ATMOsphere AMERICA
business case
natural refrigerants
June 18-19, 2013 in Washington DC

How Different Condensers and Refrigerants Affect Total Refrigeration System Energy Consumption

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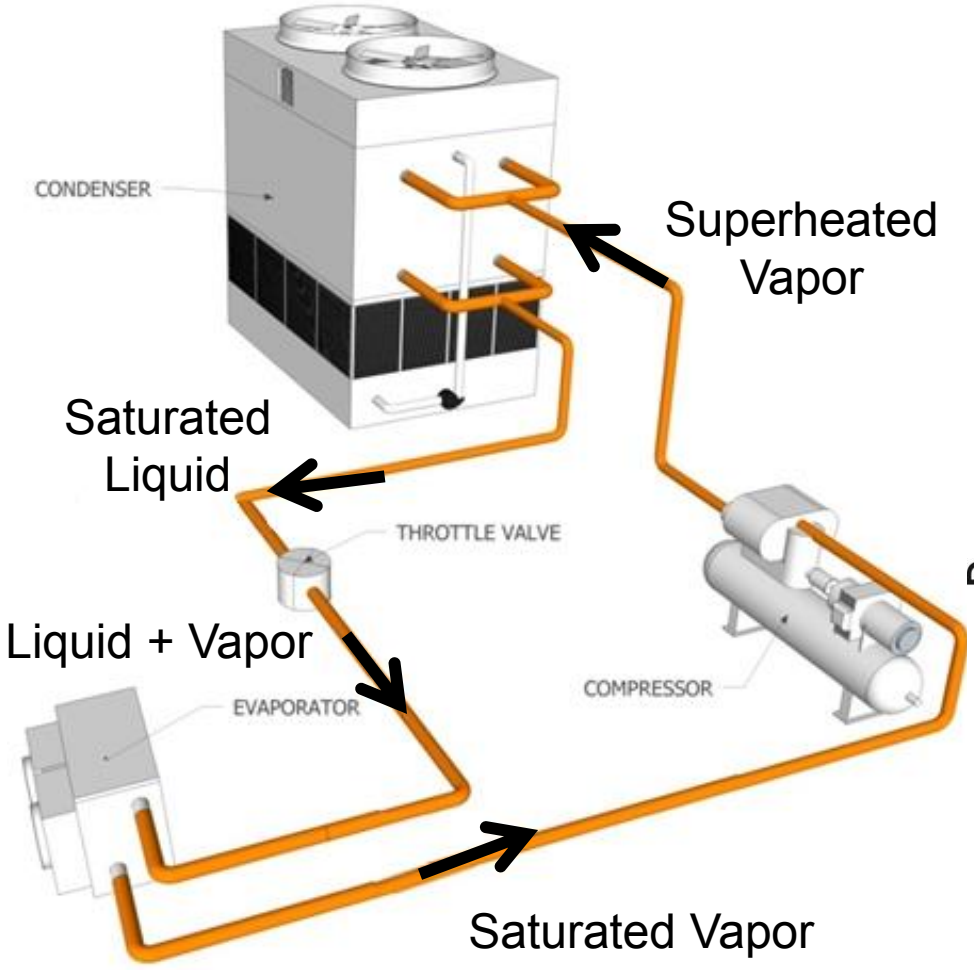
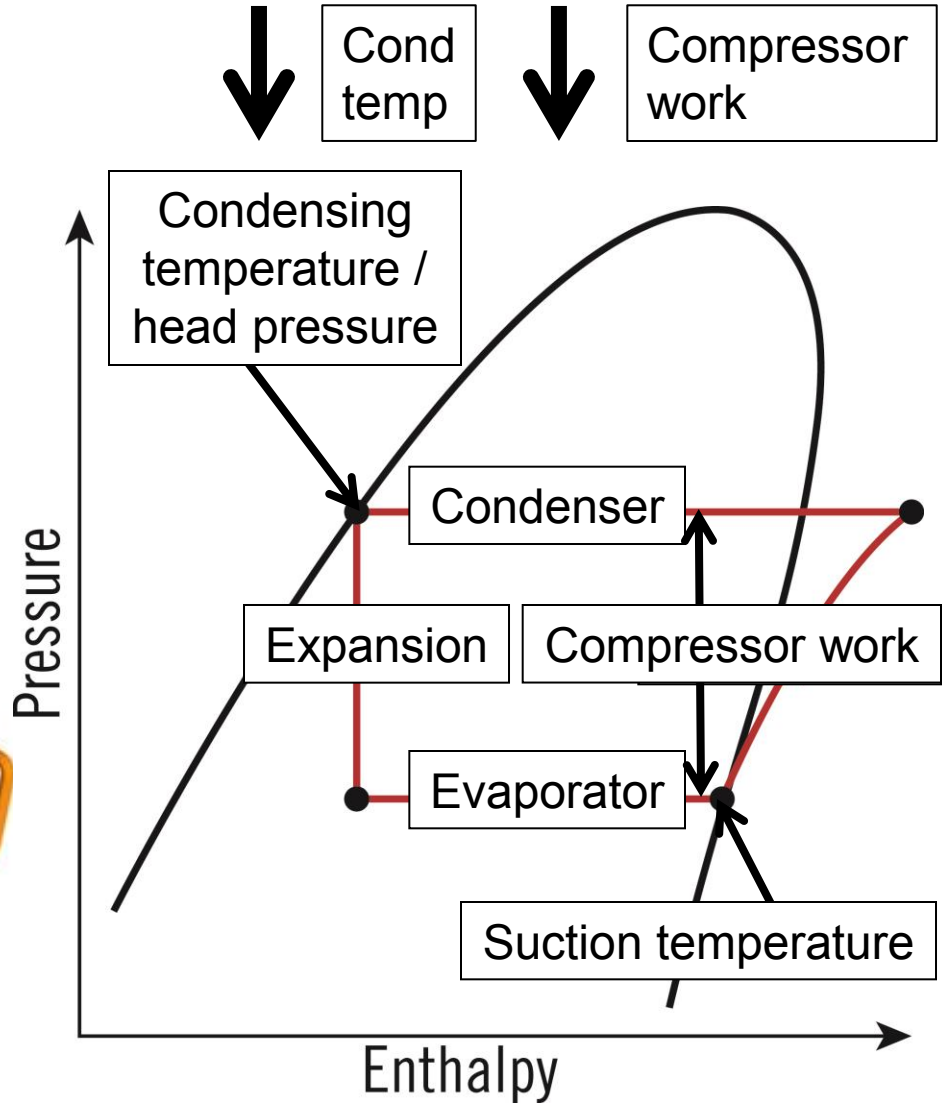
June 19, 2013

- Refrigeration system ≈ 50% total store energy[1]
- Compressor + condenser ≈ 60 – 70% refrigeration system[1]





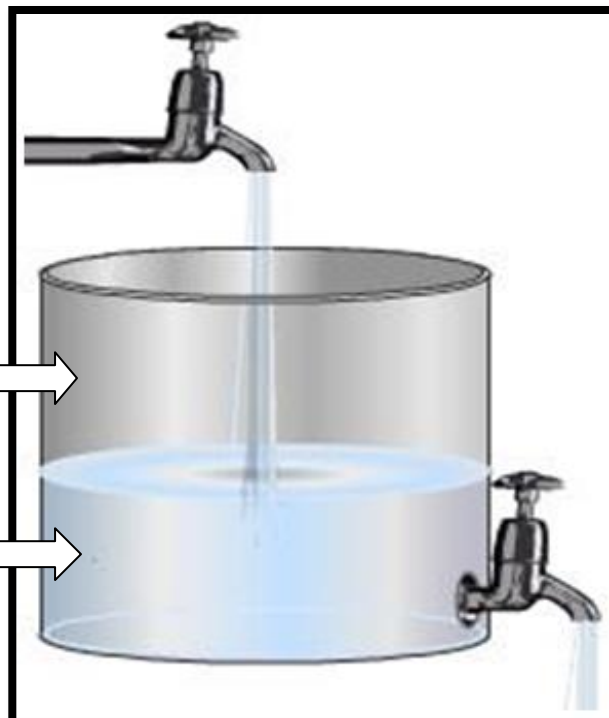
[1] Baxter, V.D.: Advances in Supermarket Refrigeration Systems. IEA Annex 26 Summary. ORNL 2006

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
- Ratchet: Demand = % * [highest peak kW in last year] * $/kW

Energy cost = water used

Demand cost = bucket size



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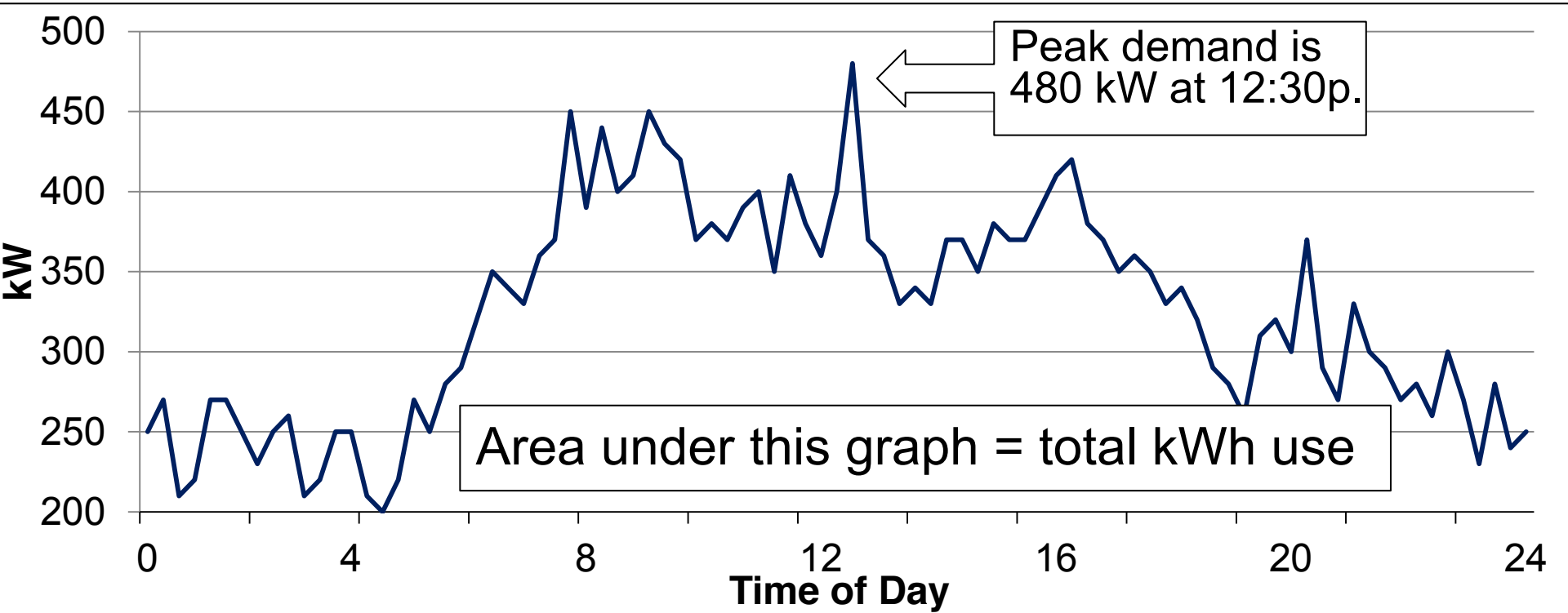
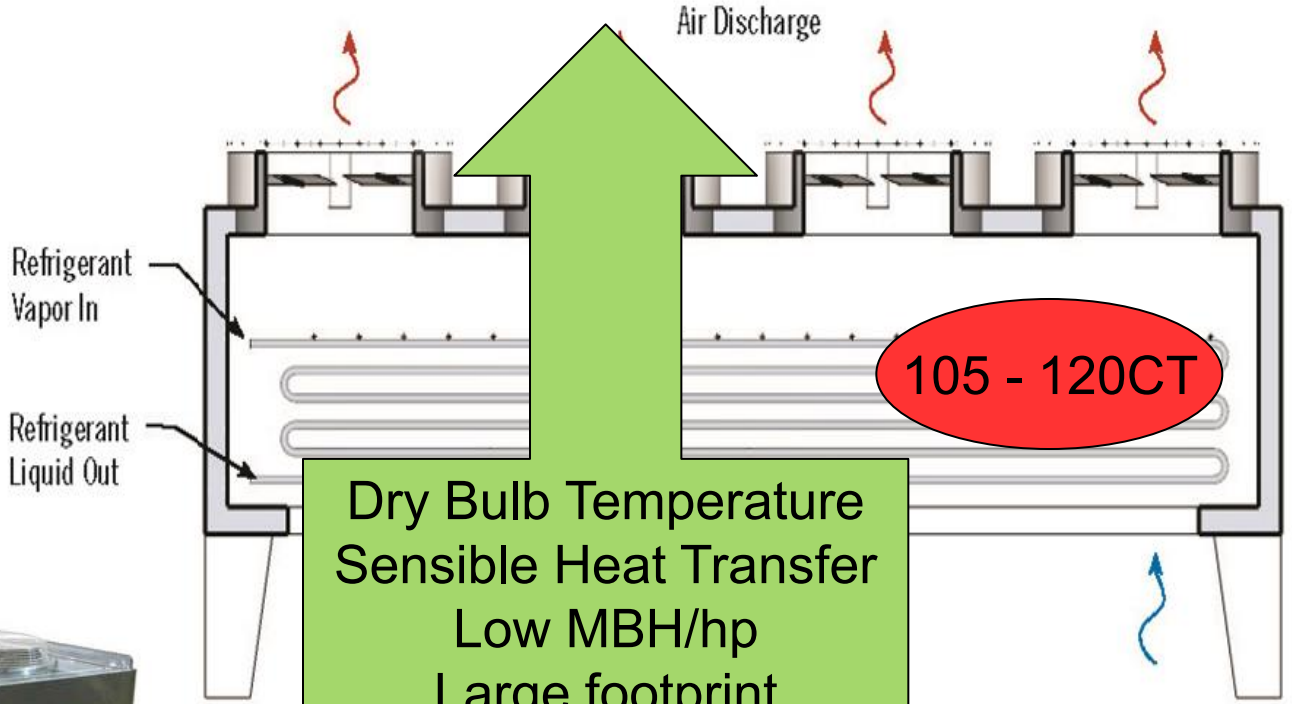


Refrigerant

Air

Conventional Air Cooled

Sensible heat transfer = temperature change



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

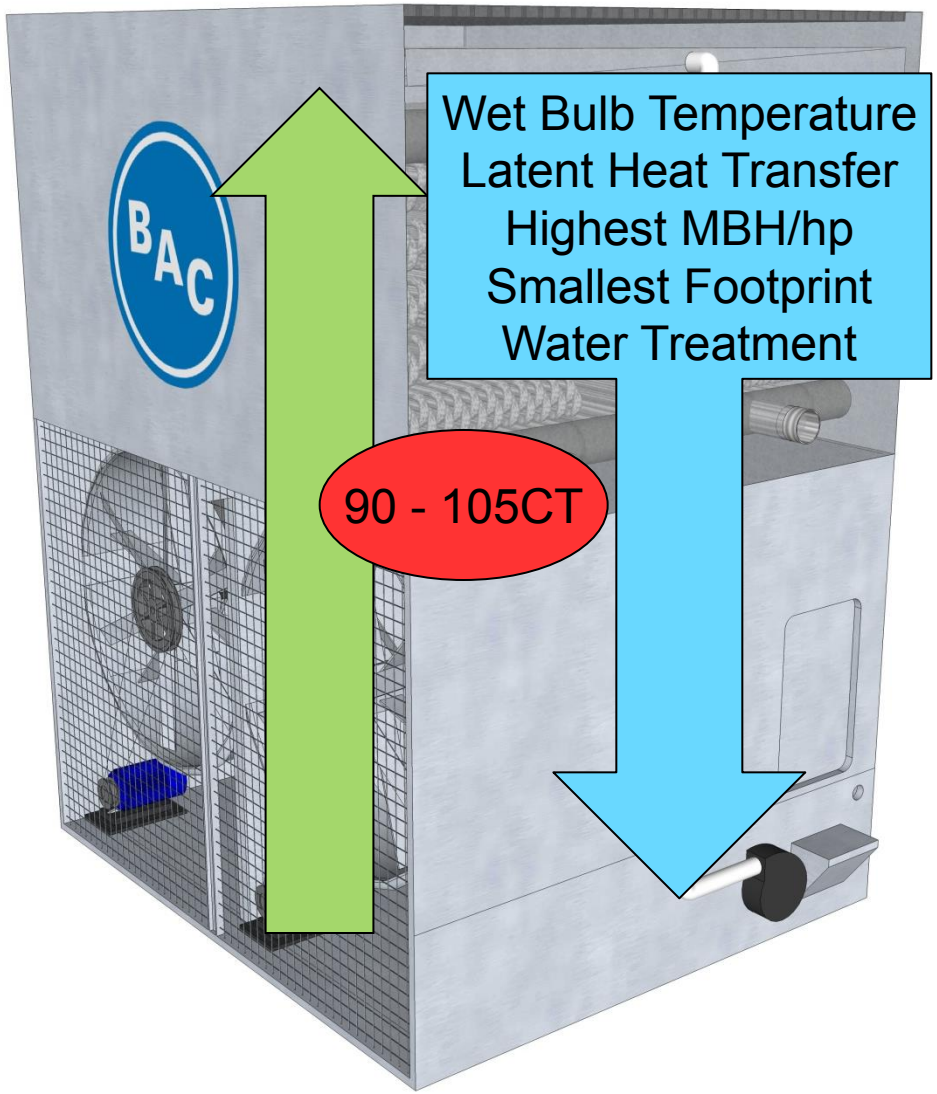
Refrigerant

Air

Water

Conventional Evaporative

Latent heat transfer = phase change (evaporation)

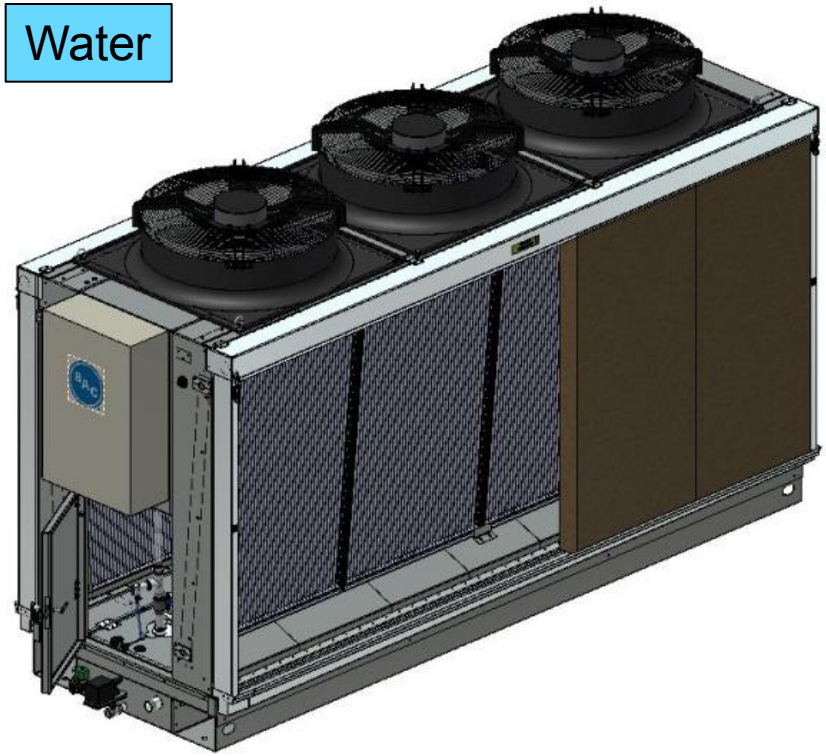


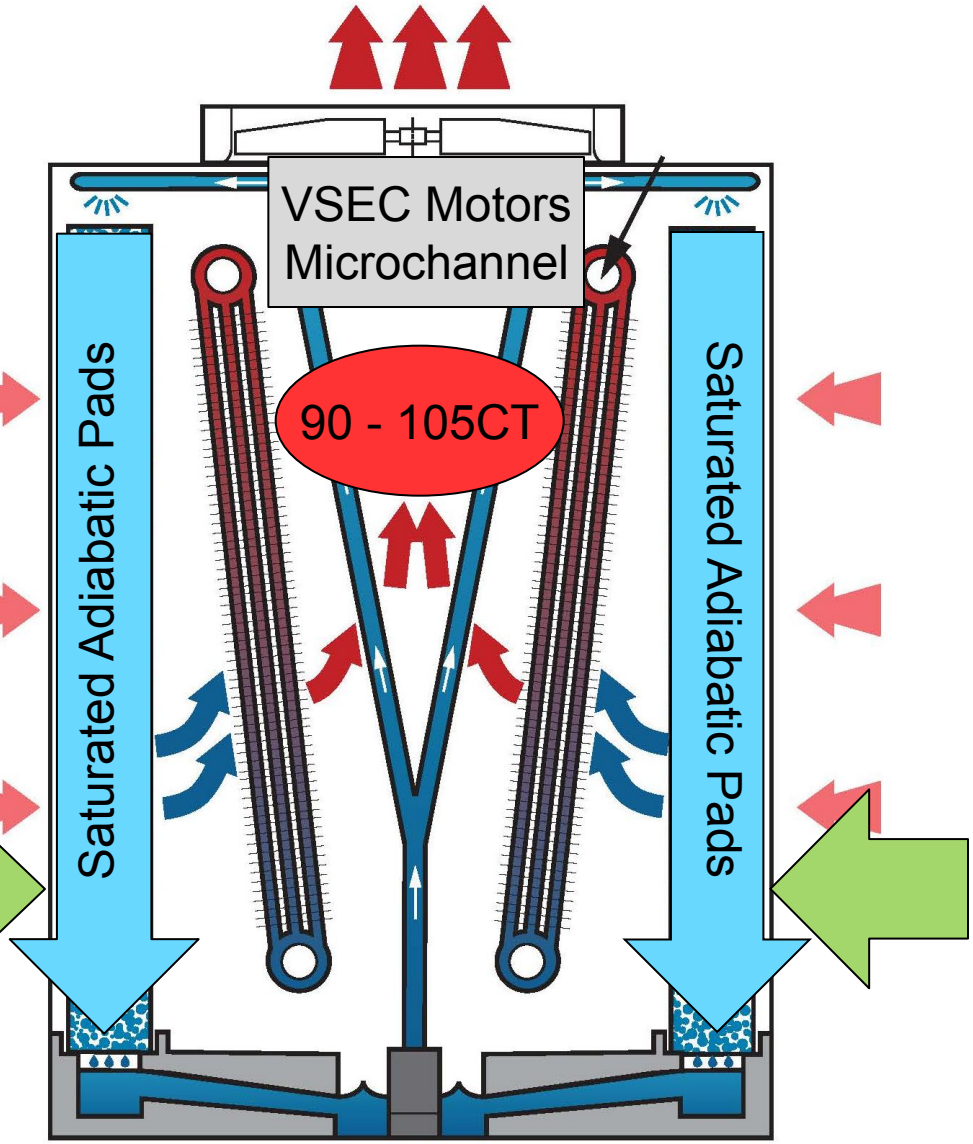
Refrigerant

Air

Water

Dry Coil Hybrid Condenser

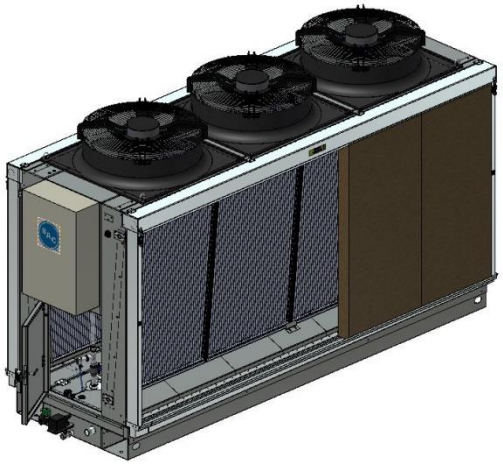




Wet bulb and dry bulb temp
Hybrid heat transfer
High MBH/hp
Small footprint
No water treatment

Condenser Types Summary

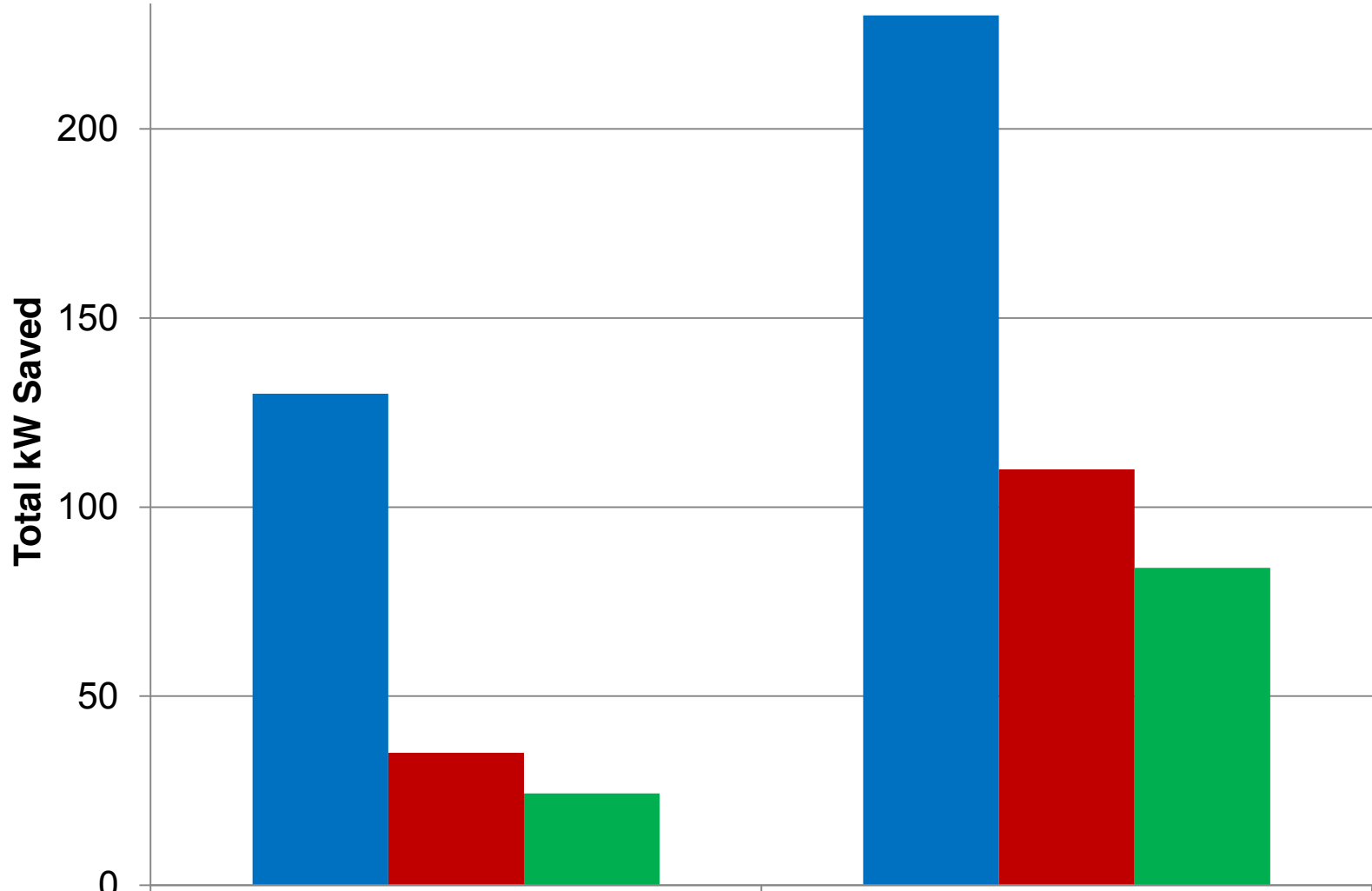
	Air Cooled	Hybrid	Evaporative
Ambient Heat Sink Temp	Dry Bulb	Dry Bulb AND Wet Bulb	Wet Bulb
Design Condensing Temp	105 – 120F	90 – 105F	90 – 105F
Efficiency	Lowest MBH/hp	High MBH/hp	Highest MBH/hp
Peak kW and Total kWh	Highest	Lower	Lowest
Footprint	Largest	Smaller	Smallest
Water Required	None	Water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



Energy Analysis: Simple System

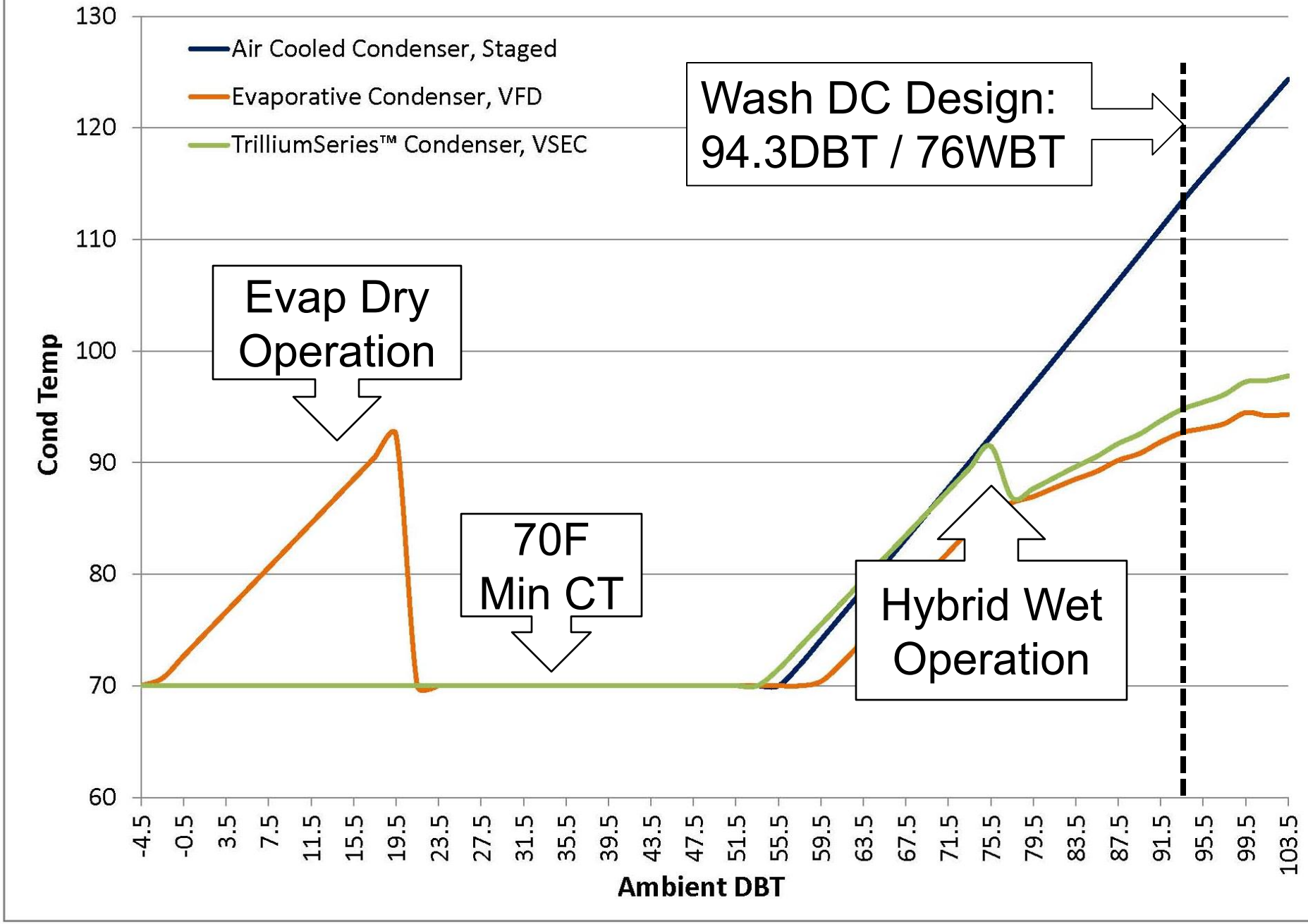
- Air Cooled vs Hybrid vs Evaporative Condensers
- R717 vs R407a
- TCO Summary

Lund's Actual vs Estimated kW Savings (R407a)



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

Example: 150 Tons R717, +20F ST, Wash DC



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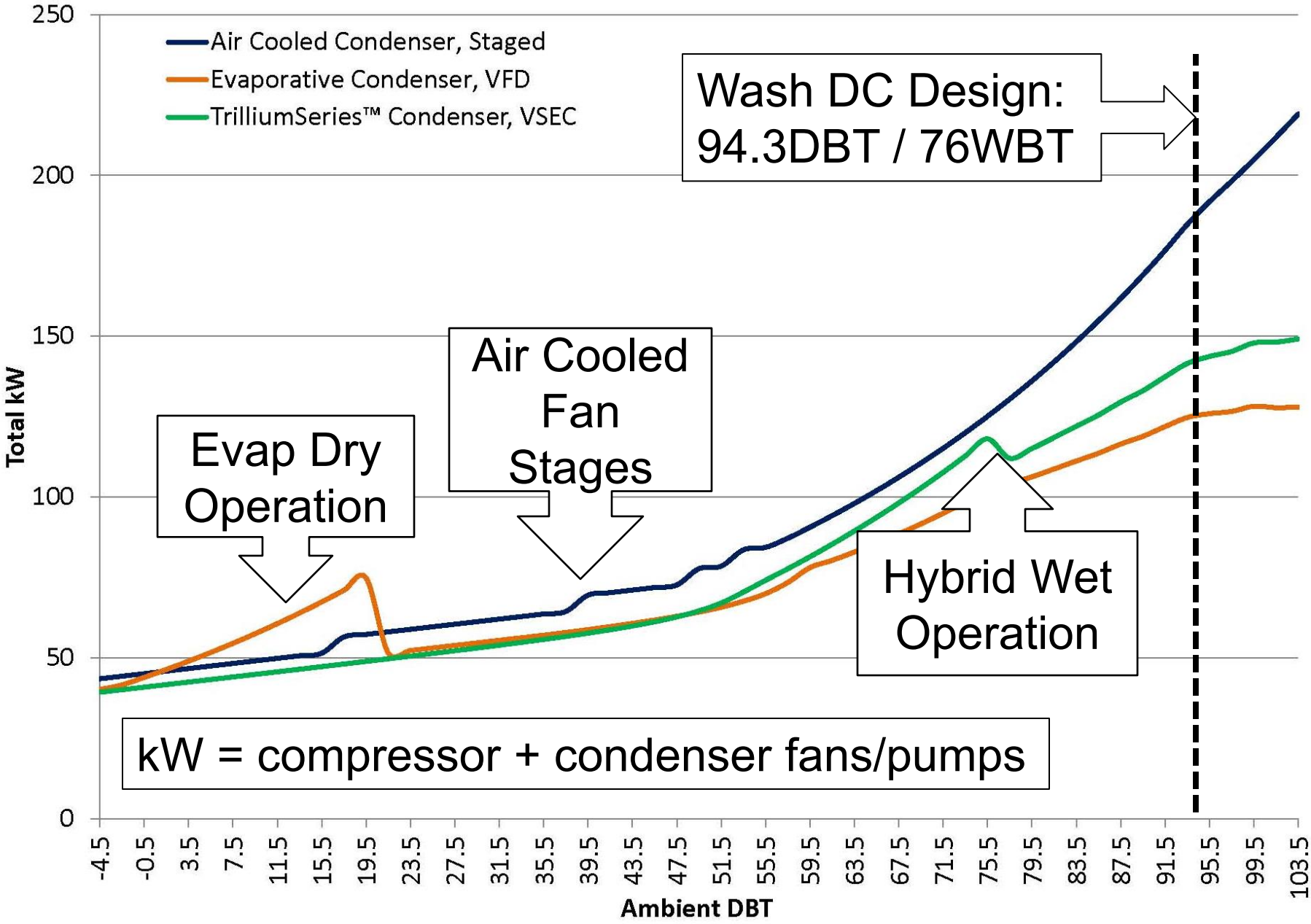
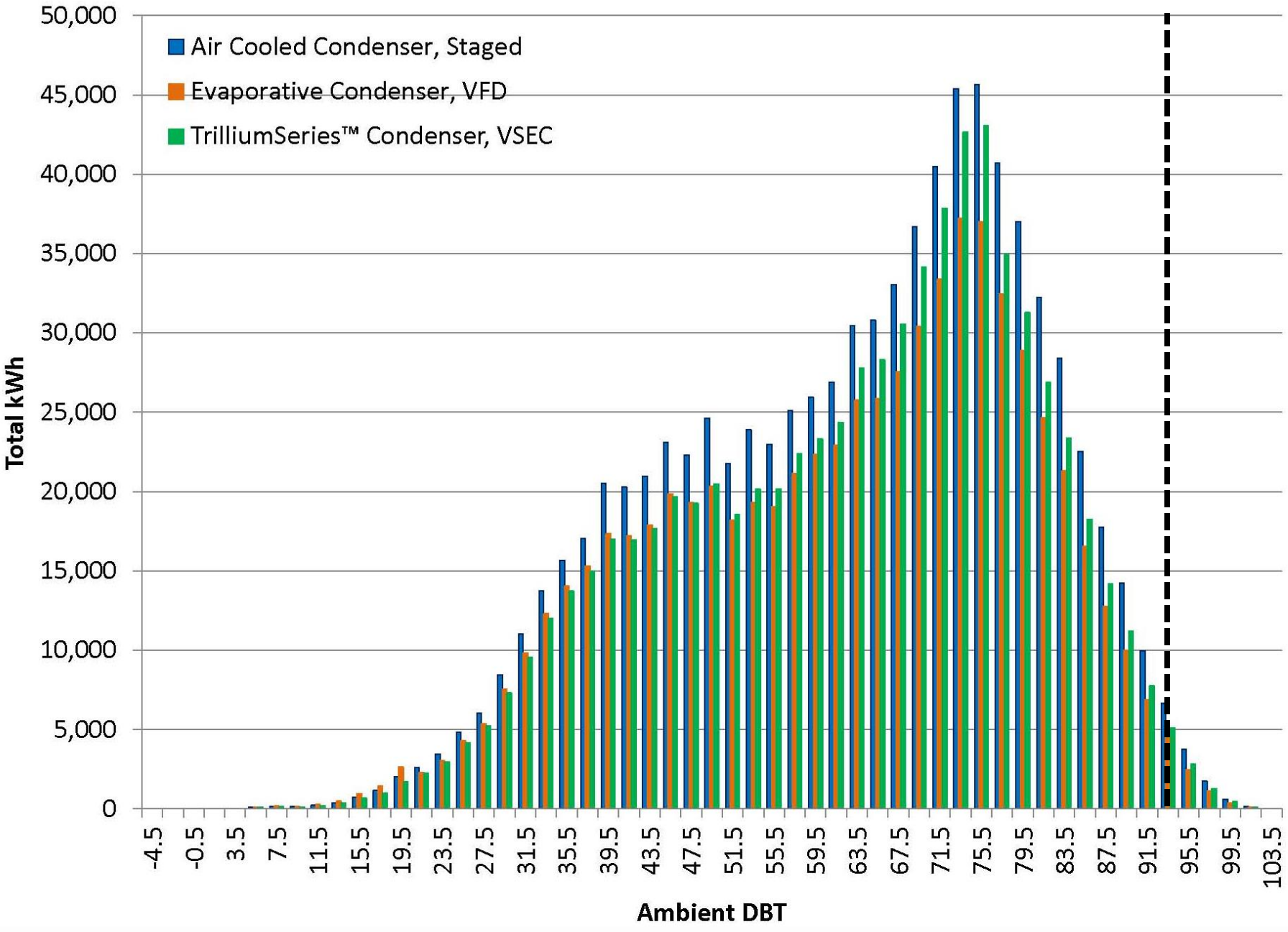


150 Tons R717, +20F ST, Wash DC



Summary: R717

Total kWh/yr	Air Cooled	Hybrid	Evaporative
R717	844,467	738,549	694,775

Energy Savings → 13% → 18%

Peak kW	Air Cooled	Hybrid	Evaporative
R717	219	149	128

Peak Demand Reduction → 32% → 42%

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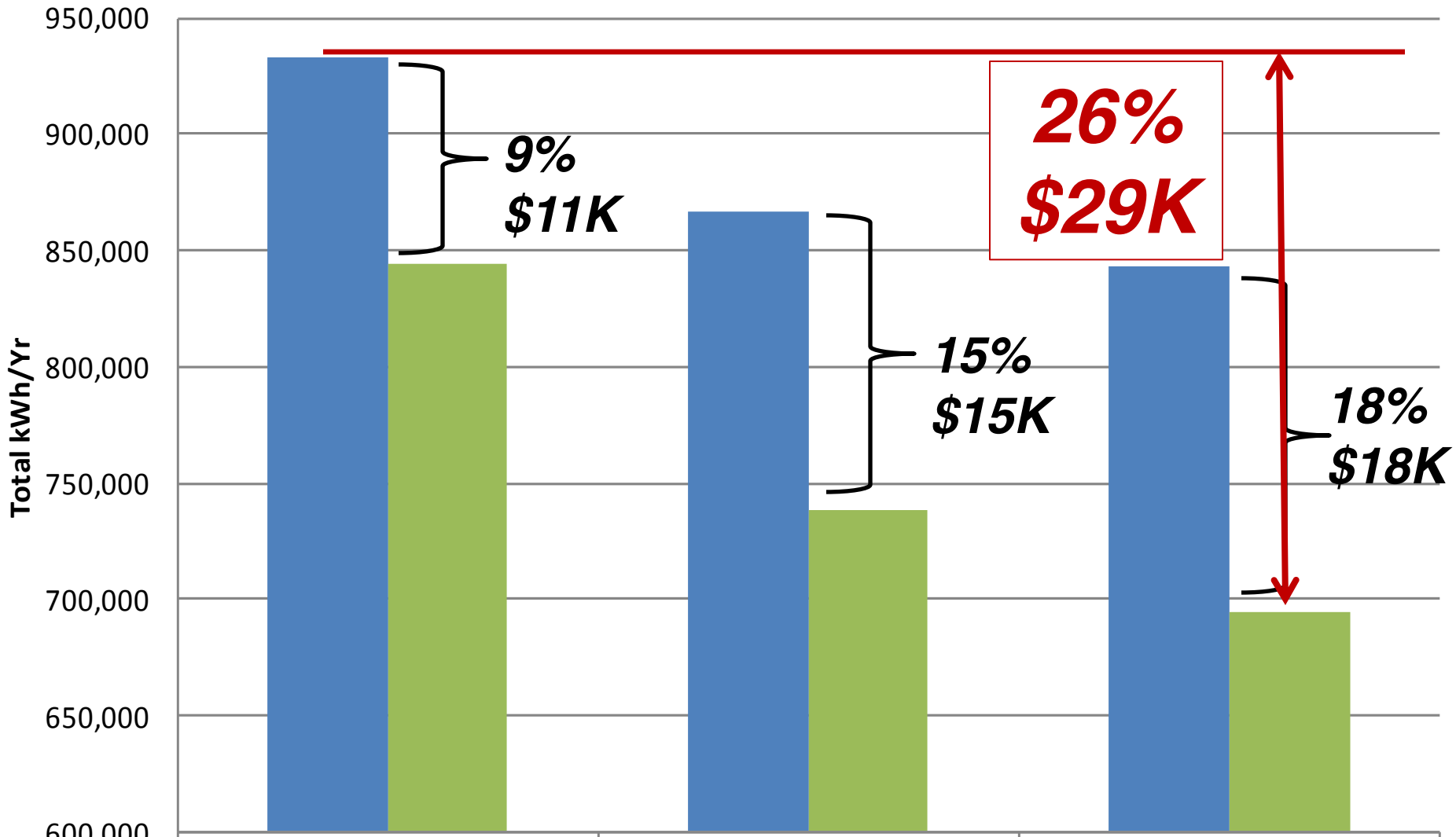
BAC

$0.12/kWh

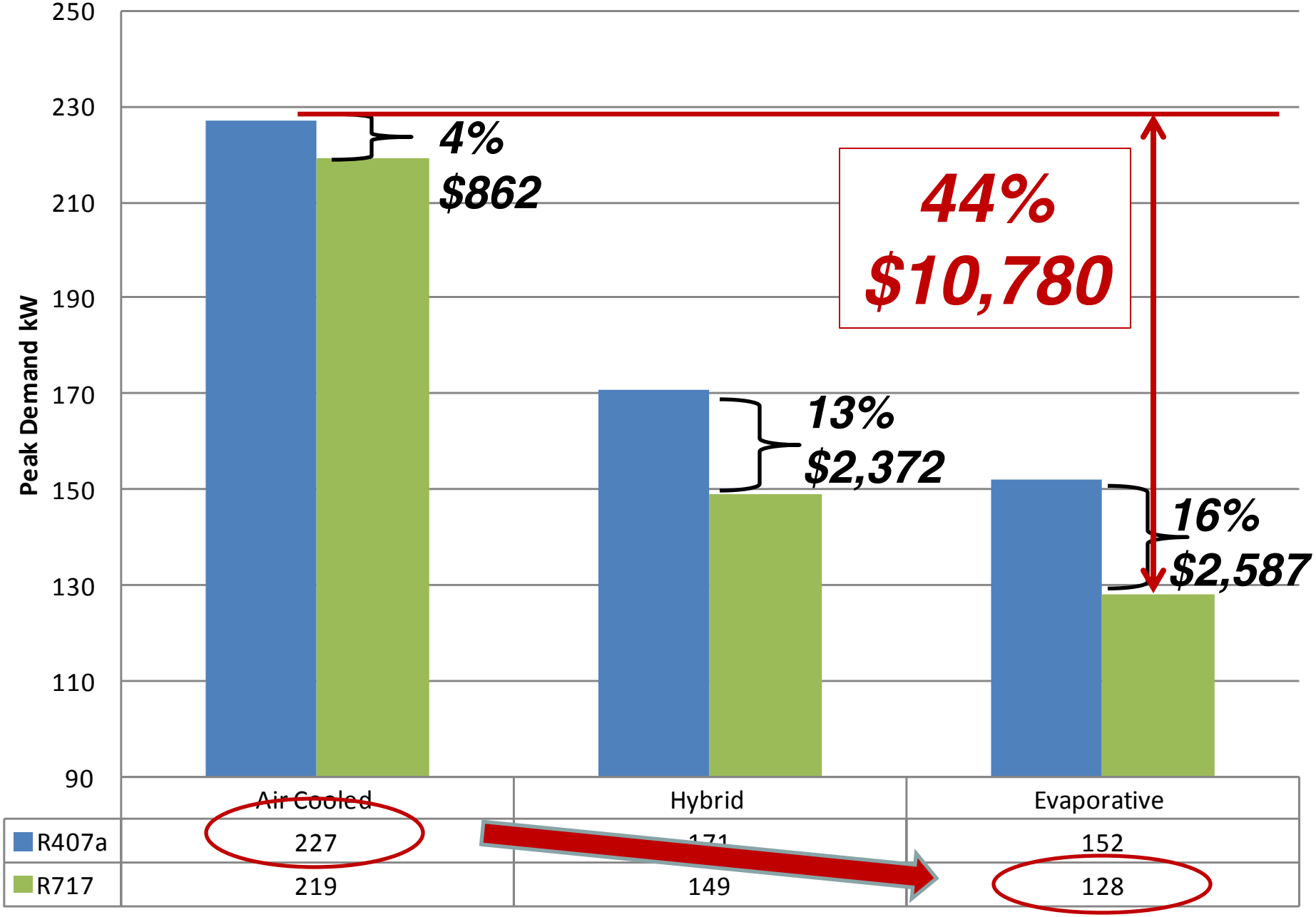
150 TR System, +20F Suction, Washington DC



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

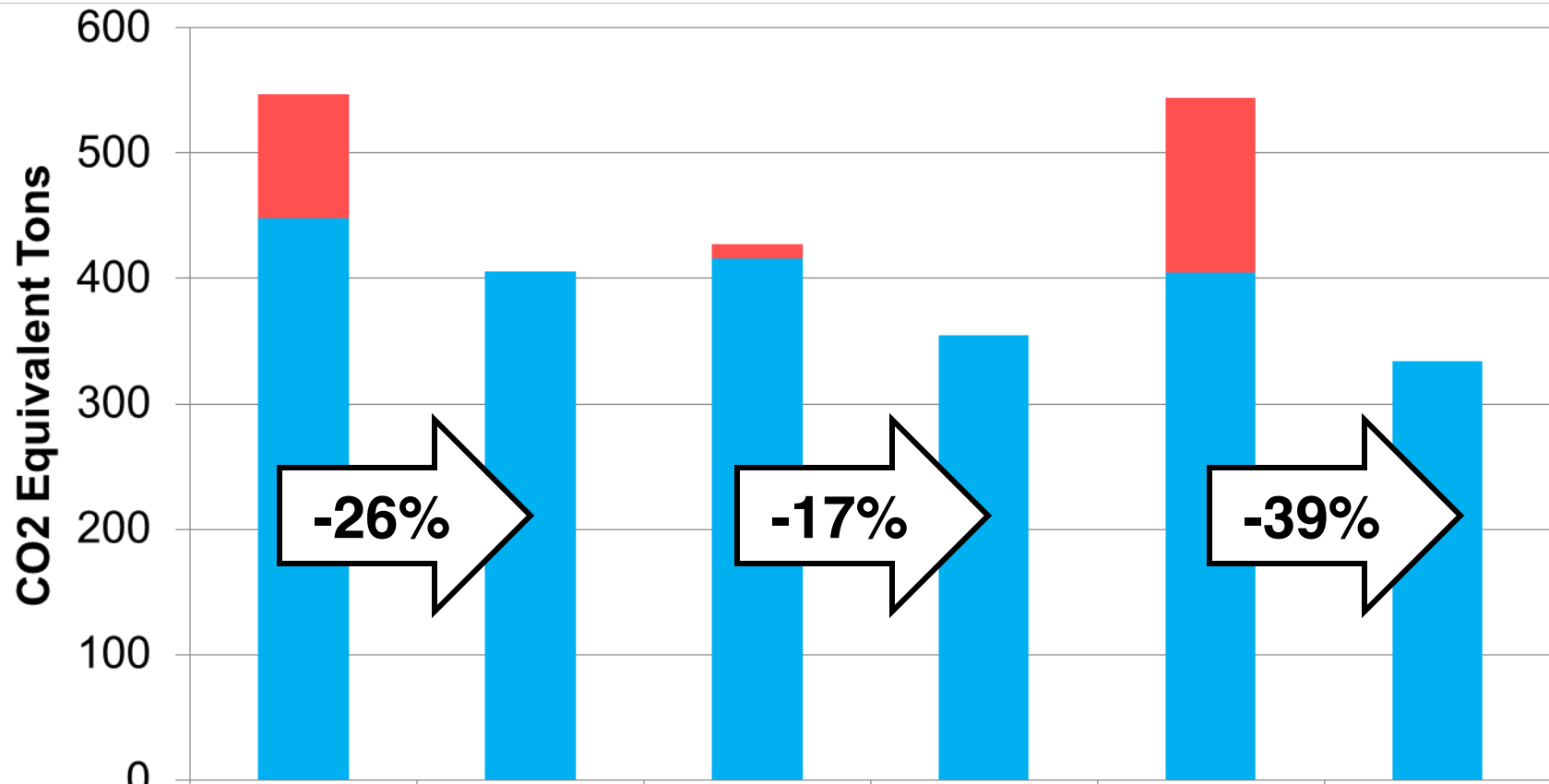
$11/kW
80% ratchet

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

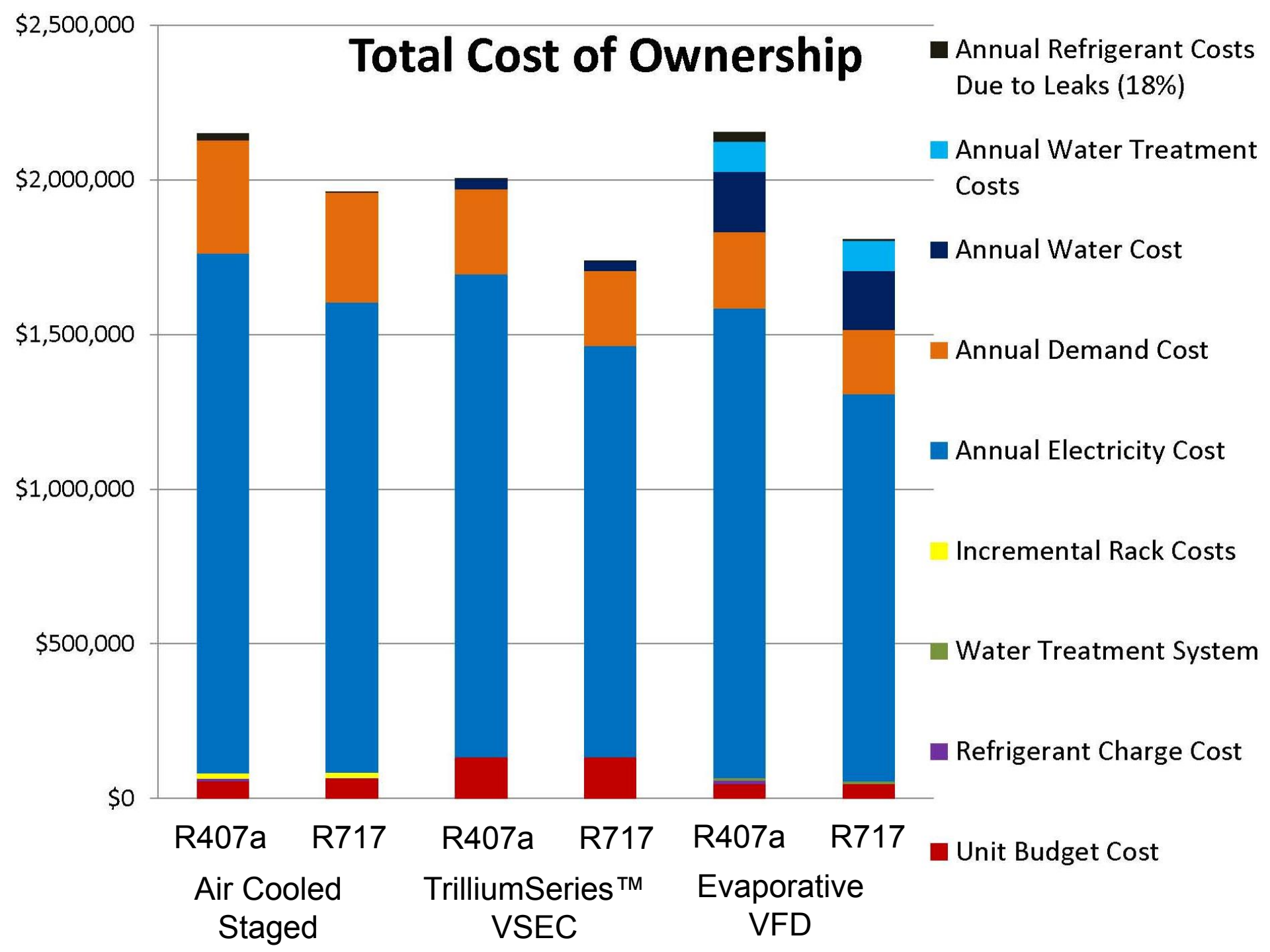


	Air Cooled	Hybrid	Evaporative
R407a	227	171	152
R717	219	149	128

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


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

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