Native Village of Eyak Wind Energy Feasibility Study

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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
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
Power From The Wind

\[ P = \frac{1}{2} C_p A_s \rho v^3 \]

\( C_p = \text{Coefficient of Performance} \)

\( A_s = \text{The swept area of wind turbine blades} \)
NorthWind 100/21 Wind Turbine Power Curve
Standard Density

Electrical Power (kW)

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

\[ P = \frac{1}{2} C_p A_s \rho v^3 \]
Make The Calculation

AEP = Expected Power × Availability × Time

Case 1: 10m/s 50% of the time
AEP = 60kW × (8760 × 0.5)
= 262,800 kWh/year

Case 2: 5m/s all of the time
AEP = 10 × (8760 × 1)
= 87,600 kWh/year
### Wind Shear

<table>
<thead>
<tr>
<th>Height (m)</th>
<th>Wind Speed, m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>12.6</td>
</tr>
<tr>
<td>40</td>
<td>12.2</td>
</tr>
<tr>
<td>30</td>
<td>11.7</td>
</tr>
<tr>
<td>20</td>
<td>11</td>
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<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>8.8</td>
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</tbody>
</table>

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
Pt Whitshed Statistics

- Average wind speed at 29m: 13.1mph (5.9m/s)
- Average power density at 29m: 346W/m²
- Estimated resource at 50m: 14mph, 410W/m²
- 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

• 781 observations 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

Diagram showing different foundation systems:

- a) Hie Group
- b) Anchored Footing
- c) Single Pier
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
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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Actual Wind Speed and Forecasted Wind Speed

MAPE = 9.2%
MSE = 1.2

yPred
y3

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, NH₄
- Smart Grid applications
Grid Connected

Flow Battery

NaS battery
Optimization Model

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