Alaska Wind Update

BIA Providers Conference

Dec. 2, 2015

Unalakleet wind farm

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Energy Efficiency First

akenergyefficiency.org
Solutions For Alaska

- Make homes, workplaces and communities energy efficient thru weatherization and efficient lighting/appliances.
- Because of PCE, residential rate payers won't see as much benefit from a wind farm as do commercial customers.
- Once efficient, pursue renewable energy. Otherwise, money is wasted to build an oversized system.
- EE makes economic sense – faster payback (2-3 years vs. 15-20 for wind projects in rural Alaska) than any other option and immediate reduction in monthly heat and electric bills.

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How windy is it, really?

- Anecdotal weather data or observations can be deceptive. For example:
  - A few windy days get some people wanting to install wind turbines.
  - It only takes one or two rainy days for people to think that fire danger is reduced.
  - A short cold spell can fool us into not seeing an overall warming trend.
  - Our bodies can sense the weather, but we need to collect data to understand the long-term climate and minute-to-minute variability.
- What matters is the wind speed throughout the course of an entire year.

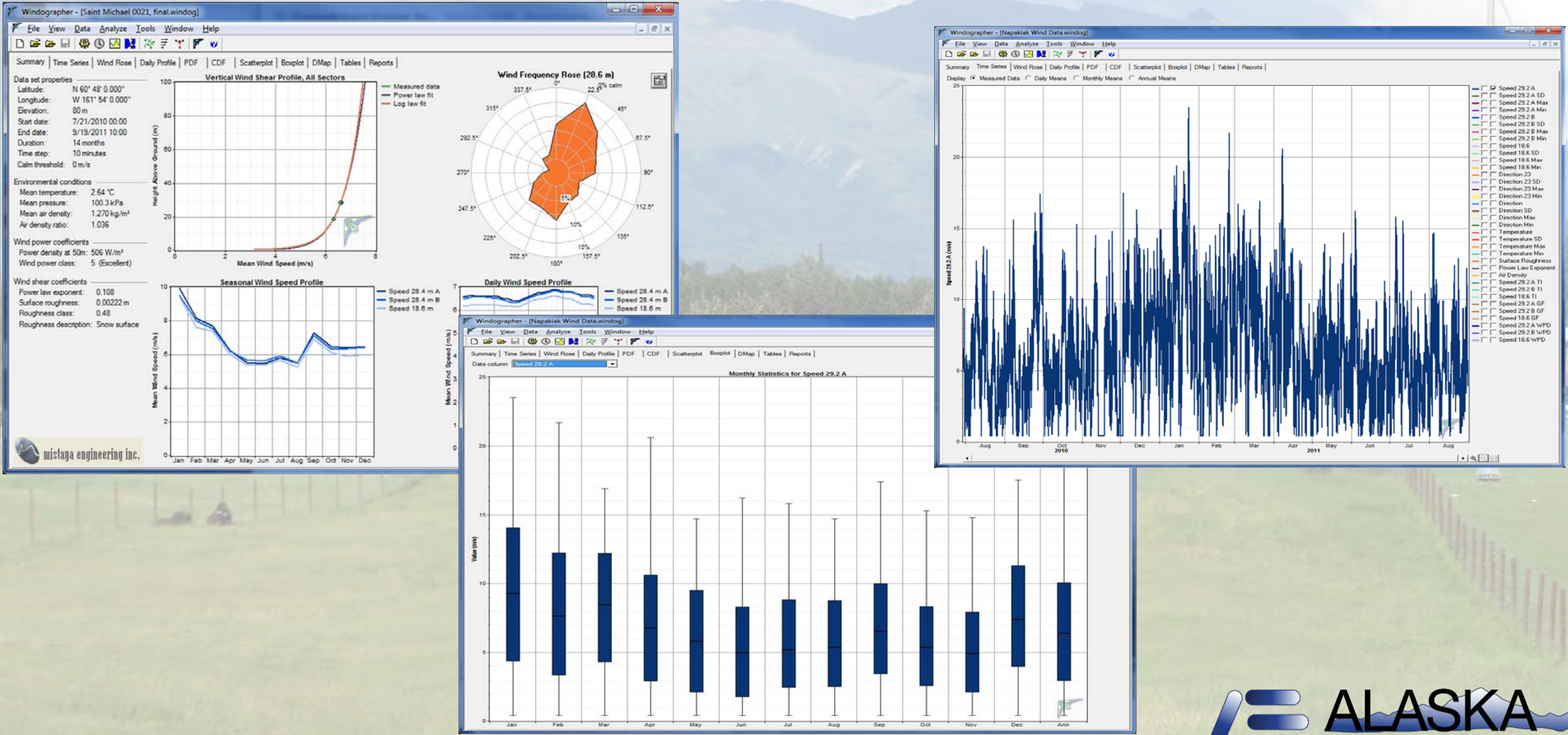
The formula for wind power is:
Power = 0.5 x Rotor Swept Area x Air Density x Velocity^3

Thus, doubling the wind speed from 3 meters/sec to 6 meters/sec increases the power by 8X.

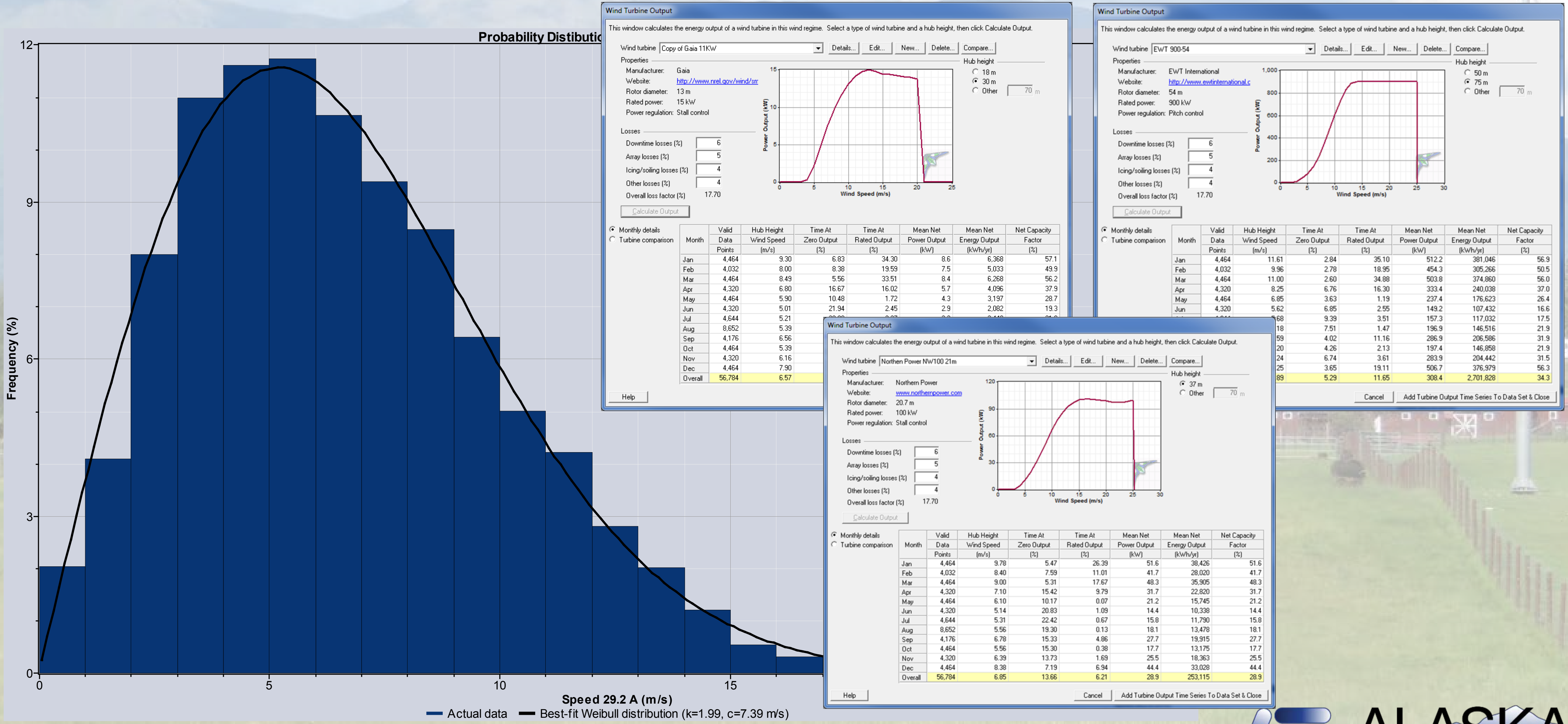
How windy is it, really?

- Install guyed meteorological (met) towers to collect data at 10m, 30m, 50m or higher.
- Met towers require a permit from the FAA and consultation with US Fish & Wildlife, State Historic Preservation Office and possibly other agencies.
- Measure the wind for a minimum of one year.

What the met tower data tells us



Wind distribution vs. turbine power curve

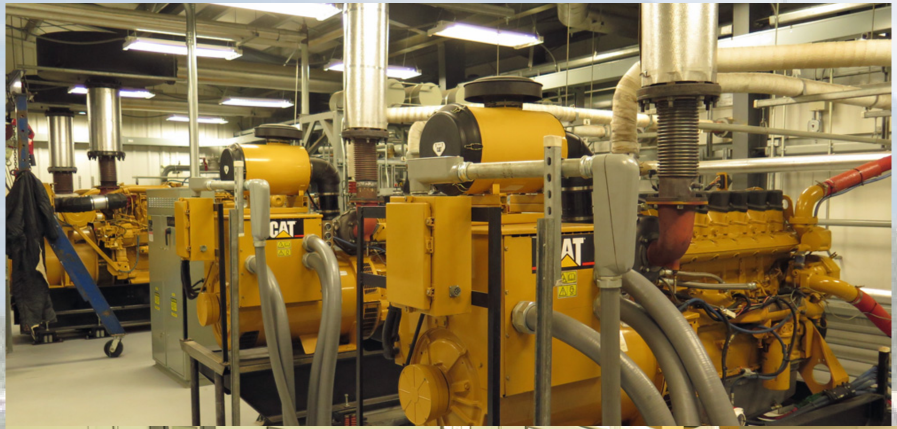


Stop! Do you really want to attempt this on your own?

- Village and utility must be partners - MOU.
- Contact your regional Native corporation to see if they have engineering resources or can help fund the project.
- Request proposals (RFP) from engineering firms, environmental permitting consultants and project management companies.
- Even experienced utilities like AVEC, Kodiak Electric and GVEA partner with consultants.

Can your existing electrical distribution system support wind technology?

- Do you have newer diesel gensets with fast, electronic injection controls or mechanical governors?
- Are your gensets sized so that you can run at optimum fuel efficiency both when the wind is blowing and when it's calm?
- Are your distribution lines, transformers and meters up to code?
- Are your phases balanced?
- If you can't answer "yes" to all of these questions, you could save more money by fixing your existing power system.



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Pick a potential site

- Pick a site that is close to the existing power distribution grid.
- Site should have little or no tall vegetation and no buildings to block prevailing winds.
  - Site met tower at a minimum distance that is 5X the height of any obstructions.
- Consult AEA's Energy Pathway document (ftp://ftp.aidea.org/AlaskaEnergyPathway/2010EnergyPathway8-12Press.pdf), the Community Database (ftp://ftp.aidea.org/2010AlaskaEnergyPlan/2010%20Alaska%20Energy%20Plan/Community%20Deployment%20Scenarios/) and the state wind resource maps.

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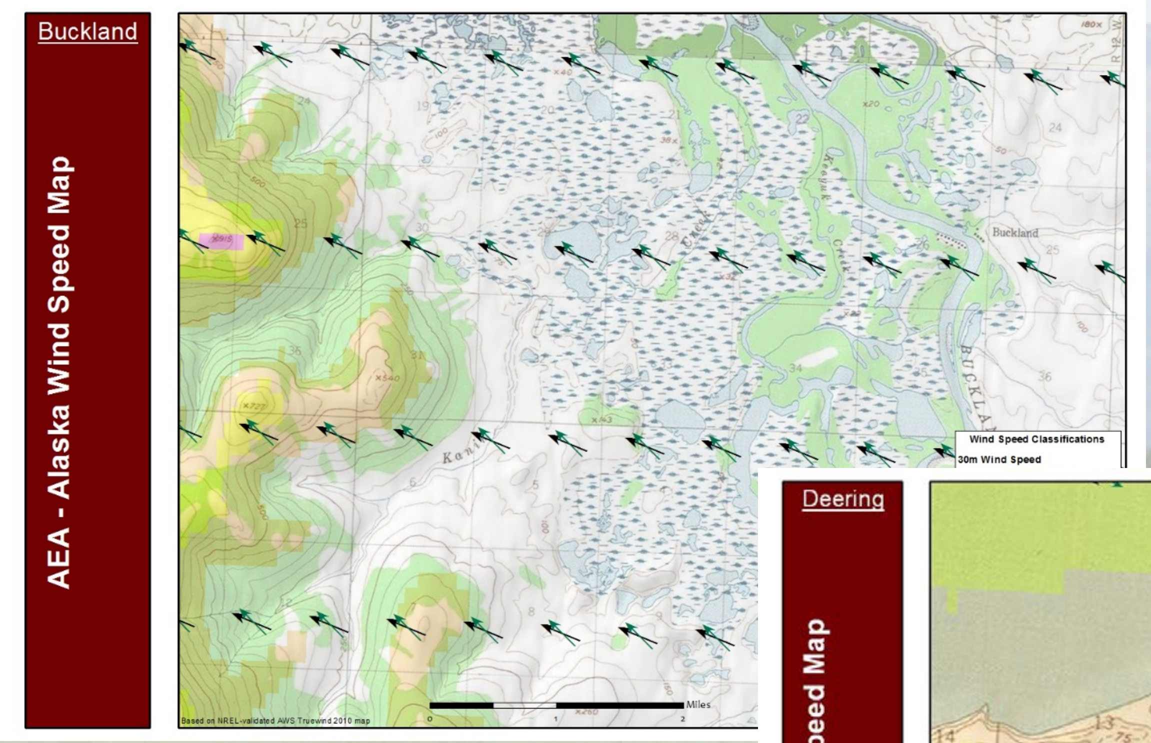
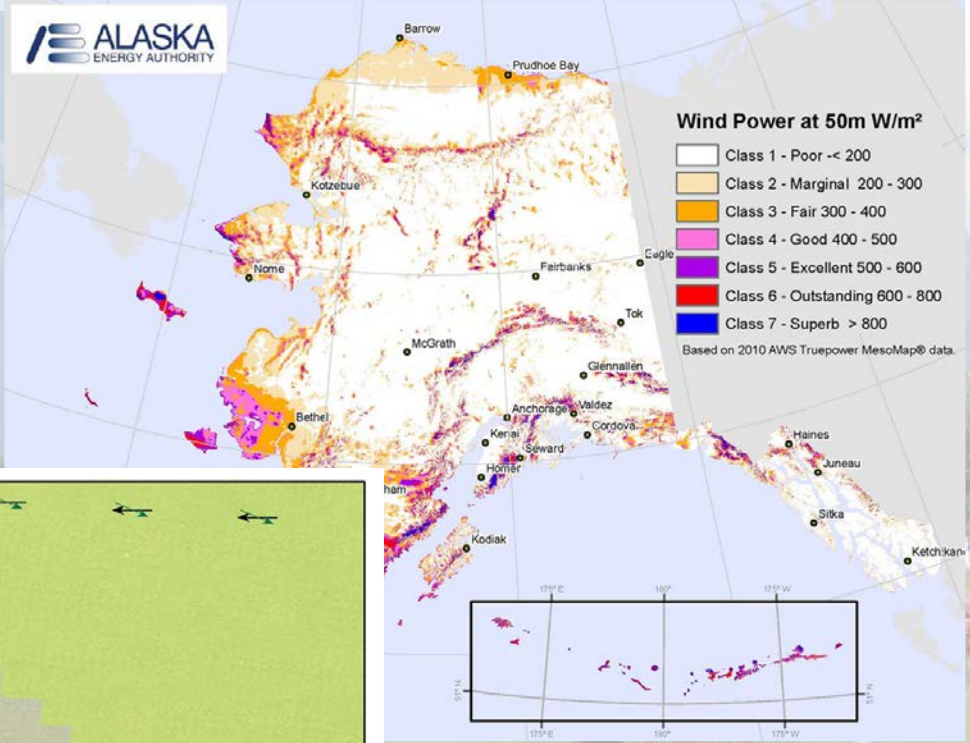
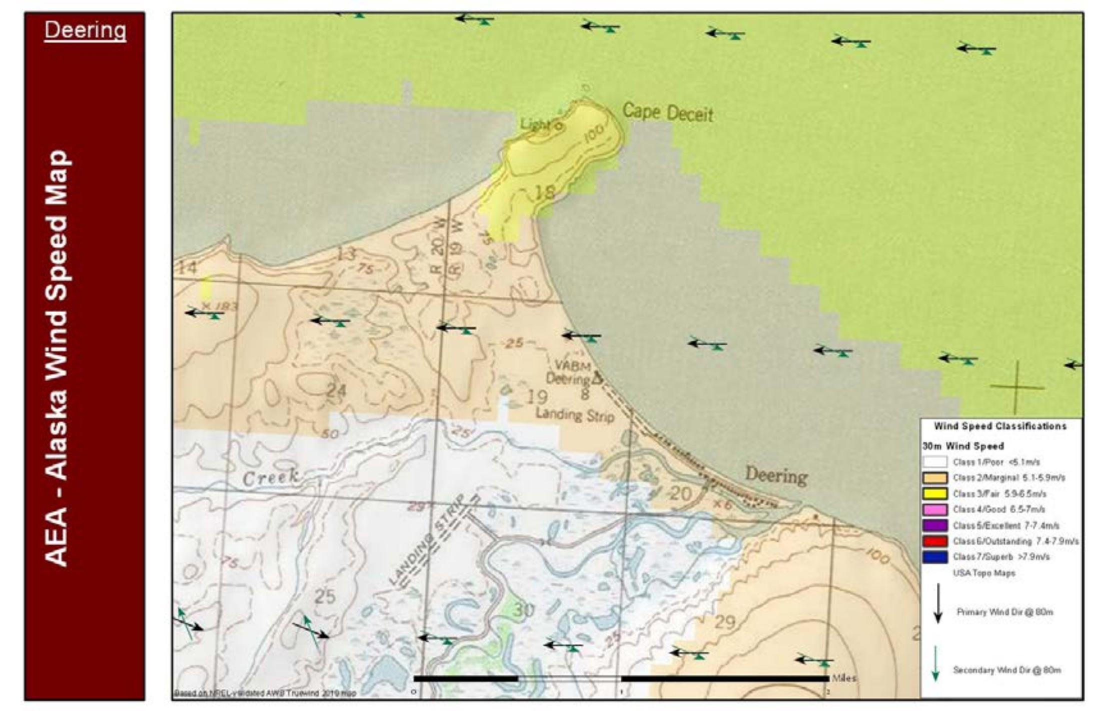
Wind Resource Maps







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Wind Classifications

- Class 1/Poor: Pursue options other than wind
- Class 2/Marginal: High costs of development in rural Alaska prevent an economical project.
- Class 3/Fair: A large project on the Railbelt may be cost effective. Remote village projects may have a payback longer than the 20-year life of wind turbines.
- Class 4/Good: A well-designed project will have a payback of 15-20 years.
- Class 5/Excellent: A well-designed project will have a payback of 12-15 years.
- Class 6/Outstanding: A well-designed project will have a payback of 10-12 years, but damaging high-wind events may be a concern.
- Class 7/Superb: Project developer may want to find a sheltered site to protect turbines from periodic damaging winds.

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Set up a met tower

- Finding suitable anchors in permafrost, logging slash or rocky soils can be difficult. AEA can help select good sites.

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Portable met towers

- Install multiple 10-meter towers simultaneously to identify the best location for a long term study
- Tower costs ~ $1,000
- Weighs 75 lbs.
- Can be erected with two people and hand tools.

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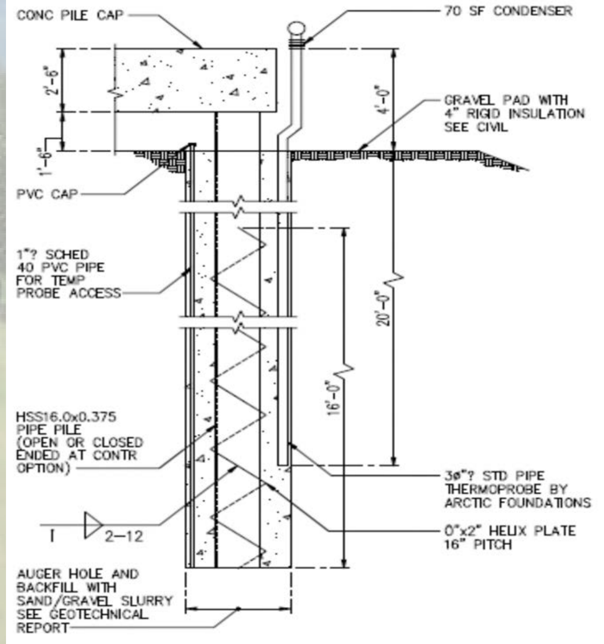
Project milestones *

- Feasibility / $120k-$140k:
  - Purchase, ship and erect met tower
  - Obtain site control, right of entry and permits for met tower
  - Geotech site recon visit and report
  - Dismantle met tower
  - Draft and final wind and solar resource analysis
  - Draft and final conceptual design report

Construction costs $1.5 million to >$5 million >$20 million depending on community size



- Permitting/Design / ~$250k
  - Permitting
  - Negotiate site control
  - Avian and other environmental analyses
  - 65% Civil, Mechanical, and Electrical Design
  - Revise Budget and Schedule

* This is the bare minimum. Some projects require additional steps.

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Project sizing and economics

Penetration Class	Operating Characteristics	Penetration Instantaneous	Penetration Average
LOW	• Diesel runs full-time • Wind power reduces net load on diesel • All wind energy goes to primary load • No supervisory control system	< 50%	< 20%
MEDIUM	• Diesel runs full-time • At high wind power levels, secondary loads are dispatched to insure sufficient diesel loading or wind generation is curtailed • Requires relatively simple control system	50% – 100%	20% – 50%
HIGH	• Diesels may be shut down during high wind availability • Auxiliary components are required to regulate voltage and frequency • Requires sophisticated control system	100% – 400%	50% – 150%

- Projects that are too small won't take advantage of economies of scale.
- Projects that are too large may have excess power that never gets used.

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RE Fund Grant	$ 4,000,000
Total Project Cost	$ 6,000,000
Est Fuel Displaced/yr	90,000 gal

Capacity: 600 kW

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Kotzebue EWT 900s + Battery

RE Fund Grant	**$ 8 million**
Total Project Cost	**$10.8 million**
Est Fuel Displaced/yr	**265,000 gal**

Added Capacity: 1800 kW

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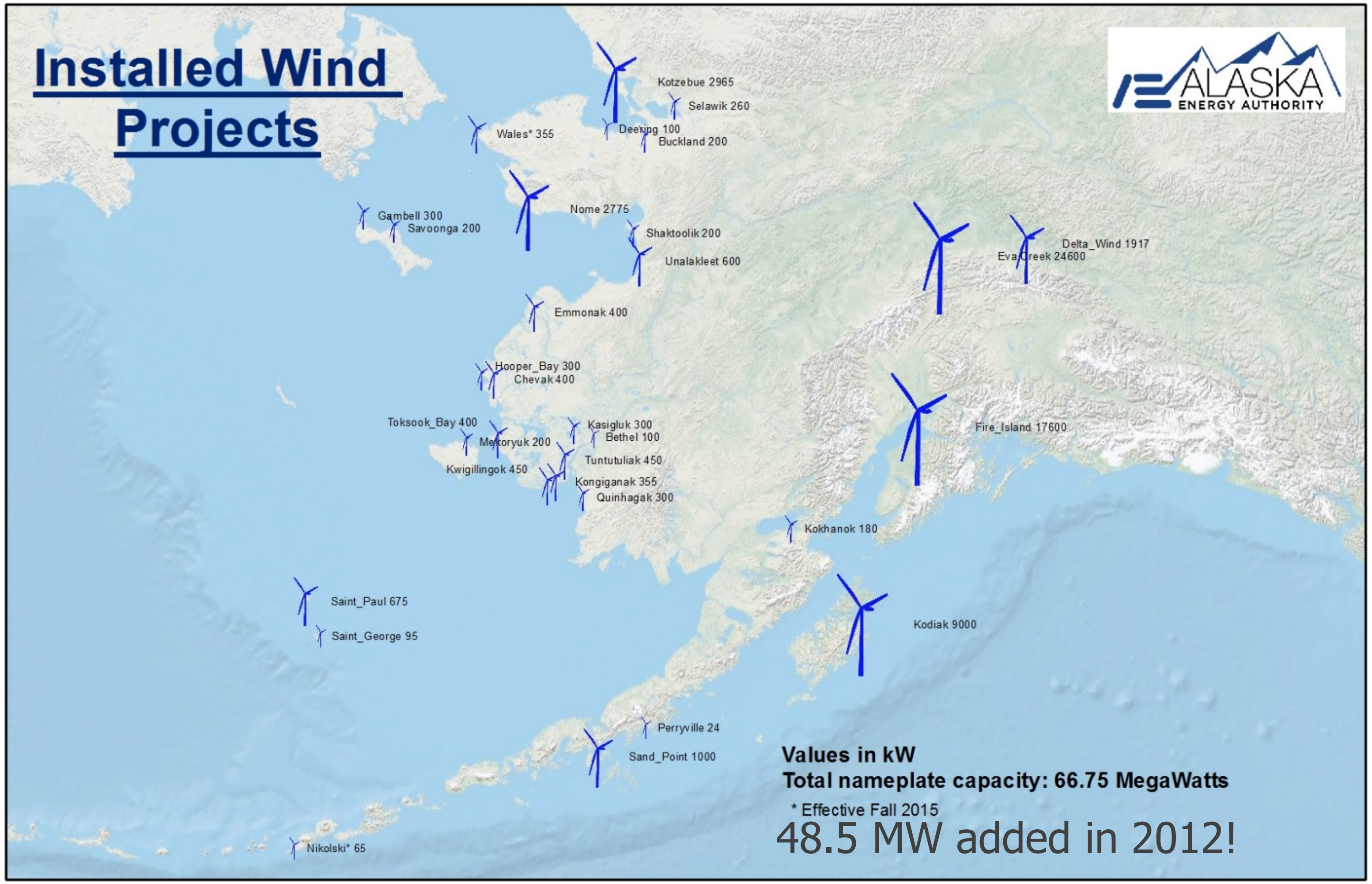
Installed Wind Capacity – 66.8MW



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PCE Impacts

Village name:	Emmonak	Comments
Total kWh produced:	3,188,632	
kWh sold:	3,024,511	
Station service:	164,121	5.43%
PCE eligible residential kWh:	777,774	25.72%
PCE eligible community facilities kWh:	633,539	20.95%
Non PCE eligible kWh:	1,613,198	53.34%
Diesel kWh:	2,450,690	76.86%
Wind kWh:	737,942	400kW turbines at 21.1% Cap Factor
Non fuel expenses:	$767,671	
Fuel expenses	$738,967	
Calculated res/comm rate - before PCE	$0.4981	Without wind energy
Calculated PCE reduction	$0.3365	Without wind energy
Calculated residential rate after PCE	$0.1616	Without wind energy
Fuel expense with wind energy	$577,975	
Drop in fuel cost per kWh with wind	$0.0532	
Calculated res/comm rate with wind	$0.4449	With wind energy
Drop in Calculated residential rate	$0.0532	
Calculated PCE reduction with wind	$0.2860	With wind energy
Drop in PCE discount with wind	$0.0506	
Calculated residential post PCE rate	$0.1590	With wind energy
Actual change to residential rate after PCE----->	**$0.0027**	
Actual change to commercial rate with wind energy	**$0.0532**	

* Actual rates will be higher when residential customers exceed the 500kWh per month PCE limit.

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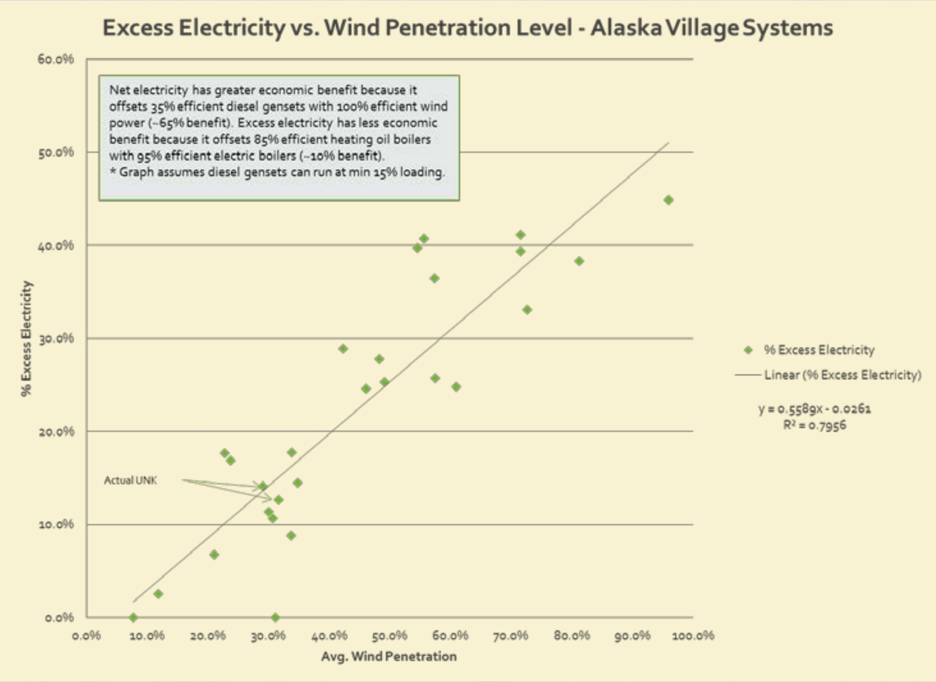
Secondary Heat Loads – Critical to Project Success

- Failing to fully consider, model and design secondary loads in hybrid wind systems ensures a least a 15-20 point gap from expected annual energy production.



- Impacts of curtailment:

Installed Wind Capacity (kW)	Total Wind Energy Produced (kWh)	Excess Electricity	Net Elec kWh	Net Thermal kWh	Control Method	Fuel Savings @ $4.5.gal	Potential Benefit
300 (Hi Pen)	888,180	292,307	595,873	292,307	Elec Boiler or ETS units	$240,274.89	100.00%
300 (Hi Pen)	888,180	292,307	595,873	0	Turbine max setpoint	$206,263.73	85.84%
300 (Hi Pen)	888,180	292,307	595,873	0	Non value dump load	$206,263.73	85.84%
300 (Hi Pen)	489,227	0	489,227	0	Curtailment	$169,347.81	70.48%
300 (Hi Pen)	888,180	262,731	625,449	0	15-min Batt/FW storage	$216,501.58	90.11%
200 (Med Pen)	592,117	107,310	484,807	107,310	Elec Boiler or ETS units	$180,303.78	100.00%
200 (Med Pen)	592,117	107,310	484,807	0	Turbine max setpoint	$167,817.81	93.08%
200 (Med Pen)	592,117	107,310	484,807	0	Non value dump load	$167,817.81	93.08%
200 (Med Pen)	396,716	0	396,716	0	Curtailment	$137,324.77	76.16%
200 (Med Pen)	592,117	90,975	501,142	0	15-min Batt/FW storage	$173,472.23	96.21%

*Net load = village demand – min diesel loading

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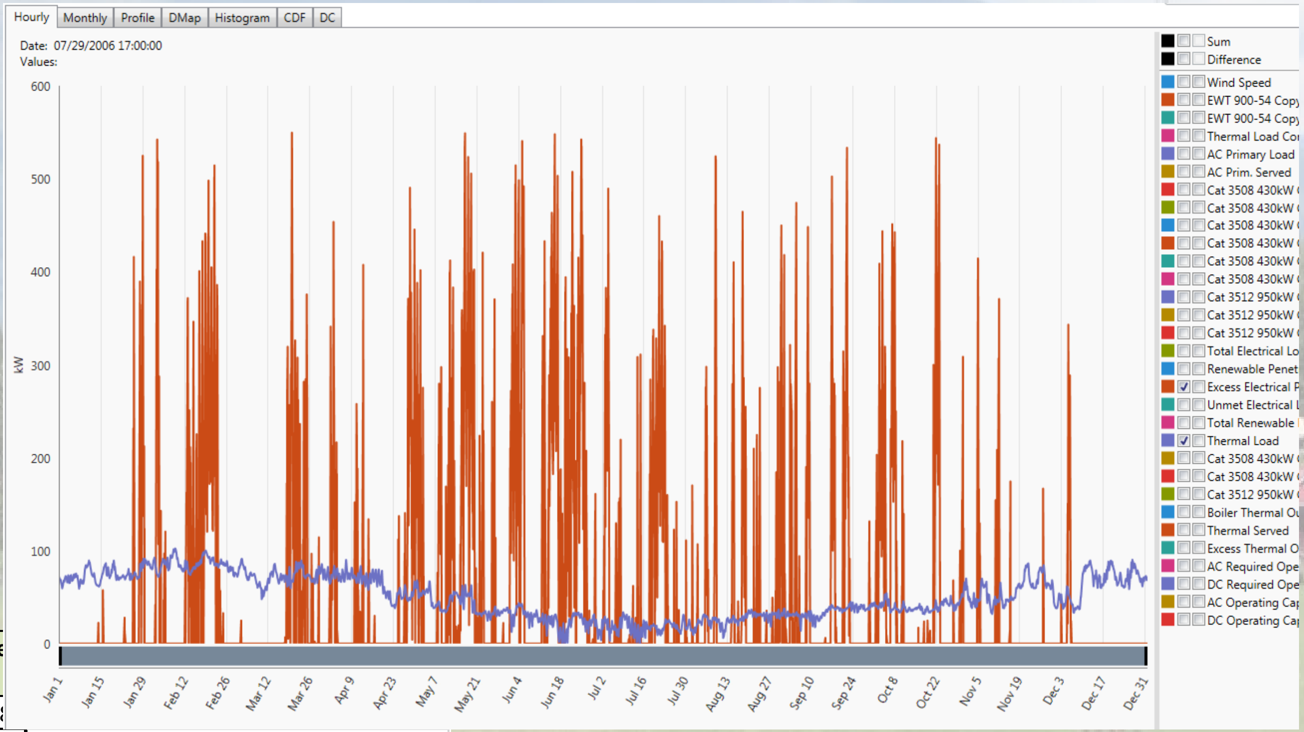
Modeling of Thermal Systems

- Simply comparing annual heat demand with annual excess energy leads to significant error in system design.
- While the health clinic in this village consumes almost twice as much energy over the course of a year, the heat load is much less variable than the excess wind. Additional heat loads must be added to the system design to avoid significant curtailment of wind turbines.



^^ Poorly matched excess vs. heat load

Community building/load	Connected to HR Loop?	Current annual heating oil consumption*	Thermal mass - Equiv. gals. of storage	MMBTU Equiv	kWh Equiv	Average kW		
Public Works-HEMF	Y	19,216		2,652	743,163	84.[illegible]		
Sewer Plant	Y	13,695		1,890	529,639	60.46	Estimate 20% of total load is unmet	
School	N	116,800		16,118	4,517,240	515.67	1840000	
PSO	N	6,348		876	245,5[illegible]	28.03	100000	<BTU/Hr
Health clinic	N	14,219		1,962	549,925	62.78	224000	<BTU/Hr
Water plant	N	11,426		1,577	441,904	50.45	180000	<BTU/Hr
Fire Station	N	16,758		2,313	648,126	73.99	264000	<BTU/Hr
Power plant	Y	1,625		224	62,847	7.17	Estimate 20% of total load is unmet	
				0	0	0.00		
				0	0	0.00		
Totals		200,087		27,612	7,738,346	883.37	331,107	<<Excess kWh from HOMER

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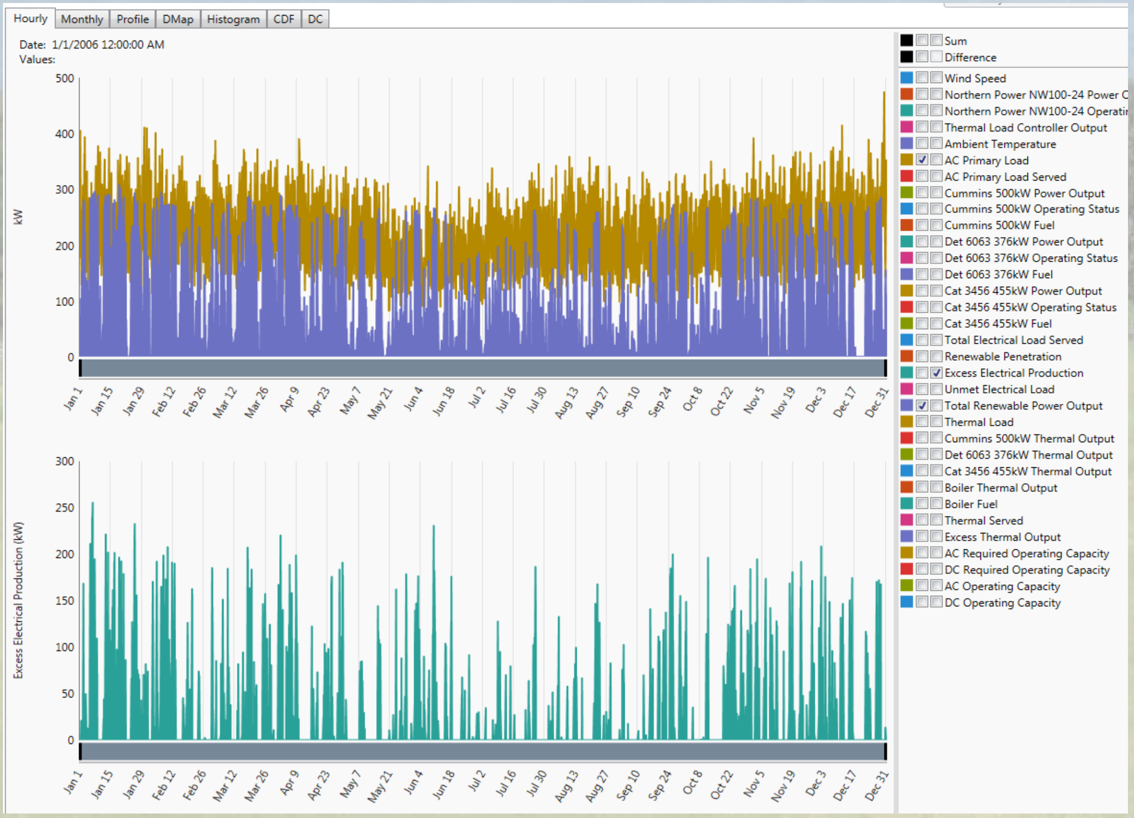
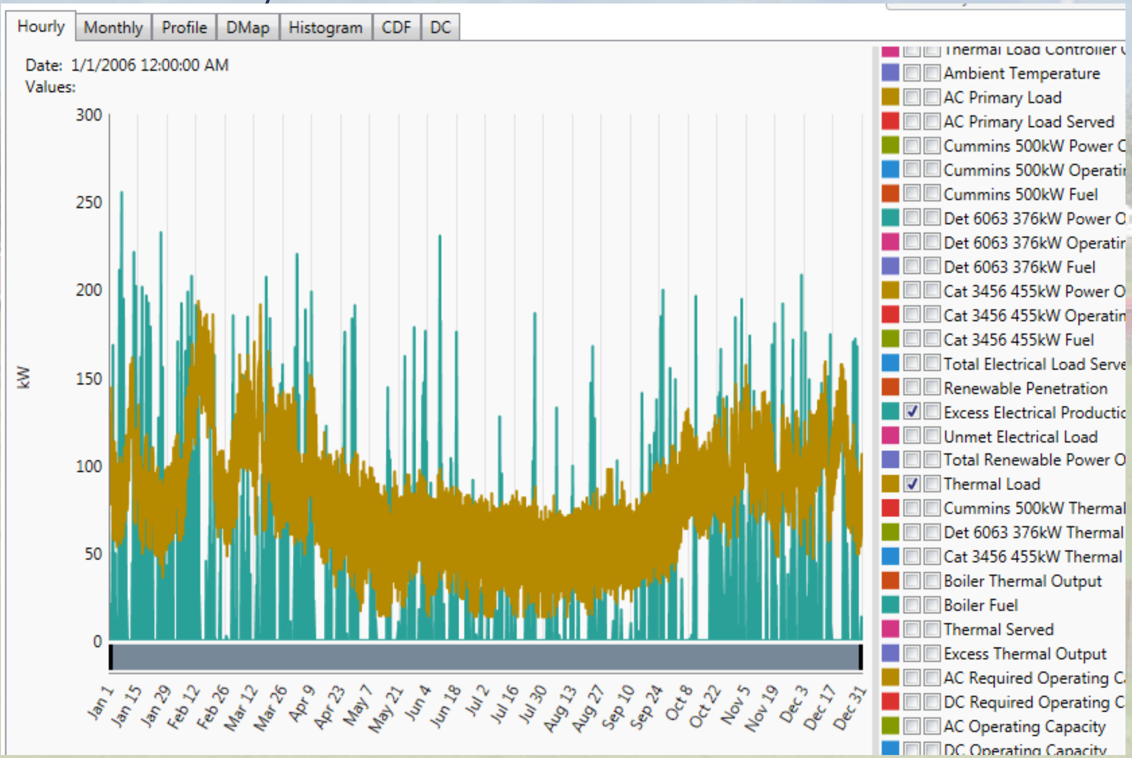
Detailed modeling of electric load, heat load and wind energy

- Because wind energy is variable, there are times throughout the year when there is more energy available (turquoise = excess) from the wind turbines (purple) than the current net* village electrical load (gold).



- Thermal loads (gold) for buildings and facilities in a community can make use of this excess wind energy (turquoise) to supplement other sources (power plant heat recovery or oil-fired boiler). Reasonably well-matched excess and load:



*Net load = village demand – min diesel loading

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Key Learnings

- Energy efficiency programs should be pursued first to maximize community benefit.
- Partner up with people who have a track record of success on other Alaska projects.
- Collection of wind data and electrical load data helps to build an accurate system model that can identify issues before you build the project.
- AEA can assist with initial site selection, wind data analysis, system modeling and defining project scope.
- Wind systems have excess energy that must be accounted for in your system design with secondary loads or energy storage.
- Good planning, design and project management drives high-performing wind energy systems.

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