Isolate UW Process Steam Loads

Proposed Technologies for the Magnuson Health Sciences Center (MHSC)

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University of Washington, Mechanical Engineering · In Partnership with AEI Engineers · Scott Rushing (Faculty Supervisor) · Winter/Spring 2026

Background & Introduction

The Central Plant:

- Generates **93%** of the campus's **greenhouse gas emissions.**
- Provides steam to campus through **8 miles** of tunnels with loss-heavy piping.

UW Energy Renewal Plan:

- Strategy to decarbonize UW's steam and hot water system
- Designs to change campus wide building heat to hot water instead of steam

Our goal:

- Propose a plan to supply **electrified process steam** to a high steam use building as a **blueprint for future projects**

Cleaver-Brooks Electric Boiler

AtmosZero Steam Heat Pump

Rock Energy Storage bGen Zero

Technology Evaluation

Three electric steam boiler technologies were evaluated against pressure certification (50–80 psig) and capacity scale:

Technology	Type	Notes
Single Central Electric Resistance Boiler Cleaver-Brooks Model S-480	Electric Resistance Steam Boiler	- Simplest controls - Long steam distribution runs increase heat loss - High electrical load - Cheapest capital and installation cost
2x Wing-Zone Electric Resistance Boilers Cleaver-Brooks Model S-362	Electric Resistance Steam Boiler	- Shorter piping runs - Fault isolation per wing - High electrical load - Great balance of reliability and capital cost
3x AtmosZero Boiler 2.0	Air-Source Steam-Generating Heat Pump	- High COP reduces operational cost vs resistance heating - Relatively large footprint and upfront cost relative to other solutions
ROCK Energy Storage bGen Zero	Thermal Energy Storage (TES)	- Off-peak charging and energy storage allows for cheaper electricity - Very simple design provides a long life cycle and ease of installation - Slightly higher electrical load than electric resistance boiler.

Methodology/Plan

Connected Load Survey

- Gather **end-use load data** via an **in-person visit**
  - Conducted a survey to inventory all steam-consuming end-uses in the MHSC
    - Took nameplate data to determine individual steam consumption of each end-use

Usage Profile Analysis

- Analyze process steam loads of the building, including a **design load** and **diversity factor**
  - Create a usage profile for process steam generation loads

Steam Generation Solutions

- Propose multiple **steam generation systems** to meet our design load
  - Contact manufacturers and gather information regarding different solutions

Cost Analysis and Carbon Abatement

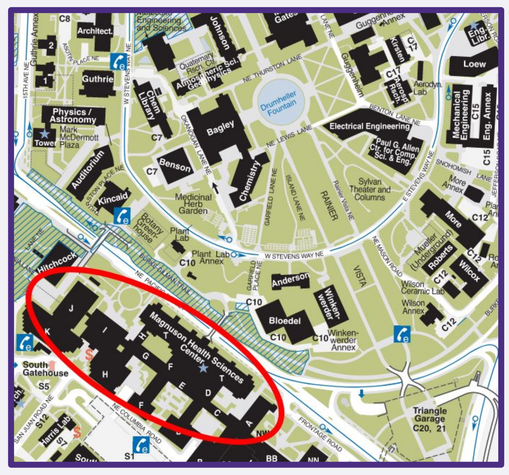
- Perform **Life Cycle Cost Analysis** and **cost of decarbonization** for each steam generation system

References

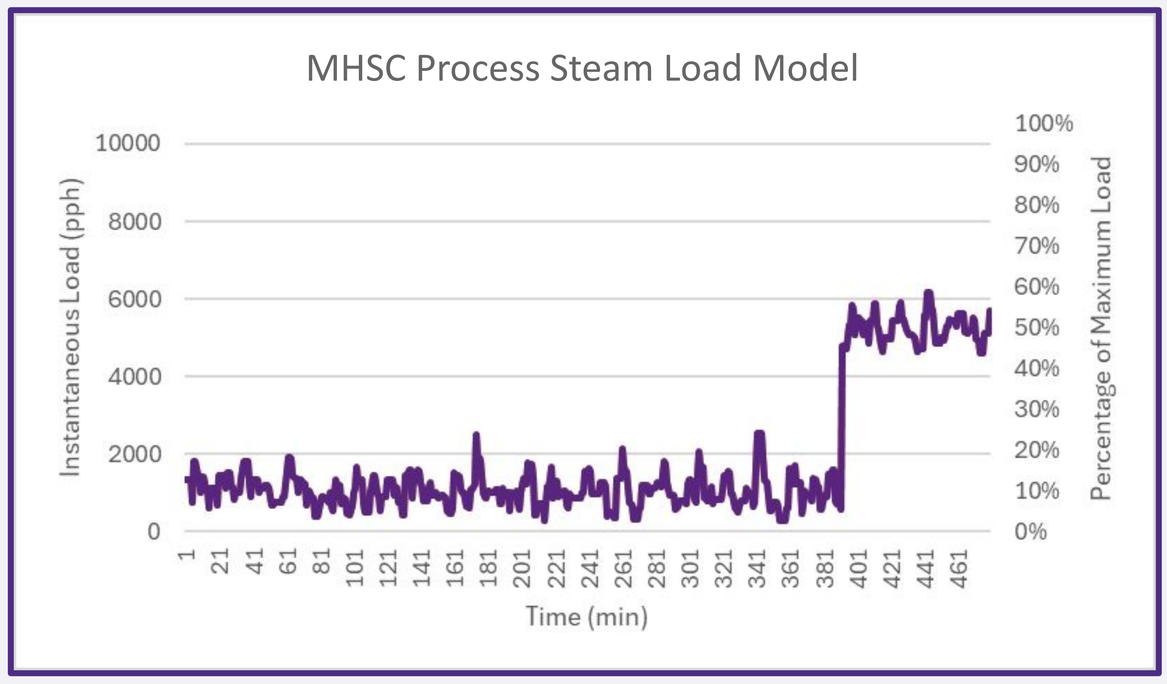
Acknowledgments

AEI Engineers: Robby Oylear and Phillip Atwater
UW Faculty Supervisor: Scott Rushing
UW Facilities Services: Alex Wilson, Jesse Caffey, and Lance Hendrix
Cole Industrial (Cleaver-Brooks Sales Representative): Rand Ingham
ROCK Energy Storage: Jim Koontz and Mariel Leszczynski
AtmosZero: Dylan Cutone-Dion
UW Department of Mechanical Engineering Faculty: Eli Patten, Sirine Maalej, and Mahsa Shabani

Site visit to gather end-use information



Location of the MHSC



Steam Usage

10,515 lb/hr
Maximum Connected Steam Load

6,680 lb/hr
Design Peak Load (0.64 Div. Factor)

614– 1944 kW
Electric Power Requirement (range for different technologies)

50–80 psig
Required Steam Pressure

Autoclave end-use

Tunnel Washer end-use

Cost Analysis Results

Model Chosen For Cost Analysis	Gas Boiler Reference	3x AtmosZero Boiler 2.0	Bren-Miller bGen system	2x CleaverBrooks S-362	CleaverBrooks S-480
Initial Investment	$876,979.61	$5,009,812	$3,509,812	$1,137,131	$1,019,624
Life Cycle of Product	20 years	20 years	30 years	20 years	20 years
Maintenance NPV 2026-2075	$1,459,529	$8,337,675	$5,841,272	$1,892,492	$1,696,929
Usage NPV 2026-2075	$8,552,046	$29,217,944	$17,079,908	$36,797,737	$36,797,737
Total NPV 2026-2075	$14,164,987	$61,282,291	$32,867,990	$44,075,729	$43,323,651
Carbon Abatement 2026-2075 ($/ton CO2)	$0	$3,065	$1,228	$1,951	$1,902

- **Carbon abatement** = cost to remove 1 metric ton of carbon dioxide from the atmosphere
  - Lower values are desired for decarbonization
  - Often compared to the "Social Cost of Carbon" (SCC), which is prescribed at $190 from the EPA
- **NPV/Net present value** = cost of all expenses projected for the future, "discounted" back to the value of money today
  - Allows for a more tangible dollar figure since it removes inflation while keeping potential price variation