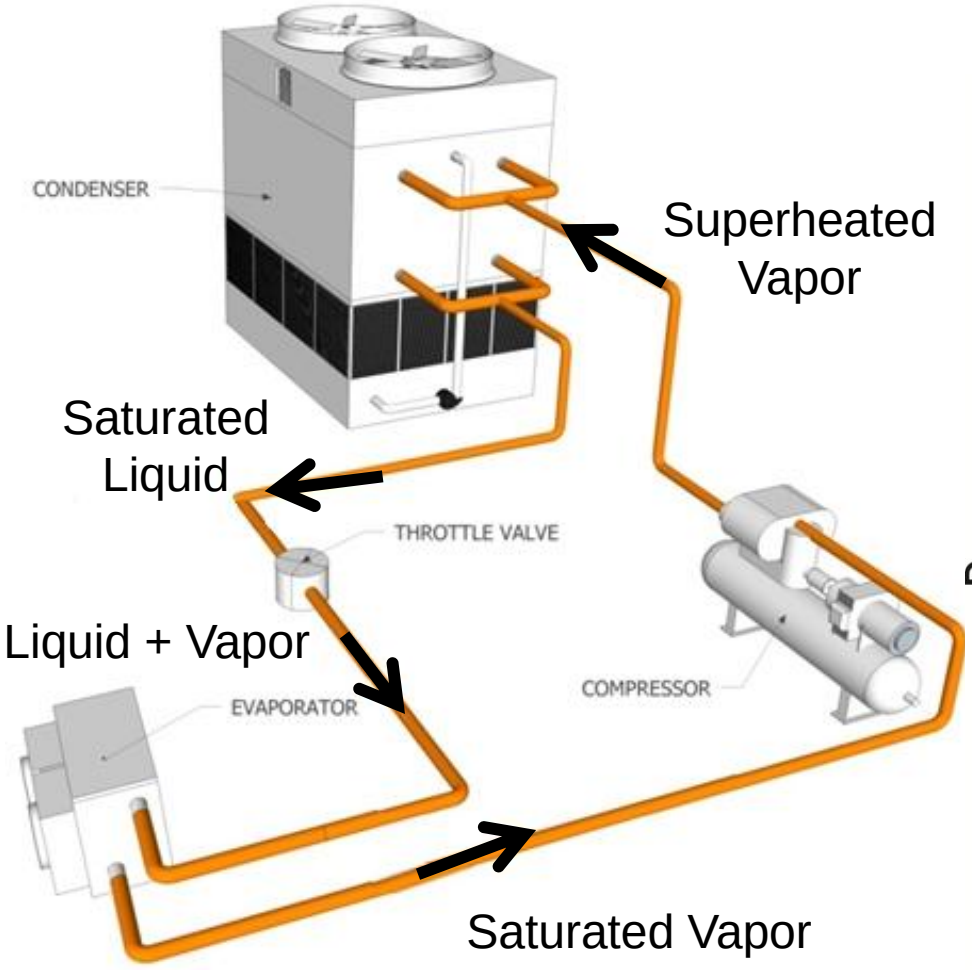
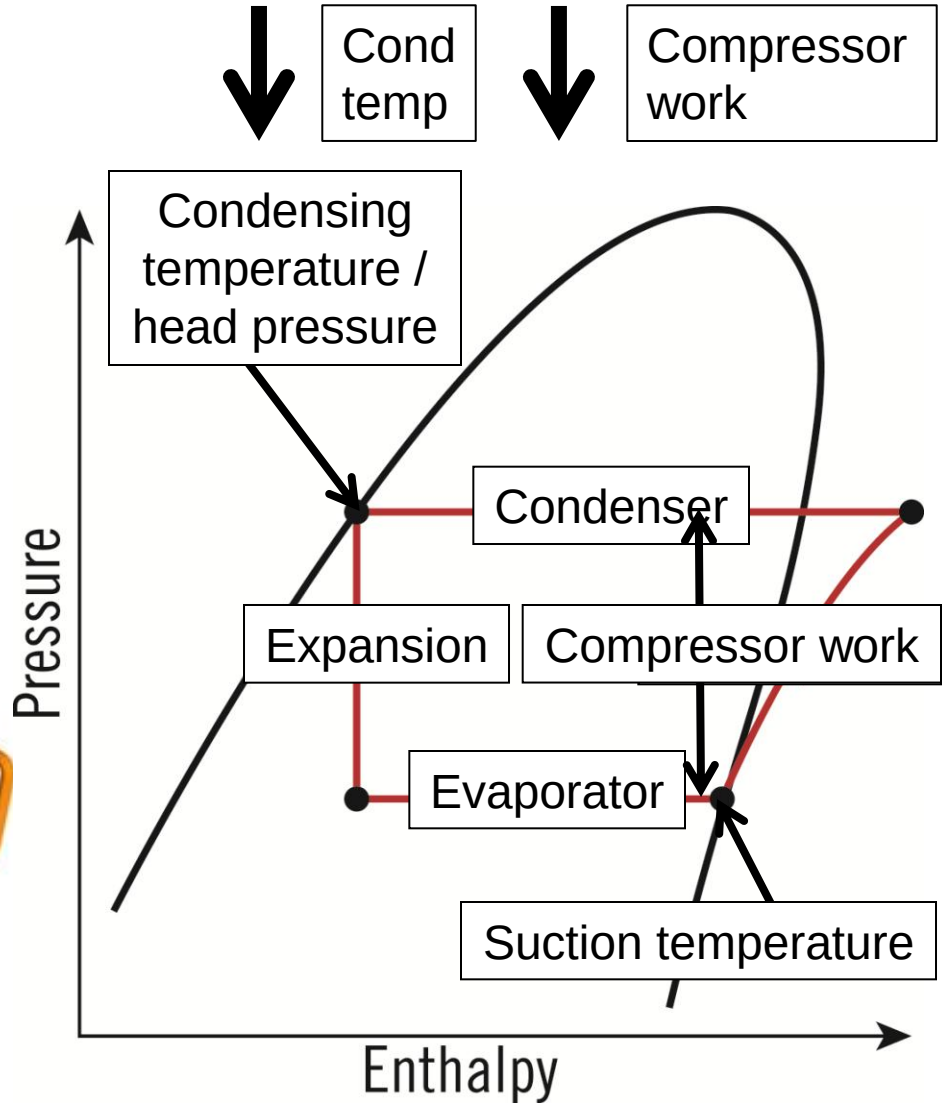
ATMOsphere AMERICA
business case
natural refrigerants
June 18-19, 2013 in Washington DC

How Different Condensers and Refrigerants Affect Total Refrigeration System Energy Consumption

Preston Blay
Ilana Cember
June 19, 2013

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

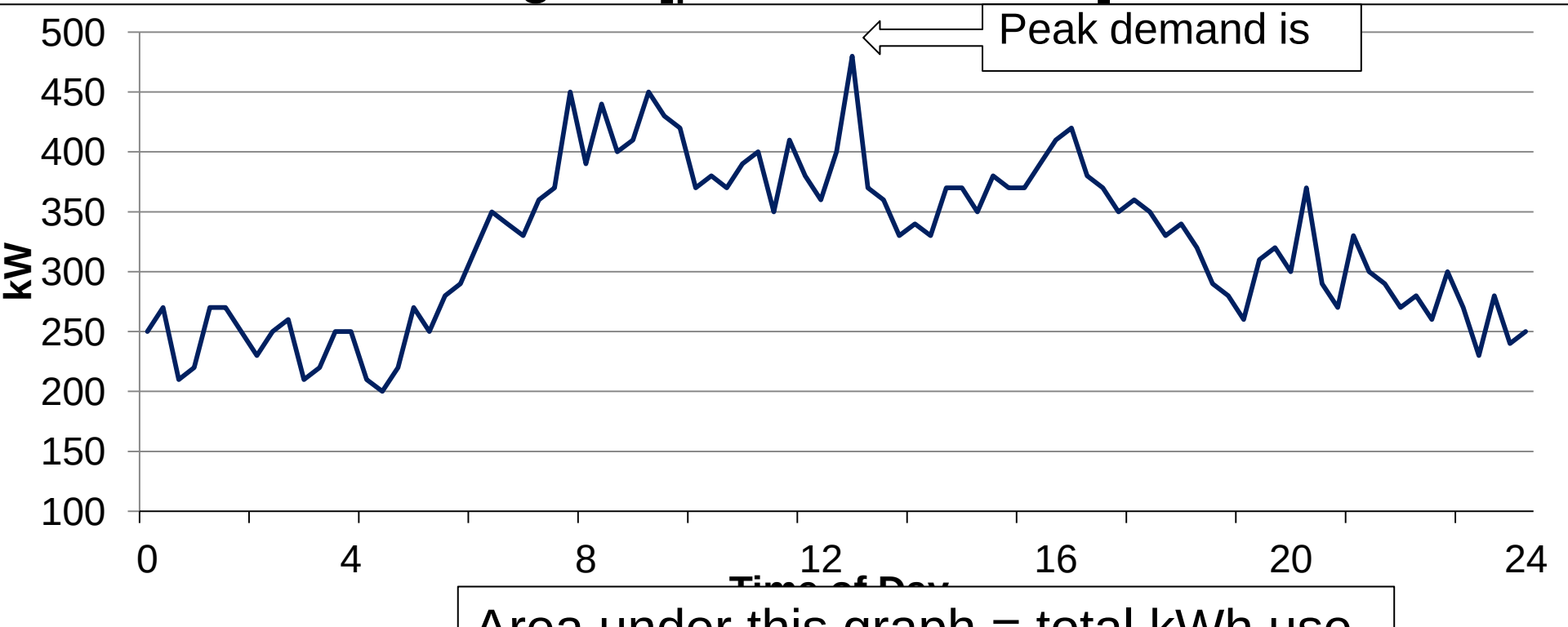




[1] Baxter, V.D.: Advances in Supermarket Refrigeration Systems. IEA Annex 26 Summary. ORNL 2006

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

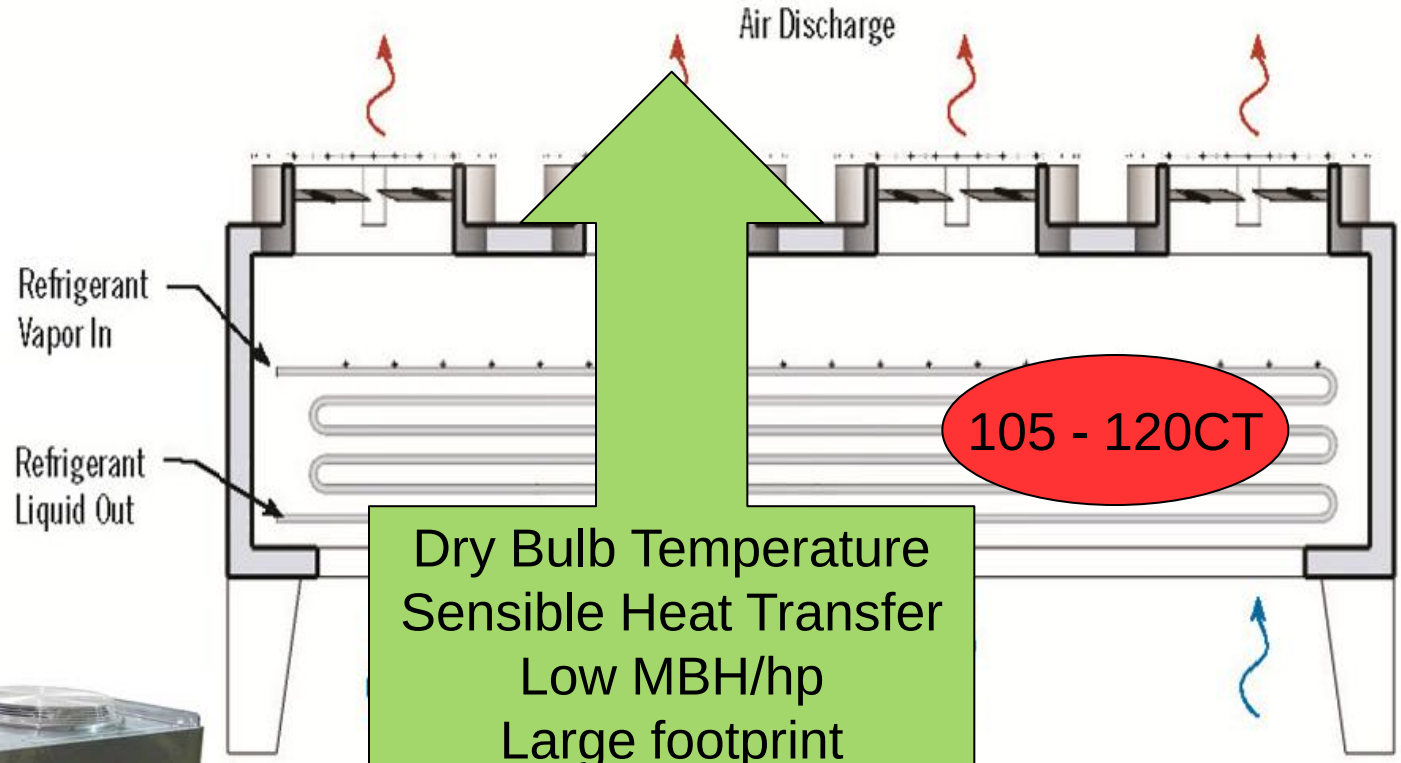


Refrigerant

Air

Conventional Air Cooled

Sensible heat transfer = temperature change



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

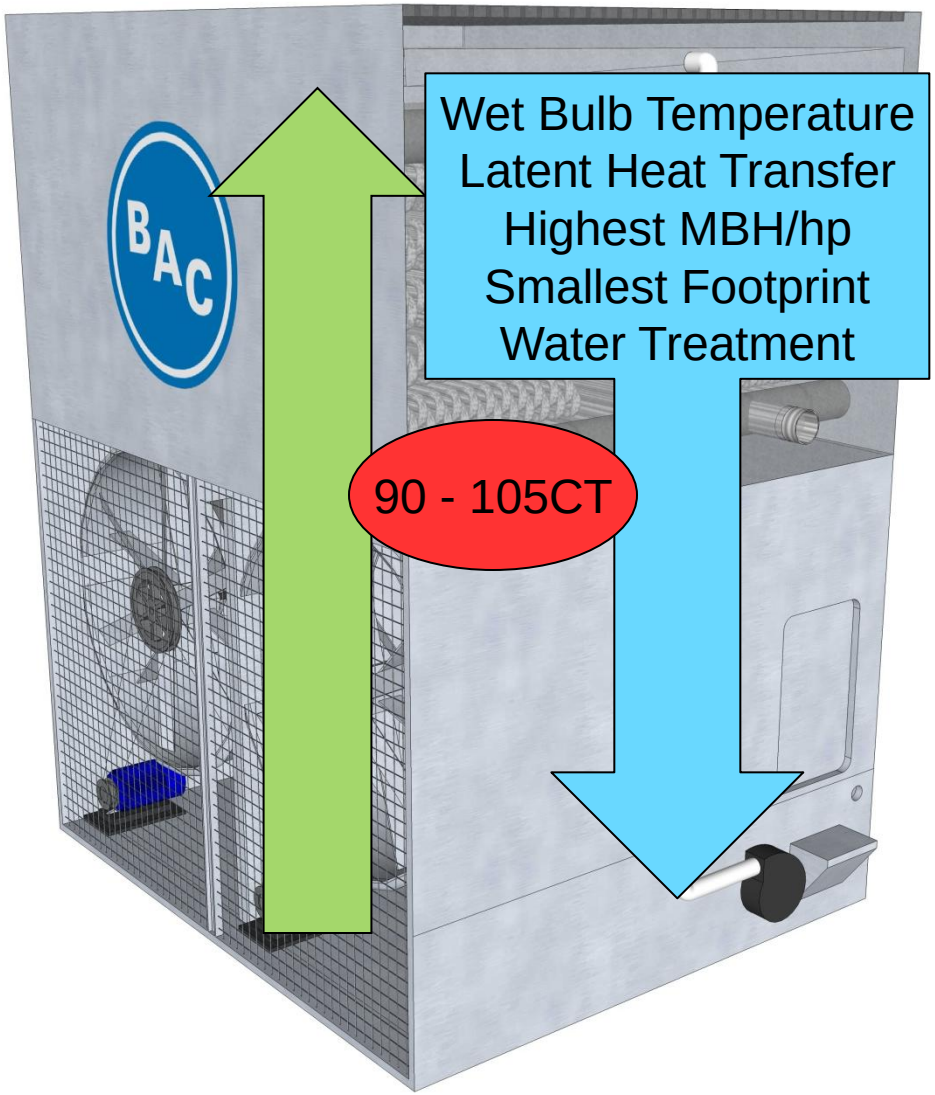
Refrigerant

Air

Water

Conventional Evaporative

Latent heat transfer = phase change (evaporation)

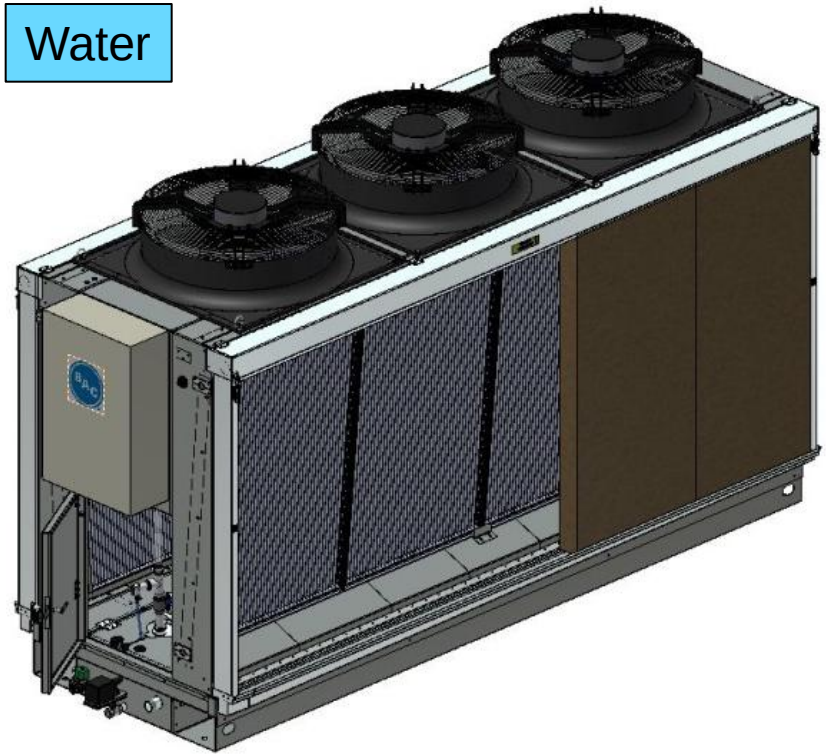


Refrigerant

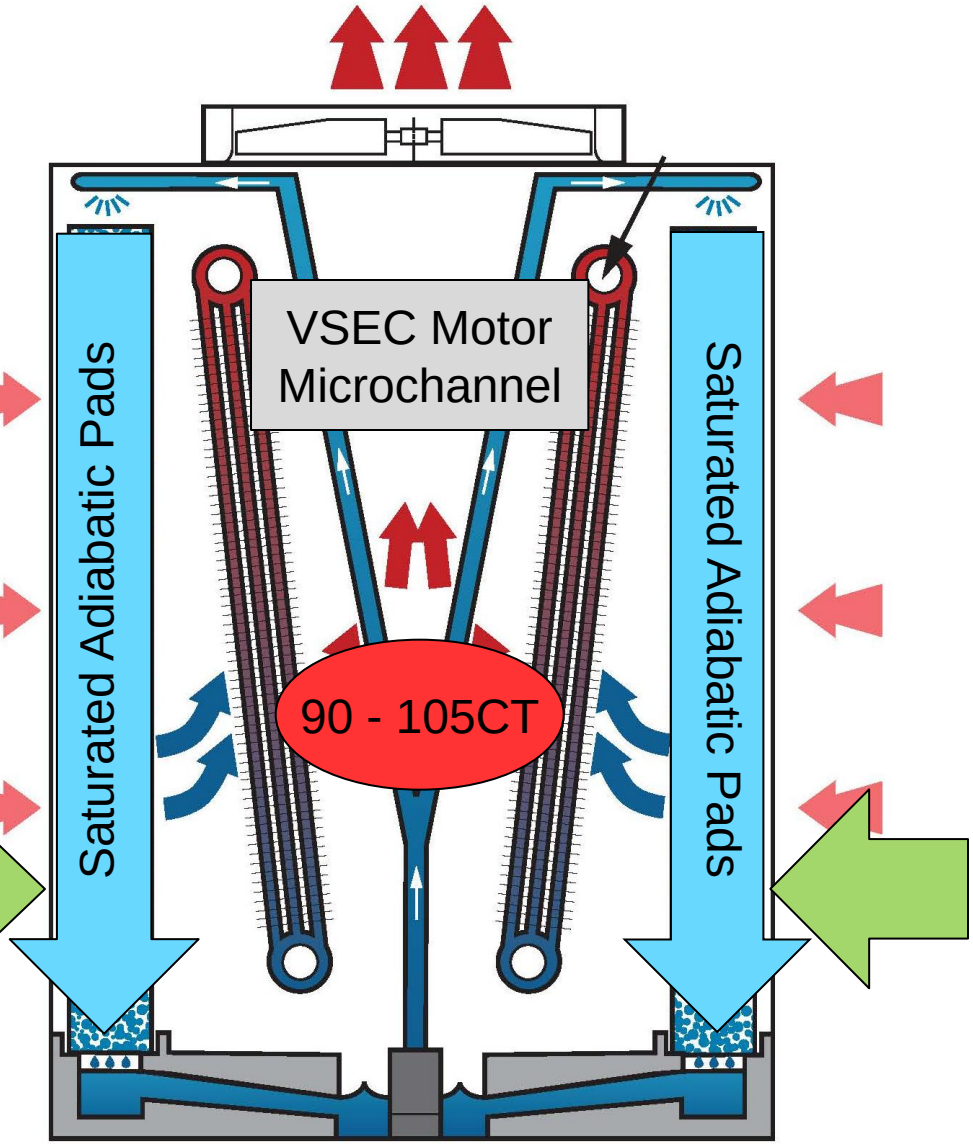
Air

Water

Dry Coil Hybrid Condenser



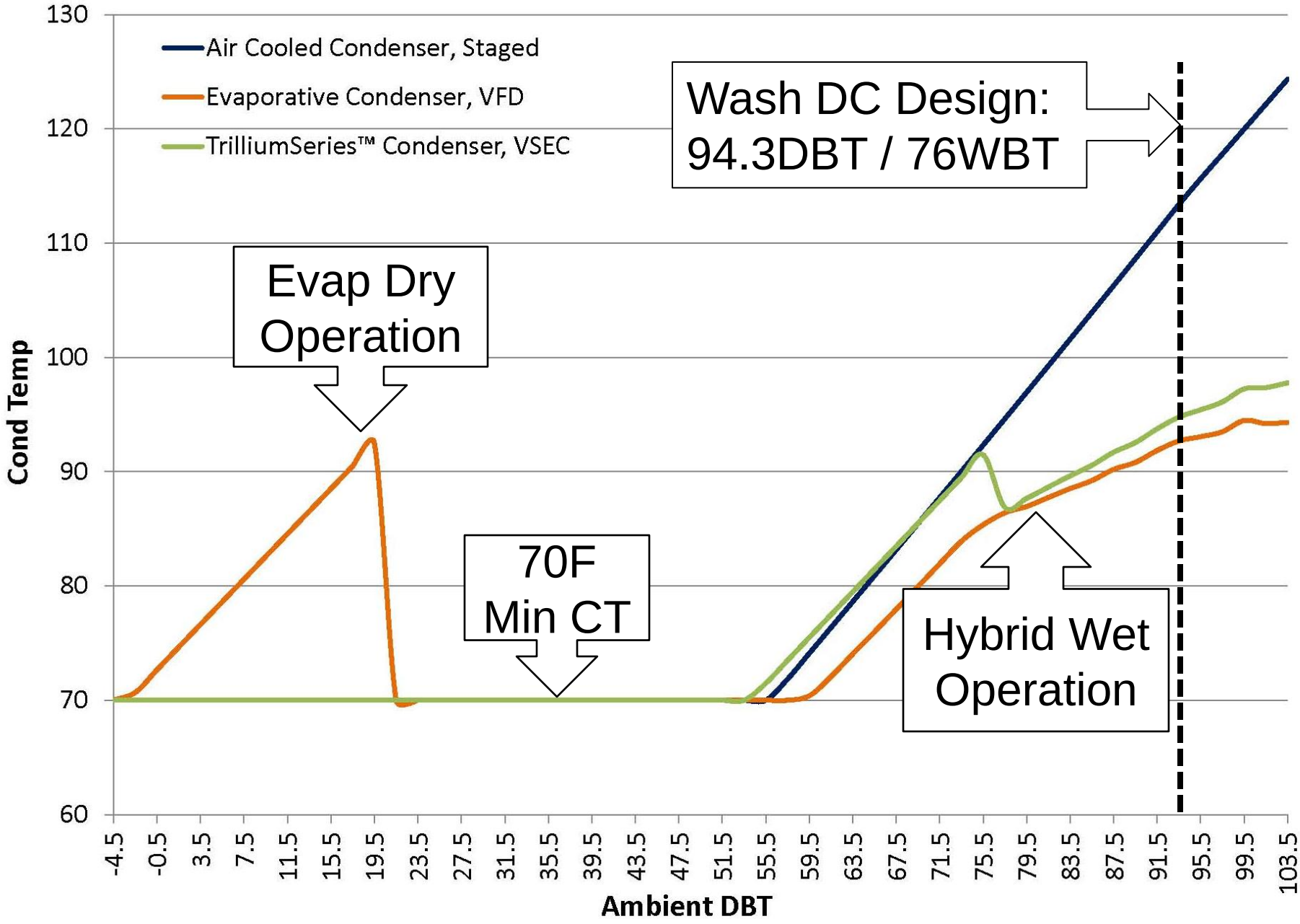
Wet bulb and dry bulb temp
Hybrid heat transfer
High MBH/hp
Small footprint
No water treatment



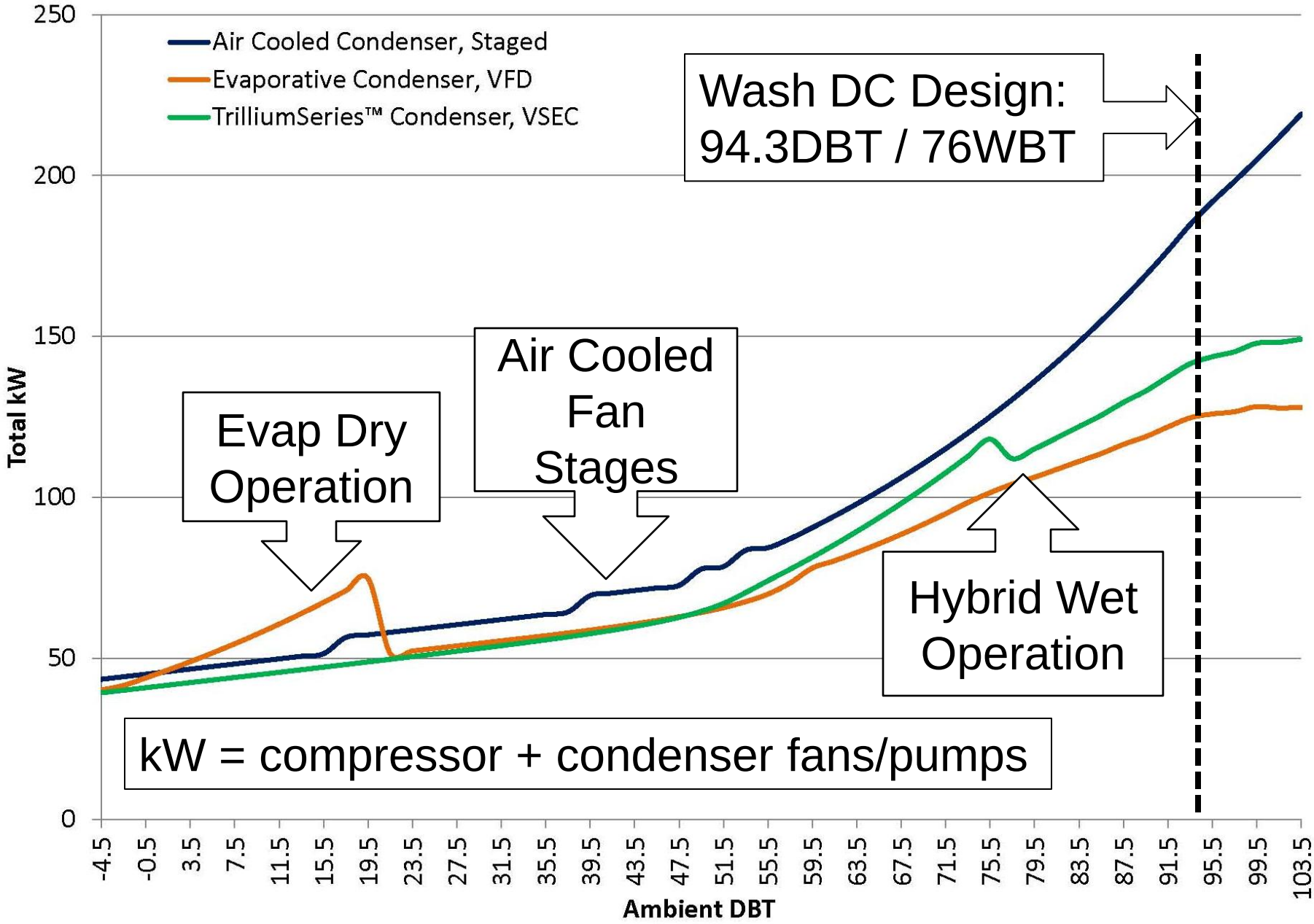
Energy Analysis: Simple System

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

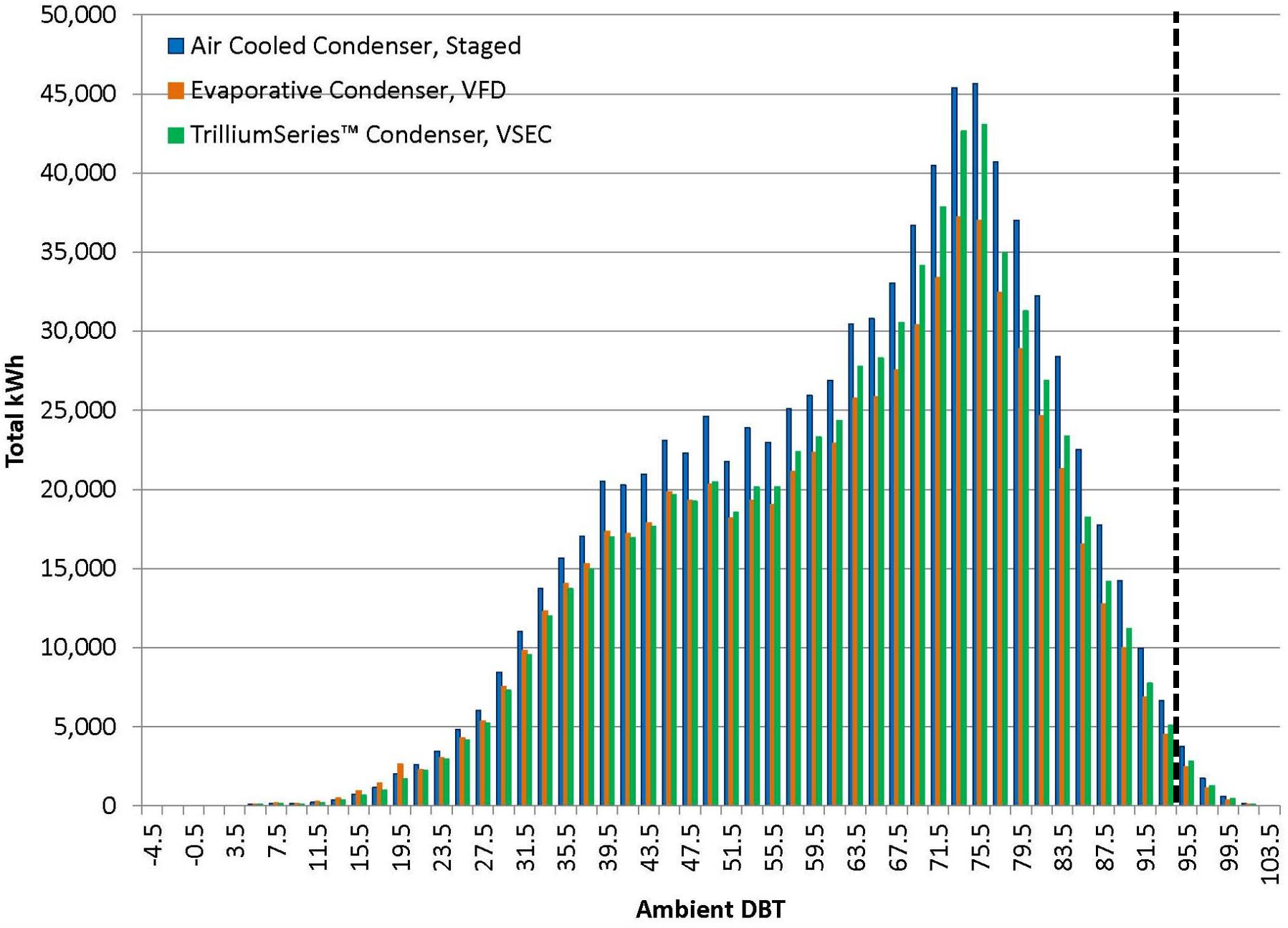
150 Tons R717, +20F ST, Wash DC



150 Tons R717, +20F ST, Wash DC

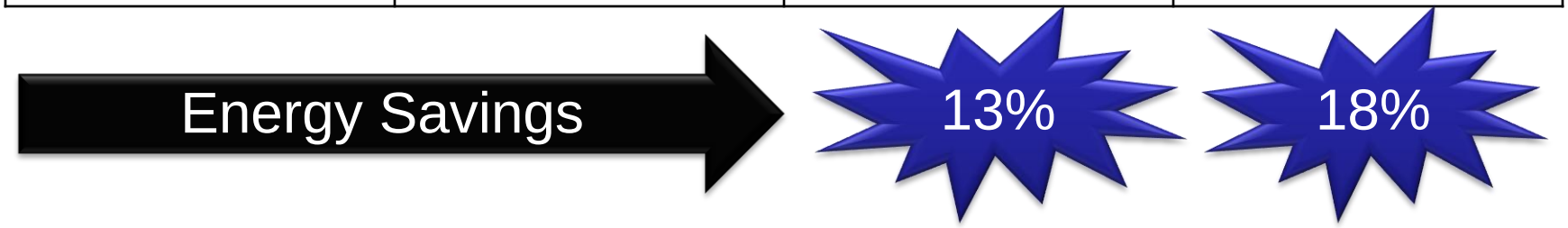


150 Tons R717, +20F ST, Wash DC

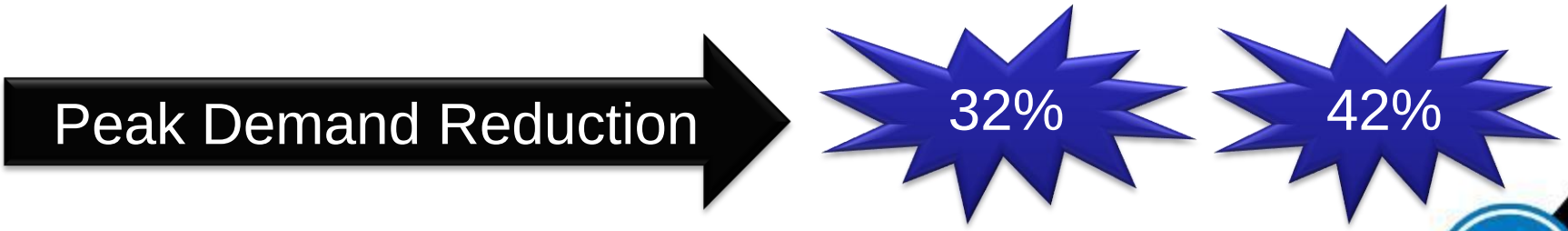


Summary: R717

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



Peak kW	Air Cooled	Hybrid	Evaporative
R717	219	149	128



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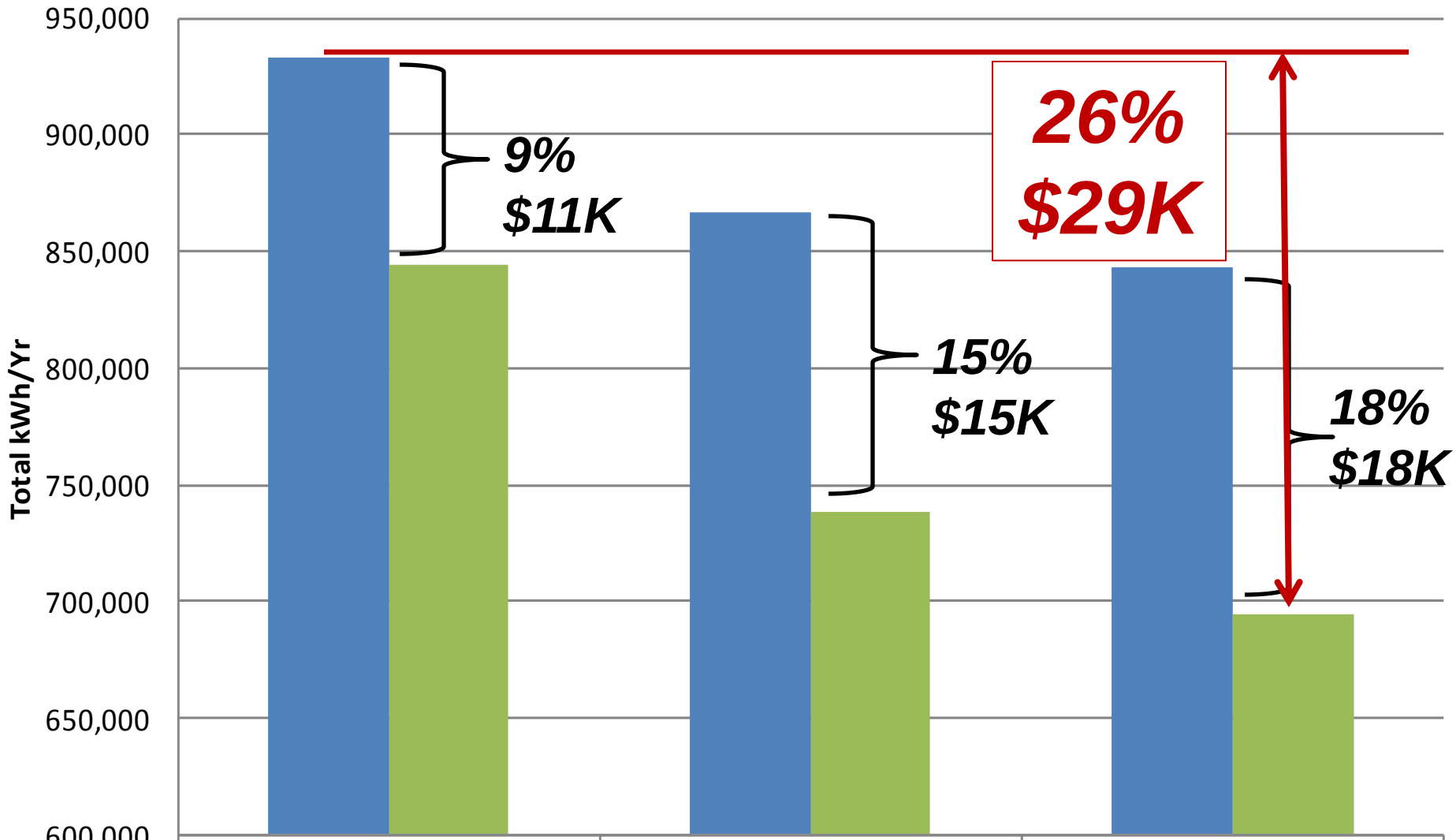
BAC

$0.12/kWh

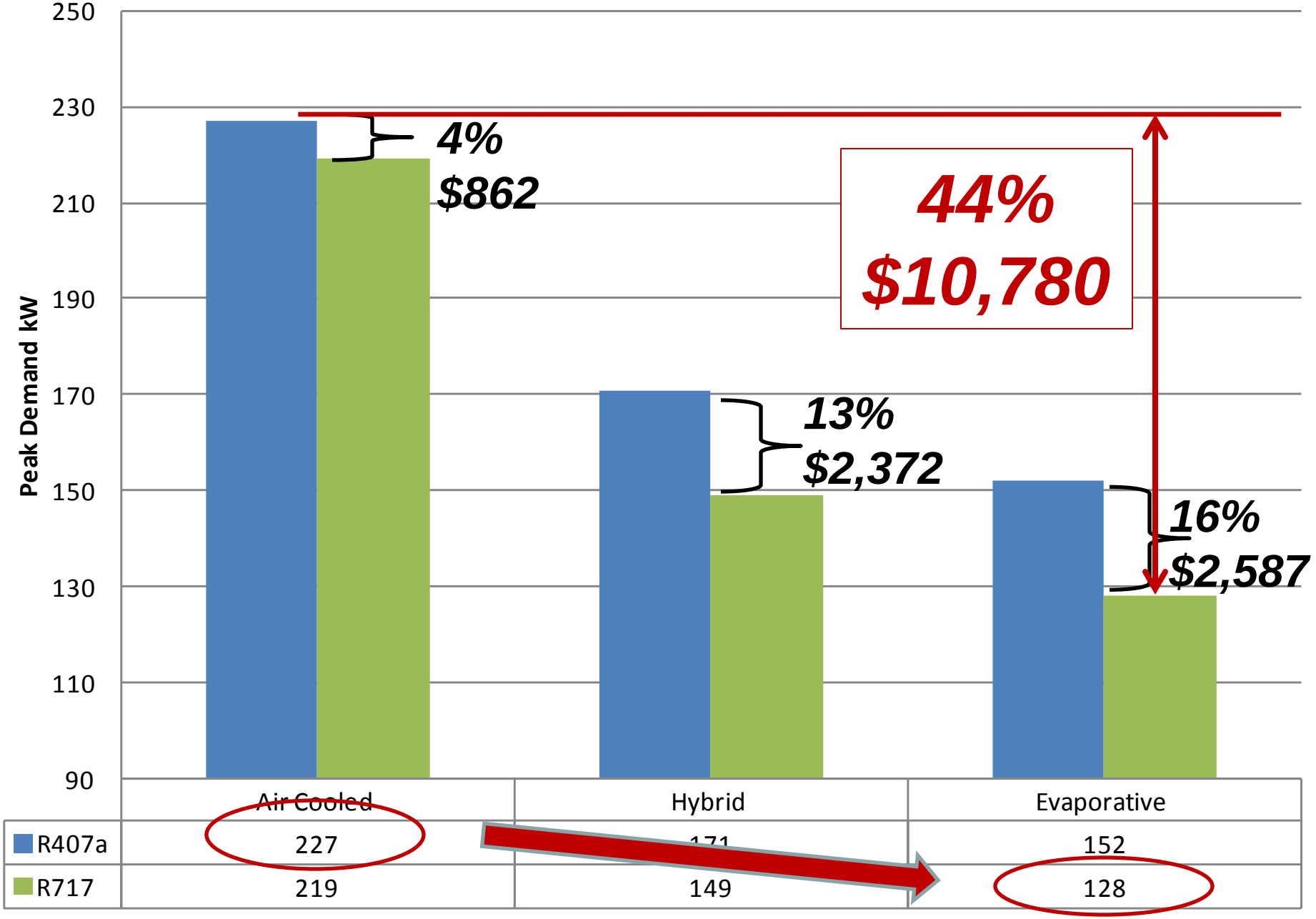
150 TR System, +20F Suction, Washington DC



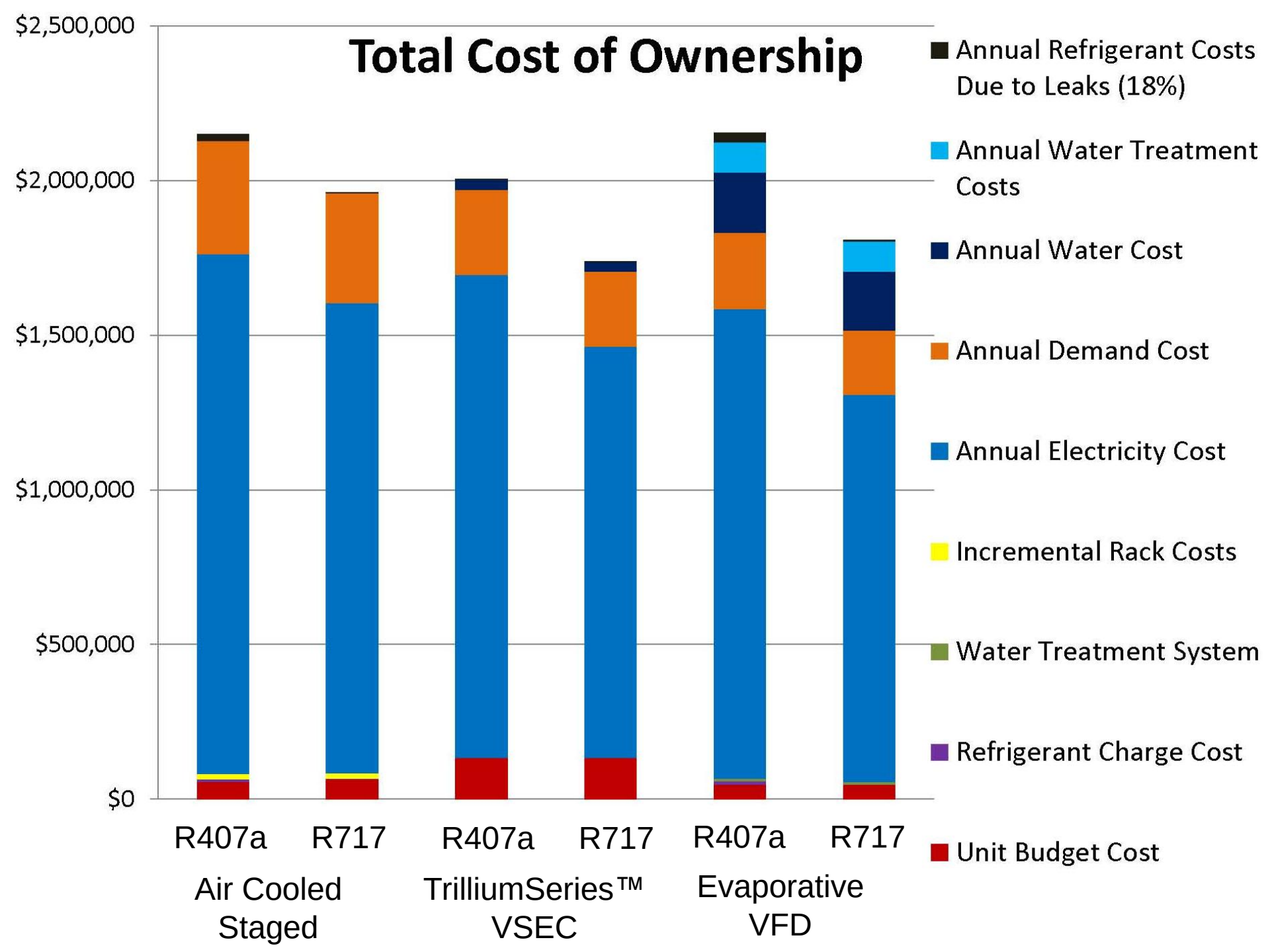
	Air Cooled	Hybrid	Evaporative
R-407A	932,561	866,251	842,786
R-717	844,467	738,549	694,775

$11/kW
80% ratchet

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



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


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