UNIVERSITY OF ALASKA ANCHORAGE
Rasmuson Hall Building
Boiler Replacement Upgrades
Greenhouse Gas Emissions Reduction Analysis

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Table of Contents

University of Alaska Anchorage
Rasmuson Hall Building
Boiler Replacement Upgrades
Grennhouse Has Emissions Reduction Analysis

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Objectives

RSA Engineering has been hired by the University of Alaska Anchorage (UAA) to evaluate the potential greenhouse gas (GHG) emission reduction potential if existing cast iron sectional boilers were to be replaced with high-efficiency condensing boilers at UAA Rasmuson Hall. The results of the evaluation will be included in the grant application, which could provide UAA with funding to help perform the building retrofits.

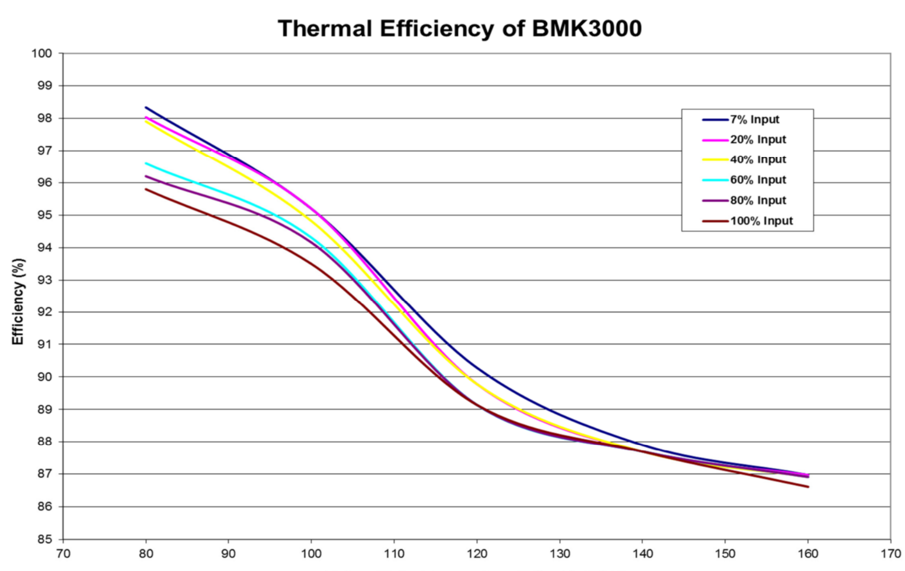
Building and Systems Description

UAA Rasmuson Hall is a four-story building built in the early 1990s. The building is roughly 80,000 square feet, and contains a mix of classrooms, offices, lecture halls, and other facets of academia. The building is currently heated by two natural gas Weil-McClain 1188 cast iron sectional boilers, with an inactive steam boiler present in the mechanical space. Each boiler has a gas input of 3,428 MBH and a gross output of 2,848 MBH. An AKWarm calc was created, using the architectural as-builts dated Nov. 1990, looking primarily at perimeter heat loss from the floor, walls, windows, doors, and roof, as well as the ventilation load for the building.

Calculation Assumptions

For this process of determining of the difference in fuel consumption with an AKWarm calc, it should be stated that there are limitations to the functionality of the software, and some assumptions were made to aid in the determination of the final values.

Warm weather temperature setbacks cannot be programed in. Warm weather setbacks are where the temperature of the heating water is reduced during the milder temperatures of fall and spring, when less heat is needed in the building. Heating the water to a lower temperature a pivotal component in the energy savings of a high efficiency condensing boiler. The graph below represents the thermal efficiency of a typical condensing boiler.



Typical Efficiency Curve for High-Efficiency Condensing Boiler ("BMK 3000 Efficiency Curves - AERCO," n.d.)

These boilers will not always be in condensing mode during the colder days of the year, but they will be able to operate at lower temperatures during the fall and spring. Therefore, a median value of 91% efficiency was used in the calculations for a new condensing boiler. This is determined by looking at a ratio of the time where the boiler will be running at a high temperature versus at a temperature set-back. In contrast, the thermal efficiency of 82% was used for a 30 year old cast iron sectional boiler.

Supplemental equipment shifts, such as pump replacements, were not considered in this report, as they are assumed to be relatively equivalent in electrical consumption between the two systems. Variances in electrical consumption between the boilers were also not considered, as they were assumed relatively equivalent. All other facets of the building were assumed equivalent between the two systems.

Calculations

The AKWarm short audit report can be found in the appendix. The software AKWarm for this comparative analysis is looking exclusively at perimeter heat loss and ventilation heating loads over the course of a year. A comparison is made between the two boiler options, looking at the efficiency of the existing system and the potential efficiency of a new boiler system. There is an inverse relationship between fuel consumed and the efficiency the boiler, resulting in a reduction of the total heating load per square foot. It was determined that the building had a design space heating load of approximately 8,175,750 BTU/hr. The EUI (Energy Use Intensity, measured in kBTU/Sq.Ft.) of the building with the existing boiler system was 230.5, whereas the propose retrofits would yield 204.9, a reduction of over 11%.

GHG Summary

To determine the reduction of GHG, the amount of fuel consumed is compared. The software utilizes heating degree days to determine a projected amount of fuel consumed annually. The ccf (100 cubic feet) of natural gas has an equivalent value of lbs of CO_2. Approximately 117lbs of CO2 is produced per million BTU(MMBTU) of natural gas consumed (“Natural Gas in the Environment,” n.d.). Below are quantitative comparisons between the two systems.

Boiler Type	Natural Gas Annual Consumption	Heating Capacity	Greenhouse Gas Emissions
Weil McClain 1188 (NC*)	176,245 ccf	17,624 MMBtu	2,062,066 lbs CO_2
Aerco BMK 3000 (C*)	160,134 ccf	16,013 MMBtu	1,873,567 lbs CO_2

NC = Non-Condensing Boiler, C = Condensing Boiler

There is an approximate reduction of 188,499 lbs of CO_2 annually. Over a five year period between 2025 and 2030, that equates to a reduction of roughly 427 metric tons of CO_2. A 25 year period between 2025 through 2050 would result in a reduction of roughly 2,137 metric tons of CO_2. Shifting to a condensing style boiler will permanently reduce the annual production of GHG from the system for the life of the boilers.

These reductions in CO_2 are only from a change in equipment type. Additional modifications to the building, such as changing the heating system over to water from glycol, will result in a higher heating performance, which would directly correspond to an even greater reduction in GHG.

Conclusion

In conclusion, a swap to condensing boilers from traditional cast iron sectionals results in a significant reduction in CO_2. Condensing boilers have features, such as a higher turn down ratio, which allow them to operate with greater modulation, leading to direct reductions to fuel consumption. Additional advantages of condensing boilers come from a relatively quick payback period, due to the cost saved over the life of the boiler by consuming less gas to produce the same amount of heat.

Citations

BMK 3000 efficiency curves - AERCO. www.aerco.com. (n.d.). https://www.aerco.com/dfsmedia/0533dbba17714b1ab581ab07a4cbb521/57931-source/bmk-3000-efficiency-curves

Natural gas and the environment - U.S. Energy Information Administration (EIA). (n.d.). https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php

APPENDIX A:
AKWarm Short Audit Report

ENERGY AUDIT REPORT – PROJECT SUMMARY – Created 3/11/2024 4:07 PM

General Project Information

PROJECT INFORMATION	AUDITOR INFORMATION
Building: UAA Rasmuson Hall	**Auditor Company:**
Address: 3416 Seawolf Drive	**Auditor Name:** Paul Owens
City: Anchorage	**Auditor Address:**
Client Name: Andi McKinzie	
Client Address:	**Auditor Phone:** (907) 276-0521
	Auditor FAX:
Client Phone: (907) 786-1800	**Auditor Comment:**
Client FAX:	

Design Data

Building Area: 81,128 square feet	**Design Space Heating Load:** Design Loss at Space: 8,175,750 Btu/hour with Distribution Losses: 8,175,750 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 12,463,030 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Anchorage	**Design Outdoor Temperature:** -13.9 deg F
Weather/Fuel City: Anchorage	**Heating Degree Days:** 10,484 deg F-days

Utility Information

Electric Utility: Chugach Electric North - Commercial - Lg	**Natural Gas Provider:** Enstar Natural Gas - G4
Average Annual Cost/kWh: $0.159/kWh	**Average Annual Cost/ccf:** $0.941/ccf

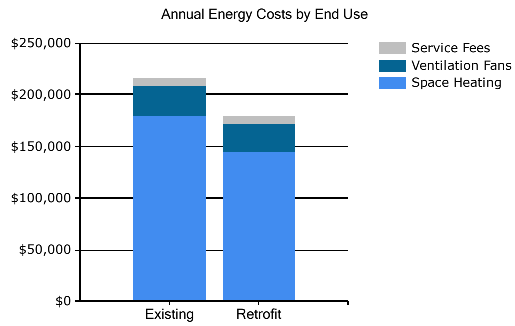
Annual Energy Cost Estimate

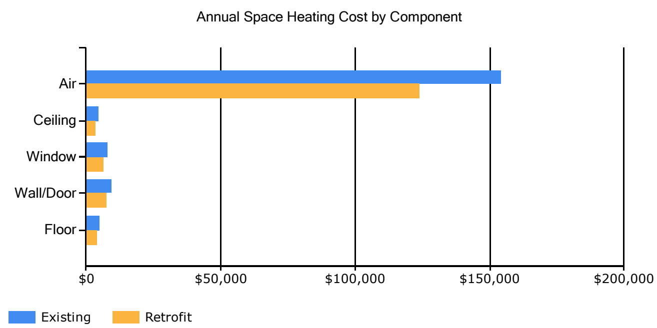
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Service Fees	Total Cost
Existing Building	$180,313	$0	$0	$27,965	$7,571	**$215,849**
With Proposed Retrofits	$144,774	$0	$0	$27,965	$7,571	**$180,310**
Savings	$35,539	$0	$0	$0	$0	**$35,539**

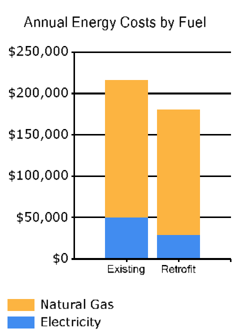
Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	230.5	21.98	$2.66
With Proposed Retrofits	204.9	19.55	$2.22

EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.


Annual Energy Costs by End Use
$250,000
$200,000
$150,000
$100,000
$50,000
$0
Existing
Retrofit
Service Fees
Ventilation Fans
Space Heating


Annual Space Heating Cost by Component
Air
Ceiling
Window
Wall/Door
Floor
$0
$50,000
$100,000
$150,000
$200,000
Existing
Retrofit


Annual Energy Costs by Fuel
$250,000
$200,000
$150,000
$100,000
$50,000
$0
Existing
Retrofit
Natural Gas
Electricity