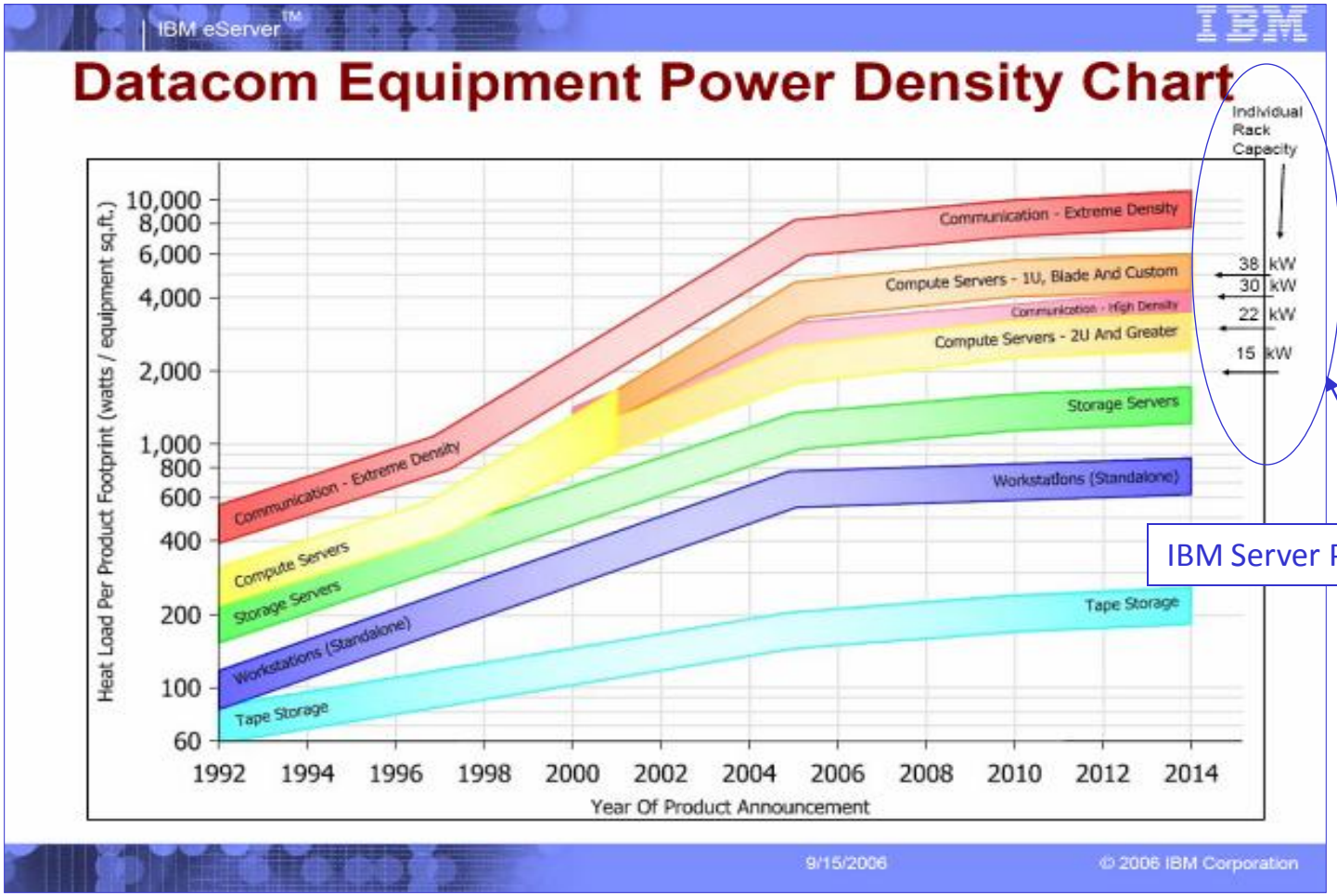
Rack Level Passive (no data-center fans) Water Cooling for Maximum Energy Efficiency

Shlomo Novotny

MEPTEC March2011

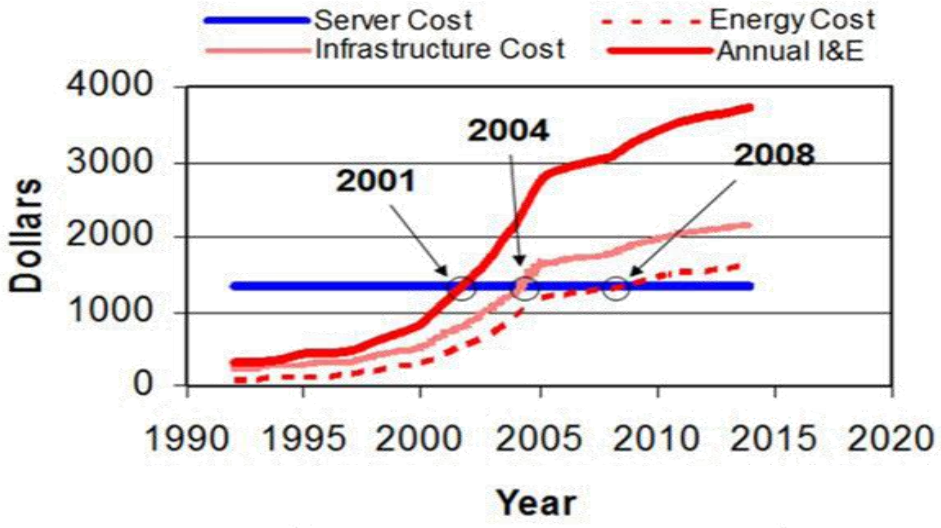
Commercial Computing and Network Telcom Power Density Trends



Source: S. Bechu, Vice President, i Series, "IBM eServers," IBM Power Technology, September 9, 2006; The Uptime Institute (USA).

OPEX Exceeds CAPEX in <2 Years

Annual Amortized Costs for a 1U Server in a Data Center



3 year server life
10 year infrastructure life

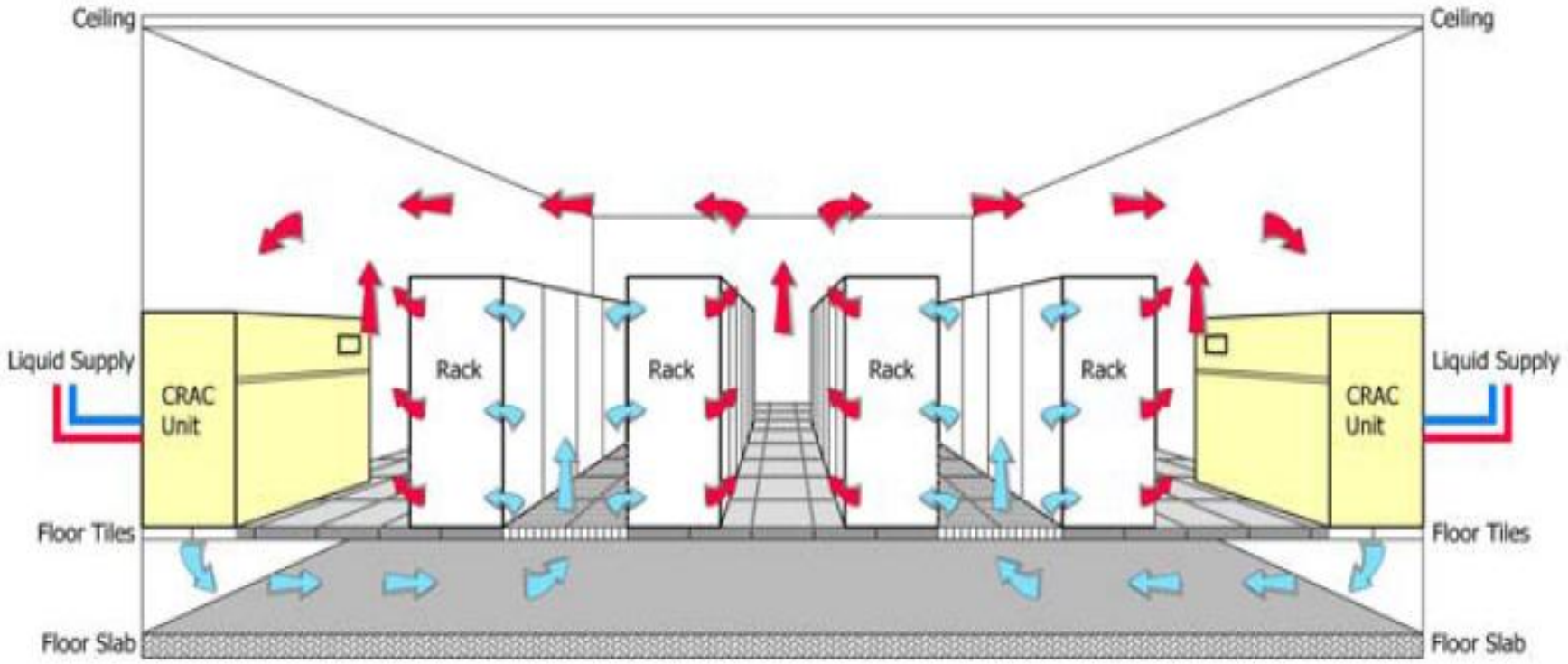
Source: Belady, C., "In the Data Center, Power and Cooling Costs More than IT Equipment it Supports", Electronics Cooling Magazine (Feb 2007)

- Data Center facility costs are growing 20% vs. IT spend of 6%
- Opex over lifetime of a server growing to 4X original purchase cost
- Cooling infrastructure can consume up to 55% of Data Center energy

Typical Air Cooled Data Center

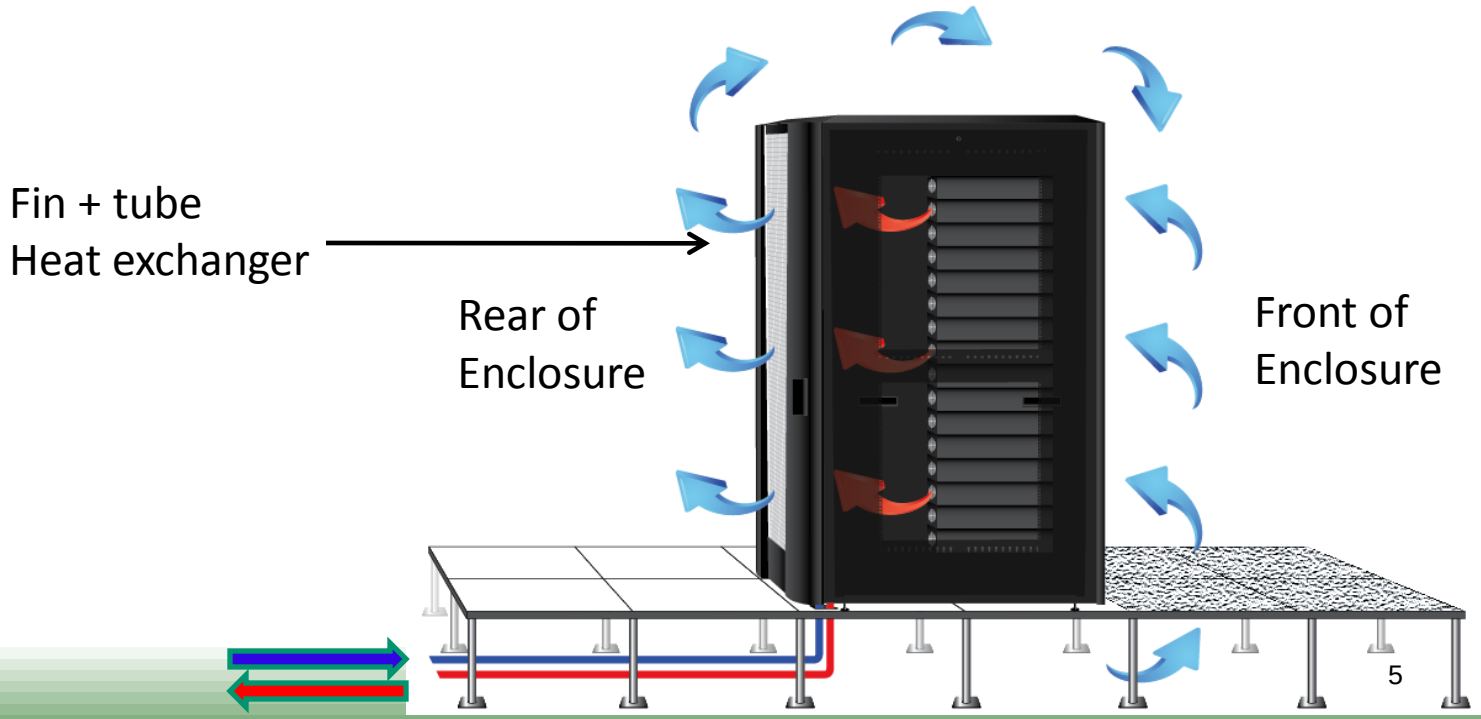
Power Dissipation Limit per Rack – 3-7KW

X86 racks (load per rack)	3-5 kW	15-20kW
Blade server	5-7 kW	20-25kW
Watts/SF	100-150 w/SF	500-750w+/SF



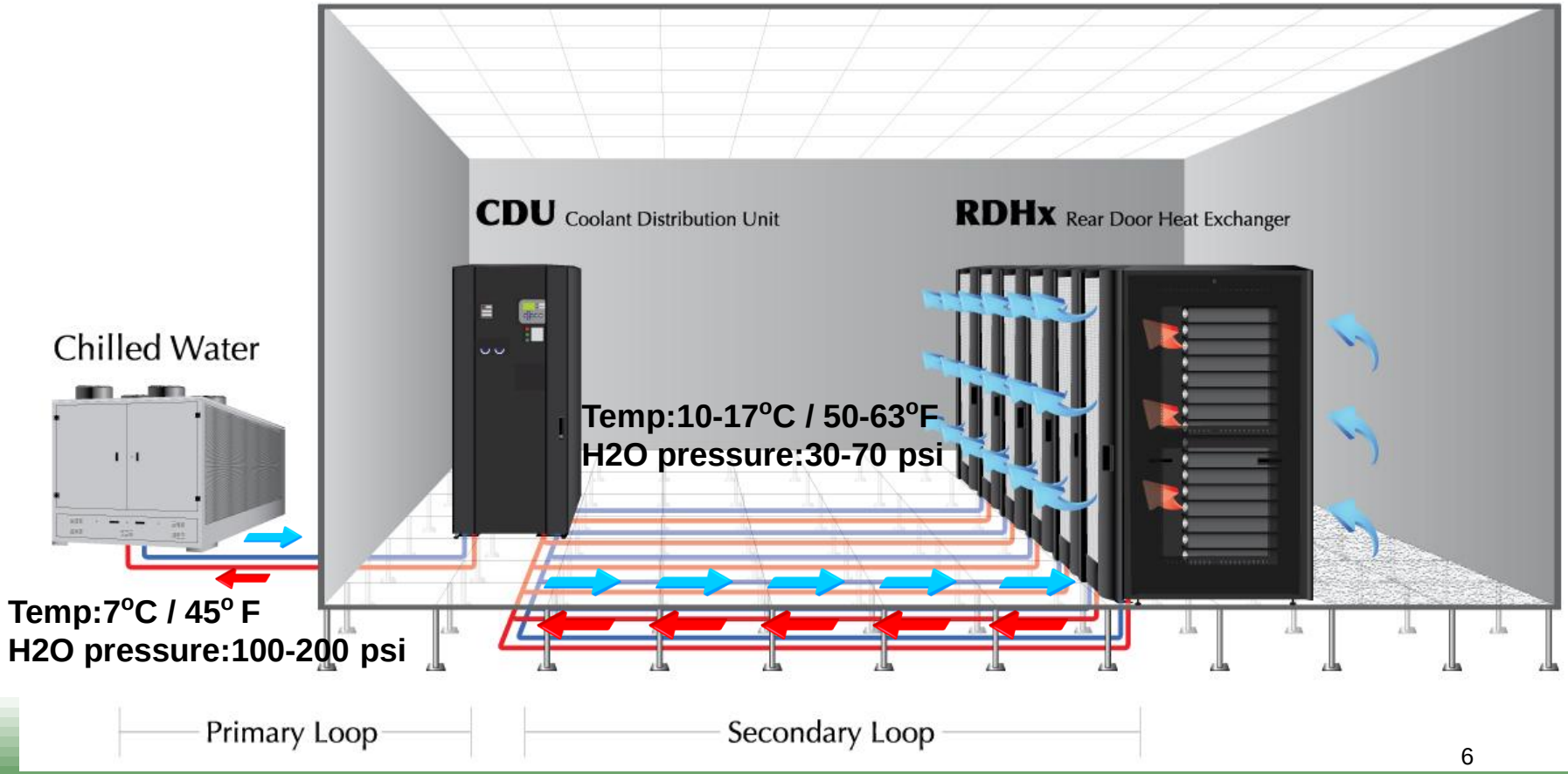
Rear Door Heat Exchanger
How Does It Work?

- Rear Door Heat Exchanger (RDHx) replaces existing rear door of IT enclosure
- RDHx has chilled water Supply & Return quick connections at bottom OR top
- Chilled water circulates through tube+fin coil from Supply connection
- Equipment exhaust air passes through coil and is cooled before re-entering the room
- Heat is rejected from room through Return water connection

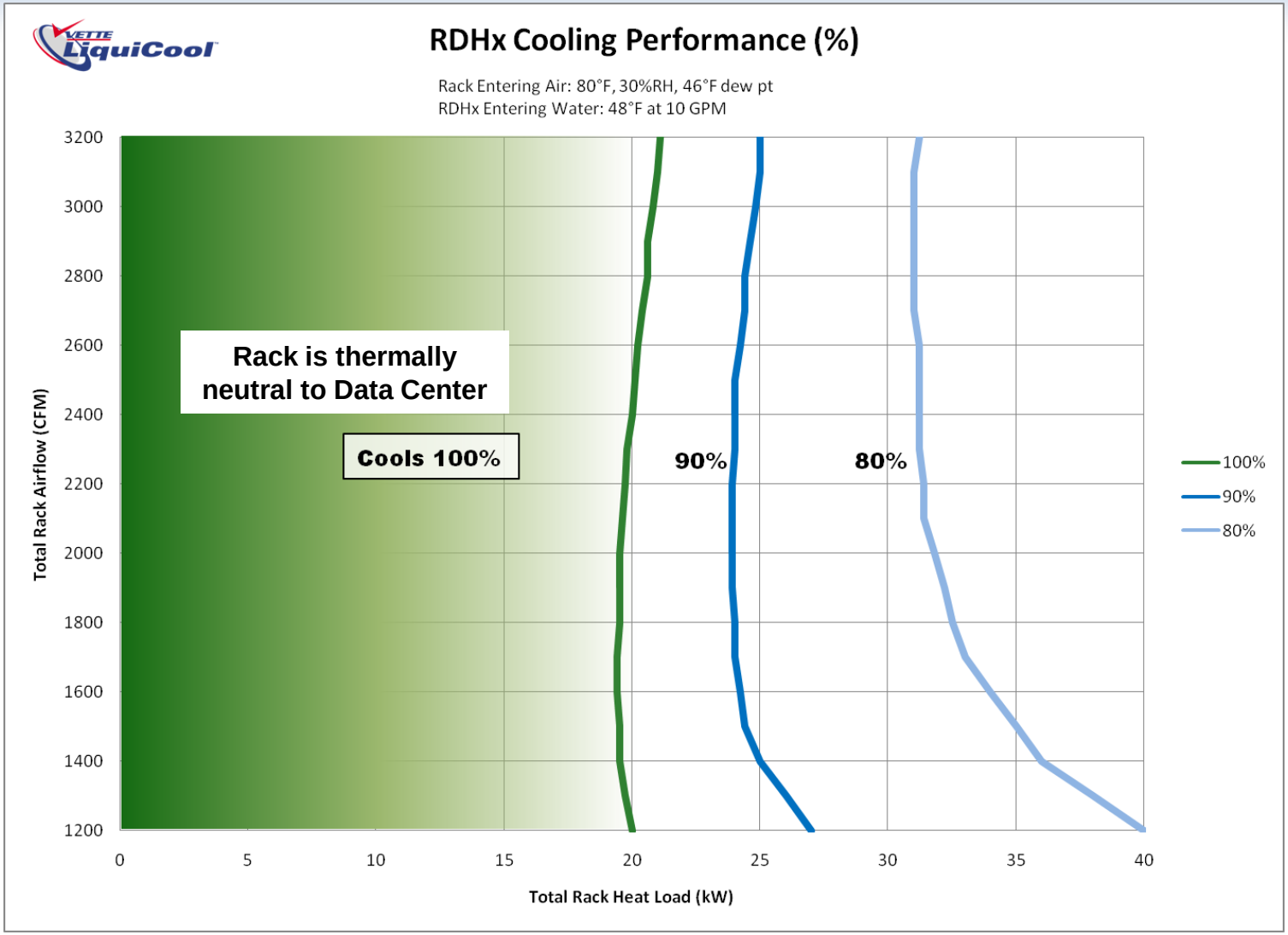


LiquiCool® System
How Does It Work?

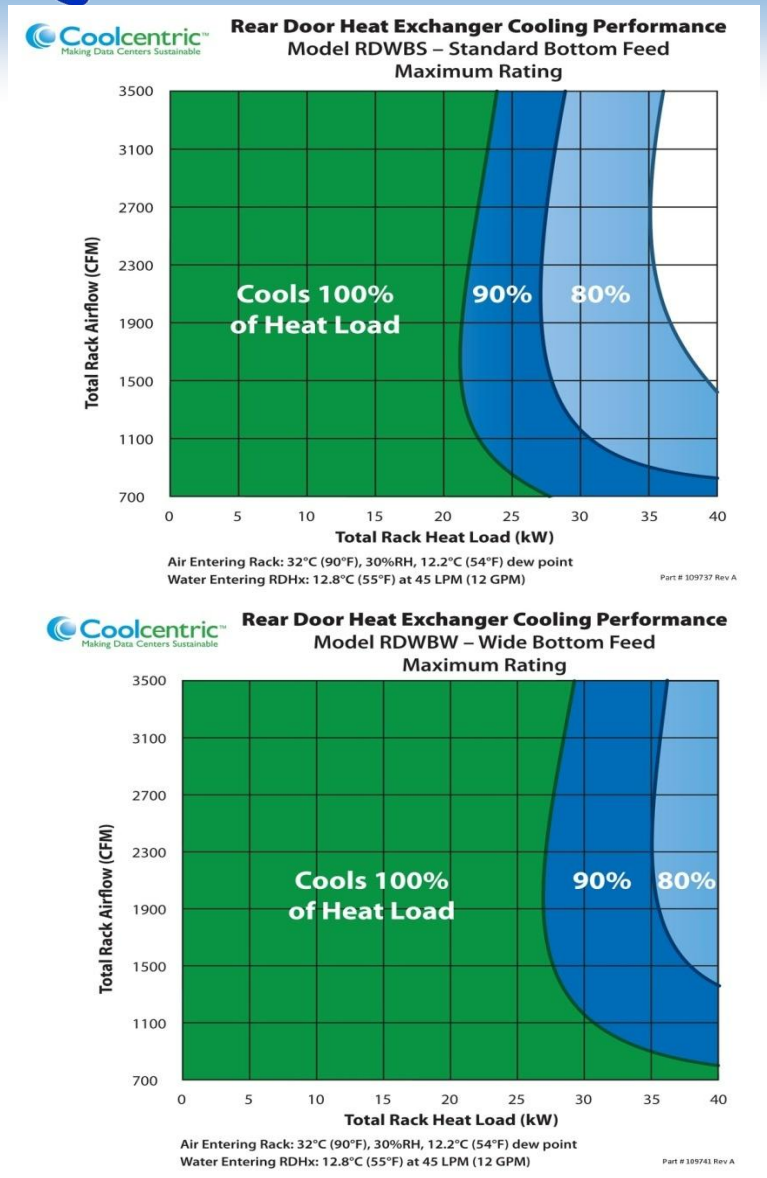
- RDHx provides 100% sensible cooling
  - No condensation, no need for reheat or humidification
- CDU creates a fully isolated, temperature controlled Secondary Loop
- Chilled water source - city water, building chilled water, packaged chiller…

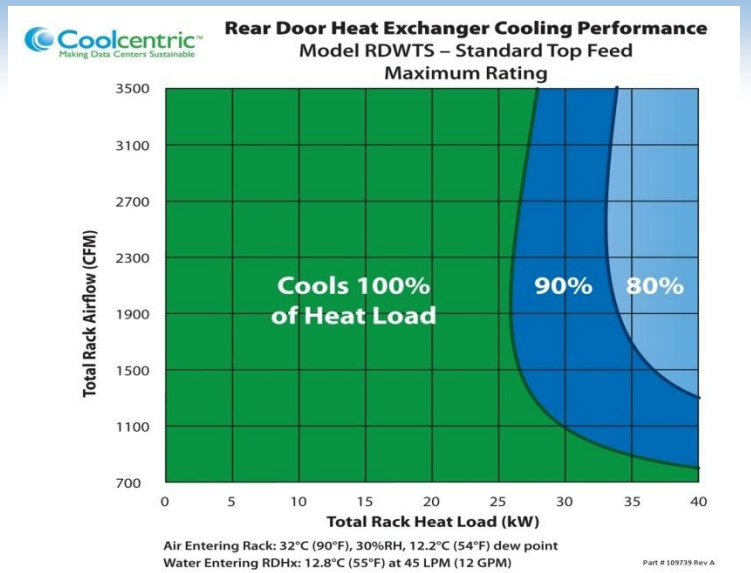


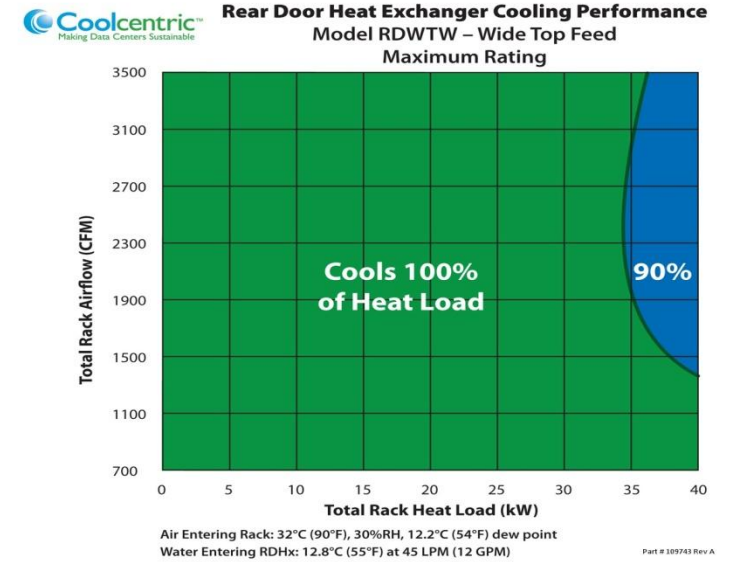
Optimized Neutral Zone



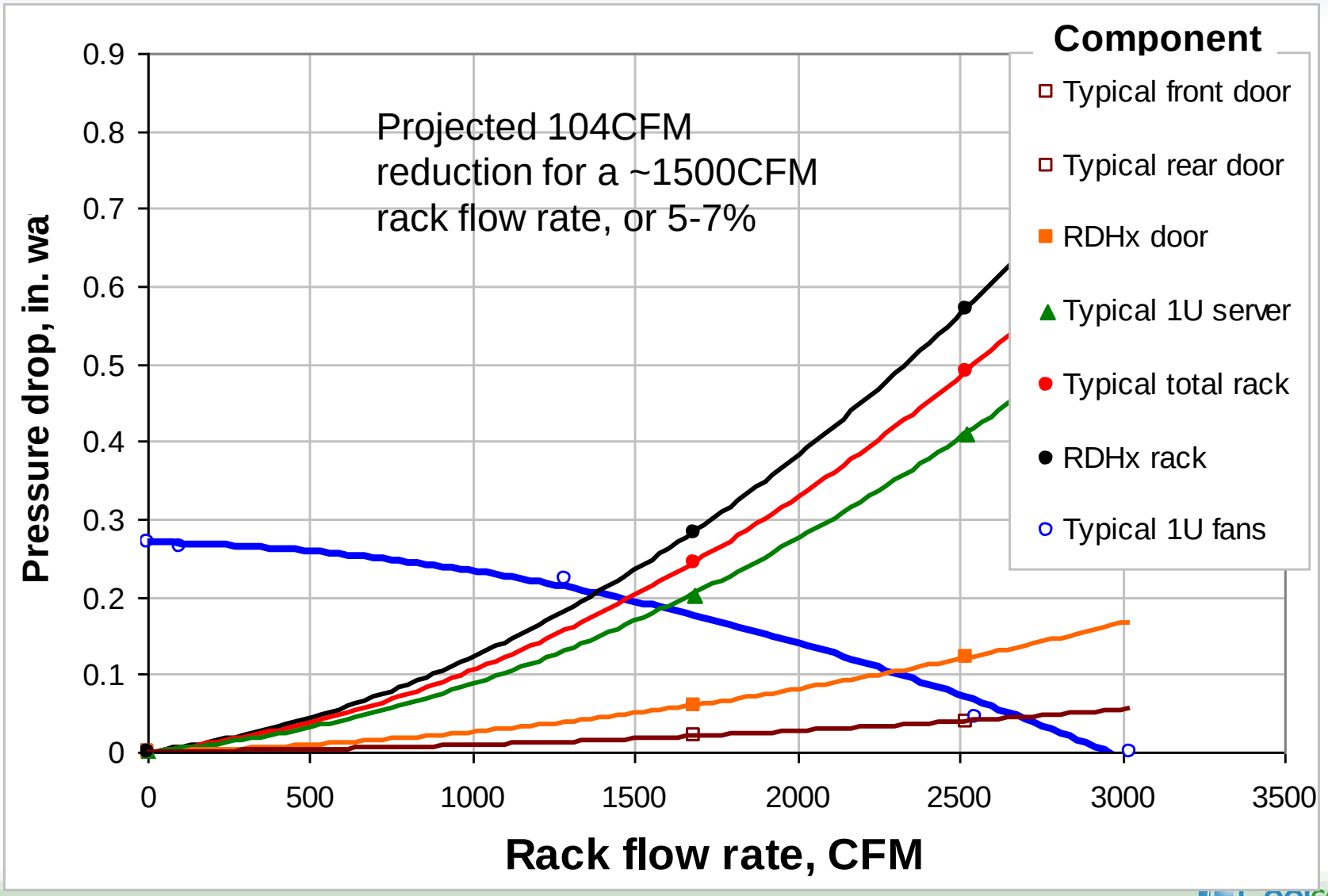
Can Fully Neutralize up to 25kW (ASHRAE max Recommended Guidelines)







Pressure Drop



RDHx vs. Perforated Door Test Results

- **Test setup**
  39 Nodes in (1) 600mm enclosure – IBM x3550 1U Servers
  Each Node = 12x40mm fans in 3 banks of 4 fans each operating at flowrate of 35 cfm with 25C inlet air temperature. The standard rear door perforated cover is 55 - 60% open.

- Measured total rack power with perforated rear door cover: 15.51 kW(39 nodes installed)
  Measured total rack power with rear door heat exchanger: 15.58 kW (+70 watt increase or 0.05%)
  Measured average fan speed with perforated rear door cover: 8100 rpm
  Measured average fan speed with rear door heat exchanger: 8185 rpm(1.1 % increase)
  Measured average delta temperature in inlet air temperature between 2 tests(Rear door heat exchanger - perforated rear door): 0.05 C
  Measured average delta temperature in processor temperature sensor between 2 tests(rear door heat exchanger - perforated rear door): 0.65 C

Chill Off

Presented at SVLG Data Center Energy Summit - June 26, 2008

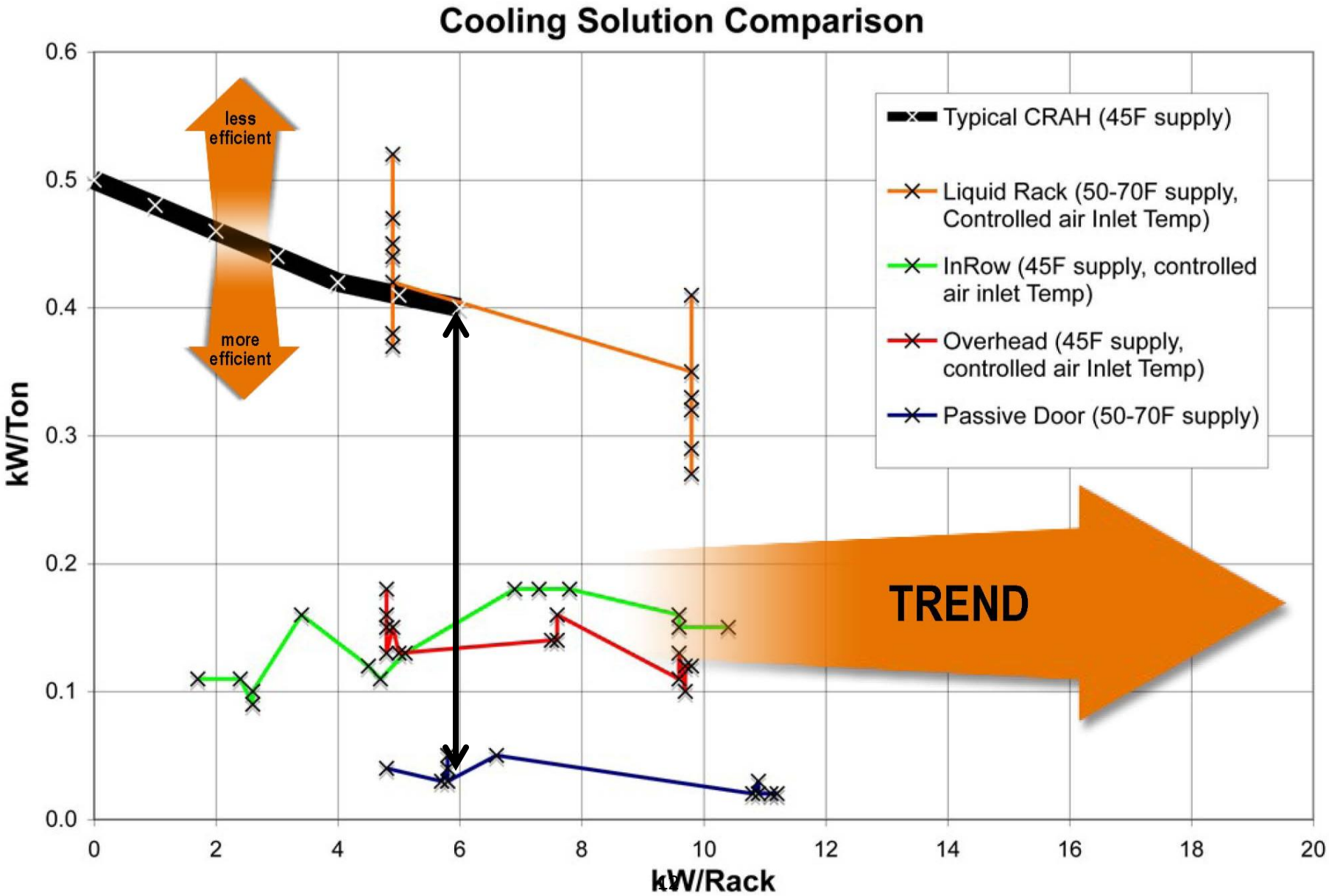
Dean Nelson, Sr Director, *Sun Microsystems*

Tim Xu, Ph.D., PE, *Lawrence Berkeley National Laboratory*

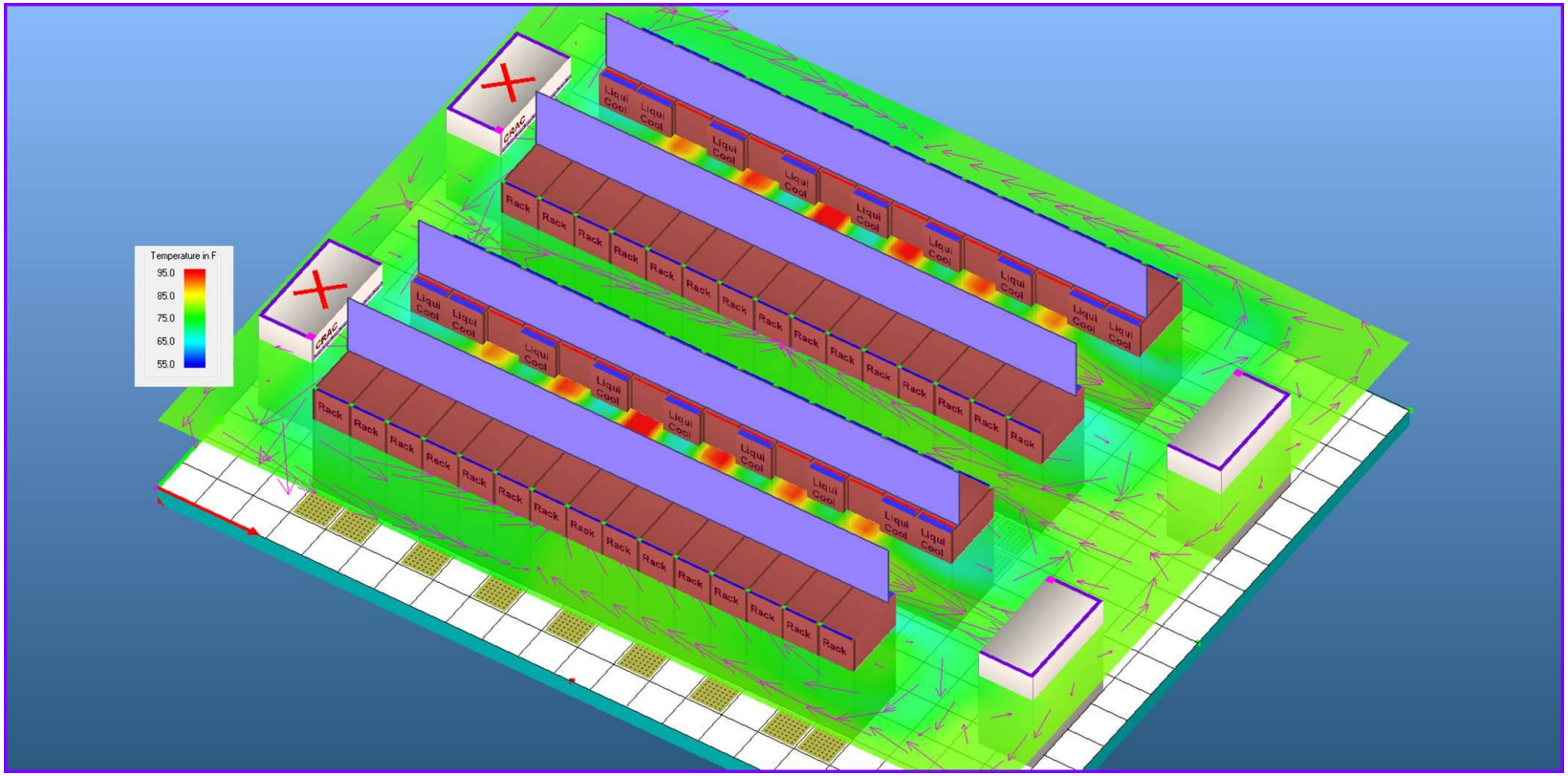
(Plus Ken Schneebeli & Alan Claassen *IBM* and John Menoche, *Vette Corp*)

Results

https://microsite.accenture.com/svlgreport/Documents/pdf/case%20study_sun_modularv2.pdf

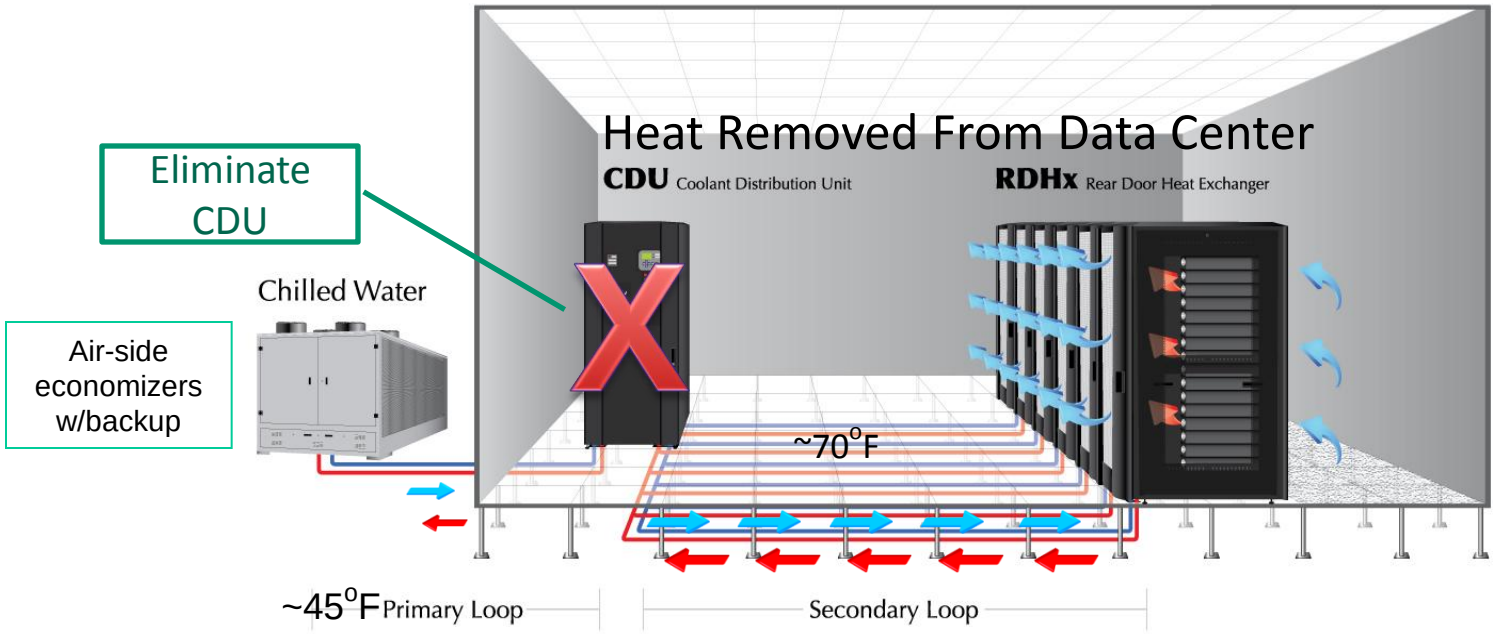


Cost Effective Low Power Per Rack RDHx (4-6KW)



Free Cooling – New Build & Retrofit

Water-side Economizer Significant advantage over Air-side Economizers

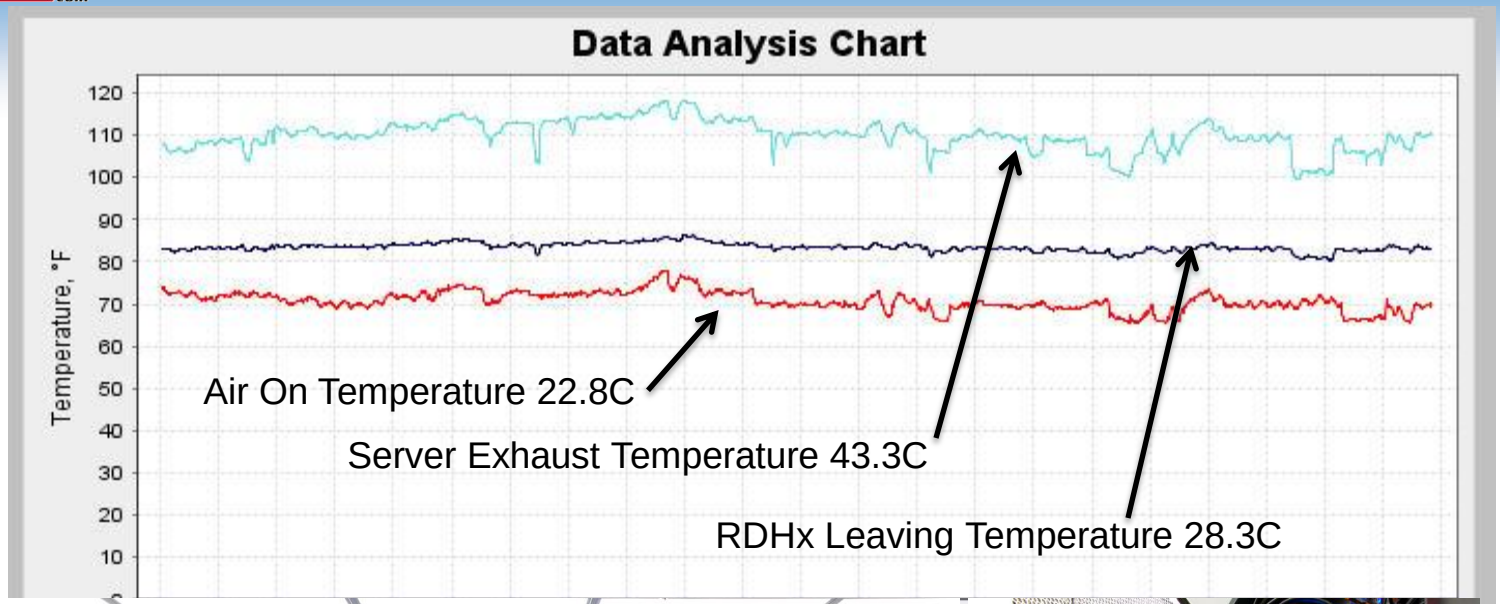


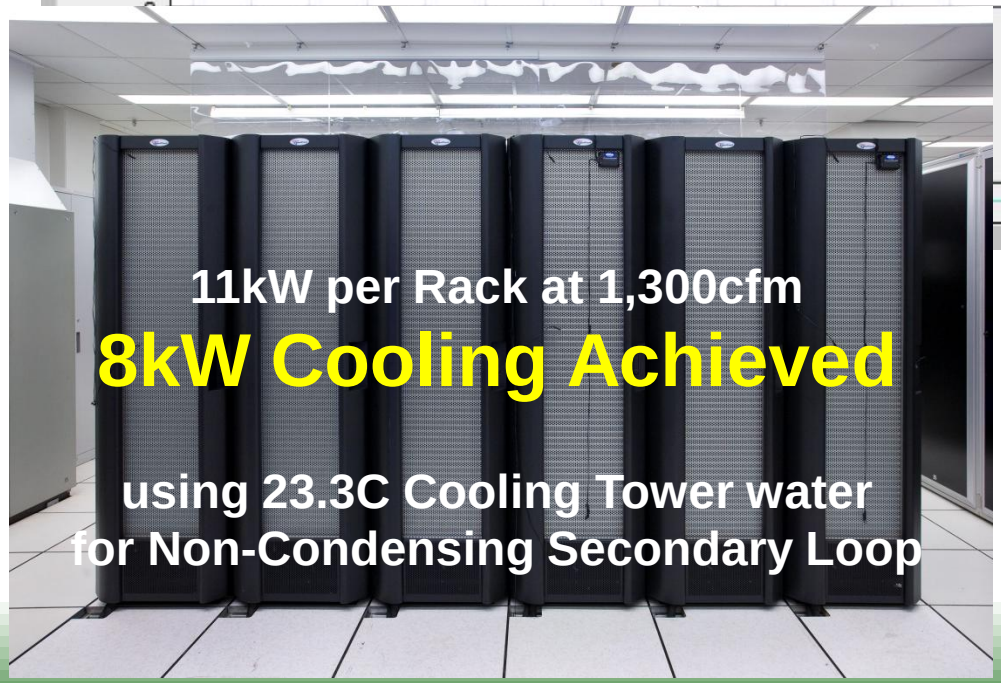
- RDHx with water temperatures up to 70F
- RDHx paired with water-side economizer allows chiller free cooling up to 11 months/year
- Can reduce chiller plant energy up to 90%
- Scalable solution: Pay as you Grow
  - Day 1 Investment = fraction of legacy cost

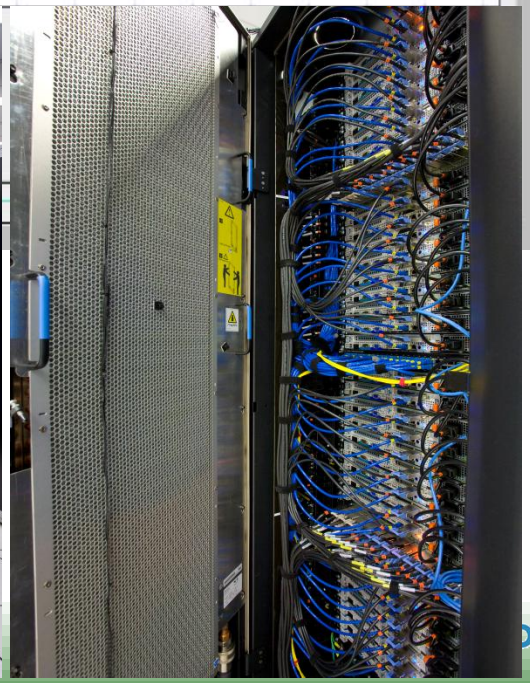
- Compared to Air-side free cooling:
  - No sub-floor/overhead plenum
  - No particulate contamination
  - No noise
  - Air requires containment and limited to approximately 12kw per rack

Coolcentric™

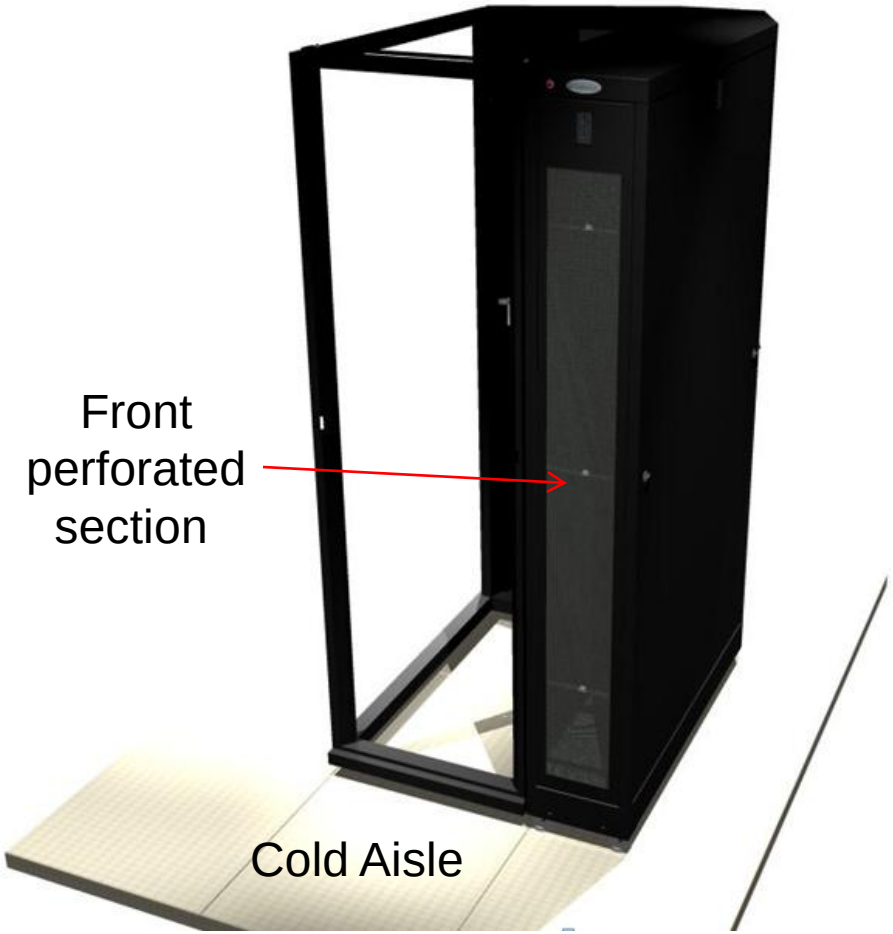
Extreme Efficiency

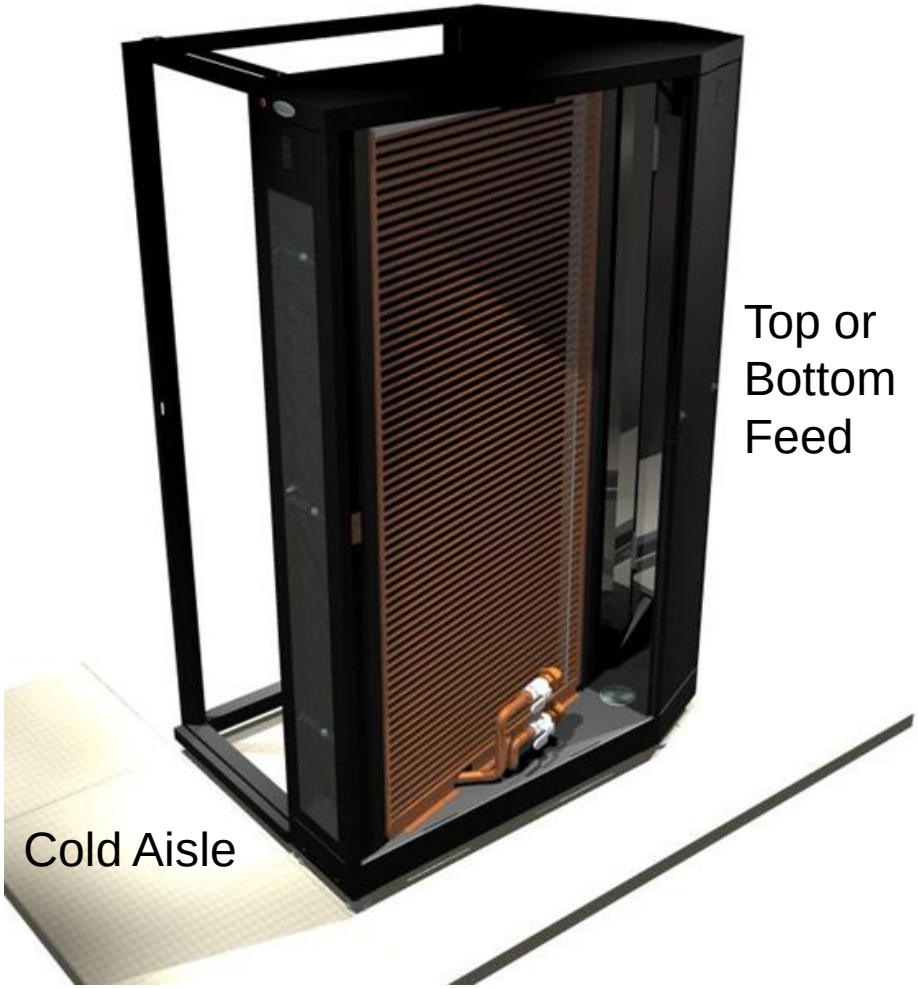






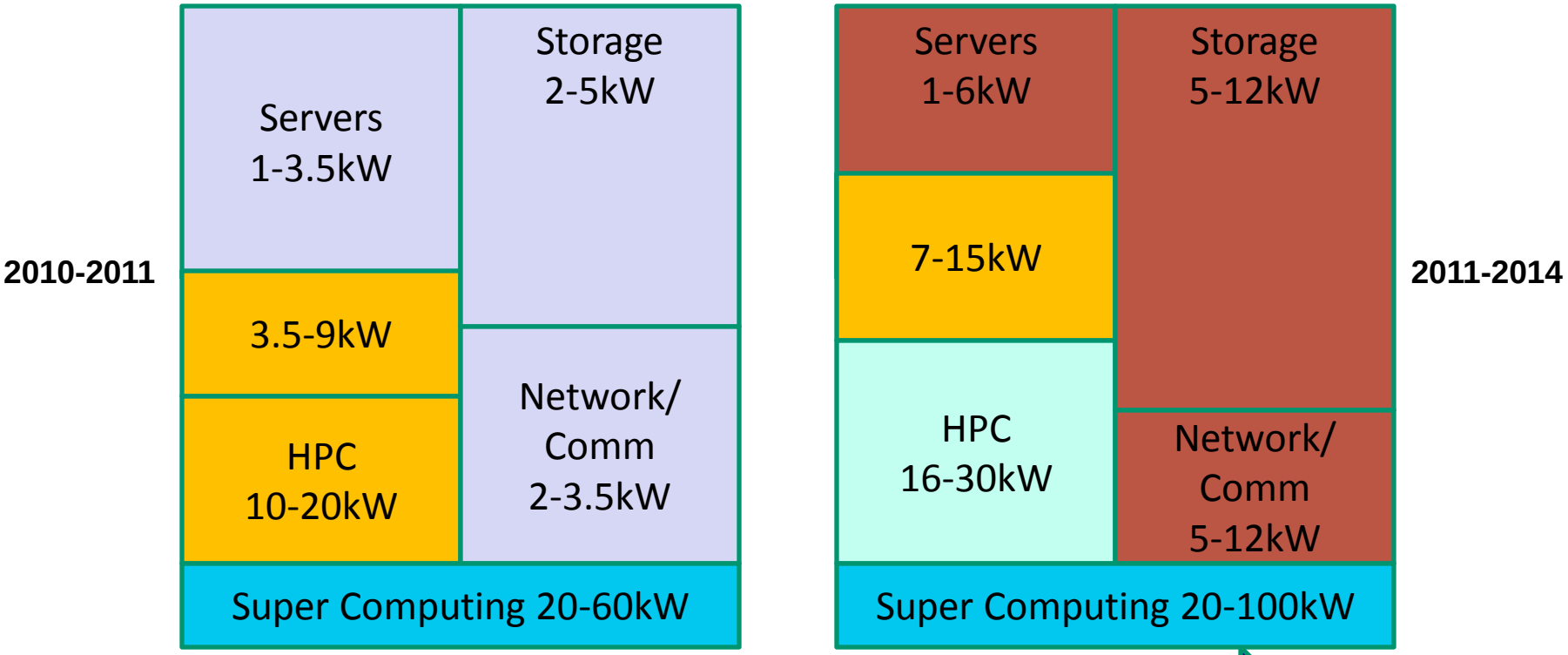
Side Cooler – Front View
40KW @ 55F water; 20KW @ 65F water





Data Center Efficiency Evolution

Power per Rack

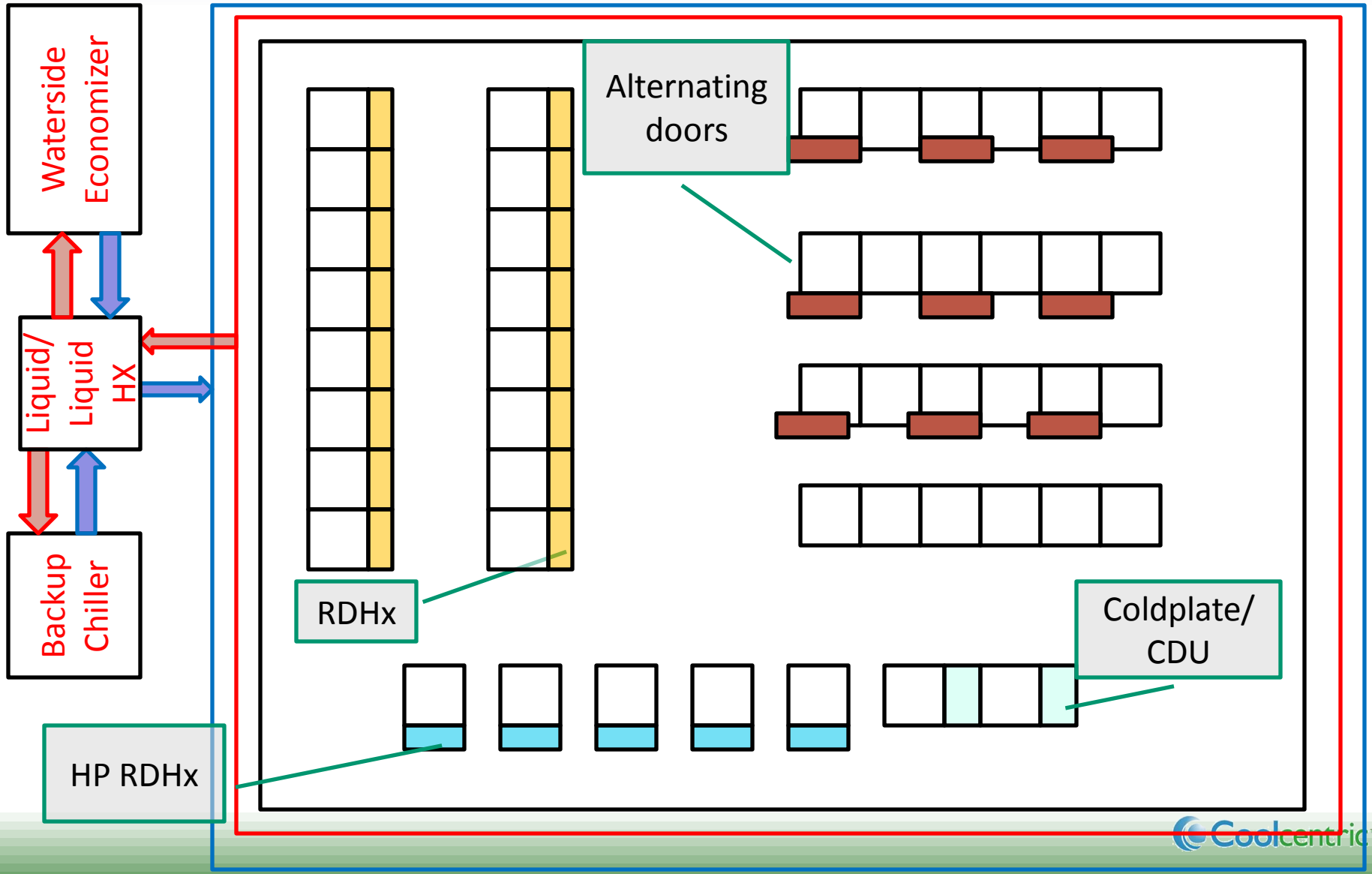


High performance RDHx or side car	RDHx
CRAC or alternating	RDHx or alternating
Liquid and Hybrid RDHx	

Traditional CRAC's could be eliminated in the new Basis of Design

Coolcentric™

All Water Cooling Data Center



Conclusion

- Infrastructure energy cost exceeding IT cost drives a focus on data center cooling efficiency
- Sizable energy savings can be found by re-thinking how data centers are cooled
- Traditional methods of spreading loads and adding space will no longer be cost effective
- Localized liquid cooling at rack-level and rack proximity minimizes energy consumption by eliminating air-cooling
- Makes cooling more predictable and allows optimized designs (no need to overcompensate as with air cooling), thus saving energy
- Water Cooling enables either running the chiller more efficiently by delivering “warmer” water or by eliminating the chiller and using an evaporative tower
- Localized liquid cooling is no longer simply a “hot-spot” solution, but the basis of design for new sustainable data-centers