Kotzebue Electric Association, Inc
1/3/2011
Quarterly Project Report

Wales Diesel-Off High Penetration Wind System

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

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-Nov-10
	Airfare x 3	
	KEA	
	AVEC	
Task 1.4	Construct Preliminary Engineering Design	1-Feb-11
	KEA	
	AVEC	
Phase Two-Installation		
Task 2.1	Procure Equipment	15-Apr-11
	Satellite Gear	
	Radio Upgrades	
	Wind Turbine Parts	
	Miscellaneous	
Task 2.2 Installation	Wind Turbine Repair	15-Apr-11
	Wind Technician	
	Travel Kotzebue to Wales	
Task 2.3	Electrical installation	15-May-11
	Travel from Anchorage to Wales x 2	
	KEA	
	AVEC	
	Consultant	
Task 2.4	Final Troubleshooting	15-Jun-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

1.0 Background

In 1995 the Alaska Energy Authority (AEA), Kotzebue Electric Association (KEA), Alaska Village Electric Cooperative (AVEC), and the National Renewable Energy Laboratory (NREL) implemented a high penetration wind diesel hybrid power system to reduce diesel consumption for Alaskan communities. This project we intended to be a technology demonstration and a pilot project for commercial replication in other Alaskan communities. The project was commissioned in Wales in the spring of 2001.

The system was designed to have an original capacity factor of 57.5% and utilize short term energy storage to ensure power quality. Due to degradation of the equipment and controls over the past eight years, the system in currently no longer functioning. The goal of this project is to demonstrate a diesel-off configuration for a remote wind-diesel hybrid power system through the retrofit of existing equipment and controls in Wales, Alaska.

2.0 Current Status of Schedule and Budget

Currently KEA has had to adjust the original schedule of tasks, beginning on task 1.4, moving the timeline for completion back. This is due primarily to the need for repairs on the turbine blades which are critical to the safe operation of the system (see Appendix 1). In June, 2010, KEA contracted Western Community Energy to visit Wales and complete a detailed diagnostic of the two AOC wind turbines. See Appendix 1 for complete diagnostic details, repairs and recommendations.

As mentioned in KEA's September Quarterly Report to the Commission, further operating tests need to take place on the Wales system; however, cracks in the turbine blades currently prevent operation of the system (See Appendix 1 for photos). The blade crack repair is fairly simple and can be done with epoxy. The epoxy was shipped to Western Community Energy in September, but they did not travel to Wales prior to the onset of winter weather conditions. Severe weather and cold temperatures will prevent the repair of the turbines until sometime in the spring of 2011 (this is due to the epoxy's reluctance to bond in cold temperatures).

Prior to further operational testing, which will be done after turbine blade repair, KEA will continue to work with involved parties on the system designs and control upgrades.

Depending on local weather conditions KEA will facilitate the turbine blade repairs and further testing in the spring of 2011.

As of December 2010 the Wales Diesel-off High Penetration Wind System project is on budget—mostly due to the fact that very few tasks have been completed and KEA has had minimal financial outlays to date. So far from the review of the wind turbines and the November visit to Wales it appears that the system including the ESS (energy storage system) the controller and the thermal storage units are intact. Although it can't be verified that they system in its entirely will work until the blades are repaired and KEA is able to run the system. KEA will need to see they system run in order to make meaningful recommendations for the upgrades. Once the system in operational KEA can evaluate the system performance to (1) ensure that there are no significant safety issues and (2) ensure that they system will not damage any of the power plant systems. At this point there are issues with the power plant that need to be understood before any evaluation can be done. Currently they are experiencing problems with the diesel engines being able to synchronize. KEA will be meeting with AVEC to understand what the issue is, and to determine if there other potential power plant problems that need to be addressed before the wind/diesel system can be operated. It will be critical to see the system run in its entirety in order to make recommendations for system upgrades, but it must be done safely.

There will also need to be a discussion concerning the upgrades to the wind turbines. The upgrades that have been recommended will need to be evaluated to determine which will enhance the turbine performance for system testing, and which will need to be deferred. The original grant request anticipated that the turbines were operational with minimum maintenance. The turbines had been repaired approximately 6 months before the grant was submitted, and other than an issue with the speed sensor they could have been operational. Since that repair a number of other significant issues have developed. This has complicated the entire budget outlook as more funding will need to go to the turbine repair than was anticipated. In this case a review of the budget will be needed to see if there are available funds from other categories that could be shifted without affecting the overall outcome of the project.
The main goal of the project is to get the system up and running again.

3.0 Tasks Completed This Quarter

KEA has coordinated with Western Community Energy to proceed with the repair of the cracks in the turbine blades.

In November 2010 Matt Bergan traveled to Wales with several ACEP employees. The following is a review compiled by Mr. Bergan:

3.1 Status of Hybrid Power System Controls

As of November 2010 the Wales Diesel-Off High Penetration hybrid control system was semi-functional and utilized in "Mode 0" by the powerplant operator.

3.1.1 Master Controller

"Mode 0" operation is diesel generation only (no wind generation). The operator uses the control system to start, stop and switch engines without having to manually synchronize and load/unload units.

The power plant operator indicated that the master controller was not able to synchronize one of the engines successfully due to a switchgear issue. The master controller automatic operation of the plant is predicated on reliable starting, synchronizing and loading of engines. Thus, the genset control components need to be fully functional for wind generation to be integrated into the diesel plant.

Communications technologies have changed in the past ten years and new communications should be evaluated for connection to the other system components from the master controller.

3.1.2 ESS ("Energy Storage Subsystem")

The batteries and rotary converter system appeared to be operable as of November 2010. The batteries have been kept warm the cell water levels have been maintained by the plant operator. A charge/discharge cycle had not been accomplished in many years and should be done.

The transducers and control components in the ESS should be recalibrated to correct any drift in the analog circuits that may have developed over time.

A solid-state power converter has become commercially available that could replace the mechanical, rotary converter (RC). The benefits of the solid-state converter should be evaluated based on the operation experience with the RC thus far. The magnetic mass of the rotary converter may be more beneficial though slower to respond that a solid-state system.

3.1.3 Local and Remote Dumploads (Secondary loads)

The local dump load appears to be operable however the remote dump load at the Wales school was not inspected. Controls and protective devices on each dump load should be tested and recalibrated accordingly.

Communications to each dump load should also be evaluated based on newer technology. Wireless communications to the remote dump load was problematic in the past. Remote I/O and PLC hardware and software for the dump loads should be evaluated to determine if they should be upgraded or will suffice.

Moving the remote dump load to the Wales water plant/washeteria should be considered due to the close proximity for high-speed, hard wired communications.

3.1.4 Wind Turbine Controls and Communications

Communication link to the master controller should be evaluated to determine if a better technology or product is available. The wind turbine to master controller link is critical to system operation.

The turbine controller should also be evaluated to determine how a "soft starter" or similar motor starter could incorporated. During previous operation of the Wales system, significant inrush current to the wind turbine induction generator was causing light flicker related to momentary voltage drop. A soft starter may help alleviate this issue.

4.0 Existing Problems

Currently, the main hurdle is the cracked turbine blades— as the system is not able to run until they are repaired. Once repaired KEA can evaluate the system in its entirety. KEA will coordinate with Western Community Energy to repair the blades in the spring of 2011.

5.0 Tasks to be Completed Next Quarter

- Preliminary Engineering Design
- Evaluate Equipment for: Satellite Gear, Radio Upgrades, Wind Turbine Parts, Misc.
- Repair of turbine blades, dependent on weather conditions.

6.0 Conclusion

Currently the wind-diesel hybrid power system in Wales is not functional. The repair of the turbine blades is critical for the functioning of the system as well as completing all diagnostic testing in order to further upgrade the system in accordance with the goals of this project.

Based on observations from Matt Bergan from a quick visit to Wales in conjunction with ACEP staff, and talking with Bill Crisci, the hybrid wind-diesel control system is still functional. Bill still uses the wind-diesel control to switch engines however there are some issues with the paralleling gear in the AVEC switchgear that is causing him some headaches. This will need to be evaluated as it pertains to the rest of the project.

Additionally, the battery connex (ESS) has been kept warm and the batteries are still full of water, though they are probably due for a cycle charge before re-commissioning.

This project is currently on budget but behind schedule. The adjusted schedule (above) should prove sufficient for completion of the milestones, though at a delayed date. The

delay in repairs to the turbine blades has caused the necessity to shift the schedule back until appropriate weather conditions allow the repairs to commence.

Following turbine blade repair and successful diagnostics of the remainder of the system upgrades will be needed for the communications and other control hardware. Following upgrades the system will need to be re-commissioned.

Appendix 1: Status of Wind Turbines

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 turbines were in good shape and the 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 wind turbine 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 test of the wind turbines.

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 wind turbines 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 set point. WCE verbally confirmed this with Steve Drouilhet, 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.

Wind Turbine 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 installed.
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 was shipped to Western Community in September, but they did not schedule a trip into Wales which will delay the entire project. Severe weather and cold temperatures in will prevent a trip to repair the blades until sometime in the spring of 2011. Repair of the blades will be critical to safe operation of the wind turbines.

Pictures 1 and 2 show cracks in the blades and general corrosion.

Western Community

Picture 1: Blade Crack

Picture 2: Blade Crack and Corrosion