BYU IDAHO | Facilities Management

RMH GROUP

FROM COGEN TO TRIGEN

Hello!

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THE RMH GROUP – MECHANICAL ENGINEER

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

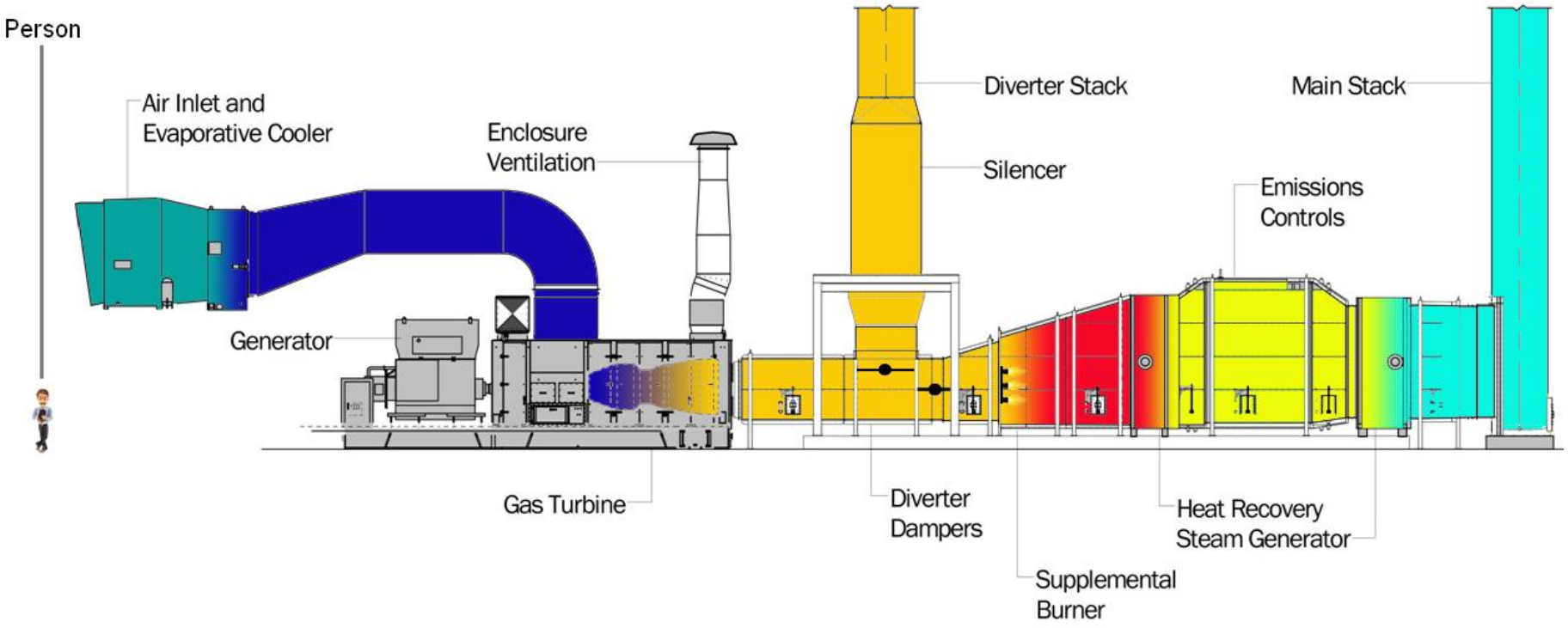
1,800-ton chilled water plant

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

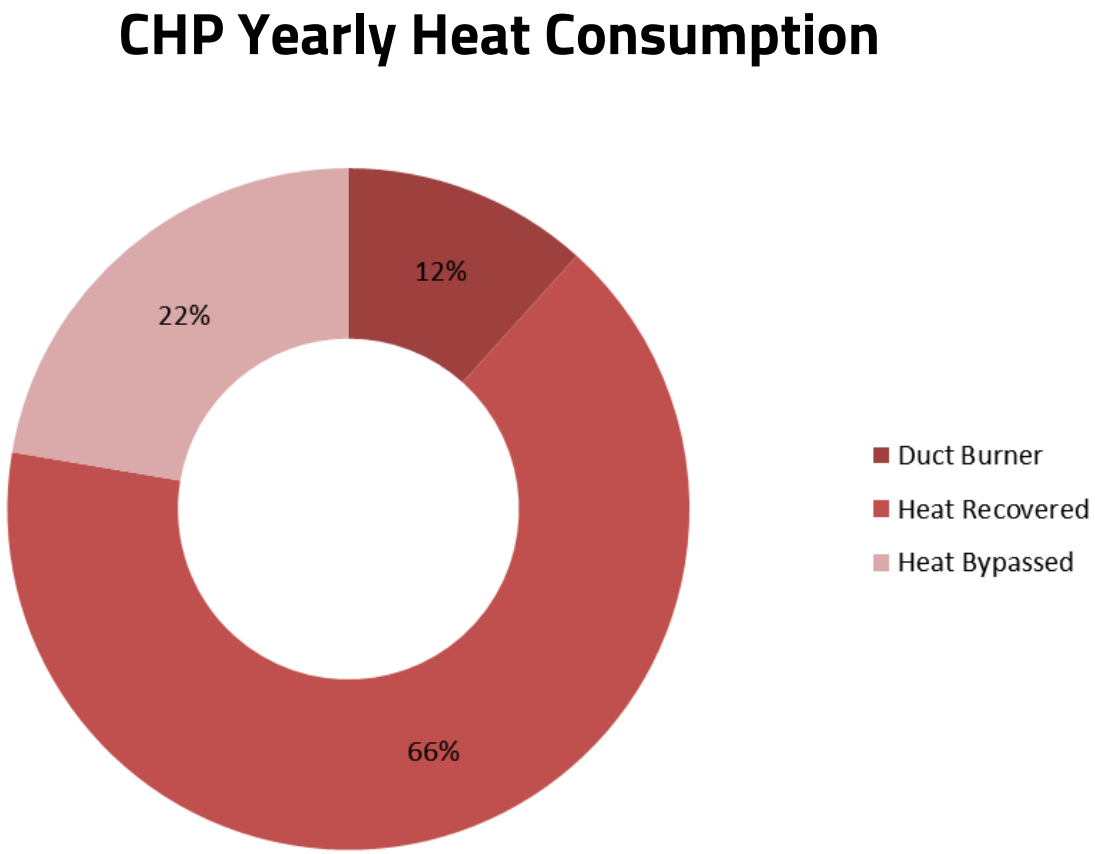
COGEN
CHP


Person
Air Inlet and
Evaporative Cooler
Enclosure
Ventilation
Diverter Stack
Silencer
Main Stack
Emissions
Controls
Generator
Gas Turbine
Diverter
Dampers
Heat Recovery
Steam Generator
Supplemental
Burner

WHAT HAPPENS WHEN
CHP = TOO MUCH HEAT?

What options do we have?

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



BYPASS
THE HEAT RECOVERY

Divert excess turbine exhaust to atmosphere, bypassing the heat recovery unit

This is the current practice at BYUI

REJECT IT TO ATMOSPHERE

Rejecting steam to the atmosphere requires infrastructure to automate and regulate 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!

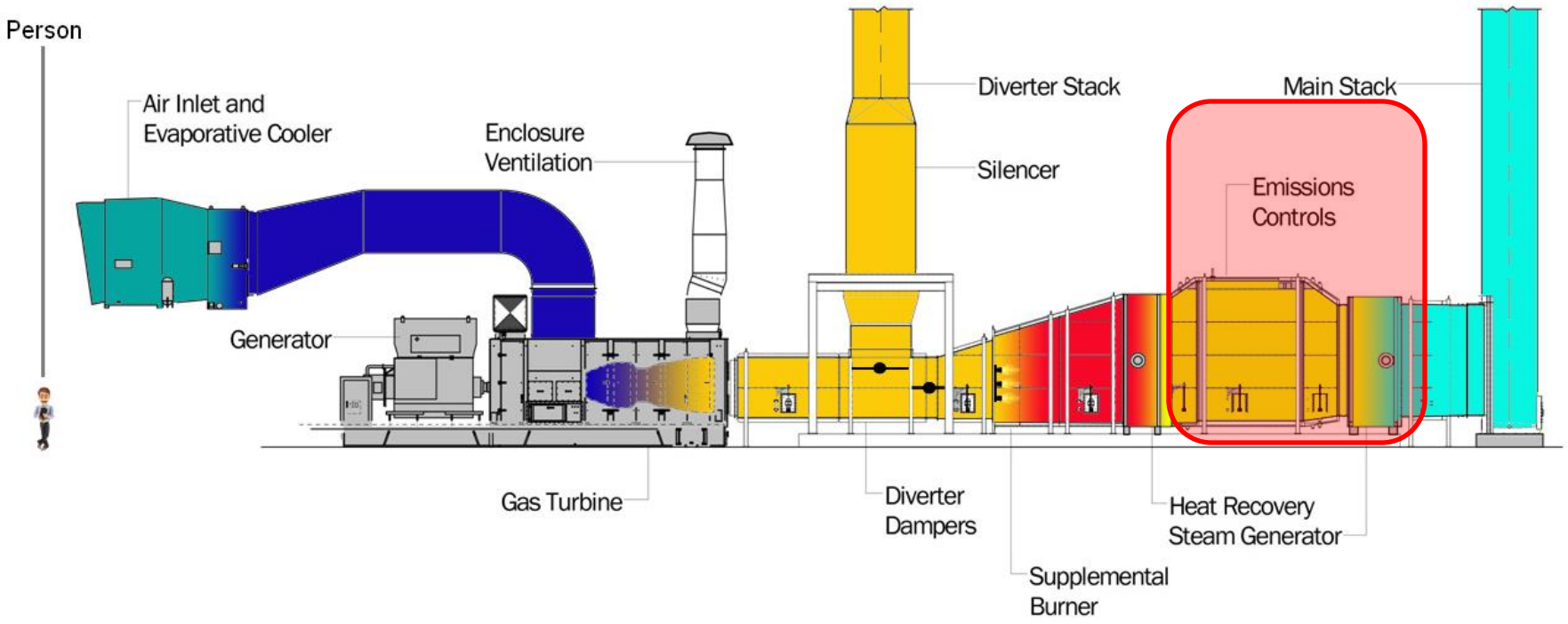
TURN IT OFF?

BYUI is under contract to produce power

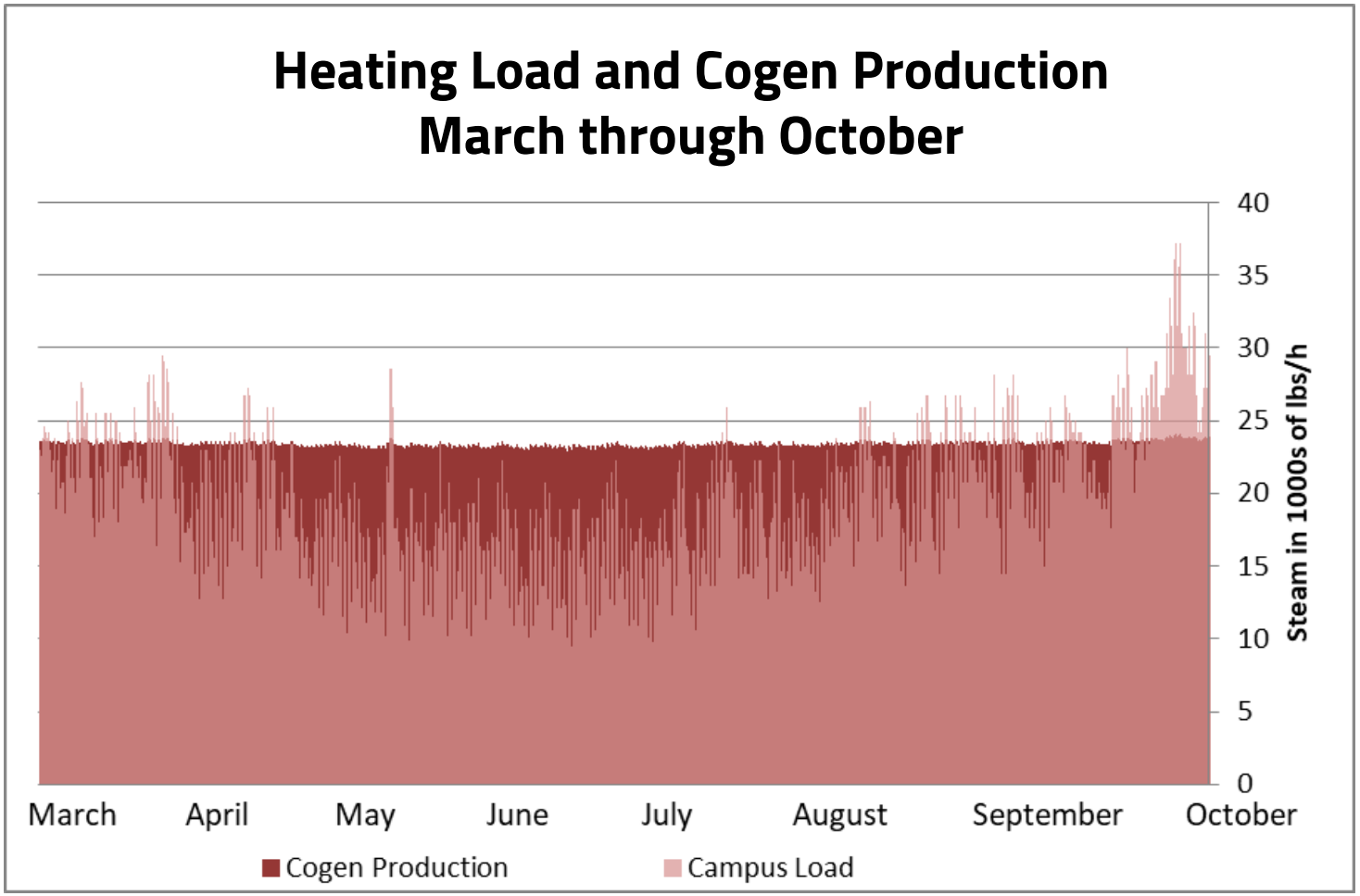
The cooling season is when you NEED the power

But, in installations without built-in infrastructure , turning off the turbine may be the only option

STACK
EMISSIONS



A PROBLEM OR
AN OPPORTUNITY?



STUDY: PROJECT REQUIREMENTS

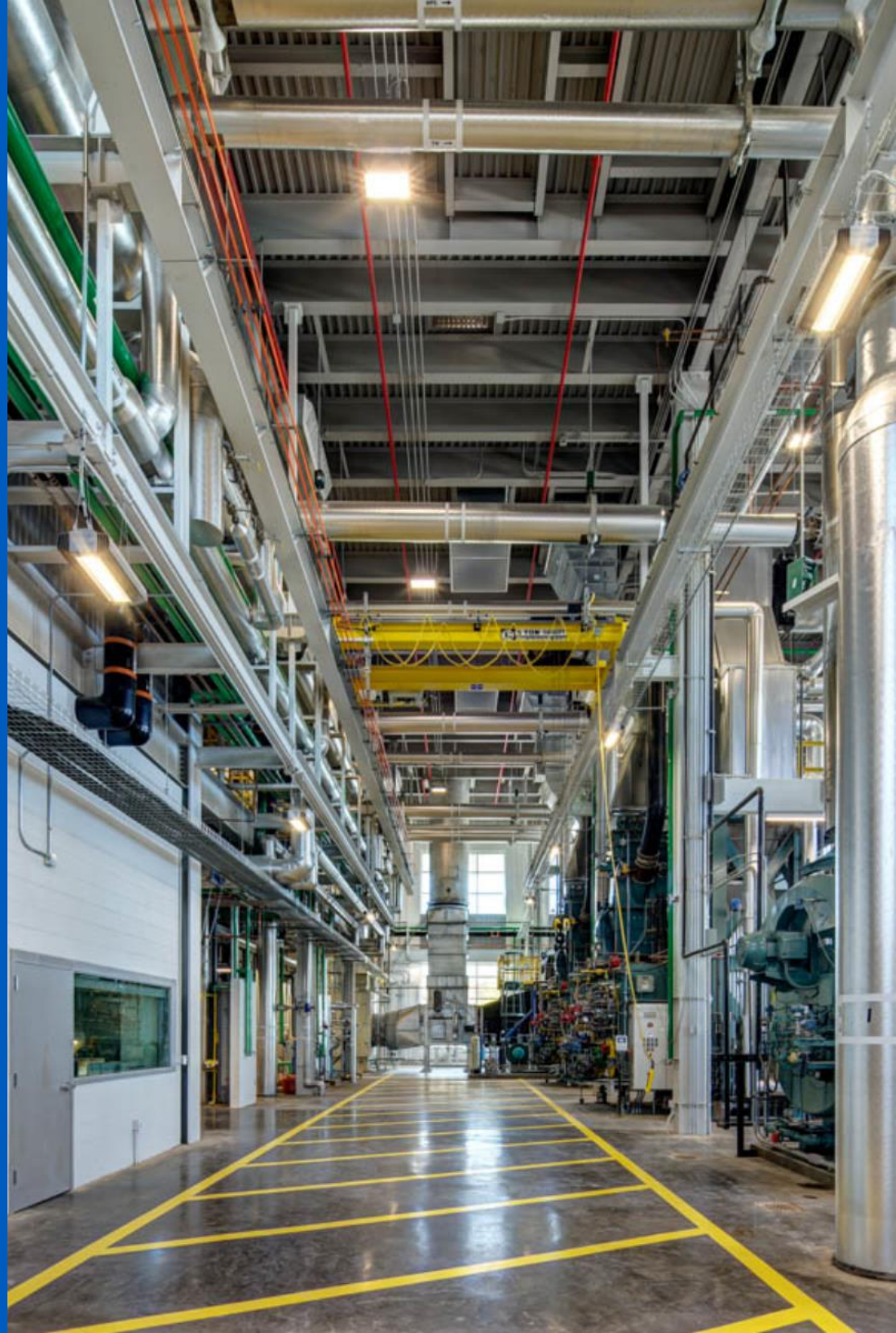
Use as much “wasted” heat as possible

AND

Meet future campus chilled water demands

AND

Provide a reasonable return on investment



WHAT CAN EXTRA STEAM DO?

Process Use

Nothing significant on campus…

WHAT CAN EXTRA STEAM DO?

Store it?

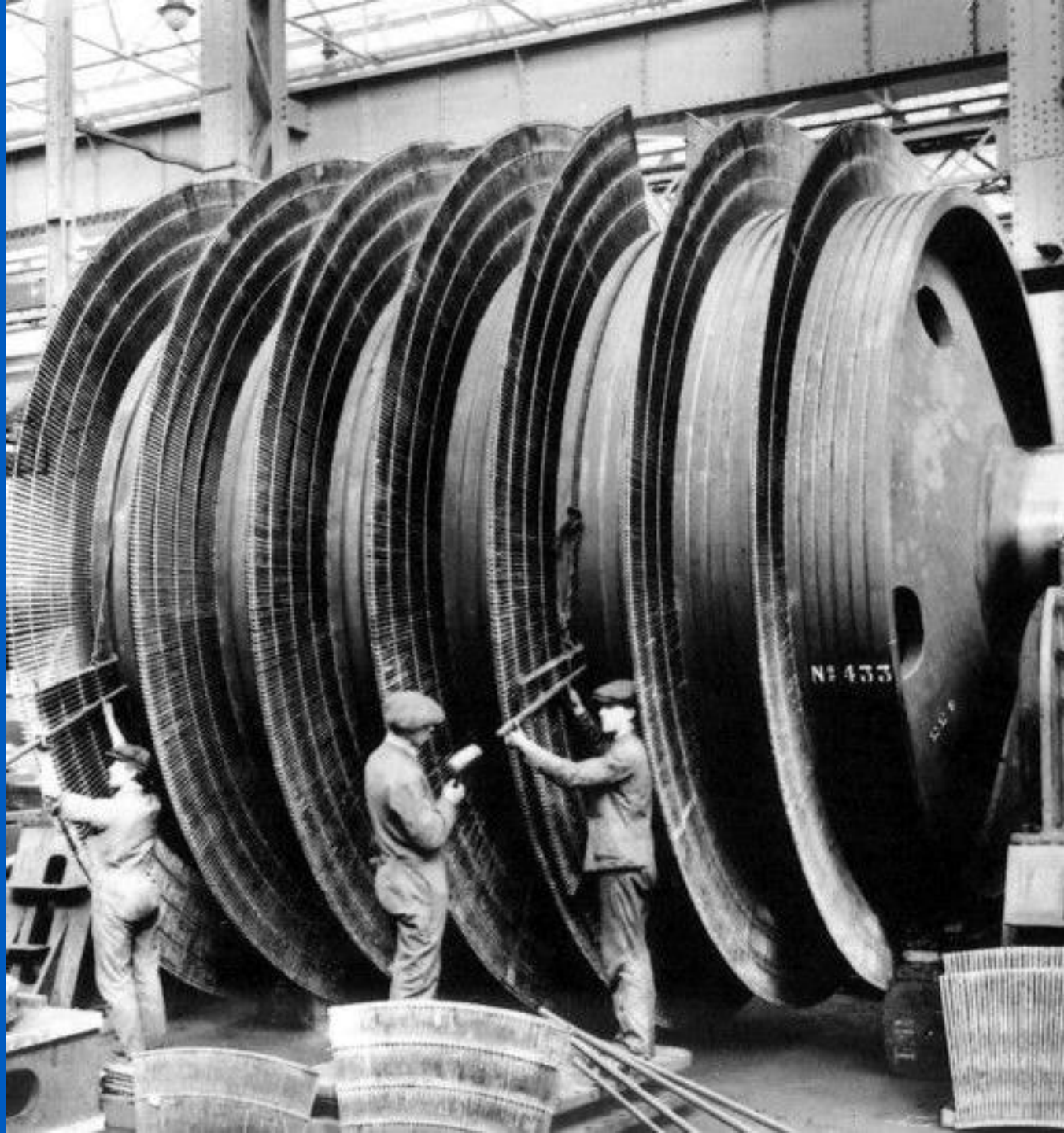
Impractically large storage required

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

WHAT IS A STEAM TURBINE CHILLER?

Same as a standard chiller with a turbine instead of a motor

Steam is condensed at partial vacuum

Condenser water must carry away heat of condensation as well as heat removed from chilled water

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

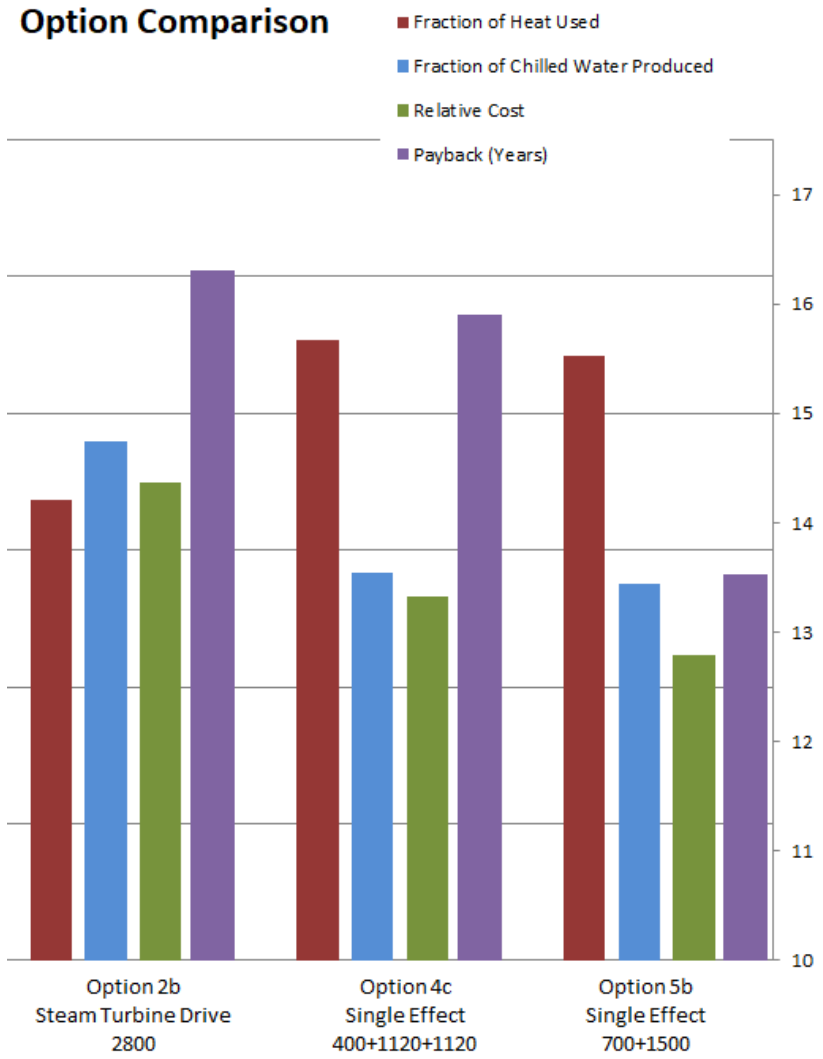
The other option:

- Cooling without a compressor
- Works with steam or hot water
- Single, Double, and triple effect machines available
- Works at high vacuum and with somewhat corrosive solutions

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

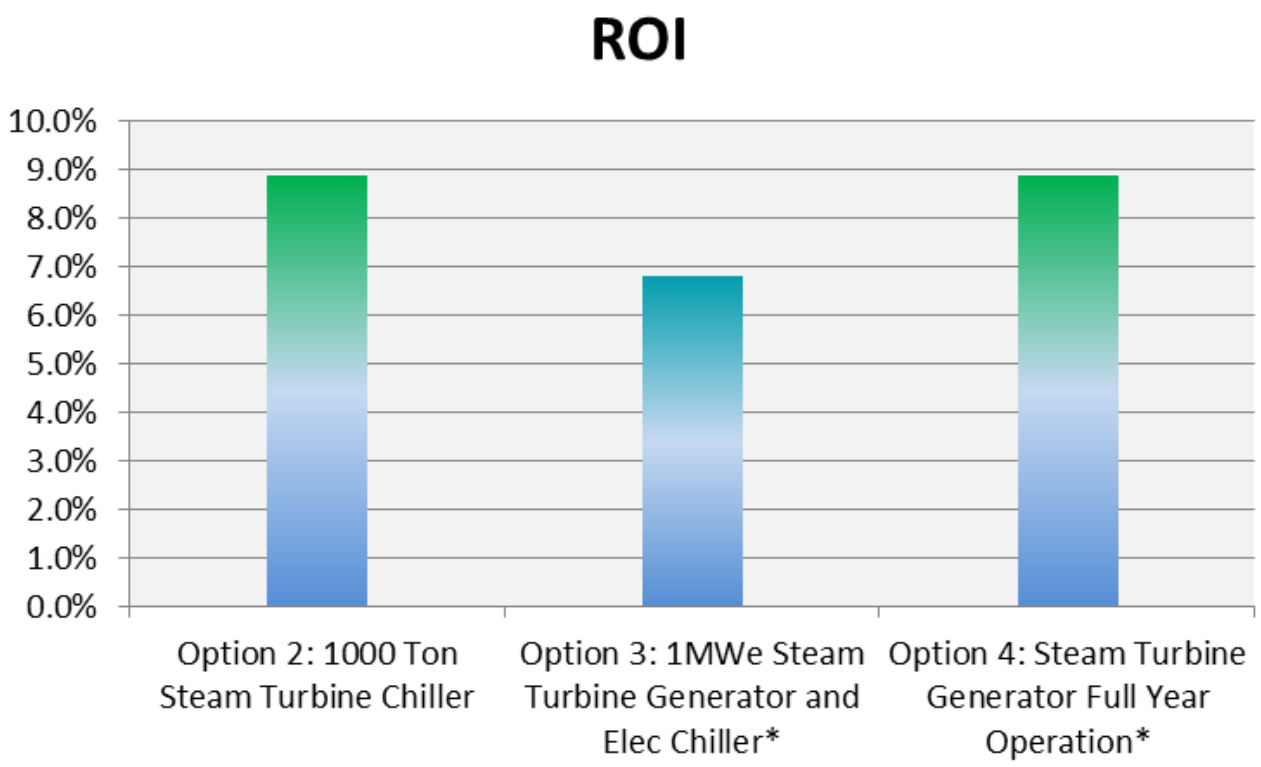


WHAT ABOUT STEAM-DRIVEN EQUIPMENT?

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



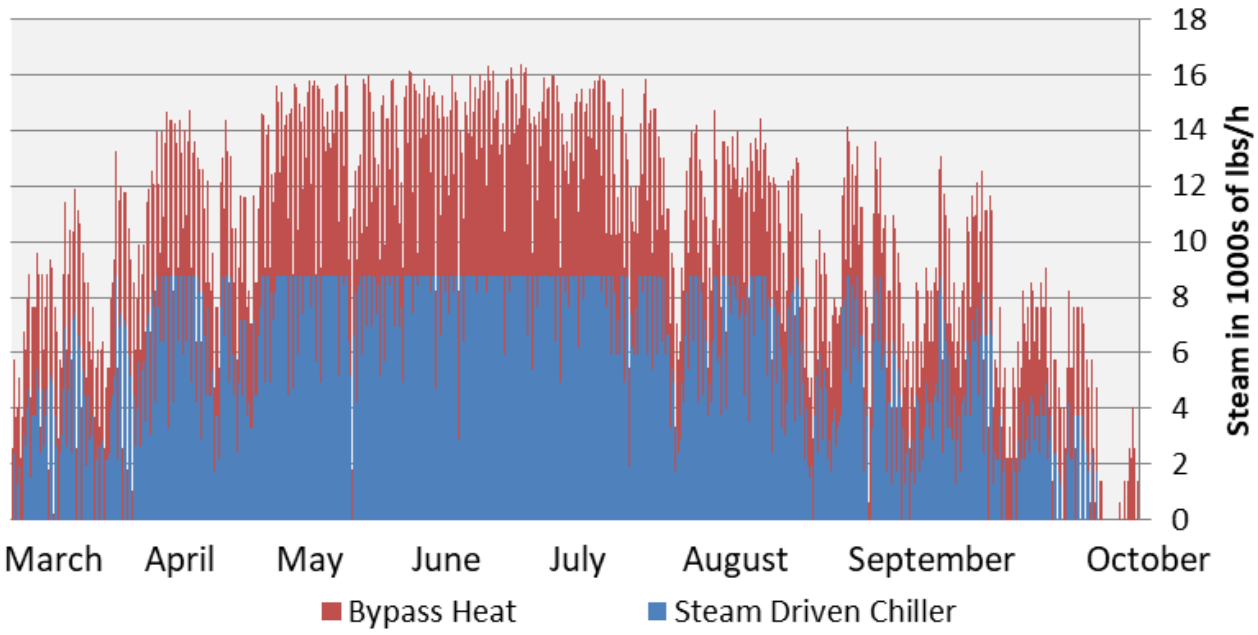
STEAM STUDY RESULTS: STEAM TURBINE CHILLER

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

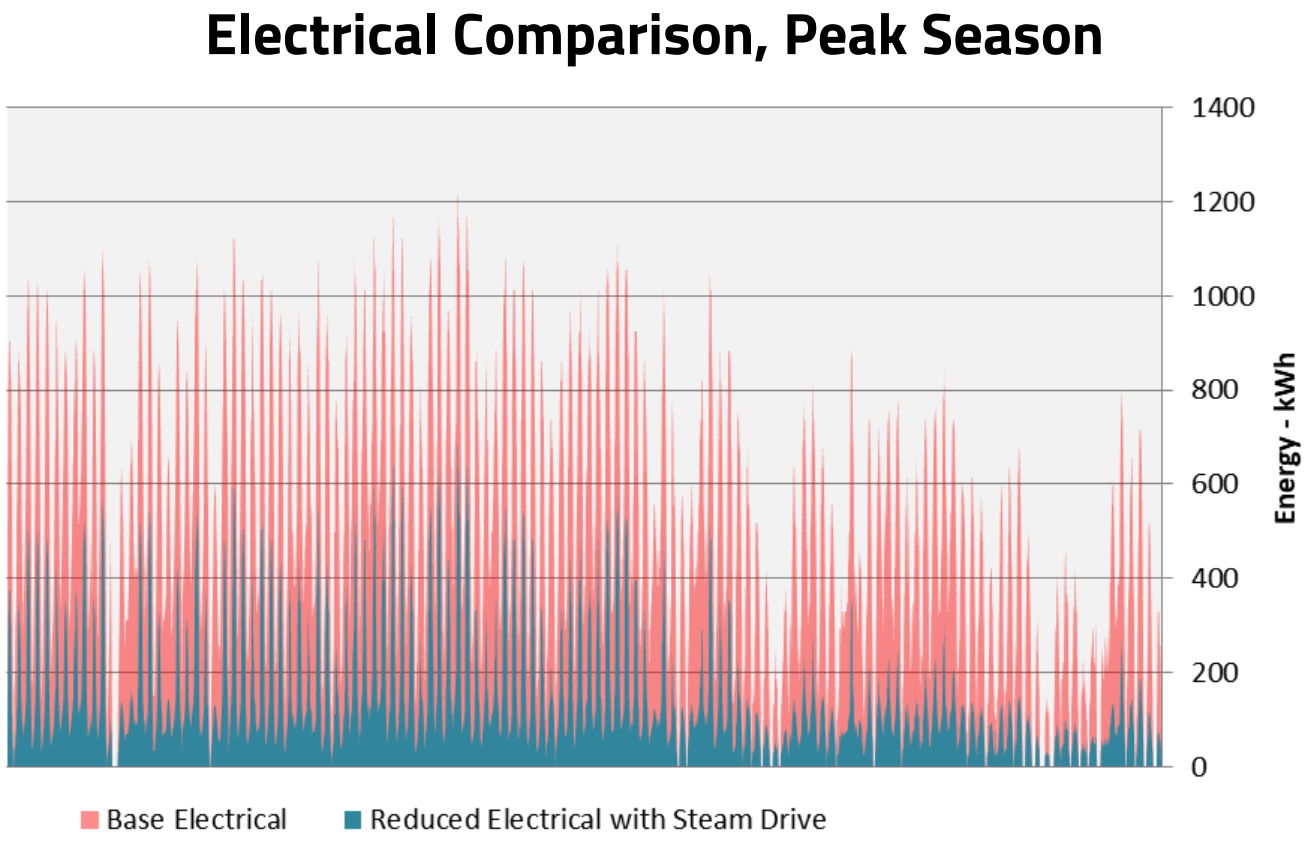


STEAM STUDY RESULTS: STEAM TURBINE CHILLER

Electrical Savings

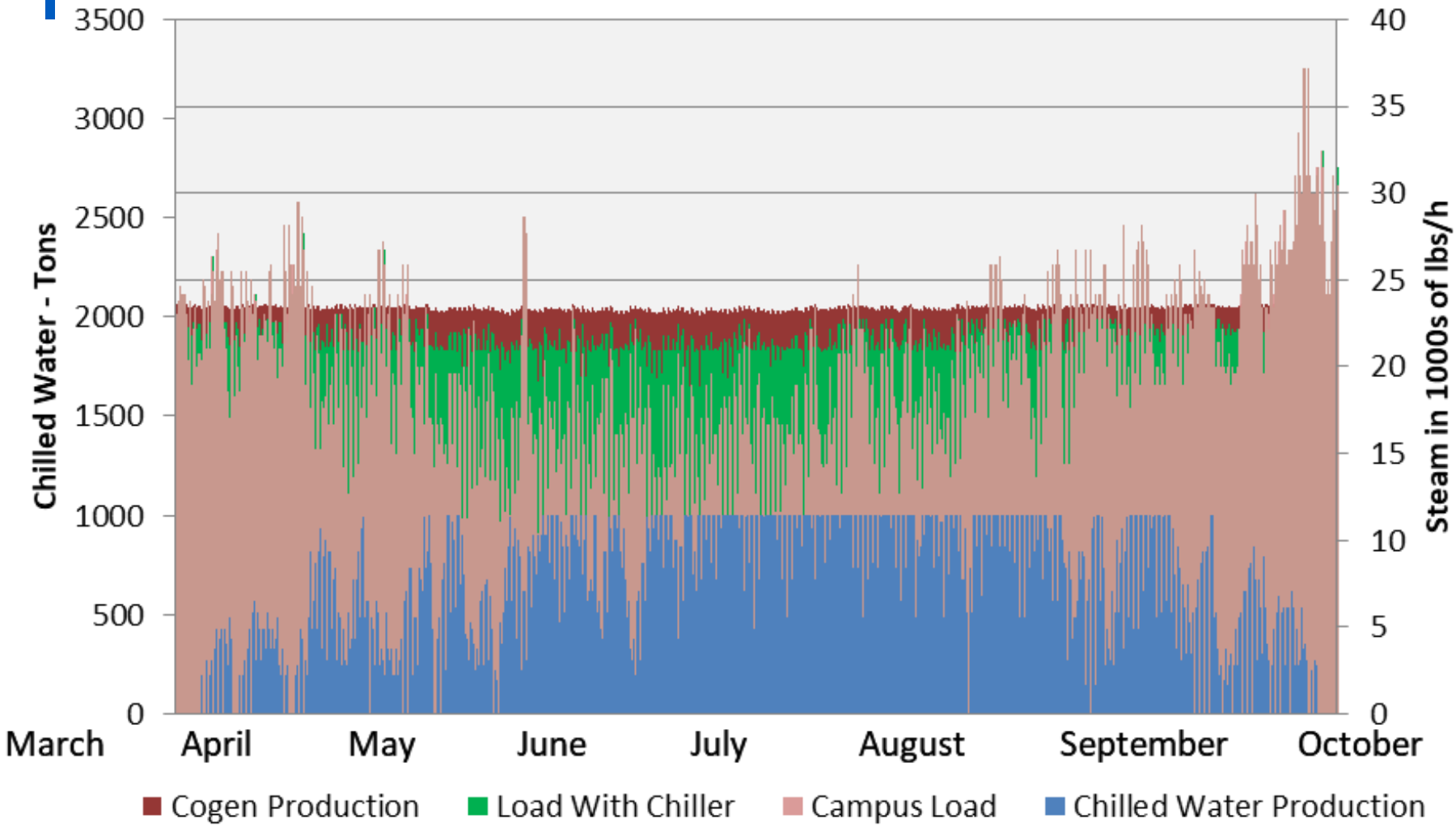
Consumption savings whenever the steam drive is operating

Demand savings because chiller operation coincides with peak campus demand



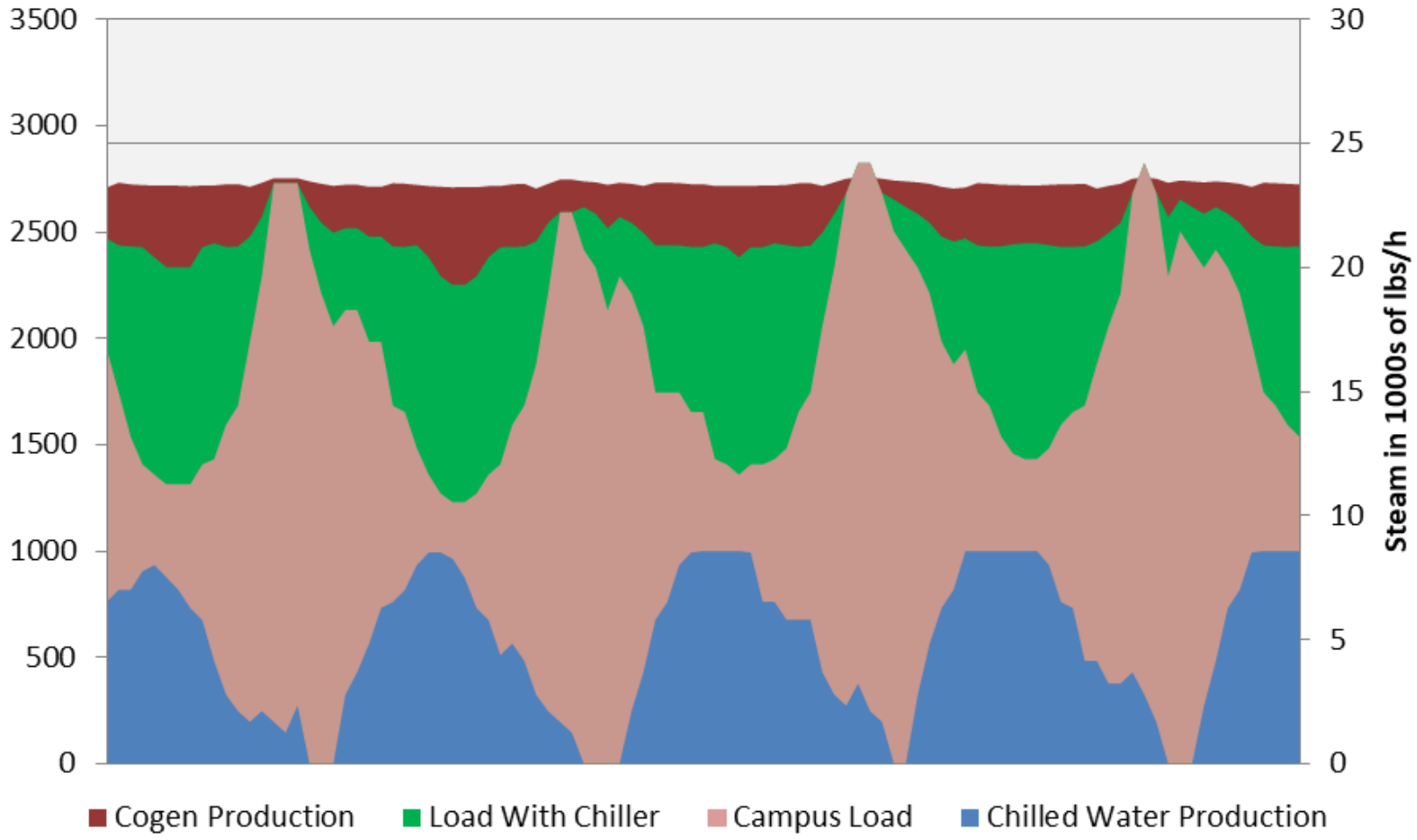
PREDICTED PERFORMANCE

Trigeneration Production
March through October
-Uses more than half of bypass



PREDICTED PERFORMANCE
A CLOSER LOOK

Five Representative Days



FINAL
DECISION

1,000-ton steam turbine chiller

Project is currently underway!

Construction Progress

Construction in two phases

1. Prep work in winter while the chillers were offline
2. Installation through the summer while the plant is operational

Chiller procurement was
Anticipated at 9 months
And to arrive in August

Construction Progress

But…. Chiller was delayed until September, to late to show you pictures of it installed.

Full operation spring of 2020

Lessons learned on subcontracts of equipment suppliers

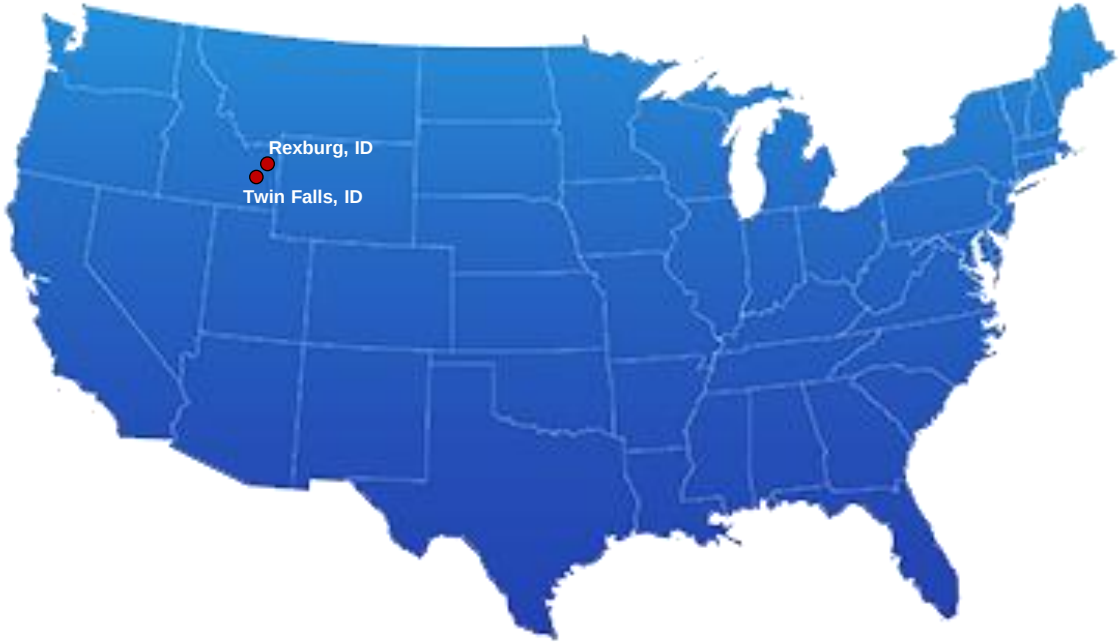
PROJECT COSTS

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 in 2017:

- 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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