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*High performance. Delivered.*



## **Leadership Group and Accenture Data Center Energy Forecast Report**

July 8, 2008



## Outline

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- **Introduction**
- Approach
  - Summary of EPA Report
  - Case study coverage
- Findings
- Conclusion



# Silicon Valley Leadership Group's 2008 Data Center Demonstration Project



A Silicon Valley Leadership Group Event

## DATA CENTER ENERGY SUMMIT

June 26



- US EPA Energy Star Report published in August 2007 presented energy use of datacenters and extrapolated energy savings based on adoption of identified technologies
- Data Center Demonstration Project took the initiative to validate the energy savings suggested within the EPA report by conducting case studies in commercial environments of study participants
- This study is unique in that 3rd party industry data centers implemented these initiatives and revealed the energy savings

m2

***Accenture has provided support throughout this effort and has consolidated the findings of the study participants into a single point of view.***

## Slide 3

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m2

Included Yahoo, Oracle, Sun Microsystems, Net App, Symantec etc  
teresa.tung, 6/17/2008



## About the Report

This report is a companion to the EPA report

Answers the call-to-action from the EPA report

***“Objective, credible information is needed about the performance of new technologies and about best practices as well as the effect of both on data center availability”***

Compares the energy estimates of the EPA report with measured results

- To encourage increased adoption of energy saving initiatives
- To help shape potential standardization, regulation, or certification around energy use
- To demonstrate commitment of data center operators to environmental responsibility





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# EPA Report documents U.S. servers and data center energy use



Scenario	Electricity Consumption	Electricity Costs	Environmental Impact
<b>Today (2006)</b>	Use about 61 billion kWh Doubled since 2000 1.5% of total U.S. consumed More than U.S. TVs Equivalent to 5.8 million average U.S. households	Costs \$4.5 billion annually	Peak load on power grid is equivalent to the output of 15 power plants.
<b>Current Trends (by 2011)</b>	<b>Use nearly doubles to more than 100 billion kWh</b>	<b>Costs \$7.4 billion annually</b>	<b>Requires an additional 10 power plants</b>
<b>EPA Scenarios (by 2011)</b>	<b>Annual savings of approximately 23 billion to 74 billion kWh over current trends</b>	<b>Reduces costs by \$1.6 billion to \$5.1 billion annually</b>	<b>Reduces peak load by equivalent of up to 15 new power plants Reduces 15 to 47 MMTCO<sub>2</sub></b>



## EPA Energy Scenarios by maturity

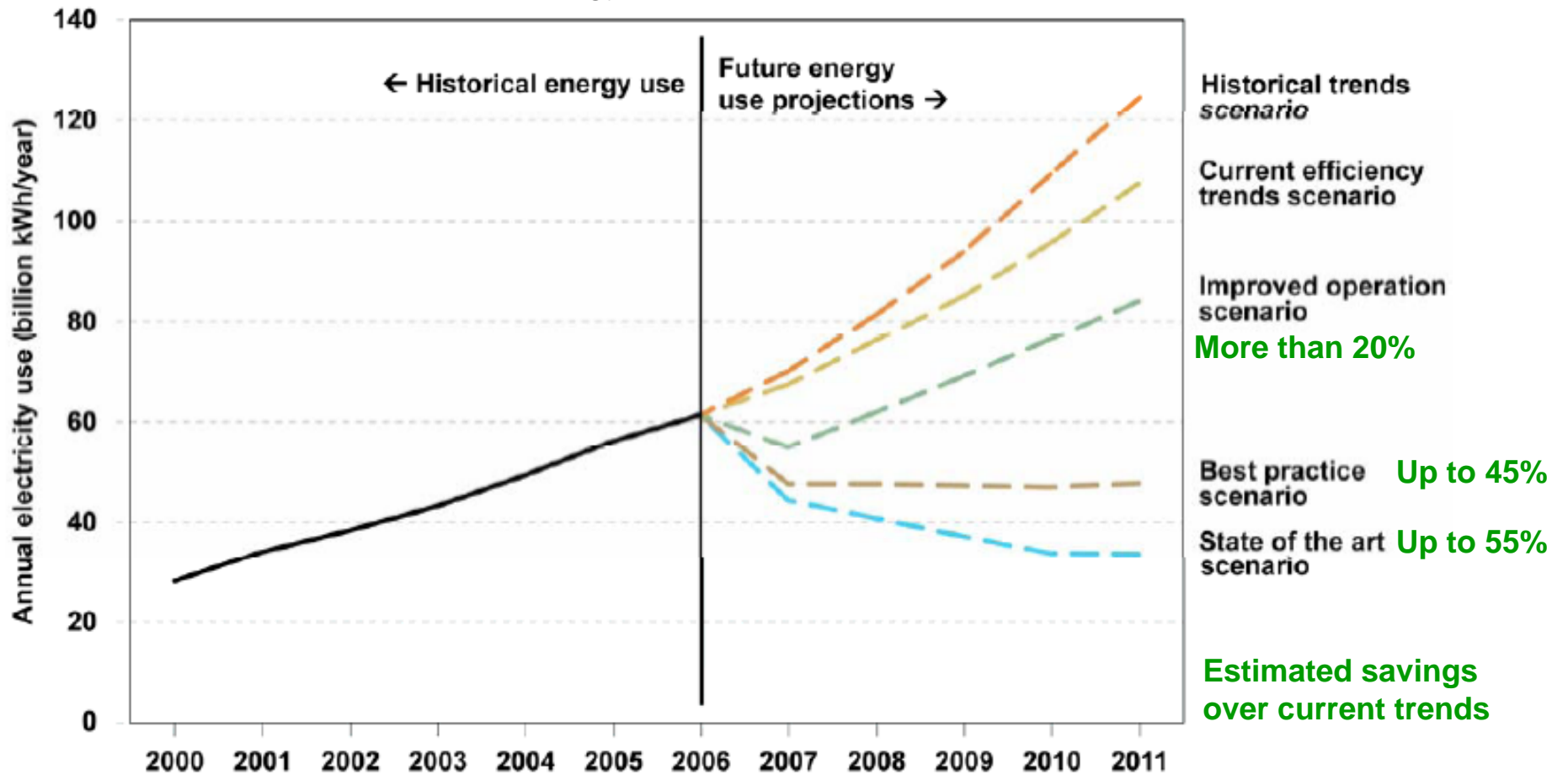
Scenario	Definition
<b>Historical Trends</b>	Extrapolates observed 2000 to 2006 energy-use trends <i>In 2006, energy use of servers &amp; data centers more than doubled from 2000</i> <i>Site infrastructure accounts for 50% of data center energy consumption</i>
<b>Current Trends</b>	Projects the energy use based on recently observed efficiency trends
<b>Improved Operations</b>	Represents “low-hanging fruit” from operating existing capital efficiently <i>Eliminate unused servers, turn on power management</i> <i>Improved air flow management</i>
<b>Best Practice</b>	Represents the increased adoption of the practices and technologies used in the most energy-efficient facilities in operation today <i>Moderate consolidation of servers and storage</i> <i>Improved efficiency for power and cooling delivery and free cooling</i>
<b>State-of-the-Art</b>	Identifies the maximum energy savings using only the most efficient technologies and management practices available today <i>Aggressive consolidation of servers and storage</i> <i>Direct liquid cooling</i>



# EPA Energy Projections

## *Can we achieve these results?*

In the best practice scenario, energy use reduced below the 2006 level





# Data Center Demonstration Project

## *Answering the call-to-action*

### Result of informal collaboration of Leadership Group members

- Demonstrate the effectiveness and implementation realities of EPA identified solutions
- Entirely a volunteer effort for all involved donating time, effort, equipment
- Covers 11 technologies with 17 case studies

Organizers	Host Data Center	Technology Partner	Case Study Sponsor
Silicon Valley Leadership Group (Leadership Group)	Digital Realty Trust	APC	CEC
Accenture	LBNL	Cassatt	LBNL
Lawrence Berkeley National Labs (LBNL)	NetApp	IBM	PG&E
California Energy Commission (CEC)	Oracle	Liebert	Silicon Valley Power
Department of Energy (DOE)	Sun Microsystems	Modius	
Hosted by	Symantec	Power Assure	
Sun Microsystems	Synopsys	Powersmiths	
	US Postal Service	Rittal	
	Yahoo!	SprayCool	
		SynapSense	



# Case Study Coverage At-a-glance

Initiative	Improved Operations	Best Practice	State of the Art
<b>Data Center Site Infrastructure Projects</b>			
<b>Data Center Cooling</b>			
Data Center Airflow Management		X X	
Free Cooling in Large Scale Data Centers	X		X X
Data Center Cooling Optimization		X	
High Efficiency Chilled Water Systems		X	
Modular Cooling Systems		X X	X X X
Wireless Sensor Network Adaptive Cooling			X
<b>Data Center Power Distribution</b>			
High Efficiency Power Transformation		X X	
High Voltage AC Power			X
High Efficiency Stand-by Power Systems		X X	
<b>IT Infrastructure Projects</b>			
<b>Consolidation and Optimization</b>			
IT Computing Resource Optimization		X	X
IT Consolidation and Virtualization	X	X	
Server Power Characterization & Modeling			X



## Outline

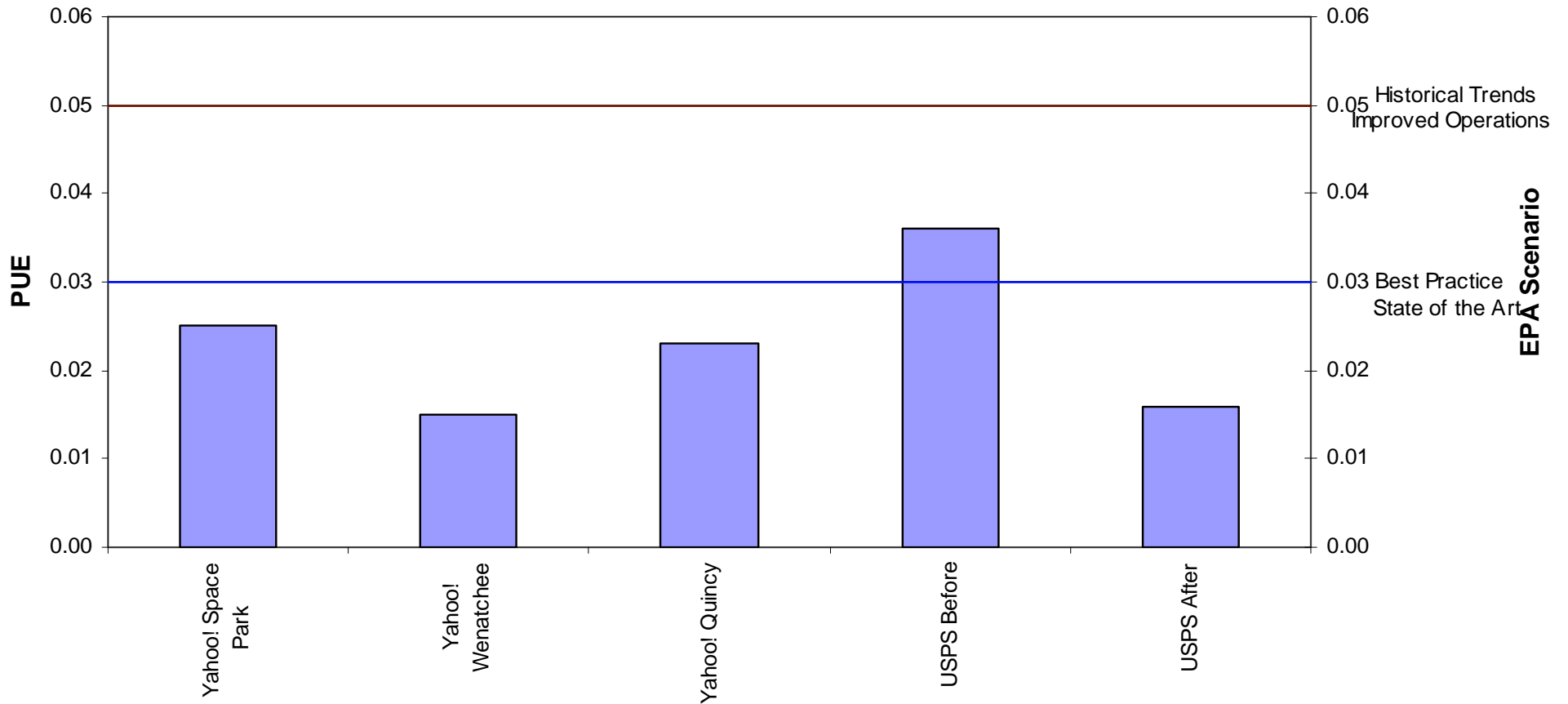
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# New transformers are state-of-the-art

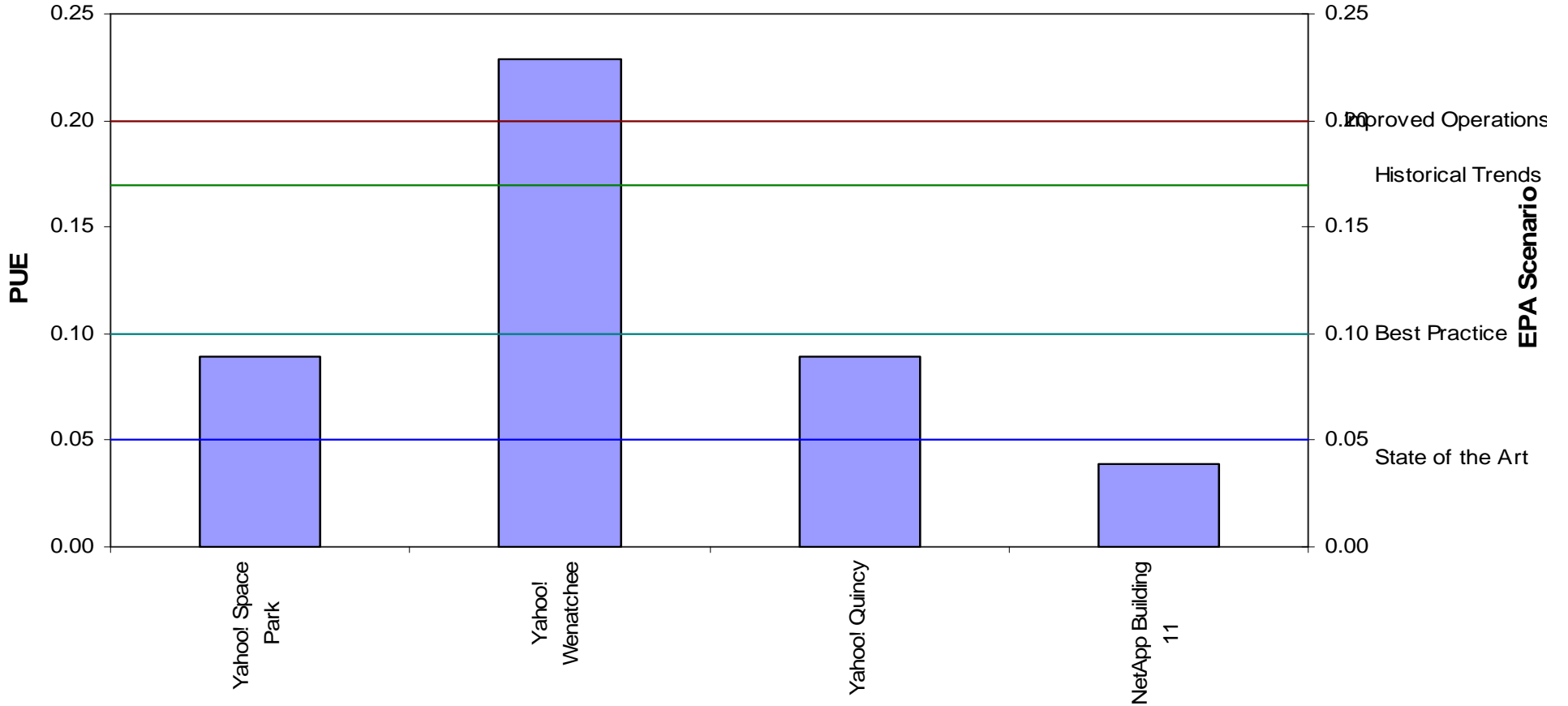
Effect on Total PUE - Transformers





# Right-sizing and flywheel technology reduces UPS losses

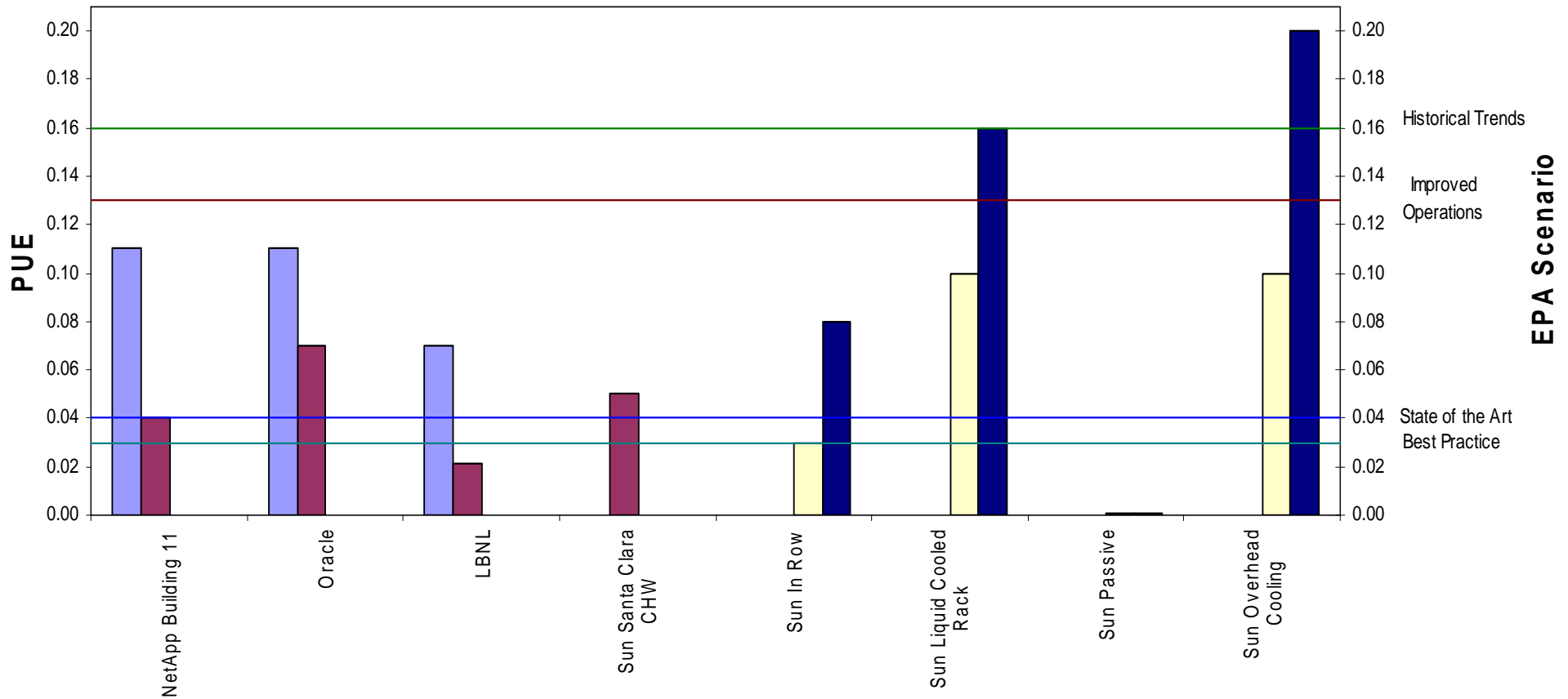
Effect on Total PUE - UPS





# Air-flow management and modular cooling achieve highest efficiency

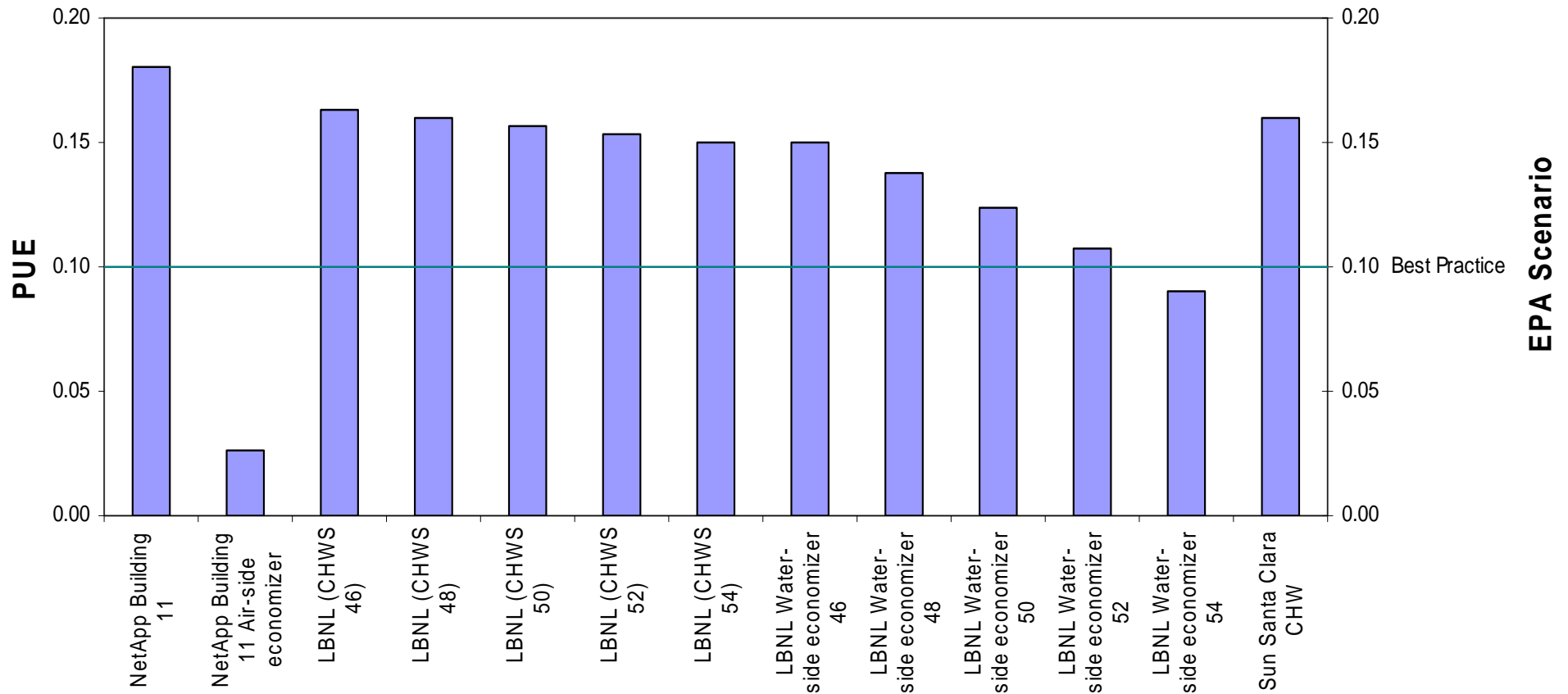
Effect on Total PUE - Cooling Delivery (Fans and Modular Units)





# Raising supply temperature improves chilled water system efficiency

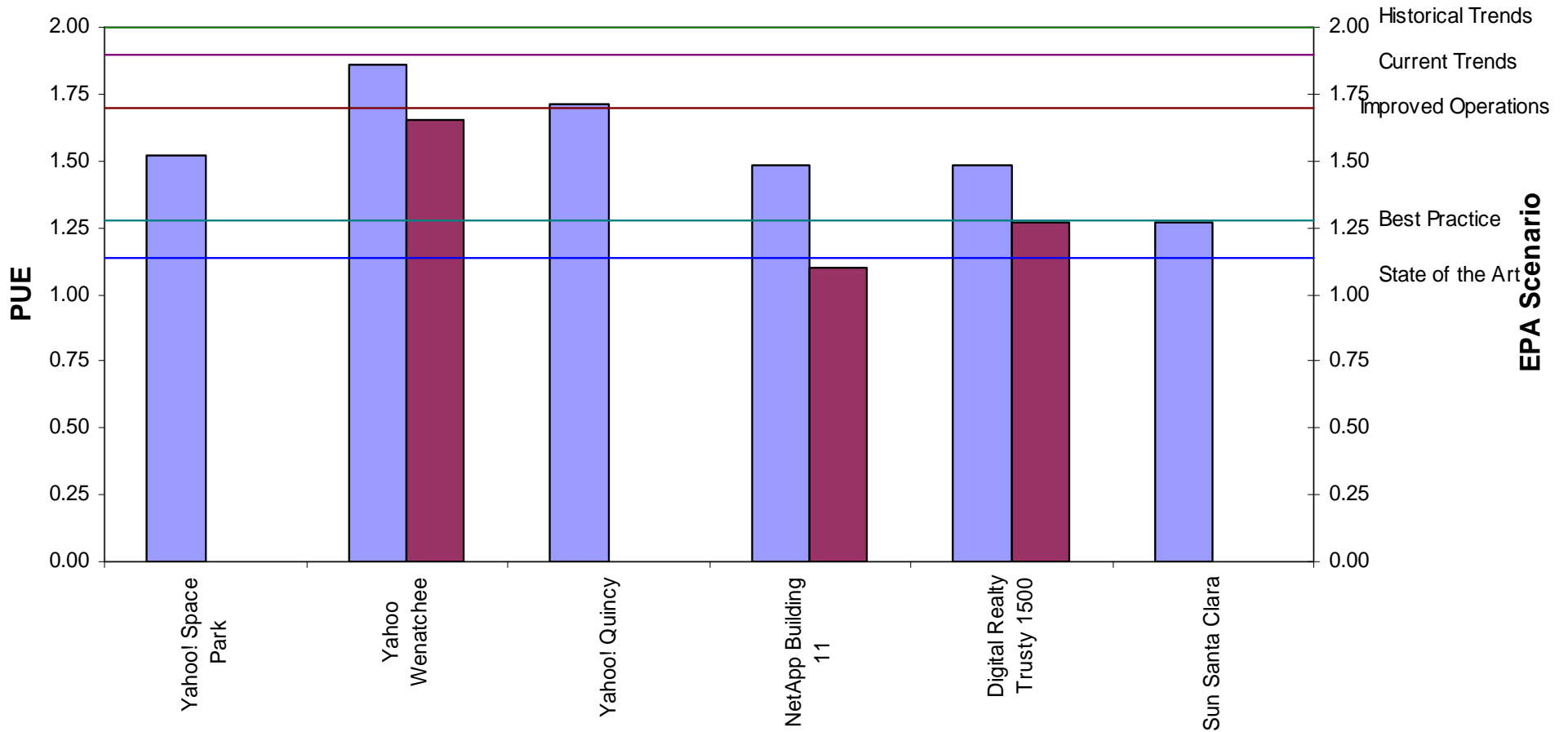
Effect on Total PUE - Chilled Water System





# Free-cooling delivers considerable savings in cool, dry climates

Total PUE



# Findings for Site Infrastructure



1. High efficiency site initiatives exist today  
Participants start PUE 1.2-1.6
2. Legacy retrofits can almost be as efficient as new commissions

*E.g., applying measured results*

*Air management + VFDs + water-side economizer in a legacy retrofit results in a 0.23 contribution to PUE*

*High efficiency chilled water plant + modular cooling in a new data center results in a 0.21 contribution to PUE*

**Consolidated Legacy PUE 1.355**

**Consolidated New PUE 1.265**

Scenario	PUE
Historical Trends	2.0
Current Trends	1.9
Improved Operations	1.7
<b>Best Practice</b>	<b>1.3</b>
<b>State-of-the-Art</b>	<b>1.2</b>

*PUE, PSRR, and % adoption of power management & energy efficient servers based on expert estimates*

# Findings for IT equipment



Scenario	PSRR
Historical Trends	N/A
Current Trends	1.08:1
Improved Operations	<b>1.08:1</b>
Best Practice	<b>2:1</b>
State-of-the-Art	<b>5:1</b>

1. Holistic IT transformation initiatives deliver larger impact in our studies
2. Companies need to better demonstrate aggressive IT infrastructure reduction
  - Yet to fully harness virtualization and rationalization
  - Must consider storage and networks

**Consolidated R&D PSRR 2.1:1**

**Consolidated Production PSRR 3:1**



# Demonstration Scenarios

## IT Infrastructure

Production  
Consolidation

**Legacy Production**

**New Production**

R&D  
Resource Optimization

**Legacy R&D**

**New R&D**

### Legacy Retrofit

- Variable Fan Drives
- Air Management
- Water-side economizer
- Right-sizing power, cooling

### Newly Commissioned

- Air side economizer
- High efficiency chilled water plant + Modular cooling
- High efficiency standby power
- High efficiency PDU

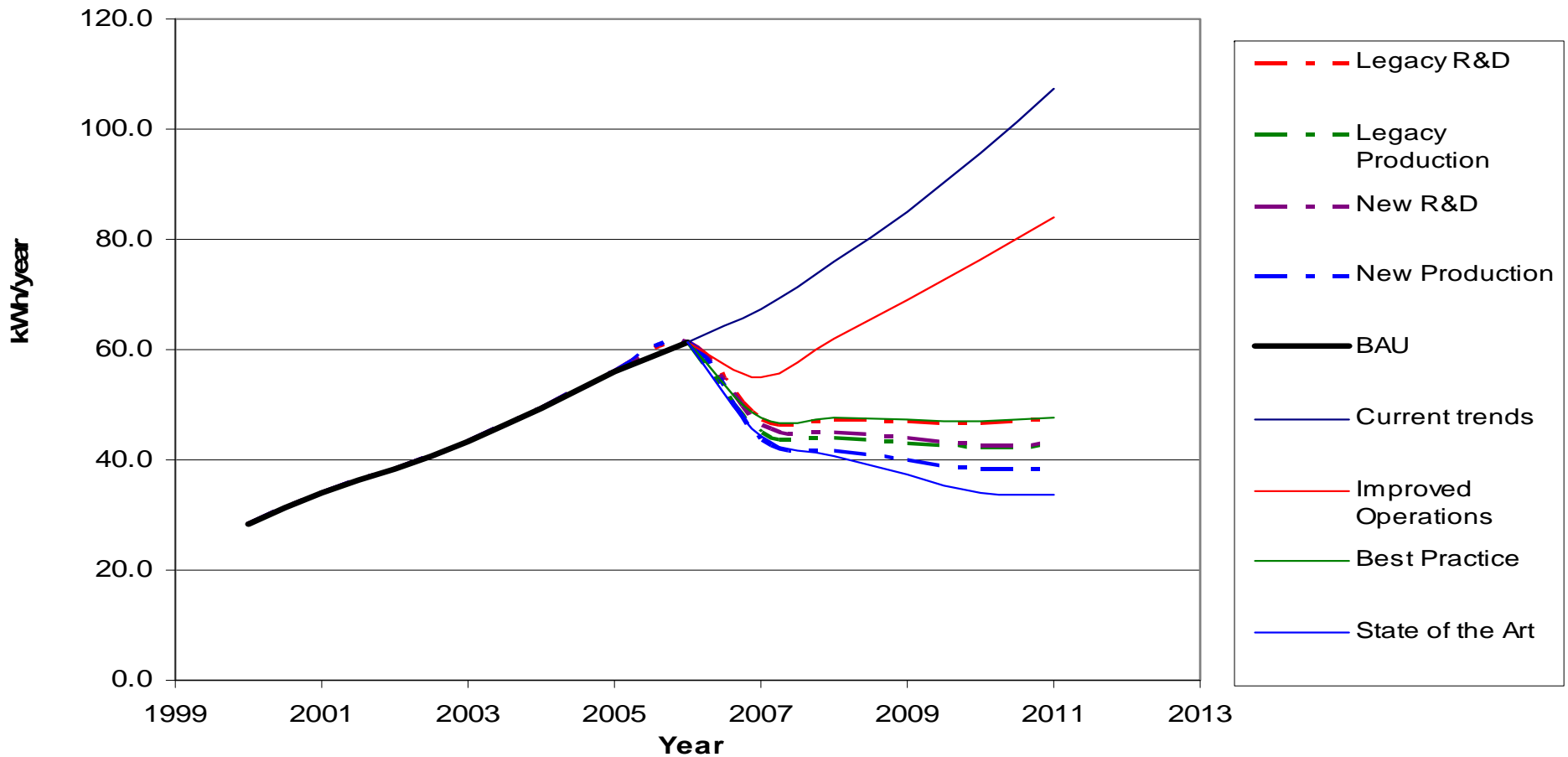
## Site Infrastructure



# Comparison with EPA results

## *We can achieve Best Practice*

### Energy Use by Scenario





## By 2011, significant savings over 2007 trends

### Legacy retrofits

- Savings of 59.9 to 64.6 billion kWh/year annually
- Up to \$4.5 billion saved annually
- 40.9 MMTCO<sub>2</sub> reduced (more than 7 million cars) annually

### New commissions

- Savings of 64.2 to 68.9 billion kWh/year annually
- Up to \$4.8 billion saved annually
- 43.6 MMTCO<sub>2</sub> reduced (almost 8 million cars) annually



In 2011

- Consumes between 38 to 47 billion kWh annually
- Costs between \$2.6 to 3.3 billion kWh annually  
(computed for 8 cents/kWh, imagine if this doubles!)
- Produces between 24.3 to 30.1 MMTCO<sub>2</sub> annually  
(between 4.3 to 5.3 million cars)





## Summary

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- Data centers continue to be large energy consumers  
*Costs about \$3 billion annually*
- Best practice levels defined in the EPA report are achievable
  - IT initiatives offer large savings
  - Yet to fully harness virtualization & rationalization
  - Site technology near state-of-the-art
  - Legacy upgrades can nearly match new commissions in terms of efficiency



Implement today's technologies and have significant impact

*Reduces carbon dioxide emissions by up to 8 million cars*