Energy & Store Development Conference

E+SD 2013

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THE VOICE OF FOOD RETAIL

Energy & Store
Development Conference

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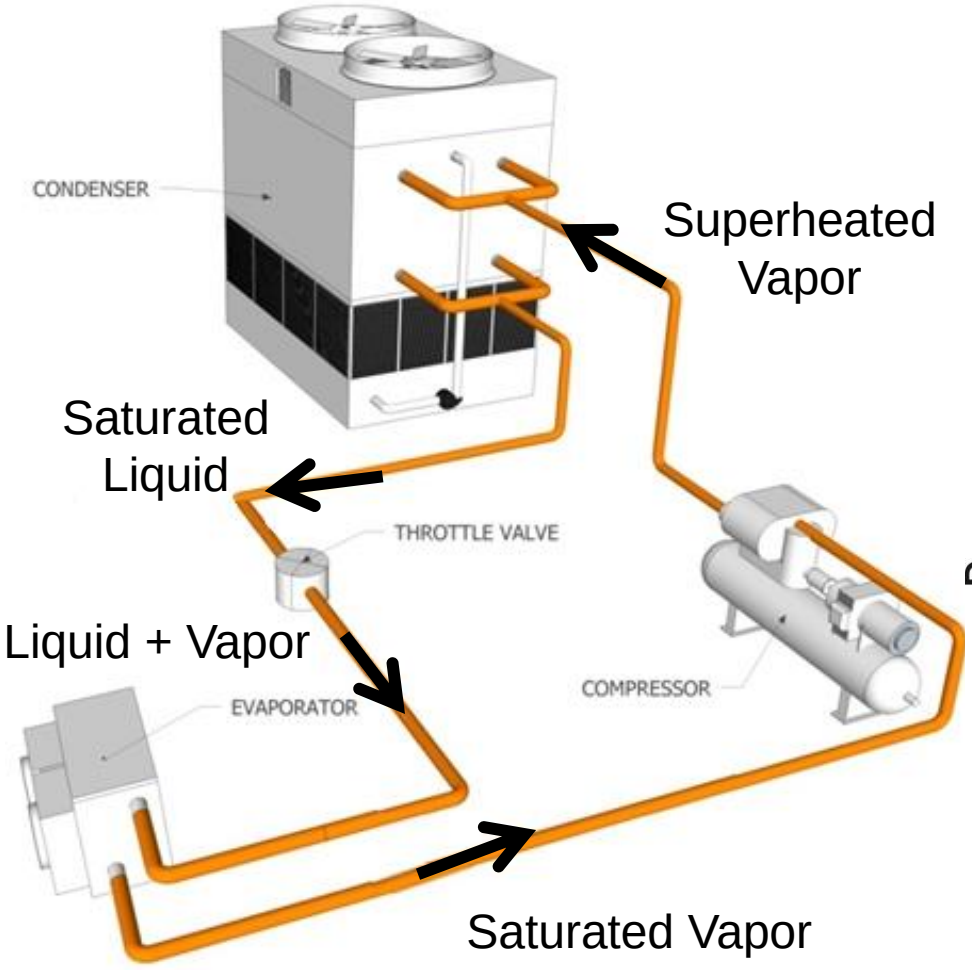
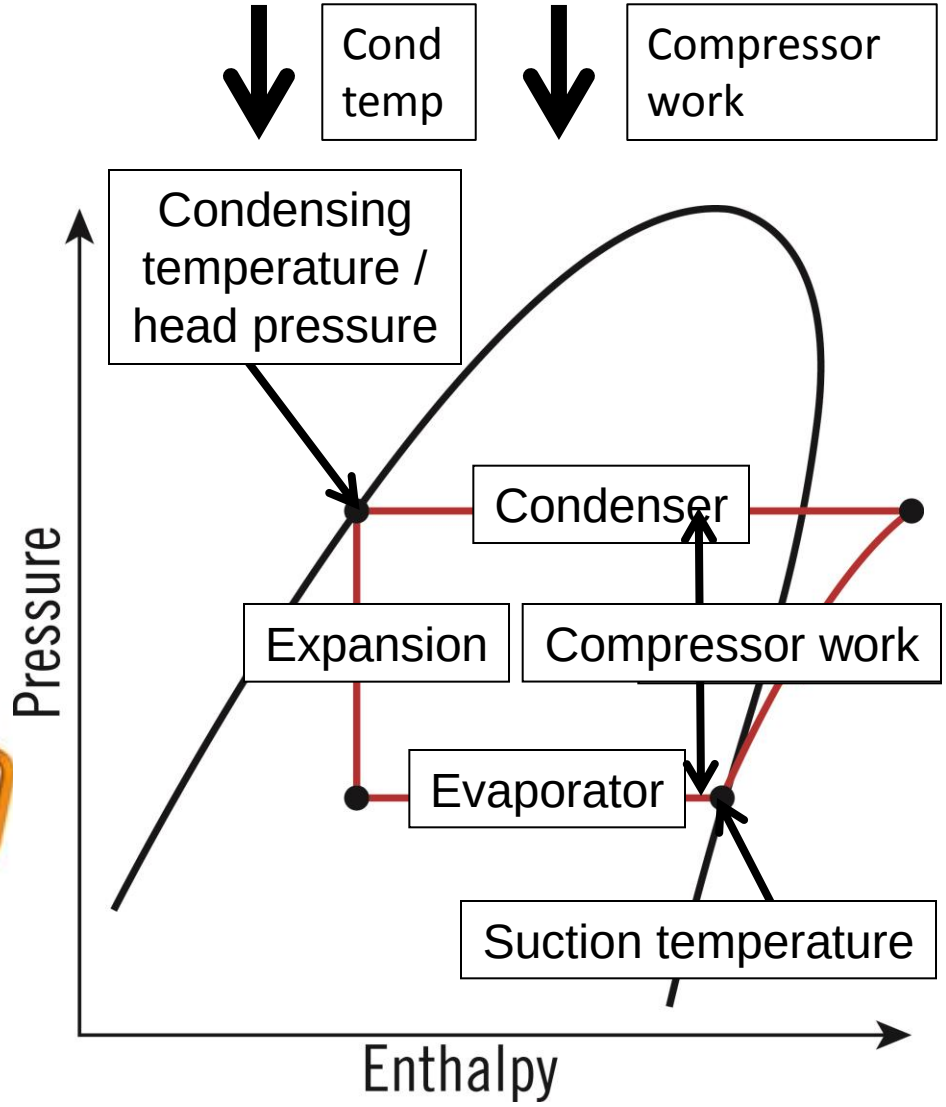
How Different Condensers and Refrigerants Affect Total Refrigeration System Energy Consumption

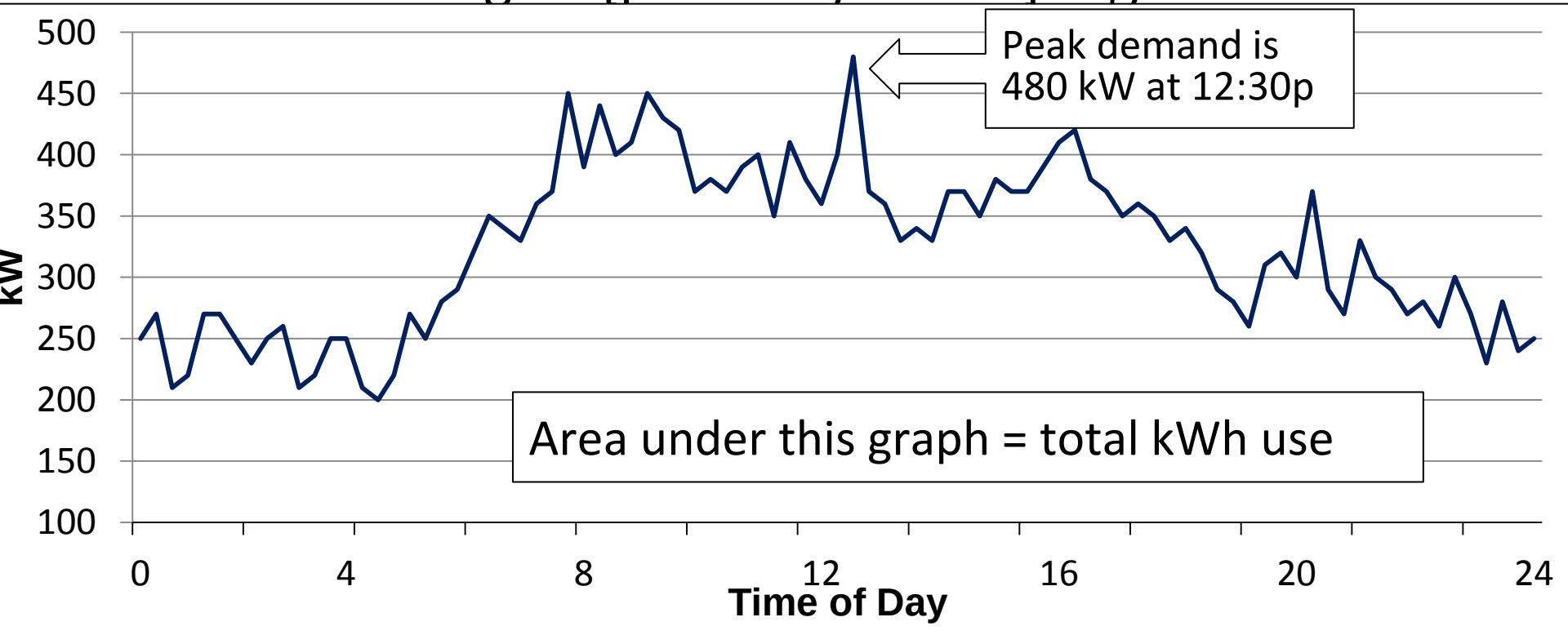
- Refrigeration system ≈ 50% total store energy
- Compressor + condenser ≈ 60 – 70% refrigeration system





Electricity Billing

- Kilowatt = rate of energy use
- Kilowatt-hour = quantity of energy used
- Electricity charge = [total kWh/month] * $/kWh
- Demand charge = [peak kW/month] * $/kW

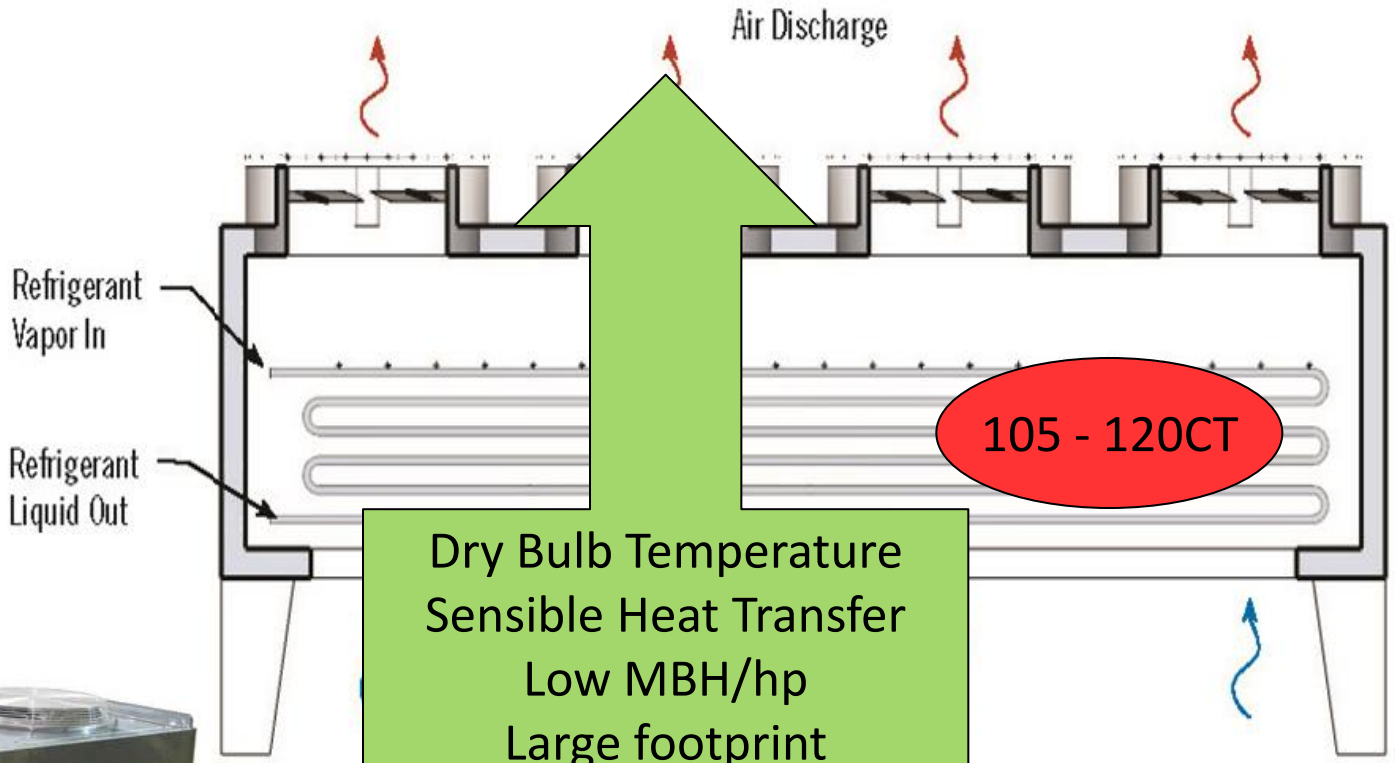


Refrigerant

Air

Conventional Air Cooled

Sensible heat transfer = temperature change



Dry Bulb Temperature
Sensible Heat Transfer
Low MBH/hp
Large footprint
No water

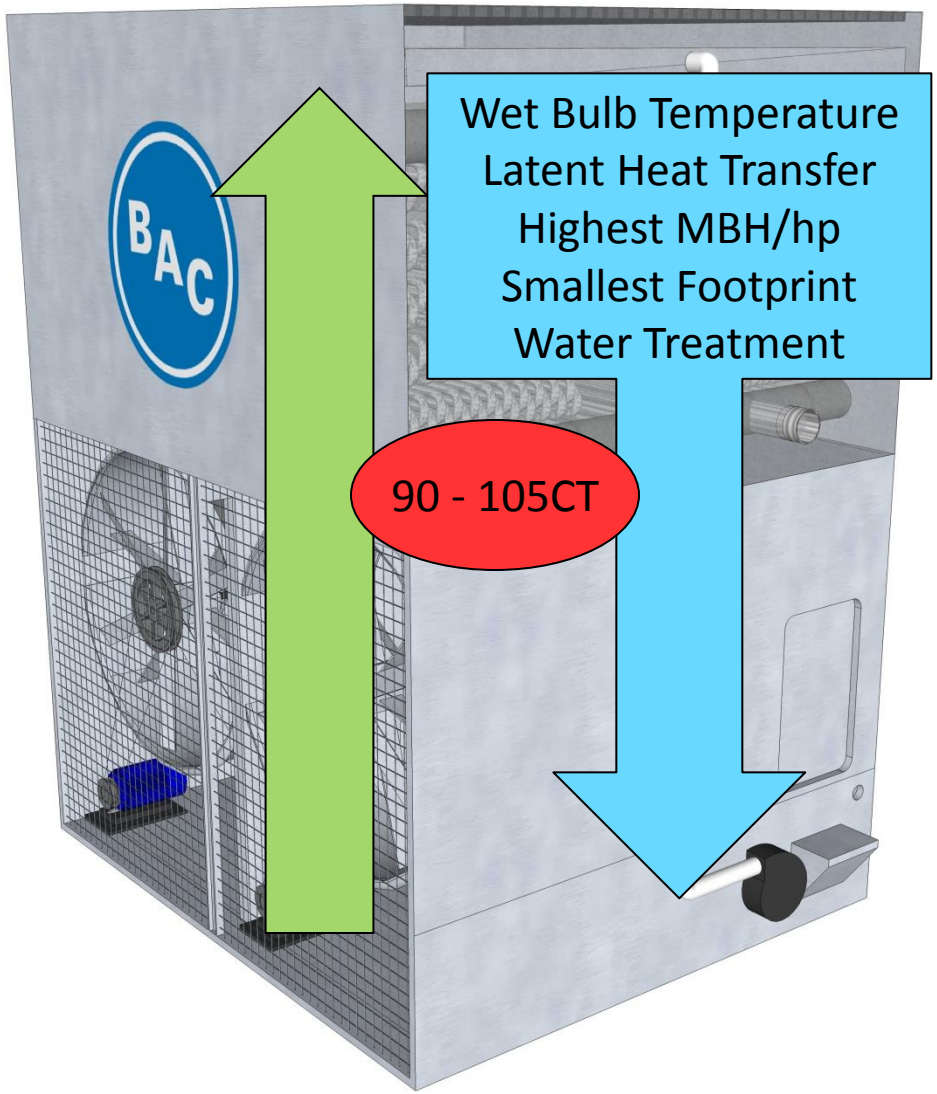
Refrigerant

Air

Water

Conventional Evaporative

Latent heat transfer = phase change (evaporation)

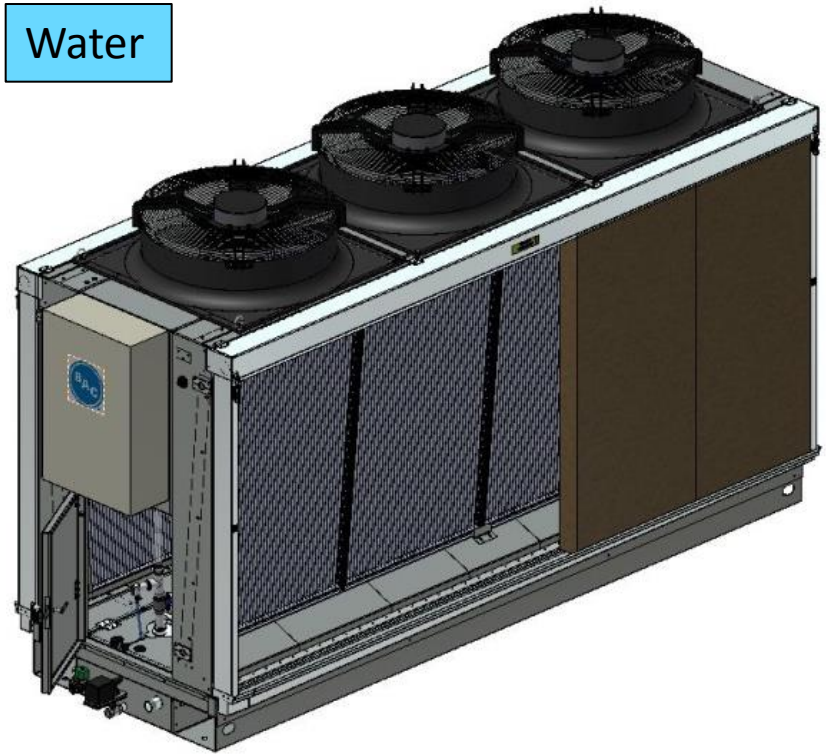


Refrigerant

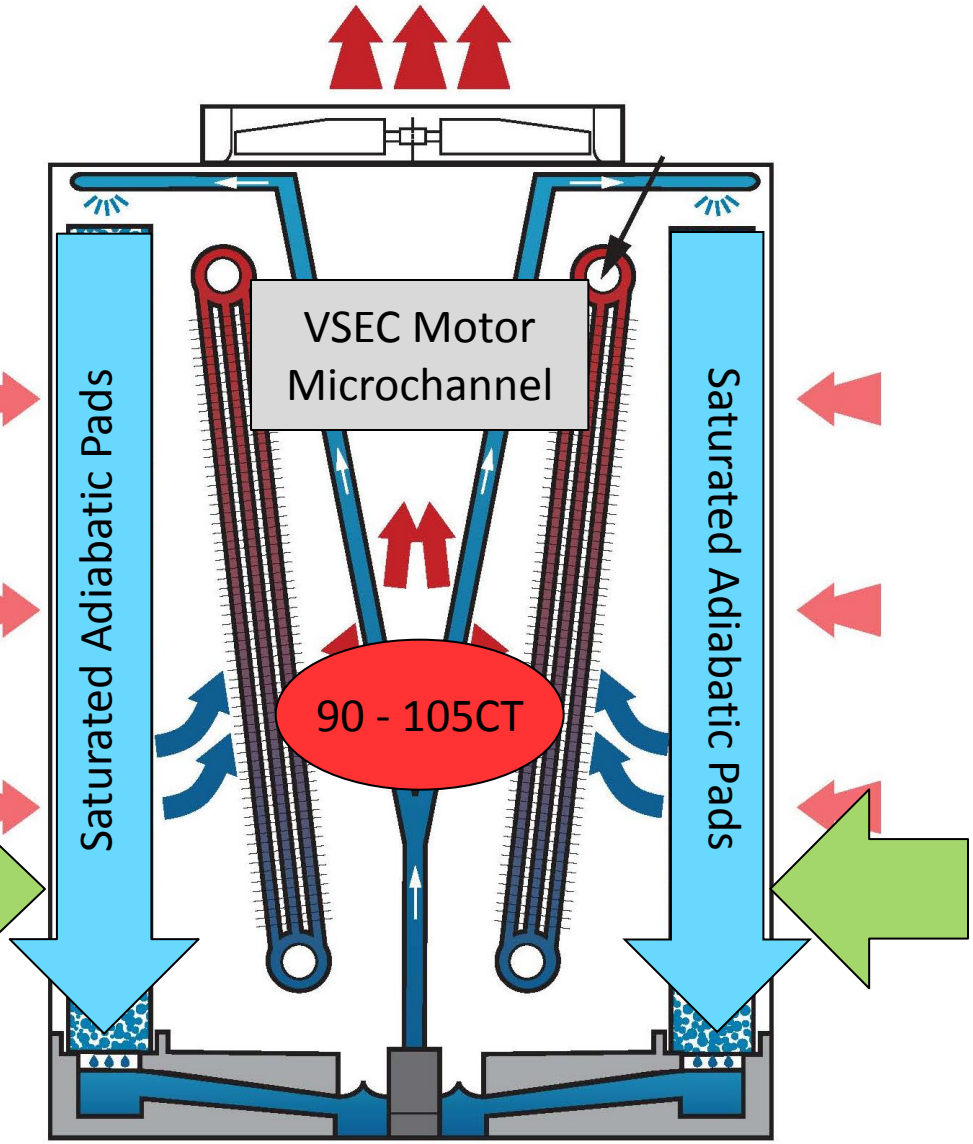
Air

Water

Dry Coil Hybrid Condenser

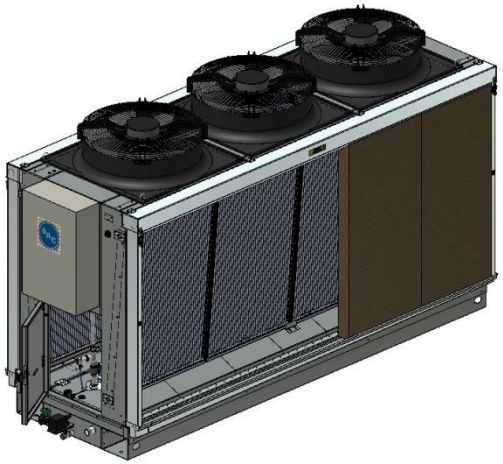


Wet bulb and dry bulb temp
Hybrid heat transfer
High MBH/hp
Small footprint
No water treatment



Condenser Types Summary

	Air Cooled	Hybrid	Evaporative
Ambient Heat Sink Temp	Dry Bulb	Dry Bulb AND Wet Bulb	Wet Bulb
Design Condensing Temp	105 – 120F	90 – 105F	90 – 105F
Efficiency	Lowest MBH/hp	High MBH/hp	Highest MBH/hp
Peak kW and Total kWh	Highest	Lower	Lowest
Footprint	Largest	Smaller	Smallest
Water Required	None	Water	Water + treatment



Case Study:
Edina, MN

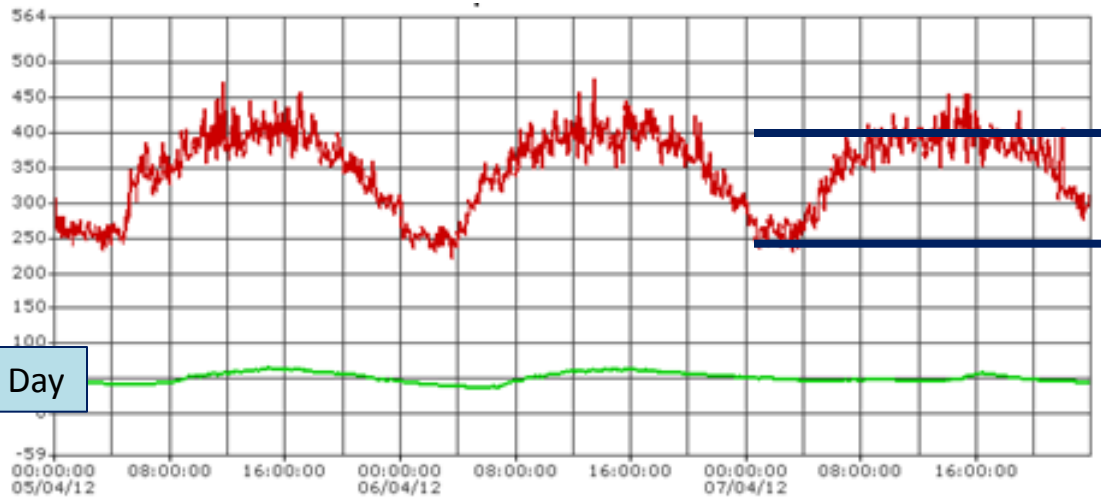
Pilot Store Retrofit

Before: Five Air-cooled Condensers

After: Five Hybrid Condensers

Total Store: 50F Day

Before

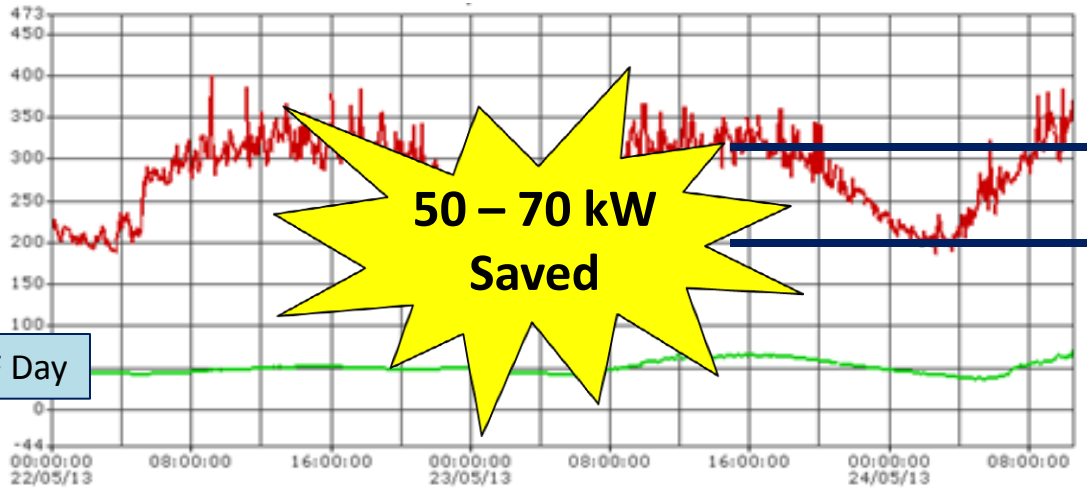


400 kW max

250 kW min

Ambient 50 F Day

After



50 – 70 kW Saved

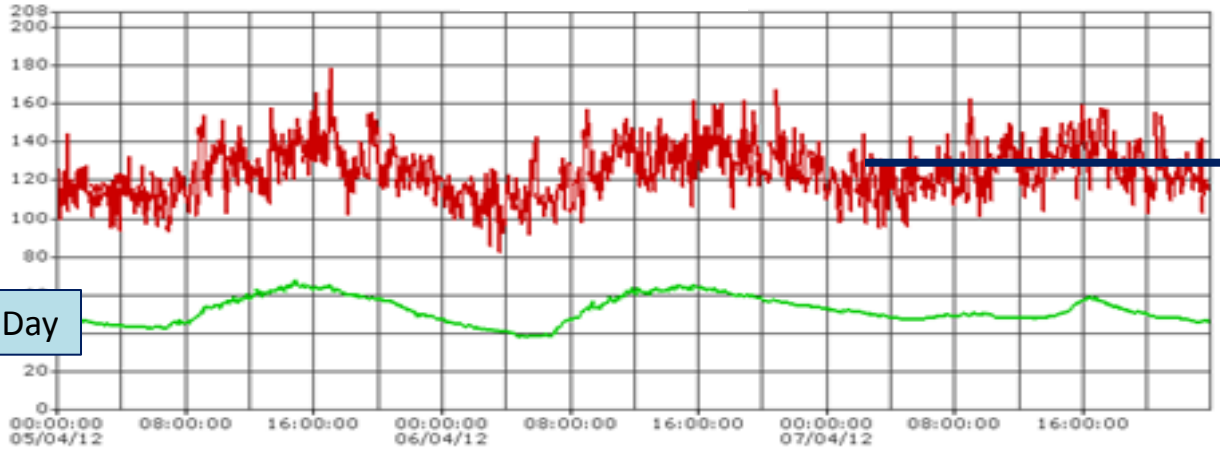
330 kW max

200 kW min

Ambient 50 F Day

Total Refrigeration: 50F Day

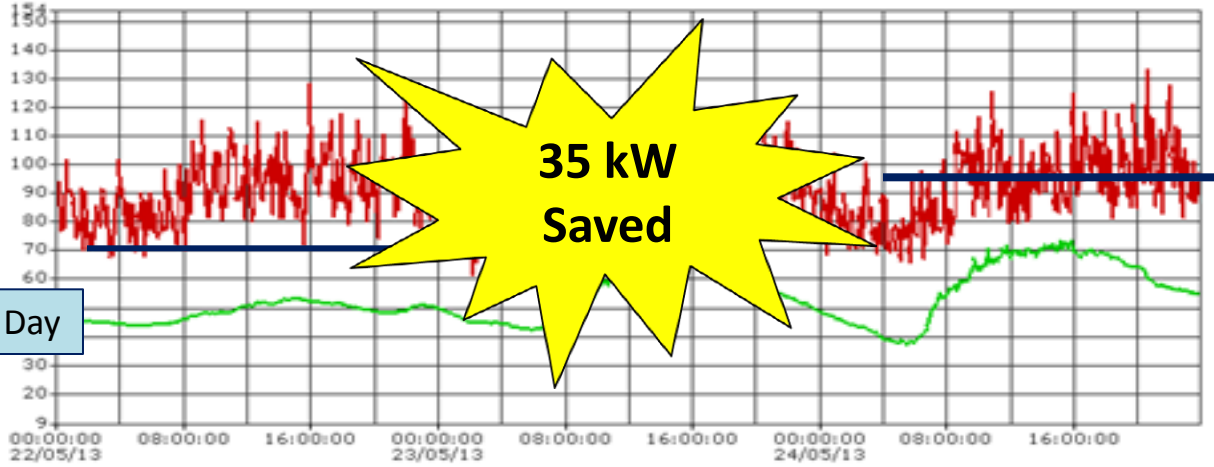
Before



130 kW Avg

Ambient 50 F Day

After



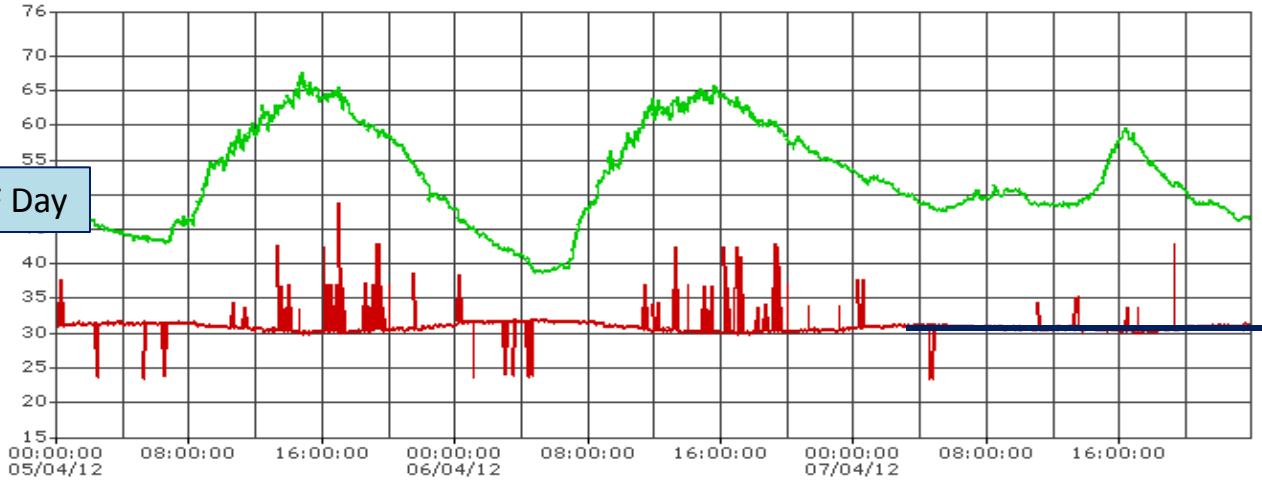
35 kW Saved

95 kW Avg

Ambient 50 F Day

Total Fan Power: 50F Day

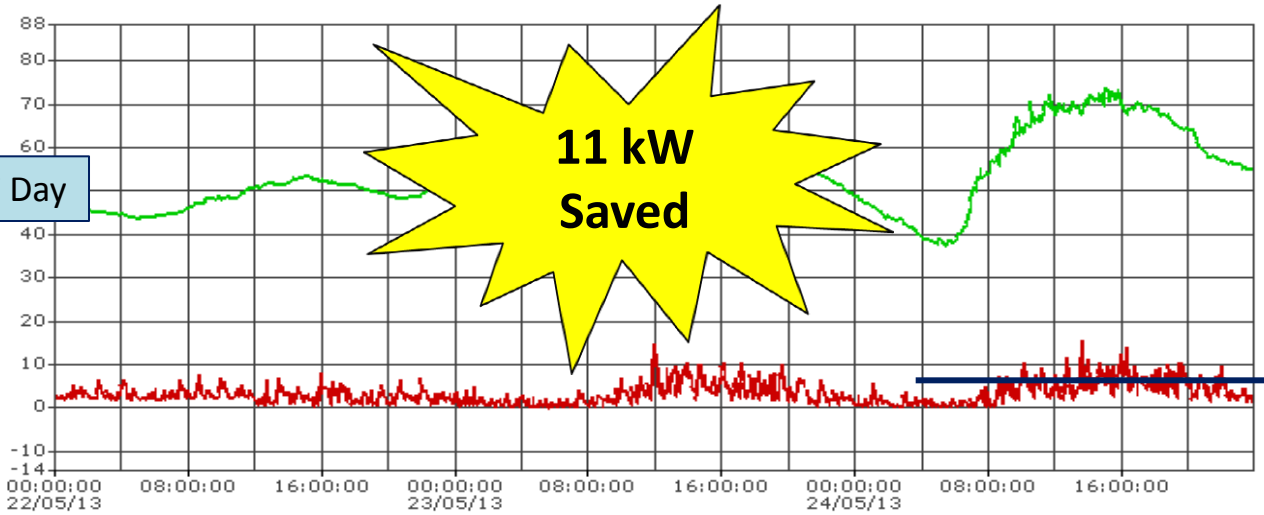
Before



Ambient 50 F Day

15 kW Avg

After



Ambient 50 F Day

11 kW Saved

4 kW Avg

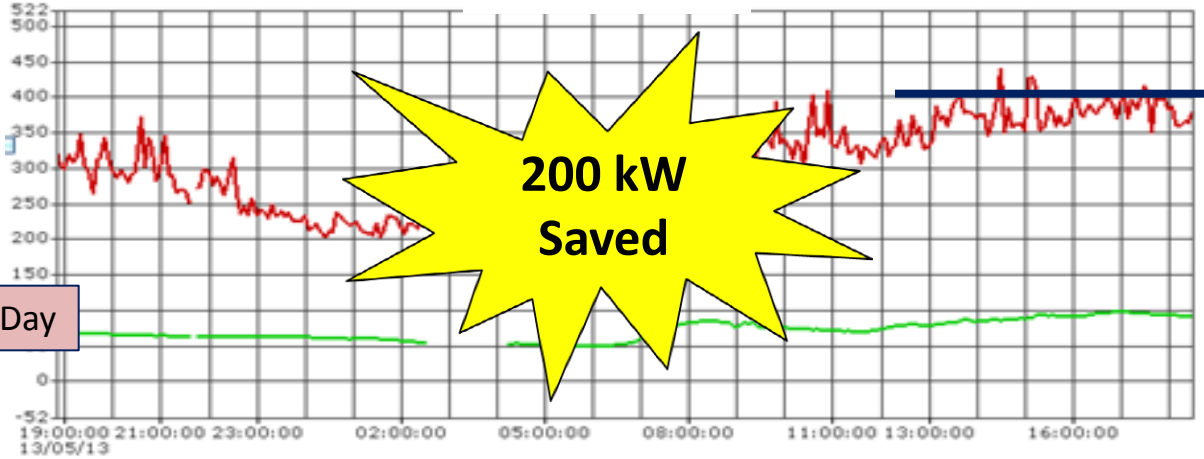
Total Store: 100F Day

Before

600 kW

Ambient 100F Day

After



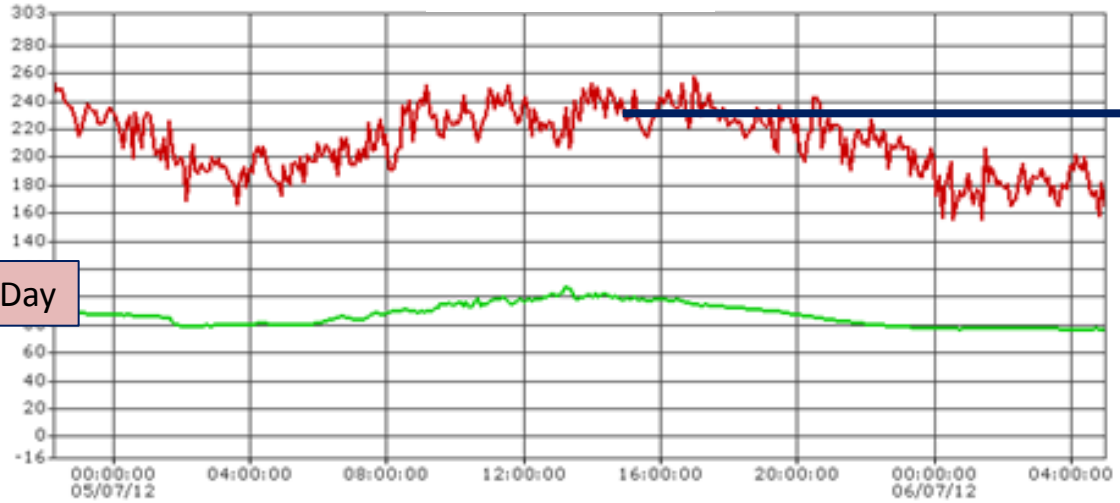
400 kW

200 kW Saved

Ambient 100F Day

Total Refrigeration: 100F Day

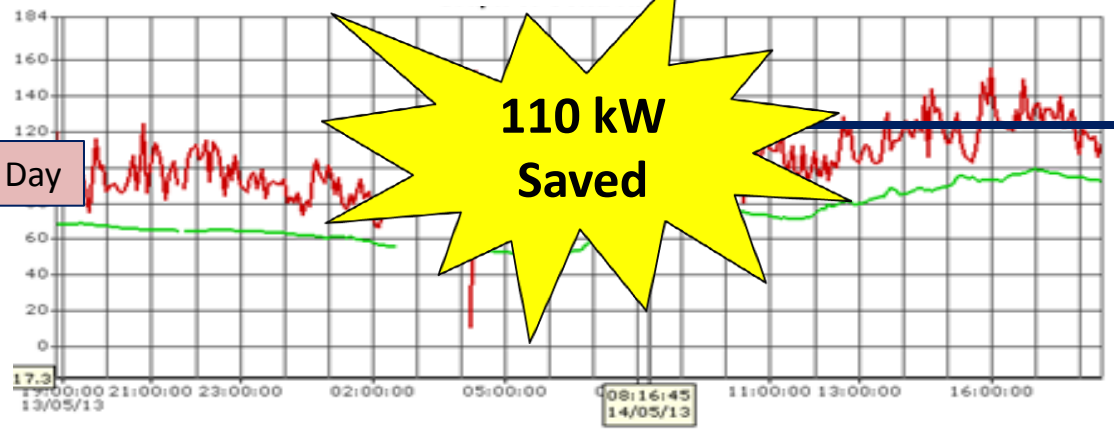
Before



230 kW Avg

Ambient 100F Day

After



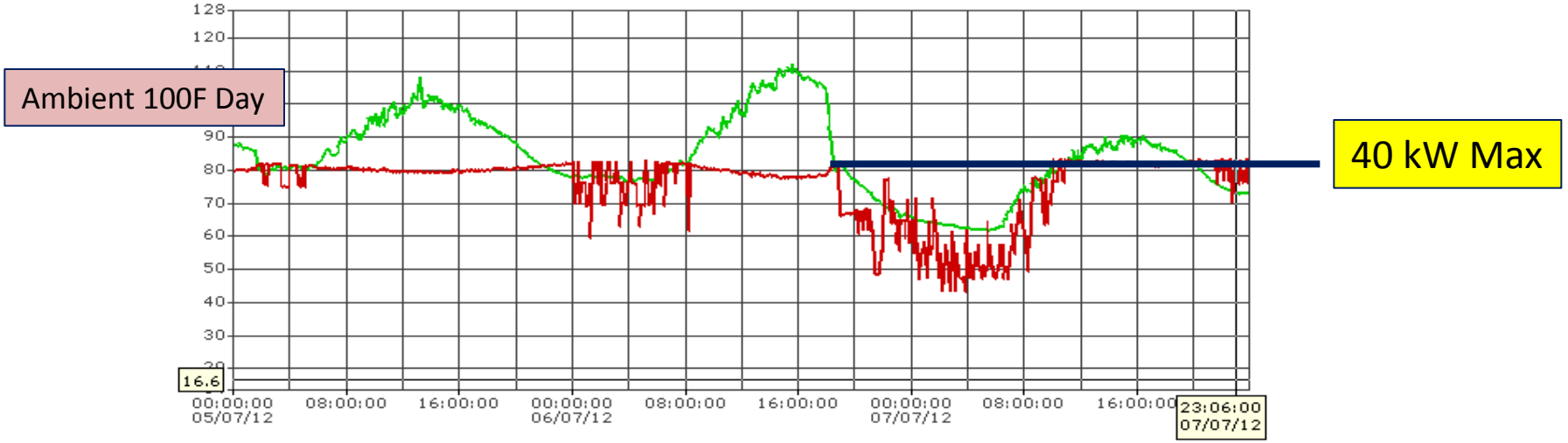
110 kW Saved

120 kW Avg

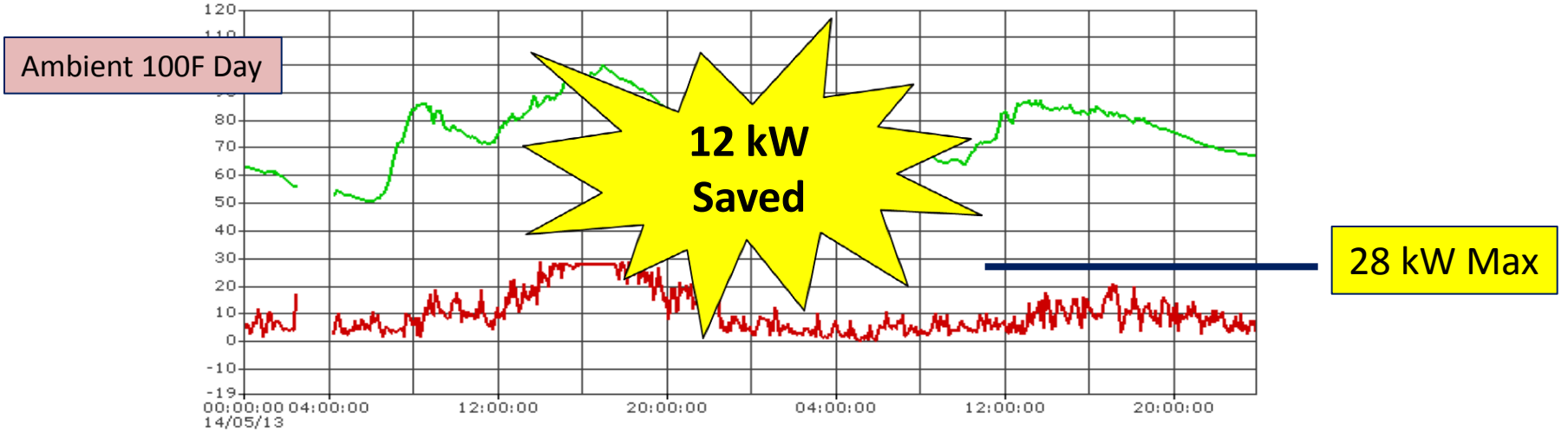
Ambient 100F Day

Total Fan Power: 100F Day

Before

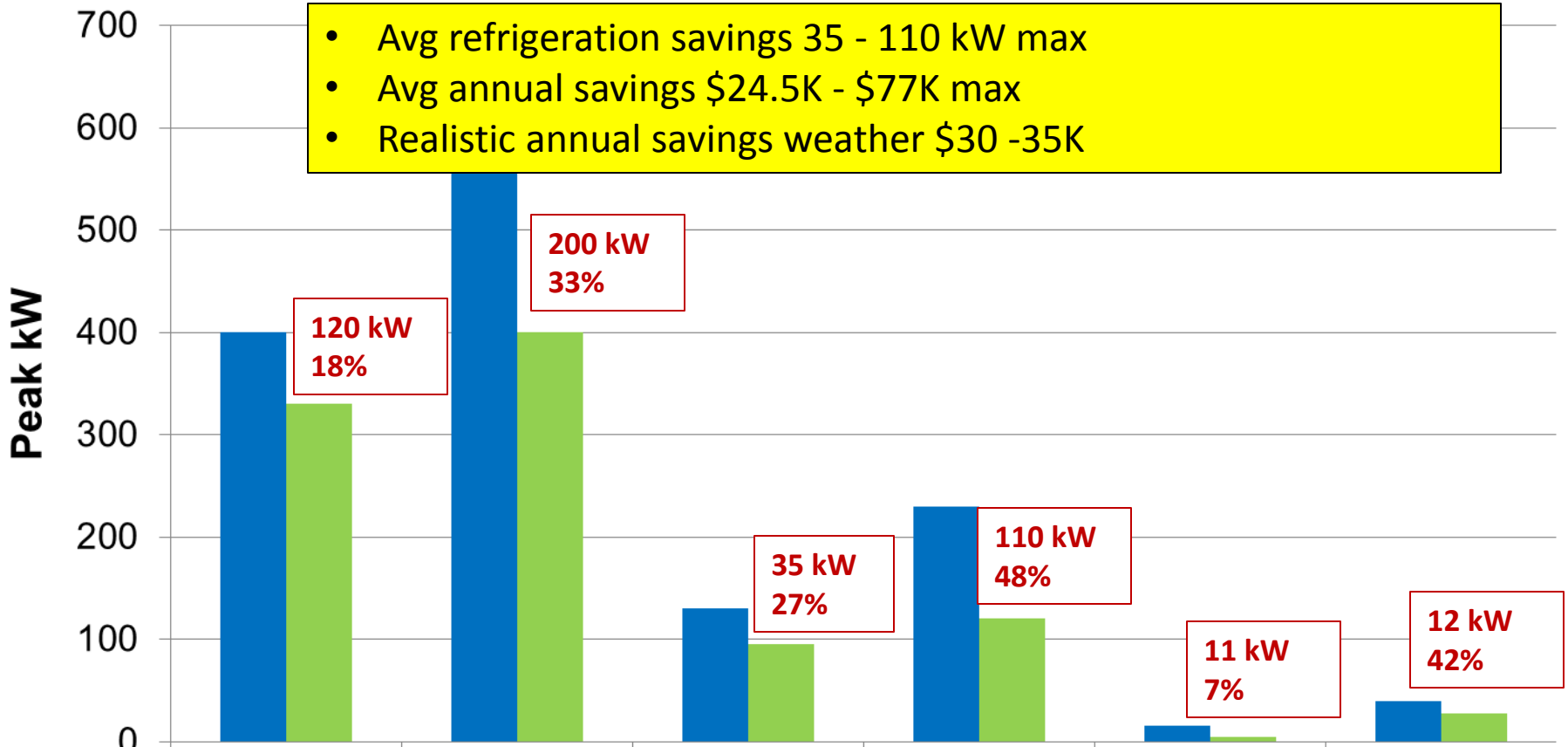


After



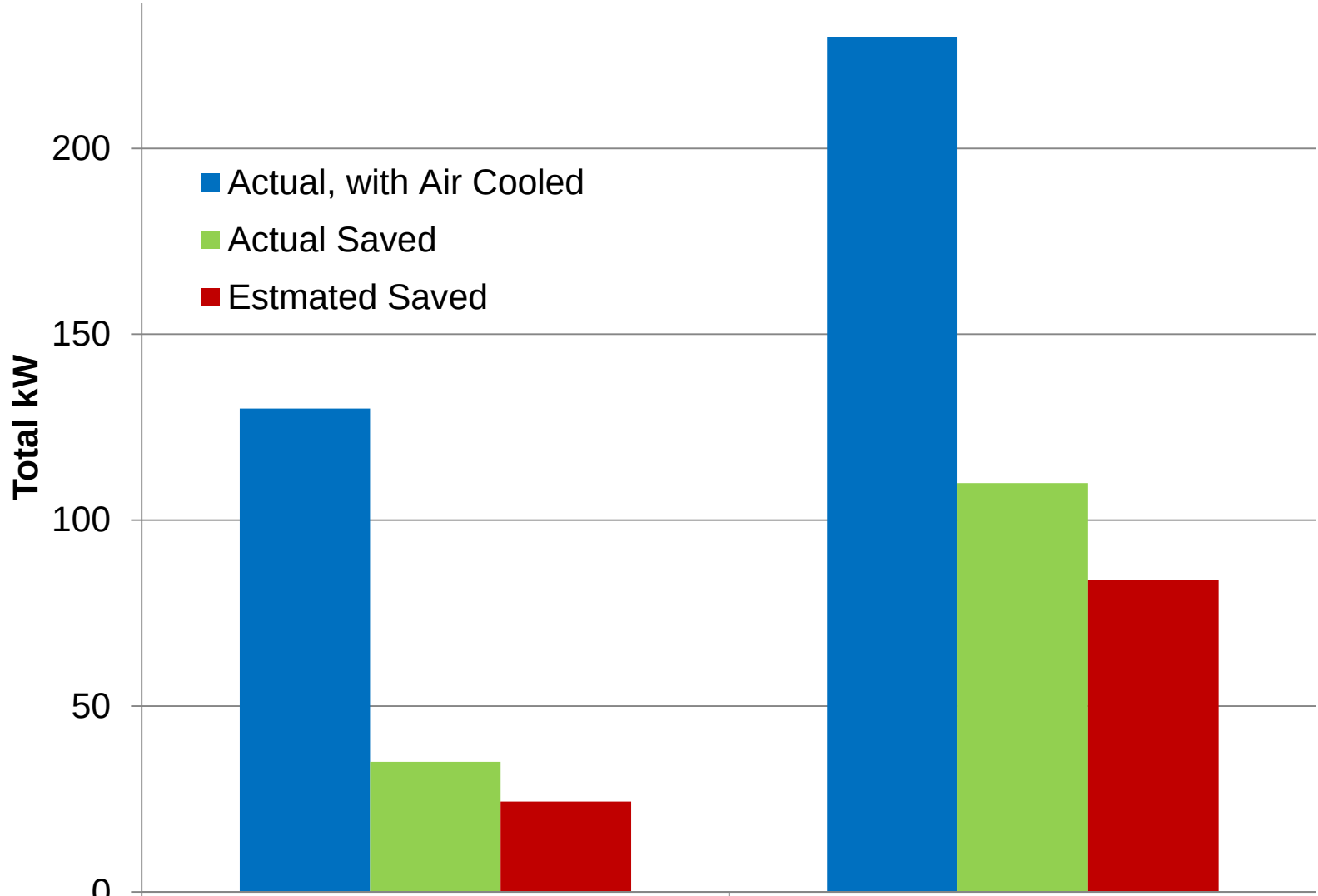
Summary

- Avg refrigeration savings 35 - 110 kW max
- Avg annual savings $24.5K - $77K max
- Realistic annual savings weather $30 -35K



	Total Store (50F)	Total Store (100F)	Total Refrig (50F)	Total Refrig (100F)	Condenser Fans (50F)	Condenser Fans (100F)
Air Cooled	400	600	130	230	15	40
Hybrid	330	400	95	120	4	28

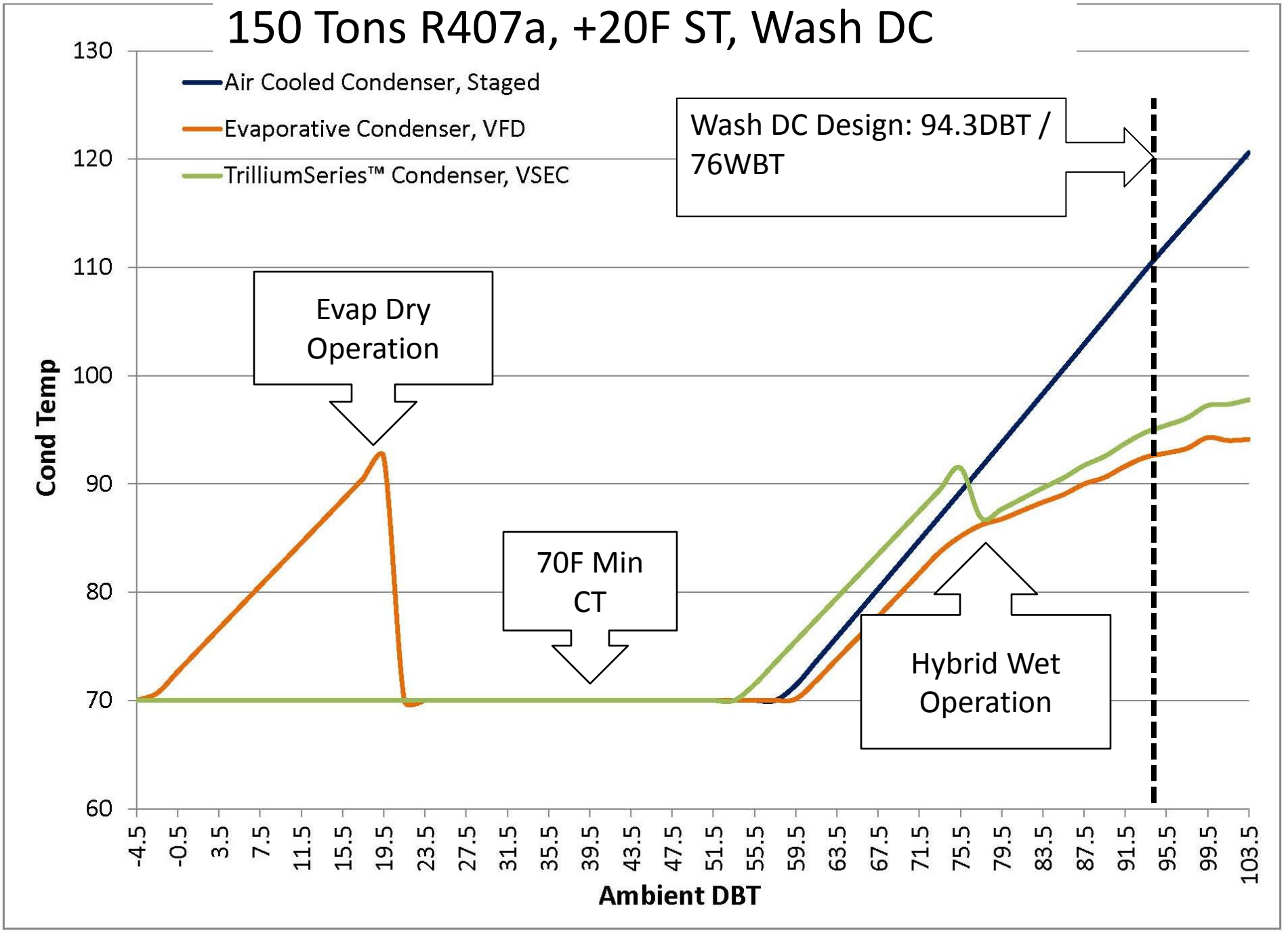
Pilot Store: Actual vs Estimated kW Savings



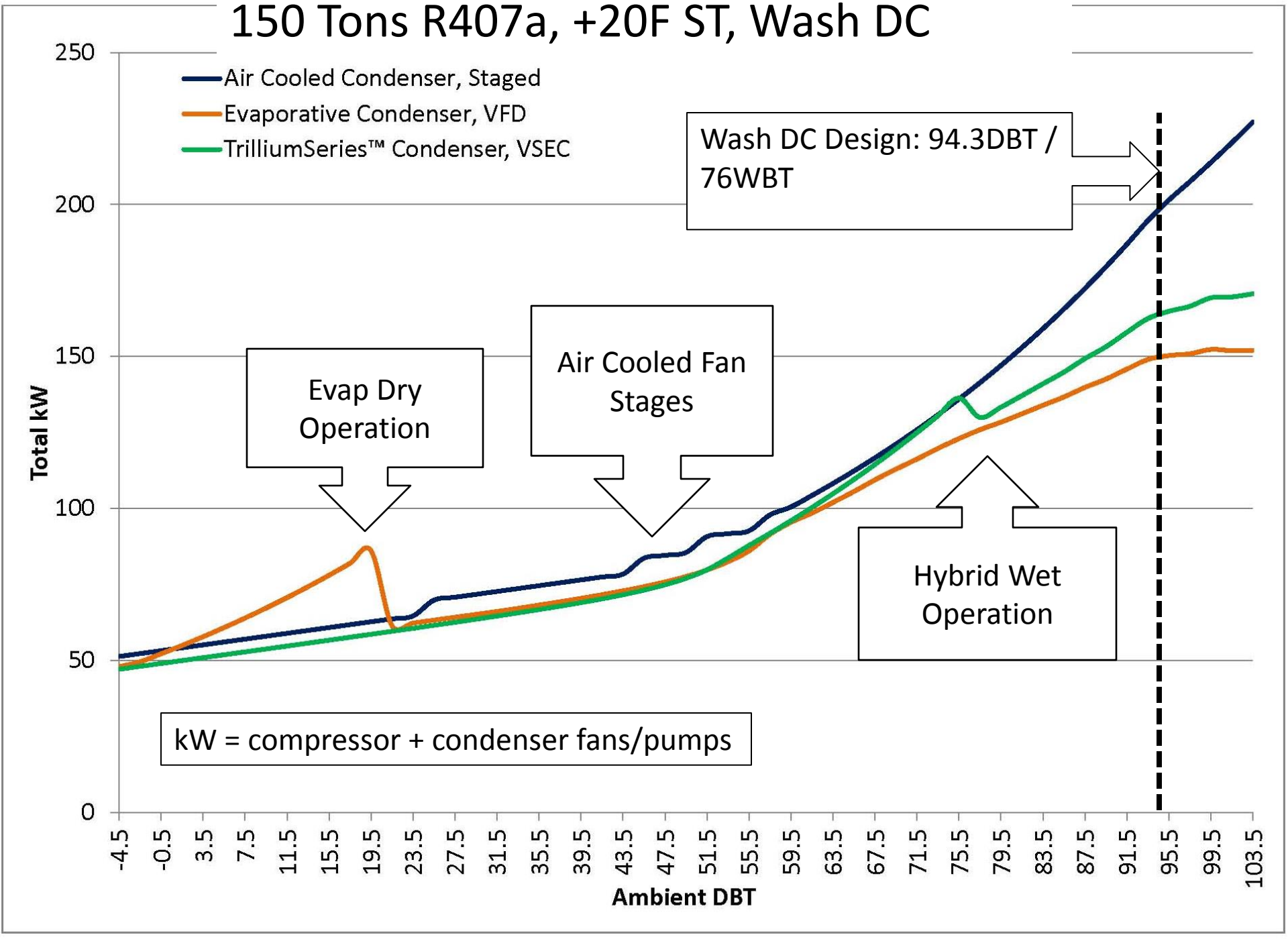
	50F Day	100F Day
Actual, with Air Cooled	130	230
Actual Saved	35	110
Estmated Saved	24	84

Energy Analysis: Simple System

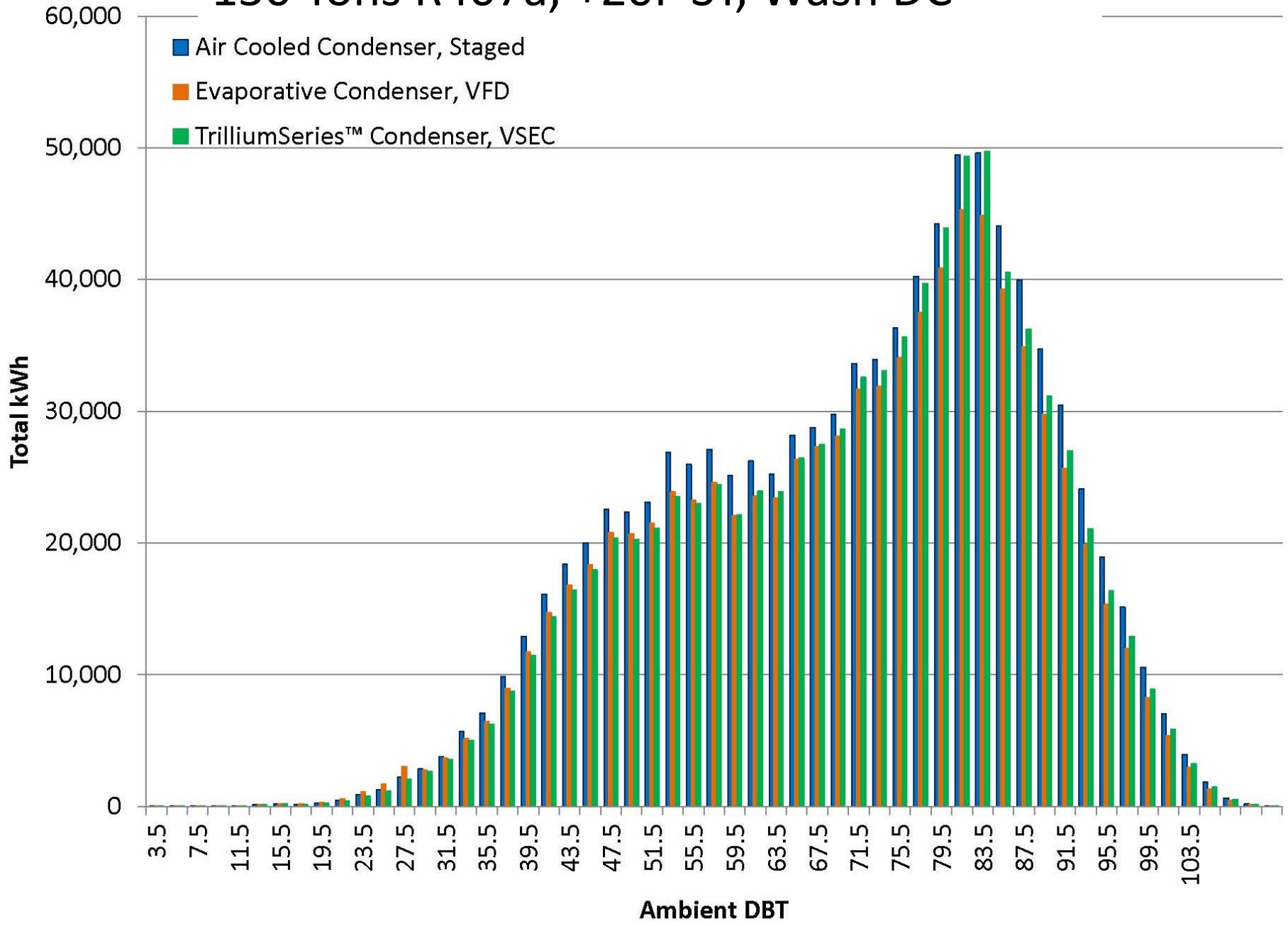
Air cooled vs hybrid vs evaporative


150 Tons R407a, +20F ST, Wash DC
Air Cooled Condenser, Staged
Evaporative Condenser, VFD
TrilliumSeries™ Condenser, VSEC
Wash DC Design: 94.3DBT / 76WBT
Evap Dry Operation
70F Min CT
Hybrid Wet Operation
Cond Temp
130
120
110
100
90
80
70
60
-4.5
-0.5
3.5
7.5
11.5
15.5
19.5
23.5
27.5
31.5
35.5
39.5
43.5
47.5
51.5
55.5
59.5
63.5
67.5
71.5
75.5
79.5
83.5
87.5
91.5
95.5
99.5
103.5
Ambient DBT

150 Tons R407a, +20F ST, Wash DC

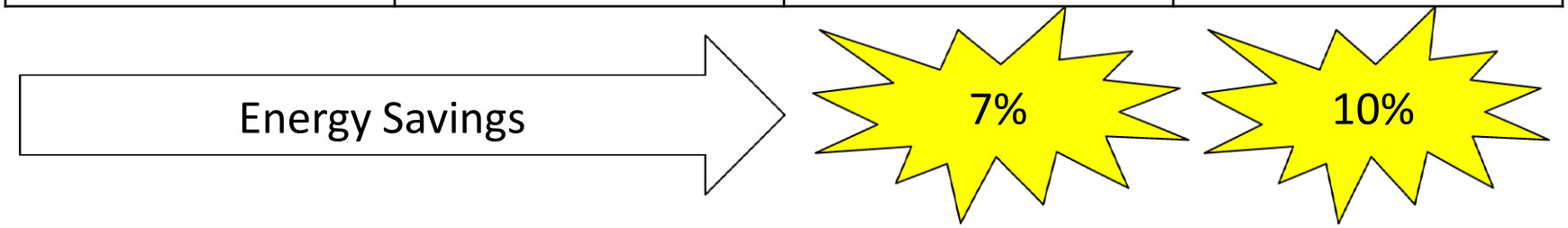


150 Tons R407a, +20F ST, Wash DC

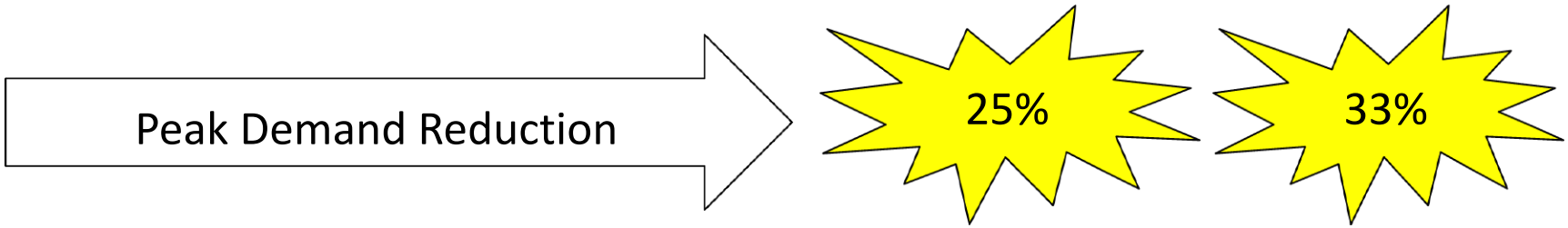


Summary: R407a

Total kWh/yr	Air Cooled	Hybrid	Evaporative
R407a	932,561	866,251	842,786



Peak kW	Air Cooled	Hybrid	Evaporative
R407a	227	171	152

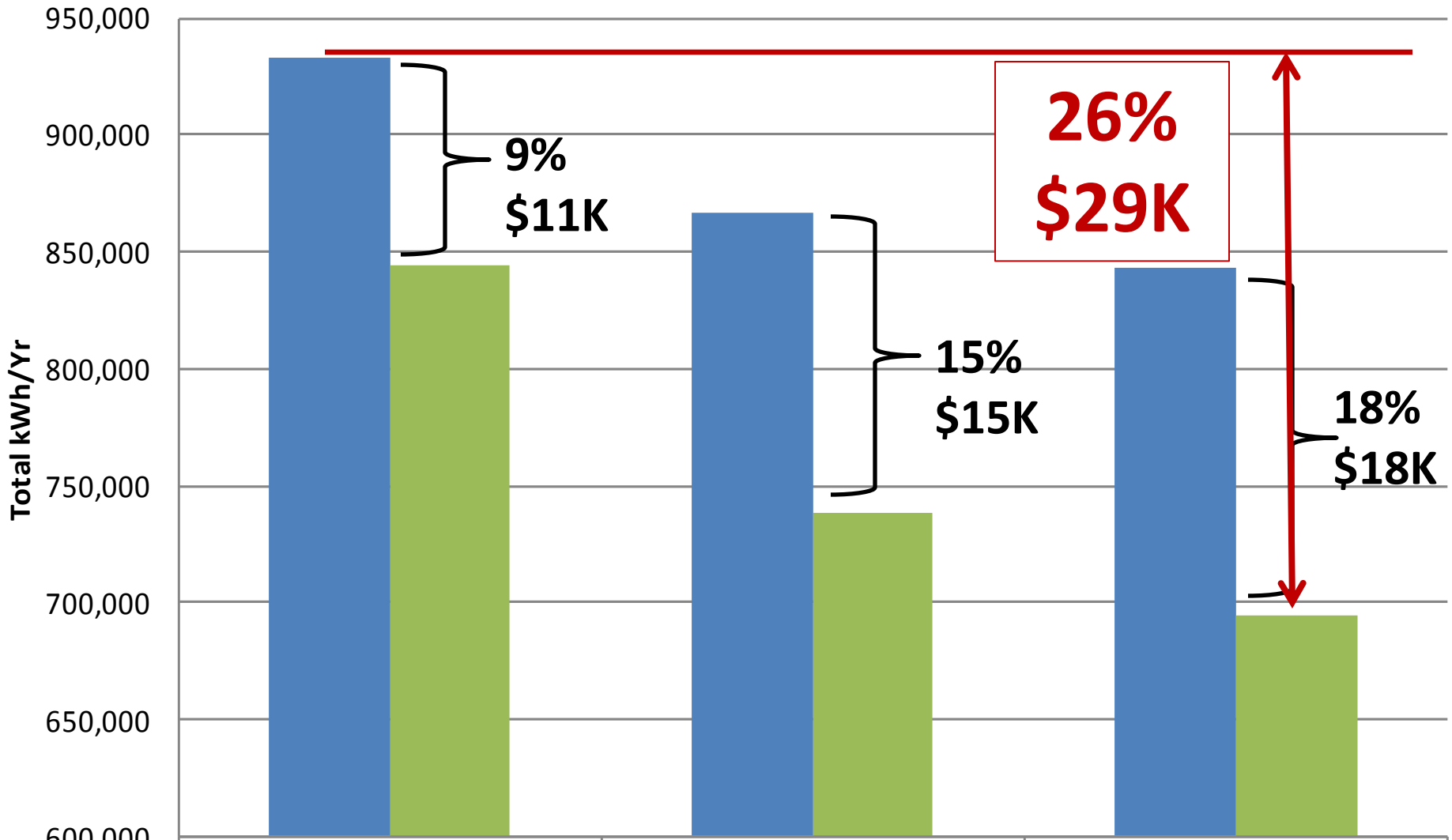


Energy Analysis: Simple System

R407a vs R717

$0.12/kWh

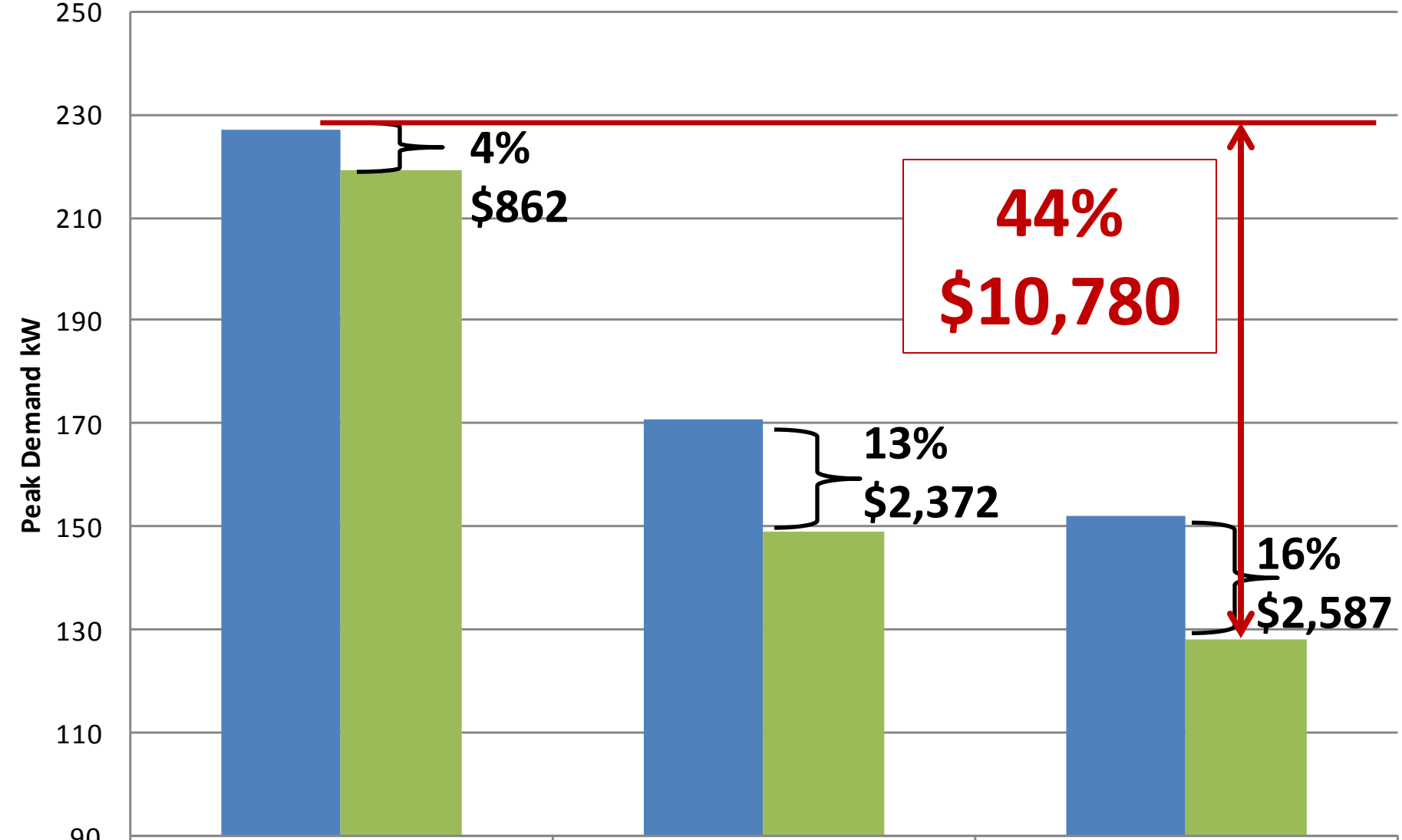
150 TR System, +20F Suction, Washington DC



	Air Cooled	Hybrid	Evaporative
R-407A	932,561	866,251	842,786
R-717	844,467	738,549	694,775

$11/kW
80% ratchet

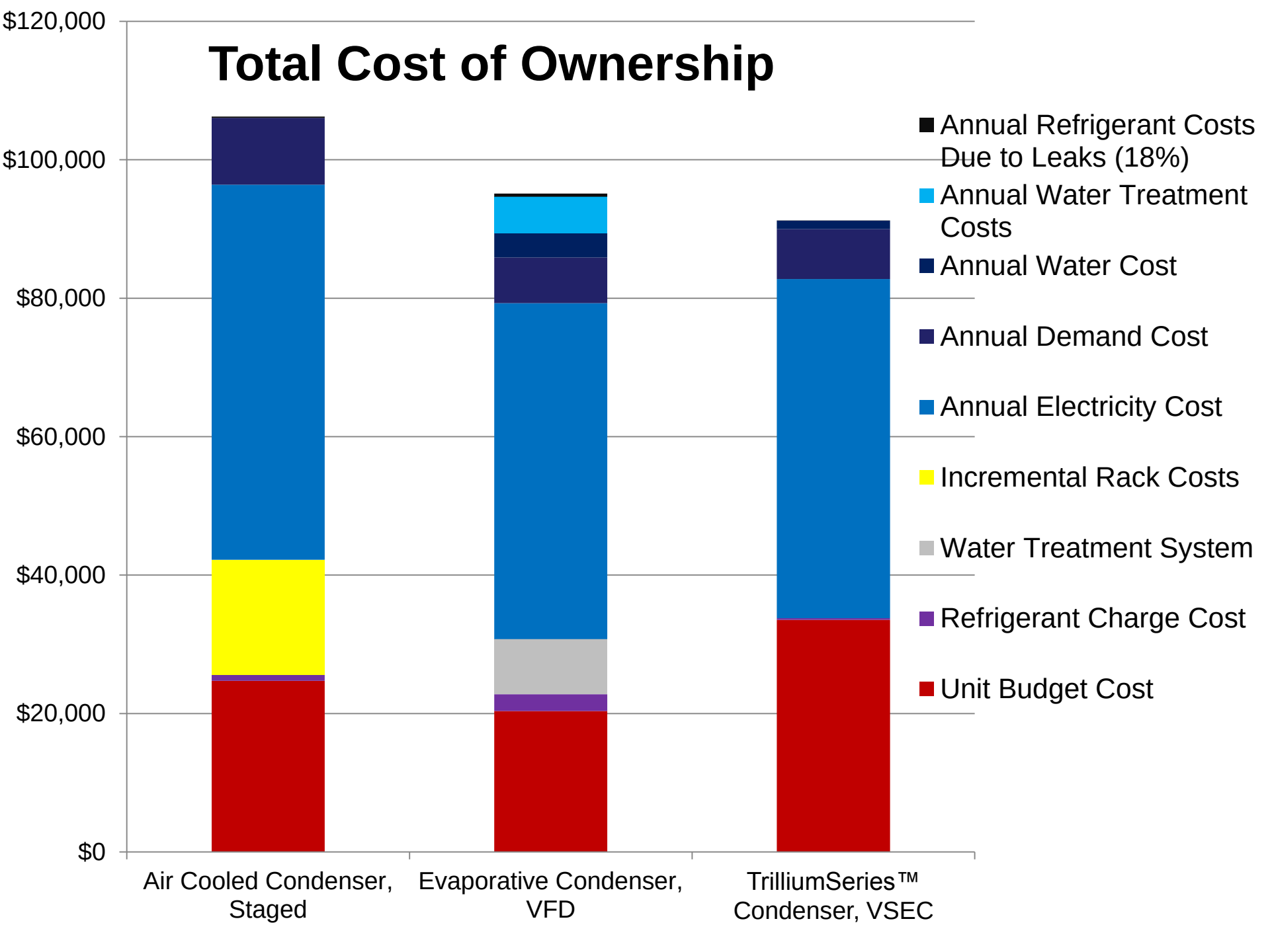
Peak, 150 TR System, +20F Suction, Washington DC

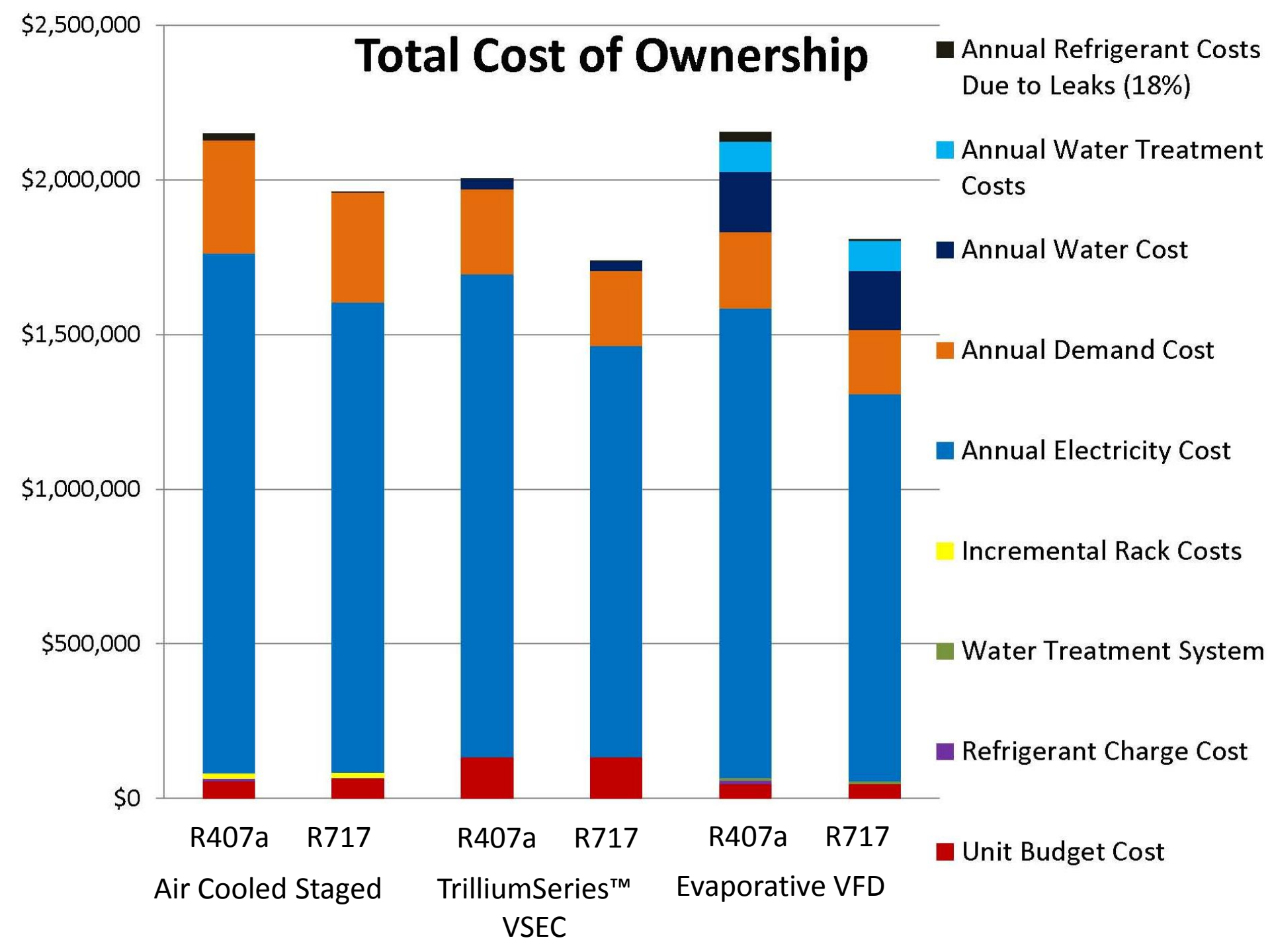


	Air Cooled	Hybrid	Evaporative
R407a	227	171	152
R717	219	149	128

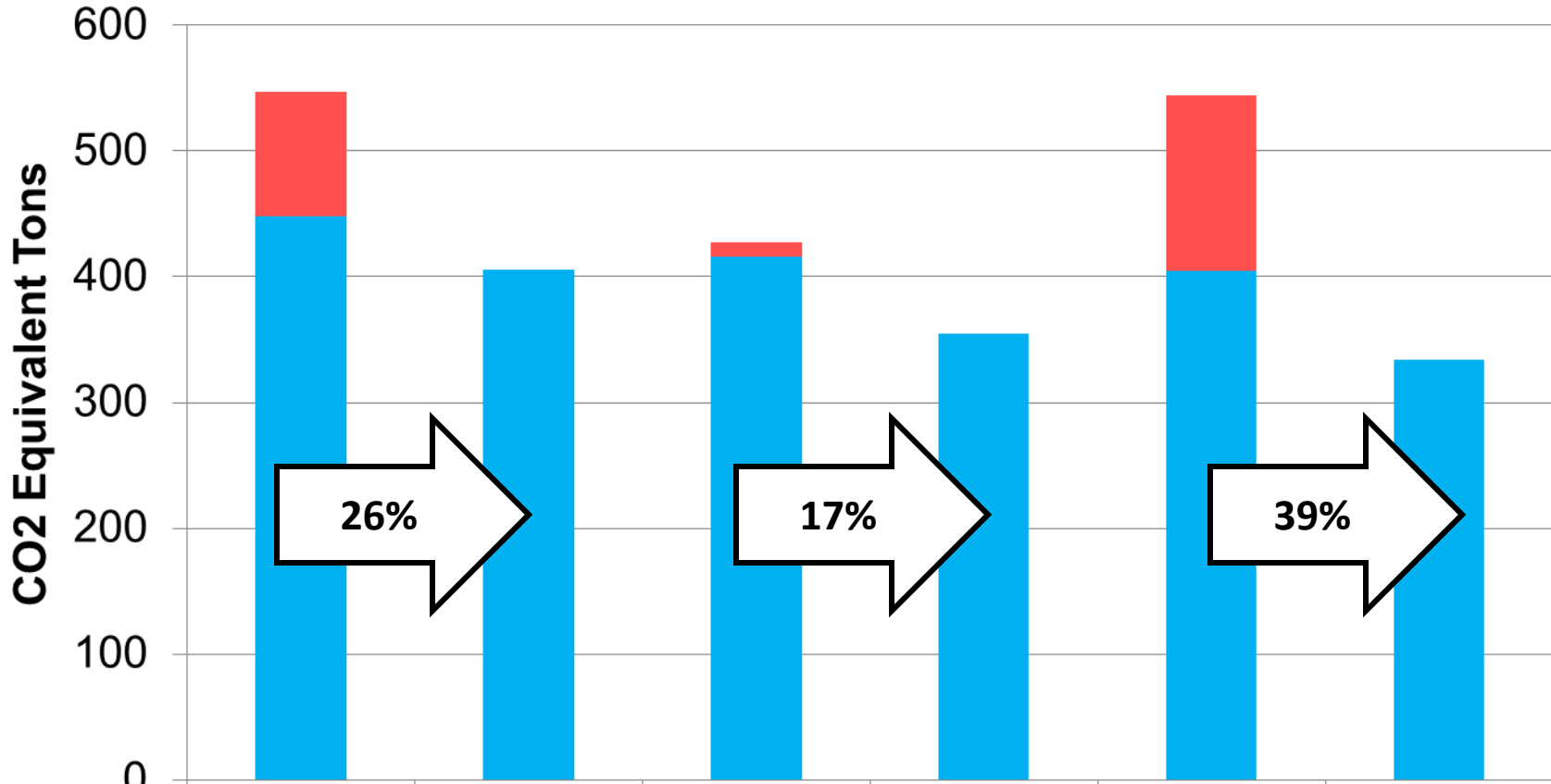
Energy Analysis: Simple System

Total Cost of Ownership Summary


Total Cost of Ownership
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
Air Cooled Condenser, Staged
Evaporative Condenser, VFD
TrilliumSeries™ Condenser, VSEC
Annual Refrigerant Costs Due to Leaks (18%)
Annual Water Treatment Costs
Annual Water Cost
Annual Demand Cost
Annual Electricity Cost
Incremental Rack Costs
Water Treatment System
Refrigerant Charge Cost
Unit Budget Cost


Total Cost of Ownership
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
R407a
R717
R407a
R717
R407a
R717
Air Cooled Staged
TrilliumSeries™ VSEC
Evaporative VFD
Annual Refrigerant Costs Due to Leaks (18%)
Annual Water Treatment Costs
Annual Water Cost
Annual Demand Cost
Annual Electricity Cost
Incremental Rack Costs
Water Treatment System
Refrigerant Charge Cost
Unit Budget Cost

Summary: Carbon Footprint



	Air Cooled R407a	Air Cooled R717	Hybrid R407a	Hybrid R717	Evap R407a	Evap R717
Direct CO2 Tons (Refrigerant)	99	0	11	0	139	0
Indirect CO2 Tons (Electricity)	448	406	416	355	405	334

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