The Power of Wind
Helping 4-H’ers Understand Wind Power in Oklahoma
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Location, location, location

Good Site

speed up effect over smooth hills

Bad Site

turbulence at top and bottom of cliff

Source: http://www.greenspec.co.uk/html/energy/windturbines.html
Location, location, location

The Power of Wind Curriculum

• How can we think like an engineer?
• How do we study the wind?
• How do we use the wind?
• How do geography and community influence wind power projects?
• How does wind inspire creativity and design?
How Do Geography and Community Influence Wind Power Projects?

[The Oklahoma Version]
So why is it so windy in the southern Great Plains?
But what about Oklahoma specifically?
A Map of Oklahoma’s Wind Resources

Current Wind Farms
A – Oklahoma (Woodward)
B – Blue Canyon (Lawton)
C – Weatherford
D – Centennial (Fort Supply)
E – Sleeping Bear (Fort Supply)
F – Buffalo Bear (Ft. Supply / Buffalo)
G – Red Hills (Hammon)

Source: Oklahoma Wind Power Initiative
Top 10 States by Installed Wind Energy Capacity

<table>
<thead>
<tr>
<th>State</th>
<th>Installed Wind Power Capacity, MW</th>
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<tbody>
<tr>
<td>Texas</td>
<td>7,116</td>
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<tr>
<td>Iowa</td>
<td>2,790</td>
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<tr>
<td>California</td>
<td>2,517</td>
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<td>Minnesota</td>
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<td>New York</td>
<td>832</td>
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<tr>
<td>Oklahoma</td>
<td>830</td>
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</tbody>
</table>
States with Renewable Portfolio Standards

Oklahoma’s Installed Utility-Scale Wind Power Capacity

Source: Oklahoma Wind Power Initiative
What concerns do communities have about wind power?
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Image courtesy Brian Hobbs, WFEC
What concerns do communities have about wind power?
How Do We Study The Wind?
How do we study the wind?
Measuring Oklahoma’s wind
How Do We Think Like an Engineer?
Power is a function of air density, swept area, and wind speed

- Doubling rotor length gets us $2^2 = 4$ times the swept area and thus four times the power.
- Since power increases as a cubic function of velocity, we see $2^3 = 8$ times the power.

\[ P = \frac{1}{2} \rho v^3 \sqrt{\pi r^2} \]

A sense of turbine scale

How big is a wind turbine?

Hub Weight: 35,000 lbs (17.5 tons, 2 1/3 elephants)
Blade Length: 113 feet (wingspan of a 747 jet)
Blade Weight: 17,500 lbs (8.75 tons, 1.1 elephants)
Total Rotor Weight: 87,500 lbs (43.75 tons, 5 2/3 elephants)
How big is a wind turbine?

60 TON NACELLE
(about the size of a small school bus)

COURTESY: OMPA
How big is a wind turbine?

THE TOP SECTION WEIGHS 24.5 TONS

COURTESY: OMPA
An example from Woodward/Freedom

Average ~800 ft. Between turbine

~1 mile

Spacing Out: The spatial impacts of projects

- American Wind Energy Association estimates total area of \( \approx 60 \text{ acres/MW of capacity} \).
- \( \approx 3 \text{ acres (5\%)} \) to actual physical occupation of land.
- \( \approx 57 \text{ acres (97\%)} \) to exclusion area for windflow preservation.

Image from Google Earth