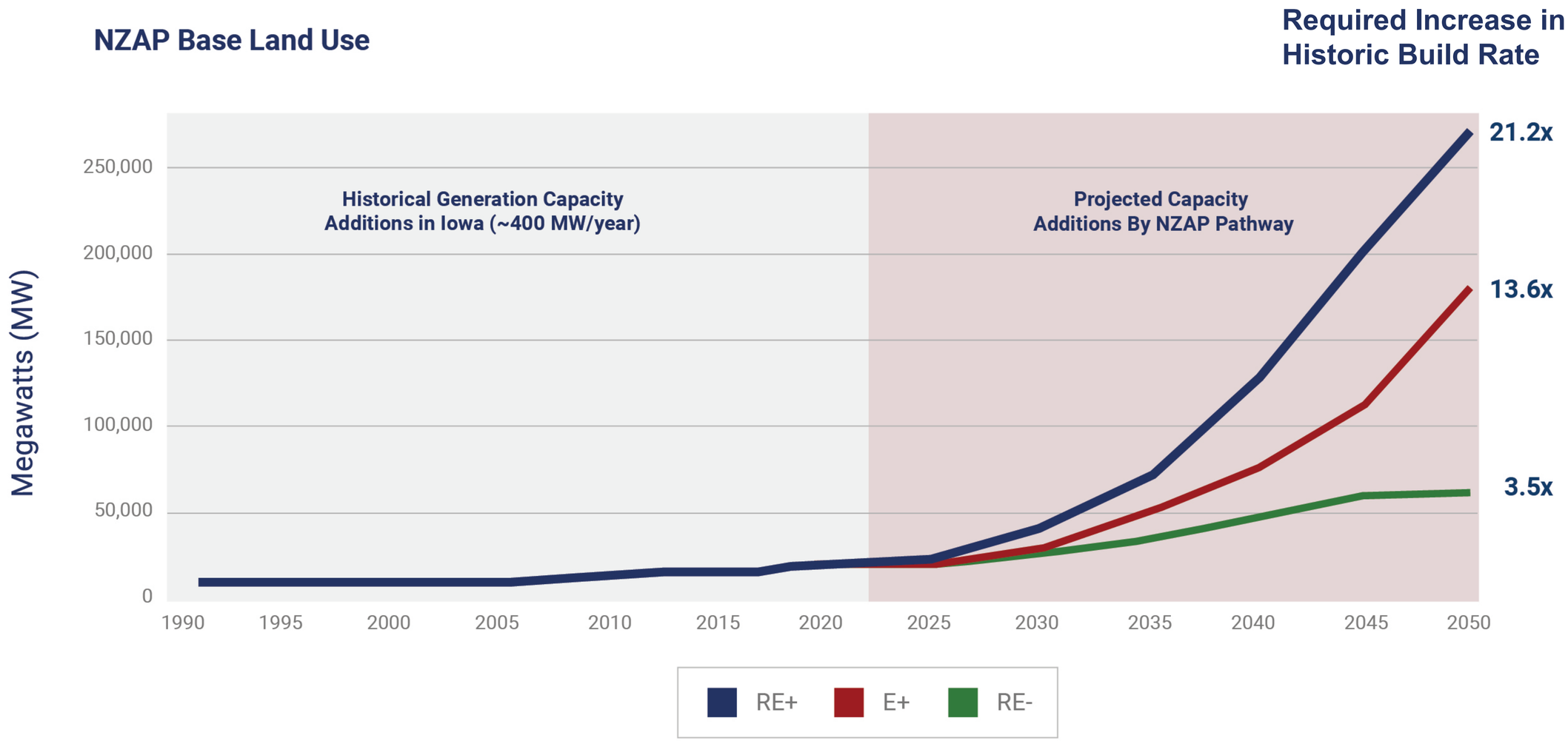


ADAPTED FROM NZAP (2021)

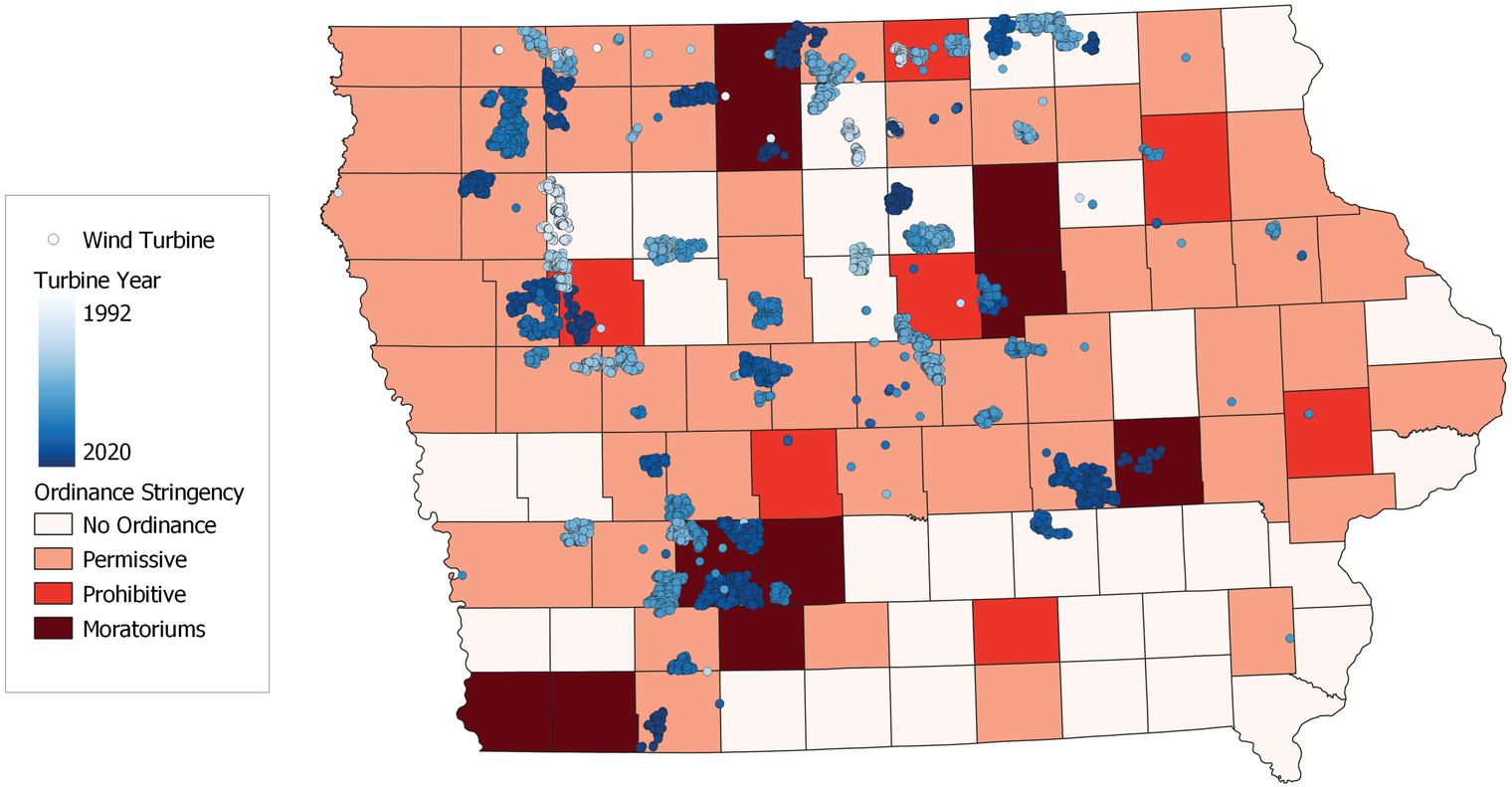
In 2020, Iowa had 11,406 MW of installed wind capacity, which accounted for 57% of Iowa's net electricity generation, making it the second-largest wind power producer after Texas.[6]

NZAP identified Iowa as the second- or third-largest state for installed wind capacity by 2050. Iowa has the greatest fraction of impacted land from solar and wind development in the country, at 37% in the E+ BLUA scenario in 2050.

NZAP'S WIND CAPACITY PROJECTIONS FOR IOWA



WIND ORDINANCES AS OF 2022

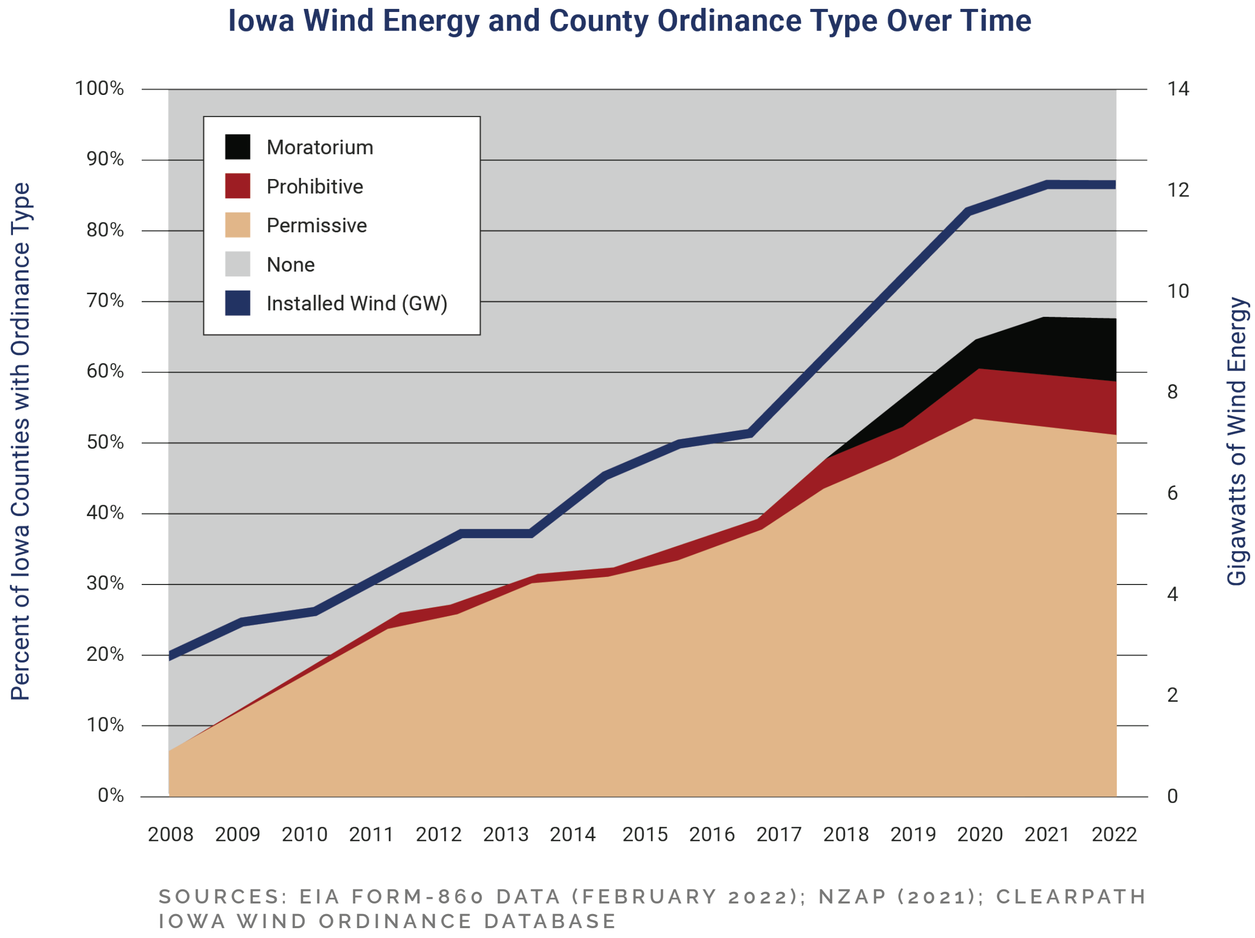


SOURCE: EIA USWTDB (2021); CLEARPATH IOWA WIND ORDINANCE DATABASE

OF THE 99 COUNTIES IN IOWA, CURRENTLY:

- **34 have No Ordinance in place**
  - Some counties don't adopt wind ordinances because they prefer to consider wind development on a project by project basis.
- **49 have Permissive Ordinances**
  - Setbacks *less than* or equal to 1,600 ft from buildings, 1.5x total turbine height from roads, and no height limitations
- **7 have Prohibitive Ordinances**
  - Setbacks greater than 1,600 ft from buildings, 1.5x total turbine height from roads, and/or height limitations.
- **9 have Moratoriums**
  - Indefinite or temporary prohibition on development or a cap on the total number of turbines that can be built.

IOWA INSTALLED WIND CAPACITY AND ORDINANCE PREVALENCE



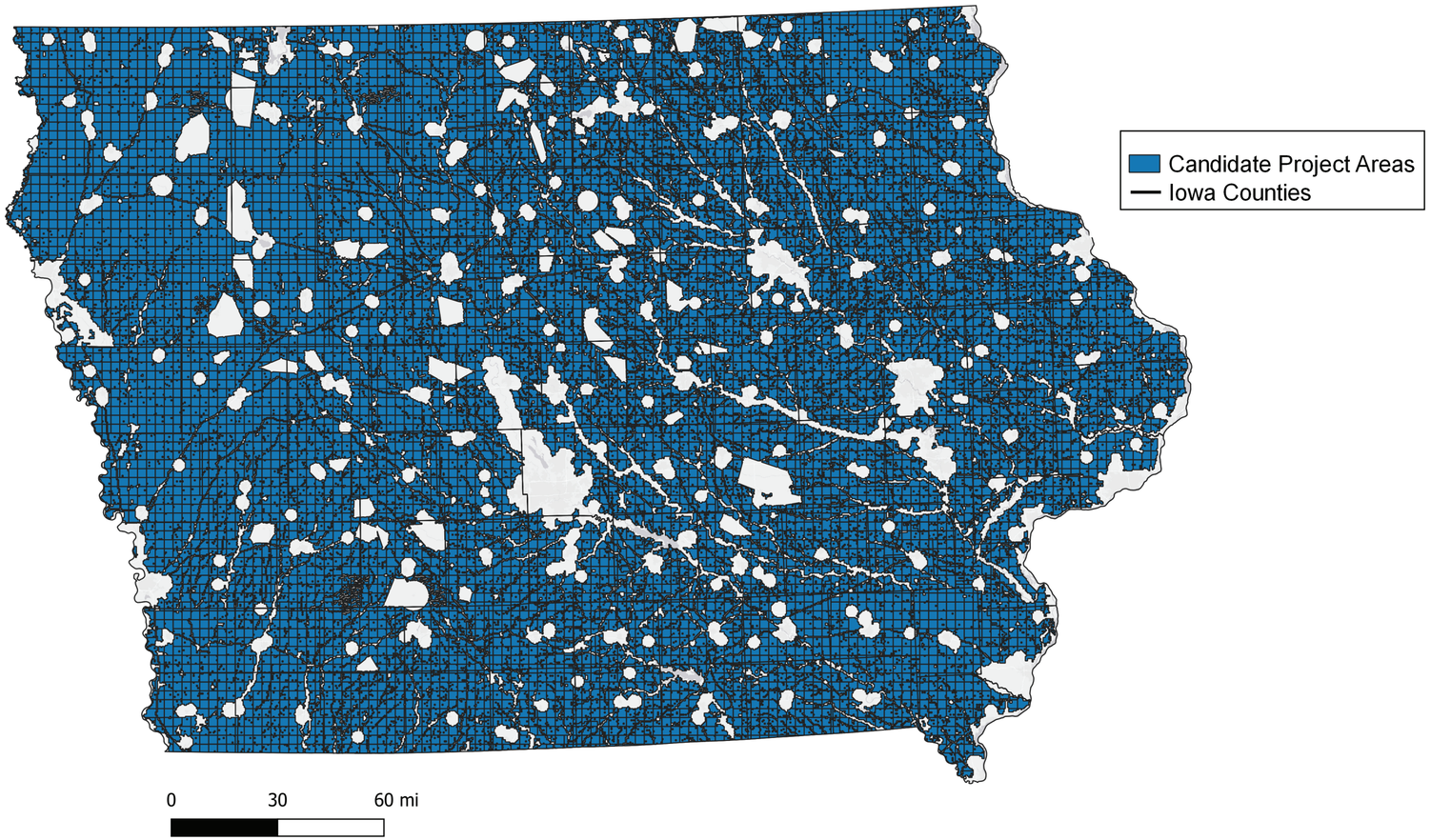
SOURCES: EIA FORM-860 DATA (FEBRUARY 2022); NZAP (2021); CLEARPATH IOWA WIND ORDINANCE DATABASE

Permissive ordinances can play a critical role in balancing cost-effective wind development with protecting the interests and safety of participating landowners, non-participating landowners, and community members.

However, ordinances that prohibit or severely limit the cost-effective development of wind farms have become increasingly prevalent as deployment has boomed across the state.

CANDIDATE PROJECT AREAS (CPAS)

IOWA CANDIDATE PROJECT AREAS FROM PRINCETON NET-ZERO AMERICA PROJECT



SOURCE: NZAP (2021); IOWA DNR (2020)

Candidate Project Areas (CPAs) represent potential wind development areas that passed Princeton's land use screening process.

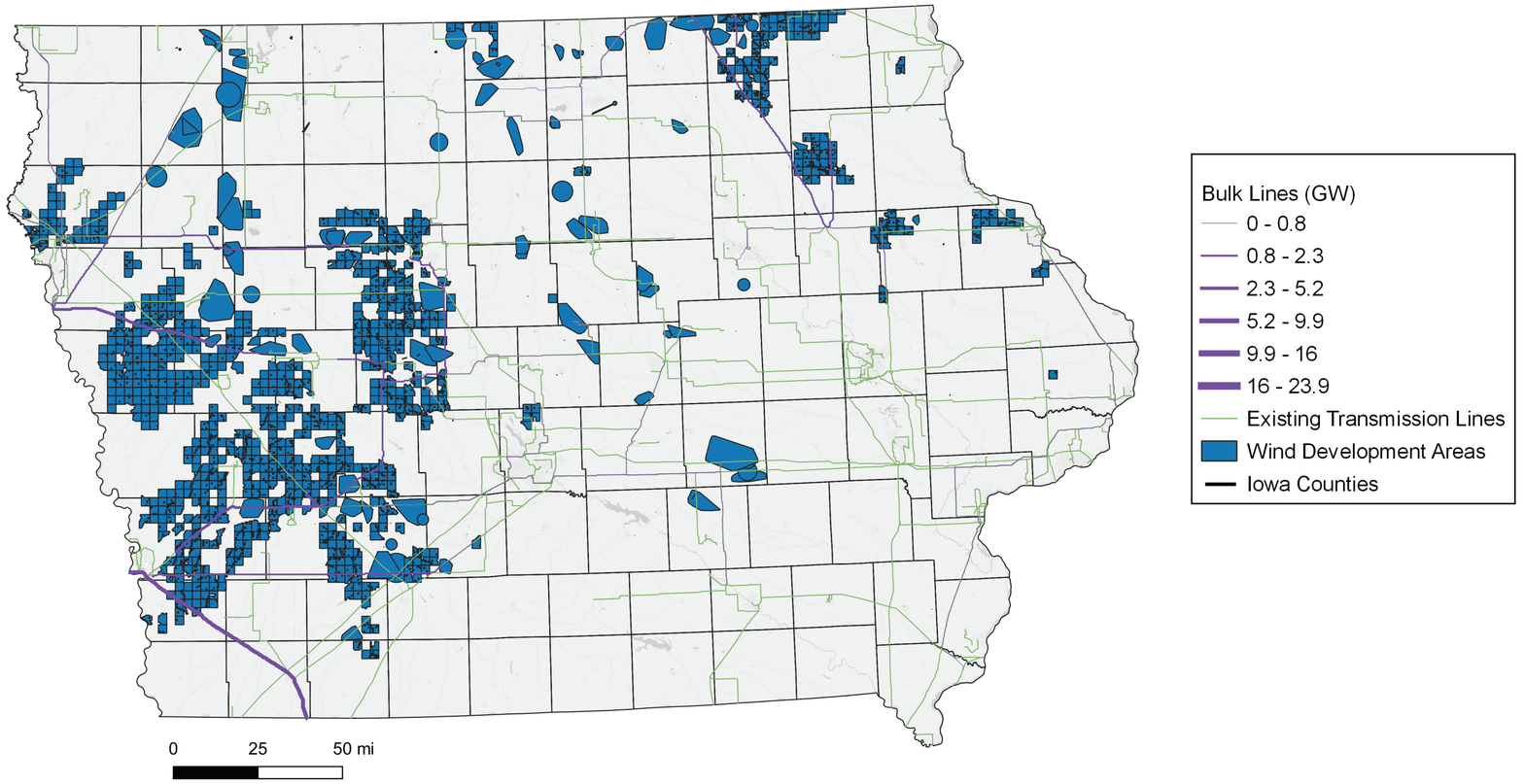
Filters included protected land, steep slopes, water bodies, and population centers. A full list of exclusions can be found in Princeton's technical appendix.[1]

76% of land in Iowa is identified as CPAs.

299 GW Total Capacity Potential

RE- POTENTIAL TOTAL LAND IMPACTS BY 2050

RENEWABLE CONSTRAINED AND BASE LAND USE ASSUMPTIONS



SOURCE: NZAP (2021); IOWA DNR (2020); HIFLD (2022)

NZAP Renewable Constrained, Base Land Use Land Impacts by 2050:

- Indirect
  - 12% of land in Iowa
  - ~6,735 square miles
- Direct*
  - 0.1% of land in Iowa
  - ~53 square miles

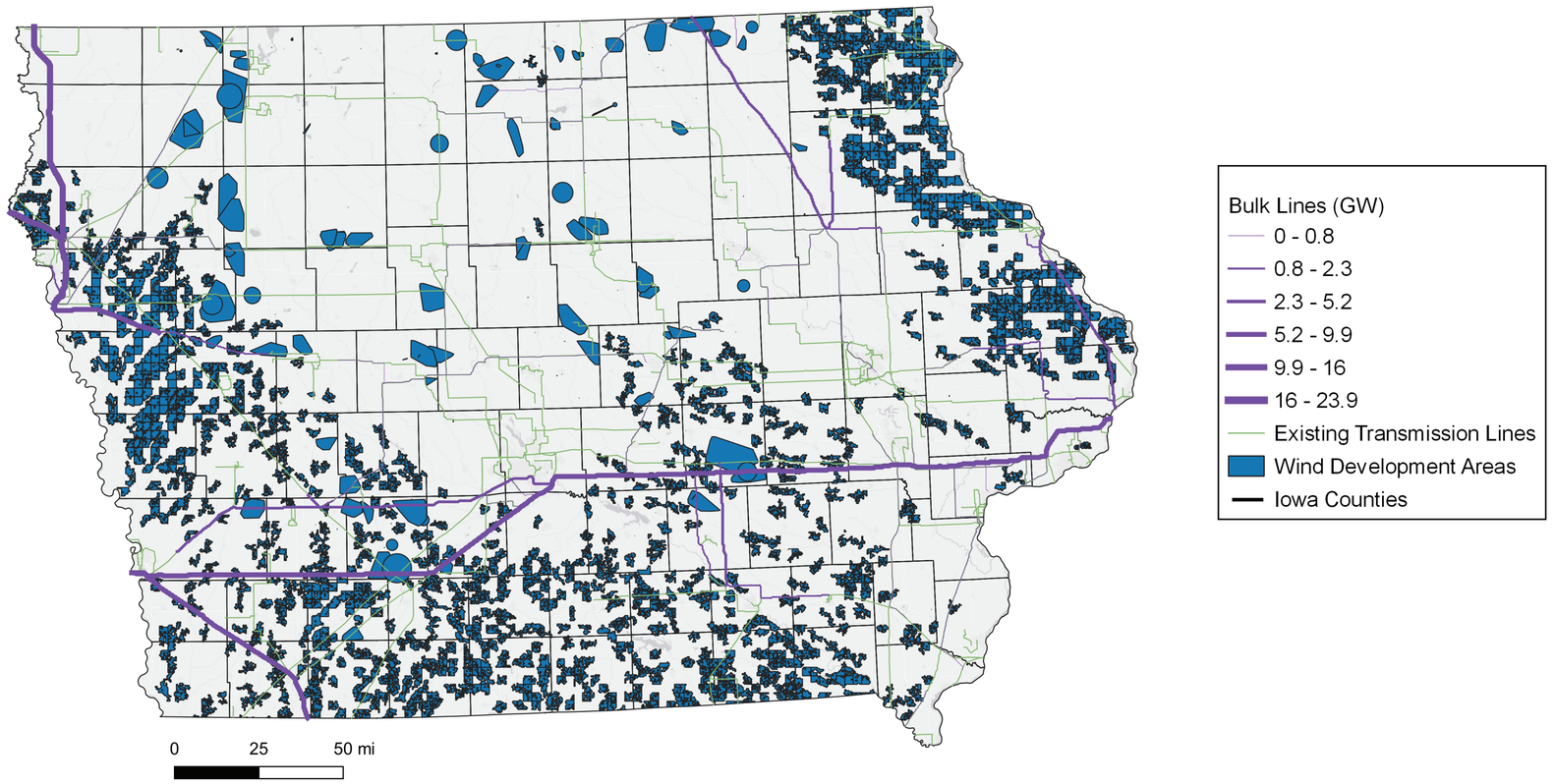
Total Wind Capacity:

- 46 GW

*DIRECT LAND USE ESTIMATIONS ASSUME 3 MW TURBINES AND 0.74 ACRE/MW.[10]

E+ CLUA POTENTIAL TOTAL LAND IMPACTS BY 2050

HIGH ELECTRIFICATION AND CONSTRAINED LAND USE ASSUMPTIONS



SOURCE: NZAP (2021); IOWA DNR (2020); HIFLD (2022)

NZAP High Electrification, Constrained Land Use Land Impacts by 2050:

- Indirect
  - 15.6% of land in Iowa
  - ~8,766 square miles
- Direct*
  - 0.1% of land in Iowa
  - ~70 square miles

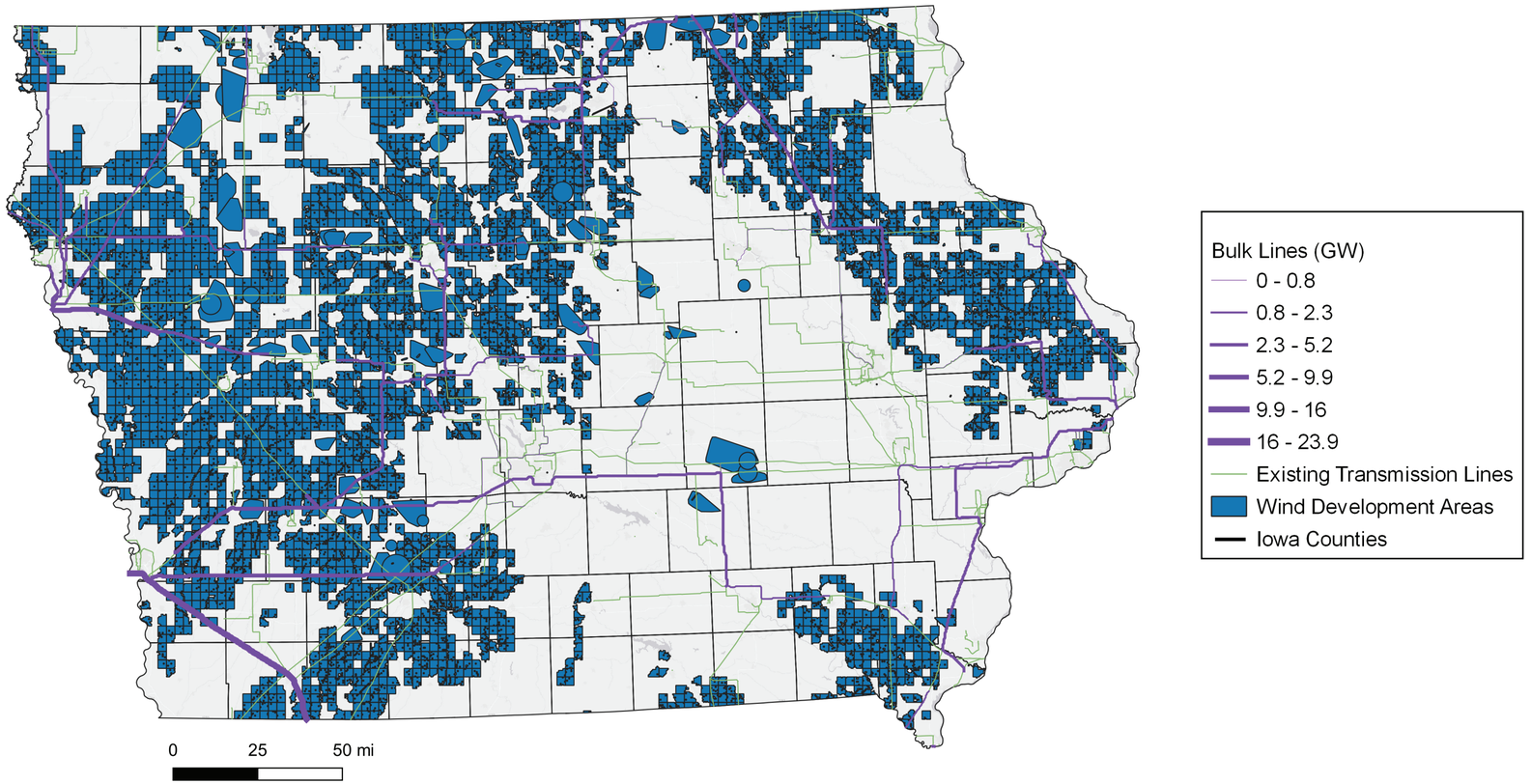
Total Wind Capacity:

- 60 GW

*DIRECT LAND USE ESTIMATIONS ASSUME 3 MW TURBINES AND 0.74 ACRE/MW.[10]

E+ BLUA POTENTIAL TOTAL LAND IMPACTS BY 2050

HIGH ELECTRIFICATION AND BASE LAND USE ASSUMPTIONS



SOURCE: NZAP (2021); IOWA DNR (2020); HIFLD (2022)

NZAP High Electrification, Base Land Use Land Impacts by 2050:

- Indirect
  - 36.2% of land in Iowa
  - ~20,388 square miles
- Direct*
  - 0.3% of land in Iowa
  - ~166 square miles

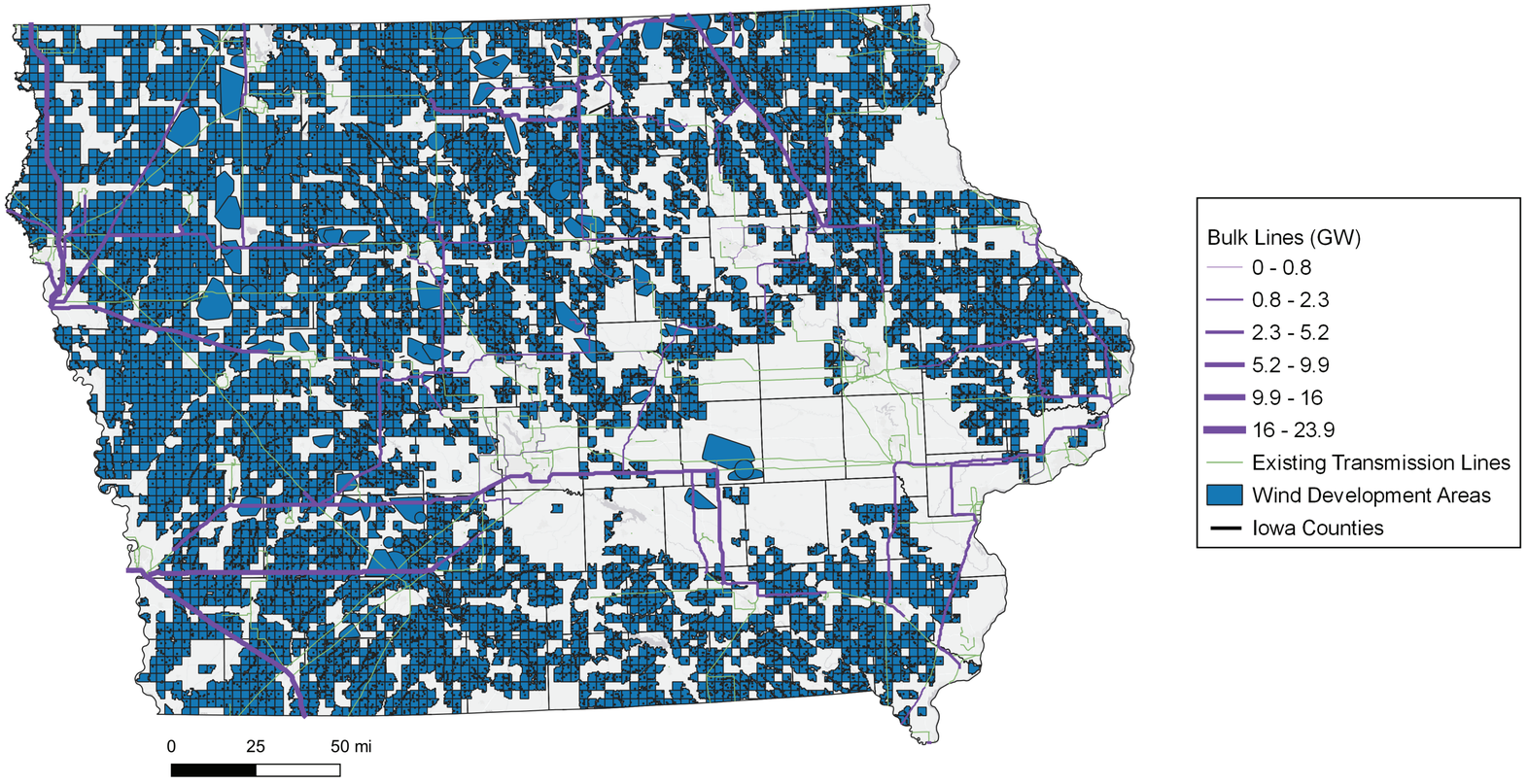
Total Wind Capacity:

- 144 GW

*DIRECT LAND USE ESTIMATIONS ASSUME 3 MW TURBINES AND 0.74 ACRE/MW.[10]

RE+ POTENTIAL TOTAL LAND IMPACTS BY 2050

100% RENEWABLES AND BASE LAND USE ASSUMPTIONS



SOURCE: NZAP (2021); IOWA DNR (2020); HIFLD (2022)

NZAP 100% Renewables, Base Land Use Land Impacts by 2050:

- Indirect
  - 53% of land in Iowa
  - ~29,798 square miles
- Direct*
  - 0.4% of land in Iowa
  - ~243 square miles

Total Wind Capacity:

- 210 GW

*DIRECT LAND USE ESTIMATIONS ASSUME 3 MW TURBINES AND 0.74 ACRE/MW.[10]

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OVERVIEW

NZAP CPAs AND PATHWAYS

We identified Candidate Project Areas (CPAs) as well as the least-cost siting of wind development to achieve 2050 net-zero economy.

ORDINANCE ASSESSMENT

We investigated and collected wind ordinance data from each of the 99 counties in Iowa.

SETBACK/ TECHNOLOGY SCENARIOS

We designed two setback and turbine size scenarios to proxy changing regulatory and technology landscapes.

BUFFER ANALYSIS DEMONSTRATION

We used county-specific setbacks for roads and buildings to eliminate land ineligible for development.

WIND ORDINANCE ASSESSMENT



DATA POINTS OF INTEREST

MORATORIUMS

Prohibitions on all future development or requirements that effectively act as moratoriums. Examples of the latter include caps on the number of turbines allowed in the county.

Some moratoriums are temporarily in place to give counties time to create or update a wind ordinance.

SETBACK REQUIREMENTS

Spatially explicit building use information was unavailable, so the largest setback distance specified, either dwelling or non-dwelling, was applied for all structures.

For roads, setbacks are typically a multiplier (ex. 110%) of total turbine height, defined as the sum of hub height and rotor radius.

HEIGHT LIMITATIONS

Setting a maximum total turbine height precludes the construction of large turbines with greater per-turbine capacity.

DATE OF WIND ORDINANCE

Some counties have had iterations of wind ordinances, so effective dates were recorded when possible to ensure accuracy.

EXPLORATION OF FUTURE REGULATORY ENVIRONMENTS

We designed two scenarios for both setback and turbine size to better understand and quantify the impacts of the changing regulatory landscape and turbine technology on decarbonization.

To reflect increasing ordinance prevalence and wind deployment across the state, we quantified the impact of every county having an ordinance by assuming counties currently without an ordinance or without setback regulations for buildings and roads will adopt permissive ordinances.

Ordinances commonly use total turbine height as a multiplier to determine setback distances. Therefore, as turbines increase in size, the available land area shrinks. We used turbine size projections from the National Renewable Energy Laboratory's 2022 Annual Technology Baseline (ATB). We used ATB's Conservative 2030 turbine size projection because these values have the greatest alignment with the current technology marketplace. To assess the impact of future turbine size on land availability, we used the Advanced 2030 projections.[11]

SCENARIOS

EXISTING ORDINANCES

For counties currently with wind ordinances, we utilized those requirements.

For counties currently without a wind ordinance, we have made no setback assumptions.

ORDINANCES IN ALL COUNTIES

For counties currently with wind ordinances, we utilized those requirements for buildings and roads.

For counties currently without a wind ordinance or with only one type of setback, the assumed setback requirements are the greater of 1,250 ft or 2xH from buildings and/or 1.1 x total height to roads.

CONSERVATIVE TURBINES

ATB Conservative 2030 turbine height of 110 m and a rotor diameter of 150 m for a total turbine height of 185 m.

ADVANCED TURBINES

ATB Advanced 2030 turbine height of 135 m and a rotor diameter of 200 m for a total turbine height of 235 m.

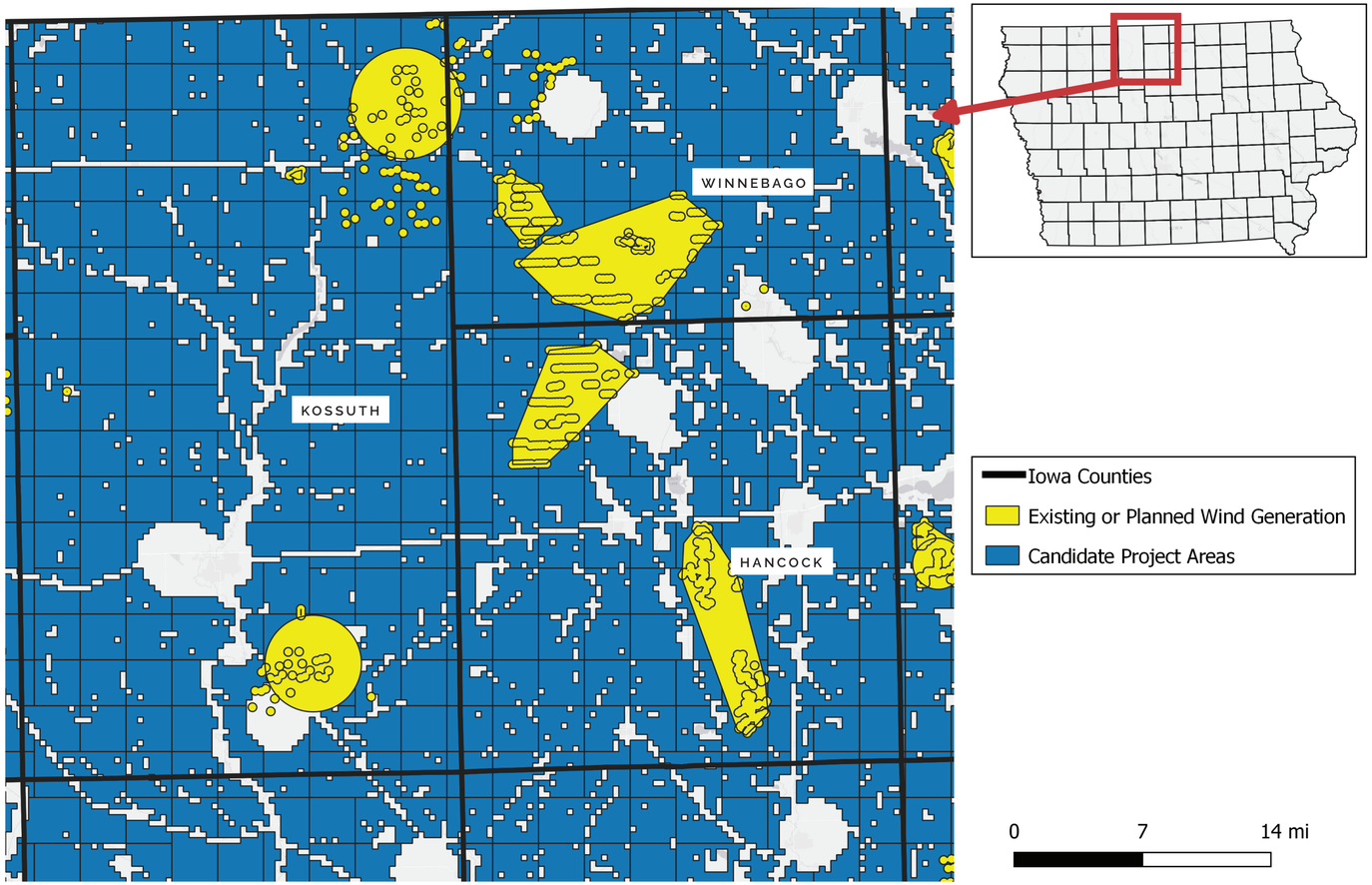
SCENARIO IMPLICATIONS ON LAND AVAILABILITY

SCENARIOS			
EXISTING ORDINANCES AND CONSERVATIVE TURBINES	EXISTING ORDINANCES AND ADVANCED TURBINES	ORDINANCES IN ALL COUNTIES AND CONSERVATIVE TURBINES	ORDINANCES IN ALL COUNTIES AND ADVANCED TURBINES



As the prevalence of setbacks and the size of turbines increase across our scenarios, the limitations on land available for future development increase accordingly.

DOWNSCALING METHODOLOGY DEMONSTRATION



SOURCE: EIA USWTDB (2021); NZAP (2021); IOWA DNR (2020)

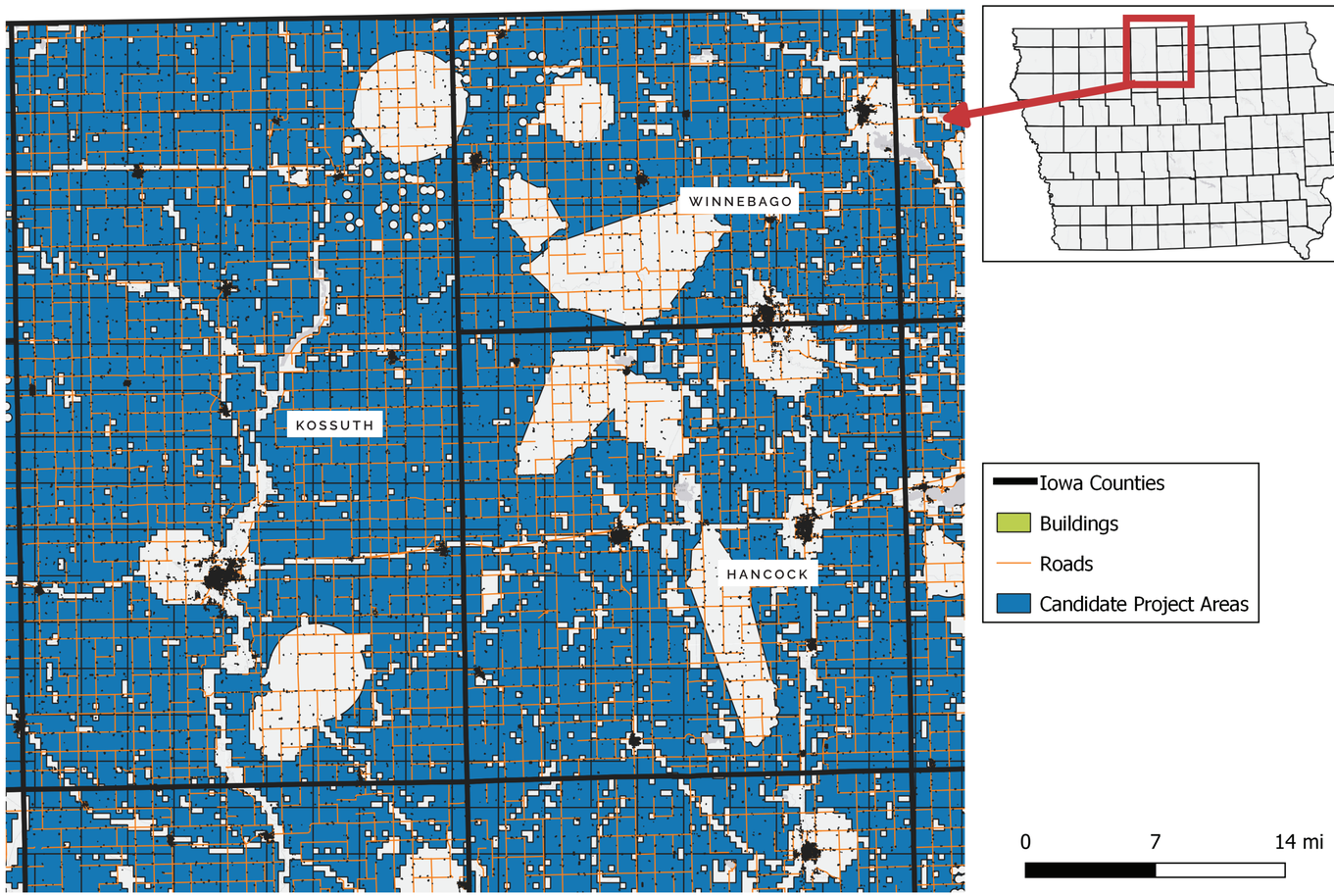
This map displays Candidate Project Areas for three counties in Iowa.

Blue features represent potential wind energy development areas.

Yellow features, representing existing or planned wind farms and turbines, were removed.

Our results, therefore, only reflect differences in potential wind development areas.

DOWNSCALING METHODOLOGY DEMONSTRATION (CONT.)



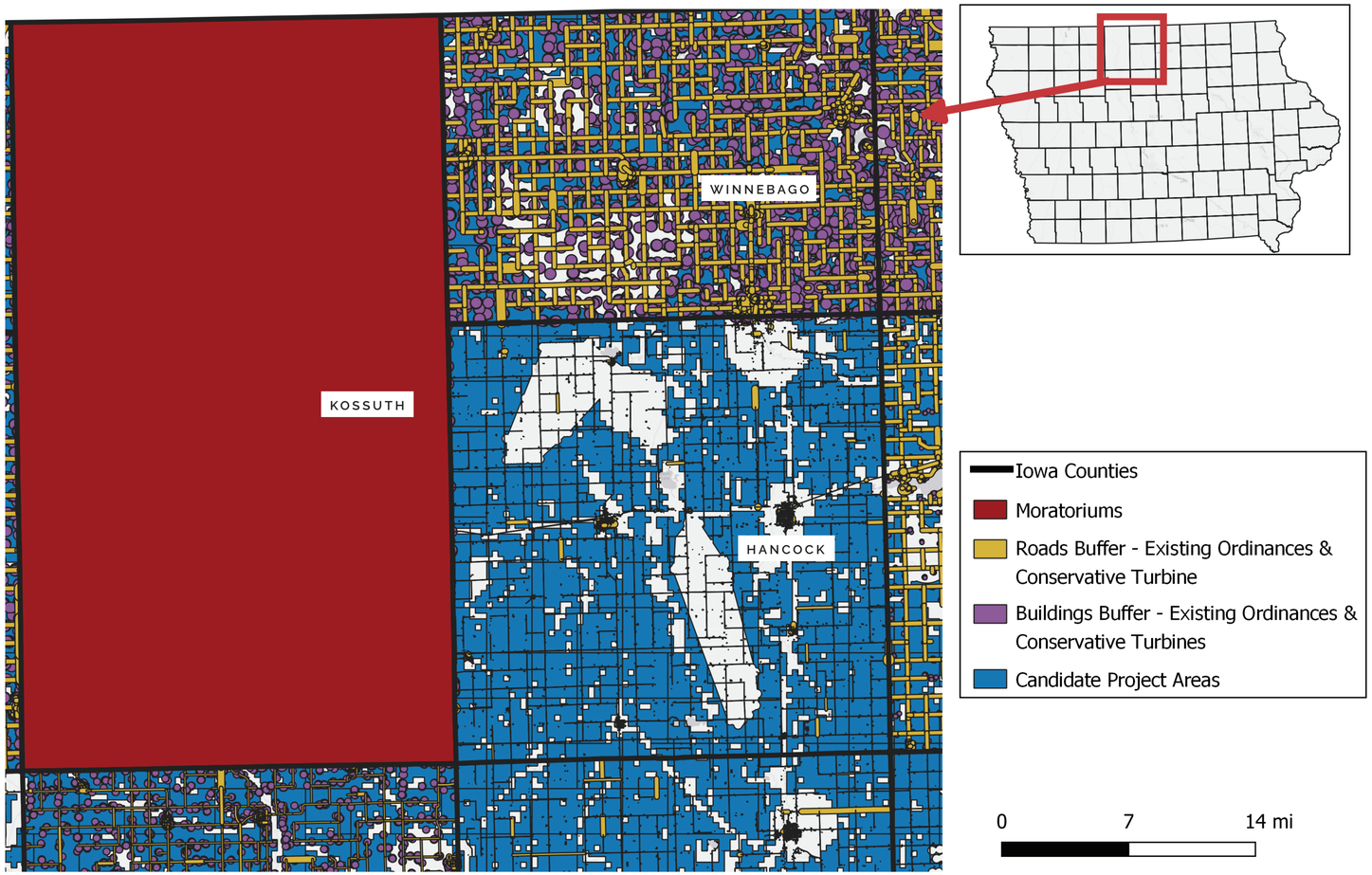
SOURCE: NZAP (2021); IOWA DNR (2020); IOWA DOT (2021); MICROSOFT MAPS (2021)

Spatial datasets for buildings and roads in Iowa overlay the area identified as Candidate Project Areas.

Differences in land use, particularly the density and distribution of roads and buildings, across counties contribute to variations in the availability of Candidate Project Areas.

We don't assess the impact of future land use changes in this analysis. We expect that increasing the density and extent of the built environment would further constrain land availability.

DOWNSCALING METHODOLOGY DEMONSTRATION (CONT.)



Setbacks from Existing Ordinances using Conservative Turbines are applied to buildings and roads as buffers. Road buffers represent the width of each road and the setback distance.

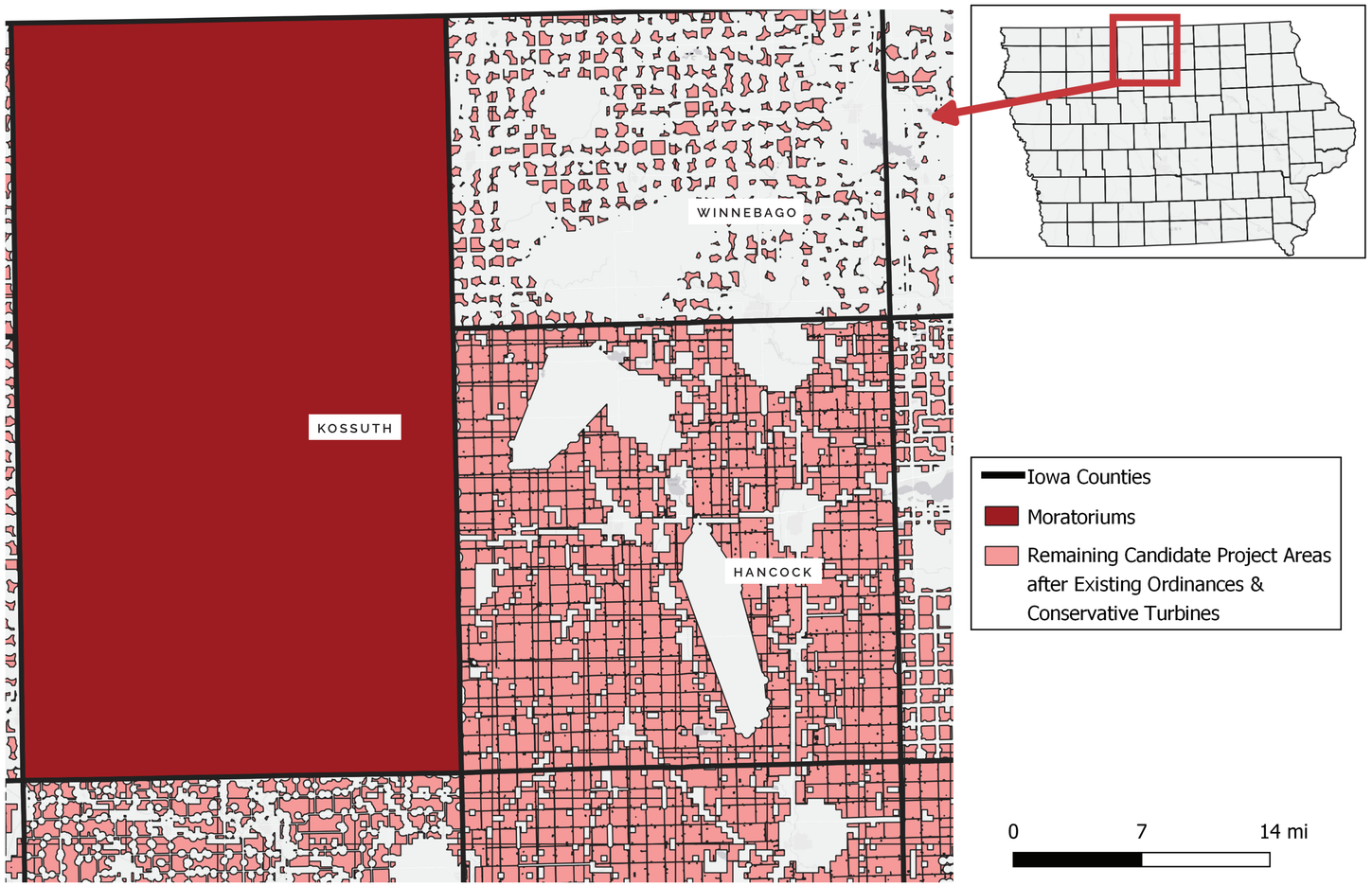
Moratorium counties were removed entirely. This is exhibited by the red rectangle overlaying Kossuth County.

Hancock County currently does not have a wind ordinance, so road and building footprints were removed.

Winnebago County has a wind ordinance with permissive setback requirements for buildings and roads, which are applied.

SOURCE: NZAP (2021); IOWA DNR (2020); IOWA DOT (2021); MICROSOFT MAPS (2021);CLEARPATH IOWA WIND ORDINANCE DATABASE

DOWNSCALING METHODOLOGY DEMONSTRATION (CONT.)



Buffered areas are removed from development areas to display the remaining land available for wind development.

In Kossuth, no land is available as a result of the moratorium.

In Hancock, there is no ordinance, so the only reduction in available area reflects road and building footprints.

In Winnebago, wind ordinances greatly reduce the amount and intactness of the area available for development.

SOURCE: NZAP (2021); IOWA DNR (2020);CLEARPATH IOWA WIND ORDINANCE DATABASE

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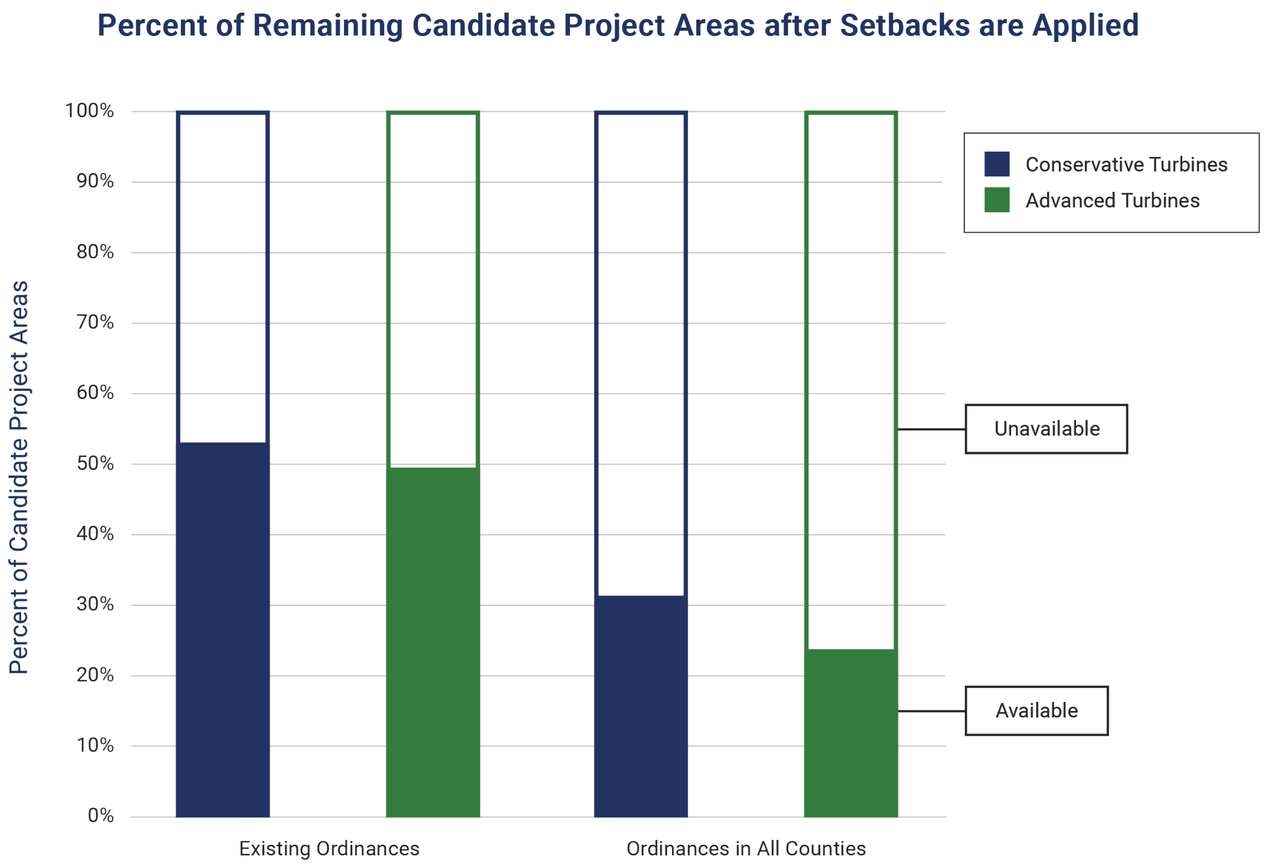
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ORDINANCES GREATLY REDUCE TOTAL DEVELOPABLE AREA



49-52% of total CPAs are unavailable under Existing Ordinances.

70-77% of total CPAs are unavailable under Ordinances in All Counties (scenario assumes that counties without ordinances adopt permissive setback requirements).

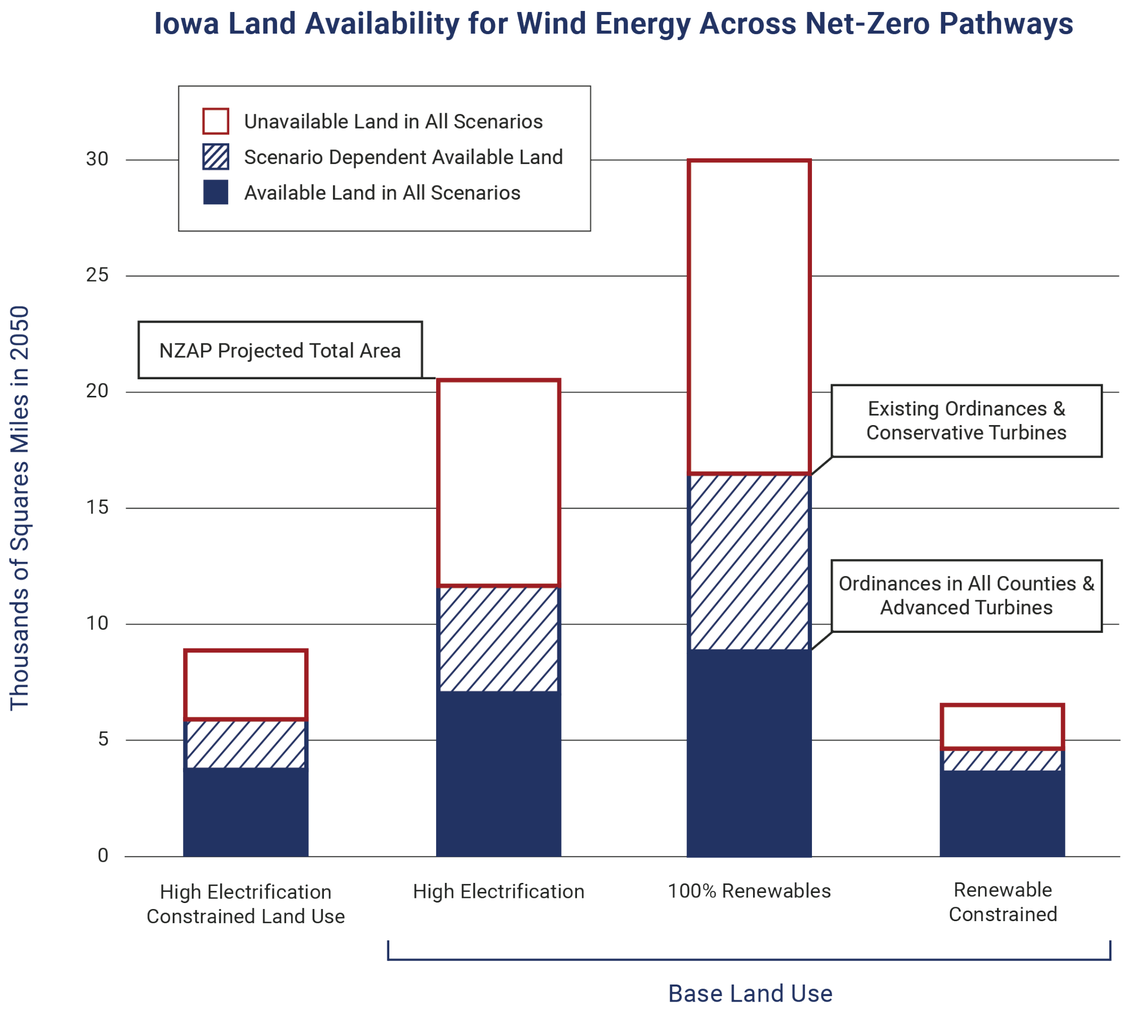
The increasing prevalence and stringency of ordinances in areas with the best wind resources may lead to even greater reductions in potential wind capacity.

The ability to offset capacity losses through larger turbines with higher production is unclear.

- Larger turbines have greater setbacks and require greater spacing between turbines, further constraining land availability.

- Many counties have adopted height limits that would prevent the adoption of these advanced technologies, indicating that increased size may result in more opposition.

AVAILABLE LAND FALLS SHORT OF NZAP TARGETS

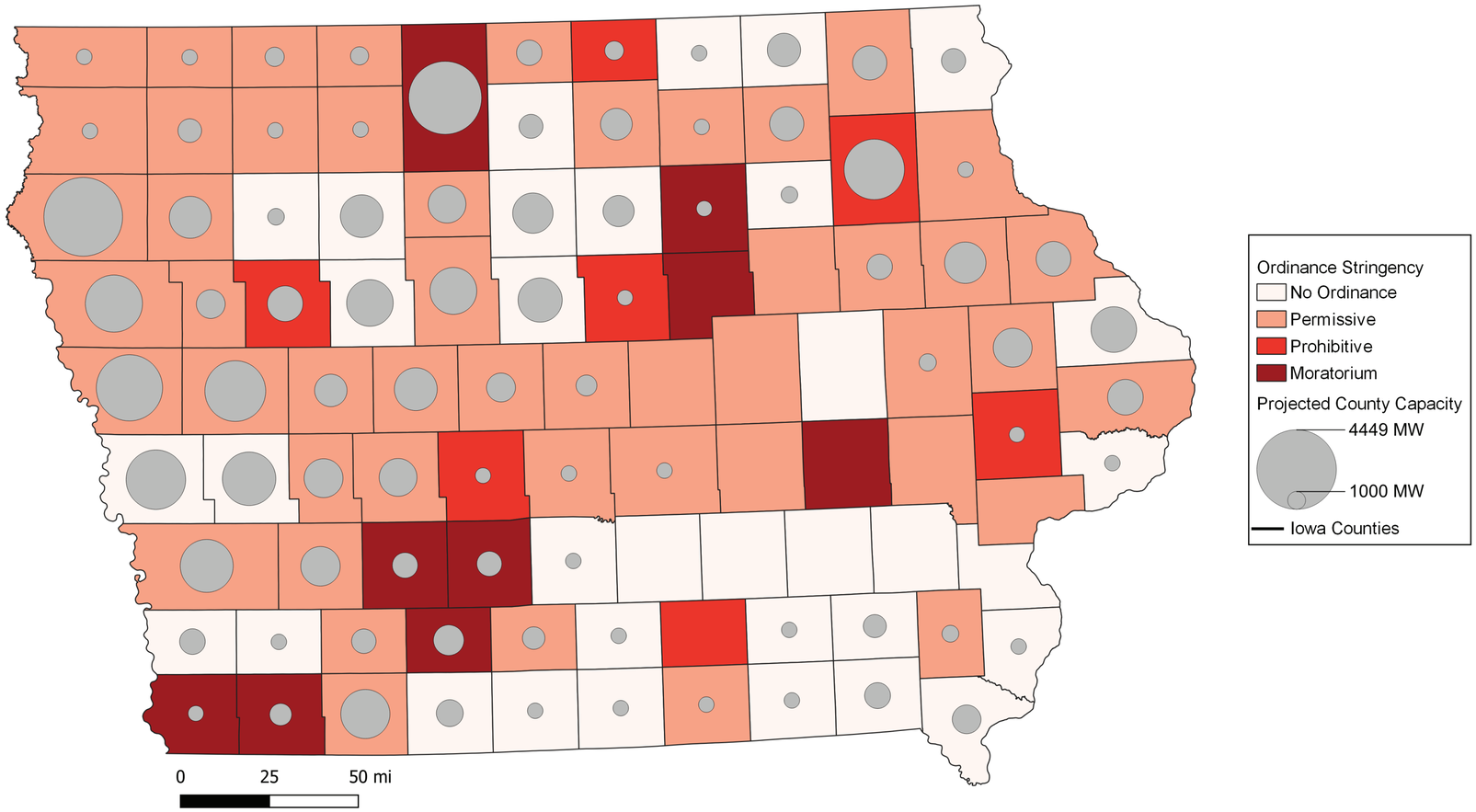


The least-cost siting projections for each net-zero pathway are not feasible under any ordinance or turbine-size scenario we assessed.

The interplay between the highly variable and unpredictable landscape of local regulations and the dynamism of turbine technology demonstrates the importance of considering local siting-derived land use constraints in net-zero planning.

Land with existing and planned wind development is included in these figures.

OVERLAY EXAMPLE: E+ BLUA SCENARIO COMBINED WITH EXISTING ORDINANCES



Map displays total new capacity built by county in 2050 within NZAP's High Electrification, Base Land Use Pathways (E+ BLUA), overlaid on existing ordinance status in Iowa.

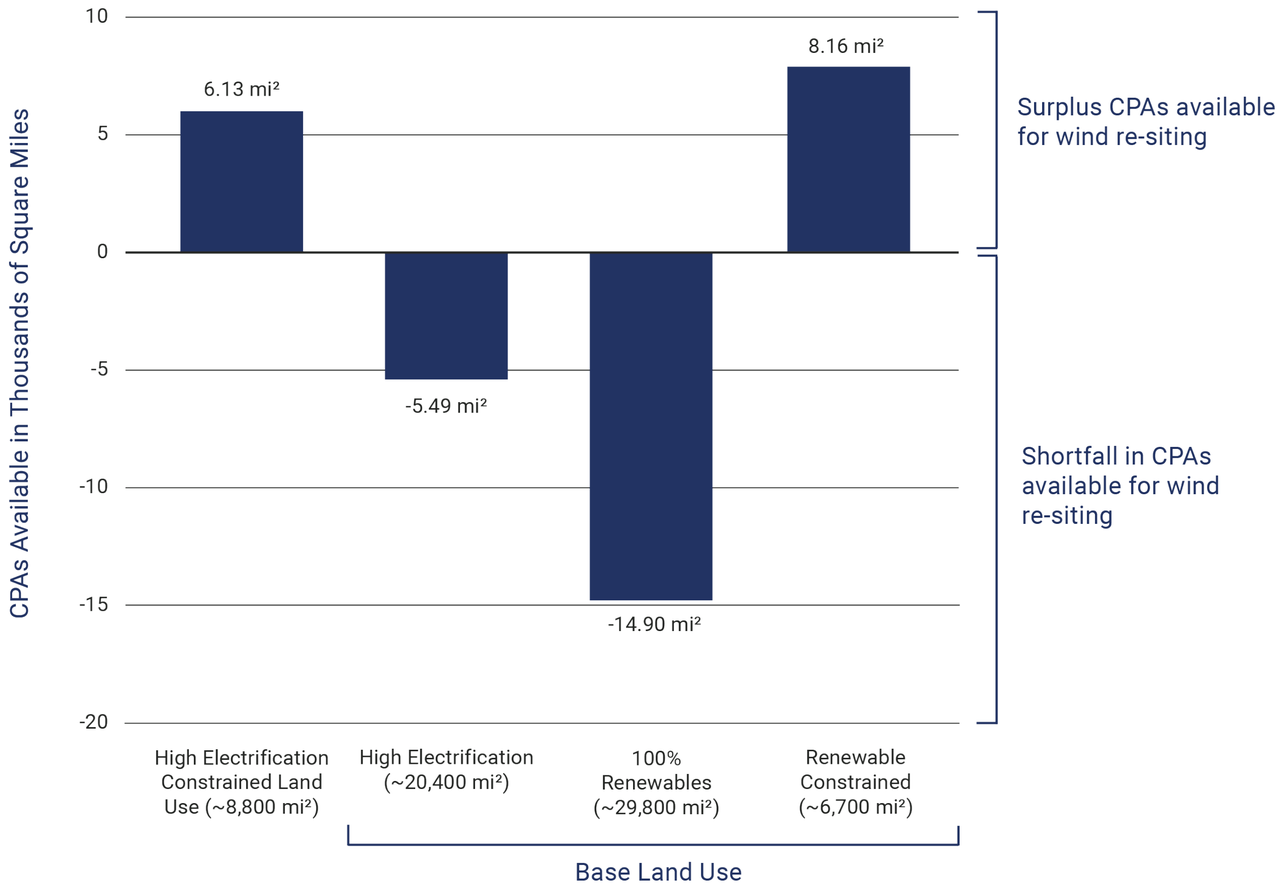
19 GW of wind is sited in counties with a Prohibitive ordinance or Moratorium.

49% reduction state-wide in land available for wind development due to setbacks under our Existing Ordinances and Conservative Turbines scenario.

SOURCE: NZAP (2021); IOWA DNR (2020); CLEARPATH IOWA WIND ORDINANCE DATABASE

RE-SITING IS POSSIBLE, BUT NOT IN ALL PATHWAYS

Available Land in Iowa to Re-site Wind Turbines Across Net-Zero Pathways, Assuming Ordinances in All Counties and Conservative Turbines



Even if specific sites are unavailable due to setbacks, it may be possible to re-site wind farms elsewhere in the state to achieve net-zero deployment levels.

Constrained Renewables is the most plausible net-zero pathway, with the most alternative land available for in-state wind siting in each scenario we assessed.

Reaching the deployment targets for a **100% Renewable net-zero pathway is infeasible** in every ordinance and turbine scenario we assessed.

The High Electrification net-zero pathway plausibility depends on the land use and scenario. There is enough land for re-siting with existing ordinances, but if new ordinances are adopted, that would no longer be possible.

LIMITATIONS AND OPPORTUNITIES FOR FUTURE RESEARCH

The High Electrification net-zero pathway was assessed under two land use assumptions: base and constrained. The constrained land use assumptions restrict development on prime farmland or intact landscapes. As a result, Princeton's model selected areas outside the grain belt further west and in areas with greater human modification. Our findings that the constrained land use pathway has greater viability than the base land use for the High Electrification net-zero pathway should be tempered with the reality that Iowa's role was minimized.

Wind ordinances and sociopolitical dynamics driving moratoriums are occurring throughout the United States. The degree of flexibility in alternative areas for re-siting wind will vary geographically, reflecting both the technical potential of the resource and regulatory feasibility.

The growth of the built environment could further constrain the availability of land for wind development in the future and was not considered in our analysis. The impact of future development and modifications to land, mainly changes in the built environment, on the availability of land for wind turbines and other energy infrastructure is an important area for future research. Communities interested in attracting wind development could consider the preservation or strategic development of their built environment in economic development plans to ensure future wind development remains viable in their communities.

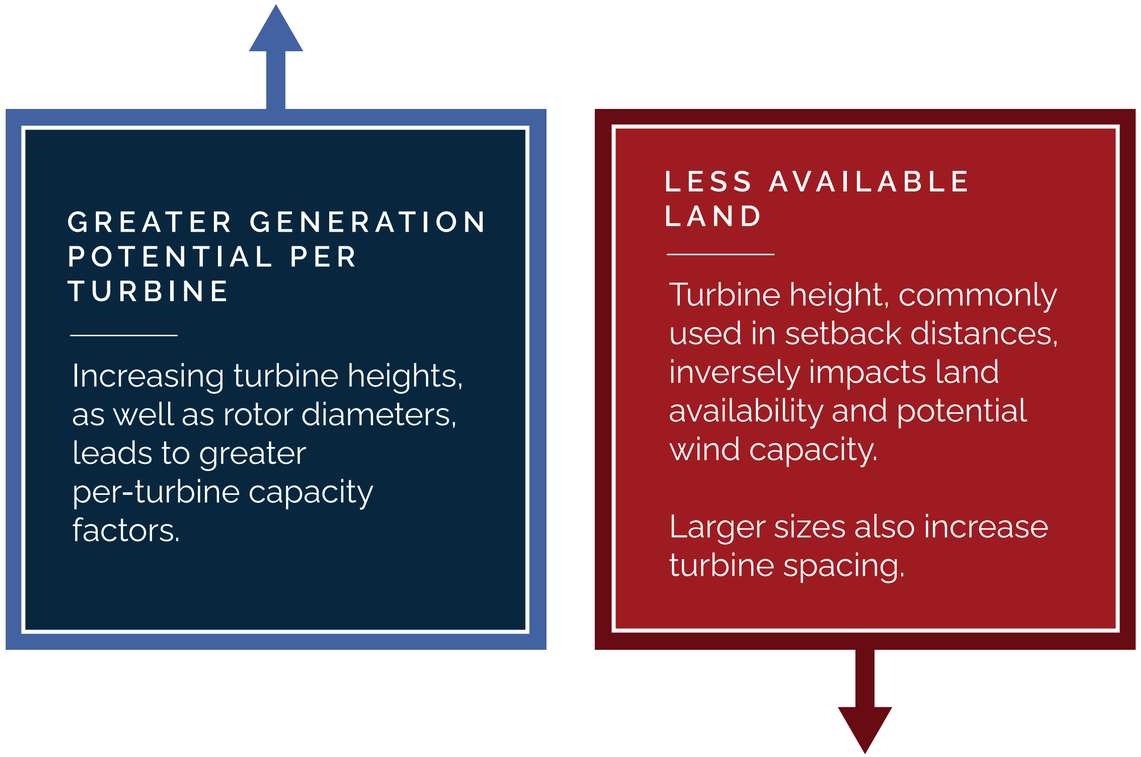
THE TRADEOFFS OF LARGER WIND TURBINES

The ability to compensate for reduced land availability through greater turbine capacity factors and generation potential from larger turbines depends on turbine specifications and local conditions.

Community preference for fewer larger turbines vs. more smaller turbines is an important consideration for developers and an area for future research.

Repowering wind turbines entails upgrading turbine components or replacing entire turbines to improve performance without additional land use expansion.

Repowering wind turbines over time is not captured in our analysis and could play a key role in reaching decarbonization targets.



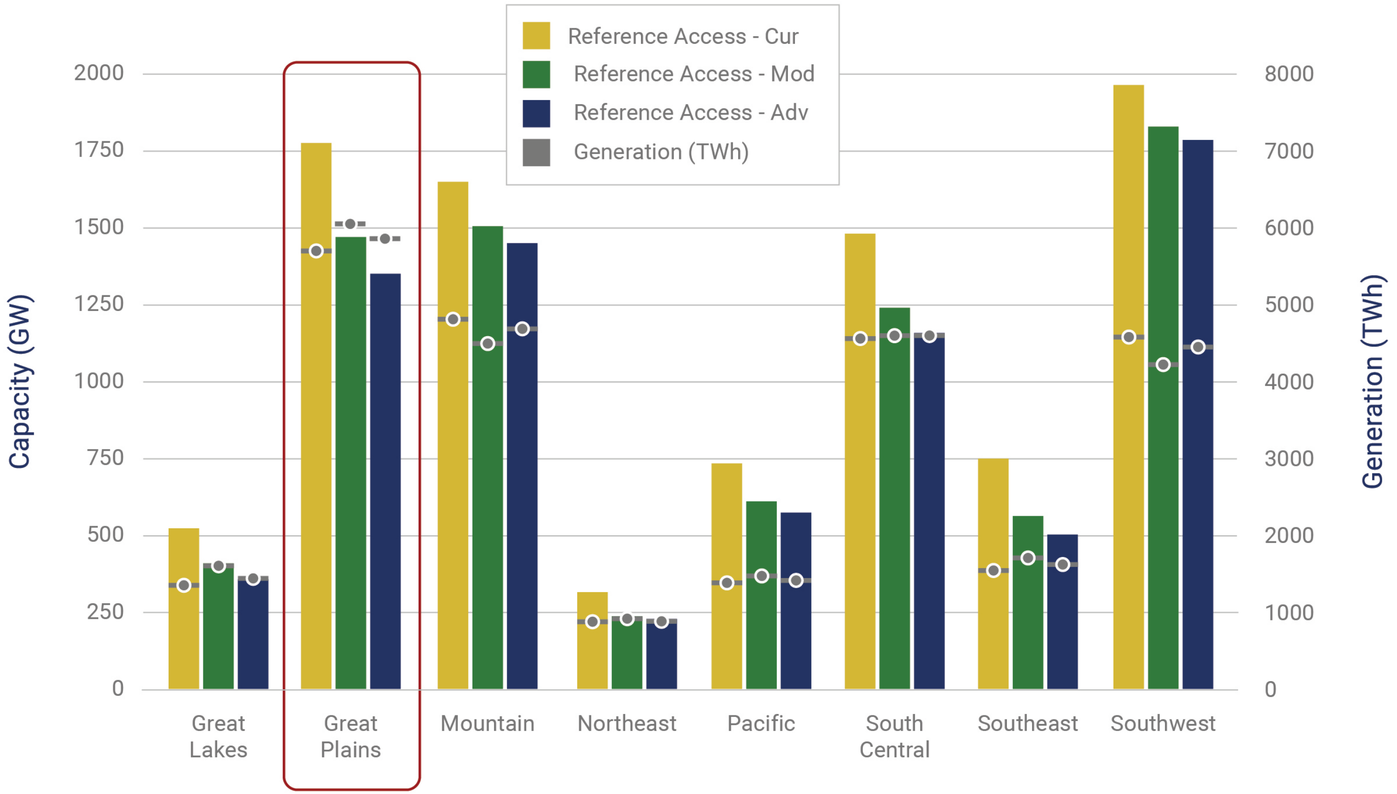
NREL STUDIED SENSITIVITY OF TURBINE PERFORMANCE TO LAND CONSTRAINTS

A 2021 National Renewable Energy Lab study[12] examined the sensitivity and potential of onshore wind across the conterminous U.S. under three setback and turbine-height scenarios.

- Reference Access:
  - Applies site screening filters similar to those employed by NZAP.
  - Adopts county setback restrictions comparable to our Ordinances in All Counties setback scenario.
- Three turbine scenarios — Current, Moderate, and Advanced — ranging from 146 to 235 meters in total height.

Key Findings:

- Increasing turbine size results in less than 1% difference in national onshore wind generation potential. However, region-specific wind characteristics have variable impacts.
- In the Great Plains, including Iowa, moderate turbines can compensate for decreased land availability and capacity better than advanced turbines.
- Increasing rotor diameters, rather than increasing hub height, may mitigate the reduction in capacity potential and generation and is an area for further research or assessment on a site-specific basis.



ADAPTED FROM LOPEZ ET AL., (2021)

SETBACK ANALYSIS TAKEAWAYS

Setback requirements for both roads and buildings impose significant constraints on the land available for wind deployment. There is considerable variation across counties due to differences in ordinances and the configuration of roads and buildings.

We find that there is room to expand wind in Iowa several times over on a pure land use availability basis. However, the feasibility of net-zero pathways that rely on high levels of wind energy will be significantly challenged.

The use of wind turbine size as a function of setback distance has a pronounced impact on land availability, but improved technology performance could compensate.

When setbacks have multiple restrictive requirements, they can become significant barriers to achieving the scale of deployment necessary for a net-zero economy. This is especially true in the context of technological innovation, as the combination of increasing setback distances and height limitations may nullify technology advancements that could overcome land constraints.

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INFLUENTIAL FACTORS FOR WIND DEVELOPMENT ACCEPTANCE

PERCEPTIONS OF NOISE AND AESTHETICS

- Perceptions of turbines fitting within the landscape and/or community.
- Annoyance with either the visual or noise impact of wind turbines.

PROCEDURAL AND DISTRIBUTIVE FAIRNESS

- Actions taken during the wind project planning and development process by local government officials, planning consultants, and wind developers and the degree of participation extended to community members is procedural fairness.
- What are the costs and benefits of wind development, and who receives them is distributive fairness.

PERCEPTION OF VISUAL AESTHETICS AND NOISE ANNOYANCE

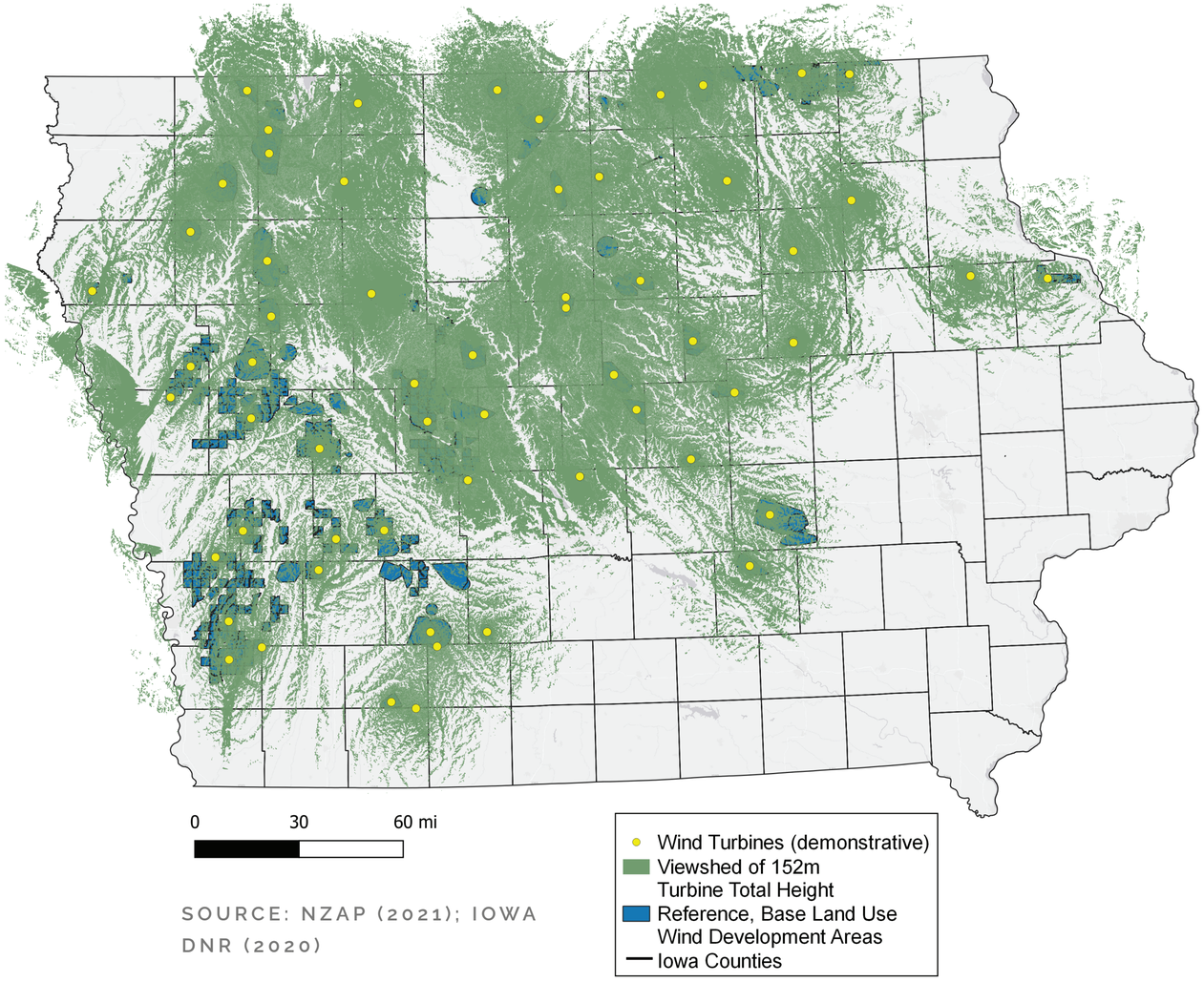
Perception of turbines — the like or dislike of their aesthetics — is a stronger predictor of attitude than the proximity of turbines to one's home or turbine characteristics.[13]

Research has found that wind turbine noise annoyance is primarily an expression of personal experience and visual perceptions rather than an objective response to wind turbine sound level.

- However, the direction of the causal relationship between aesthetic perceptions and noise annoyance remains undetermined.[13]

The expectation of adverse effects, such as the perception of turbines as a health risk, contributes to reduced support, despite epidemiological research concluding that turbine sound does not directly or adversely affect human health or sleep quality.[14]

TECHNOLOGY ADVANCEMENT IMPACTS ON VISUAL EXTENT



SOURCE: NZAP (2021); IOWA DNR (2020)

VISUAL EXTENT

Turbines need unobstructed wind to operate efficiently, so selected sites also tend to have few visual obstructions.

Princeton found wind farms' visual extent in Iowa is **7,080-30,558 mi²** across each NZAP technological pathway relative to the Reference in 2050.[15]

We performed a Viewshed Analysis using randomly selected points within NZAP Reference, Base Land Use Wind Development Areas to exemplify turbine locations. We assessed the visual extent of turbines for a person of average height, 5 ft 7 in. Surface features that can obscure line of sight were not considered in this analysis, only elevation.

We found that the visual extent of wind turbines **increased 13%**, from between turbine heights of 152 m to 185 m, and **increased 29%**, going from a turbine height of 152 m to 235 m. In 2019, when moratoriums began to take effect across Iowa, typical turbine heights were around 152 m.

TECHNOLOGY ADVANCEMENTS MAY INTENSIFY OPPOSITION

Six counties in Iowa include turbine height limits in their wind ordinances, suggesting that larger turbines may exacerbate negative attitudes and opposition to wind.

Turbine accessibility — the frequency with which individuals see turbines — will increase with deployment and as a function of increasing turbine size.

- The increase in visual extent widens the pool of individuals and communities that are visually impacted and may differentially alter the landscape for individuals and communities. Perceptions of how turbines fit into the community are likewise not homogenous across individuals or communities.

Lack of firsthand experience and perceptions of process and compensation fairness have greater explanatory power for the geographical extent of noise concerns.[16]

Studies suggest that noise concerns extend beyond what sound propagation models predict,[16] so we can expect noise concerns and opposition to grow with increasing turbine size. The impact of larger turbines on sound levels is itself an important area of future research.

PROCEDURAL AND DISTRIBUTIVE FAIRNESS

The question of who participates, who is compensated, and to what extent will need to adapt as the compounding and cumulative impacts of increasing turbine size and deployment cross property lines and political boundaries.

- Research suggests that the perceived fairness of wind planning processes has long-term impacts on attitudes and support, which will play a pivotal role in sustaining "support for adding new and repowering old turbines."[17]

Community preference for fewer larger turbines vs. more smaller turbines is an important consideration for developers and an area for future research.

- Fewer turbines mean fewer participating landowners compensated by the developers, most commonly for hosting turbines or related infrastructure. Participating landowners often have more opportunities to provide input on the development process than non-compensated members of the community.
- This may exacerbate wind development's observed effect of dividing communities and widening socioeconomic disparities between community members.[18]

BEST PRACTICES MAY NOT BE ENOUGH

Developer best practices identified in Elmallah & Rand, (2022) and amplified in the broader literature include:

- Afford non-participants similar information and opportunities to provide input and voice concerns as participating landowners.
- Provide resources for and knowledge-sharing opportunities among local governments.
- Create structures for participation, information provision, and decision-making throughout the wind development process.
- Consider local contexts of historical power generation and residents' connections to the land.

In Indiana, Apex Clean Energy's Exploring Wind Vermillion campaign incorporated these best practices, yet Vermillion County adopted a wind ordinance whose prohibitive requirements effectively cancelled the project.[20]

This example underscores the importance of maintaining a tech-neutral decarbonization approach that implements policies and best practices to maximize wind deployment in communities that encourage development in addition to policies and programs that support other low-carbon resources.

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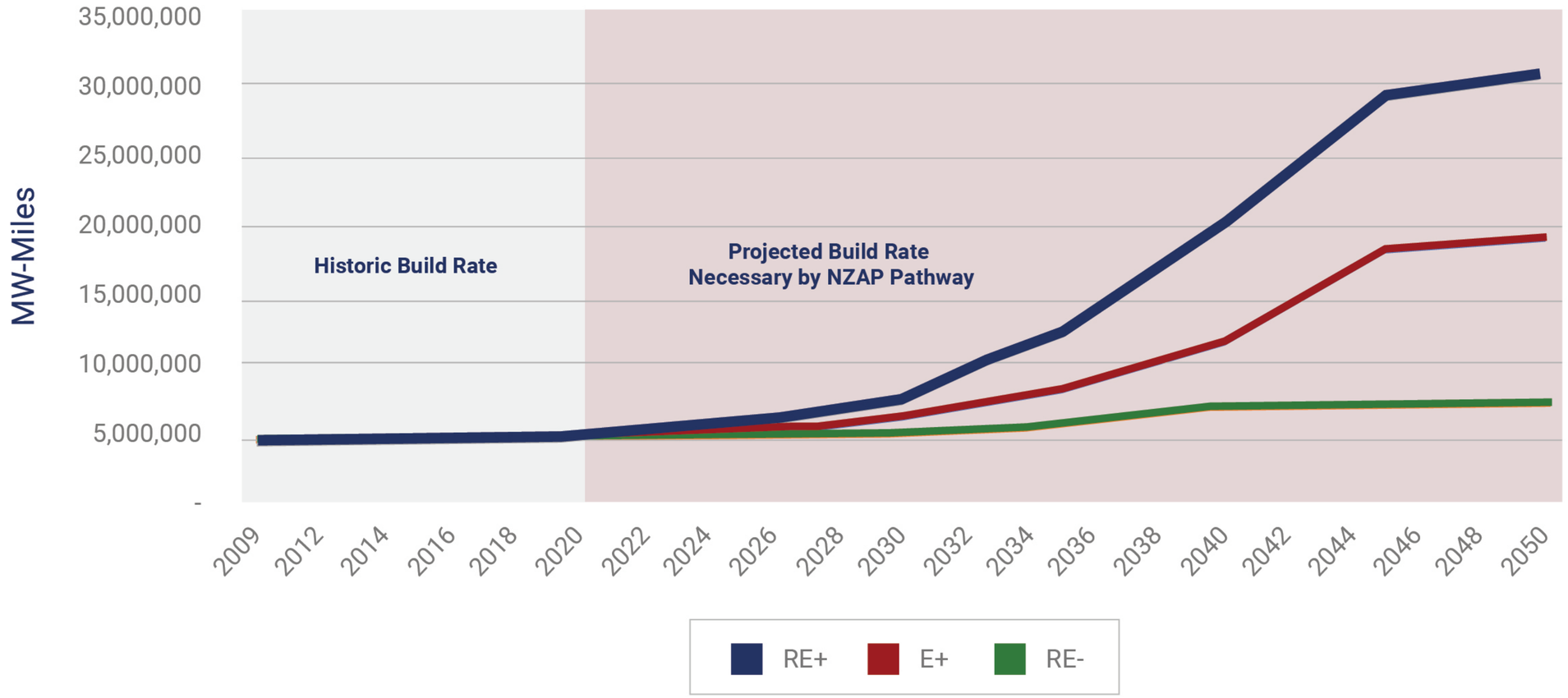
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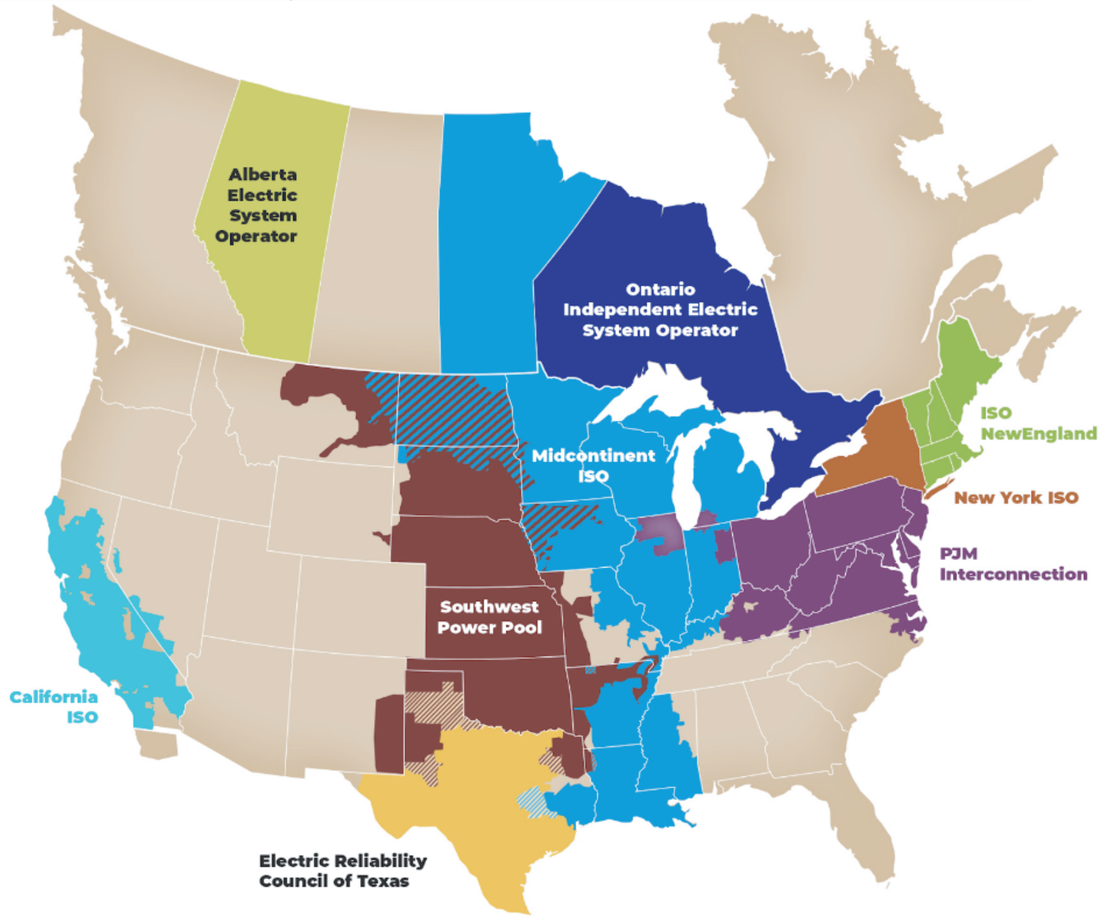
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IOWA'S TRANSMISSION BUILD RATES NEED TO INCREASE RAPIDLY



According to NZAP, absent the renewable constrained scenario, new transmission capacity will need to rise sharply beginning in the late 2020s.

OVERVIEW OF TRANSMISSION IN IOWA



Transmission is the backbone of the electric grid and is essential to providing reliable, low-cost, low-carbon electricity through the transport of electricity, especially over long distances.

Operation of Iowa's grid is divided between two organizations: Midcontinent Independent System Operator (MISO) and Southwest Power Pool (SPP). States and local utilities are responsible for siting of regional and interregional transmission projects planned by and located in MISO and SPP.

- Utilities are also responsible for transmission and distribution infrastructure within their service footprint to meet reliability and economic needs.

OVERVIEW OF TRANSMISSION IN IOWA (CONT.)

- MISO operates most of the grid in Iowa and served roughly 93% of the load through its wholesale electricity markets in 2020, according to EIA Form-861 data.

- The MISO Transmission Expansion Plan (MTEP) has been at the forefront of designing and implementing an innovative, transparent, and forward-looking transmission planning process.

- In 2011, MISO identified Multi-Value Projects that address "reliability, economic and public drivers in the development of transmission solutions that provide benefits in excess of its cost" across the service footprint.[21] The first MVP portfolio included 17 transmission projects covering over 2,000 miles of 345 kV or 765 kV lines that are nearly all in service today. The benefit-cost ratio of these projects over the next two decades is between 2.4 and 10.4x.[22]

- Transmission investment returned to historic levels in the years following the approval of the MVP portfolio and did not meet or exceed that level of investment despite the addition of the South Subregion to MISO's footprint that began in 2012.[23]

- Additionally, the shared boundaries along SPP and MISO – known as seams – compound existing difficulties in connecting new generation to the grid.[24] Seam areas, in particular, introduce additional temporal and cost uncertainty because they are more likely to necessitate the evaluation of a new generation project's impact on the neighboring system's grid, known as affected system studies. The procedure and timing of these studies are not standardized and have the potential to introduce significant costs to an interconnection customer late into the process.[25] [26]

TRANSMISSION AND INTERCONNECTION QUEUE METHODOLOGY

- **Understanding the transmission landscape is critical to evaluating the feasibility of developing the wind capacity suggested in the NZAP study.**

- **To illustrate the historic high-voltage transmission build rates,* existing capacity, and forecast build, we reviewed the following:**

    - All Iowa Utilities Board dockets on proposed lines from 2010 to 2020.

    - Harvested information on voltage, line length, initial franchise submission date, construction completion date, instances of public opposition during the process (i.e., written or verbal comments during hearings), and the use of eminent domain.

    - MISO's Interconnection Queue for Large Generation Projects and MISO's interactive Point of Interconnection Map (which shows available capacity at POIs in Iowa).

    - Historic generation deployment (which is used as a proxy for transmission development) and forecast generation for each NZAP scenario.

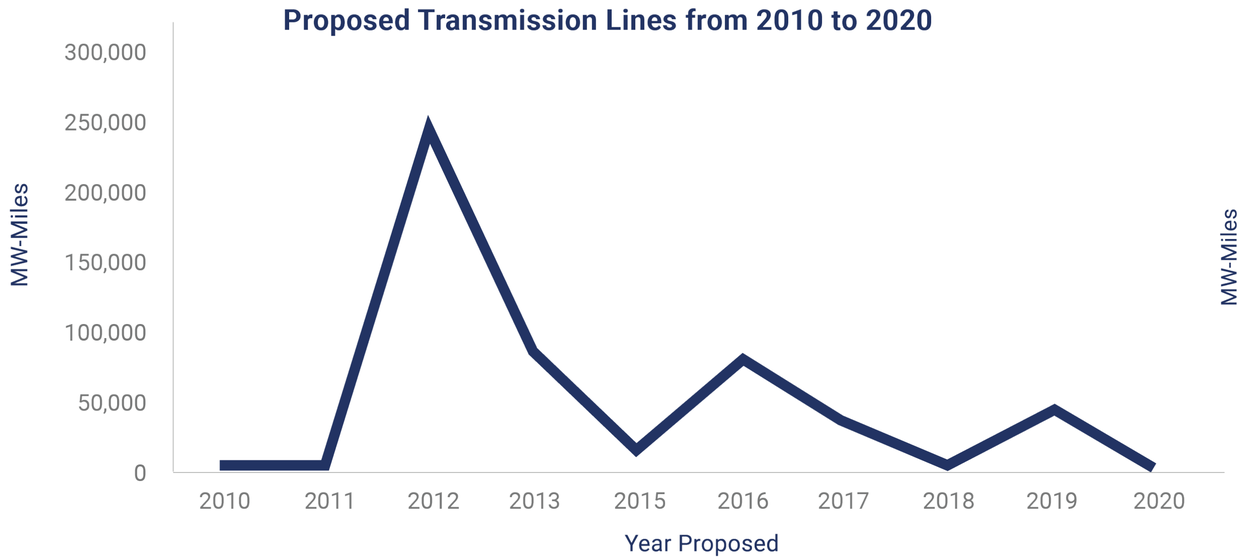
***161 kV and 345 kV only**

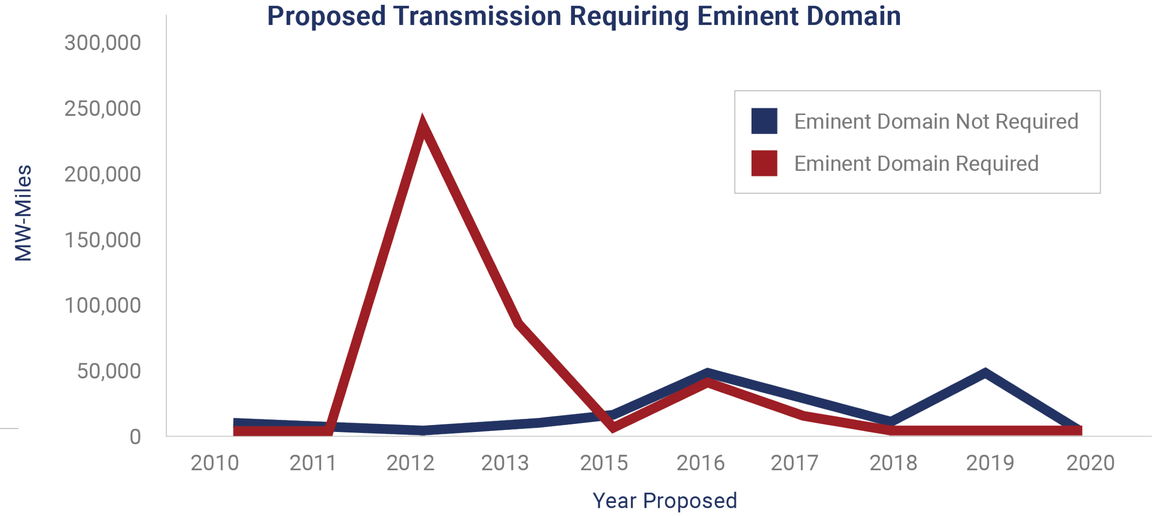
IOWA'S TRANSMISSION BUILD RATE IS TRENDING DOWN

LucidCatalyst reviewed all 71 dockets for transmission line proposals overseen by the Iowa Utilities Board for 161 kV and 345 kV lines proposed between 2010 and 2020.

Proposals for new high-voltage transmission capacity (measured as MW-miles) trended down over the past decade.

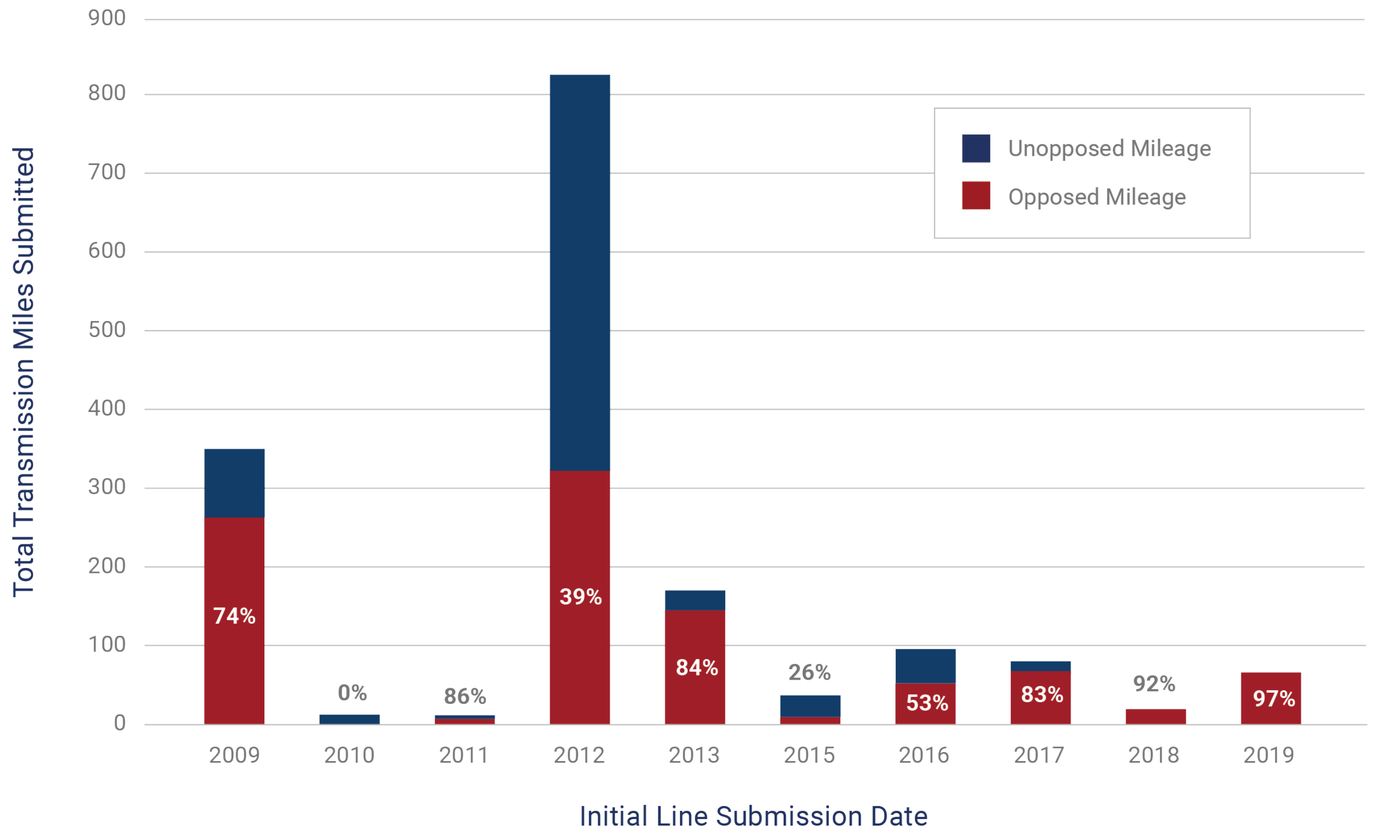
More than 50% of transmission projects required eminent domain to complete; however, this requirement has trended down.





TRANSMISSION PROJECTS IN IOWA FACE SIGNIFICANT OPPOSITION

Proposed Transmission in Iowa Declining; Opposition Proportion Consistently High

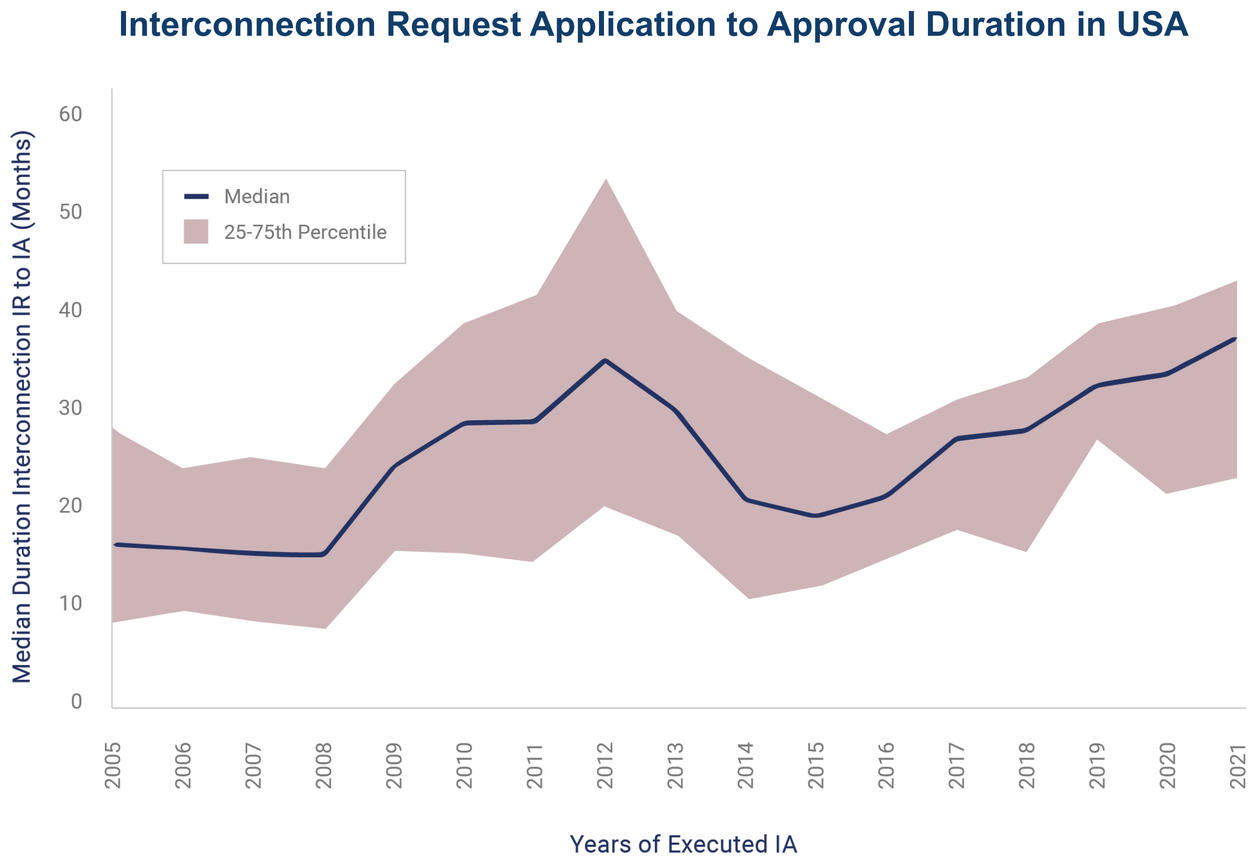


Public opposition noted in Iowa Utilities Board dockets is increasing in absolute terms and as a proportion of proposed projects.

On average, 47% of 161 kV line segments have faced opposition, and 61% of 345 kV lines have faced opposition.

Only projects over 1 mile in length were considered.

WHAT IS THE NATIONAL TREND FOR INTERCONNECTION TIMELINES?



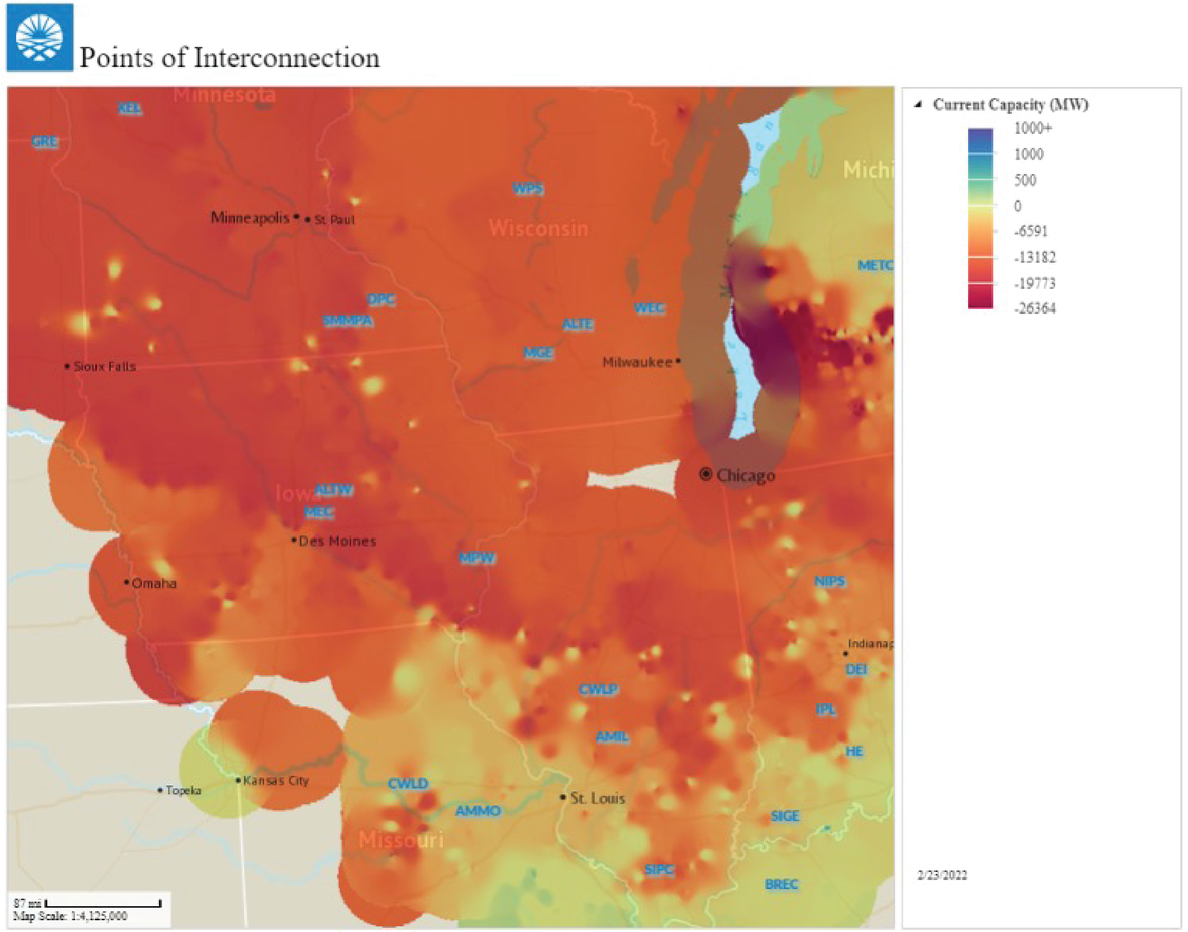
ADAPTED FROM LBNL (2022)

Utilities and grid operators require new electricity projects seeking grid connection to undergo a system impact study before being built. This process establishes necessary transmission upgrades before a project can connect to the system, then estimates and assigns the costs of that equipment.

An analysis of the national interconnection queue by Lawrence Berkeley National Laboratory found that wait times – the period between an Interconnection Request (IR) and Interconnection Agreement (IA) – have increased over time.[27]

In four ISOs, the typical duration from interconnection request to agreement has increased sharply since 2015 and is now longer than three years.

TRANSMISSION CAPACITY IN IOWA IS LIMITED



SOURCE: MISO POI MAP

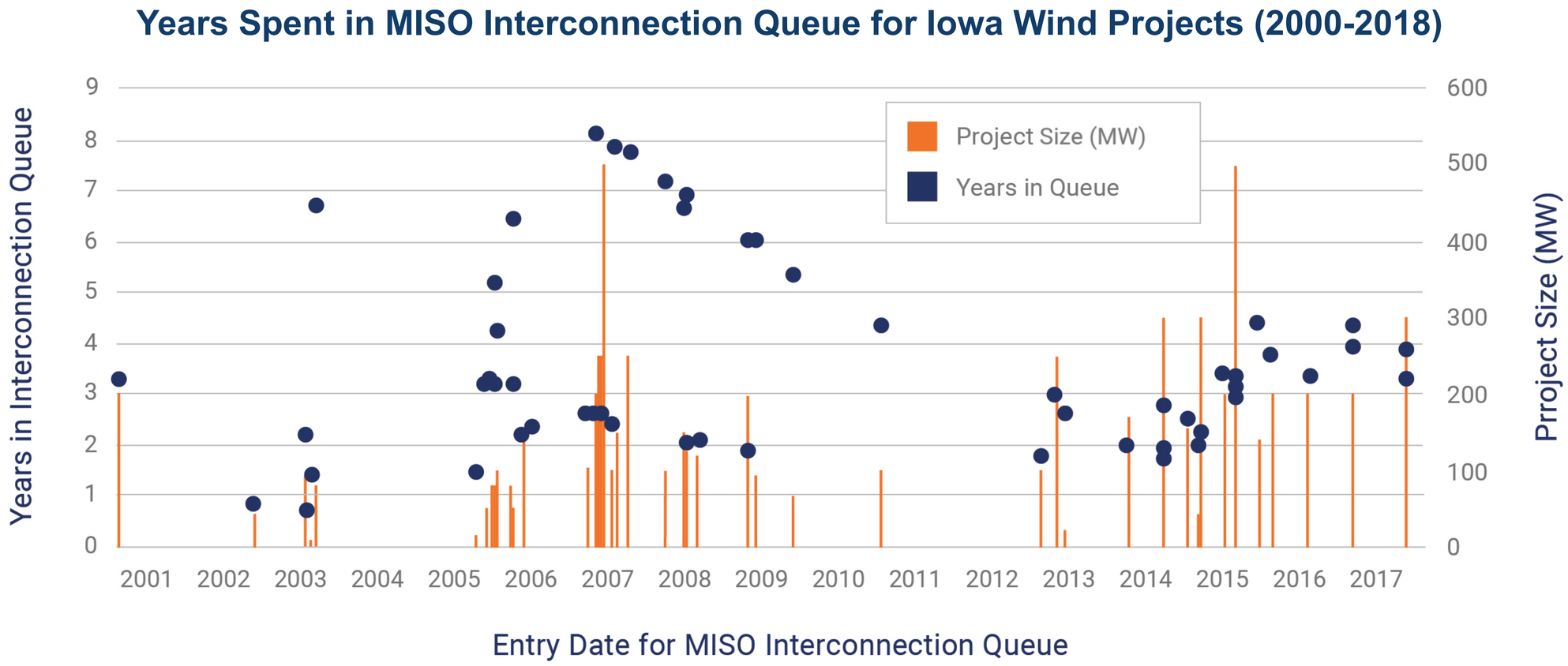
There are currently ~2,500 MWs of Iowa wind capacity in MISO's interconnection queue, the list of transmission and generation projects in the process of connecting to the electric grid.

According to MISO's Point of Interconnection (POI) map, no POIs are available on 161 kV or 345 kV lines that do not require network upgrades to interconnect new projects above 1 MW.

Most POIs appear to require significant upgrades to accommodate large projects.

IOWA'S WIND INTERCONNECTION TREND FOLLOWS NATIONAL PATTERN

Overall, Iowa's wind queue wait time has fallen but is trending up.



INNOVATION AND INCREASED COORDINATION ARE KEY

MISO's Long Range Transmission Planning (LRTP) initiative builds on the MVP framework and incorporates 3-Future Scenarios into the transmission planning process.[23]

Recently MISO published the first tranche of projects that has a total cost of $10.4 billion and achieves a benefit-cost ratio of 2.6, which is comparable to the MVP portfolio.[28]

The MISO-SPP Joint Targeted Interconnection Queue study[24] published in 2022 identified several transmission projects that provided significant reliability and economic benefits across both SPP and MISO, including:

- Enabling generator interconnections in the range of 28 GW to 53 GW
- 48 reliability constraints resolved
- Economic benefits of $724 million in the MISO footprint and $247 million in the SPP region

Identification and agreement on a cost-allocation methodology for the estimated $1.65 billion in transmission investment is the next step in this process and has historically been a barrier for interregional projects.[29]

SUMMARY OF TRANSMISSION AND INTERCONNECTION FINDINGS

- Across Iowa, there is minimal, if any, available transmission capacity, and proposals for new high-voltage transmission lines have trended down over the past decade.
- Eminent domain has been required to secure rights-of-way on nearly half of all high-voltage transmission line projects since 2009 (about two-thirds of all 345 kV projects).
- Public opposition to transmission projects has been consistently high; every project proposed in the last five years has faced opposition.
- Wait times in MISO's interconnection queue have increased steadily over the past few years. These findings are consistent with the escalating wait times documented across the country.
    - While the JTIQ and the LRTP portfolio of projects offer cost-effective solutions, agreement on cost-allocation and siting still pose challenges.
- At the federal level, the Federal Energy Regulatory Commission is prioritizing reforms for interconnection queue procedures and agreements in addition to regional and interregional transmission planning and cost-allocation procedures. Despite the procedural improvements that may manifest from these proposed rulemakings, the development and siting of high-voltage lines and generation resources still require several layers of state and local approvals.
- Ultimately, transmission and interconnection delays could limit wind energy growth just as much as, or more than, local turbine siting.

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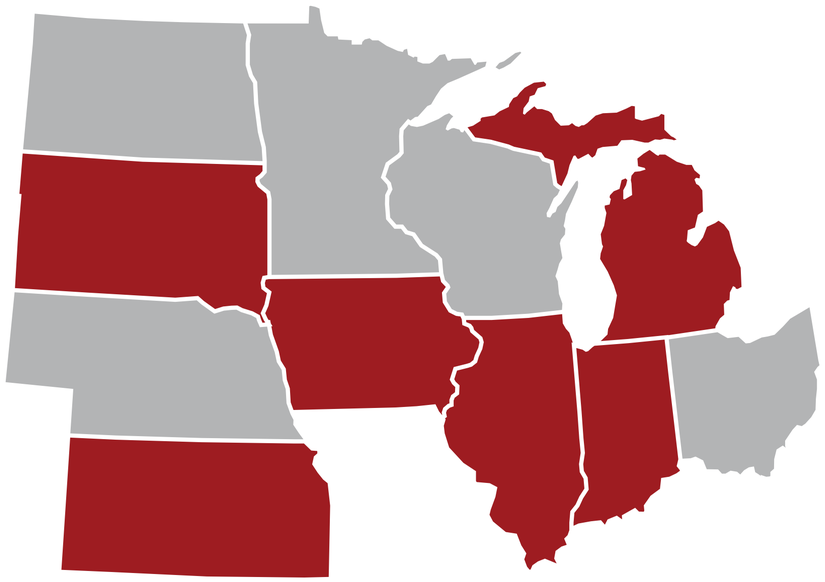
6
TRANSMISSION & INTERCONNECTION

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WIND ENERGY SITING REGULATIONS ACROSS STATES

PRIMARY SITING AUTHORITY FOR WIND ENERGY



LOCAL AUTHORITY

SOME KIND OF MIXED OR JOINT AUTHORITY AMONG STATE AND LOCAL GOVERNMENTS

ADAPTED FROM CSG MIDWEST

Wind potential in consistently high across most states in the midwest.

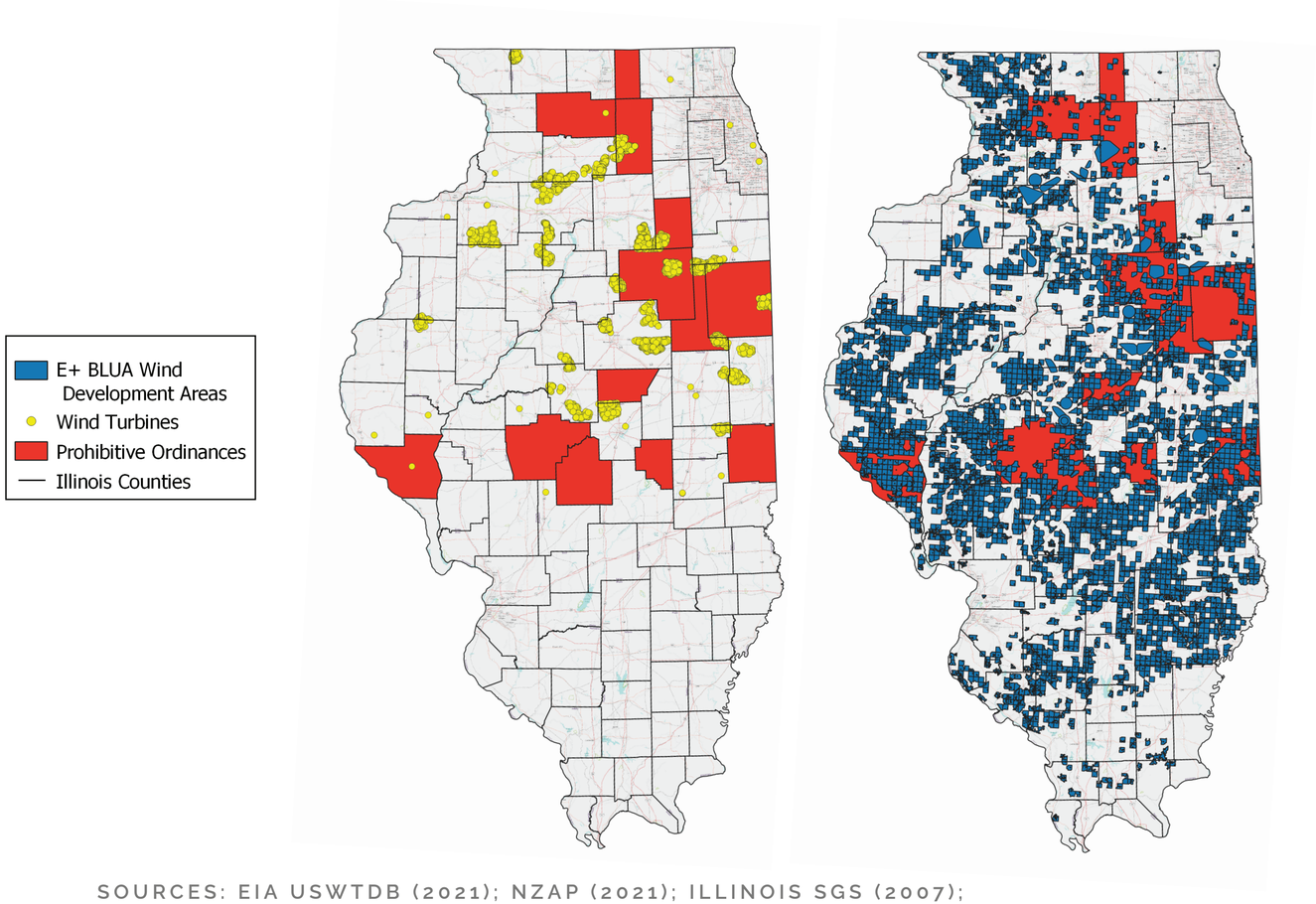
Wind energy siting regulations vary across states, but most states across the Midwest provide some level of local control. In Iowa, projects below 25 MW in size are locally regulated.

Other states with local siting regulations and significant wind development face similar prohibitive ordinances.

Prohibitive ordinances are increasingly common in Iowa, Illinois, Indiana, and Ohio.

ILLINOIS COMPARISON: PROHIBITIVE ORDINANCES PREVALENT IN OTHER STATES

ILLINOIS WIND TURBINES, ORDINANCES, AND OPTIMAL DEVELOPMENT SITES



SOURCES: EIA USWTDB (2021); NZAP (2021); ILLINOIS SGS (2007); INVENERGY WIND ORDINANCE DATABASE

Illinois has a state law requiring 50% renewable energy by 2040 and has 13 windy counties with prohibitive wind ordinances.[30]

NZAP's E+ scenario projects 135 GW of wind in Illinois by 2050, compared to its current capacity of 7 GW. Nearly 30 GW of that amount is in counties with prohibitive ordinances.

Public opposition and prohibitive ordinances could limit development in many other states.

STATEWIDE SITING POLICY COULD MAKE OR BREAK WIND DEVELOPMENT

DETERRING POLICIES

- State proposals to limit wind siting have become common. Recently, Ohio enacted a law allowing counties to outlaw new wind energy developments.[31]

- Other states have seriously considered additional statewide wind restrictions, such as a 5,800 ft setback requirement in Kansas[32] and statewide wind siting regulations in Iowa.[33]

ENABLING POLICIES

- Other states, such as New York, have enacted laws to guarantee decisions on wind farm permits within a year; otherwise, they are automatically approved. If the project is on a previously approved brownfield site, the timeline is six months.[34]

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POLICY RECOMMENDATIONS

MAINTAIN NET-ZERO OPTIONALITY

- Diversified, technology-inclusive net-zero portfolios had greater feasibility than the 100% Renewable pathway when county-level siting regulations were considered.
- Massively scaling up wind energy in a short time period will be extraordinarily difficult. Any clean energy or climate policy should be as tech-neutral as possible.

TAILOR POLICY TO SUPPORTIVE COMMUNITIES

- Counties should be able to access federal aid or technical assistance if they enact permissive ordinances for clean energy development. Another option would be to seed energy extension programs at local universities.
- To balance community autonomy and decarbonization goals, it is essential to understand and acknowledge individual and community concerns, proactively provide resources and tools for communities and decision-makers, and for developers to implement best practices with respect to procedural and distributive fairness.

REIMAGINE EXISTING INFRASTRUCTURE

- Large-scale infrastructure siting across vast swaths of land will be incredibly difficult and will likely worsen over time. Reducing emissions while avoiding greenfield construction — by reusing assets and relying on non-wire transmission alternatives — is essential.
- This includes repurposing existing generation with nuclear or CCUS, optimizing existing transmission lines, repurposing gas pipelines for H_2 or CO_2, and using federal land or rights-of-way.

CONCLUSIONS

SITING LIMITATIONS WILL GREATLY REDUCE ONSHORE WIND CAPACITY

- Local ordinances have a meaningful impact on wind energy siting potential. When these factors are not considered in modelling, potential is likely to be overestimated.
- **Net-zero is still possible, but there are real land limitations to highly wind-dependent futures.**

IMPROVING WIND ACCEPTANCE IS VITAL—BUT NOT A CURE-ALL

- **All nine of Iowa's moratoriums were enacted in the past three years,** highlighting the increasing **prevalence** and **stringency** of wind ordinances.
- The increasing size of turbines and scale of projected deployment underscore the importance of addressing community concerns, providing resources and tools, and implementing best practices throughout the development process.

TRANSMISSION CONSTRAINTS PRESENT ADDITIONAL CHALLENGES

- Long infrastructure development timelines and interconnection queue wait times imperil the ability to build cleaner and faster. Currently, **there is little to no room to add wind energy in Iowa without additional transmission.**
- Opposition to transmission projects has been increasing, further compounding the issue.

TECH-INCLUSIVE, PUBLIC-ORIENTED PROCESSES ARE ESSENTIAL

- These results demonstrate the importance of considering land use constraints when evaluating a technology's potential role in deep decarbonization.
- Research suggests that early, open engagement results in more public support for wind energy.
- Several policies can be implemented to improve permitting, encourage appropriate development, and minimize land use impacts.

SOURCES

1. Leslie, E., Pascale, A., & Jenkins, J. D. (2021). Princeton's Net-Zero America Study Annex D: Solar and Wind Generation Transitions. https://netzeroamerica.princeton.edu/img/NZA%20Annex%20D%20-%20Solar%20and%20wind%20generation.pdf

2. Clean Power Annual Market Report 2021. (2022). American Clean Power. https://cleanpower.org/wp-content/uploads/2022/05/2021-ACP-Annual-Report-Final_Public.pdf.

3. Clean Jobs Midwest. Iowa Fact Sheet 2021. (2021). Clean Jobs Midwest. https://cleanjobsmidwest.com/wp-content/uploads/2021/08/E2-State-Reports_Iowa.pdf.

4. Good for Jobs, Good for Economic Growth, and Good for Our Environment. (2021). Environmental Law & Policy Center. https://elpc.org/wp-content/uploads/2021/01/FINAL-Iowa-Supply-Chain-Report-1.4.pdf.

5. Iowa Wind Energy Fact Sheet. (2021). Iowa Environmental Council. https://iaenvironment.org/webres/File/Wind%20Energy%20Fact%20Sheet%20-%202021%2C%20Revised%203_17_21.pdf.

6. Iowa State Profile and Energy Estimates. (2021). Energy Information Administration. https://eia.gov/state/analysis.php?sid=IA.

7. Headline Statements from the Summary for Policymakers. (2021). Intergovernmental Panel on Climate Change https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Headline_Statements.pdf

8. Larson Eric, Greig, C., Jenkins, J., Mayfield, E., Pascale, A., Zhang, C., Drossman, J., Williams, R., Pacala, S., Socolow, R., Baik, E., Birdsey, R., Duke, R., Jones, R., Haley, B., Leslie, E., Paustian, K., & Swan, A. (2021). Net-Zero America: Potential Pathways, Infrastructure, and Impacts Final Report. https://www.dropbox.com/s/ptpg2f65lgds5n2/Princeton%20NZA%20FINAL%20REPORT%20%2829Oct2021%29.pdf?dl=

9. Johannsen, K. (2011). Successful County Wind Siting Practices in Iowa. https://www.iaenvironment.org/webres/File/Best%20Practices%20FINAL%2011_2_18.pdf

10. Wind Vision: A New Era for Wind Power in the United States. (2015). Office of Energy Efficiency & Renewable Energy. https://www.energy.gov/eere/wind/downloads/wind-vision-new-era-wind-power-united-states

11. Annual Technology Baseline: Land-Based Wind. (2022). National Renewable Energy Laboratory. https://atb.nrel.gov/electricity/2022/land-based_wind

12. Lopez, A., Mai, T., Lantz, E., Harrison-Atlas, D., Williams, T., & Maclaurin, G. (2021). Land use and turbine technology influences on wind potential in the United States. Energy, 223. https://doi.org/10.1016/J.ENERGY.2021.120044

13. Haac, T. R., Kaliski, K., Landis, M., Hoen, B., Rand, J., Firestone, J., Elliott, D., Hübner, G., & Pohl, J. (2019). Wind turbine audibility and noise annoyance in a national U.S. survey: Individual perception and influencing factors. The Journal of the Acoustical Society of America, 146(2), 1124. https://doi.org/10.1121/1.5121309

14. Rand, J., & Hoen, B. (2017). Thirty years of North American wind energy acceptance research: What have we learned? Energy Research & Social Science, 29, 135–148. https://doi.org/10.1016/J.ERSS.2017.05.019

15. Net-Zero America: State-level health, employment, and land use impacts. (2021). Princeton University. https://netzeroamerica.princeton.edu/img/State%20-Summaries.pdf

16. Dällenbach, N., & Wüstenhagen, R. (2022). How far do noise concerns travel? Exploring how familiarity and justice shape noise expectations and social acceptance of planned wind energy projects. Energy Research & Social Science, 87, 102300. https://doi.org/10.1016/J.ERSS.2021.102300

17. Mills, S. B., Bessette, D., & Smith, H. (2019). Exploring landowners' post-construction changes in perceptions of wind energy in Michigan. Land Use Policy, 82, 754–762. https://doi.org/10.1016/J.LANDUSEPOL.2019.01.010

18. Fast, S., Mabee, W., Baxter, J., Christidis, T., Driver, L., Hill, S., Mcmurtry, J. J., & Tomkow, M. (2016). Lessons learned from Ontario wind energy disputes. Nature Energy, 1. https://doi.org/10.1038/NENERGY.2015.28

19. Elmallah, S., & Rand, J. (2022). "After the leases are signed, it's a done deal": Exploring procedural injustices for utility-scale wind energy planning in the United States. Energy Research and Social Science, 89. https://doi.org/10.1016/J.ERSS.2022.102549

20. Tomich, J. (2022). "Indiana experiment highlights wind siting challenge". E&E News. https://www.eenews.net/articles/ind-experiment-highlights-wind-siting-challenge/

21. Multi-Value Projects (MVPs). (n.d.). Midcontinent Independent System Operator. https://www.misoenergy.org/planning/planning/multi-value-projects-mvps/#t=10&p=0&s=&sd=

22. Proposed Revisions to MISO Tariff to Modify Cost Allocation for Multi-Value Projects. (2022). Docket No. ER22-995-000.

23. MTEP21 Report Addendum: Long Range Transmission Planning Tranche 1 Portfolio Report. (2022). Midcontinent Independent System Operator. https://www.misoenergy.org/planning/planning/mtep21/

24. Joint-Targeted Interconnection Queue Executive Summary. (2022). MISO-SPP Collaboration. https://cdn.misoenergy.org/JTIQ%20Report623262.pdf

25. vander Vorst, A., & Stern, A. (n.d.). Plugging In: A Roadmap for Modernizing & Integrating Interconnection and Transmission Planning. https://www.federalregister.gov/documents/2021/07/27/2021-15512/building-for-the-future-through-

26. EDF v. MISO, 168 FERC ¶ 61,173., (2020).

27. Rand, J., Wiser, R. H., & Gorman, W. (2022). Queued Up: Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2021. https://www.osti.gov/biblio/1864543-queued-up-characteristics-power-plants-seeking-transmission-interconnection-end

28. LRTP Tranche 1 Portfolio Detailed Business Case. (2022). Midcontinent Independent System Operator. https://cdn.misoenergy.org/20220329%20LRTP%20Workshop%20Item%2002%20Detailed%20Business%20Case623671.pdf

29. Lieberman, J. (2021). How Transmission Planning & Cost Allocation Processes are Inhibiting Wind & Solar Development in SPP, MISO, & PJM. https://acore.org/wp-content/uploads/2021/03/ACORE-Transmission-Planning-Flaws-in-SPP-MISO-and-PJM.pdf

30. Gov. Pritzker Signs Transformative Legislation Establishing Illinois as a National Leader on Climate Action. (2021). State of Illinois. https://www.illinois.gov/news/press-release.23893.html

31. Tomich, J. (2021). "'Volatile place.' New laws thwart Ohio renewables". E&E News. https://www.eenews.net/articles/volatile-place-new-laws-thwart-ohio-renewables/

32. Wu, T. (2021). "Controversial restrictions on wind turbines pop up again in Kansas". Topeka Capital-Journal. https://www.cjonline.com/story/news/politics/state/2021/03/23/controversial-restrictions-wind-turbines-pop-up-again-kansas-renewable-energy-setback-politics/6956380002/

33. Eller, D. (2020, January 12). Iowa Farm Bureau backs statewide regulations for wind, solar construction. Des Moines Register. https://www.desmoinesregister.com/story/money/agriculture/2020/01/12/iowa-farm-bureau-backs-statewide-regulations-wind-solar-construction/2828556001/

34. Office of Renewable Energy Siting. (n.d.). New York State Energy Research and Development Authority. https://www.nyserda.ny.gov/All-Programs/Clean-Energy-Siting/Siting-for-Large-Scale-Renewables/Office-of-Renewable-Energy-Siting

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