CHP Development

Hindsight is 20/20

Introduction

Speakers

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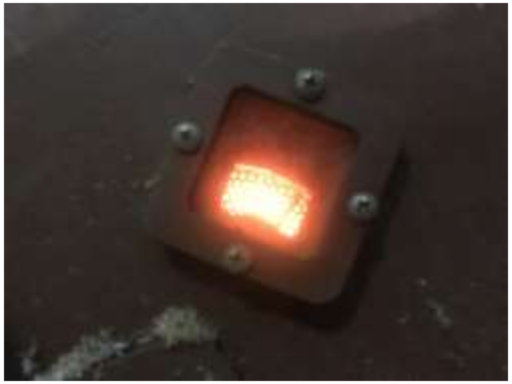
Objective

- Discuss lessons learned from each phase of the UAF CHPP Replacement Project
- Utilize the framework provided by the CHP Project Development Guide
  - US EPA Combined Heat and Power Partnership

The University of Alaska Fairbanks

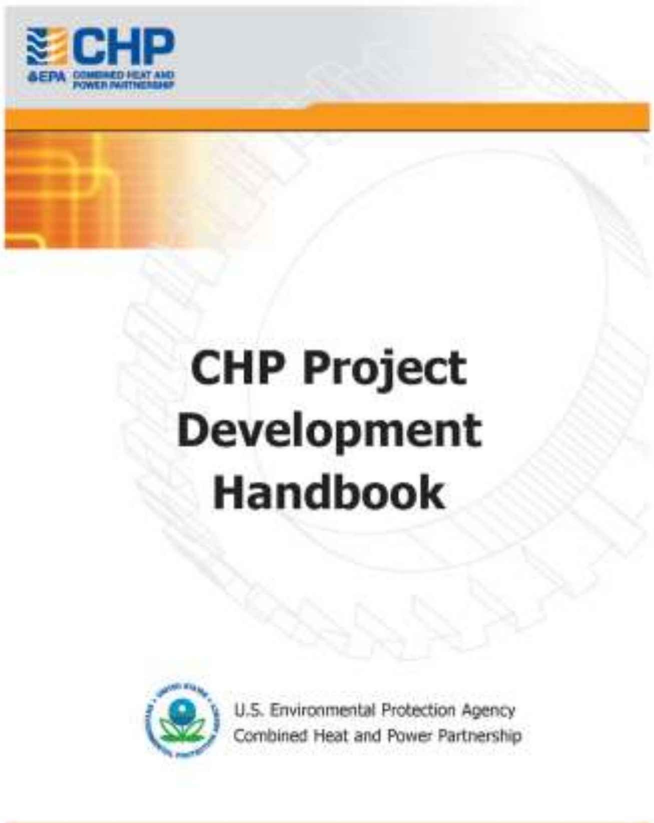
- Founded in 1917
- Located in Fairbanks Alaska
- Approximately 10,000 students at the Fairbanks campus
- 3,400,000 square feet of academic, research, administrative and housing space
- $124 Million in Research grants per year
- Extreme temperature variation: -66°F to 99°F
- Approximately 14,000 degree heating days

CHPP Replacement Project Status



- Construction complete
- Startup and commissioning in progress
- Turbine-Generator sync to grid: Sept 4
- First fire on natural gas: Sept 25
- First fire on coal: Dec 19
- Anticipated Completion: Mid April

CHP Project Development Guide



- Formerly the CHP Project Development Handbook
- How-to guide for
  - New installations
  - Retrofit/Replacement of existing CHP facilities
- Project development framework
  - Five stages of development
- Tools and resources
  - Forms / Questionnaires
  - Estimators / Spreadsheets
  - Sample Reports
  - Checklists
- All information (and more) available on EPA website

https://www.epa.gov/chp

The Five Stages of Project Development

- Stage 1 - Qualification
  - Is CHP a good fit?
- Stage 2 – Level 1 Feasibility Analysis
  - High level screening
  - Fatal flaws
  - Project hurdles
  - Cost
- Stage 3 – Level 2 Feasibility Analysis
  - Finalization of design basis
  - Finalize project economics
- Stage 4 – Procurement
  - Detailed Design
  - Equipment Procurement
  - Construction
  - Startup and Commissioning
- Stage 5 – Operation and Maintenance

Stage 1 – Qualification

One Question: Is CHP right for you?

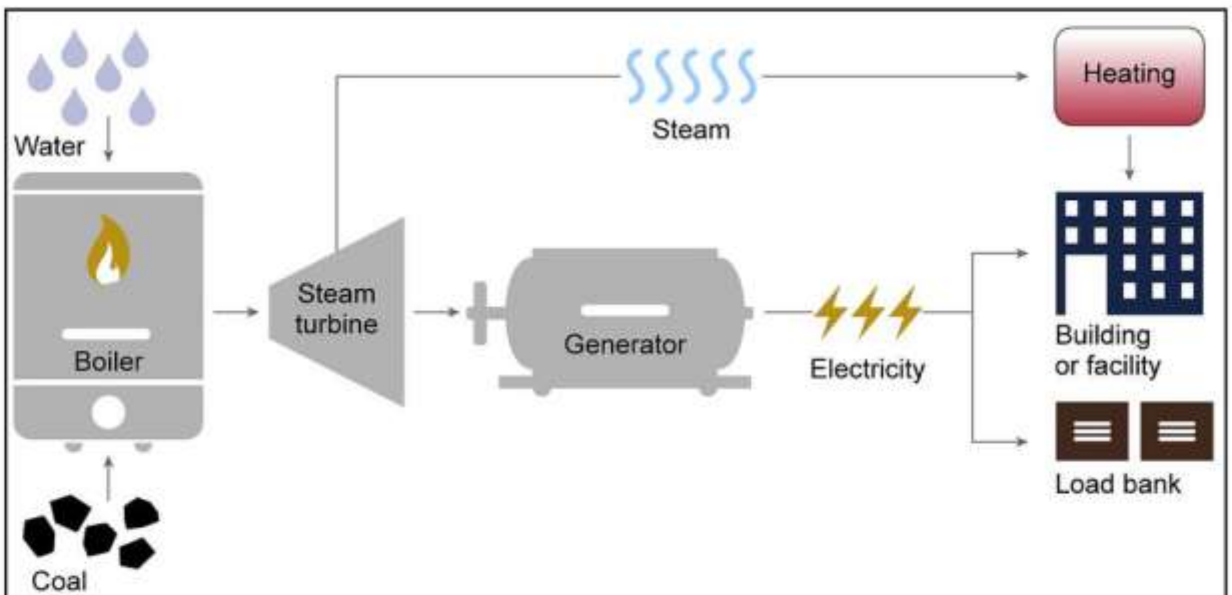
Lessons Learned:

- Plan on completing this step even if you have an existing CHP
  - UAF has had some form of CHP since the 1930's
  - Needed to build the case for CHP from scratch
  - Hired GLHN to conduct a screening study
- Focus on project drivers
  - 50+ year old plant
  - Insufficient capacity for future demand
  - Power is important, but heat is essential
  - Significant use of renewables is unrealistic
  - Natural gas is unavailable
  - Unnatural gas (vaporized LNG) and oil are expensive
  - Coal supply is local and affordable
- Consider a broad array of options
  - Defense against the "Why don't we just ____" argument
  - The more visible the project, the deeper you have to dig
  - Results also useful during public outreach phase

Stage 1 – Qualification

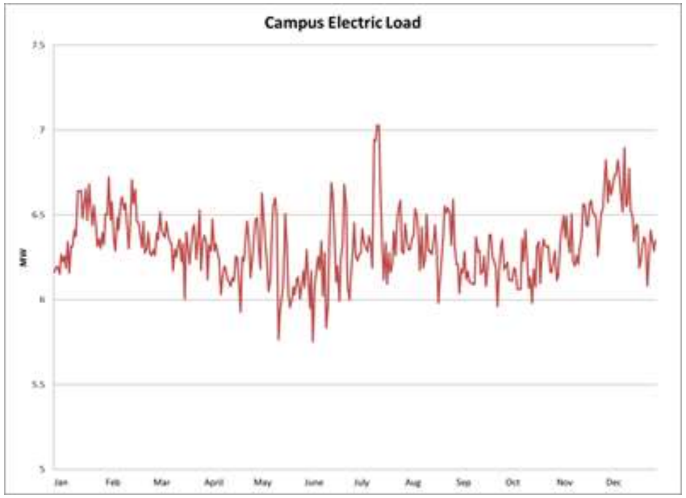
Lessons Learned:

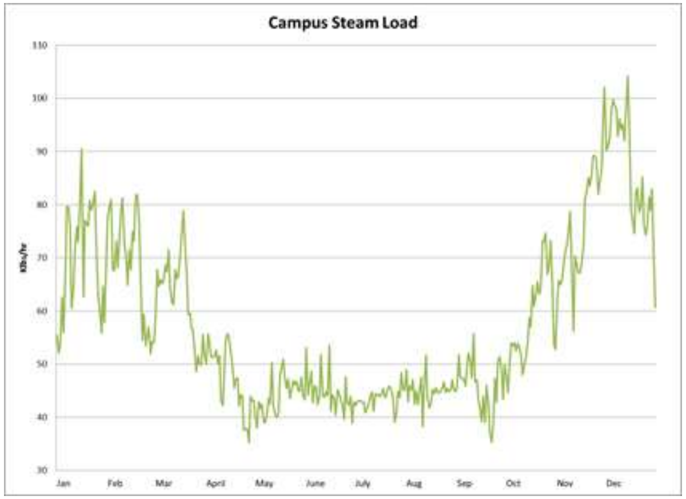
- Consider secondary factors
  - Impacts of a failure (resiliency)
  - Local grid reliability
  - Likelihood of natural disasters
  - Does the plant support a "Place of Refuge?"
  - Would you consider your facility "essential?"
  - Does your facility stand out to the public
- ???



Source: GAO analysis of Air Force information.

Stage 2 – Level 1 Feasibility Analysis





<u>Primary Activities:</u>

- Conceptual Design / Project Scoping
- Environmental studies / early permitting
- Budgetary cost estimate

<u>Lessons Learned:</u>

- Power, Heat, or Both?
  - Heat is essential in cold climates
  - Power is more valued in hot climates
  - Many facilities are somewhere in the middle
  - Local factors can have a large influence
- Energy needs determine technology
  - Thermal plants generate heat, power comes second
  - Gas turbines and engines generate power, heat comes second
  - Hybrid options are possible
- Do not constrain scope or costs
  - If it might be necessary, include it
  - Square footage is your friend
  - Easier to reduce scope or costs later
- Perform environmental engineering in parallel
  - Include emission points that may or may not be needed
  - A local environmental consultant can be invaluable

Stage 3 – Level 2 Feasibility Analysis

Primary Activities:

- Project design basis
- Contracting and procurement philosophy
- Project schedule
- Design optimization
- Refined cost estimate
- Project funding
- Early procurement

Stage 3 – Level 2 Feasibility Analysis

<u>Lessons Learned:</u>

- Lather, rinse, repeat….
  - The activities in this stage are iterative
  - UAF repeated Stage 3 at least 3 times
- CMAR can be an effective contracting approach
  - Best when there are many “unknown unknowns”
  - Requires an active owner
  - Likely not lowest first cost approach
  - Approach is much more tolerant of change
  - Reduces uncertainty relating construction methods before price is finalized
- Keep stakeholders in the loop
  - Both internal and external stakeholders
  - Consider PR help for high visibility projects
- Focus on design optimization
  - Consider both peak and off-peak loads in plant design
  - Be prepared to cut non-essential scope

Stage 3 – Level 2 Feasibility Analysis

Lessons Learned Continued:

- Consider early procurement of major equipment
  - Gets ball rolling on long lead equipment
  - Pay close attention to scope and liability boundaries
  - Can complicate project risk
- Finalize equipment and material sourcing early
  - Identify acceptable locations to source from
  - Will alternate sources be allowed as an option
  - Ensure sourcing approach is accurately reflected in bid documents
- Expect the unexpected in your schedule
  - Try to maintain float throughout the schedule
  - Startup and commissioning is likely to result in surprise delays
  - “Operational Excursions” can have a significant impact

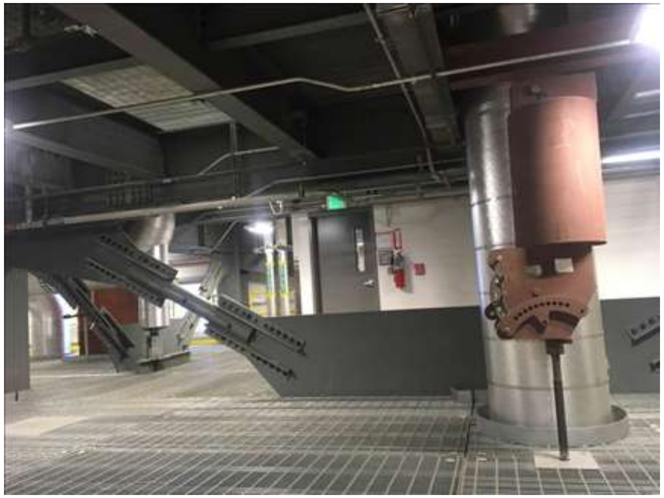
Stage 4 – “Procurement” (a.k.a Execution)

EPA Guide lumps a lot of the project into one stage

<u>Primary Activities:</u>

- 4A – Detailed Engineering
- 4B – Procurement
- 4C – Construction
- 4D – Startup and Commissioning

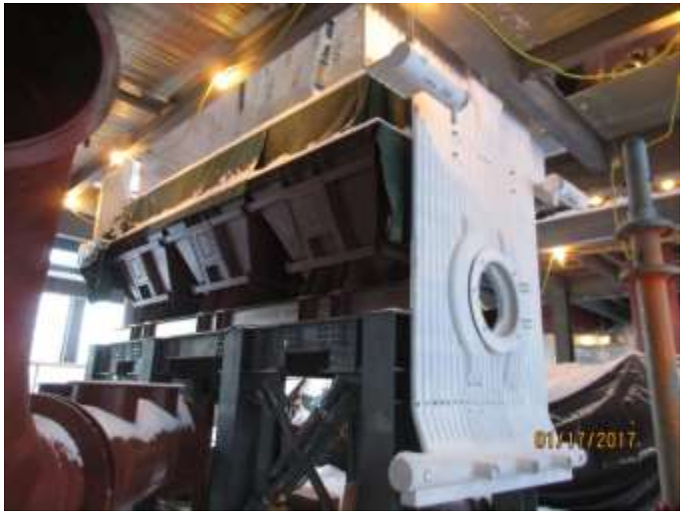
Stage 4A – Detailed Engineering



<u>Structural Lessons Learned:</u>

- Choose the boiler structural steel scope carefully
  - Focus on the interface points
  - Insist on early, frequent, and direct communication with boiler vendors structural engineer
- Avoid basements
  - Design of ground floor can get very complicated
  - Particularly true in high seismic areas
- Minimize cross bracing where possible
  - Cross bracing in high seismic areas can get quite large
  - Consider use of Buckling Restrained Brace (BRB) system or similar
- Don’t use the phrase “Essential Facility” lightly
  - Structural loads get multiplied by 1.5x
  - Impacts are compounded in a high seismic area

Stage 4A – Detailed Engineering



Mechanical Lessons Learned:

- Ensure sufficient equipment redundancy
  - Consider additional redundancy for "must-run" equipment
  - Consider likely failure scenarios in redundancy decisions
  - Consider the requirements of applicable codes and the equipment manufacturers
- Evaluate feed pump energy sources carefully
  - Code requires a backup source of power for feed pumps on certain boilers
  - Typical backup power source is steam
  - For smaller boilers, also consider the use of an emergency generator
  - If separate steam pump is selected, size it for at least 50% capacity
- Avoid mixing HVAC and process systems
  - Engineering approaches are completely different
  - Installation is completely different

Stage 4A – Detailed Engineering

I&C Lessons Learned:

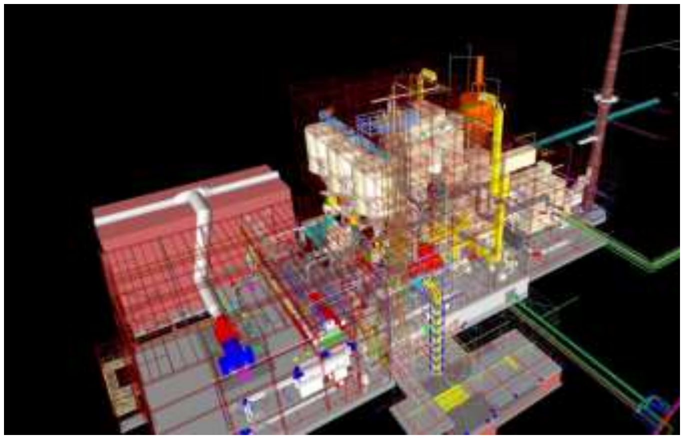
- Coordinate loop power requirements carefully
  - Power instruments from control cabinets
  - Design control cabinets with sufficient space (36" minimum)
  - Ensure that all equipment vendors are using the same loop voltages
- Avoid switches
  - Switches do not provide a continuous signal
  - No way to know if a switch is working or not
  - Flow/Pressure/Temperature/Level meters are a better choice for critical or high energy systems
- Procure the control system early
  - Engineer can customize design to best work with chosen system
  - Opportunity for system vendor to provide input into design
- Coordinate with electrical contractor early
  - Discuss and agree upon content of engineering deliverables
  - Consider on-site engineering support

Stage 4A – Detailed Engineering

Electrical Lessons Learned:

- Use caution when selecting VFDs
  - Be sure to understand the characteristics of the power source and the requirements of the driven load
  - Pay close attention to the drive specifications. Standard components and options can vary widely between brands
- Pay attention to system harmonics
  - Existing system harmonics can negatively impact plant reliability and performance
  - New generators can introduce new harmonics or make existing harmonics worse
  - Utilize transformers to mitigate system harmonics issues where possible
- Be Prepared to perform a grid interconnection study

Stage 4B – Procurement



- Invest in project management / coordination software
  - UAF utilized Aconex for all project email, RFI's, and document management
  - Document submittals and reviews were also conducted inside the Aconex product
- Major vendors should design using a 3D model
  - Frequent sharing of 3D models is critical
  - Multiple design and coordination issues could have been avoided
- Coordinate egress paths with vendors
  - Standard specification language is not sufficient
- Budget for engineering coordination with vendors
  - Ensure there is one engineer for each major vendor that is tasked with engineering coordination or dedicate one engineer to coordinate with all major vendors.
  - Engineers assigned to specific systems should take responsibility for coordinating with miscellaneous equipment vendors inside their systems

Stage 4C – Construction

- Scope boundaries
- Sub-vendors
- Work plan coordination
- Communications protocols
- Delays of materials
- Commissioning agent was through the general contractor
- Wrong steel
- Impossible to clean coal unloading area

Stage 4C – Construction

- $245 Million project on budget and nearing completion
- Low fidelity Simulator
- CMAR construction method work very well

Questions?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New CHP Facility