FROM COGEN TO TRIGEN
Hello!

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CASE IN POINT

BYUI Central Utilities

4.5 MWe gas combustion turbine

25 MMbtuh heat recovery steam generator (50 MMbtuh with duct burner)

155 MMbtuh steam boiler plant

1,800-ton chilled water plant

Up to 45% of turbine exhaust bypassed on hot days

22% of turbine exhaust bypassed in a typical year

More chiller capacity needed by Summer 2020
COGEN
CHP

Original plant built in the 1960’s with two coal boilers. Retrofits in the 1960’s, 1970’s, 2001 and 2010 added two additional boilers and a chilled water plant.
WHAT HAPPENS WHEN
CHP = TOO MUCH
HEAT?

What options do we have?

What is the most efficient way to deal with the heat?

CHP Yearly Heat Consumption

- Duct Burner
- Heat Recovered
- Heat Bypassed
Rejecting steam to the atmosphere requires infrastructure to automate and regulate the pressure. It also requires additional water, chemical treatment, and heat energy.
TURN IT DOWN?

Turning the turbine down is a less efficient way to operate

AND

The cooling season is when you NEED the power!
TURN IT OFF?

BYUI is under contract to produce power.

The cooling season is when you NEED the power.

But, if infrastructure is not built-in, turning off the turbine may be the only option.
BYPASS THE HEAT RECOVERY

Modulate the extra heat to atmosphere

This is the current practice at BYUI
STACK EMISSIONS
A PROBLEM OR AN OPPORTUNITY?

Heating Load and Cogen Production
March through October

- Cogen Production
- Campus Load
STUDY: PROJECT REQUIREMENTS

Use as much “wasted” heat as possible

AND

Meet future campus chilled water demands

AND

Provide a reasonable return on investment
WHAT CAN EXTRA STEAM DO?

Process Use

Nothing on campus...
WHAT CAN EXTRA STEAM DO?

Make More Power
Steam turbine
Rankine cycle
WHAT CAN EXTRA STEAM DO?

Use Steam to Produce Cooling

Absorption (single, double, and triple effect)

Steam turbine-driven chiller
STUDY: ADDING A CHILLER

Absorption Chiller

OR

750-ton Electric Chiller (baseline)

OR

1000-ton Steam Turbine Chiller

OR

1MWe Steam Turbine Generator + 750-ton Chiller
WHAT ABOUT ABSORPTION CHILLERS

In other studies:

- Absorption is less expensive per ton but uses more heat per ton of cooling produced
- Steam turbine chillers are more compact per ton
- The legacy of older absorption chillers has created a poor reputation
WHAT ABOUT STEAM-DRIVEN EQUIPMENT?

Study Results
Return on investment vs. baseline for:

- Steam turbine chiller
- Steam turbine generator and chiller
- Steam turbine generator – always on
- Ignores sunk cost of CHP system

![Bar chart showing ROI for different options:]

- Option 2: 1000 Ton Steam Turbine Chiller
- Option 3: 1MWe Steam Turbine Generator and Elec Chiller
- Option 4: Steam Turbine Generator Full Year Operation

Ignores sunk cost of CHP system
STEAM STUDY RESULTS:
STEAM TURBINE
CHILLER

No boiler/duct burner operation needed for chiller

Boilers/duct burner would be needed for steam turbine generator

Short cooling season reduces ROI for all options

Available Steam March through October

- Bypass Heat
- Steam Driven Chiller
STEAM STUDY RESULTS: STEAM TURBINE CHILLER

Electrical Savings
Consumption savings whenever the steam drive is operating
Demand savings because chiller operation coincides with peak campus demand
Trigeneration Production
March through October
-Uses more than half of bypass
PREDICTED PERFORMANCE
A CLOSER LOOK

Five Representative Days
1,000-ton steam turbine chiller project is currently underway!
Initial estimates in the range of $2.5 million

Bids came in over $3.3 million due to material cost increases and construction climate

The following cities experienced the highest construction cost change year-over-year:

- Richmond, VA
- Fargo, ND
- Elizabeth City, NC
- Twin Falls, ID
- Shreveport, LA
- Sioux Falls, ND
- Lynchburg, VA
- Wenatchee, WA
- Augusta, ME
Thanks!

Any questions?

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