WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

INNOVAS TECHNOLOGIES

University of Wisconsin-Madison Case Study Chiller Performance Improvement Via Tube Fouling Prevention

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IDEA – Campus Energy

CampusEnergy2020
THE POWER TO CHANGE
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UW-Madison Location

University of Wisconsin-Madison

- Founded in 1848 as Wisconsin's land-grant university
- Flagship campus of the 26-campus University of Wisconsin System

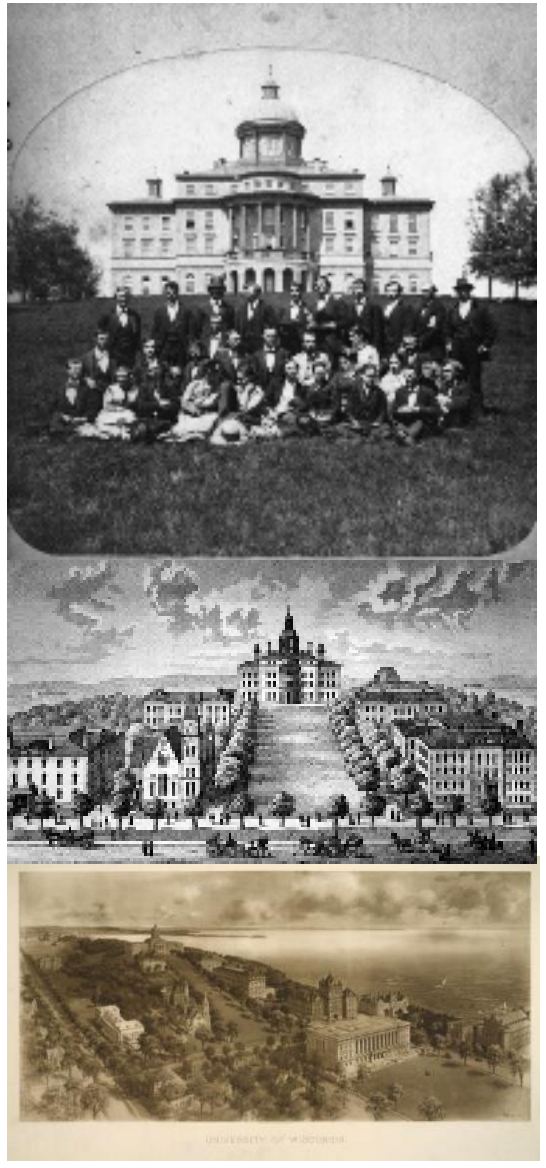
- 936-acre main campus (including 300-acre Lakeshore Nature Preserve)
- Largest land owner on Lake Mendota with 4 miles of lakefront

- 9,647 acres statewide including agricultural research stations, experimental farms, arboretum lands and other off-campus properties

- Over 45,300 students and almost 22,400 faculty & staff (67,700 total)
- Over 24 million GSF of conditioned space

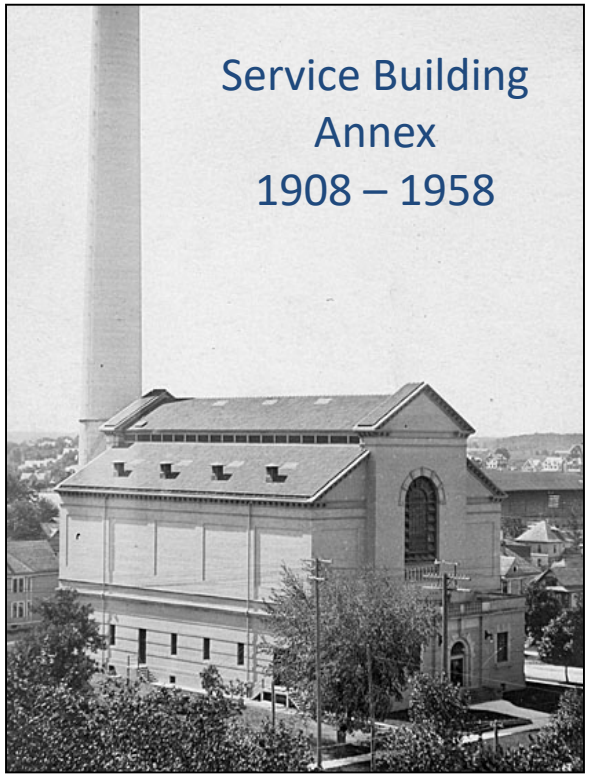
- Over 451,000 living alumni worldwide

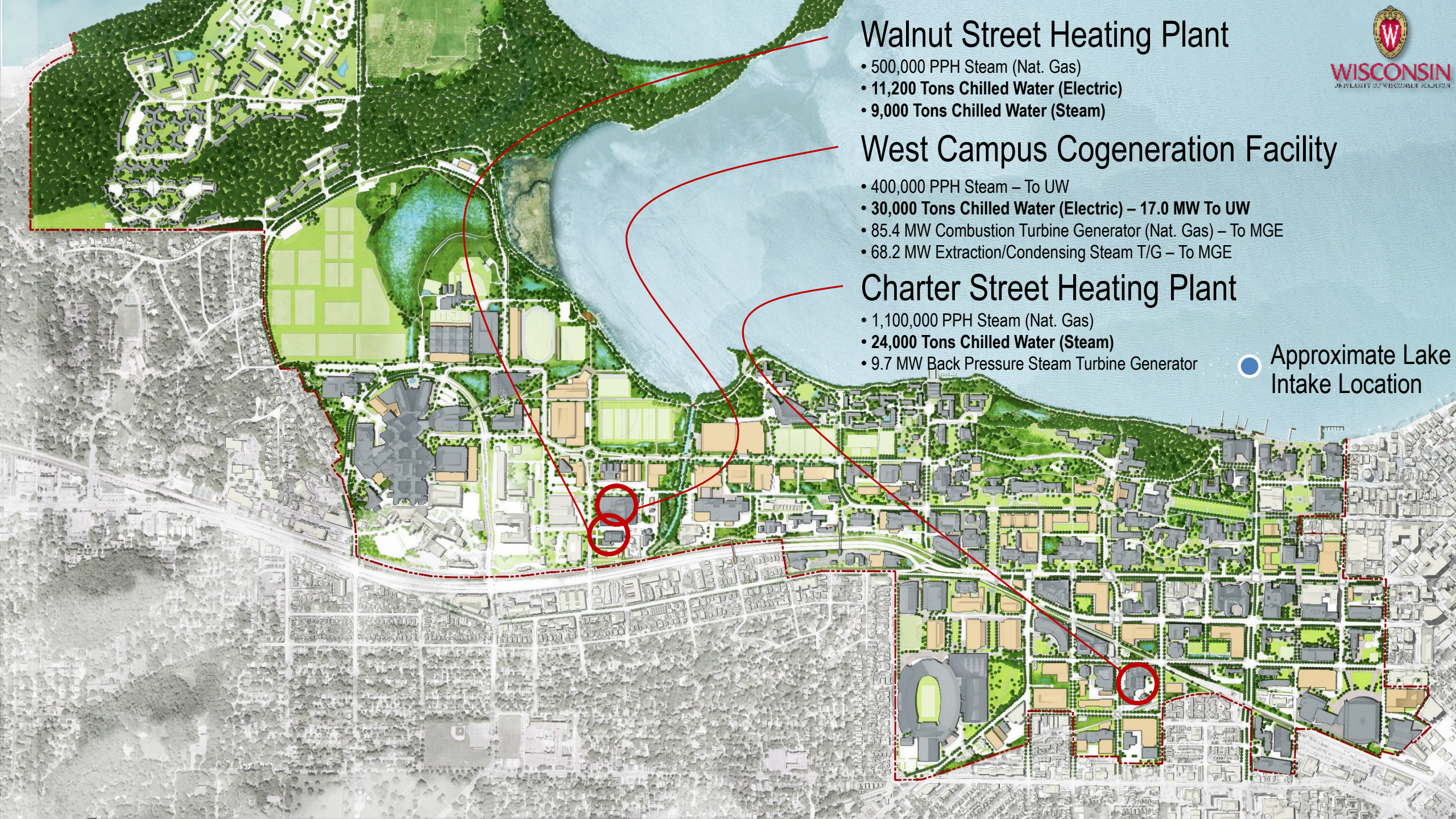
- $3.2 billion annual operating budget
- Ranked 6th nationally in research funding



UW-Madison Campus Utility Plant Evolution

• Radio Hall	1885 – 1908
• Ag Bulletin	1899 – 1937
• Service Building Annex	1908 – 1958
• Charter Street Utility Plant **(Cooling - 1966)**	1958 – Present
• Walnut Street Utility Plant	1975 – Present
• West Campus Cogeneration Plant	2005 – Present




Walnut Street Heating Plant
• 500,000 PPH Steam (Nat. Gas)
• 11,200 Tons Chilled Water (Electric)
• 9,000 Tons Chilled Water (Steam)
West Campus Cogeneration Facility
• 400,000 PPH Steam – To UW
• 30,000 Tons Chilled Water (Electric) – 17.0 MW To UW
• 85.4 MW Combustion Turbine Generator (Nat. Gas) – To MGE
• 68.2 MW Extraction/Condensing Steam T/G – To MGE
Charter Street Heating Plant
• 1,100,000 PPH Steam (Nat. Gas)
• 24,000 Tons Chilled Water (Steam)
• 9.7 MW Back Pressure Steam Turbine Generator
Approximate Lake Intake Location
WISCONSIN

UW-Madison Campus Utility Summary

- Steam Summary
  - 2,100,000 PPH Total (Installed)
  - 1,800,000 PPH Firm (Less Largest Unit)
  - 1,316,000 PPH Peak (Historical Max)
  - 879,000 PPH Peak (Jan 2019)
- **Chilled Water Summary**
  - **74,000 Tons Total (Installed)**
  - **66,000 Tons Firm (Less Largest Unit)**
  - **64,000+ Tons Peak (Historical Max)**
  - **56,000 Tons Peak (Jul 2019)**
- Electrical Summary
  - 88.7 MW Peak (Sep 2013 Max)
  - 82.6 MW Peak (Sep 2016)
  - 83.4 MW Peak (Jul 2019)

CSHP

WSHP

WCCF

UW-Madison Utility Plant Water Source

- Primary Uses:
  - Cooling Tower Make-Up
  - Boiler Make-Up (Restarting in 2020)
  - Process Cooling
- 2016 Consumption
  - 435 Million Gallons – UW
  - 165 Million Gallons – MG&E
  - 600 Million Gallons – Total
- Approximately the Amount Lost From Lake Evaporation During 11 Hot Summer Days
- Cost:
  - City Water $5.89/1,000 Gallons
  - Lake Water $0.25/1,000 Gallons
  - Savings $5.64/1,000 Gallons
  - Savings $2,450,000/Year UW Consumption

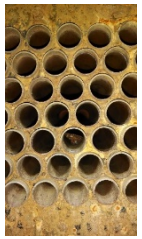
Defining the Problem

- Chillers represent >50% of building's energy use during warm months

- Studies show >97% of shell & tube heat exchangers suffer tube fouling
(Muller-Steinhagen, 2011; Steinhagen et al., 1992; Garrett-Price et al., 1985)

Scale Particulate Biofilm

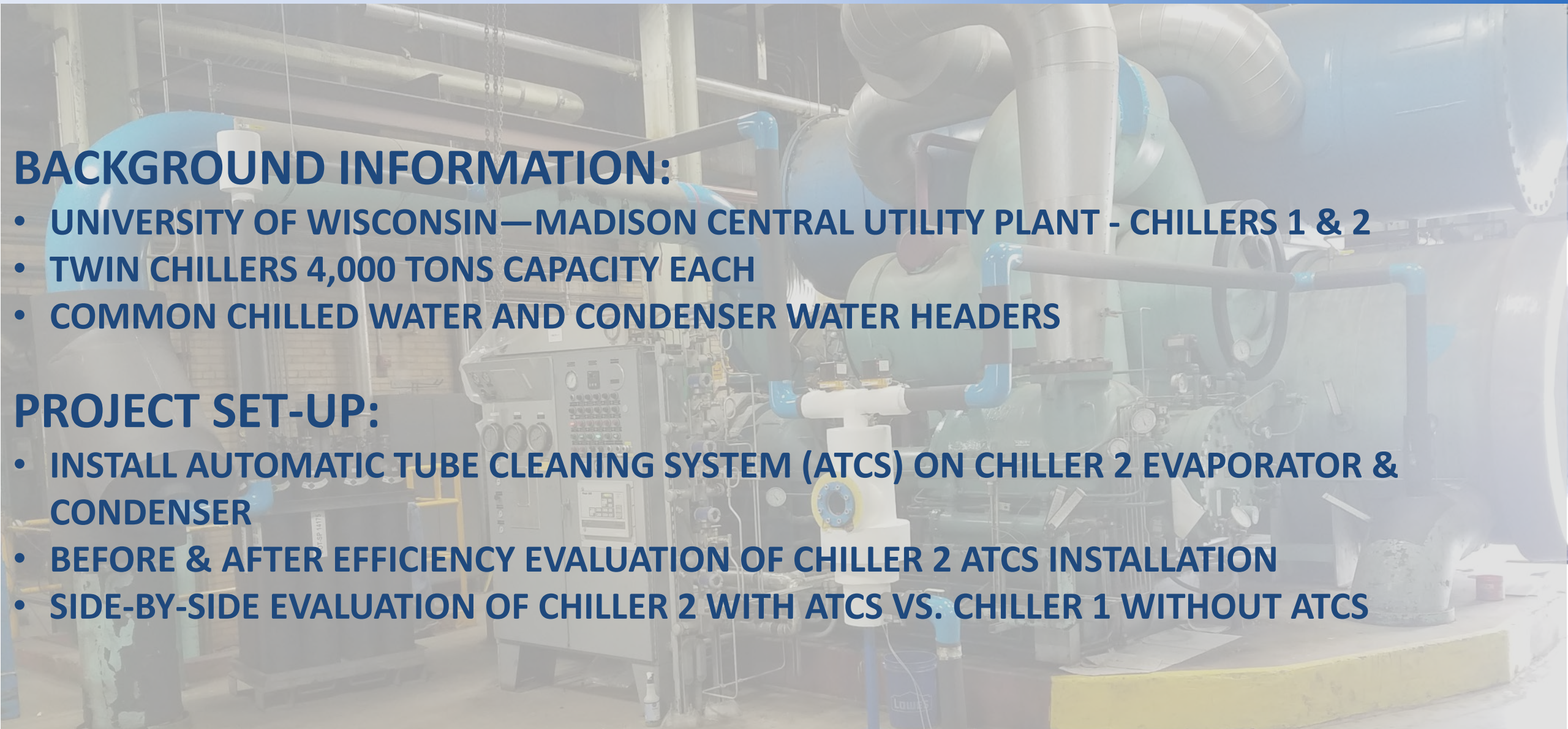





- >$25 Billion wasted every year in USA due to chiller inefficiency



Background Info & Project Setup



BACKGROUND INFORMATION:

- UNIVERSITY OF WISCONSIN—MADISON CENTRAL UTILITY PLANT - CHILLERS 1 & 2
- TWIN CHILLERS 4,000 TONS CAPACITY EACH
- COMMON CHILLED WATER AND CONDENSER WATER HEADERS

PROJECT SET-UP:

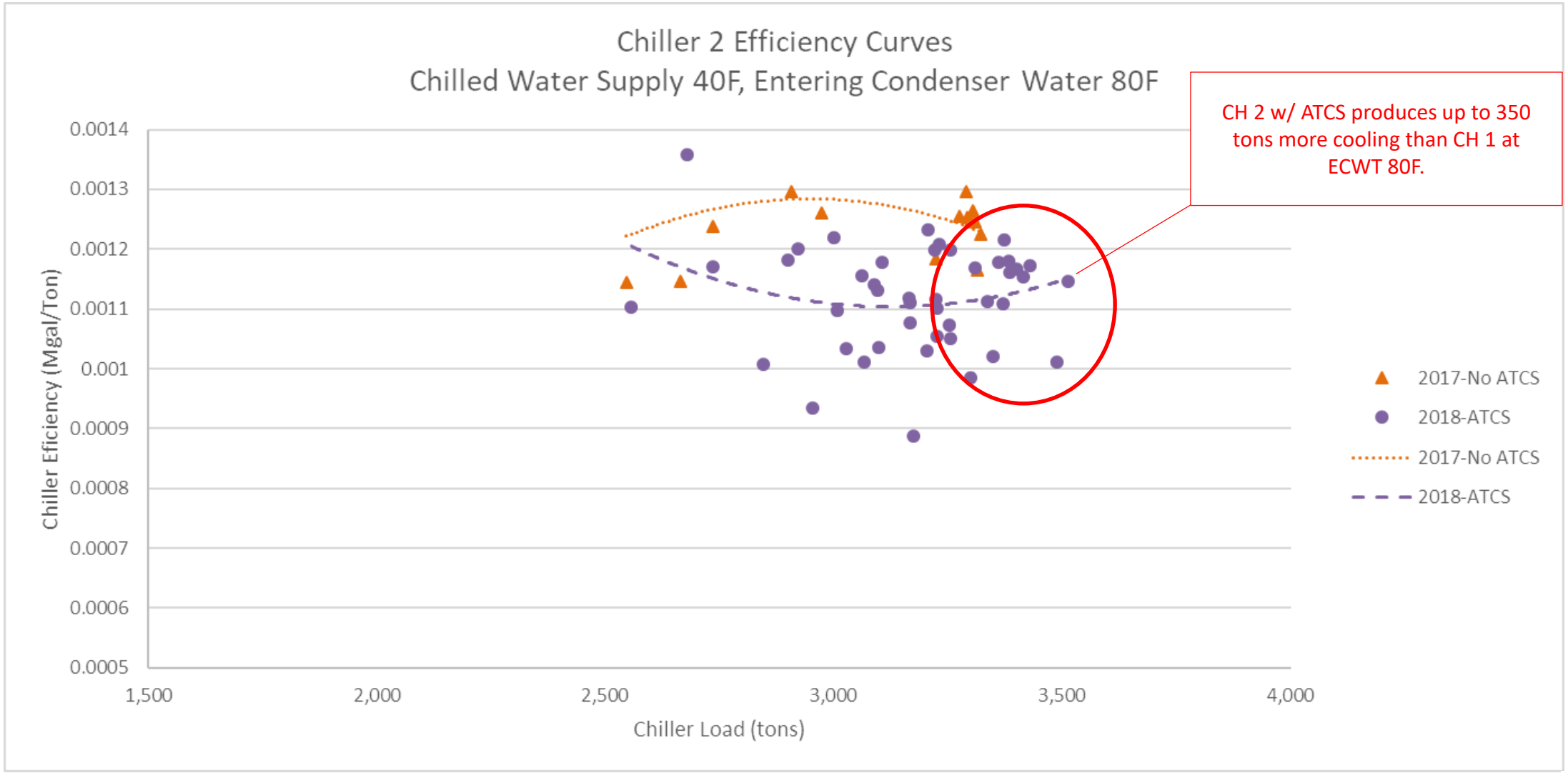
- INSTALL AUTOMATIC TUBE CLEANING SYSTEM (ATCS) ON CHILLER 2 EVAPORATOR & CONDENSER
- BEFORE & AFTER EFFICIENCY EVALUATION OF CHILLER 2 ATCS INSTALLATION
- SIDE-BY-SIDE EVALUATION OF CHILLER 2 WITH ATCS VS. CHILLER 1 WITHOUT ATCS

ATCS – Condenser Side Installation

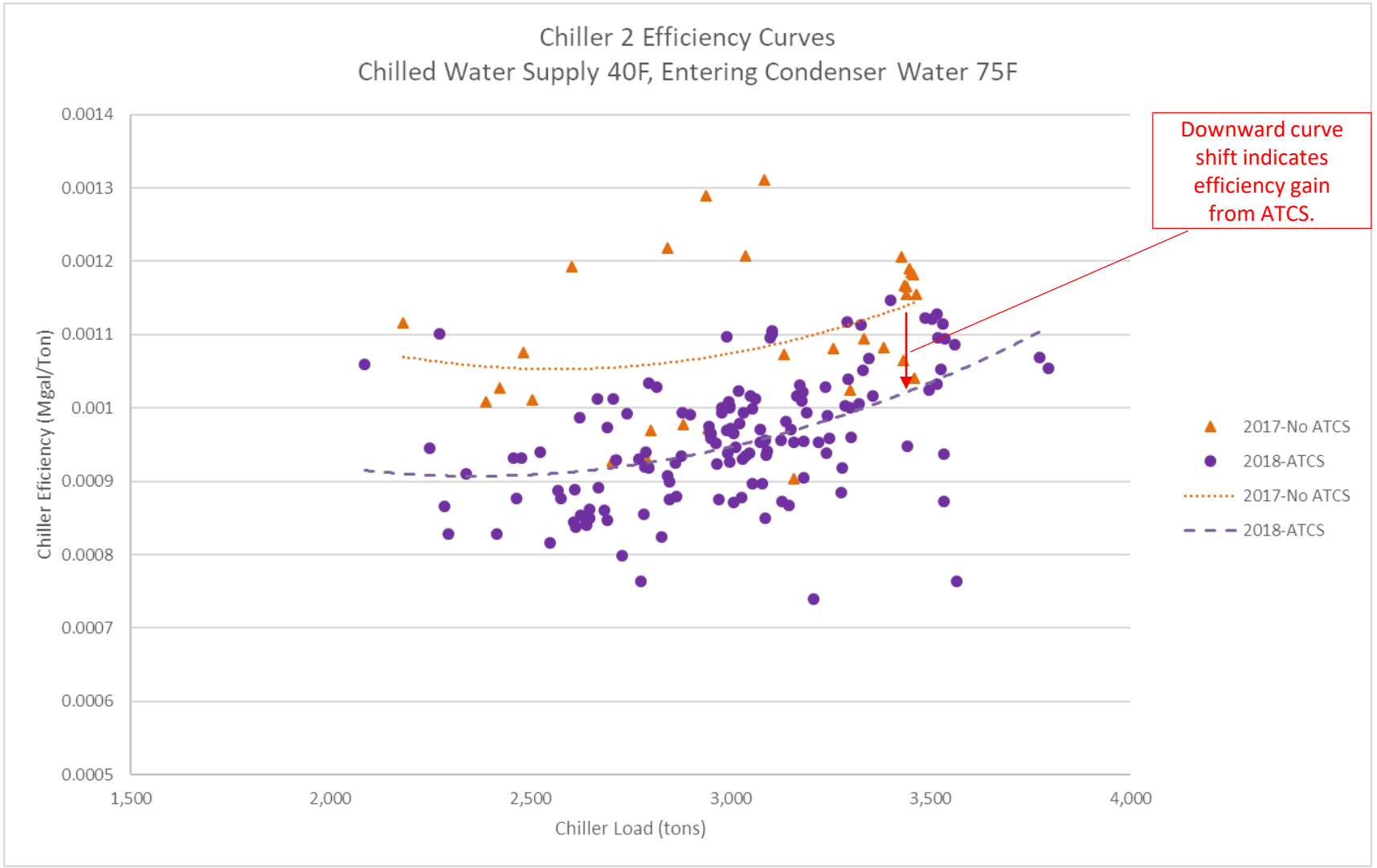
ATCS – Evaporator Side Installation

ATCS – Evaporator & Condenser Pump Skids

ATCS Increased Chiller Cooling Capacity!

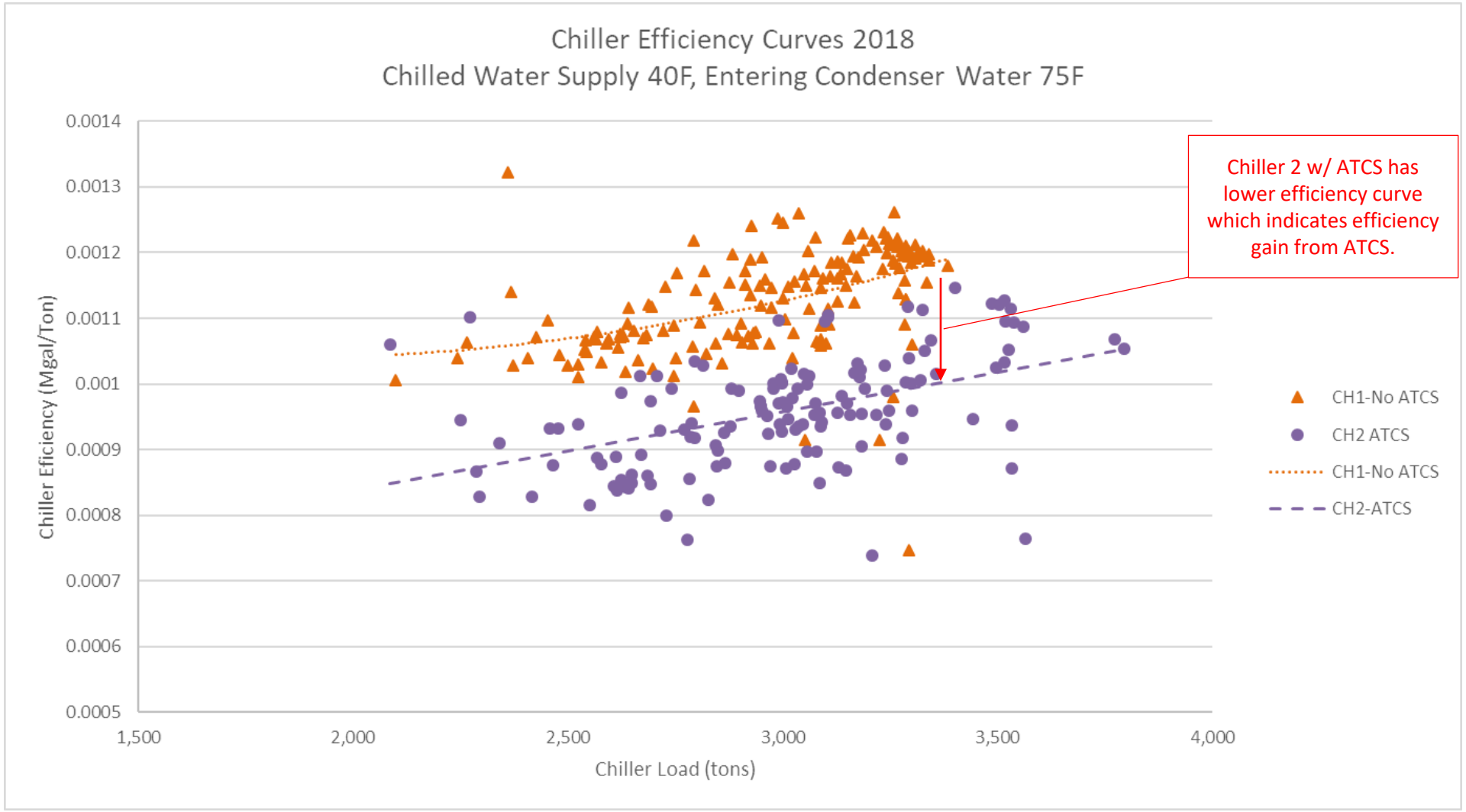


Chiller 2 Efficiency Curve Before & After ATCS



Average Efficiency Gain After Helios: 11%

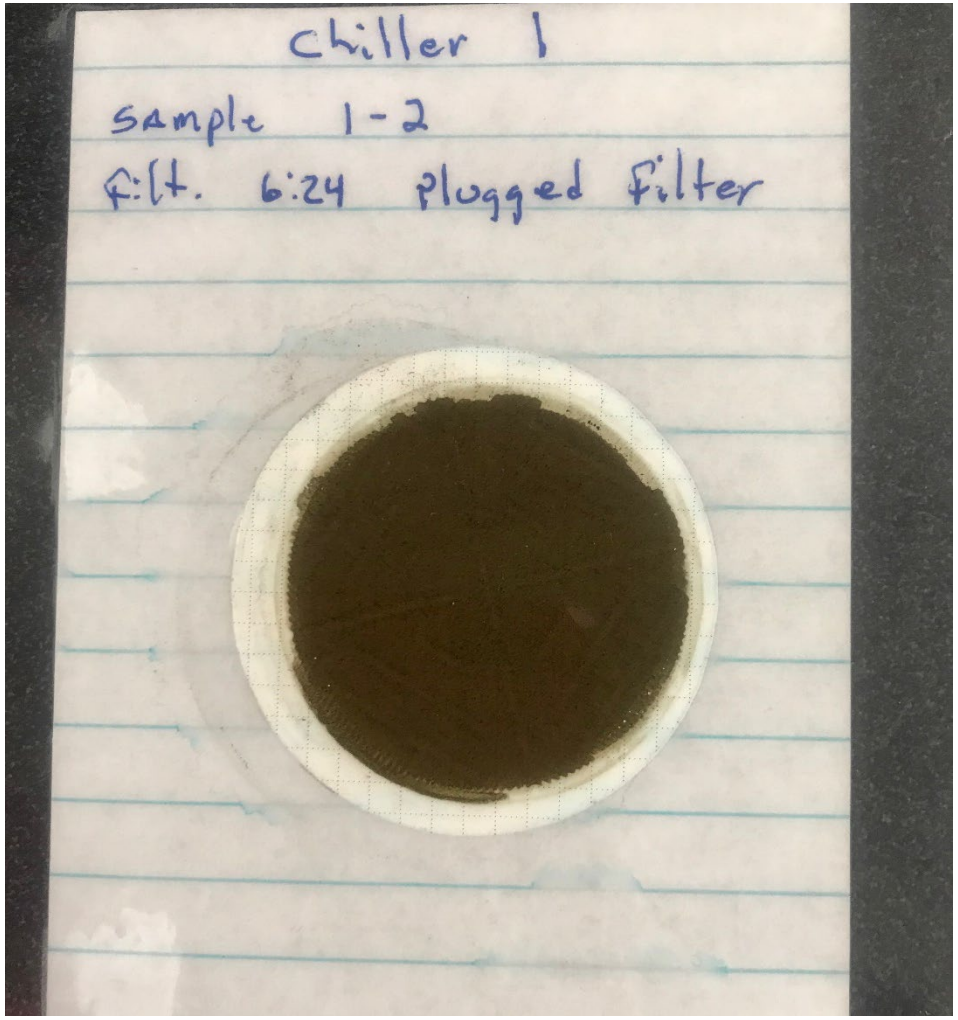
Chiller Efficiency Curves Side by Side Comparison



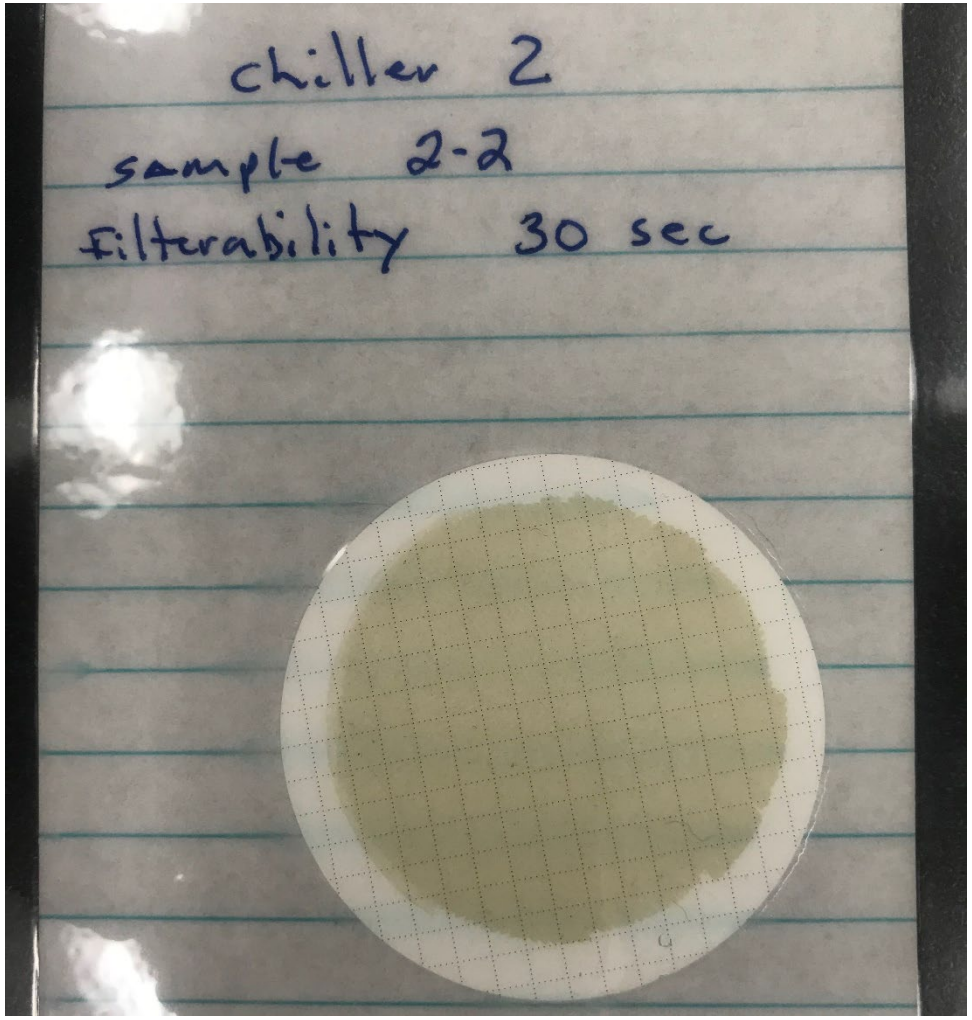
Average Efficiency Advantage With Helios: 15%

Chiller Tube Cleanliness Millipore Test

Chiller #1 Without ATCS



Chiller #2 With ATCS



University of Wisconsin Case Study Results

University of Wisconsin Case Study Summary Results	
Average Chiller Efficiency Gain:	12%
Chiller Capacity Increase:	Up to 400 tons
Annual Energy Savings:	10,370 MMBtu
Annual Energy Cost Savings:	$40,000
Project Lifetime CO2 Emission Reductions:	9,200 tons
Project Lifetime Savings (15 Yrs):	$850,000

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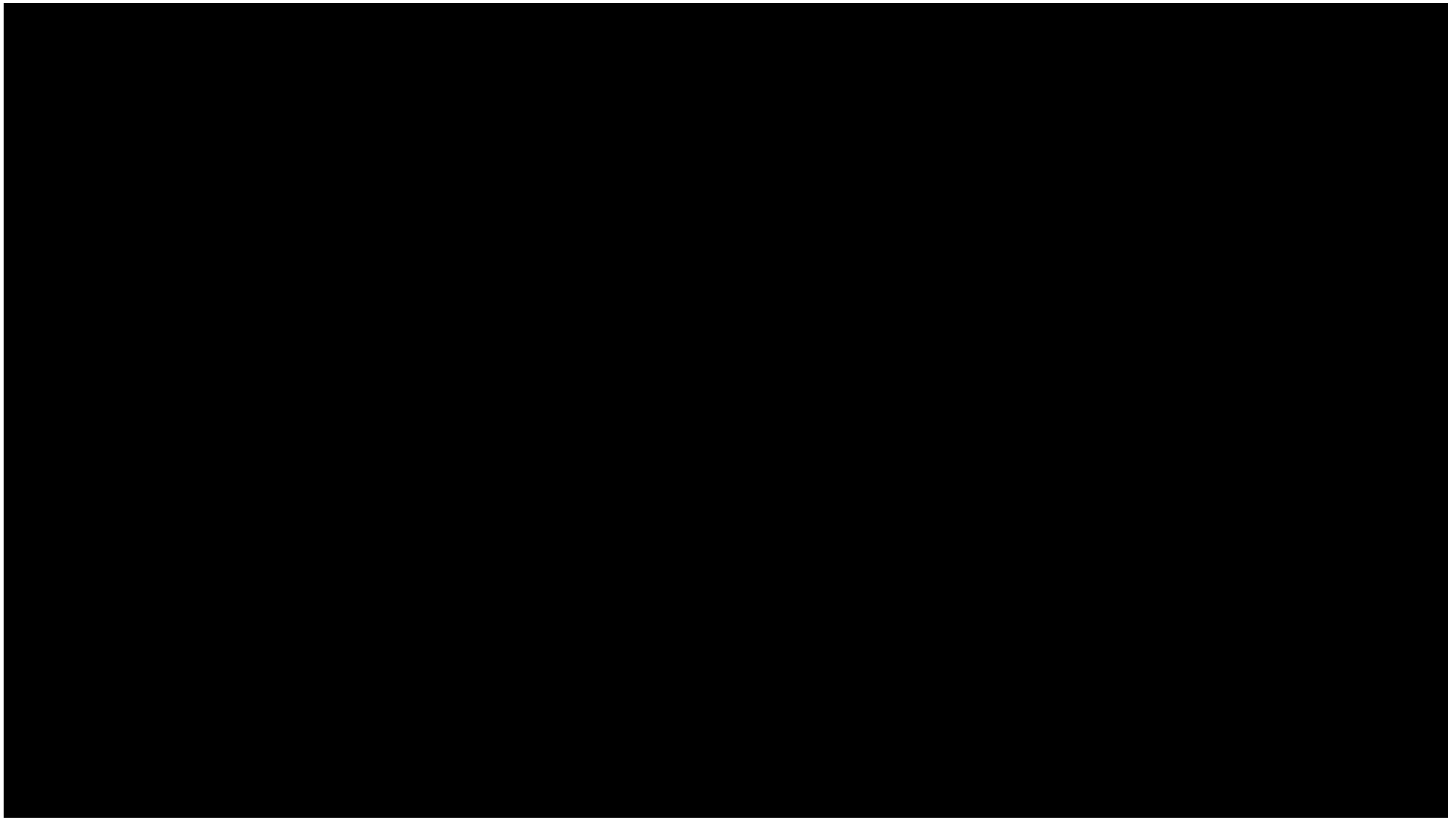
Automatic Tube Cleaning Systems (ATCS): Multiple Value Dimensions

- Avg. chiller efficiency improves 5-15%
- Increase chiller cooling output up to 10%
- Reduce or eliminate manual tube brushing & chemical cleaning
- Improves chiller plant availability
- Reduce GHG emissions and environmental impact

INNOVAS TECHNOLOGIES

How Auto Tube Cleaning Systems (ATCS) Work



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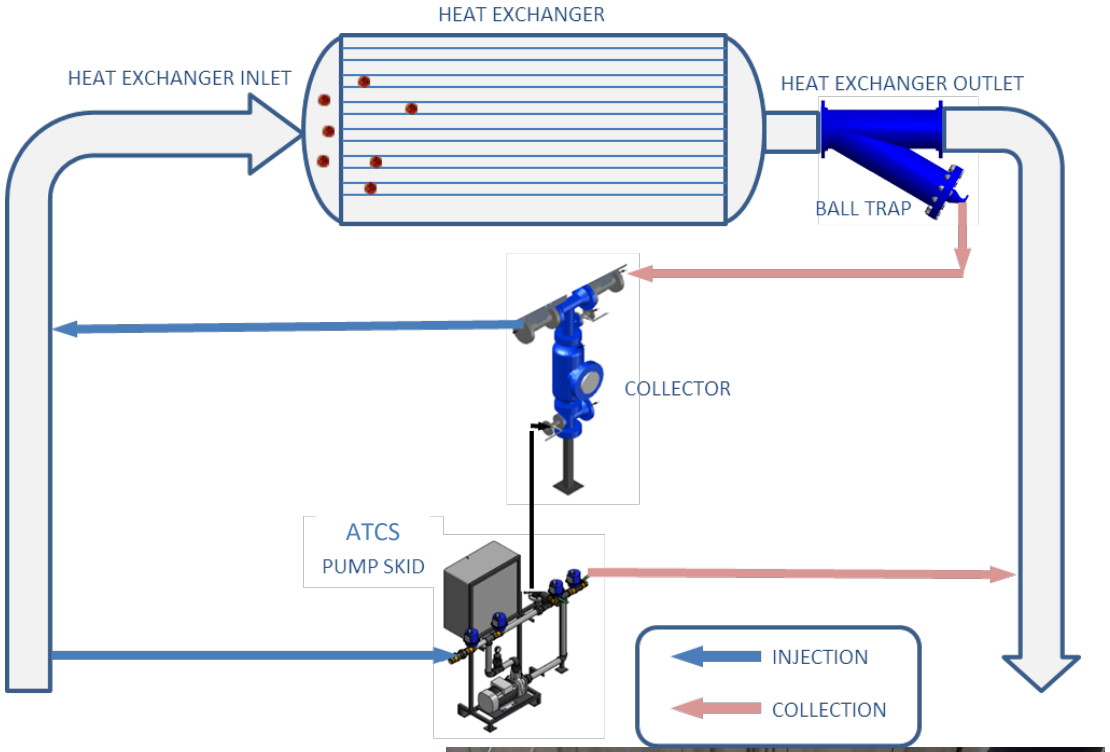
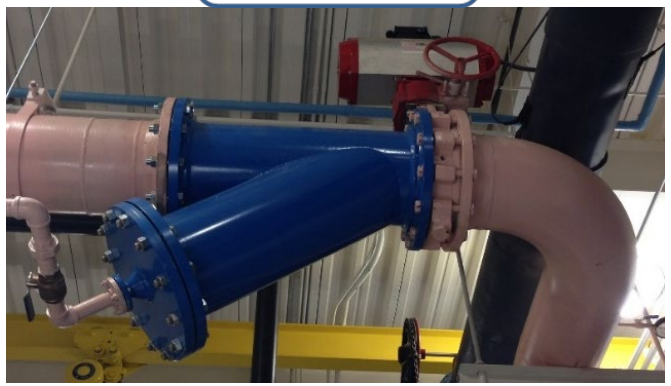
How Auto Tube Cleaning Systems (ATCS) Work





INNOVAS TECHNOLOGIES

-Consistent Performance Elsewhere-
Xcel Energy Case Study

BACKGROUND INFORMATION:

- **XCEL ENERGY DISTRICT COOLING PLANT – CHILLER 4**
- **2,500 NOMINAL TONS**
- **DENVER DOWNTOWN DISTRICT COOLING**

INNOVAS TECHNOLOGIES

-Consistent Performance Elsewhere-
Xcel Energy Case Study Results

Xcel Energy Case Study Summary Results	
Average Chiller Efficiency Gain:	4%
Chiller Capacity Increase:	Up to 200 tons
Annual Energy Savings:	180,000 kW-hrs
Annual Cost Savings:	$20,000
Project Lifetime CO2 Emission Reductions:	2,200 Tons
Project Lifetime Savings (15 Yrs):	$410,000

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-Consistent Performance Elsewhere-
George Mason University

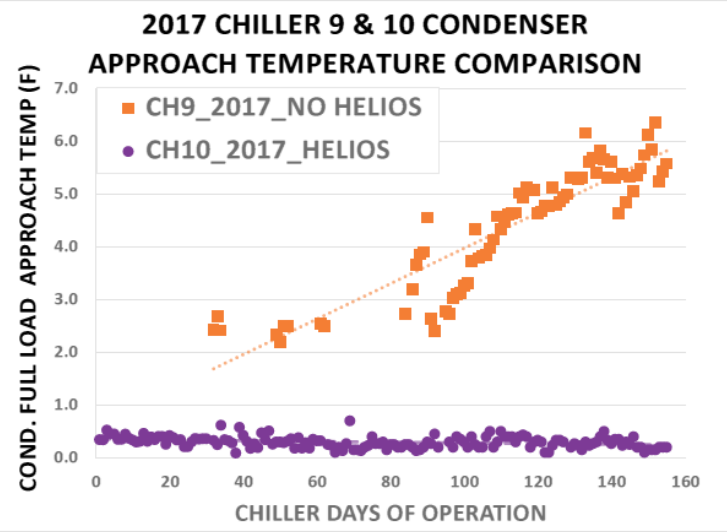

FIGURE 1
Chiller 10 Approach Temperature Maintained at 0.5 Degree F with Helios Tube Cleaning System® while Chiller 9 Approach Temperature Increases Due to Tube Fouling.

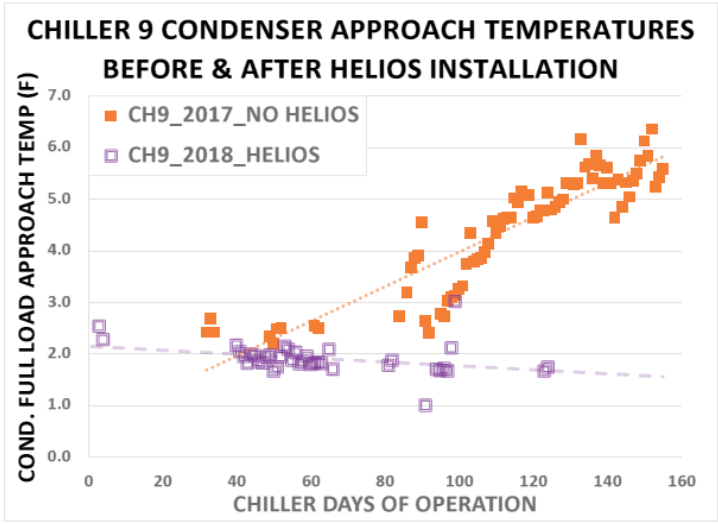

FIGURE 2
Chiller 9 Approach Temperature Flatlines After Helios Tube Cleaning System® Installation.

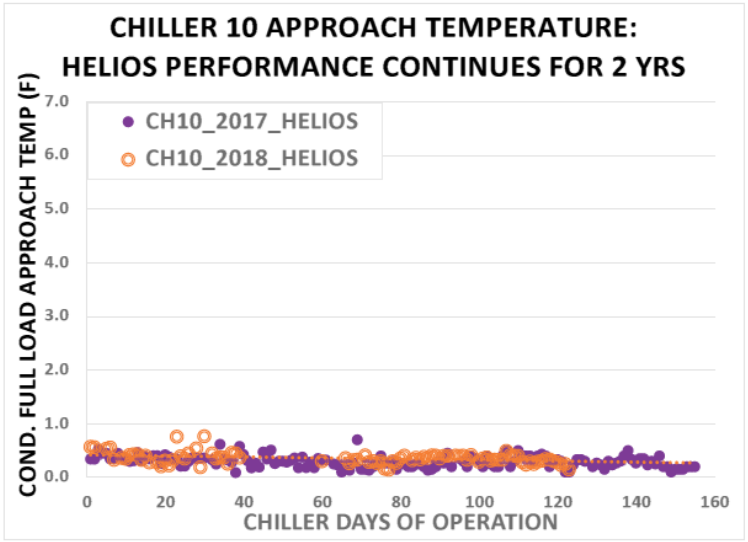

FIGURE 3
Chiller 10 Approach Temperature Maintained at 0.5 Degree F for 2 Years due to Helios Tube Cleaning System®.

George Mason University Case Study Results	
Average Chiller Efficiency Gain:	10%
Chiller Capacity Increase:	Up to 200 tons
Annual Energy Savings:	550,000 kW-hrs
Annual Cost Savings:	$45,000
Project Lifetime GHG Reductions:	6,500 Tons
Project Lifetime Savings (15 Yrs):	$900,000

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Questions?

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