



Industry Trends Impacting Alternative Energy Leases
WSLCA Summer Conference – Whitefish, Montana
July 29th, 2019

Dr. Shannon L. Ferrell
Professor, Agricultural Law
Oklahoma State University

Go here!

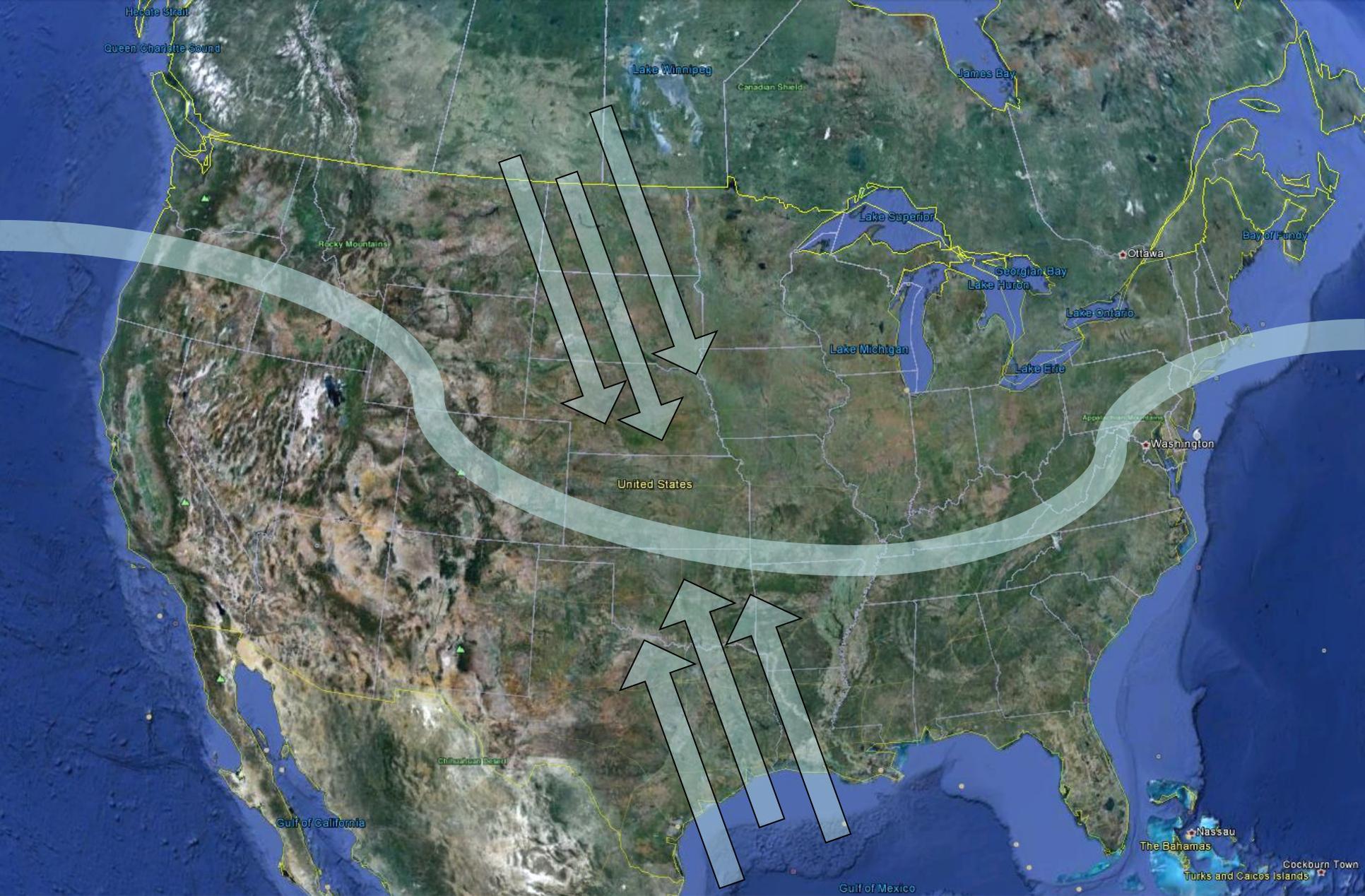
<http://agecon.okstate.edu/wind/>

Today's program

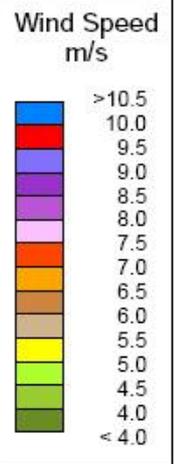
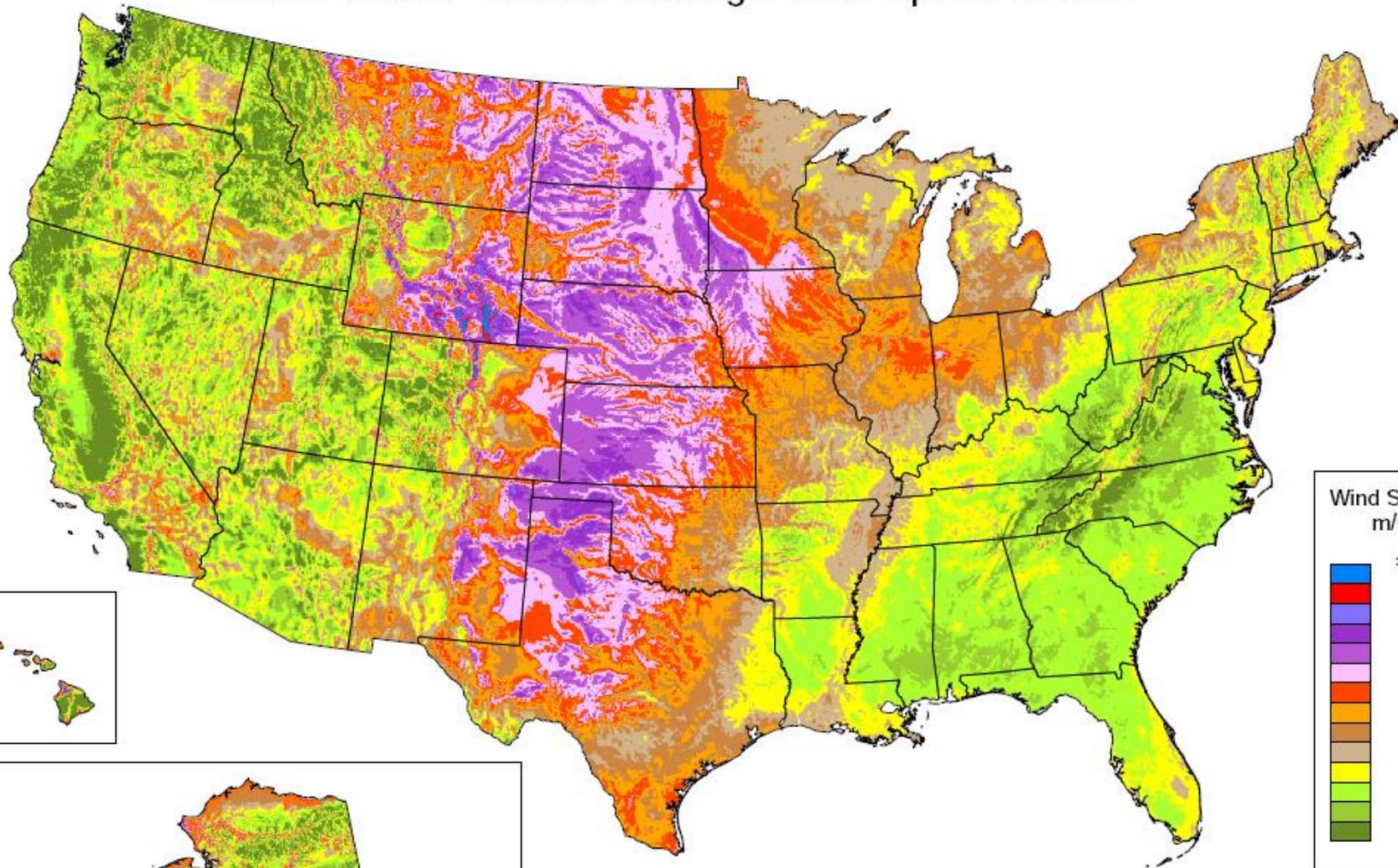
- Western U.S. wind and solar resources
- Understanding renewable energy fundamentals
- Five questions every land manager should ask:
 - Physical impacts to land use
 - Duration of agreement
 - Landowner's obligations
 - Compensation
 - Cleanup



Western U.S. wind and solar resources



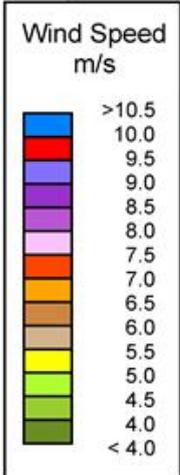
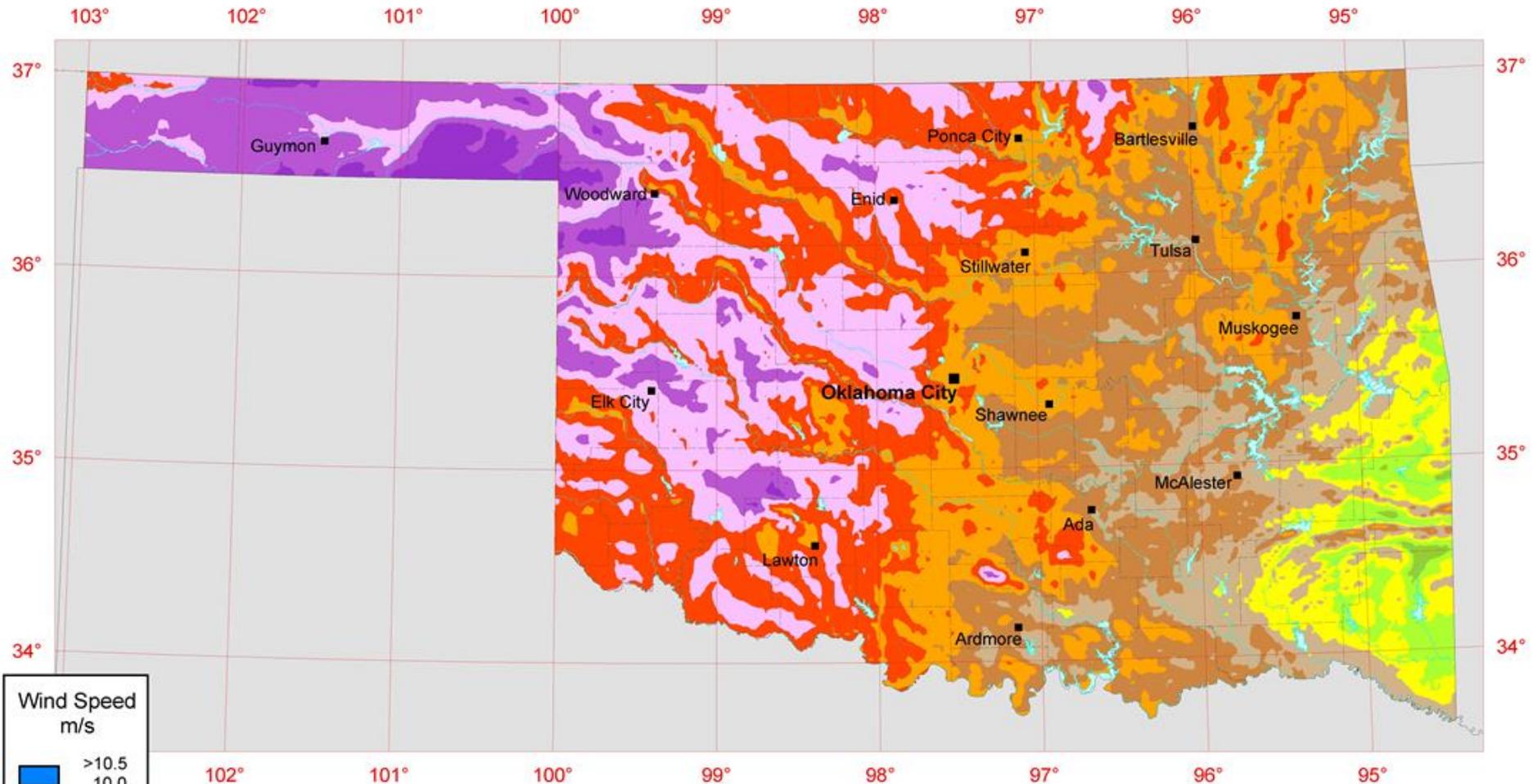
United States - Annual Average Wind Speed at 80 m



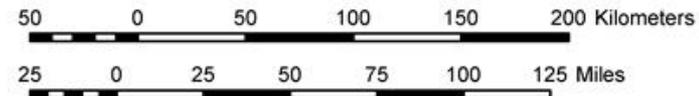
Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: <http://www.windnavigator.com> | <http://www.awstruepower.com>. Spatial resolution of wind resource data: 2.5 km. Projection: Albers Equal Area WGS84.



Oklahoma - Annual Average Wind Speed at 80 m



Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: <http://www.windnavigator.com> | <http://www.awstruepower.com>. Spatial resolution of wind resource data: 2.5 km. Projection: UTM Zone 14 WGS84.

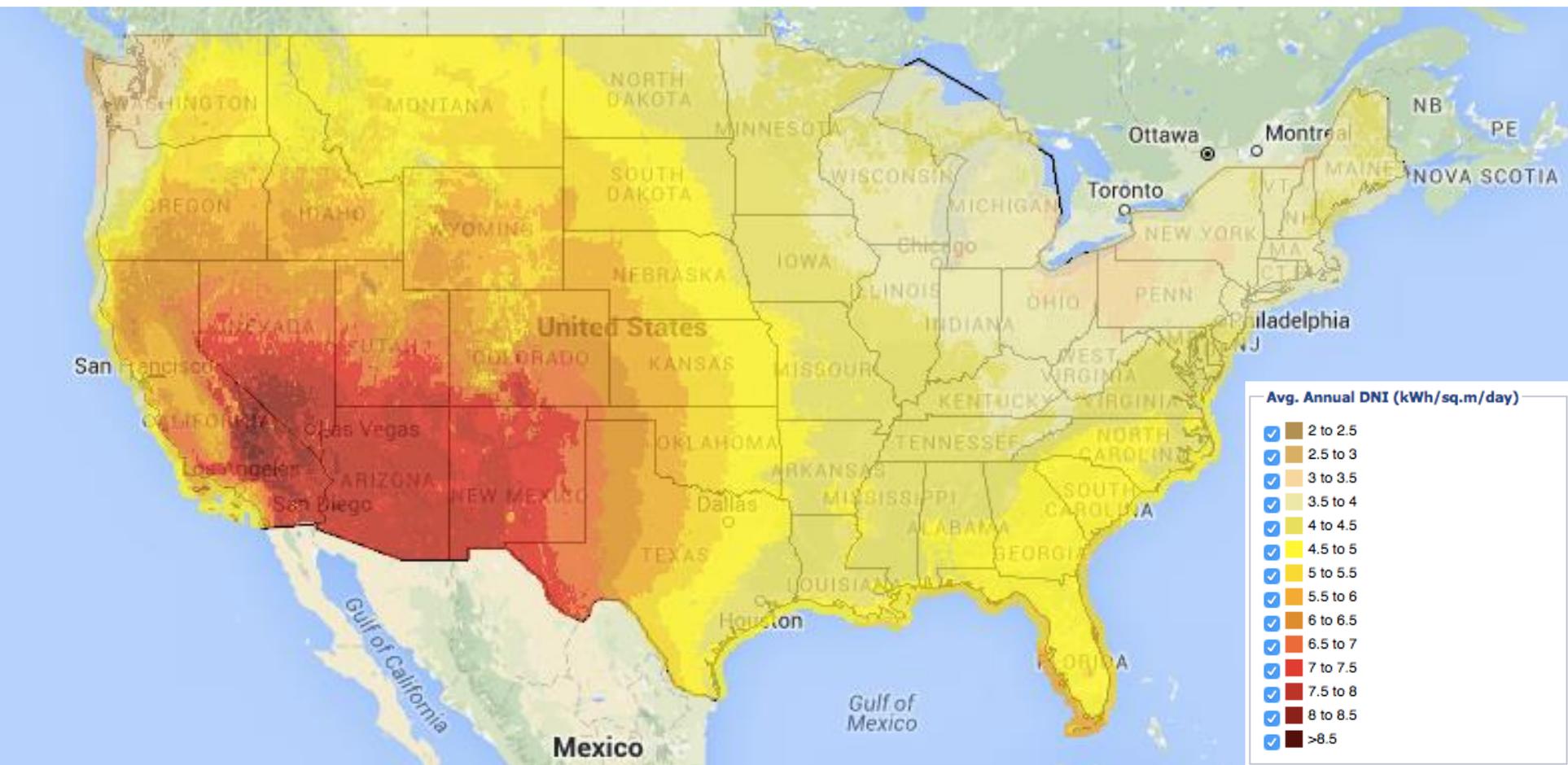


AWS Truepower™
Where science delivers performance.



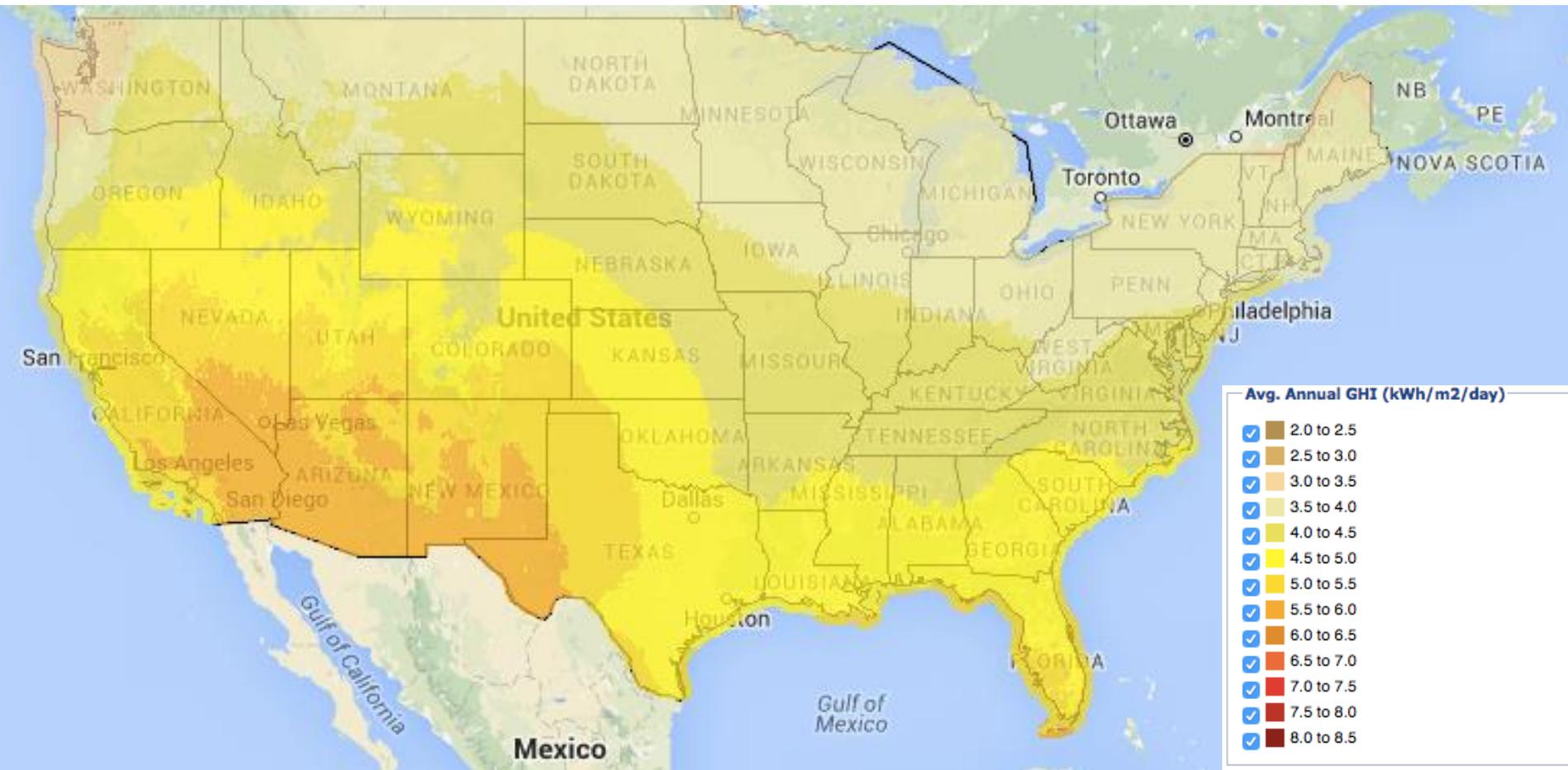
The U.S. solar resource

Direct Normal Irradiance (DNI)

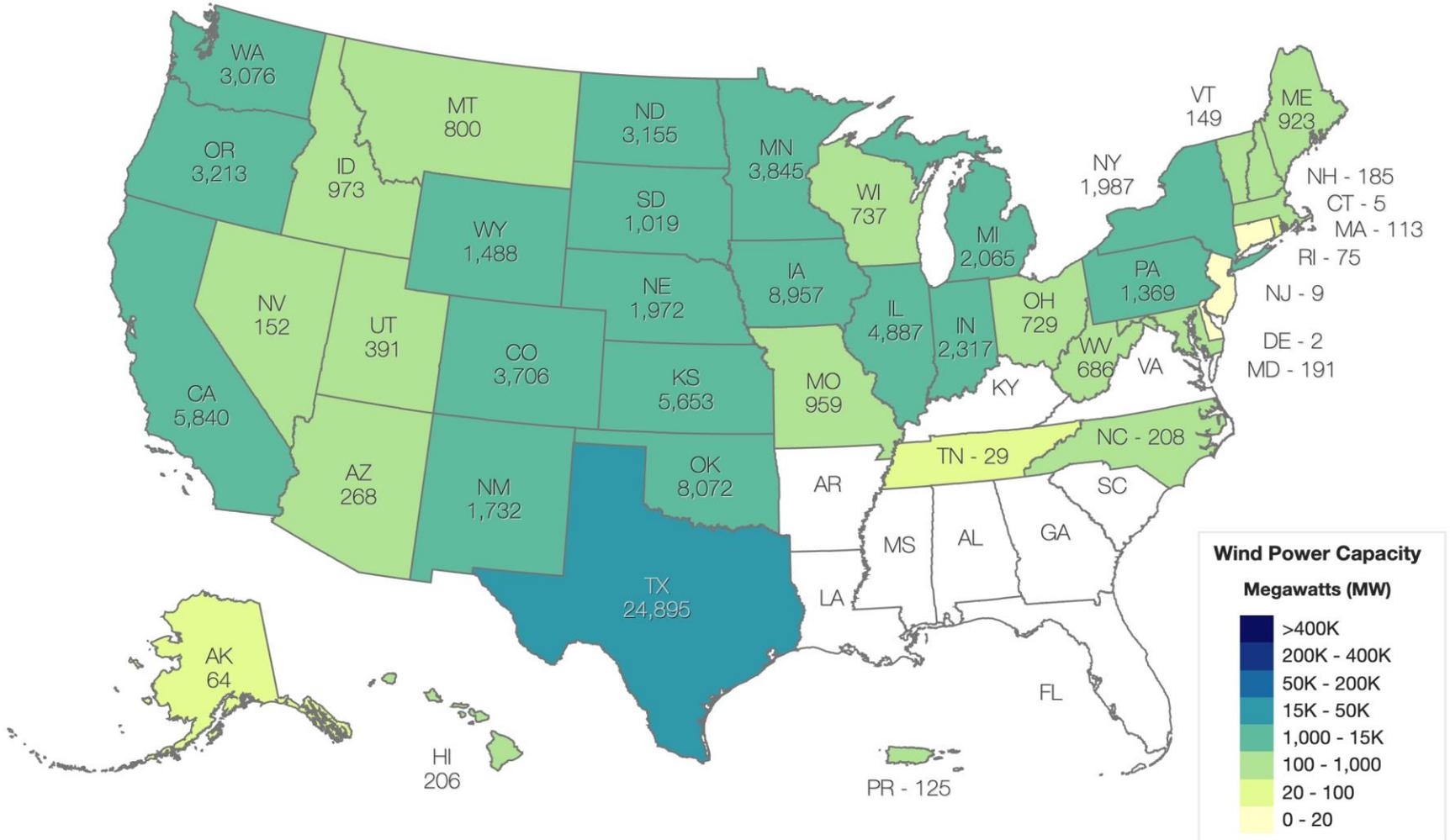


The U.S. solar resource

Global Horizontal Irradiance (GHI)



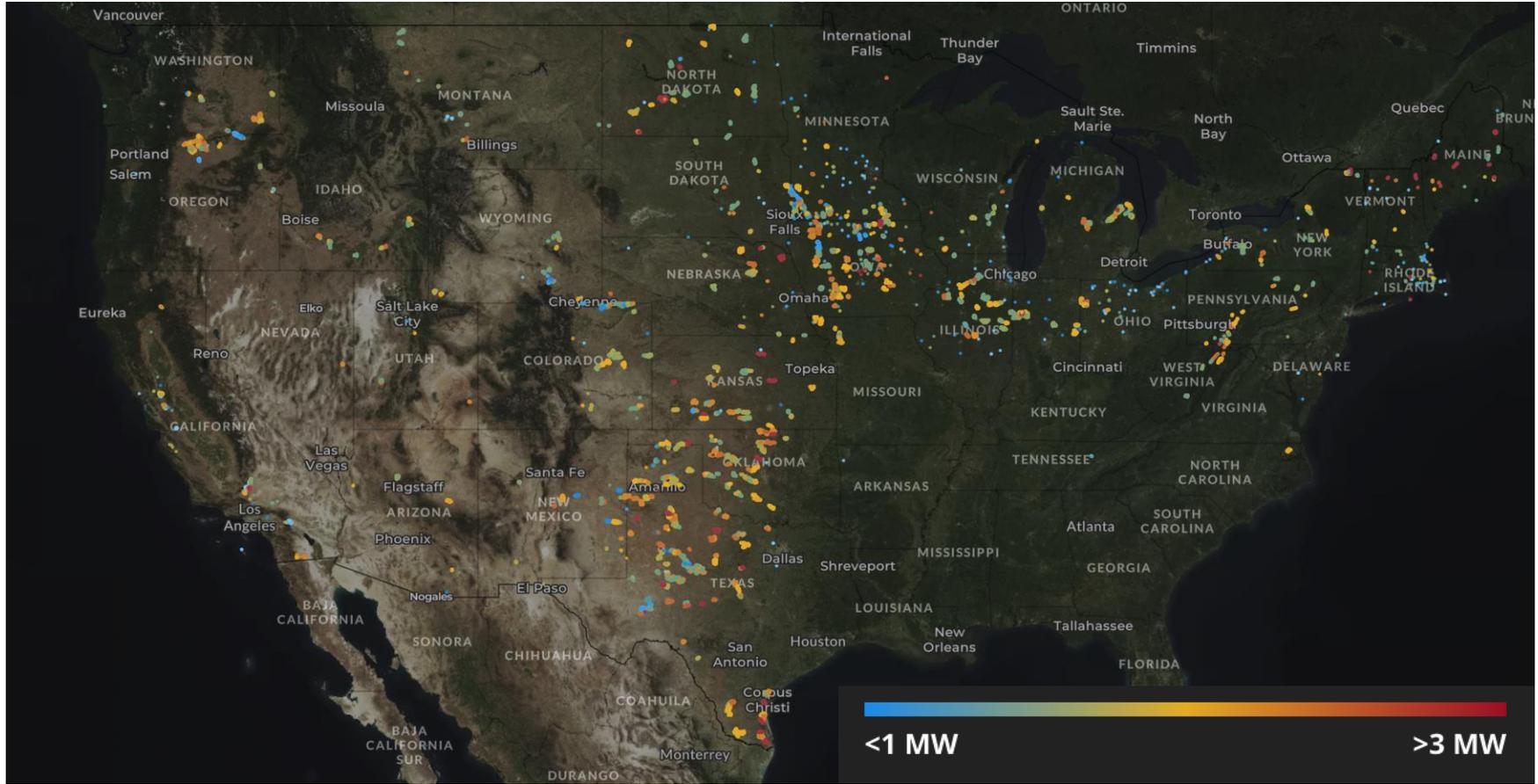
Q1 2019 Installed Wind Power Capacity (MW)



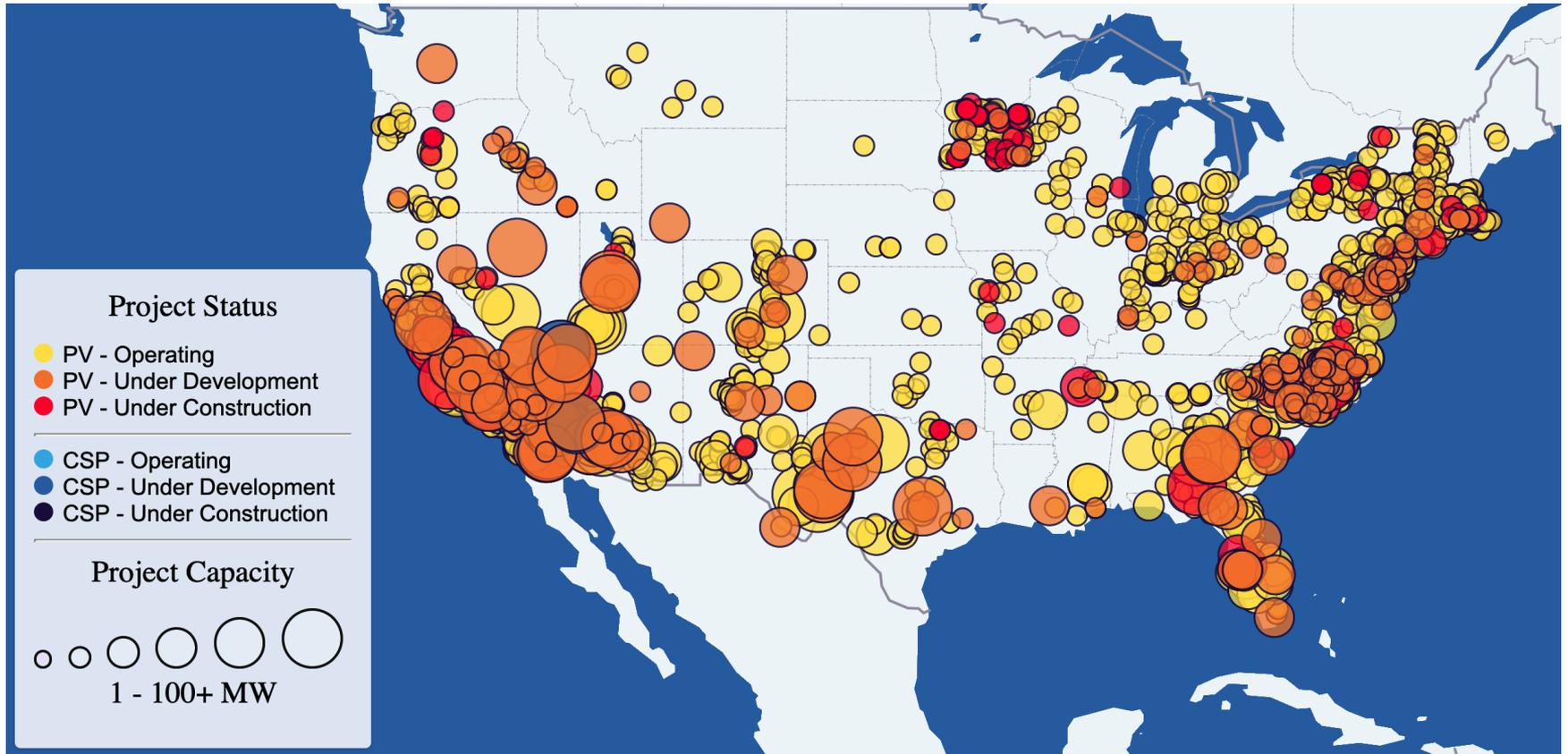
Total Installed Wind Capacity: 97,227 MW

Source: American Wind Energy Association Market Report

U.S. wind projects



U.S. solar projects



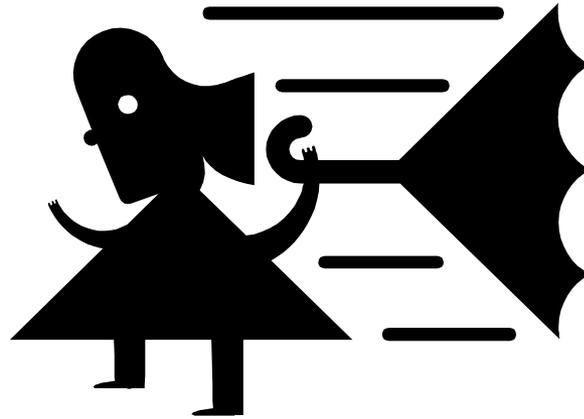
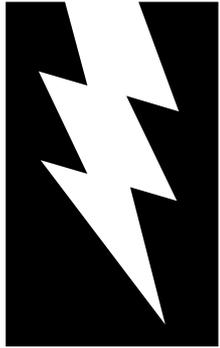


How do they work?

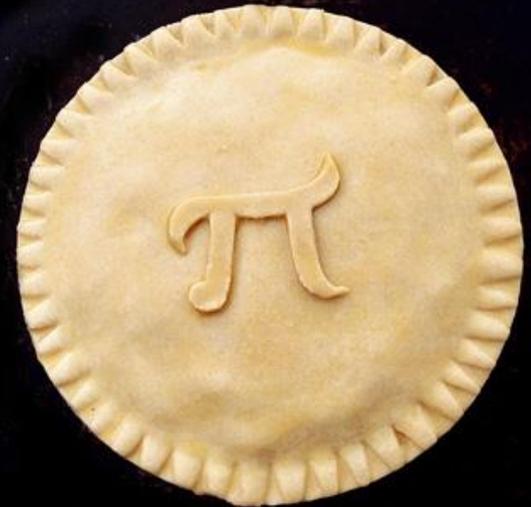
Wind & solar fundamentals

P

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Πr^2



GE WIND TURBINE

BLADES

Lift and rotate when hit by wind, causing the rotor to spin.

ROTOR

Combination of the blades and hub.

PITCH SYSTEM

Turns blades out of the wind to control rotor speed. Also, stops the rotor from spinning in conditions where wind is blowing too slow or too fast.

GENERATOR

Produces 60-cycle AC electricity within the turbine.

CONTROLLER

Starts and stops the turbine from working, depending on conditions.

YAW DRIVE

Controls upwind turbines to orient them should wind direction change.

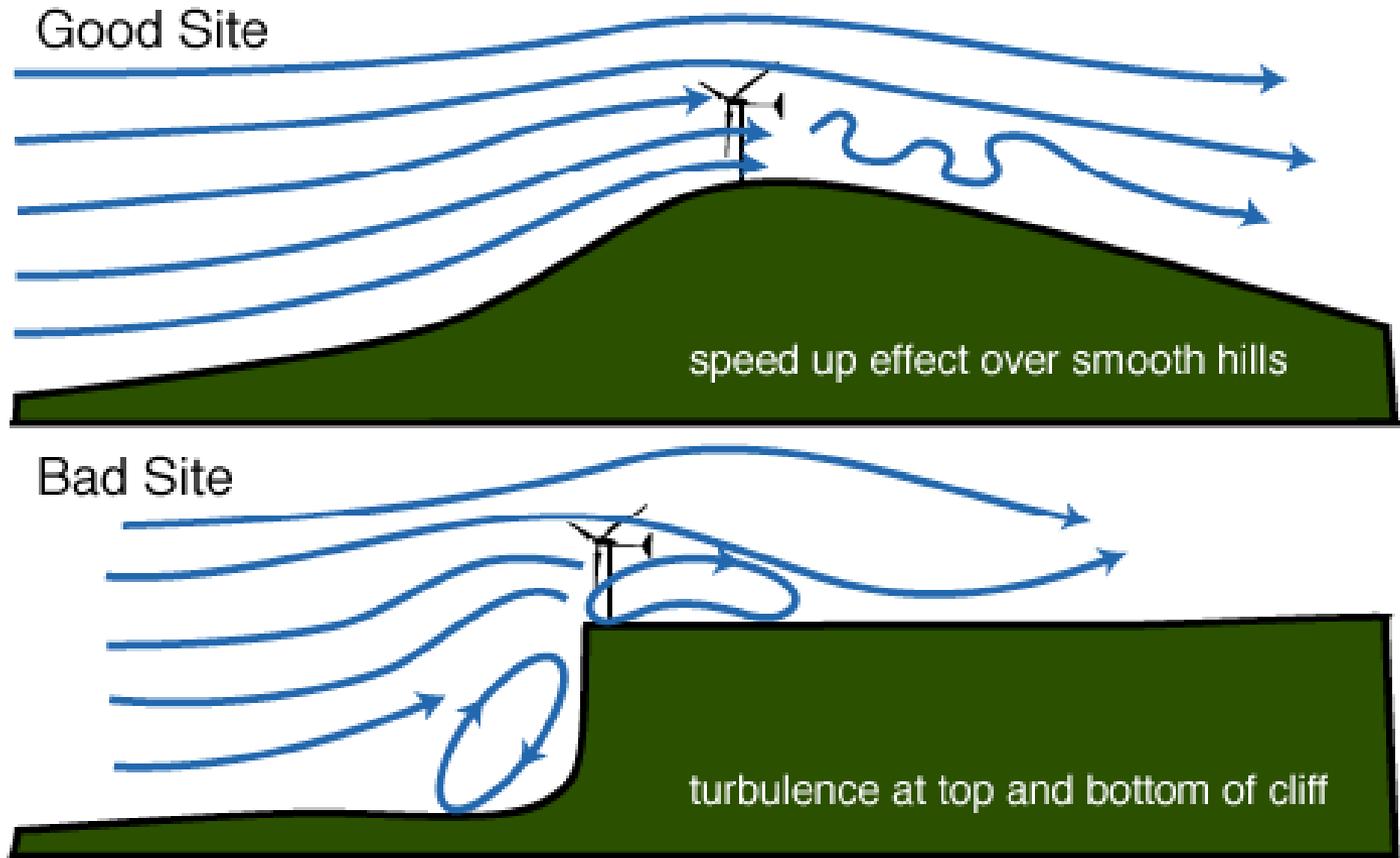
TOWER

The base of the turbine, built to support the rest of the structure.



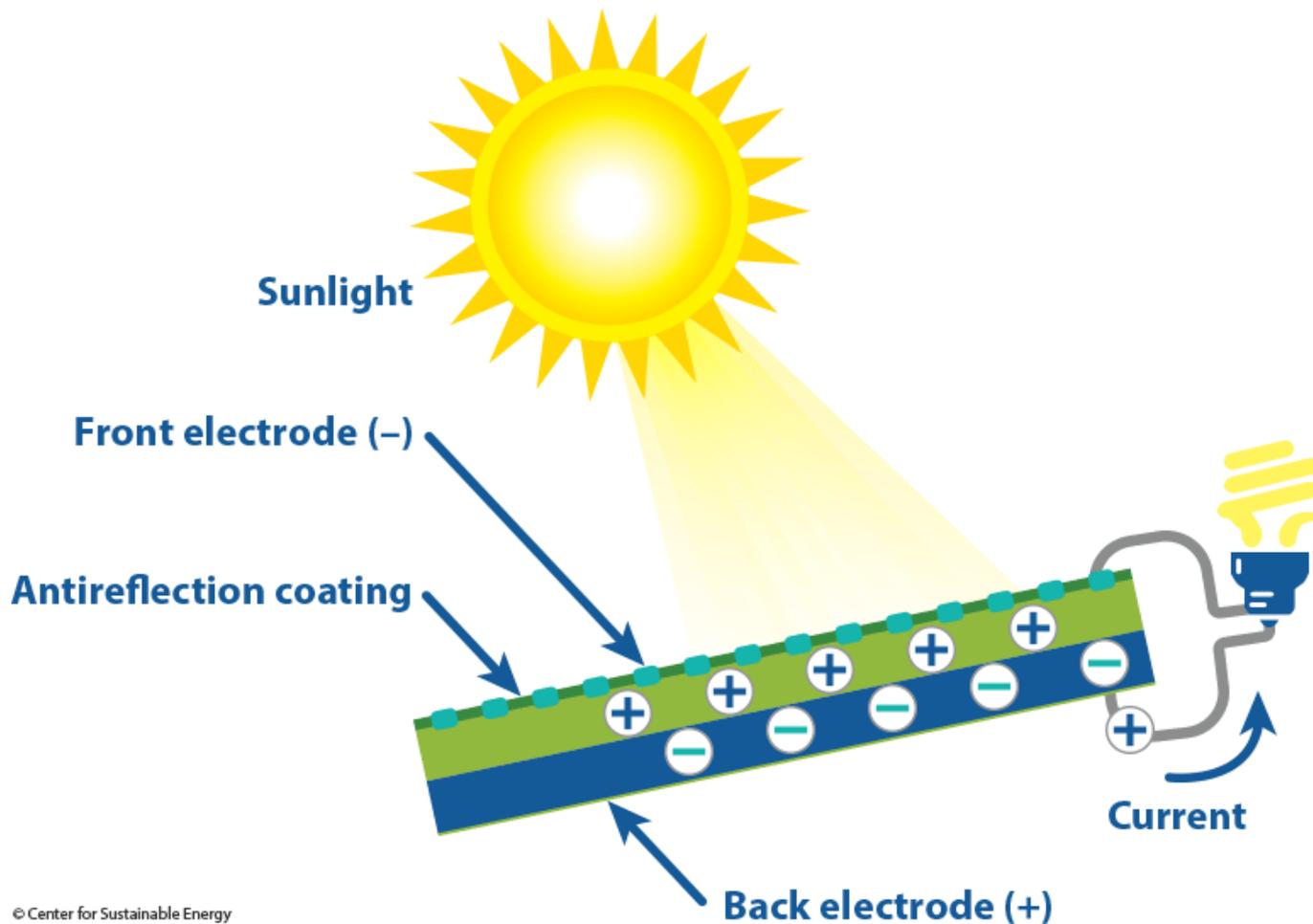
Source: GE

Location, location, location



Source: <http://www.greenspec.co.uk/html/energy/windturbines.html>

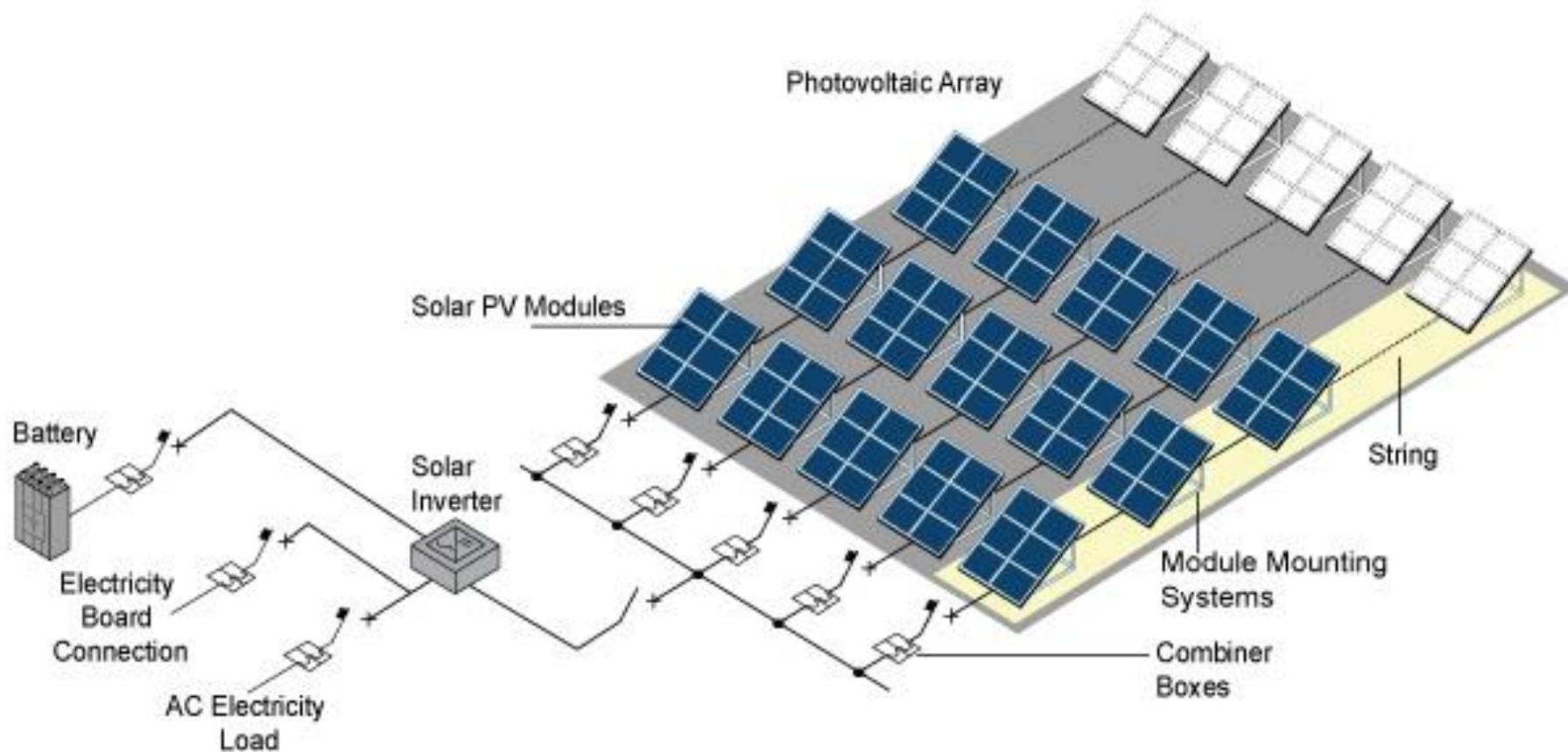
Photovoltaic (PV): The basic idea



© Center for Sustainable Energy

Source: Center for Sustainable Energy

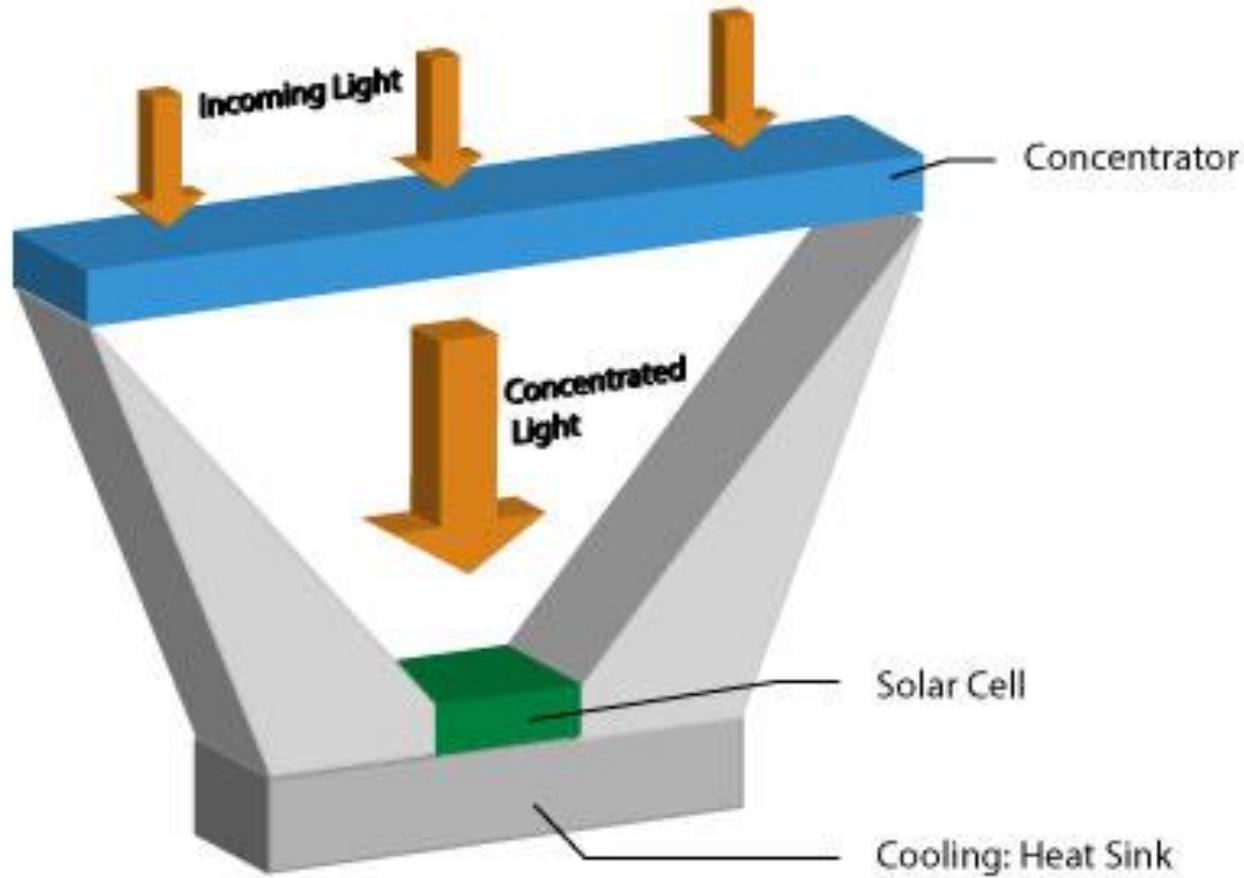
Photovoltaic (PV): The basic idea



Photovoltaic (PV) in action



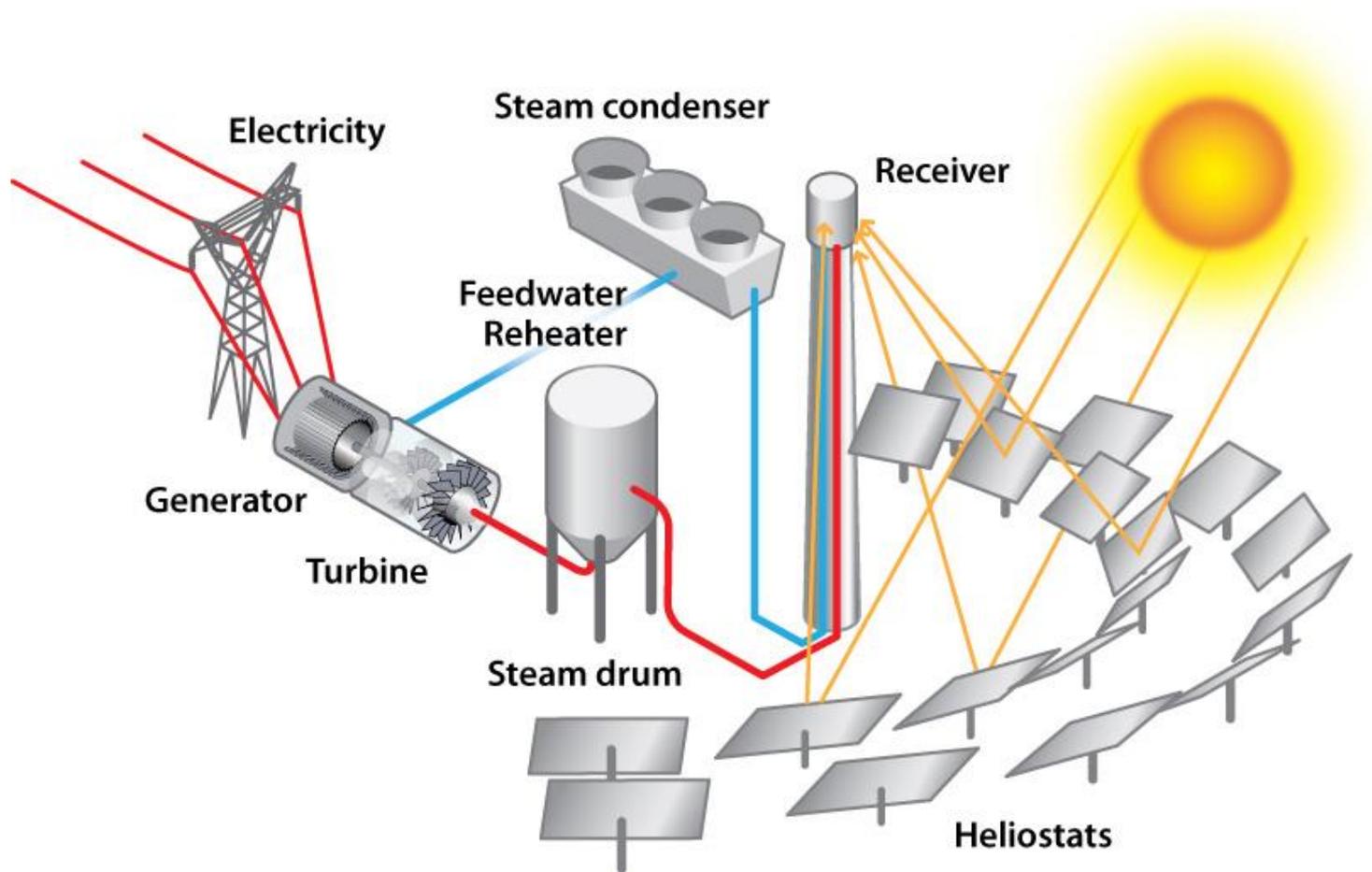
Concentrated Photovoltaic (CPV): The basic idea



Concentrated Photovoltaic (CPV) in action



Concentrating Solar Power (CSP): The basic idea

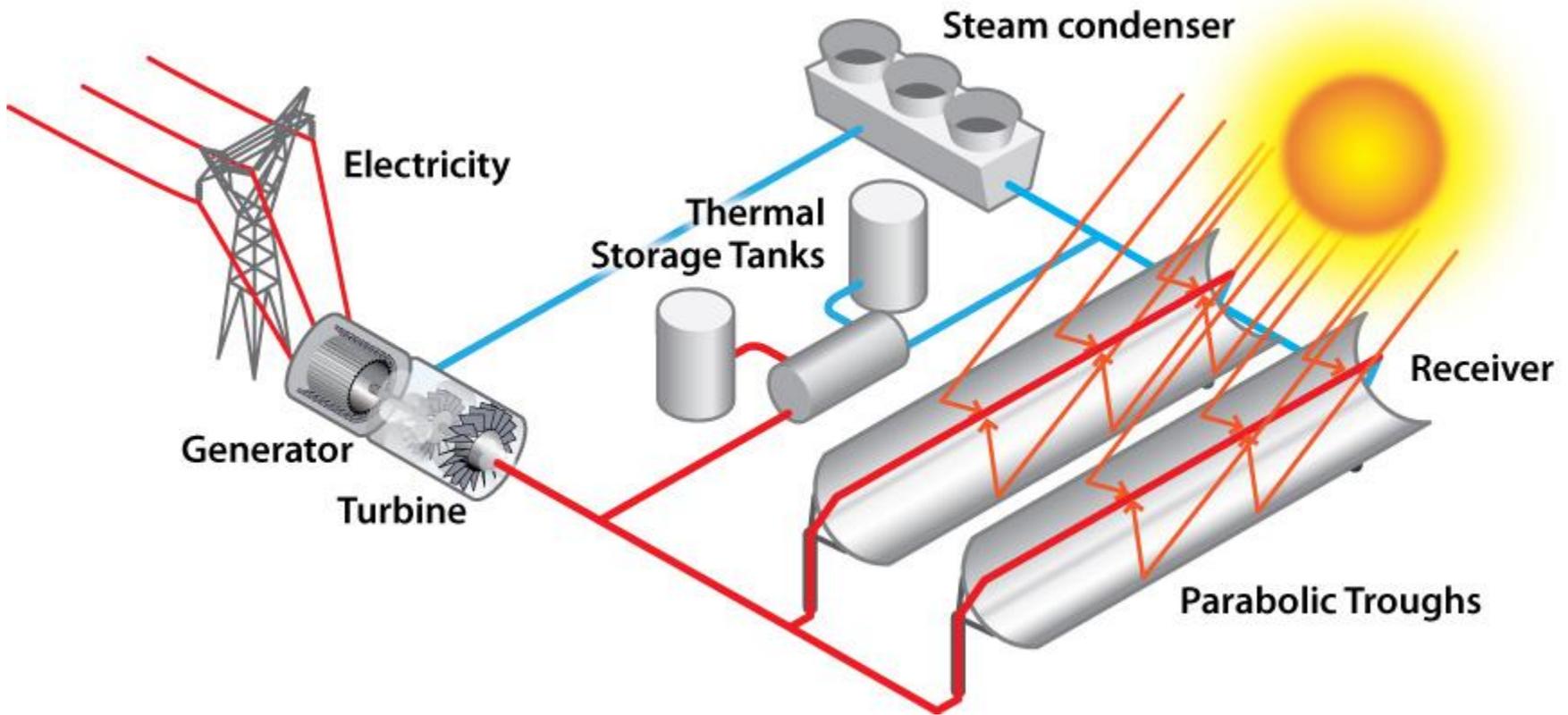


Concentrating Solar Power (CSP) in action



Source: U.S. DOE, Office of Energy Efficiency and Renewable Energy

Concentrating Solar Power (CSP) – parabolic trough



Concentrating Solar Power (CSP) parabolic trough in action



The developer's dilemma:



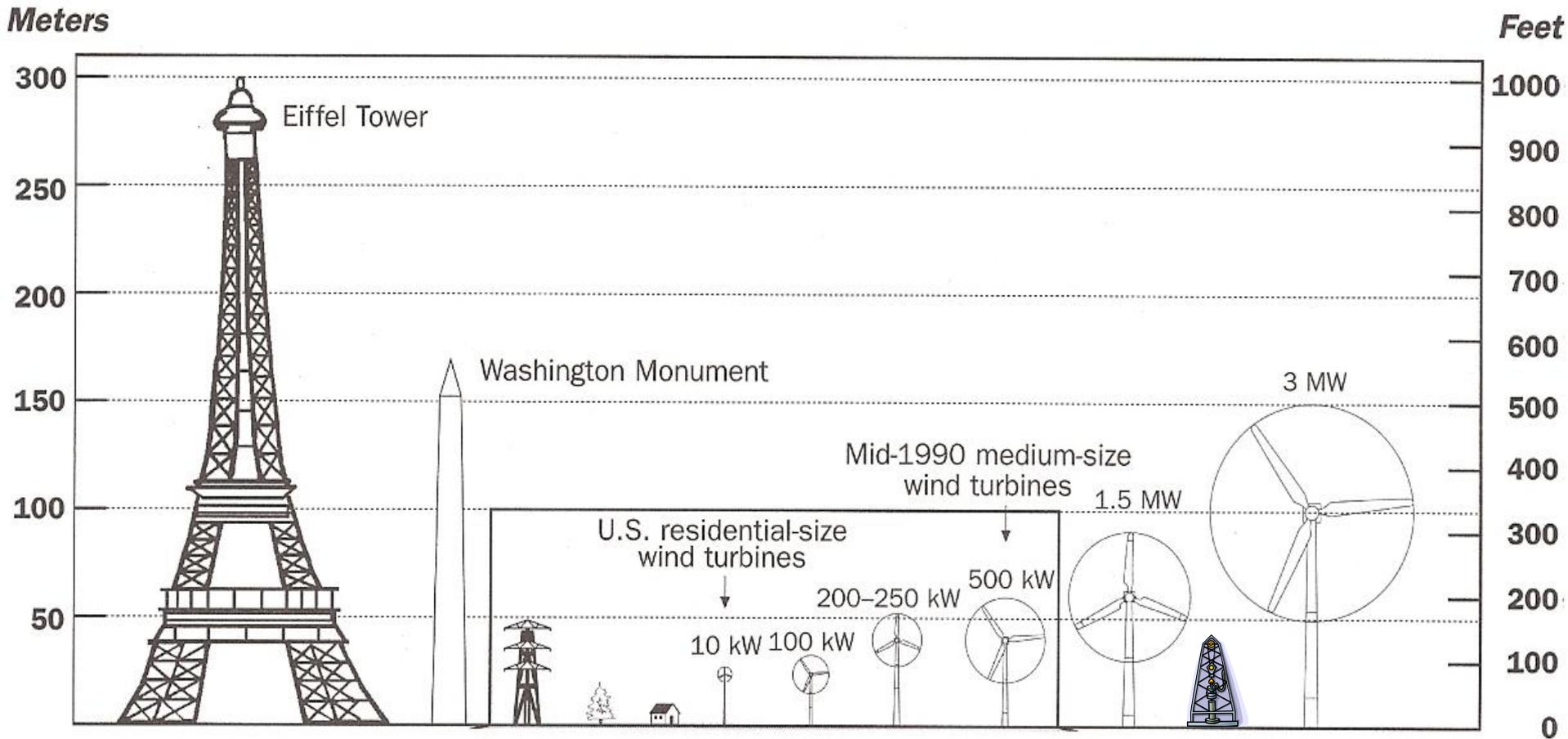
Five questions every land manager should ask

1. What are the impacts to property use?
2. How long will agreement last?
3. What are the landowner's obligations?
4. How will the landowner be compensated?
5. What happens when the project ends?



**What are the physical
impacts to property use?**

A sense of turbine scale



Source: Paul Gipe, *Wind Energy Basics* (Chelsea Green Publishing Co., 1999)



Source: Western Farmers Electric Cooperative

Tower staging



Source: Western Farmers Electric Cooperative

Nacelle staging

Rotor Hub
20 tons

Nacelle
51 tons

Dude
0.09 tons
(not permanently
installed)



Source: Western Farmers Electric Cooperative

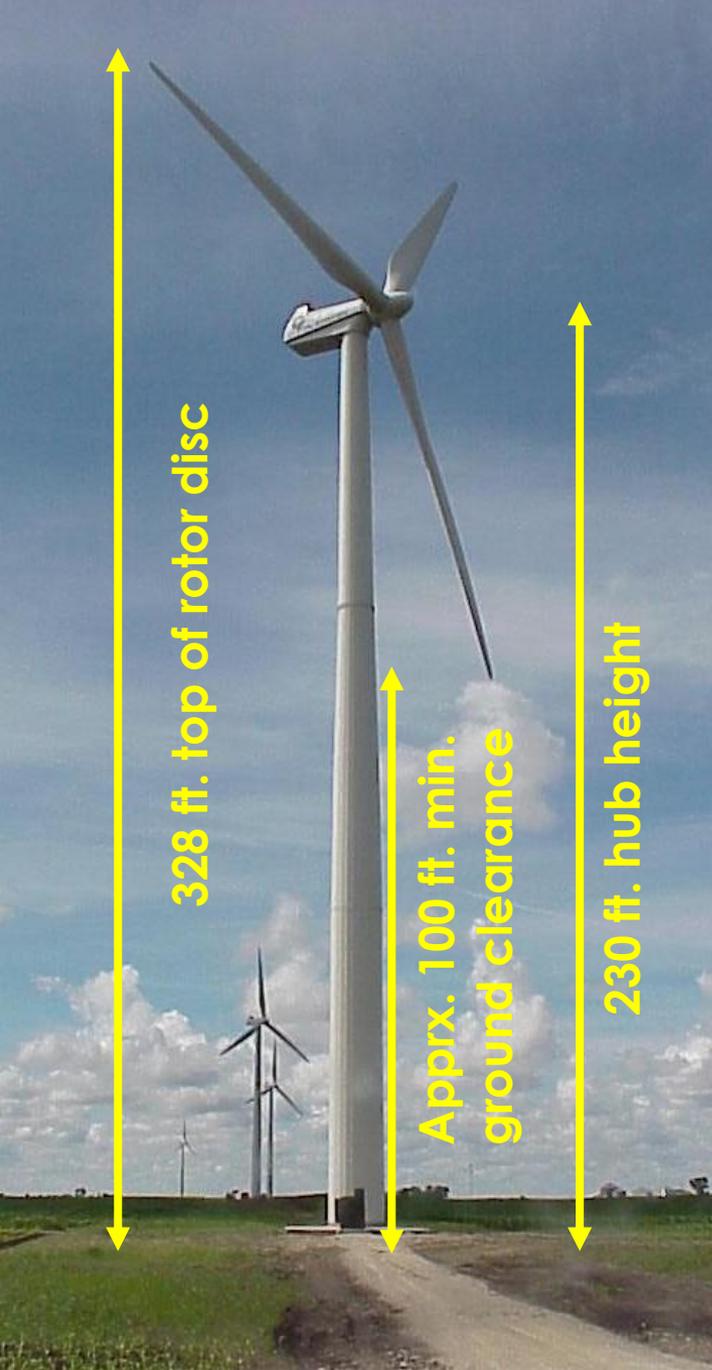
Turbine blades



**115 feet long
9.5 tons**

Source: Western Farmers Electric Cooperative

Final configuration



Weatherford Wind Energy Center Density Example

X

Legend



Field Geometry and Land Use





Oklahoma wind energy land use statistics

- Average land use per turbine: 0.87 acres
- Average land use per MW: 0.46 acres
- Project land use (over all projects):
 - Turbines: 11%
 - Support systems: 13%
 - Roads: 76%



E1000 Rd

Arapaho Rd

N2360 Rd



Total field area: 156.88 ac

© 2016 Google

Google earth

Imagery Date: 12/2/2013 lat 35.561851° lon -98.760515° elev 0 ft eye alt 4498 ft



Total field area: 156.88 ac
Total obstructed area: 3.85 ac
Use ratio: 2.46%

© 2016 Google



Total field area: 15.51 ac

© 2016 Google

Google earth

Imagery Date: 9/10/2015 lat 39.567045° lon -77.721428° elev 0 ft eye alt 1473 ft

Total field area: 15.51 ac
Total obstructed area: 6.81 ac
Use ratio: 43.92%

© 2016 Google

Google earth

Imagery Date: 9/10/2015 lat 39.567045° lon -77.721428° elev 0 ft eye alt 1473 ft

Land use requirements for PV and CSP projects in the U.S.

Technology	Direct Area		Total Area	
	Capacity-weighted average land use (acres/MWac)	Generation-weighted average land use (acres/GWh/yr)	Capacity-weighted average land use (acres/MWac)	Generation-weighted average land use (acres/GWh/yr)
Small PV (>1 MW, <20 MW)	5.9	3.1	8.3	4.1
Fixed	5.5	3.2	7.6	4.4
1-axis	6.3	2.9	8.7	3.8
2-axis flat panel	9.4	4.1	13	5.5
2-axis CPV	6.9	2.3	9.1	3.1
Large PV (>20 MW)	7.2	3.1	7.9	3.4
Fixed	5.8	2.8	7.5	3.7
1-axis	9.0	3.5	8.3	3.3
2-axis CPV	6.1	2.0	8.1	2.8
CSP	7.7	2.7	10	3.5
Parabolic trough	6.2	2.5	9.5	3.9
Tower	8.9	2.8	10	3.2
Dish Stirling	2.8	1.5	10	5.3
Linear Fresnel	2.0	1.7	4.7	4.0

Livestock and turbines



Source: Western Farmers Electric Cooperative

Livestock and turbines



Source: Apex Wind Energy – kingfisherwind.com

Livestock and turbines



Source: Sarah Coffey

Sheep and modules



Shared land use



- Limited use possible for sheep grazing with above-ground mounted PV
- Much broader uses with rooftop-mounted PV
- Be sure shared uses are explicitly protected in written agreement

From USFWS

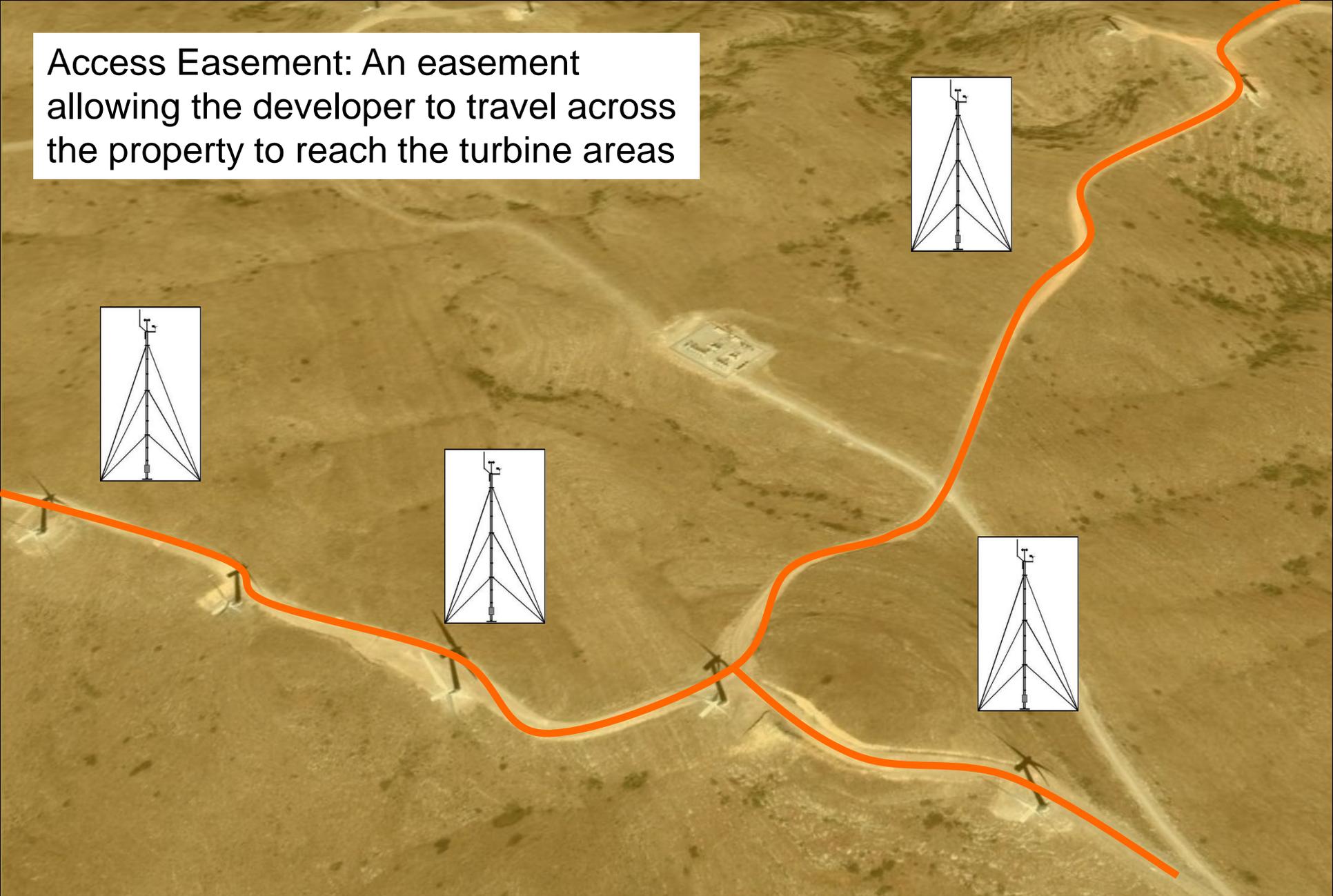


- Estimated birds killed by wind turbines in US per year: 38,000
- Estimated birds killed per year by domestic cats in WISCONSIN ALONE: 39,000,000 – Kill ratio 1000:1
- Ask yourself, America - who's the real enemy?

Site selection considerations

- Wind:
 - Access for construction, connection lines, and utilities
- Utility scale CSP, PV: large, flat areas
 - $<1\%$ slope for CSP
 - CPV may use rougher terrain
- Rooftop solar: roofs and suitability for distributed generation (DG) applications

Access Easement: An easement allowing the developer to travel across the property to reach the turbine areas

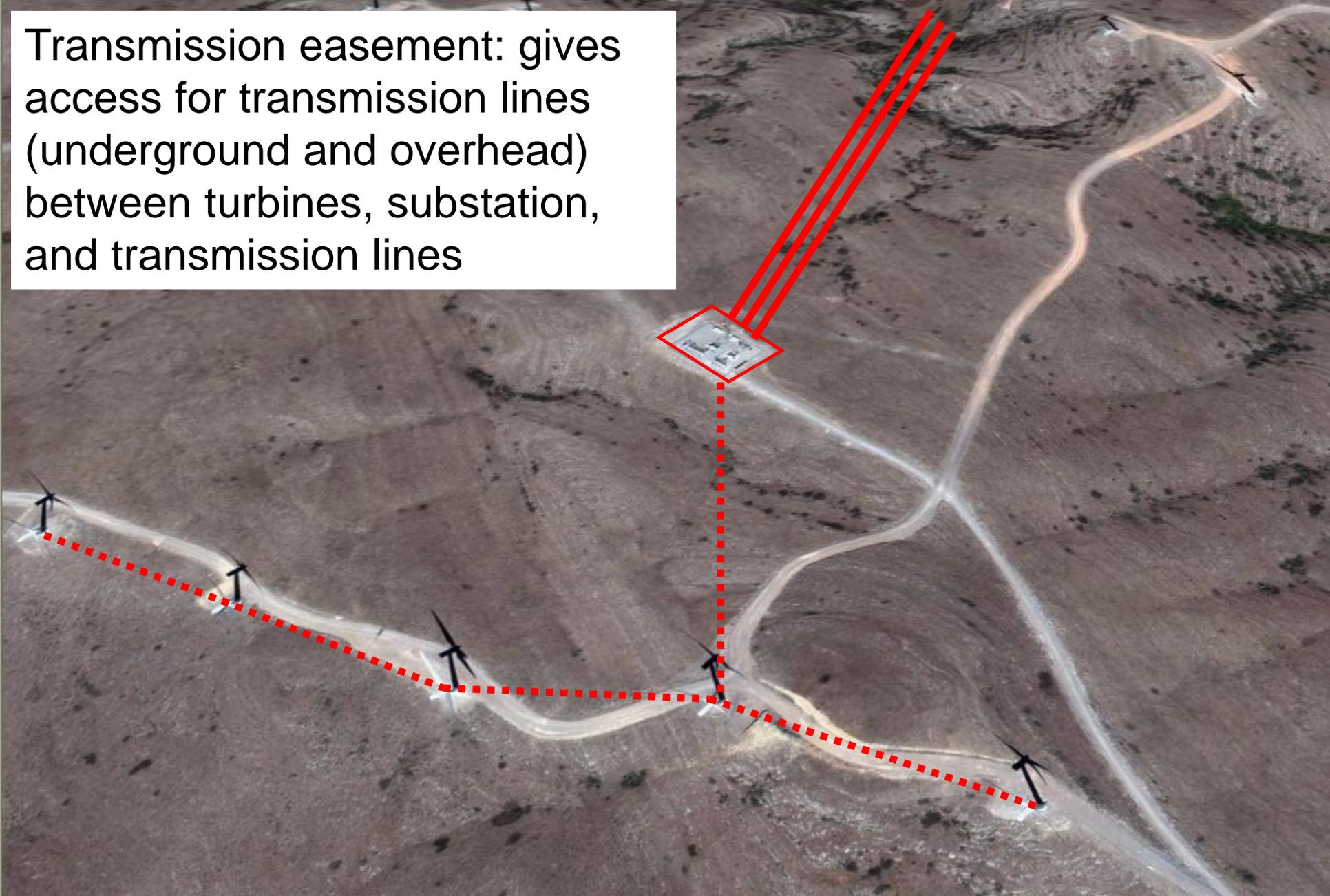


Construction Easement: Often tied to access easement. Gives access for construction of turbines and support systems.

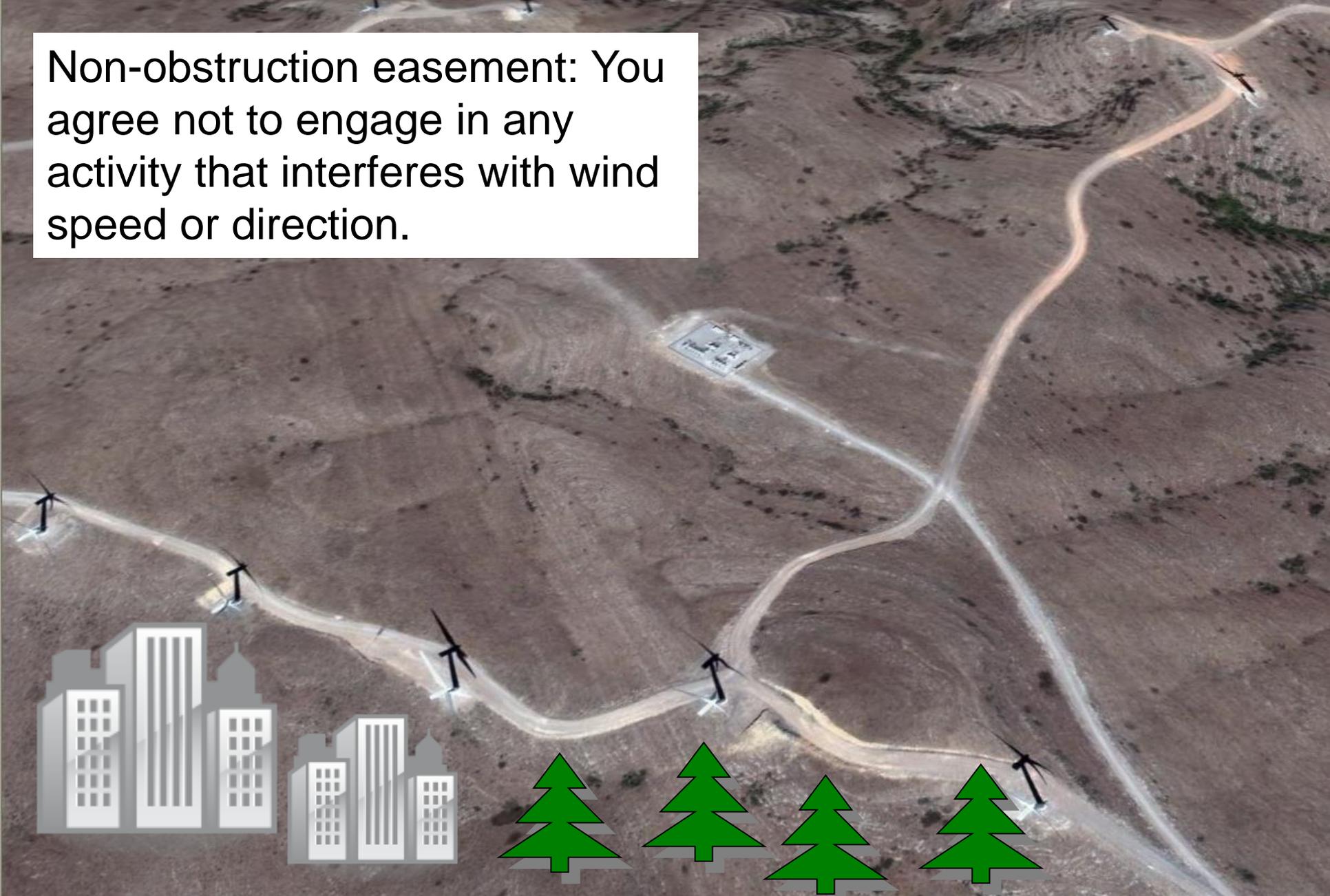
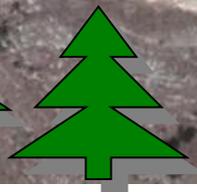
May also allow for a “lay-down” area(s)



Transmission easement: gives access for transmission lines (underground and overhead) between turbines, substation, and transmission lines



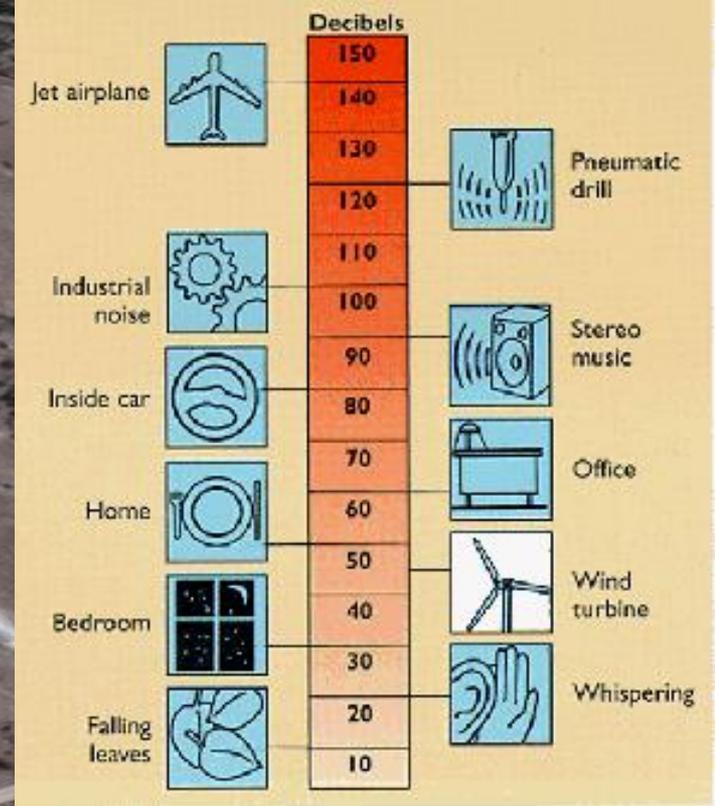
Non-obstruction easement: You agree not to engage in any activity that interferes with wind speed or direction.



Overhang/encroachment easement: You agree to allow turbine blades to overhang your property, even if turbines are on adjoining property.



Noise easement: Allows for noise from operations up to a certain level (usually measured in decibels [dB]), often within a specific radius.



Nuisance / aesthetic easement



Post-construction restoration

- Construction areas generally larger than operational areas
- Decompaction
- Restoration of
 - Topsoil (double trenching)
 - Terraces / conservation structures
 - Native vegetation

Dealing with damages

- How does agreement handle damages to growing crops / livestock?
- How does agreement handle “blocking” crop or livestock production for a season?
- Possible tools
 - Set schedule (pre-determined price per head, per acre, etc.)
 - Defined calculations (ex. local market price for comparable animal, nearest cash bid for crop, etc.)



**How long will the
agreement last?**

How long will the agreement last?

- Agreements typically run from 30 – 99 years (150!)
- Review renewal clauses (automatic?)
- Notice of renewal provided?
- Opportunity to re-open?
- Maintain market parity (or do you want to?)





What are the landowner's obligations?

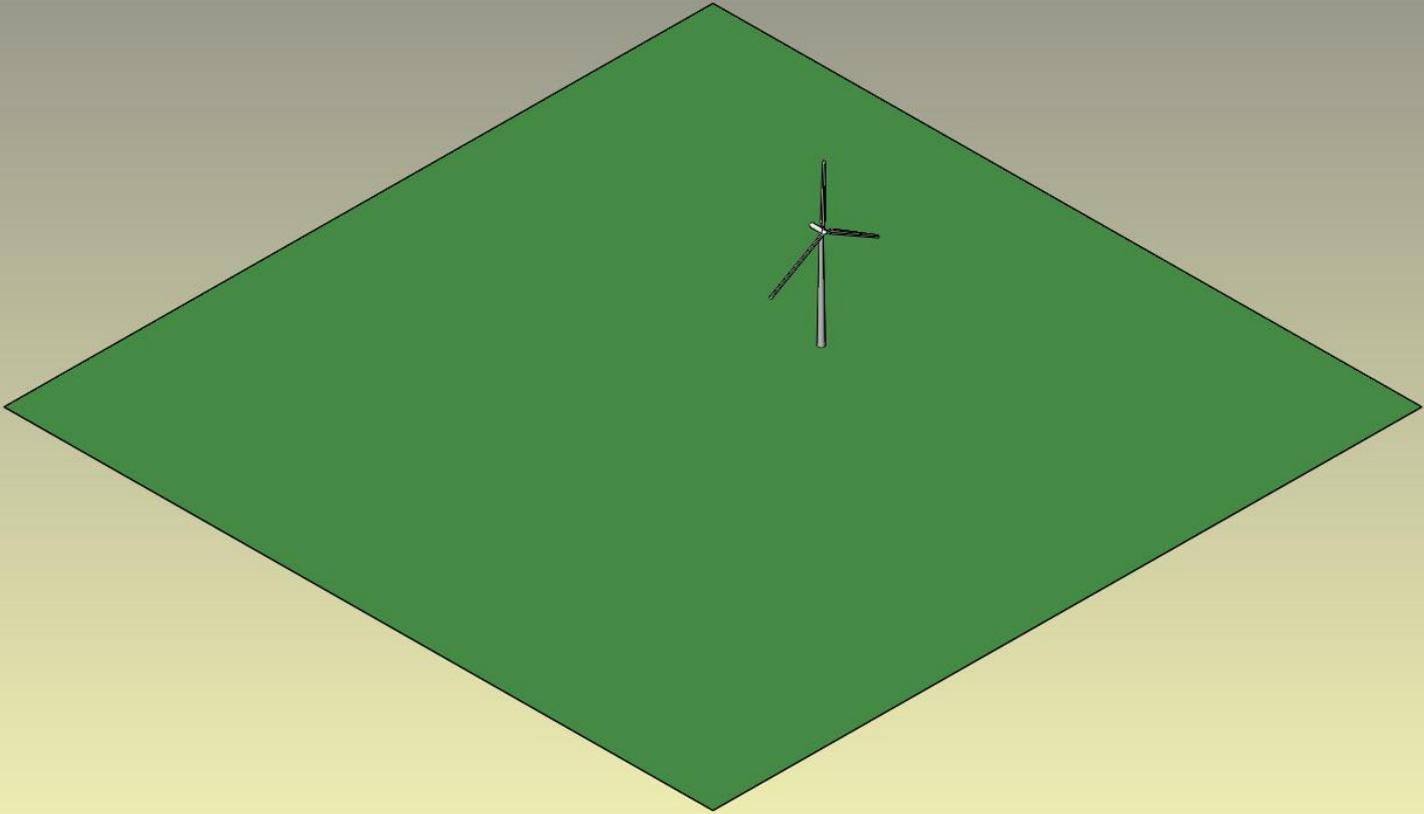
What are the landowner's obligations?

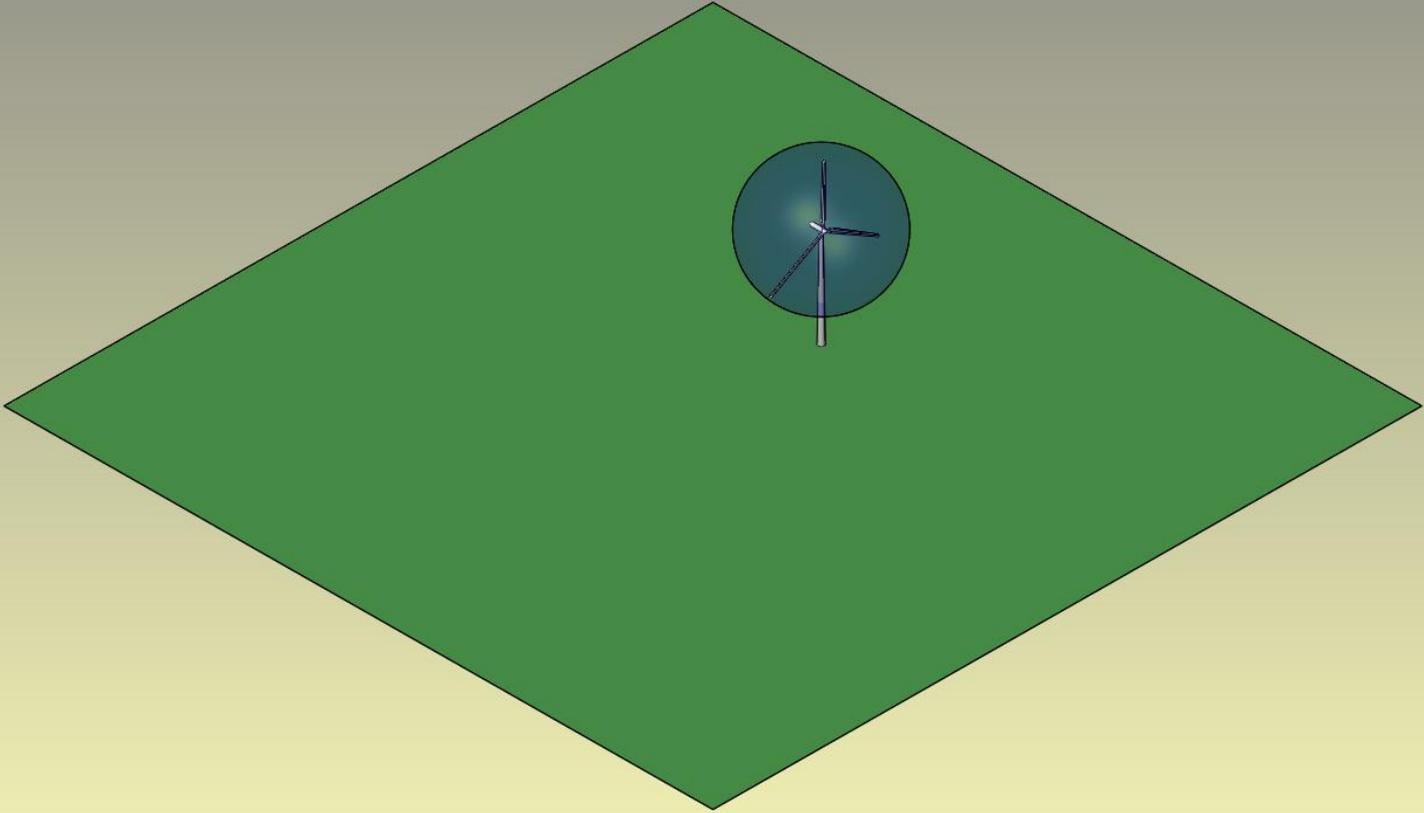
- Indemnity?*
- Property taxes?
- Subordination / property interests
- Federal program compliance (CRP, EQIP, WHIP)?

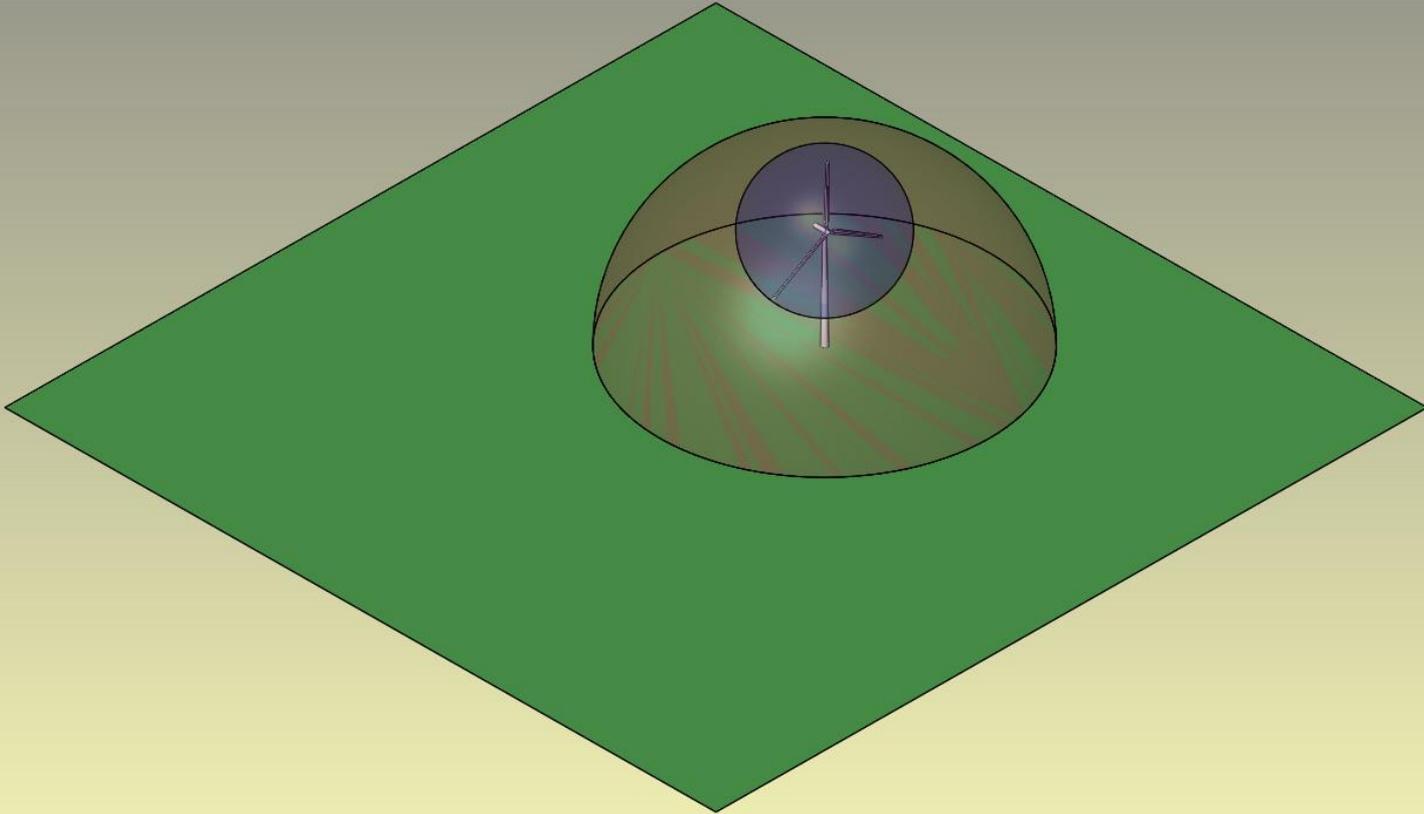


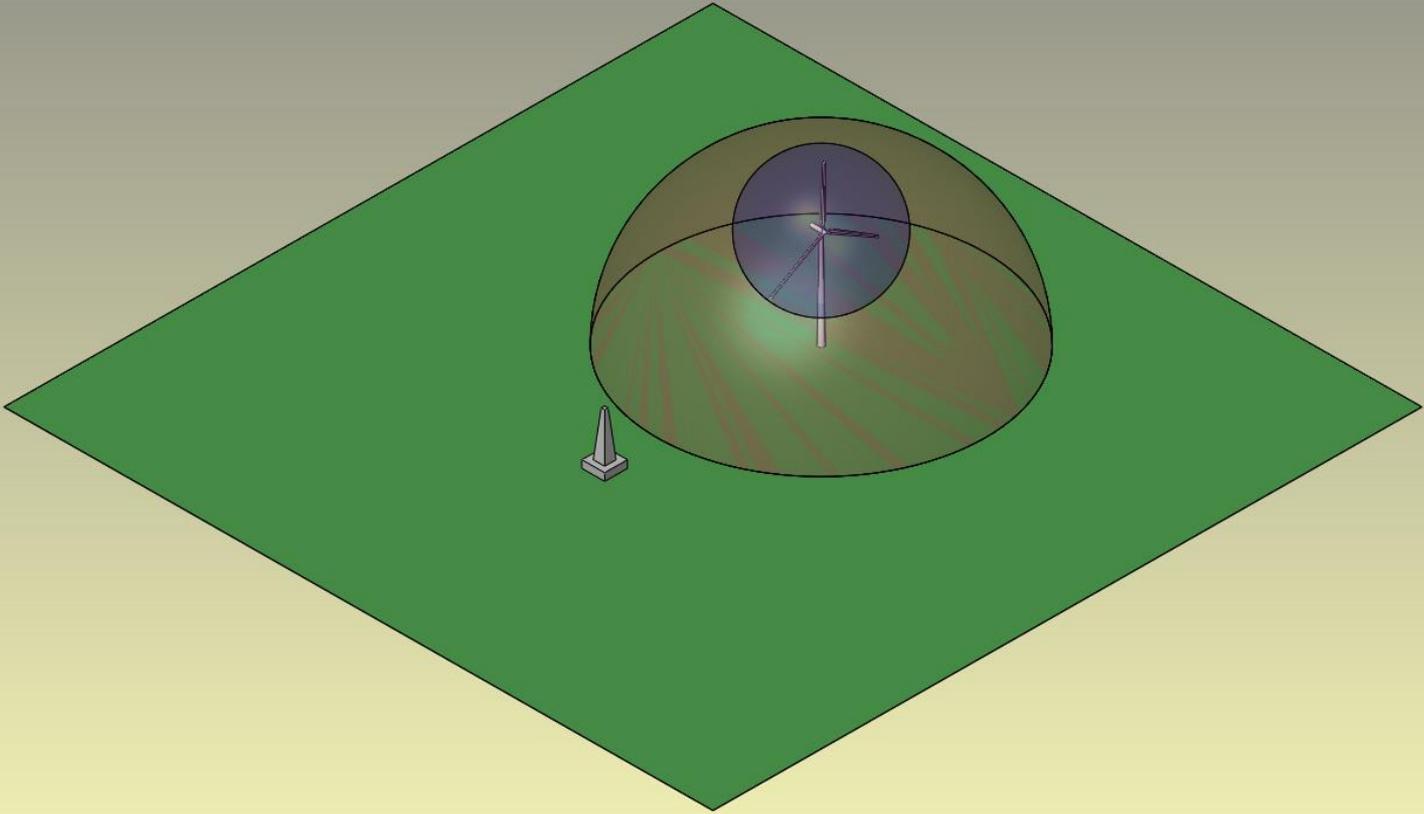
Minerals and renewables

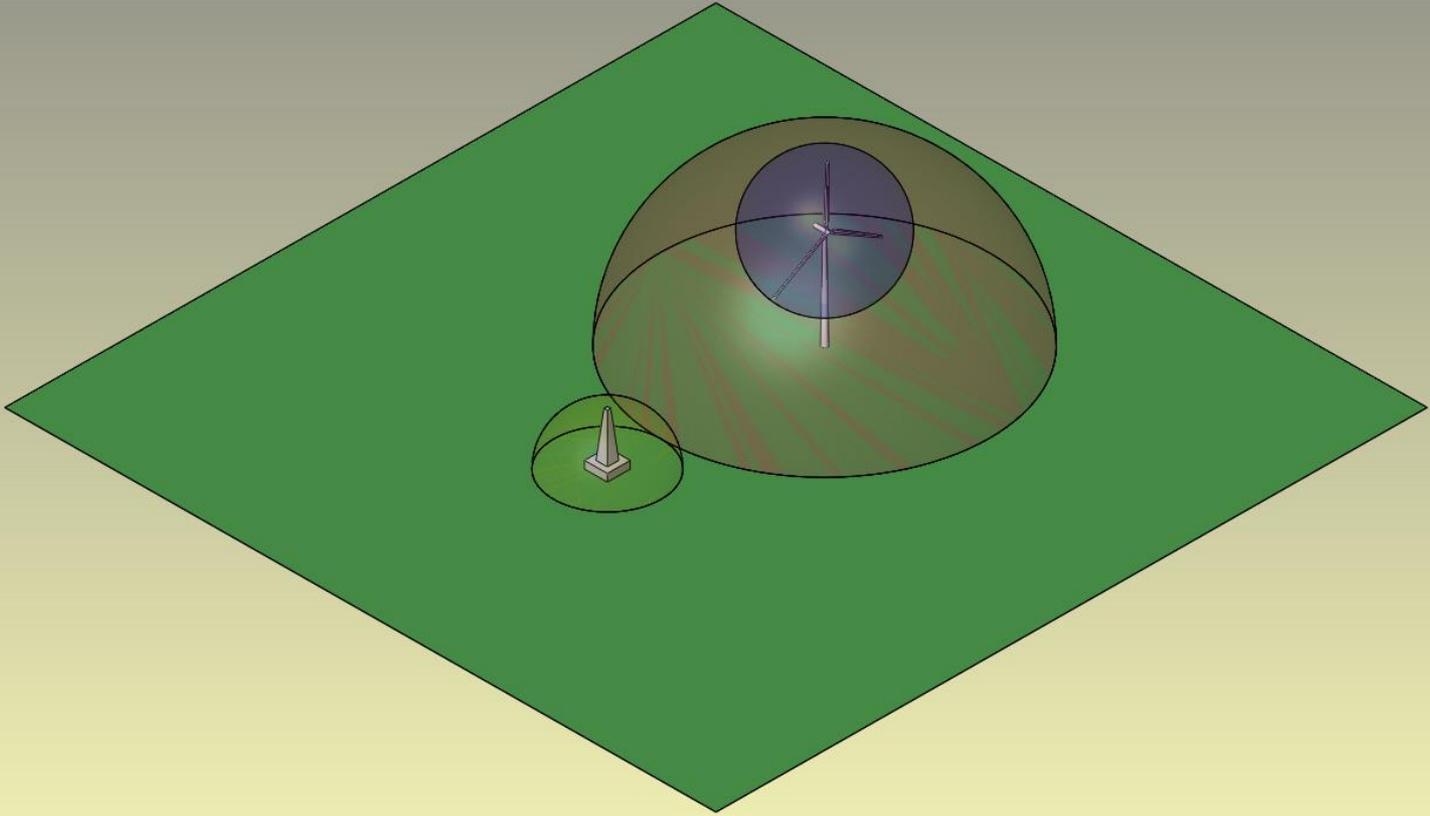






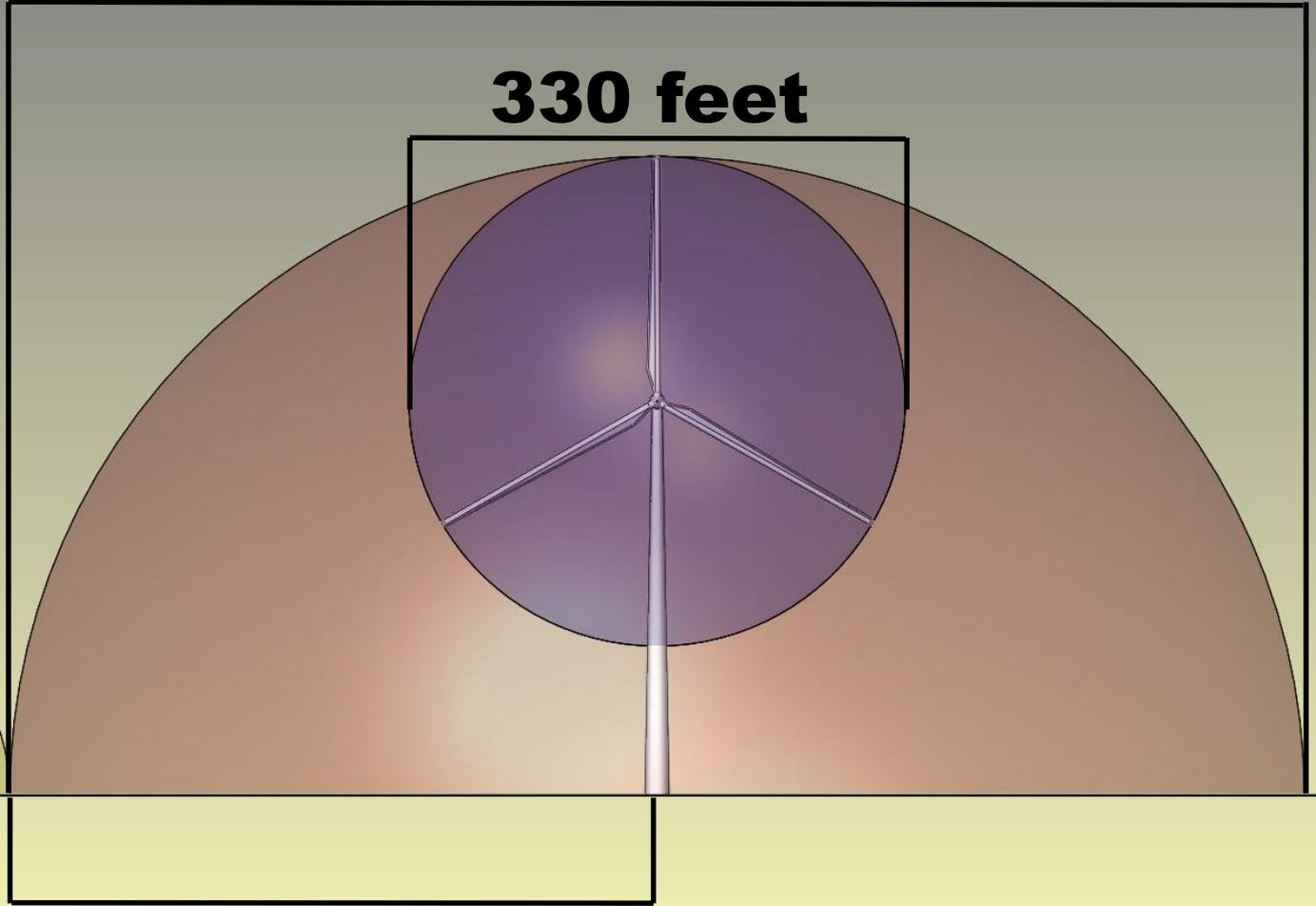
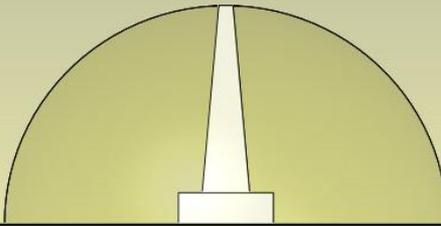






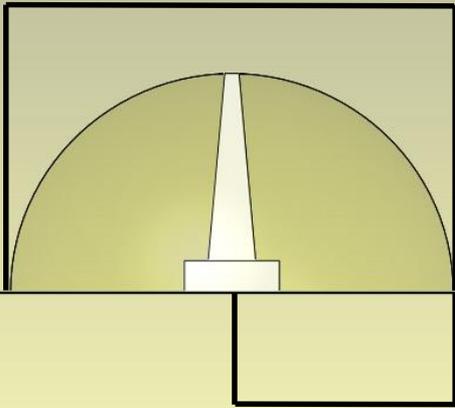
860 feet

330 feet

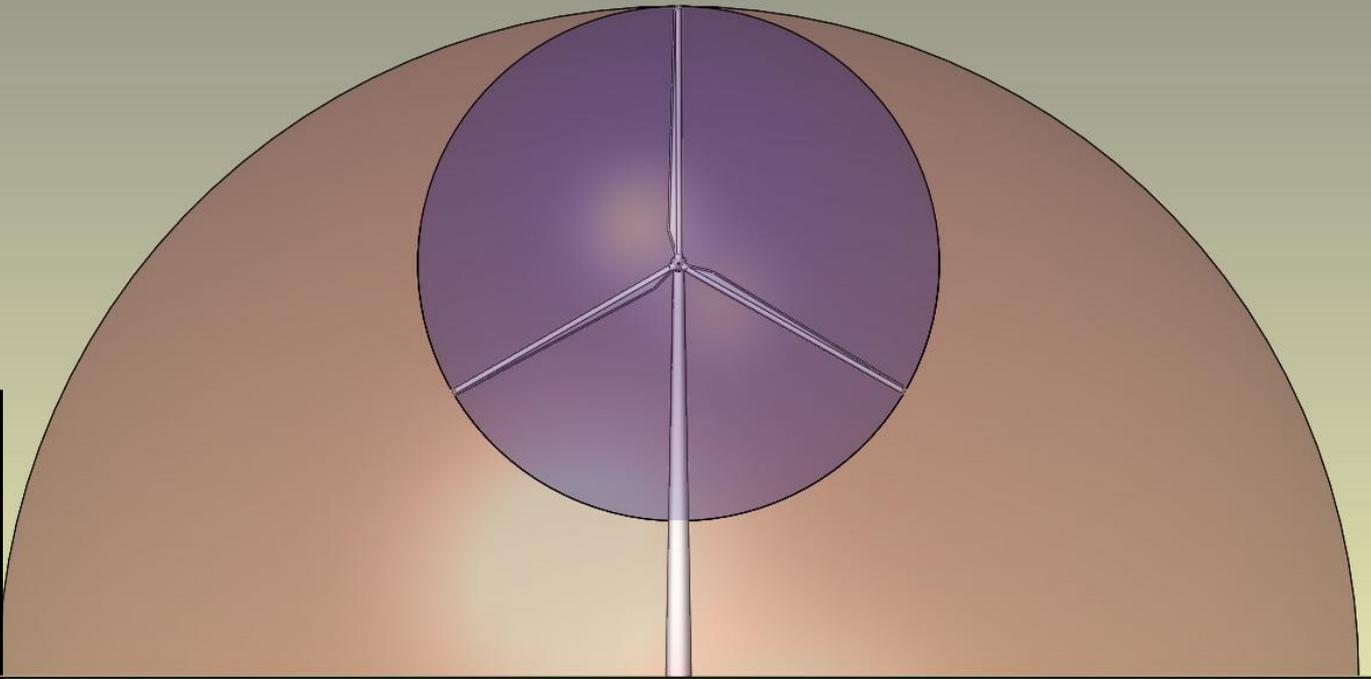


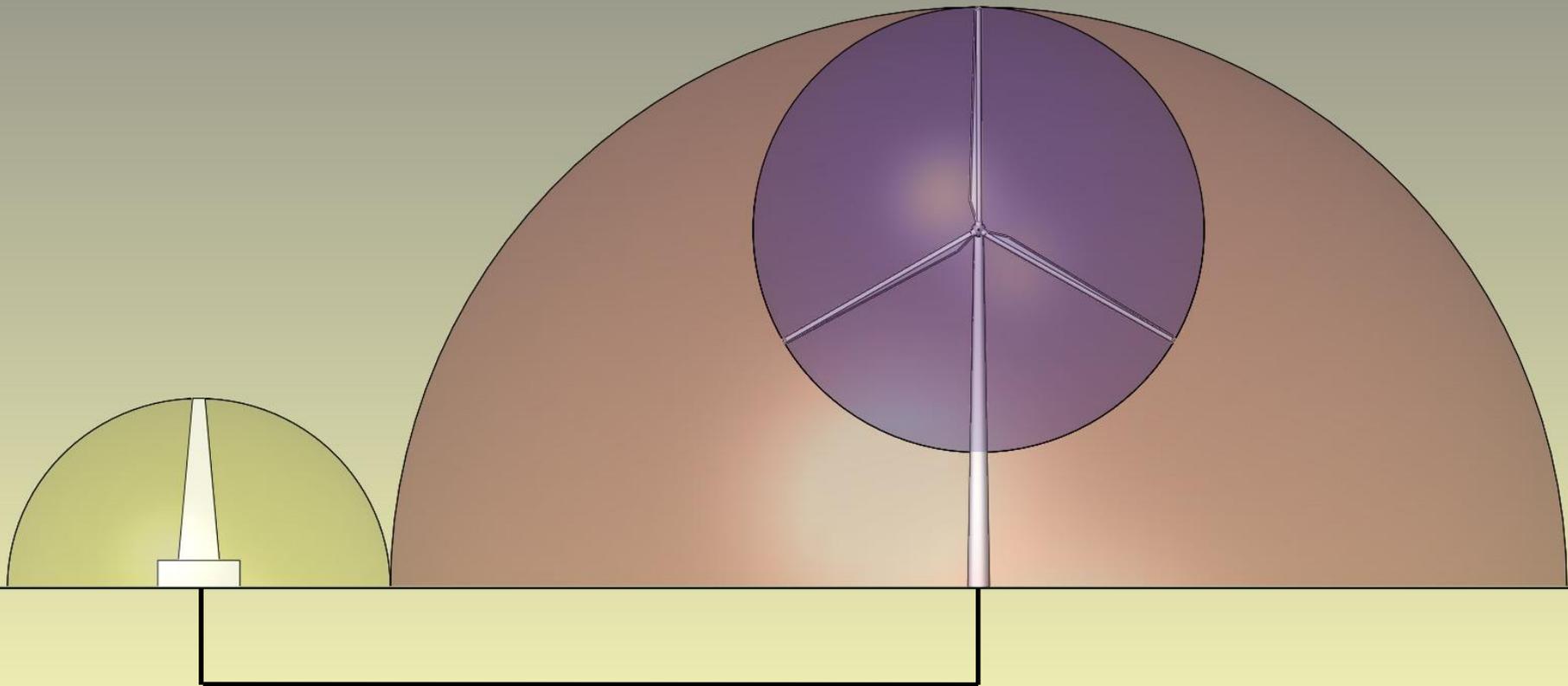
430 feet

280 feet

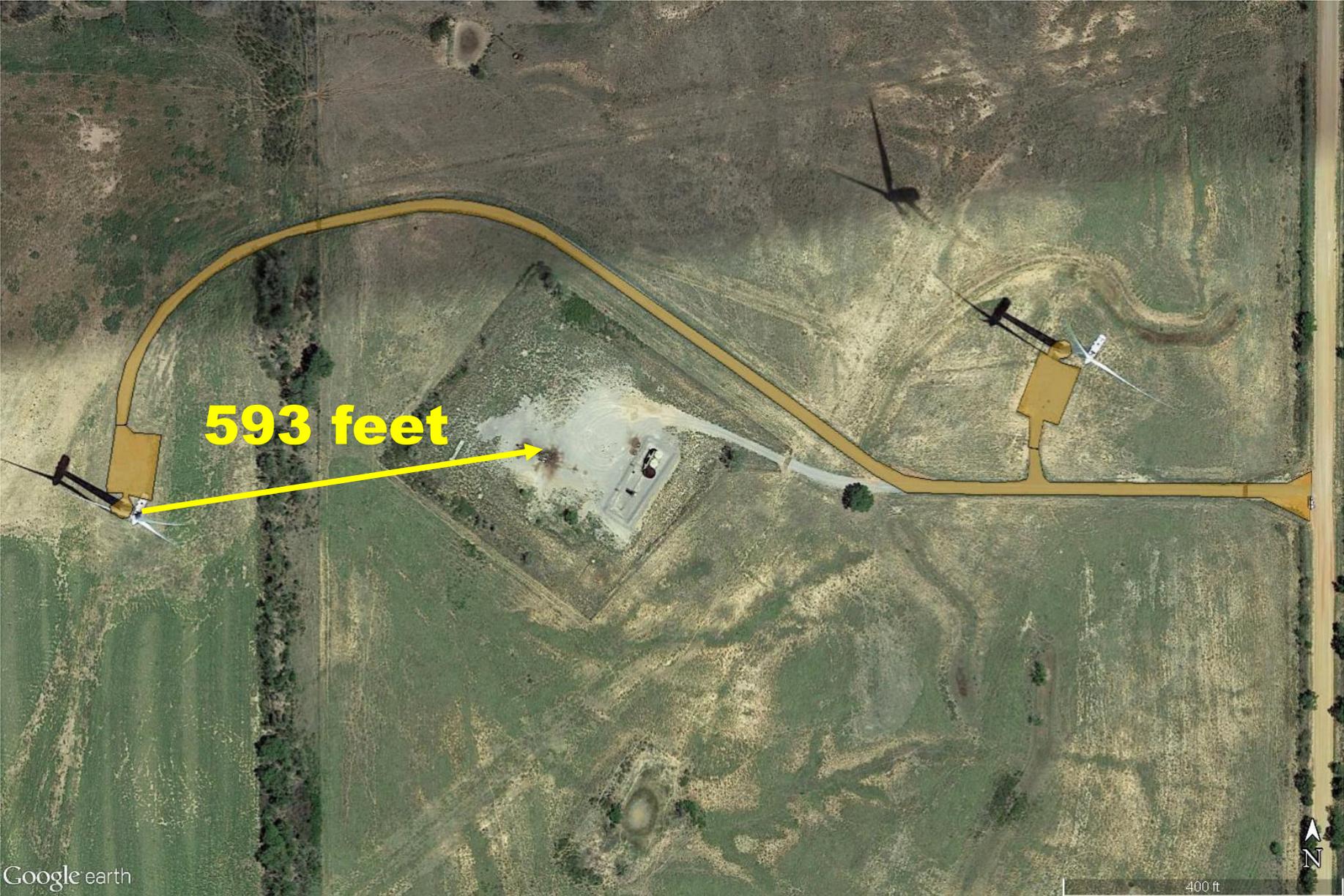


140 feet





570 feet

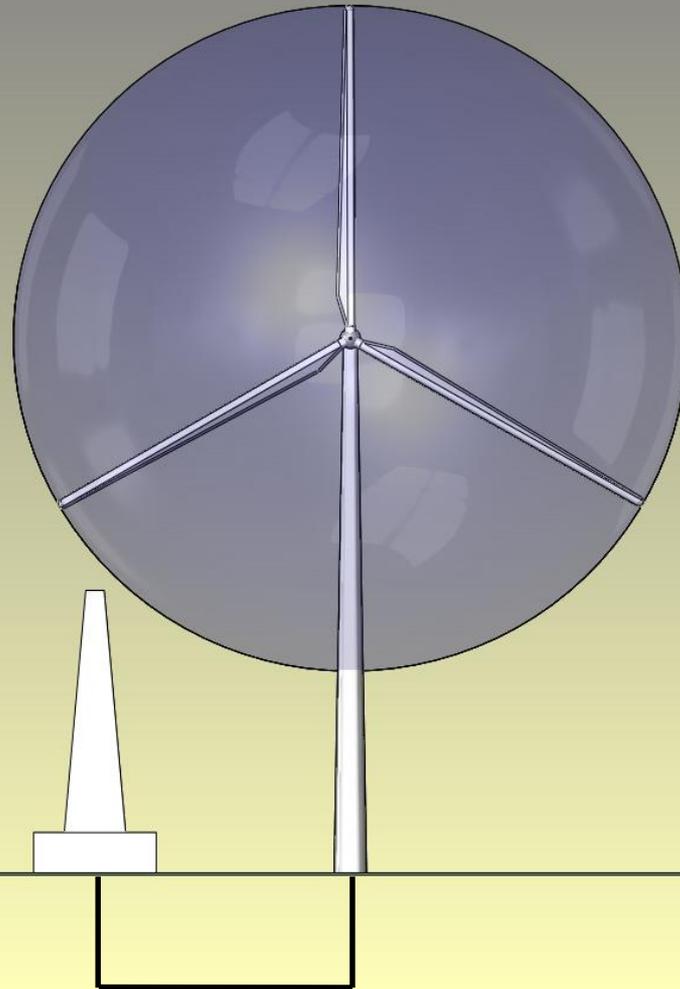


593 feet

Google earth

400 ft





125 feet

Oklahoma Airspace Severance Restriction Act

60 OKLA. STAT. § 820.1

- Permanent severance of airspace for wind energy development prohibited
- Wind energy rights tied to the surface estate





**How will the landowner
be compensated?**

How will you be compensated?

- What are your payments for easements?
- What are your lease payments?
 - Per turbine, per megawatt, or a “royalty?”
 - Definitions matter!
 - How will accuracy be verified?
- Oklahoma Wind Energy Development Act
 - Payment statement
 - Right to audit



Example

(your mileage may vary)

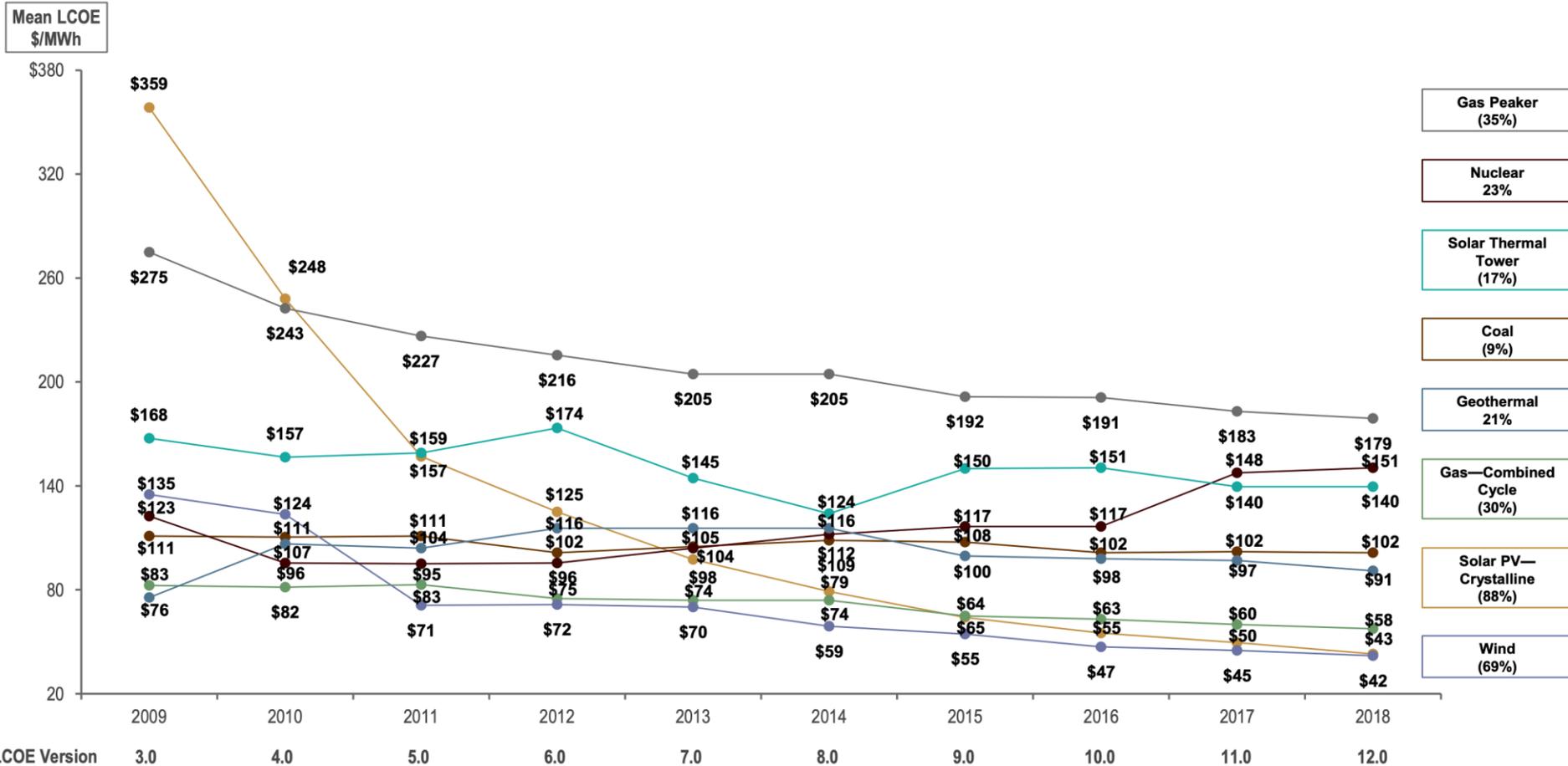
- Example: Assume one 2.0 MW capacity turbine, a capacity factor of 35%, a PPA price of electricity at \$0.03/kWh, and a royalty of 4% of gross revenues
- Electricity produced in a year=
 $2 \text{ MW} \times 8,760 \text{ hr/yr} \times 35\% = 6,132 \text{ MWh}$ or
 $6,132,000 \text{ kWh}$
- Gross revenues =
 $6,132,000 \text{ kWh} \times \$0.03/\text{kWh} = \$183,960$
- Royalty = $\$183,960 \times 4\% = \$7,358.40$ or
 $\$3,679.20$ per MW of turbine capacity.

Solar example



Trends in energy cost

Selected Historical Mean Unsubsidized LCOE Values⁽¹⁾



Source: Lazard, 2018



Increased revenue is just a quadrant of the picture...

Column A	Column B
Increased revenues	Increased costs
Decreased costs	Decreased revenues
Subtotal Column A	Subtotal Column B
Net change (Column A subtotal minus Column B subtotal)	



**What happens when
the project ends?**

What happens when the project ends?

- Decommissioning requirements
 - disassembly and removal of equipment
 - restoration of grades and soils
 - replacing vegetation
- Bond requirement
- Contingency for default





A bit o' mythbusting

Mythbusting: Wind Edition

- They don't sound like supersonic bombers
- No, they don't cause cancer
- There is no peer-reviewed scientific research confirming “turbine syndrome” or other “infrasonic” effects

Wind projects and property values

- 2009 Lawrence Berkley National Laboratory Study (updated 2013)
 - 50,000 home sales, 27 counties, 9 states
 - No statistical evidence of effects on home prices in post-construction or post-announcement/pre-construction periods
- 2014 University of Connecticut
 - No net effects due to “arrival” of turbines

Wind projects and property values

- 2014 Canadian study of impacts from Melancthon projects
 - No statistically significant impacts from turbines on property values
- 2013 University of Rhode Island study
 - 48,554 transactions over 13 years
 - No statistically significant impacts on home prices

Wind projects and property values

- 2009 US DOE Office of Energy Efficiency and Renewable Energy / Lawrence Berkeley National Laboratory
 - 7,500 sale transactions
 - No evidence of widespread property impacts

Mythbusting: Solar Edition

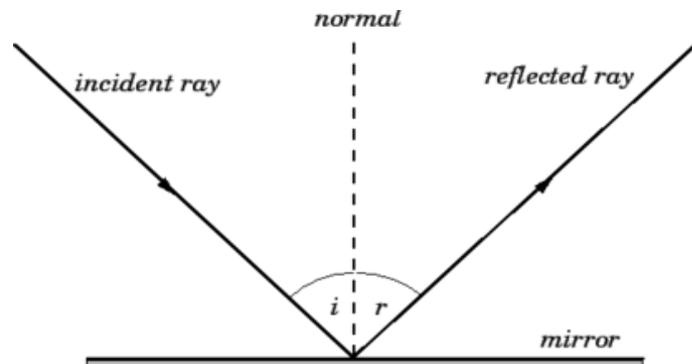
- No, they won't suck up the sun
- No, they don't cause cancer
- Property value impacts – no peer-reviewed research found (but still looking)
 - Similar research in wind has found no statistically significant impact on property values

Nuisance issues: Reflection and glare

- Remember that solar panels only make money from the energy they absorb
- Most PV panels use anti-reflective coatings
- Ask
 - Do the solar cells used in the modules have anti-reflective coatings?
 - Is the surface of the solar modules smooth or stippled?
 - Do the solar modules incorporate any type of “light trapping” technology?
 - Is there documentation from the panel manufacturer of the panels’ reflectivity (“albedo”)?
 - What color is the surface in the absence of the solar modules?

Nuisance issues: Reflection and glare

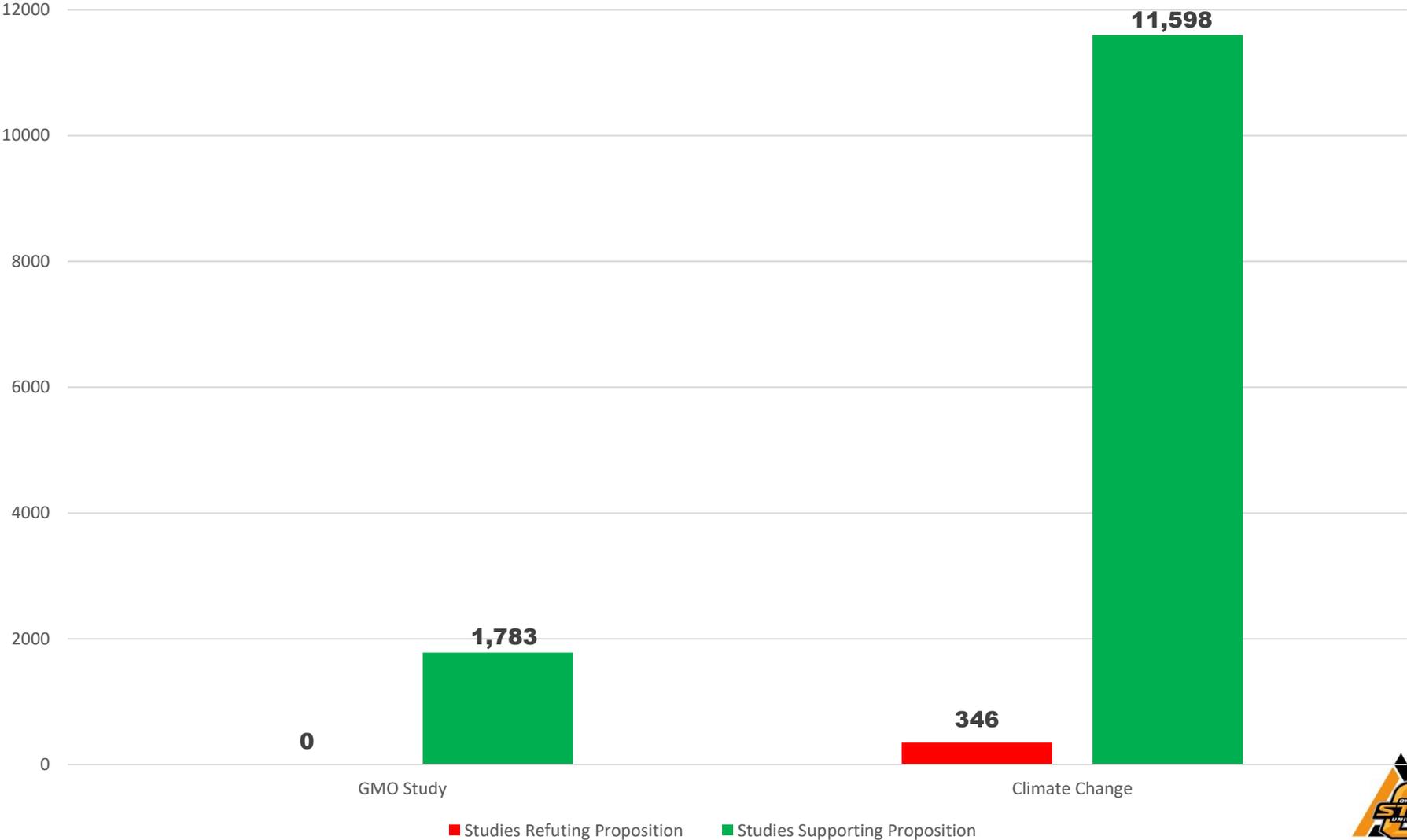
- Actual localized impacts are a function of astronomy (*eek!*), geometry (*gasp!*), and trigonometry (*SCREAM*!)
 - Vertical position (“altitude”) and horizontal position (“azimuth”) of sun relative to the solar module, as well as the relative position of the receptor (you) to the solar module.
- Everything is in motion, and no reflection is permanent
- Siting matters
 - Map planned location of modules, terrain, and potential receptors
 - Run mathematical analysis of reflectance to receptors and duration of reflectance





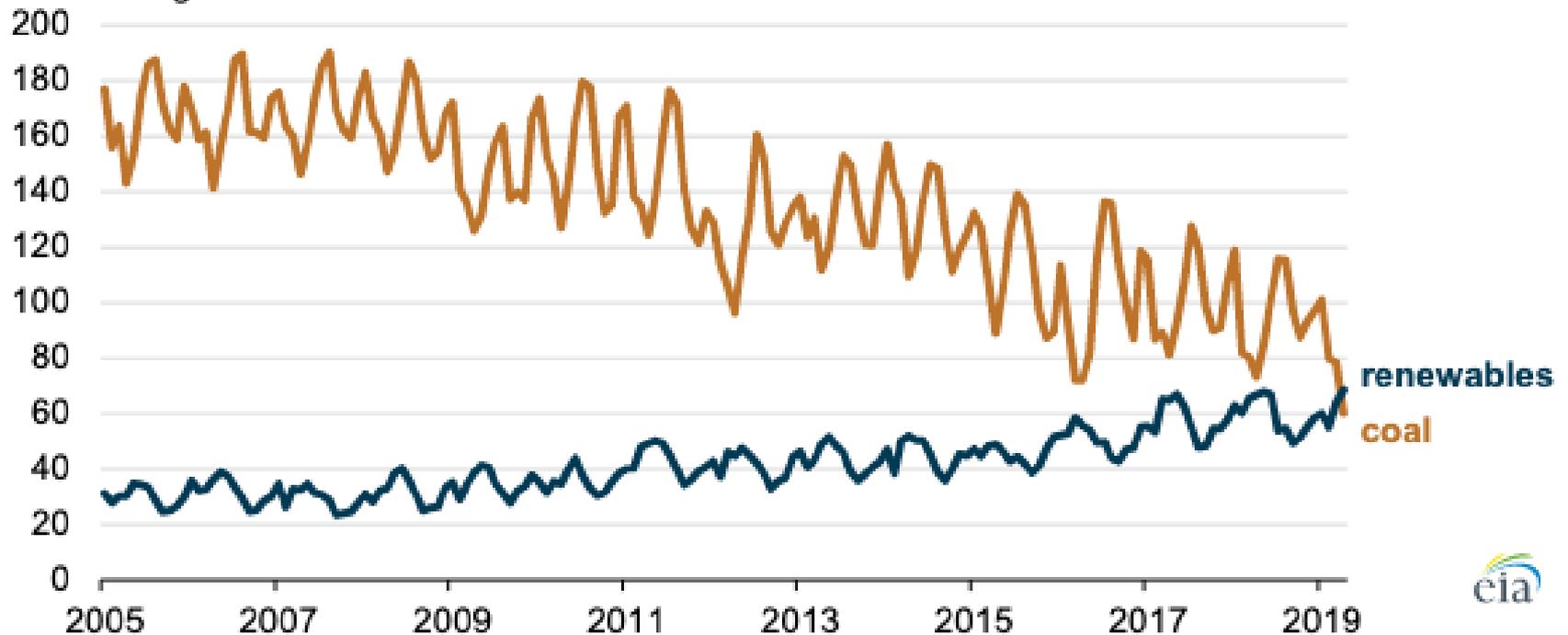
What does the future hold?

Comparison of Meta-studies Regarding GMO Safety and Anthropogenic Global Warming



The tipping point?

U.S. monthly electricity generation from selected sources (Jan 2005-Apr 2019)
million megawatthours



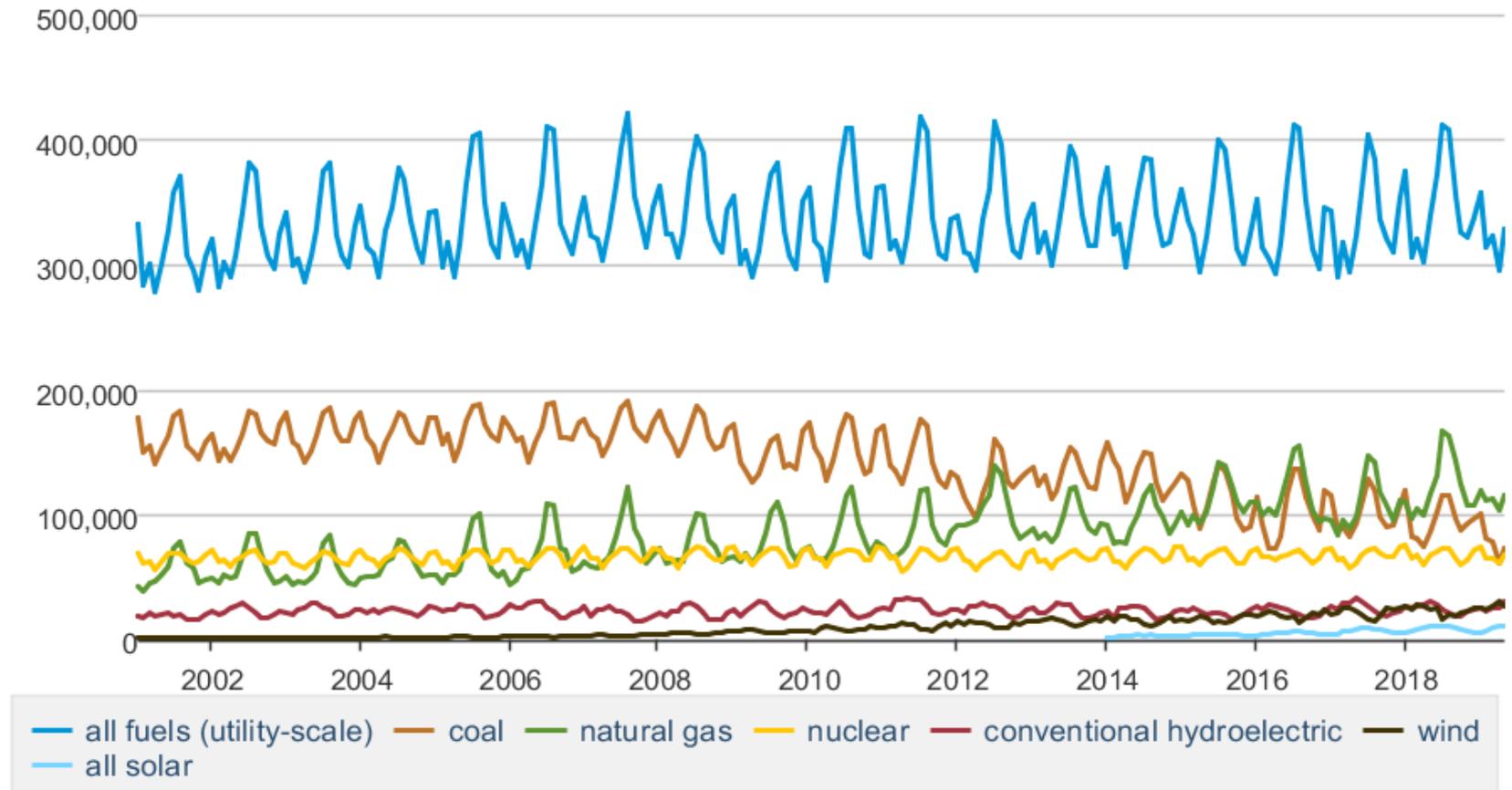
Source: EIA



Generation by source

Net generation, United States, all sectors, monthly

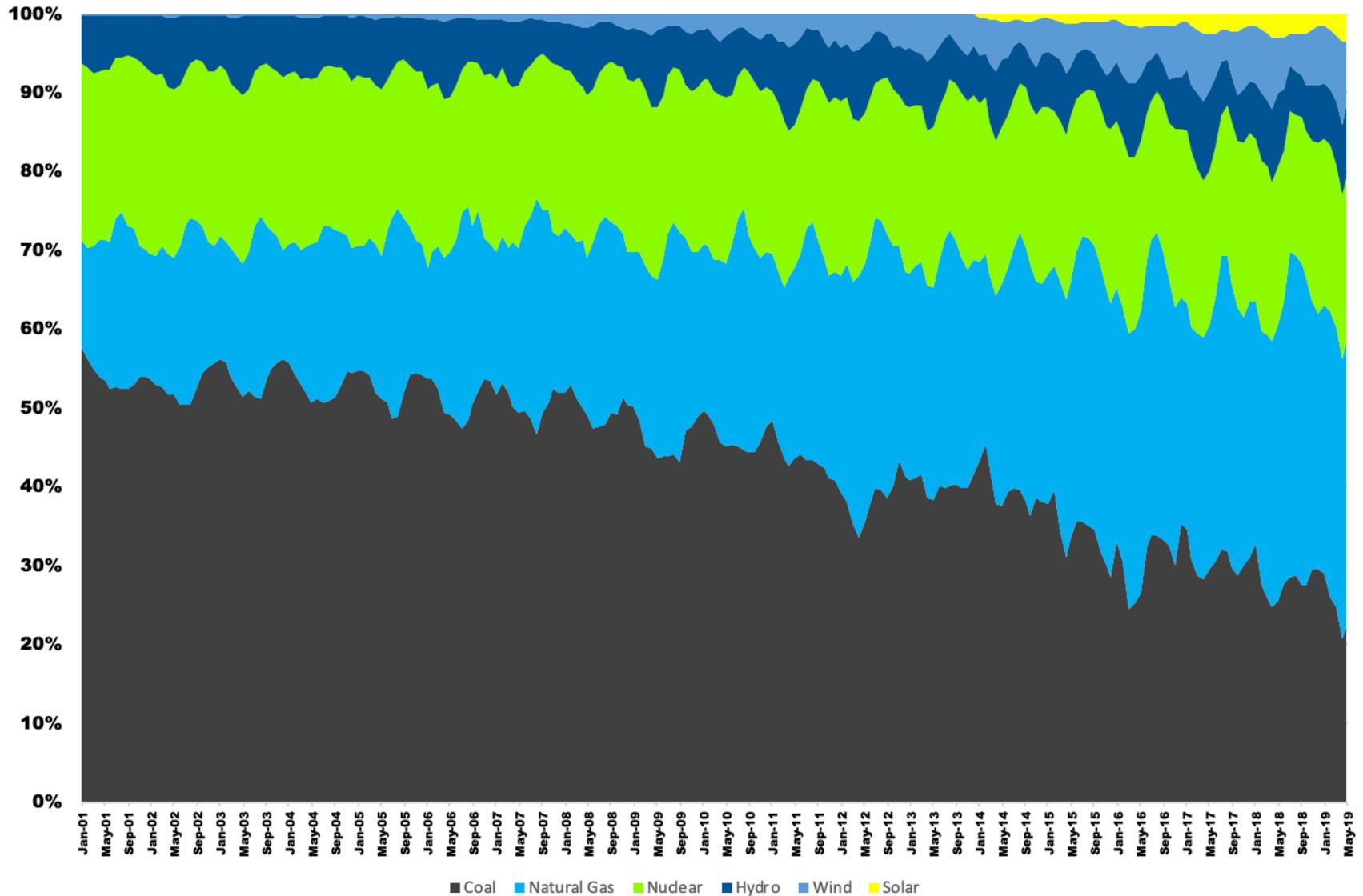
thousand megawatthours

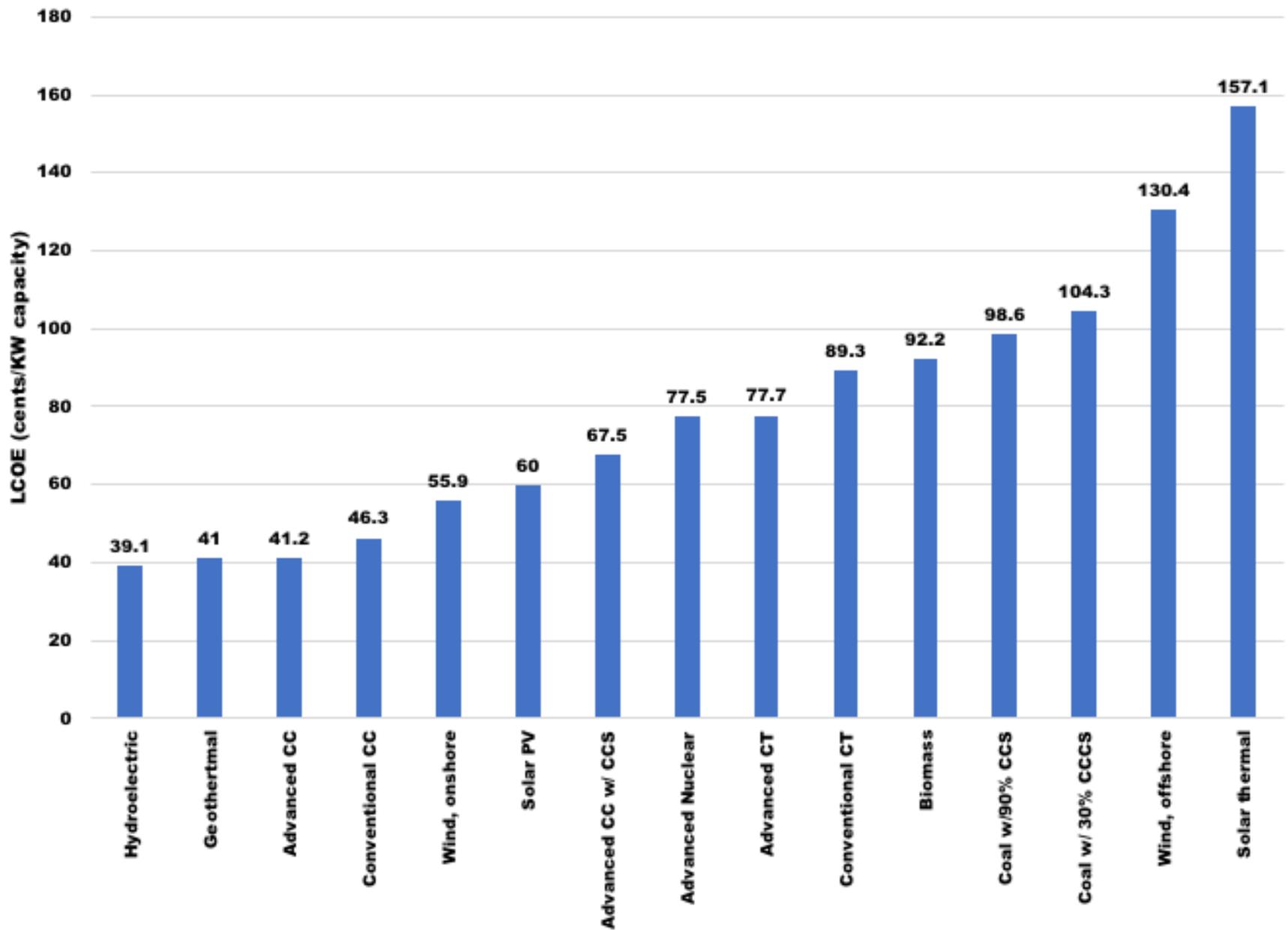


Source: U.S. Energy Information Administration



US Electrical Generation by Source, 2001 - 2019





The storage of power and the power of storage



Source: Tesla

The storage of power and the power of storage



Source: Engineering.com

The storage of power and the power of storage



Source: CleanTechnica.com

...and the power of billionaire bets



Mike Cannon-Brookes    @mcannonbro... · Mar 9, 2017 

Replying to @mcannonbrookes

Lyndon & @elonmusk - how serious are you about this bet? If I can make the \$ happen (& politics), can you guarantee the 100MW in 100 days? twitter.com/mcannonbrookes...



Elon Musk 

@elonmusk

Tesla will get the system installed and working 100 days from contract signature or it is free. That serious enough for you?

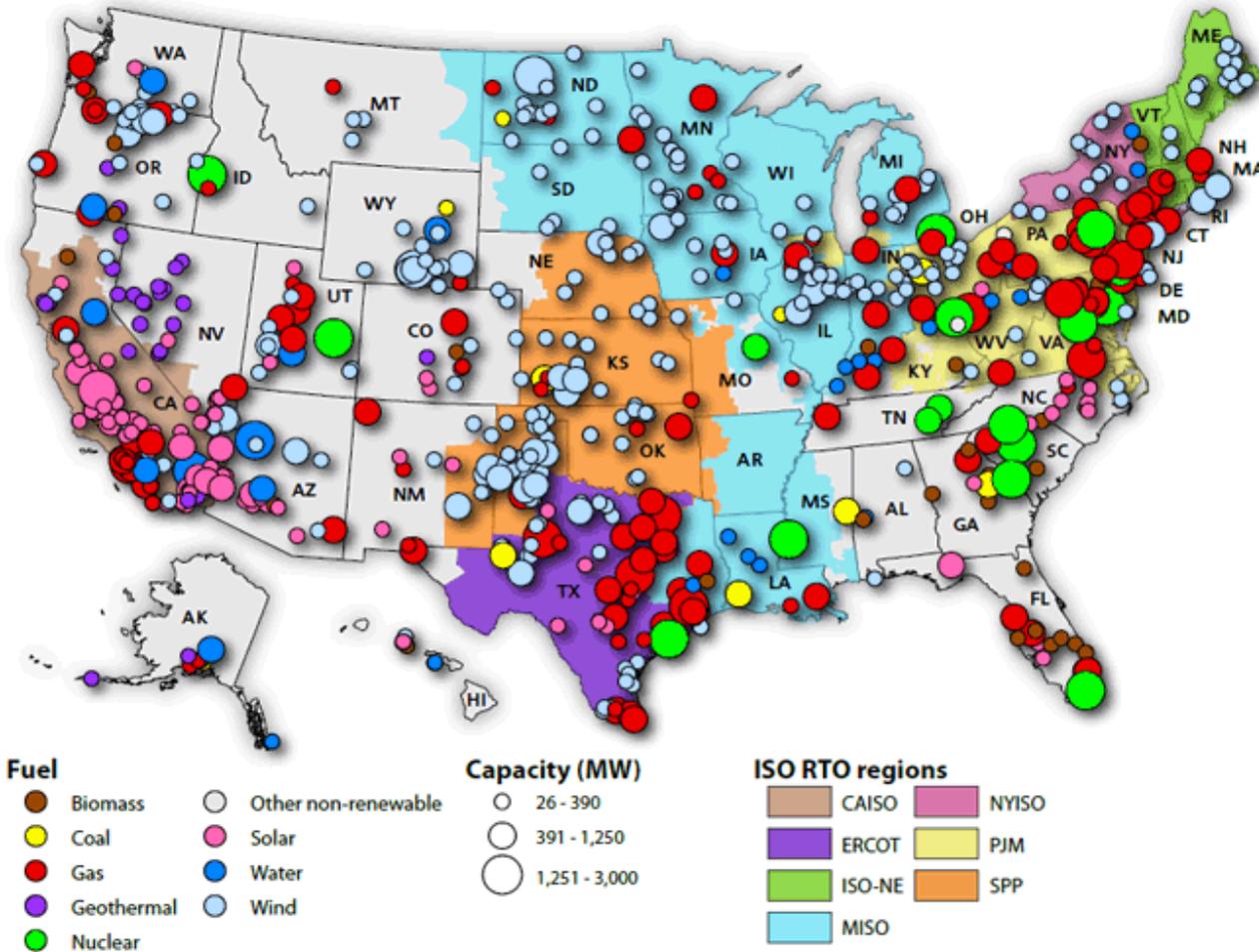
10:50 PM - Mar 9, 2017

 16.2K  7,422 people are talking about this



Conclusions

Capacity in early development, advanced development or under construction

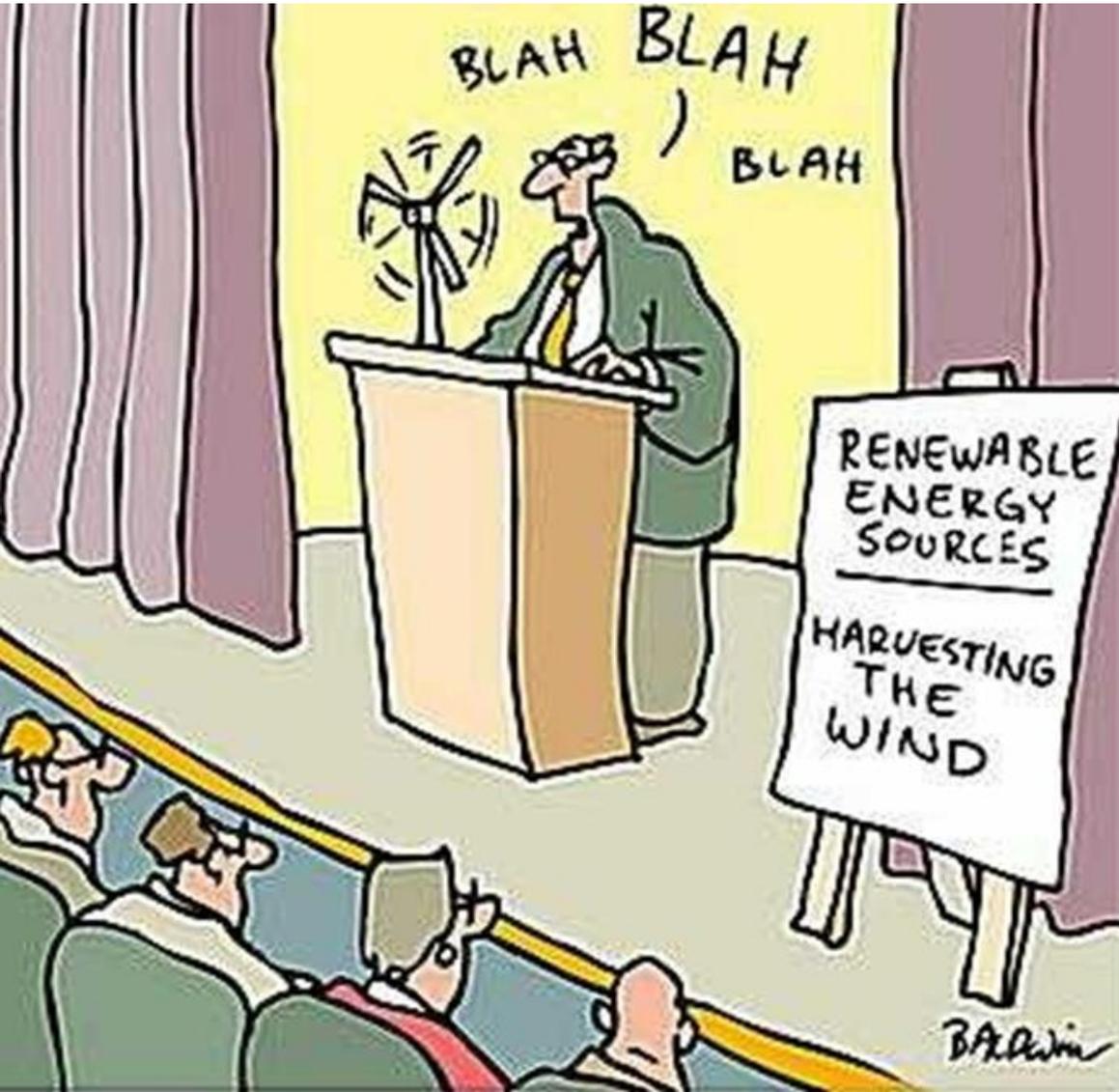


Includes only those plants with development capacity above 25 MW.
 As of April 3, 2014.
 Source: SNL Energy
 Map credit: Whit Varner

Go here!

<http://agecon.okstate.edu/wind/>

Thanks!



Shannon L. Ferrell,
OSU Department of
Agricultural Economics
shannon.l.ferrell@okstate.edu