

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

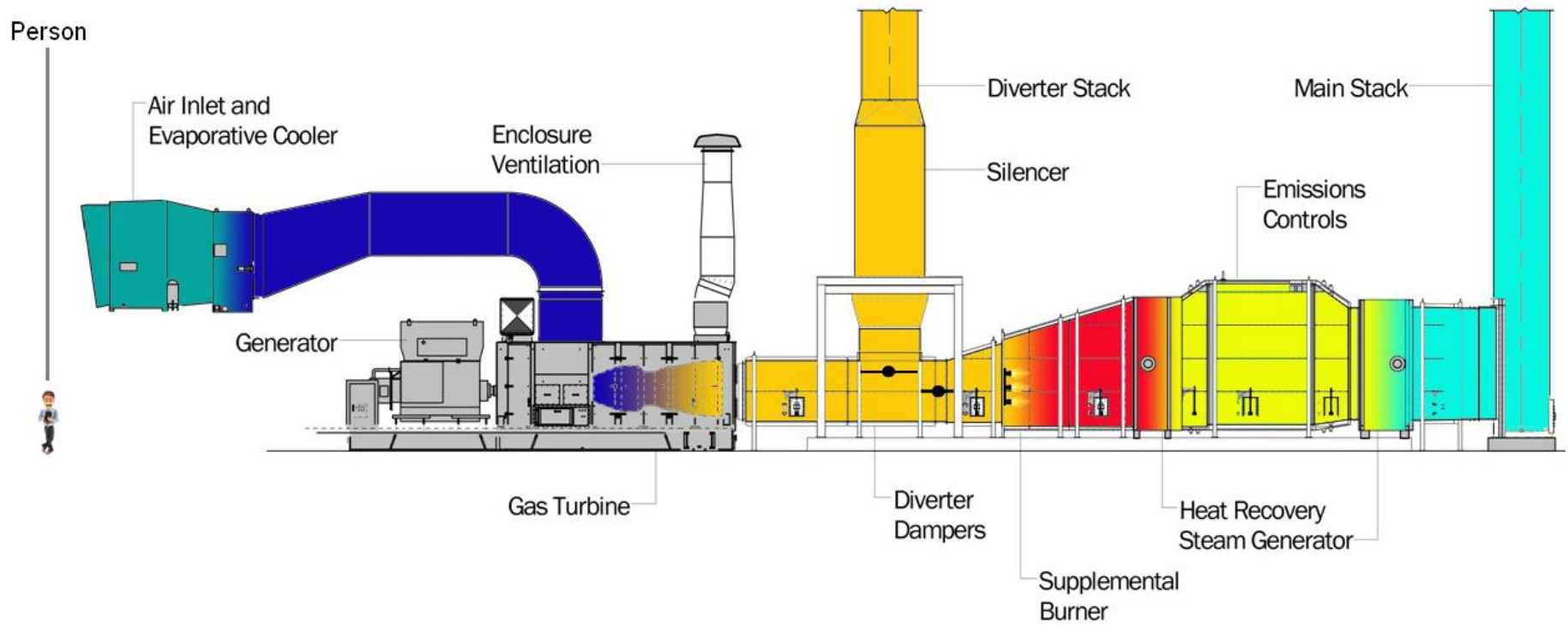
Up to 45% of turbine exhaust bypassed on hot days

22% of turbine exhaust bypassed in a typical year

More chiller capacity needed by Summer 2020



COGEN CHP

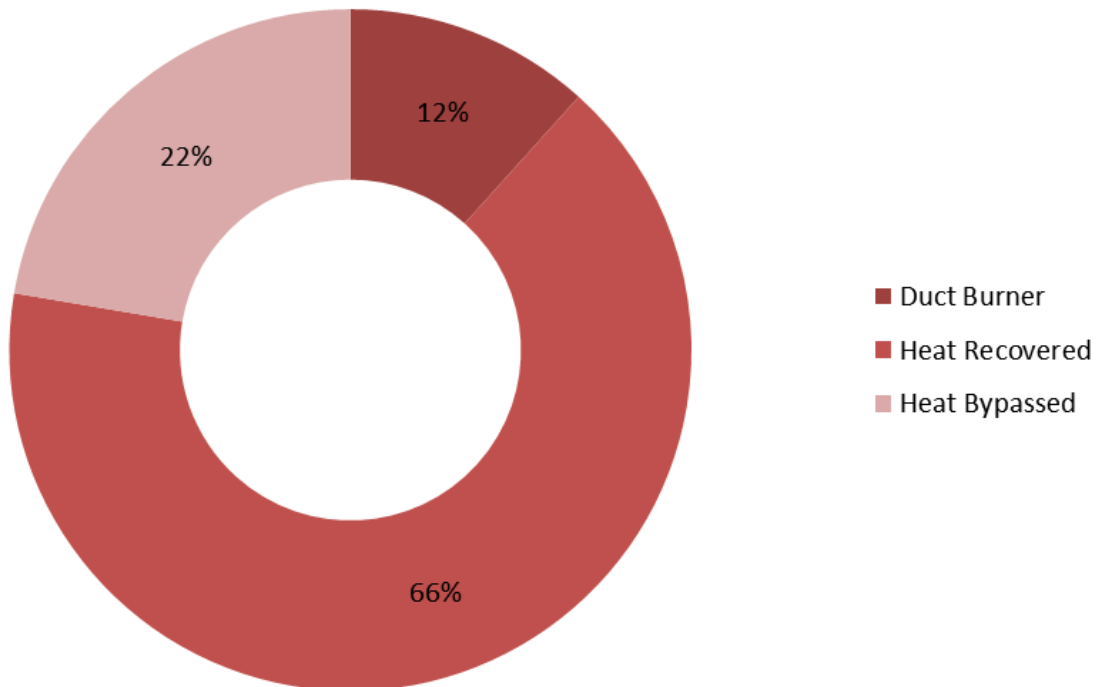


WHAT HAPPENS WHEN CHP = TOO MUCH HEAT?

What options do we have?

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

CHP Yearly Heat Consumption



BYPASS **THE HEAT** **RECOVERY**

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

This is the current practice at BYU



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

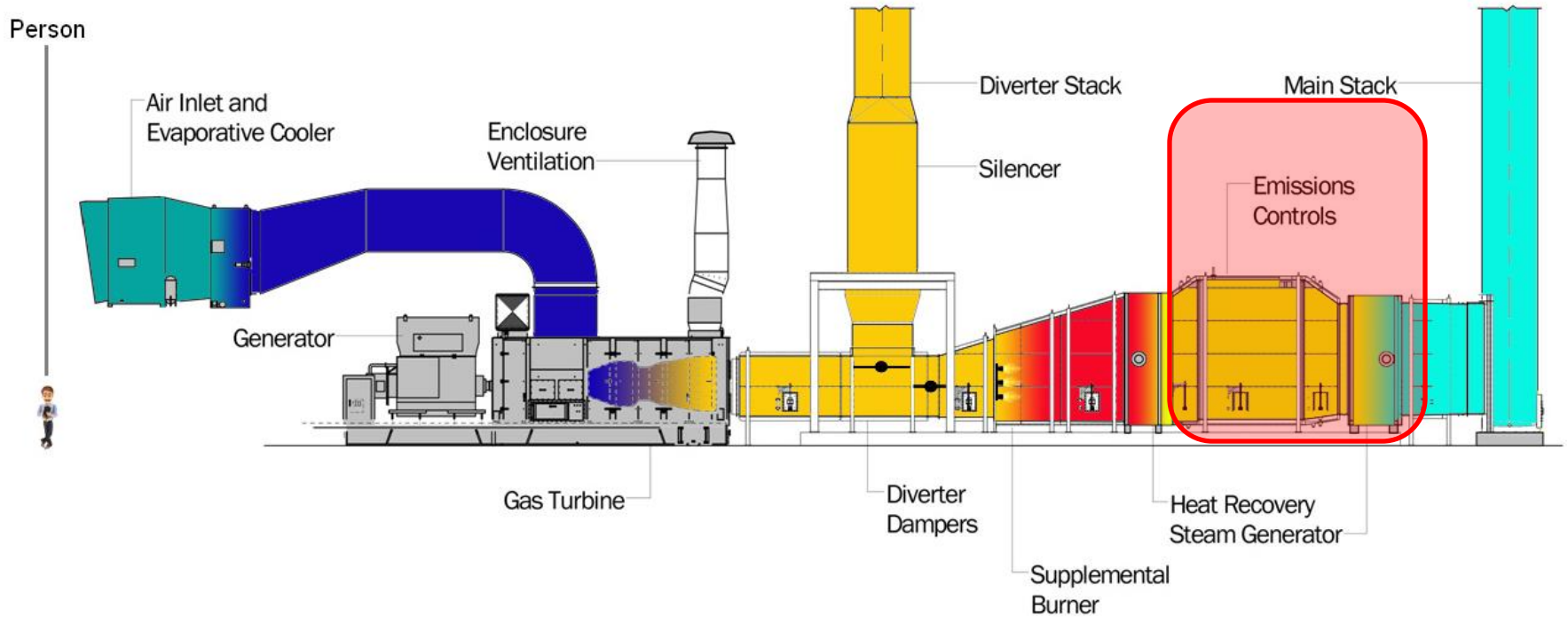
The cooling season is when you NEED the power

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

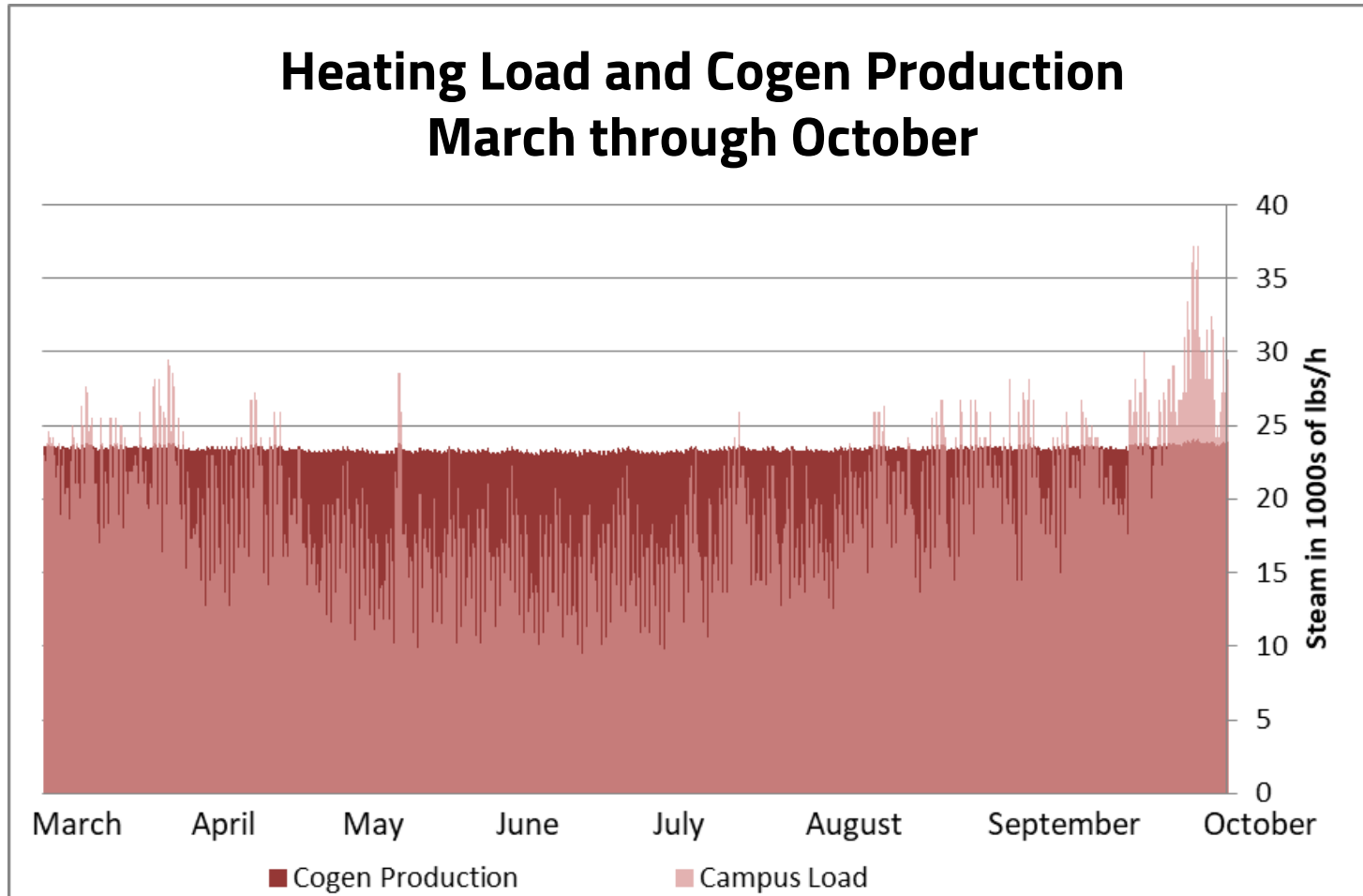


**POWER
SHUT-OFF**

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

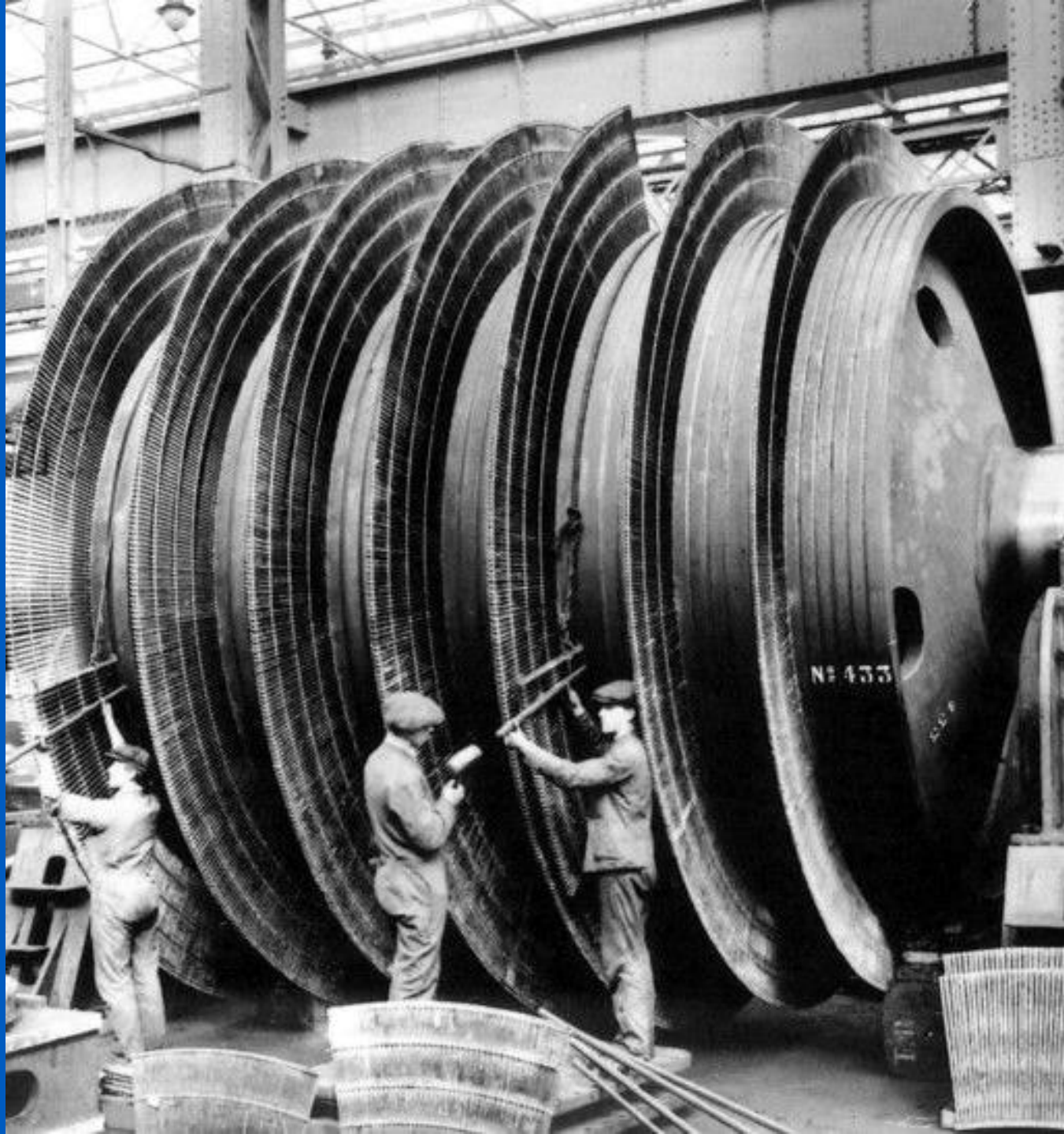


WHAT CAN EXTRA STEAM DO?

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

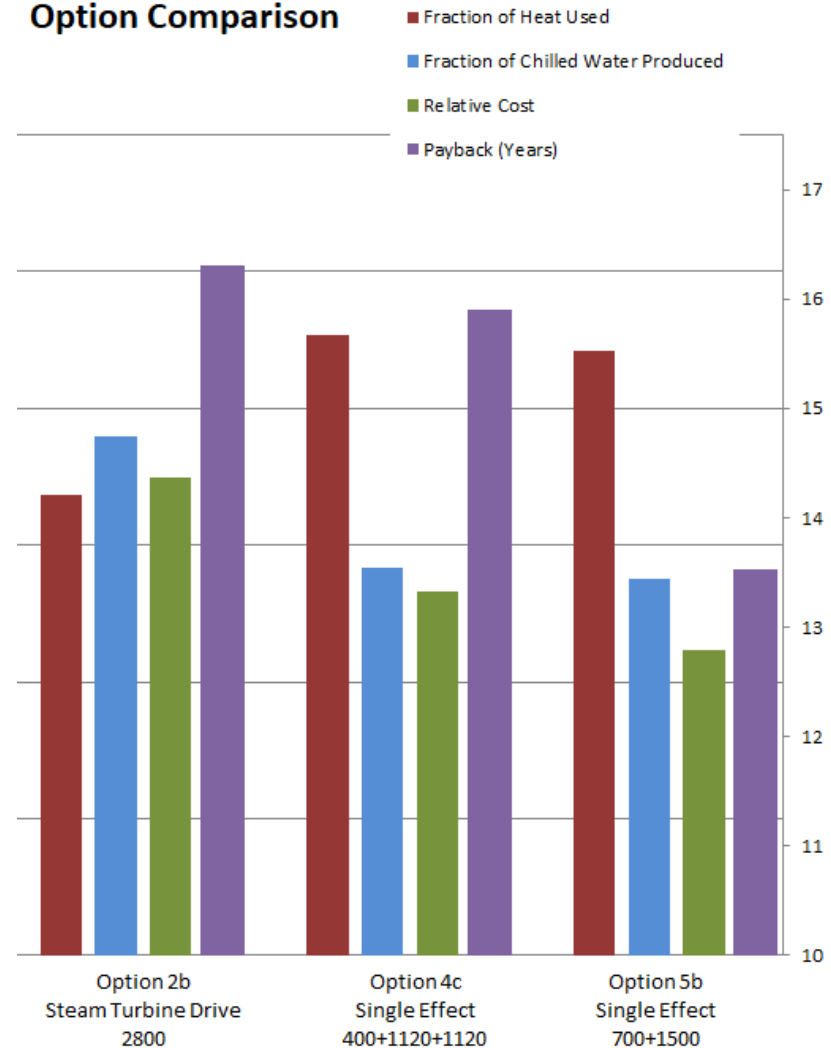


WHAT ABOUT ABSORPTION CHILLERS

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

Option Comparison

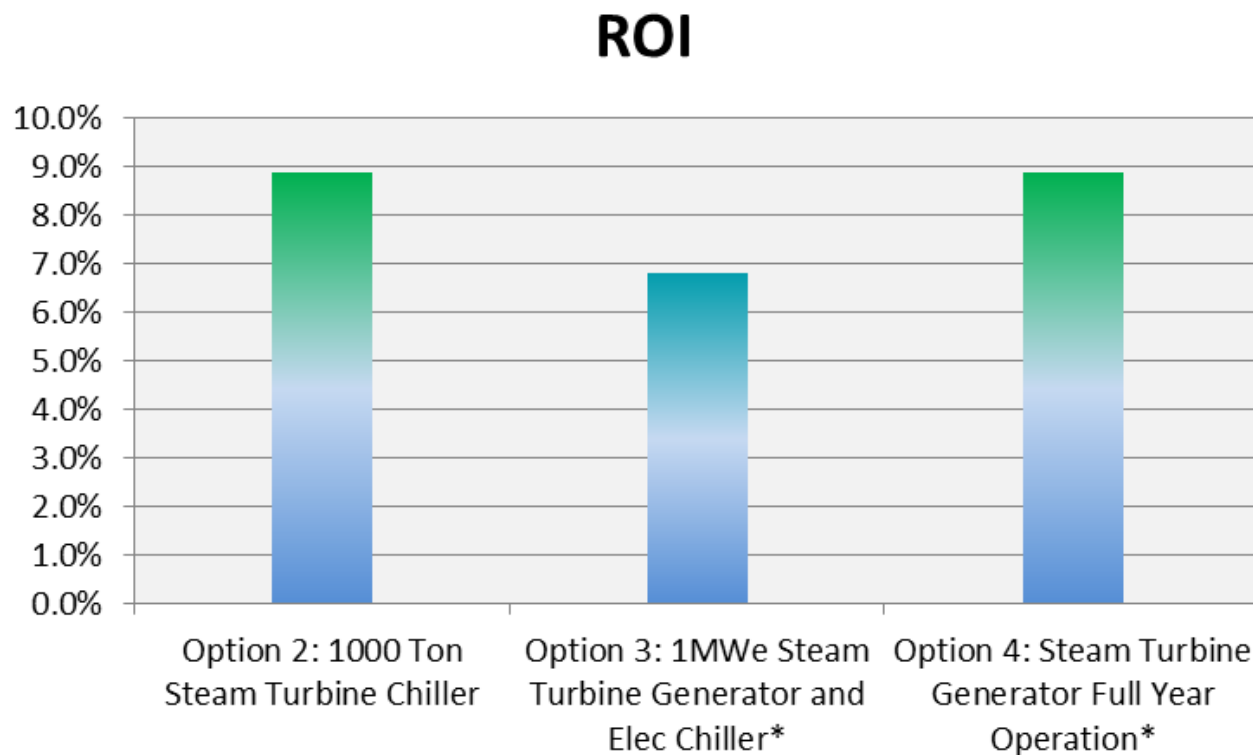


WHAT ABOUT STEAM-DRIVEN EQUIPMENT?

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



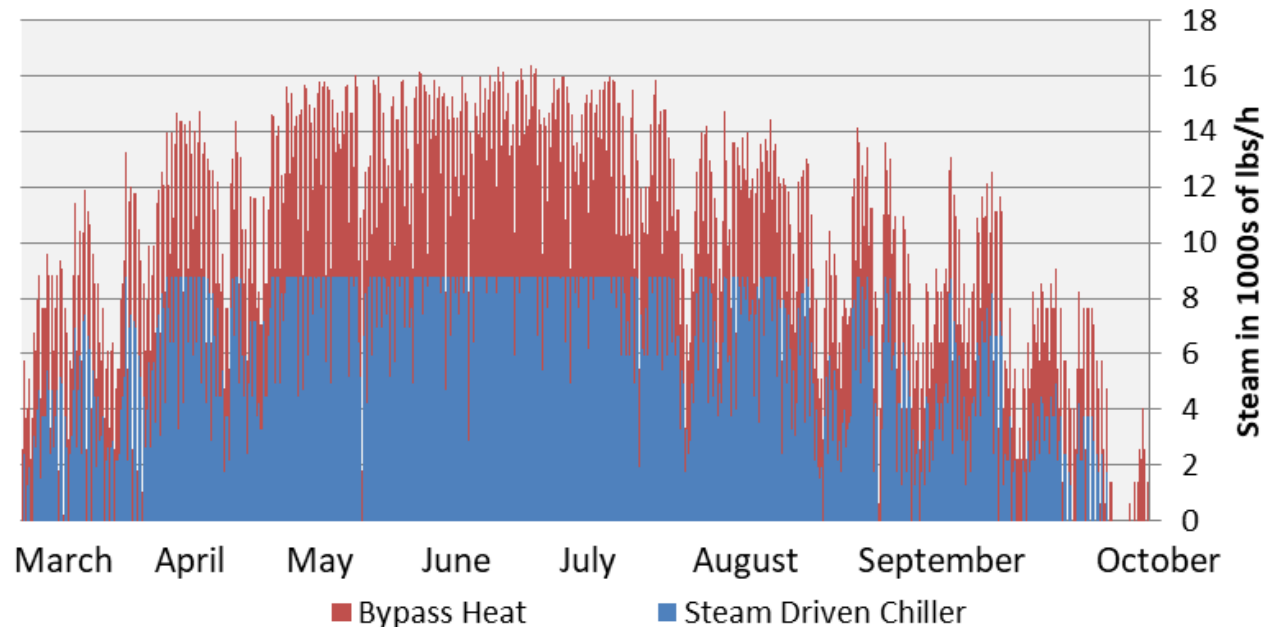
STEAM STUDY RESULTS: STEAM TURBINE CHILLER

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



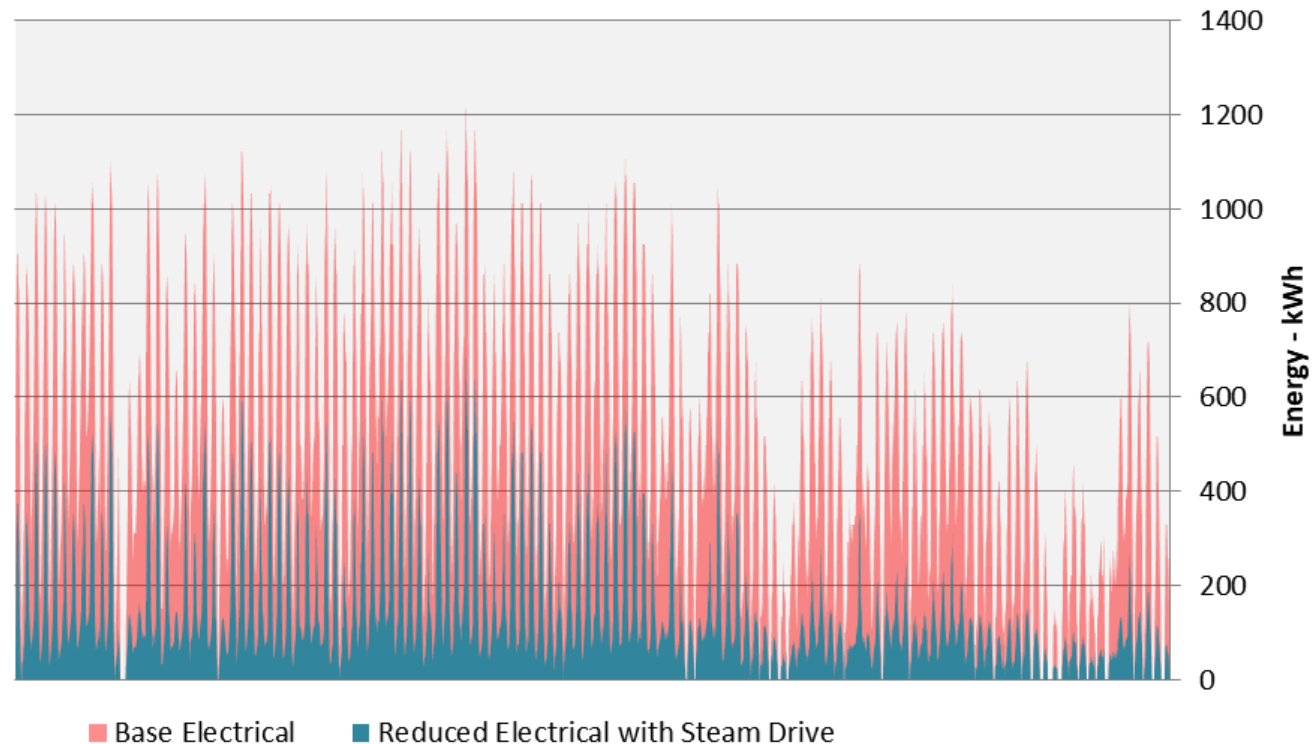
STEAM STUDY RESULTS: STEAM TURBINE CHILLER

Electrical Savings

Consumption savings whenever the steam drive is operating

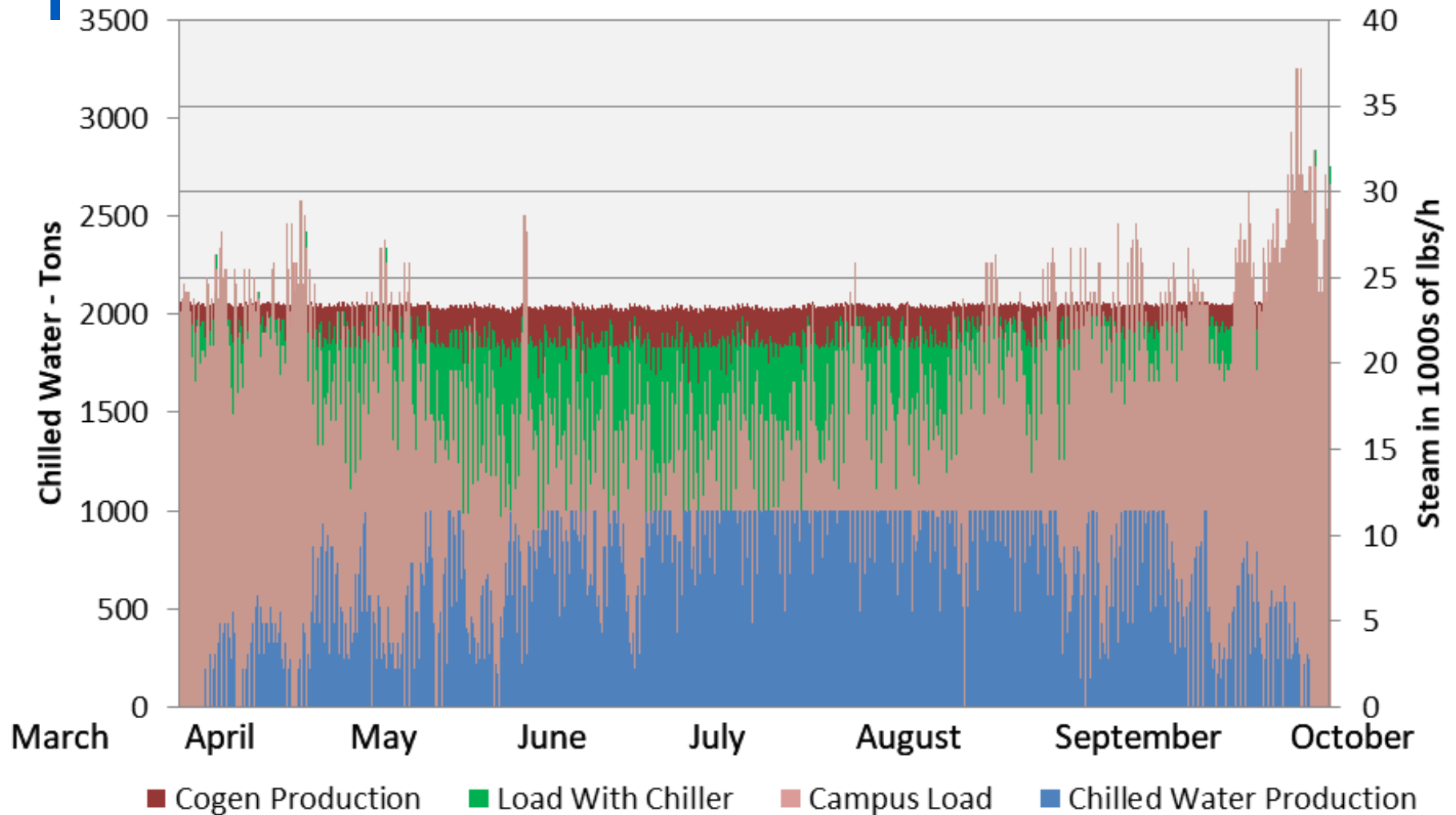
Demand savings because chiller operation coincides with peak campus demand

Electrical Comparison, Peak Season



PREDICTED PERFORMANCE

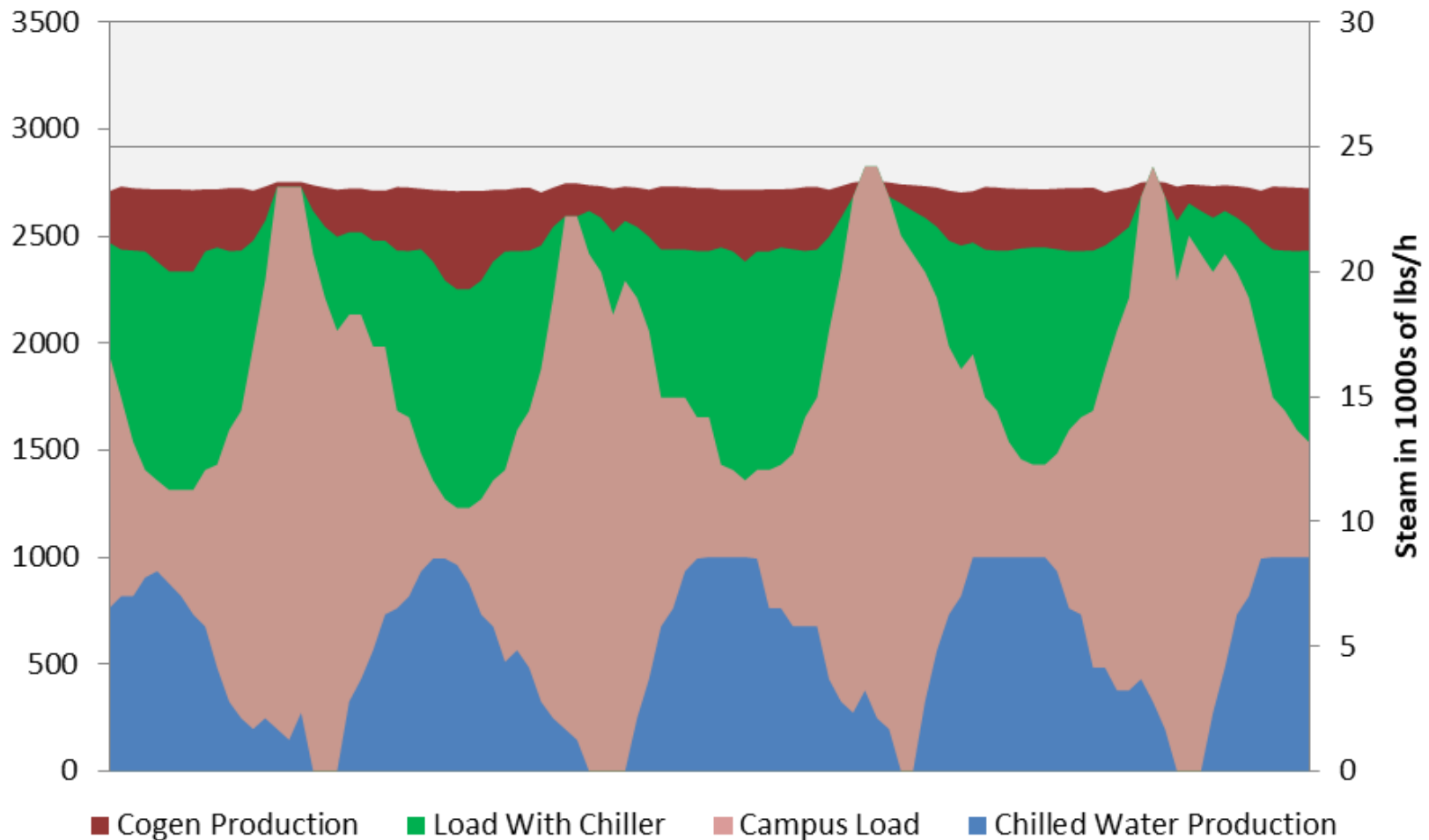
Trigeneration Production March through October -Uses more than half of bypass



PREDICTED PERFORMANCE

A CLOSER LOOK

Five Representative Days



FINAL DECISION

1,000-ton steam
turbine chiller

Project is currently
underway!



Construction

Chiller Procurement
9 months
November to August

Construction in two phases
Prep work in winter
Final install in summer



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:

- 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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