Addressing Financial, Operational, & Technical Issues of Aging Infrastructure within a Coal Steam System at the University of Wyoming

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Presentation Objectives

- Project Background
- Basics
- Case Study - University of Wyoming
  - Process
  - Analysis
  - Implementation
  - Lessons learned
General Campus Statistics

- Founded in 1886
- Located in Laramie Wyoming
- Student Enrollment - 9,500 (Laramie) – 14:1 Student/Faculty Ratio
- Buildings on Steam - 83 (6.0M sqft)
- Buildings on CHW - 30 (1.9M sqft)
- 400 Division 1 Student Athletes
Laramie Design Conditions

- 7,200’ Above Sea Level
- Summer 1%
  - 82 DB, 58 WB
  - 80 CDD (65F)
- Winter 1%
  - -3 DB
  - 8,690 HDD (65F)
- Climate Zone 6B
Typical Steam System

Steam Generation and Production System

Coal Conveyance

Plant Processes
Campus Heating Information

Heating System Information

• (3) IBW Coal/NG Fired Nom. 60 Klbd/hr Stoker Fed 130 PSIG Steam Boilers
• (1) Keeler NG Fired, Nom. 30 Klbd/hr 130 PSIG Steam boiler
• (3) 300 Ton Day Storage Coal Silos
• (3) 150 Ton Coal Bunkers
• Steam Load: 119.6 KPPH max., 11KPPH min.
• Steam Dist. Tunnels ~ 18,500LF
• Steam & Cond. DB piping ~ 25,000LF
• 5:1 Turn Down of IBW’s on Coal
• Now Plant is on NG Transport
• NG Used IF Within ~$0.75/MMBTU of Coal
Campus Heating Information

Heating Load Profile

EXISTING STEAM LOAD/WEATHER COMPARISON

- Existing Steam Production Load Profile
- Dry Bulb Average High Temperatures
- Dry Bulb Average Low Temperatures
- 30 and 60MMBTU Load Points
- Boilers Turned Off

Heating Btu/hr

Temp F

1/1 1/11 2/1 3/1 4/1 5/1 6/1 7/1 8/1 9/1 10/1 11/1 12/1 1/1

Existing Campus Load
DB Temp (F)
Coal Supply

Coal Fuel Issues

- Stoker Grade
- Trucking Cost
- NG Costs
- Increased Regs
- Coal Quality
- Ash Disposal
- Reliability of supplier
- Increased
- Operational Costs
Steam Distribution Issues

- 18,500 LF of Tunnels
- ~99,000 LF St + Cond Piping
- Thermal losses in System = 12% reduction in generation capacity, ~$700K cost & a system efficiency of ~53%.
- Continuous Maintenance (4 week shut down, $350-$400K/yr.)
- Steam to HW Conversion
Steam Distribution Issues

- Tunnel Structural, Asbestos & Egress Issues
Building Heating Systems

- Mixture of Direct Steam and Hot Water Conversion
- Local HW Conversion
- Some Point of Use Steam (Autoclaves, humidification, etc.)
- Newer Building HW Coil Design (Low Supply Temperatures, High Delta T)
Operations and Maintenance Costs

- Coal Systems Require Continuous 24/7 Support
- Steam Systems Require a High Level of Maintenance
- 4 week shutdown
  ~$400K/yr. being spent on Shut Downs
- $6.7M spent on CEP Repairs Since 2007
- Coal & Ash Conveying are High Wear Systems
- Stoker Boilers are Dinosaurs
- PRV Maintenance Cost
- Costly Repair Parts Costs
- Lack of Coal Boiler Technician Expertise
Thermodynamics

Typical Steam Generation and Production System

Pros
- High Energy Density
- Low Changes in Temperature
- Existing Infrastructure (UW)

Cons
- Many Components
- Harsh Environment
- Energy Lost (heat and mass)
- High Repair Costs
- Gravity Return Required (or the need for pumps)
- Potential for Water Hammer
- Low System Efficiency

Steam @ 330F
1,190 BTU/Lb

Water @ 330F
300 BTU/Lb

100 psig

1 Unit of Volume

250 Units of Volume
Hot Water System
Hydronic Systems

Typical HW Generation and Production System

Pros
• Lower Temperature Operation
• System Efficiency
• Number of System Components
• Less of a Hazard over Steam
• Closed System
• Less potential for System Heat Loss
• Overall lower Installed and Operational Costs

Cons
• Larger Piping
• Distribution Pumps
• Flat Plate HX’s at each service
Projected Major Growth Areas

- North-West Campus-Project Focus
- North-East Campus

Capacity vs Load Growth
Life Cycle Cost Analysis—Basic Steps

- Facility Condition of Existing System (Equipment, Distribution, Efficiencies)
- Identify Campus Loads (Current and Projected)
- Determine Potential Options
- Identify 30 Year Costs
- Capital-New and Renewal, Equipment, Distribution
- O&M—Utility, Labor, Taxes, Fees
- Compare Performance
- Determine Cost of Financing
- Generate Cash Flow Diagrams
- Compare Net Present Value
- Identify Intangibles
- Perform a Sensitivity Study
Analysis Results

University of Wyoming Hot Water Heating System

- New Satellite Plant Located in the Heart of Projected Load
- Start of a Well Insulated Direct Buried HW Distribution System
- Modular, Condensing Type Boilers
- Distribution Pumps
- Provisions for Steam Backup at Plant with Coal as a possible fuel source
- System Can Be Expanded
- Remove/abandon Unrepairable Tunnels
- Unmanned and High Efficient

Note: High Heating Coil Temperature Differential Design will Help in System Efficiency
Visually Acceptable?

• Overall Architectural Design
• Scale
• Existing Views
• Integration with Masterplan

Relaying the Importance

• Communication to the Admin.
• Critically Approaching Heating Equipment Firm Capacity
• The 2019 UMP Update Verified Approach
• Synergies Utilized to Up the Priority
• New Lab Designs Created Need for HW/CW
• Buy In From UW Ops to the Trustees Needed
All Issues Had To Be Part of the Solution:

- Providing the Necessary Heating/Cooling Utilities
- Tunnel repair or replacement
- Asbestos
- Have an Efficient System to Keep Future Costs as low as possible
- W Campus Chilled Water Growth
- W Campus Heating Load Growth
- ADA Access for North Campus+
- Adherence to the University’s LRDP
Appearance

Architectural Design

Contemporary Architecture

Classical Architecture
Compare Costs and Acceptable Solutions

• 2018 Exterior Design Advisory Committee
  • Architectural Design
  • Location
  • Future Vision of the University
University of Wyoming

Outcome

- Transition to a Natural Gas fired, Hot Water Production/Distribution System with Steam Backup
- Standardize new Campus Design Requirements & relocated site further to the north
- Phase I Construction complete Spring 2021
Thank You!

Open Question Session

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