Saving Energy in Data Centers
Low Cost Energy Efficiency Measures
Case Studies

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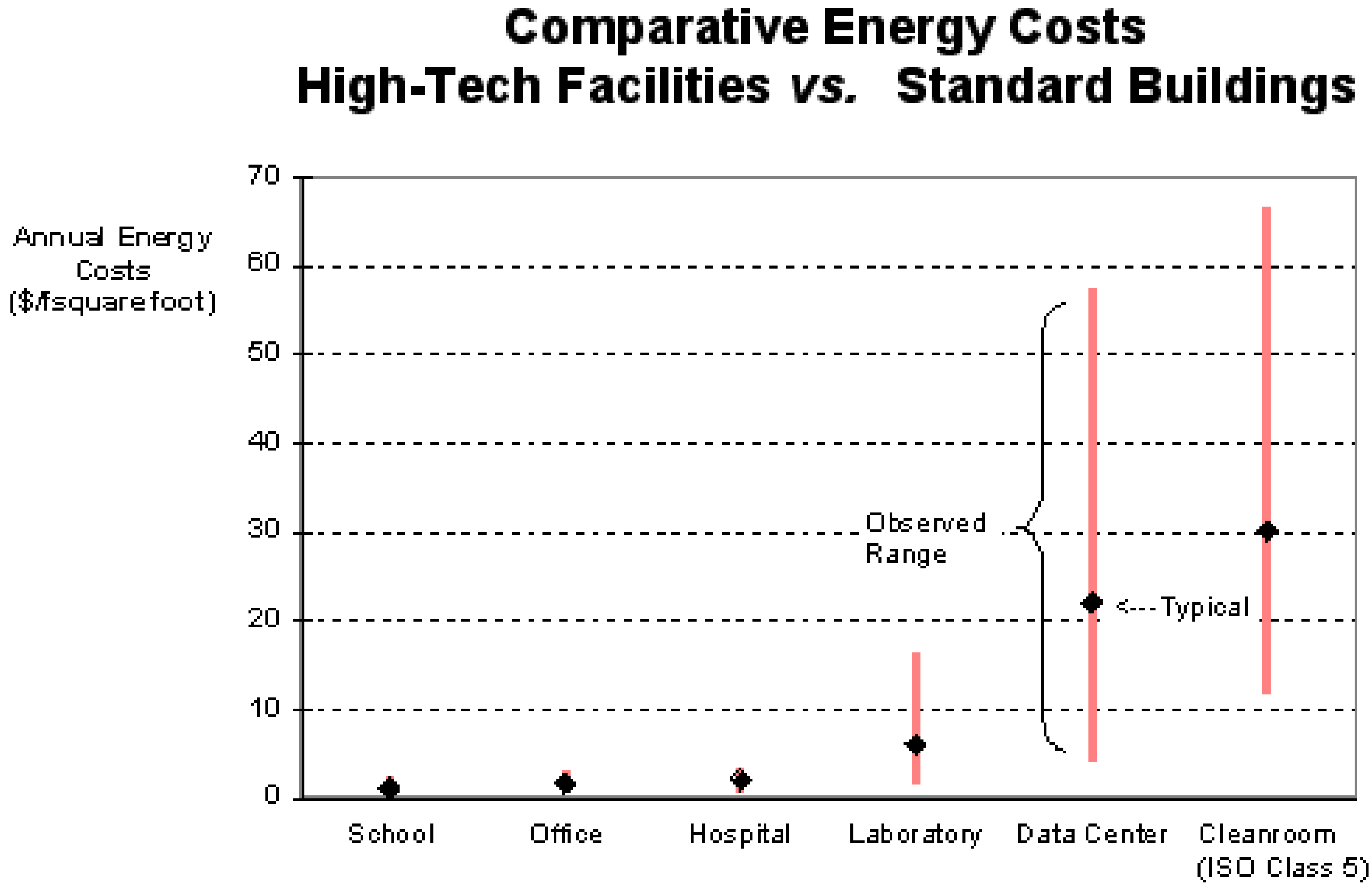
Objective

- Explore why saving energy in Data Centers?
- Get a general idea of the best practices
- Learn about low cost EEMs
    - Environmental conditions adjustments
    - Air management improvements
    - Chiller Plant
- Examine three Case studies

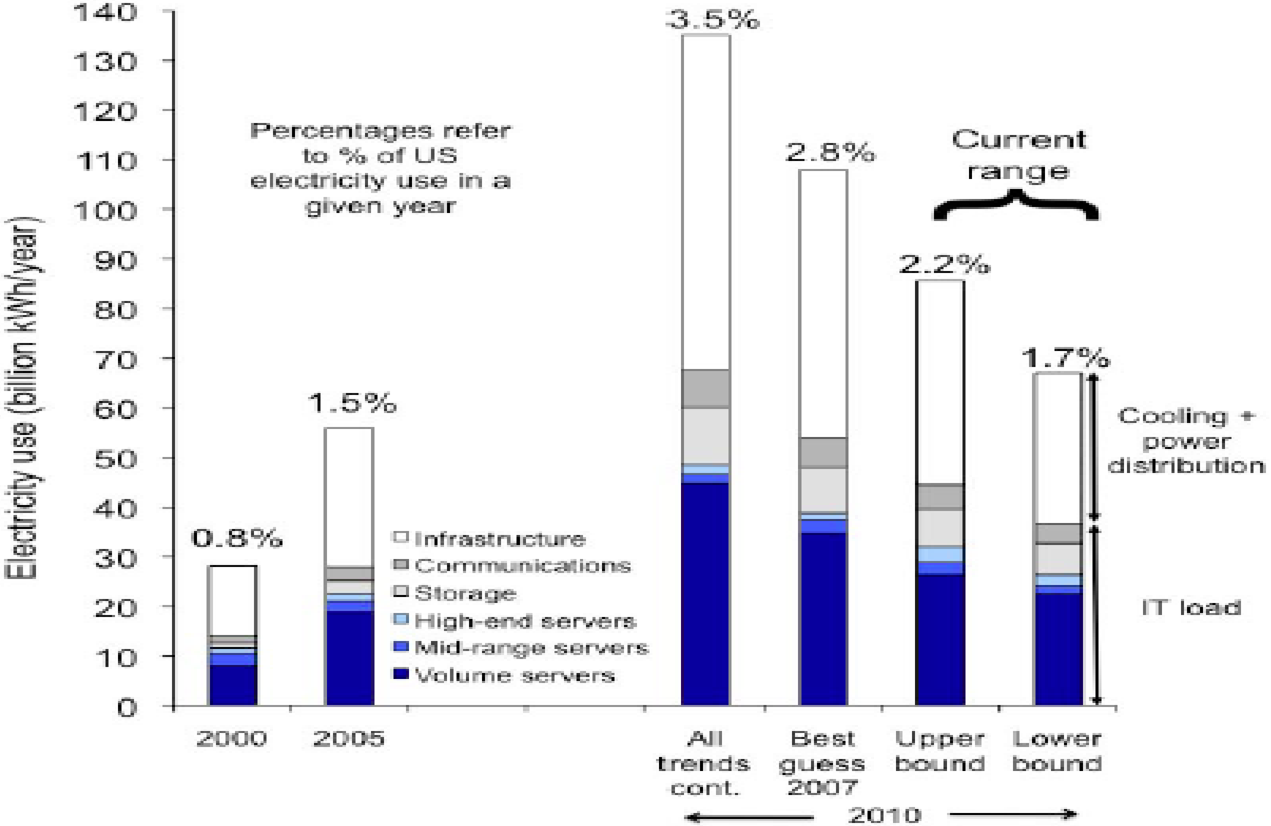
High Tech Buildings are Energy Hogs:



US Data Center Electricity Use - 2000, 2005, and 2010

2% of US Electricity consumption

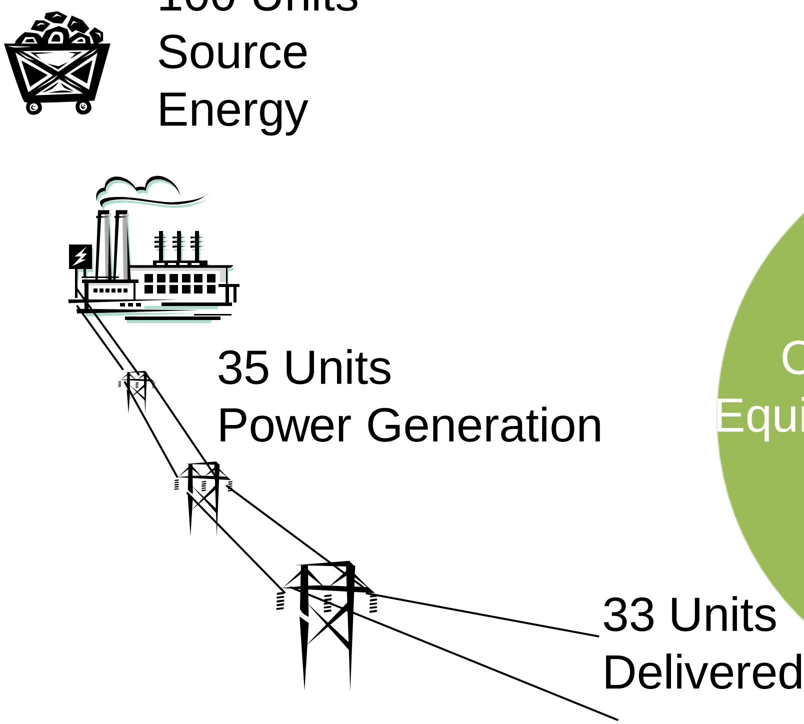
Potential to double in next 5 years



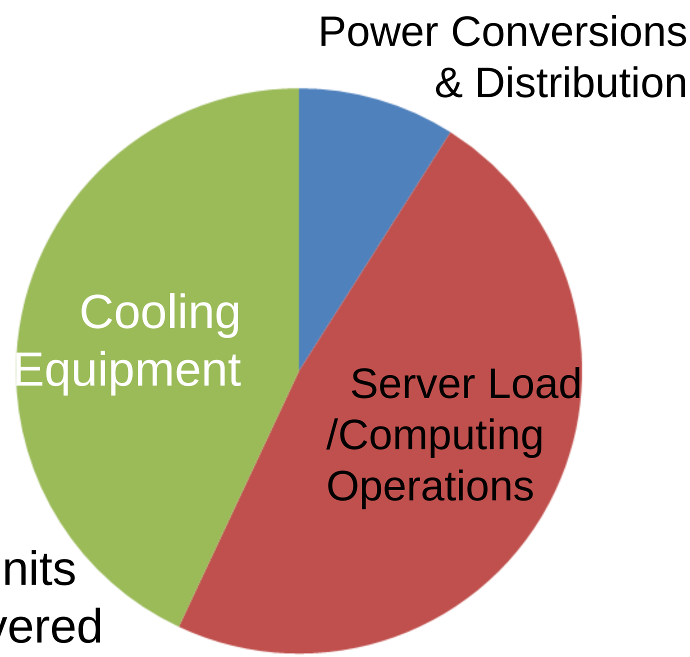
Source: Koomey 2011

Data Center Energy Efficiency = 15% (or less)

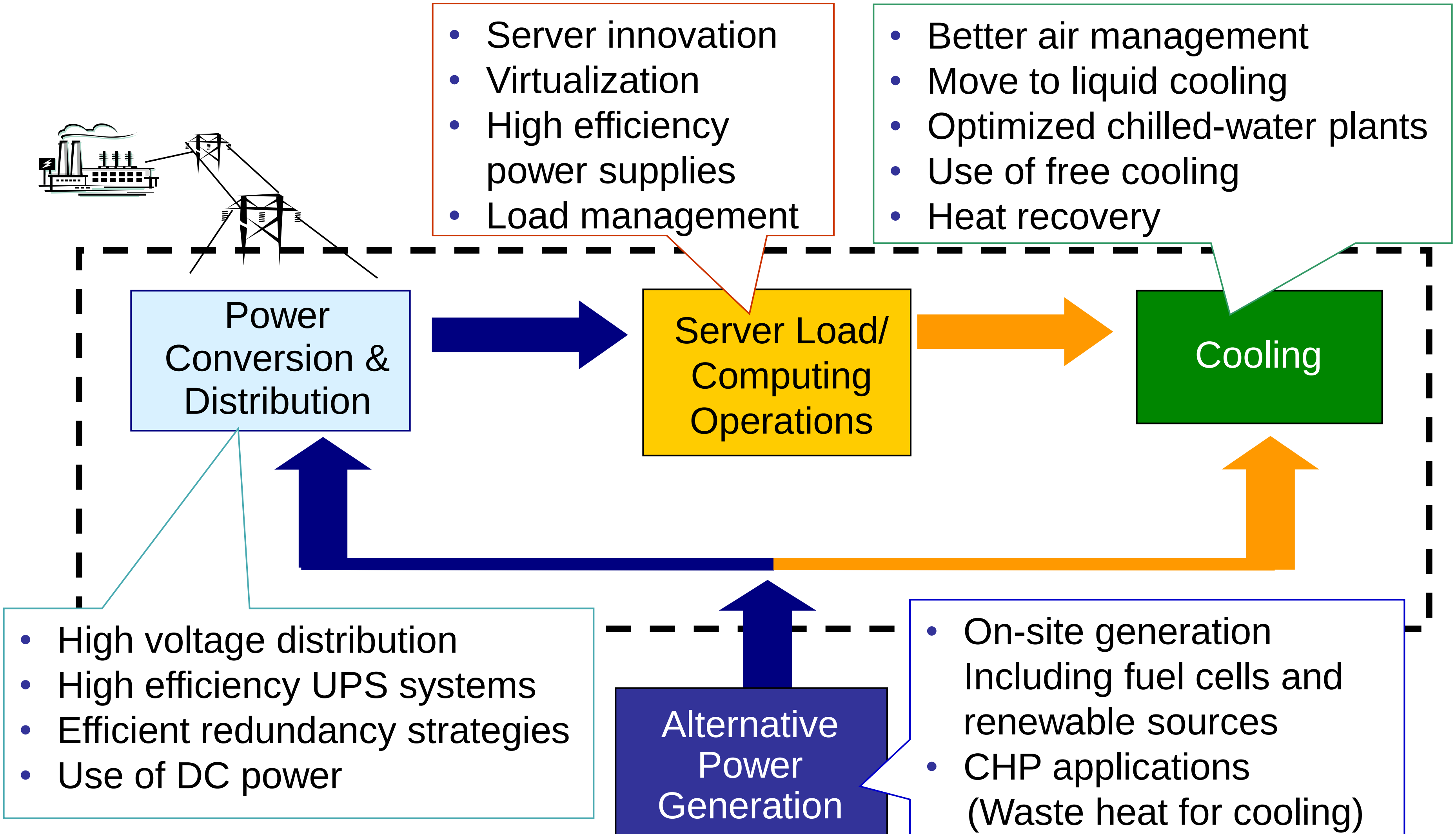
(Energy Efficiency = Useful computation / Total Source Energy)



Typical Data Center Energy End Use



Energy efficiency best practices



LBNL develops publically available resources

DC Pro tools
Data Center Energy Practitioner program
Computing metrics development

Federal consolidation guideline
ESPC contract content

Wireless assessment kit
Compressor- less cooling

Low Cost EEMs:

- Environmental conditions adjustments
- Air management improvements
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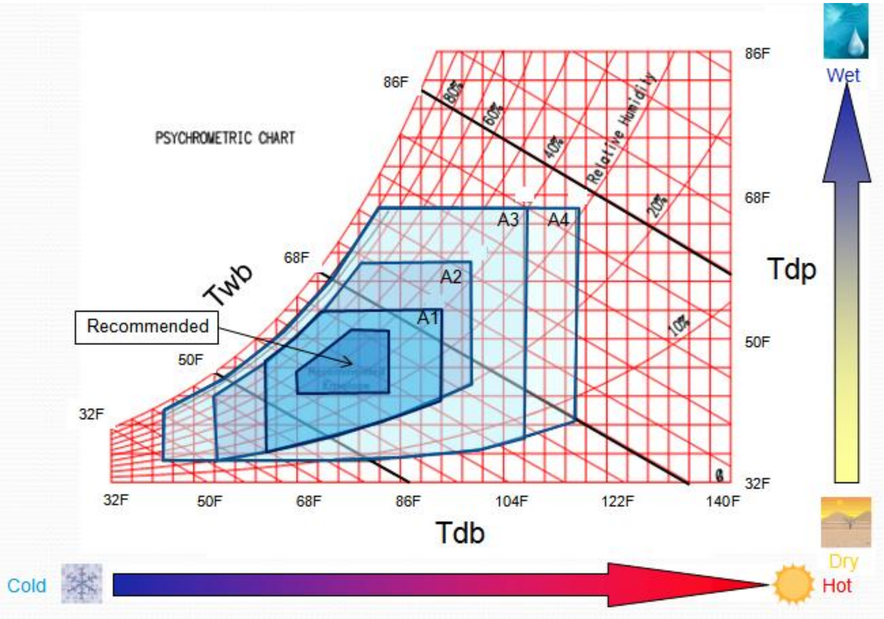
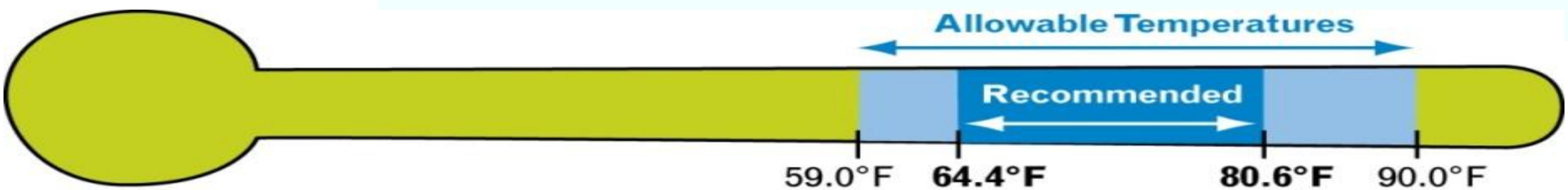


ASHRAE 2011

ITE Environment – 2011 Environment Specifications Table (Partial)

Class: Previous	Class: Current	Dry Bulb (°F)	Humidity Range	Max Dew Point (°F)	Max Elevation (ft)	Max Rate of Change (°F / hr)
Recommended						
1 & 2	**A1 to A4**	**64.4 to 80.6**	**41.9°F DP to 60% RH & 59°F DP**	N/A		
Allowable						
1	A1	59 to 89.6	20% to 80% RH	62.6	10,000	9* / 36
2	A2	50 to 95	20% to 80% RH	69.8	10,000	9* / 36
N/A	A3	41 to 104	10.4°F DP & 8% RH to 85% RH	75.2	10,000	9* / 36
N/A	A4	41 to 113	10.4°F DP & 8% RH to 90% RH	75.2	10,000	9* / 36

* More stringent rate of change for tape drives

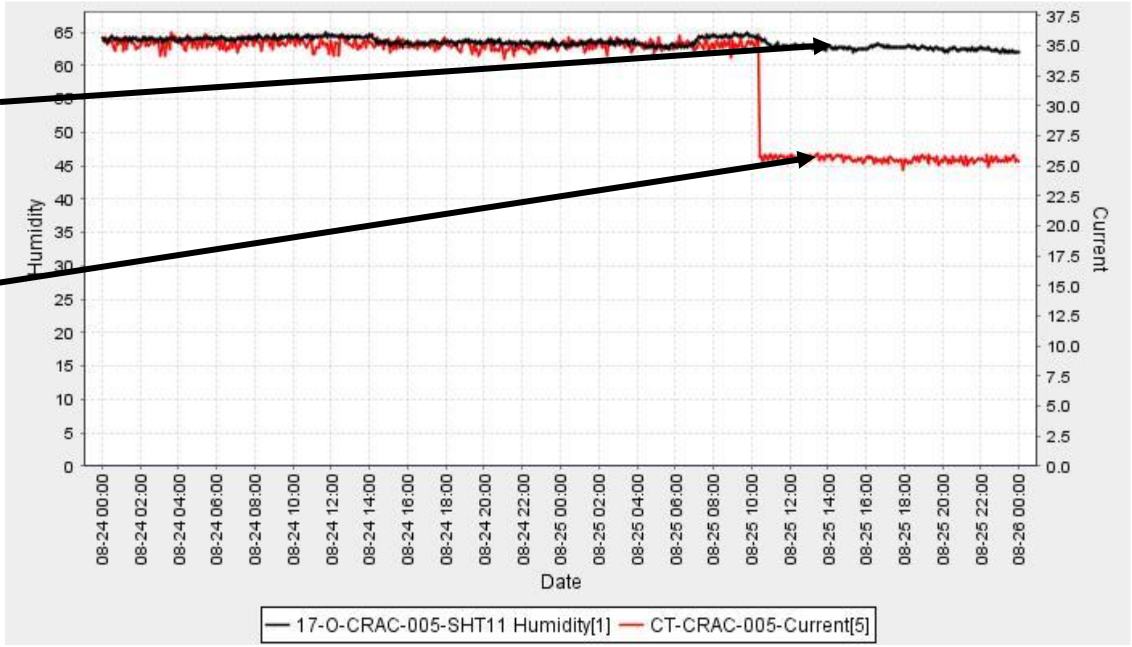


The Cost of Unnecessary Humidification

	Visalia Probe			CRAC Unit Panel			
	Temp	RH	Tdp	Temp	RH	Tdp	Mode
AC 005	84.0	27.5	47.0	76	32.0	44.1	Cooling
AC 006	81.8	28.5	46.1	55	51.0	37.2	Cooling & Dehumidification
AC 007	72.8	38.5	46.1	70	47.0	48.9	Cooling
AC 008	80.0	31.5	47.2	74	43.0	50.2	Cooling & Humidification
AC 010	77.5	32.8	46.1	68	45.0	45.9	Cooling
AC 011	78.9	31.4	46.1	70	43.0	46.6	Cooling & Humidification
Min	72.8	27.5	46.1	55.0	32.0	37.2	
Max	84.0	38.5	47.2	76.0	51.0	50.2	
Avg	79.2	31.7	46.4	68.8	43.5	45.5	

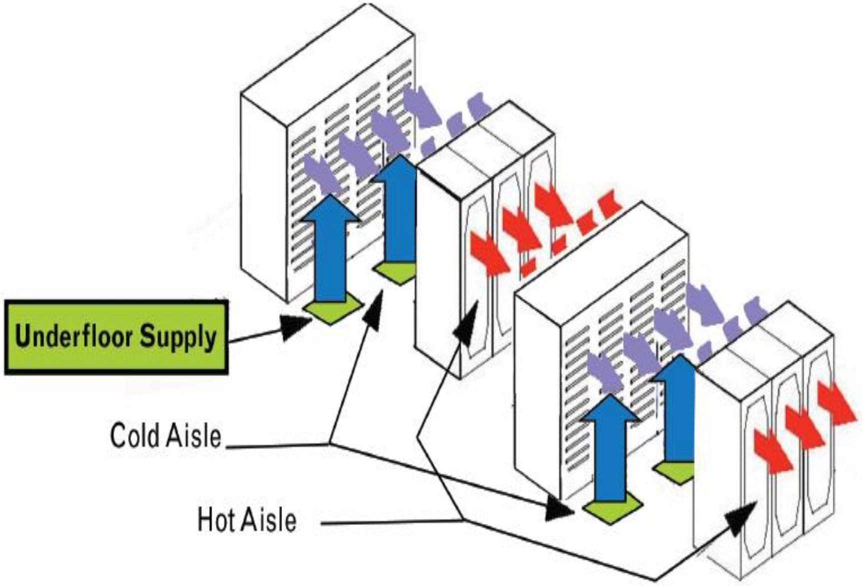
Humidity down 3%

CRAC power down 28%

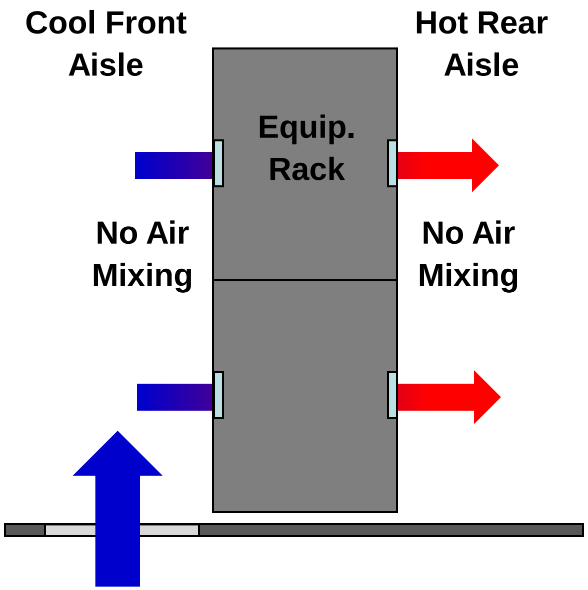


Low Cost EEMs:

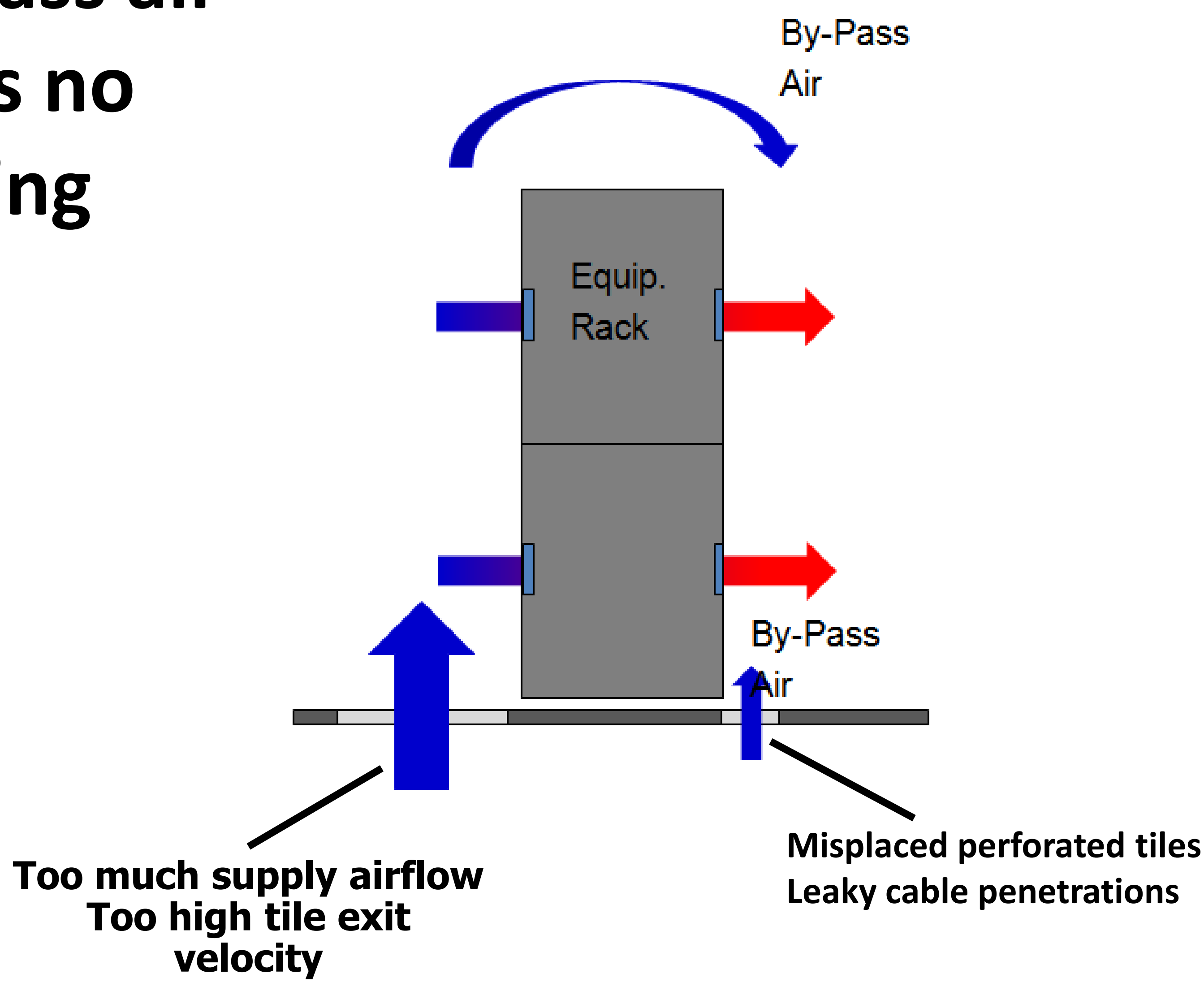
- Environmental conditions adjustments
- Air management improvements
- Chiller plant



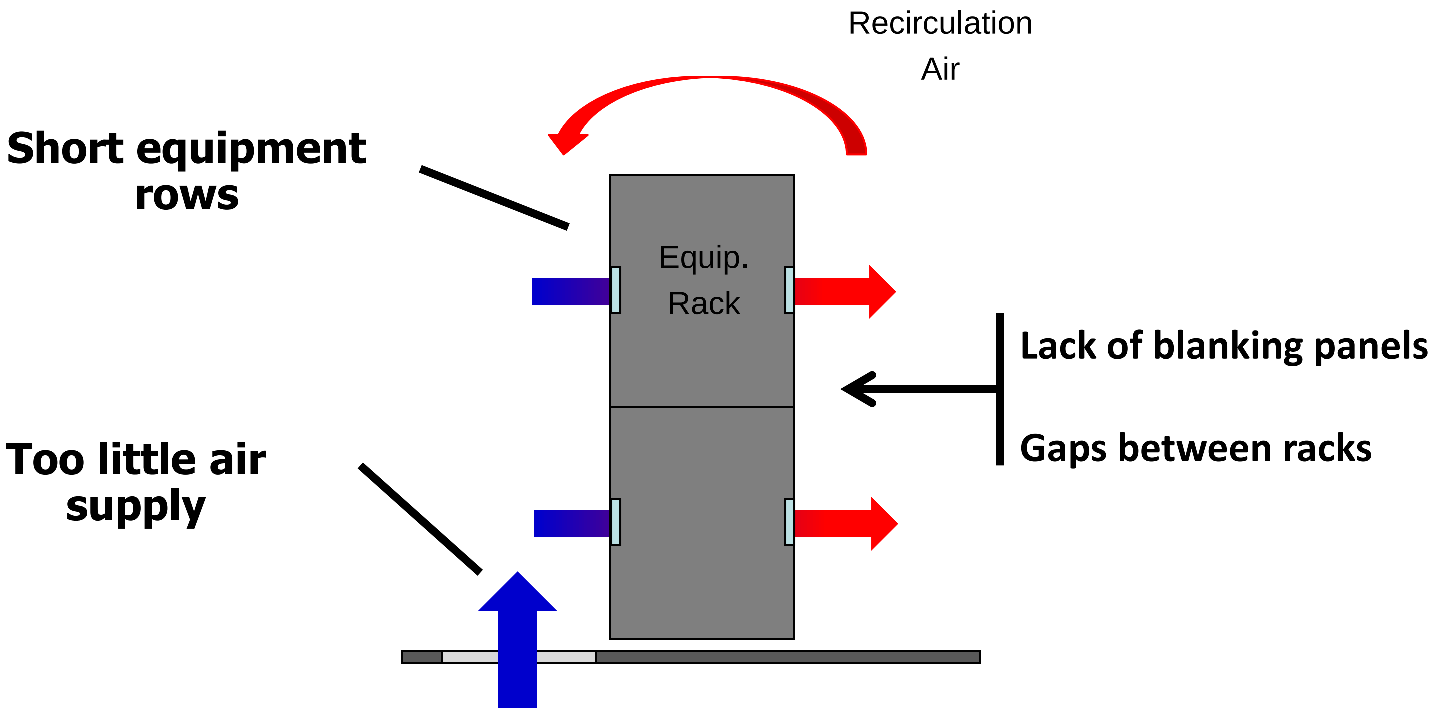
Goal: Supply air directly to equipment intakes without mixing



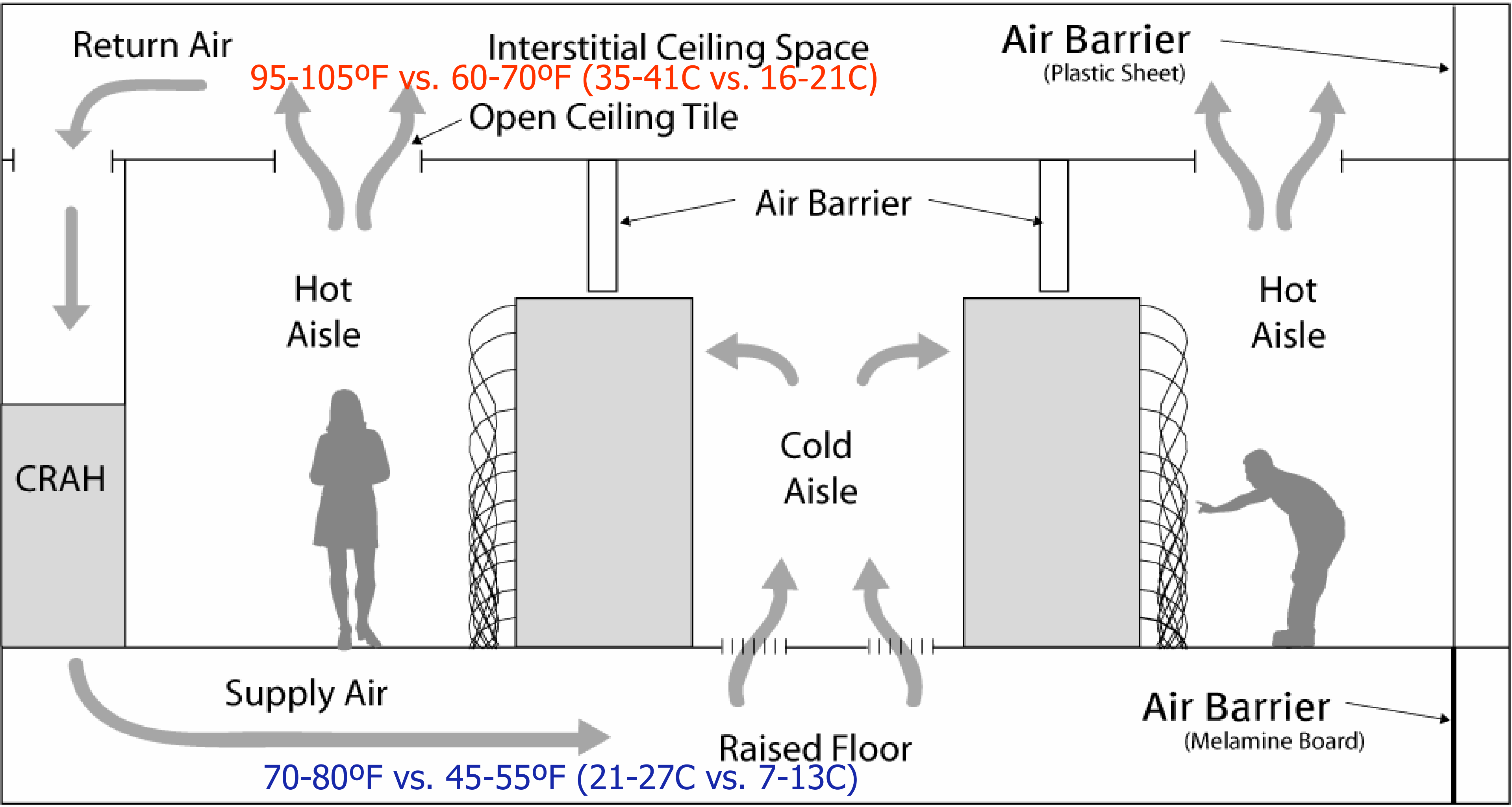
By-pass air does no cooling



Recirculated air causes localized cooling problems



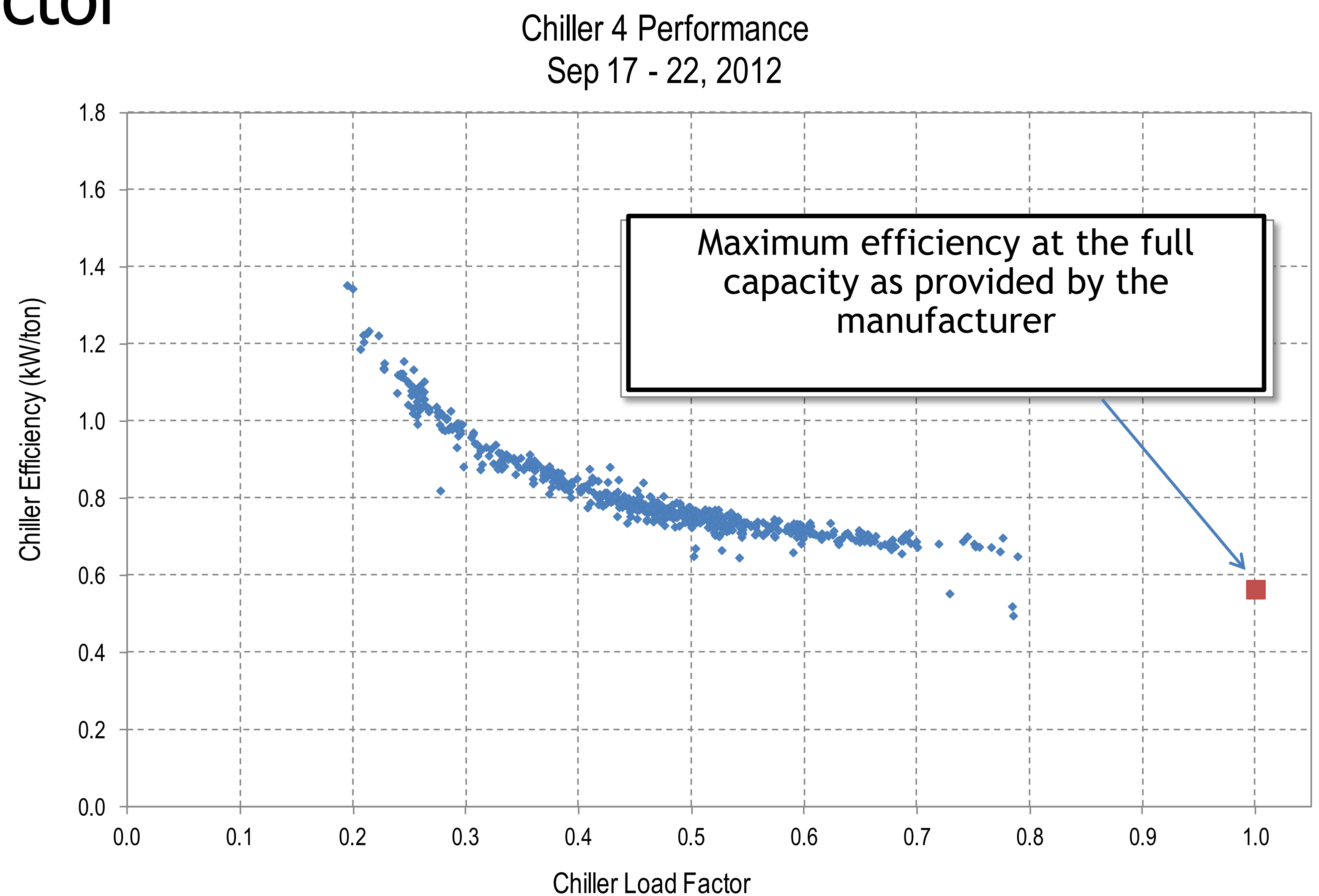
Adding Air Curtains for Hot/Cold Isolation


Return Air
Interstitial Ceiling Space
95-105ºF vs. 60-70ºF (35-41C vs. 16-21C)
Air Barrier
(Plastic Sheet)
Open Ceiling Tile
Air Barrier
Hot
Aisle
Hot
Aisle
CRAH
Cold
Aisle
Supply Air
Raised Floor
Air Barrier
(Melamine Board)
70-80ºF vs. 45-55ºF (21-27C vs. 7-13C)

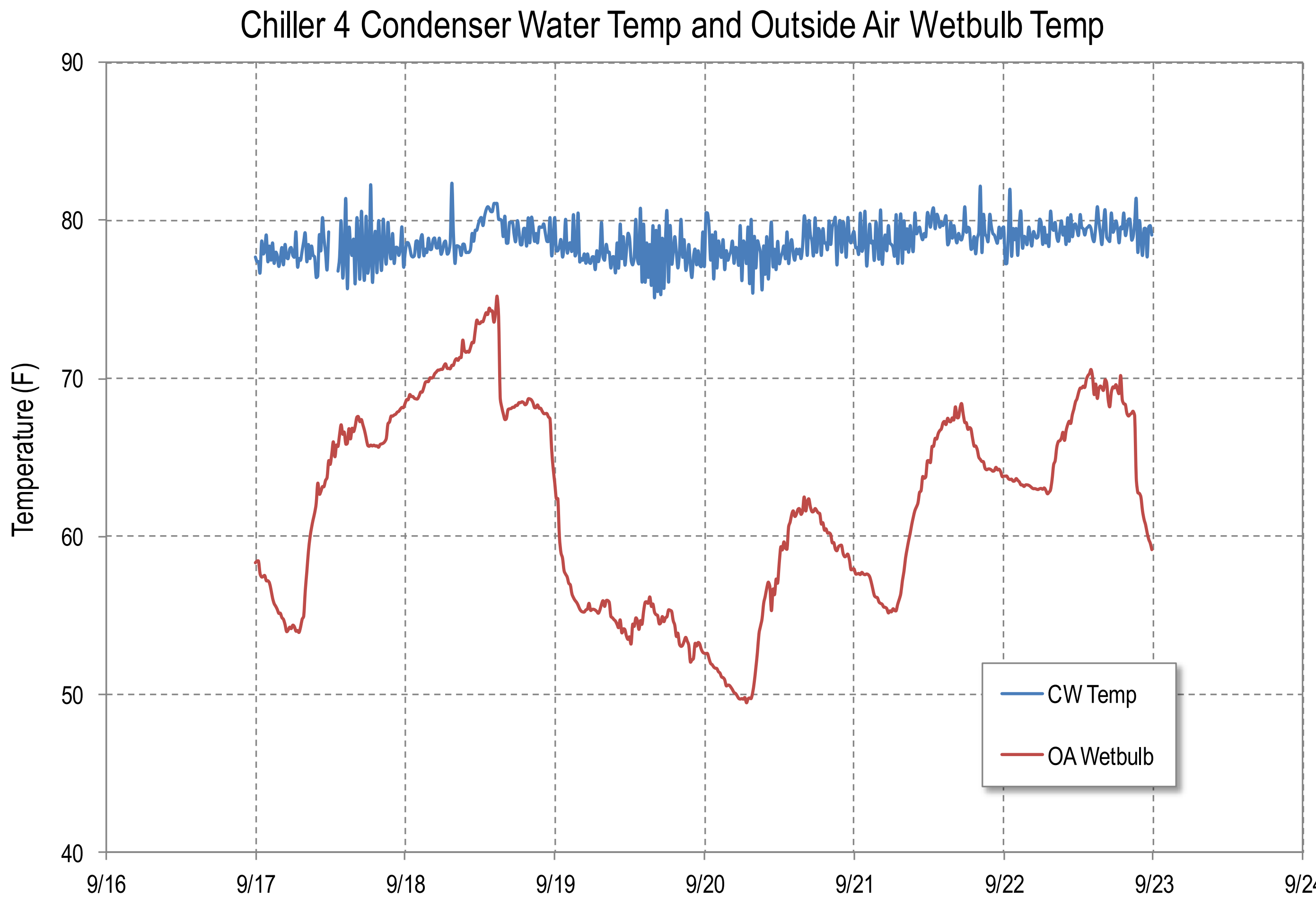
Low Cost EEMs:

- Environmental conditions adjustments
- Air management improvements
- Chiller Plant

Better efficiency of chiller with higher load factor



Condenser water supply temperature

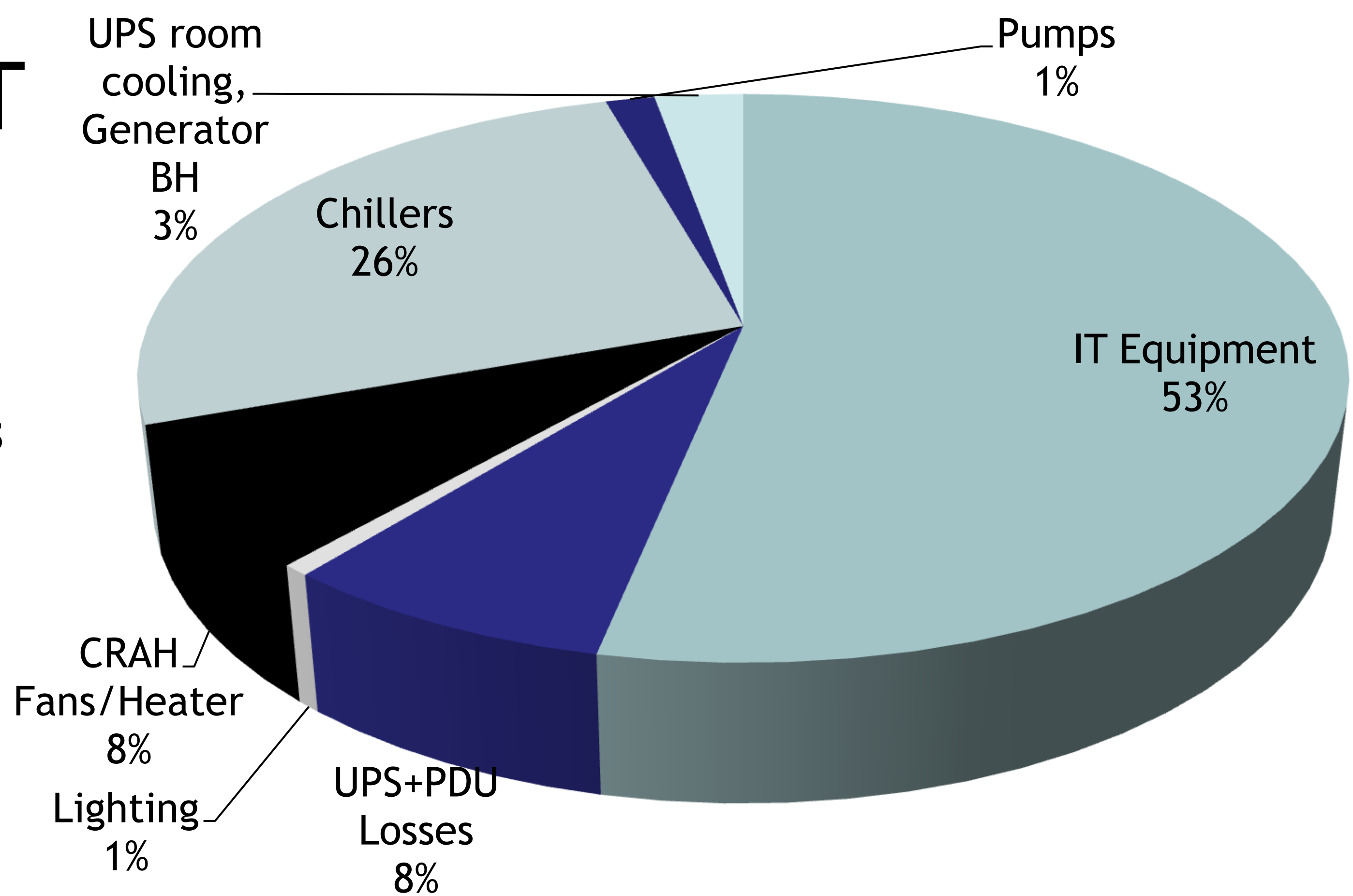


Federal Data centers Case studies

Data center 1

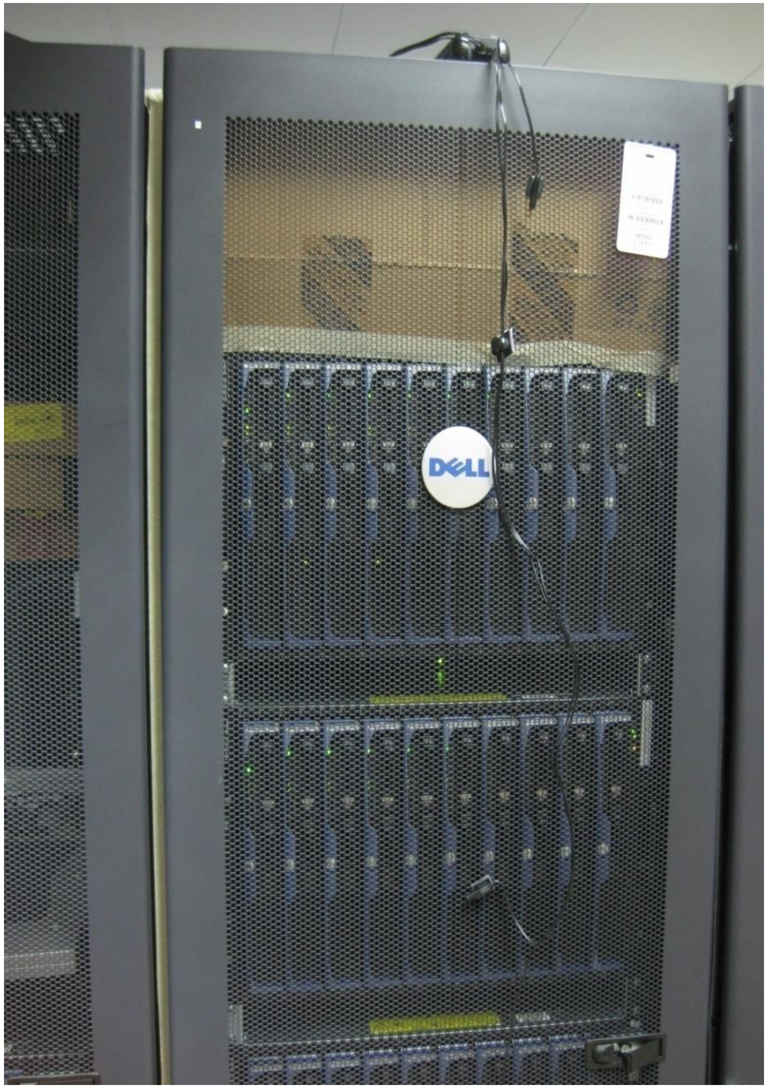
5,000 sf
500 kW IT
8GWh

Tropical climate
Air-cooled Chillers
CRAHs



Case studies

Seal all floor leaks and those between and within the racks



Case studies

Lesson learned: Seal the opening between the rack and floor

Supply Air temperature out of the perf tiles = 61.6degF

Case studies

Air temperature between perf and rack pedestal= 89.1degF

Case studies

Air temperature after space taped = 69.3degF

Case studies

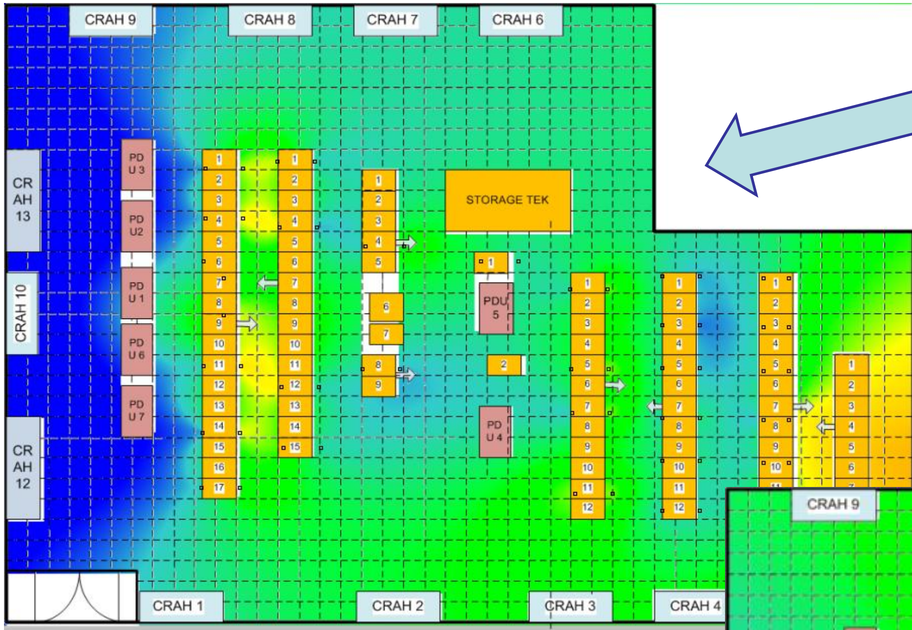
Replaced Perf tiles

Redirect cold air from the CRAHs

Case studies

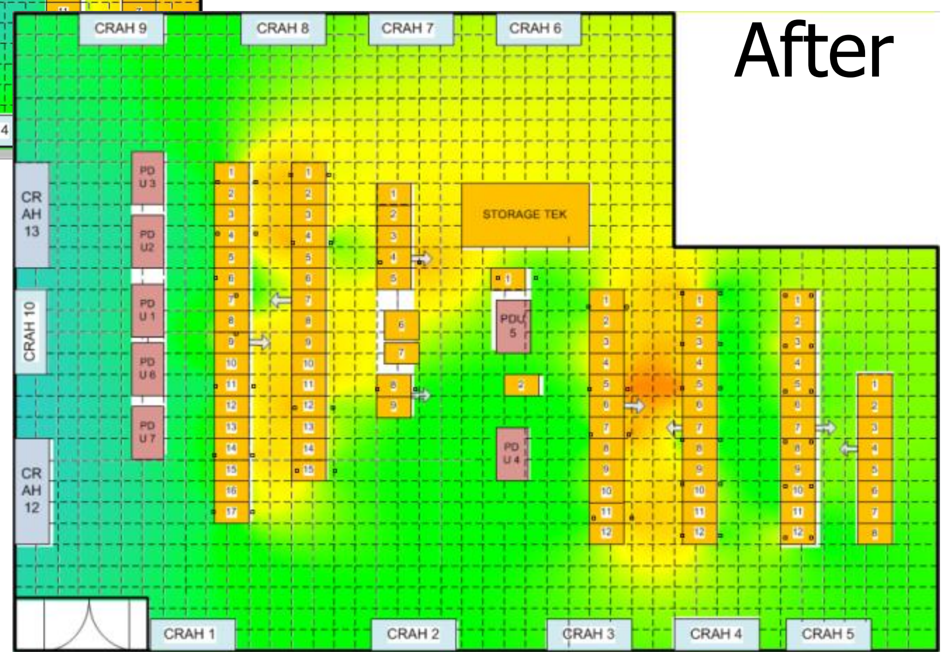
Ceiling space as a plenum

Case studies

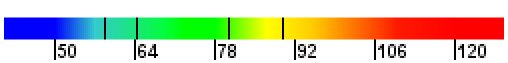


Before trials begin

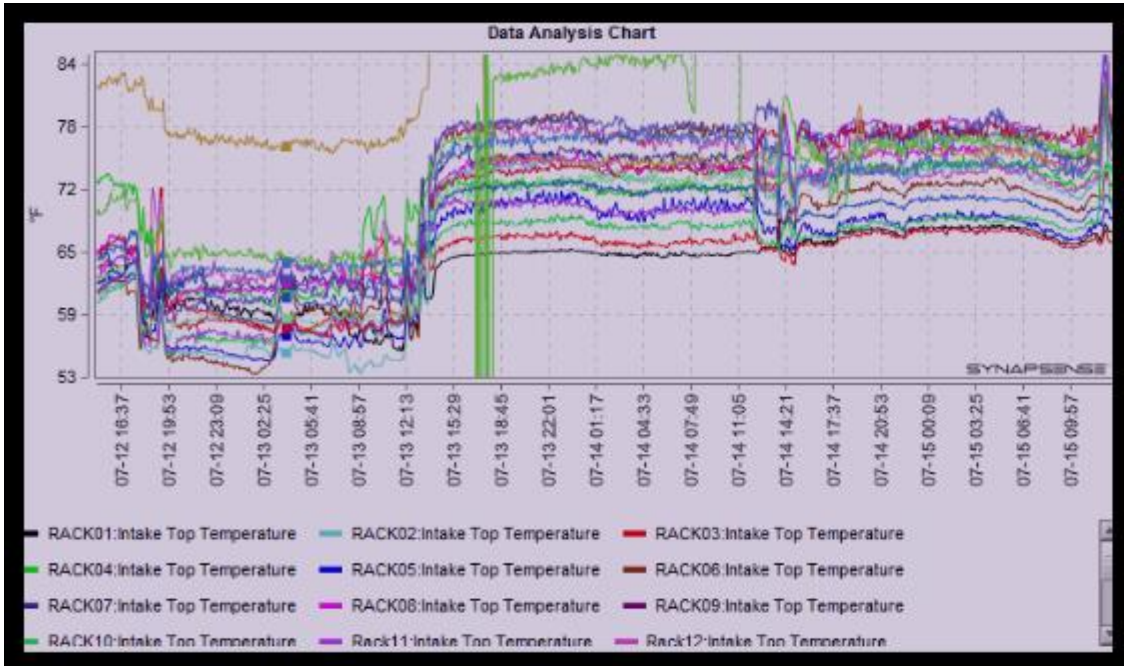
After



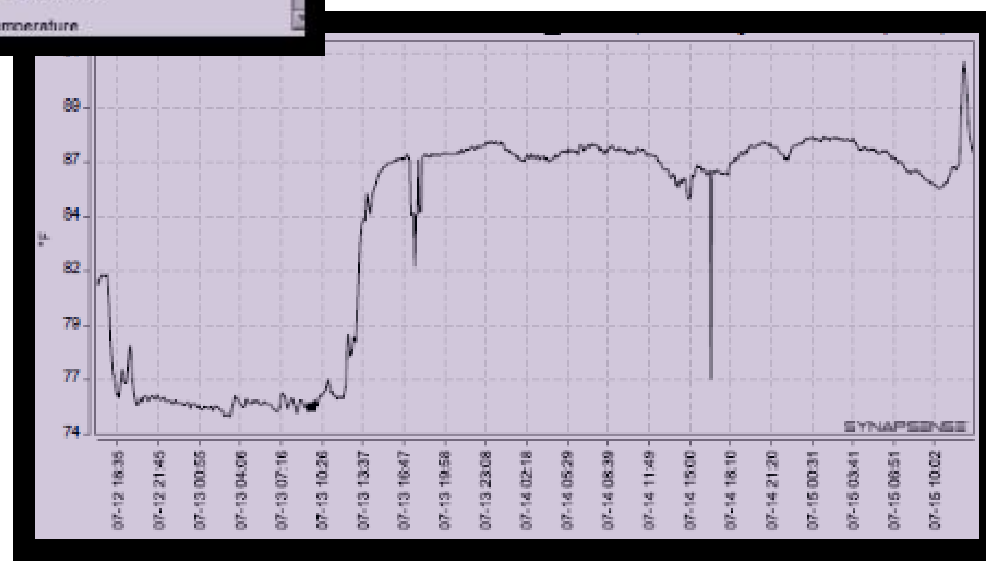
RAT increased from 74degF to 84degF



Case studies

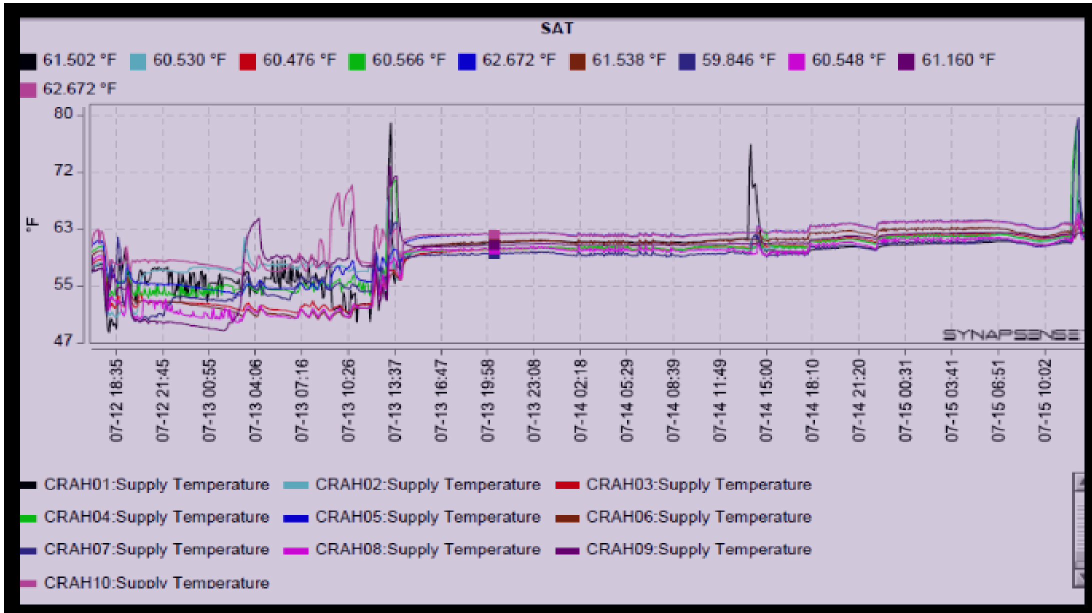


Individual racks intake top temperature change during trials (60-72)

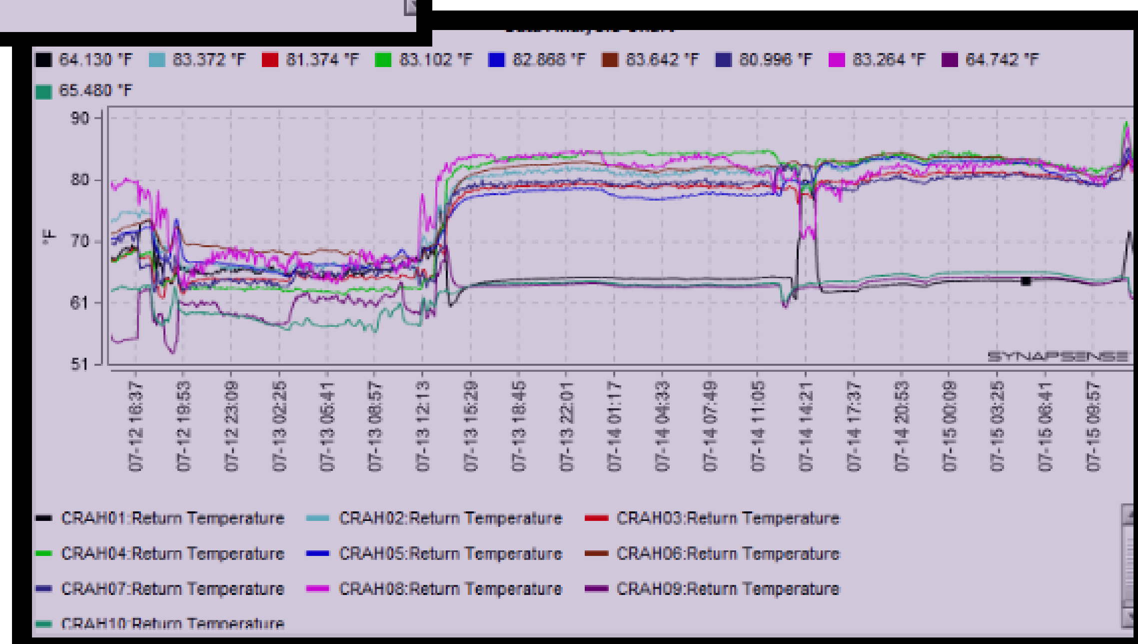


Average rack exhaust temperature change during trials (75-87)

Case studies

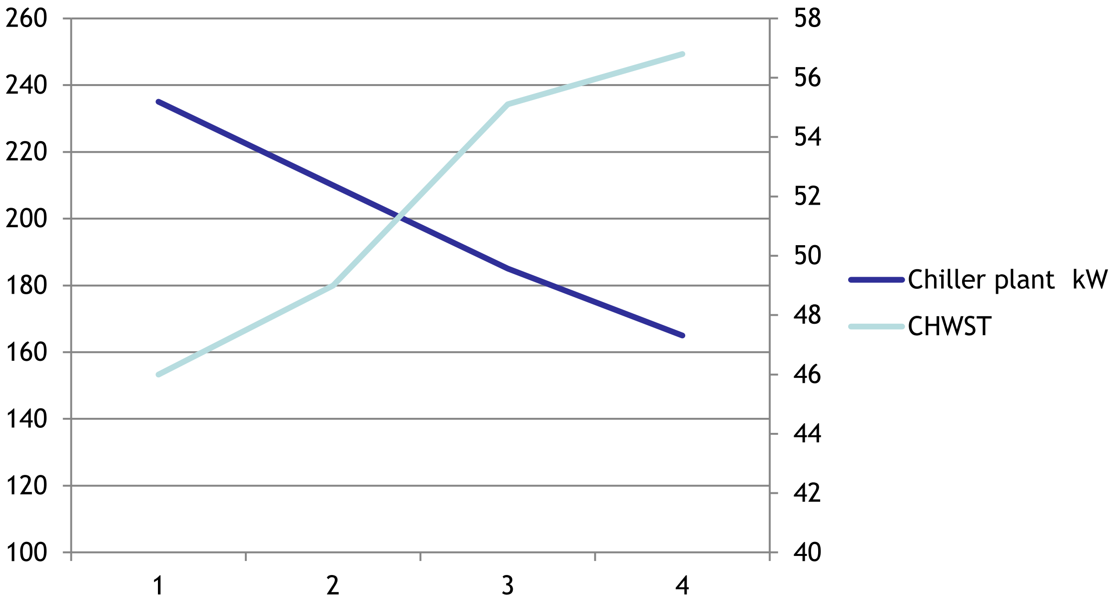


CRAHs Supply Avg. Temperatures 53 to 62



CRAHs Return Avg. Temperatures 64 to 83

Chillers Efficiency Improvement

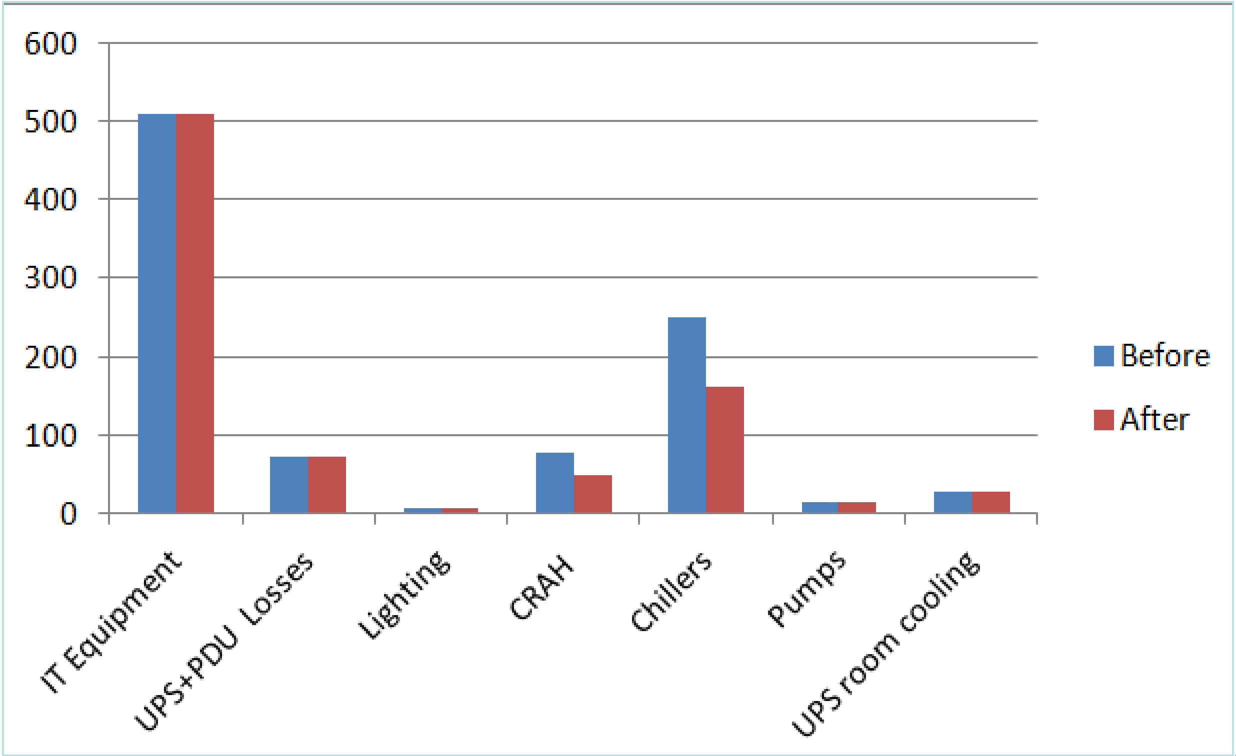


CHWST sp degF	*45*	*49*	*54*	*56*
CHWST degF	46	49	55.1	56.8
CH1 kW	75	75	0	0
CH2 kW	75	75	100	75
CH3 kW	75	50	75	75

Case studies

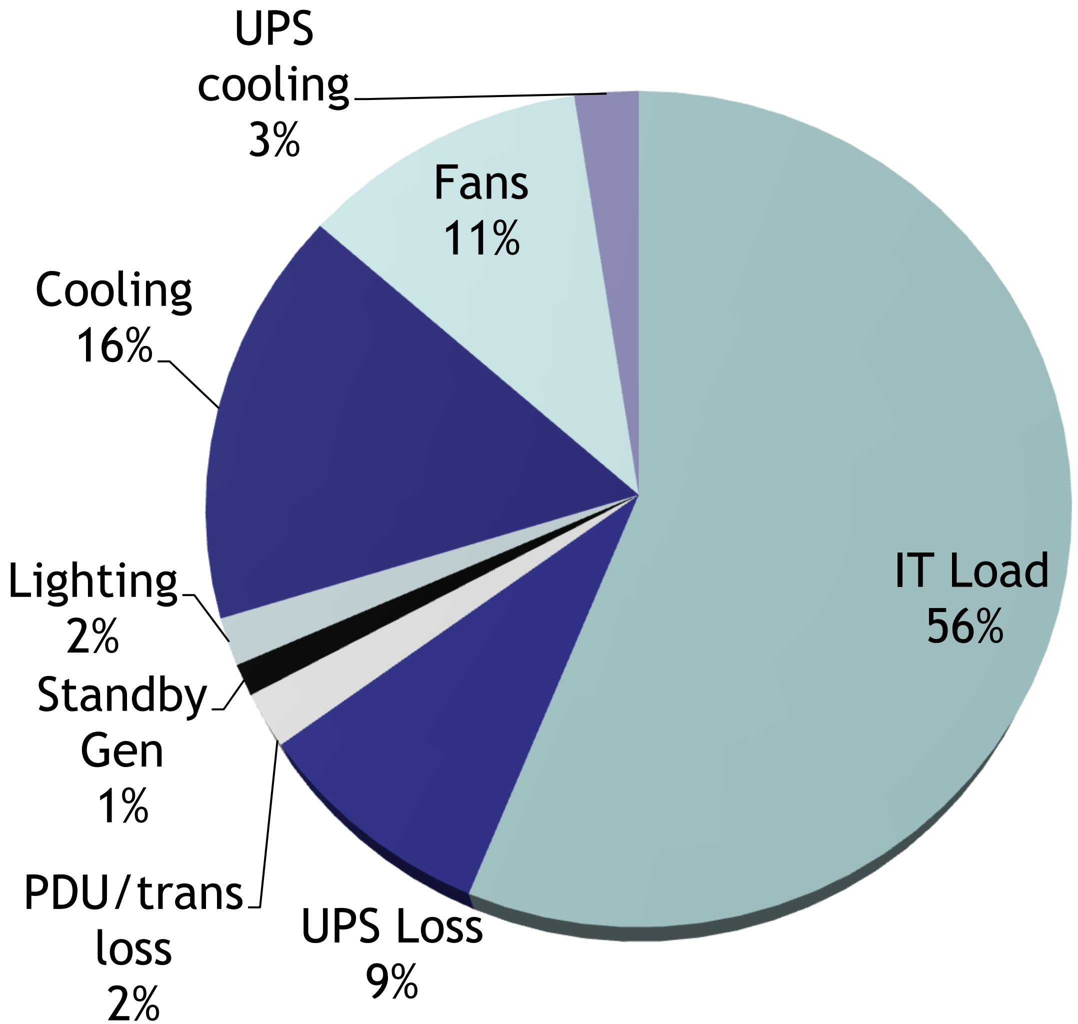
Saved annually:

800MWh
$240,000 utility cost
780 metric tons of
GHG emission



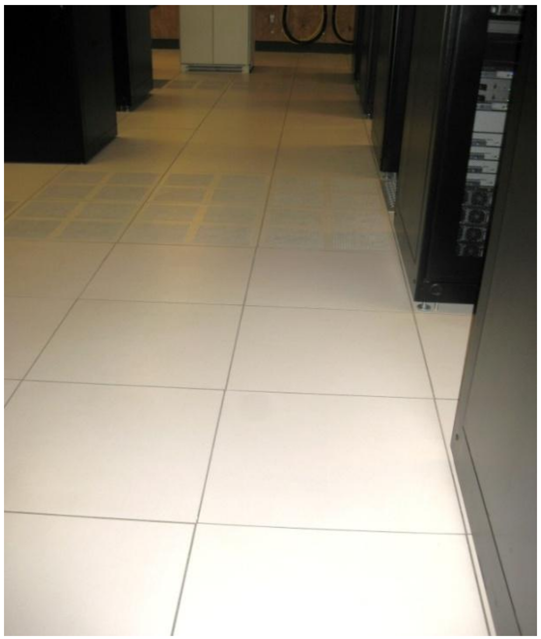
Data center 2

30,000 sf
1,850 kW IT
30GWh



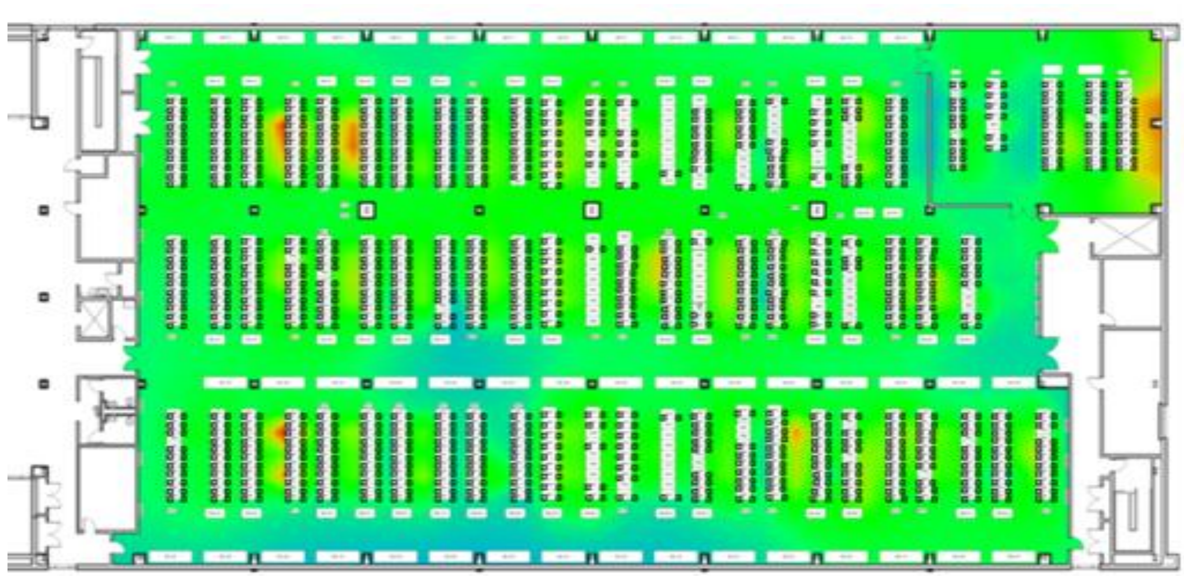
Case studies

Air management issues

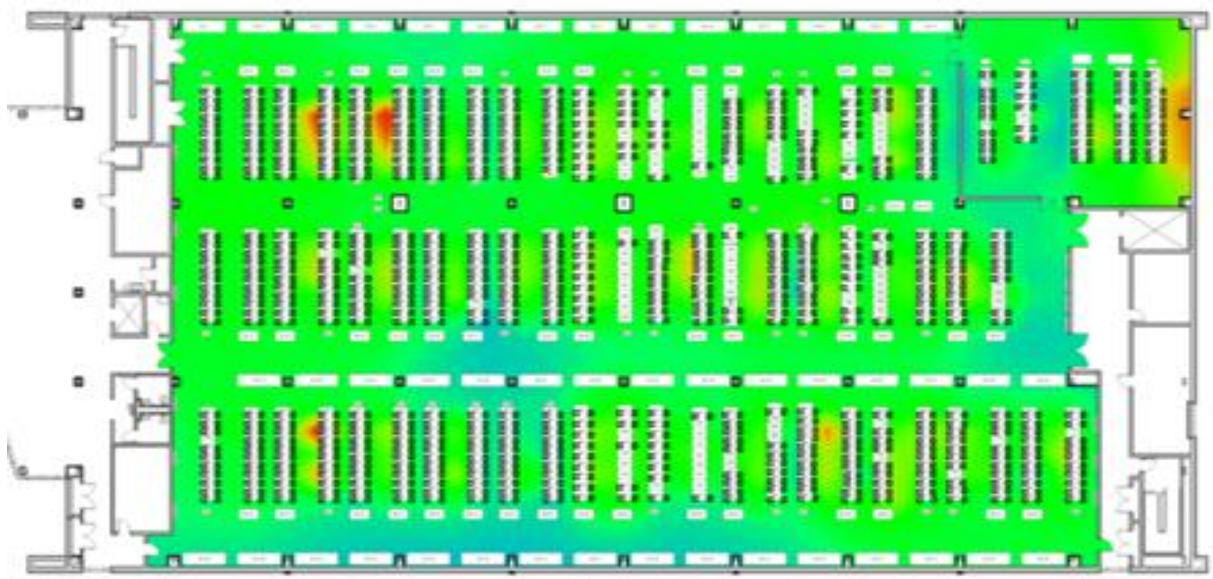


Case studies

Top rack intake temp before shutting down 20% of the CRAHs

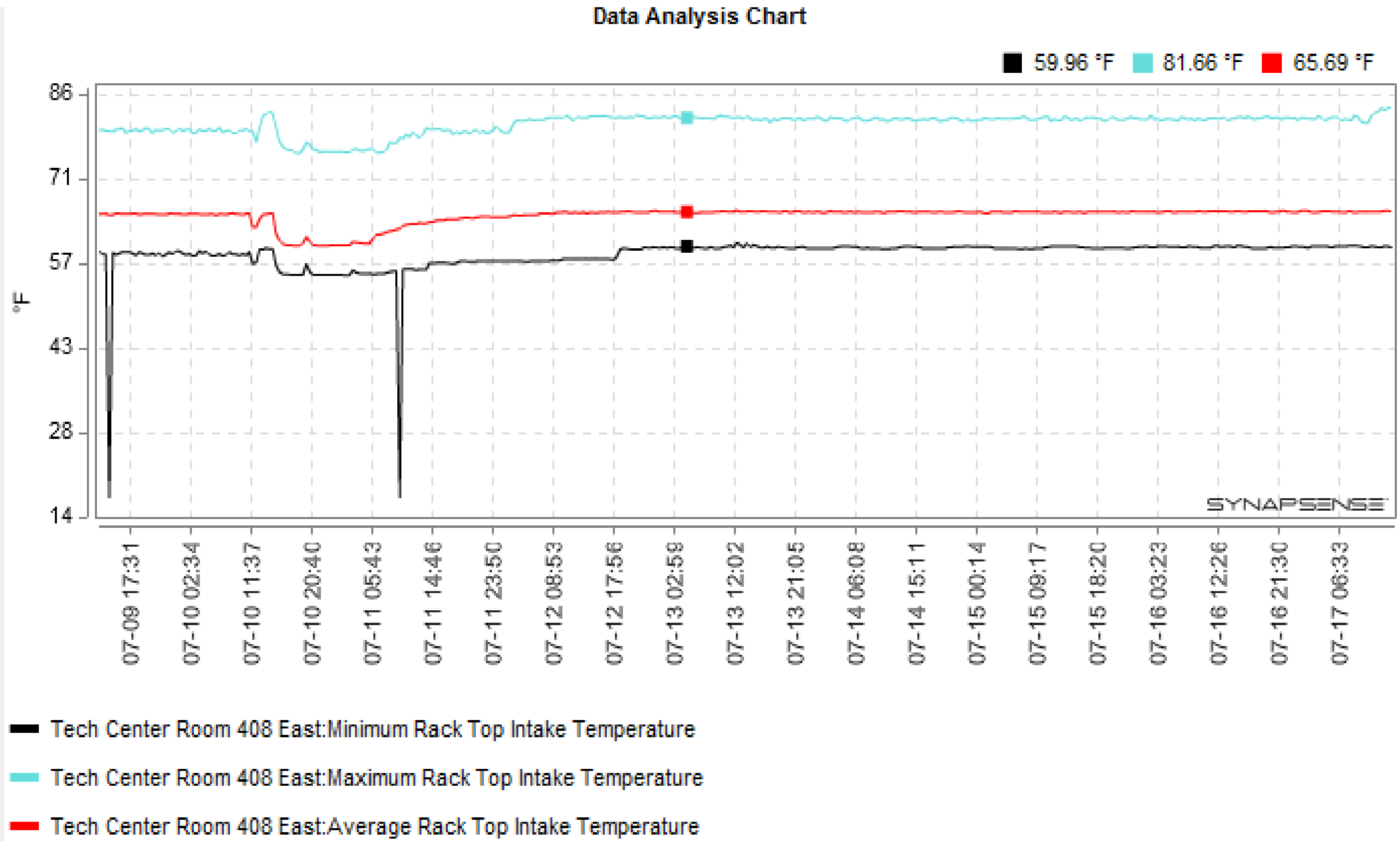


Top rack intake temp after



Case studies

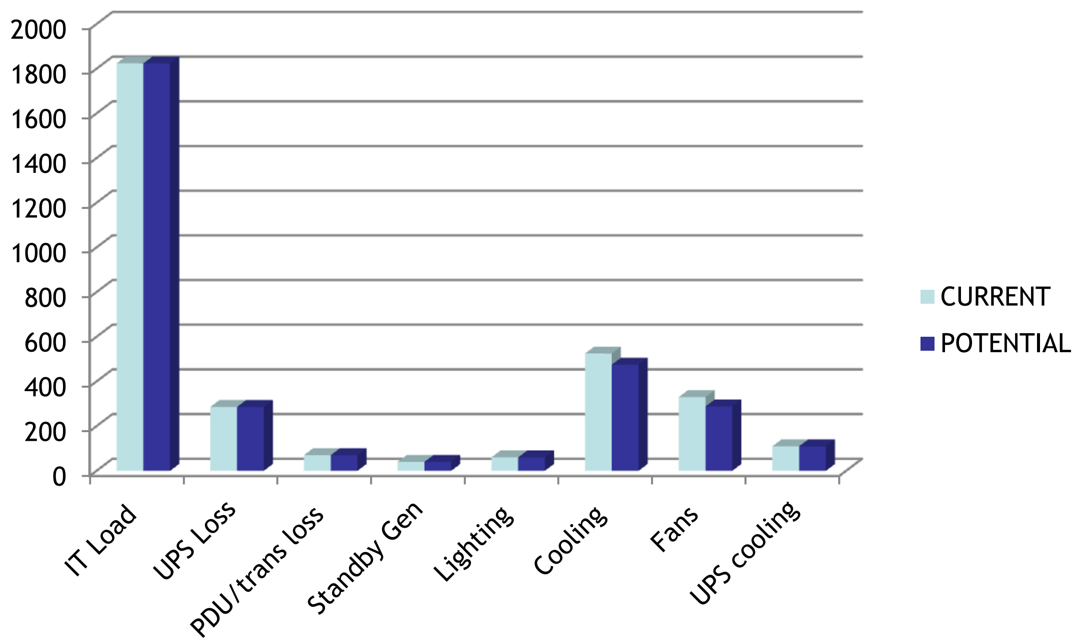
Little rack intake temperature change after CRAHs shutdown



Case studies

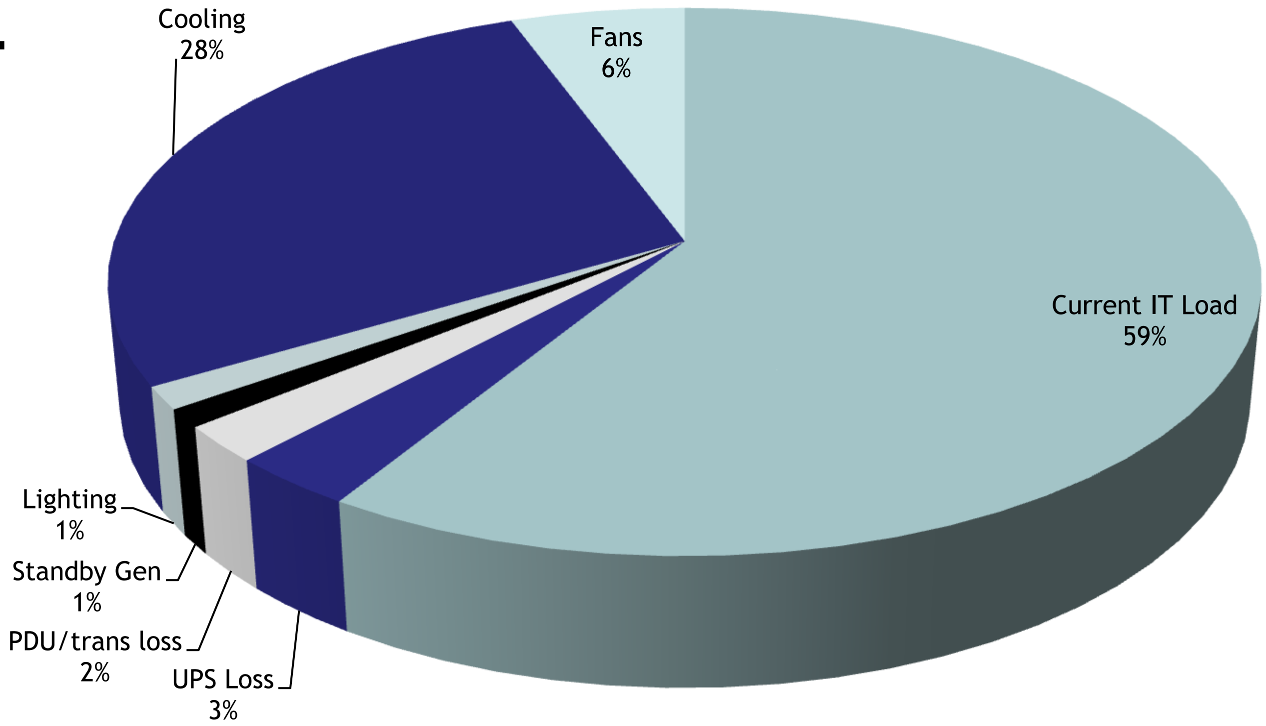
Saved annually:

850MWh
$55,000 utility cost
820 metric tons of GHG emission

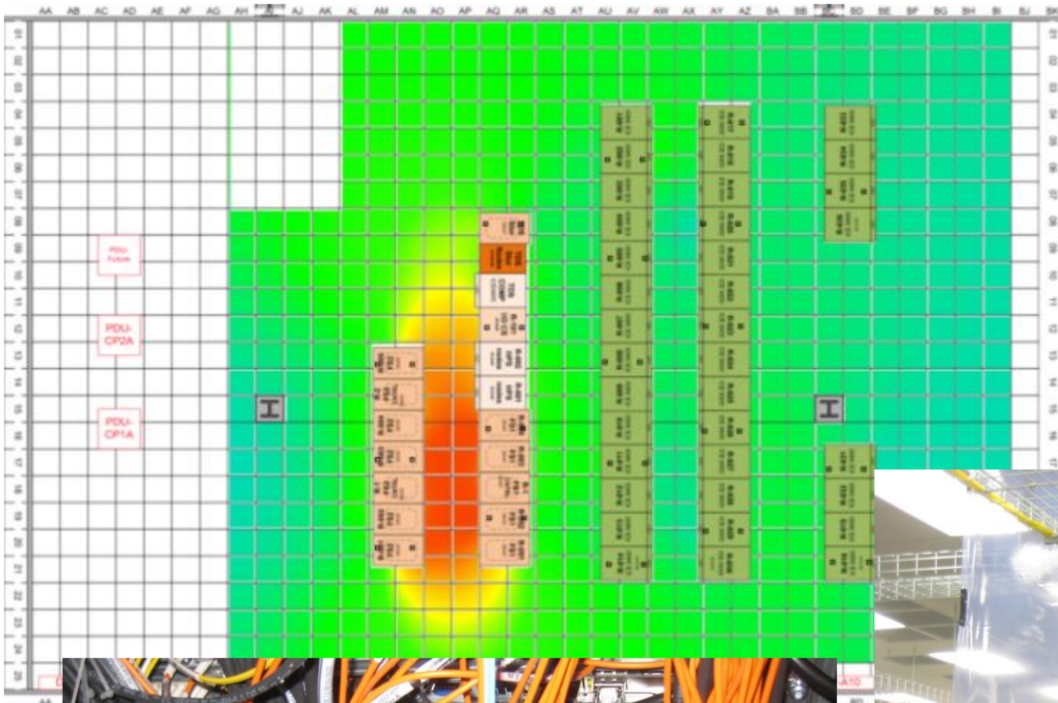


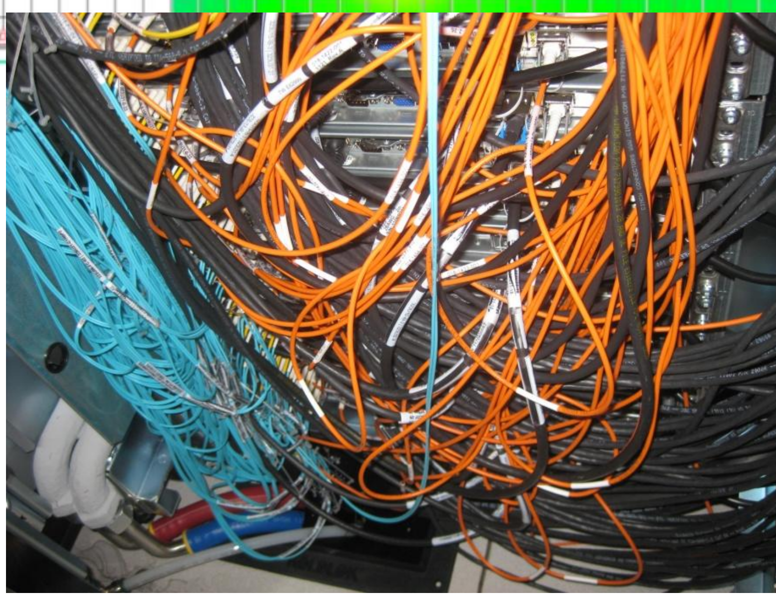
Data center 3

8,000 sf
800 kW IT
12GWh

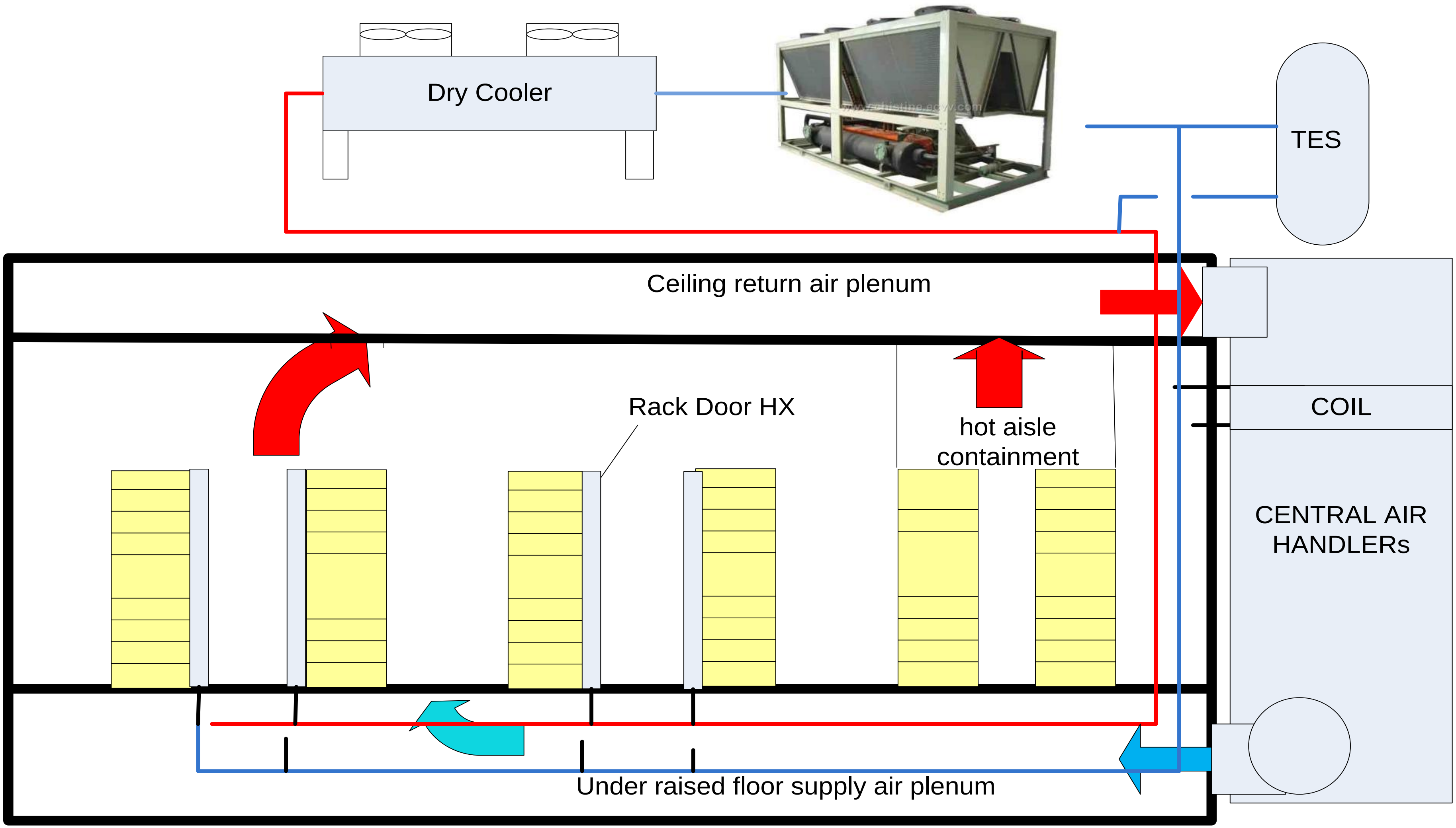


Case studies





Case studies



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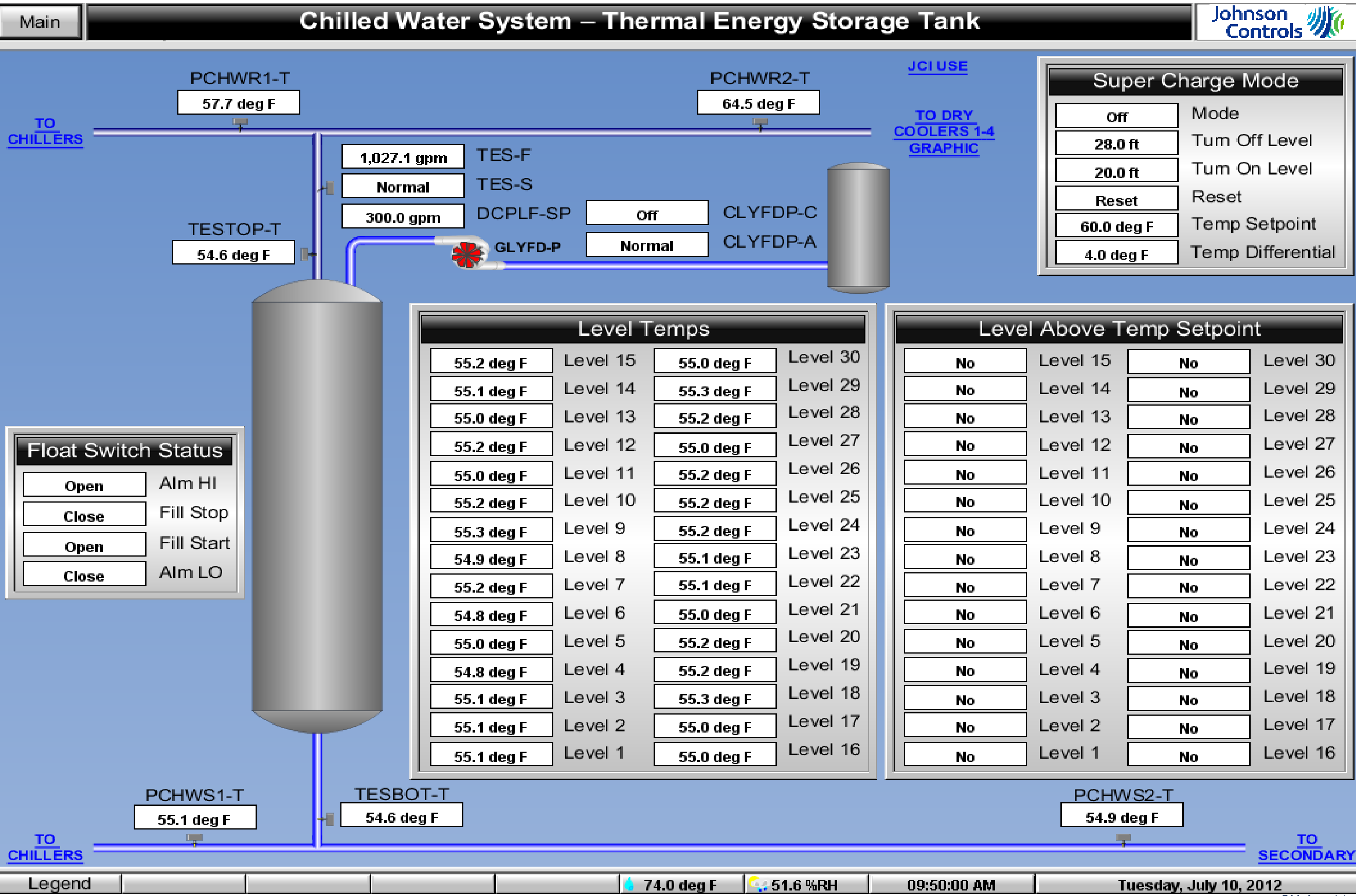
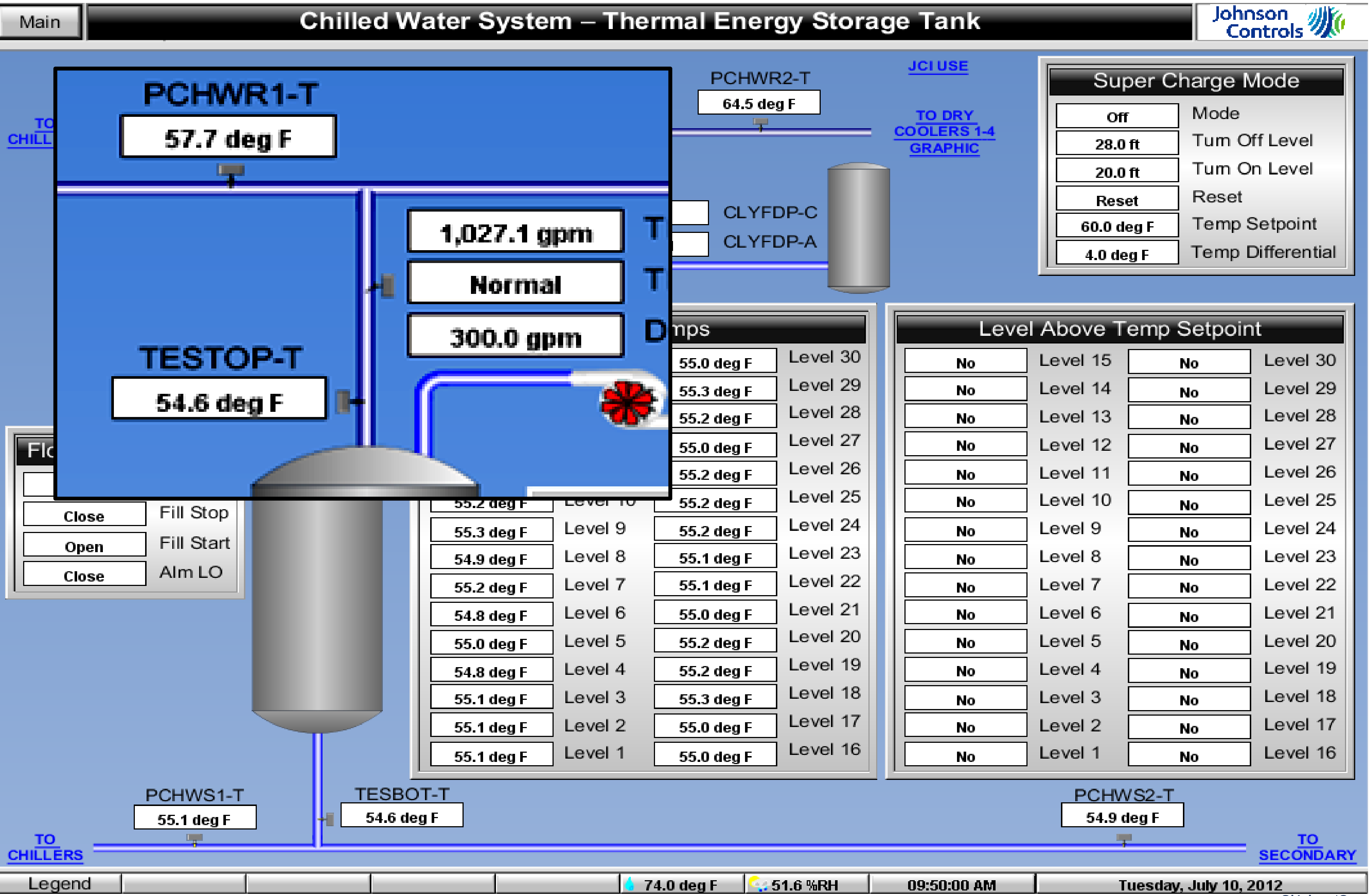
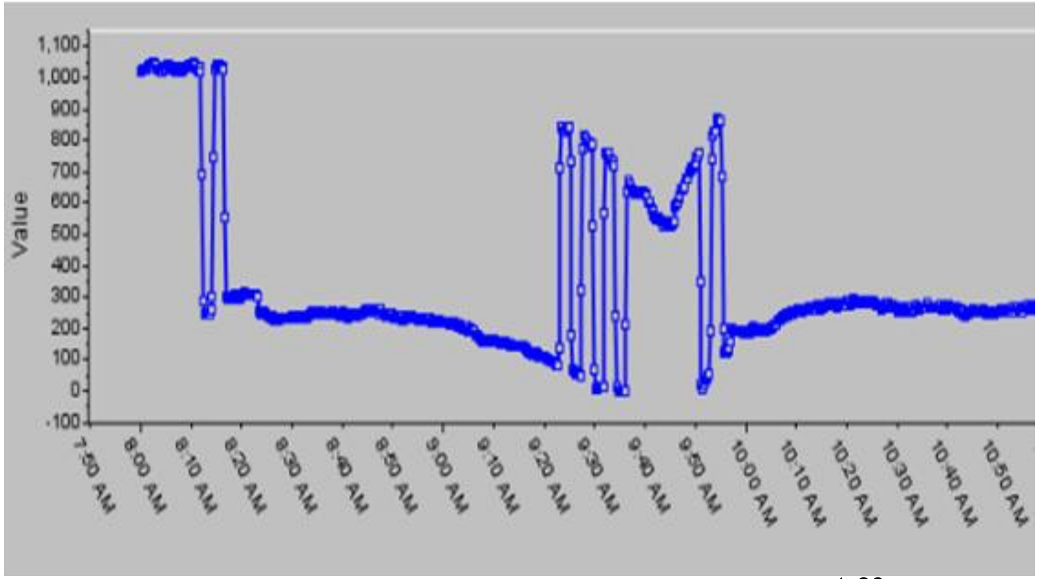


Case studies



Case studies

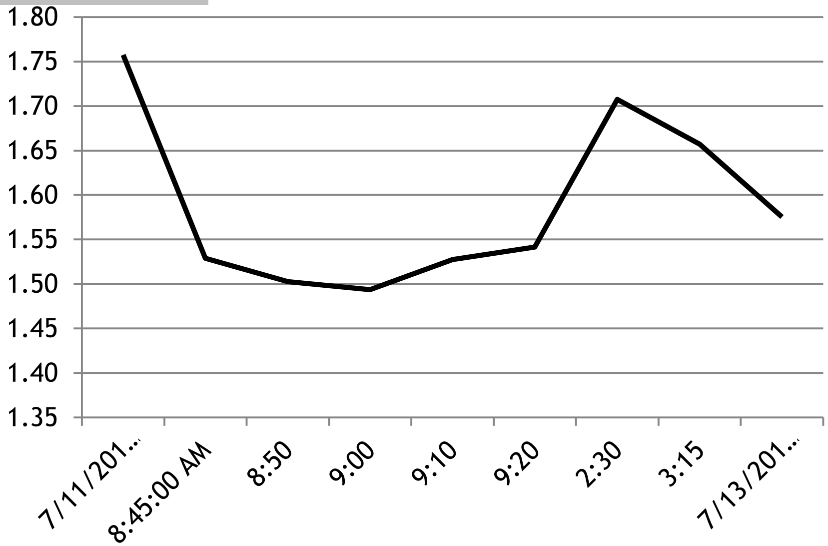


Reduction of water flow to TES from 1,000 to 300 gpm

Pump power reduced

Chiller more efficient (higher delta T and load factor)

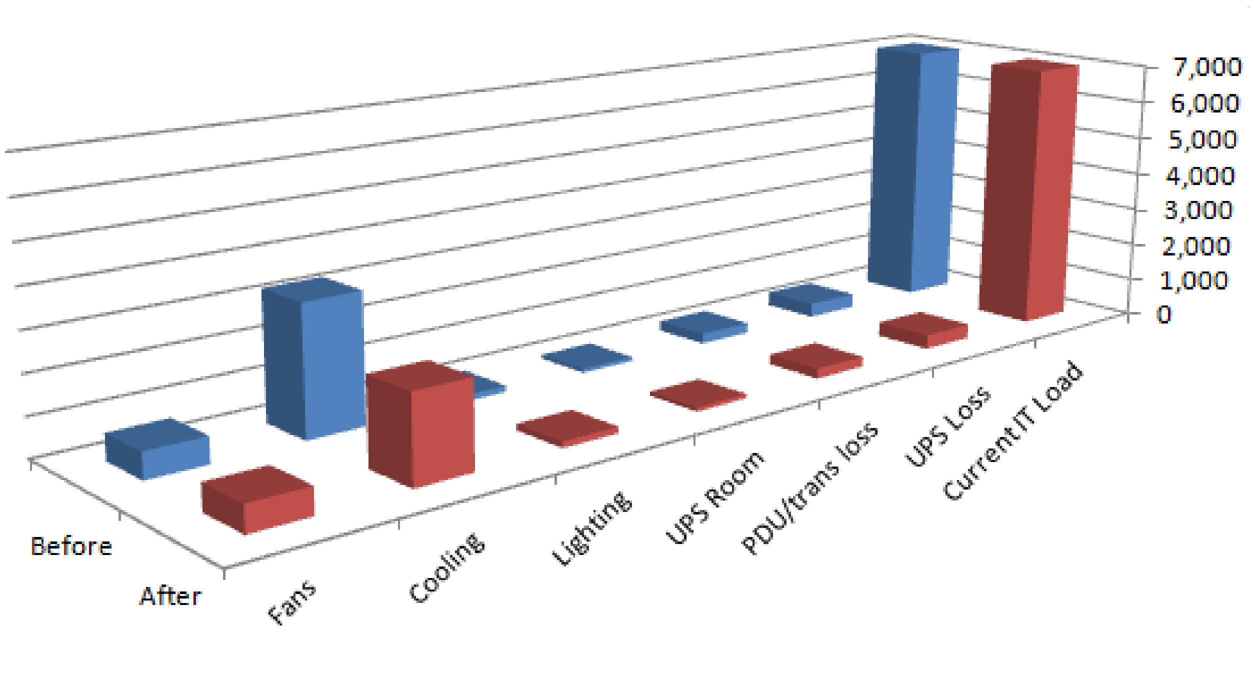
PUE improved



Case studies

Saved annually:

2,100MWh,
$125,000 utility cost
2,000 metric tons of
GHG emission



Questions?

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