Recommissioning of a Large Acute-Care Hospital

The hospital recommissioned is a nine-story, 600,000 square feet acute care facility in Minneapolis, MN. The first floor was built in 1981, and the rest of the floors were added in 1982. The building has been well maintained by a full complement of in-house maintenance staff. Figure 1 is the front view of the building. The building has three electric vapor-compression chillers and one steam absorption chiller, with a total cooling capacity of 3409 tons. The chiller plant also supplies chilled water to two adjacent buildings. Two small process chillers (52.5 ton each) provide chilled water to medical equipment within the building. Steam is supplied by a campus steam plant. Steam-to-hot water converters serve reheat coils, radiators, and ceiling radiation panels. The building has 16 major single-duct terminal reheat air handling units (AHUs), twelve variable volume and four constant volume. Control is provided by a first-generation building automation system (BAS) that has most of the capabilities of a modern system, but is substantially less user-friendly.

Objectives and Approach

The owner’s objective in recommissioning the building was to reduce operating costs while maintaining or improving indoor air quality and comfort. For this project, CEE partnered with the Energy Systems Lab at Texas A&M University, the most experienced and effective healthcare recommissioning provider in the U.S. At the owner’s request, the project made use of in-house operations and maintenance staff to implement almost all of the recommissioning measures, with only a limited amount of labor provided by outside contractors due to staffing constraints. This not only reduced external costs and helped to assure that the operators were
comfortable with the changes made, but also gave the operators an opportunity to develop a deeper understanding of overall system operation and the cost consequences of operating and maintenance decisions they make on a daily basis. The recommissioning process started with a training workshop for key facility O&M staff. The project engineers then worked closely with the staff to investigate existing operating sequences, identify operational and comfort problems, develop recommissioning measures, and supervise in-house staff implementing the measures.

**Major Recommissioning Measures**

Opportunities for recommissioning measures were identified through field measurements carried out by highly-skilled and experienced engineers to quickly zero in on sub-optimal central-system operating strategies that waste energy. Major recommissioning opportunities identified included:

1. Calibration of control system instrumentation;
2. Resetting supply air temperature set point;
3. Resetting duct static pressure set point;
4. Replacing bad inlet guide vanes with VFDs;
5. Calibration of VAV terminal boxes;
6. Improving economizer operation;
7. Optimizing the chiller and chilled water pump operation;
8. Performing hot water and chilled water balance;
9. Optimizing heating water temperature reset schedule and on/off sequence;
10. Reducing outside air flow;
11. Calibration of thermostats;
12. Performing air balance;
13. Determining the minimum outside air damper position; and
14. Repairing kinked flex ducts and leaky reheat control valves.

A key element of the recommissioning process is the diagnosis and correction of zone-level problems that might otherwise prevent key central-system measures from being fully implemented.

**Savings, Costs and Payback**

Results were monitored using a $35,000 monitoring system installed for this purpose. The cost of this system, included in the overall project cost, was justified by the size of the project, the trade-off of equipment costs against greater labor costs with numerous small portable loggers lacking remote downloading capability, and the importance of energy savings, both to the provision of utility rebates, and to the owner’s evaluation of the value of the project.

A baseline model of the energy use of the building was developed from the consumption data gathered before any recommissioning measures were performed. The model was then used to predict what the building consumption would have been if the recommissioning had not been performed, using the post-recommissioning weather data. Savings were then determined by subtracting the measured post-recommissioning energy use from the baseline predictions of building use without the recommissioning. All of the major recommissioning opportunities identified had been implemented at the time of the analysis except #7 and parts of #9 and #10.
Figures 2 and 3 compare the whole building electricity and steam consumption before and after the implementation of major recommissioning measures. (The few dozen high steam consumption points during mild weather conditions occurred when the absorption chiller was under test runs.) Three- and four-parameter change point baseline models were developed for both electricity and steam consumption. Analysis showed that total electricity consumption savings were 1,120 MWh or $56,004 per year, and steam consumption savings were 16,638 MMBtu or $124,785 per year. Annual energy consumption and costs savings are summarized in Table 1.

![Figure 2. Pre- and post-recommissioning whole building electricity consumption](image1)

![Figure 3. Pre- and post-recommissioning whole building steam consumption](image2)

### Table 1. Summary of Energy Consumption and Cost Savings.

<table>
<thead>
<tr>
<th></th>
<th>Baseline Energy Consumption</th>
<th>Actual Consumption</th>
<th>Energy Savings</th>
<th>Cost Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Building Electricity (MWh)</td>
<td>23,169</td>
<td>22,049</td>
<td>1,120</td>
<td>$56,004</td>
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<tr>
<td>Whole Building Steam (MMBtu)</td>
<td>72,578</td>
<td>55,940</td>
<td>16,638</td>
<td>$124,785</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$180,789</strong></td>
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</tbody>
</table>

The total cost of the project was roughly $208,000 or $0.35/sf. Use of in-house staff to implement the recommissioning measures reduced the external costs to $133,000 or $0.22/sq.ft. Xcel Energy, the electric utility, provided a rebate of $200 per kW of summer peak demand reduction, or $45,480, further reducing the owner’s external costs.

The savings from measures implemented during the project are $181,000/yr, giving a payback of 1.2 years on total project cost prior to the utility company rebate and 0.9 years after the rebate. The payback on the net external costs after rebate was 0.5 years.

### Summary

This project shows substantial recommissioning savings with a very attractive payback for a well-maintained and operated 20 year old hospital. It demonstrates recommissioning that was successfully carried out using in-house staff, while also improving that staff’s technical skills. In other cases, where in-house staff may be unable to implement recommissioning measures in a timely fashion, lost energy cost savings may be greater than savings on external labor.

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