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Mini-Retro-Commissioning

City of Urbana City Building Complex

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SEDAC is sponsored by the Illinois Department of Commerce and Economic Opportunity in partnership with investor-owned utilities to achieve energy efficiency savings in buildings throughout the State of Illinois. SEDAC is an applied research program at the University of Illinois at Urbana-Champaign. SEDAC works in collaboration with the 360 Energy Group and the Energy Resources Center at the University of Illinois at Chicago.

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1 Summary and Recommendations

This report provides information and strategies to reduce annual utility consumption and costs through building scheduling controls and temperature setpoints at the Urbana City Building Complex, located in Urbana, Illinois.

The City Building is a 41,140 square foot (sf), two-story with partial basement, municipal building. The building includes city offices, fire station, police station, and meeting space. Constructed in the 1960's the building was renovated with an addition in the 1990's. This project has an initial energy use intensity of 170 kBtu/sf/yr, which is high for a building of this type. The building's energy use data is provided in Table 1.

Table 1: Existing Building Data

Annual Consumption	Electricity (kWh)	Electric Demand (kW)	Natural Gas (Therms)	Annual Utility Cost ($)
Existing Building Consumption	989,276	unknown	36,439	$121,045

The report identifies a total of $4,200 in potential annual energy cost savings for the facility from the implementation of setbacks and setpoint changes. These savings represent a potential 4% reduction in total energy consumption (kBtu/sf/yr) and a 3% reduction in annual energy costs.

Table 2: Annual Savings Summary

Modeled Annual Savings from ECRMs and Packages	Annual Facility Savings					
	Electricity (kWh)	Electric Demand (kW)	Natural Gas (Therms)	Energy Cost Savings ($)	Cost Savings (%)	Energy Savings (%)
ECRM 1: Setpoints	0		1221.3	$1,124	1%	2%
ECRM 2: Setbacks	23,856		1068.81	$3,090	3%	3%
Package1: ECRMs 1 and 2	23,856		2,290	$4,214	3%	4%

Overall savings can be achieved from implementing setbacks of 4°F for ten hours each work day and all day each weekend day. Additional savings are likely as specific area schedules are not covered here. Rather, an overall schedule that includes the time needed for the Board Conference Room is used. SEDAC recommends additional setback hours as specific rooms or areas used allow.

Additional (non-quantified) measures considered and recommended in this report include:

- **Outside air settings.** Install demand control ventilation or schedule outside air damper settings to adjust outdoor air intakes based on occupancy needs.
- **Reheat.** Reduce the level of reheat used during the cooling periods.

This analysis does not replace engineering design, which will be necessary for project implementation and bid preparation.

To demonstrate its effectiveness to the State of Illinois, SEDAC is asked to compile quarterly reports that document implementation of energy efficiency measures. We ask that you keep us apprised of all work towards implementation of our recommendations; this information will allow us to accurately reflect subsequent savings. We will also contact you periodically to discuss the recommendations, answer questions, and review status.

Thank you for participating in the Smart Energy Design Assistance Program.

2 Program Overview

Acknowledgements

The Smart Energy Design Assistance Center (SEDAC) thanks the City of Urbana for participating in the Smart Energy Program and for providing access to the information necessary to develop this report. Kristine Chalifoux of SEDAC is the architect responsible for the analysis and is the primary author of this report. Additional assistance in report preparation by Jean Ascoli and the rest of the SEDAC staff is gratefully acknowledged.

SEDAC Background

The objective of SEDAC is to encourage communities, building owners and operators, design professionals, and building contractors to incorporate energy efficiency practices and renewable energy systems. SEDAC supports the Smart Energy Program in advocating the efficient and effective use of energy by businesses and public buildings throughout Illinois. SEDAC is sponsored by the Illinois Department of Commerce and Economic Opportunity (DCEO) and is managed by the University of Illinois at Urbana-Champaign.

Analysis Approach

The goal of the Mini-RCx program is to review schedules and setbacks used in buildings to determine if the changing of these setbacks could impact overall energy use. Large buildings are able to take advantage of full-scale retro-commissioning, but smaller buildings also have proportional needs. By looking at a limited scope, this report looks at a specific aspect of the building in saving energy.

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3 Existing Building and Site Conditions

On March 6, 2013 SEDAC staff inspected the City of Urbana City Building, located in Urbana, Illinois to gather data for the analysis and recommendations in this report.

The City Building is a 41,140 sf multi-use civic building which houses general offices, the police station, fire station, city council chambers, and other city functions. The building is occupied by 90 people during a typical day. The building is open based on the schedule shown in Table 2.

The mechanical systems are controlled by a Sieman's building automation system (BAS) for the majority of the building. Several spaces use timers or programmable thermostats. There are currently only a few temperature setbacks used in this building.

Table 3 reviews the various areas of the building, how they are controlled, and the current setpoint/setback levels for each area.

Table 3: Facility Hours of Operation

Building Area	Typical Hours of Operation	Notes
Community Development	Monday to Friday 8AM-5PM	Some overtime hours
City Building	Monday to Friday 8AM-5PM	Some IT people over the weekend, evening meetings in Council Chambers
Police Evidence	Monday to Friday 8AM-5PM	With exceptions for big cases
Addition/Police: Front desk, parking enforcement, animal control	Monday to Friday 8AM-5PM	
Addition/Police: Police/Fire Department Administration	Monday to Friday 8AM-5PM	With exceptions
Addition/Police: Police/Fire Department, Investigations	24/7	
Fire Station Apparatus Bay	24/7	
Fire Station Dormitory	All hours outside 8AM-5PM	7 days per week

Figure 1: Aerial Photo[1]

[1] From Bing Maps® 2013 Microsoft Corporation

Table 4: Building Area Control Summary

Floor Level - Function	Square Footage	Schedule Info	Annual Hours	Control W/sf	Existing kWh
Basement					
Community Development	2,240	M-F 8-5 + some late workers	2,522	BAS w/ 2° override T'stat	74°F heating 74°F cooling no setbacks used
City Building (Includes Police Evidence Storage)	4,725	M-F 8-5 + some late workers	2,522	BAS	74°F heating 74°F cooling no setbacks used
Server Room (B003)	200	M-F 8-5 + some late workers	2,522	BAS	74°F heating 74°F cooling no setbacks used
Infill (Police Station)	4,930	24/7?	8,760	BAS	74°F heating 74°F cooling no setbacks used
First Floor					
Community Development	2,425	M-F 8-5 + some late workers	2,522	BAS w/ 2° w/ override T'stat	74°F heating 74°F cooling no setbacks used
City Building (excluding spaces listed below)	2,500	M-F 8-5 + some late workers	2,522	BAS	74°F heating 74°F cooling no setbacks used interogation room set at 56°F
City Building Council Chambers	2,280	M-F 8-5 + evening events	2,522	BAS	74°F heating 74°F cooling no setbacks used
City Building AV Controller Room (B107) [also referred to as "UPTV"]	145	24/7?	8,760	BAS	74°F heating 74°F cooling no setbacks used
Infill (Police Station, Atrium Entry)	4,515	24/7?	8,760	BAS	74°F heating 74°F cooling no setbacks used
Fire Station (Apparatus Bay & Exterior heated storage)	3,605	24/7	8,760	Thermostat	62°F heating no cooling no setbacks used
Second Floor					
City Building Offices, Corridors	4,685	M-F 8-5 + some evening events	2,522	BAS	74°F heating 74°F cooling no setbacks used
City Building Conference Room (B211/B212)	510	M-F 8-5 + some evening events	2,522	BAS	71°F heating setback to 79°F setback to 67°F 74°F cooling
Infill (Police Station Offices)	4,370	M-F 8-5 + some evening events	2,522	Programmable T'stat	69°F heating 69°F cooling no setbacks used
(Fire Station Offices)	see above			Programmable T'stat w/ override	72°F heating 72°F cooling no setbacks used
Fire Station (Dormitory, Dayroom, Dining, Training, etc.)	4,010	5:00 PM to 8:00 AM	5,220	Programable T'stats	Change Training room to setback
Building Total	**41,140**				

4 Energy Consumption Analysis

The City of Urbana provided electrical and natural gas bills from March, 2011 through February, 2013.

Benchmarking

A good method for benchmarking a building's energy efficiency is to determine its energy use intensity (kBtu/sf/yr) and energy cost intensity ($/sf/yr). Establishing an existing baseline serves as a metric for comparison with future energy usage.

Based on the provided square footage and analysis of the utility bills, the total energy use intensity for the building is 170 kBtu/sf/yr and the corresponding energy cost intensity is $2.94/sf/yr.

A summary of the annual energy profile for the facility is provided in the following table.

Table 5: Benchmarking Statistics

	Annual Consumption		Annual Costs		Average Unit Cost	
Electricity[1]	989,276	kWh	$87,361	72%	0.088	$/kWh
Natural Gas[2]	36,439	therms	$33,684	28%	0.924	$/therm
		Total	$121,045	100%		
Floor Area	41,140	sf				
Site Energy Use Intensity	170.64	kBtu/sf/yr	**Energy Cost Intensity**	2.94	$/sf/yr	
Electricity Use Intensity	24.05	kWh/sf/yr	**Natural Gas Use Intensity**	0.89	therms/sf/yr	

Notes to Table 5:
(1) Electric energy is supplied and delivered by Ameren Illinois, billed on the DS-3 rate class.
(2) Natural gas is supplied and delivered by Ameren Illinois, billed on the Small User rate class.

Energy Consumption Profile

Graphic summaries of the electric and gas utility bills for the facility are provided below. Charts are compared to heating and/or cooling degree days, which are indicative of the duration and intensity of the heating or cooling season.

Figure 2 shows the reported monthly electric energy consumption profile for this building. The graph indicates that the building is following the cooling loads closely, however, there is a very high baseload of about 55,000 kWh per month indicating that the building is likely running systems for longer periods that necessary. Much of this is likely fans running 24 hours and 50% outside air 24 hours a day.

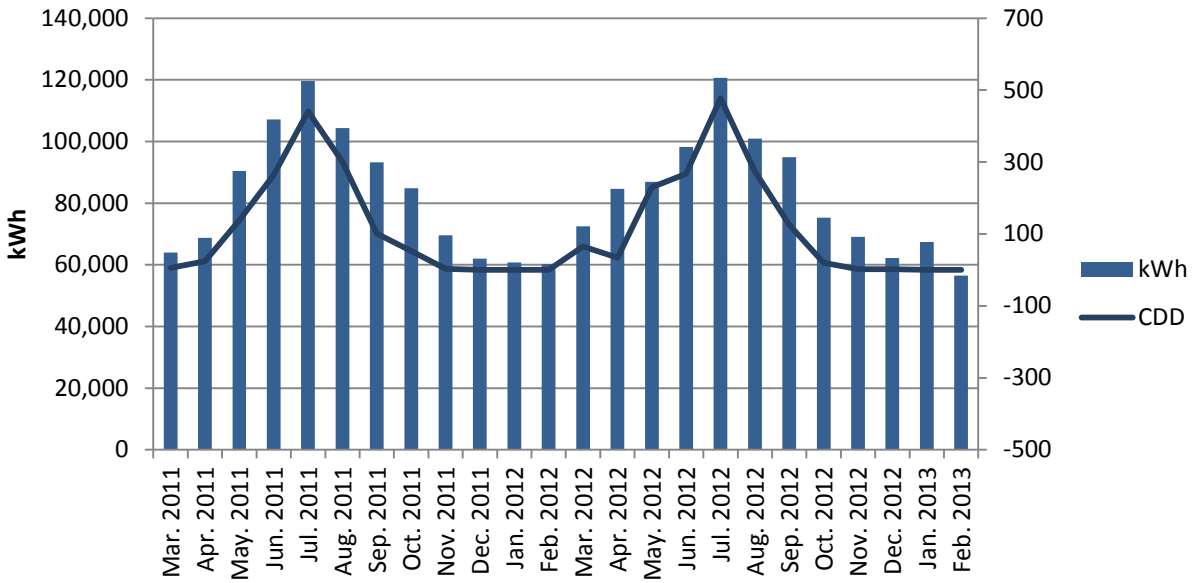

Figure 2: Electric Usage

Figure 3 shows reported monthly natural gas energy consumption profiles compared with heating degree days for the period from March 2011 to February 2013. The chart shows the energy use for space heating and domestic hot water (DHW). Note that the chart for gas use follows the weather cycles closely, which is expected since heating is the primary gas use. A baseload of approximately 1,750 therms is shown and would account for excessive heating during the year and reheat during the summer.

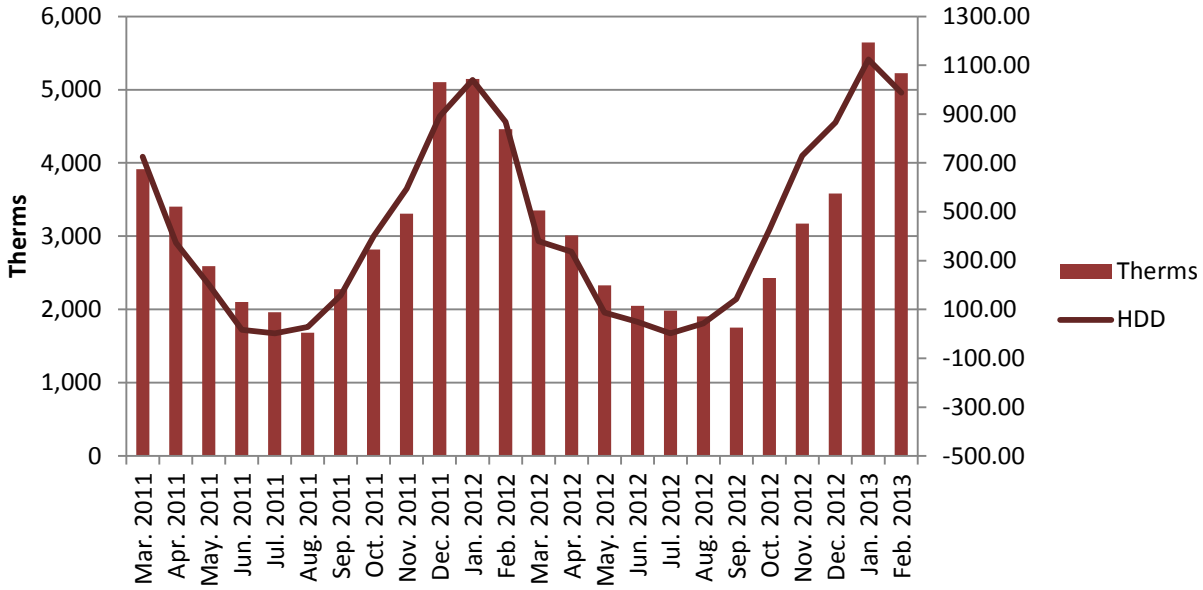

Figure 3: Natural Gas Usage

5 Energy Cost Reduction Measures Analysis

Spreadsheets and other analysis tools were developed using building plans, discussions with on-site operating personnel, and a site tour to verify conditions.

Note that energy models used the average of the last year of utility data provided to SEDAC. The economics of all strategies will improve if utility rate increases occur in the future. Breakdowns of cost assumptions and incentives are outlined in Section 5.

Table 6: Annual Savings Summary

Modeled Annual Savings from ECRMs and Packages	Annual Facility Savings					
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ECRM 1 – Adjust Setpoints

Adjust setpoints to 70°F during the winter and leave setpoints at 74°F during the summer

More seasonably appropriate temperatures throughout the year would save energy. These temperatures may be able to be adjusted further based on building conditions and occupant comfort.

ECRM 2 – Setbacks

Setback temperatures 4°F during heating and cooling season.

Setting back temperatures during unoccupied times is a cost effective energy savings strategy. This recommendation assumed a 4°F setback for ten hours each day using the schedule of the City Council Chambers. This leaves 14 hours each day for setpoint due to the extended hours of the Chambers. However, many spaces could be set back even further such as offices and circulation spaces. If additional areas are controlled more closely based on occupancy, the savings will be greater.

Table 7: Setpoint Recommendations

Time period	Heating	Cooling	Total hours weekdays	Total hours weekends
Existing	74	74	24*5=120	24*2=48
Occupied	70	74	14*5=70	0
Unoccupied	68	78	10*5=50	24*2=48

Package 1: ECRMs 1 and 2

Each of the recommended ECRMs discussed individually in this report offers a payback based on the investment and savings. Keep in mind that the cost of doing nothing for each of these strategies is higher than implementation.

SEDAC recommends finding a local controls contractor who is qualified to work on the Sieman system to provide controls work and training for staff.

Additional Energy Cost Reduction Measures

The following additional measures are outside the scope of this report and have not been quantified, but are recommended for further consideration. These strategies were covered in the original energy assessment report but are important to mention again as they are consuming large amounts of energy and should be a priority in reducing the energy use of the City Building.

Outside Air Settings

Install demand control ventilation or schedule outside air damper settings to adjust outdoor air intakes based on occupancy needs. The outside air dampers are currently set open at 50% outside air 24 hours a day. It is only necessary to bring in outside air during times of high occupancy. A system that monitors occupancy, such at CO2 sensors, will allow the dampers to only open as fresh air is needed.

Reheat

Reduce the level of reheat used during cooling periods. This strategy is expected to save over 8,000 therms and 51,000 kWh a year, or over $12,000 annually.

6 Incentives and Assistance

If the cost to implement these strategies is more than a year's worth of energy cost savings, ECRMs presented in this report may be eligible for DCEO Energy Efficiency Portfolio Standards (EEPS) incentives. Special Incentives are currently available at a double of the natural gas incentives for projects completed and applied for by May 15.

The basic rules for the DCEO's Illinois Energy Now programs are:

- Energy efficiency improvements not covered under the standard incentive program are eligible for custom incentives.
- The maximum incentive that will be awarded a single facility per program year is $300,000 total from both the standard and custom incentives.
- Custom incentives are based on $0.12/kWh of estimated savings and $1.50/therm of savings. Calculations and documentation are required to estimate the energy saved
- Pre-approval before purchasing equipment is required.
- The maximum value of the incentive cannot exceed 75% of the total project cost and no more than 100% of the incremental measure cost.
- The annual energy savings, both before and after the incentive, must show a payback between 1 and 7 years using total or incremental cost.
- http://www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Energy/Energy+Efficiency/

Table 4 provides current information on the grants available at the time this report was published. Further information and links to the web sites are listed in the Appendix B.

Table 8: Financial Incentives

ECRM	Incentive	Total Incentive	Provider
Package	$0.12 per kWh and $1.50/therm	$6,297	DCEO
	w/ Double Up incentive	$12,594	DCEO

Finding Additional Funding and Incentives

- Illinois Clean Energy Community Foundation provides grants for energy efficiency improvements and renewable energy projects: http://www.illinoiscleanenergy.org/
- For information on state and federal rebates and tax credits, see Database of State Incentives for Renewables and Efficiency (DSIRE): http://www.dsireusa.org/index.cfm?EE=0&RE=1
- SEDAC provides a web page to post relevant documents and link to programs and services. Bookmark this page and watch for further developments. Incentives.sedac.org

Illinois Association of County Board Members

The Illinois Association of County Board Members is available to help you through the entire application process. Their expert staff is available to assist in

completing incentive applications and helping owners during each step of implementing energy efficiency. For addition information, call 217-741-2489 or email kulek79@aol.com

Finding Contractors and Installers

Several websites list information on qualified providers for implementation.

- DCEO Illinois Energy Now: http://www.erc.uic.edu/tradeallies/index.php
- Ameren Illinois ActOnEnergy: http://www.actonenergy.com/for-contractors/non-residential-contractors
- ComEd Smart Ideas: https://www.comed.com/business-savings/contractors/Pages/default.aspx