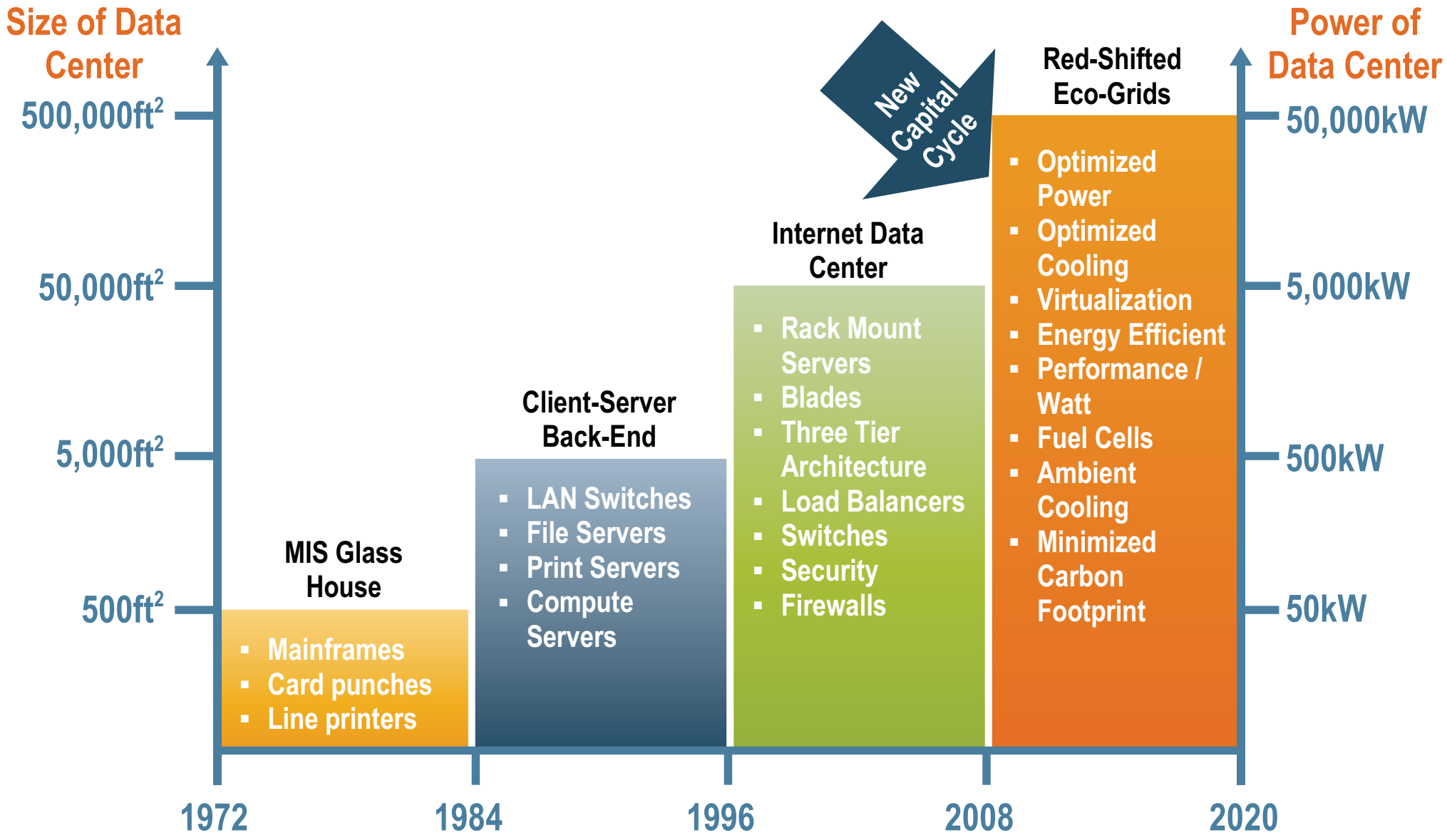
The Future of Data Centers
(... and the Stuff That Goes In Them)

Subodh Bapat
Vice President, Energy Efficiency
Sun Microsystems

The Coming Data Center Revolution



Number of Data Centers Growing

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Very Large	100	106	120	160	175	185	210	230	250	270
Large	900	870	880	900	920	990	1,040	1,100	1,170	1,250
Medium	1,405	1,385	1,395	1,420	1,490	1,585	1,665	1,765	1,870	1,975
Small	2,180	2,100	2,110	2,190	2,230	2,290	2,360	2,430	2,500	2,570
Total	**4,585**	**4,461**	**4,505**	**4,670**	**4,815**	**5,050**	**5,275**	**5,525**	**5,790**	**6,065**
Growth Rate		-2.70%	1.00%	3.70%	3.10%	4.90%	4.35%	4.74%	4.80%	4.75%

Small Data Center

- Between 350 – 500 Servers Installed
- 15,000 Sq Feet Of Raised Floor
- Predominately Volume Server Architecture, with 1 -3 High End Server Systems

Medium Data Center

- Between 1,500 – 1,700 Servers Installed
- 20,000 Sq Feet Of Raised Floor
- Four or Five High End Systems Form The Basis Of Enterprise Systems

Large Data Center

- Between 2,000 – 2,500 Servers Installed
- 35,000 Sq Feet Of Raised Floor
- House Up To 7 High End Systems

Very Large Data Center

- Up to 25,000 Servers Installed
- 100,000+ Sq Feet Of Raised Floor
- Eight+ High End Systems

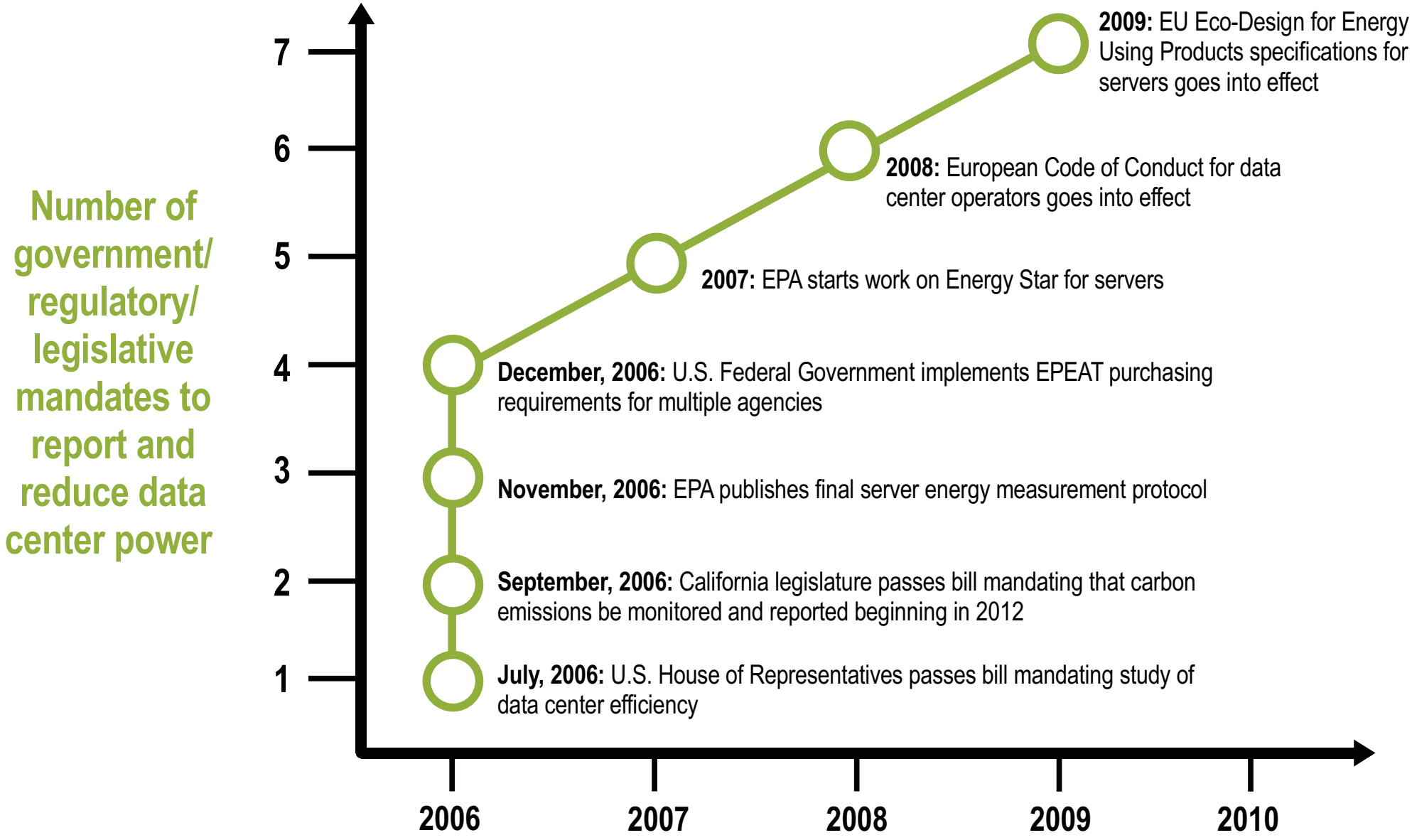
Source: Presentation by Vernon Turner from IDC at the Sun Summit on 21st Century Eco-Responsibility, November 14, 2005 for US Data Centers

Number of Servers in Data Centers Growing

	2008	2009	2010	2011	2012
Very Large	449	503	565	630	695
Greenfield	40	54	62	65	67
Brownfield	409	449	503	565	630
Servers in Very Large	11,227,357	12,572,577	14,115,316	15,754,862	17,509,290
Large	2,340	2,491	2,700	2,949	3,208
Greenfield	140	151	209	249	255
Brownfield	2,200	2,340	2,491	2,700	2,949
Servers in Large	5,265,040	5,603,777	6,075,723	6,635,948	7,295,537
Medium	3,746	3,987	4,333	4,714	5,095
Greenfield	220	241	346	381	385
Brownfield	3,526	3,746	3,987	4,333	4,714
Servers in Medium	5,994,227	6,379,685	6,932,461	7,542,168	8,196,942
Small	5,413	5,652	5,965	6,302	6,673
Greenfield	210	239	313	337	375
Brownfield	5,203	5,413	5,652	5,965	6,302
Servers in Small	2,300,426	2,401,961	2,535,233	2,678,327	2,833,263
Total Number of Servers	**24,787,050**	**26,958,000**	**29,658,733**	**32,611,304**	**35,835,032**

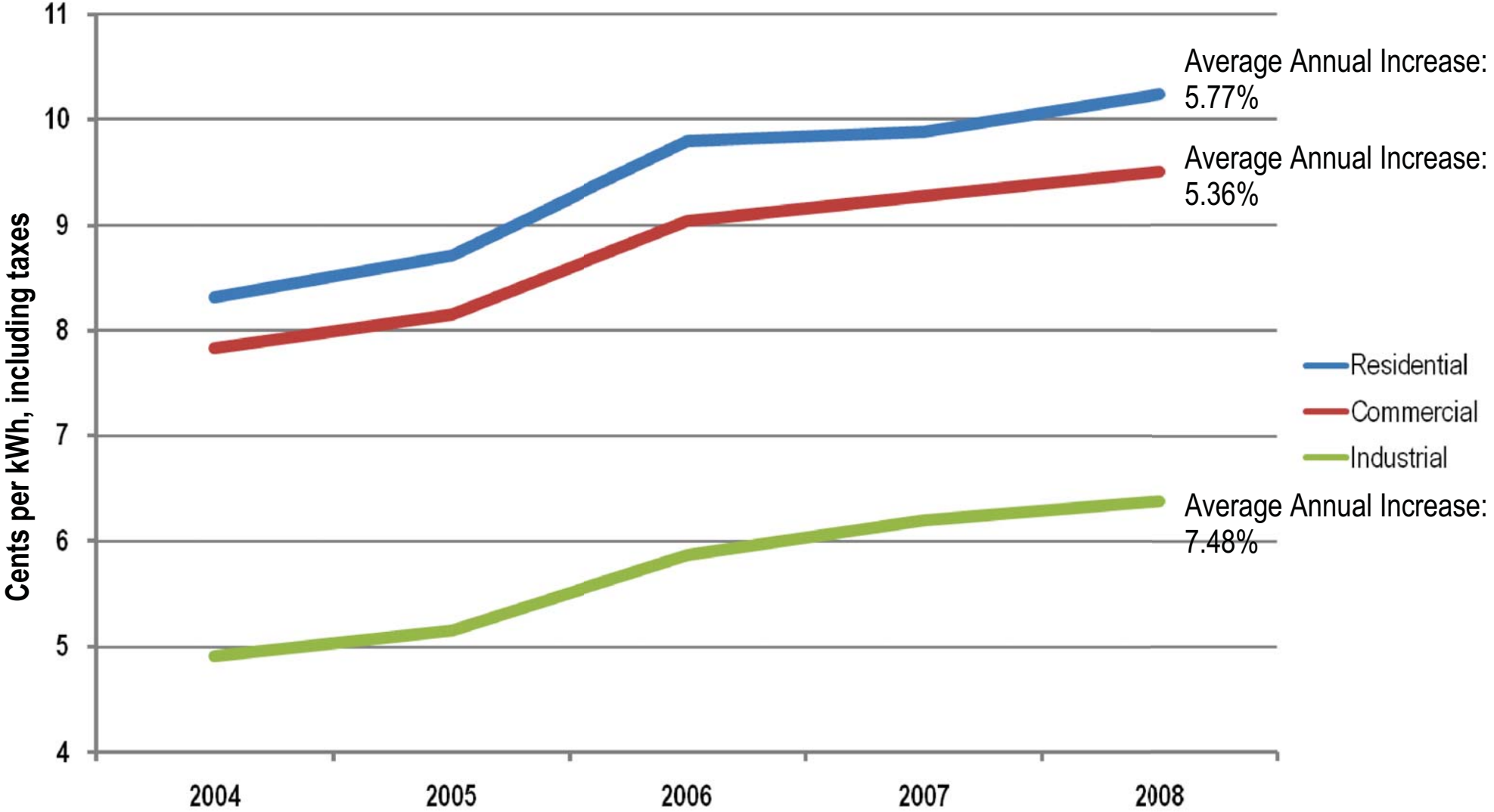
Source: IDC Document #34867 “US and Worldwide Server Installed Base 2006-2009 Forecast (February 2006)”

Number of Regulations Growing



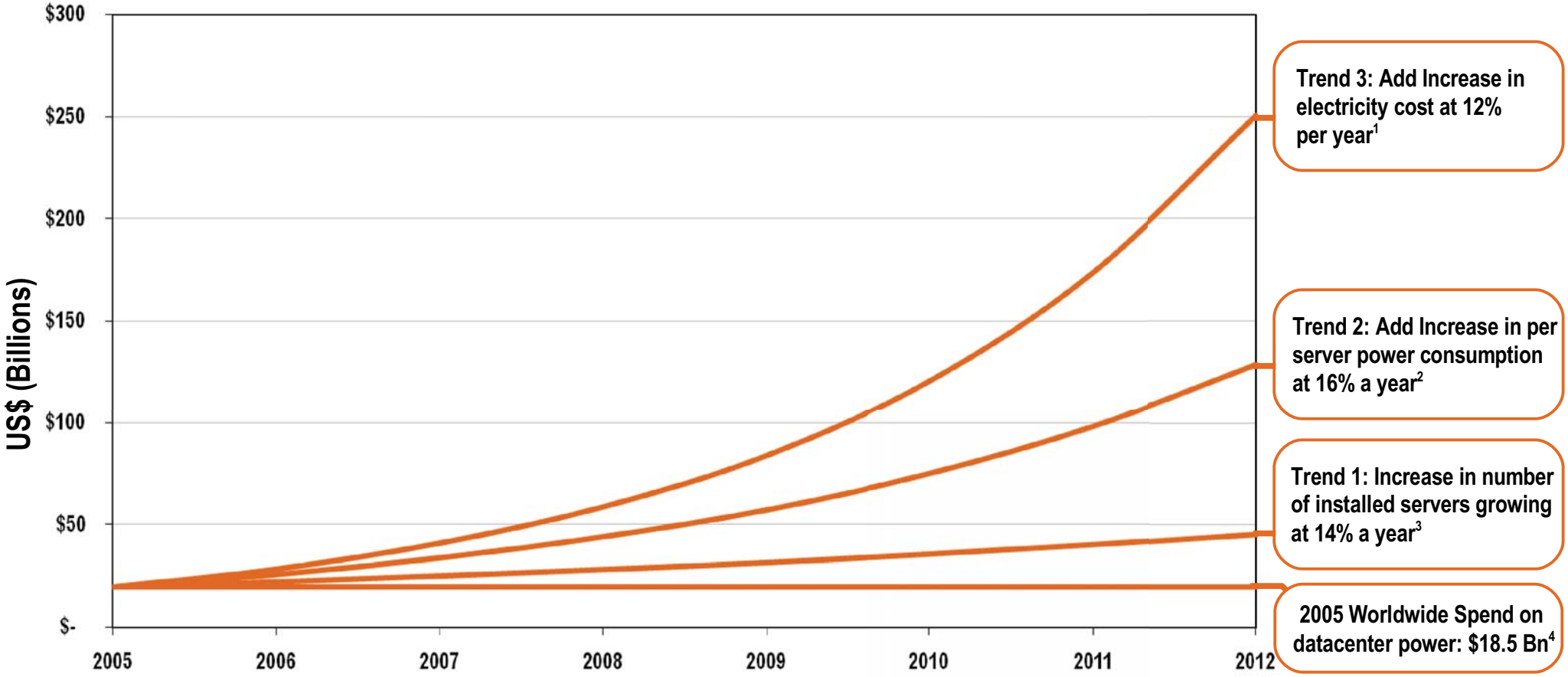
National Average Retail Price of Electricity

Year-to-Date: February 2004 - 2008



Source: Energy Information Administration Electric Power Monthly Archives; Average Retail Price of Electricity by Sector
http://www.eia.doe.gov/cneaf/electricity/epm/epm_ex_bkis.html, epmxlfile5_6_a.xls

The Cubing Effect



By 2012 data center power consumption costs could grow to $250B worldwide – demanding proactive energy management solutions

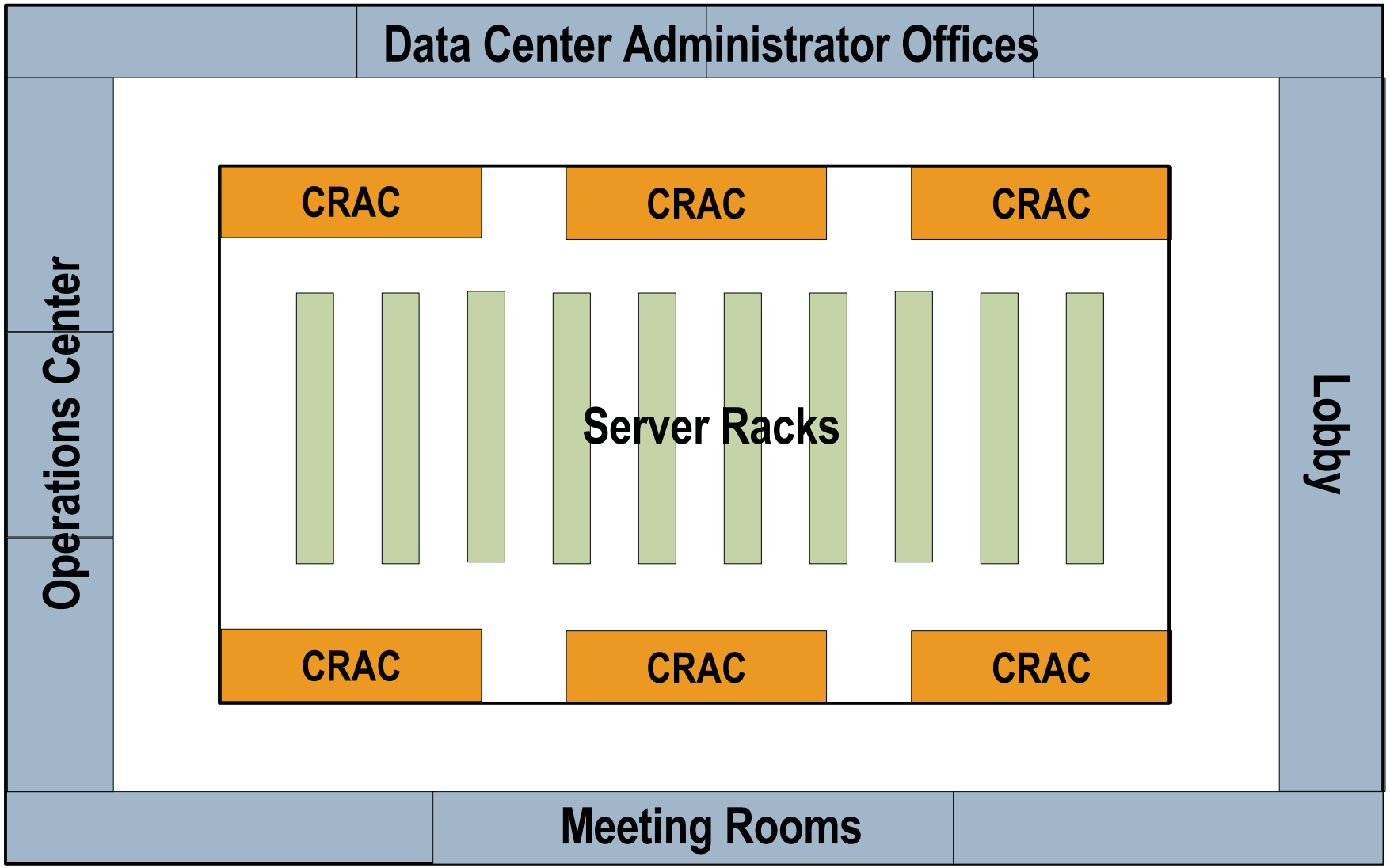
1. U.S. Energy Information Administration (www.eia.doe.gov)
2. Sun primary research
3. IDC#34867 U.S. and Worldwide Server Installed Base 2006-2009 Forecast (February 2006)
4. IDC Worldwide Server Power and Cooling Expense 2006-2010 Forecast

What % of IT Costs is Power?

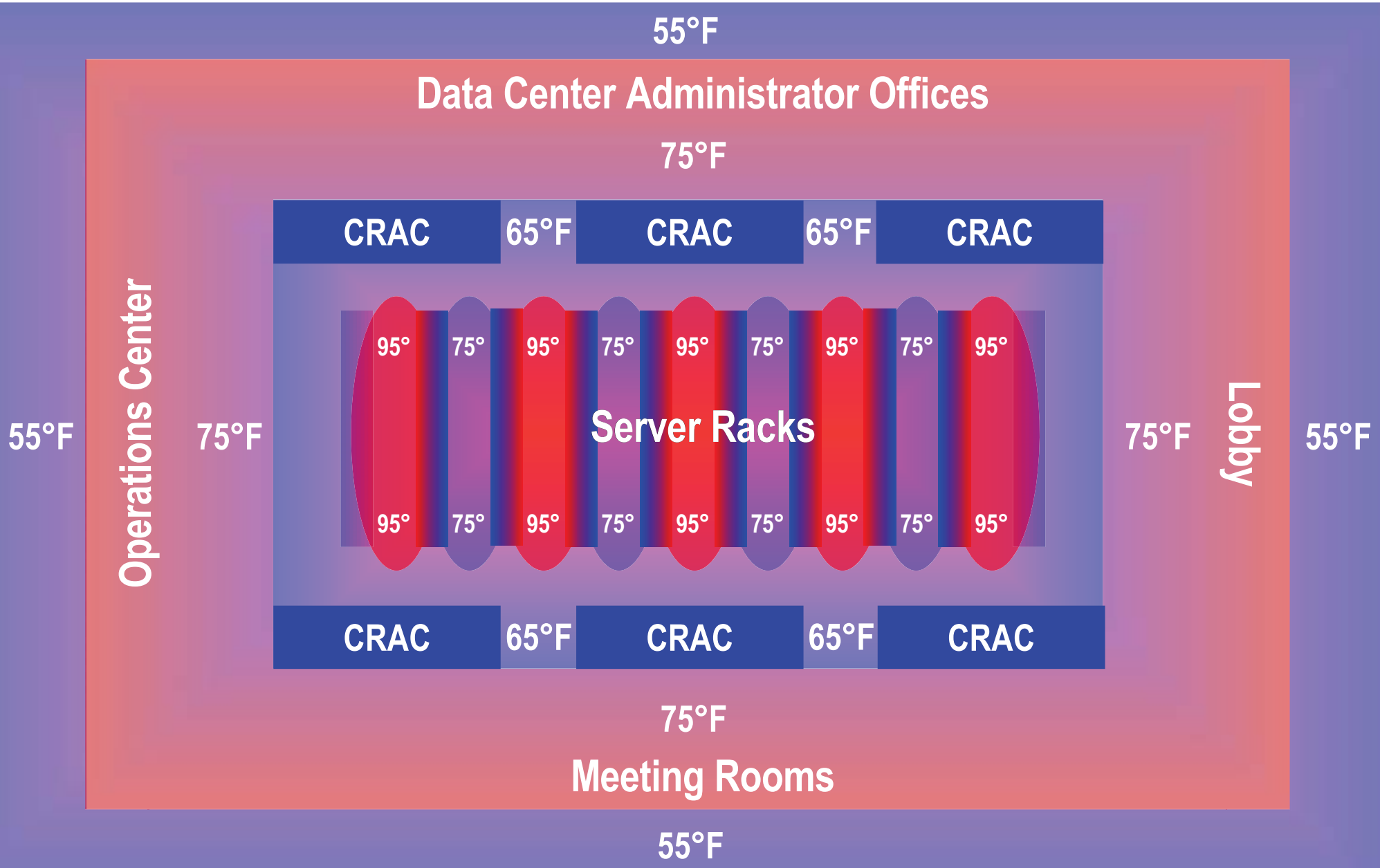
Small Enterprise Data Center	20% - 30%
Large Enterprise Data Center	25% - 45%
Managed Hosting and Colocation Provider	50% - 80%

Source: Gartner, IDC

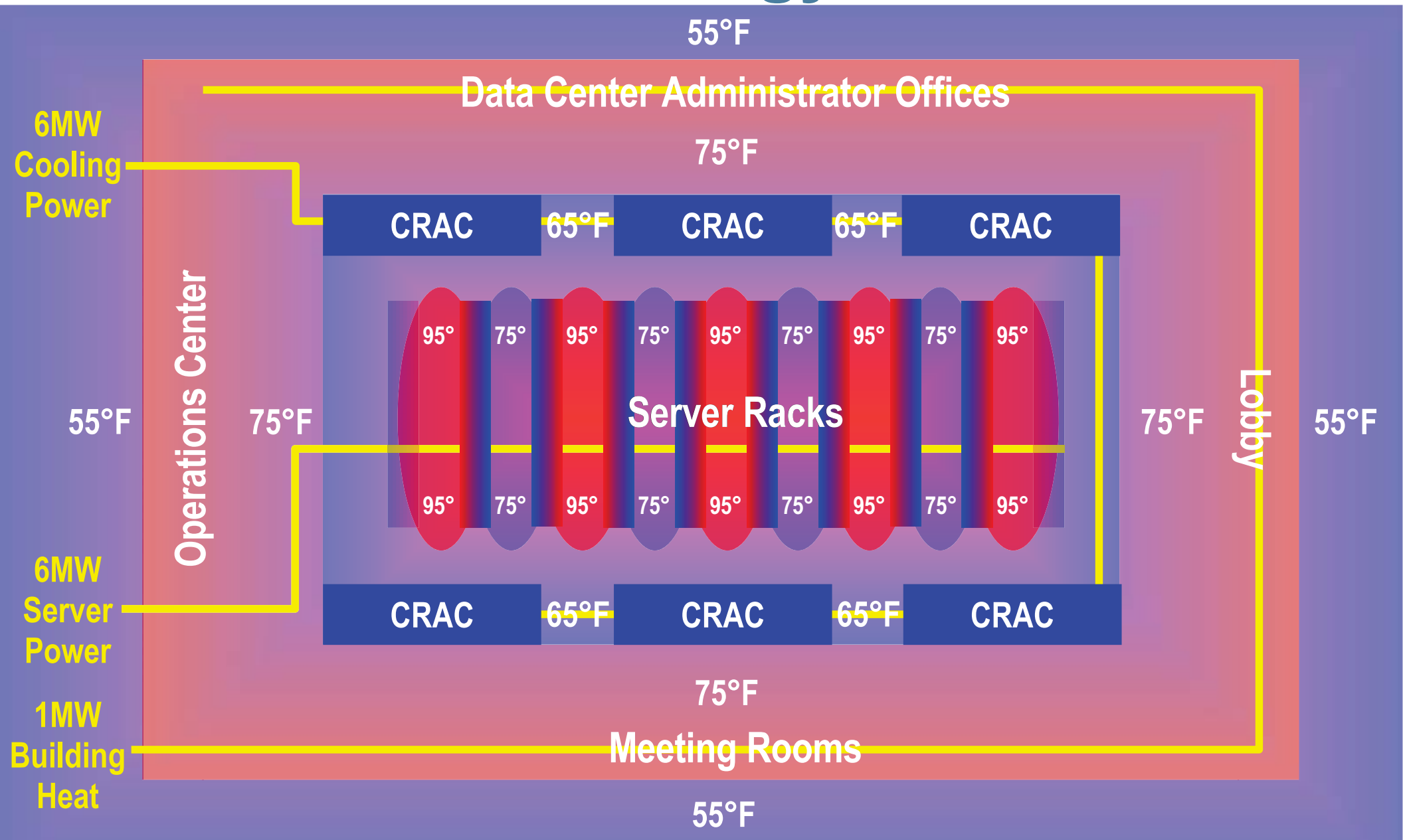
What's Wrong With This Data Center?



What the Infrared Camera Sees



Effective Use of Energy?

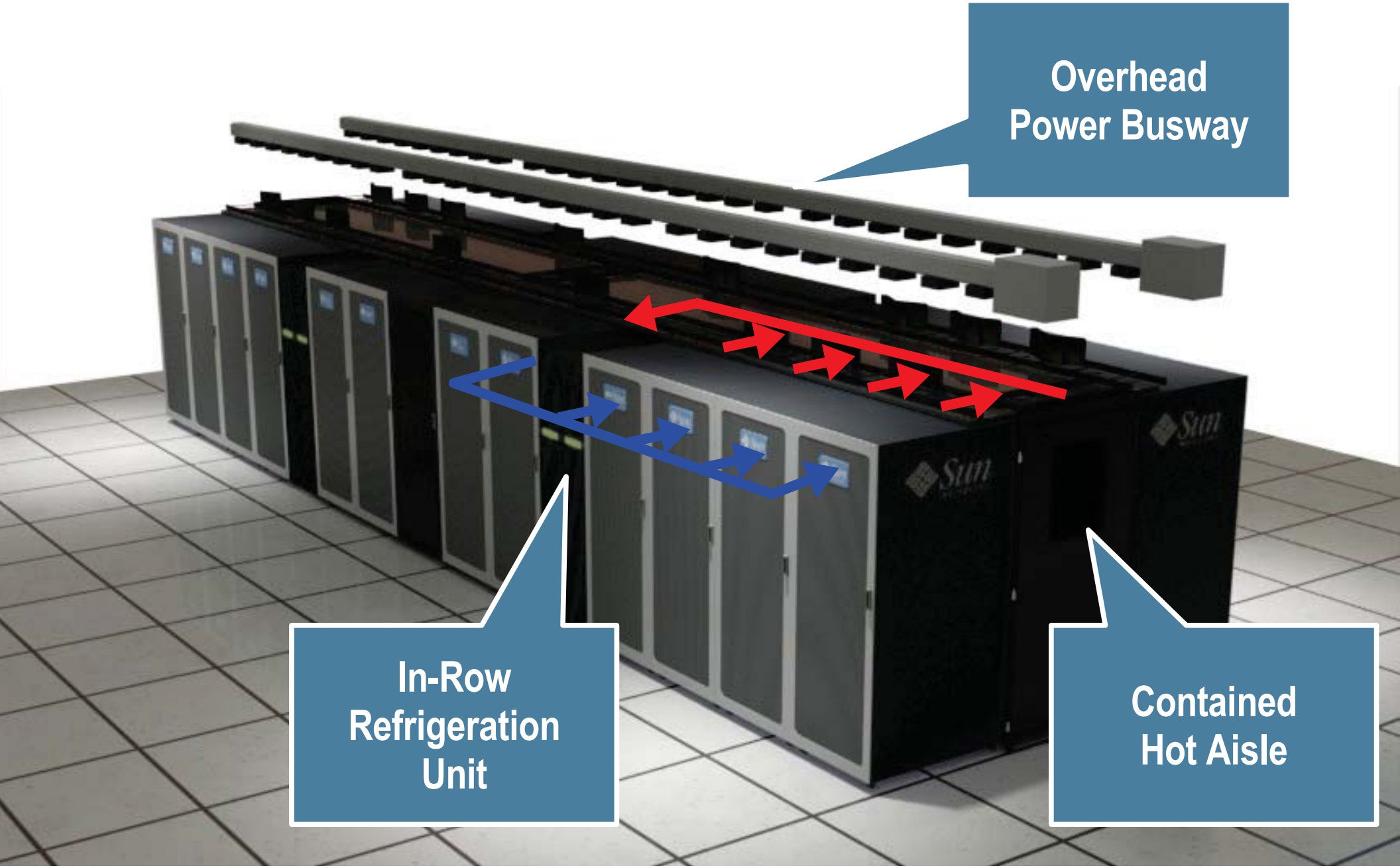


Modularity: Sun's Pod Architecture

- A group of racks with a common hot aisle used as a building block to simplify datacenter design for power, cooling, & cabling.

Can be used on concrete slab floor or raised floor

Hot Aisle Containment



Air Side Economization

Outside Air
65°F

Return Air
85°F

In milder climates, free air cooling with 100% outside air can be used for most of the year (San Francisco: 8,500 out of 8,760 hours annually)

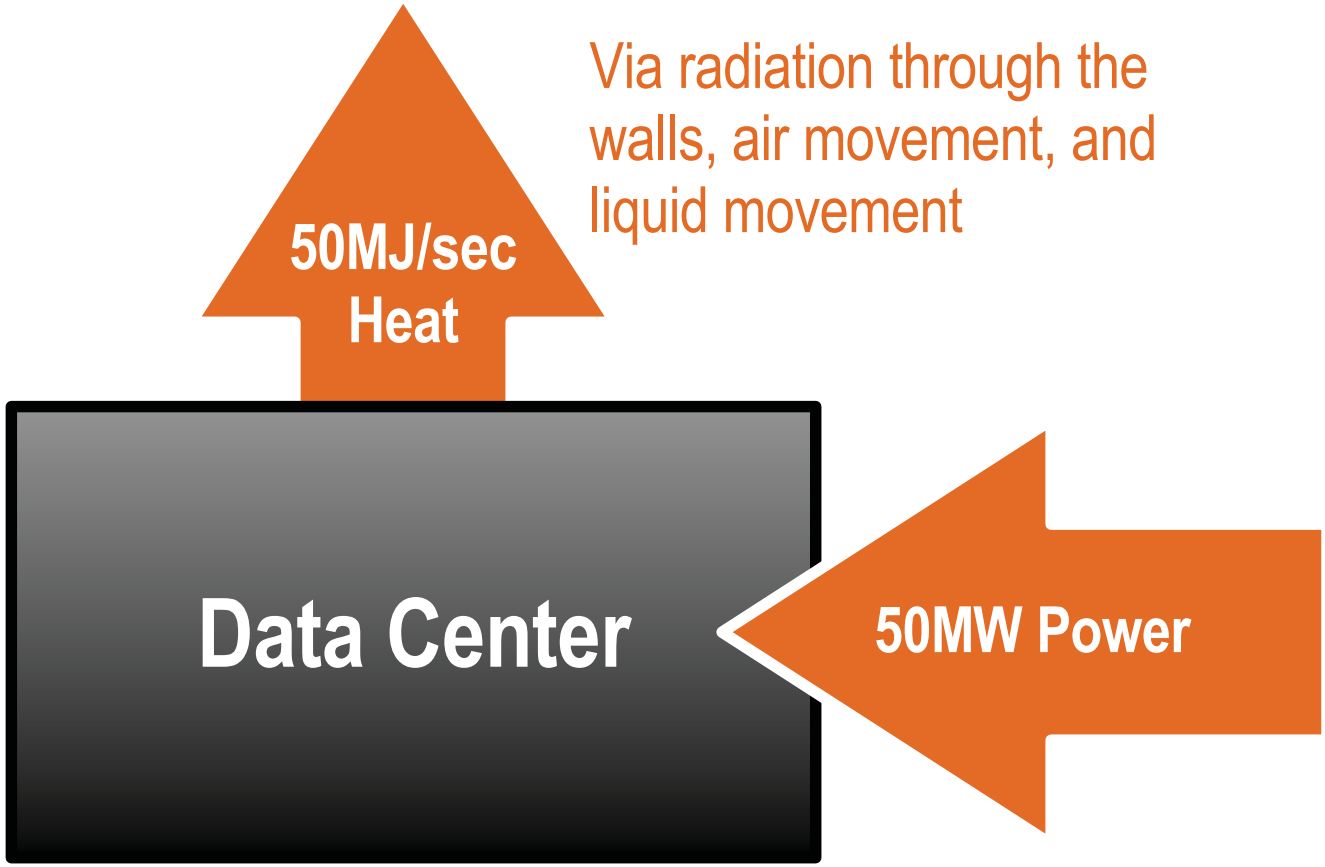
Earth Pipes

Data Centers Underground

The Floating Data Center

The Law of Energy Conservation

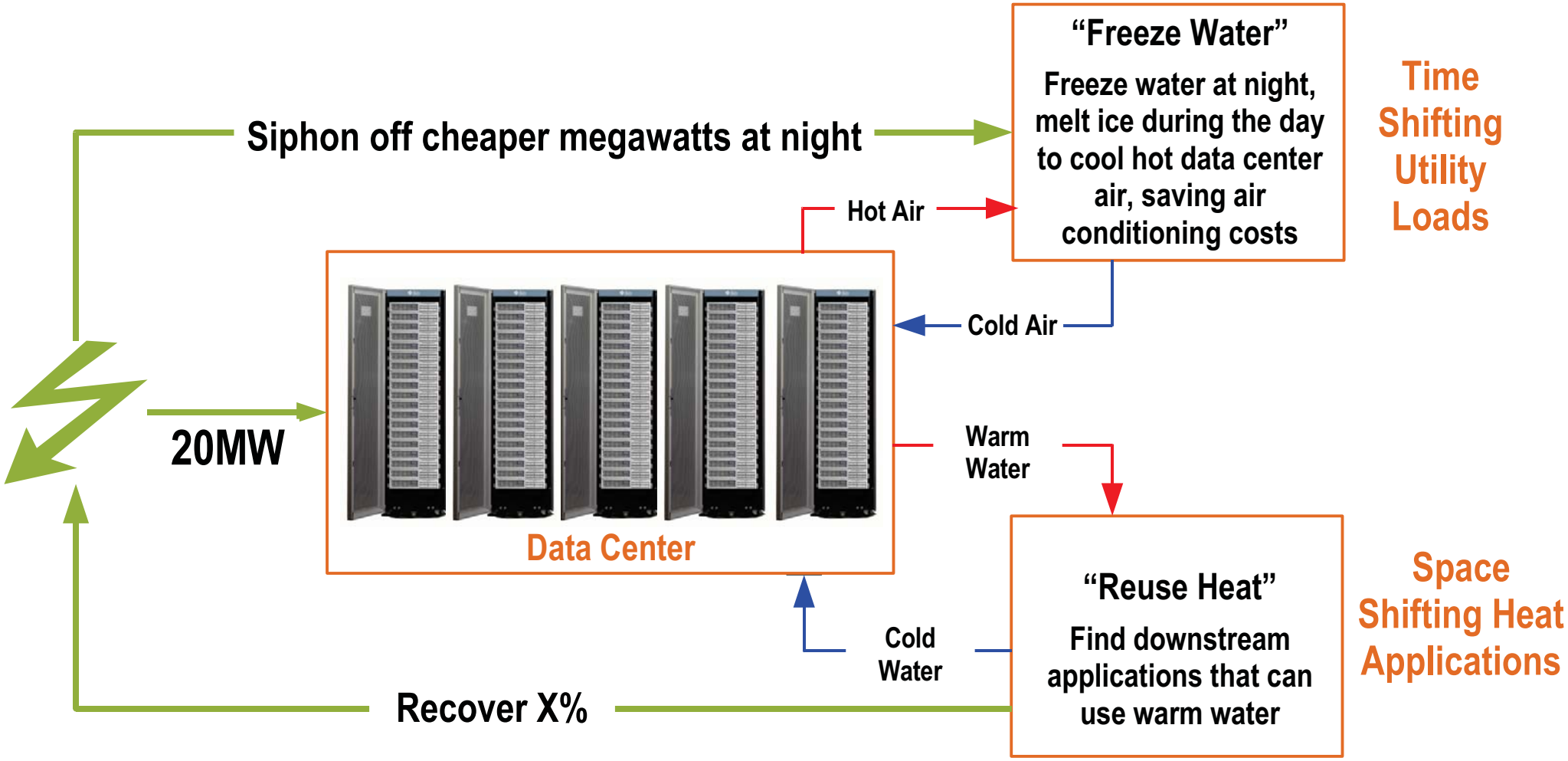
- At steady-state operation, the total power coming into a data center must equal the total heat leaving the data center by radiation, conduction and convection



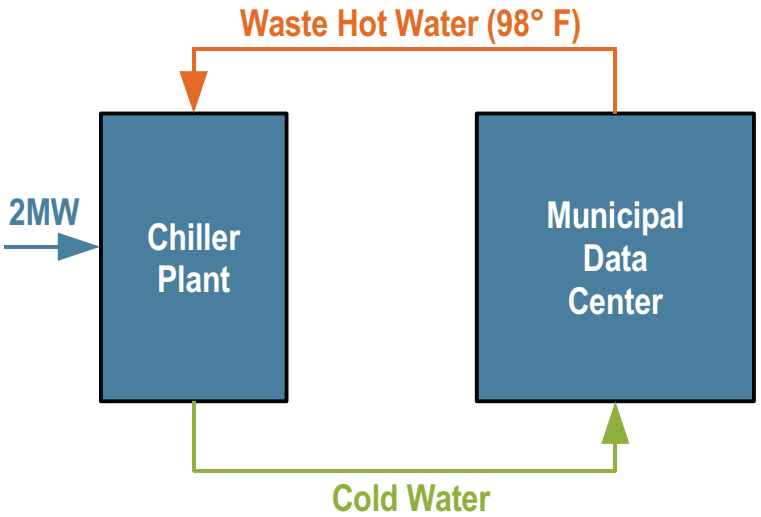
MegaWatt Scale Energy Capacitors

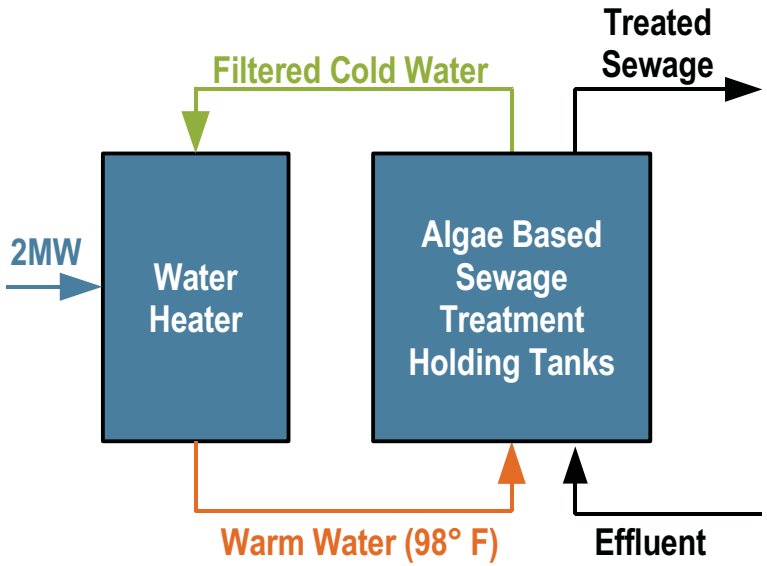
"Today a data center just looks like a giant resistor in a multimegawatt circuit. It would be nice if it also was a capacitor."

-- Mark Bramfitt, PG&E



Putting 2 + 2 Together





Downstream Applications of Energy: 1

Treated, Filtered and Cooled Effluent

Treated Sewage

Warm Data Center Exhaust Water

Raw Sewage

Downstream Applications of Energy: 2

Treated, Filtered and Cooled Effluent

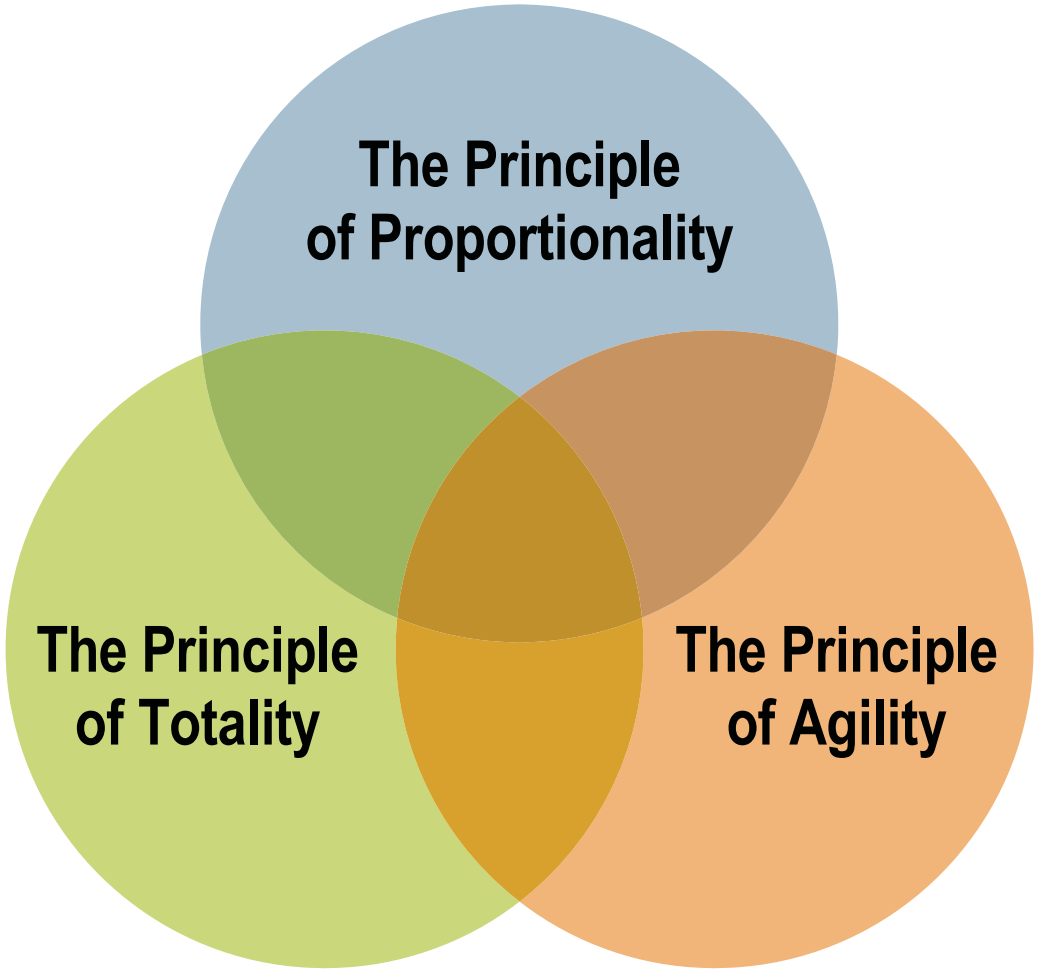
Warm Data Center Exhaust Water

Downstream Applications of Energy: 3

Treated, Filtered and Cooled Effluent

Warm Data Center Exhaust Water

The Three Principles of Data Center Energy Efficiency



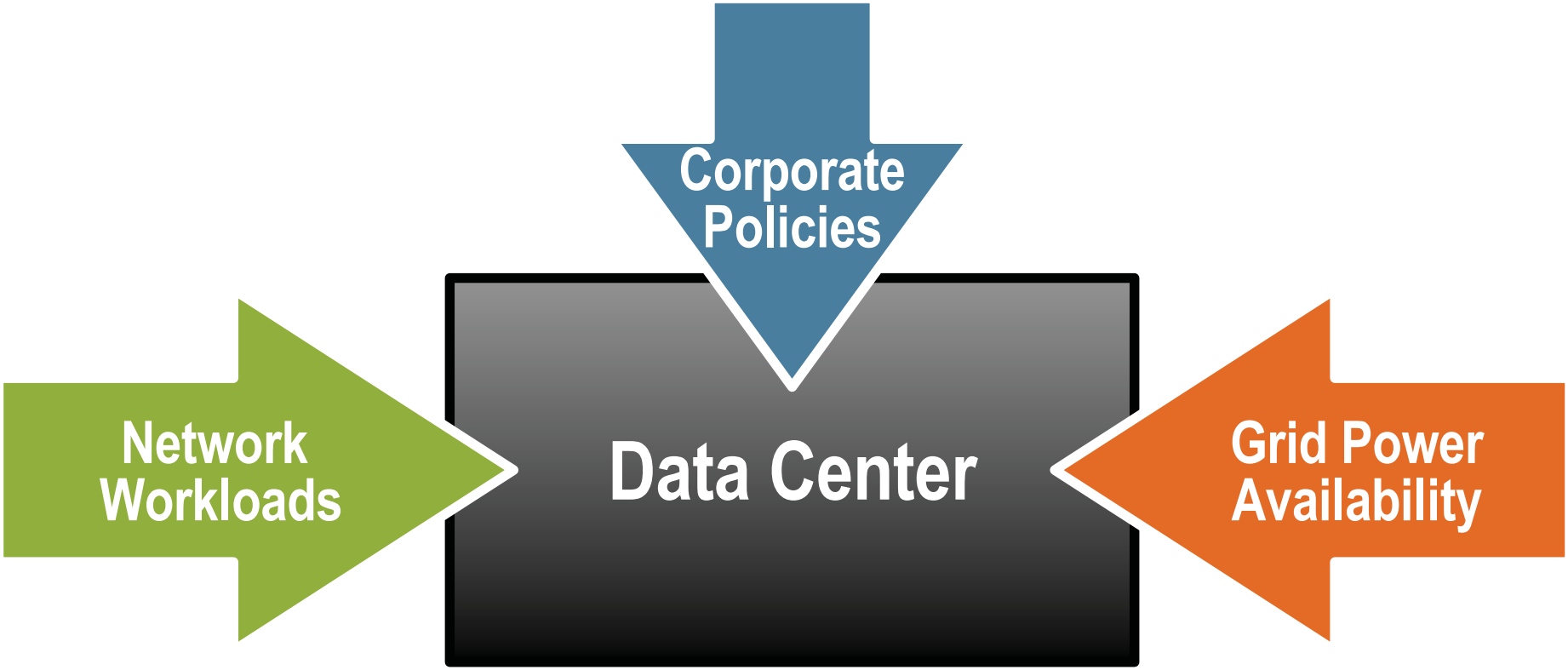
Principle of Totality

An energy efficient data center has every component appropriately harnessed to deliver the most energy efficient operation possible.

Corollary: It is not just a chip problem, a server problem, a hypervisor problem, an OS problem, an application problem, a network problem, a storage problem, a PDU problem, a UPS problem, an air conditioner problem, or a chiller problem: All need to be involved

Principle of Agility

An energy efficient datacenter must be responsive to fluctuating demand inputs (network workloads), fluctuating supply inputs (grid power availability) and changing corporate IT requirements (corporate policies).



Principle of Proportionality

An energy efficient data center calibrates its energy consumption in proportion to the computational work it is expected to deliver.

Corollary: It is not just servers that must deliver energy proportional computing, the entire data center must deliver proportionality

Subodh Bapat
Eco-Responsibility Office
Sun Microsystems