Eva Creek – Year One

ACEP Community Energy Lecture Series - Blue Loon

Paul Morgan GVEA, Eva Creek Manager February 18, 2014





Blade Repairs



Location, Location, Location...



GVEA's first met tower At Eva Creek, 2003

30 m tall

Later towers were hub height 80 m / 262 ft



REpower MM92 CCV WEC

415

Feet

Cold Climate Version* – Wind Energy Convertor

Installed 12 REpower CCV MM92 Turbines **2.05MW** rated output @ 12.5 m/s (28 mph) 80 m (262 ft) Hub Height 92.5 m (303 ft) Rotor Diameter 6,720 m² (72,333 ft²) Swept Rotor Area - (1.66 Acres) 45.2 m (148 ft) Blade Length 3.0 m/s Cut-in Speed (6.7 mph) 24.0 m/s Cut-out Speed (53.7 mph)

> *Cold Climate Version – Additional Pitch Heating, the first turbine in the MM class with the NGX/CSC4/Next Generation converter including liquid cooling & heating of IGBTs, additional gearbox heating, two stage cooling fans. Ultrasonic anemometer for wind speed & direction even in icing.



REpower renamed SENVION in 2014



SENVION

Costs – Eva Creek

- Capital Costs
 - Capital Costs: \$94 million (including grants)
 - State Renewable Energy Fund: \$3.6 million
 - State Grant: \$10 million
 - CREB (renewable energy bonds) Financing at 1.05%
 - Operating Costs: \$1,200,000/year
- Cost of energy: 8.7 cents/kWh
 - Exclusive of regulation costs



Regulation Cost (Load Following)

- A load following power plant is one that adjusts its output as demand for electricity fluctuates throughout the day
- With Eva Creek load following is more complicated. Grid demand can go up while wind energy drops, causing ramp rates which potentially exceed a plant's capacity to respond



Conceptual Fairbanks 24 Hour Load Curve



Performance Measurements

- Net output
 - energy produced minus energy used at the site
- Capacity Factor
 - the total electricity a generator actually produces as a percentage of the maximum it could produce, for a given period
- Availability
 - the amount of time a plant is able to produce electricity, divided by the amount of the time in the period



Production for Jan 2014, typical month, no days at full load and no days without wind



yield analysis

Eva Creek Grid 98 : Energy delivery [kWh]

	Eva	Creek	Monthly Pe	2013		
	Month	Days	Output MWh	Capacity Factor	Availability	
	Jan-13	31	8,713	47.6%	98.31%	
	Feb-13	28	6,754	40.9%	98.60%	
	Mar-13	31	6,903	37.7%	99.71%	
	Apr-13	30	3,808	21.5%	99.04%	
	May-13	31	3,335	18.2%	99.51%	
	Jun-13	30	4,438	25.1%	99.78%	
	Jul-13	31	4,857	26.5%	98.37%	
	Aug-13	31	5,298	28.9%	99.74%	
	Sep-13	30	6,005	33.9%	99.83%	
	Oct-13	31	9,513	52.0%	99.12%	
	Nov-13	30	5,873	33.2%	99.53%	
	Dec-13	31	5,513	30.1%	96.01%	
	Year - 2013	365	71,010	33.0%	99.00%	

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Output in terms of homes powered

 Average home around Fairbanks uses 660 kWh/month

 Eva Creek supplied electricity for 8,966 homes for a whole year



Availability



Eva Creek Monthly Output

Eva Creek Net Output MWh



2013 Eva Creek Capacity Factor 33.0%



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Predicted Performance





						Capacity Factor%	
	Output **	Dispatch	Total Output w/	Total	Actual vs.		V-Bar
2013	High Side T1	Curtailed	Curtailed	V-Bar Estimate	Estimate	Actual	Estimate
1st Quarter	22,474 MWh	976 MWh	23,450 MWh	22,330 MWh	5.0%	44.1%	42.0%
2nd Quarter	11,740 MWh	337 MWh	12,077 MWh	15,908 MWh	-24.1%	22.5%	29.6%
3rd Quarter	16,262 MWh	732 MWh	16,994 MWh	15,583 MWh	9.1%	31.3%	28.7%
4th Quarter	21,005 MWh	852 MWh	21,857 MWh	20,455 MWh	6.9%	40.2%	37.7%
Total	71,481 MWh	2,897 MWh	74,378 MWh	74,276 MWh	0.1%	34.5%	34.5%

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- Primary concern is related to impact from ice, which can be thrown over 1,000 ft
 - There are no local highway routes or buildings
- Secondary concern is exceeding design capacity due to rotor imbalance or vibration
- Thirdly is performance degradation
 - We estimate 1% to 3% reduction in capacity factor due to icing, depending on the year







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- Phase 1, reduced to 1.5 MW
 - When differences detected between heated and unheated anemometers
- Phase 2, full shutdown
 - Due to deviations from anticipated power curve
- No means as yet to calculate actual verses possible production



Superhydrophobic Coatings

- Ice shedding coatings involve nanotechnologies still in their infancy
- No anti-icing technology is as yet sufficiently developed



Treated Power Lines





Generation Hierarchy – Least Cost First

• Delta Plant Frame 5 Gas Turbine

- Zehnder Plant Frame 5 Gas Turbines
- North Pole Frame 7 Gas Turbines
- Eva Creek Wind (requires load following)
- North Pole Combined Cycle Plant
- Healy Coal Plant

More cost

Less cost

- Purchased gas power over Intertie
- Bradley Lake Hydro



Regulation Issues - GVEA's System

- Purchased power is scheduled a day ahead, so GVEA must have flexible generation to fill the gap
- Wind will reduce the availability of purchased energy (other utilities must load follow wind in their area)
- Coal and combined cycle plants used to load follow can trip due to low limit or sudden instability. Once off they cannot immediately start back up

Start time and start-up costs



LM6000 (747 engine) used for load following



Combined Cycle Plant

Efficiency

Stean	n Turbine (4	Gas Turbine (44% max efficiency in simple cycle)			With ST
BASE LOAD >	-12 MW Nominal	100% Fuel Flow	-50 MW Nominal Highest Efficiency	44%	52%
	-9 MW		-40 MW	33%	39%
	-6 MW		-30 MW		
	4.2 MW st	eam	-25 MW, 50% load, 65% fuel	22%	24%
			-20 MW		
			-10 MW	11%	
		30% Fuel	-0 MW – Lowest Efficiency	0%	
			Cost of Operation		
		0% Fuel			
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Combined Cycle Plant



Combined Cycle Plant



North Pole LM6000 Gas Turbine Low load near trip condition



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Conceptual Fairbanks 24 Hour Load Curve



2013 Eva Creek Capacity Factor with Curtailment 34.5%



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Concepts for more economical load following:

- STORAGE:
 - Store wind energy in a reservoir and use it later like any other dispatched resource
 - Water storage (pumped hydro)
 - Compressed air storage
 - Batteries (flow batteries)
- LOAD MANAGEMENT:
 - Smart Grid type control of loads
 - Electric storage heaters in homes and businesses controlled by utility SCADA system
 - Capacity to delay less critical loads for a time when generation resources can be more efficiently applied, as in, with plants fully loaded or off-line



Concepts for more economical load following:

Incremental generation

Banks of diesel engines



As the load increases additional engines are brought on, all the engines but one are at full load and therefore at their highest efficiency

> INCREMENTAL GENERATION SMALL UNIT LOAD FOLLOWING

Five 5 MW gensets, fast on, fast off, auto-synchronizing





Maintenance – typical daily events:

DATE: 03 February 2014

CURRENT WEATHER: ESE Breeze @ 5 m/sec. Temp -2C @ Site, -18C in Ferry. Clear.

TODAY:

- 12 Turbines Online
- WEC 16 Pitch Comm Slipring, Inspect & Swap for Clean & Lube (begin)
- WEC 16 Cable Guide & Top Ladder Strengthening (resume)
- Sitewide LOTO Verification & Documentation (continue)
- Sitewide Tower Ladder Cable Guide Upgrade (continue)

FRIDAY & WEEKEND:

- 12 Turbines Online
- Sitewide Tower Ladder Cable Guide Upgrade (continue)
- Sitewide Converter Cabinet Inspection Temp Sensors & Hose Fittings (completed)
- WEC 16 Pitch Comm Errors, Slipring Faults (Sunday, Remote Reset)

Larger Maintenance Issues in 2013

- 1. Burned slipring (January)
- 2. Frequency Converter Contactor (June)
- 3. Frequency Converter Choke (December)



Maintenance Issues

- Road Maintenance
 - 17 miles of road
 - Snow removal
 - Visibility
 - Ice on road (chains)









- 0 %



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Eva Creek Overview

30-Aug-13 12:42:19

0.07 MW 8.07 MPH RUNNING 0.07 MW WT4	0.03 MW 7.00 MPH RUNNING	0.20 M 14.03 M 8.47 MPH RUNN RUNNING WT		Power Available Set Point Actual	Now 1.05 MW 24.50 MW 1.10 MW 1.51 Mvar 1.86 MVA	10m AVG NO DATA 1.51 MW 1.57 Mvar 2.18 MVA			
10.55 MPH RUNNING	18 (6)	WT7		Performance	e Today	Yesterday	MTD	YTD	
WT3				Production (MWh)	19.015	31.972	5203.258	43559.70	
		53115714C		Availability (%)	100.00	100.00	99.66	98.90	the state
				Capacity Factor (%)	4.25	5.90	30.33	31.46	
Weather W Wind Dir Speed 1	E S 252 DEG 10.1 MPH	0.10 MW 9.61 MPH RUNNING WT6	0.14 MW 13.07 MPH RUNNING WT9 RUNNING WT10	0.06 MW 9.18 MPH RUNNING WT11	0.10 MW 9.66 MPH RUNNING WT14	0.06 MW 7.57 MPH RUNNINC WT15	0.11 M 8.87 MP RUNN W	LEGEND = Normal = Fault	3
Speed 2 Temp Humidity Pressure	6 Deg.	Plant Overview	221 × • × • • • • 24.00 ho AND SPEEL 1 VEPAGE TO SIN FARM AVAILABLE MW VIND FARM REAL POWER	urs 🜓 C	30-Aug-1	01 MW 13 12:42:21 MW	dlence 967		

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Bird Mortality Study

- Only four birds (one ptarmigan and three song birds) found dead at site. No raptors or large birds of any kind
- This is less than expected, based on an earlier study performed for the Intertie in that area
- Scavenging rate is high for small birds so some birds will have been carried away, but there have been no feathers or any sign of larger bird remains
- The observers were tested and found almost all the test birds
 - There is a two year third party study in progress



Related Projects at Eva Creek

• Prospective balloon mount wind generator comparative icing test



Related Projects at Eva Creek

• State of Alaska LiDAR testing



Thank you for attending



White Maria Little

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Paul Morgan GVEA, Eva Creek Manager February 18, 2014

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