Energy Audit of the Education Building

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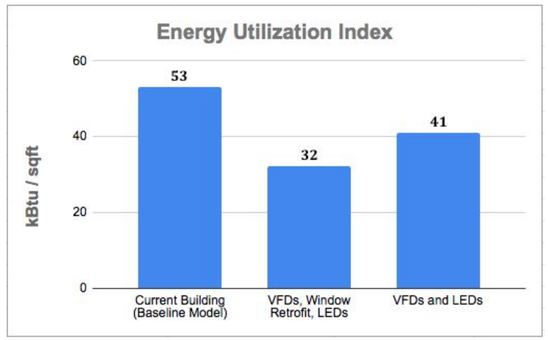
Abstract

The focus of this project has been to optimize the efficiency of the Education Building at the University of Regina. Since the building's initial construction in 1967 for the first four floors, the original HVAC mechanical system has not undergone any substantial retrofits or upgrades since. The fifth and sixth floors were then added in 2001 along with a separate HVAC system.
The primary directive of this project is to pinpoint opportunities for energy optimization. The applied method to this project involving the performance of an ASHRAE energy audit while taking an engineering approach to test conceptual energy efficiency measures (EEMs), which are changes that optimize system efficiency. The quantifiable results obtained are then used to provide the university with an economic analysis report.

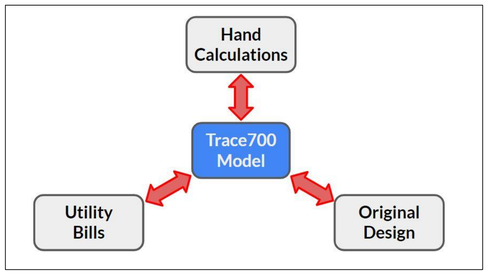


Project Goals/Objectives

To complete an energy analysis on the current performance of the Education Building and propose new alternatives for the University of Regina. Implementation of the new proposed upgrades will not only lower costs and make for a more efficient system, but it will also ensure that the building continues to comply with ASHRAE's standards and building codes, by increasing the building's overall efficiency, indoor air quality, and ensure the thermal comfort for the occupants within the building.

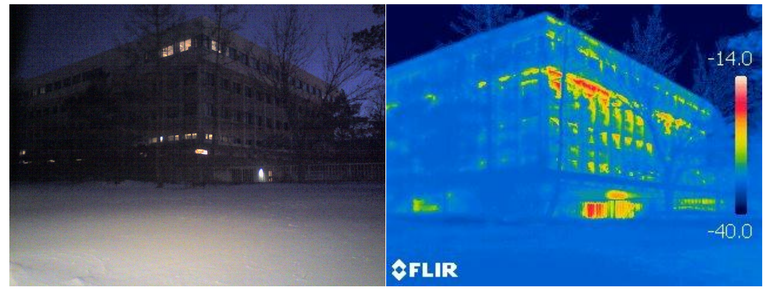
Methods/Process

In order to perform accurate and detailed cost-savings calculations, a dynamic model of the Education Building was created using the program *Trace700*. This building model was calibrated using actual room dimensions and characteristics, validating model accuracy through historical energy use data by reference to the building's actual utility bills.
Once the current-condition building model was proven to be accurate, the feasibility of EEM's such as alternative interior lighting solutions, the implementation of variable frequency drives on glycol pumps or heat recovery wheels to transfer energy between exhaust and intake ducts, window retrofit solutions, or the addition of window awnings were all considered and compared within the *Trace700* modelling software.
Once the theoretical energy savings were determined, performance of an economic analysis illustrates the buyback period for each EEM and the overall feasibility for the investment to the client.



Results/Outcomes

EEM's	Capital Cost	Maintenance Cost	Annual Benefit	Payback Period
Interior Lighting	$320,000	$49,500	$796,000	0.46
Run-Around Heat Exchanger	$208,000	$1,000	$11,500	18.17
Variable Frequency Drives	$88,500	$500	$21,000	4.24
Window Retrofit	$850,000	0	$265,000	3.21
Window Film	$223,000	0	$103,500	2.15
Interior Lighting and VFD's	$408,500	$50,000	$717,000	0.64
Interior Lighting, VFD's, and Window Retrofit	$1,258,500	$50,000	$980,500	1.33



Thermal Imaging of Southwest Corner of the Education Building at the University of Regina

Conclusions/Recommendations

The most optimized solution for the Education Building's energy efficiency recommends upgrading the interior lighting to LED's, implementing variable frequency drives on existing pumps, along with a retrofit of the exterior windows on the building.
Addressing these EEM's resulted in an approximate capital cost of $1,258,500, a payback period of 1.33 years, and the annual benefit of $980,500/year.
The realistic solution disregards retrofitting the exterior windows from the listed EEM's, as it lowers the approximate capital cost by 67% to $408,500. This will also reduce the payback period to 0.64 years, while still keeping approximately 75% of the annual benefit at $717,000/year.

Acknowledgments

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Rob Kleisinger - U of R Facilities Management Team

References

- ASHRAE Standard 55-2020. Thermal Environmental Conditions for Human Occupancy
- ASHRAE Standard 62.1-2019. Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 90.1-2019. Energy Standard for Buildings Except Low-Rise Residential Buildings
- Procedures for Commercial Building Energy Audits 2nd Edition (2004)
- Fundamentals of HVAC Systems SI Edition (2003)