

Wind Energy Basics



Abigail Krich
President, Boreas Renewables LLC
Northeastern University School of Law
January 20, 2012

1980's California Lattice Towers



Late 1980's California, Tubular Towers

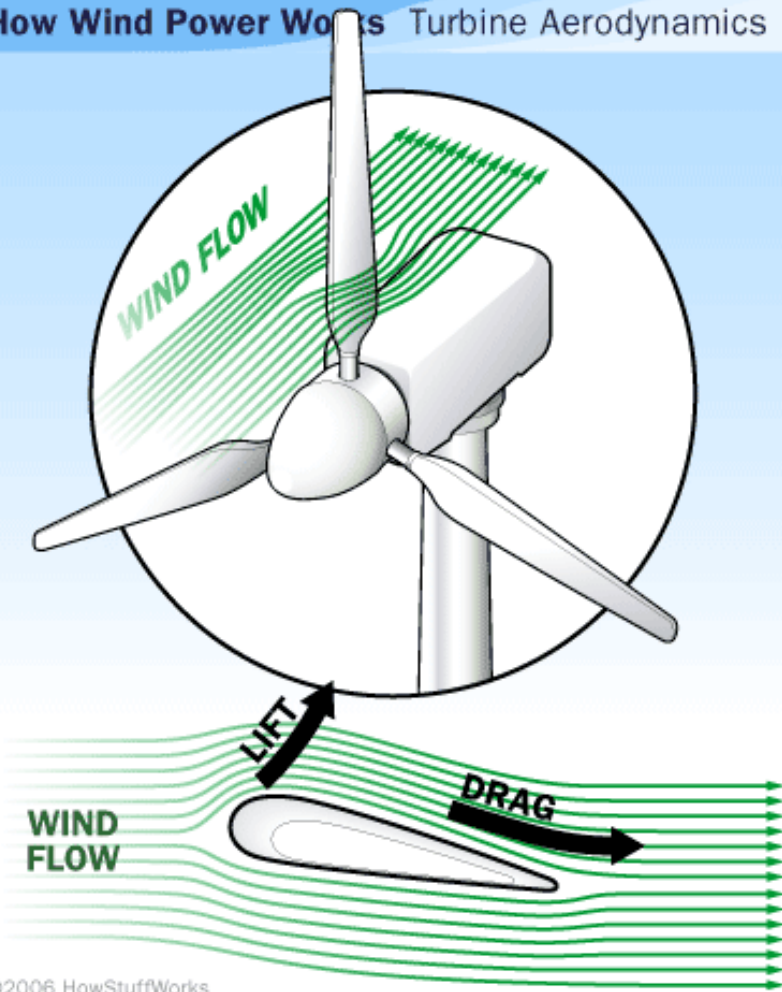


2002 Fenner, New York

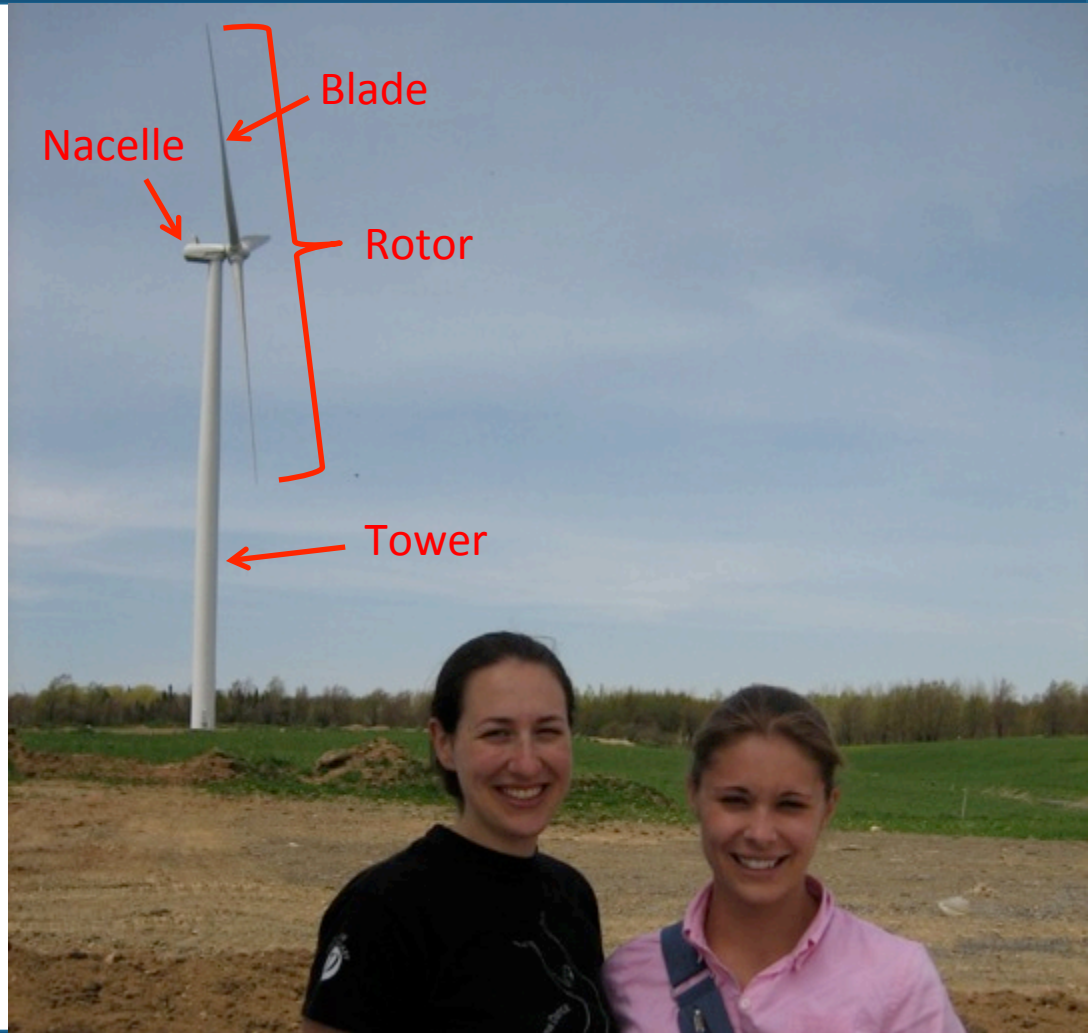


How it Works

How Wind Power Works Turbine Aerodynamics



©2006 HowStuffWorks



Small Wind



Medium Wind – Medford 100 kW



Medium Wind – Hull 660 kW



Big Wind - 1.65 MW and 2.3 MW



Big Wind - 2.3 MW (150' blade)



Transportation



Staging



CAUTION
Cranes
Ahead

Assembly



Land Impact – Temporary vs Permanent



Per MW, typical direct land impact:

- 1.25 acre temporary
- 0.4 acre permanent

Source: <http://www.nrel.gov/docs/fy09osti/45834.pdf>

Land Use Comparison



U.S. Coal mining
disturbs 400k ha/yr

20% US electricity
from wind would
disturb up to 250k
ha **total**

Source: DOE report *20% Wind Energy by 2030*
Image: www.ohvec.org/galleries/mountaintop_removal/007/

Visual Impact



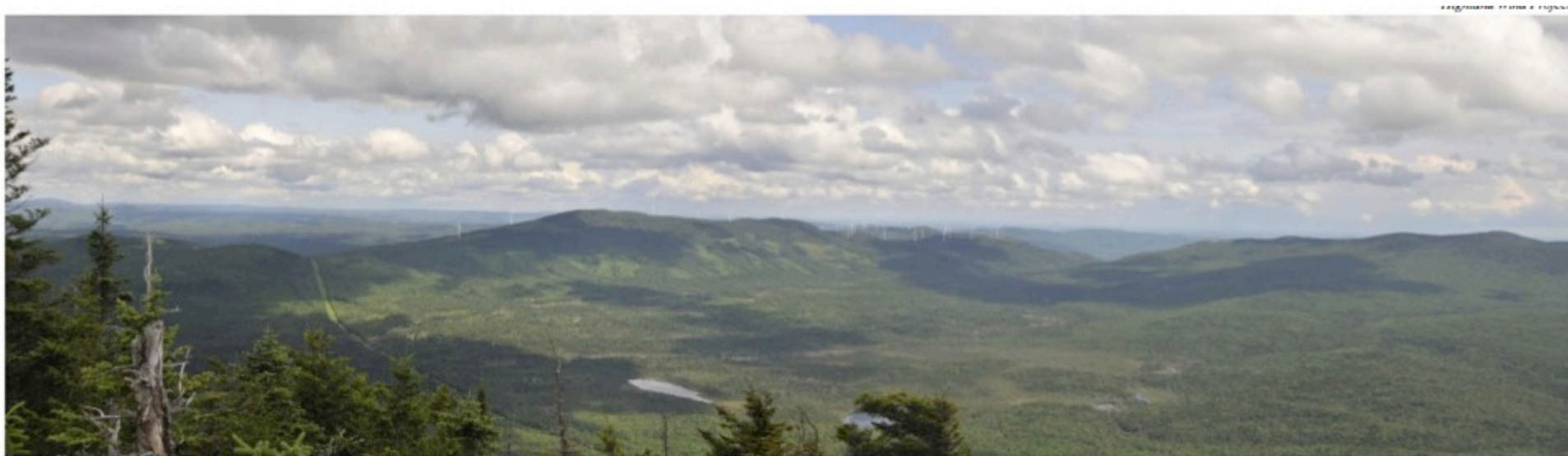
10/16/2011

Visual Impact



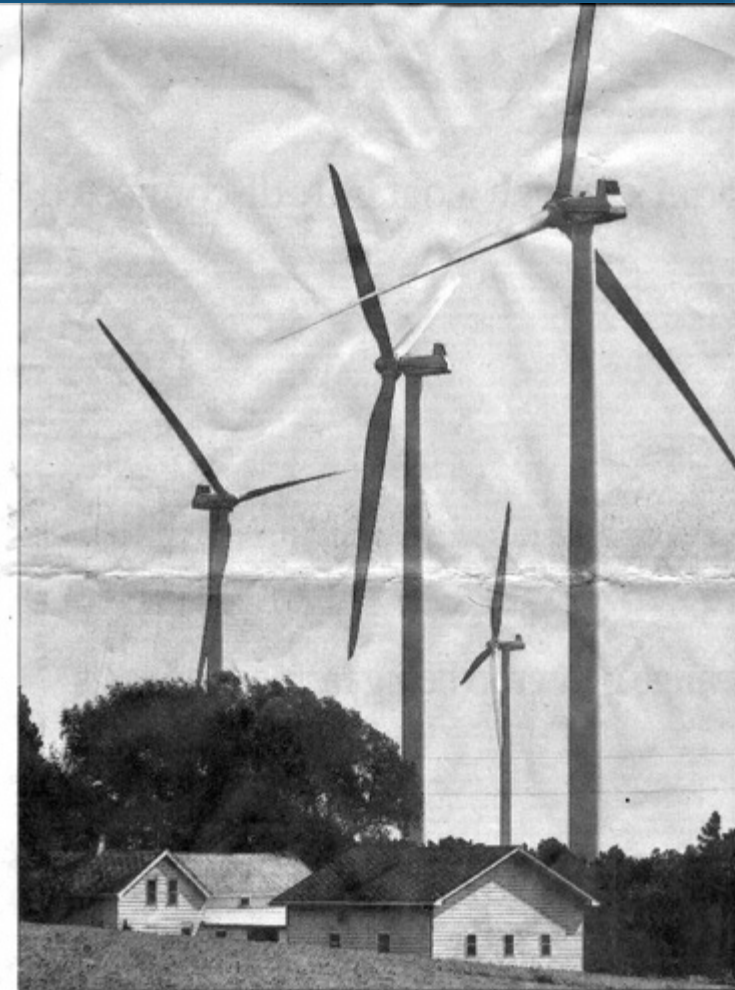
Visual Impact

Photo simulation of a wind project 4.3 to 10.9 miles from the Appalachian Trail



Photosimulation 2: Panoramic view from the eastern summit of Little Bigelow Mountain on the Appalachian Trail, looking east to southeast toward the proposed Highland Wind Project. Turbines visible from this location would be between 4.3 to 10.9 miles away. The existing 115kV transmission line is visible in the midground as it passes between Little Bigelow Mountain and the northern end of Stewart Mountain.

Beauty is in the Eye of the Beholder



Maple Ridge Wind Farm windmills loom large over Factor Road in West Marquette.

NBC J. KALLANOTOS/WATERTOWN DAILY

Beauty Is in the Eye of the Beholder



Avian Impact

Wind Project and Location	Total Fatalities
Stateline, OR/WA	2.92
Vansycle, OR	0.95
Combine Hills, OR	2.56
Klondike, OR	0.95
Nine Canyon, WA	2.76
Foote Creek Rim, WY (Phase 1)	2.50
Foote Creek Rim, WY (Phase 2)	1.99
Wisconsin	1.97
Buffalo Ridge, MN (Phase 1)	3.27
Buffalo Ridge, MN (Phase 2)	3.03
Buffalo Ridge, MN (Phase 3)	5.93
Top of Iowa	1.44
Buffalo Mountain, TN	11.67
Mountaineer, WV	2.69

Total annual avian fatalities per MW from a sampling of operating wind projects

Source: Data adapted from Strickland and Johnson (2006)

Avian Impact In Context

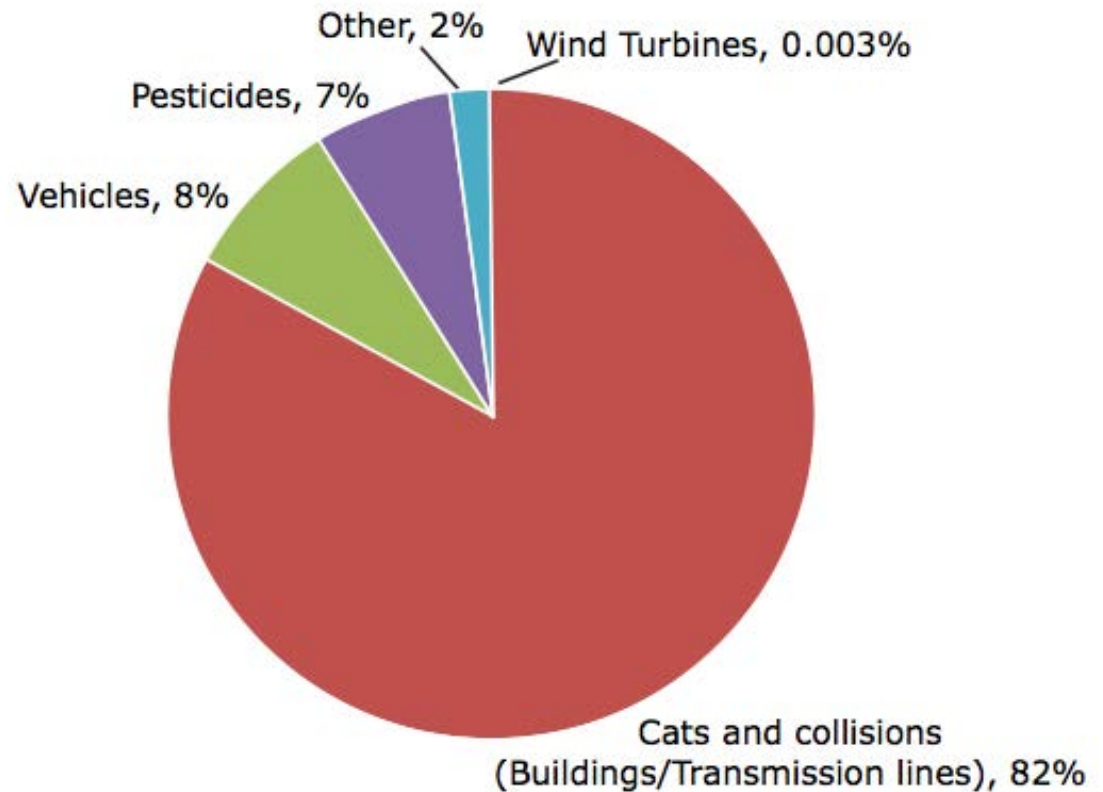
Wind Turbines: Compatible with Birds

Causes of Bird Fatalities,
Number per 10,000 fatalities



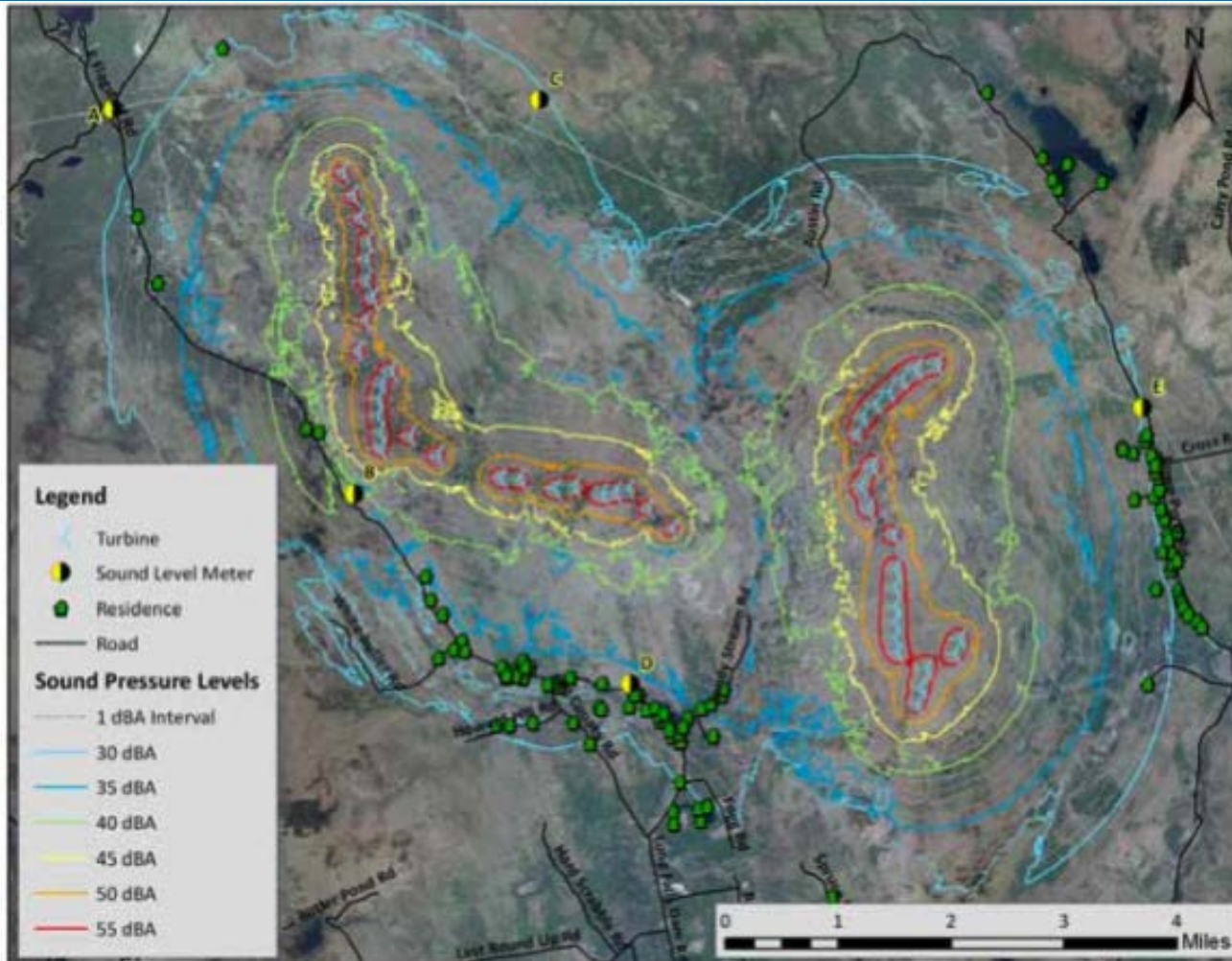
Data Sources: Erickson et al., 2002. Summary of Anthropogenic Causes of Bird Mortality.

Bird Mortality from Human Activity



Source: Erikson et al. 2005

Sound Impact



Key Findings of MA Wind Turbine Health Impact Study

- There is **no evidence** for a set of health effects from exposure to wind turbines that could be characterized as a "**Wind Turbine Syndrome.**"
- The weight of the evidence suggests no association between noise from wind turbines and measures of psychological distress or mental health problems.
- There is limited epidemiologic evidence suggesting an association between exposure to wind turbines and annoyance.
- There is limited evidence from epidemiologic studies suggesting an association between noise from wind turbines and sleep disruption.

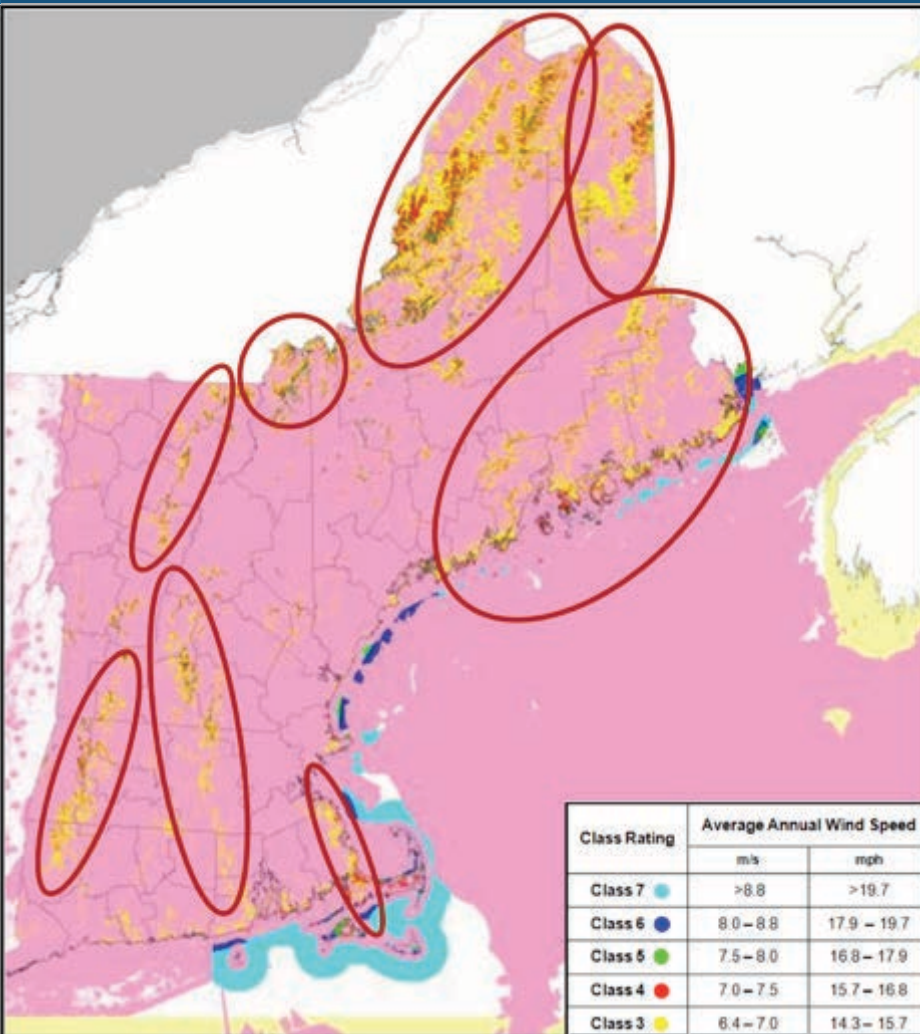
Source: <http://www.mass.gov/dep/public/press/0112wind.htm>

Wind – Good Neighbor?



- Hull 2
- 1.8 MW Community-Owned Turbine, 350' tall
- Built on old landfill
- Closest house is under 500'
- Homeowner said turbine is a great neighbor

Where is the Wind Potential?

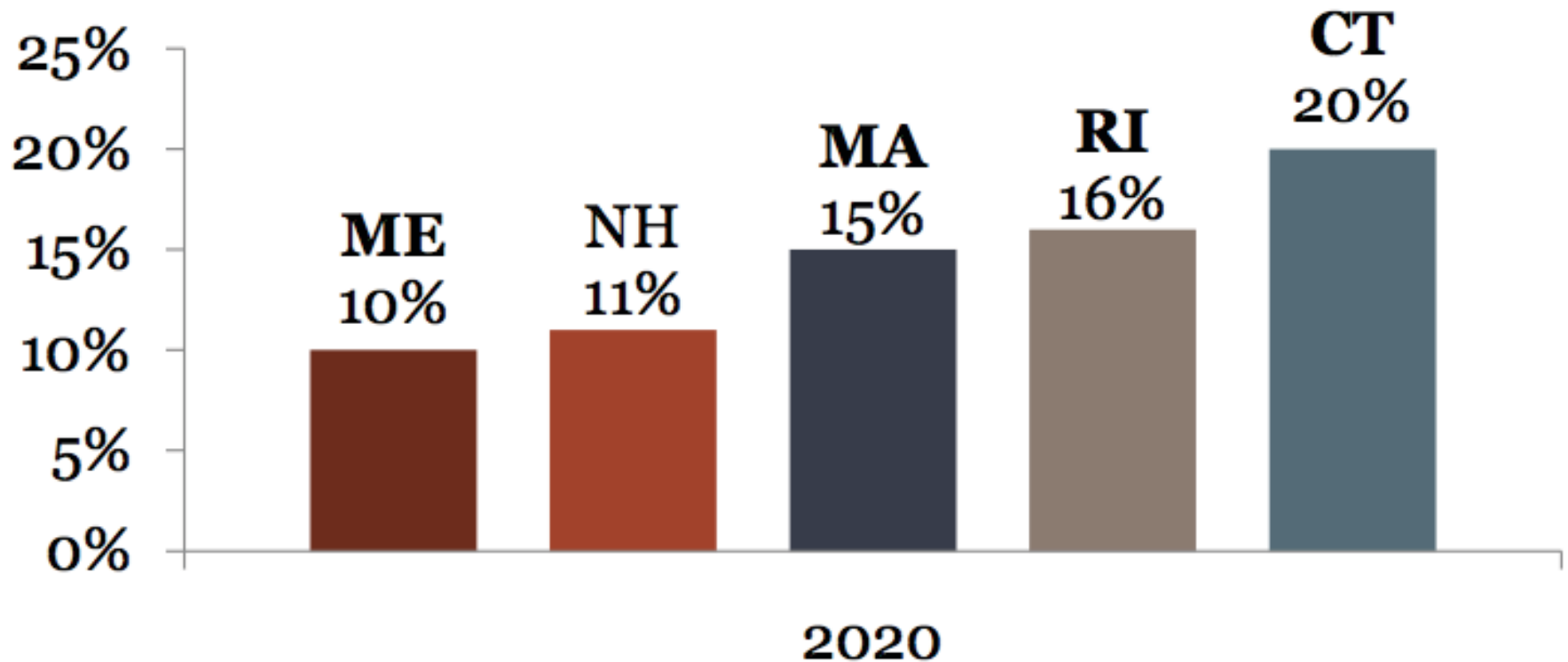


- Best wind potential is in mountains or along coast
- Wind in pink areas unlikely: low wind or siting concerns
- 215 GW potential shown here, >4x New England's annual electricity usage
- 4 GW would meet remaining RPS targets in 2020

Image Source: 2009 Northeast Coordinated System Plan
http://iso-ne.com/committees/comm_wkgrps/othr/ipsac/ncsp

New England Renewable Portfolio Standards

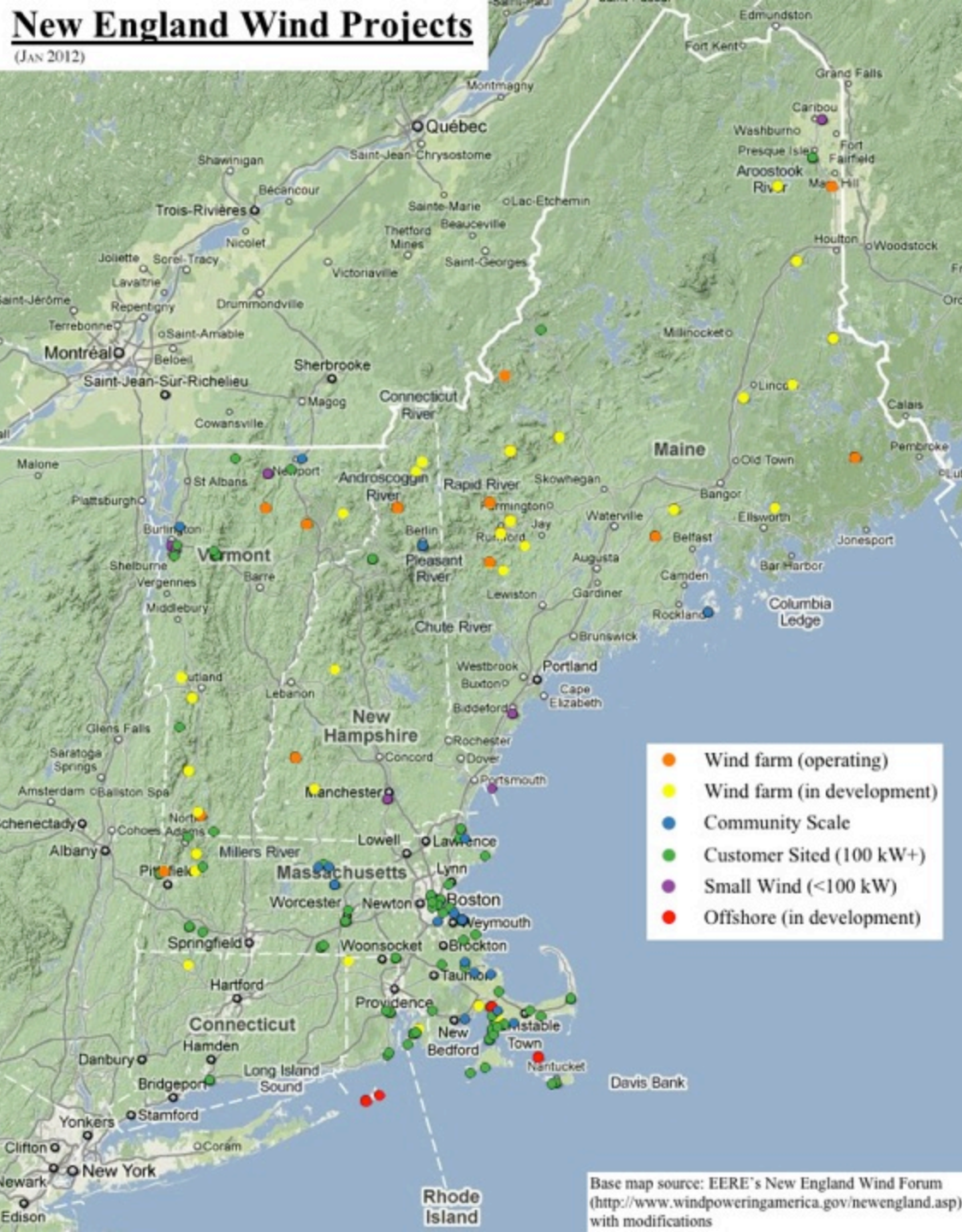
State Renewable Portfolio Standards



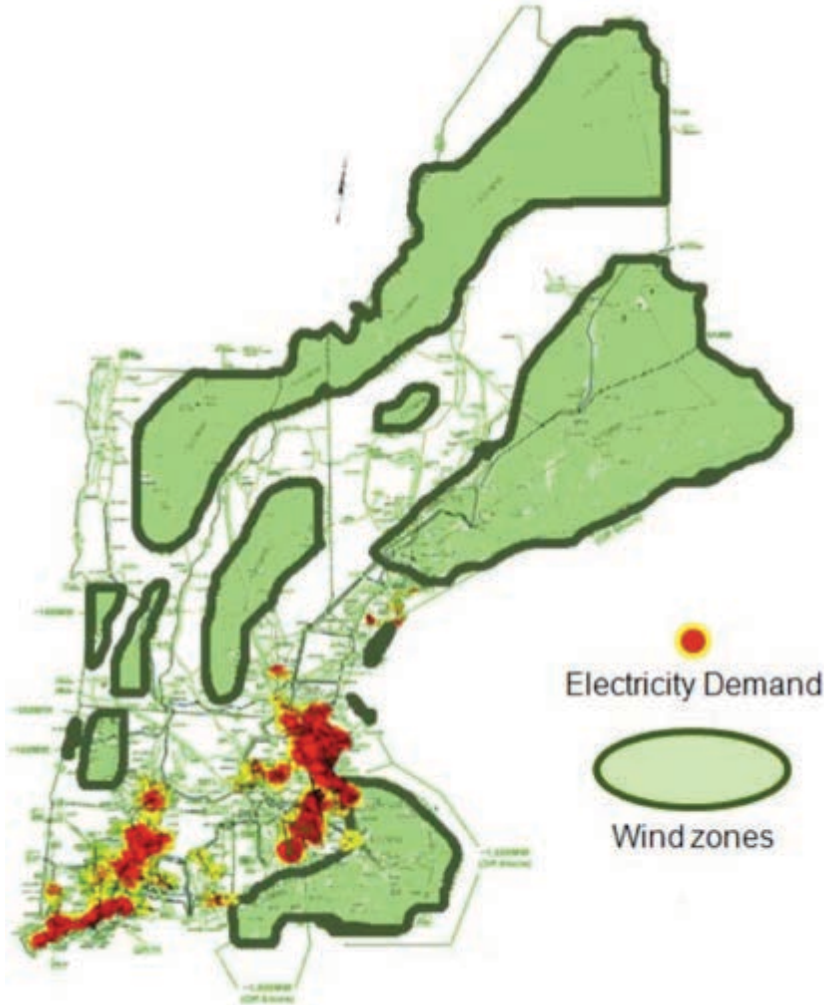
Wind Projects In New England

Most wind farms in mountains or near coast

Community Scale and Customer Sited Turbines closer to demand



Wind and Demand Not In the Same Place



Transmission lines needed to move energy from windy areas to areas with demand for electricity

Transmission Lines – Scary?



This is neither what New Hampshire looks like nor what the Northern Pass would look like

Image Source: Stop the Northern Pass Facebook Page

Different Size Power Lines

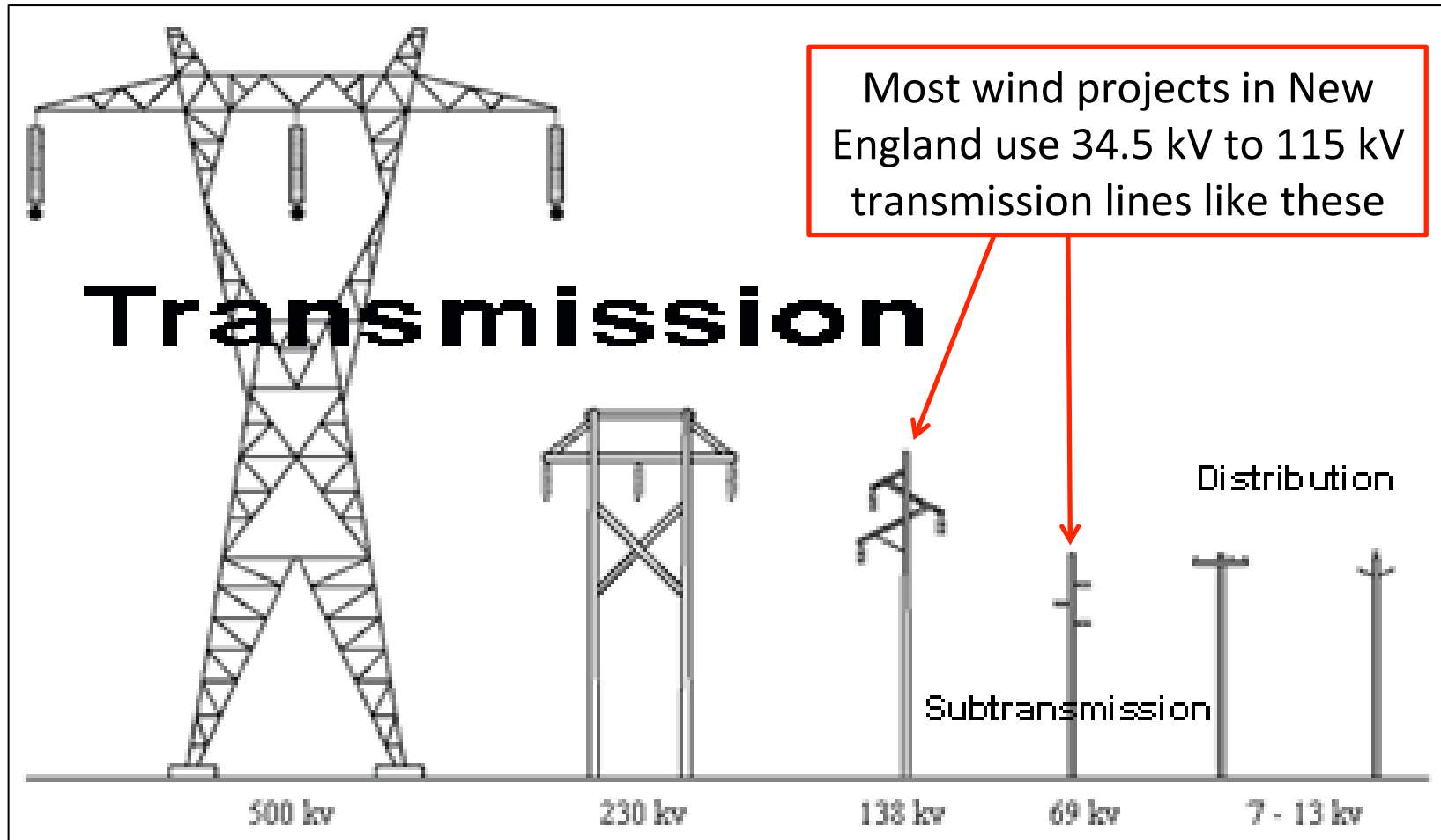


Image Source: http://www.osha.gov/SLTC/etools/electric_power/illustrated_glossary/transmission_lines.html

New England's Energy Mix

**New England's 2010 Electric Energy Generation Mix by Fuel Type
Compared with the 2010 Nationwide Energy Mix (%)^(a)**

Fuel	New England	United States ^(b)
Coal	11.2	44.9
Natural gas	45.6	23.8
Oil (heavy and light)	0.4	0.9
Nuclear	30.4	19.6
Hydroelectric, pumped-storage, and other renewable	12.5	10.8

(a) Percentages may not add to 100 because of rounding.

(a) National figures are from EIA 2010 data. The raw data are available at http://www.eia.doe.gov/cneaf/electricity/epm/table1_1.html.

Wind Primarily Displaces Fossil Fuel

“Considering that wind generation primarily displaces natural-gas-fired generation in New England, the overall CO₂ production declines by 25% with 20% wind energy penetration”

Wind Penetration (Energy)	CO ₂ Reduction
2.5%	2.5%
9%	9%
14%	17%
20%	25%
24%	30%

- New England Wind Integration Study (NEWIS), ISO-NE, 2010

Questions?



Abigail Krich

Boreas Renewables

www.BoreasRenewables.com

Krich@BoreasRenewables.com