Alternative Heating Hot Water System

Katie Day, Megha Gongireddy, Hannah Perkinson, Jackson Willett
Advisor: Frankie Dirisio

NC STATE UNIVERSITY

FUJIFILM Diosynth biotechnologies

1. Project Motivation

- Human activity has increased atmospheric CO_2 levels by 50% since the start of the Industrial Revolution in 1750
- Global surface temperature has risen by 1.8°F since 1880
- Consequences include:
  - Melting glaciers and sea ice
  - Rising sea levels
  - Intense wildfires
  - Ocean acidification
  - Extreme natural disasters
- Pharmaceutical manufacturing requires a significant amount of energy to support production
- FDBU has a goal for **net-zero carbon emissions** by 2040

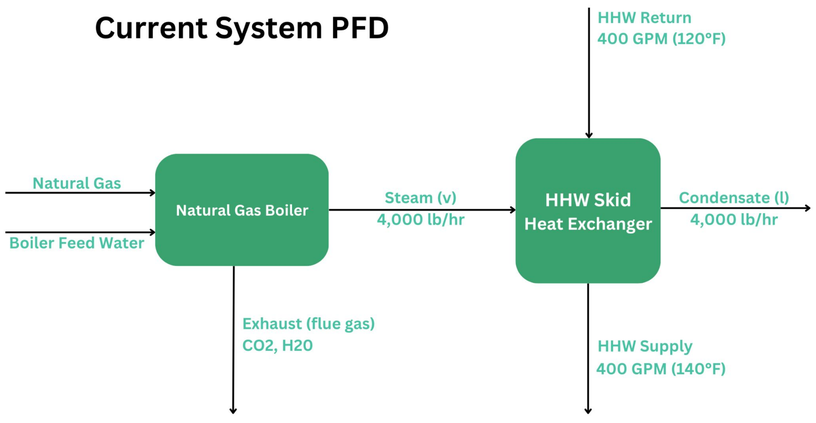
2. Objective

Identify and design an alternative HVAC heating hot water system that provides the best carbon reduction while having an economically feasible return on investment.

3. Current System

Uses a natural gas boiler to create 4,000 lb/hr steam which enters a heat exchanger. This heat exchanger uses the steam to heat 400 GPM of hot water return from 120°F to 140°F.

Current System PDF



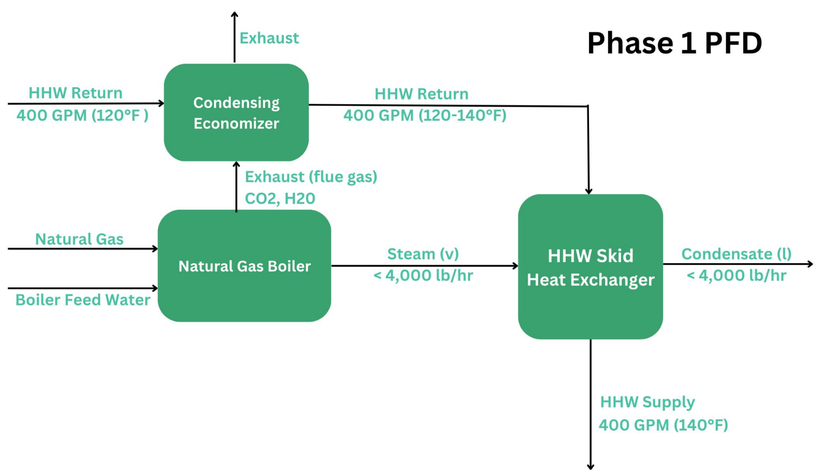
4. Process of Selection

- Researched 4 systems
- Narrowed down to **2 selections**:
  - Condensing economizer and water source heat pump

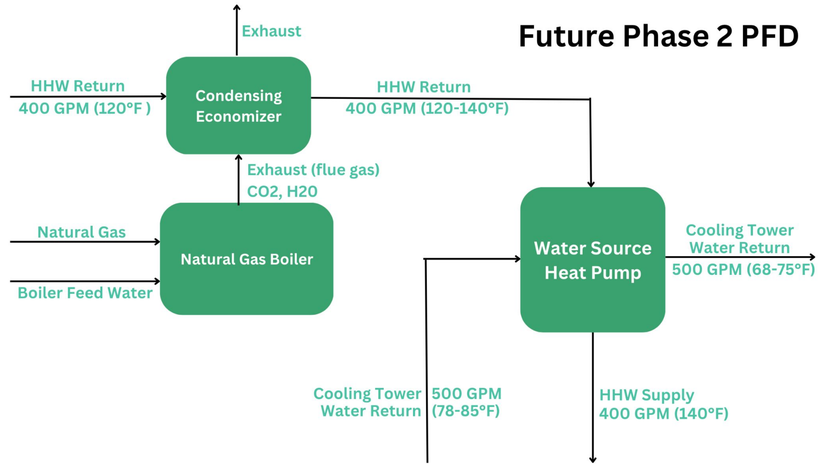
Methods	1 Description	2 Advantages	3 Disadvantages
Condensing Economizer	Increases the efficiency of the boiler by cooling flue gas below dew point	Reduces natural gas consumption, decreases operating costs and carbon emissions, low capital cost	Uses current HHW skid and still releases some carbon emissions
Water Source Heat Pump	Uses the heat from a water source to heat the refrigerant, which heats desired water line	Uses electricity to heat water, doesn't use natural gas, doesn't release carbon emissions	High capital cost, would take up too much space on site
Condensing Boiler	Extremely efficient boiler that uses heat from flue gas and combustion of natural gas	Reduces natural gas consumption, decreases operating costs and carbon emissions, replaces HHW skid	Would be a new piece of equipment that releases carbon dioxide
Solar Thermal System	System of flat plate collectors that absorb radiation and transfer heat to water	Doesn't release carbon emissions	Not enough roof space to accommodate for level of solar collectors necessary for project

5. System Design

Phase 1 PFD



Future Phase 2 PFD

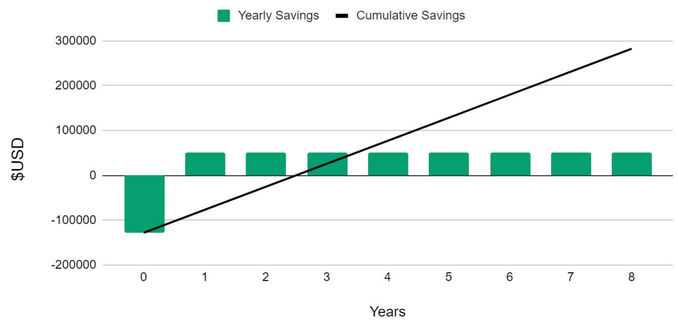


6. Economic Analysis

- **Phase One (Condensing economizer system):**
- **NPV:** $128K **ROI:** 40% **Payback:** 2.5 years **Annual Savings:** $51K

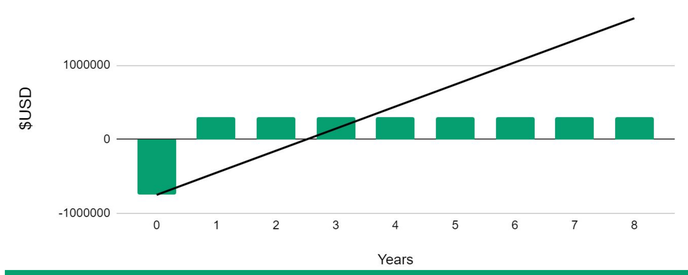
- **Phase Two (Implementation of WSHP):**
- **NPV**: $622K **ROI:** 40% **Payback:** 2.5 years **Annual Savings:** $298K

Cash Flow for Two Economizers (w/credits)



14% CO_2 reduction

Cash Flow for Economizers + WSHP (w/credits)



83% CO_2 reduction

7. Recommendations

PHASE 1: IMPLEMENT 2 CONDENSING ECONOMIZERS → FUTURE PHASE 2: IMPLEMENT WATER SOURCE HEAT PUMP TO REPLACE HHW SKID

Acknowledgements

Team 9 would like to thank their mentor, Frankie Dirisio, for her guidance and direction throughout this project. Team 9 would also like to thank Joe Brenzovich for his help throughout this year. Additionally, we would like to thank Dr. Bullard, Dr. Cooper, and the faculty of the NC State ChemE department for their teaching, which allowed the team to complete this project.

References

"Condensing Economizers." Condensing Economizers | Cain Industries, http://www.cainind.com/condensing-economizer.php.