Thesis Proposal

Charles E. Smith Center Renovation

Washington, DC

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Mechanical Option

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Table of Contents

Executive Summary

The Charles E. Smith Center is an athletic facility for the George Washington University located in downtown Washington, DC. It is open year round and is home to many of GWU's sports teams. Included in the Smith Center are a natatorium, multiple gymnasiums, multiple offices and locker rooms, fitness and weight rooms, and suites.

The purpose of this report is to propose viable alternatives to the current systems in place. The goal of these alternatives is to increase energy efficiency, decrease costs, and work towards the highest level of sustainability available.

The two mechanical alternatives proposed include replacing the current boilers with a combined heat and power plant and replacing the current second and third floor AHU's with an energy recovery system that implements an energy recovery wheel. These systems were chosen to help meet the goals of this report stated above.

Two other alternatives were proposed for architecture and construction management. For architecture, a new façade that includes phase changing materials is proposed to lighten thermal loads. The construction management alternative was chosen to increase construction efficiency and decrease construction time and cost.

Due to the complexity of this proposal and the problems that accompany it, several specific tools have been chosen to evaluate the proposed systems. These tools include eQuest, Trane TRACE, Engineering Equation Solver, Microsoft Excel, Microsoft Project, RS Means, and the valuable knowledge of current industry professionals. With these tools, an accurate analysis of this proposal should be obtained.

Building System

Introduction

The Charles E. Smith Center is an athletic facility for the George Washington University located in downtown Washington, DC. The facility is over 104,000SF and is home to most of the sports teams of the GWU. It is currently under major construction which has been ongoing since fall of 2008 and is expected to be completed this year.

Design Objectives

The Charles E. Smith Center had a main objective of being sustainable. To accomplish this in the design process a number of objectives were set. Energy efficient equipment was selected as well as building automation and commissioning in order to reduce operating costs and maintain that all systems continue to work as designed. Other requirements that were set forth were to comply with ASHRAE Std. 62.1 for ventilation and ASHRAE Std. 55 for comfort. Of these requirements, the entire basement was to be supplied with 100% OA because of the types of rooms such as locker rooms and high sensible loads and contaminants associated with these spaces.

Overall System Summary

The existing mechanical system heating and cooling employ both electric and natural gas. Natural gas is used for the four boilers which supply the heating water to the building. Electric is used to power the two cooling towers and two chillers which supply the buildings refrigeration system.

The pool area relies on its own packaged air conditioner specifically designed for the humidity. It uses 100% OA and a heat recovery system that is used to heat the pool. The entire first floor is supplied by an Air Conditioning DOAS system with an enthalpy wheel for heat recovery. The air is distributed throughout the floor by blower coils. In addition, the men's and women's basketball locker rooms and the weight room have packaged dehumidification units. The second and third floors are supplied by typical CAV and VAV Air Handling Units almost all of which providing greater than 50% OA. The arena is supplied by four single zone VAV AHUs providing about 40% OA.

Alternative Systems

The current systems set in place were designed to work well for this facility and the owner. There are always alternatives that could be implemented to help achieve different goals. A few possible system alterations or replacements will be looked into with the associated changes.

Combined Heat and Power (CHP)

Currently the heating system uses boilers and electrical resistance. Combined heat and power is another type of system that integrates the production of energy and heat on location. CHP is similar to a typical power plant except that instead of discarding the heat that is produced, the heat is captured and used to heat the facility. This produces both electric energy for use as well as heat. Diagram 1 shows an example of the CHP cycle.

Diagram 1 – Combined Heat and Power Cycle

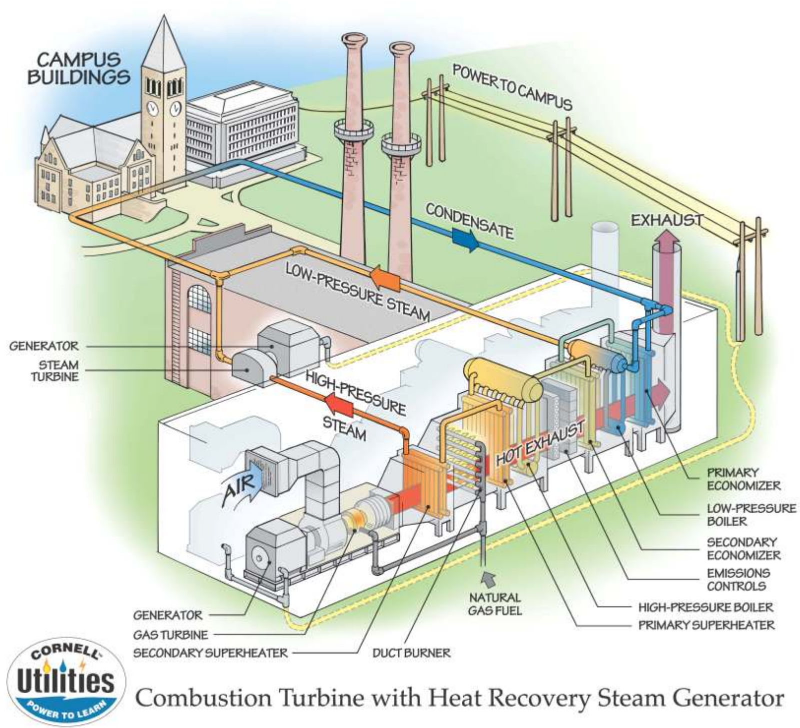

Image from: http://energyandsustainability.fs.cornell.edu/util/heating/production/cep.cfm

With CHP, the electric dependency should be reduced along with the production of heat which can be used for the hot water. A CHP system does occupy more space so there will have to be other changes that will be looked into to accommodate such a system. The system also has a greater first cost but should be offset by the added usage savings.

Energy Recovery Wheel

The first floor of the building currently uses an energy recovery system because of the high percentage of OA required. Floors two and three do not require 100% OA but they do require between 50% and 70% OA. This gives a lot of wasted heat that could be recovered. A similar system to that of the first floor with one air conditioner and subsequent blower coils would enable an energy recovery wheel. The energy recovery wheel would be placed between the supply and exhaust and recover the leftover energy from the exhaust air. Diagram 2 shows the energy recovery wheel.

Diagram 2 Energy Recovery Wheel

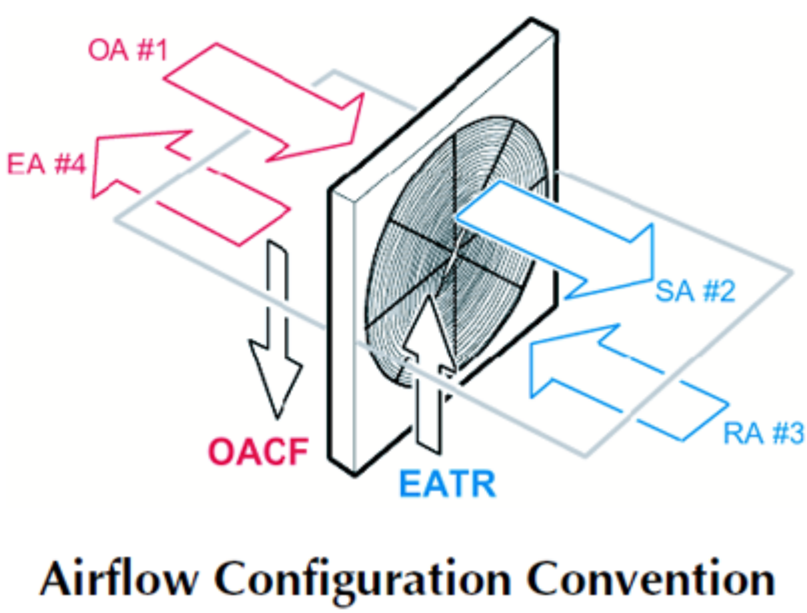

Image from http://www.airxchange.com/Collateral/Images/English-US/Airflow.png

The installation of an energy recovery wheel for the additional floors would reduce the amount of heat required. This system would be able to occupy the same amount of space as the current air handling units.

Breadth Topics

Architecture

The construction of the facility has included a large glass main entrance. This could potentially have a large impact on the mechanical loads of the building. A possible alternative would be to include a phase changing material to increase which would essentially act like an increase in thermal mass without the added mass. Other aspects of the architecture would include the interior where a CHP system may need to be located. This could change room orientation and should be taken into account.

Construction Management

To reduce the total time and cost of construction, a construction management breadth will be explored. Time is a large factor when it comes to construction which in turn relates to the cost. With a shorter construction period, there will be less labor charges as well as a sooner move in time both of which will reduce overall cost. Because this is used for athletic events and is an existing building, the schedule should take into account the seasons of the respected sports.

Tools

In order to accurately analyze the proposed system changes and model them to the best of their ability, a variety of programs will be utilized.

eQuest

eQuest is an energy modeling program that can be used to simulate building conditions and accurately produce expected results. It also returns a detailed analysis that enables users to see where a possible error may have occurred. A concern with using eQuest is that the user only has minimal experience with the program compared with others such as Trane TRACE and may take more time to create. Because of this reason Trane TRACE may be a viable alternative.

Engineering Equation Solver (EES)

EES is a program in which you can input numerous equations to solve simultaneously. This tool can be used to go into further detail that may not be able to be accurately modeled in a traditional energy modeling program. Another similar program that may be utilized would be Microsoft Excel.

Microsoft Project

Microsoft Project enables users to construct anticipated project schedules in order to better manage time and resources. This program in conjunction with RS Means as well as professional contacts would be able to project future schedules.

Preliminary Research

Combined Heat and Power Partnership. U. S. Environmental Protection Agency. Web. 6 December 2010. <www.epa.gov/chp>

Combined Heat and Power. International Energy Agency. Web. 6 December 2010. <www.iea.org/papers/2008/chp_report.pdf>

Srebric, Jelena. "AE 454/455." Fall 2009/Spring 2010. Class

Phase Change Materials. NAHB Research Center. Web. 6 December 2010. <http://www.toolbase.org/Technology-Inventory/HVAC/phase-change-materials>

Appendix:Work Plan