

Greening Data Centers

Dallas Thornton

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ON*VECTOR

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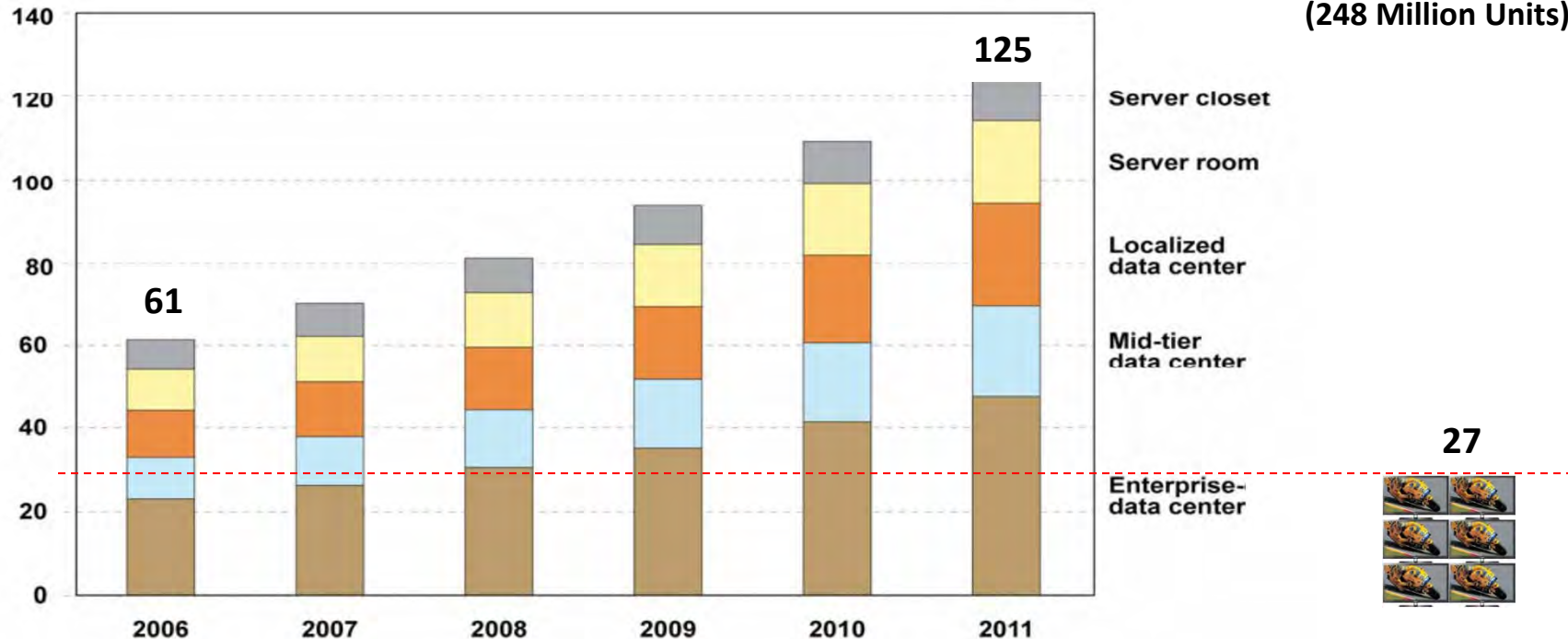
SDSC  **UCSD**
SAN DIEGO SUPERCOMPUTER CENTER at the UNIVERSITY OF CALIFORNIA, SAN DIEGO

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Cyberinfrastructure Services Division

Data Centers Are Enormous Users of Power

US Data Centers (TeraWatt Hours per Year)

US Televisions
(248 Million Units)

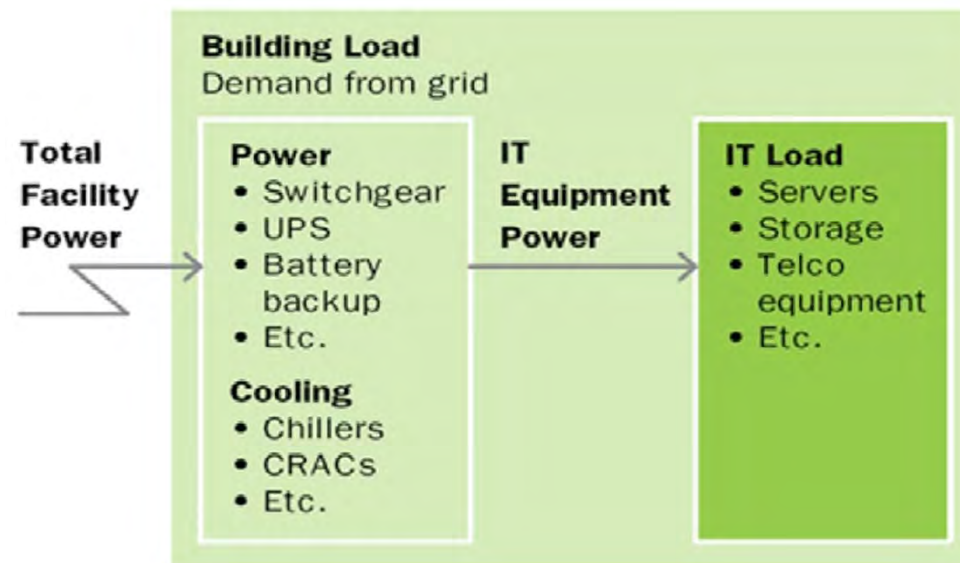


Sources: Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431; U.S. Environmental Protection Agency ENERGY STAR Program, August 2, 2007; Kaufman, Ron. Television's Hidden Agenda. TurnOffYourTV.com, 2004

Measuring Data Center Facility Efficiency

- The most common measure is Power Use Efficiency (PUE):

$$\text{PUE} = \frac{\text{[Total Datacenter Electrical Load]}}{\text{[Datacenter IT Equip. Electrical Load]}}$$



Source: Green Grid

PUE Tabletop Reference...

PUE	Level of Efficiency
3.0	Very Inefficient
2.5	Inefficient
2.0	Average
1.5	Efficient
1.2	Very Efficient
1.0	Ideal



Typical Server Rooms

From office conversions (worst) to basic hot/cold aisle legacy data centers (better)

Optimized Data Centers

Hot/cold aisle containment, HVAC throttling based on loads, and high-efficiency UPSes



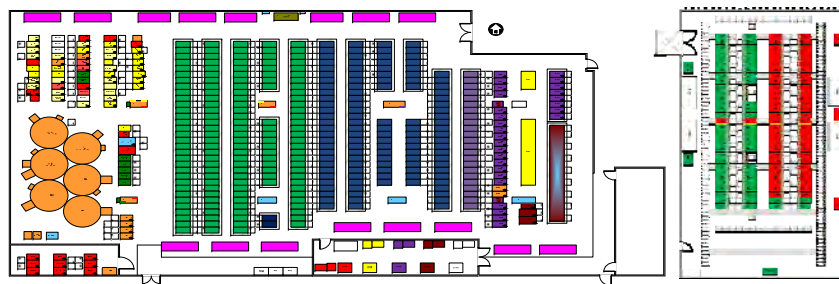
Greenfield Design in Canada

All of the above + innovative climate-leveraging technologies and designs

Sources: Green Grid, 2008 UC NAM Data Center Audit, 2009 UCSD/SDSC NAM Data Center Audit, 2010 SDSC/McGill University Joint Data Center Design

SDSC Data Center Overview

- ~19,000 sq. ft., 13 MW of on-site power
- Regional co-location data center for UC system
 - 100+ projects from 6 campuses
- Energy efficient alternative to server closets, offices, etc.
- Home of SD-NAP
 - Many 10 Gb and 1 Gb connections to other organizations and networks:
 - CENIC, Cox, Time Warner, Salk Institute, Scripps Research Institute, SDSC, etc.



Optimizing Features

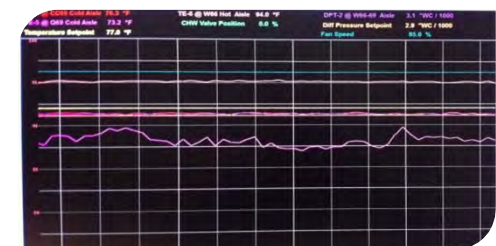
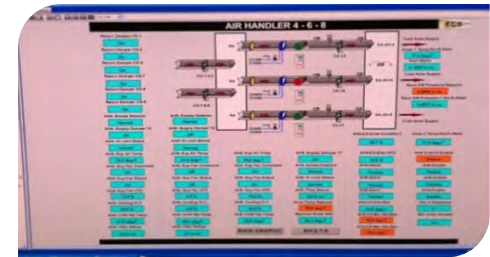
- **Aisle Thermal Containment**

- 15° ΔT from top to bottom of rack \rightarrow 1° ΔT
- 10° - 15° increase in return temperatures
- Cold aisle and hot aisle options
- Fire code considerations



Optimizing Features (Cont.)

- **Increased Supply Temperatures**
 - Move to near top of ASHRAE spec. (80° F)
 - Drives AHU return temperatures higher, allowing more cooling from chilled water
- **VFD Fans on AHUs**
 - Allows for fan energy savings... IF accurate controls can be put in place.
- **Adaptive Controls**
 - Address redundancy and inefficient cooling
 - Allow 'big picture' control of cooling, throttling based on real-time loads



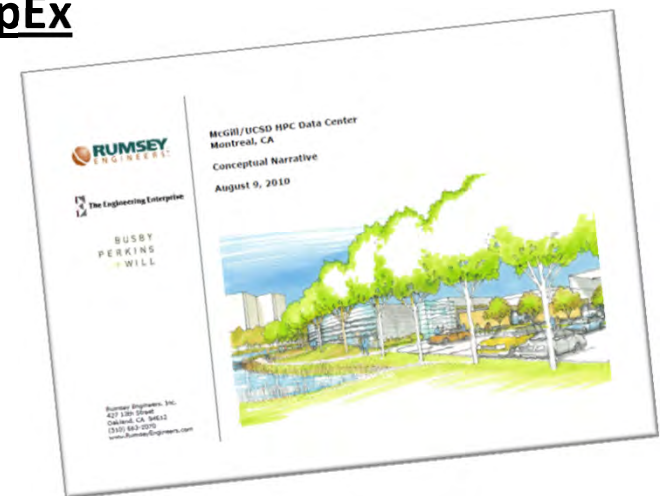
Optimizing Features (Cont.)

- **Rack Blanking Panels**
 - Cost effective solutions: Coro-plast
- **Floor Brushes**
 - Conveyor belt brush: sold in varying lengths
- **Efficient Electrical Systems**
 - 480V/277V or (even better) 400V/240V power
 - Efficient UPS and generator configs



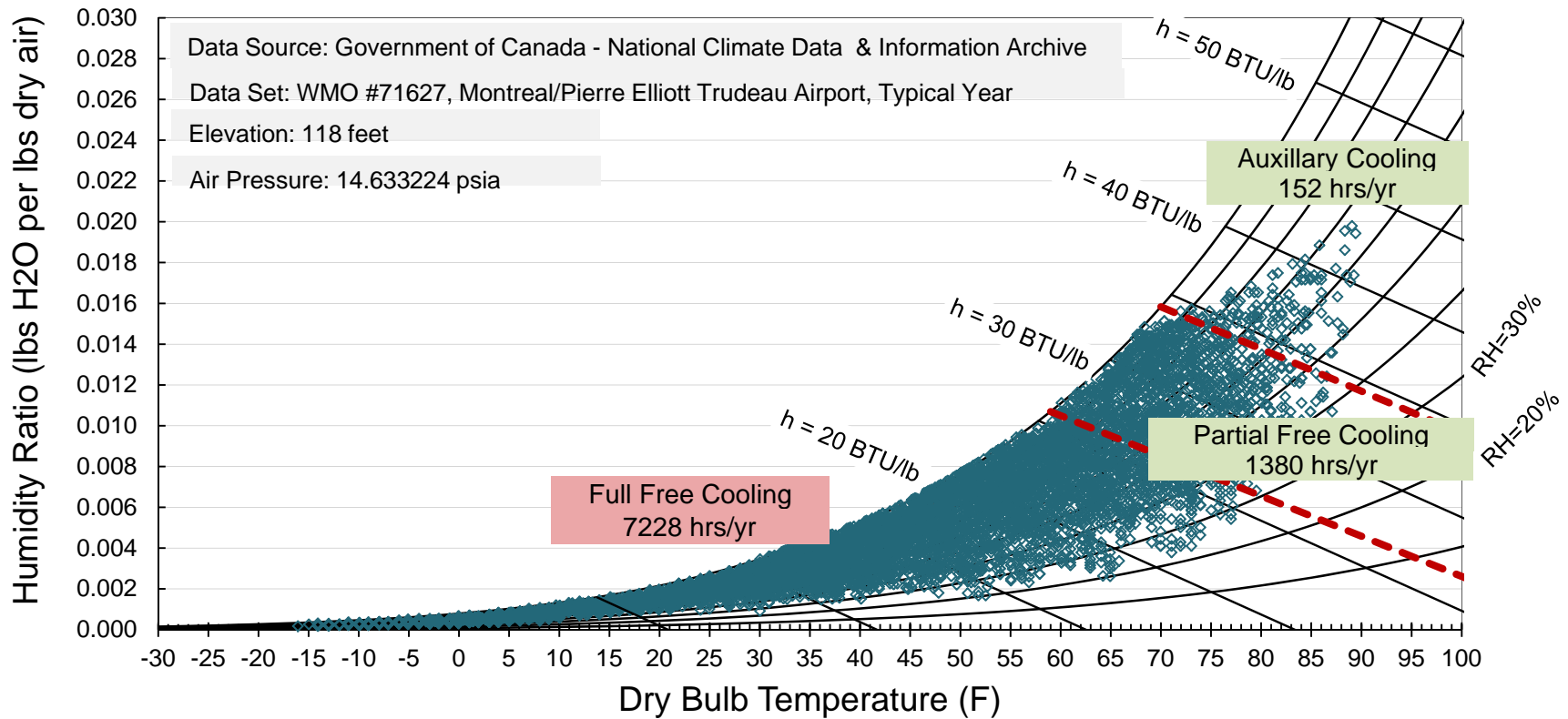
SDSC/McGill Data Center Conceptual Design

- **Goal: Most Efficient Class One Data Center in North America**
- **Optimize Cooling Systems for Quebec Climate**
 - Evaporative free cooling – Primary cooling
 - Seasonal ice storage – Top up cooling
 - No compressor based cooling
- **1.06 PUE means UC could potentially recover CapEx in less than 10 years with energy cost savings**
- **Lower-cost, green hydro power**
 - \$0.045/kWh vs. \$0.08-\$0.15/kWh in California
- **Design funded by grants from Canada-California Strategic Innovation Partnerships (CCSIP) and CLUMEQ**



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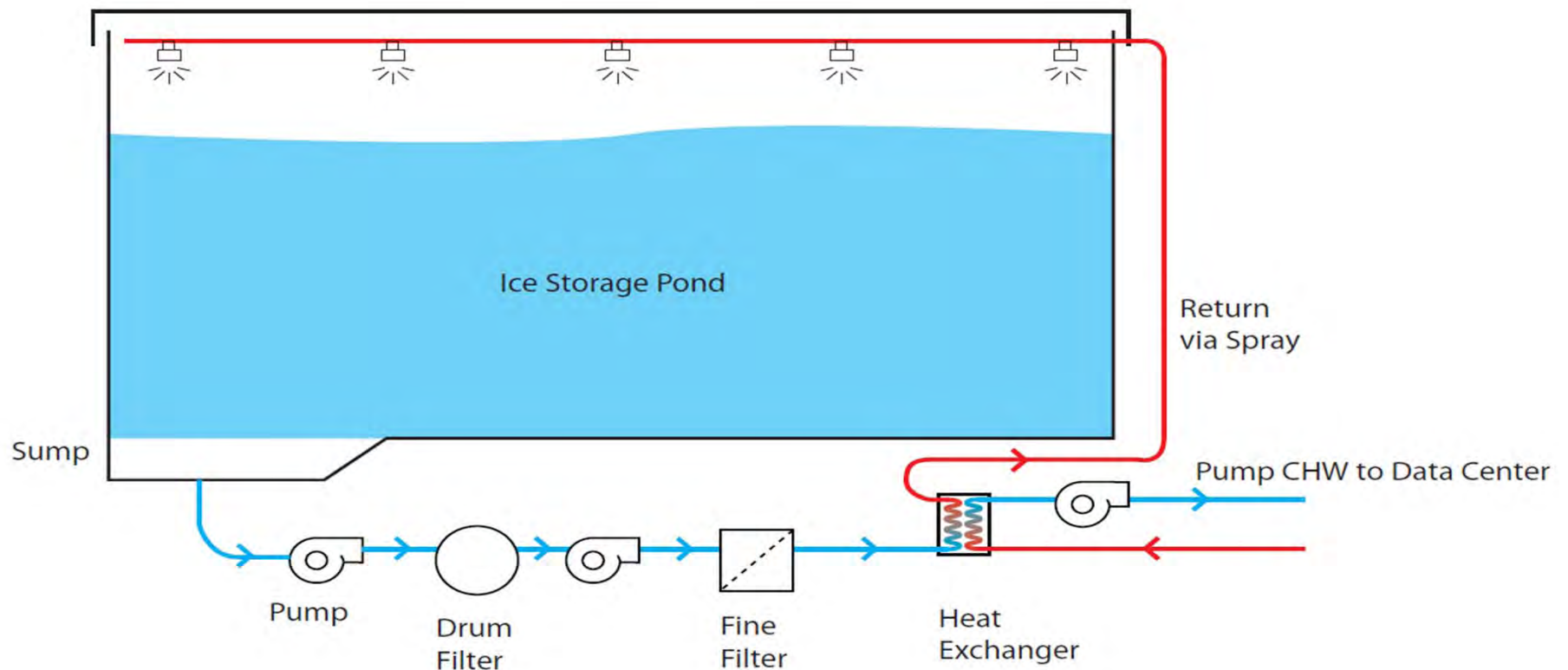
Free Cooling Analysis with 65F CHWS



Supplemental Cooling: Seasonal Ice Storage Pond System

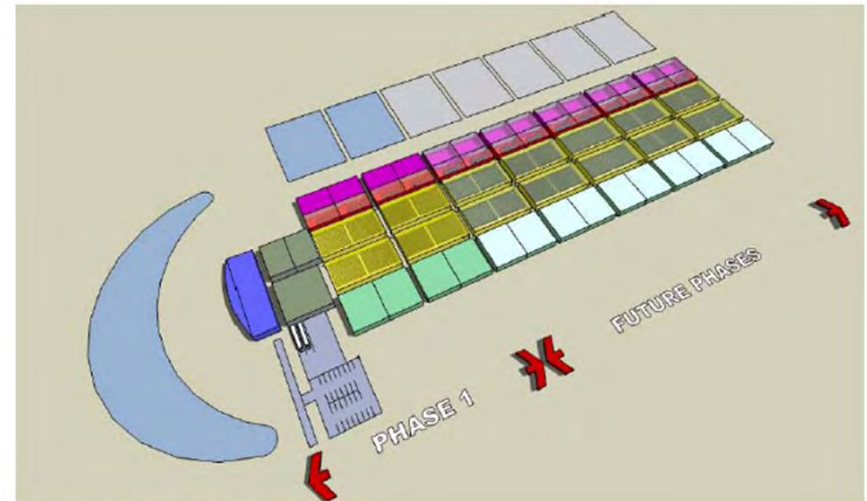


Supplemental Cooling: Seasonal Ice Storage Pond System



Backup

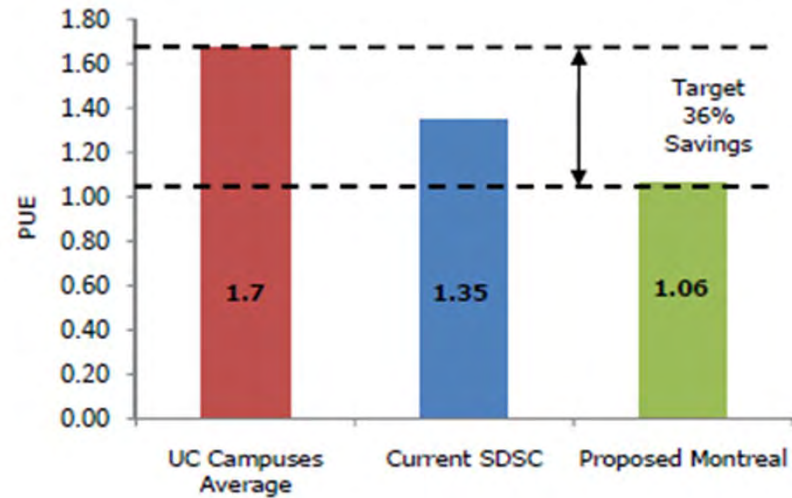
- Pay for rental chillers only when (if) you ever need it
- Design for portable chillers to connect in an emergency



Typical Data Centre Expansion plan

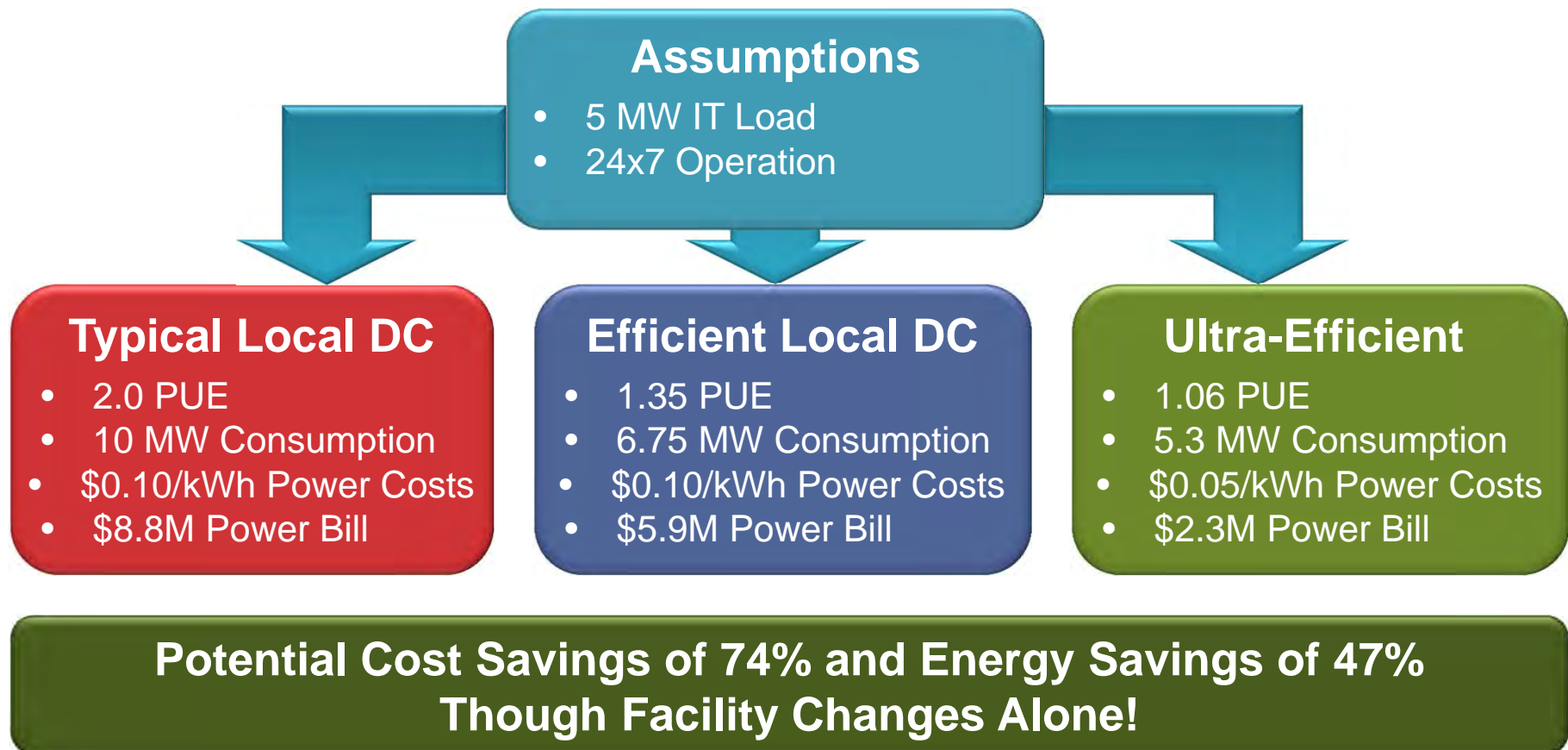
Results

Power Utilization Efficiency (PUE) Comparison



Air Cooled	Water Cooled	Supply Temperatures				Hours of Free Cooling / year		PUE	Annual Energy Use		Mechanical Cooling Needed		Water Usage		
		Air Cooled		Water Cooled					Energy	Cost (\$0.058/kWh)	Hours per Year ¹	Additional Load at Extreme Weather (wetbulb = 68.7°F)	Evaporation + Carry Over	Blowdown	Cost (\$5.52/1,000 gal)
		°C	°F	°C	°F										
		hrs/yr	% of yr	kWh/yr ²	\$	gallons	gallons		\$						
10%	90%	29.4	85.0	23.9	75.0	8,532	97%	1.06	74,543,000	\$4,323,000	228	0	33,200,000	8,100,000	\$228,000

Potential Facility-Related Cost Savings





“Anyone who knows all the answers most likely misunderstood the questions.”