Best Practices in Siting Small Wind

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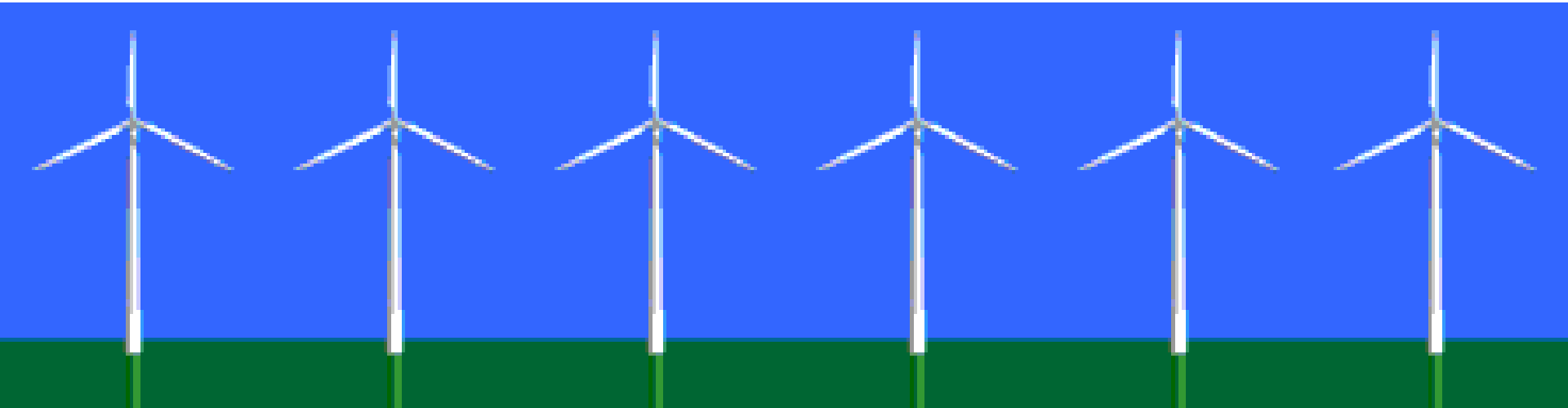
Cape & Islands Self-Reliance



Cape and Islands Self-Reliance Corporation

- **Founded in 1980 through the efforts of the New Alchemy Institute, the Wampanoag Council and Housing Assistance Corporation.**
- **Our mission is to promote environmentally sound technologies and sustainable practices through education, advocacy and collective membership that provides tangible benefits.**
- **At Self-Reliance, we pride ourselves on our ability to collaborate with partners to achieve higher goals, reach broader audiences and provide fact-based educational programs to the public.**

Self-Reliance is committed to providing high quality, hands-on educational workshops and conferences as part of our workforce development training. We work to bring well-sited and appropriate renewable energy applications to the region.

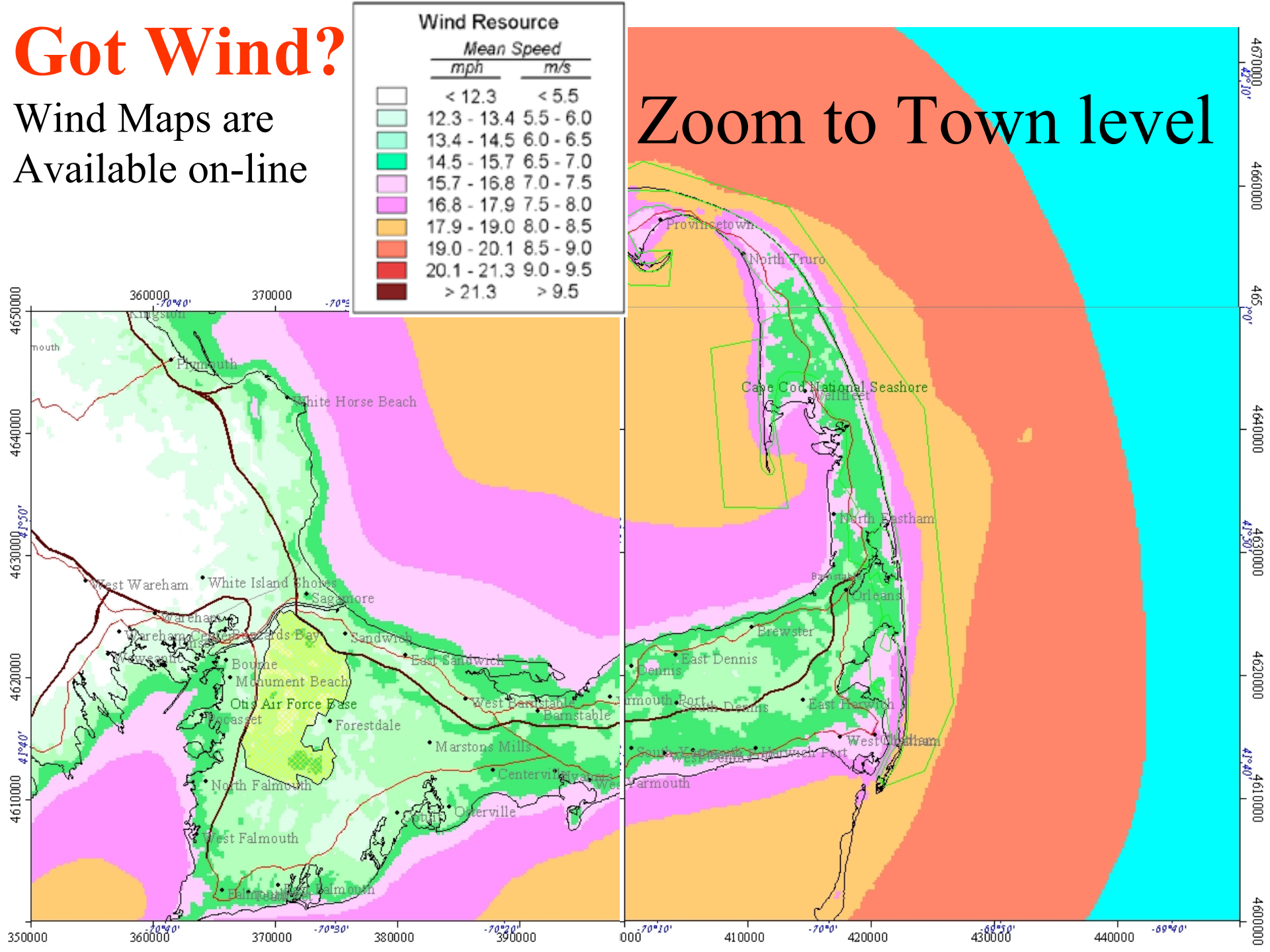
Appropriate Siting of Small Land-based Wind

PLEASE CONSIDER:

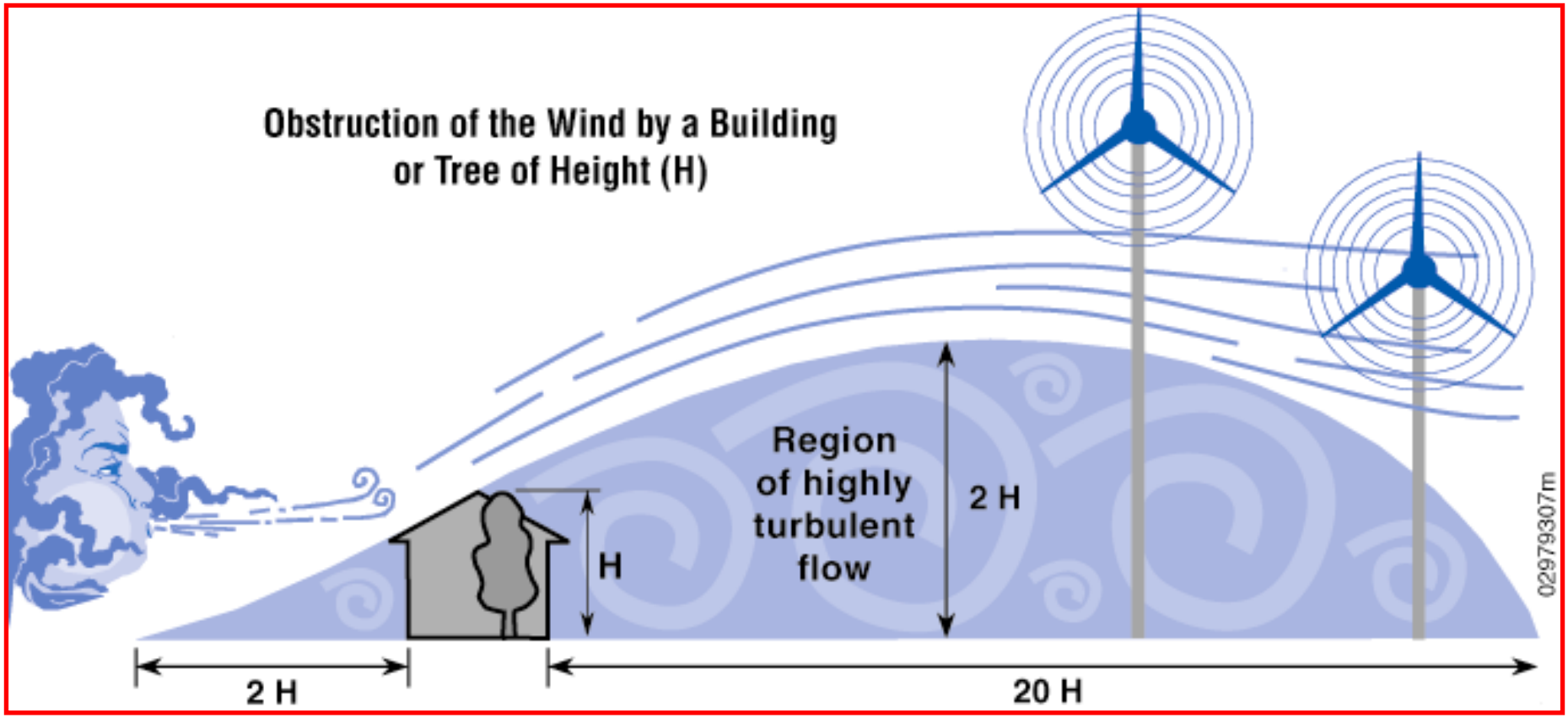
- Being an advocate for renewable energy doesn't mean giving blanket support to all projects and technologies.
- The small wind industry wants to avoid making the mistakes that the solar industry's made in the '70's and '80's.
- All renewable energy systems must be well sited, using equipment that has a proven track record and real data to back up the manufactures' claims.

Got Wind?

Wind Maps are Available on-line



Effect of Obstructions



Some Facts to Consider…

- All wind turbines vibrate when in the wind, and they transmit this vibration to the structure on which they're mounted.
- All rooftops create turbulence that interferes with the wind turbine's operation. Even if the manufacturer’s engineers were able to design a sophisticated dampening system that isolated the wind turbine from the structure, they couldn't eliminate the power-robbing and damaging turbulence created by the building and other obstacles at that level.

Roof Mounted Turbines

- To avoid rooftop turbulence, the wind turbine must be raised **well** above the roof line. The tower is often the most expensive part of a wind installation, but installing the machine in good, This often negates any potential savings on the tower, and increases the complexity of mounting the wind turbine and installing it safely.

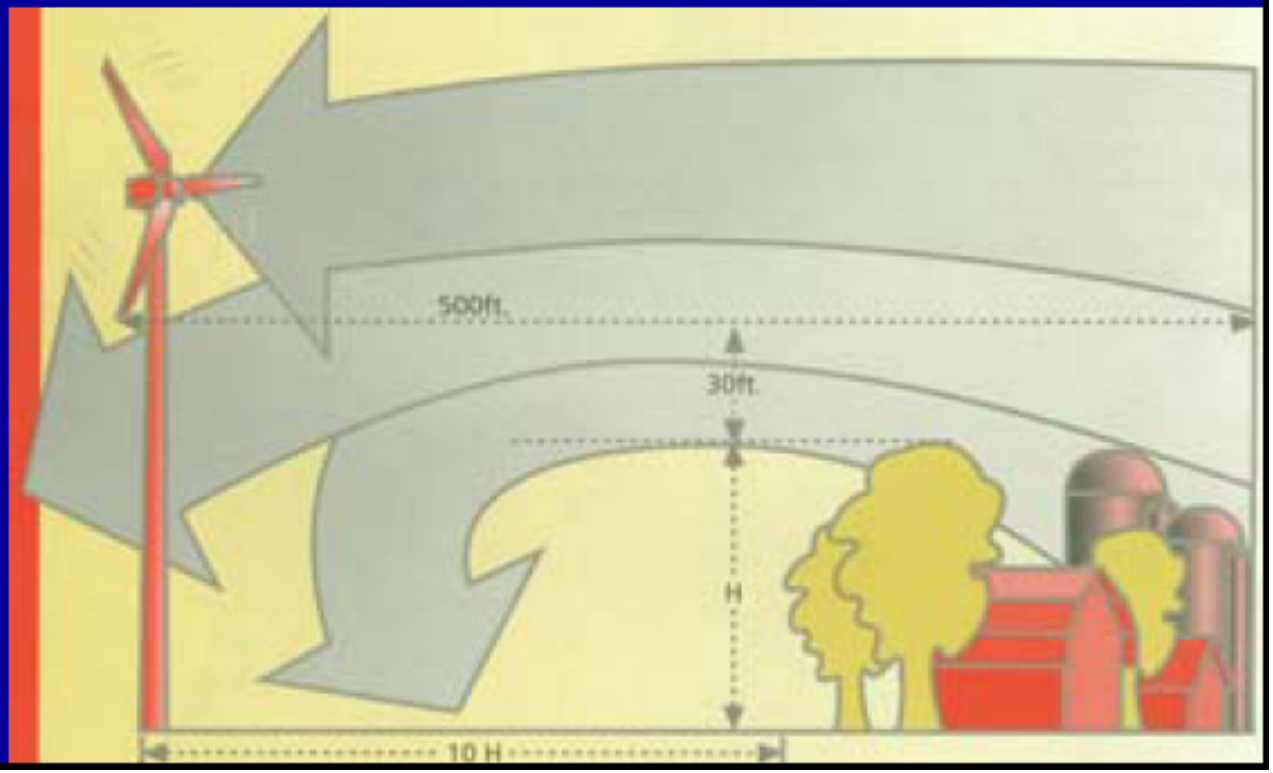
- Worse, a rooftop-mounted turbine can provide a nasty surprise, as one owner in upstate New York learned. One stormy night his roof-mounted turbine destroyed itself--and then plunged through his roof. That was the end of his experimentation with rooftop mounting. There are quite a few stories like this and more that indicate the machines have been tied off and are not functioning.

“But Why?” is often the question.

- **In order to generate electricity and set a good precedent for wind energy, we need good examples of well-installed, appropriately-sited technology.**
- **The bad installations are what people remember. Let’s learn from the early mistakes made in the solar industry.**

Rules of thumb for siting residential wind turbines

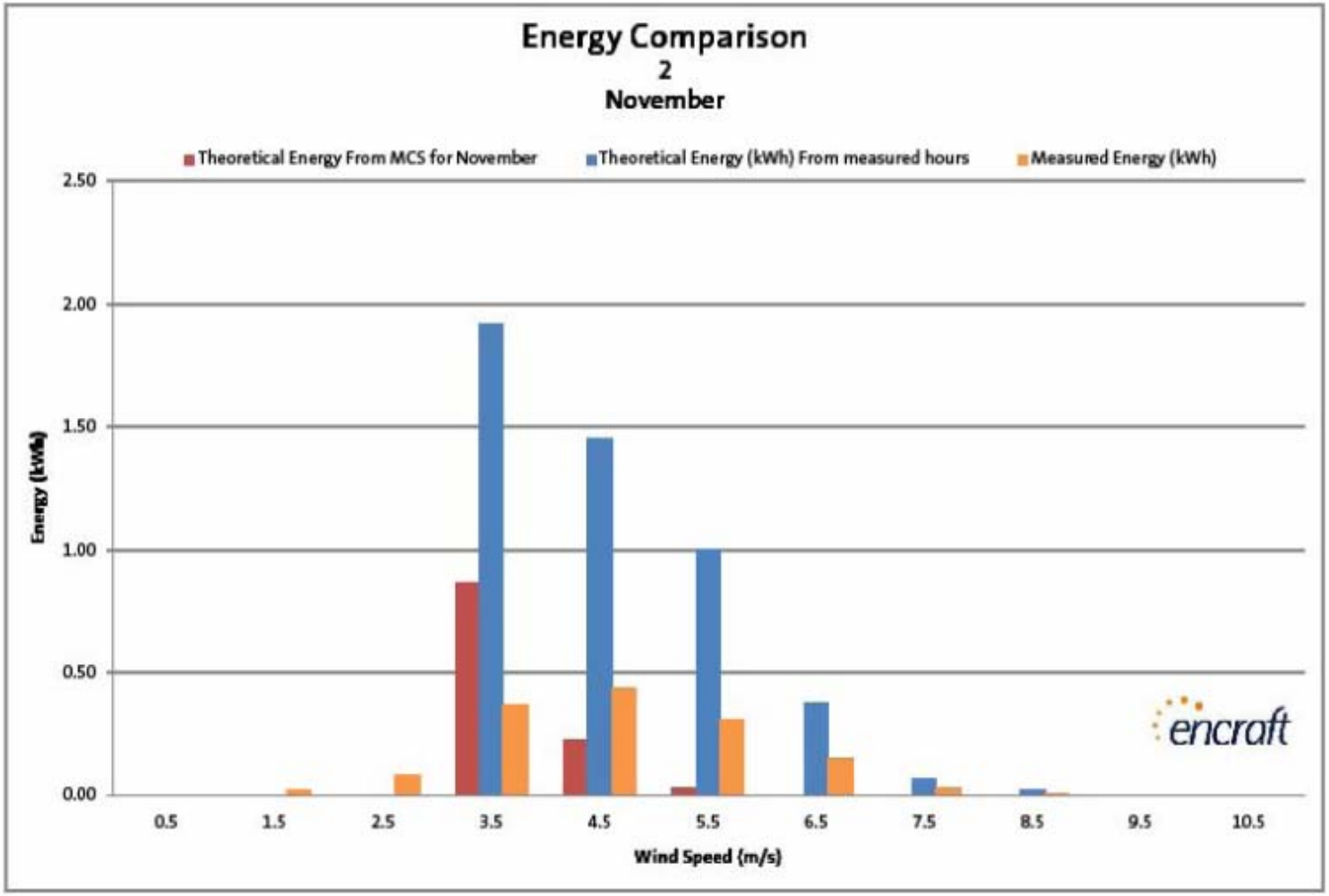
- 30'↑ within 500'
- Or treeline, which ever is higher



Slide courtesy of Mick Sagrillo

Wind Data from Rooftop Study

conducted through Warwick Wind Trial in UK



The Warwick Wind Trials shows that most of the new generation of rooftop turbines also fail to meet their claimed output, often only achieving 30% or less.

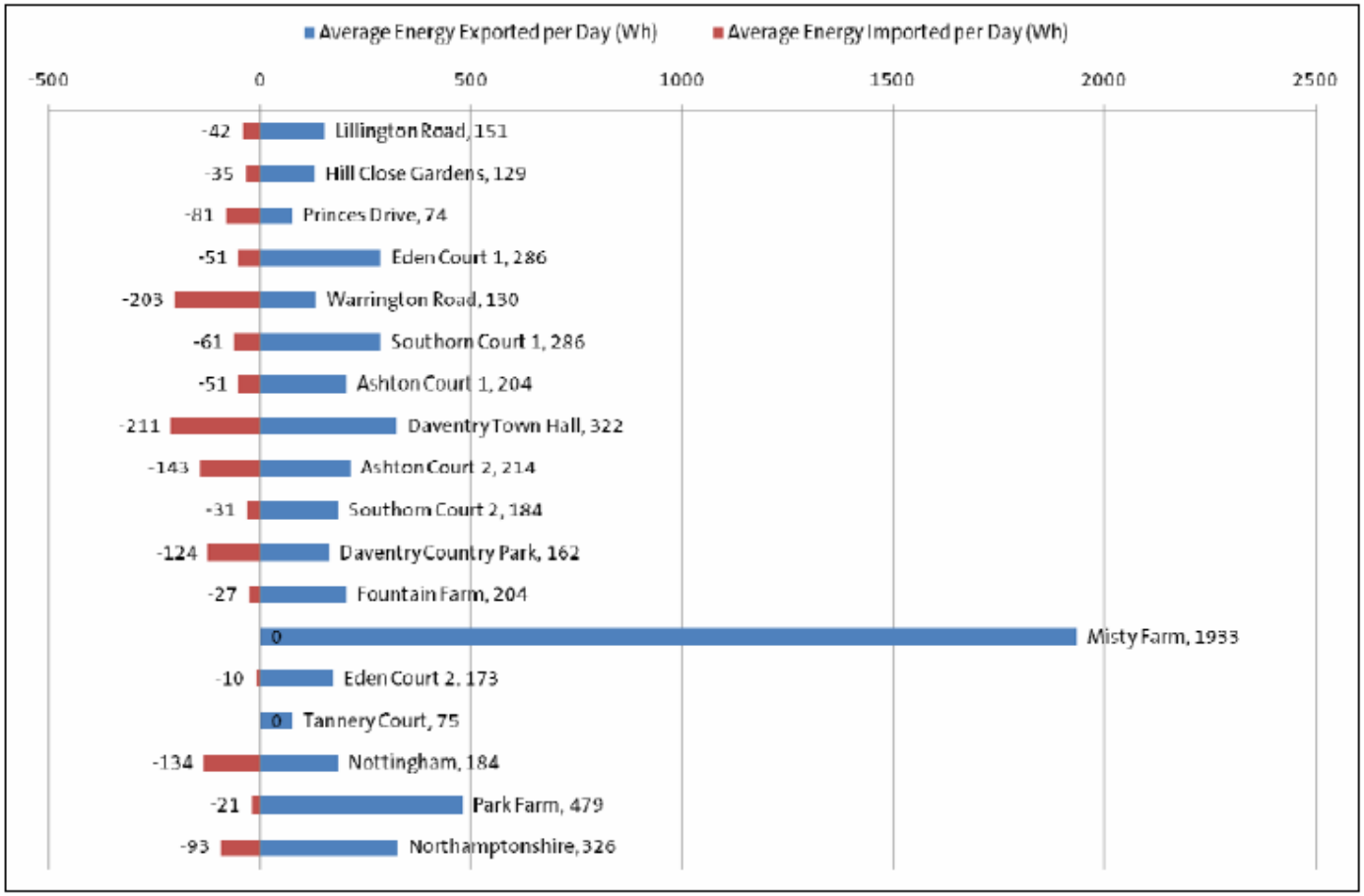
In many cases the inverter's standby power consumption exceeds any power generated on urban sites.

Looks great, but….

Actual Data from the Encraft report " Micro-wind-a catalyst for change in UK energy culture?" *April 2008*

This data is extracted from the most recent technical report on the trials. It is "real-life" data, representing actual recorded energy generated including all outages for maintenance, turbines switched off because of wildlife or noise concerns etc (whether or not these outages are justified). An outage will reduce average energy generated because it shows as zero output, sometimes for days or weeks.

Average daily electrical energy generated and used by each system – September 2007 to January 2008
[Multiply these figures by 0.4 to get an approximation of annual projected output in kWh



http://www.warwickwindtrials.org.uk/resources/Microwind+-+a+catalyst+for+change+in+UK+energy+culture.pdf

Ensuring good wind installations is key to having higher public acceptance of the technology.

- Towers that are tall enough-the bottom sweep of the blade tip being at least 30 feet above the tallest obstacle within 500' of tower.
- Turbines that are high quality and have proven track record.
- Avoiding roof-mounted and vertical axis machines that look like they are generating power when they are NOT.

Case Studies

- Cape Cod Regional Technical School
  - 1.5 kW
- Upper Cape Tech
  - 10 kW

Cape Cod Regional Technical School

African Windpower AWP 3.6 Turbine (installed June 2005)

- 1.5 kW capacity
- ~250-350 kWh/month

  (about half of an average household's demand)

127 foot, tilt-up, guy-wired tower

SMA WindyBoy Inverter

Installed as an educational tool

(It's a demonstration of small wind energy technology, not necessarily an example of what to do)

Upper Cape Tech

Aircon 10 turbine

- 10 kW capacity
- ~1250-1750 kWh/month

  (2½ - 3 times an average household's demand)

Freestanding, tubular, counterbalancing tower

Controller from manufacturer.

	Cape Tech	UCT
Design & Permitting	$1,500	$1,500
Turbine	$3,350	$36,000
Tower	$8,550	$20,000
Installation	$10,000	$13,000
Installed Cost	$22,400	$70,000
Rebate from MTC*	$5,825	$50,000
Cost to School	$16,575	$20,000
Expected Output	300 kWh/m	1500 kWh/m
Savings/year@22¢/kWh	$792	$3,960
Simple Payback	21 years	5 years

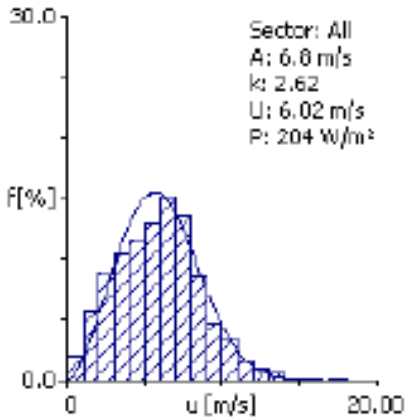
*** Rebate structure improved from Cape Tech to UCT example; rebate will be different for other applications, and additional incentives may be available.**
--All prices are provided for example only – actual prices may vary--

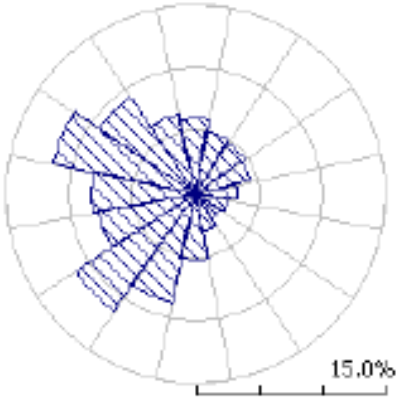
Why Consider Appropriately Sized On-Site Wind?

- Offsets more expensive retail power rates
- Short payback, good long term investment
- Environmental benefits
- Local economic development
- Provides local grid stability
- Energy security

Analysis Results

	100kW	600kW
Annual Energy Production	180,000kWh	1,000,000kWh
Installed Cost After Incentive	$240,000	$1,100,000
Internal Rate of Return	13-14%	15-17%
Payback Period	7-9 Years	6-8 Years
Lifetime Savings	$700,000	$4,000,000





Analysis courtesy of SED

To install a meterological tower or not…

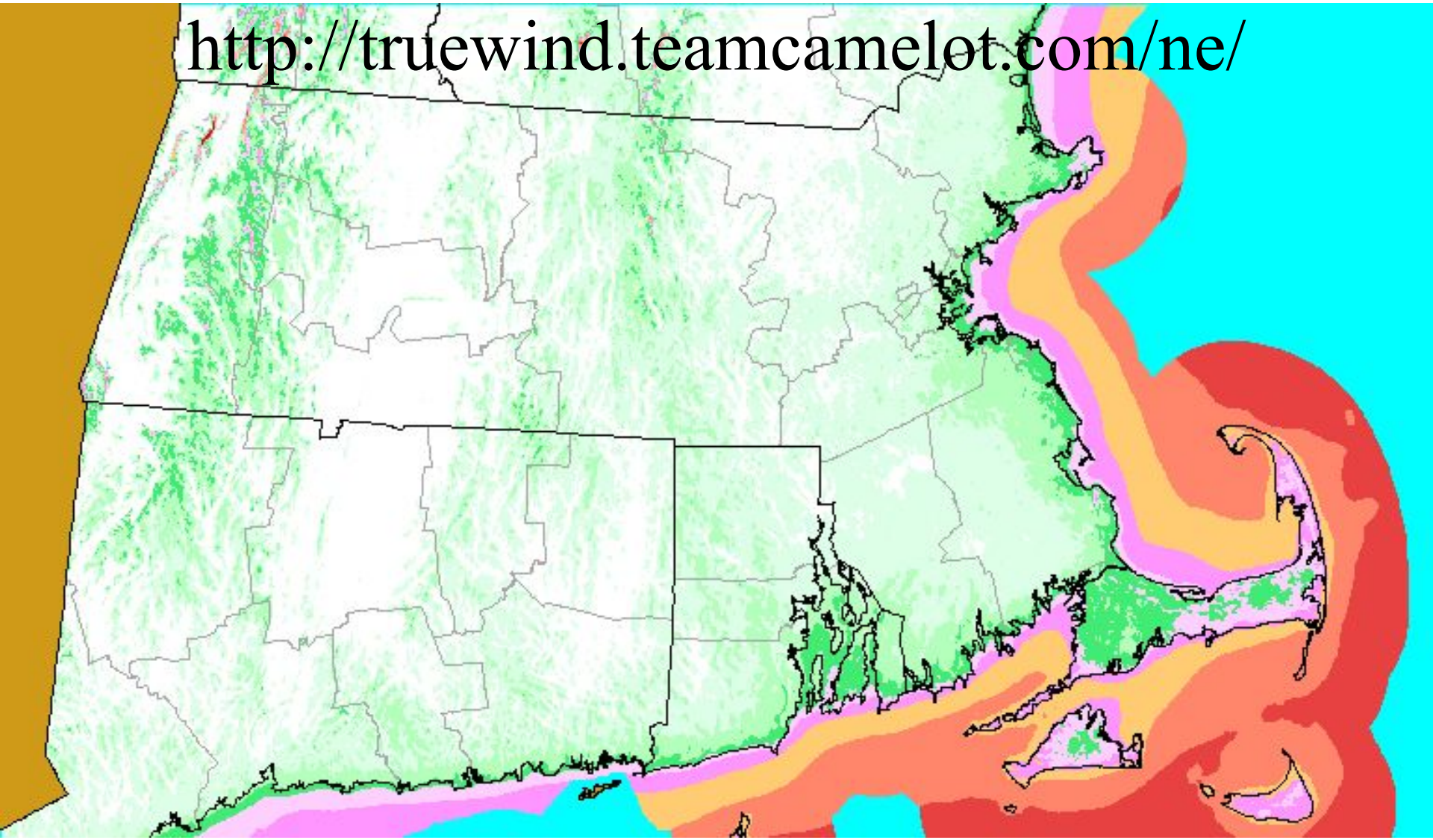
- Cost prohibitive for small installations.
- On-line wind maps are good for determining if there is sufficient wind and at what height.
- Using other local wind data can work too for making projections on the resource.
- This approach can be used for larger on-site installations.

- Installation of a guyed monopole met tower.
- Now available in heights up to 60 meters, with an installed cost and data acquisition for 2 years in the range of $23k.
- Many states off a met tower loan program.

Guyed lattice towers are available in heights up to 100 meters.
More expensive than the guyed tower.

Online Wind Map of New England

http://truewind.teamcamelot.com/ne/



Get Data on Specific Location

Wind Data - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://truewind.teamcamelot.com/bin/TrueWind.dll?DetailSheet?Area=NE&X=350&Y=4600&Z=50&Map=?492,431

Connecticut Clean Energy Fund | Northeast Utilities Systems | MASSACHUSETTS TECHNOLOGY COLLABORATIVE | View Wind Rose

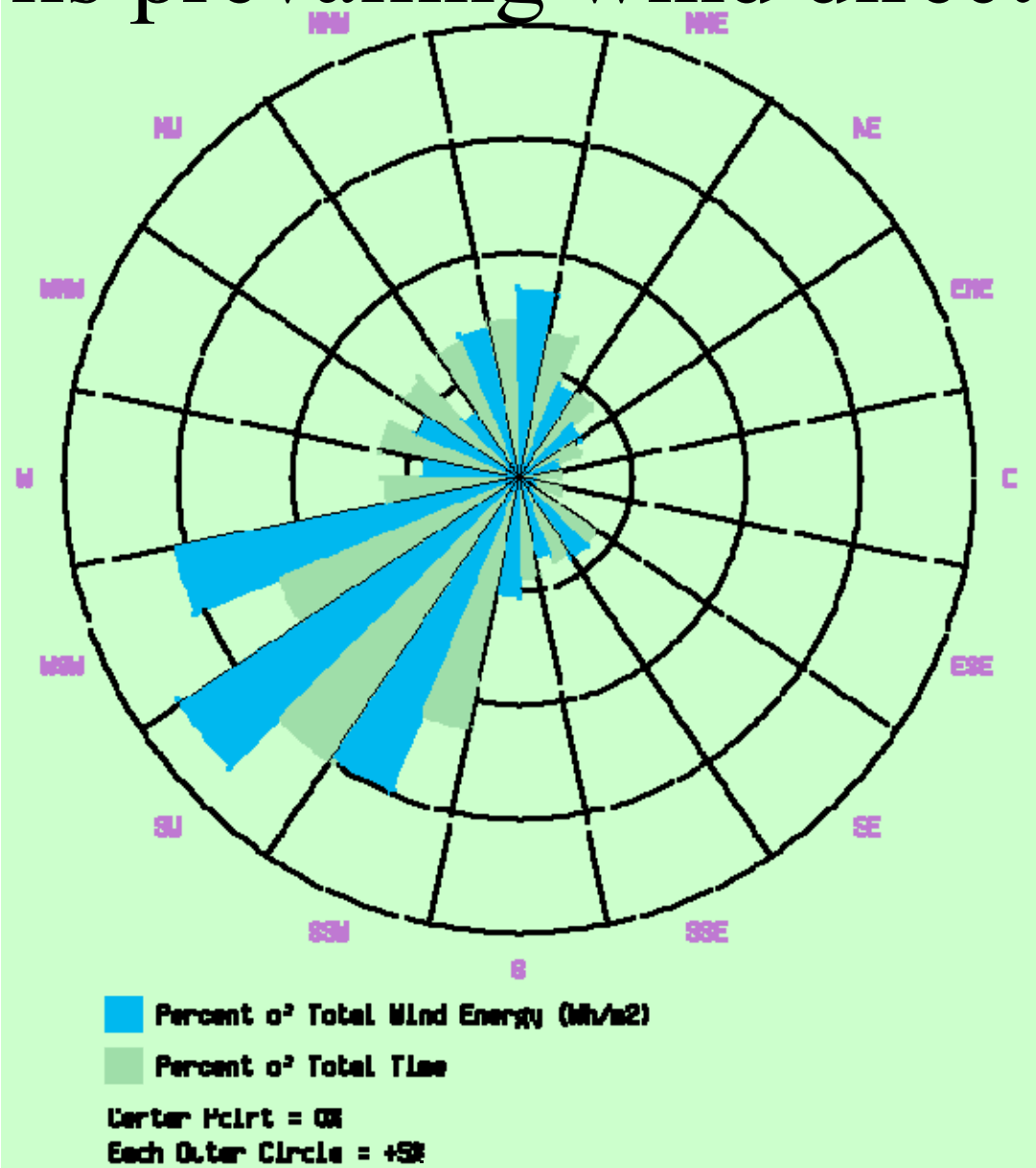
Data Sheet:						
Latitude:	41:41:24	Longitude:	-70:20:24	Elevation:	30m.	(98) ft.
decimal:	41.69	decimal:	-70.34	Roughness:	0.01m.	
UTM Coordinates: 388500 x 4616500						

Wind by Time and Height

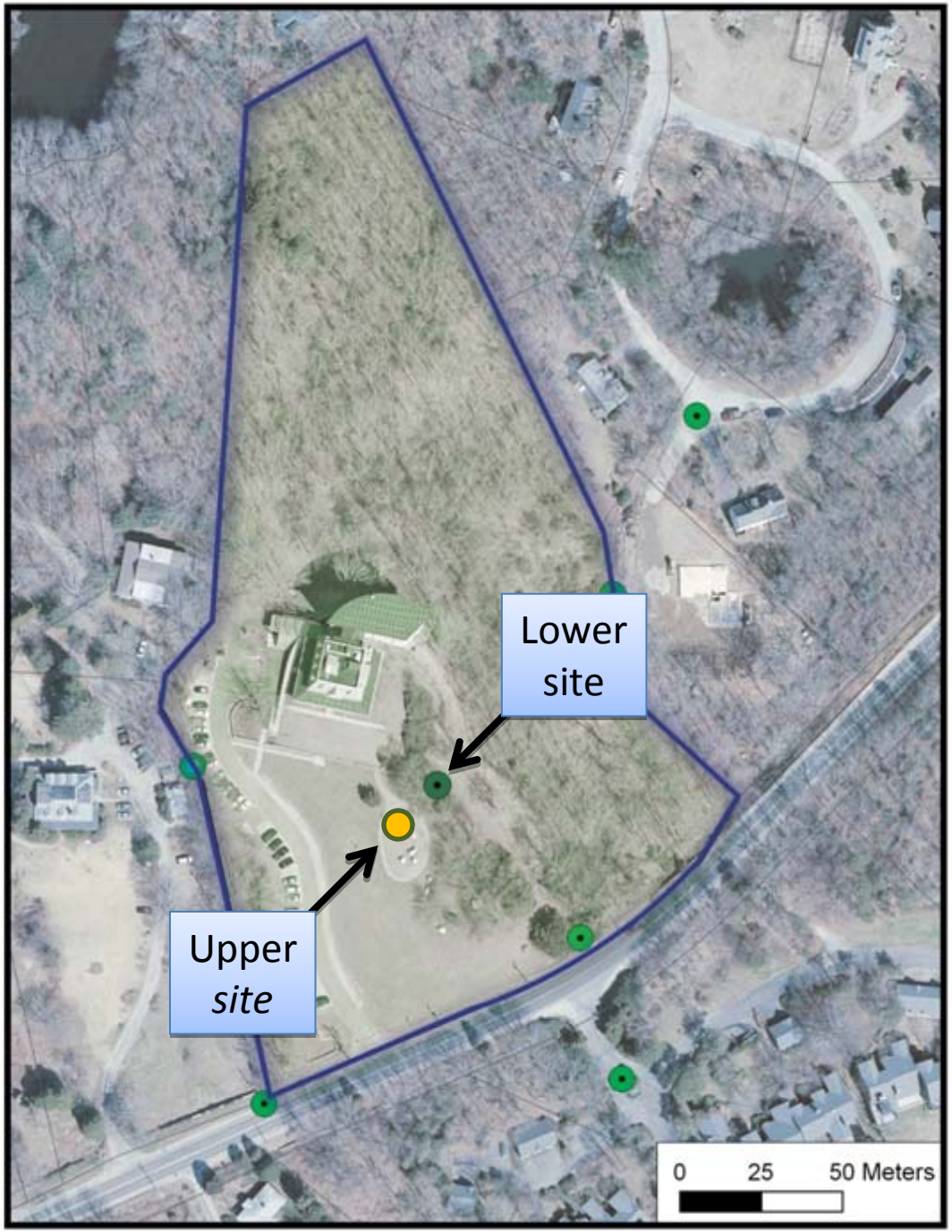
	Avg. Wind Speed (m/s)	Avg. Wind Power Density (W/m2)	Weibull Parameters	
			c	k
30m Annual	5.8			
50m Annual	6.4	307	7.4	2.13
70m Annual	6.9			
100m Annual	7.6			
50m Spring	6.9	343	7.8	2.62
50m Summer	5.4	153	6.1	2.39
50m Fall	6.2	278	7.2	2.25
50m Winter	7.4	454	8.2	1.95

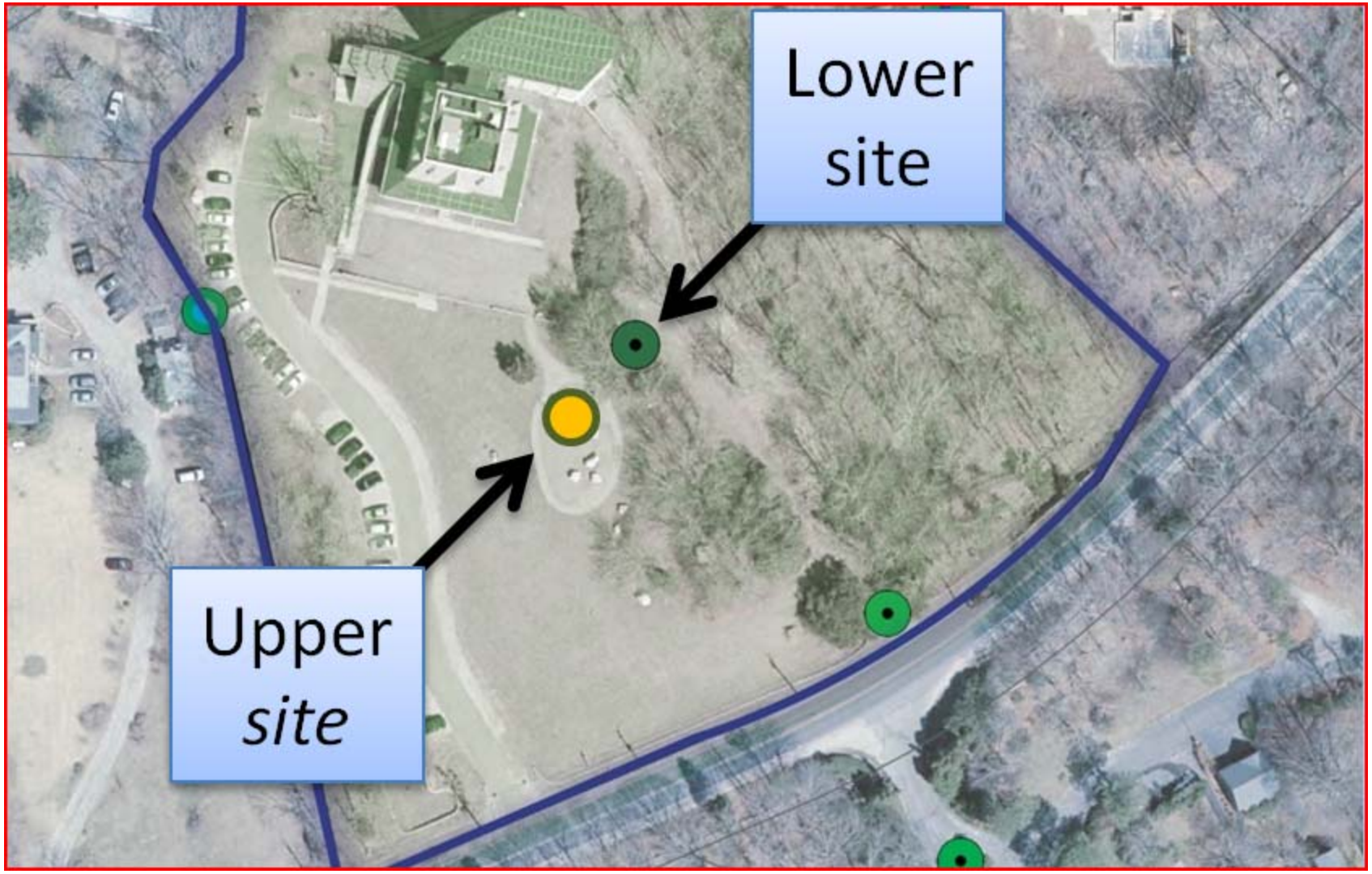
Internet

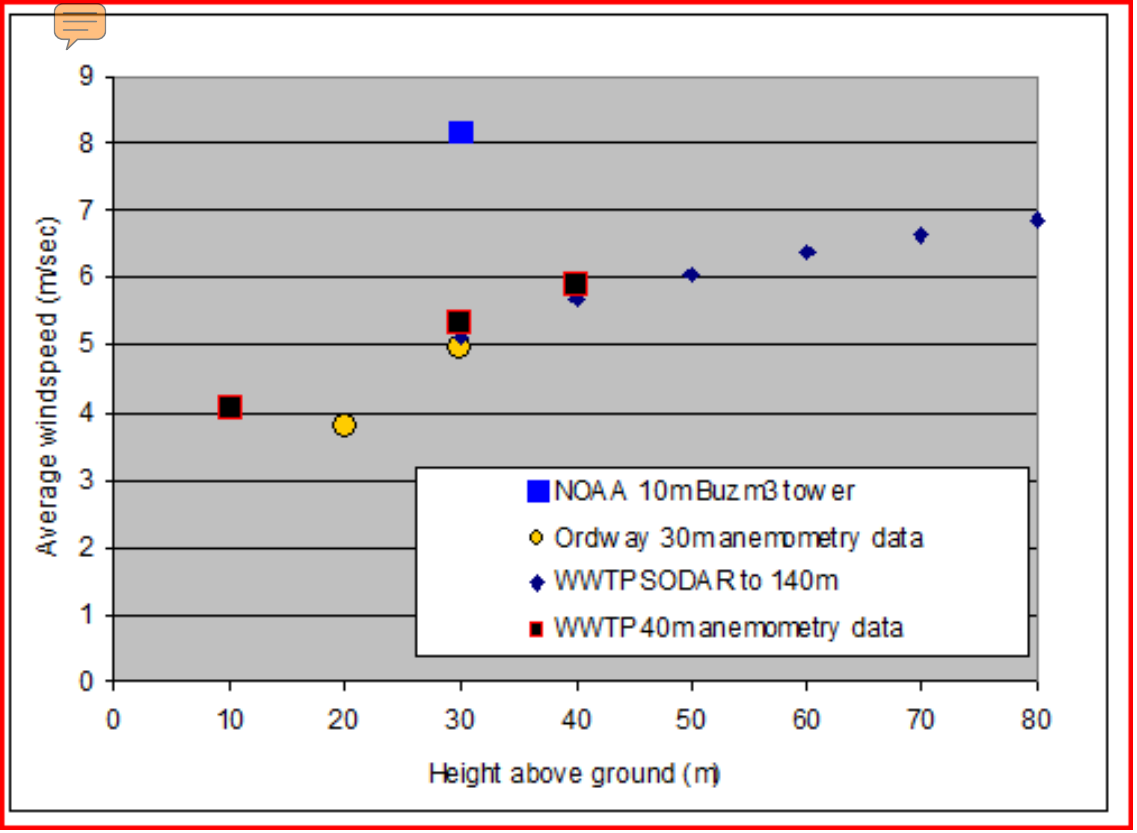
Wind Rose Diagram
Tells prevailing wind directions



The Woods Hole Research Center


Lower site
Upper *site*
0 25 50 Meters

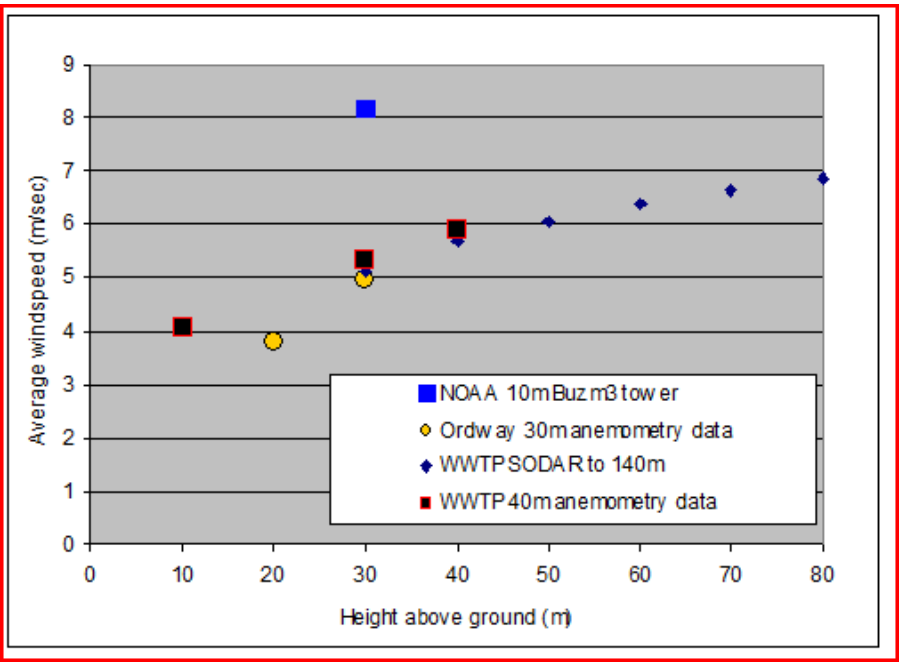

Lower
site
Upper
site

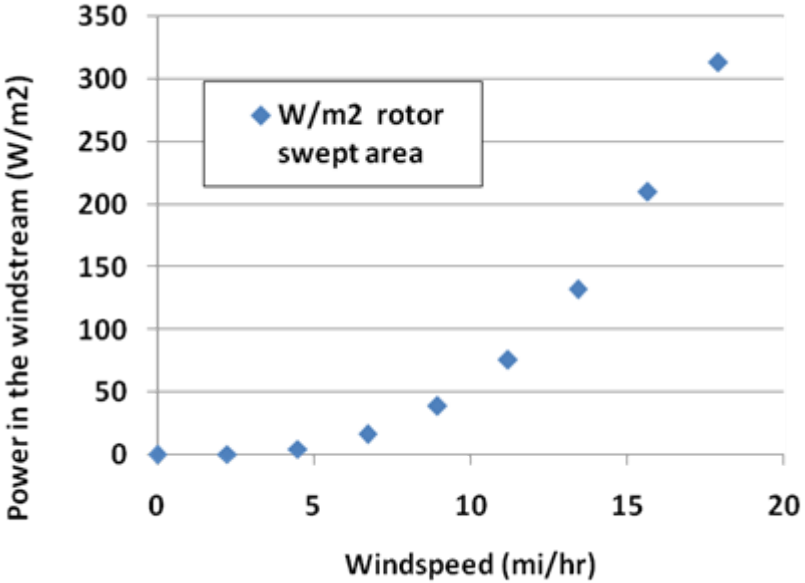


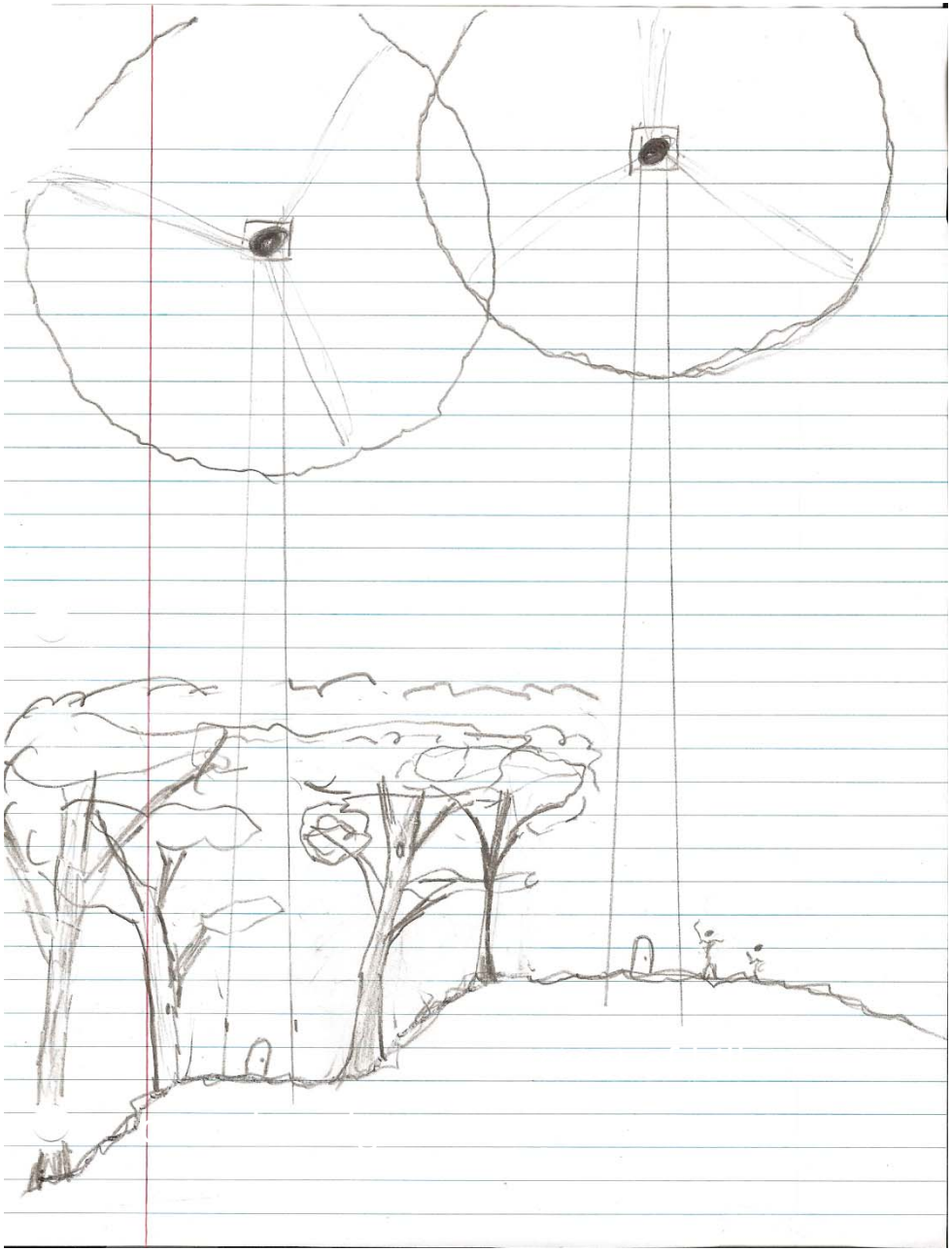
	Shear exponent	Resultant windspeed increase for additional 10m tower height
Ordway 20-30m	0.66	30.4%
WWTP anemometry 10-30m	0.25	7.6%
WWTP anemometry 30-40m	0.36	10.0%
WWTP SODAR 30-40m	0.39	11.8%

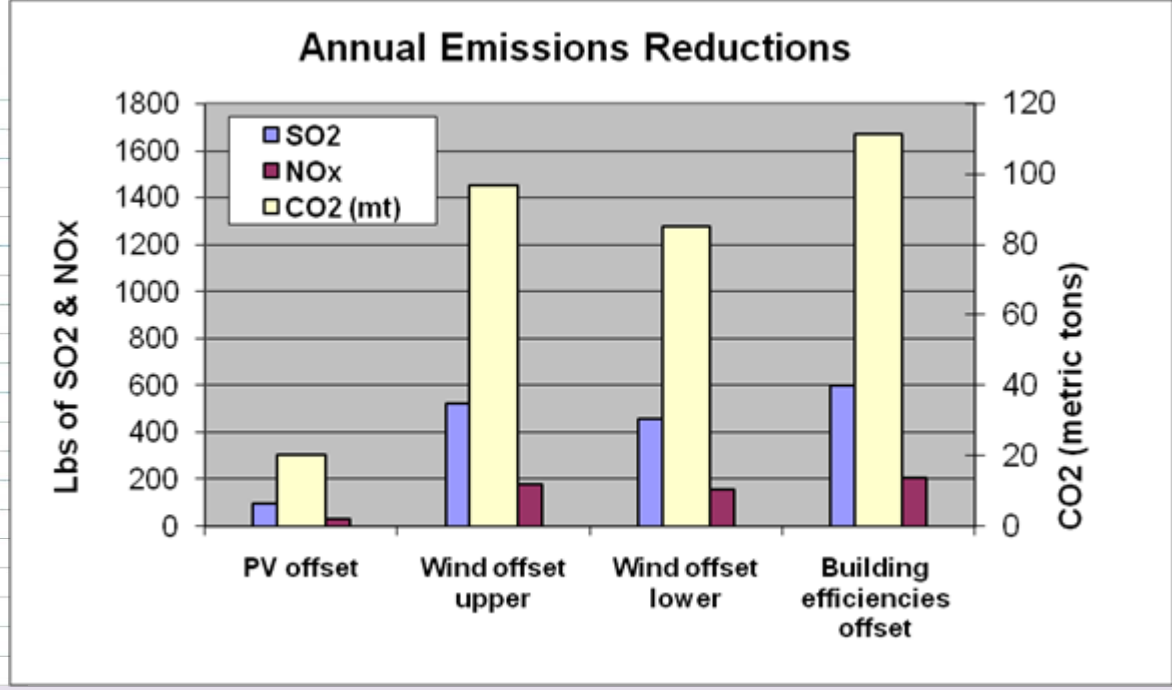
Shear exponent = ln(V2/V1)/ln(H2/H1)

% increase with height: $(V2/V1) = (H2/H1)^{\text{shearexponent}}$


Average windspeed (m/sec)
Height above ground (m)
NOAA 10m Buzm3 tower
Ordway 30m anemometry data
WWTP SODAR to 140m
WWTP 40m anemometry data


Power in the windstream (W/m2)
Windspeed (mi/hr)
W/m2 rotor swept area





	Over the edge	Crest of Hill	PV
Power Production kWh/hr	$ 140,000	$ 160,000	30,410
Initial Cost	550,000	500,000	$ 225,000
Capacity Factor	16.0%	18.3%	13.1%
Avoided CO2 emissions (mt C)	85	97	18
Years to positive cash flow	14	11	19
Power Cost ($/kWh {simple 20yr})	$0.20	$0.16	$ 0.37
Shadow flicker	less flicker effect	flicker will occur on front of building during on sunny winter mornings	
Additional overhead (thos. replies)	"Why didn't-ya just put it on the top of the hill?"		

Carpe Ventem!

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Crop of the 21ST Century

U.S. Department of Energy
Wind Energy Program
http://www.eren.doe.gov/wind/

Photo provided by Clean Water Action Alliance

WIND POWERING AMERICA

http://www.eren.doe.gov/windpoweringamerica/