Kotzebue Electric Association, Inc
09/15/2010
Quarterly Project Report

Wales Diesel-Off High Penetration Wind System

Total Project Budget	**155,000**
Denali Commission	155,000
total	**155,000**

	Grant Budget	Prior Expenditures	Expenditures This Period	Total Expenditures	Grant Balance
KEA	$43,800.00	$3,905.70	$1,835.68	$5,741.38	$38,058.62
AVEC	$10,000.00	$0.00	$0.00	$0.00	$10,000.00
Contractor	$50,200.00	$0.00	$4,920.00	$4,920.00	$45,280.00
Labor Subtotal	**$104,000.00**	**$3,905.70**	**$6,755.68**	**$10,661.38**	**$93,338.62**
Equipment	$41,000.00	$0.00	$195.00	$195.00	$40,805.00
Travel	$10,000.00	$0.00	$1,347.00	$1,347.00	$8,653.00
Total	**$155,000.00**	**$3,905.70**	**$8,297.68**	**$12,203.38**	**$142,796.62**

Wales Diesel-Off High Penetration Wind System

Kotzebue Electric Association

Timeline

		Start dates
Phase One-Project Design and Engineering		
Task 1.1	Create Project Plan	1-Jan-10
	KEA	
	AVEC	
	Consultant	
Task 1.2	Evaluate Existing System-Create Prelim. Report	15-Aug-10
	KEA	
	AVEC	
	Consultant	
Task 1.3	Trip to Wales for Analysis	1-Jun-10
	Airfare x 3	
	KEA	
	AVEC	
Task 1.4	Construct Preliminary Engineering Design	1-Jan-11
	KEA	
	AVEC	
Phase Two-Installation		
Task 2.1	Procure Equipment	15-Jan-11
	Satellite Gear	
	Radio Upgrades	
	Wind Turbine Parts	
	Miscellaneous	
Task 2.2 Installation	Wind Turbine Repair	15-Nov-10
	KEA Wind Technician	
	Travel Kotzebue to Wales	
Task 2.3	Electrical installation	15-Mar-11
	Travel from Anchorage to Wales x 2	
	KEA	
	AVEC	
	Consultant	
Task 2.4	Final Troubleshooting	15-Apr-11
	Travel from Anchorage to Wales x 2	
	KEA	
	AVEC	
	Travel Kotzebue to Wales	
	KEA Wind Technician	
Phase Three-Data Analysis		
Task 3.1	Review of Past System Performance	15-Dec-10
	Consultant	

Task 3.2	3 months of Data Evaluation Data Network Established Ongoing Data Analysis-ACEP	1-Aug-11
Task 3.3	6 month Preliminary Report KEA	1-Nov-11
Task 3.4	Close out Report	31-Dec-11

As of September 2010 the Wales Diesel-Off High Penetration Wind System project is on budget. One change in the schedule is task 2.2 "Turbine Repair." This is due in part to cracks in the turbine blades (see pictures) that need to be filled and repaired with epoxy. The epoxy is on order from the lower 48.

In June of 2010 KEA contracted Western Community Energy (WCE) visited Wales to complete a detailed diagnostic on the two AOC wind turbines currently in Wales. Upon completion of the needed tests on the main turbine components it is believed that with improvements laid out below, and in conjunction with the AVEC operating team, that the machines could begin producing power quickly in an automated state.

According to Western Community Energy the main components of the system where in good shape and these turbines still have a good deal of value and a lot of rotational health. Sub systems like the tip brakes, parking brake, and heaters all checked out which was better than expected.

Upgrading the system to mimic the control systems present on the Nome and Kotzebue systems will provide commonality for maintenance teams and easier remote support.

Repairs

The following repairs were done quickly in order to run a complete system test.

1. Re-termination of the Turbine 1 and Turbine 2 control cables at the twist cable junction boxes.
    a. Turbine 1 had experienced a lightning event and destroyed the control cable going into the junction box. Turbine 2 had severe corrosion and less than optimal connections. Both were repaired to ensure control cable circuit integrity.
2. Broken tip barks on both Turbine 1 and Turbine 2 were replaced to ensure full testing function of the tip brakes.
    a. Two tip brakes on Turbine 1 replaced
    b. One tip brake on Turbine 2 replaced

3. Anemometer wires on both Turbine 1 and Turbine 2 were compromised at the sensors, all four were re-terminated. Also, connections were re-terminated and pulled at the twist cable junction box due to wear and electrical damage.

Diagnosis

The main goal of this trip was to diagnose the ability of the two AOC turbines to produce sustainably for a cost effective period of time. WCE was able to identify all major component functionality in the system. Included in this diagnosis was the confirmation of correct function of the following systems:

1. Drive Train free rotation including: low speed shaft, gearbox, generator coupling, and generator
    a. All rotation was tested and verified in both low speed and high speed conditions.
    b. Both machines were holding sufficient oil, minor leaks on low speed side of turbine 2.

2. Parking Brake Functioned Correctly
    a. Correct operation tested in both high and low speed conditions.
    b. Correct amperage and voltage was present on the circuit to the parking brake on both machines. (Turbine 1: 120V, 1.48A; Turbine 2: 120V, 1.49A)
    c. WCE will bring new sets of pads for more high speed testing.

3. Tip Brake Circuits functioned correctly
    a. Correct operation tested in both low and high speed conditions. The amperage seems acceptable; during more high speed testing the correct functionality of all the magnets will be exhibited.

4. Speed Sensors:
    a. Correct operation of the speed sensor was recorded on Turbine 1, correct resistance on the circuit, and correct registry information within the controller.
    b. Correct operation of the speed sensor was recorded on Turbine 2, but the resistance was zero- this is believed to be a short in the speed sensor and needs replacement. Yet the Frequency converter (Ultra Slim PackG478) was having issues on both machines and could be the potential source of the signal problem. WCE is not sure how the turbine was able to connect the contactor and could not find the source of the discrepancy I the controller code. (Turbine 2: 0 Ohm on the speed sensor, showing a short to ground.
    c. WCE was able to identify that the contactor closing algorithm was dictated by the acceleration in the RPM not the 1800 RPM standard stet point. WCE verbally confirmed this with Steve Drouliegh, and the

reasoning was to connect the generator to lower loads to minimize inrush current and kVAR.

5. Condensation Heaters on both turbines where working correctly
    a. Turbine 1: 1.66A; Turbine 2: 1.43A

6. Anemometers on both machines where working correctly as seen on the control registers. Also in the control shed onsite there are several replacement units if needed when more thorough full power tests are conducted.

7. Yaw bearings were rotating with minimal resistance on both machines, grease was added to both. Yaw locks were rotating with minimal resistance. Yaw seal is intact on both machines.

8. Blades structurally seem to be fine: bending without cracking noise, no rattling inside the cavity, however, there are surface cracks of concern.

    a. Surface cracks were observed on all leading edges of the blades on Turbines 1 and 2.
    b. It seems the crack is indeed within the surface structure of the blade and could be repaired with epoxy on the next site visit.
    c. Cracks were between 1 and 4.5 feet in length, and 1/16 of an inch at the widest point.
    d. Minor swelling was present in the end of the blade due to water buildup, which made the tip brakes fit very tight.

9. Generator was working correctly in both motor jog and connection states on both machines.
    a. Phase rotation was verified
    b. Correct Amperage in motor job and connection modes
    c. Voltage was correct line-line and line-ground.

System Improvements to Consider

The following is a list of system improvements recommended by WCE in order or importance.

1. Orbital Controllers installed in place of the KOYO DirectLogic PLC controllers.
2. Enable Remote Control interface for the machines.
3. New Satellite Communication Linkage is thought to be needed as a secure line to the turbines, power plant, and dispatchable thermal loads in town.
4. New twist cable junction boxes are desirable as the existing ones are severely rusted and don't hold out the elements. Additionally, it is recommended that new cable drops with easy twist connectors are intalled.

5. Thyristor soft start implementation for sequential phase connection of the turbine generators in high load.
6. Install new climbing cables. These cables are in fairly good shape (about 3-4 kinds each), but at the very least different standoffs are recommended for easy climbing of the tower rather than unhooking the ascender several times.
7. Install permanent tip brake platforms- for ease of future work and safety.
8. Install maintenance platforms.

Further operating tests need to take place, but the blade cracks currently prevent this. The epoxy is on order and should arrive in the region shortly. Sever weather in the Wales area often prevents travel, so the scheduling of site visits remains fluid. Pictures 1 and 2 show cracks in the blades and general corrosion.

Picture 1: Blade Crack

Picture 2: Blade Crack and Corrosion