



AMCA International

Optimizing an Existing Air System for Performance and Energy Efficiency

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Air System Engineering & Technology (ASET) Conference-US

San Antonio, TX • Hyatt Regency San Antonio Riverwalk • March 6 - 7, 2018

Professional Development Hours (PDH) Certificates

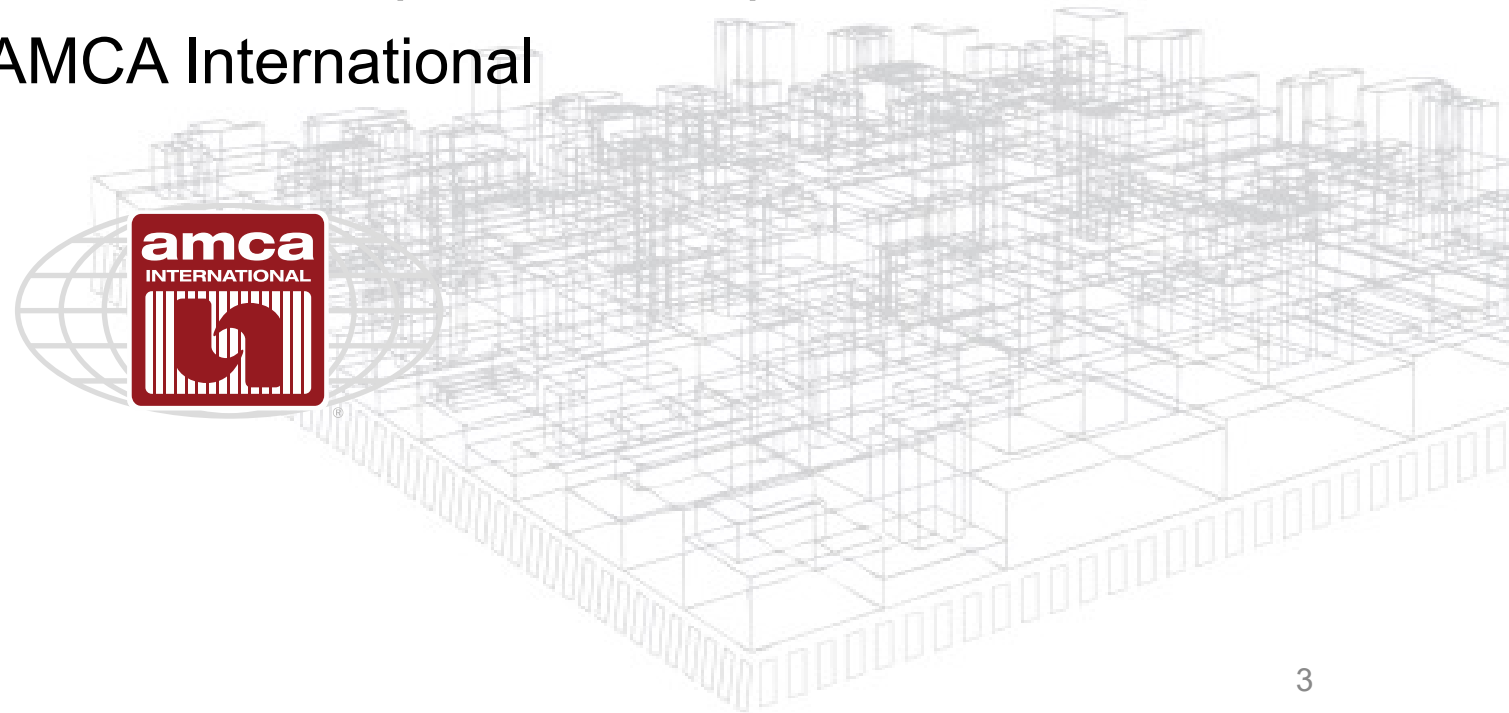
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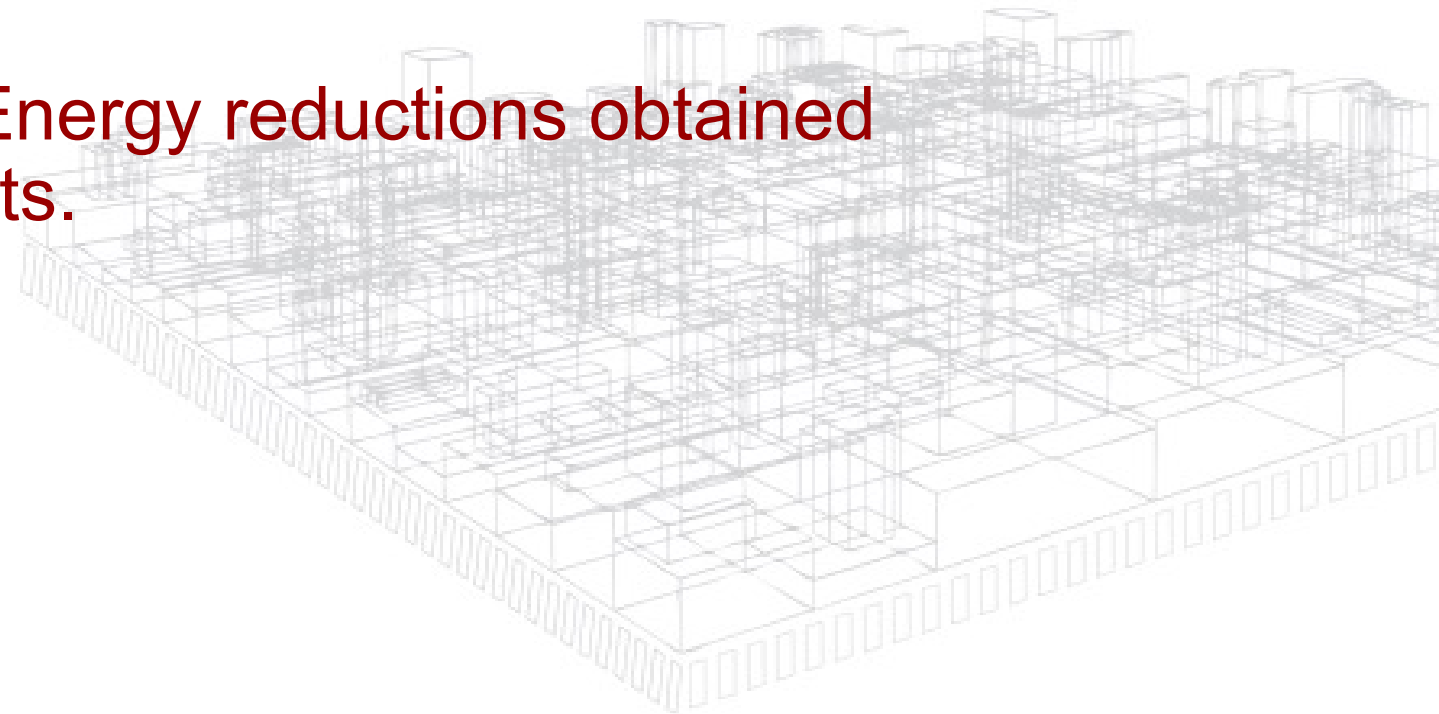
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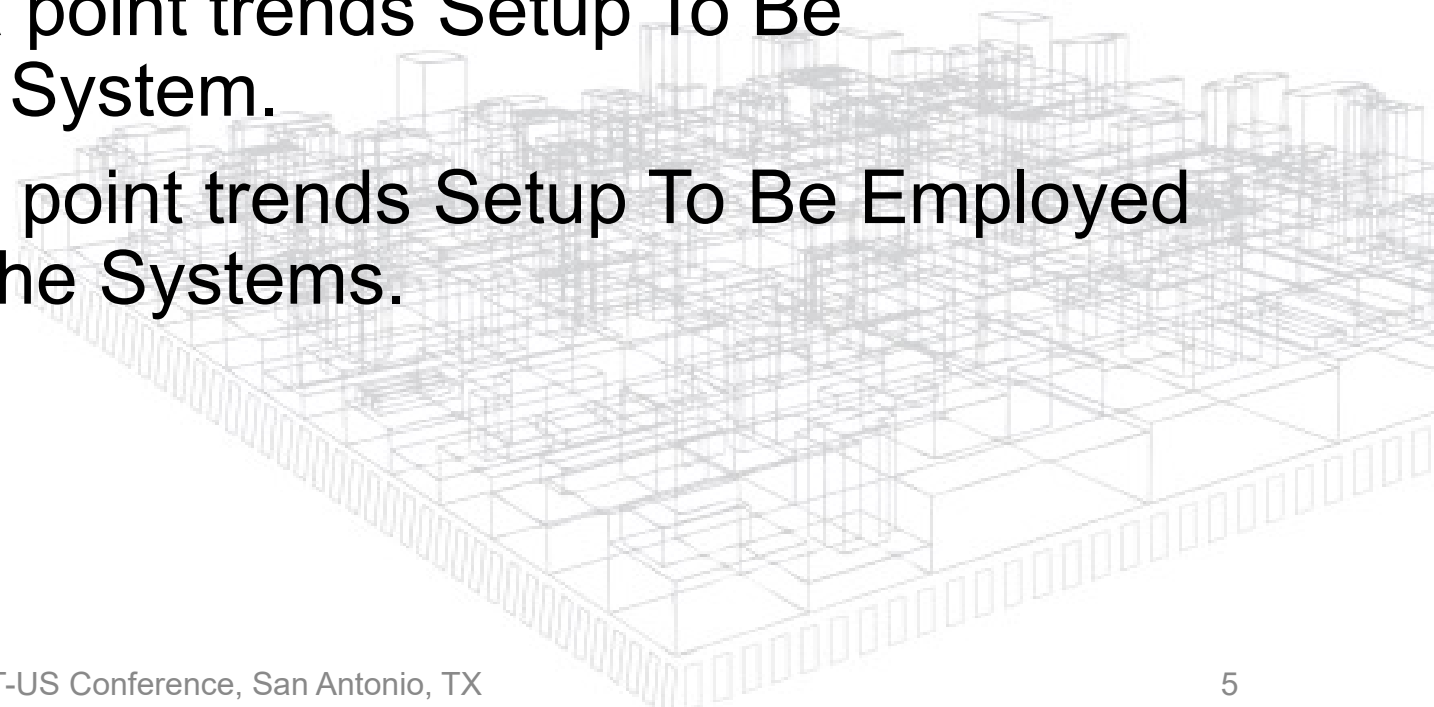
Learning Objectives

- What is Air Handling Unit Optimization?
- How to Optimize AHU systems and verify proper operation.
- How to document Energy reductions obtained during these projects.



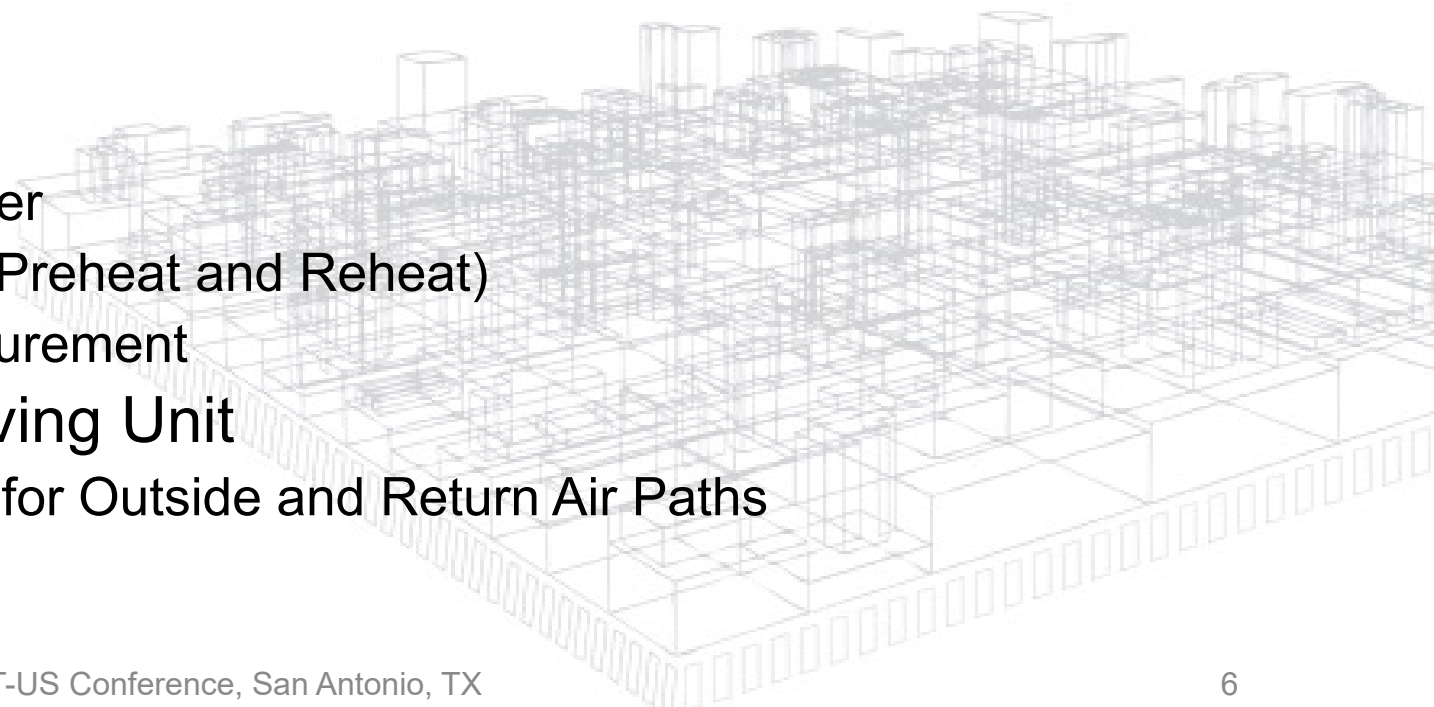
Definitions

- **Optimization** - Adjust And Control Each System To Consume The Least Energy Possible To Meet The Owner's Project Requirements (OPR) or Current Facility Requirements (CFR).
- **Long Term Trends** – Data point trends Setup To Be Permanently Active In The System.
- **Short Term Trends** - Data point trends Setup To Be Employed During The Validation Of The Systems.

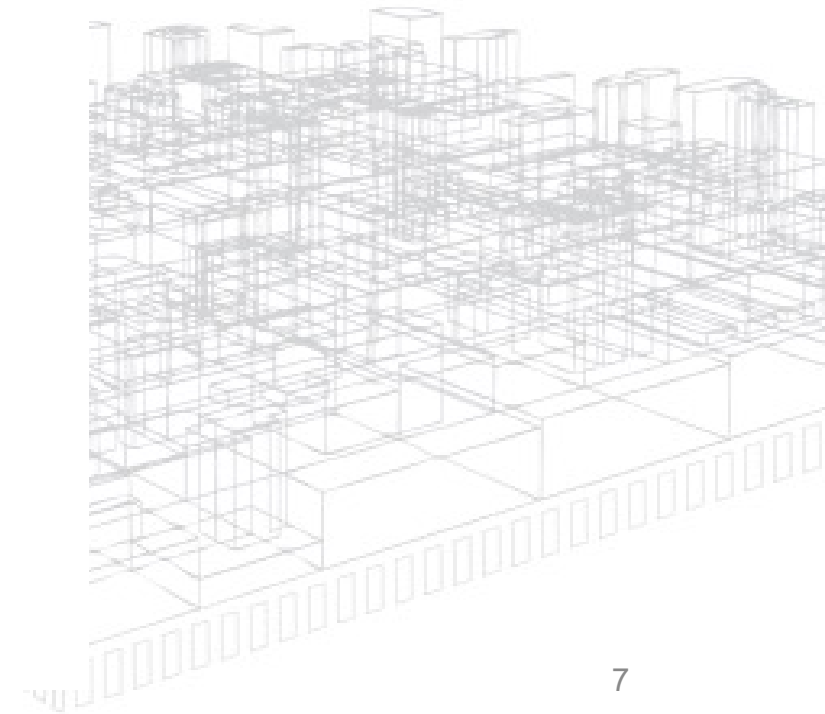


Establishing System Level Baselines

- Performance Elements
 - Electrical Energy Consumed
 - If Submetering Exists
 - BAS/Drive Info if incorporated
 - Independent Datalogging
 - Coil Energy
 - Entering/Leaving Chilled Water
 - Entering/Leaving Hot Water (Preheat and Reheat)
 - If Electric Heat Current Measurement
 - All Airstreams Entering/Leaving Unit
 - Sensible Temps Only Except for Outside and Return Air Paths



Establishing System Level Baselines

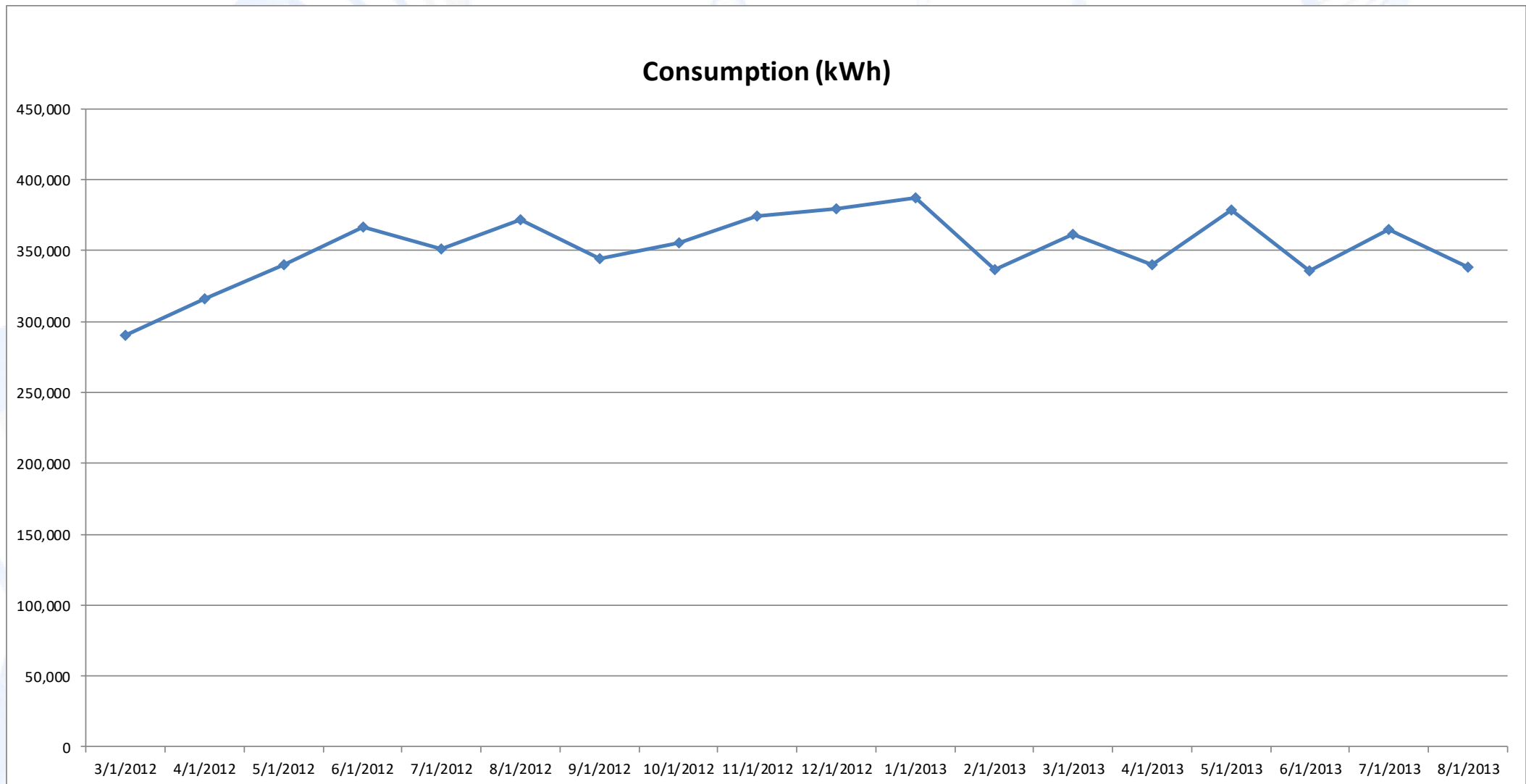


Establishing System Level Baselines

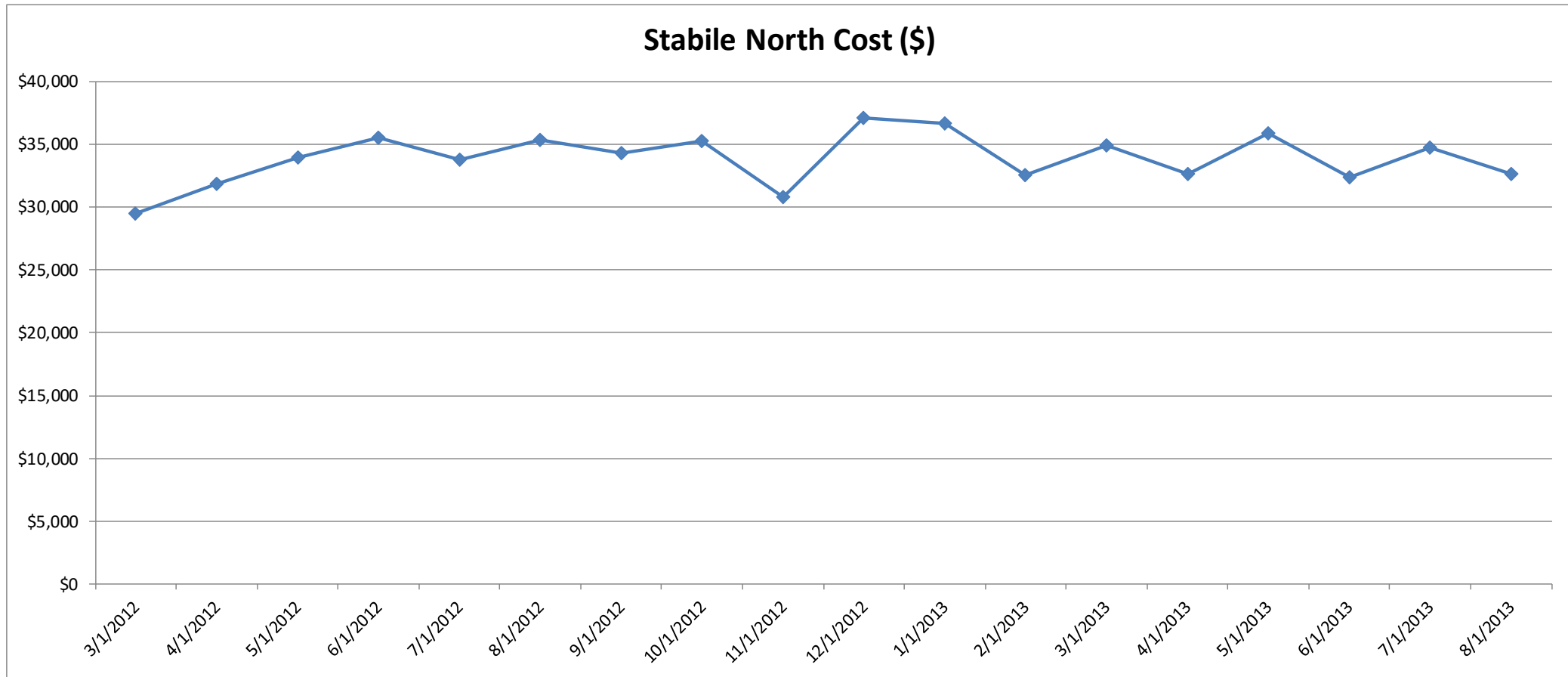


- Develop Current Facilities Requirements Document
 - Kickoff Meeting and Interviews With Key Stakeholders
 - Identify Today's the Facility Systems
 - Identify Areas Of Concern
 - Develop Logging Plan (Energy Consumption and Environmental Conditions)
 - Launch Loggers “Let'em Cook!!”
 - Obtain Historical Energy Data

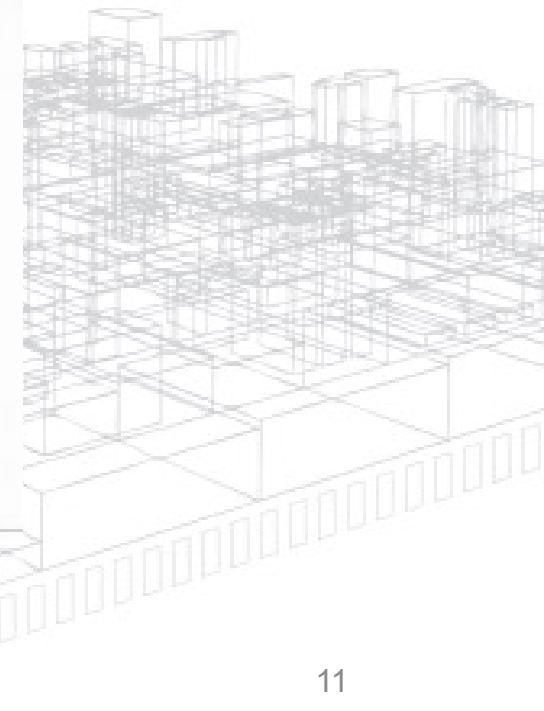
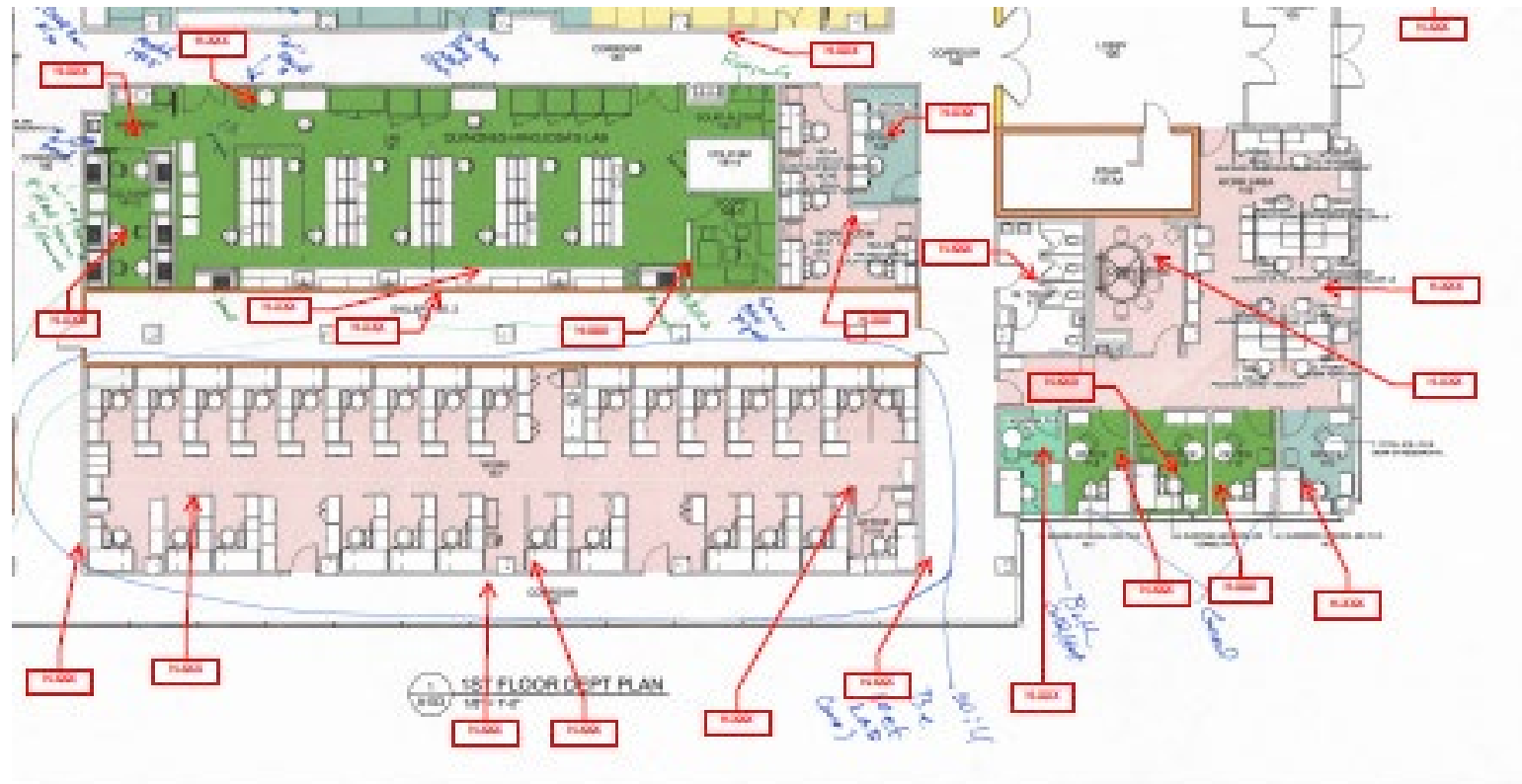
Establishing System Level Baselines



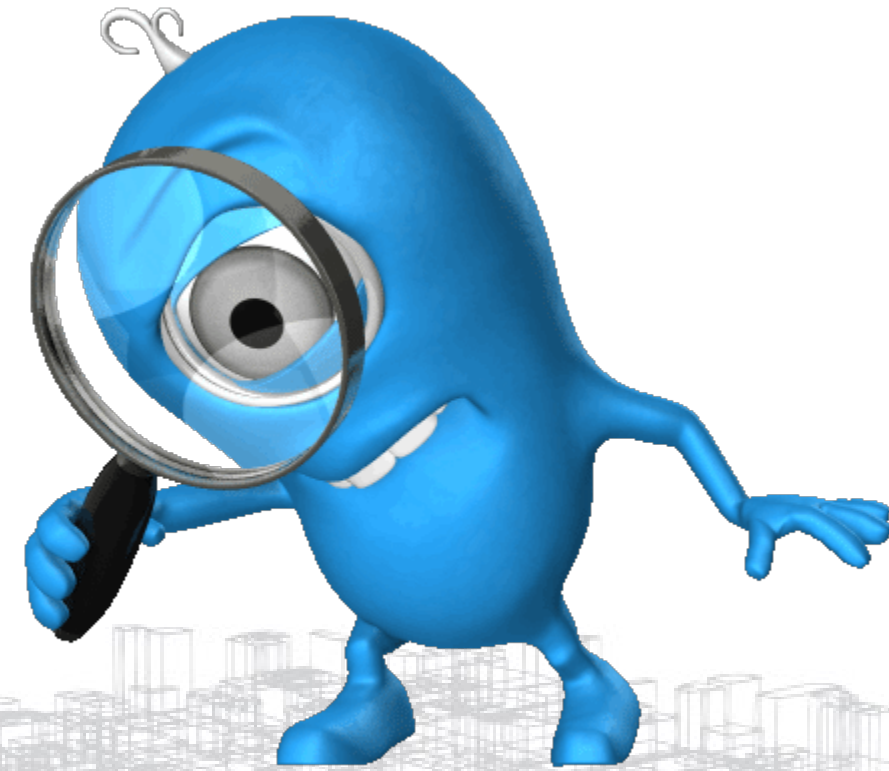
Establishing System Level Baselines



Establishing System Level Baselines



System As Found



Plot Title: AHU-1-5

#	Date	Time	Curr (Amps)	CHWS	CHWR	SA Temp	MA Temp	RA Temp
1	9/25/2012	11:00:00	22.857	46.391	61.761	50.709	72.523	70.072
2	9/25/2012	11:05:00	24.322	46.301	61.677	50.664	72.523	70.115
3	9/25/2012	11:10:00	23.297	46.301	61.72	50.664	72.437	70.072
4	9/25/2012	11:15:00	21.538	46.301	61.977	50.621	72.567	70.158
5	9/25/2012	11:20:00	26.081	46.301	61.977	50.621	72.567	70.243
6	9/25/2012	11:25:00	24.615	46.301	62.019	50.621	72.48	70.201
7	9/25/2012	11:30:00	24.322	46.301	61.977	50.621	72.48	70.158
8	9/25/2012	11:35:00	23.883	46.301	61.848	50.621	72.394	70.115
9	9/25/2012	11:40:00	24.615	46.301	61.633	50.621	72.48	70.158
10	9/25/2012	11:45:00	24.762	46.301	61.72	50.621	72.437	70.115
11	9/25/2012	11:50:00	23.443	46.301	61.677	50.621	72.394	70.029
12	9/25/2012	11:55:00	24.615	46.256	61.677	50.576	72.394	70.029
13	9/25/2012	12:00:00	24.176	46.211	61.891	50.576	72.351	69.901
14	9/25/2012	12:05:00	24.615	46.211	61.934	50.576	72.437	69.901
15	9/25/2012	12:10:00	25.055	46.256	62.148	50.621	72.394	69.901
16	9/25/2012	12:15:00	24.176	46.256	62.019	50.621	72.351	69.901
17	9/25/2012	12:20:00	24.469	46.301	62.019	50.621	72.48	69.901
18	9/25/2012	12:25:00	24.322	46.301	61.934	50.621	72.264	69.858
19	9/25/2012	12:30:00	24.322	46.211	61.891	50.533	72.264	69.814
20	9/25/2012	12:35:00	23.443	46.211	61.59	50.533	72.221	69.771
21	9/25/2012	12:40:00	24.322	46.211	61.761	50.533	72.264	69.858
22	9/25/2012	12:45:00	24.322	46.211	61.804	50.533	72.264	69.942
23	9/25/2012	12:50:00	24.615	46.166	61.848	50.488	72.221	69.942
24	9/25/2012	12:55:00	25.348	46.166	61.848	50.488	72.307	69.985
25	9/25/2012	13:00:00	24.762	46.166	61.804	50.488	72.221	70.029
26	9/25/2012	13:05:00	24.176	46.211	62.105	50.533	72.221	70.029
27	9/25/2012	13:10:00	24.322	46.166	61.633	50.533	72.136	69.985
28	9/25/2012	13:15:00	23.443	46.211	61.891	50.533	72.093	69.901
29	9/25/2012	13:20:00	24.469	46.166	61.891	50.533	72.136	69.985
30	9/25/2012	13:25:00	24.908	46.166	61.72	50.488	72.136	70.072
31	9/25/2012	13:30:00	23.736	46.166	61.633	50.488	72.178	70.115
32	9/25/2012	13:35:00	26.52	46.121	61.891	50.445	72.093	70.072
33	9/25/2012	13:40:00	24.322	46.076	61.891	50.445	71.964	69.901
34	9/25/2012	13:45:00	24.176	46.121	61.848	50.445	71.92	69.901
35	9/25/2012	13:50:00	24.469	46.121	61.891	50.488	71.964	69.942
36	9/25/2012	13:55:00	24.322	46.121	61.934	50.488	71.92	69.942
37	9/25/2012	14:00:00	23.883	46.166	61.934	50.488	71.964	69.901
38	9/25/2012	14:05:00	26.081	46.121	61.934	50.488	71.791	69.771
39	9/25/2012	14:10:00	25.348	46.076	61.72	50.4	71.791	69.771
40	9/25/2012	14:15:00	24.762	46.121	61.506	50.4	71.748	69.771
41	9/25/2012	14:20:00	25.055	46.076	61.934	50.4	71.791	69.814
42	9/25/2012	14:25:00	25.055	46.076	61.848	50.4	71.92	70.029

Data Analysis

AHU Energy Consumption MASTER - Excel

File Home Insert Page Layout Formulas Data Review View Help BLUEBEAM Acrobat Tell me what you want to do

Clipboard Font Alignment Number Styles

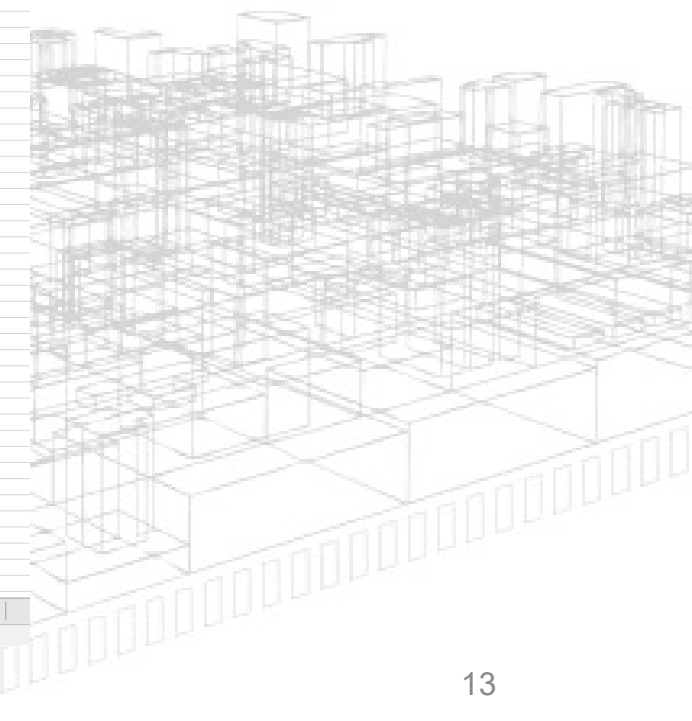
AutoSave

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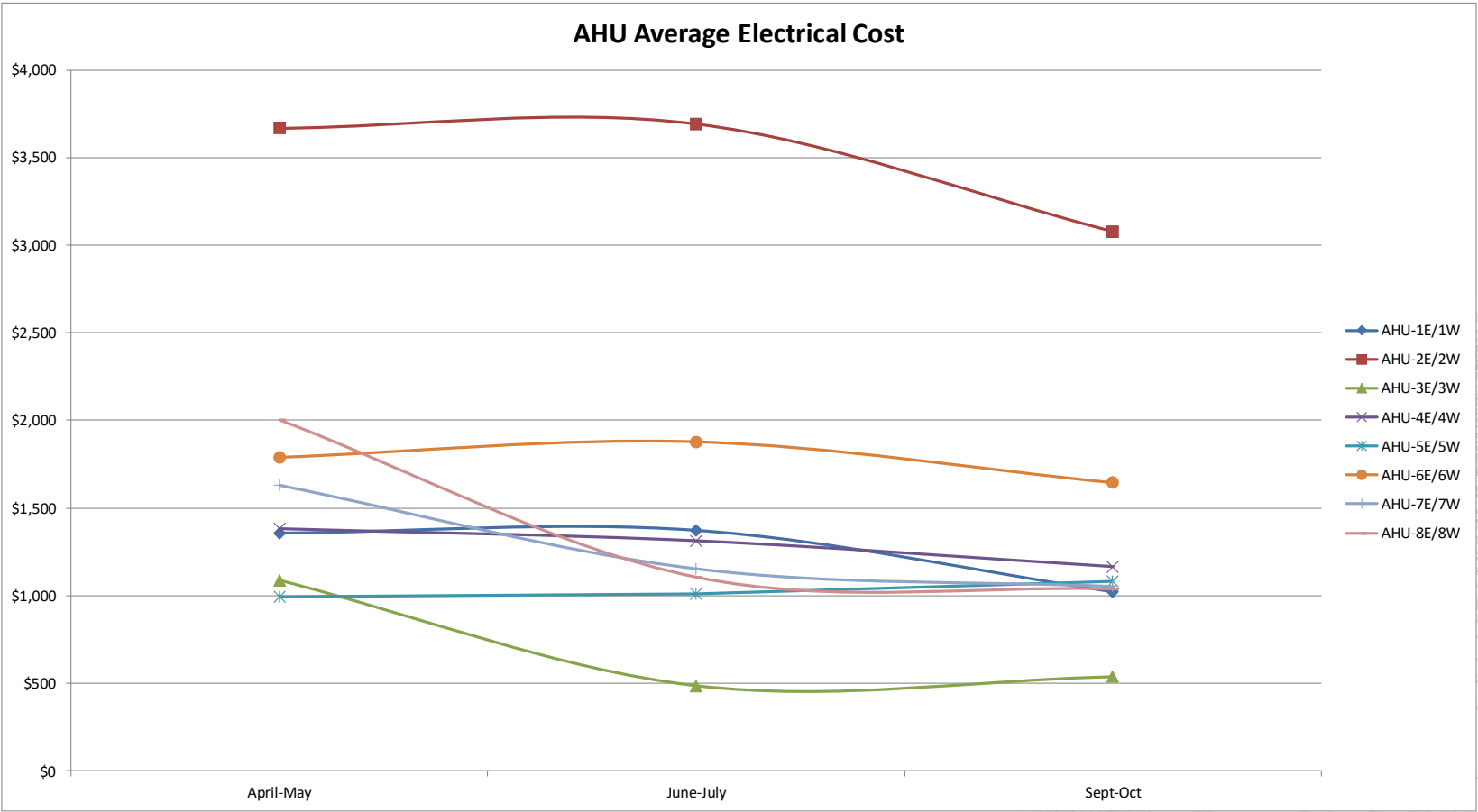
#	Date Time, GMT-04:00	AC Curr, Amps	Temp, °F	Temp, °F	Temp, °F														
Plot Title: SN AHU-1E						CALCULATED MONTHLY TOTALS				AHU ENERGY COST									
1	9/13/2013 0:00	0.098	73.256	59.83	60.647	Fan Power =	1,152	kWh	Electrical cost/month =	\$115									
2	9/13/2013 0:05	0.134	73.256	59.788	60.647	Cooling =	13,087	ton-hours	CHW cost/month =	\$942									
3	9/13/2013 0:10	0.208	73.256	59.788	60.69	Heating =	613	therm-hours	HHW cost/month =	\$398									
4	9/13/2013 0:15	0.183	73.342	59.873	60.733					Cost/month =	\$1,456								
5	9/13/2013 0:20	0.171	73.213	59.873	60.69	INPUT VALUES													
6	9/13/2013 0:25	0.085	73.213	59.873	60.775	Design Airflow	15,431	CFM	9/13/2013 0:00	START									
7	9/13/2013 0:30	0.171	73.256	59.916	60.818	Voltage	460	V	10/20/2013 16:20	END									
8	9/13/2013 0:35	0.134	73.213	59.916	60.861	Fan Power	16.66	HP	37.7	DAYS									
9	9/13/2013 0:40	0.147	73.17	59.959	60.818	Electric Cost	\$0.10	kWh	904.3	HOURS									
10	9/13/2013 0:45	0.11	73.126	59.959	60.861	Chilled Water Cost	\$0.07	ton-hour	54,260	MINUTES									
11	9/13/2013 0:50	0.159	73.083	59.959	60.904	Hot Water Cost	\$0.65	therm-hour	10,852	5-MINUTE BLOCKS									
12	9/13/2013 0:55	0.147	73.083	60.003	60.948	Mixed Air WB	63.0	°F	500	ELEVATION (FT)									
13	9/13/2013 1:00	0.147	73.083	60.003	60.948	Supply Air WB	53.6	°F	8.1	Avg. Reheat delta-T (°F)									
14	9/13/2013 1:05	0.147	73.17	60.003	60.904	SUM TOTALS OF 5-MINUTE INTERVALS													
15	9/13/2013 1:10	0.098	73.256	60.003	60.948	AC Curr, Amps	21,785		Return Air, °F	788,036	Mixed Air, °F	662,329	Supply Air, °F	1,083,008					
16	9/13/2013 1:15	0.183	73.126	60.046	60.904	AVERAGES													
17	9/13/2013 1:20	0.183	73.213	60.003	60.948	AC Curr, Amps	2.0	kW	BHP	2.1									
18	9/13/2013 1:25	0.134	73.17	60.046	60.948	Return Air, °F	72.6	Mixed Air, °F	71.7	Supply Air, °F	55.6	Delta-T, °F	16.1						
19	9/13/2013 1:30	0.134	73.213	60.003	61.032	Mixed Air, grains	74.0	Supply Air, grains	55.6										
20	9/13/2013 1:35	0.11	73.126	60.046	61.032	MA Enthalpy, Btu/lb	28.8	SA Enthalpy, Btu/lb	22.5	Delta-h, Btu/lb	16.1								
21	9/13/2013 1:40	0.147	73.126	60.003	60.991	Airflow, CFM	7,792	Tons, Cooling	18.2	Therms, Reheat	0.7								
22	9/13/2013 1:45	0.134	73.083	60.046	61.032														
23	9/13/2013 1:50	0.171	73.04	60.046	60.991														
24	9/13/2013 1:55	0.159	73.083	60.046	61.032														
25	9/13/2013 2:00	0.122	73.083	60.046	61.032														
26	9/13/2013 2:05	0.147	72.997	60.046	61.032														
27	9/13/2013 2:10	0.134	72.955	60.089	61.032														
28	9/13/2013 2:15	0.183	73.04	60.046	61.075														
29	9/13/2013 2:20	0.073	73.04	60.046	61.032														
30	9/13/2013 2:25	0.147	72.955	60.046	61.075														
31	9/13/2013 2:30	0.134	72.997	60.046	61.075														
32	9/13/2013 2:35	0.11	72.997	60.046	61.075														
33	9/13/2013 2:40	0.122	72.997	60.046	61.119														
34	9/13/2013 2:45	0.134	72.997	60.046	61.075														
35	9/13/2013 2:50	0.134	72.997	60.003	61.119														
36	9/13/2013 2:55	0.122	72.997	60.046	61.119														
37	9/13/2013 3:00	0.098	72.955	60.046	61.119														
38	9/13/2013 3:05	0.085	72.869	60.089	61.075														
39	9/13/2013 3:10	0.134	72.912	60.089	61.119														
40	9/13/2013 3:15	0.134	72.912	60.046	61.119														
41	9/13/2013 3:20	0.122	72.869	60.089	61.075														
42	9/13/2013 3:25	0.134	72.997	60.046	61.119														

SUMMARY AHU-1E AHU-1W AHU-2E AHU-2W AHU-3E AHU-3W AHU-4E AHU-4W AHU-5E AHU-5W AHU-6E AHU-6W AHU-7E AHU-7W AHU-8E AHU-8W

Ready Calculate

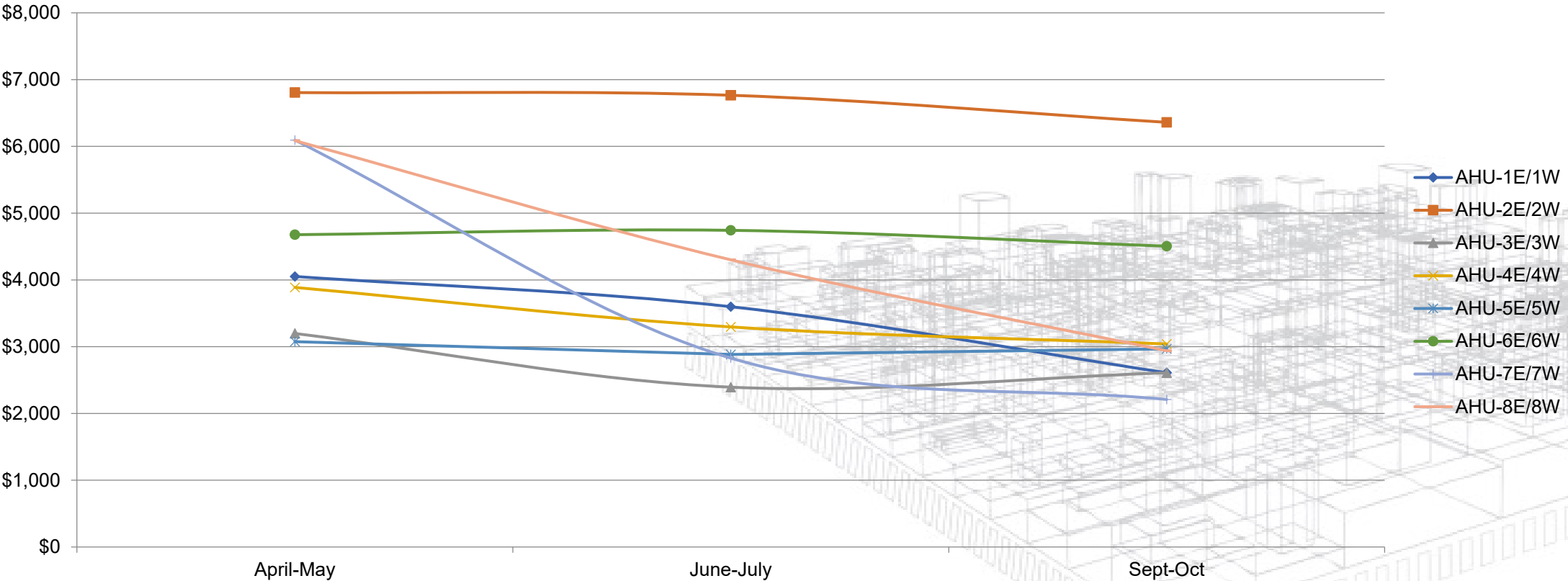


Verifying Results



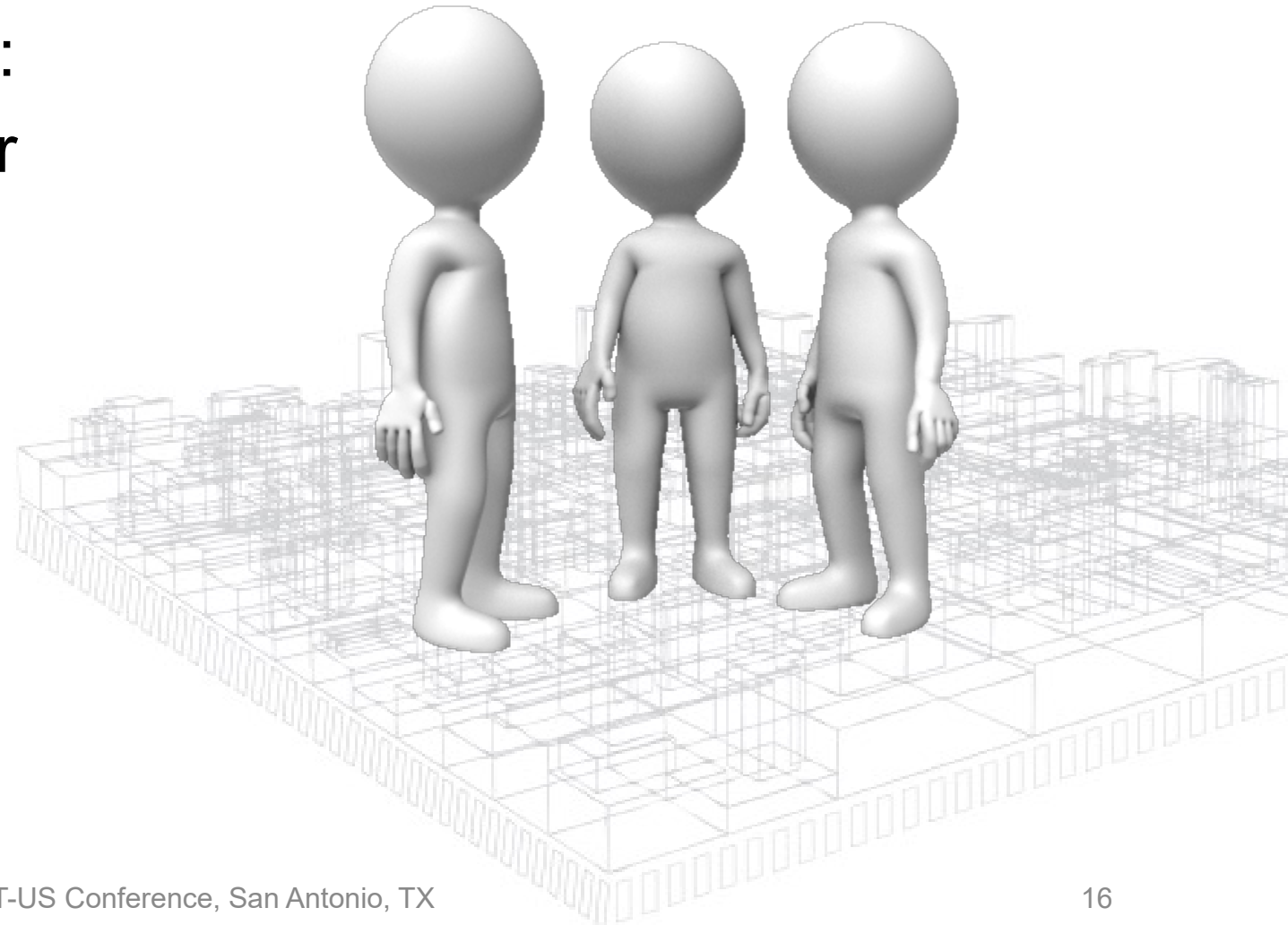
Verifying Results

AHU Average CHW Cost



Verifying Results

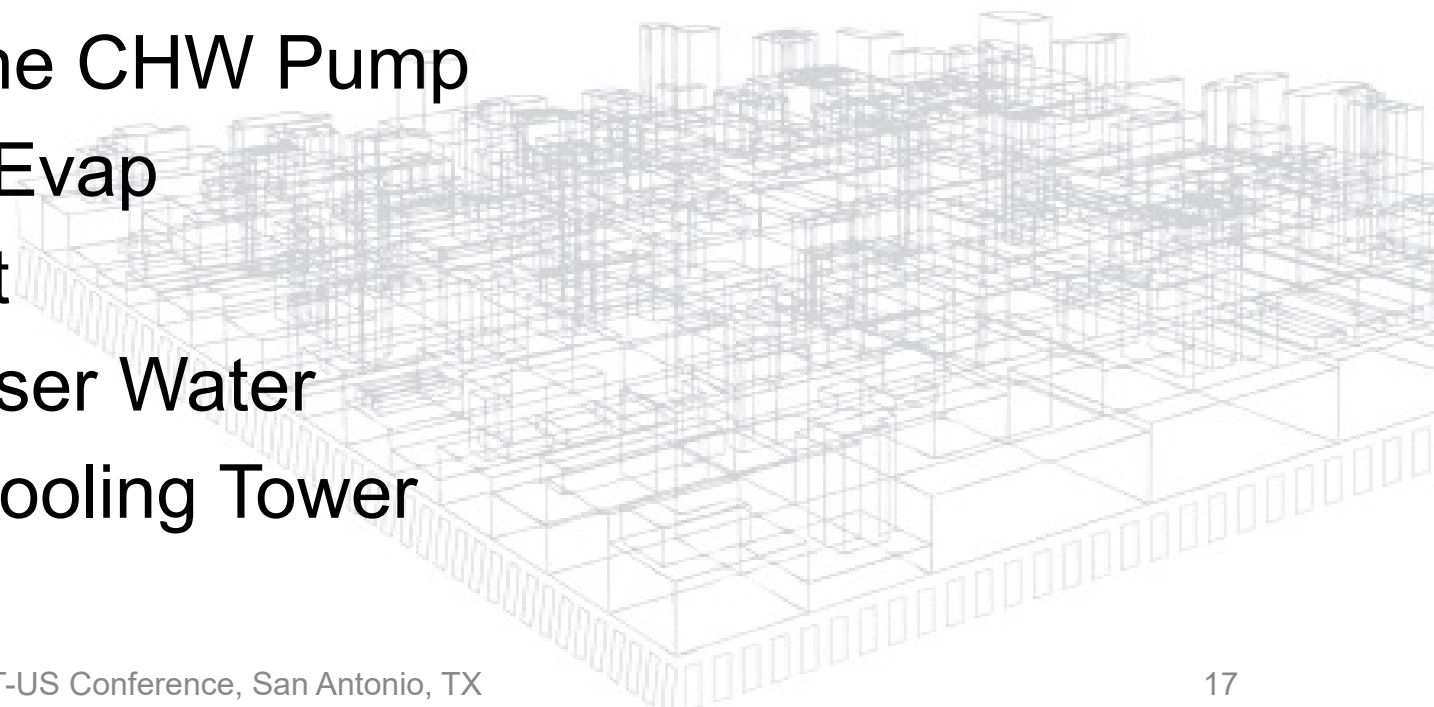
- Estimated Energy Savings:
 - ~ \$11,750 Per Month, or
 - ~ \$141,000 Per Year



Heat Transfer

“From The Beginning To The End”

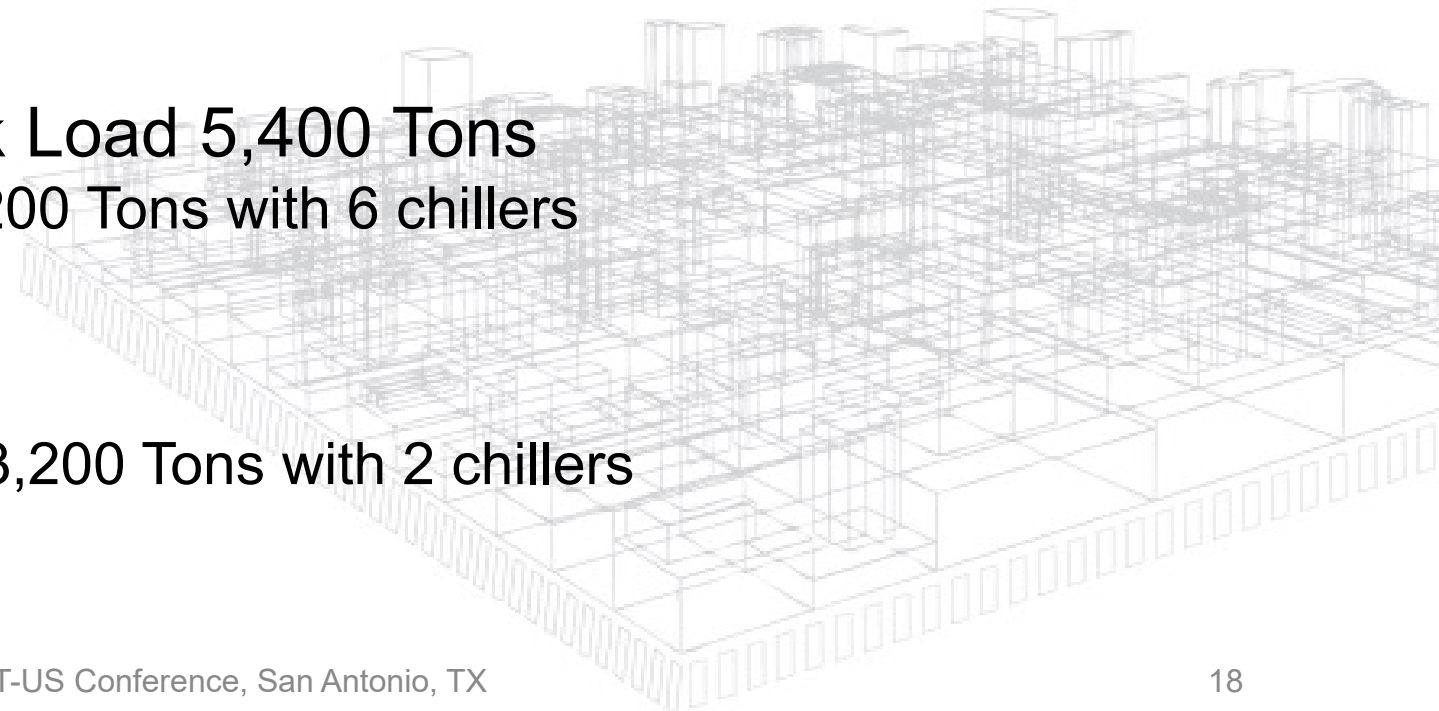
- VAV Terminal Unit To The AHU AHU To The Central Plant
- Room Air To Cooling Coil
- Cooling Coil To Chilled Water Return
- Chilled Water Return To The CHW Pump
- CHW Pump To the Chiller Evap
- Chiller Evap To Refrigerant
- Refrigerant To the Condenser Water
- Condenser Water To the Cooling Tower



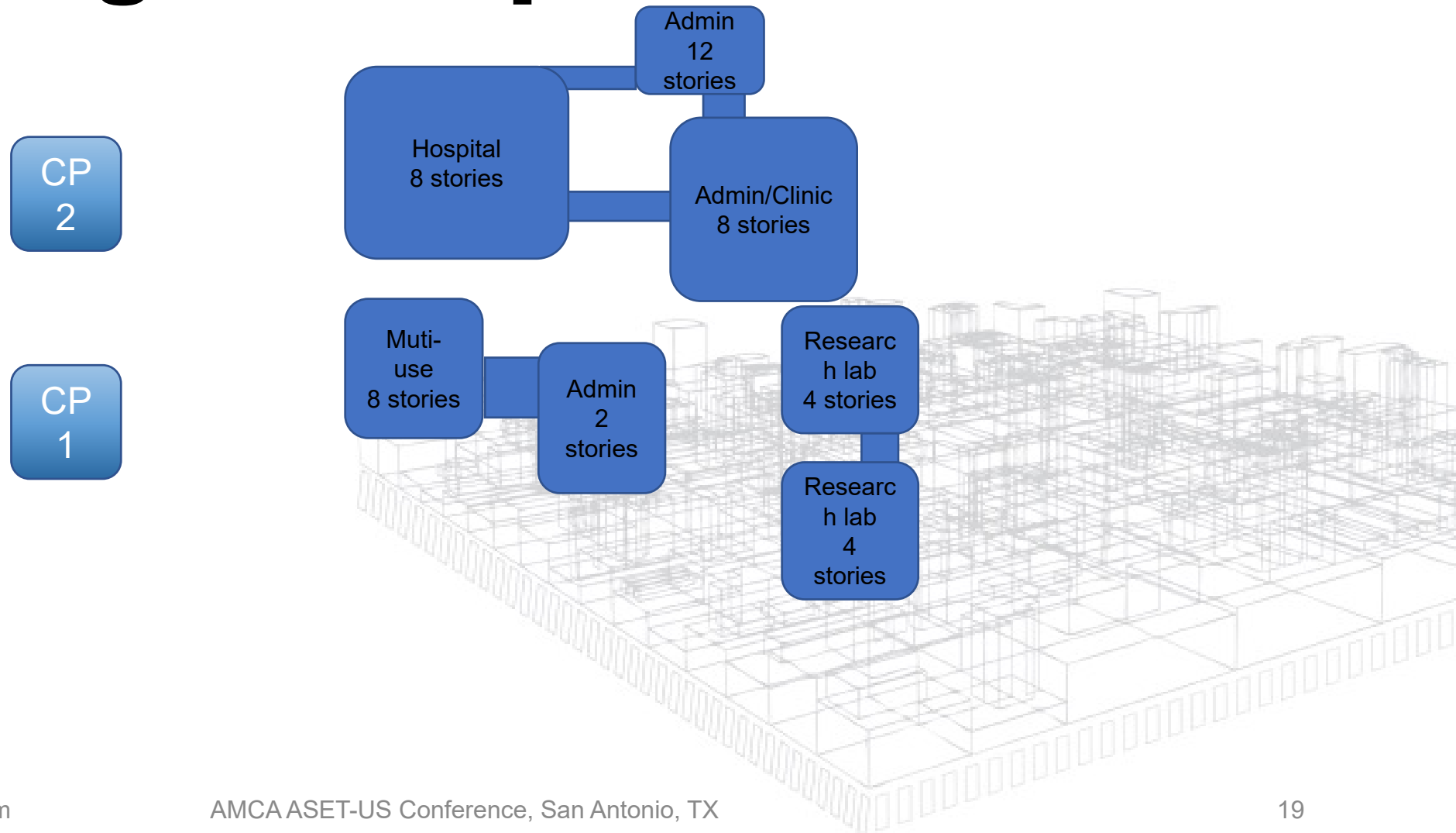
Optimizing A Campus

Chiller Staging Example

- Large Hospital Campus
 - Main Hospital
 - Admin Buildings
 - Research Buildings
- 2 chilled water plants – Peak Load 5,400 Tons
 - CP1 - (primary/secondary) 6,200 Tons with 6 chillers
 - 4 x 1,100 tons
 - 1 x 1,000 tons
 - 1 x 800 tons
 - CP2 - (variable flow primary) 3,200 Tons with 2 chillers
 - 2 x 1,600 tons



Optimizing A Campus



Optimizing A Campus

Chiller Staging Example

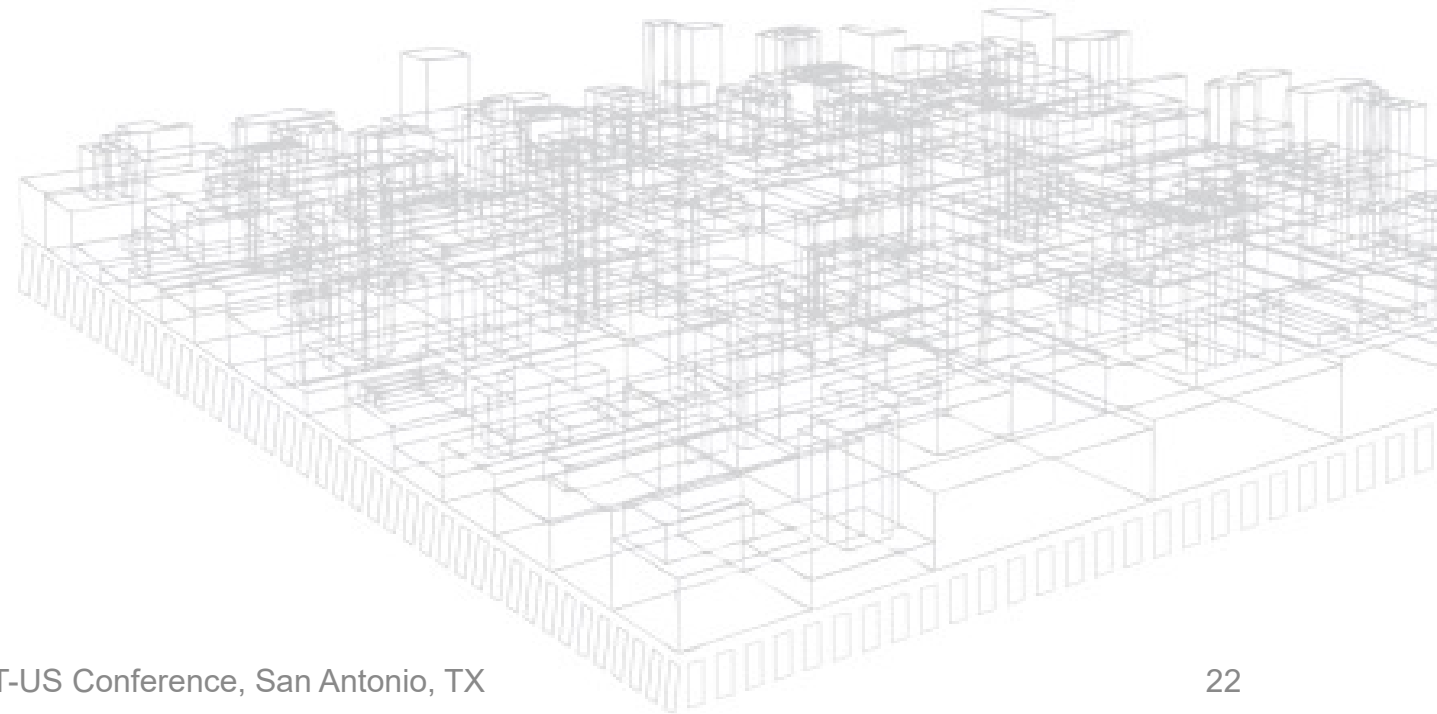
- Sequence of operation
 - Load Primary/Secondary System Trim With Variable Flow Primary
 - CP-1
- Optimization
 - To Truly Optimize A Central Plant System The Served Facilities Should be Optimized First.
 - Optimize Air Side First, Then Optimize Water Side
 - CP-1 When in “Flow” mode, Pumps fixed CHW flows to each chiller, These flows will be adjusted during Cx to ensure chillers are fully loaded
 - CP-2 Chiller CHW flow Is varied per facility load demand when in “Pressure” Mode.

Optimizing A Campus

- Each Building has “MM” Riser Setup To Flow ONLY the water that is needed for that facility.
- With Properly Operating AHUs Monitor Valve Positions and Control Central Pumping to keep most open valve 90-95 open.
- Each “MM” riser valve position is monitored and current “Lead” building valve should be 100% open. All other valves should be partially closed.
- Central Utility Pumps are controlled to maintain “0” vote at worst facility.

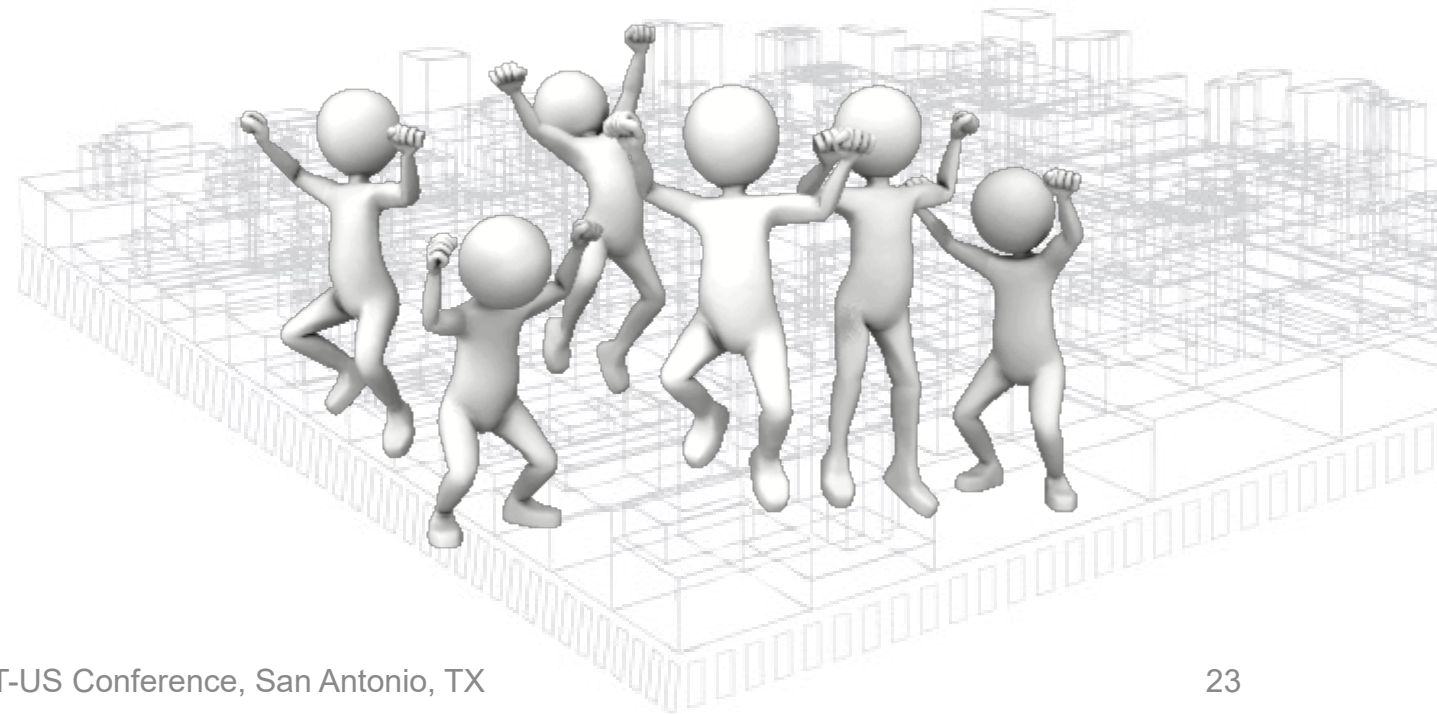
Optimization

- Condenser water temperature reset
- Chilled Water differential pressure reset
- Increase water side economizer operation
- Make-up water
 - Non-potable water
 - Stuck fill valve



Verifying results

- Campus Utility Costs were at \$8,000,00 annually
- With addition of four floors of buildings annual cost have dropped \$1,500,000



Questions?

Steve Wiggins

Director of Commissioning

Newcomb & Boyd

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