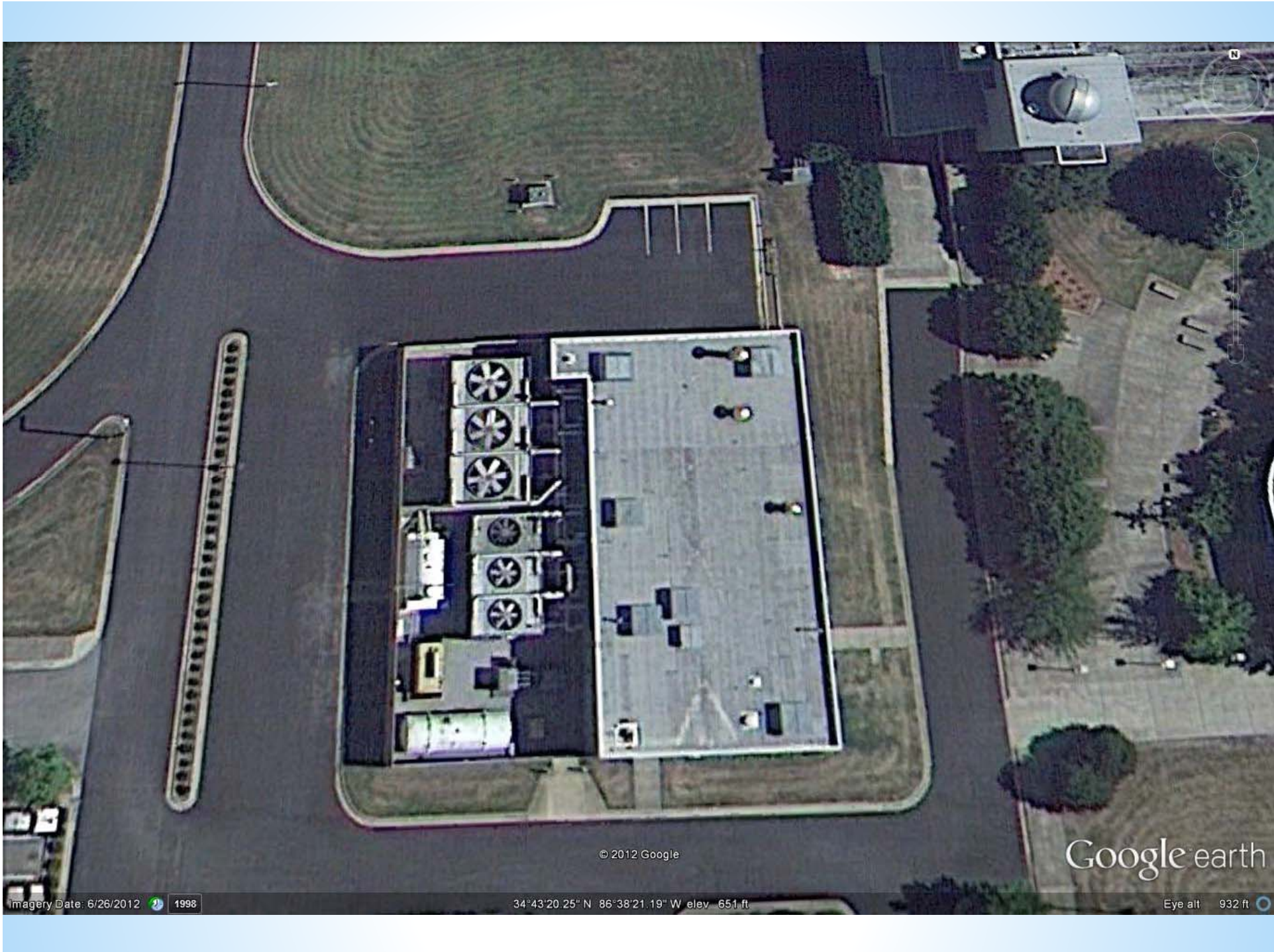


# Real World Application of the Heat Machine

- Serves app. 1 million square feet
- Dorms, classrooms and research labs
- Half a million square feet in research labs
- Once through air has to be de-humidified
- Accomplished by chilling air to 55 and reheating to maintain comfort conditions
- Year round heating demand
- 3600 tons of conventional chillers
- 1300 Boiler horsepower

# UAH Central Plant



© 2012 Google

Google earth

Imagery Date: 6/26/2012 1998

34°43'20.25" N 86°38'21.19" W elev 651 ft

Eye alt 932 ft



AQUAFORCE™

CAUTION - NOTICE TO RIGGERS

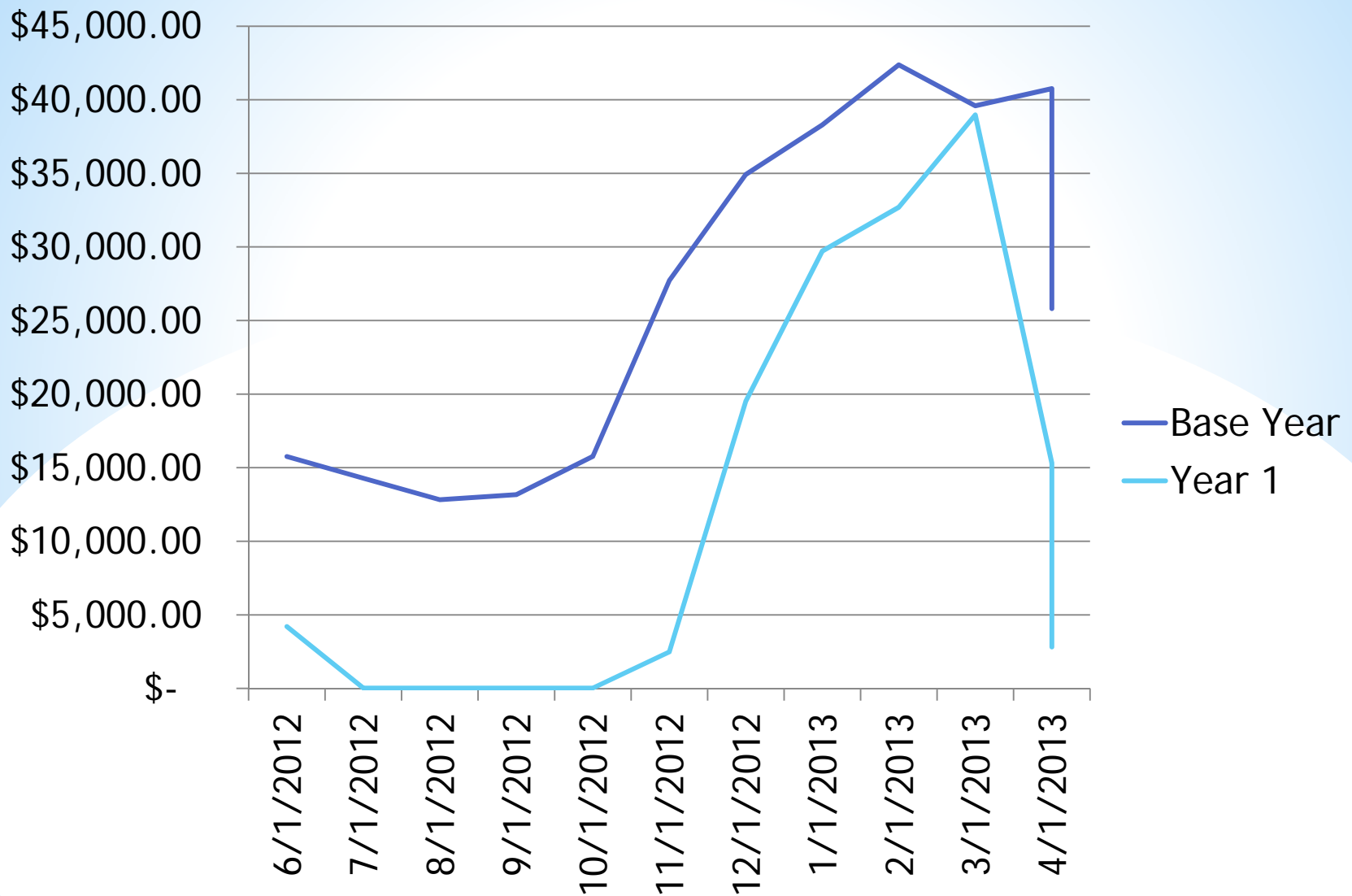


OH-E  
480 VOLT 3PH  
175 KW 450

Carrier

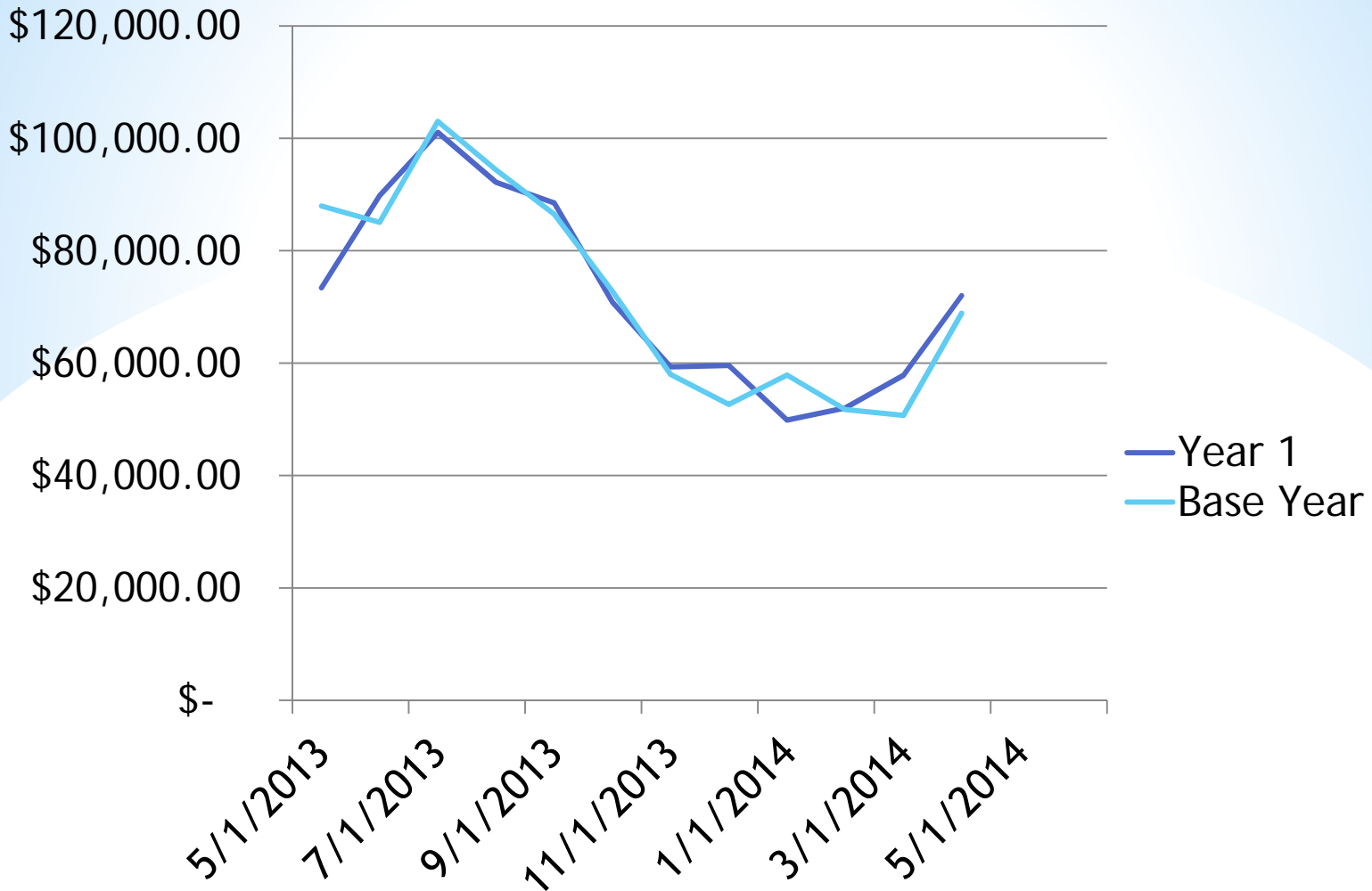
REFRIGERATING  
MACHINE  
UNITS

CAUTION  
REFRIGERANT  
LEAKAGE  
DANGEROUS  
TO HEALTH  
AND ENVIRONMENT  
SEE INSTRUCTIONS  
FOR PROPER  
HANDLING



# \* Gas Costs

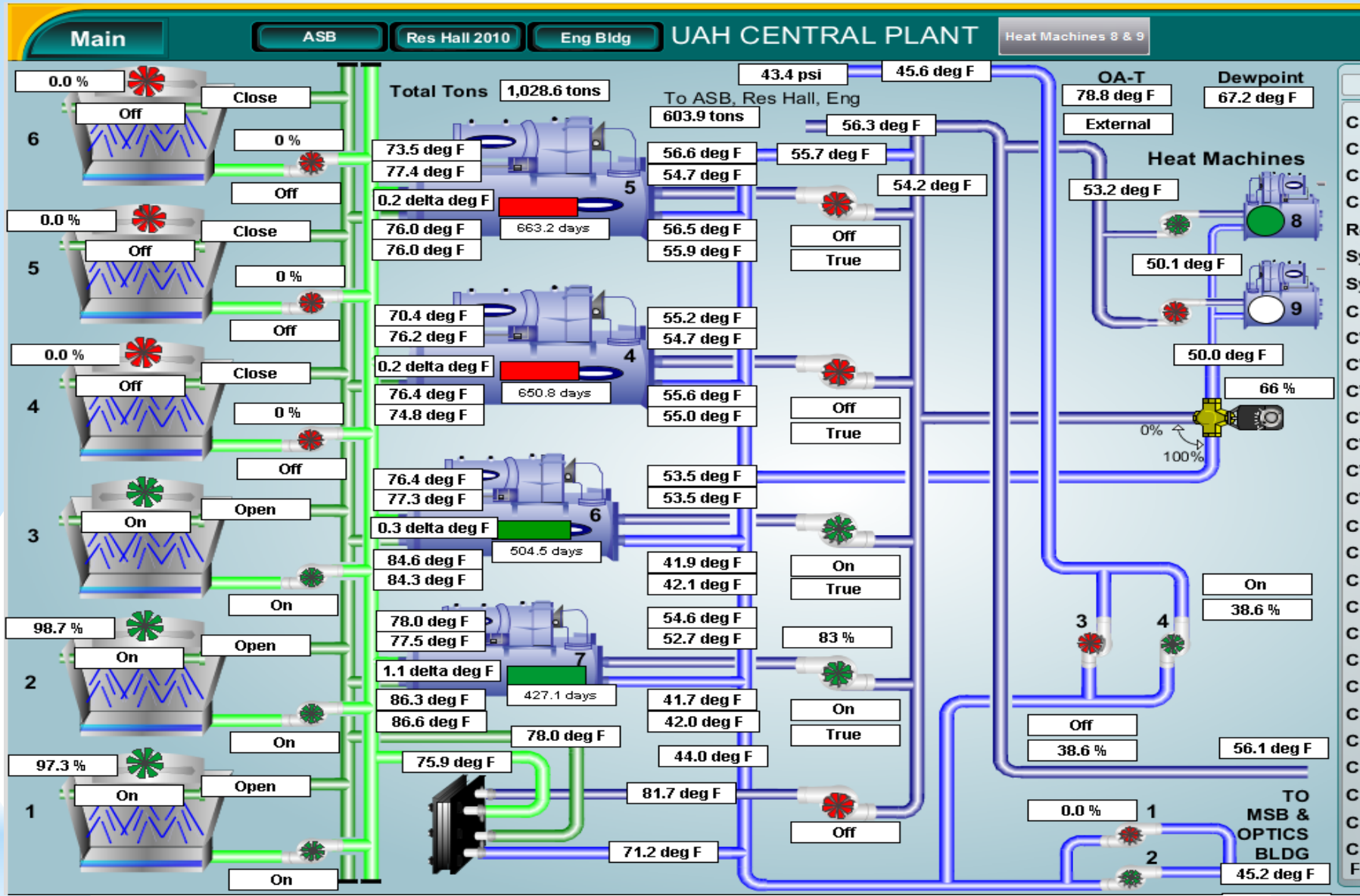
## Electric Costs



**\* Raw Electric Costs**

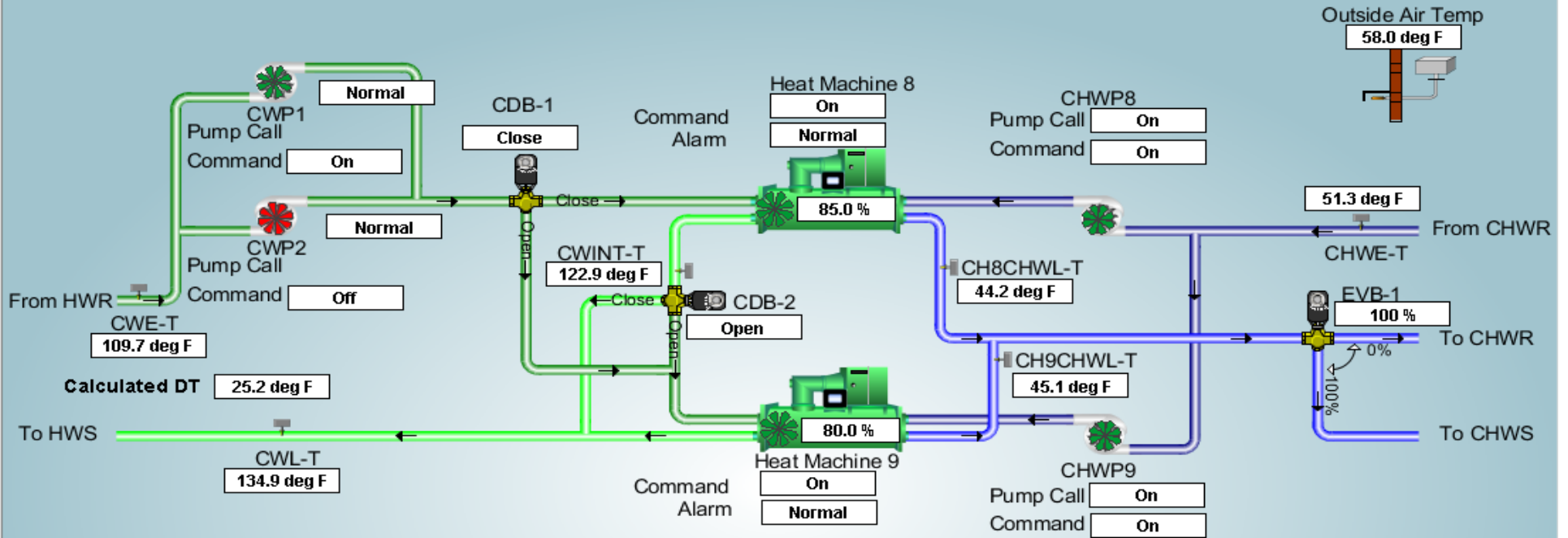
- Low Delta T syndrome
  - Characterized by:
    - Over pumping primary system
    - Higher chilled water supply temperatures
    - Forcing additional chillers on before chillers are fully loaded.

## Primary/Secondary Pumping



# UAH Chilled Water Plant





System

System Enable	<input type="checkbox"/> True
Stage Up Delay	<input type="text"/> 10.0
Stage Down Delay	<input type="text"/> 10.0
SP Reset OAT-HI	<input type="text"/> 75.0
SP Reset OAT-LO	<input type="text"/> 50.0
SP Reset CWLT-LO	<input type="text"/> 120.0
SP Reset CWLT-HI	<input type="text"/> 135.0
System Reset	<input type="checkbox"/> Off
Rotate Devices	<input type="checkbox"/> False

Heat Machine 8

Maintenance Switch	<input type="checkbox"/> Enable
CW Output SP	<input type="text"/> 122.3 deg F
Status	<input type="checkbox"/> On
CW Entering Temp	<input type="text"/> 109.7 deg F
CW Leaving Temp	<input type="text"/> 122.9 deg F
CHW Entering Temp	<input type="text"/> 51.3 deg F
CHW Leaving Temp	<input type="text"/> 44.2 deg F
Alarm	<input type="checkbox"/> Normal
Number of HM Calc	<input type="text"/> 2.0

Heat Machine 9

Maintenance Switch	<input type="checkbox"/> Enable
CW Output SP	<input type="text"/> 135.0 deg F
Status	<input type="checkbox"/> On
CW Entering Temp	<input type="text"/> 109.7 deg F
CW Leaving Temp	<input type="text"/> 134.9 deg F
CHW Entering Temp	<input type="text"/> 51.3 deg F
CHW Leaving Temp	<input type="text"/> 45.1 deg F
Alarm	<input type="checkbox"/> Normal

# UAH Heat Machines

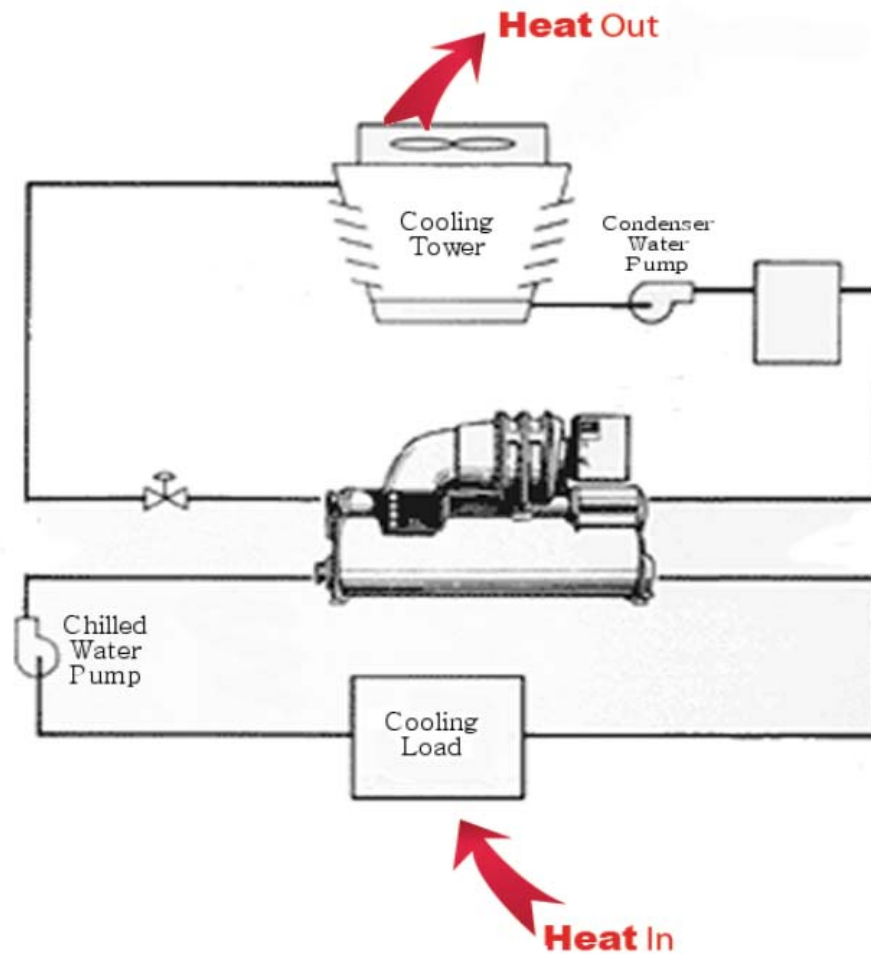
- Lowest first cost option
  - Reduced run time on boiler by 3
  - Reduced maintenance on boiler
- Essentially solved low Delta T syndrome

## Reasons for Heat Machine

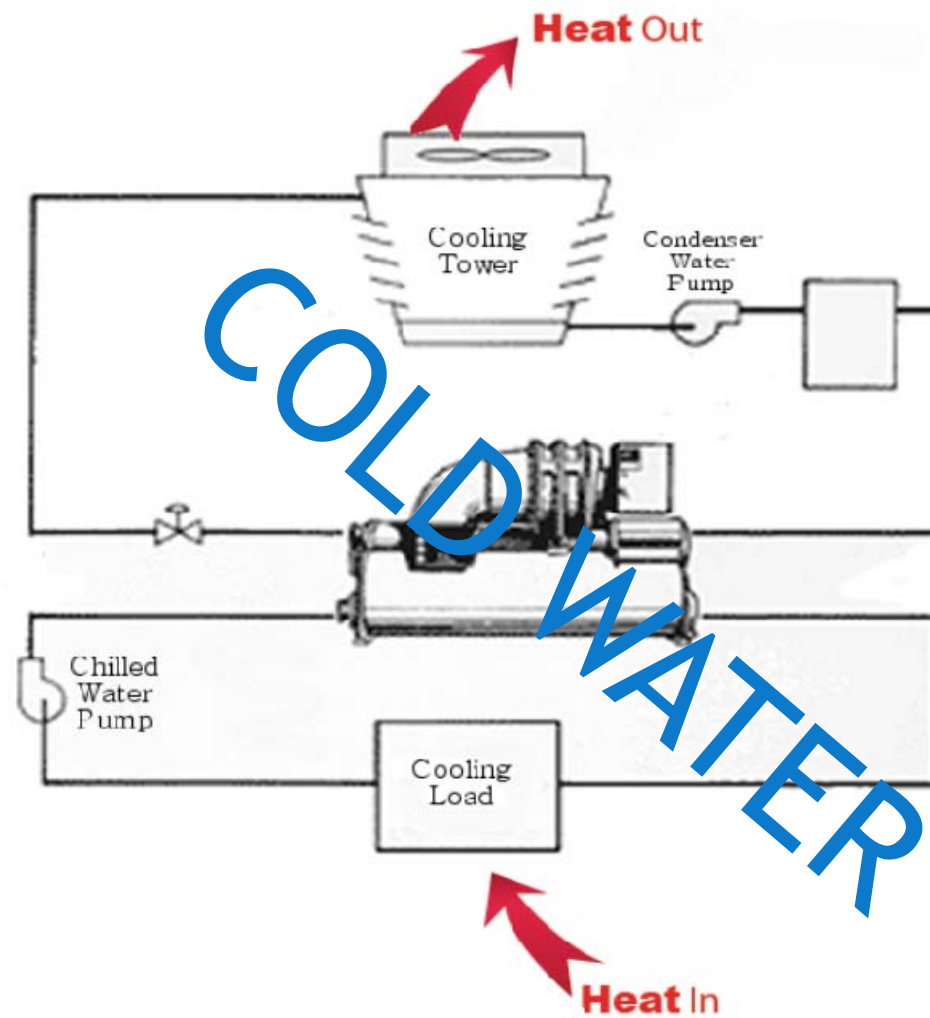
- Allowed Us To Condition Our New Student Center From Our Existing Central Plant
  - ❑ No Square Footage Needed for Boiler in New Building
  - ❑ No Air-Cooled Chiller Near Building (Noise)
- Lowest Design/Construction Option
  - ❑ Total Project Cost ~ \$550,000
- Added Cooling and Heating Redundancy
  - ~ 400 Tons of Cooling (4,800,000 BTUH)
  - ~ 180 Boiler Horsepower (6,000,000 BTUH)
- Most Economical Way For Us to Make Hot Water

**Why We Decided To  
Install Heat-Machines**

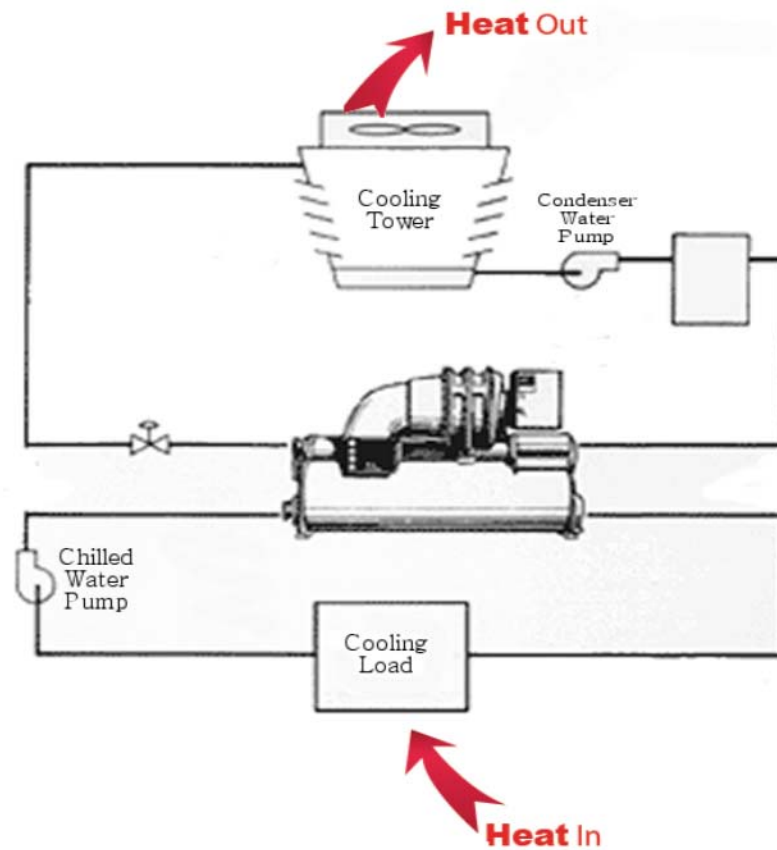
# What Is The Product Of A Water To Water Chiller?



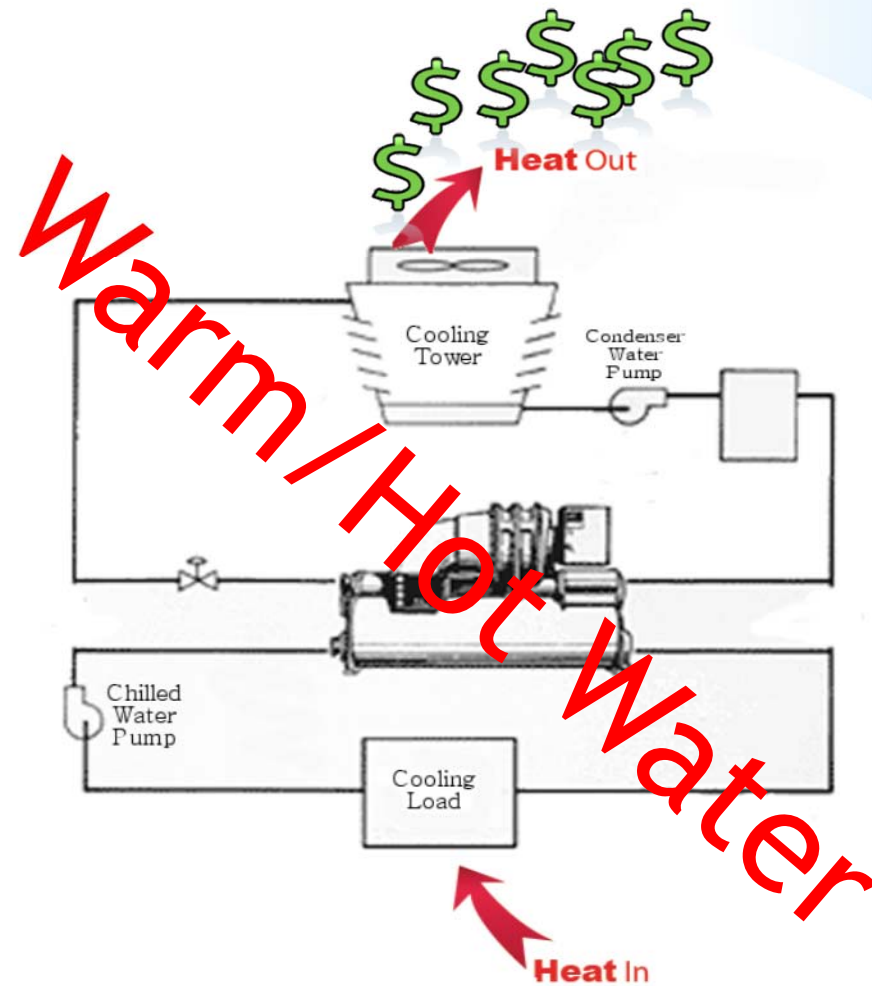
# What Is The Product Of A Water To Water Chiller?



# What Is The **BY**-Product Of A Water To Water Chiller?

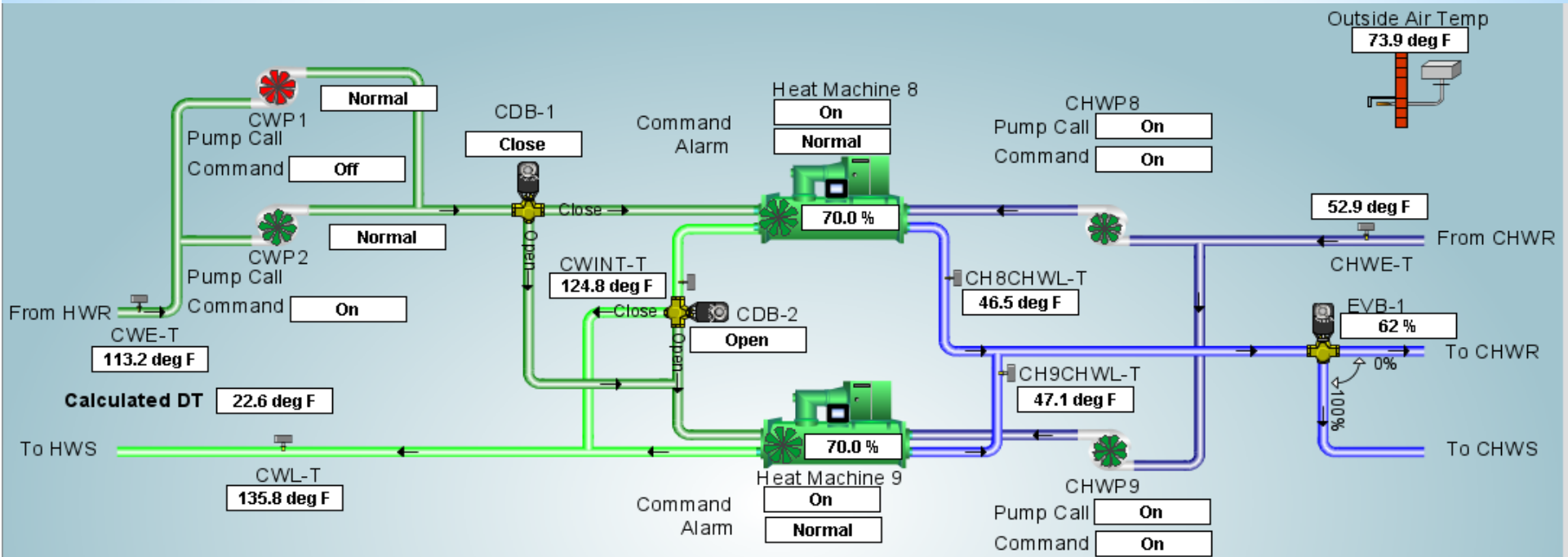


# What Is The **BY**-Product Of A Water To Water Chiller?



# September 21, 2014 Heat-Machine Snapshot

## What Is The Product - What Is The By-Product?



### System

System Enable	<input type="checkbox"/> True
Stage Up Delay	<input type="text"/> 10.0
Stage Down Delay	<input type="text"/> 10.0
SP Reset OAT-HI	<input type="text"/> 75.0
SP Reset OAT-LO	<input type="text"/> 50.0
SP Reset CWLT-LO	<input type="text"/> 120.0
SP Reset CWLT-HI	<input type="text"/> 135.0
System Reset	<input type="checkbox"/> Off
Rotate Devices	<input type="checkbox"/> False

### Heat Machine 8

Maintenance Switch	<input type="checkbox"/> Enable
CW Output SP	<input type="text"/> 124.1 deg F
Status	<input type="checkbox"/> On
CW Entering Temp	<input type="text"/> 113.2 deg F
CW Leaving Temp	<input type="text"/> 124.8 deg F
CHW Entering Temp	<input type="text"/> 52.9 deg F
CHW Leaving Temp	<input type="text"/> 46.5 deg F
Alarm	<input type="checkbox"/> Normal
Number of HM Calc	<input type="text"/> 2.0

### Heat Machine 9

Maintenance Switch	<input type="checkbox"/> Enable
CW Output SP	<input type="text"/> 135.0 deg F
Status	<input type="checkbox"/> On
CW Entering Temp	<input type="text"/> 113.2 deg F
CW Leaving Temp	<input type="text"/> 135.8 deg F
CHW Entering Temp	<input type="text"/> 52.9 deg F
CHW Leaving Temp	<input type="text"/> 47.1 deg F
Alarm	<input type="checkbox"/> Normal

Energy Dollars Saved **276,035.0**  
**TOTAL SAVINGS** 291,370.2

Gallons of Water Saved 4,319,950

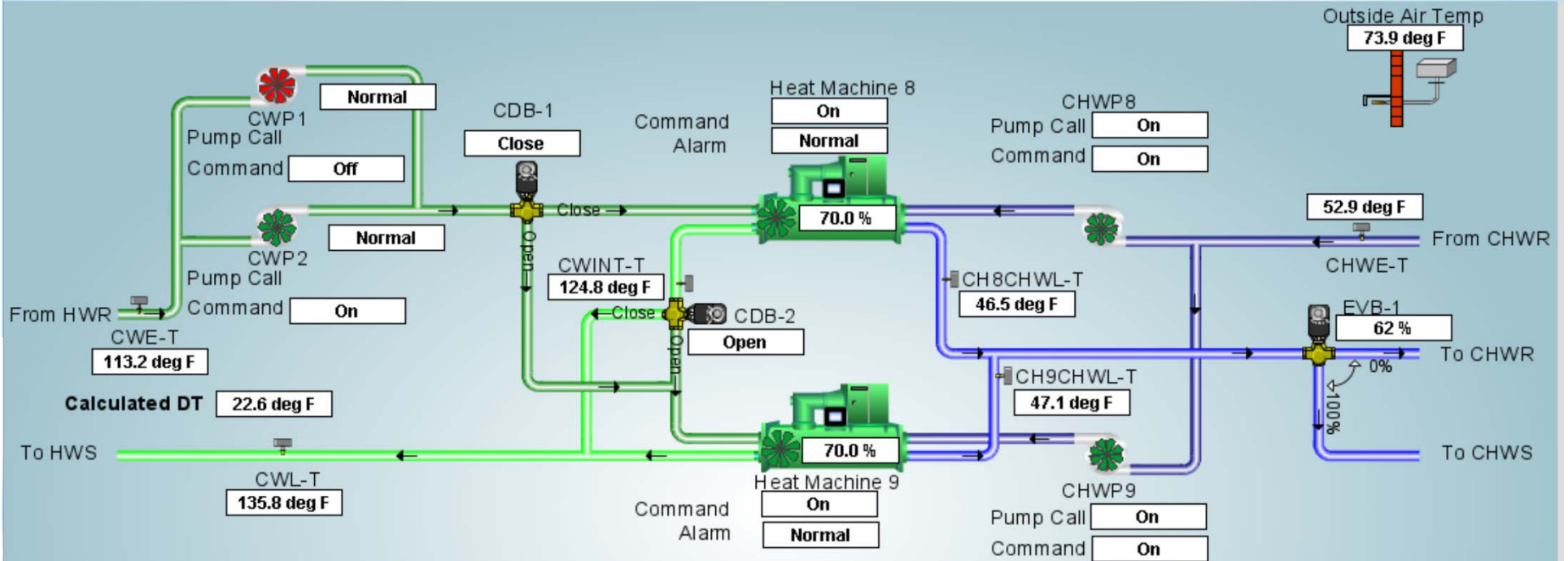
CT Water Savings 6,695.92  
 Chemical Savings 8,639.9

MISC ...

UAH CAMPUS



# September 21, 2014 Heat-Machine Snapshot



System	
System Enable	True
Stage Up Delay	10.0
Stage Down Delay	10.0
SP Reset OAT-HI	75.0
SP Reset OAT-LO	50.0
SP Reset CWLT-LO	120.0
SP Reset CWLT-HI	135.0
System Reset	Off
Rotate Devices	False

Heat Machine 8	
Maintenance Switch	Enable
CW Output SP	124.1 deg F
Status	On
CW Entering Temp	113.2 deg F
CW Leaving Temp	124.8 deg F
CHW Entering Temp	52.9 deg F
CHW Leaving Temp	46.5 deg F
Alarm	Normal
Number of HM Calc	2.0

Heat Machine 9	
Maintenance Switch	Enable
CW Output SP	135.0 deg F
Status	On
CW Entering Temp	113.2 deg F
CW Leaving Temp	135.8 deg F
CHW Entering Temp	52.9 deg F
CHW Leaving Temp	47.1 deg F
Alarm	Normal

Energy Dollars Saved	276,035.0	Gallons of Water Saved	4,319,950	CT Water Savings	6,695.92	MISC ..	UAH CAMPUS
<b>TOTAL SAVINGS</b>	<b>291,370.2</b>			Chemical Savings	8,639.9		

# March 26, 2014 Snapshot

## FLOW RATES FOR HEAT MACHINES

HM8 EVAP 524 GPM  
 HM9 EVAP 558 GPM  
 ONE MACHINE RUNNING  
 CONDENSER 442 GPM  
 TWO MACHINES RUNNING  
 CONDENSER 369 GPM

HM8 RUNTIME	3,589.0 hours
HM9 RUNTIME	3,632.0 hours
HM8 STARTS	268.0
HM9 STARTS	213.0
HM CALC BLR HP	92.4
HM8 CALC TONS	94.8
HM9 CALC TONS	107.3

- ### TREND STUDIES
- CP-CHILLER-TREND
  - CP-CHLR AMPS Trend
  - CP-Total-Tons
  - CP-CHWS-Total-Tons
  - Tonage Generated by Chiller
  - CP-PRIMARY-CHWST
  - CP-CT-MAEKUP-WATER
  - CP-HM-HEATING BTUS

ENG FLOW-VALVE OUTPUT	60.0 %
CV FLOW-VALVE OUTPUT	0.0 %
SCST FLOW-VALVE OUTPUT	15.0 % Cmd

**Product 92.4 Boiler Horsepower  
 3,723,500 BTUH**

CP-SECONDARY-CHWST	44.2 deg F
--------------------	------------

CP-SCHWP3	11 %	On
CP-SCHWP4	11 %	Off
EB-138-RH	15.4 %RH	

CP-HM8-HEATING-COP	3.6	6.1
CP-HM8-COOLING-COP	2.5	
CP-HM9-HEATING-COP	2.9	
CP-HM9-COOLING-COP	2.5	5.4

**By-Product 200 Tons of Cooling  
 2,425,200 BTUH**

HM COP Trend Study

Total COP

March 26, 2014 @ 08:00

## For 1,000,000 BTUs

Electricity \$25.25

Nat. Gas \$8.02

#2 Fuel Oil \$24.51

# Current Fuel Cost

## For 1,000,000 BTUs

Electricity \$25.25 \_\_\_\_\_ with COP of 7.09

Nat. Gas \$8.02 \$9.22 if used in 85% eff.  
Boiler COP 0.85

#2 Fuel Oil \$24.51 \$28.84 if used in 85% eff.  
boiler COP 0.85

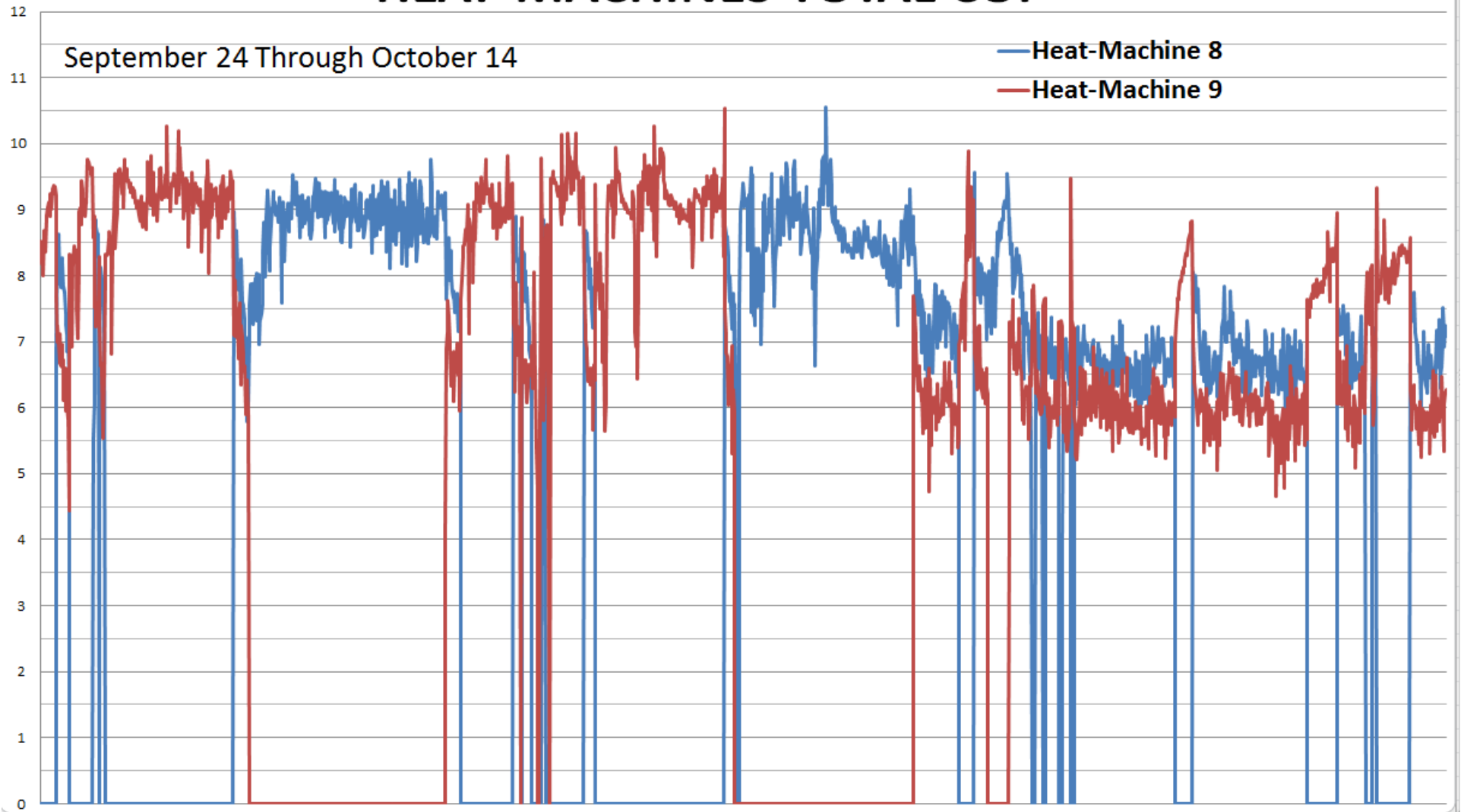
# Current Fuel Cost

## For 1,000,000 BTUs

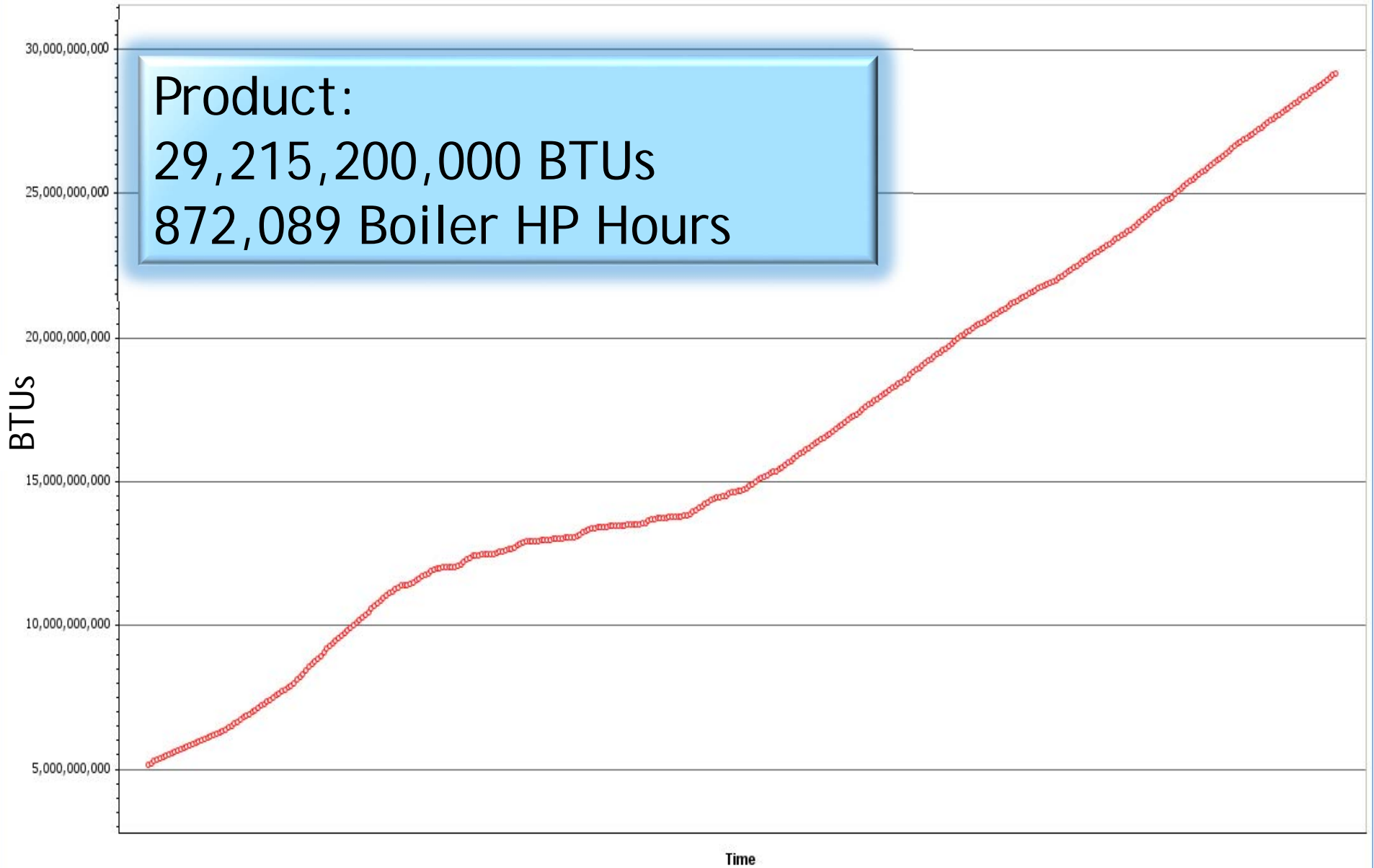
Electricity	\$25.25	<u>\$3.56</u> with COP of 7.09
Nat. Gas Boiler	\$8.02	\$9.22 if used in 85% eff. COP 0.85
#2 Fuel Oil boiler	\$24.51	\$28.84 if used in 85% eff. COP 0.85

# Current Fuel Cost

# HEAT-MACHINES TOTAL COP

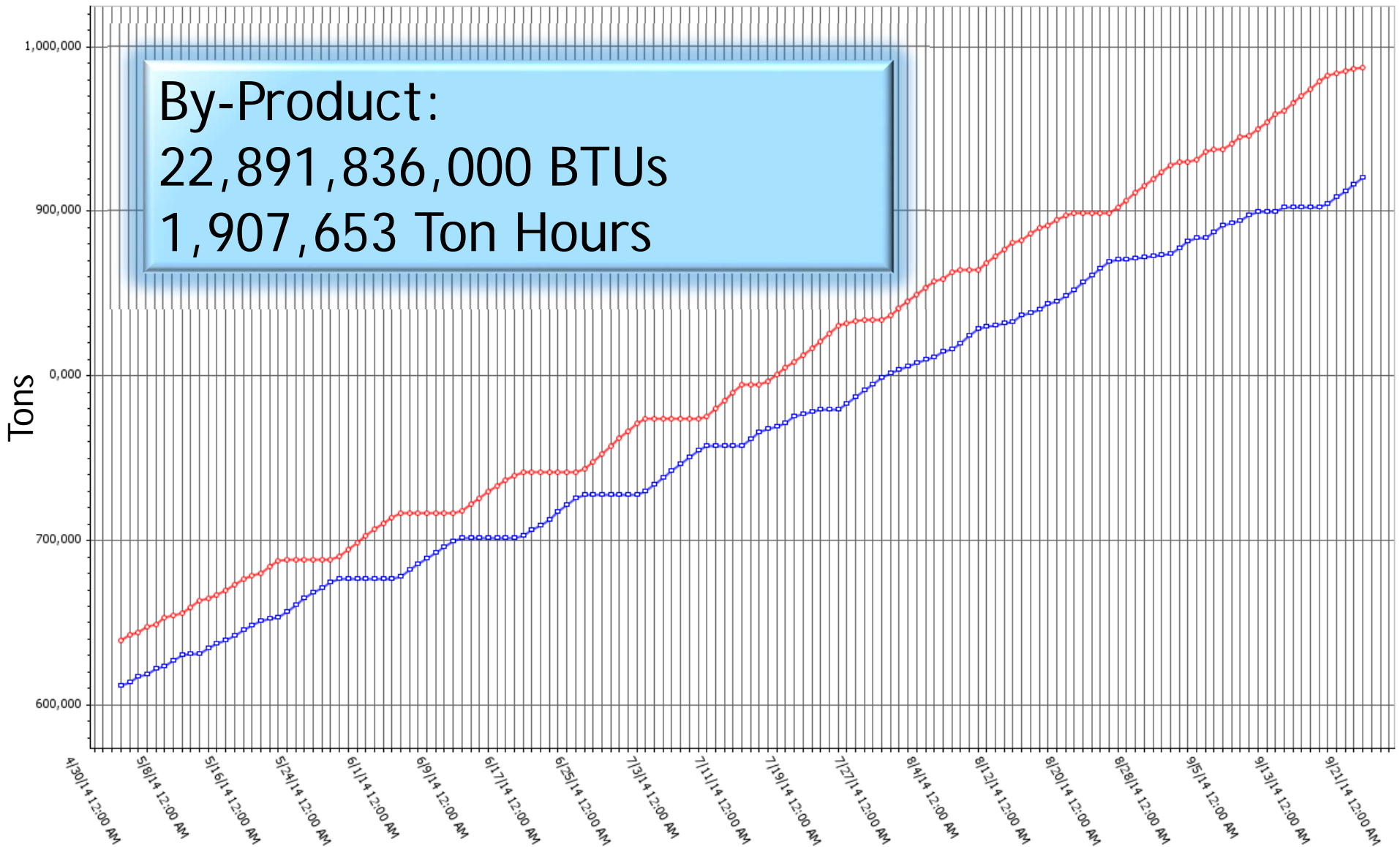


COP TREND DATA



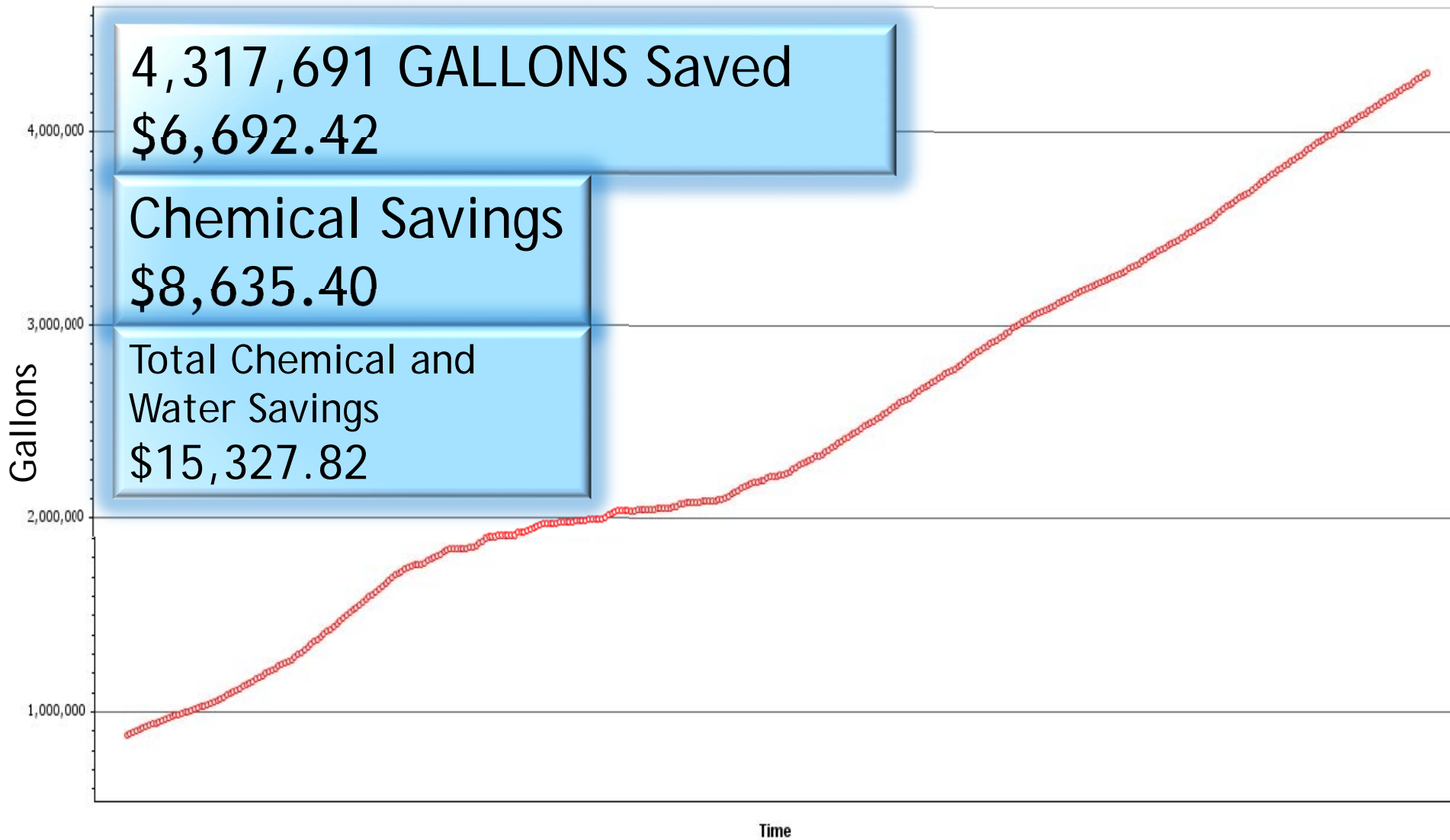
# HEATING RESULTS TO DATE

(09-21-14)



# COOLING RESULTS TO DATE (09-21-14)





# WATER SAVINGS TO DATE

(09-21-14)

May 13<sup>TH</sup> 2013  
To  
Sep, 21<sup>th</sup> 2014

**\$ \$291,219**

**Cumulative Savings  
Since Installation**

\$

\$

218,412

**Annual Savings Rate**

**0 YEARS?**

**2.52**

**YEARS**

**Payback**



Questions