Native Village of Eyak Wind Energy Feasibility Study

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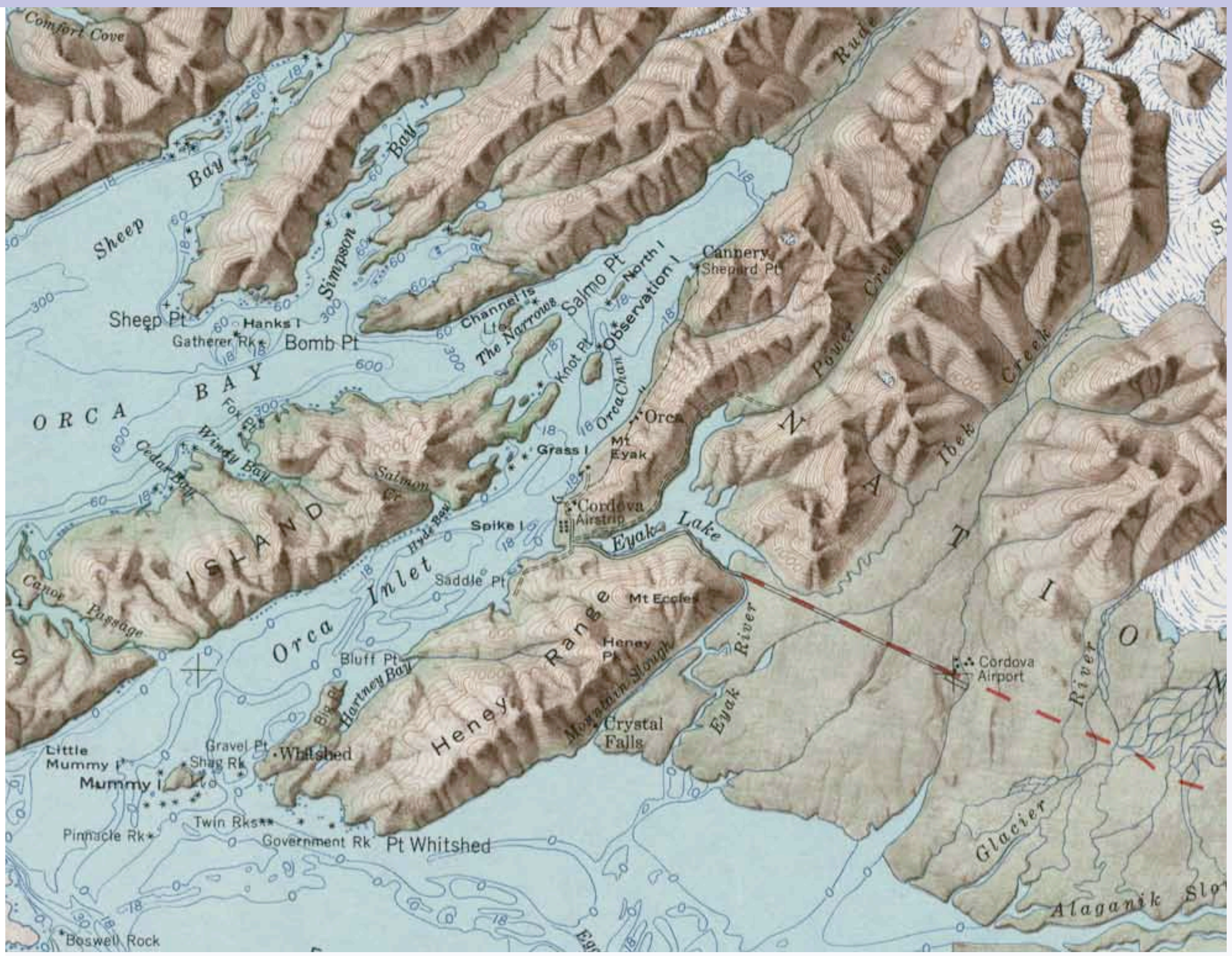
Alternative Energy Coordinator

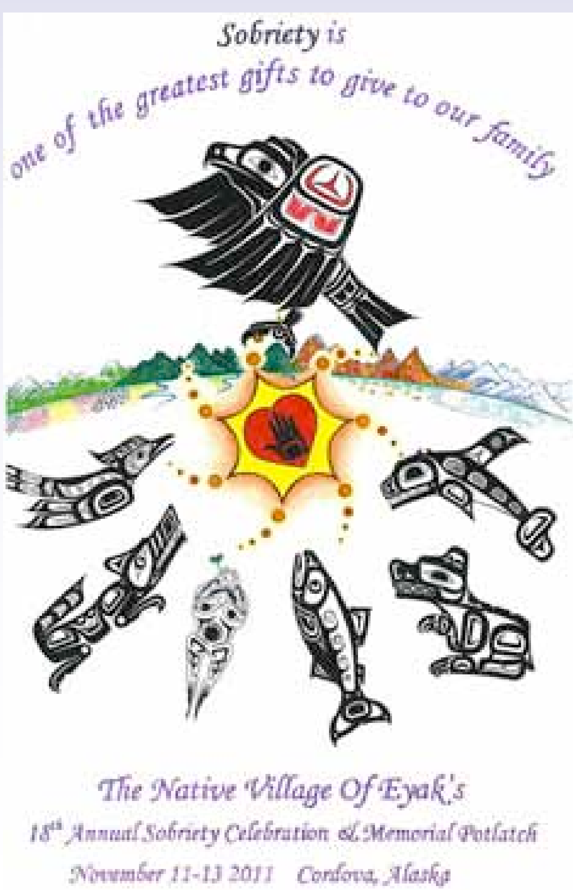
Native Village of Eyak

- Federally Recognized Tribe in Cordova, AK
- Governed by a five-member tribal council
- Provides health and social services, economic development, job training and environmental and resource management
- 525 Tribal members

Location of Project



Native Village of Eyak

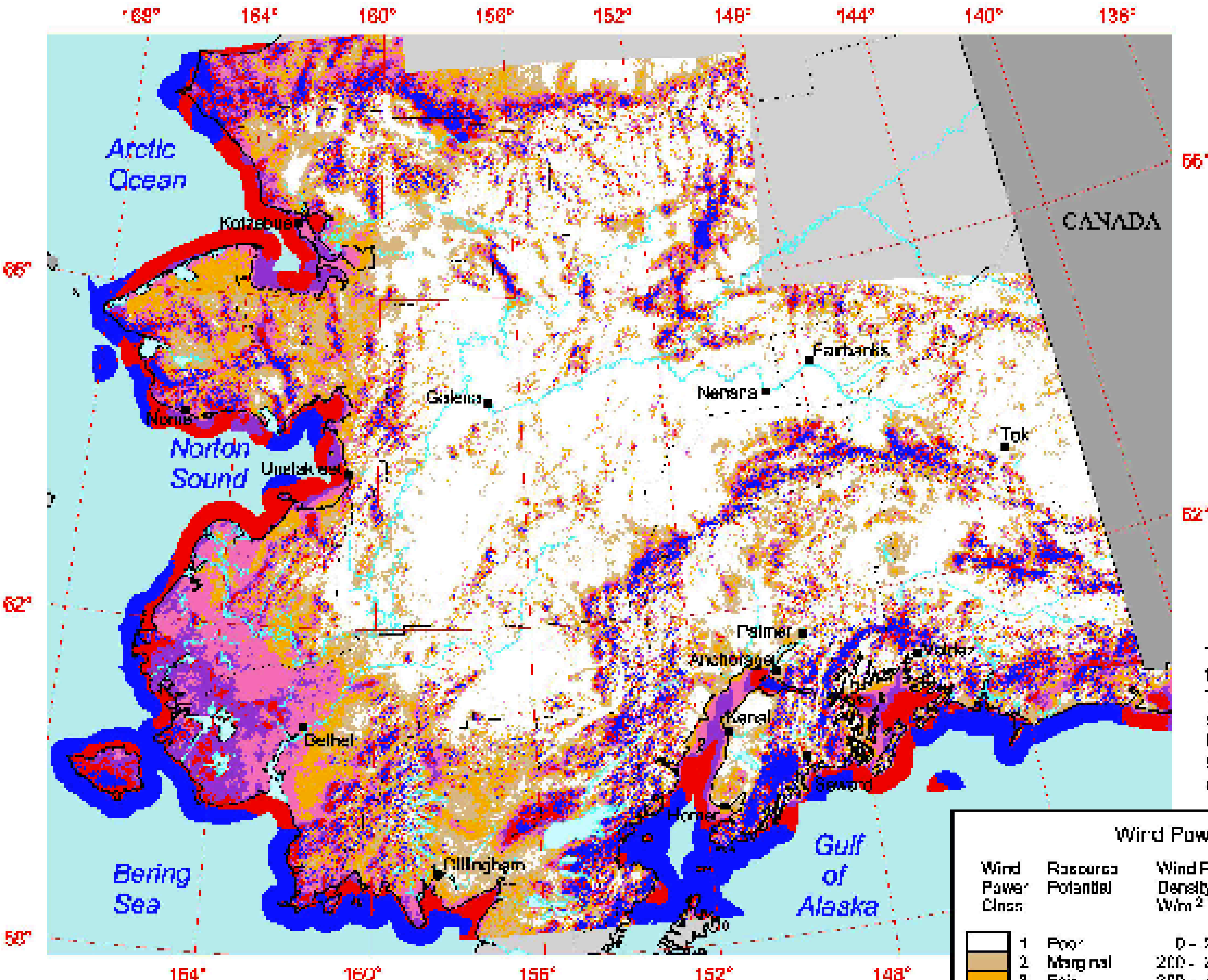




Why Wind Power?

- Reduces petroleum use
- Reduces carbon footprint
- Cost can be competitive with diesel generator production
- When used with storage medium it can greatly reduce diesel generator use and improve grid reliability

Alaska Mainland Regions 50 m Wind Power



The annual wind power estimates for this map were produced by AWS Truewind using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

Wind Power Classification

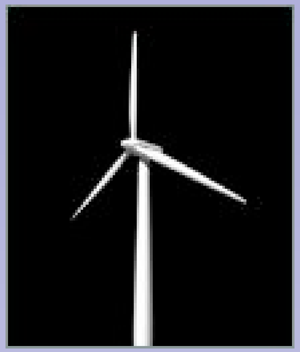
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m ^{2}	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
1	Poor	0 - 200	0.0 - 5.3	0.0 - 11.9
2	Marginal	200 - 300	5.3 - 6.1	11.9 - 13.7
3	Fair	300 - 400	6.1 - 6.7	13.7 - 15.0
4	Good	400 - 500	6.7 - 7.3	15.0 - 16.4
5	Excellent	500 - 600	7.3 - 7.7	16.4 - 17.2
6	Outstanding	600 - 800	7.7 - 8.5	17.2 - 19.0
7	Superb	> 800	> 8.5	> 19.0

[a] Wind speeds are based on a Weibull k of 1.8. Weibull k values in Alaska vary from 1.4 to 2.0

NREL

U.S. Department of Energy
National Renewable Energy Laboratory

100 0 100 200 300 400 Kilometers
50 0 50 100 150 200 250 Miles

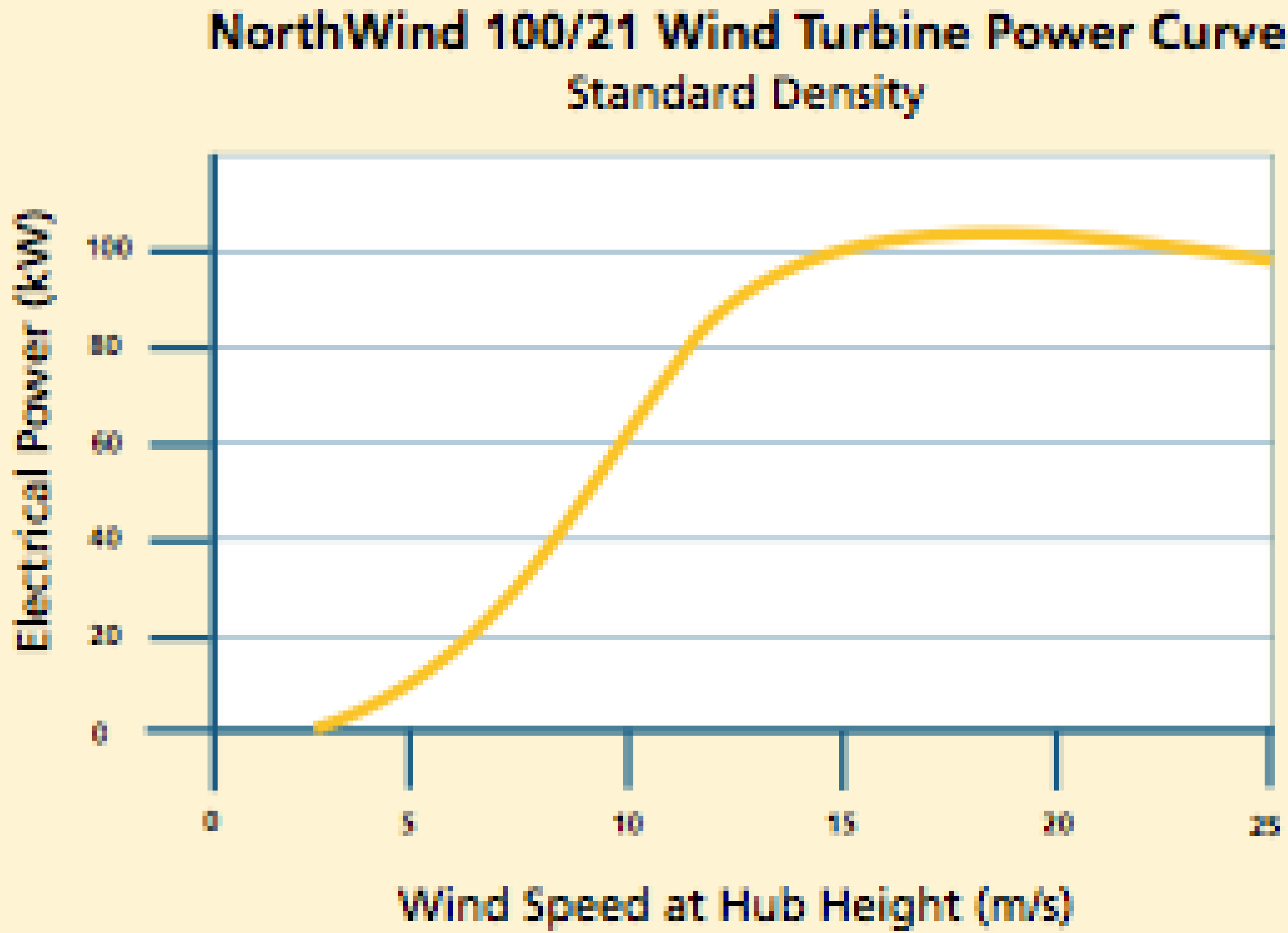


Power From The Wind

$$P = \frac{1}{2} C_p A_s \rho \mathbf{v}^{\mathbf{3}}$$

C_p = Coefficient of Performance

A_s = The swept area of wind turbine blades



NorthWind 100/21 Wind Turbine Power Curve
Standard Density
Electrical Power (kW)
100
80
60
40
20
0
0
5
10
15
20
25
Wind Speed at Hub Height (m/s)

So Which is Better

1. A location where the wind blows only 50% of the time at 10m/s but is calm the rest of the time
2. A location where the wind blows all of the time at 5m/s

Both have exactly the same annual mean wind speed

$$P = \frac{1}{2} C_p A_s \rho \mathbf{v^3}$$

Make The Calculation

$$AEP = \text{Expected Power} \times \text{Availability} \times \text{Time}$$

Case 1: 10m/s 50% of the time

$$AEP = 60kW \times (8760 \times 0.5)$$

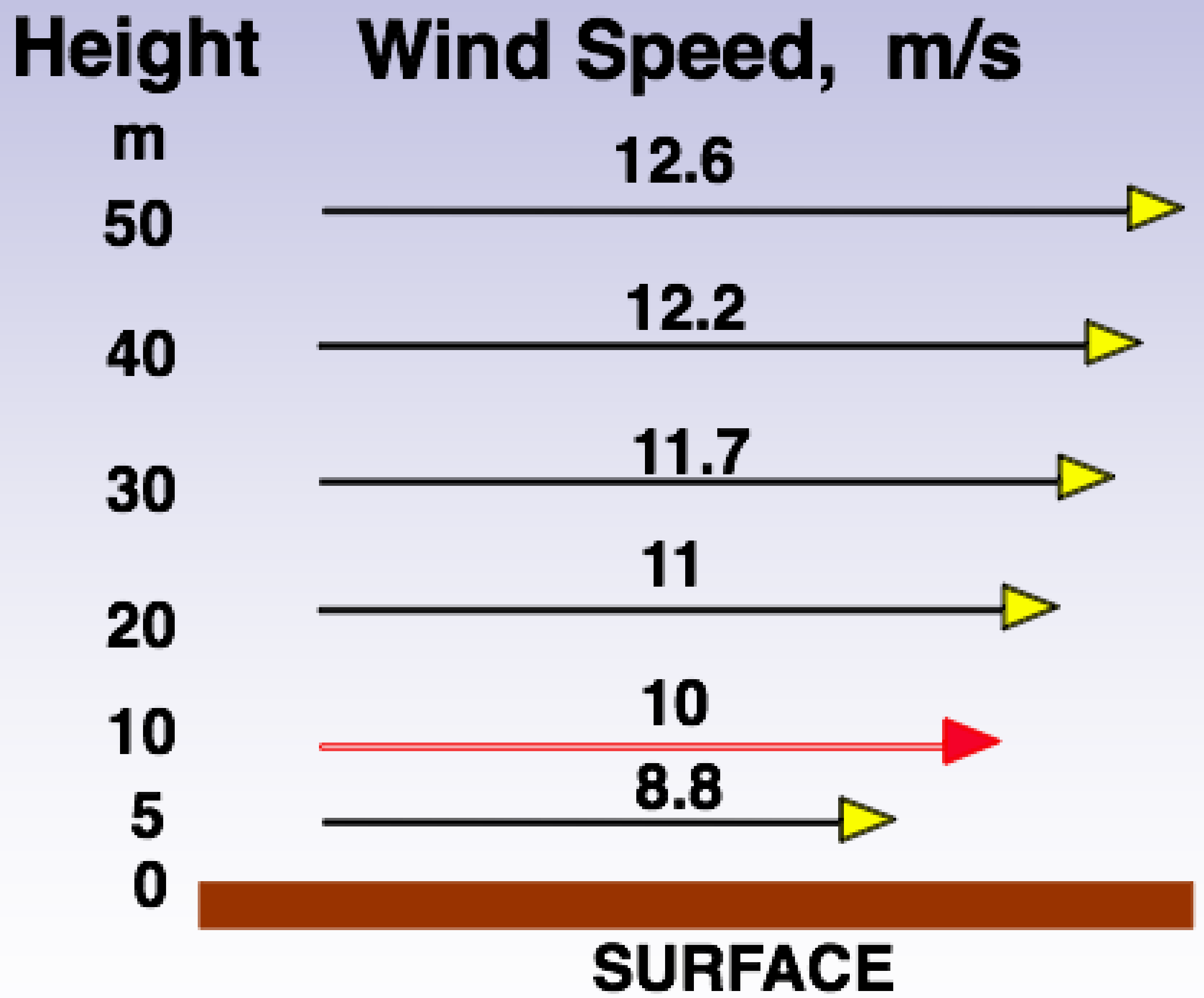
$$= \mathbf{262{,}800}\ \text{kWh/year}$$

Case 2: 5m/s all of the time

$$AEP = 10 \times (8760 \times 1)$$

$$= 87{,}600\ \text{kWh/year}$$

Wind Shear



The type of surface (grass, trees)

Slope of surface (flat, hilltop)

Current Energy Generation

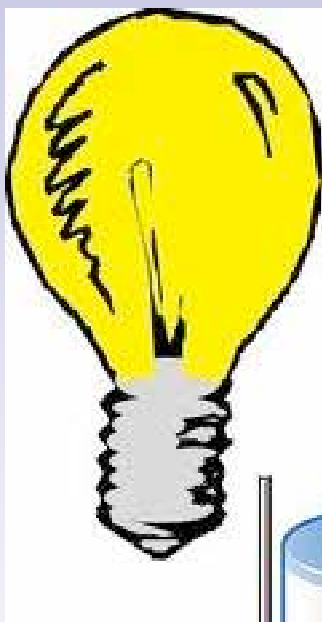
Hydro Electric Power

- 2 run of river facilities (5 turbines)
- ~7.5 MW of capacity

Diesel Generator

- 4 diesel generator units
- 7.1 MW of capacity

Current Energy Use



Peak Load

- 7500 kW

Average Load

- 3500 kW (summer)
- 2000 kW (Oct-Apr)

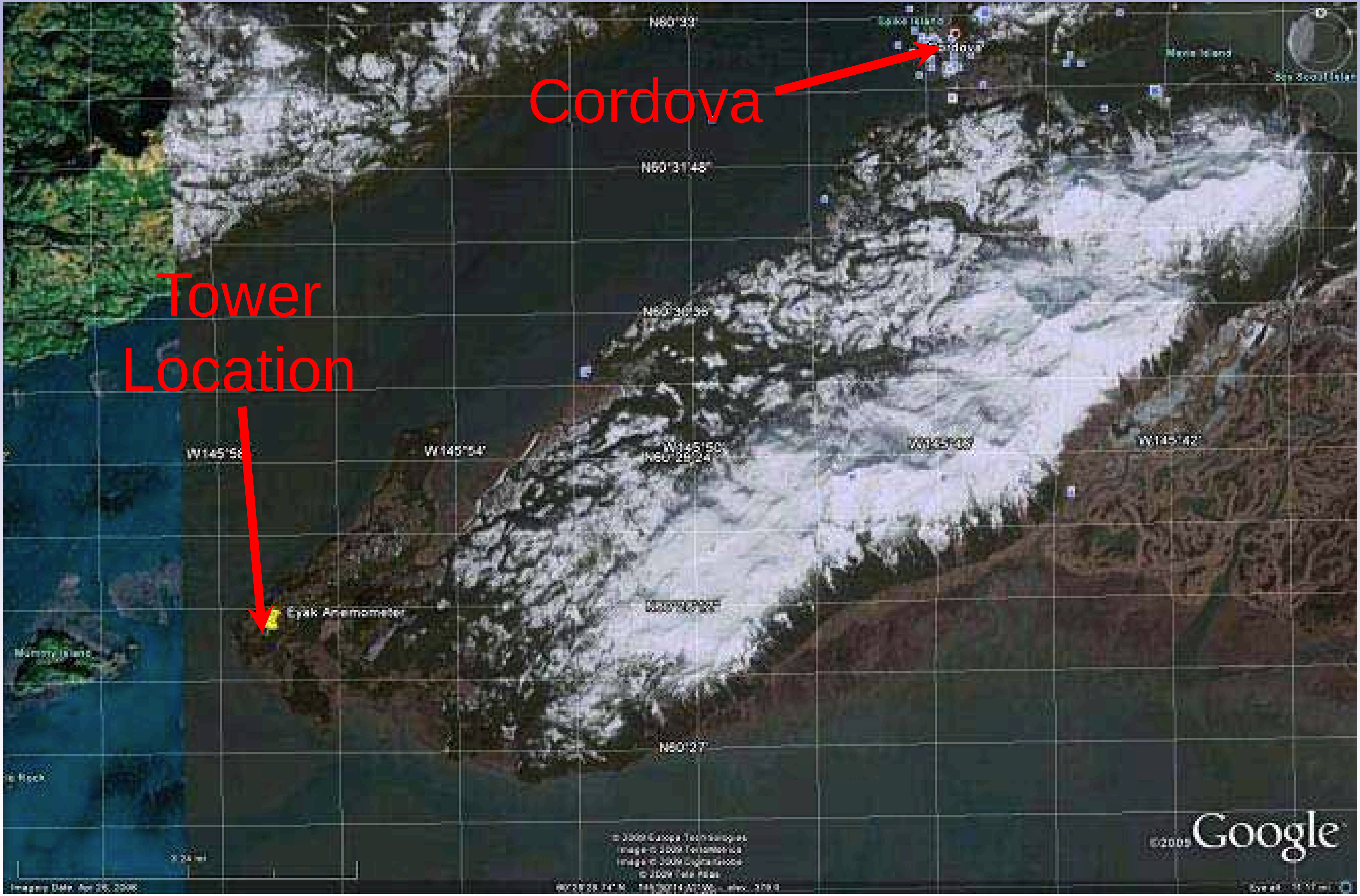
Minimum Load

- 1400 kW

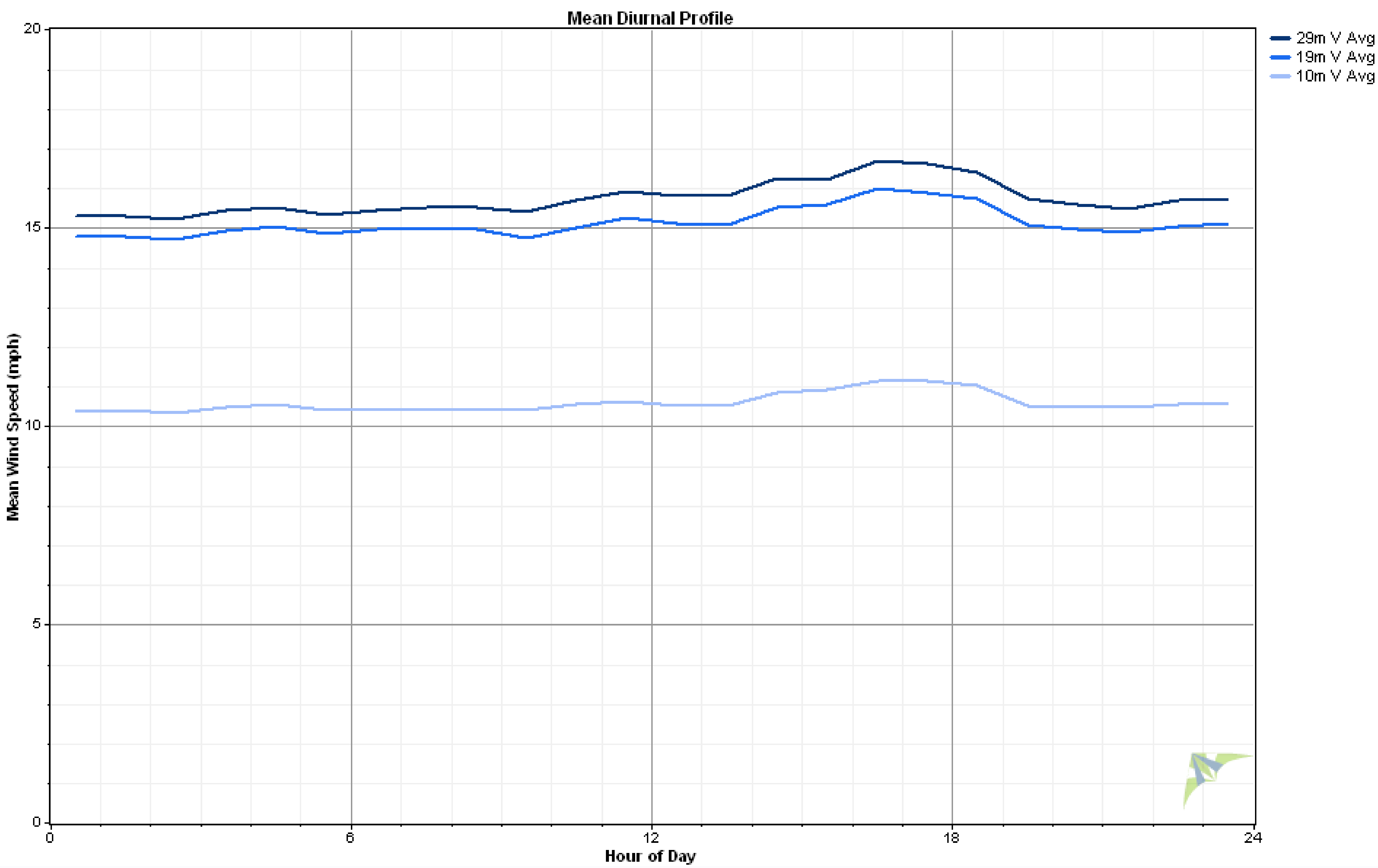
Diesel Use: ~900,000 gallons/yr

NREL Study

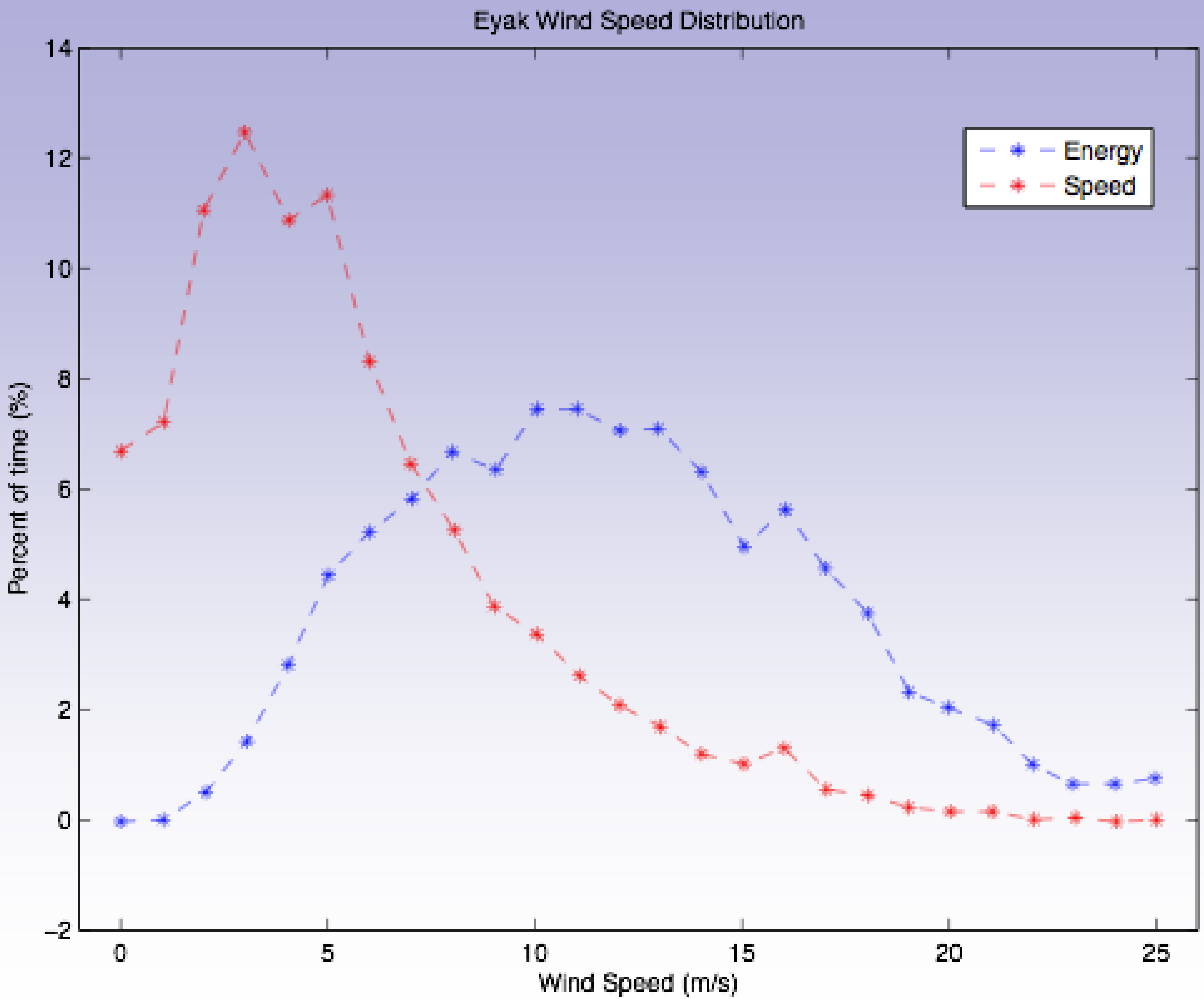
- DOE Tribal loan program
- 30m tower erected at Point Whitshed
- Data collected for 18 months
- Reviewed by NREL analyst
- Class 4 wind resource



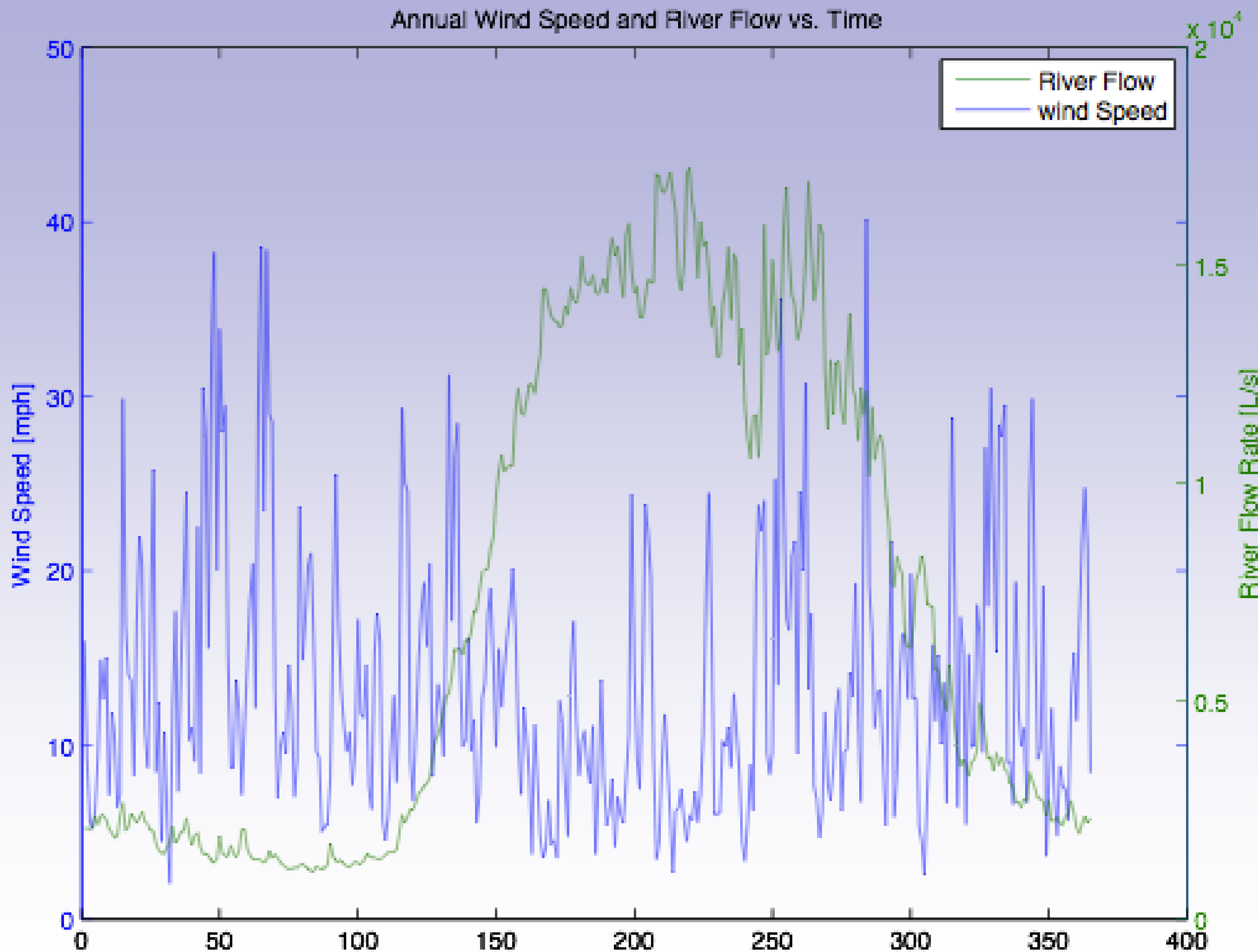
Cordova
Tower Location
Eyak Anemometer
N60°33'
N60°31'48"
W145°58'
W145°54'
W145°42'
N60°27'
Mummy Island
©2009 Google



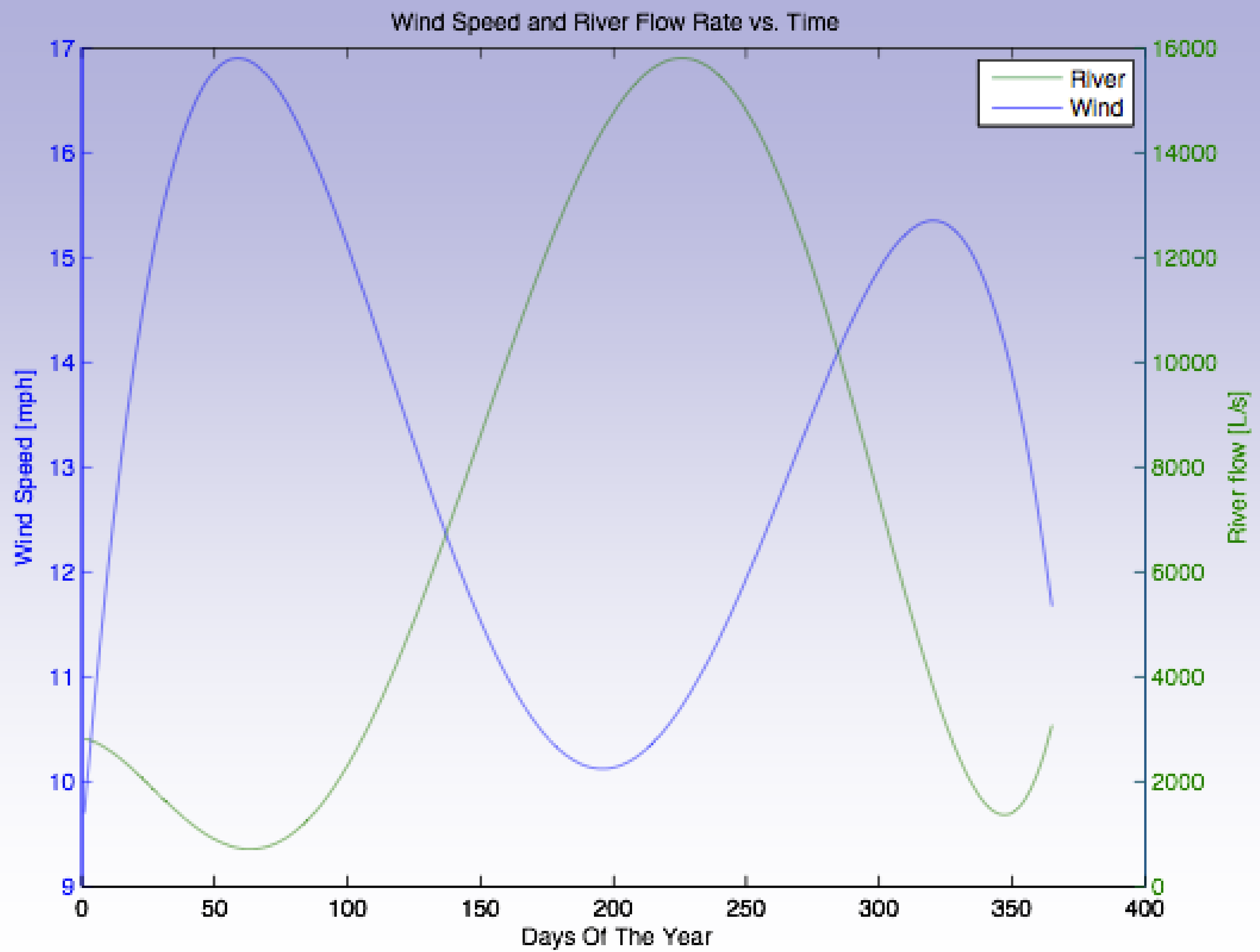
Mean Diurnal Profile
29m V Avg
19m V Avg
10m V Avg
Mean Wind Speed (mph)
20
15
10
5
0
0
6
12
18
24
Hour of Day



Eyak Wind Speed Distribution
Energy
Speed
Percent of time (%)
Wind Speed (m/s)
14
12
10
8
6
4
2
0
−2
0
5
10
15
20
25



Annual Wind Speed and River Flow vs. Time
River Flow
wind Speed
Wind Speed [mph]
River Flow Rate [L/s]
x 10^4
0
10
20
30
40
50
0.5
1
1.5
2
0
50
100
150
200
250
300
350
400


Wind Speed and River Flow Rate vs. Time
River
Wind
Wind Speed [mph]
River flow [L/s]
Days Of The Year
17
16
15
14
13
12
11
10
9
0
50
100
150
200
250
300
350
400
16000
14000
12000
10000
8000
6000
4000
2000
0

Pt Whitshed Statistics

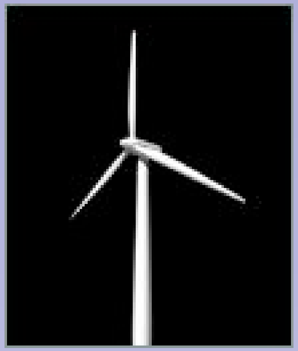
- Average wind speed at 29m: 13.1mph (5.9m/s)
- Average power density at 29m: 346W/m^2
- Estimated resource at 50m: 14mph, 410W/m^2
- Mean turbulence intensity: 0.18
- Capacity factor: 24%, 42% in winter
- Levelized cost of energy: ~$0.25/kWh

Site Analysis

- MET Towers Installation
- Data Analysis
- Avian Studies
- Environmental Assessment

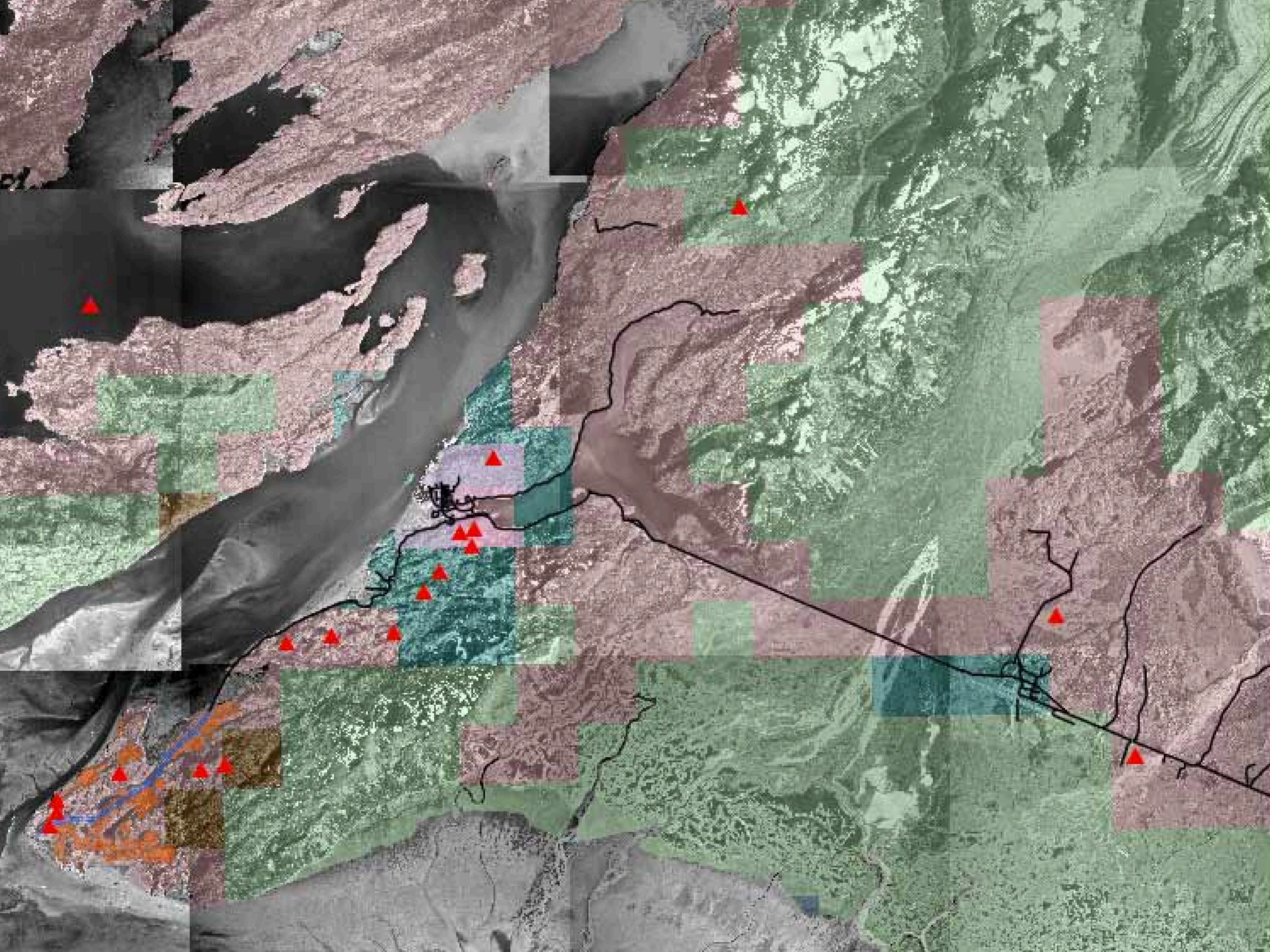
MET Towers

- 1 - 30 meter towers, 18 months of continuous data collection (returned to NREL 2010)
- 2 - 10 meter towers, placed on location at 4 month intervals (NVE owned)
- 1 – 60 meter tower, on loan from NREL to be installed on Copper River delta



Site Selection

- Soil analysis
- Transmission line access
- Road access: Crane, Turbine blades, tower sections
- Turbine model and quantity
- GIS Multi-Criteria Analysis



Avian Studies

- Spring 2011 migration studies of Point Whitshed and Reservoir were conducted from April 14 to May 24, 2011
- 781observations were tallied during 42 3-hour surveys – a total of 17,767 individuals
- Of those 781 observations:

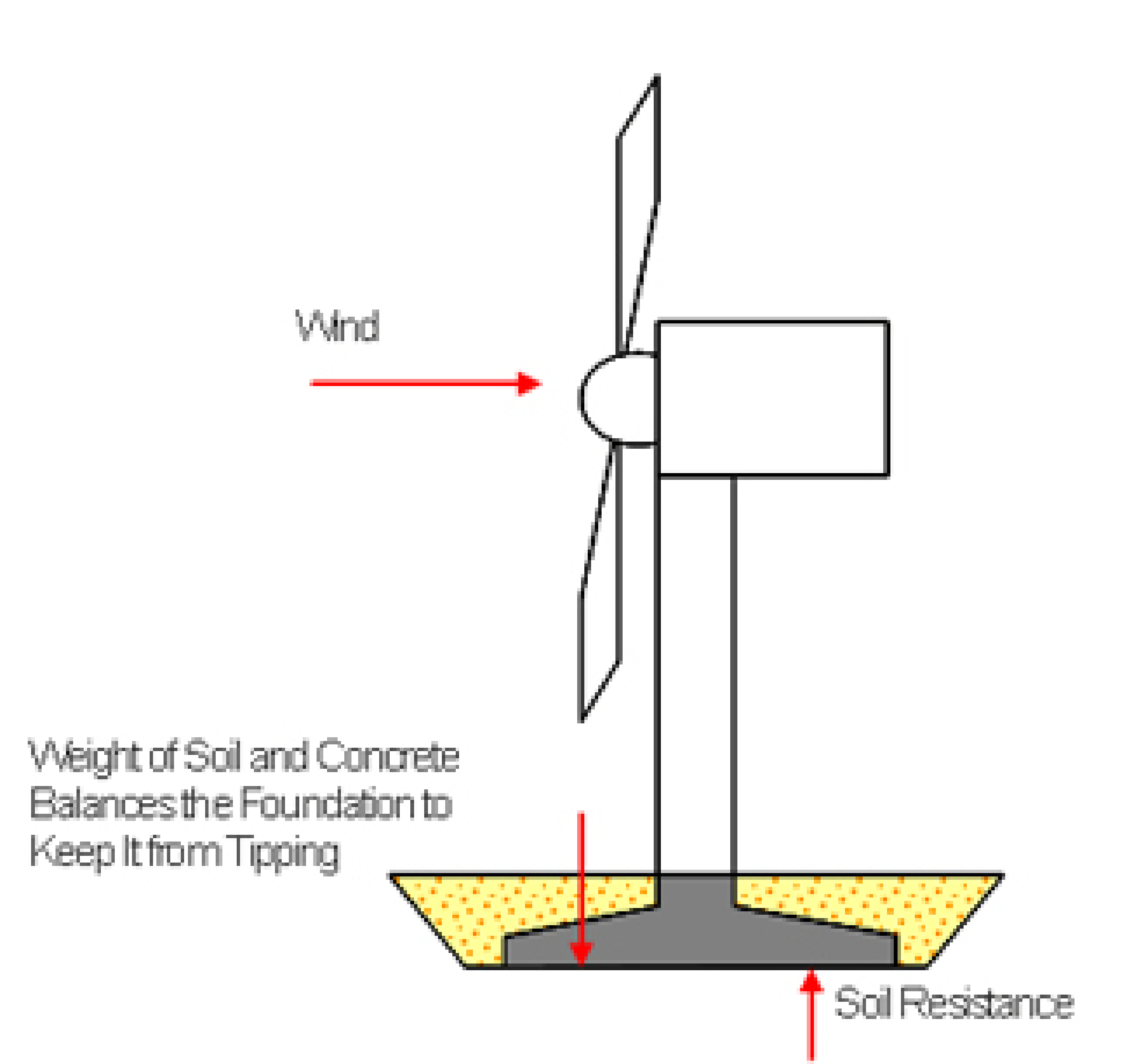
  203 (26%) – waterfowl

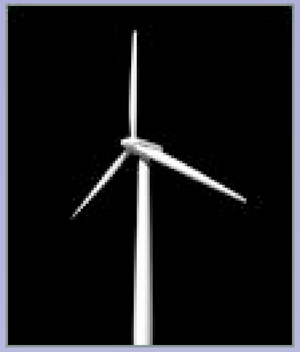
  20 (3%) – cranes

  94 (12%) – raptors

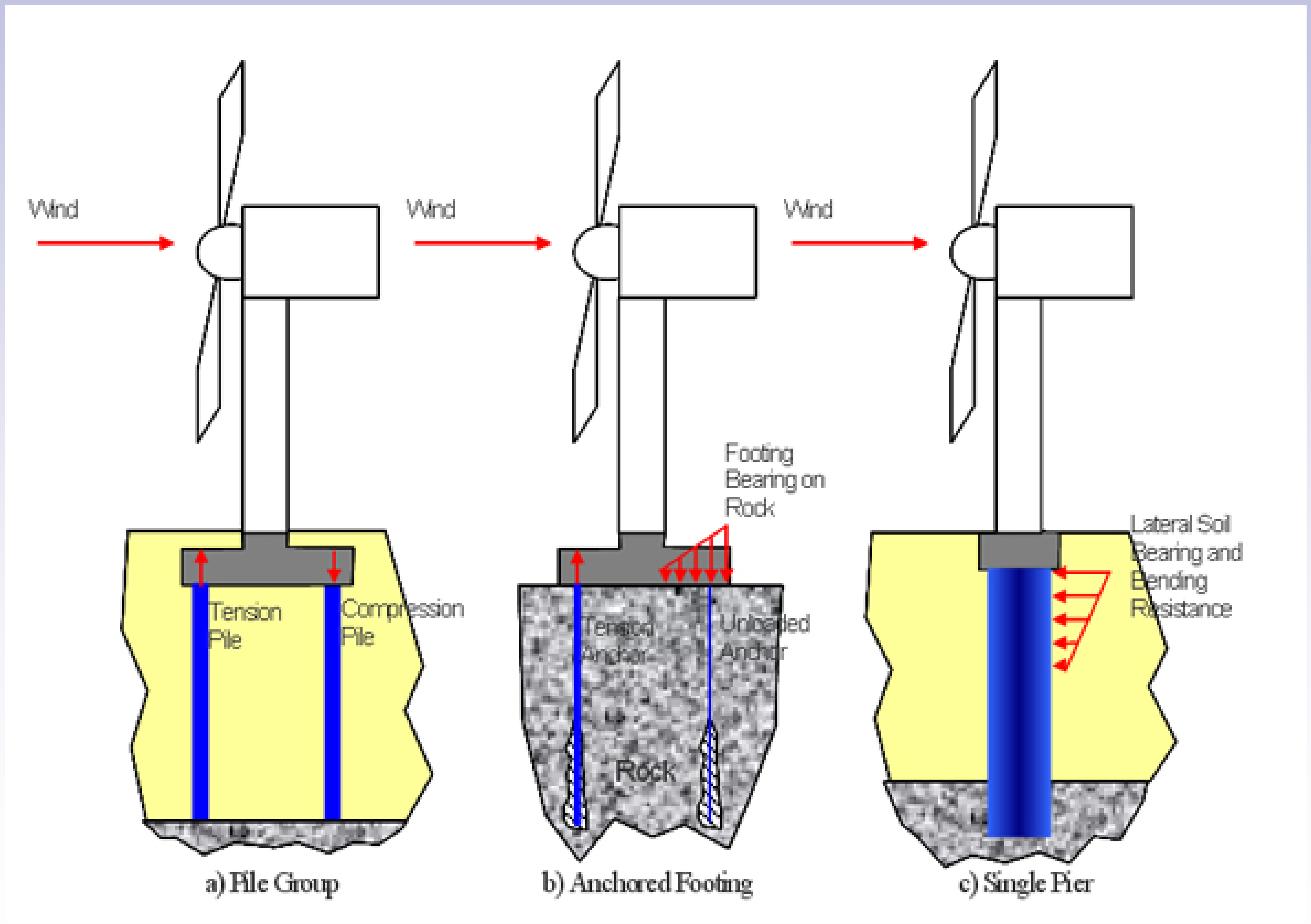
  464 (59%) – various species, primarily gulls (95%)

Soil Analysis





Soil Analysis



Transmission Access

- Current best site - No Transmission (submerged cable)
- Mile 14 : 1-2 miles needed

Road Access

- Weight Limits (80 ton crane for larger turbines)
- Current best site has no road
- Temporary road at Point Whitshed


OVERSIZE LOAD

Lessons Learned

- Understand your current energy profile and how wind can play a supporting role
- Conduct regular meetings and obtain community input often
- Use grant money efficiently in the short-term in order to have retain long-term usefulness
- Be realistic with your site selection
- Diversify specialty knowledge and training (factor in personnel turn around)

Thank You

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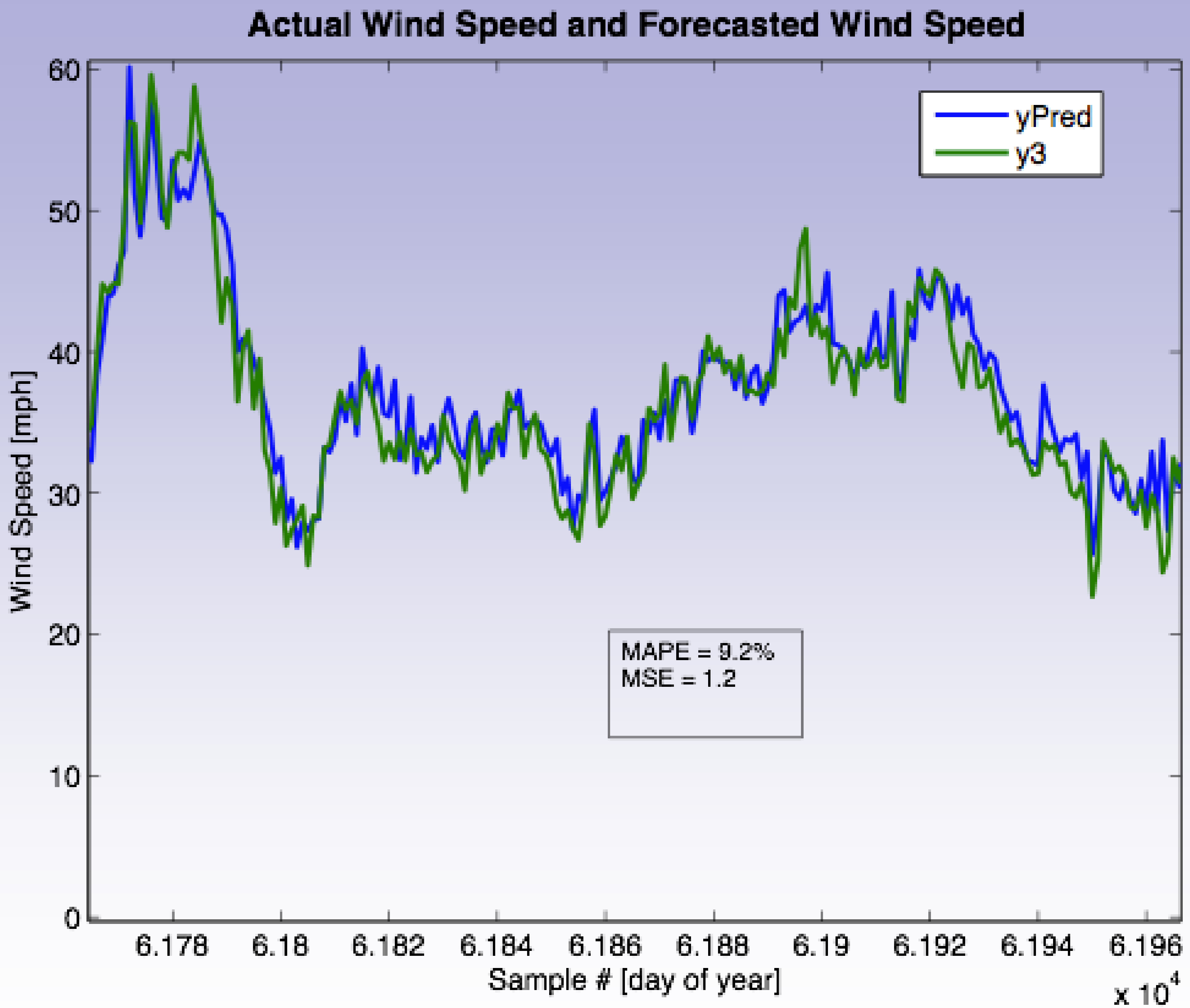


ANN

Temp

Insolation

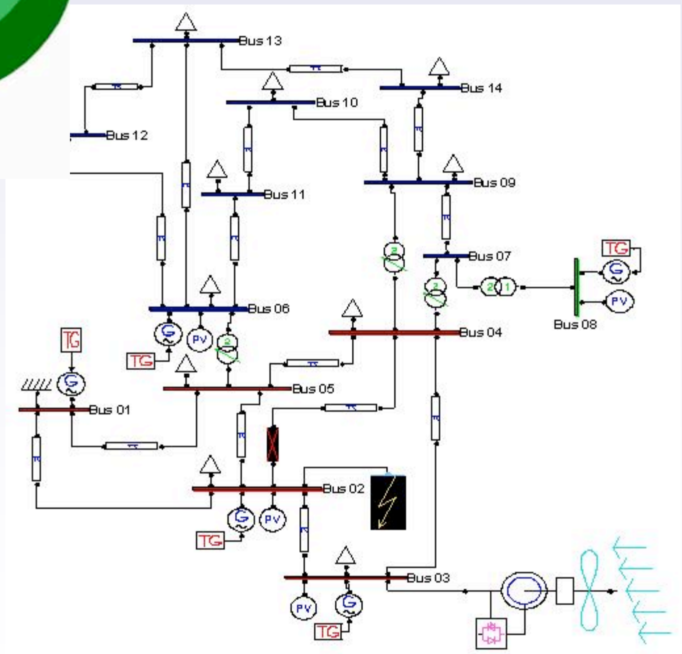
Vmax

Dir

Pres

Std

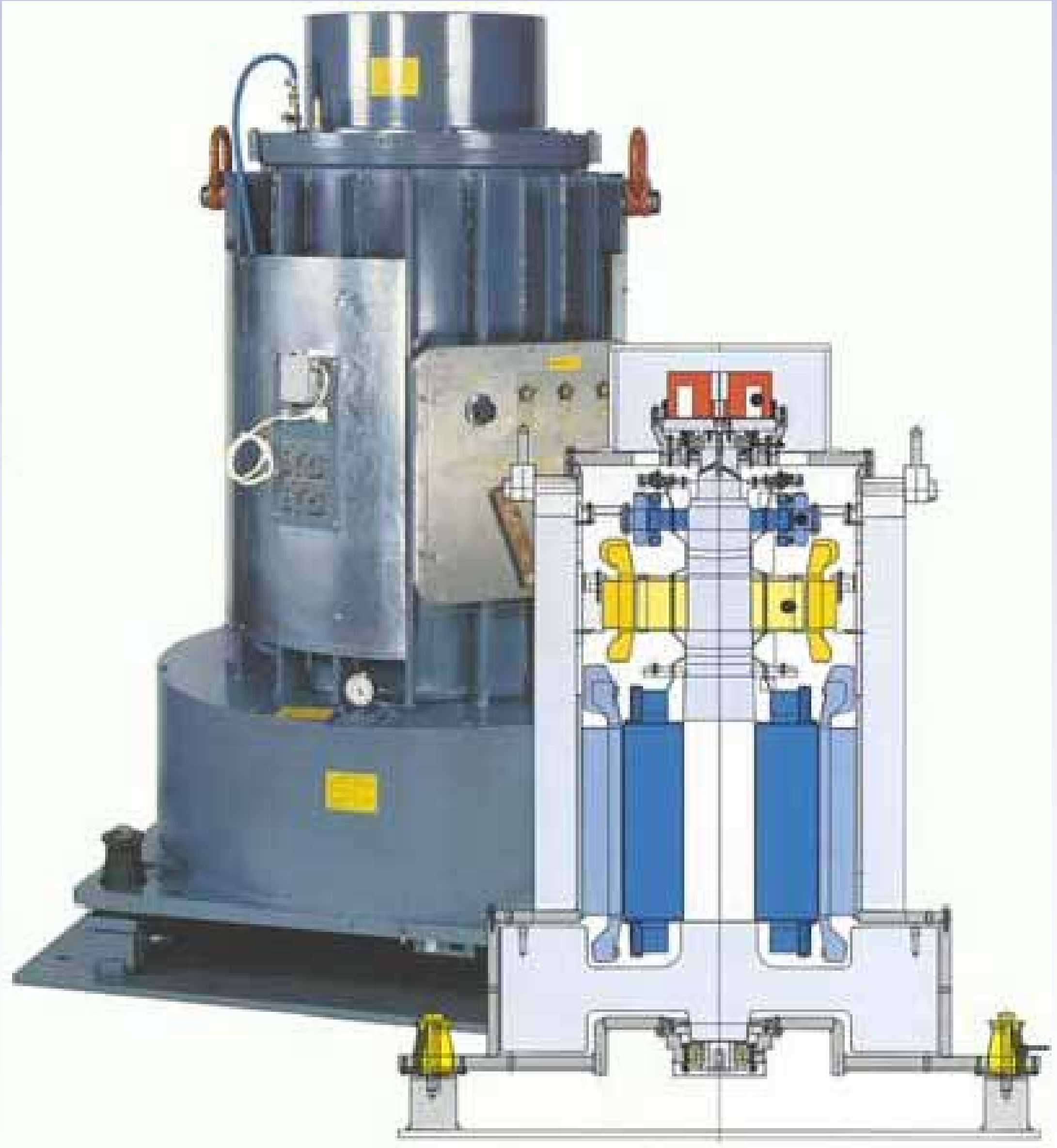
System Modeling



- Power System Modeling
  - Grid Connected System
  - Community Power
- Financial Modeling

Grid Connected

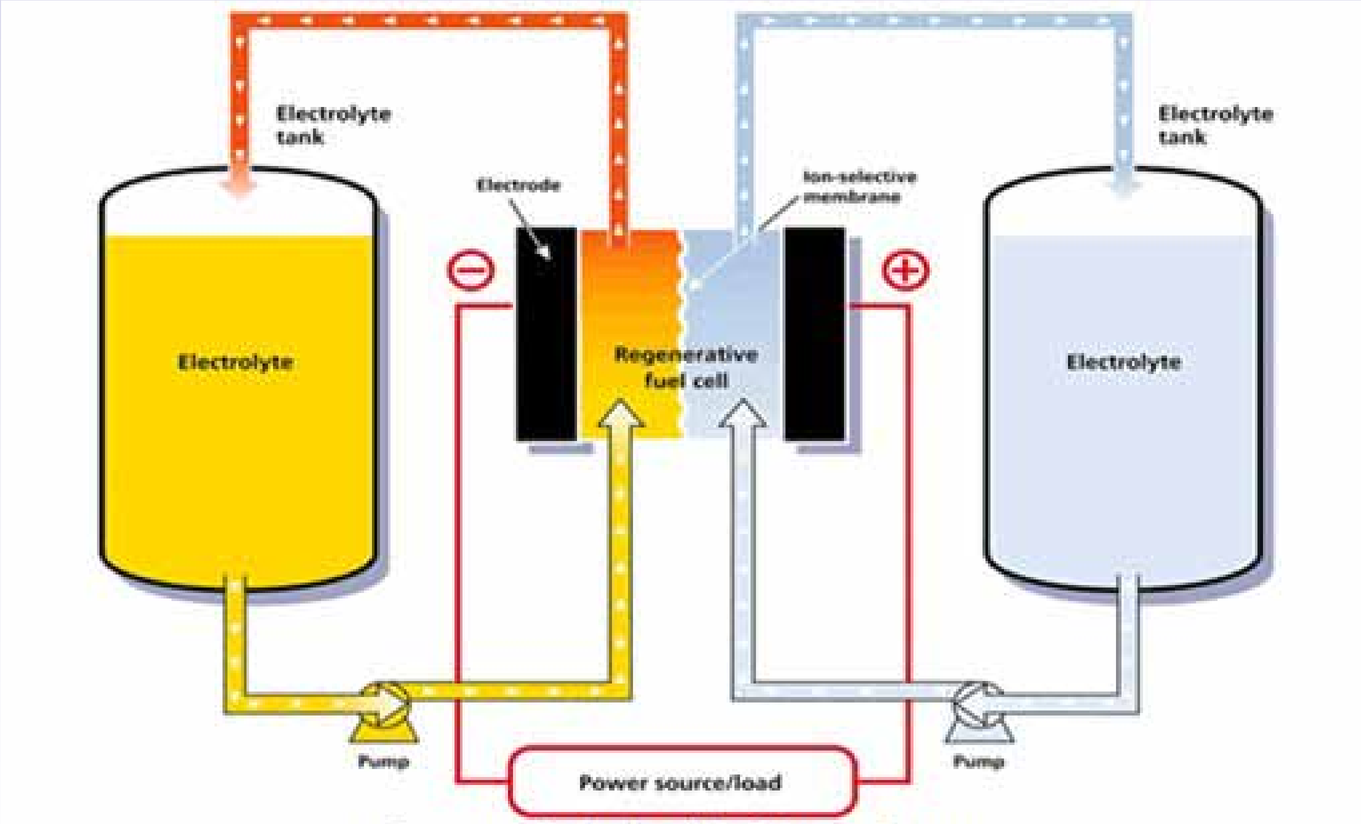
- Penetration levels: Lo/Med/Hi
- Controls issues Wind/Diesel/Hydro
- Controls system has not been implemented on larger systems
- Energy Storage: Batteries, EV’s, Flywheels, Compressed Gas, NH_4
- Smart Grid applications



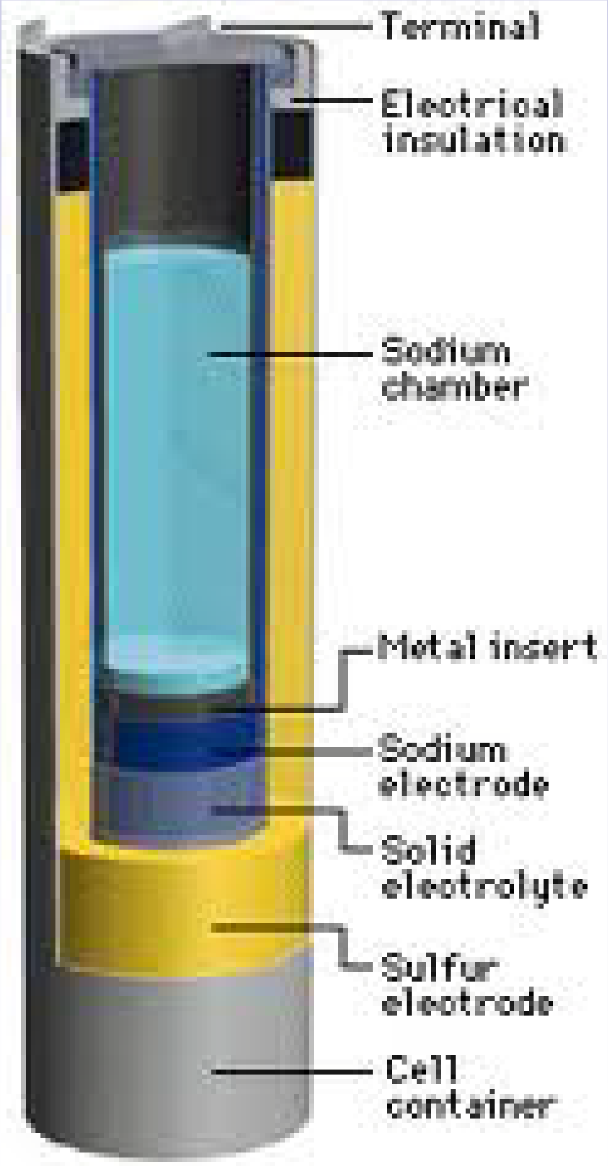
Grid Connected

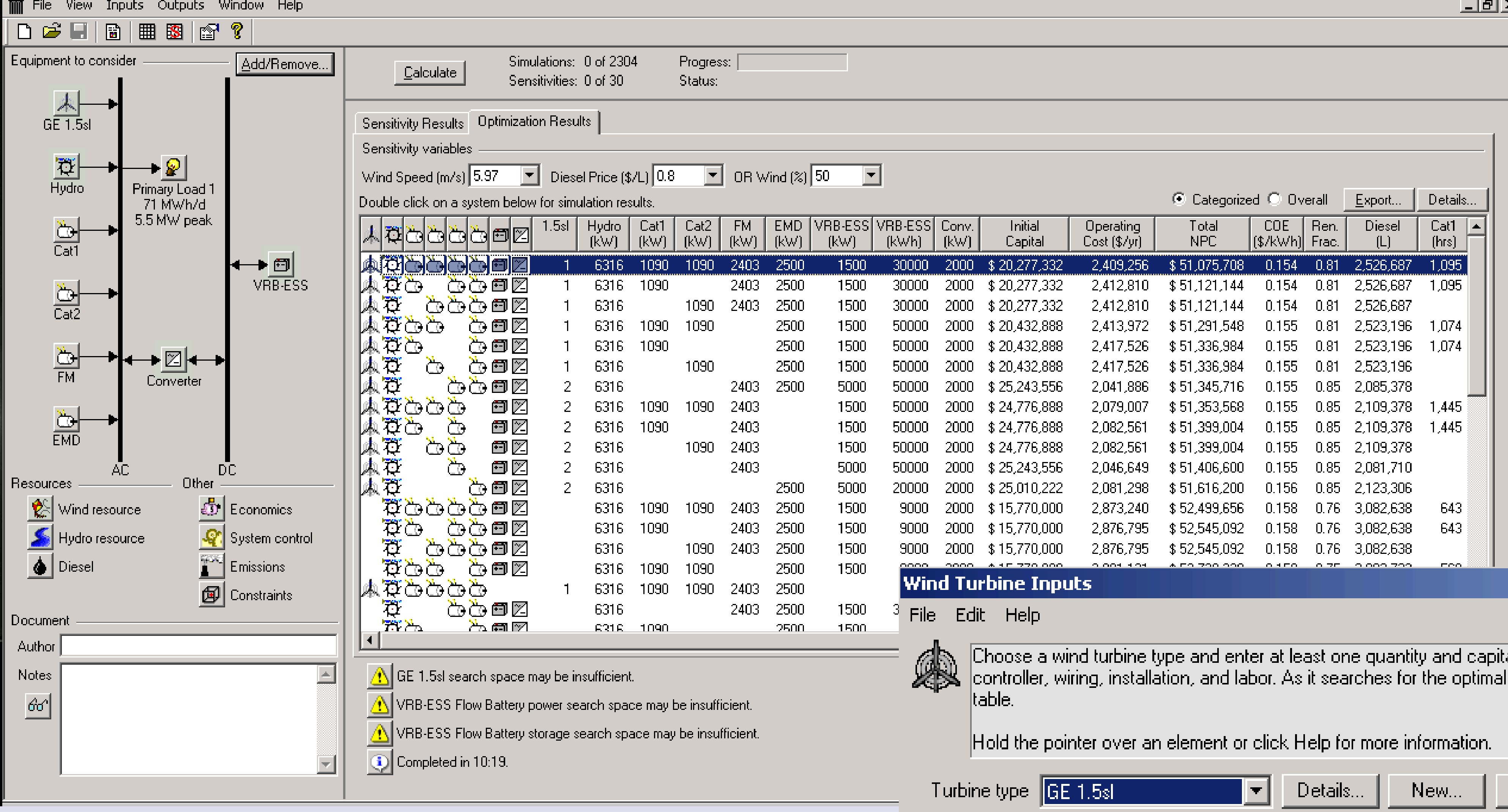
Flow Battery

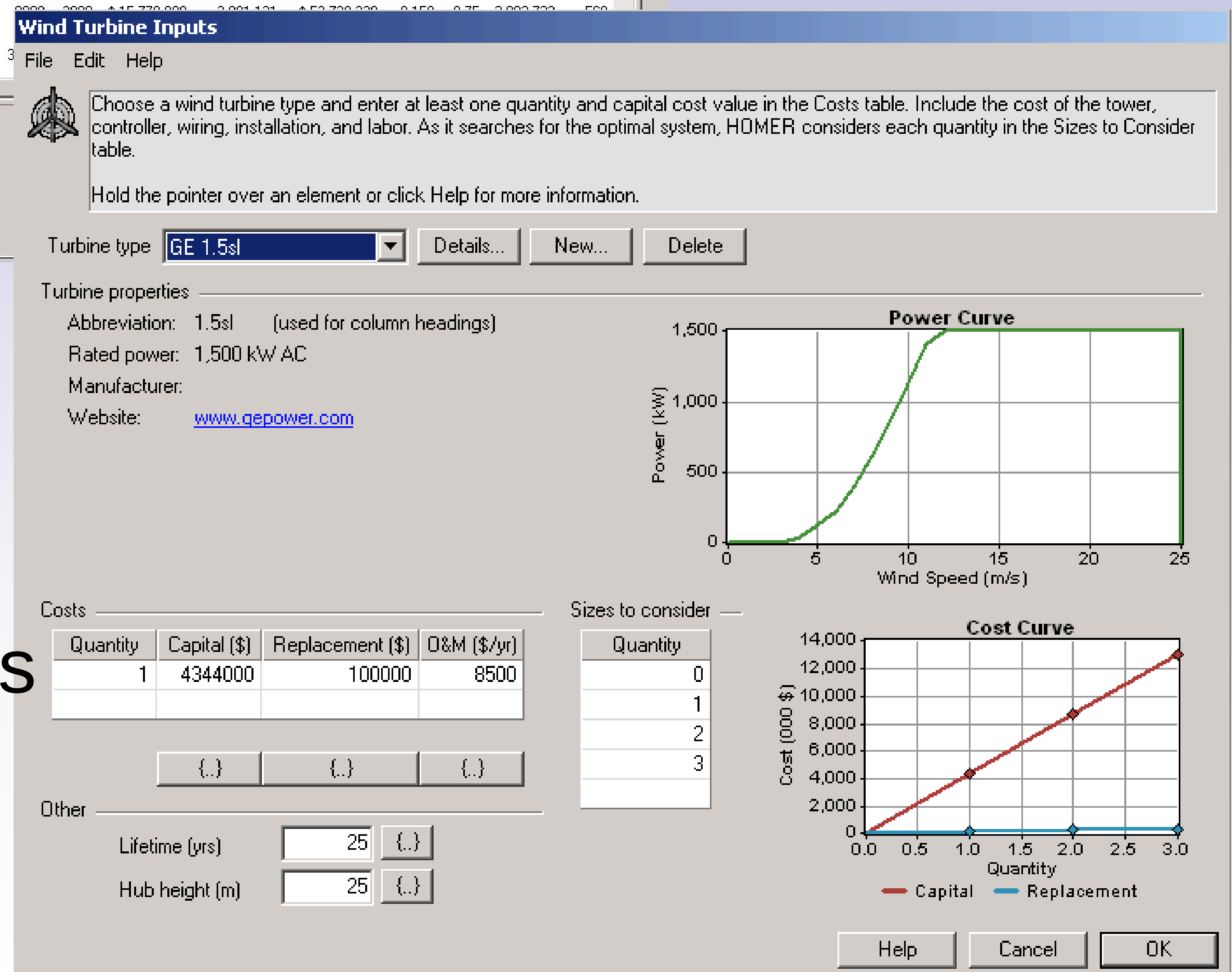
NaS battery



Concept of a Redox Flow Battery System

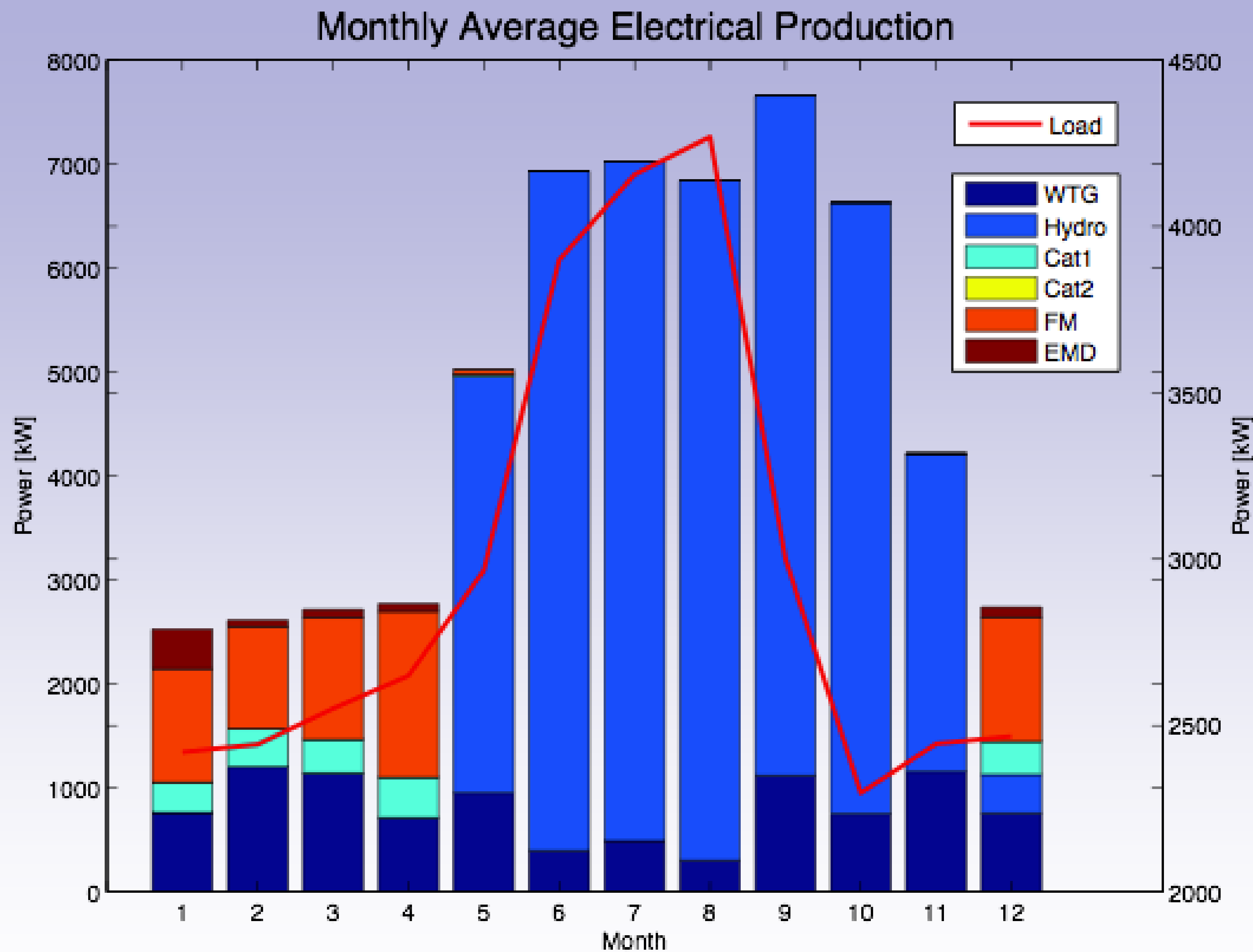






Optimization Model

Finds the least cost combination of components that meet electrical and thermal loads



GE 1.5 MW Turbine

Community Wind

- Determining community load
- Possible dump loads: District heating, battery storage

Project Funding

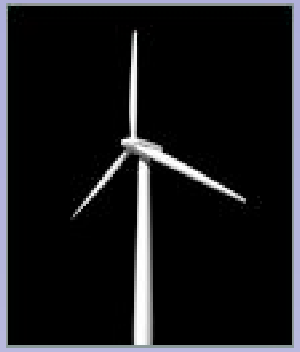
- Site specific: Eyak corp, City land, USFS
- Tax incentives: CEC, NVE and City are ineligible for most incentives
- Clean Renewable Energy Bonds for Cooperatives
- Possible DOE funding

Project Status

- Site assessments complete, ready for MET tower installation
- Avian studies ready for next years migrations
- Educational outreach
- Working with High School science club on wind study

To Be Completed

- Once funds are available order MET tower components and erect
- Avian studies completed Spring and Fall of 2011 (migratory times)
- System modeling (HOMER, Matlab,Hybrid2)

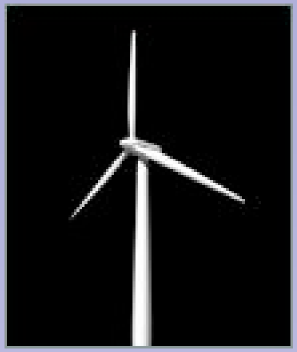


Go No Go

- More data may be needed based on turbine selection (Taller MET tower data needed at site)
- Is it financially viable?
- Current Outlook: Battery storage needed first due to non-dispatchable power of wind and to allow for higher penetration levels (decreasing diesel consumption)

Project Participants

- Cordova Electric Cooperative
- Eyak Corporation
- Cordova School District
- Alaska Energy Authority



Small Wind

Small Wind Power
300 W to 10 kW Units

- Installed at individual homes, businesses, schools, etc.
- On the “demand” side of the meter, or off the grid entirely
- High reliability, low maintenance
- 9 mph (4m/s) average wind speed

Small Wind

Generator: direct-drive, permanent magnet alternator (no brushes), variable-speed operation

Controller: electronic device that delivers -DC power for charging batteries -AC power for utility interconnection

Result:
Simple, rugged design
Only 2–4 moving parts
Little regular maintenance required

Small Wind Incentives

- Rebate grant programs: USDA
- Net metering
- Reasonable interconnection requirements
- State/City zoning ordinance
- US Treasury tax credit: 30% of project cost (2016)