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From Ross Hammond Date: June 28, 2011

To Mary Cooney (and the Kennedy Center Committee)

Re: Summary of the Kennedy Center Energy Report and Evaluation of 9 months of Building Operation

1. Introduction – Summary of Recommendations

This letter is intended to provide a summary of the Preliminary Energy Assessment completed at the end of 2010 on the Kennedy, MN Go Green Business Incubator. Both the Report and Supplement from the assessment are attached.
The letter includes a current assessment of energy costs and an estimate of future costs.
The key findings of the preliminary assessment are delineated as well as some information and recommendations on how to proceed. The key findings include:

- the building is sound structurally, however it is about average efficiency for buildings constructed in the 1950s. As such, it uses 3-5 times as much energy as it would if it were insulated properly.

- the heat pump system is running efficiently as designed, it is just not big enough for the heating load

- the wind turbine generator is now running reliably, however, there appears to be a metering problem so that the revenue generated is only a fraction of what it should be.

- the building as configured for the last winter (heating the gym, main hall section, offices and lunchroom) will cost approximately $35,000 per year to operate, heat and maintain, (this does not include major maintenance / capital items including roof repairs, etc).

- some of the energy efficiency work has been started, including: window repair, sealing off the tunnels and unused sections of the building, sealing openings and holes – however there is still much to do.

2. Background – History of Building and Project

A summary of the timeline is as follows:
1955 and 1959 -- The Main building built in 1955 and 1959. Like most buildings of the period, the building has brick walls that contain little insulation. There were large window walls in each room. A membrane roof was added later, however little insulation was added at that time. The original heating system consisted of two 15psi at 250 deg F coal fired Kewanee steam tube boilers and the system was designed with redundancy to operate with just one boiler in service at below zero temperatures. Typically, the North unit was the primary boiler, however both were used most of the winter except during maintenance.

1960s -- The boilers were later converted to No.6 fuel oil: the North boiler has one 9,800,000 BTU/HR input oil burner and the South boiler has two oil burners, totaling 7,000,000 BTU/HR input. The design efficiency is assumed to be 65%, while the actual maximum efficiency at load would have been about 60% after conversion to oil. This would yield a boiler output of 5,880,000 and 4,550,000 BTU/HR respectively.

1977 -- Due to the increasing price of oil, the school board decided to insulate the window walls. They had dense Styrofoam and fiberboard installed inside nearly all of the windows. Later the outside was also covered with wooden paneling.

2008 -- The school was shut down and combined with the Hallock School. The boilers were shut down and were not mothballed, as they were not planned to be used again.

2009 -- The NWRDC worked with the City of Kennedy to make a Go Green Business Incubator - a showcase for Energy efficiency in Northwest Minnesota. Grants were sought and received for a wind turbine generator and a high efficiency heat pump system.

2010 -- The wind turbine generator and a high efficiency heat pump system was installed early in 2010. Two auxiliary propane fired furnaces were also installed to provide additional heat in the gym. Parts of the building were closed off and not heated until needed.

3. Summary of Energy Audit Completed Nov – Dec 2010

Summary of Findings

The building appears to be comparable for buildings built in the 1950s. The evaluation used three indexes to determine how the building compares to other similar structures, (please see the Report pages: 4 and 18 - 23).

The building uses much more energy than buildings constructed in the last 20 years. For example, the Total Energy Cost (a US DOE measure) index for the Kennedy building is $1.20 $/ Sq Ft/Yr. This is much higher than average cost per square foot. A typical structure built today would have an energy cost no more than $.80 / Sq Ft / Yr. and the ideal cost for a "green" building would be $0.40 / Sq Ft / Yr.

4. Energy and Cost: Results To Date and Estimate Going Forward

a. Results: Oct 2010 – March 2011

Heat Pump System

A very efficient Ground Source Heat Pump System was installed for the office, main hall and Northeast rooms. The 500,000 BTU/Hr heat pump system was run all winter, along with the (2) 80,000 BTU/Hr propane furnaces. The heat pump system appears to be running as designed. A large section of the building was heated all winter with this system (and the two propane furnaces in the gym). The only problems with the heat pump system were the result of the building drawing too much energy from the system. It must be pointed out that, the building used to have 4 to 9 million BTU's per hour of heat input from the oil furnaces – it now has only 660,000 BTU/HR.

Wind Turbine Generator

The 33KW Next Generation Wind Turbine Generator was procured from Juhl Wind and was installed by Todd Electric. The Wind Turbine Generator ran intermittently due to some minor maintenance problems.
The generator is set up to produce the net generation, i.e., if the building load is more than the wind turbine generator output, the power produced is subtracted from the total being used. The wind then creates a reduction of the Kennedy center electric bill.
The KWHr of net generation and the electric bill savings for various capacity factors are shown below. The capacity factor is the percentage of generation as compared to the full capacity all of the time. For example, if the wind was blowing such that the turbine was generating 8 KW for an entire month, the capacity factor would be 8/33 = 24%.

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KW	**33**	33	33	33	33
Hours / Month Avg.	**730**	730	730	730	730
Capacity Factor	**3.0%**	5.0%	10.0%	20.0%	25.0%
KWHr / month	**722.7**	1204.5	2409	4818	6022.5
Electric Bill Reduction	**$57.82**	$96.36	$192.72	$385.44	$481.80

The above is theoretical. The table below shows the actual results at Kennedy.

Kennedy Center Electrical Cost Actuals	**Electrical Use Est.**	**Electrical Use - Heat Pumps Estimate**	**Cost for Energy**	**Demand Cost**	**Electrical Use Total**	**Wind Turbine Electrical Generation**		**Net Otter Tail Bill Total**
	kwhr	kwhr	@ $06.80 / kwhr	dollars	kwhr	kwhr	dollars	
January **2011**	8500	12780	$1,451.30	$42.18	21280	0	$0.00	$1,916.17
February	8500	10140	$1,271.25	$42.18	18640	80	$6.73	$1,700.06
March	8500	8620	$1,167.58	$41.98	17120	0	$0.00	$1,575.61
April	8500	10780	$1,314.90	$42.18	19280	0	$0.00	$1,692.83
May	8500	3020	$785.66	$40.67	11520	880	$74.03	$944.94
June								
October **2010**	8500	220	$594.70	$42.18	8720	720	$57.37	$750.36
November	8500	3420	$812.94	$42.18	11920	400	$31.87	$1,036.96
December	8500	16460	$1,702.27	$42.18	24960	160	$12.75	$2,173.98
Total 9 Months			$9,100.60		133440	2240	$182.75	$11,790.91
Average 9 mo.			$1,011.18	0.00	14826.67	248	$20.31	$1,310.10
12 month estimate								$15,721.21

Dan Juhl, an expert on wind has indicated that this wind turbine should be generating 10% to 25% capacity factor. This would mean that the turbine should be crediting the bill between $200 and $500 per month - not $50!

During on-site visits last fall, when the wind turbine was operating at a good speed, the consultants found that the output transformer located in the Furnace Room was quite warm – normal heat that indicated good power flow through transformer from the generator, (the heat is normal, as it is generated by copper and iron losses due to current flow).
Otter Tail is showing the correct Retail Rate on the bill, thus, there appears to be an electric metering or other problem.

b. <u>Estimate Going Forward</u>

The operating cost has been estimated based upon the first 9 months (below).

Operating Cost Estimate	per month avg.	per year
Electricity Net	$1,310.10	$15,721.21
General Building Maintenace	$900	$10,800.00
Insurance	500	$6,000.00
Building Repair (on Average)	$250	$3,000.00
Total	$2,960.10	$35,521.21

5. Recommendations

1. Wind Turbine Generator

a. Resolve Electric Metering Issues

The problem will need to be identified and resolved so that Kennedy can get the proper credit for the power generated. A formal request must be made of Otter Tail to test the current flow from the generator and the metering circuitry. The wiring and metering from the WTG must be checked by Otter Tail Power technicians. The Current Transformer Ratio may be incorrectly set or there may be another connection problem whereby the meter is not recording the correct amount of power produced.

b. Resolve Maintenance and Monitoring of Turbine and Generator

Once the metering issue is resolved, there will be funds to pay for monitoring and maintenance of the wind turbine to ensure that it runs properly and if it trips out, it is restored to service as soon as practicable. Once the turbine is metered properly, it should generate (and thus reduce the electric bill by) an amount on average of $15 to $20 per day.

A maintenance contract must be completed and executed.

2. Sell the wooden floor in the Gym

It is important to sell the wooden floor in the Gym before it is ruined. If there are temperature excursions or roof leaks:

- the floor will be worthless for sale;
- the floor will become a tripping hazard and;
- this will render the gym not useable.

The contract should state that the floor will be removed and the remaining linoleum flooring underneath cleaned for use.

The linoleum will still be usable for sports, but will also be ready for industrial equipment, should a renter wish to lease the gym for such a use.

This will allow the temperature in the gym to be allowed to drop to 35 deg F at night and is expected to save 40% of the cost to heat using propane each winter.

3. Continue to seal the Building

a. Seal the "Outer Envelope"

Continue to seal any holes in the outside walls, doors not being used, etc.

Continue to seal the windows and or replace the windows with the worst frames.

The original building had large two pane plate glass windows in each classroom and in other areas. In the late 1970s, the inner windows were removed and replaced with extruded dense Styrofoam insulation and wallboard which was painted. The outer wall was later covered with masonite and cedar siding panels. Each 9' section of wall had one smaller single pane window installed, (approximately 30" x 42"). Later, some of these single pane

windows were replaced with double pane hinged or sliding windows. Still later, additional windows were replaced with even better quality double pane insulated sliding windows.
However, nearly half of the original single pane or hinged two pane windows remain. Many of these leak and some have sills and sash that have deteriorated to the point where it is possible to see holes through to the outside.

Miscellaneous air leaks – holes in walls etc. It appears that the building is fairly tight given the age and type of construction (except for the windows and doors). Later, after the tunnels are sealed and the old windows have been replaced, it may be prudent to do a blower door test on sections of the building to determine actual leakage rates.

b. Seal the "Inner Envelope"

Continue to seal the tunnels sections and wings that will not be in use in the near future. Cover the other wing hall entrances with poly and tape to reduce leakage.

c. Seal the "Tunnels"

Continue to seal the tunnels sections and wings that will not be in use in the near future.
Seal the tunnels going to the East and Center wings and if possible to the North under the front sidewalk.

d. Seal all of the "slots"

Seal all of the "slots" that are under the old heating radiators in most of the rooms. It is critical to do this to reduce the air leakage into the building and to prevent any humid air from coming up should there be a heavy rain and some water seeps into the tunnel. Seal the slots under the radiators (in all of the rooms with slots) before spring 2011 in order to prevent any damp air (if it occurs) to enter the rooms. Use expandable foam and or a 1 x 3 inch board to cover and seal the slots.
The tunnels were used to provide pre-heated air up through the radiators in each room to force circulation of warm air. These are no longer needed for this purpose. In addition, there is a serious problem of water getting into the tunnels due to poor site drainage. This water leads to moisture getting into the rooms above as each room has a slot open to the tunnel. This moisture has led to the formation of mold in a number of areas. (refer to dewatering plan; in addition, the wind turbine can provide additional power for the pump-out system).

e. Ventilate

Place a fan in the tunnel where it enters the furnace room that will pull air from the tunnel. Whenever the temperature outside is above 40degF, crack open the floor covers at the South end of the wings in order to provide a place for air to enter the tunnels for ventilation. Also place an exhaust fan in the furnace room for the spring and summer to send the air the tunnels to the outside.
Look at options to modify the two existing air handler plenum ducts in order to provide fresh air and ventilation that does not utilize the tunnels.

f. Begin to replace sections of the roof before there are leaks

Get a price from a reputable roofing contractor to replace the Gym roof and add 8 to 12 inches of Styrofoam insulation under the membrane. The membrane roof which was installed in sections over that last 10 – 15 years. It appears that no extra insulation was installed under the membrane – only 1 – 2" of fiberboard (or equivalent). This matched the original installation of 1-1/2" of fiberboard under a built up tar roof. Testimonial information is that there are problems with the flashing at various points on the outside walls, vent and exhaust outlet ducts, and especially where the main roof meets the high South gym wall. Apparently there are visible leaks during rainstorms and in addition, excess water ends up in the tunnel system.

6. Summary of Options

The current heating load far exceeds the capacity of the heat pumps and two furnaces in the gymnasium. If the building is to be used and rented, temporary or permanent furnaces need to be installed. These will be run only for peaking when the building is sealed and insulated.

In the longer term the options are as follows:

PLAN A – DO NOTHING
This is NOT recommended. It may not be possible to just walk away from the building without any cost. The structure will fall into ruin overtime and become a hazard for children and others. In addition, the asbestos must be dealt with at some point in time, as per US EPA regulations (See Plan B).

PLAN B – TEAR IT DOWN AND CLEAR THE SITE
A rough estimate to demolish the Kennedy facility and haul it away is $2.00 / Sq Ft, or $100,000. In addition, the cost for asbestos abatement could run $2 - $3/Sq Ft adding another $100 - $150,000. It will be necessary to remove the asbestos lower wall panels and any asbestos insulation on the piping and furnaces prior to demolition.
Total Estimated Cost: $200,000 to $250,000.

PLAN C – MOVE FORWARD SLOWLY / MONITOR BUILDING PERFORMANCE
Add propane furnaces and Heat Pumps over the next few years as the building is leased.
Do the improvements suggested in Section 5. Above.
Investigate the cost to begin replacing and insulating the roof
Investigate the cost to build stud walls
Initial Cost: $10,000
Total Estimated Cost of modifications: 2011- 2020 (in nominal dollars) $ 250,000,
(note: if building is leased faster, some additional expenditures will need to be made sooner, however there will be revenue that will offset the expenses).
Energy and Operating Cost: $ 35,000 / year

PLAN D – MOVE FORWARD – STAGED APPROACH - DO PROJECTS EACH YEAR- 2011 -2020
Staged Approach - Bring The Heating System into Balance (ten projects 2011 - 2020) - Bring the heating load into balance with the heating system capacity during 2011-2012. This will require a combination of windows, doors, insulation and more heating capacity.
Costs: Additional Heat Pumps, propane or bio-mass furnaces, Insulate Roof, Construct Stud / Insulation / Drywalls inside of Brick / Cinder block walls and refurbish the ventilation system.
Total Estimated Cost: 2011- 2020 (in nominal dollars) $ 532,000,
Energy and Operating Costs could remain constant at: $ 35,000 / year as two to three times as much of the structure was heated, rented and used.

PLAN F – TEAR IT DOWN AND REPLACE WITH A NEW GREEN BUILDING
This option will require part of PLAN B (above) to clear the building to the foundation and then add a new similar building using new green technologies. Cost to clear demolish but leave foundation work $150,000 - $200,000. Cost for a new structure 31,000 Sq Ft, one story one half with 12 ft ceilings and one half with 20 ft ceilings for light manufacturing: $3 - $5 million. Cost for new building similar to a gymnasium: $1.5 Million. Total Estimated Cost: a nominal cost of $100 per square foot average cost was used, which would lead to a total cost of $5,000,000 to replace the building.