Setbacks: Science, Engineering ,and the Interplay with Property Rights

Oklahoma Senate Interim Study
Wind and Solar Setbacks
Oklahoma State Capitol
Sept 3, 2025

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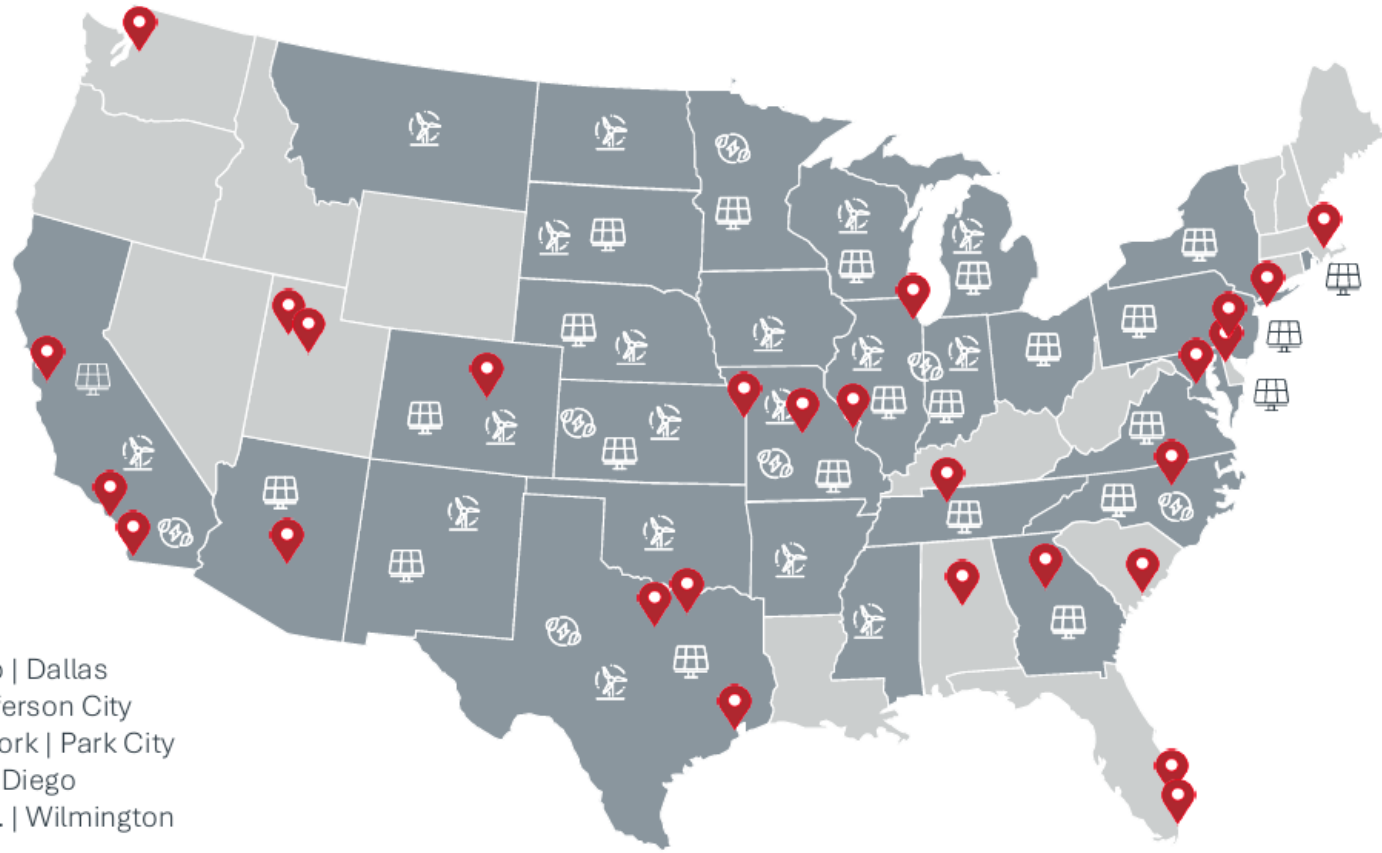

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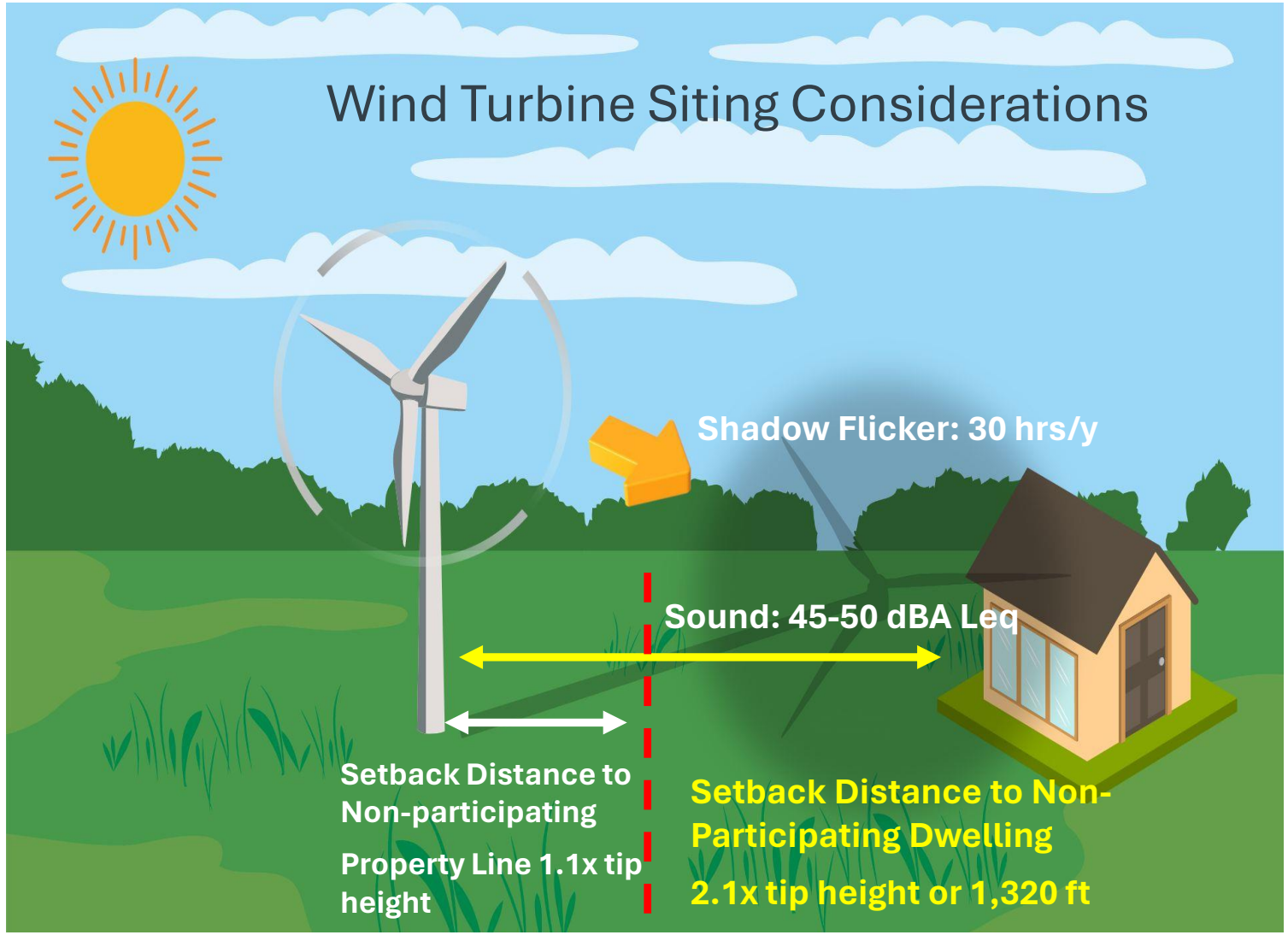
Why Setbacks Matter

- Setbacks ensure safety from rare events (blade failure, ice throw, collapse, fire).
  - When done appropriately, they provide value to surrounding landowners, counties, ratepayers, and the state
- Excessive setbacks become de facto bans on renewable development.
  - If projects cannot be sited because of excessive setbacks, new generation cannot be developed.
  - Loss of Oklahoma low-cost energy, loss of economic development, taking of property rights
- Science-based standards protect communities and allow landowners to keep and use their property rights.

We Have a Lot of Data

- As of May 2025, there are 76,051 turbines in the United States covering 45 states (plus Guam and PR)
- As of August 2025, there were 68 utility-scale wind farms in Oklahoma.
- Their total operating capacity is 12,776 megawatts (MW)
- More than 5,500 wind turbines operating in Oklahoma
- First project in Oklahoma began operating in 2003
- What was happening in 2003?

What Concerns Should Setbacks Address?



- Legitimate Areas of Focus for Setbacks:
  - Shadow Flicker (Wind)
  - Component Collapse/Failure (Wind)
  - Ice Throw (Wind)
  - Sound (Wind, Solar, BESS)
  - Emergency Scenarios (Wind, Solar, BESS)
- Whether setbacks provide sufficient safety is **highly technical** health and safety question that is often assessed by **non-technical people** with no experience in engineering risk analysis.

Blade Failure, Ice Throw, Tower Collapse

Risk Assessment of Ice Throw

Journal of Physics: Conference Series

PAPER · OPEN ACCESS

Understanding and acknowledging the ice throw hazard - consequences for regulatory frameworks, risk perception and risk communication

To cite this article: R. E. Bredesen *et al* 2017 *J. Phys.: Conf. Ser.* **926** 012001

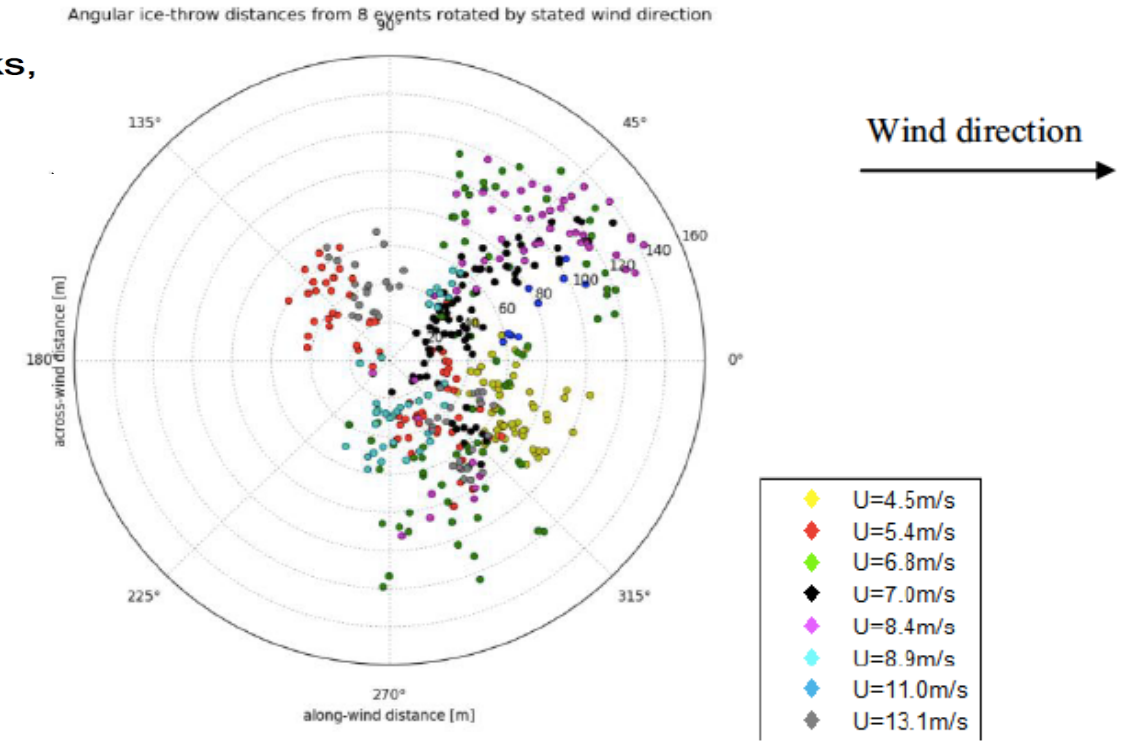


Figure 6. 417 ice pieces from the IceThrower database for the considered V90 turbine with a tipheight of 140 m. The location of all ice pieces are rotated by the given wind direction for each given case. Events are listed A-H by colored markers for increasing wind velocities.

Public Safety

Ice Shed

- Ice detection systems will be installed on all turbines and they will be shut down during icing events
- This will significantly reduce the possibility of ice throw. Ice pieces will be shed primarily directly beneath the turbine, posing no risk to the surrounding area.

Blade Failure

- Modern wind turbines are equipped with structural health monitoring systems that make blade failures extremely unlikely.
- A comprehensive analysis that accounts for blade failure rates and blade throw distances shows that the risk to property, vehicles, or personnel from blade failure is **less than 1 impact per 4 million years, an extraordinarily small risk**.
- **Blade would fall to the base of the turbine, any small debris scattered by the wind would be a physical clean up issue and will not cause long-term contamination of farm fields.**

Panther Grove 2 Wind Energy Project Ice Shed and Blade Failure Risk Assessment

Presented to: Panther Grove 2, LLC

Date: 7 August, 2024

Document No: P082024-2-002

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RESEARCH ARTICLE OPEN ACCESS

Simulation Analysis and Safety Risk Assessment of a Wind Turbine Blade Failure Event

Jonathan Rogers[1] | Christopher Ollson[2]

[1]Georgia Institute of Technology, Atlanta, Georgia, USA | [2]Ollson Environmental Health Management, Toronto, Ontario, Canada

- Case study of an actual wind turbine blade failure event caused by a lightning strike in the midwestern United States. The nature of the debris field is described, along with measurements of example blade fragments collected from the site.

- A blade throw simulation model is used to simulate the release of a representative set of debris, informed by fragment sizes and weights collected from the debris field. The debris field produced by the simulation model is shown to match the debris field observed empirically with reasonable accuracy.

- Ballistic impact models are used to determine whether any fragments thrown beyond 1.1 times the turbine tip height could have caused injury to a person.

- This ballistic analysis shows that ***debris that traveled beyond 1.1 times the tip height had relatively low kinetic energy and would be extremely unlikely to cause injury to a person***.

Sound

Largest study ever undertaken around the world on wind turbines and health.

The following were <u>not</u> found to be associated with wind turbine noise:

a. self-reported sleep disturbance (e.g., general disturbance, use of sleep medication, diagnosed sleep disorders);

b. self-reported illnesses (e.g., dizziness, tinnitus, prevalence of frequent migraines and headaches) and chronic health conditions (e.g., heart disease, high blood pressure and diabetes); and

c. self-reported perceived stress and quality of life.

The overall conclusion to emerge from the study findings is that the ***study found no evidence of an association between exposure to WTN and the prevalence of self-reported or measured health effects***.

Health Canada findings are supported by more recent US, Australian and European Studies.

Lawrence Berkley National Laboratory Wind Studies

Monitoring annoyance and stress effects of wind turbines on nearby residents: A comparison of U.S. and European samples (Hubner, 2019)

- Objective indicators, such as the distance from the nearest turbine and sound pressure level modeled for each respondent, **were not** found to be correlated to noise annoyance.
- In all cases the annoyance levels were comparable to the levels associated with traffic noise.
- Our findings provide evidence that WT annoyance and related stress effects are not a widespread problem.

Wind turbine audibility and noise annoyance in a national U.S. survey: Individual perception and influencing factors (Haac, 2019)

- The results suggest that wind turbine noise annoyance is mostly an expression of personal experience and visual perceptions rather than an objective response to wind turbine sound level.

In the shadow of wind energy: Predicting community exposure and annoyance to wind turbine shadow flicker in the United States (2022)

- Conversely, SF annoyance was not significantly correlated with SF exposure. Rather, SF annoyance is primarily a subjective response to wind turbine aesthetics, annoyance to other anthropogenic sounds, level of education, and age of the respondent.

SLEEP, 2024, 47, 1–8
https://doi.org/10.1093/sleep/zsad286
Advance access publication 6 November 2023
Perspective

Perspective

Noise-induced sleep disruption from wind turbines: scientific updates and acoustical standards

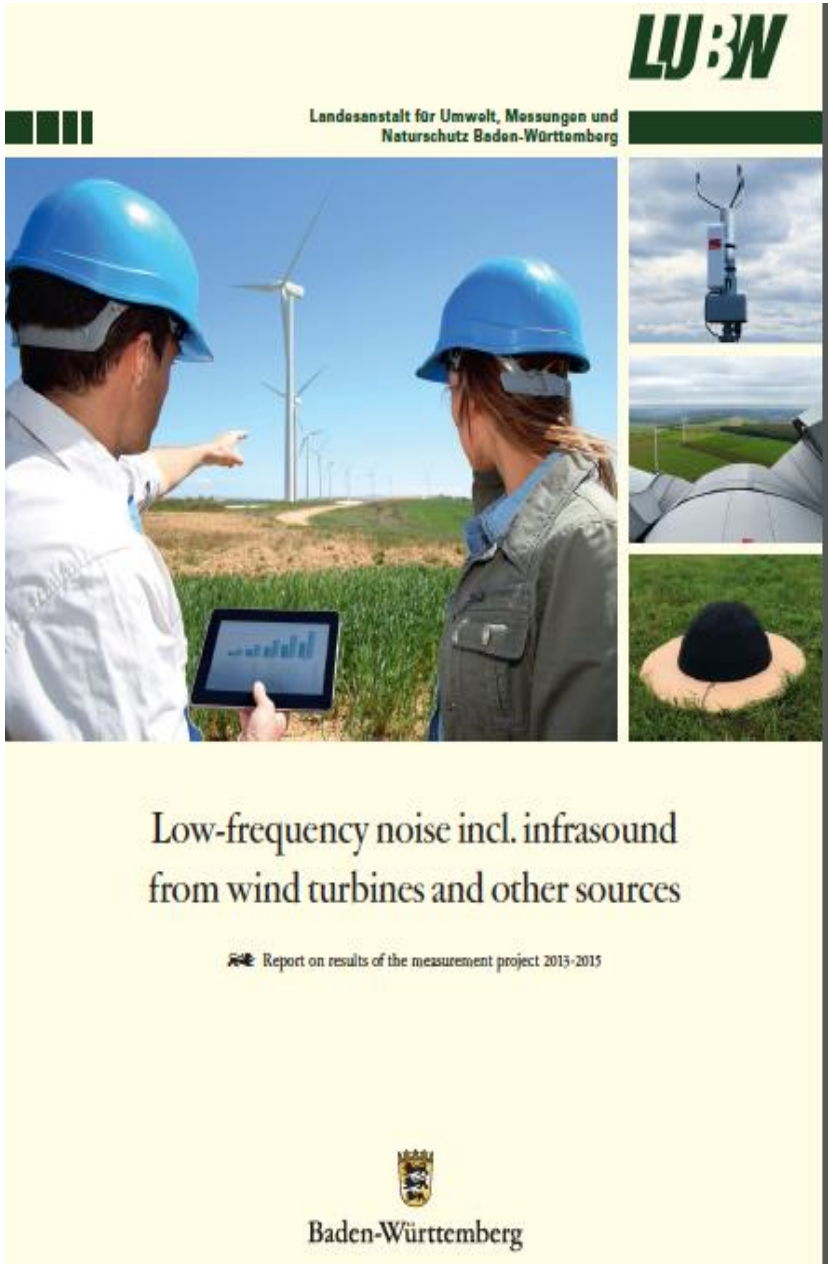
Jeffrey M. Ellenbogen[1,*], Colleen B. Kellam[2] and Michael Hankard[3]

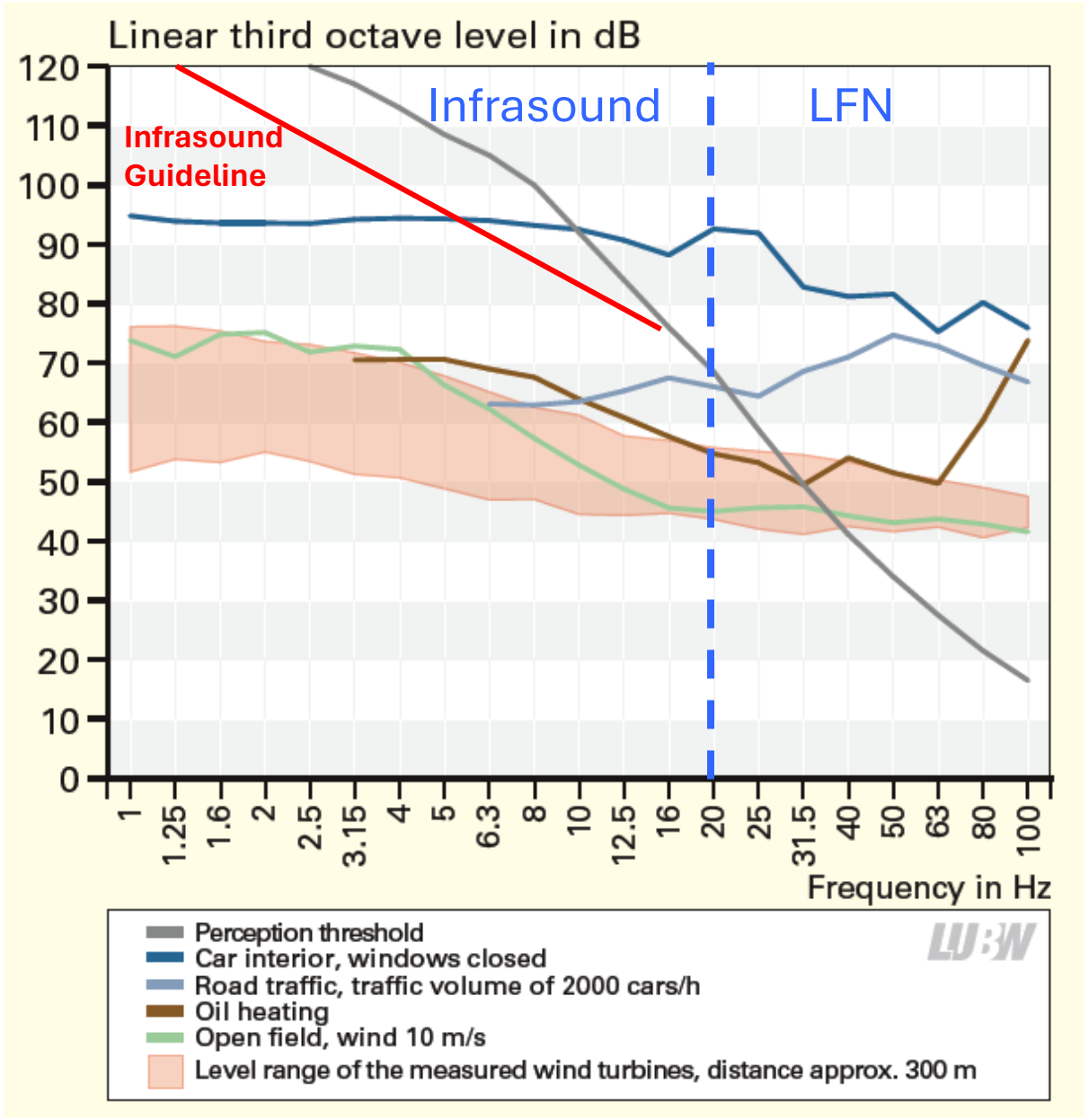
- Examining scientific literature combined with biological plausibility and principles of acoustics, we conclude that modern wind turbines do not pose a risk to sleep when developed with reasonable restrictions.

- Though the upper limit is not established, noise from wind turbines measured outside the residence, up to 46 dBA (or modeled up to 49 dBA using the new standard [ANSI/ACP 111-1]), ***poses no risk to human sleep***.

- Not at this audible range, nor its associated infrasound or low-frequency noise levels.

German Wind Turbine Infrasound Study





frontiers in
PUBLIC HEALTH

ORIGINAL RESEARCH ARTICLE
published: 24 February 2015
doi: 10.3389/fpubh.2015.00031

Health-based audible noise guidelines account for infrasound and low-frequency noise produced by wind turbines

Robert G. Berger[1], Payam Ashtiani[2], Christopher A. Ollson[3], Melissa Whitfield Aslund[3], Lindsay C. McCallum[3,4], Geoff Leventhall[5] and Loren D. Knopper[3]*

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[2] Aercoustics Engineering Limited, Mississauga, ON, Canada
[3] Intrinsik Environmental Sciences Inc., Mississauga, ON, Canada
[4] Department of Physical and Environmental Sciences, University of Toronto, Toronto, ON, Canada
[5] H.G. Leventhall – Consultancy, Surrey, UK

Over-all, the data from this and other studies suggest that health-based audible noise wind turbine siting standards (i.e., IPCB standard) provide an effective means to evaluate, monitor, and protect potential receptors from audible noise as well as Infrasound and Low Frequency Noise.

What Have Other States Done?

What Have Other States Done?

State-Level Wind Siting Standards

Setbacks	**North Dakota**	**Wisconsin**	**Illinois**	**Michigan**	**New York**	**South Dakota (State and County Generally)**
Neighboring Non- Participating Property Line	1.1x tip height	1.1x tip height	1.1x tip height	1.1x tip height	1.1x tip height	1.1x tip height
Neighboring Non- Participating Home	3x tip height	Lower of 1,250 feet or 3.1x tip height	2.1x tip height	2.1x tip height	2x tip height	1,500 ft or 2- 3x tip height
Incorporated Municipalities	Typically 1 mile	N/A	Typically 1 mile	N/A	Typically 1 mile	1 mile
Interstate, Roads, and Highways	Typically 1.1x the tip height	1.1x tip height	1.1x tip height	1.1x tip height	Typically 1.1x tip height	1.1x tip height
State Park	N/A	N/A	2.1x tip height	N/A	N/A	1 mile

What Have Other States Done?

State-Level Solar Siting Standards

Setbacks	North Dakota	Wisconsin	Illinois	Michigan	New York	South Dakota (State and County Generally)
Neighboring Non- Participating Property Line	N/A	N/A	50 ft	50 ft	N/A	N/A
Neighboring Non- Participating Home	N/A	N/A	150 ft	300 ft	N/A	N/A
Incorporated Municipalities	N/A	N/A	N/A	N/A	N/A	N/A
Interstate, Roads, and Highways	N/A	N/A	50 ft	50 ft	N/A	N/A
State Park	N/A	N/A	N/A	N/A	N/A	N/A

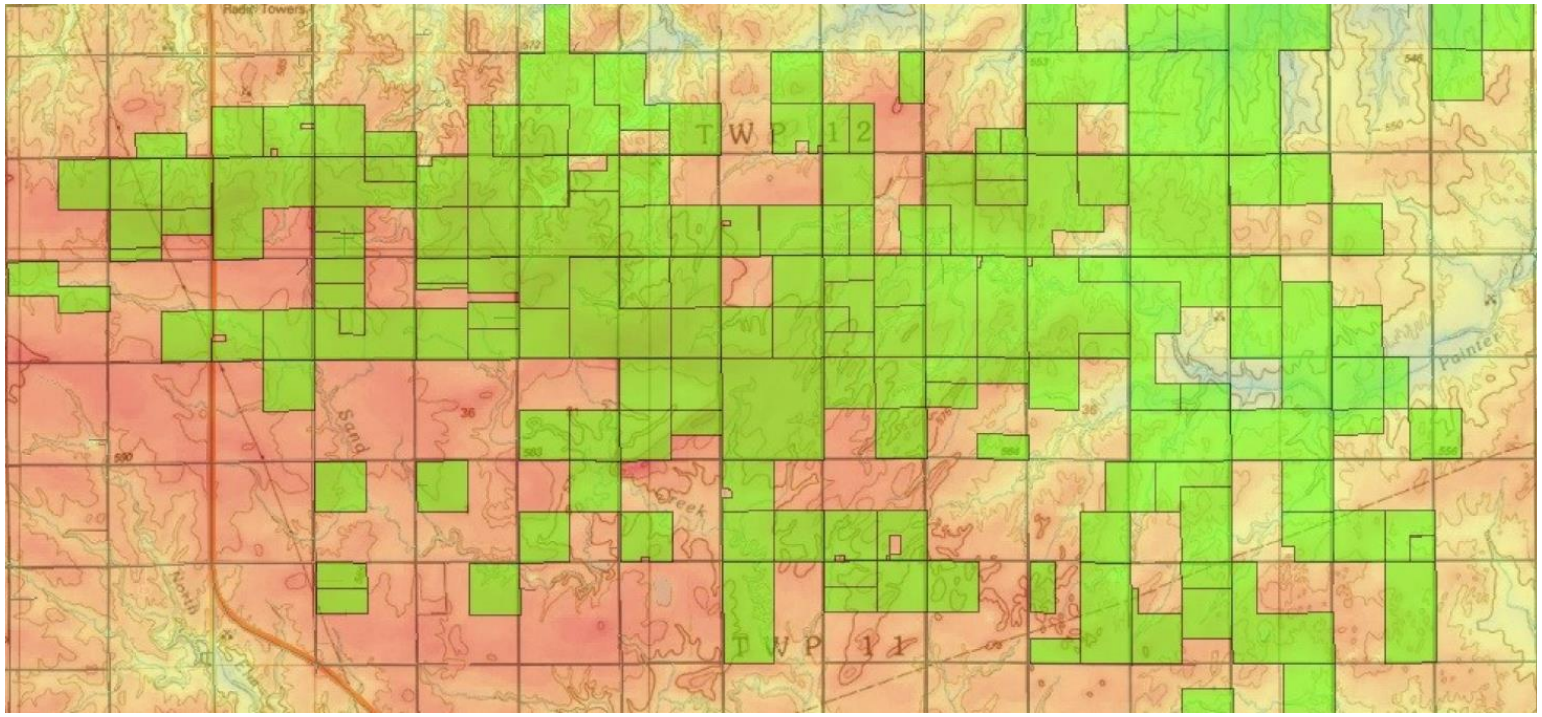
State of Wind Turbine Research and Safety and Health Effects

- Extensive Research Has Been Performed
  - Over 20 years of global research in the field
  - Over 150 peer-reviewed research papers published in the field
  - Decades of real-world evidence in Oklahoma

- The Findings Support:
  - Sound levels that meet 45 to 50 dBA at non-participating residences and occupied community buildings
  - Shadow flicker <30 actual hours a year at non-participating residences and occupied community buildings
  - Appropriate setbacks to roads and non-participating property lines 1.1x tip height
  - Setbacks to non-participating residences and occupied community buildings and 2.1x tip height (1,340 ft).

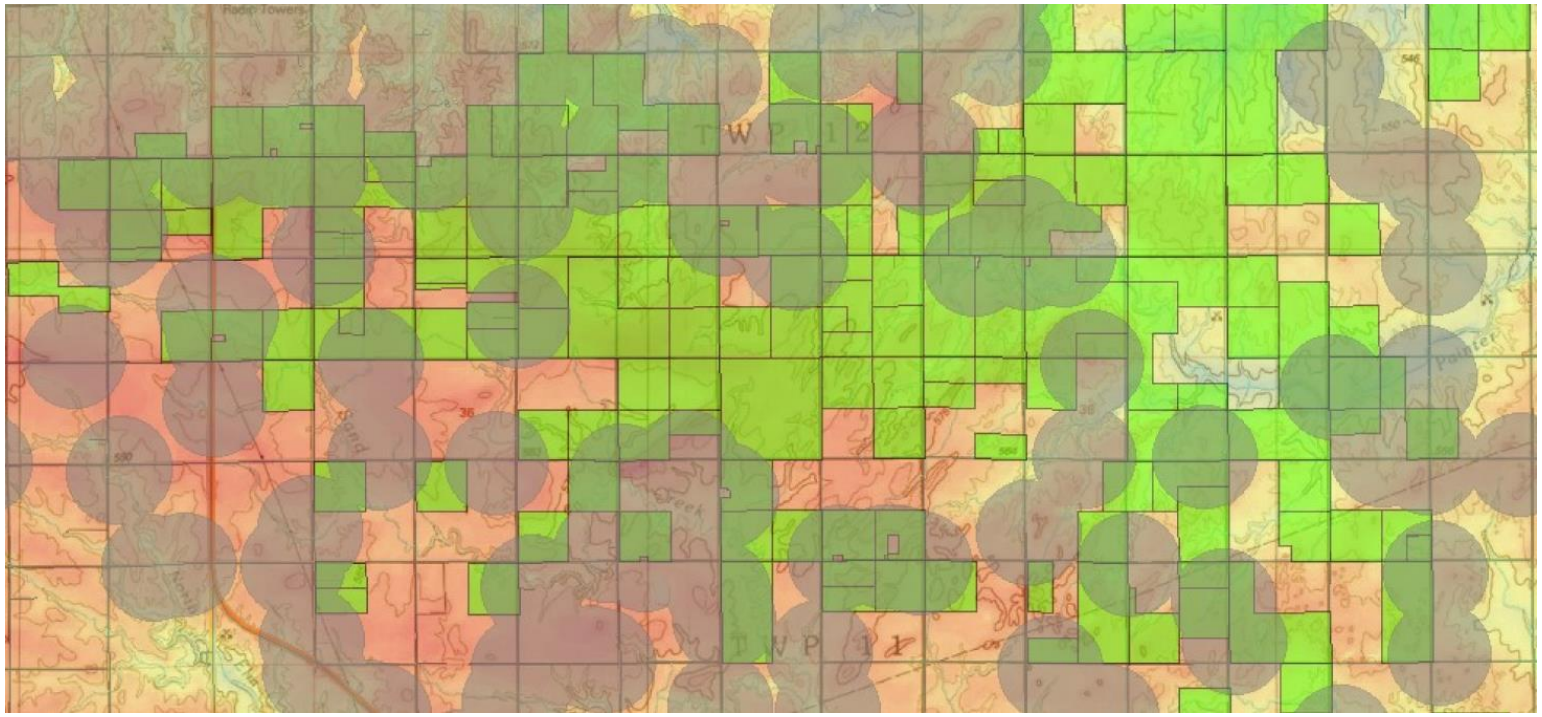
Setbacks in Action

We start with landowners who have agreed to participate in a project.



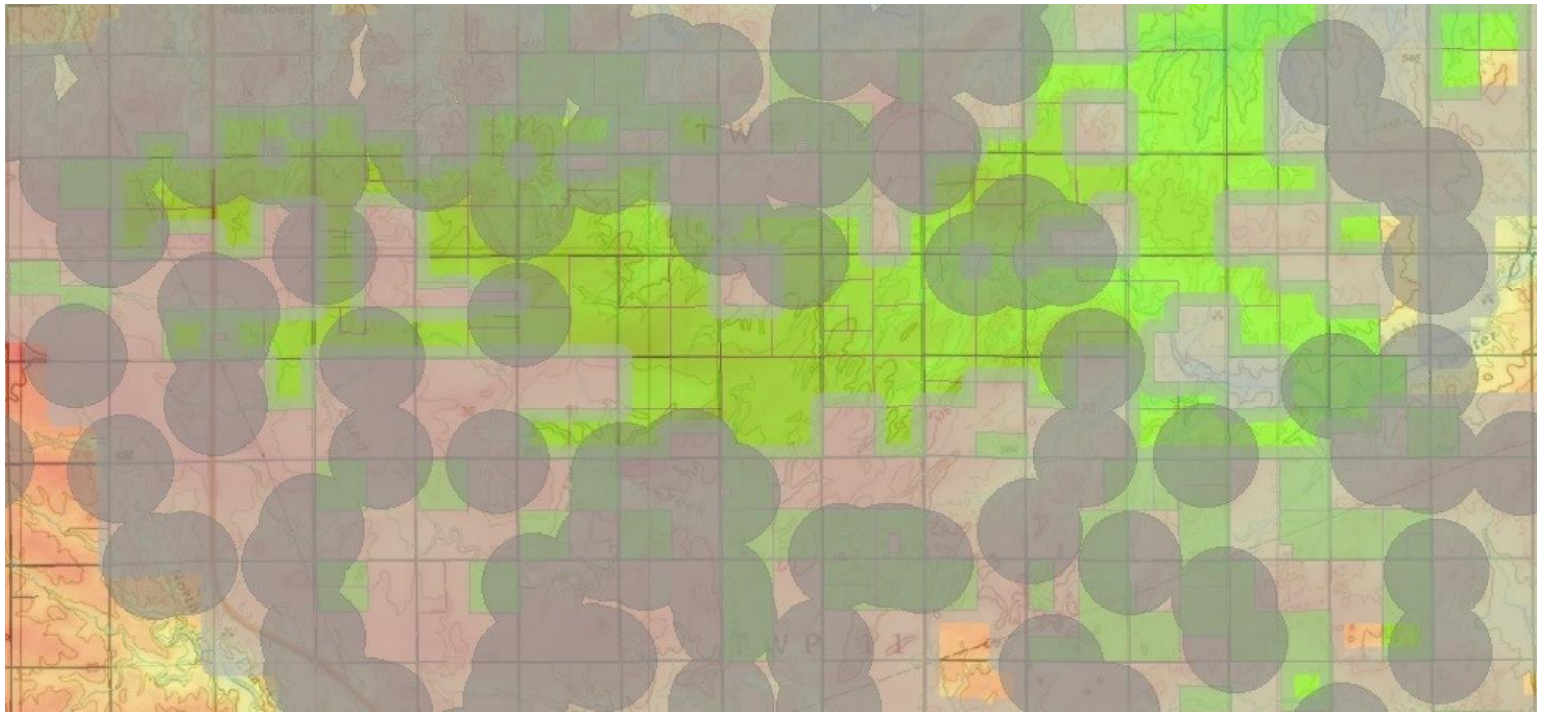
Setbacks in Action

Add a setback for occupied dwellings.



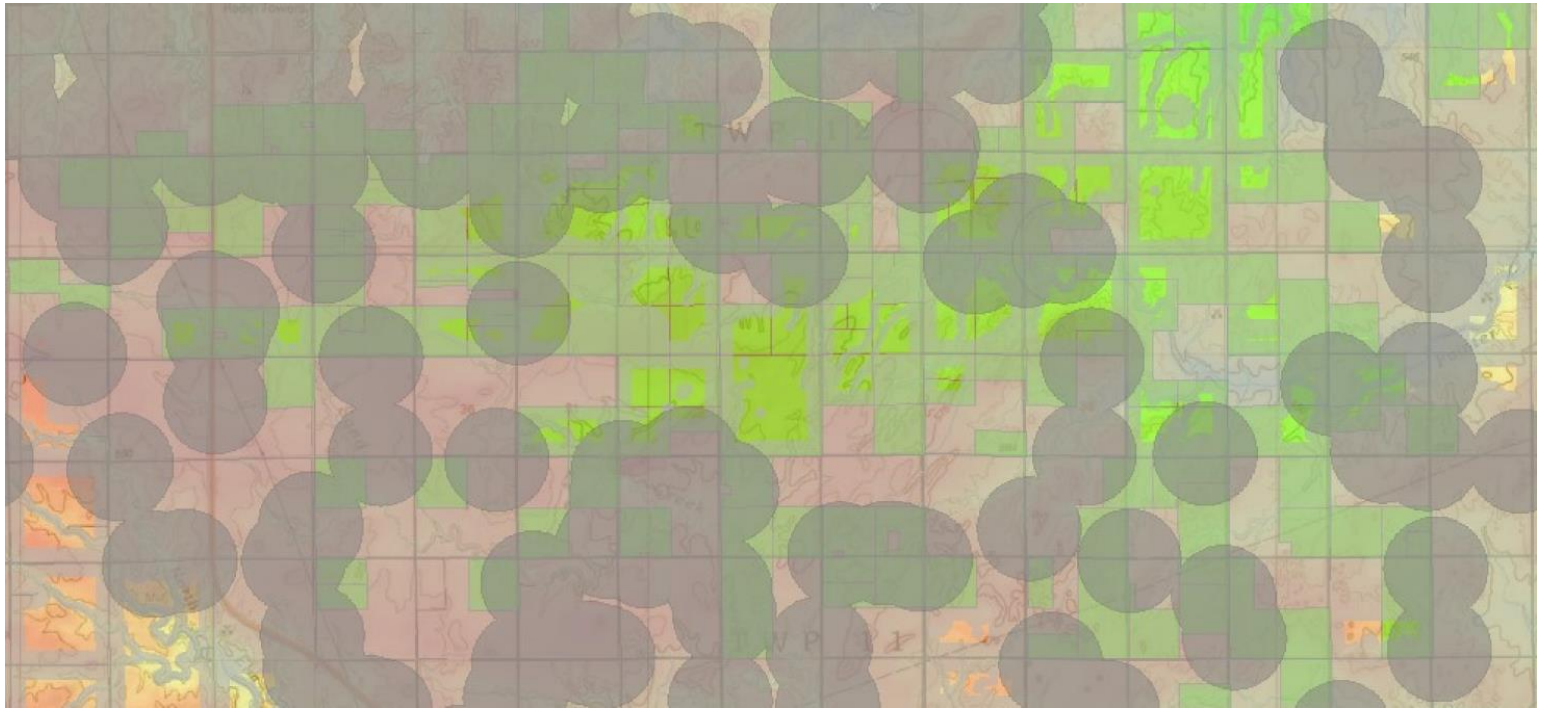
Setbacks in Action

Add a setback for non-participating property lines



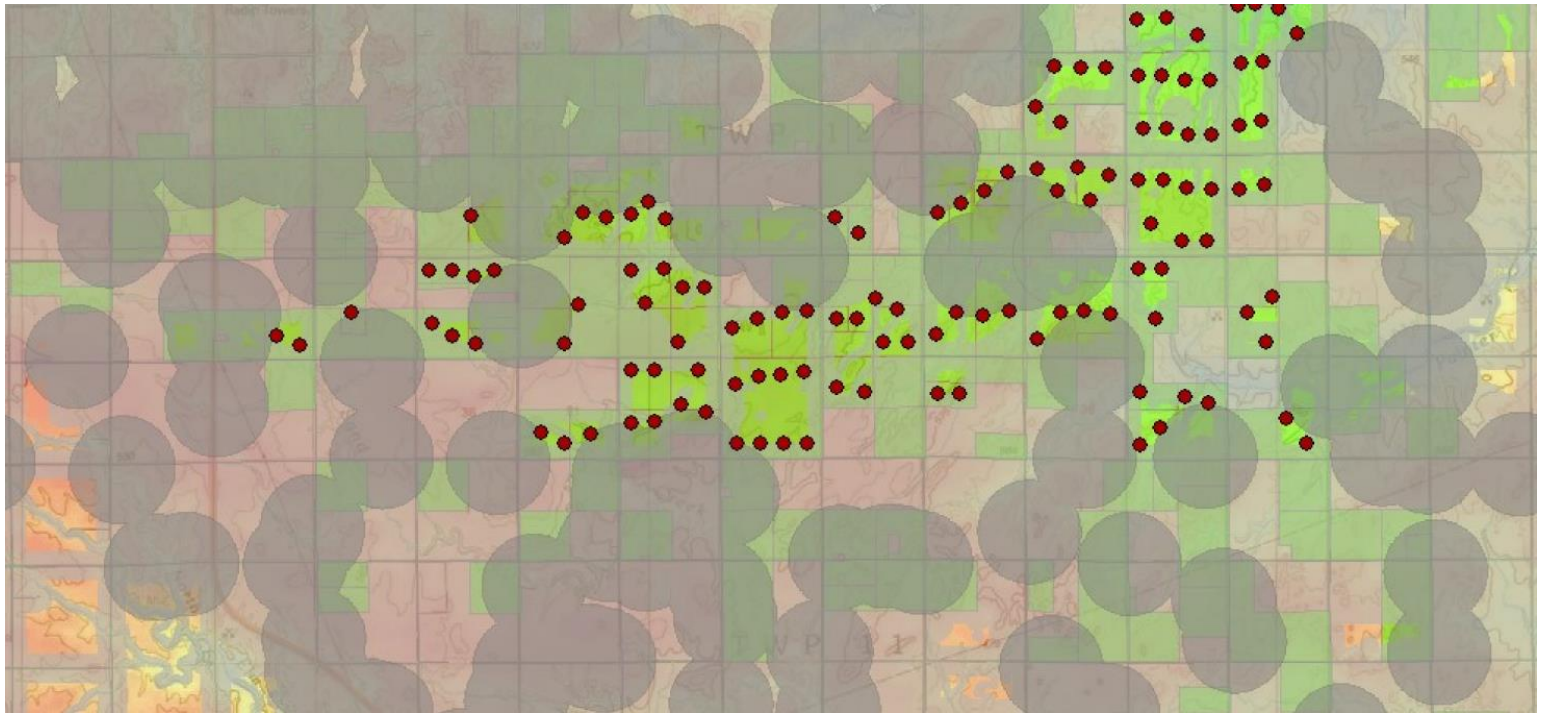
Setbacks in Action

Add a setback for other infrastructure (roads, transmission lines, etc.)



Setbacks in Action

The remaining pockets are the buildable area.

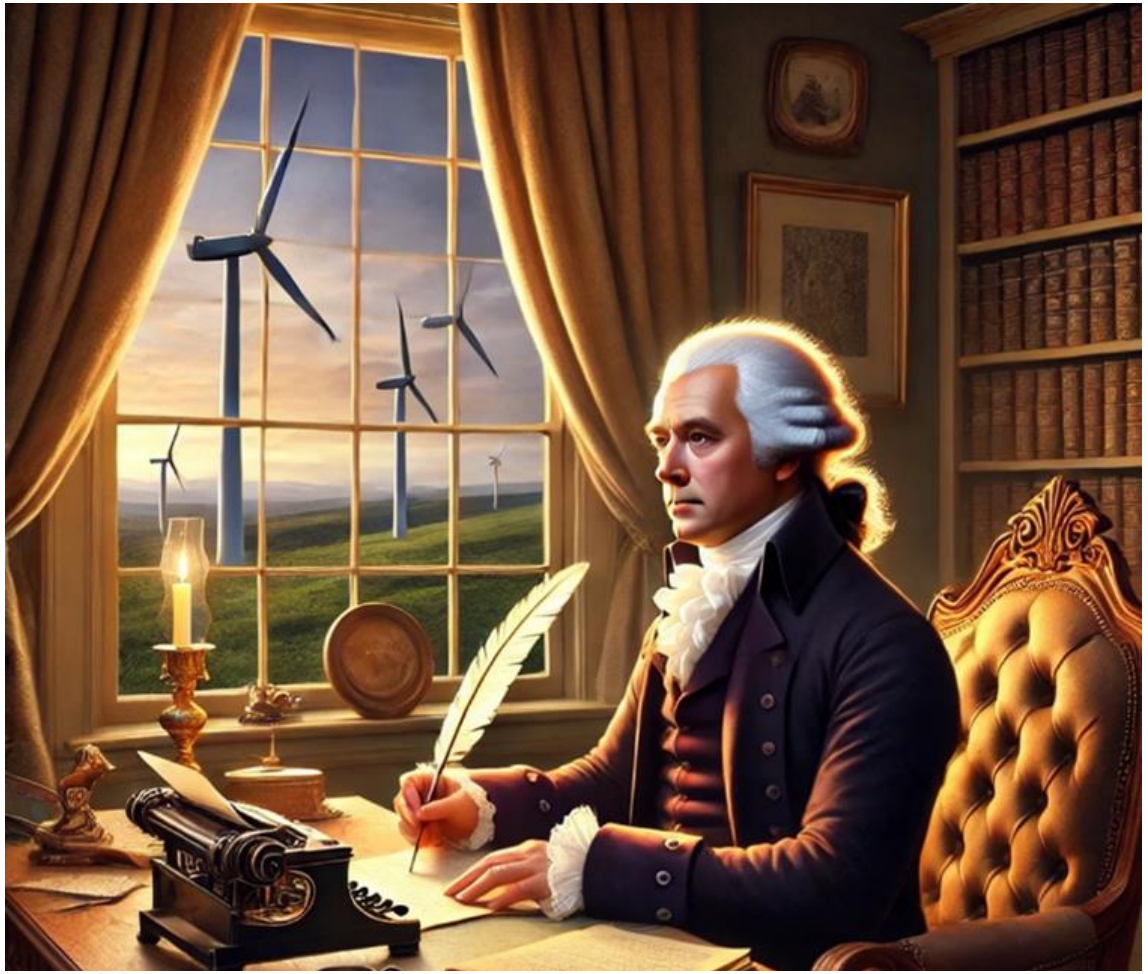


Is Oklahoma a Strong Property Rights State?

A Review of a Constitutionally Based View of Property Rights

What's the Downside of Excessive Setbacks?

- **Overview of Federalist No. 10**
  - Written by James Madison in 1787 as part of The Federalist Papers advocating for the ratification of the U.S. Constitution
  - Focuses on the dangers of factions (interest groups)
    - One main fear was groups taking away property rights



Federalist Paper No. 10

- Madison advanced a few foundational principles about property rights:
  - Property rights are a fundamental aspect of liberty
  - Government's role is to protect property from unjust interference
  - Property includes land and its economic choices

"One of the most fundamental requirements of a capitalist economic system—and one of the most misunderstood concepts—is a strong system of property rights." Professor Armen Alchian, emeritus professor of economics at UCLA, The Concise Encyclopedia of Economics, 2008.

Applying Constitutional and Capitalist Key Tenants to Renewable Energy

- We have never believed that there should be no sound, smells, or activity on farmer or rancher lands
  - Washington, Jefferson, Madison, Monroe were farmers
- Claims that you should be able to block safe uses of your neighbor's land are antithetical to the founding of our nation and free market capitalism

By the way…do you know what economic system takes away the natural resources from private ownership?

- **Communism**
  - Political and economic doctrine that aims to replace private property with public ownership and communal control of the natural resources of a society.

Where is Oklahoma on Constitutional Principles of Property Rights and Free Market Capitalism?

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