



11-17-08
Personnel + Finance
#3

September 30, 2008

Mr. Mark Ostgarden, City Planner
Brainerd City Hall
501 Laurel Street
Brainerd, MN 56401

Dear Mark:

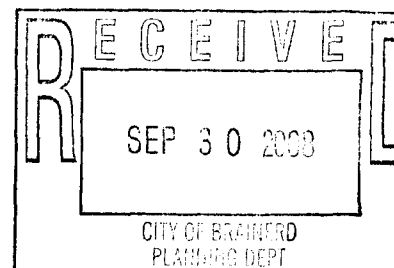
Enclosed is your copy of the Energy and Waste Reduction Assessment Report prepared by the RETAP team of William Rois, Norm Ledeboer, and me. The report gives detailed recommendations for energy savings and reduction of solid waste at Brainerd City Hall.

Included in our suggestions are ideas for saving energy through changes in lighting, HVAC, windows and doors, and plumbing fixtures. Although these changes could be paid for through city budget appropriations, we believe it would be useful to consider options such as performance contracting and the Minnesota Energy Investment Loan program, both of which are briefly discussed in the report.

It was a pleasure to work with you on the two occasions where we made site visits to the City Hall. If you have questions about the report or wish any further information, please contact us. Our email addresses and phone numbers are listed at the end of the report.

Sincerely,

Rin Porter
RETAP Team Member



ENERGY and WASTE REDUCTION
ASSESSMENT REPORT

Brainerd City Hall
501 Laurel Street
Brainerd, MN

SPONSORS

Mark Ostgarden, City Planner
Jeff Hulsether, Maintenance Supervisor

RETAP ASSESSMENT TEAM

Rin Porter, Team Leader/Report Writer
William Rois, Team Member
Norm Ledeboer, Team member
Gordon Amundson, Follow-up Coordinator

Prepared by

MINNESOTA RETIRED ENGINEERS
TECHNICAL ASSISTANCE PROGRAM

On behalf of

THE STATE OF MINNESOTA

September 24, 2008

I. Introduction and Background

The RETAP team of William Rois and Rin Porter conducted an energy use and waste reduction assessment of the Brainerd City Hall located at 501 Laurel Street, Brainerd, Minnesota, on July 10, 2008. The RETAP team met with Mark Ostgarden, City Planner, and Jeff Hulsether, Maintenance Supervisor, and then toured the building with Mr. Hulsether. A follow-up meeting was held on September 5 with Rin Porter and Norm Ledebor from RETAP, and Mr. Ostgarden and Mr. Hulsether from the City of Brainerd.

EXECUTIVE SUMMARY

Based on the site visits and analysis of the past twelve months utility bills, RETAP believes there are significant opportunities for energy savings and reduction of waste. These are summarized below with more descriptive information under Section V of this report.

- Hire an experienced HVAC contractor to evaluate the serviceability of the heat pumps and the entire HVAC system regarding number of air handlers, cooling condensers, variable frequency drives on some motors, number and control of zones, energy management system controls and overall efficiencies of the systems.
- * • Consider ways to reduce demand on the electrical system by spreading out the start-up of equipment and lights over a one half hour period. Such a procedure can save \$10 per KW, per month, when demand is reduced.
- * • Set up a quarterly cleaning schedule of the baseboard registers, to provide better heat transfer.
- * • Consider installing sun control window film on the east, south and west windows to reduce solar heat gain and UV damage to furnishings in summer, but will allow solar gain in winter.
- Consider installing a back-up generator to operate essential systems during a power outage.
- Consider replacing all existing lighting with more efficient systems, and also consider reducing the "light density" in watts per square foot, as discussed below in Section V. Lighting consumes approximately twenty five percent of electrical energy. These changes can provide energy savings of approximately \$1,500 and \$1,000 per year, respectively.
- Consider installing separate HVAC systems for the computer server and map/plan storage rooms, to control temperature and humidity within acceptable ranges.
- * • Check all exterior doors for tightness and plumb and replace weather stripping.
- Consider using office paper made from recycled content materials and instituting a recycling program for the entire building.
- * • Add a layer of insulation to the water heater and adjust the temperature setting to 115 degrees F. Typical payback is one to three years.
- Consider replacing exit signs with Light Emitting Capacitor (LEC) technology. These use approximately 0.3 watts each versus 3.0 watts for LEDs and 12 watts for CFLs.
- Consider installing low flow and automatic shut-off plumbing fixtures. Typical payback is three to five years.

II. Description of Facilities

The Brainerd City Hall was built in 1917. It is an 18,862 square foot three-story building of concrete block with brick facing. All the floors are concrete. The interior walls are 2 x 4 stud walls with drywall finish. Twenty-three people work in the building, serving a city with a year-round population of 13,900. The building is open from 7:30 AM to 4:30 PM daily, and used for one evening meeting per week, for a total of about 48 hours per week of usage.

In 1992, the building was gutted and remodeled. During the remodeling, all the old windows were removed and replaced with fixed aluminum-clad double-thermopane windows.

New natural gas boiler equipment was installed, along with 12 to 13 water source heat pumps placed in the spaces between floors.

The building is heated by a hot water convection baseboard radiant system. It is cooled by a cooling tower with air conditioned zone control.

The building does not contain any food service facilities or vending machines.

Windows and Doors

The windows are fixed aluminum-clad double-pane type. They provide extensive daylight to the interior office spaces. Staff report excessive heat gain from the windows on the east, south, and west sides of the building.

The main entry doors from Laurel Street include a vestibule. These doors have good seals and do not appear to leak air. The basement exit doors include a vestibule, but the outer doors are not well sealed and do admit air.

Lighting

We noted 116 recessed CFL can lights with magnetic ballasts, each with two 26 watt lamps. These fixtures use 56 watts each, including ballasts, for a total of 6,496 watts. We noted 142 square fluorescent light fixtures, each with three T5 size lamps, and magnetic ballasts. These fixtures draw 130 watts each, including ballasts, for a total of 18,460 watts. We noted 48 T12 two lamp fluorescent fixtures, with magnetic ballasts, each fixture drawing 92 watts with ballast, for a total of 4,416 watts; four T12 one lamp fluorescent fixtures, each drawing 50 watts, for a total 200 watts, including their magnetic ballasts; 15 incandescent floods, with eight 75 watt and seven 100 watts, for a total of 1,300 watts; 24 incandescent floods in the elevator, of 20 watts each, for a total of 480 watts; two pendant halogen lights of unknown wattage.

Security lighting is provided by four ground-mount sodium vapor exterior floods at 188 watts each, or 752 watts total and six pole-mount lights of unknown wattage, all controlled by photo cells and timers.

The total electricity drawn by these lights, not including the unknowns, is 32,024 watts, or 32 kW. In a nine-hour work day (7:30 – 4:30), this lighting would use 288 kWh, if all lights were on.

HVAC System

Heating, ventilation, and air conditioning of the building are provided by a combination of heating and cooling systems. Water source heat pumps are installed in the ceiling spaces between floors. The building is divided into four zones, with temperatures adjusted by Honeywell non-setback electronic thermostats not hooked into any kind of Building Management System. One McQuay Snyder General air handling unit provides ventilation with an automatic damper for outside air. Mr. Hulsether said that the damper seals are tight, the dampers operate freely, that outside air is brought into the boiler room through dampers, and that the dampers were automated with the boiler

operation. He said that the building operates with a positive pressure all year around. There is no economizer system on the air handler.

Two Marathon Electric of Wausau pumps (7.5 hp each) circulate loop water heated by a Gordon Piatt Energy Group natural gas burner and a Peerless boiler of 1695 kBTU (with insulated piping), through the heat pumps as well as an "emergency" baseboard heating system.

One new rooftop condenser provides AC for the council chambers. It was a Lennox LGC090S2BH2Y, rated at 3.5 tons according to the website.

A McQuay computerized control panel controls the valving in the basement to regulate the temperature of the loop water. It does not control the boiler, which has manual controls. The team observed five electrical boxes, the building telephone system, a 6000 watt A.O. Smith electric 50-gallon water heater (piping not insulated).

Centerpoint Energy provides natural gas service. Brainerd Public Utilities (BPU) provides electricity and water. BPU purchases wholesale electricity from Minnesota Power.

An older part of the building reached via a ramp is used to park city vehicles. It was about 60 x 60 feet, heated through the hot water system and a Rupp Temp Air gas heater mounted in the ceiling, and is tied into the ventilation system through ceiling ducts. The doors between this garage space and the rest of the building are not sealed tightly, but are fire-rated, according to Mr. Hulsether, and the building is equipped with carbon monoxide detectors.

Water Usage

Water is used for water fountains, rest rooms, and irrigation. There is no food service in the building.

Exit Signs

Some exit signs were not lit. They are believed to be incandescent.

Waste Hauling and Recycling

A recycling center was located outside, at the side of the building. Office paper is recycled. Two 2-yard dumpsters are emptied weekly. One 90-gallon and three 60-gallon recycling containers were observed for recycling office paper and other items.

III. Review and Discussion of Utility Bills

Electricity

Twelve months of electric bills were reviewed, for the period April 2007 to March 2008. For that year, the annual kWh used were 269,760, and the total cost of electricity was \$23,480.10, or 8.7 cents per kWh. The utility charged a power cost adjustment of \$4,115.24, which is 17.53 percent of the total bill. The kWh used per square foot of space is 14.3, which compares very favorably with the average of 16.5 kWh per square foot for similar office space within the Xcel Energy Minneapolis Metro service area.*

The highest months of kWh usage were July, August, and September, of '07, which indicates a large air-conditioning load. The City should ask whether Brainerd Public Utility offers a controlled air conditioner program, similar to the "Saver's Switch" program offered by Xcel Energy. This program provides an air conditioning credit of \$5 per ton per month for four summer months.

The power factor (PF), is not listed on the bills. The City should ask the utility what the PF typically is and whether they are incurring a penalty for low PF. The load factor (LF), is "fair", averaging 45 percent. A "good" load factor is 50 percent or higher. The demand charges for the past

year are greater than the energy charges, which indicates a high demand and/or could also indicate low PF.

(* From Northern States Power Company, "Guide to Energy Savings and Comfort", 1995).

Natural Gas

Twelve months of natural gas bills were reviewed for the period April 2007 to March 2008. For that year, the annual therms used were 13,620, or 1,362,000,000 BTU. The cost of gas for the year was \$15,467.17. The average therms per day were 36.8. The rate charged varied from 65 cents per therm to \$1.98 per therm. For the months of June, July, and August, no gas was used, and in September only 0.2 therm was used.

If the building is 18,862 square feet in area, then the therms per square foot = 0.722 or 0.722 therms x 100,000 BTU/therm = 72,200 BTU per square foot.

If both electrical use and gas use are put on a BTU basis and degree days are factored into the energy use per square foot equation, we have 269,760 kWh x 3,415 BTU/kWh = 848,395,200 BTU, plus the 1,362,000,000 BTU of gas used = 2,210,395,200 BTU total energy used. On a BTU per square foot per degree day basis, using 9,400 degree days for Brainerd, we have, 12.47 BTU/sq.ft.-DD. This compares favorably with the average of 11.59 BTU/sq.ft.-DD, for similar, typical office space in the Xcel Energy Minneapolis Metro service area, using 7,970 DD.*

(* From Northern States Power Company, "Guide to Energy Savings and Comfort", 1995).

Water and Sewer

According to the water bills for the period April 2007 to March 2008, water usage and water charges were highest in the months of May through October. Usage increases from a minimum charge of 3000 gallons to as high as 94,000 gallons. We believe that during these months, city water is being used for irrigation. If this is true, the City should install a separate meter for irrigation water. Water treatment costs should not include the additional water in the summer because it is going into the grass and not into the city wastewater treatment plant. A conversation with the city clerk might serve to reduce the City Hall water treatment costs. Perhaps the City Hall is being treated as a residential building and not as a commercial building, and minimum water charges are being levied. We did not determine when the water meter is read, but it appeared to be read only during the months of April through October. The water/sewer bills indicate potential savings could be significant, on the order of \$150 per month for five months, or \$750 per year.

IV. Issues of Concern to Staff

Mr. Ostgarden and/or Mr. Hulsether raised the following issues for RETAP:

- The existing zone controls for heating and air conditioning are not effective. Employees report being too hot and too cold and the zone controls do not provide even temperatures. There are too few zones.
- There is too much heat gain through the south windows into the office spaces.
- It is taking a lot of maintenance to keep the heat pumps working. Several of them are broken and have not been repaired because the City does not allocate sufficient maintenance funding.
- Each heat pump has to be reset manually after a power outage.

- There is no back-up power generator.
- Mr. Hulsether does not think that the motors that operate the HVAC have automatic shut-offs for power outages.
- The square fluorescent lights (T-5) are flickering in almost all the offices. This is bothering the staff.
- The computer server room gets too hot. The air conditioning is not keeping it cool enough, and the air conditioning unit freezes up.
- There is too much humidity in the basement due to outside air infiltration. One of the rooms had a small dehumidifier operating, but that was not sufficient to take care of the entire floor.
- The public exit doors from the basement level leak. They are not sealed and humidity enters through the air spaces.

(Essentially all of the above items are addressed in this assessment report and if recommendations are accomplished, many of these concerns would go away).

V. RETAP Recommendations for Energy Savings

- The City should hire an experienced contractor (such as Johnson Controls or Siemens) to evaluate the serviceability of the heat pumps and whether they should be replaced or repaired, and consider an overall Energy Management System to control all the HVAC equipment, including air handlers, cooling condensers, variable frequency drives and automatic shut-offs on motors. The usual life of a heat pump is 12 years and these units are already 16 years old. RETAP believes replacement of the system is needed. Additional zone controls should be installed along with the new heat pumps. To control the temperature in the offices, the thermostats/zone controls should be installed where there are no partition obstructions. Water source pumps can be added to the existing water loop, each with its own thermostat for zone control. Proper humidification control should be considered when the new zone control system is designed. If the City deals with a large company, they could possibly obtain a performance contracting plan that would provide for new equipment and regular maintenance but require no outlay of additional funds for five to ten years.

Another funding alternative can also be considered. Minnesota's Energy Investment Loan Program ("EILP"), managed by the Minnesota Department of Commerce, will finance up to 50% of the loan principal at 0% interest for qualifying renewable energy, energy efficiency or energy conservation "capital improvement" measures in existing buildings. The measures must have a simple payback of 10 years or less and cannot exceed \$500,000 per project. EILP participation is limited to a 5-year amortization. EILP will participate with private lenders, who are identified by the participants. Participants most often have used Tax-Exempt Lease Purchase Agreements as the financing vehicle. Minnesota cities, counties, townships, hospitals and K-12 schools are eligible for this subsidized interest rate program. Contact Amy Bicek, Minnesota Department of Commerce, (651) 296-2429; amy.bicek@state.mn.us for more information.

- The baseboard registers were observed to be covered with a layer of dust. Register fins should be cleaned quarterly for maximum heat transfer/conduction.
- The City should consider installing reflective, sun control film on the south and west windows to reduce solar heat gain and UV damage to furnishings in the summer, but allowing solar gain in winter. Typical cost for doing this is \$7 to \$9 per square foot of glass, but can provide

significant reduction in solar heating of office areas, which would enhance comfort levels and could reduce AC load. Incentives and rebates may be available from the utility or elsewhere for doing this.

- The City should purchase a back-up power generator to operate essential systems during a power outage. Grant funding may be available through the U.S. Department of Homeland Security.
- The City should consider installing low flow and automatic flush plumbing fixtures. See web site for “MagicFlush” in Section VI. Typical payback is three to five years.
- Lighting needs replacement. RETAP recommends T8 fluorescent lighting with electronic ballasts, to replace existing linear tube lighting, zone lighting and occupancy controlled lighting. Currently, lighting seems to consume about 25% of the electrical usage. Changing the 142 fluorescent lights with magnetic ballast and T5 lamps to electronic ballast T8 lamps would save about $130 - 96 = 34$ watts per fixture, or 4,825 watts or 4.83 kW total. This would also eliminate the “flicker” which was reported as a concern to the staff. Changing the 48 T12 lamps and magnetic ballasts to T8 lamps with electronic ballasts would reduce the wattage of these fixtures by 28 watts each, times $48 = 1,344$ watts. Changing the four, one lamp T12s to T8s would save another 18 watts per fixture, or $4 \times 18 = 72$ watts. If all incandescent lamps were changed out to equivalent lumens CFLs, (Twenty five watt CFLs for 100 watt incandescents; Twenty watt CFLs for 75 watt incandescents and six watt CFLs for the twenty watt incandescents), this reduced wattage would be 1,325 watts. Therefore, the total savings in energy with the above changes in lighting, would be $4,828 + 1,344 + 72 + 1,325$ watts = 7,569 watts = 7.57 kW. If these lights are on 2,340 hours per year, the savings would be $7.57 \text{ kW} \times 2,340 \text{ hrs/yr} = 17,714 \text{ kWh}$. At $\$0.087/\text{kWh}$ the dollar savings would be $\$1,541.12$ per year.
- In addition to changing lamps and ballast, the City should consider reducing the “light density”, i.e. the watts per square foot of space. The ANSI/ASHRAE/IESNA Standard 90.1-2001, recommends a “lighting power density” of 1.2 watts per square foot of space for Court Houses and 1.0 for Offices. The City Hall has a light density of about 1.34 watts per square foot, based on the lamp wattage of the existing ceiling lights. If the light density were reduced to 1.1 watt per sq. ft., the reduction in wattage would be 4,908 watts or 4.91 kW. The dollar savings in electricity would be $4.91 \text{ kW} \times 2,400 \text{ hrs/yr} = 11,784 \text{ kWh} \times \$0.087/\text{kWh} = \$1,025$ per year.
- The computer server room and map/plan storage rooms are key locations that must be kept temperature controlled. RETAP recommends installing separate HVAC for these rooms, because the cooling and ventilation requirements differ for computer rooms and document storage rooms.
- Exterior doors should be checked for plumb and level and resealed with weather stripping and bottom sweeps. The basement door has significant air leakage and is likely to be admitting moist outdoor air, adding to the basement humidity problem. Typical payback is two to three years, if building maintenance personnel can do the work.
- The City should install another layer of insulation on the water heater and turn the temperature setting down to 115 degrees F. Insulation blankets cost about \$25 and payback is typically one to three years if the maintenance personnel do the install work. Typical savings = \$15 per year.
- Use of recycled products: the restrooms were observed to use Ecosoft toilet paper made from 100% post-consumer recycled materials. This is great! We also recommend using office paper made from recycled content materials, instituting a recycling program for the building,

and appointing a Sustainability Coordinator to oversee energy efficiency, energy reduction, and waste reduction efforts for the City Hall.

- The City should consider replacing exit signs with Light Emitting Capacitor (LEC) illumination. These use approximately 0.3 watts each versus 3.0 watts for LEDs and 12 watts for CFLs and 20 watts for incandescent lamps. See the web site under Section VI.
- The City should ask utility representative what the power factor (PF), on the electrical system is. If PF is below 90 percent, the City may be paying a penalty for electricity.
- The City should look for ways to reduce demand by spreading out start-up of equipment and lighting over a one half hour to one hour time period each day. Demand charges average \$800 per month and are approximately \$10 per kW per month, so a 10 kW reduction of demand would save \$100 per month on the electric bill.

Long-Range Planning

- Mr. Ostgarden mentioned that because the City Hall is at capacity, an addition is being considered. The City owns several buildings including the City Hall, police department, fire department, street garage, ice arena, and two parks buildings. We recommend that space in each of the buildings be evaluated and a master facilities plan devised to guide future expansion. An architect can assist the city planner in determining whether options such as new construction, remodeling, leasing, or purchasing additional space are best for the next 5 to 10 years, given the growth that is expected in Brainerd.

VI REFERENCES AND CONTACTS

A. EgressTech web site, www.LimeLite.com and LightPanel Technology, www.lightpanel.com web site for Light Emitting Capacitor (LEC) exit signs.

B. Minnesota Waste Wise; www.mnwastewise.org

C. Green Guardian; www.greenguardian.com

D. Magic Flush; www.magicflush.com

E. Contacts:

RETAP

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Brainerd City Hall

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VII ATTACHMENTS

- A. Spread sheet of utility bills.
- B. Recommended light levels from the Illuminating Engineering Society.
- C. Information on the Xcel Energy "Saver's Switch" program.