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The University of Texas at Austin
Utilities and Energy Management

THE EVOLUTION OF THE UT AUSTIN UTILITY PLANTS

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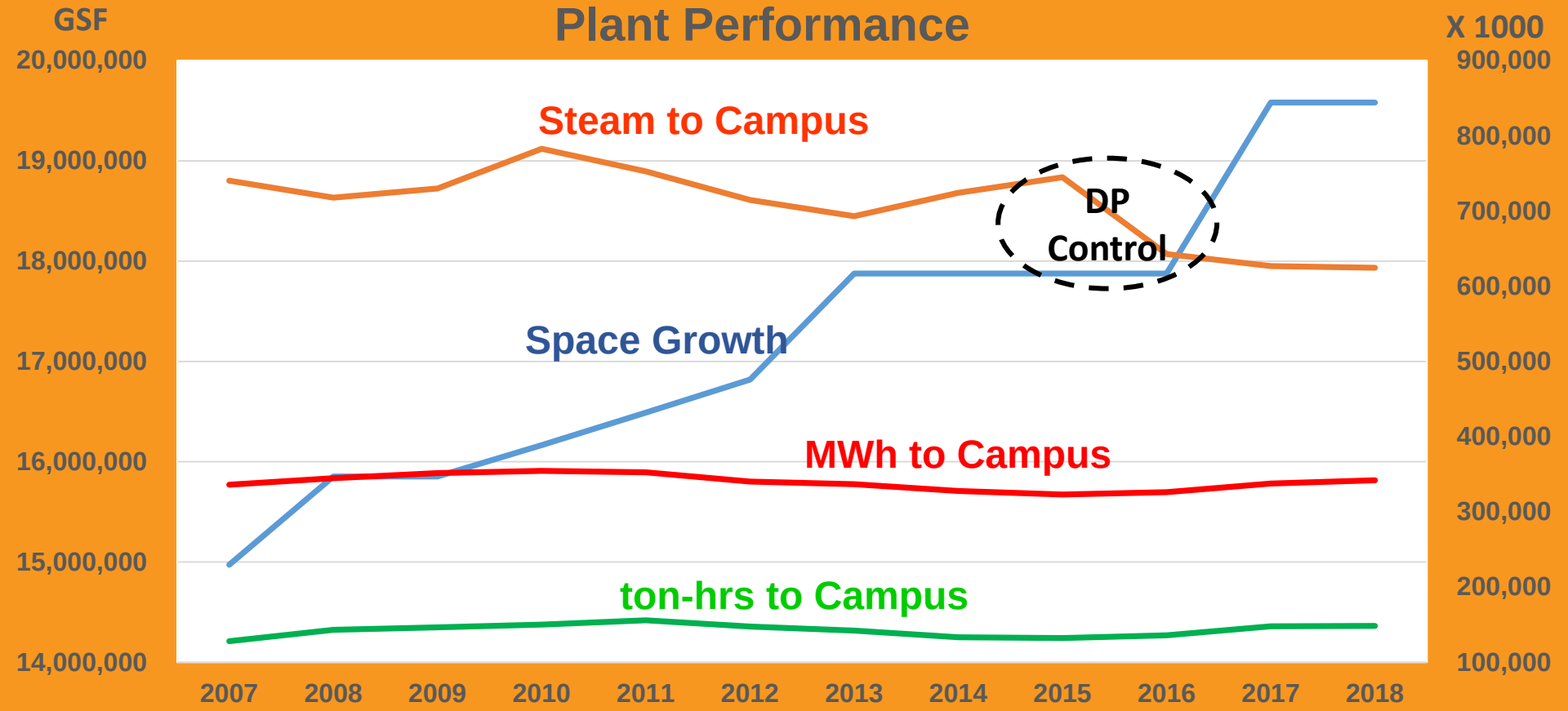
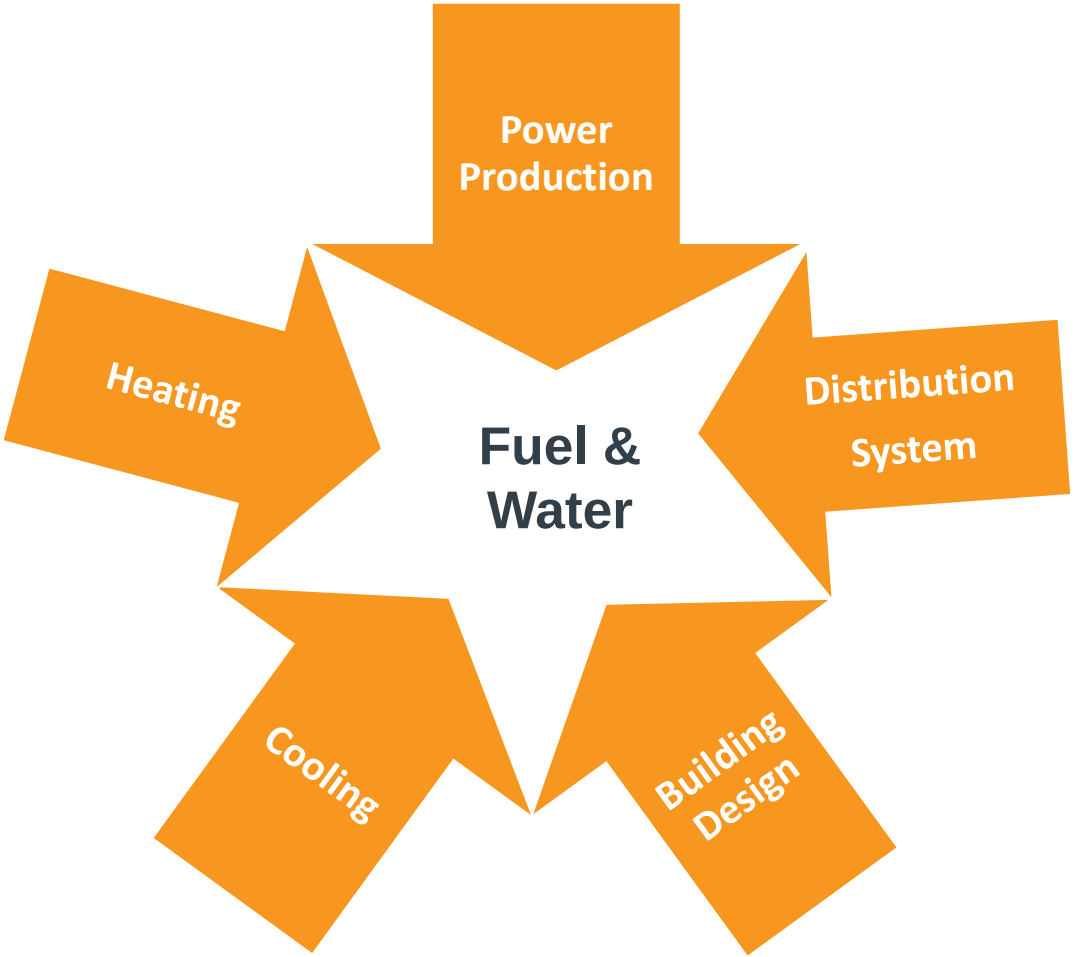
Presentation Objectives

- UT Austin's Philosophy for Cooling
- UT's Actual Historical Performance
- Impact to Power Generation
- VFD vs Constant Speed
- Next Steps

Plant Performance



Holistic Approach to Total Energy



Evolution of Optimization

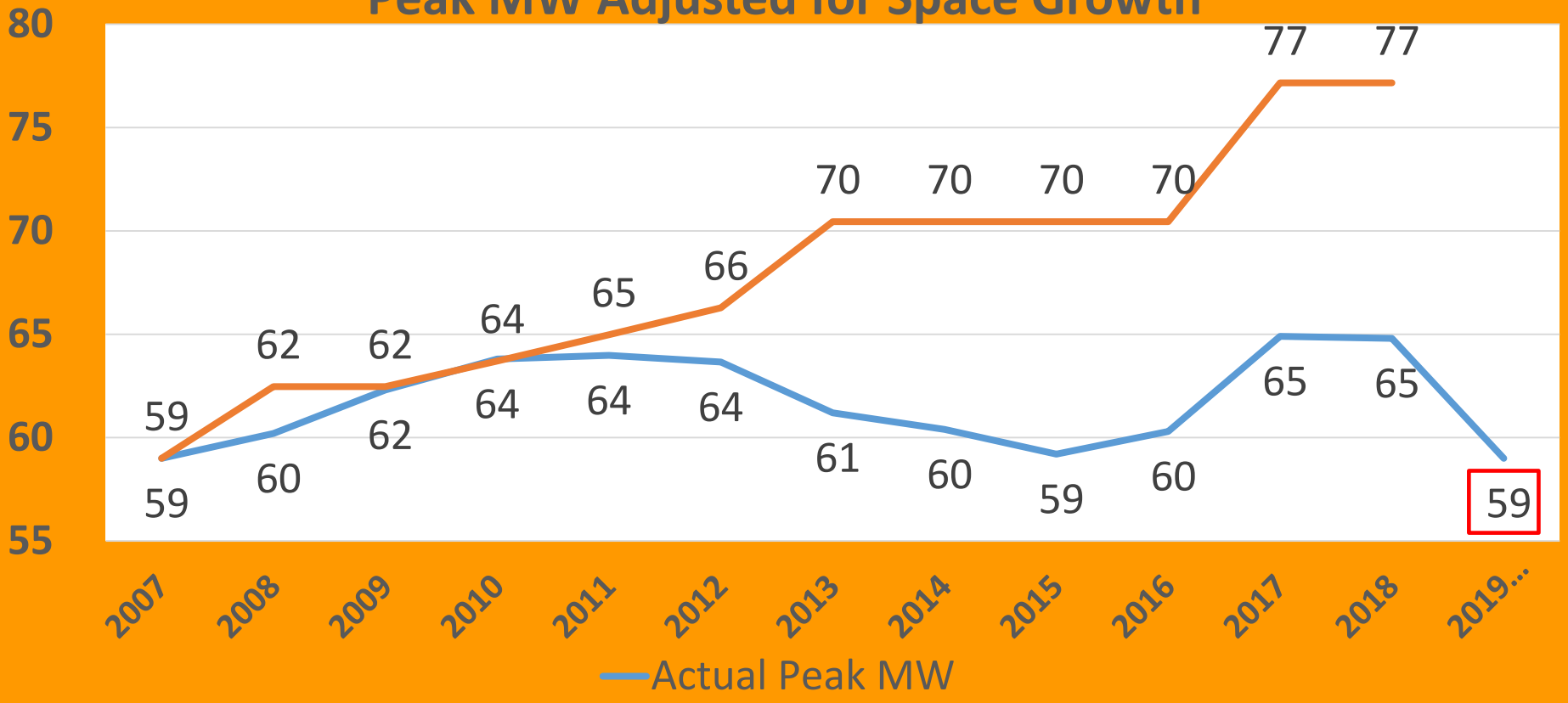
2007 **45K Tons - Eliminate Steam Turbine Chillers, Add 15K Electric Chillers w/VFD's but no Optimization**	Annual Average kW/ton = 0.84 **15 million GSF** **MW = 59, Tons = 29.3k, Steam 200k**
2008 **45k Tons - Start Optimizing 15K ton plant**	Annual Average kW/ton = 0.80 **15.9 million GSF** **MW = 60, Tons = 33.1k, Steam = 190k**
2009 **Evaluate Distribution DP control and VFD Pumps at CS3**	**Annual Average kW/ton = 0.77** **15.9 million GSF** **MW = 62, Tons = 34k, Steam = 191k**
2013 Optimize Multiple Plant Dispatch, Reduce DP to 10 to 4 psi (summer vs rest of year) (4 plants)	Annual Average kW/ton = 0.66 **17.9 million GSF** **MW = 61, Tons = 33.4k, Steam = 188k**
2014 – 2017 Start Using 4 MG TES	4-year Average kW/ton = 0.66 **18.3 million GSF** **MW = 61k, Tons = 33.6k, Steam = 203k**
2018 - 60k Tons Add 15k All VFD Plant, Add VFD to 5k ton OM Chiller, Start Using 6 MG TES	Annual Average kW/ton = 0.615 **19.6 million GSF** **MW = 65, Tons = 38.3k, Steam = 240k**

Total Cumulative Saved:

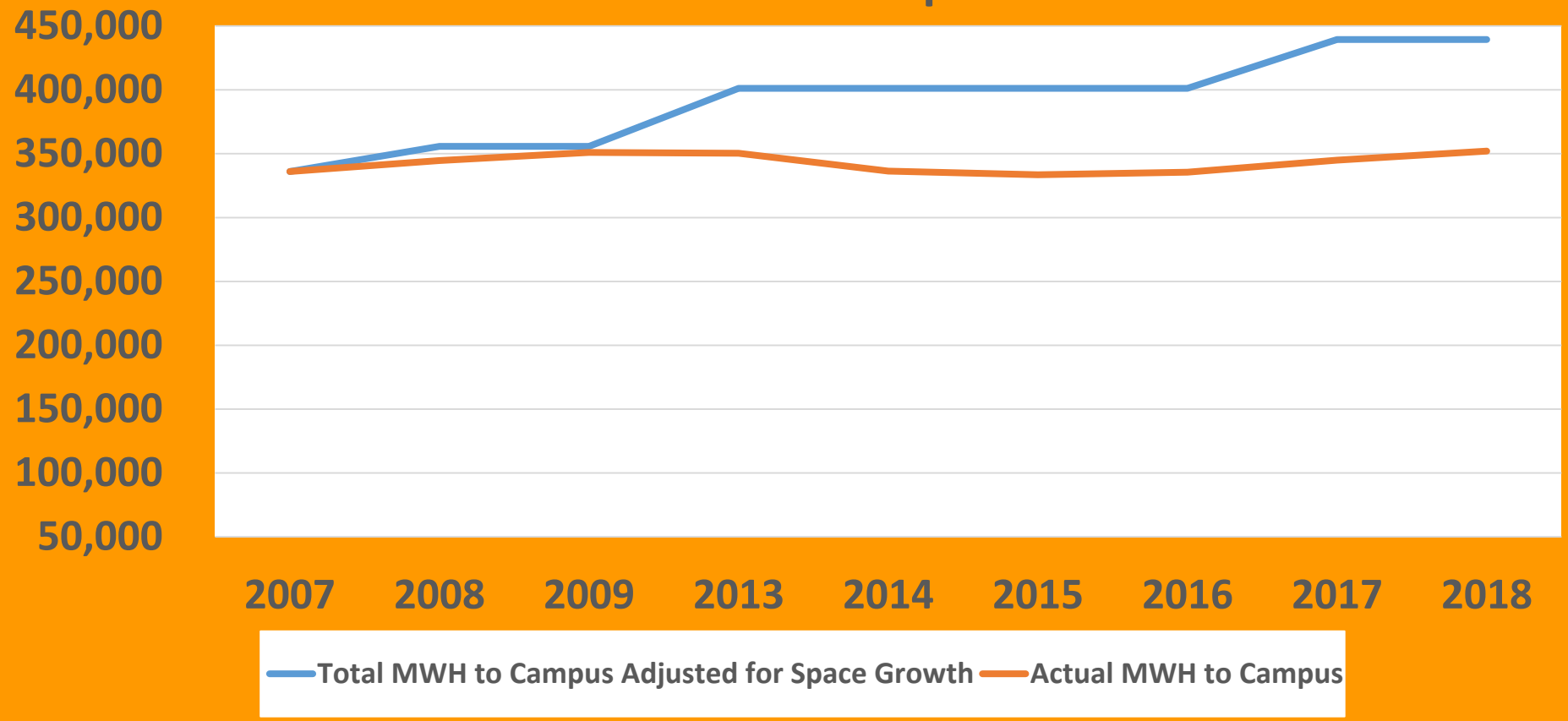
509.6K MWh

$21.3 Million

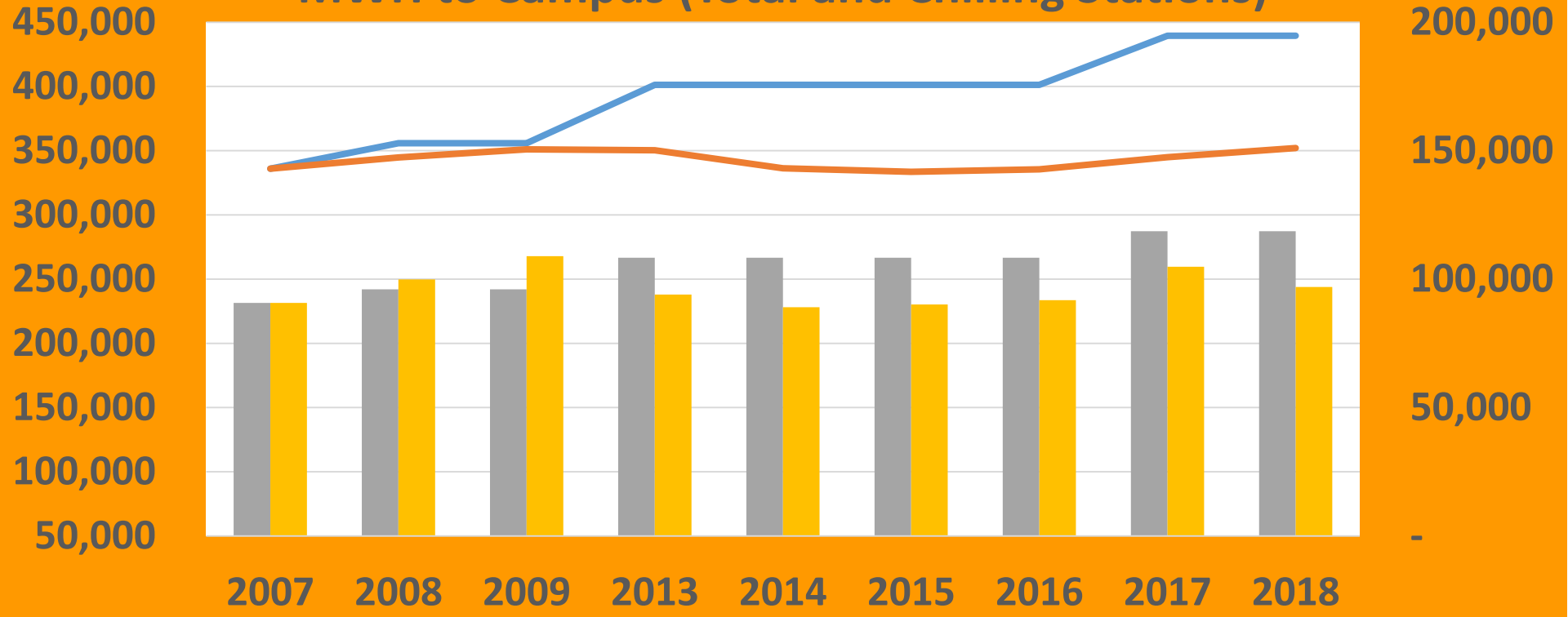
Peak MW Adjusted for Space Growth



MWH to Campus



MWH to Campus (Total and Chilling Stations)

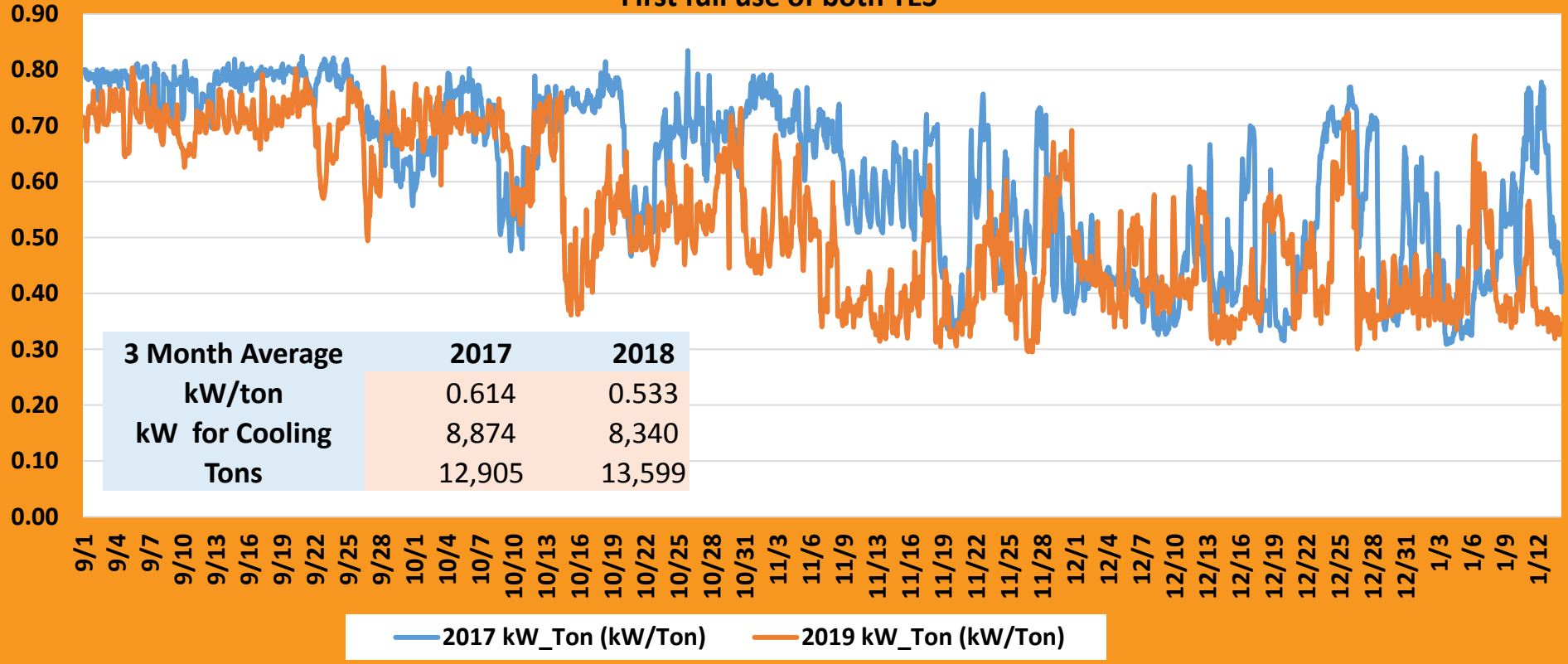


Performance To Date vs Last Year

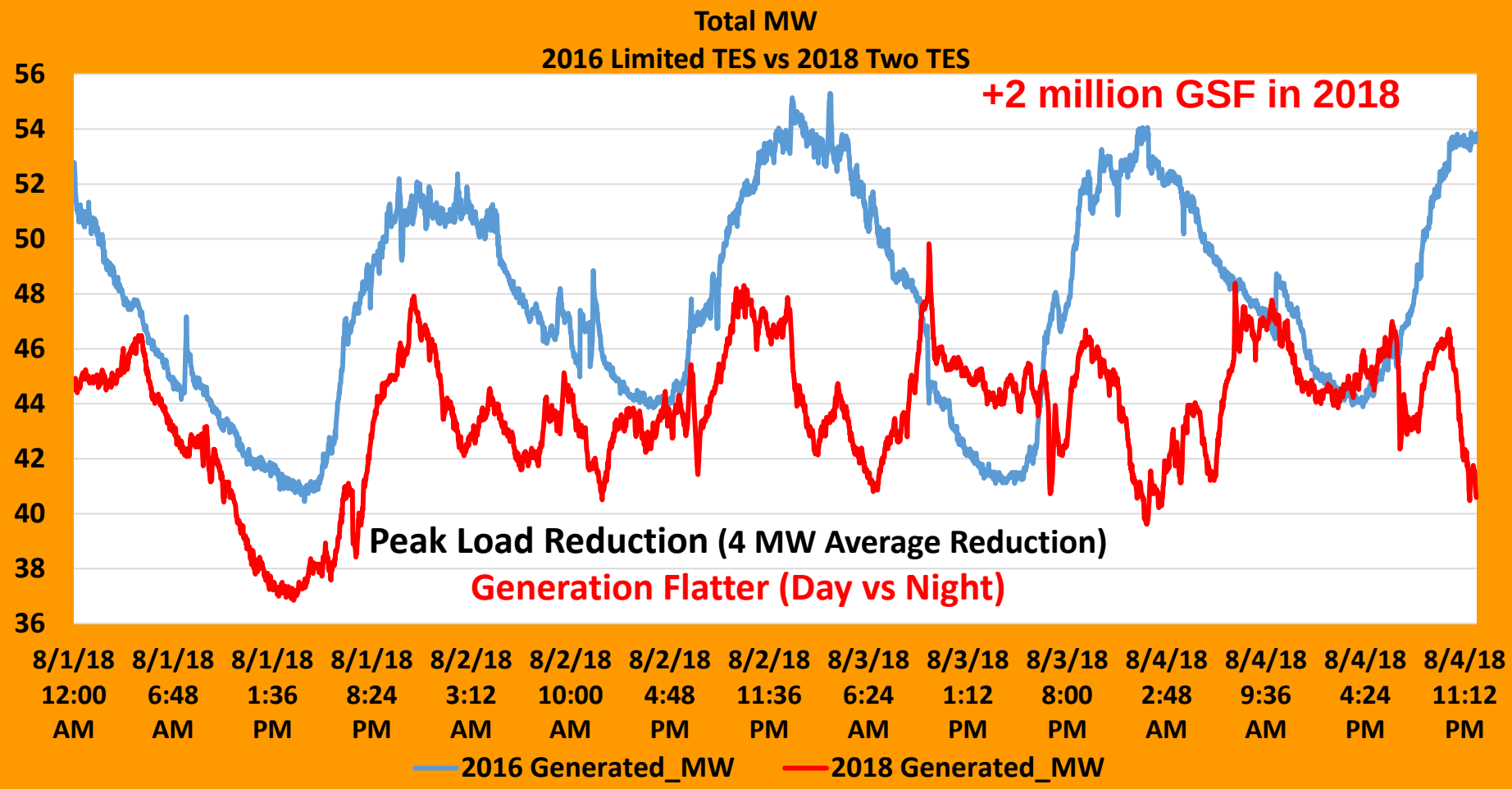
- Using Both TES for First Time (80,000 ton-hrs)
- Started TES & Chilling Station Optimization
  - Working through transitions:
    - Charging to Discharging & Vice Versa
    - Multiple Chilling Station Dispatch
  - Optimize Power Generation vs Chilled Water Production
    - Shift load to Nighttime – Increase Electrical Generation Efficiency (~3% Better)
- Peak Electrical Load and Cooling Load is August to September
  - Peak Power = 59 MW vs last year at 65 MW
  - Peak Cooling Demand = 34,118 vs last year at 38,300 (includes TES Dispatch)
  - **30,000 tons are Spare (CS3, CS4 & 5-2500 ton Chillers at CS7)**

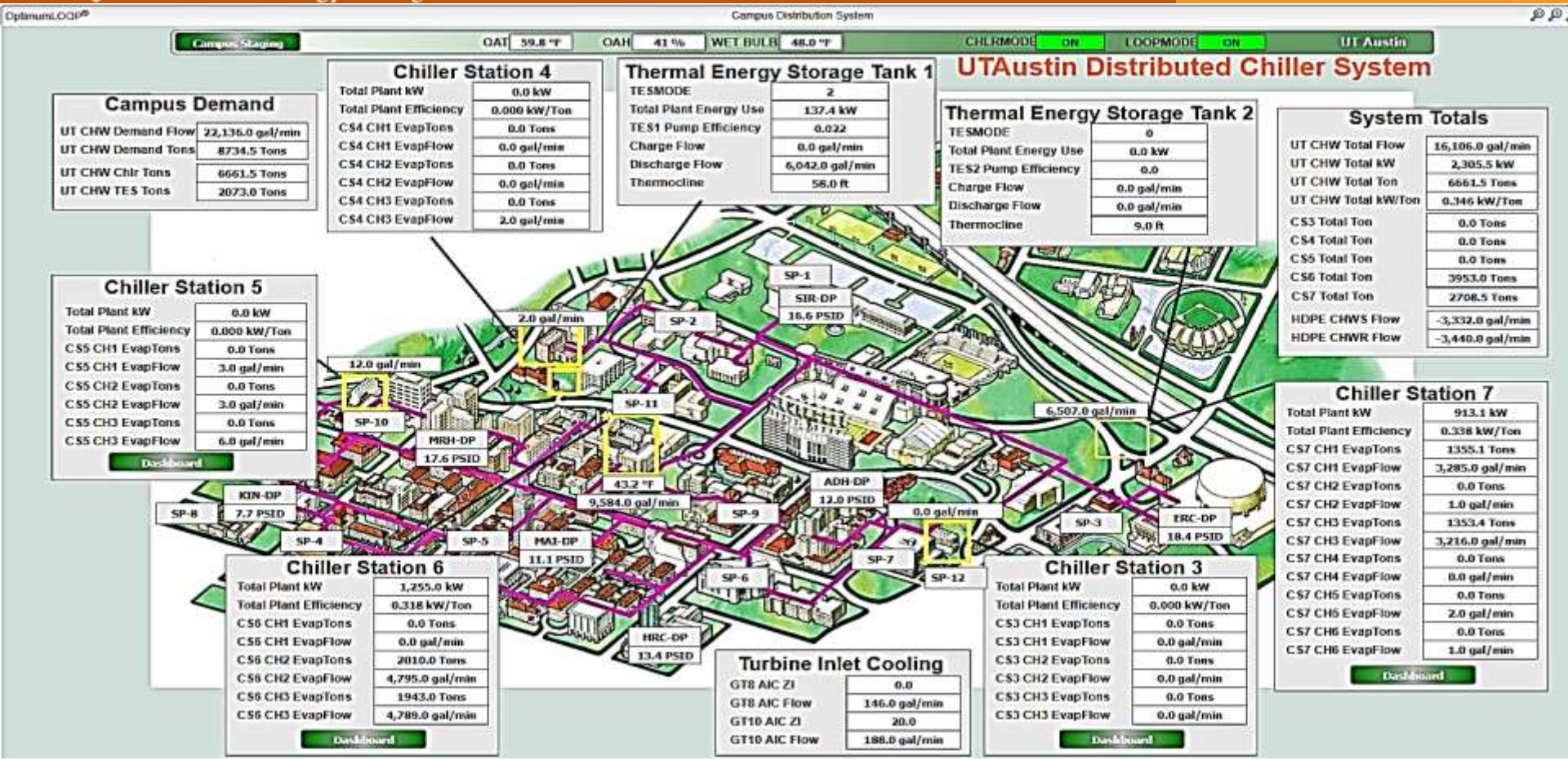
Goal is to Absorb Campus Growth With No New Plants

2017 vs 2019
First full use of both TES

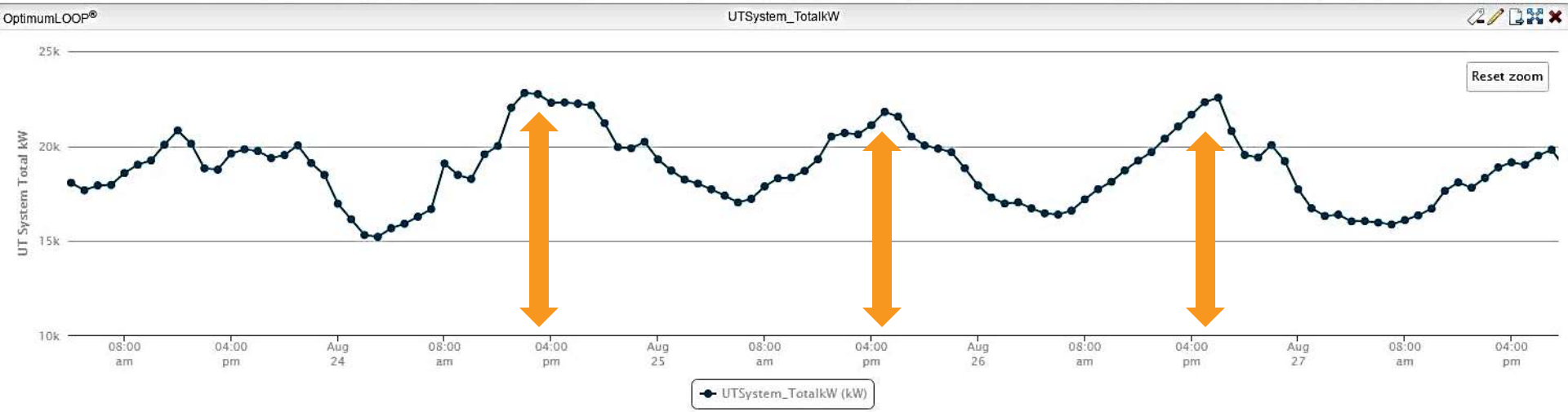


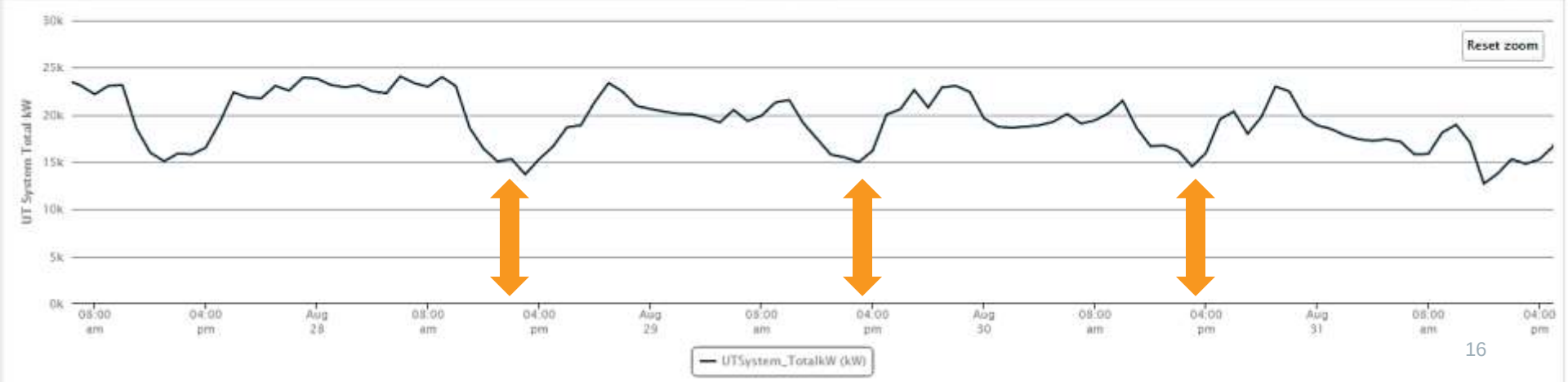
3 Month Average	2017	2018
kW/ton	0.614	0.533
kW for Cooling	8,874	8,340
Tons	12,905	13,599


Total MW
2016 Limited TES vs 2018 Two TES
+2 million GSF in 2018
Peak Load Reduction (4 MW Average Reduction)
Generation Flatter (Day vs Night)
56
54
52
50
48
46
44
42
40
38
36
8/1/18 12:00 AM
8/1/18 6:48 AM
8/1/18 1:36 PM
8/1/18 8:24 PM
8/2/18 3:12 AM
8/2/18 10:00 AM
8/2/18 4:48 PM
8/2/18 11:36 PM
8/3/18 6:24 AM
8/3/18 1:12 PM
8/3/18 8:00 PM
8/4/18 2:48 AM
8/4/18 9:36 AM
8/4/18 4:24 PM
8/4/18 11:12 PM
2016 Generated_MW
2018 Generated_MW


OptimumLOOP
Campus Distribution System
Campus Staging
OAT 59.8 °F
OAH 41 %
WET BULB 48.0 °F
CHLRMODE ON
LOOPMODE ON
UT Austin
UTAustin Distributed Chiller System
Campus Demand
UT CHW Demand Flow 22,136.0 gal/min
UT CHW Demand Tons 8734.5 Tons
UT CHW Chlr Tons 6661.5 Tons
UT CHW TES Tons 2073.0 Tons
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 2.0 gal/min
Thermal Energy Storage Tank 1
TESMODE 2
Total Plant Energy Use 137.4 kW
TES1 Pump Efficiency 0.022
Charge Flow 0.0 gal/min
Discharge Flow 6,042.0 gal/min
Thermocline 58.0 ft
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 9.0 ft
System Totals
UT CHW Total Flow 16,106.0 gal/min
UT CHW Total kW 2,305.5 kW
UT CHW Total Ton 6661.5 Tons
UT CHW Total kW/Ton 0.346 kW/Ton
CS3 Total Ton 0.0 Tons
CS4 Total Ton 0.0 Tons
CS5 Total Ton 0.0 Tons
CS6 Total Ton 3953.0 Tons
CS7 Total Ton 2708.5 Tons
HDPE CHWS Flow -3,332.0 gal/min
HDPE CHWR Flow -3,440.0 gal/min
Chiller Station 5
Total Plant kW 0.0 kW
Total Plant Efficiency 0.000 kW/Ton
CS5 CH1 EvapTons 0.0 Tons
CS5 CH1 EvapFlow 3.0 gal/min
CS5 CH2 EvapTons 0.0 Tons
CS5 CH2 EvapFlow 3.0 gal/min
CS5 CH3 EvapTons 0.0 Tons
CS5 CH3 EvapFlow 6.0 gal/min
Dashboard
SP-1
SIR-DP
16.6 PSID
2.0 gal/min
SP-2
12.0 gal/min
SP-10
MRH-DP
17.6 PSID
SP-11
43.2 °F
9,584.0 gal/min
6,507.0 gal/min
KIN-DP
7.7 PSID
SP-8
SP-4
SP-5
MAI-DP
11.1 PSID
SP-9
ADH-DP
12.0 PSID
0.0 gal/min
SP-3
ERC-DP
18.4 PSID
SP-7
SP-12
SP-6
HRC-DP
13.4 PSID
Chiller Station 7
Total Plant kW 913.1 kW
Total Plant Efficiency 0.338 kW/Ton
CS7 CH1 EvapTons 1355.1 Tons
CS7 CH1 EvapFlow 3,285.0 gal/min
CS7 CH2 EvapTons 0.0 Tons
CS7 CH2 EvapFlow 1.0 gal/min
CS7 CH3 EvapTons 1353.4 Tons
CS7 CH3 EvapFlow 3,216.0 gal/min
CS7 CH4 EvapTons 0.0 Tons
CS7 CH4 EvapFlow 8.0 gal/min
CS7 CH5 EvapTons 0.0 Tons
CS7 CH5 EvapFlow 2.0 gal/min
CS7 CH6 EvapTons 0.0 Tons
CS7 CH6 EvapFlow 1.0 gal/min
Dashboard
Chiller Station 6
Total Plant kW 1,255.0 kW
Total Plant Efficiency 0.318 kW/Ton
CS6 CH1 EvapTons 0.0 Tons
CS6 CH1 EvapFlow 0.0 gal/min
CS6 CH2 EvapTons 2010.0 Tons
CS6 CH2 EvapFlow 4,795.0 gal/min
CS6 CH3 EvapTons 1943.0 Tons
CS6 CH3 EvapFlow 4,789.0 gal/min
Dashboard
Turbine Inlet Cooling
GT8 AIC ZI 0.0
GT8 AIC Flow 146.0 gal/min
GT10 AIC ZI 20.0
GT10 AIC Flow 188.0 gal/min
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

Thermal Energy Storage (Total UT CHW Plant Electric kW)





Perform two regressions:

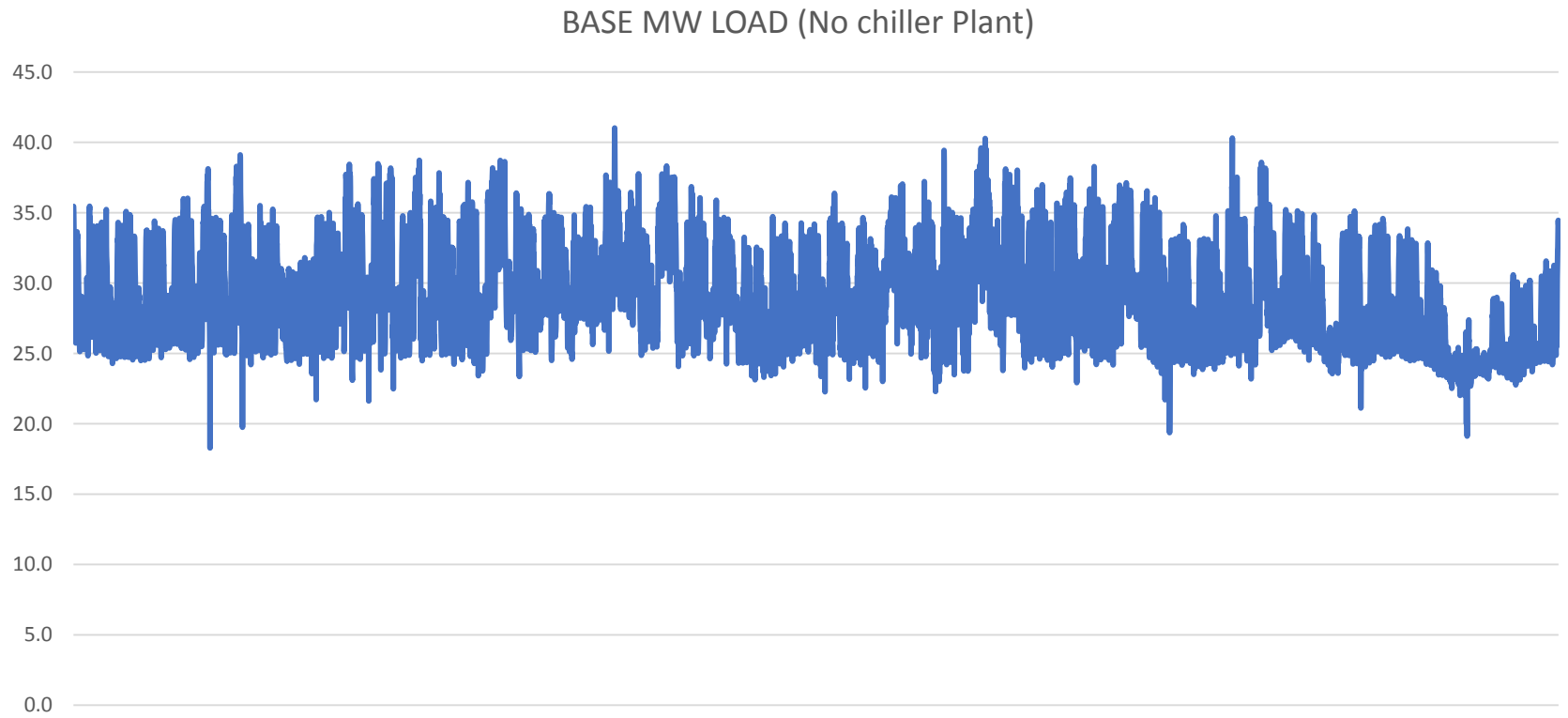
Campus Base MW Use

- More time of day and day of week driven
- Less weather driven

Chiller Plant MW Use

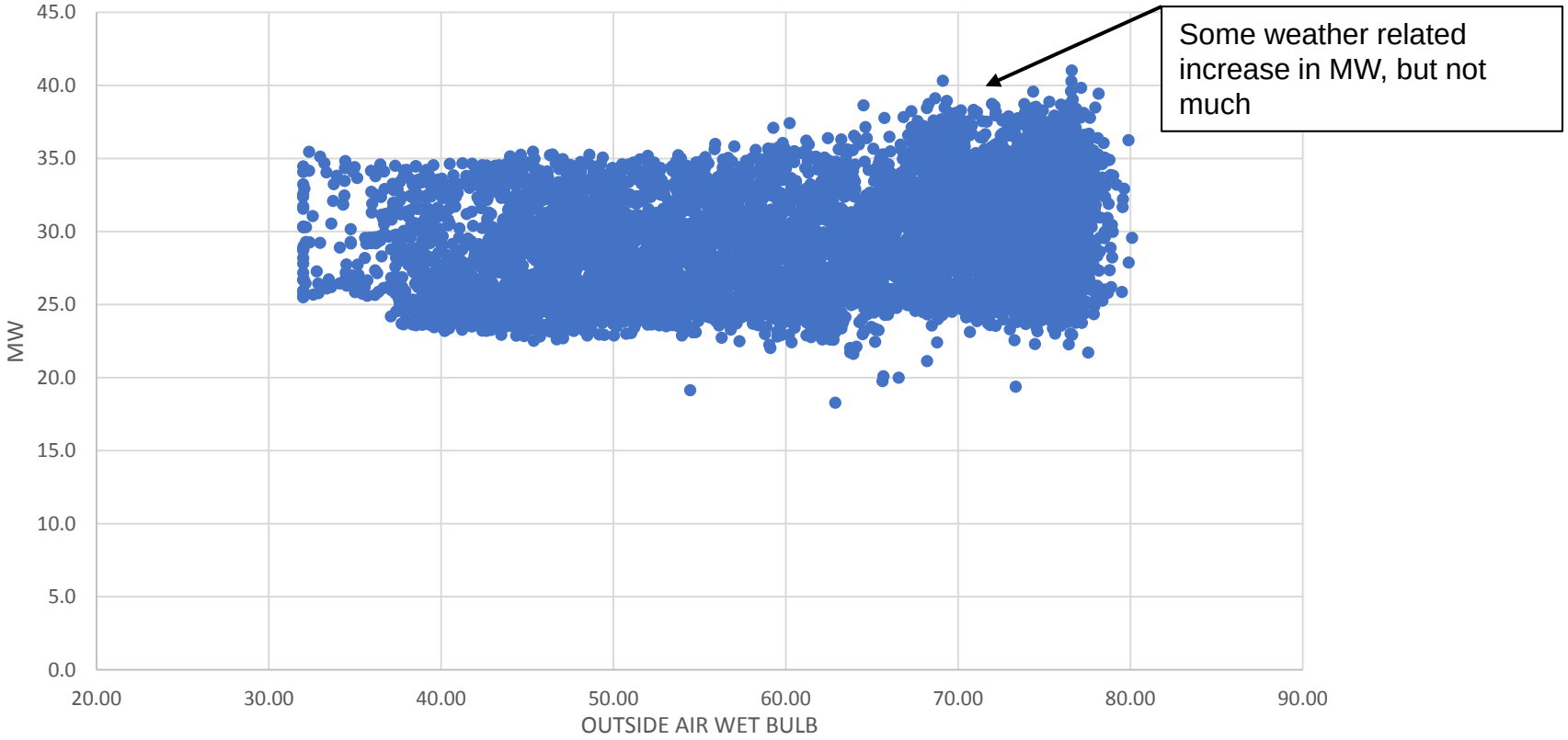
- Majority weather driven
- Less time of day and day of week driven

Sum together to get a total predicted MW value

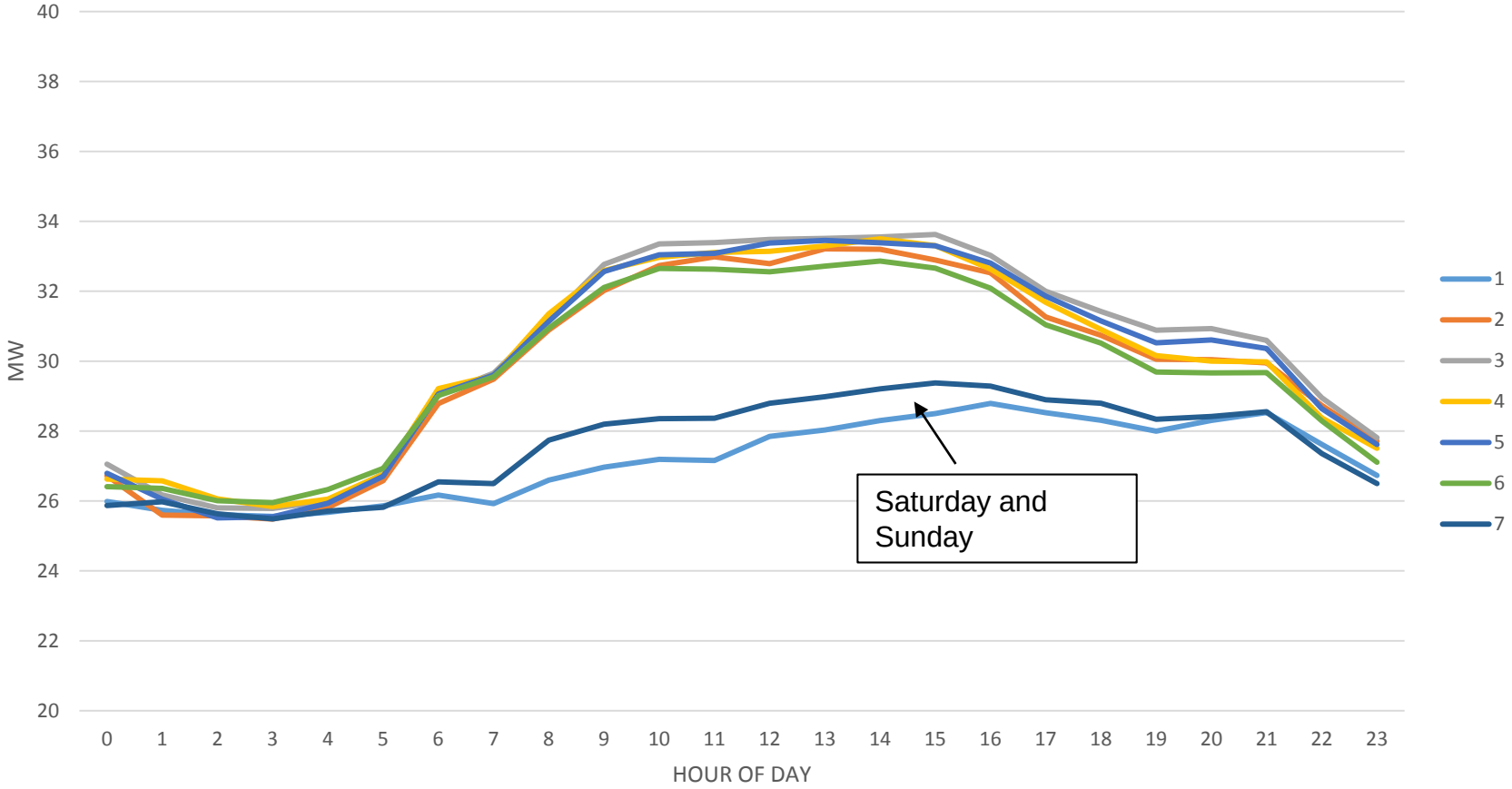


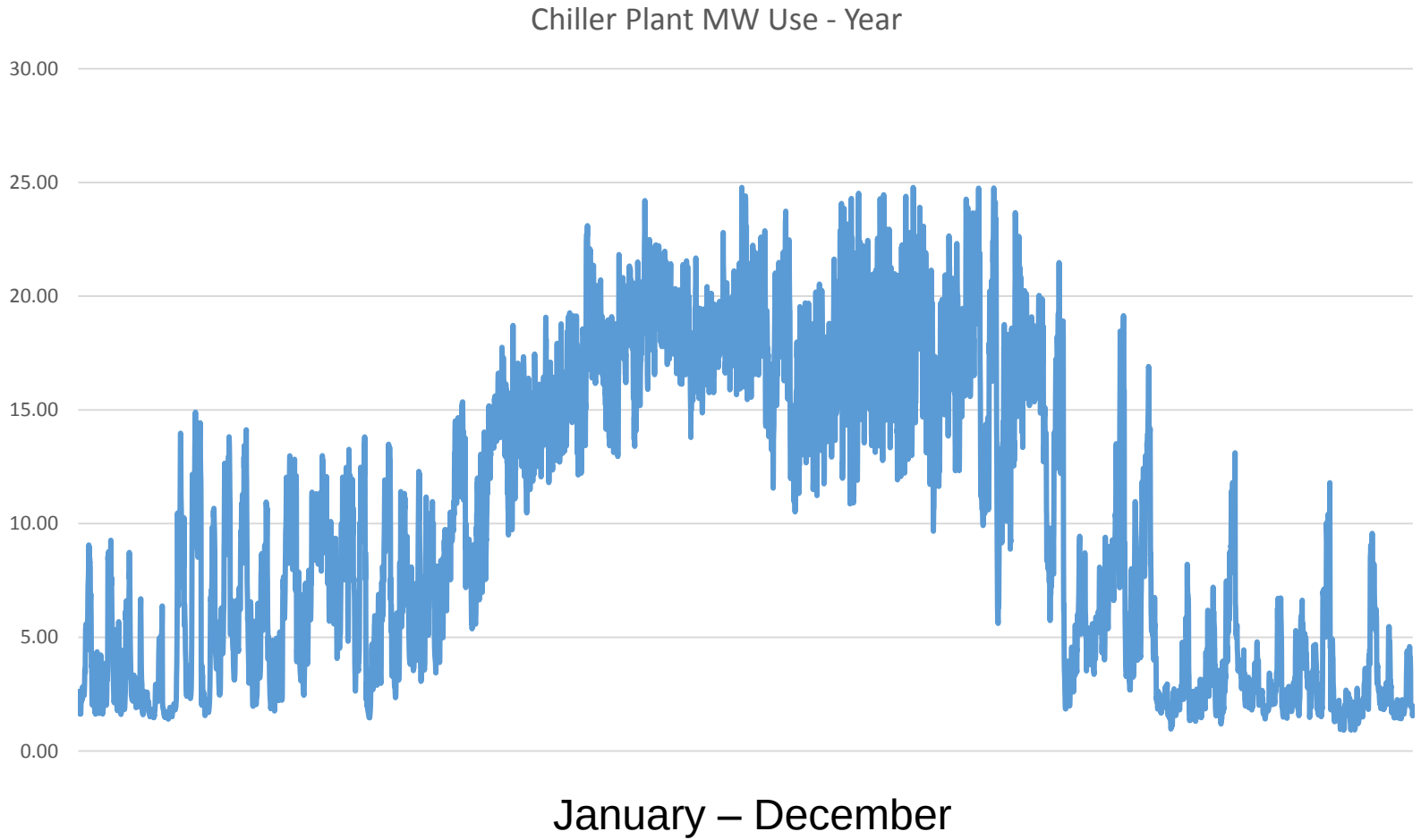
January – December

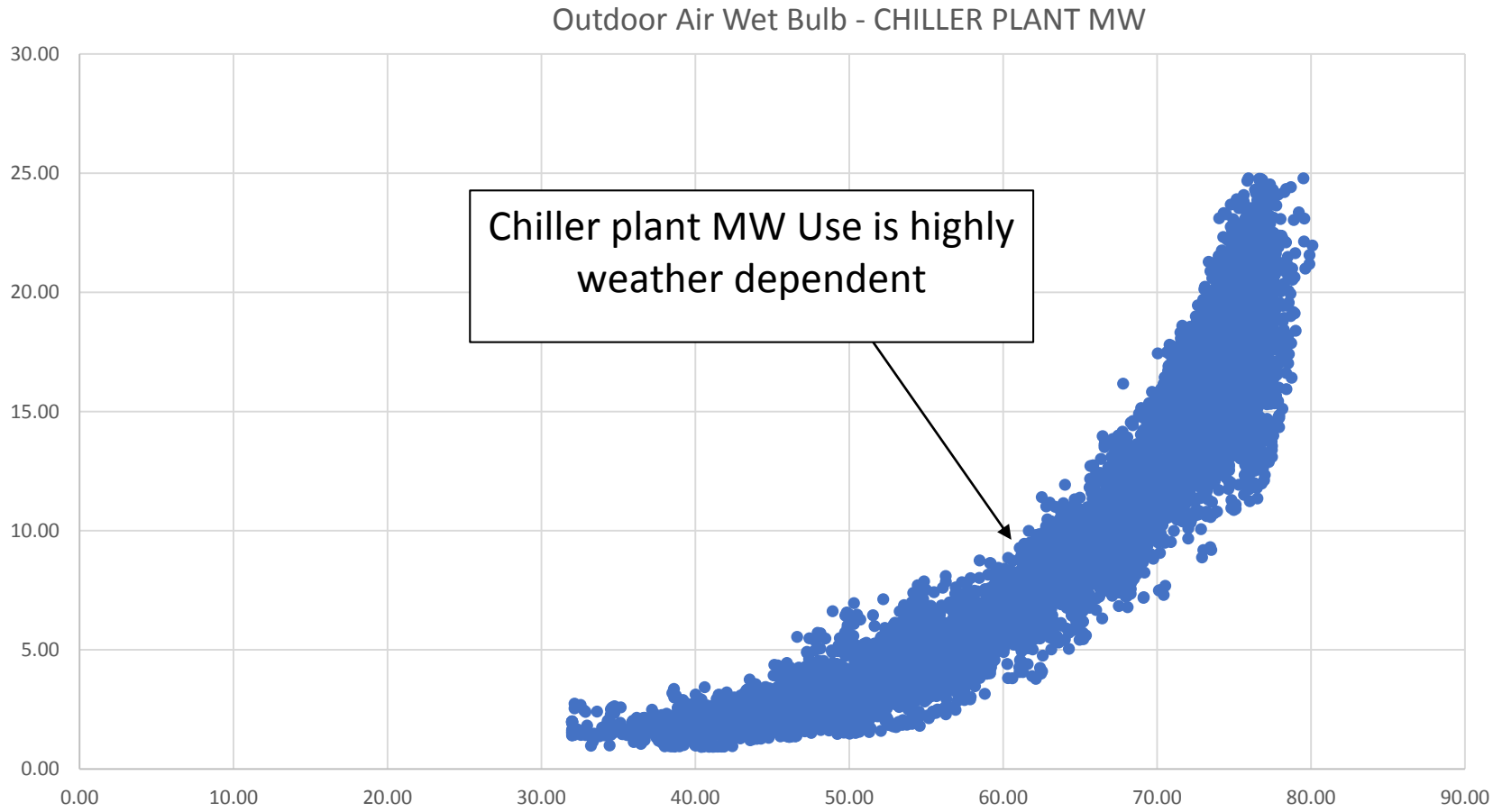
OAWB versus Base Campus MW (No Chiller Plant Load)

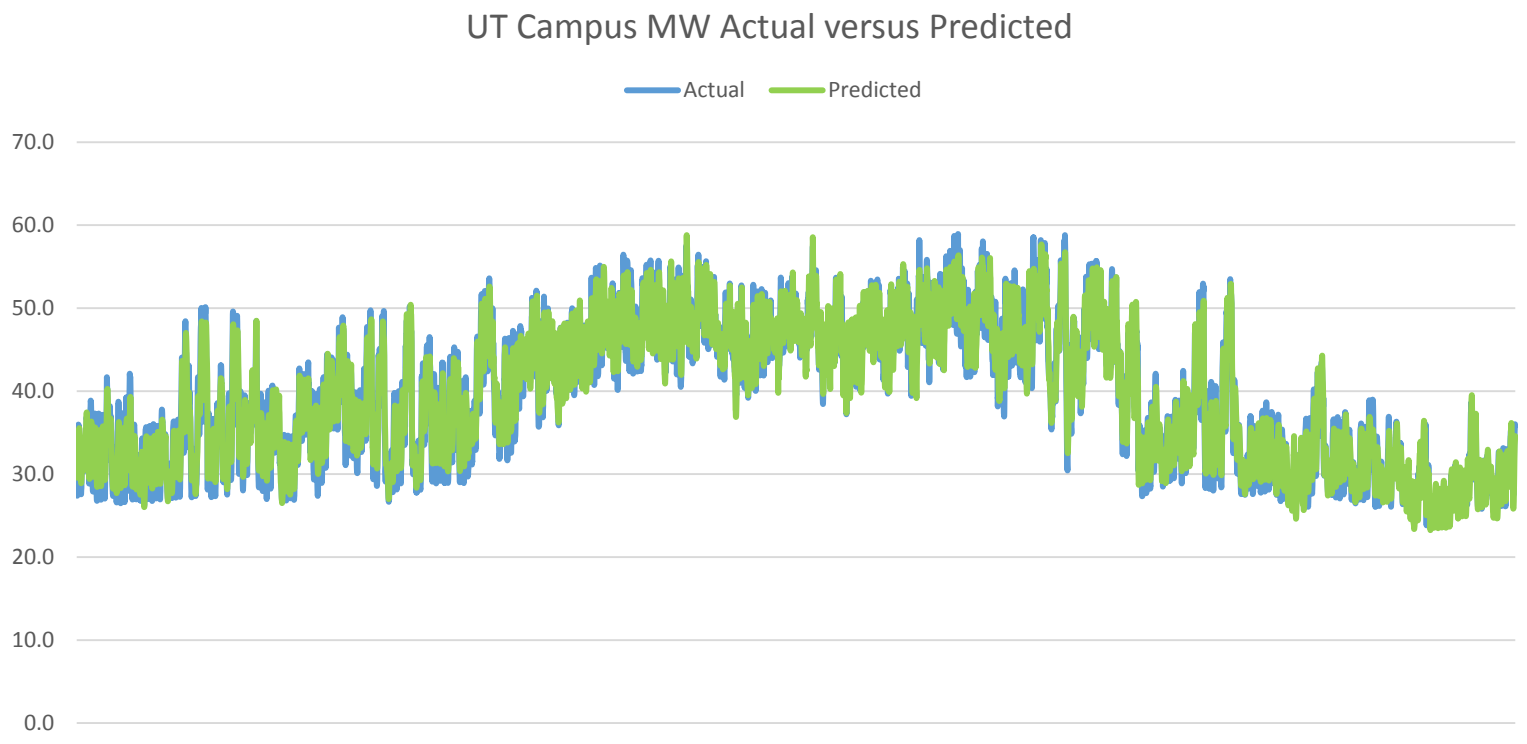


BASE MW LOAD – TIME AND DAY DEPENDENT




Chiller Plant MW Use - Year
30.00
25.00
20.00
15.00
10.00
5.00
0.00
January – December


Outdoor Air Wet Bulb - CHILLER PLANT MW
Chiller plant MW Use is highly weather dependent
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00


UT Campus MW Actual versus Predicted
Actual
Predicted
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
January – December

Optimized Dispatch of TES Systems

1. Accuweather offers 36 hrs of predicted Wet Bulb temperatures
2. We can forecast campus MW, Tons, number of chillers running, chiller add/shed events, TES discharge rates, TES charge rates, etc
3. From the data we can provide operators with a 36 hour look ahead for TES charging and discharging and chiller dispatch

Questions?

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