



DATA CENTER EFFICIENCY

**EPA Climate Leaders
Boulder, CO
Dec 2007**

Mark Monroe

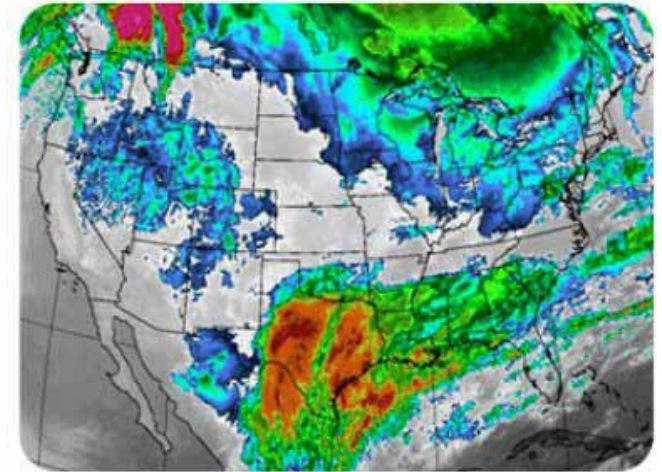
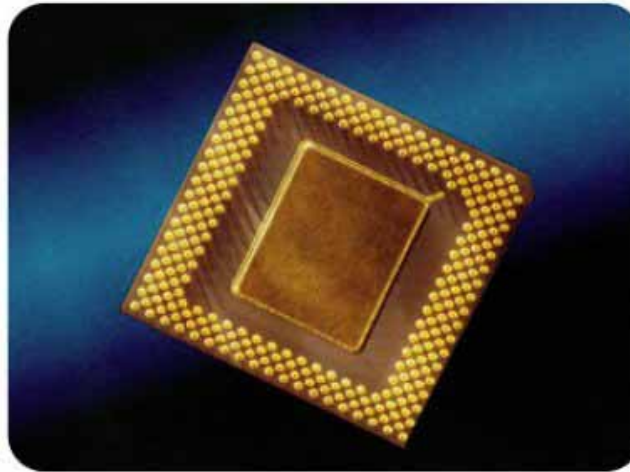
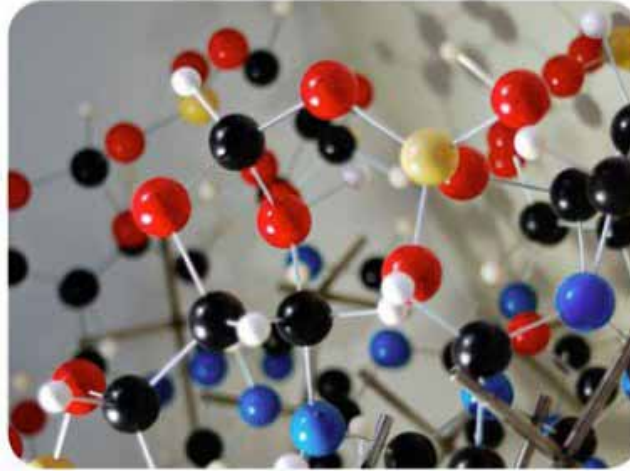
Director, Sustainable Computing
Sun Microsystems, Inc.
mark.monroe@sun.com





Sustainability Innovation Computing

Sustainability through Computing



Demand and Capacity Are Colliding...



- ↑ Demand
- ↑ Users
- ↑ Services
- ↑ Access

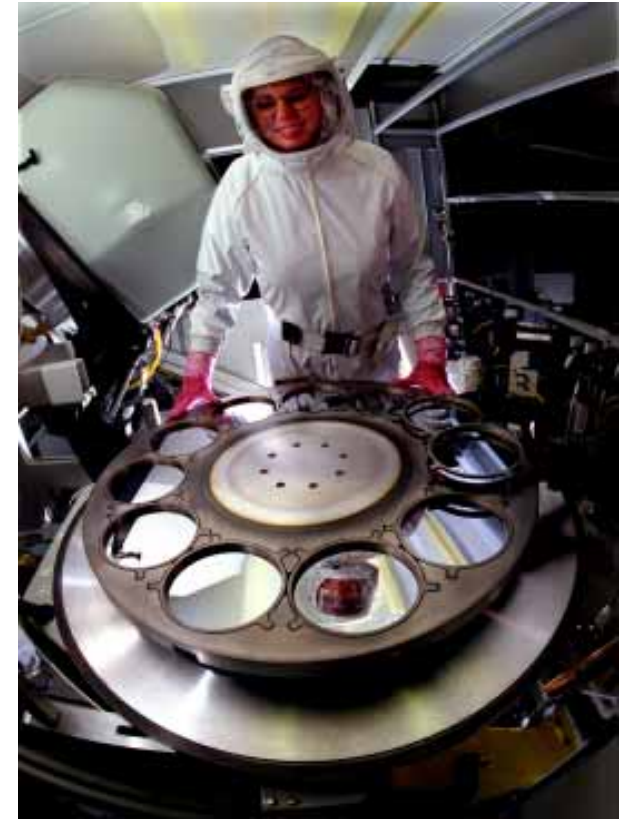


Is Computing Sustainable?

- Three reasons to say “No” today ...
 - 1) Energy and natural resources to make the products
 - 2) Electricity to run them
 - 3) Energy and waste when recycle and dispose of them

Energy Intensive Product

- Embodied energy in PCs studied since mid-1990s
- Results vary widely, but most are around 6,000 Mjoules per device*
- 6,000 MJ is approx. 1,800 KW-h, or about the energy consumed by the average U.S. House in 2 months
- IDC estimates 229M units in 2006
- Total energy to manufacture = 400B KW-h
- Equivalent to 65 x 600MW power plants
- 230M metric Tons of CO₂



* Source: <http://dx.doi.org/10.1065/ehs2002.04.038.1>, pg 8

Powering a Server


 100
Units

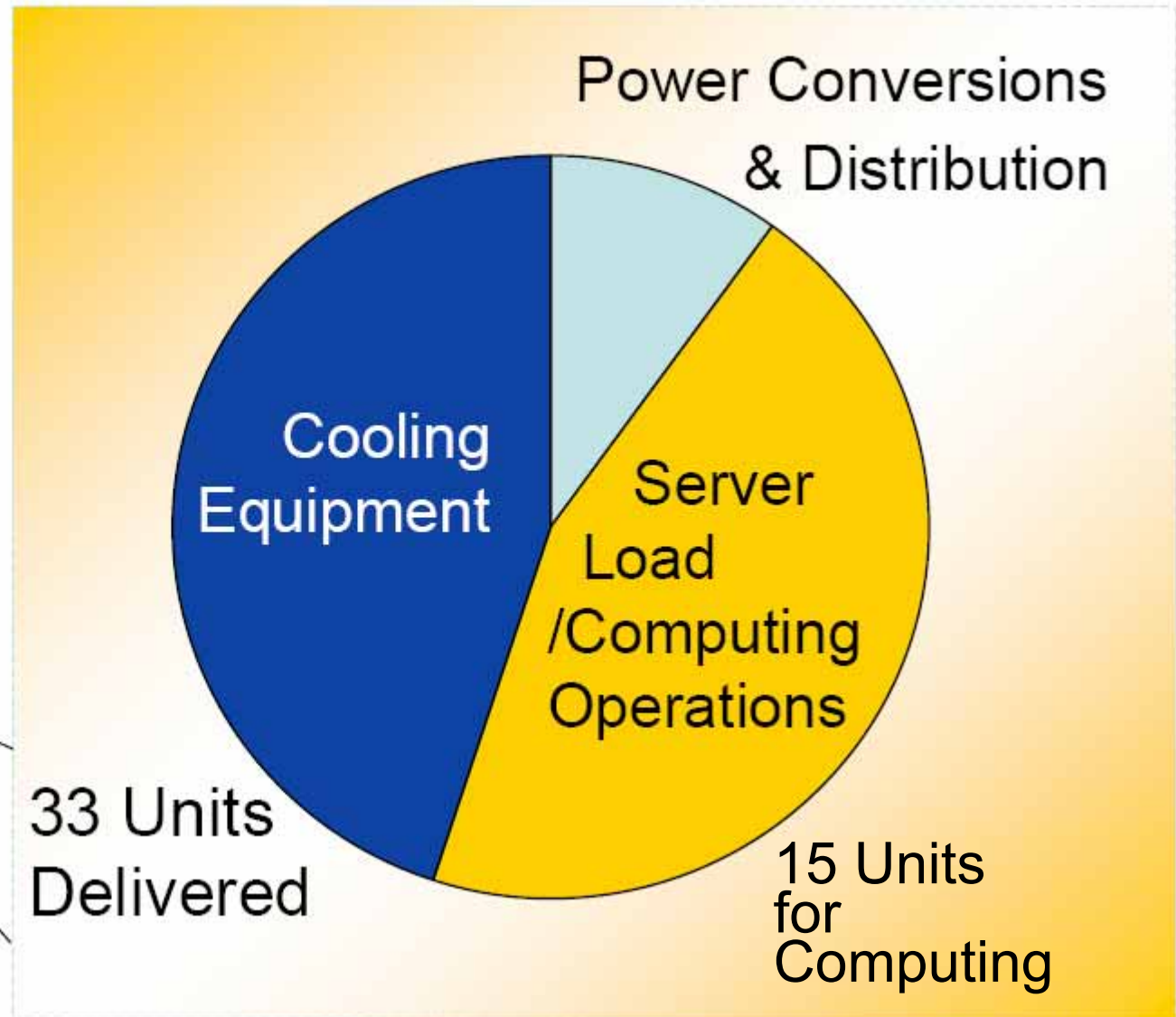

 35 Units

35 Units

35 Units



33 Units
Delivered



15 Units
for
Computing

Environmental Impact

Sun Datacenter


- 2006
- 10.5M kWh
- 10K tons of CO₂

WW Datacenters

- 2006
- 290B kWh
- 200M tons of CO₂

Growing eWaste Problem

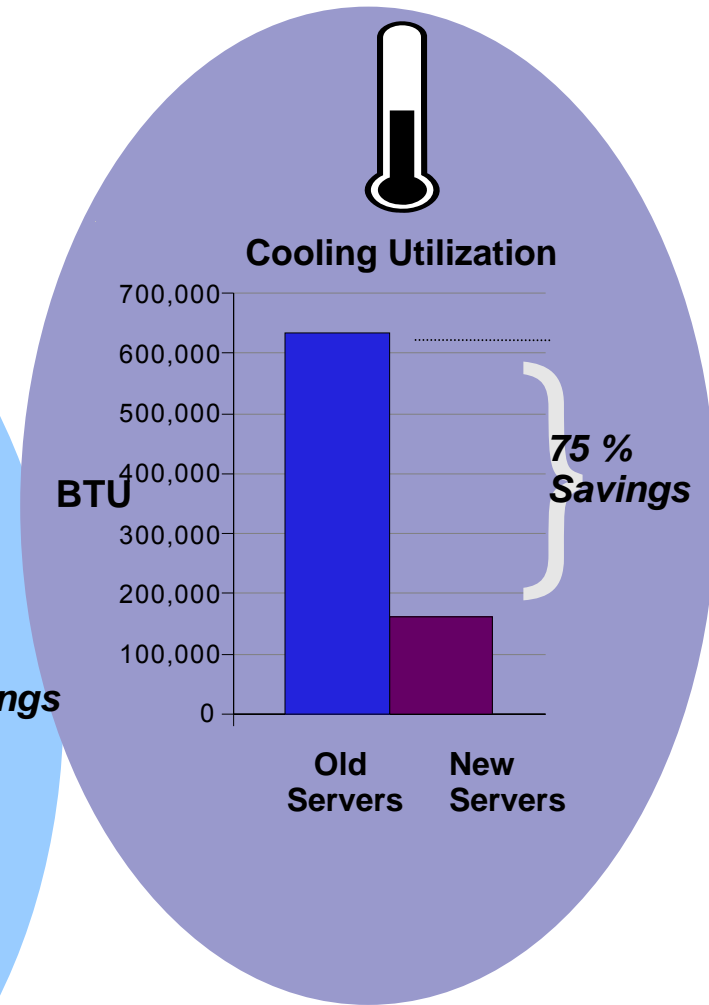
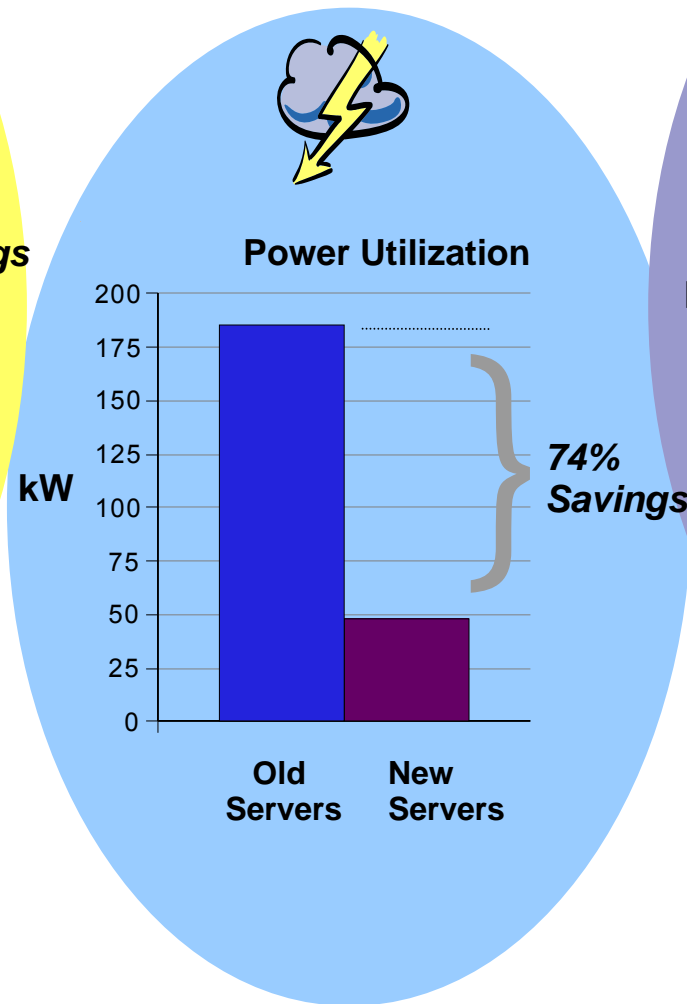
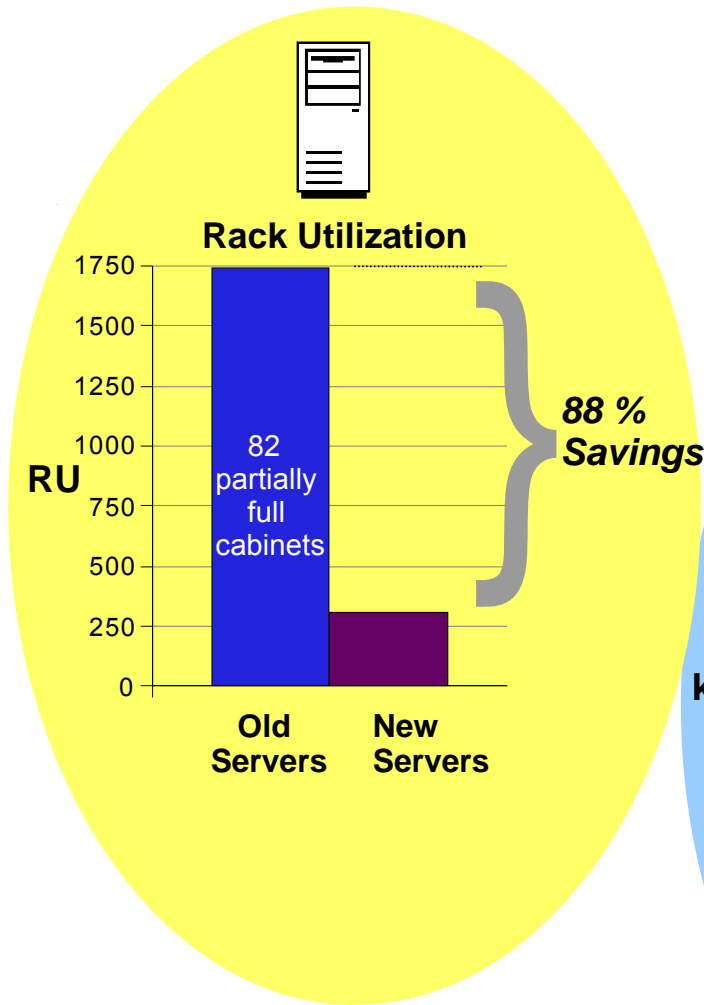
300 million computers already obsolete by 2004...

- 
- **Content problem:** over 700 esoteric compounds in each PC
 - **Volume problem:** 1 million computers amount to more than 25,000 tons of electronic junk
 - Increasingly international problem



Eco – It's About Economics AND Ecology

Holland Tech Refresh Savings





Hardware Replacement Program



09/30/2006

This picture shows 20% of the hardware that was replaced from the SLS hardware replacement program initiated for phase I of the Newark, CA campus closure. For more information contact: dean.nelson@sun.com



Break Out Innovation



The First Virtualized Datacenter



Where Should Datacenters Be?



How Should We Do Datacenters When We Can Start From Scratch?



Solar PV



Fuel Cell



Courtesy of International Fuel Cells, LLC

Natural Gas Microturbine



EPA Report to Congress – Aug 2007

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

Table 6-1: Energy Cost Savings Comparison for DG/CHP in Data Centers

CHP System	Molten Carbonate Fuel Cell/Chiller	Phosphoric Acid Fuel Cell/Chiller	Microturbine/Chiller Package	Gas Turbine/Chiller
Capacity, kW	1,000	200	200	3,364
Heat Rate, Btu/kWh	8,060	9,480	14,300	13,930
Electric Efficiency, %	42.3%	32.6%	23.9%	24.5%
Heat Available for Cooling, MMBtu/hr	1.4	0.37	1.28	19.6
Temperature, F	650	250	588	838
Cooling, COP	1.2	0.7	1.2	1.2
Cooling Provided, Tons	140	22	128	1,960
Avoided AC kW/CHP kW	0.14	0.14	0.83	0.58
Total Power Generated plus Avoided AC kW	1,140	228	366	5,324
CHP Efficiency, %	59.7%	75.0%	68.6%	66.3%
Gas Cost, \$/MMBtu	\$7.50	\$7.50	\$7.50	\$7.50
Average Electric Cost, \$/kWh	\$0.130	\$0.130	\$0.130	\$0.130
Unit Capital Cost, \$/kW	\$7,238	\$7,805	\$4,088	\$2,312
O&M Rate, \$/kWh	\$0.032	\$0.029	\$0.022	\$0.022
Annual Gas Cost	(\$503,065)	(\$118,339)	(\$178,507)	(\$2,924,767)
Annual O&M Cost	(\$266,304)	(\$48,268)	(\$36,617)	(\$615,895)
Annual Avoided Electricity Savings	\$1,103,497	\$220,756	\$354,668	\$5,153,526
Annual Savings, \$	\$334,128	\$54,149	\$139,544	\$1,612,864
Annual Savings, \$/kW	\$334.13	\$270.75	\$697.72	\$479.45
Total Capital Cost	\$7,238,000	\$1,560,900	\$817,600	\$7,778,200
California SGIP	(\$2,500,000)	(\$500,000)	(\$160,000)	(\$800,000)
MT/FC Energy Tax Credit	(\$1,000,000)	(\$200,000)	(\$40,000)	
Net Capital Cost	\$3,738,000	\$860,900	\$617,600	\$6,978,200
Net Unit Capital Cost, \$/kW	\$3,738	\$4,305	\$3,088	\$2,074
Payback, years				
Payback without incentives	21.7	28.8	5.9	4.8
Net Payback with Incentives	11.2	15.9	4.4	4.3

Total cycle efficiency of 60-75% compared to overall electric utility efficiency of 10-30% (U.S. DOE)



Eco Innovation

Good for Your Business
Good for Our Planet