



# CampusEnergy2021

BRIDGE TO THE FUTURE

Feb. 16-18 | CONNECTING VIRTUALLY

WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16





The University of Texas at Austin  
Utilities and Energy Management

# REDUCING ENERGY CONSUMPTION EVEN WITH 20% CAMPUS GROWTH

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## CampusEnergy2020

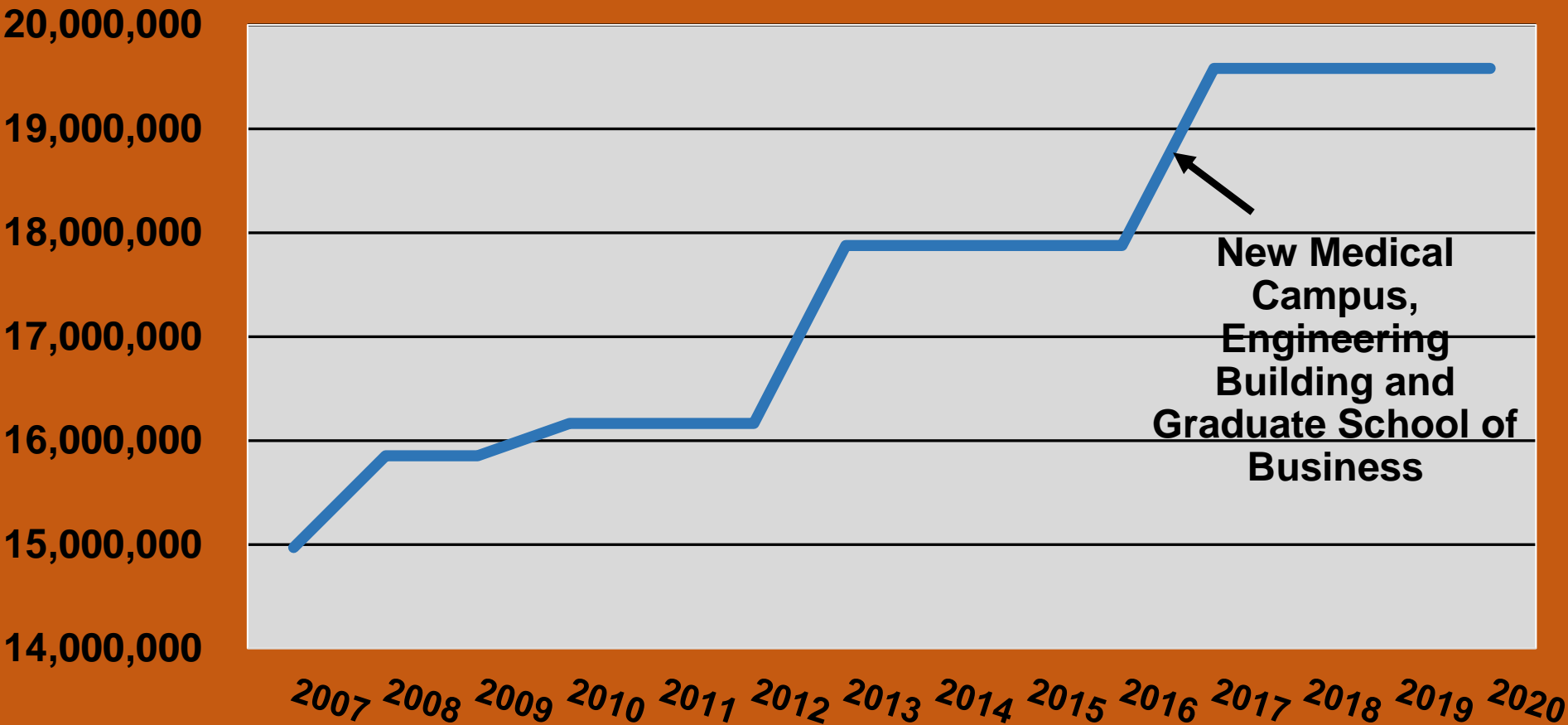
THE POWER TO CHANGE

FEBRUARY 10-14 • SHERATON DENVER DOWNTOWN • DENVER, CO



GSF

# Space Growth





# 2018 Utility Masterplan Approach

Based on the “new building types” use a combination of historical building energy use and new building design energy load projections to determine the expected load growth over the next 12 year period

- 0-6 year period
  - 13 new buildings - 3,467,792 gsf
  - 3 buildings demolished - 323,439 gsf
- 7–12 year period
  - 11 new buildings - 1,832,732 gsf
  - 4 buildings demolished - 680,383 gsf



# 2018 Findings – Main Campus Projected Load Over Next 12 Years

## Peaks

CHW  
(Tons)

STM  
(mmBtu/HR)

HW  
(mmBtu/HR)

ELEC  
(MW)

Existing

31,238

275

0

59.5

Net Short  
Term

11,309

19

52

14.1

Net Medium  
Term

5,128

7

42

9.8

Total  
Projected

47,675

331

94

83.4





# **Findings – Electrical**

## **Implications of exceeding 70 MW**

- **Operating older less efficient generation affects cost & reliability**
- ***Serve New Buildings via Austin Energy?***
  - ***Cost and reliability impacted!***
  - ***Type of building may be impacted!***
- **New “high efficiency” generation is expensive and constrained by available plant space**

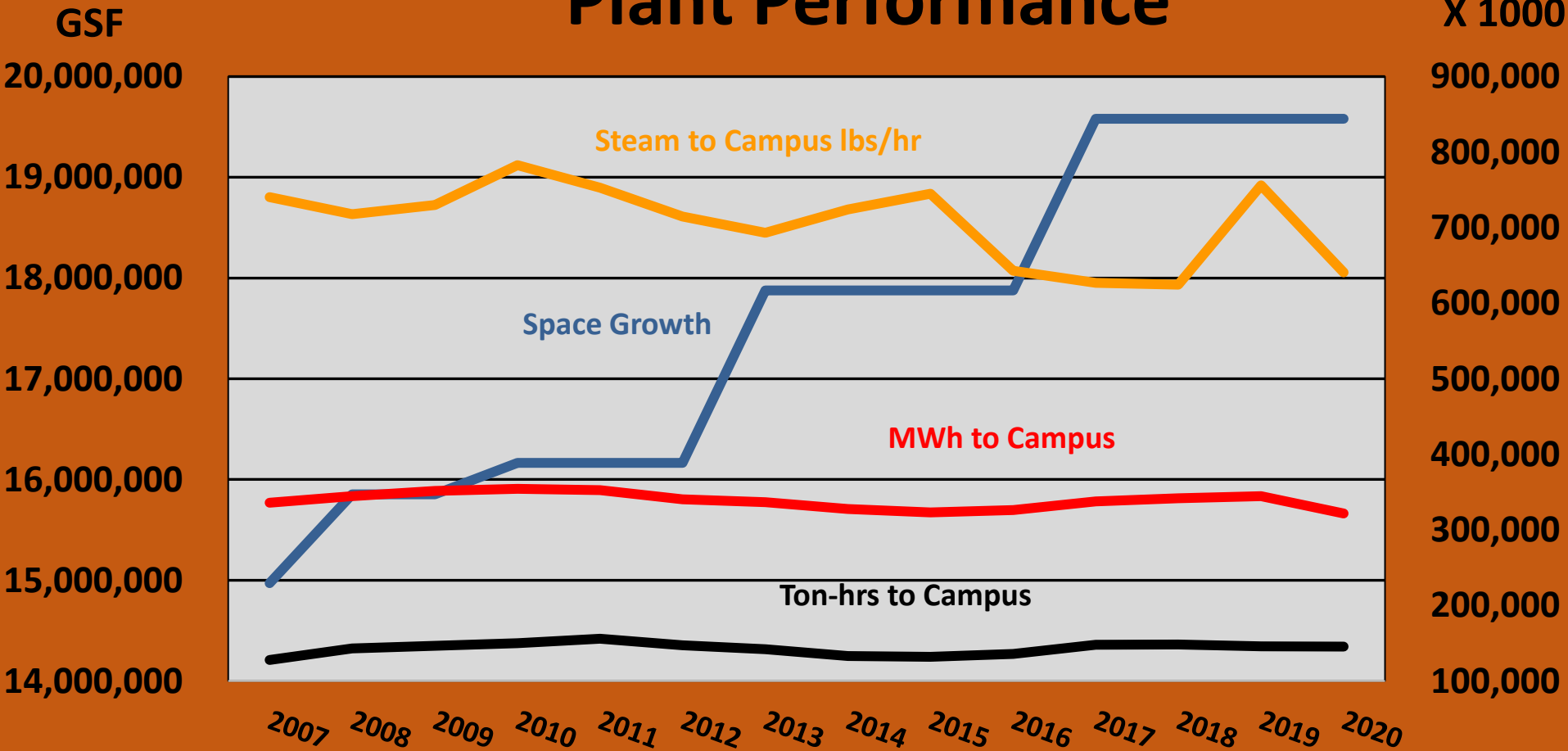


# Optimize TES & Cooling Plants to Reduce Peak Power

- 2007 - Eliminate Steam Turbine Chillers, Add 15K Electric Chillers w/VFD's
- 2008 -Start Optimizing 15K ton plant and start new 4 MG TES
- 2009 - Start Evaluating Cooling Loop DP and VFD Pumping
- 2013 - Optimize Multiple Plant Dispatch, Reduce DP to 10 to 4 psi (summer vs rest of year) (4 plants)
- 2014 to 2017 – Optimize use of 4 MG TES
- 2018 - Add 15k All VFD Plant, Add VFD to 5k ton OM Chiller, Start Using 6 MG TES
- 2019 – Use power generation data and the weather forecast to predict how to dynamically handle cooling and optimize thermal energy storage



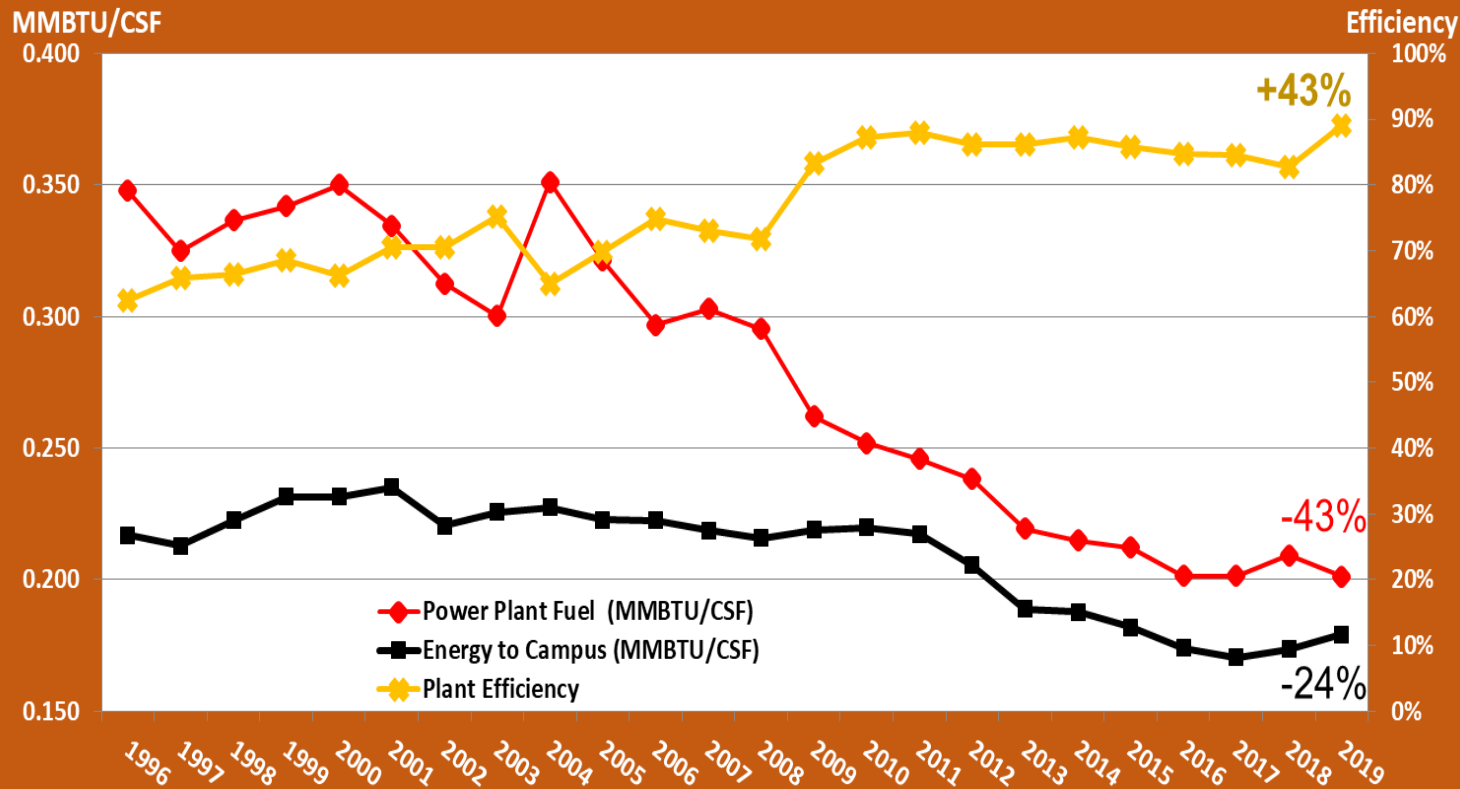
# Plant Performance







# Summary of Utility Plant Performance



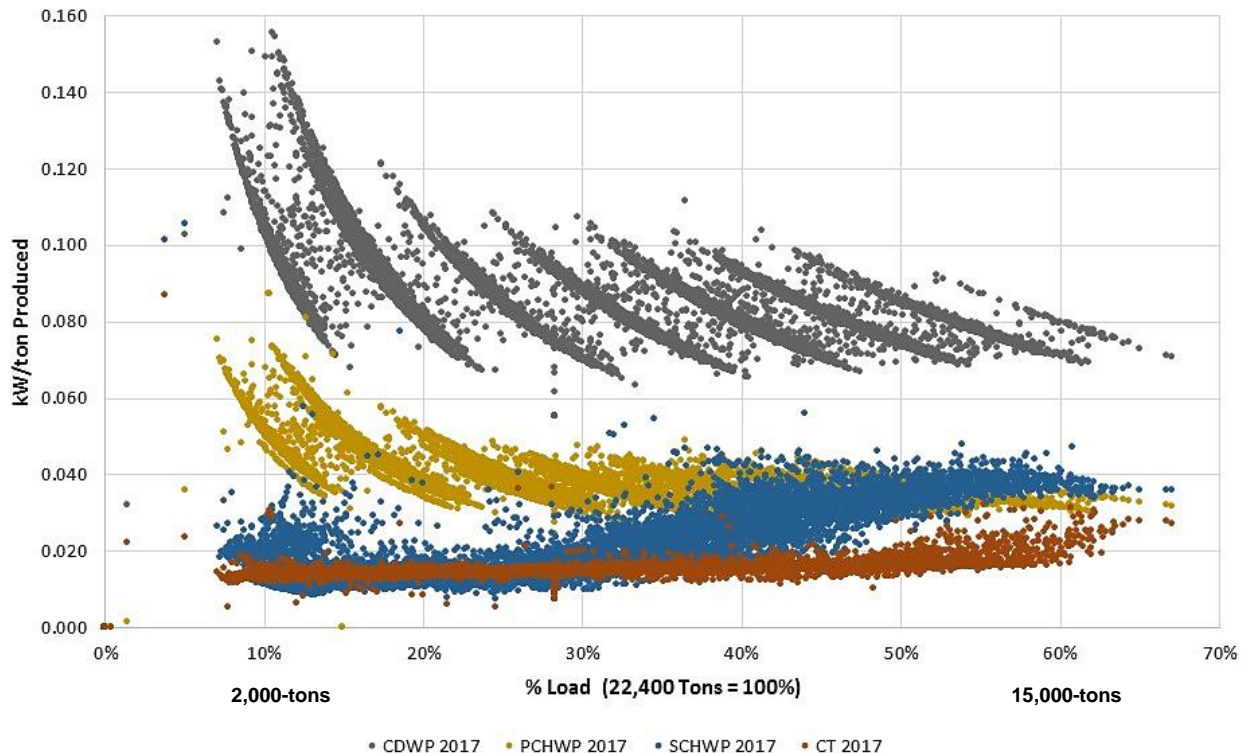
**At \$3/MMBtu  
= \$64 Million**

**Actual Cumulative  
Savings = \$122  
Million**



## Auxiliary Energy Performance – Legacy Designs

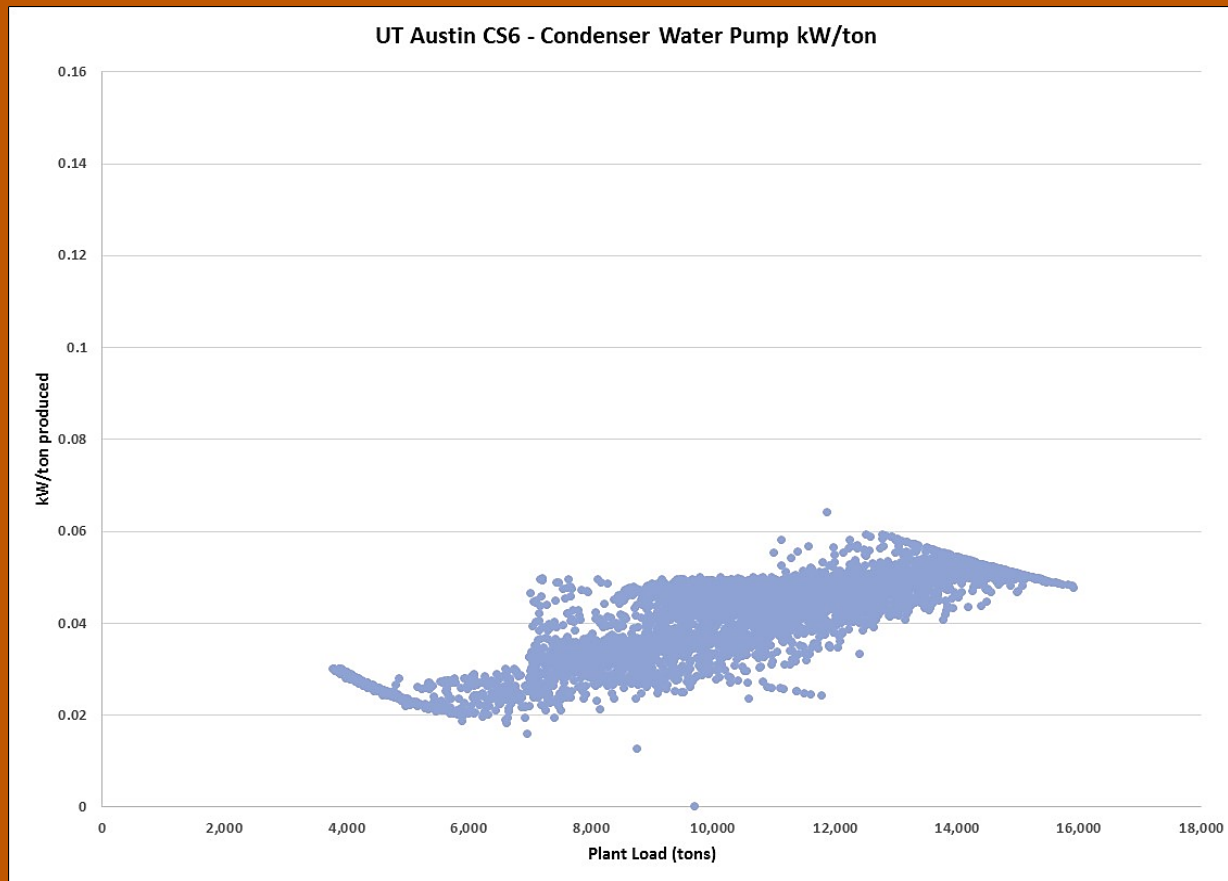
Equipment kW/ton Produced vs % Load



- Condenser water pump efficiency gets worse as load decreases
- Primary pumps behave exactly the same
- This is the result of constant speed pumping and lack of VFDs
- Pumps cannot adjust with load so efficiency is a step function based on the number of pumps running
- # Pumps On = # Chillers On
- **Chiller staging becomes a critical factor in overall efficiency**

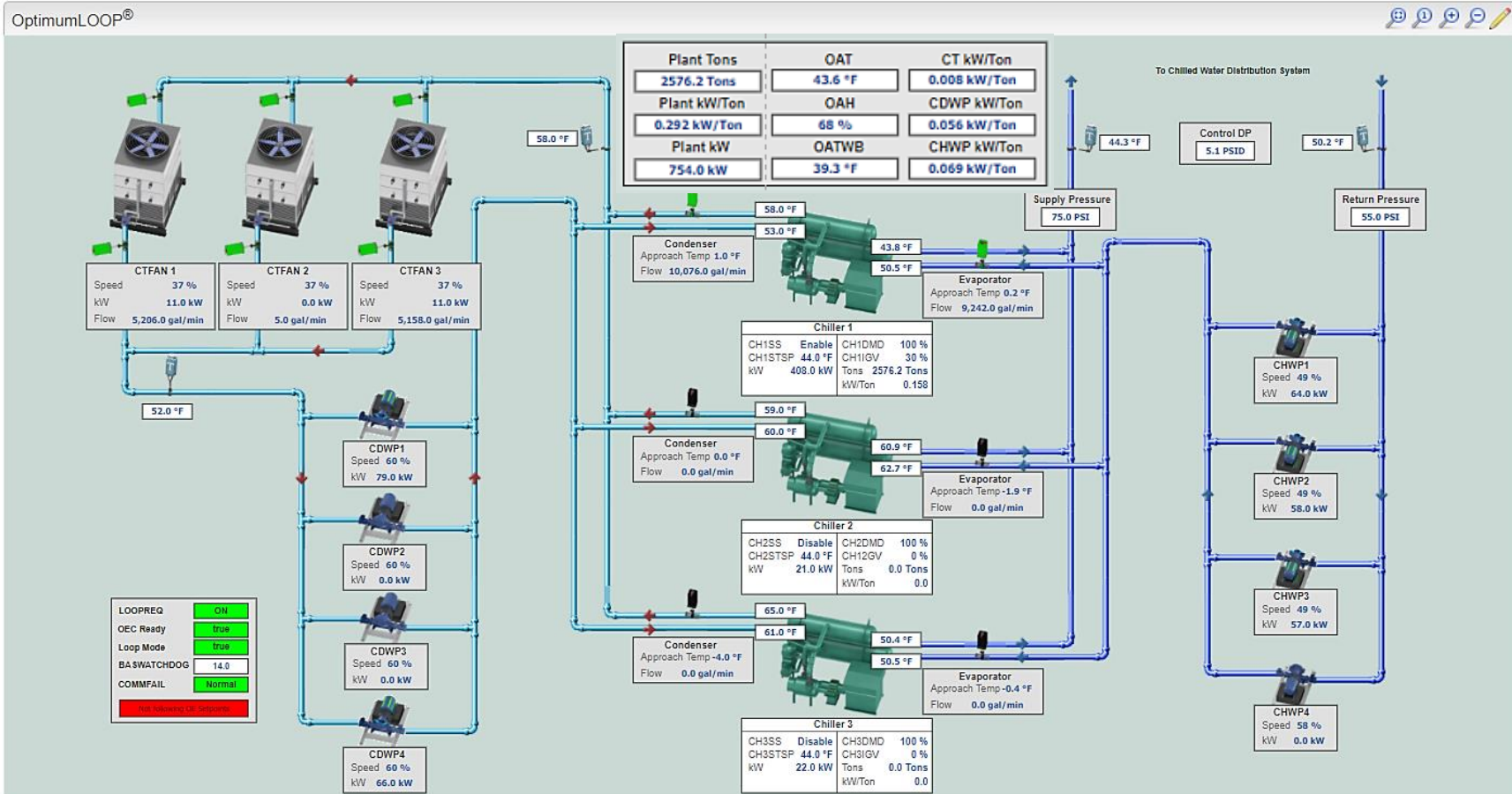


## Variable Speed Condenser Water Pumps – UT Austin



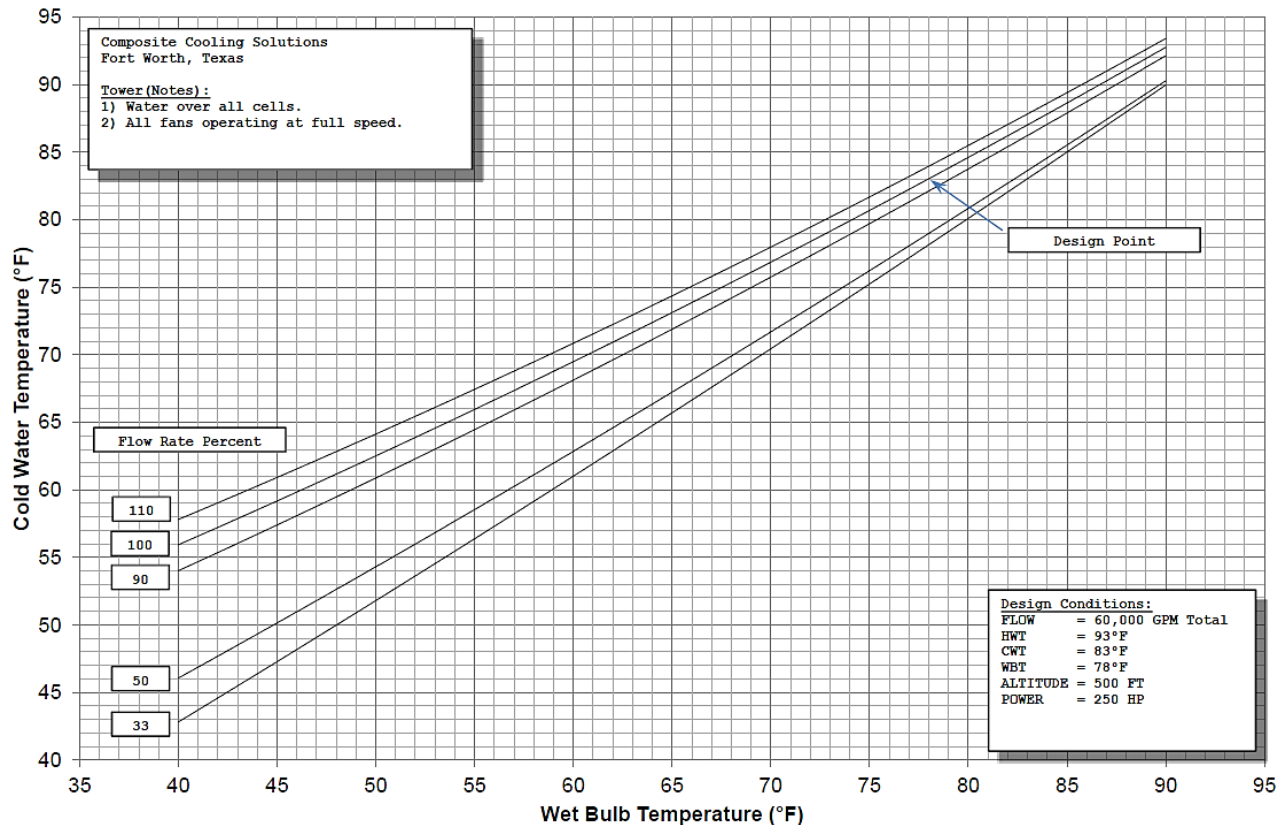
- Condenser water pump efficiency gets better as load decreases
- Variable primary-only plant (no primary secondary)
- Pumps adjust with load
- # Pumps on does not equal # Chillers On
- **Chiller staging becomes less of a factor in overall efficiency**

# 2008 – Optimization of 15,000-ton All Variable Speed Plant (CS6)





Counterflow Tower Performance Curve  
Percent Flow Curves  
CCS-1549 University of Texas CS-7  
Model Number: 4FT-4753-250-P7

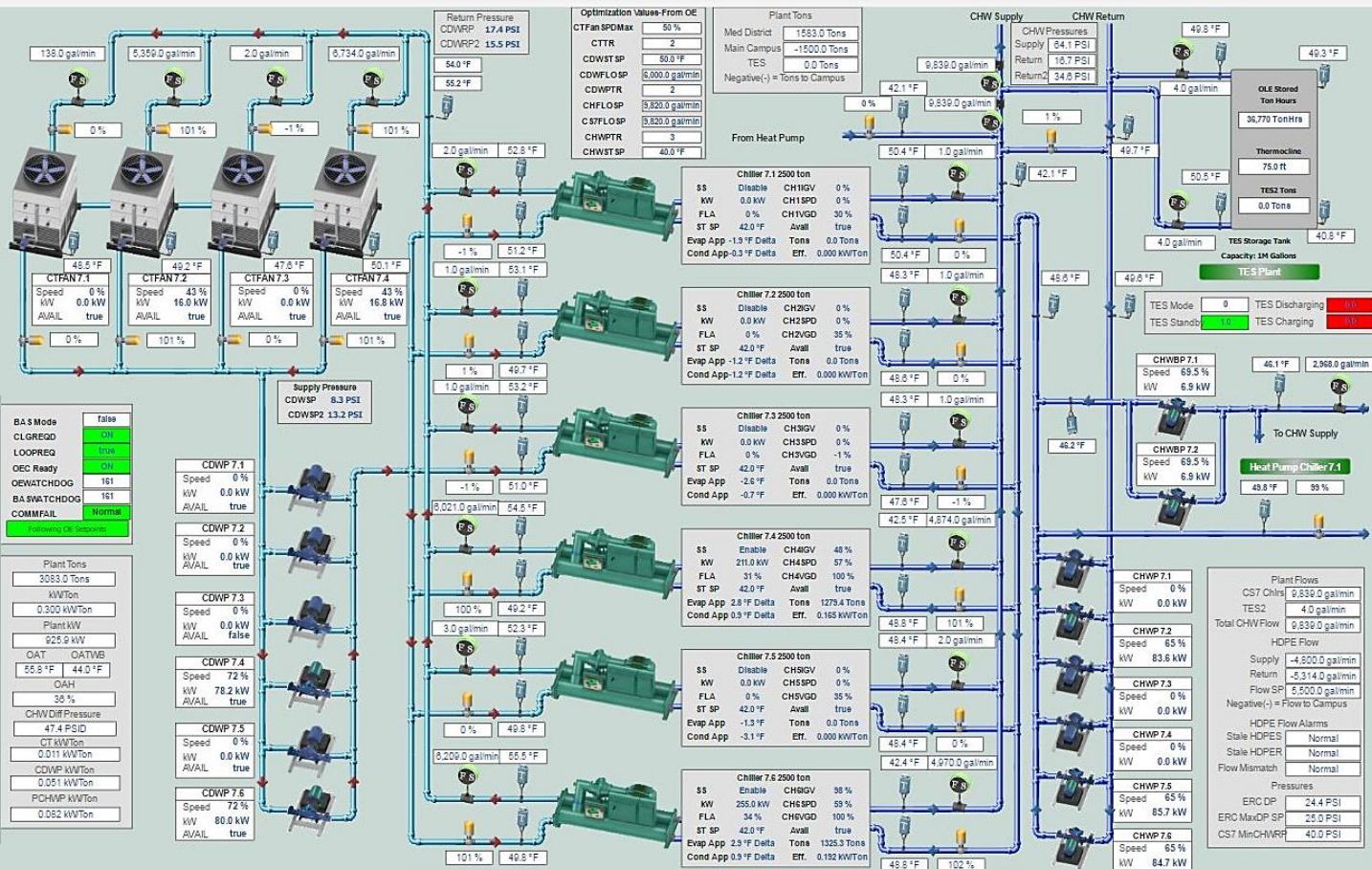


- Approach gets worse as wet bulb decreases
- Approach improves significantly at part load/flow conditions
- It is possible at 33% flow to operate at less than a 1 deg F approach
- Towers at UT Austin are consistently operating at 1.5 to 2.5 deg F approaches year round.



## 01. Plant Overview CS7

OptimumLOOP®







OptimumLOOP®

01.Distribution System



Campus Staging

OAT 88.4 °F

OAH 50 %

WET BULB 73.5 °F

CHLRMODE ON

LOOPMODE ON

UT Austin

## Campus Demand

UT CHW Demand Flow	46,391.0 gal/min
UT CHW Demand Tons	27826.4 Tons
UT CHW Chlr Tons	24343.4 Tons
UT CHW TES Tons	3483.0 Tons

## Chiller Station 5

Total Plant kW	3,101.3 kW
Total Plant Efficiency	0.634 kW/Ton
CS5 CH1 EvapTons	0.0 Tons
CS5 CH1 EvapFlow	7.0 gal/min
CS5 CH2 EvapTons	0.0 Tons
CS5 CH2 EvapFlow	4.0 gal/min
CS5 CH3 EvapTons	4885.0 Tons
CS5 CH3 EvapFlow	7,121.0 gal/min

Dashboard

## Chiller Station 4

Total Plant kW	0.0 kW
Total Plant Efficiency	0.000 kW/Ton
CS4 CH1 EvapTons	0.0 Tons
CS4 CH1 EvapFlow	0.0 gal/min
CS4 CH2 EvapTons	0.0 Tons
CS4 CH2 EvapFlow	0.0 gal/min
CS4 CH3 EvapTons	0.0 Tons
CS4 CH3 EvapFlow	0.0 gal/min

## Thermal Energy Storage Tank 1

TESMODE	2
Total Plant Energy Use	197.4 kW
TES1 Pump Efficiency	0.029
Charge Flow	0.0 gal/min
Discharge Flow	6,613.0 gal/min
Thermocline	28.0 ft

## UTAustin Distributed Chiller System

## Thermal Energy Storage Tank 2

TESMODE	0
Total Plant Energy Use	0.0 kW
TES2 Pump Efficiency	0.0
Charge Flow	0.0 gal/min
Discharge Flow	0.0 gal/min
Thermocline	43.0 ft

## System Totals

UT CHW Total Flow	39,755.0 gal/min
UT CHW Total kW	16,059.1 kW
UT CHW Total Ton	24343.4 Tons
UT CHW Total kW/Ton	0.659 kW/Ton
CS3 Total Ton	0.0 Tons
CS4 Total Ton	0.0 Tons
CS5 Total Ton	4885.0 Tons
CS6 Total Ton	13298.0 Tons
CS7 Total Ton	6160.4 Tons
HDPE CHWS Flow	-4,716.0 gal/min
HDPE CHWR Flow	-5,442.0 gal/min

## Chiller Station 7

Total Plant kW	3,685.4 kW
Total Plant Efficiency	0.590 kW/Ton
CS7 CH1 EvapTons	0.0 Tons
CS7 CH1 EvapFlow	2.0 gal/min
CS7 CH2 EvapTons	2020.5 Tons
CS7 CH2 EvapFlow	4,041.0 gal/min
CS7 CH3 EvapTons	0.0 Tons
CS7 CH3 EvapFlow	60.0 gal/min
CS7 CH4 EvapTons	2057.2 Tons
CS7 CH4 EvapFlow	4,014.0 gal/min
CS7 CH5 EvapTons	0.0 Tons
CS7 CH5 EvapFlow	4.0 gal/min
CS7 CH6 EvapTons	2082.7 Tons
CS7 CH6 EvapFlow	4,031.0 gal/min

Dashboard

## Chiller Station 6

Total Plant kW	9,075.0 kW
Total Plant Efficiency	0.683 kW/Ton
CS6 CH1 EvapTons	4420.0 Tons
CS6 CH1 EvapFlow	6,811.0 gal/min
CS6 CH2 EvapTons	4436.0 Tons
CS6 CH2 EvapFlow	6,821.0 gal/min
CS6 CH3 EvapTons	4442.0 Tons
CS6 CH3 EvapFlow	6,836.0 gal/min

Dashboard

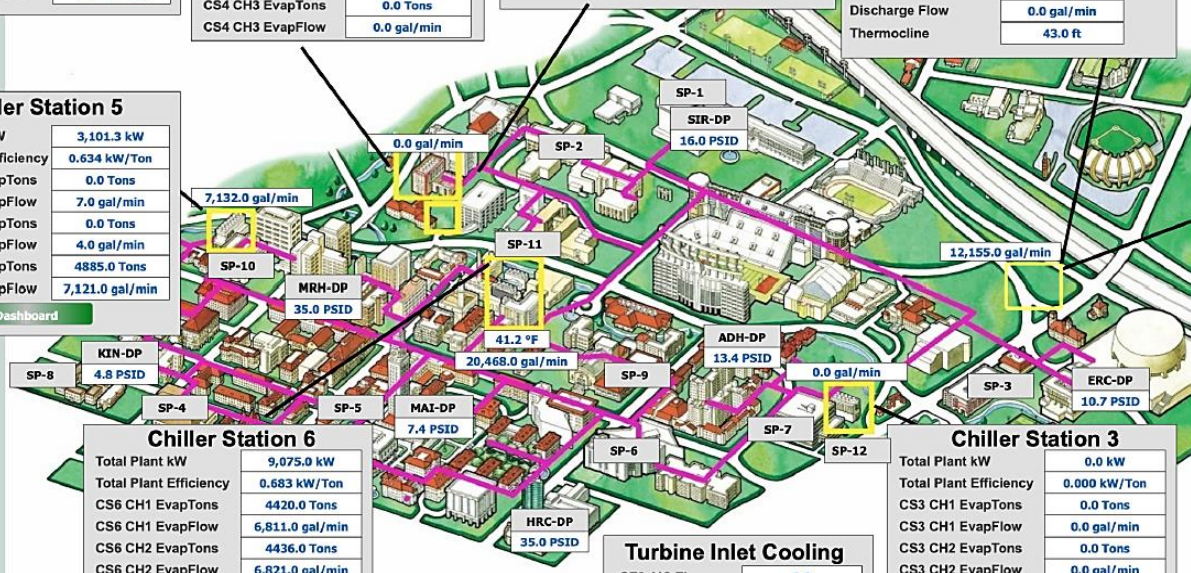
## Chiller Station 3

Total Plant kW	0.0 kW
Total Plant Efficiency	0.000 kW/Ton
CS3 CH1 EvapTons	0.0 Tons
CS3 CH1 EvapFlow	0.0 gal/min
CS3 CH2 EvapTons	0.0 Tons
CS3 CH2 EvapFlow	0.0 gal/min
CS3 CH3 EvapTons	0.0 Tons
CS3 CH3 EvapFlow	0.0 gal/min

Dashboard

## Turbine Inlet Cooling

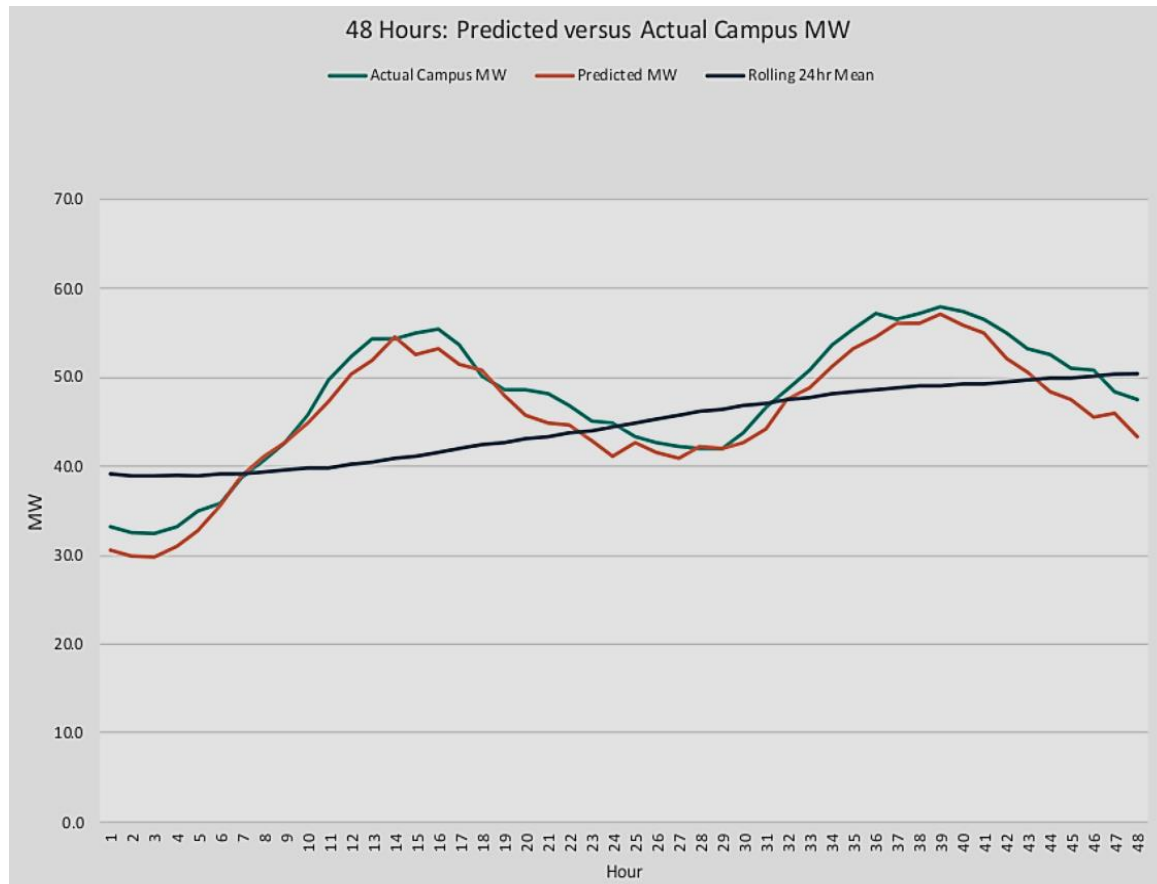
GT8 AIC ZI	0.0
GT8 AIC Flow	193.0 gal/min
GT10 AIC ZI	2.0
GT10 AIC Flow	0.0 gal/min

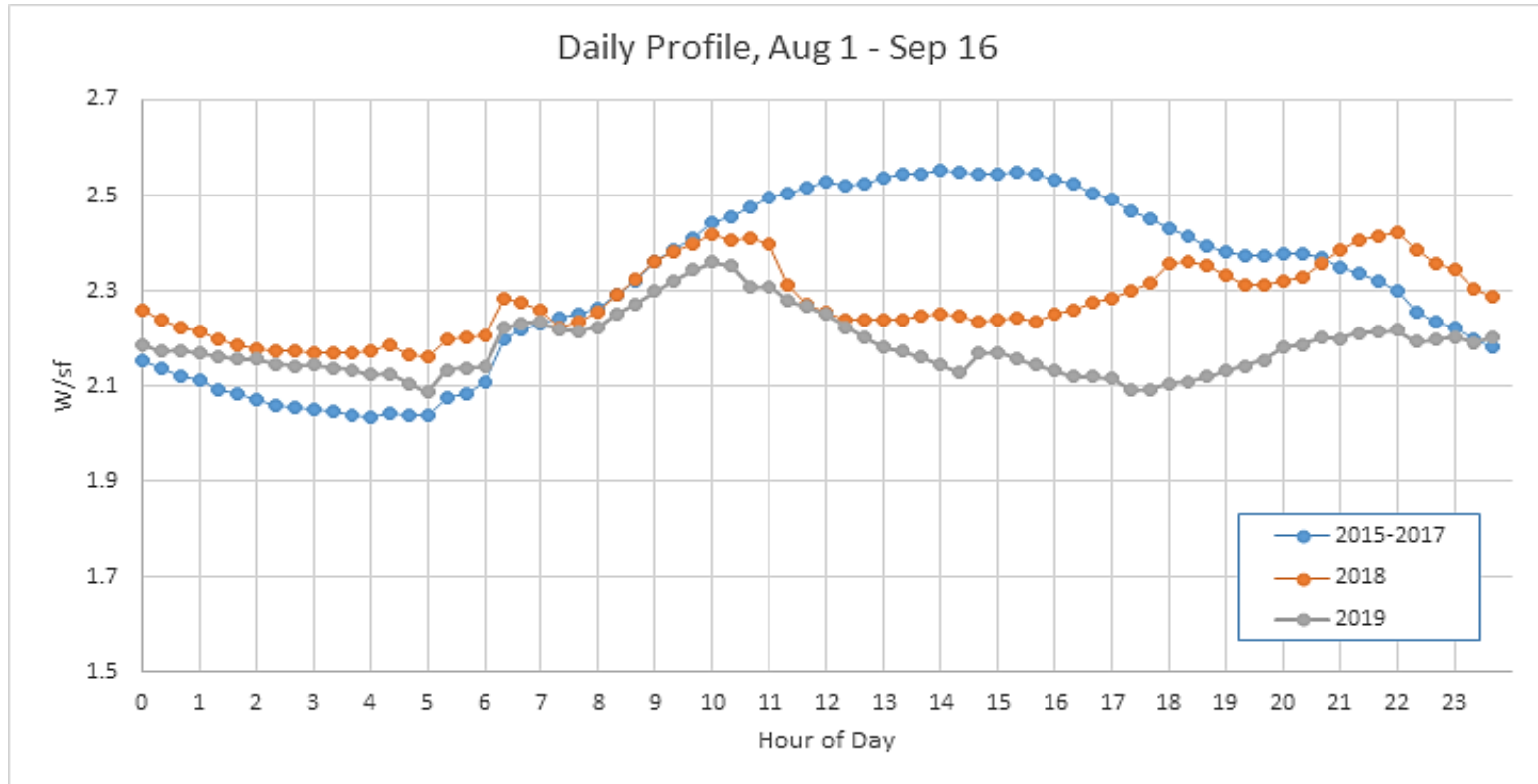




**The TES control strategy is a four-step process:**

- 1. Project the average campus MW for the next 48 hours.**
- 2. Calculate the difference between the predicted MW and the average MW**
- 3. Calculate the tonnage required to reduce or increase MW to achieve the average**
- 4. Calculate the flow required to reduce or increase tonnage from each tank.**

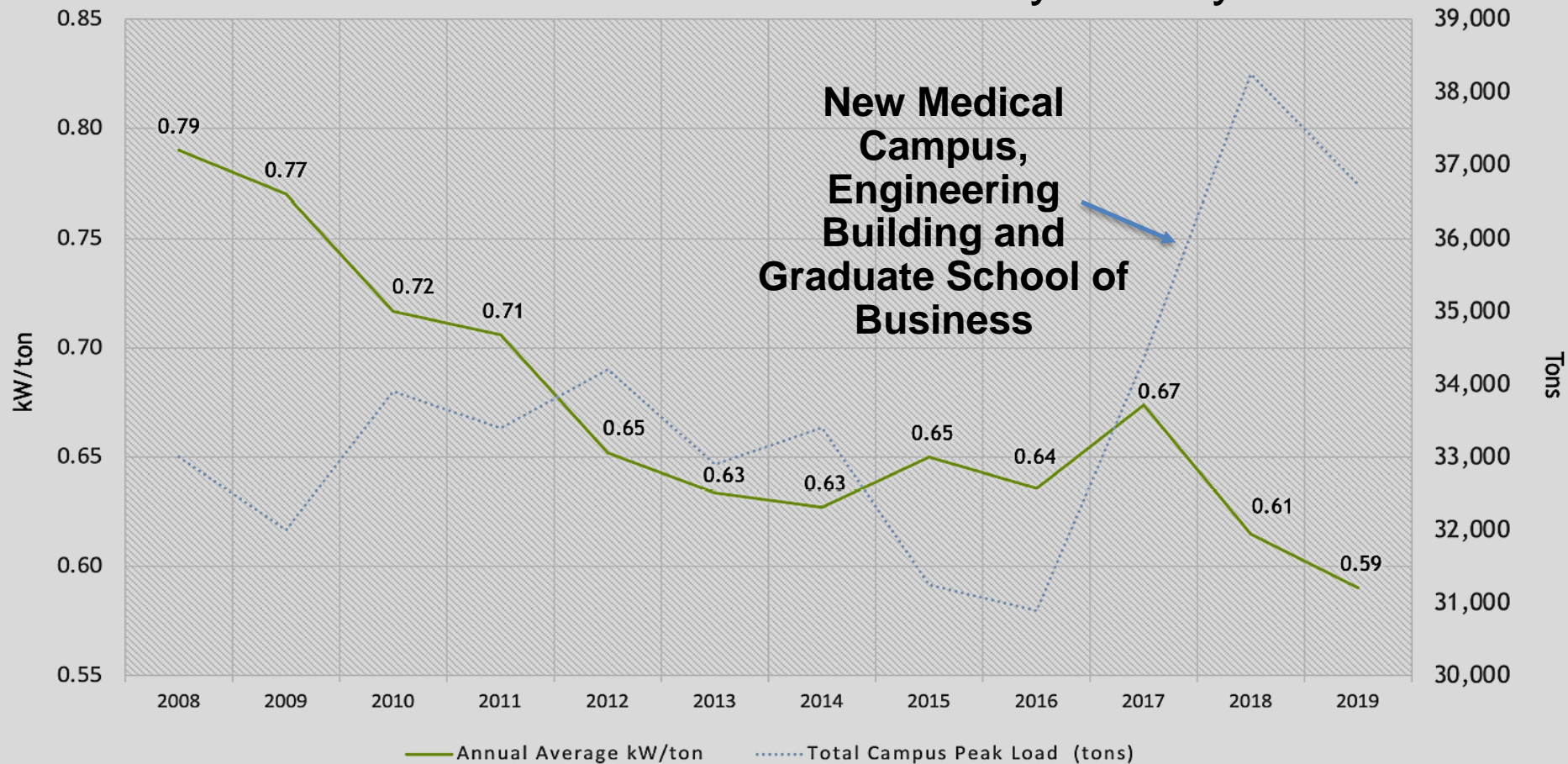




The peak electrical load in 2018 of 69 MW was reduced to 62 MW in 2019 though the campus space of 19.6 million sq ft was constant



## Total CHW Plant Efficiency History



# Questions?

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