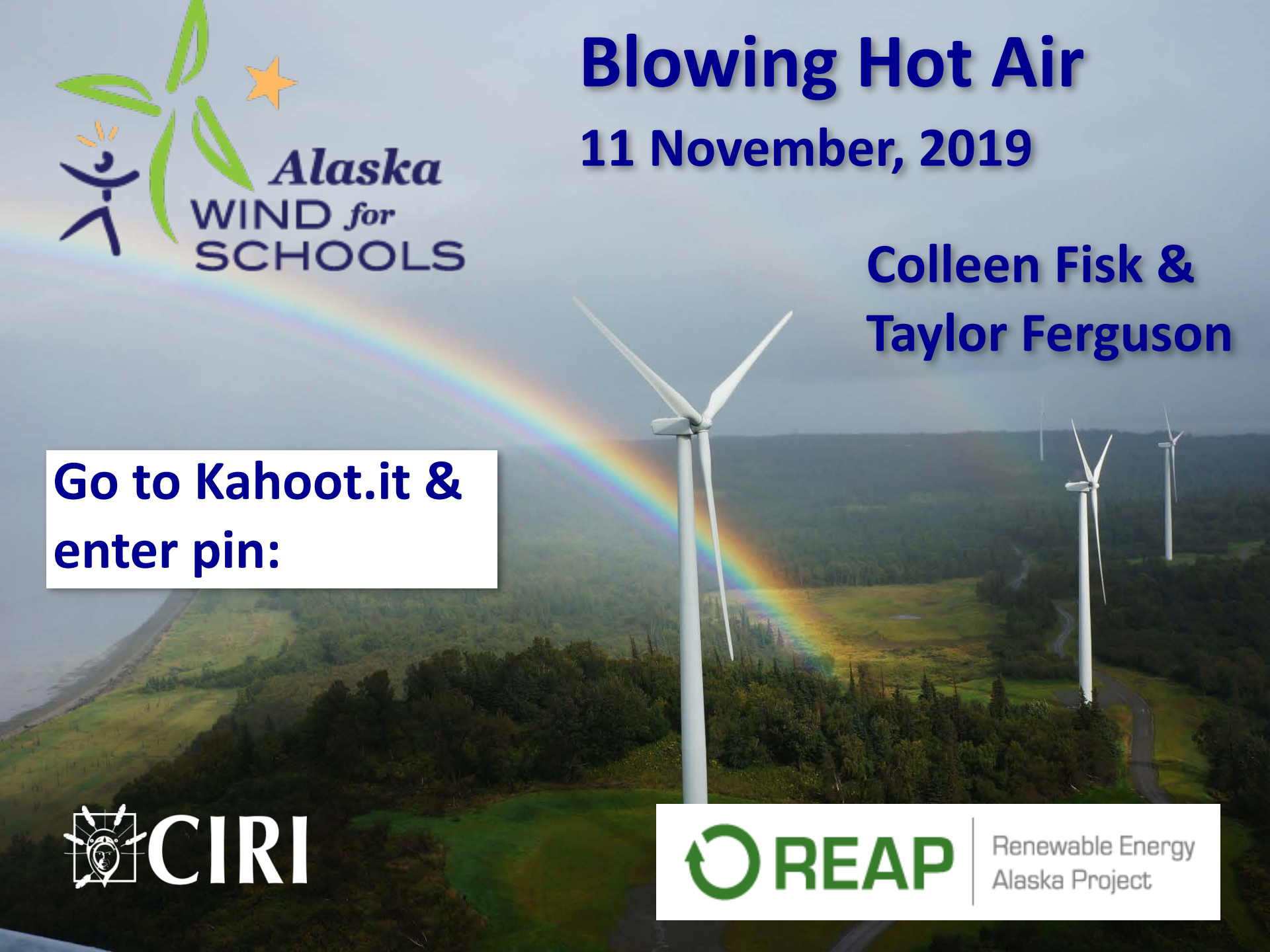


Blowing Hot Air

11 November, 2019

Colleen Fisk &
Taylor Ferguson

Go to Kahoot.it & enter pin:

CIRI

REAP | Renewable Energy Alaska Project

Objectives

- Discuss the concept of energy literacy
- Describe Alaska's electricity production energy sources
- Describe wind energy basics, pros and cons
- Explain why it is important to include energy education in the classroom and how you can do it through hands-on, engaging activities

REAP

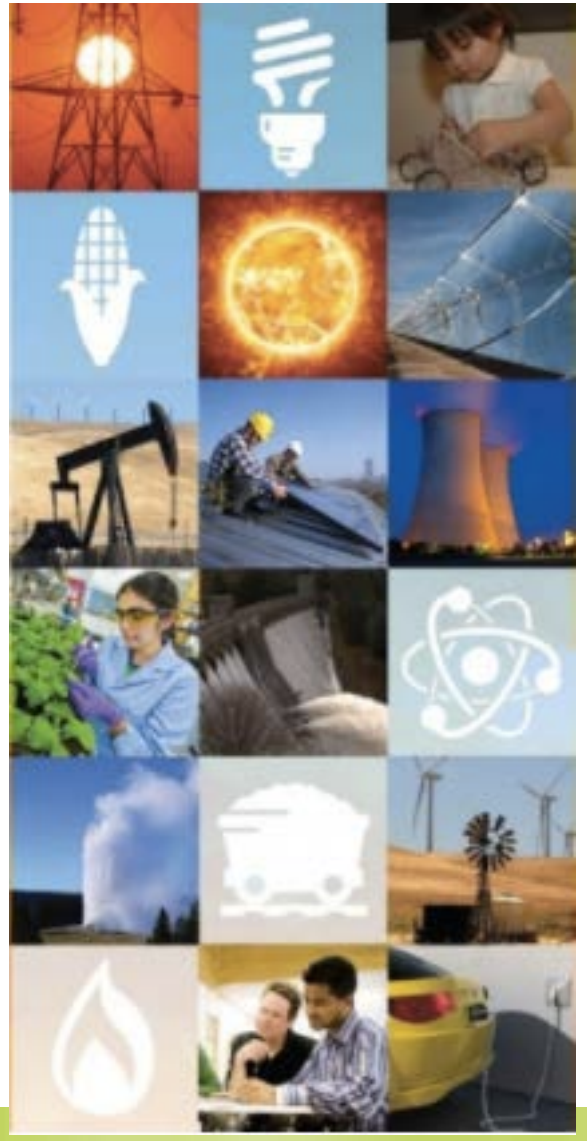
Renewable Energy Alaska Project

Mission: facilitate the increased development of clean energy in Alaska through collaboration, education, training, and advocacy.

ENERGY LITERACY

"Energy Literacy is an understanding of the nature and role of energy in the world and daily lives accompanied by the ability to apply this understanding to answer questions and solve problems."

REAP wants to increase Alaskans human capacity for understanding energy and developing energy projects, to build a resilient future



Energy Literacy – A holistic interdisciplinary approach to Energy

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

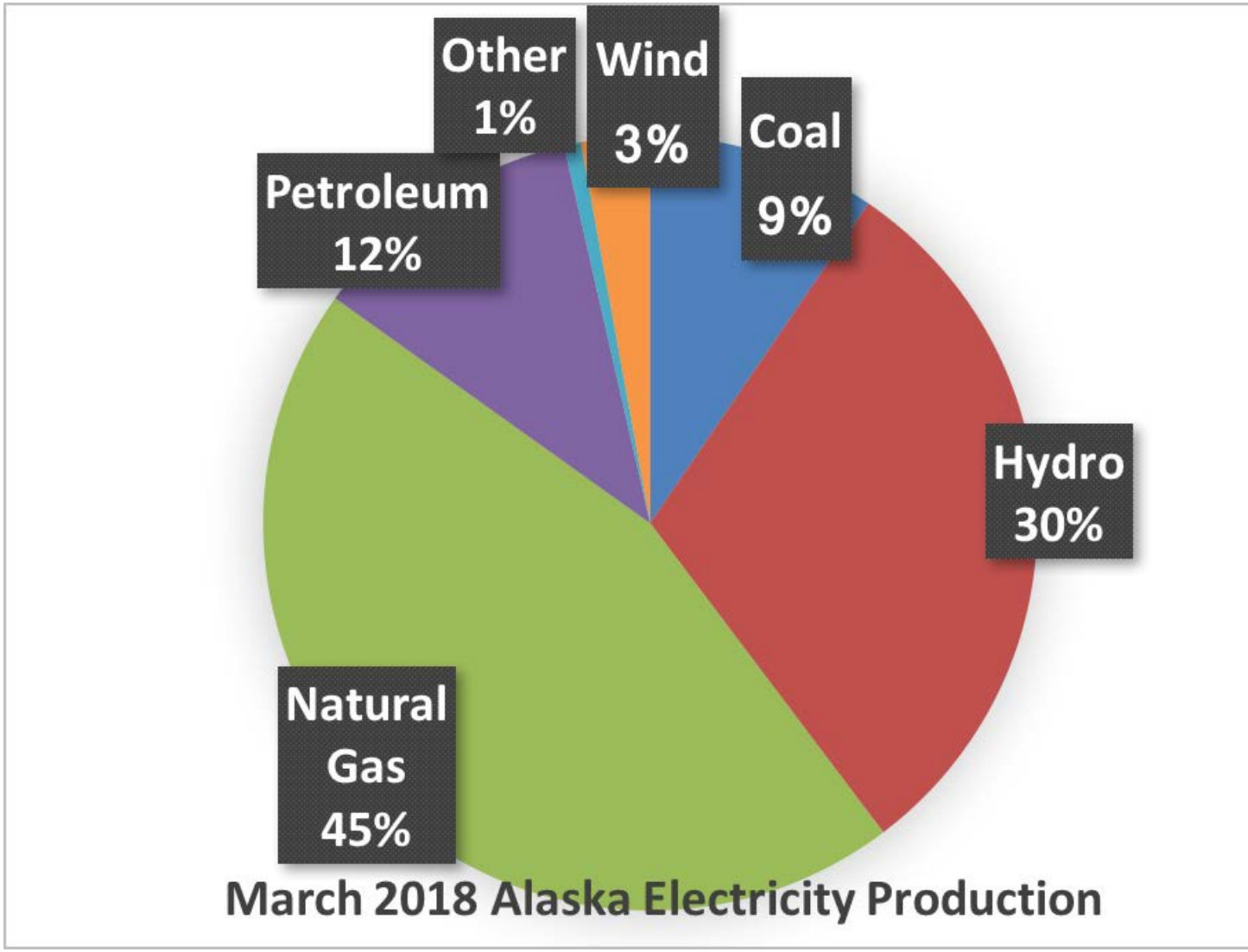
Natural Sciences
- Physics
- Chemistry
- Earth Science
- Biology

Engineering/ Technology

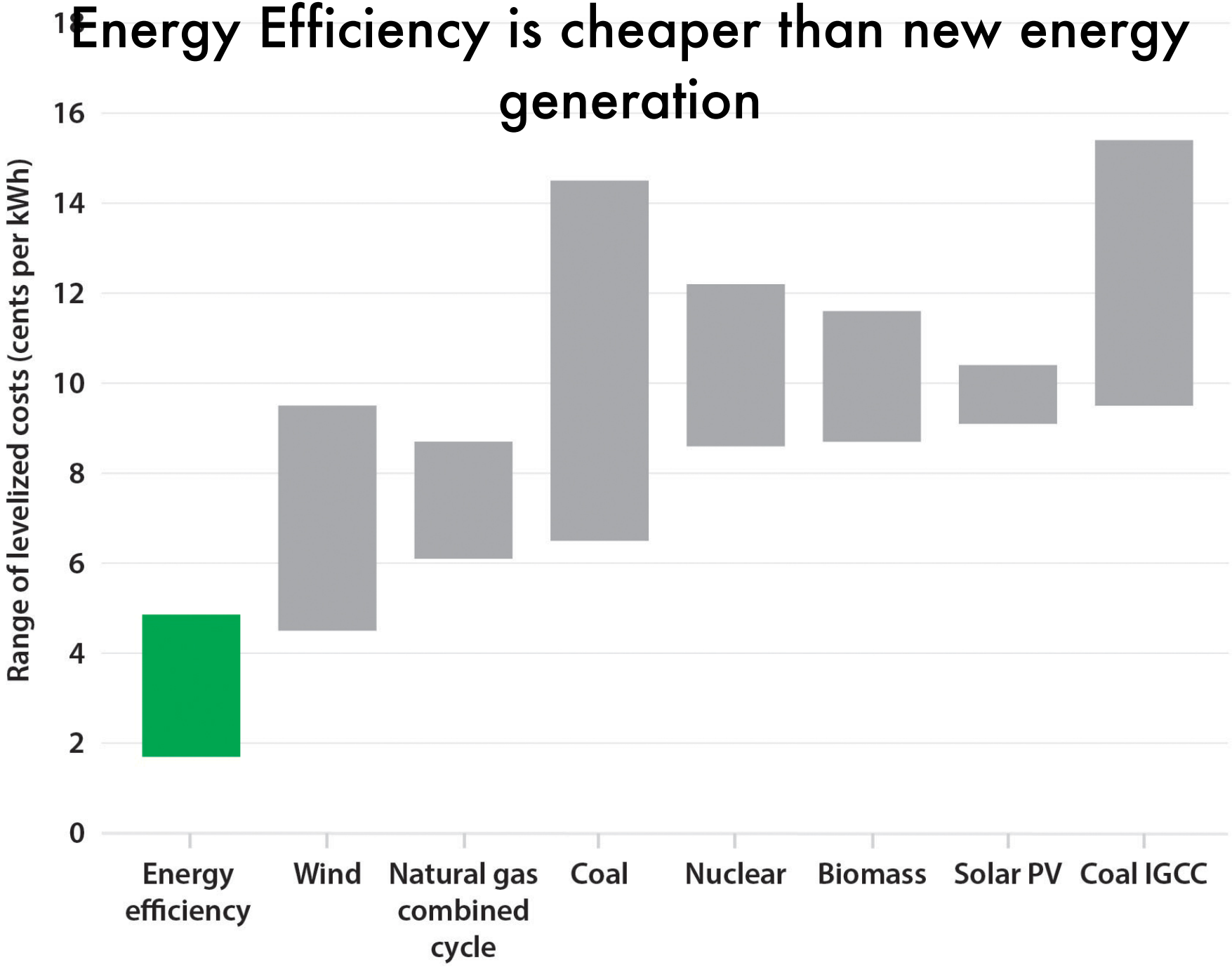
Social Sciences
- Civics
- Economics
- Psychology

1. Energy is a physical quantity that follows precise natural laws.
2. Physical processes on Earth are the result of energy flow through the Earth system.
3. Biological processes depend on energy flow through the Earth system.
4. Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination.
5. Energy decisions are influenced by economic, political, environmental, and social factors.
6. The amount of energy used by human society depends on many factors.
7. The quality of life of individuals and societies is affected by energy choices.

Alaska's Energy Profile: Electricity is mostly generated from natural gas and hydro



Energy Efficiency is cheaper than new energy generation




Wind Power
- History
- Technology
- Impacts
- Wind in the Classroom

Early “Windmill” in Afghanistan (900AD)

Architecture of the Islamic World, Its History and Social Meaning; Page 188;
Edited by George Michell; 1978 Thames & Hudson Ltd, London

Jacobs Turbine – 1920- 1960

WinCharger – 1930s – 40s

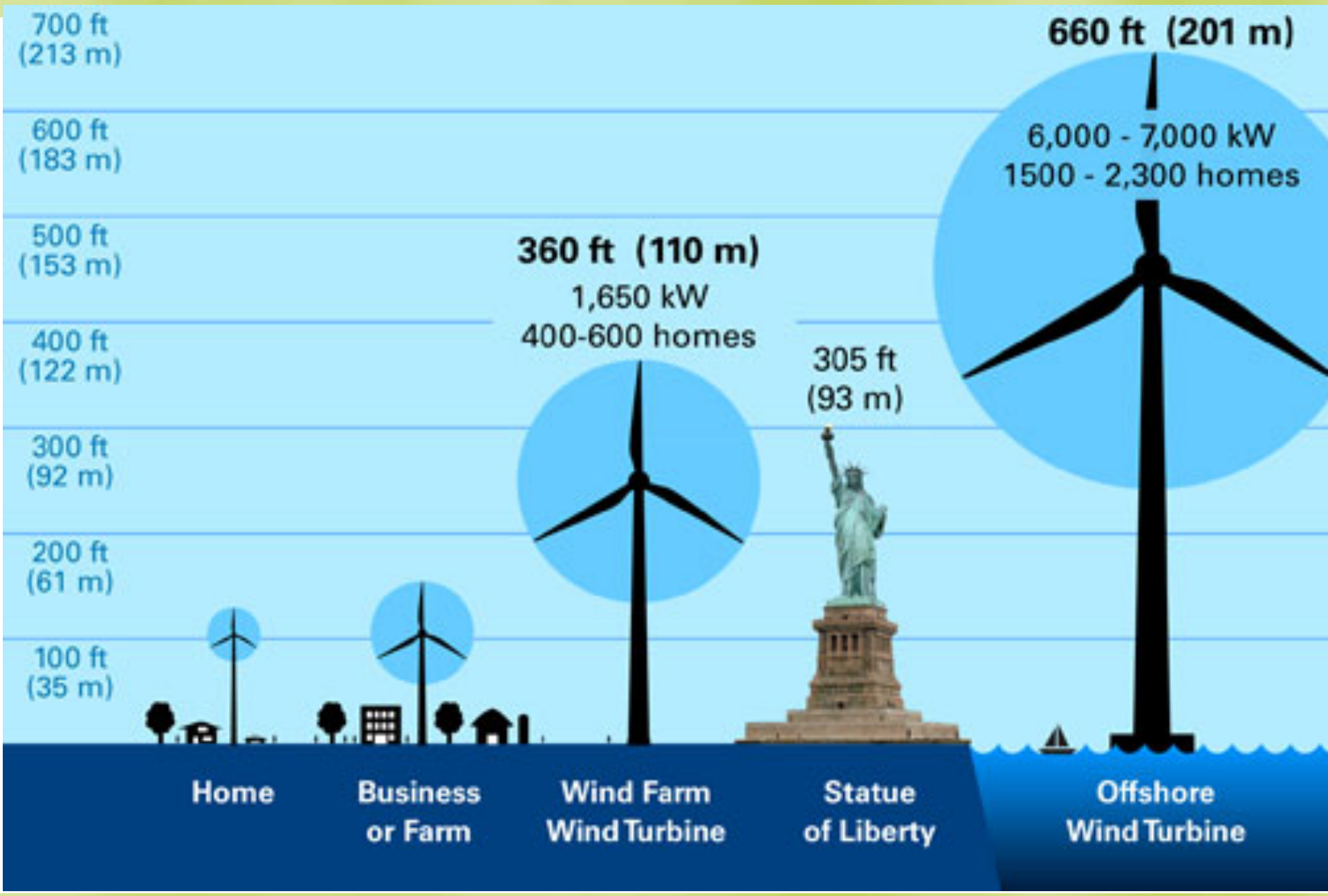
Smith-Putnam Turbine

Vermont, 1940's

1.25 MW

Modern Windmills

Rotor Orientation


700 ft
(213 m)
600 ft
(183 m)
500 ft
(153 m)
400 ft
(122 m)
300 ft
(92 m)
200 ft
(61 m)
100 ft
(35 m)
660 ft (201 m)
6,000 - 7,000 kW
1500 - 2,300 homes
360 ft (110 m)
1,650 kW
400-600 homes
305 ft
(93 m)
Home
Business
or Farm
Wind Farm
Wind Turbine
Statue
of Liberty
Offshore
Wind Turbine

Fire Island Wind turbines

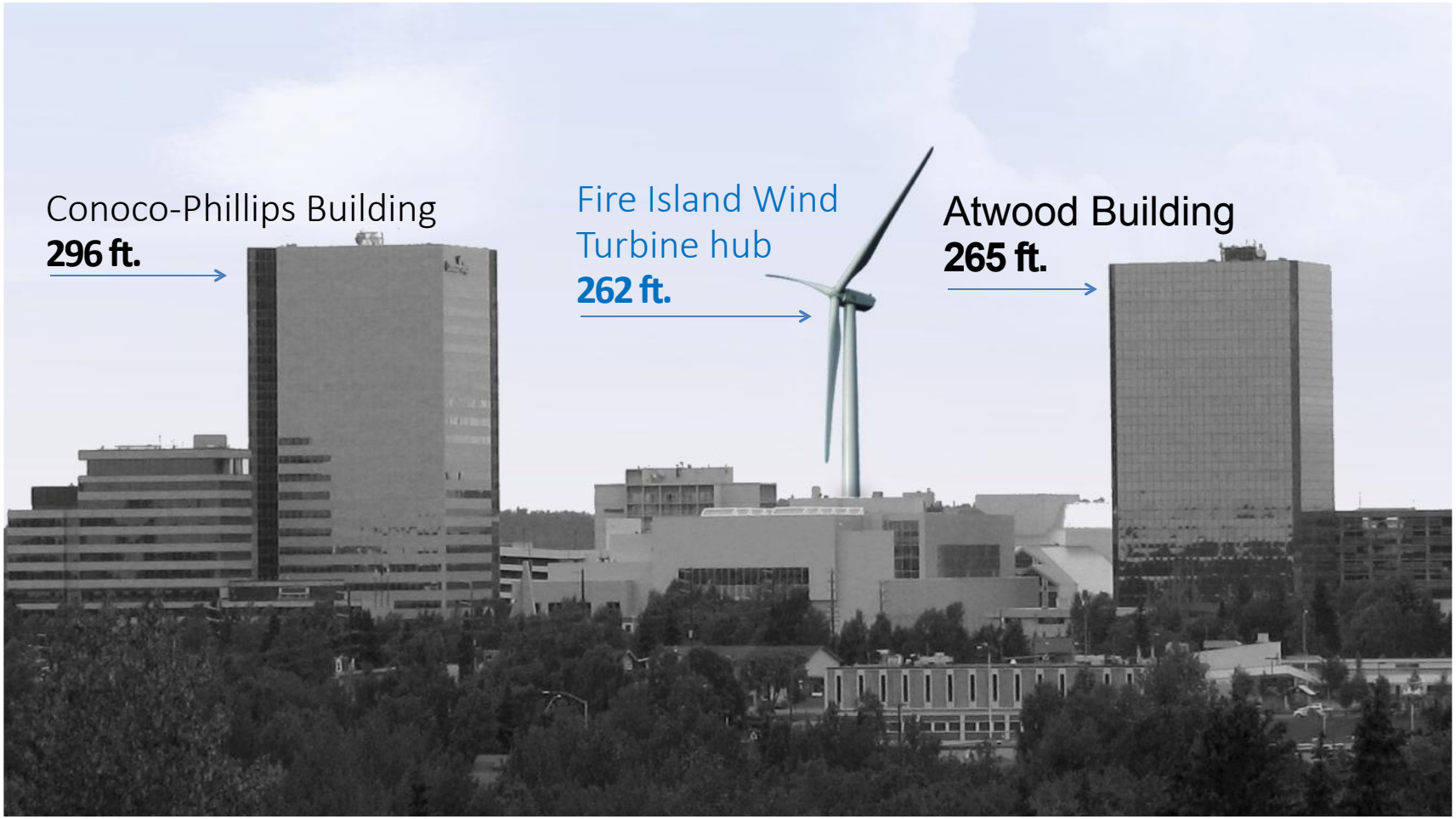
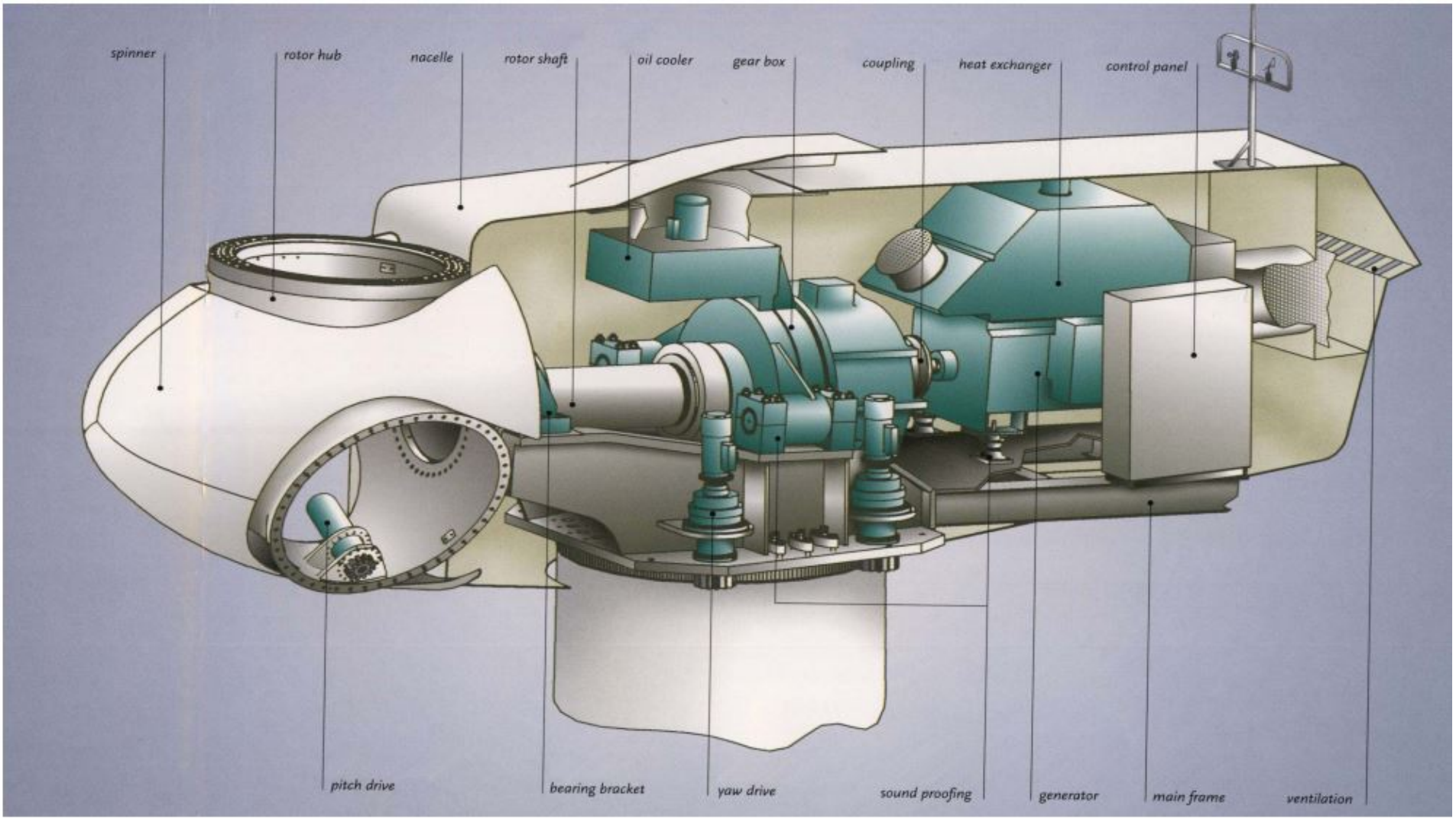


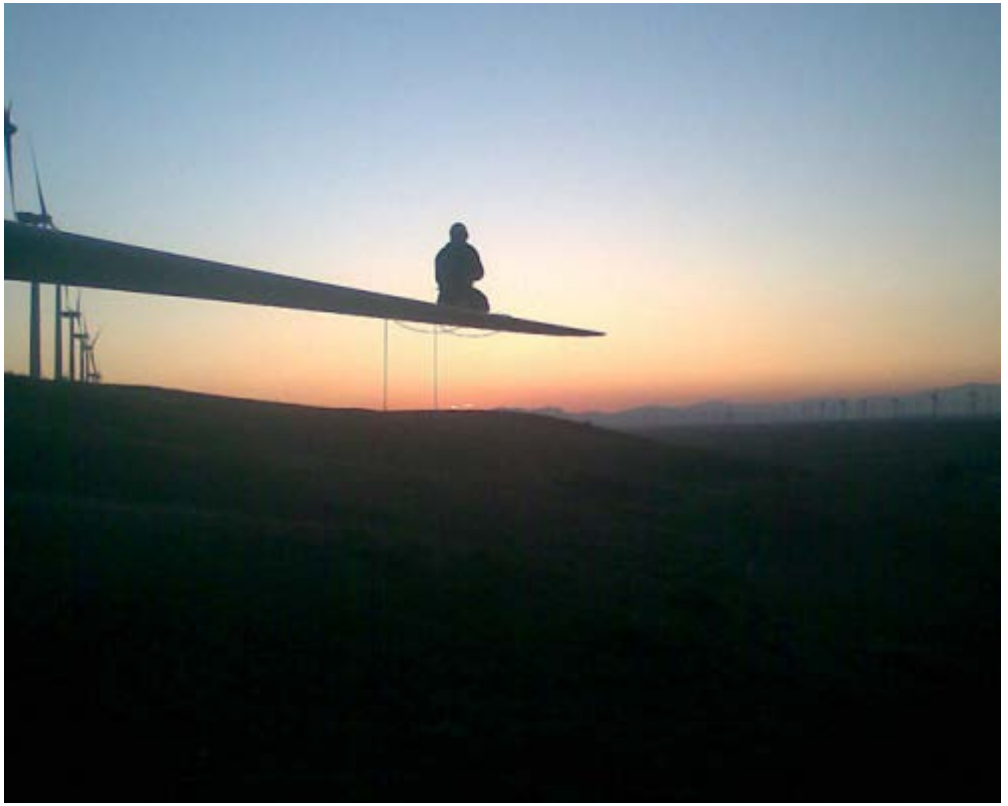
Illustration of a Fire Island Wind turbine superimposed on the Anchorage skyline to demonstrate the relative height of a turbine.


Blade
Nacelle
Hub
Tower

Turbine nacelle



Maintenance



Wind Energy in the Classroom

Wind can do Work


Importance of the WIND
RESOURCE

Energy Literacy

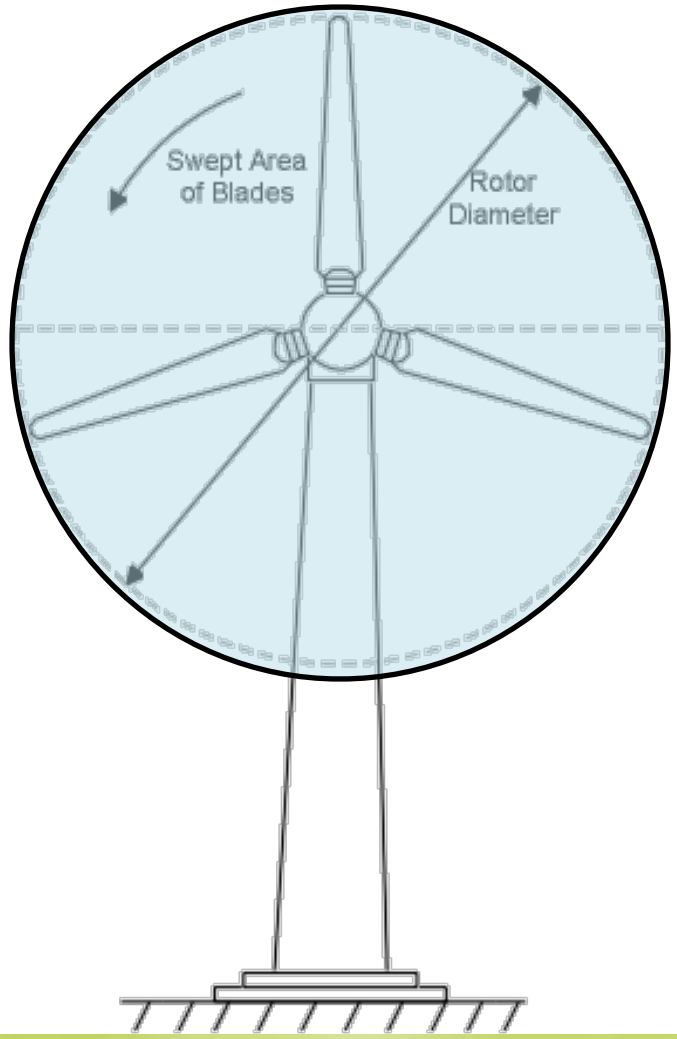
POWER (instantaneous)
VS
ENERGY (cumulative over time)

Site Assessment Rule #1

Keep in mind what we're after…

<u>Power in the wind</u>

- Air density, ρ
- Swept area, A
- Wind speed, V



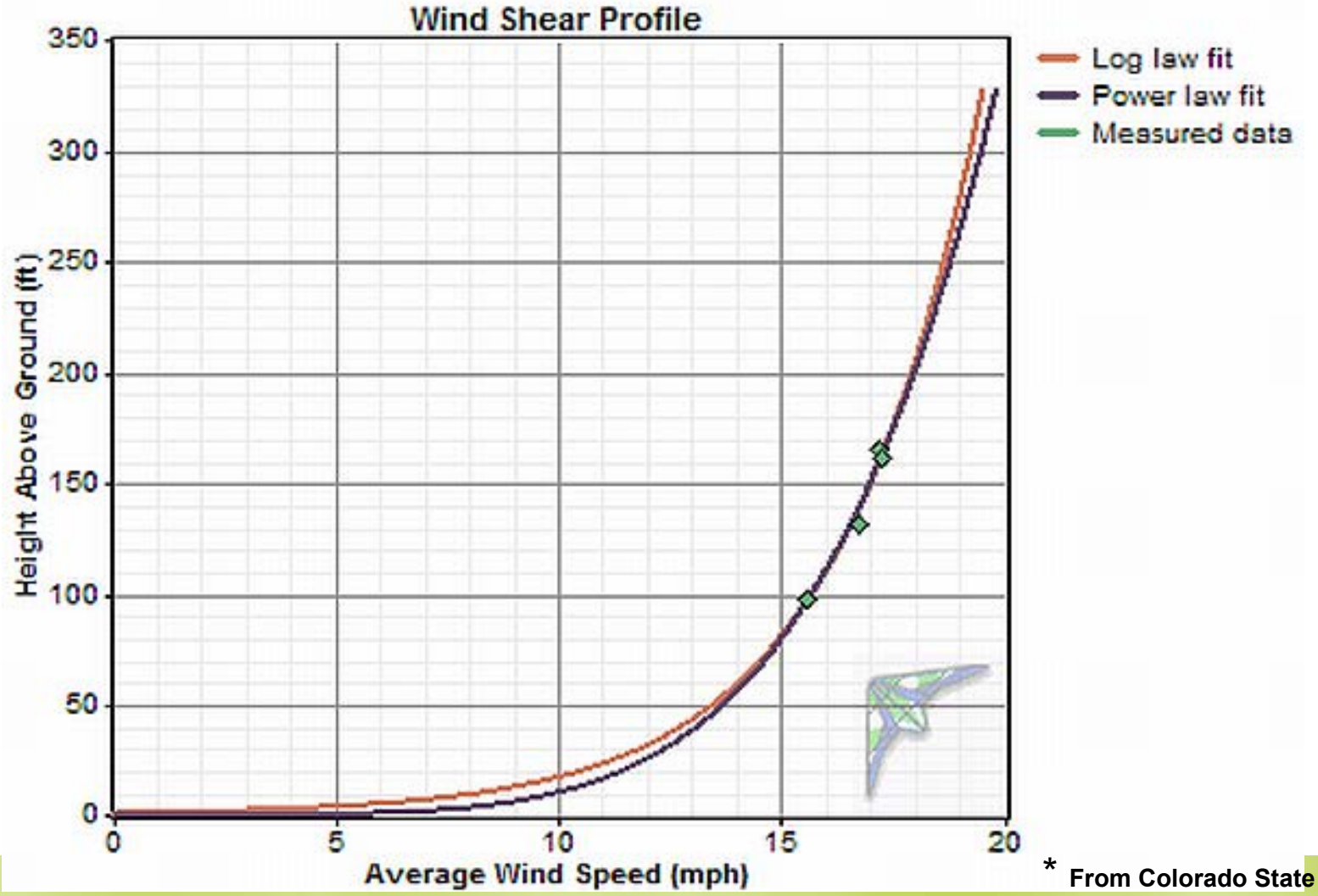
Calculating Power in the Wind

Power = ½ ρ AV^3

- Air density, ρ
- Swept area, A
- Wind speed, V

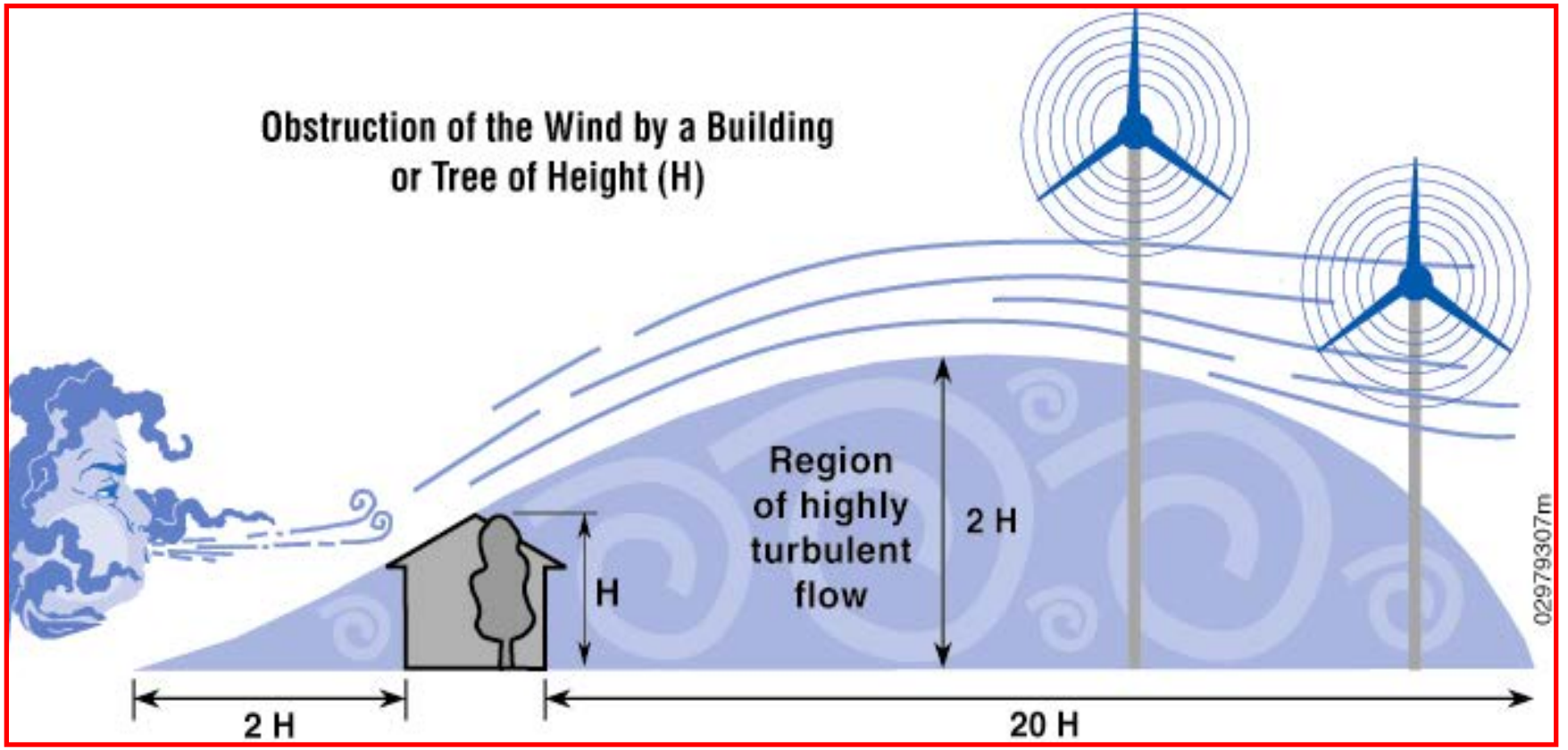
Q: *How do we get a higher wind speed?*

More Tower, More Power



* From Colorado State Univ. Study

Turbulent wind is bad wind

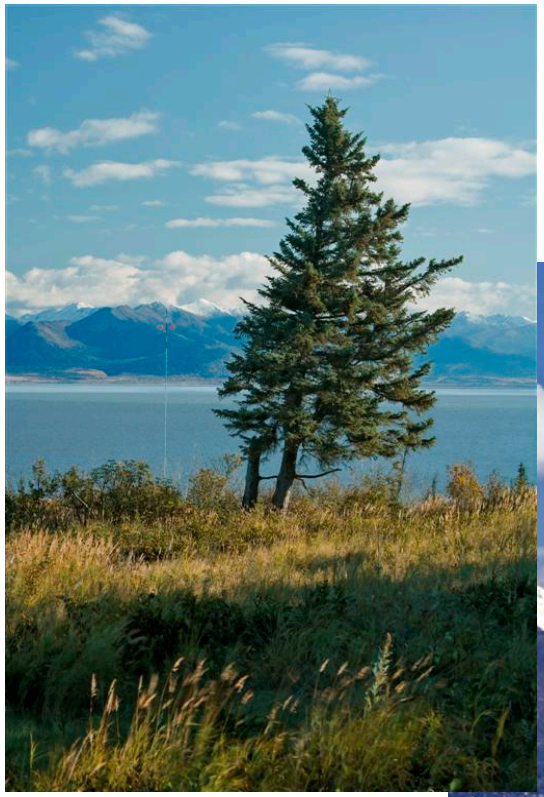


…Like turbulent waters

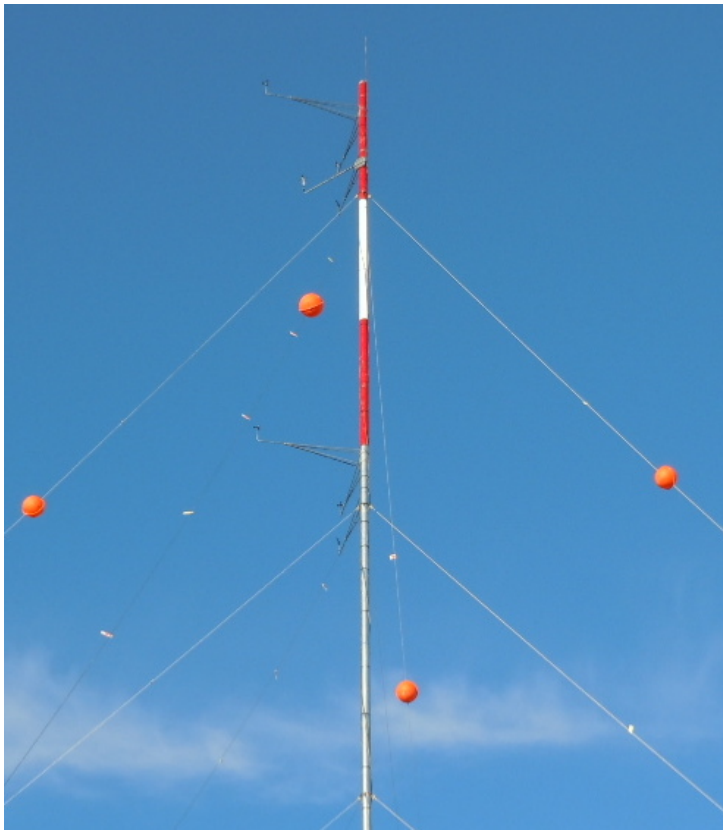
Positive Impacts

- No air pollution or greenhouse gas emissions
  - CO2, NOx, SOx, Mercury…
- No water consumption or pollution
- Diversifies national energy portfolio
- Economic Benefits
  - Jobs
  - Cost of energy
  - Landowner revenue
  - Contribution to local taxes

Where do you put a wind project?



Tree
“flagging”



Met Tower

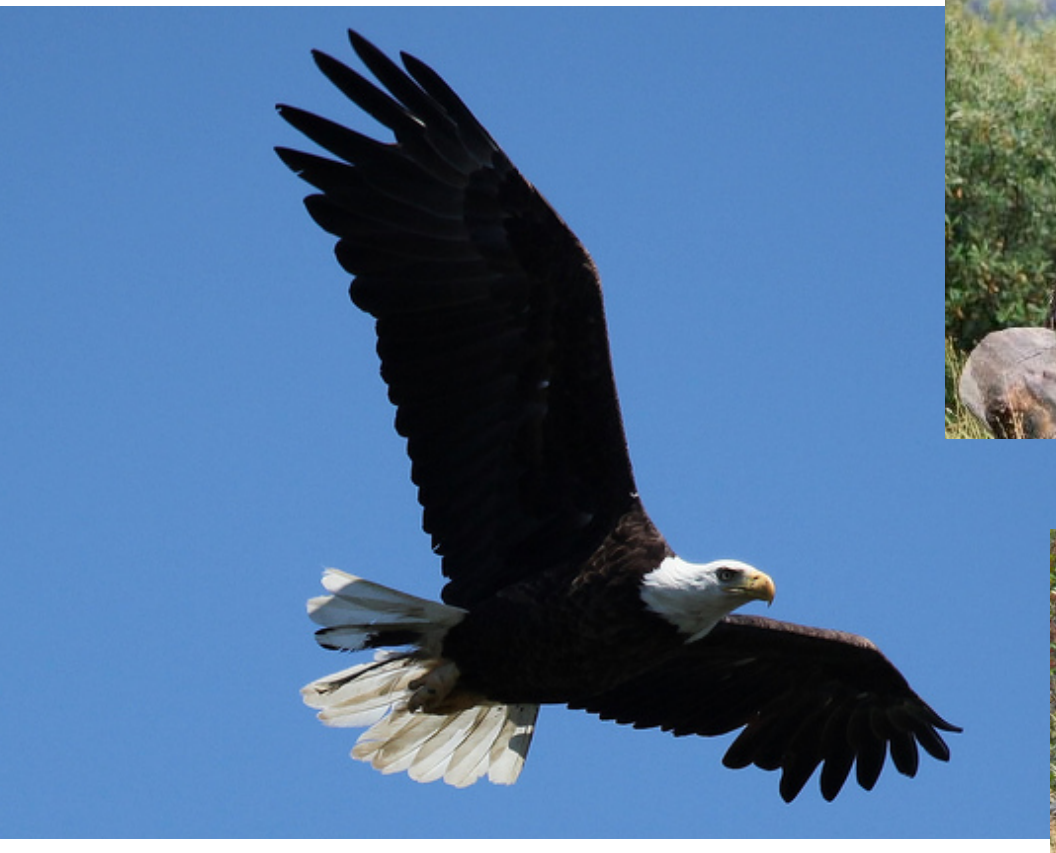
Transmission line

Crossing Cook Inlet at low tide

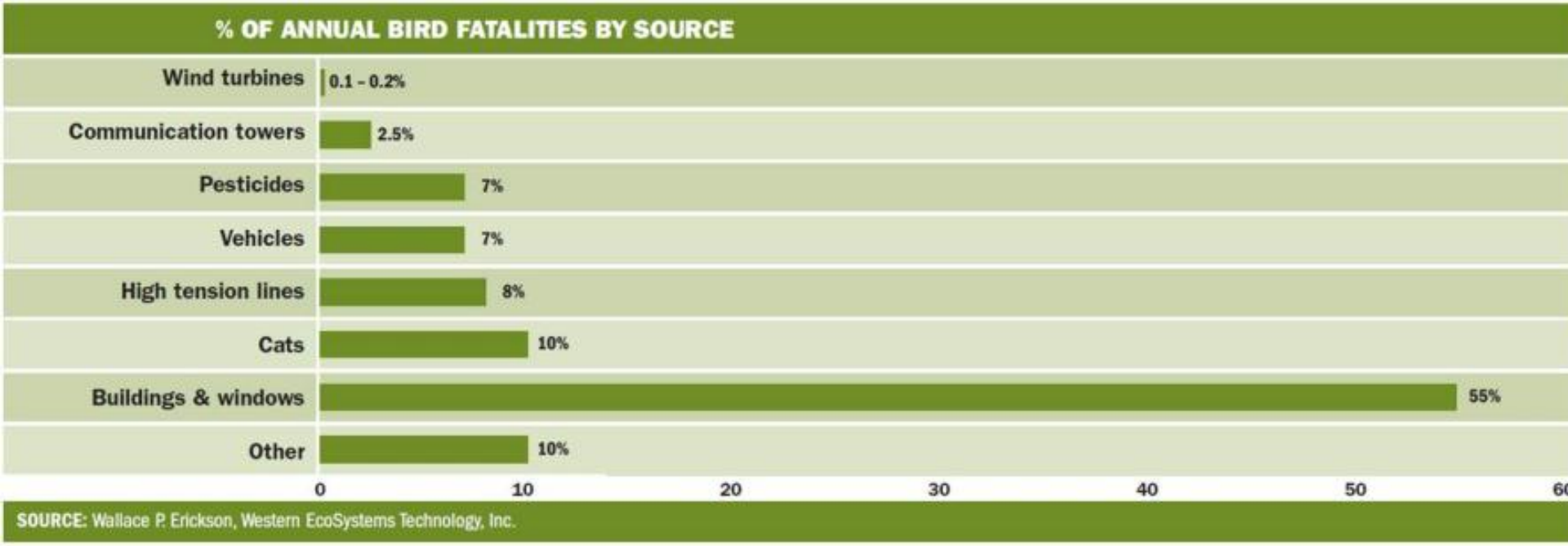
Cable bury at Point Campbell
near Kincaid Park

Construction

Environmental Issues

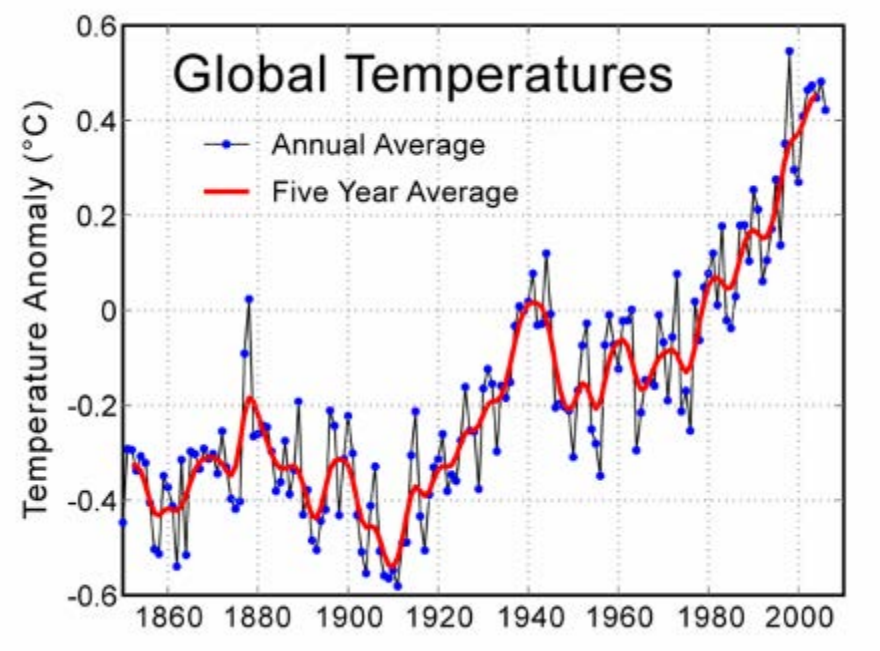


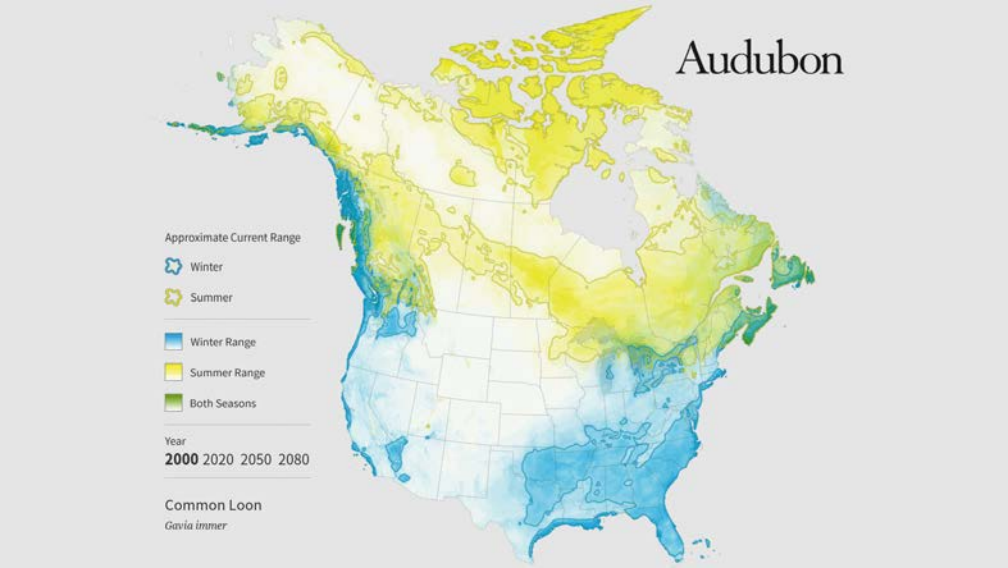
What is the biggest cause of bird fatalities in the US?



"If we don't find ways to reduce [GHG] emissions, **far more birds—and people—will be threatened by global warming than by wind turbines**. Our challenge is thus to help design and locate wind-power projects that minimize the negative impacts on birds."

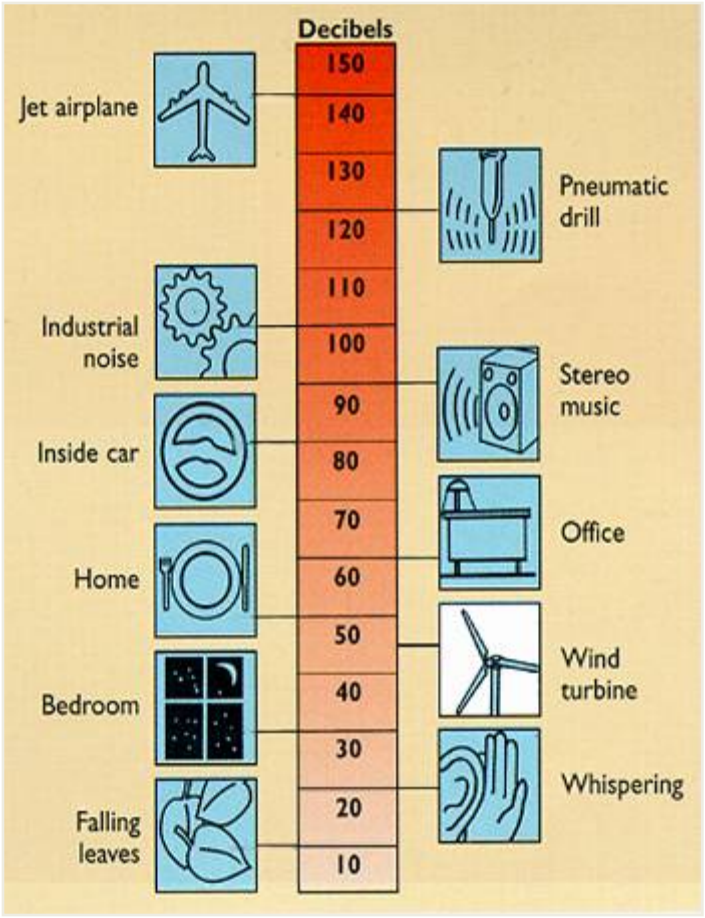
- policy.audubon.org/audubon-statement-wind-power





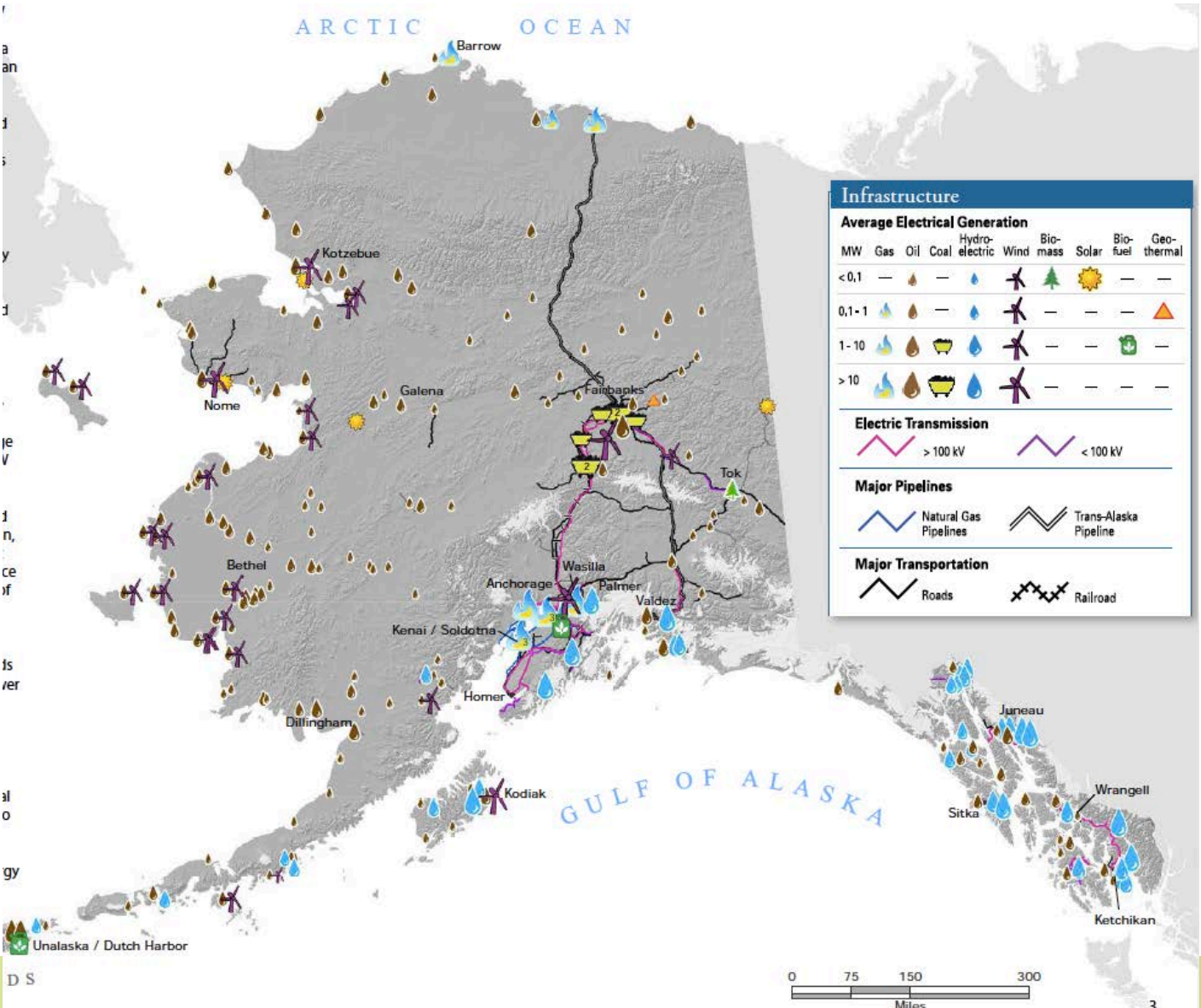
Bat Impacts

Impacts of Wind Power: Sound



- Modern turbines are relatively quiet
- Rule of thumb – stay about 3x hub-height away from houses
- Annoyance is subjective
- VERY CONTROVERSIAL

Transmission Problems



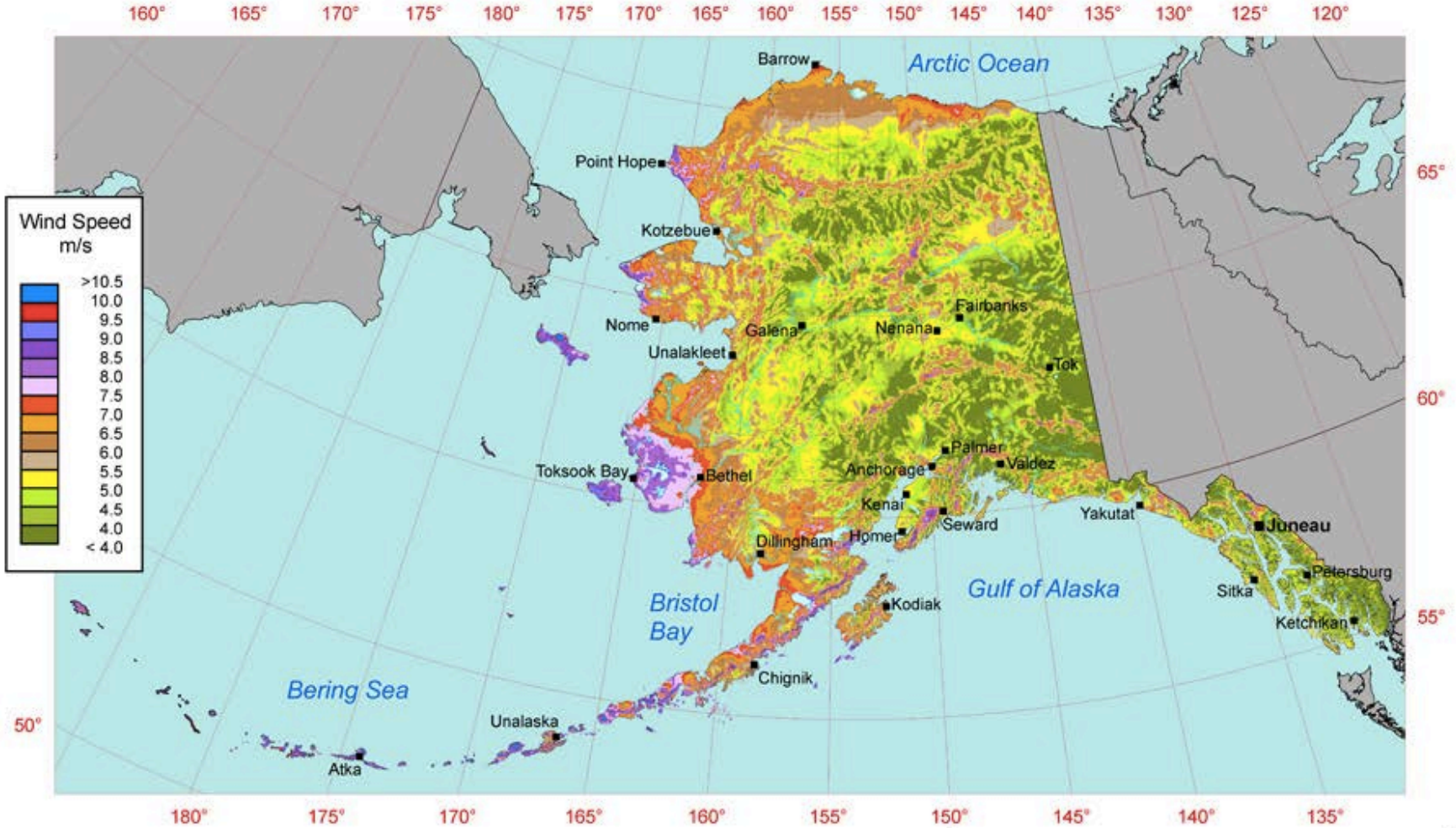
Where is the wind?

Where are the population centers?

Where are the wind farms?

How do we get wind energy from the wind farms to the population centers?

Alaska - Annual Average Wind Speed at 80 m



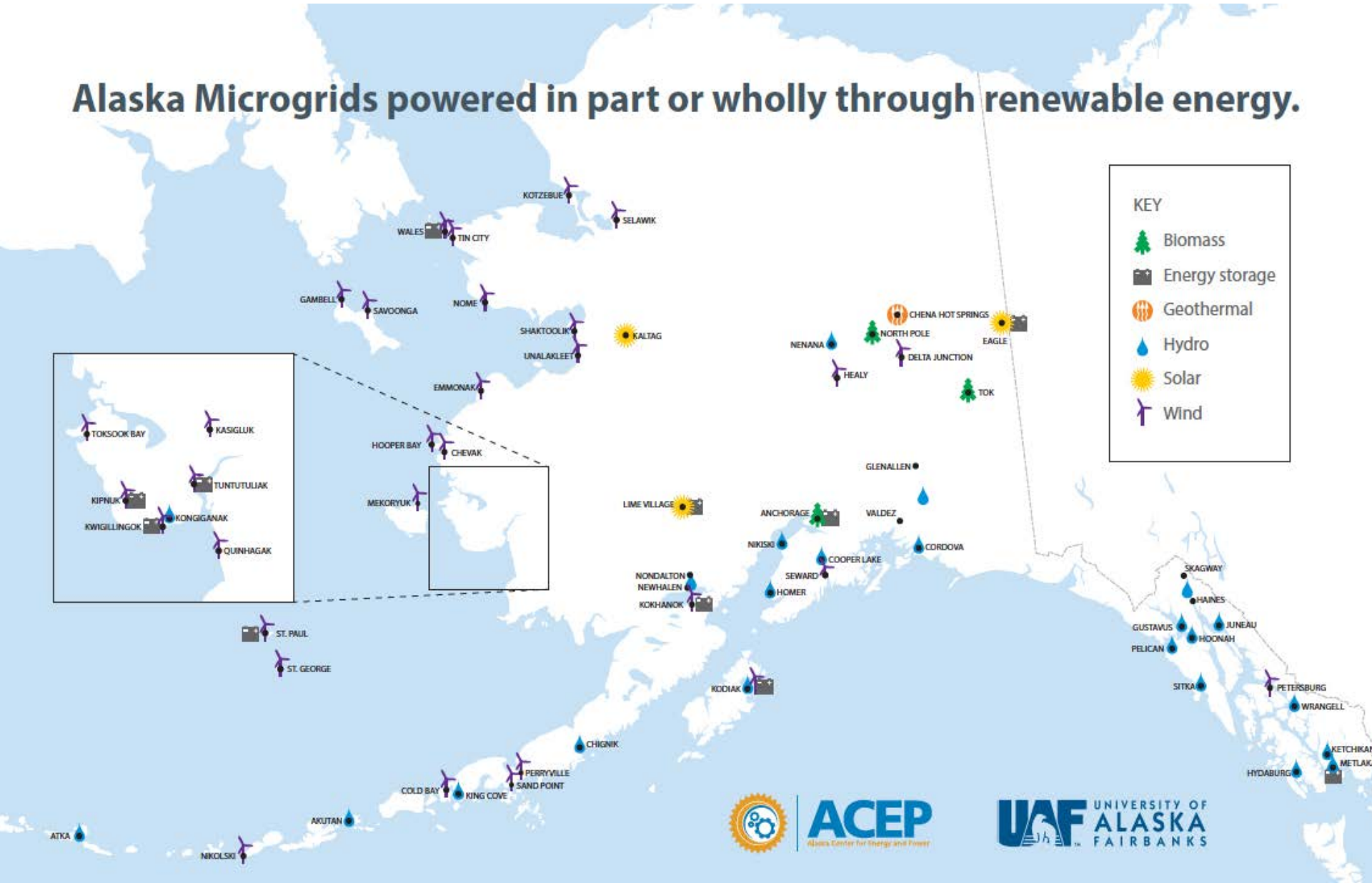
Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: http://www.windnavigator.com | http://www.awstruepower.com. Spatial resolution of wind resource data: 2 km. Projection: Albers Equal Area WGS84.

AWS Truepower™
Where science delivers performance.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

01-APR-2011 1.1.1

70 (of 200+) Microgrid Communities in Alaska Now Have Some Renewable Energy



Wind

- Wind-Diesel in rural Alaska
- Fire Island (17.6 MW)
- Banner Peak (2.7 MW)
- Pillar Mountain (9 MW)
- Eva Creek (24.6 MW)

Fire Island Wind Project

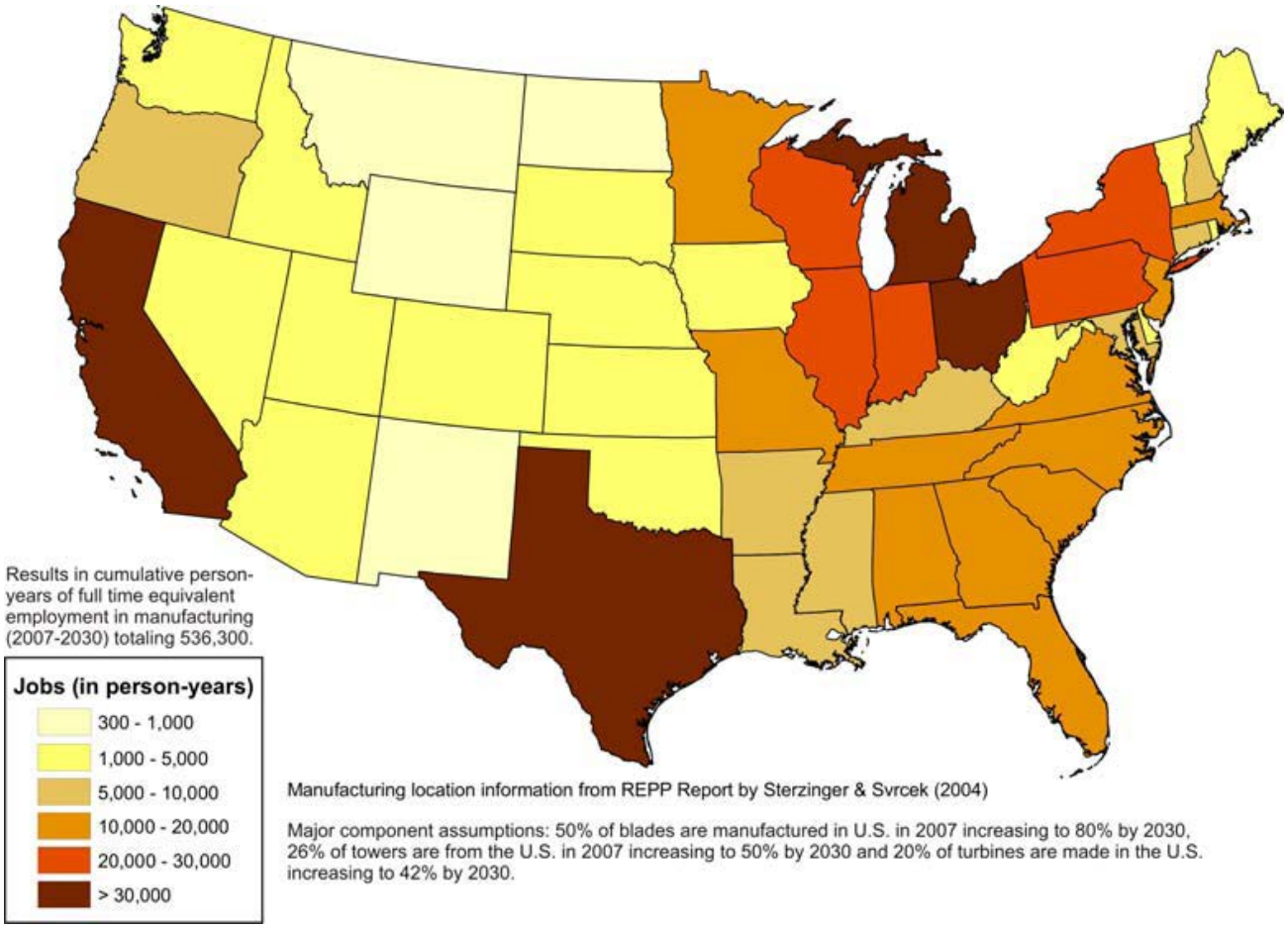
What Clean Energy Can Do For Alaska

- Reduce fossil fuel use and imports
- Stabilize energy prices
- Attract investment
- Diversify our economy and create jobs
- Help us remain an “energy state”

Jobs for the Wind Industry

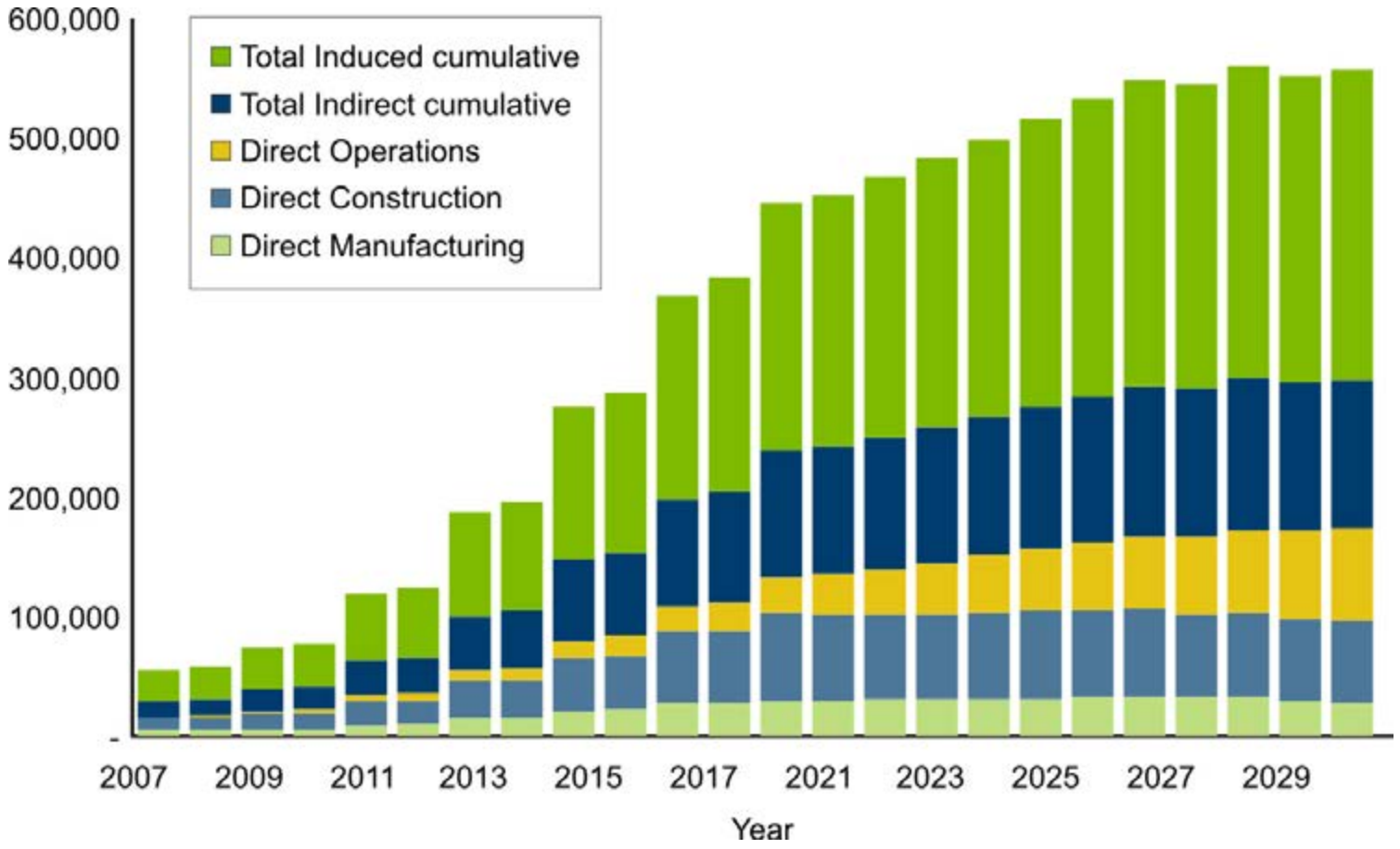
- Sales & Marketing
- Engineering (Civil, Design, Electrical, Mechanical, Quality)
- Supply Chain
- Logistics
- Purchaser/Procurement
- Entrepreneurships
- Management & Beyond
- Meteorologist/Forecasting
- Project managers
- Production Directors
- Manufacturing
- Environmental Studies
- Consulting
- Maintenance and Repair
- Non-profit

Job Potential in 2030**



**Based on AWEA 20% wind electricity by 2030

Job Potential in 2030**



**Based on AWEA 20% wind electricity by 2030

Job opportunities in Alaska

- Wind techs are limited but out there some in AK
- Other jobs with wind/RE companies
- Engineers, construction, trade workers
- Transferrable job skills for power house/plant generators, water
- Energy efficiency work
- Transportation/logistics, sales, marketing, accounting, programmers, communication, etc

Research Topics for Students

- Turbine research – Improvements to design, efficiency, and cost controls.
- Wind resource assessment – Wind data and its variability.
- Forecasting – Weather models, predicting wind behaviors.
- Utility grid integration – Grid management and technologies.
- Energy storage – Storage and conversion.

Wind Energy in the Classroom

Which Blades Are Best?
WindWise Lesson 10

- Understand how wind energy is converted to electricity
- Know the process of scientific inquiry to test blade design variables
- Be able to collect, evaluate, and present data to determine which blade design is best
- Understand the engineering design process

Key Concepts

How do windmills spin?

- **Force of the wind**
- **Deflection**
- **Equal & opposite reaction**
- **Rotor**
  - Mechanism
  - Axial Flux
  - Radial Flux
- **Wind Speed – Power in the Wind**
- **Torque (turning force)**
  - a.k.a. leverage
- **Driveshaft**
  - Pulley ratio (simple machines)
  - Friction

Rotor Variables

- Blade pitch
- Blade shape
- Blade size
- # of blades
- Solidity

Extensions
(Advanced Concepts)

ENERGY (J) = Mass (kg) x Acceleration of Gravity (9.8 m/s^2) x Height (m)

POWER (W) = Energy (J) / Time (s)

Economics: Each item you use has a dollar value attributed to it. What was the cost of your wind turbine? Cost of energy? What is the payback time?

Incorporating in the classroom

- Free lessons aligned to NGSS:
  - NEED.org
  - Windwise
- Incorporate in Physics, Energy, or Human impacts on the environment units in regular science classes
- Include "Boy Who Harnessed the Wind" in reading class; math concepts (angles, power formula, etc); social issues in history
- Include in STEM, engineering, Environmental Science, construction classes

KidWind & REcharge labs

- Monthly challenges – RECharge labs
- Regional & National competitions – KidWind

KidWind Challenge

Students build & design model wind turbines to test in a wind tunnel

2019: Palmer
-31 students, 13 teams
-1st & 2nd place teams in each division travelled to Nationals!

SAVE THE DATE:
March 18th, 2020
CIRI, Anchorage
KidWindChallenge.org

Other related REAP programs

- AKEnergySmart.org – free energy efficiency curriculum
  - Power Pledge Challenge
- Alaska Network for Education and Employment
- Weather Education Program

Thank you!

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REAP | Renewable Energy Alaska Project