Title
Self-benchmarking Guide for Data Centers: Metrics, Benchmarks, Actions

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Self-benchmarking Guide for Data Centers: Metrics, Benchmarks, Actions

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Disclaimer

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Table of Contents

1. Introduction

Purpose

This guide describes energy efficiency metrics and benchmarks that can be used to track the performance of and identify potential opportunities to reduce energy use in data centers.

Target audience

This guide is primarily intended for personnel who have responsibility for managing energy use in existing data centers – including facilities managers, energy managers, and their engineering consultants. Additionally, data center designers may also use the metrics and benchmarks described in this guide for goal-setting in new construction or major renovation.

What this guide does

This guide provides the following information:

- A step-by-step outline of the benchmarking process.
- A set of performance metrics for the whole building as well as individual systems. For each metric, the guide provides a definition, performance benchmarks, and potential actions that can be inferred from evaluating this metric.
- A list and descriptions of the data required for computing the metrics

This guide is complemented by spreadsheet templates for data collection and for computing the benchmarking metrics.

This guide builds on prior data center benchmarking studies supported by the California Energy Commission. Much of the benchmarking data are drawn from the LBNL data center benchmarking database that was developed from these studies. Additional benchmark data were obtained from engineering experts including facility designers and energy managers. This guide also builds on recent research supported by the U.S. Department of Energy’s Save Energy Now program.

What this guide does not do

While the energy benchmarking approach describe in this guide can be used to identify potential efficiency opportunities, this guide does not in and of itself constitute an energy audit procedure or checklist. (However, benchmarking may be used as part of an energy audit procedure, or to help prioritize areas for more in-depth audits). The guide does not describe how to calculate savings from the potential actions identified. This guide also does not describe detailed measurement procedures and equipment needed for obtaining the data required to compute metrics. The reader is encouraged to use the U.S. Department of Energy‘s DC Pro tool suite to conduct a more in-depth analysis of data center efficiency.

Structure of this guide

Section 2 outlines the benchmarking process and how to use this guide in this context. Users should start here.

Sections 3 through 6 describe the performance metrics and how to use them. A summary of the metrics is provides at the beginning of each section. Users can use these sections as a reference manual, to prioritize which metrics to evaluate, and determine data requirements.

Section 7 provides a list of the data required for computing the metrics and limited guidance on how to obtain the data.

Section 8 lists references.

Definitions

A **Performance Metric** is a unit of measure used to assess performance; e.g. Data Center Infrastructure Efficiency (no unit), IT Equipment Load Density (W/sf).

A **Performance Benchmark** is a particular value of the metric that is used as a point of comparison; e.g. 0.7 is “good practice” for data center infrastructure efficiency metric.

2. Benchmarking Process

- *Identify purpose of benchmarking– baselining, identifying actions, comparison to portfolio, etc.*
- *Determine extent of facility and systems to be evaluated.*

- *Use metrics/ data template*
- *Prioritize based on goals and available resources*

- *Use metrics/ data template*
- *Identify source (EMCS, drawings, temporary meters, etc.), measurement period and frequency, responsible person for each data item.*

- *Utility lending libraries may be good source for monitoring equipment.*

- *Check equipment and ensure that data is being collected as intended.*

- *Use spreadsheets and metrics/ data template to convert raw data into metrics.*

- *Compare metrics to benchmark values provided in this guide. Identify potential actions based on benchmark results.*

- *Identify which actions can be implemented immediately and which require more detailed audit.*

- *Share and compare results with peer organizations.*
- *Add results to benchmarking databases.*

3. Overall Data Center Performance Metrics

ID	Name	Priority
B1	Data Center Infrastructure Efficiency	1
B2	Power Usage Effectiveness	1
B3	HVAC System Effectiveness	1

B1: Data Center Infrastructure Efficiency (DCiE)

Description:

This metric is the ratio of the IT equipment energy to the total data center energy use. The total data center energy use is the sum of the electrical energy for IT, HVAC system, power distribution, lighting, and any other form of energy use, like steam or chilled water. All the energy data values in the ratio are converted to common units.

Units: Dimensionless

$B1 = dE2 \div (dE1 + (dE4 + dE5 + dE6) \times 293))$
where:
dE1: Annual Electrical Energy Use (kWh)
dE2: Annual IT Electrical Energy Use (kWh)
dE4: Annual Fuel Energy Use (MMBTU)
dE5: Annual District Steam Energy Use (MMBTU)
dE6: Annual District Chilled Water Energy Use (MMBTU)

See section 7 for more information on the data items.

Benchmarks:

This metric can be benchmarked relative to other facilities in the LBNL database, although the LBNL database contains DCiE based on power rather than annual energy. The LBNL database suggests that a DCiE value of about 0.5 is considered typical practice and 0.7 and above is better practice. Some data centers are capable of achieving 0.9 or higher [Greenberg et al. 2009].

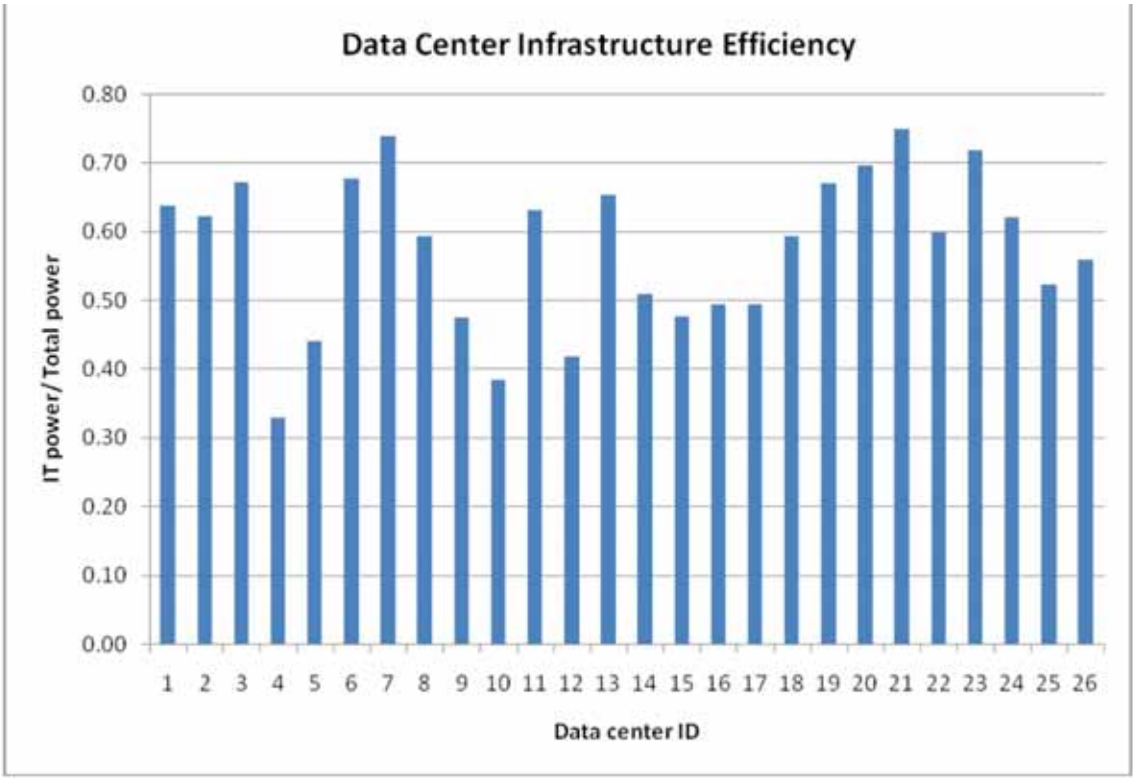

Figure 1. Data center infrastructure efficiency for data centers in the LBNL database. Note that these DCiE values are based on power, not energy.

Actions Inferred:

This metric provides an overall measure of the infrastructure efficiency i.e. lower values relative to the peer group suggest higher potential to improve the efficiency of the infrastructure systems (HVAC, power distribution, lights) and vice versa. Note that it is not a measure of IT efficiency.

Special Considerations:

This metric can be defined based on site energy, source energy, or power. When using site energy, it is not effective for comparing sites with co-generation, because it does not account for source energy of electricity.

Since this metric does not account for the efficiency of the IT itself, it is important to note that if a data center has a high DCiE, there may still be major opportunities to reduce overall energy use through IT efficiency measures such as virtualization, etc. The ability to increase DCiE is also affected by climate (e.g. free cooling offers much greater potential in cooler climates).

B2: Power Usage Effectiveness (PUE)

Description:

PUE is the inverse of the DCiE metric. This metric is the ratio of the total data center energy use to total IT energy use. The total data center energy use is the sum of the electrical energy for the servers, HVAC system, power distribution, lighting, and any other form of energy use, like steam or chilled water. All the energy data values in the ratio are converted to common units.

Units: Dimensionless

$B2 = (dE1 + (dE4 + dE5 + dE6) \times 293)) \div dE2$
where:
dE1: Annual Electrical Energy Use (kWh)
dE2: Annual IT Electrical Energy Use (kWh)
dE4: Annual Fuel Energy Use (MMBTU)
dE5: Annual District Steam Energy Use (MMBTU)
dE6: Annual District Chilled Water Energy Use (MMBTU)

See section 7 for more information on the data items.

Benchmarks:

This metric can be benchmarked relative to other facilities in the LBNL database, although the LBNL database contains PUE based on power rather than annual energy. For the LBNL dataset, the average PUE value is 1.83.

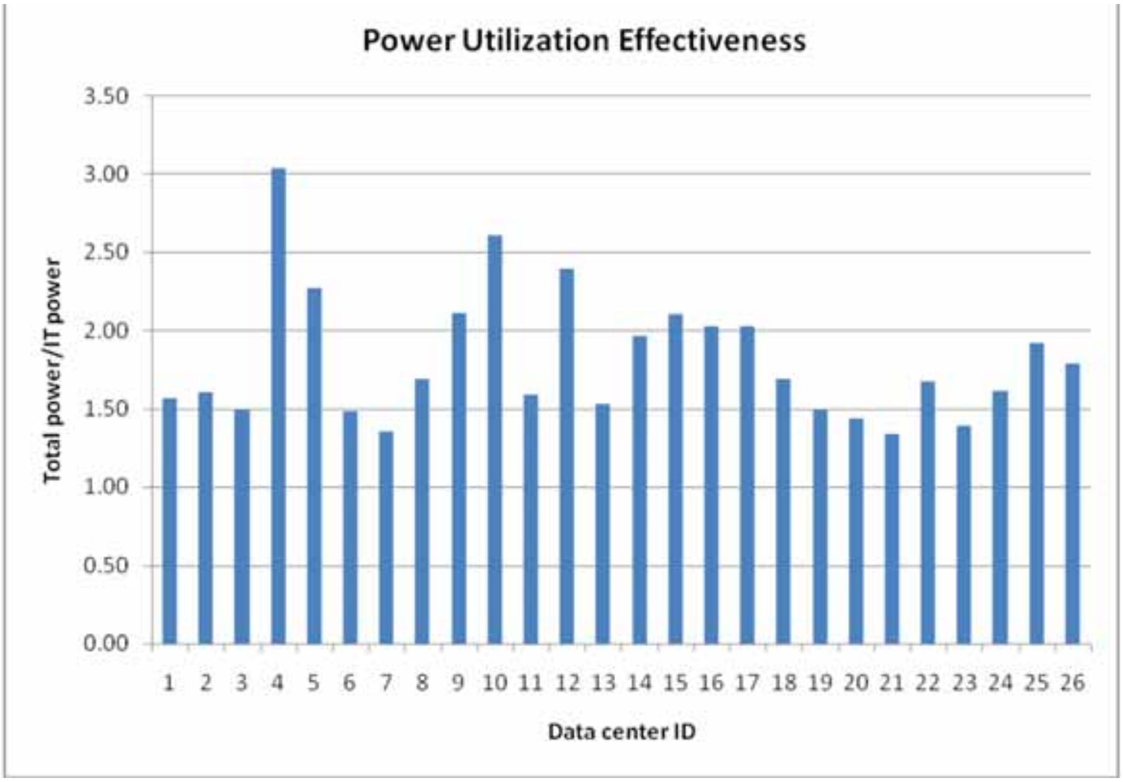

Figure 2. Power Usage Effectiveness metric for data centers in the LBNL database. Note that these PUE values are based on power, not energy.

Actions Inferred:

This metric provides an overall measure of the infrastructure efficiency i.e. higher values relative to the peer group suggest higher potential to improve the efficiency of the infrastructure systems (HVAC, power distribution, lights) and vice versa. Note that it is not a measure of IT efficiency.

Special Considerations:

This metric can be defined based on site energy, source energy, or power. When using site energy, it is not effective for comparing sites with co-generation, because it does not account for source energy of electricity.

Since this metric does not account for the efficiency of the IT itself, it is important to note that if a data center has a low PUE, there may still be major opportunities to reduce overall energy use through IT efficiency measures such as virtualization, etc. The ability to decrease PUE is also affected by climate (e.g. free cooling offers much greater potential in cooler climates).

B3: HVAC System Effectiveness

Description:

This metric is the ratio of the IT equipment energy to the HVAC system energy. The HVAC system energy is the sum of the electrical energy for cooling, fan movement, and any other HVAC energy use like steam or chilled water.

Units: Dimensionless

B3 = dE2 ÷ (dE3 + (dE4 + dE5 + dE6) x 293))
where:
dE2: Annual IT Electrical Energy Use (kWh)
dE3: Annual HVAC Electrical Energy Use (kWh)
dE4: Annual Fuel Energy Use (MMBTU)
dE5: Annual District Steam Energy Use (MMBTU)
dE6: Annual District Chilled Water Energy Use (MMBTU)

See section 7 for more information on the data items

Benchmarks:

This metric can be benchmarked relative to data centers benchmarked by LBNL, although the LBNL database contains values based on power rather than annual energy.

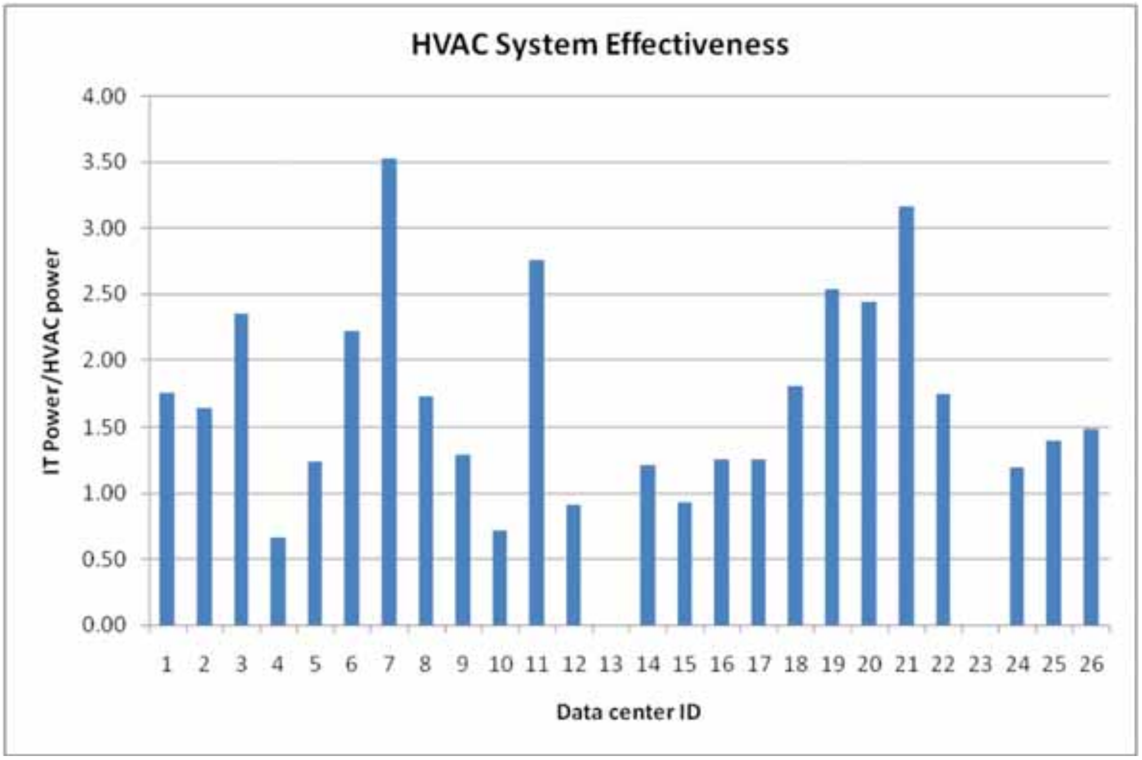

Figure 3. HVAC System Effectiveness ratio for data centers in the LBNL database. Note that these values are based on power, not energy.

Actions Inferred:

This metric provides a measure of the overall efficiency potential for HVAC systems i.e. higher values relative to the peer group suggest higher potential to reduce HVAC energy use.

HVAC energy use can be reduced substantially by using strategies such as “free cooling” with air economizers, high efficiency chillers, etc.

Special Considerations:

Note that a lower value of HVAC system effectiveness does not necessarily imply that the HVAC efficiencies are low. It may indicate that the server systems are far more optimized and efficient in comparison to the HVAC system. Therefore, this metric is only a coarse screen for HVAC efficiency potential.

4. Air Management Metrics

ID	Name	Priority
A1	Temperature Range	1
A2	Humidity Range	1
A3	Return Temperature Index	1
A4	Airflow Efficiency	1

A1: Temperature: Supply and Return

Description:

This metric is the difference between the supply and return air temperature in the data center.

Units: F

A1 = dA2 – dA1
where:
dA1: Supply air temperature
dA2: Return air temperature

See section 7 for more information on the data items

Benchmarks:

The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) guidelines [ASHRAE 2008] provide a range of allowable and recommended supply temperatures and humidity at the inlet to the IT equipment. The recommended temperature range is between 64F-80F, while the allowable is 59F-90F.

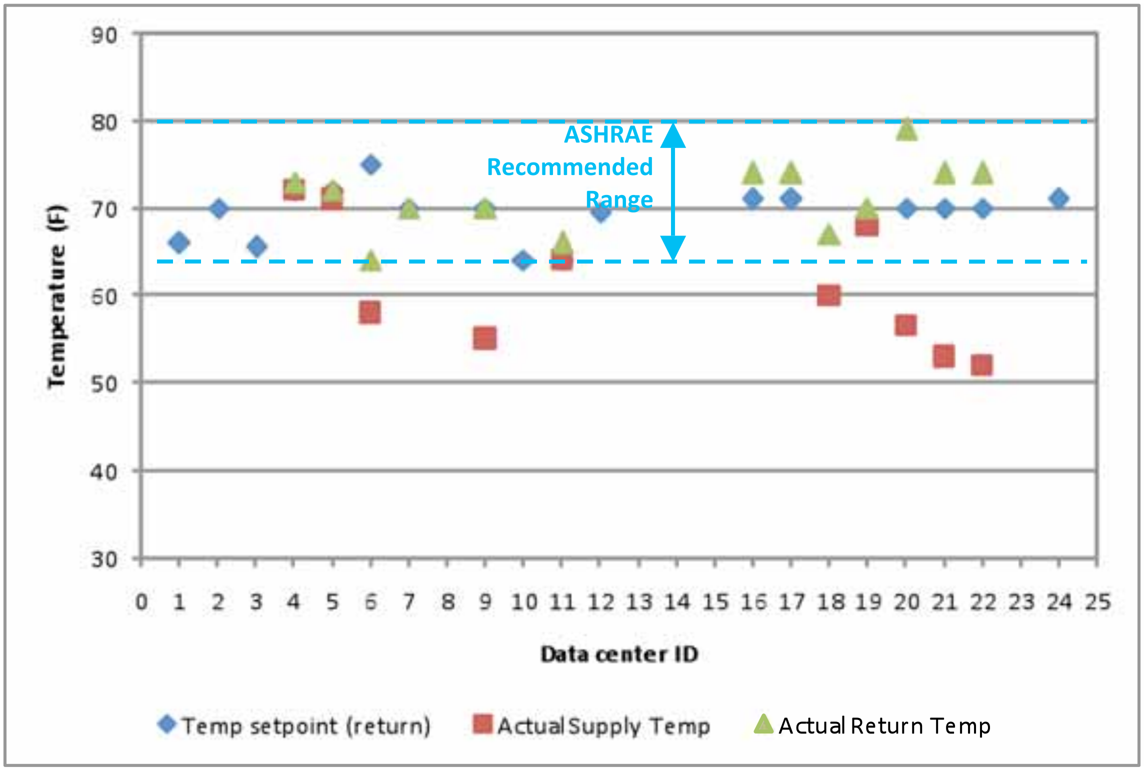

Figure 4. Return air temperature setpoints, measured supply and return temperature for data centers in the LBNL database

Actions Inferred:

A low supply air temperature and a small temperature differential between supply and return typically indicate the opportunity to improve air management, raise supply air temperature and thereby reduce energy use. Strategies to improve air management include better isolation between cold and hot aisles using blanking panels and strip curtains, optimizing configuration of supply diffusers and return grilles, better cable management, blocking gaps in floor tiles, etc.

Special Considerations:

Temperature and humidity affect the reliability and life of IT equipment. Any changes to the air management and temperature and humidity settings should be evaluated with metrics such as the Rack Cooling Index (RCI) (Herrlin 2005), which can be used to assess the thermal health of the IT equipment.

A2: Relative Humidity: Supply and Return

Description:

This metric is the difference of the return and supply air relative humidity in the data center.

Units: % RH

A2 = dA4 – dA3
where:

dA3: Supply air relative humidity
dA4: Return air relative humidity

See section 7 for more information on the data items

Benchmarks:

The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) guidelines [ASHRAE 2008] provide a range of allowable and recommended supply temperatures and humidity at the inlet to the IT equipment. The recommended humidity range is between a lower end defined as a minimum dew point of 42F and the upper end set at 60% relative humidity and 59F dewpoint. The allowable relative humidity range is between 20%-80% and 63F maximum dewpoint.

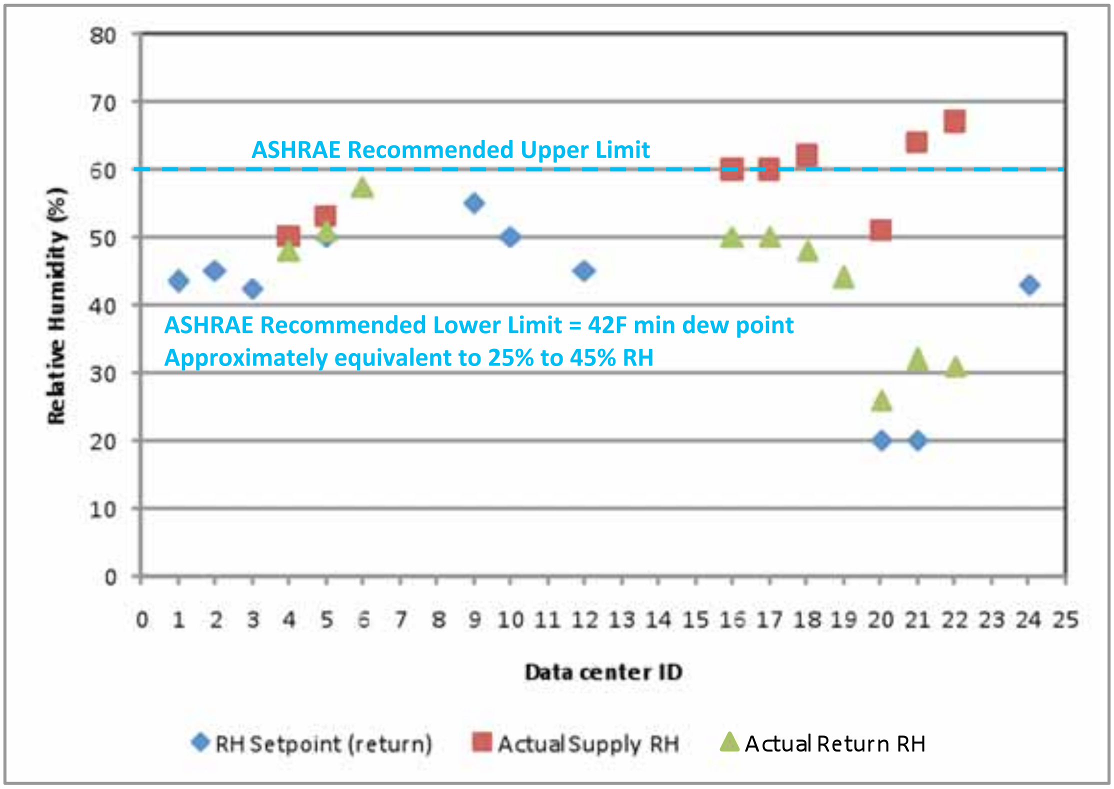

Figure 5. Return air relative humidity setpoints, measured supply and return relative humidity for for data centers in the LBNL database

Actions Inferred:

A small relative humidity range suggests opportunities to reduce energy use, especially if there is active humidification and dehumidification. Centralized active control of the humidification units reduces conflicting operations between individual units, thereby improving the energy efficiency. Many data centers operate well without active humidity control. Humidity control is important for physical media like tape storage, and generally not critical for rest of the data center equipment.

Special Considerations:

Temperature and humidity affect the reliability and life of IT equipment. Any changes to the air management and temperature and humidity settings should be evaluated with metrics such as the Rack Cooling Index (RCI) (Herrlin 2005), which can be used to assess the thermal health of the IT equipment. Studies by LBNL and the Electrostatic Discharge Association suggest that humidity may not need to be as tightly controlled.

A3: Return Temperature Index

Description:

This metric is a measure of the energy performance of the air management (Herrlin 2007). The primary purpose of improving air management is to isolate hot and cold airstreams. This allows elevating both the supply and return temperatures and maximizes the difference between them while keeping the inlet temperatures within ASHRAE recommendations. It also allows reduction of the system air flow rate. This strategy allows the HVAC equipment to operate more efficiently. The return temperature index (RTI) is ideal at 100% wherein the return air temperature is the same as the temperature leaving the IT equipment and the supply air temperature is the same as the rack inlet temperature.

Units: %

A3 = ((dA2 – dA1) / (dA6 – dA5)) × 100
where:
dA1: Supply air temperature
dA2: Return air temperature
dA5: Rack inlet mean temperature
dA6: Rack outlet mean temperature

See section 7 for more information on the data items

Benchmarks:

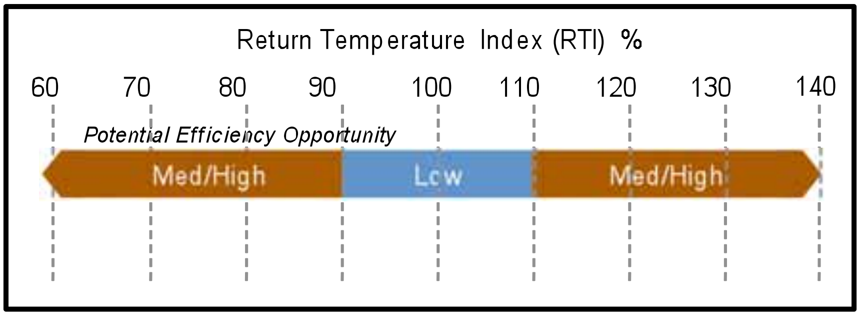

Figure 6. Benchmarks for Return Temperature Index

Actions Inferred:

RTI is also a measure of the excess or deficit of supply air to the server equipment. An RTI value of 100% is ideal. An RTI value of less than 100% indicates that the some of the supply air is by-passing the racks, and a value greater than 100% indicates that there is recirculation of air from the hot aisle. The RTI value can be close to ideal (100%) by improving air management.

Special Considerations:

Temperature and humidity affect the reliability and life of IT equipment. Any changes to the air management and temperature and humidity settings should be evaluated with metrics such as the Rack Cooling Index (RCI) (Herrlin 2005), which can be used to assess the thermal health of the IT equipment.

A4: Airflow Efficiency

Description:

This metric characterizes overall airflow efficiency in terms of the total fan power required per unit of airflow. This metric provides an overall measure of how efficiently air is moved through the data center, from the supply to the return, and takes into account low pressure drop design as well as fan system efficiency.

Units: W/cfm [W/l-s^{-1}]

$A4 = dA7 \times 1000 \div dA8$
where:
dA7: Total fan power (supply and return) (kW)
dA8: Total fan airflow (supply and exhaust) (cfm)

See section 7 for more information on the data items

Benchmarks:

There are limited data on airflow efficiency in data centers. The data from the LBNL database suggest that 0.5 W/cfm might be considered a threshold of better practice.

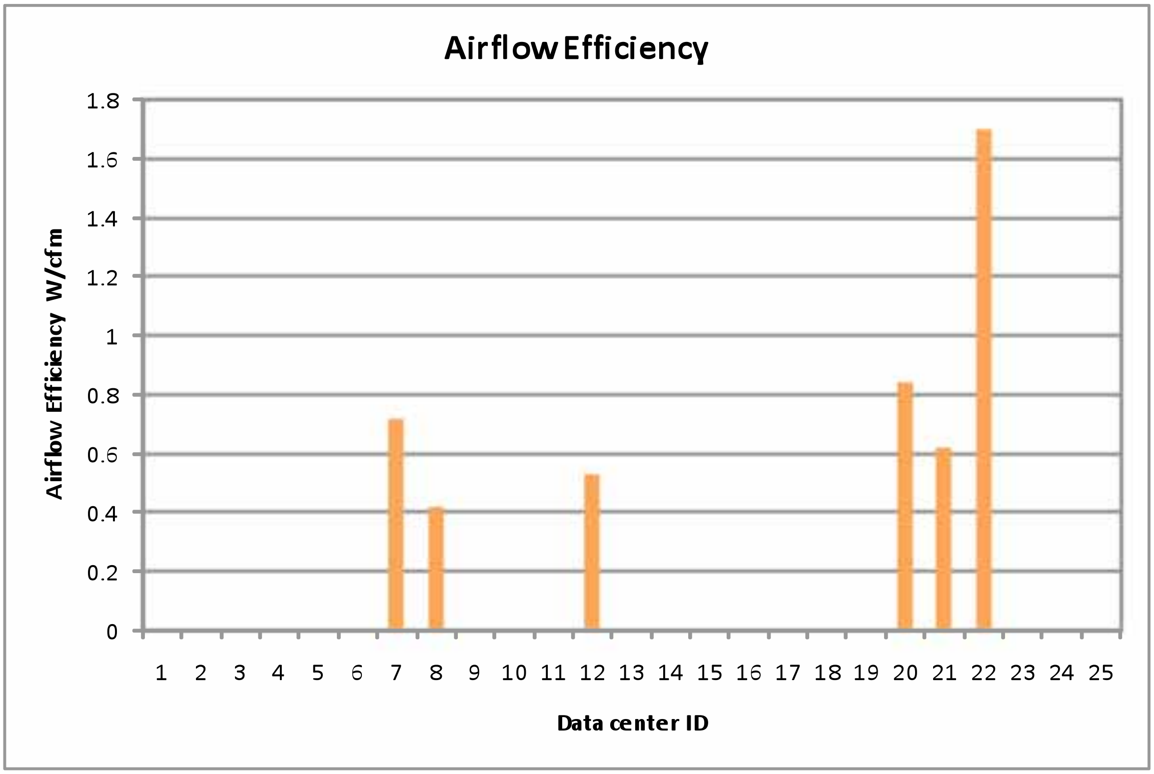

Figure 7. Airflow efficiency for data centers in the LBNL database

Actions Inferred:

A high value of this metric indicates that the fan system (motors, belts, drives) is inefficient and the pressure drops airflow distribution system need to be reduced. Improving the design of the duct work can significantly reduce the pressure drop in the system.

5. Cooling Metrics

ID	Name	Priority
C1	Data Center Cooling System Efficiency	1
C2	Data Center Cooling System Sizing Factor	1
C3	Air Economizer Utilization Factor	1
C4	Water Economizer Utilization Factor	1

C1: Data Center Cooling System Efficiency

Description:

This metric characterizes the overall efficiency of the cooling system (including chillers, pumps, and cooling towers) in terms of energy input per unit of cooling output. It is an average value depicting average power of the cooling system with respect to the cooling load in the data center.

Units: kW/ton

C1: (dC1) ÷ (dC2)
where:
dC1: Average cooling system power usage (kW)
dC2: Average cooling load in the data center (tons)

See section 7 for more information on the data items

Benchmarks:

Based on data from the LBNL database, 0.8 kW/ton could be considered as good practice benchmark and 0.6 kW/ton as a better practice benchmark.

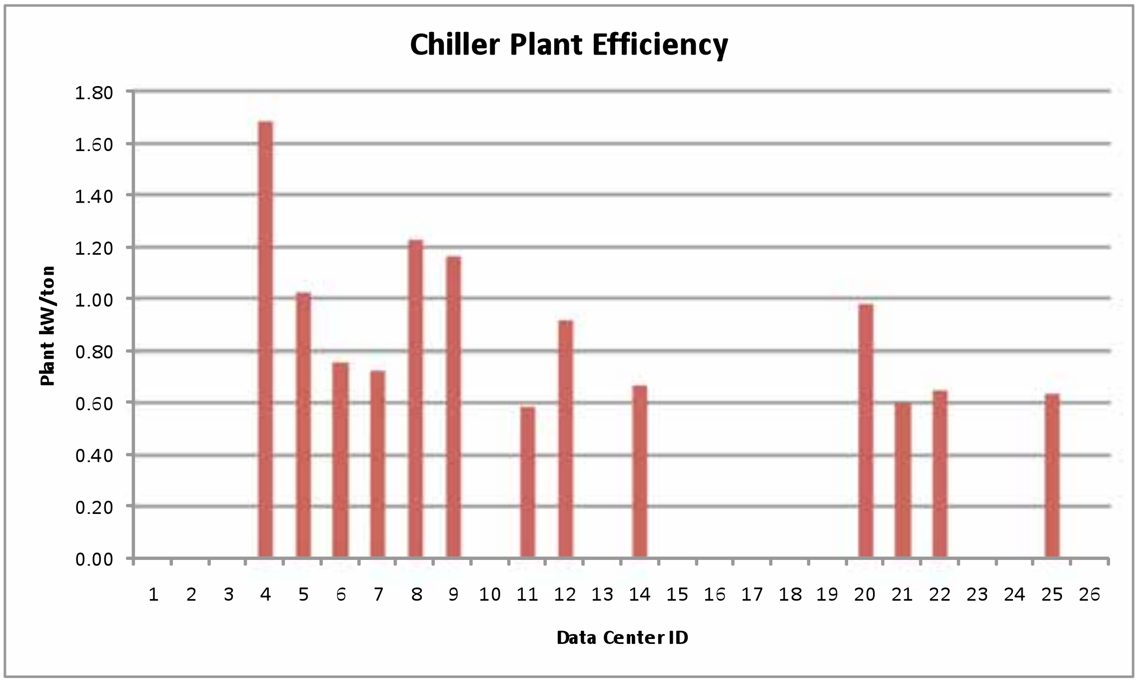

Figure 8. Cooling plant efficiency for LBNL benchmarked data centers

Actions Inferred:

There are many efficiency actions that can be used to improve the overall efficiency of the chiller plant. These include:

- Modularization
- High efficiency chillers
- All-variable-speed system
- Premium efficiency motors
- Increased chilled water temperature
- Water-side economizer
- Controls optimization (staging, resets, etc.)

C2: Cooling System Sizing Factor

Description:

This metric is the ratio of the installed cooling capacity to the peak cooling load.

Units: -

C2 = dT8 ÷ dT9
where:
dT8: Installed Chiller Capacity (w/o backup) (tons)
dT9: Peak Chiller Load (tons)

See section 7 for more information on the data items

Benchmarks:

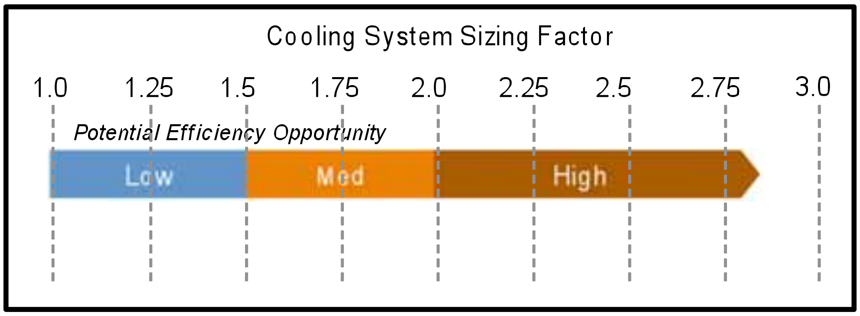

Figure 9. Benchmarks for Cooling System Sizing Factor

Actions Inferred:

A high value for this metric indicates the opportunity to "right-size" the cooling plant and improve part load efficiency. Part load efficiency can also be improved by using a modularized plant design.

C3: Air Economizer Utilization Factor

Description:

This metric characterizes the extent to which air-side economizer system is being used to provide "free" cooling. It is defined as the percentage of hours in a year that the economizer system can be in full or complete operation (i.e. without any cooling being provided by the chiller plant).

Units: %

$C3 = (dC5 \div 8760) \times 100$
where:
dC5: Air economizer hours (full cooling)

See section 7 for more information on the data items

Benchmarks:

The number of hours that the air economizer is being utilized could be compared to the maximum possible for the climate in which the data center is located. This can be determined from simulation analysis. As a point of reference, the chart below shows results from simulation analysis for four different climate conditions.

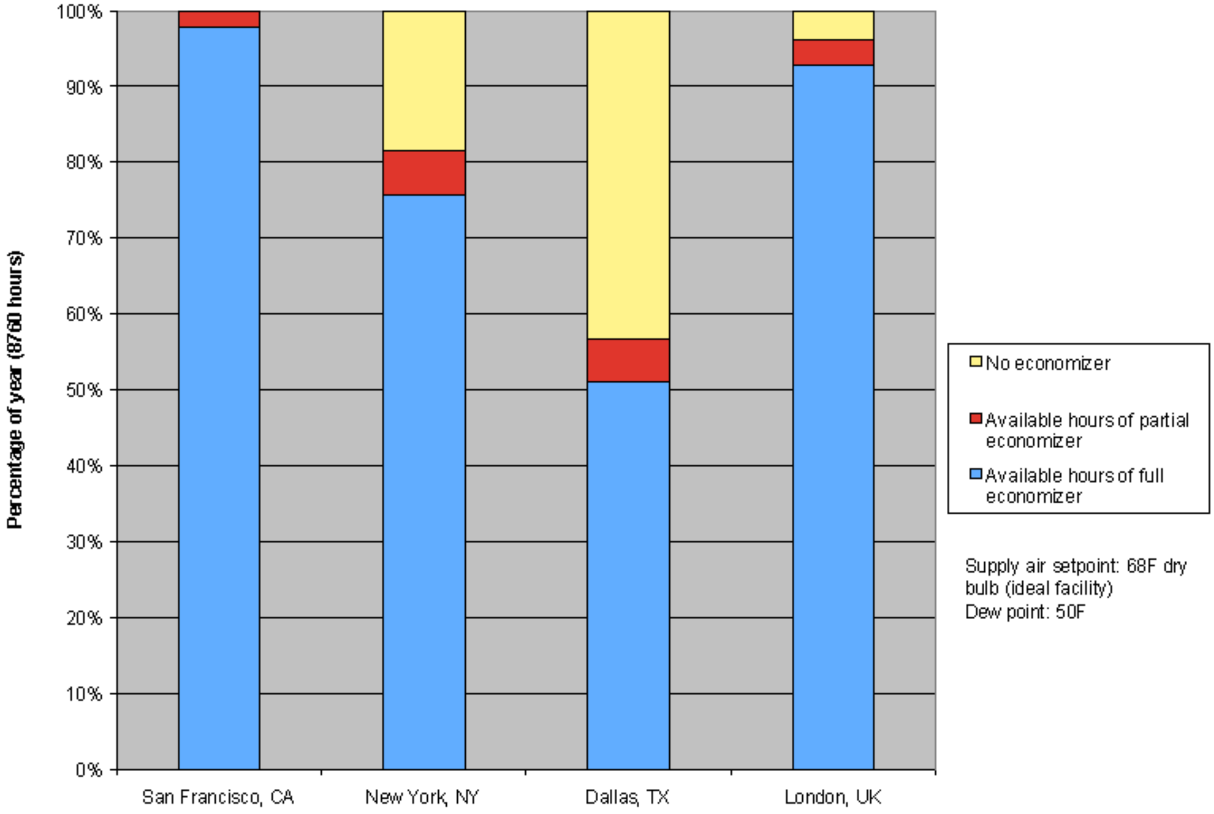

Figure 10. Simulated air-side economizer utilization potential for four different locations. Data source: Syska Hennessy 2007

Actions Inferred:

A low value for this metric indicates potential for increasing energy savings from using an air-side economizer system. Increasing the supply air temperatures to the data center increases the hours of economizer use. Also, humidity restrictions need to be relaxed to maximize its use. Air-side economizers can provide significant savings if properly designed and controlled. The energy savings from economizer use will vary depending on the climate.

Special Considerations:

Concern over potential degradation from hygroscopic particles (from outside air) and relaxed humidity controls need to be properly evaluated based on the climate (location) of the data center. Particulate contamination can be significantly reduced by using improved HVAC filters. Most data center equipment is not sensitive to humidity changes, and those that are can be placed in a separately controlled area.

C4: Water Economizer Utilization Factor

Description:

This metric is the percentage hours in a year that the water side economizer system meets the entire cooling load of the data center.

Units: %

$$C4 = (dC6 \div 8760) \times 100$$

where:
dC6: Water economizer hours (full cooling)

See section 7 for more information on the data items

Benchmarks:

The number of hours that the water economizer is being utilized could be compared to the maximum possible for the climate in which the data center is located. This can be determined from simulation analysis.

Actions Inferred:

This metric provides information on the energy savings from using a water-side economizer system. Increasing the chilled water temperatures to the chiller plant increases the hours of economizer use. Water-side economizers can provide significant savings if properly designed and controlled.

Special Considerations:

Using water-side economizer removes the concern over particulate contamination from outside air. However, they require pump and tower energy to provide cooling. They are most cost-effective in very dry climates were air-side economizers may have humidity concerns.

6. Electrical Power Chain Metrics

ID	Name	Priority
P1	UPS Load Factor	1
P2	UPS System Efficiency	1
P3	IT or Server Equipment Load Density	1
P4	Lighting Density	3

P1: UPS Load Factor

Description:

This metric is the ratio of the peak load of the uninterruptible power supply (UPS) to the design value of its capacity. This provides a measure of the UPS system over-sizing and redundancy.

Units: Dimensionless

P1 = dP1 ÷ dP2
where:
dP1: UPS peak load (kW)
dP2: UPS load capacity (kW)

See section 7 for more information on the data items.

Benchmarks:

UPS load factors below 0.5 may indicate an opportunity for efficiency improvements, although the extent of the opportunity is highly dependent on the required redundancy level.

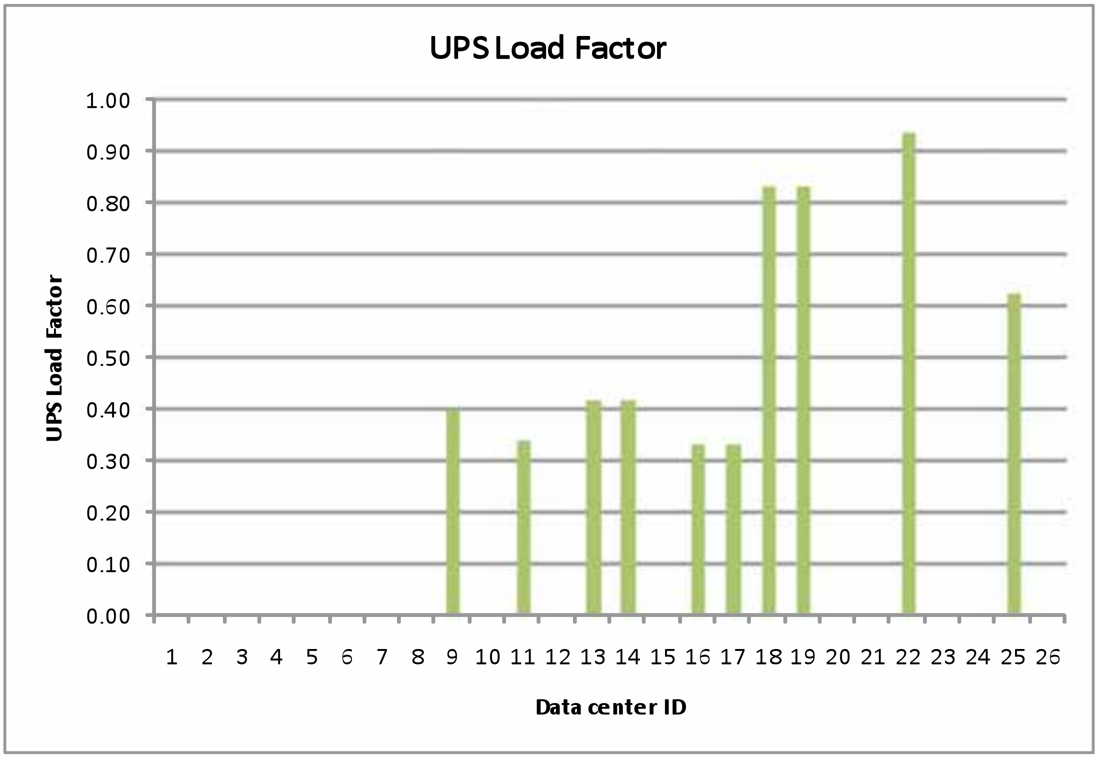

Figure 11. UPS load factor for data centers in the LBNL database

Actions Inferred:

Since UPS efficiency decreases at lower load factors, increasing the load factor can decrease UPS energy losses. The load factor can be improved by several means, including the following:

- Shutdown some UPS modules when Redundancy Level exceeds N+1 or 2N
- Install a scalable/modular UPS
- Install a smaller UPS size to fit present load capacity
- Transfer loads between UPS modules to maximize load factor % per active UPS

P2: Data Center UPS System Efficiency

Description:

This metric is the ratio of the UPS output power to the UPS input power. The UPS efficiency varies depending on its load factor.

Units: %

P2 = (dP4 ÷ dP3) x 100
where:
dP3: UPS input power (kW)
dP4: UPS output power (kW)

See section 7 for more information on the data items

Benchmarks:

The UPS efficiency varies depending on its load factor and therefore the benchmark for this metric depends on the load factor of the UPS system. At UPS load factors below 40% the system usually is highly inefficient due to no load losses. Figure 12 shows the range of UPS efficiencies from factory measurements of different topologies. Figure 13 shows the UPS efficiencies for data centers in the LBNL database. These measurements taken several years ago illustrate that efficiencies vary considerably. Manufacturers claim that improved efficiencies are available today. When selecting UPS systems, it is important to evaluate performance over the expected loading range.

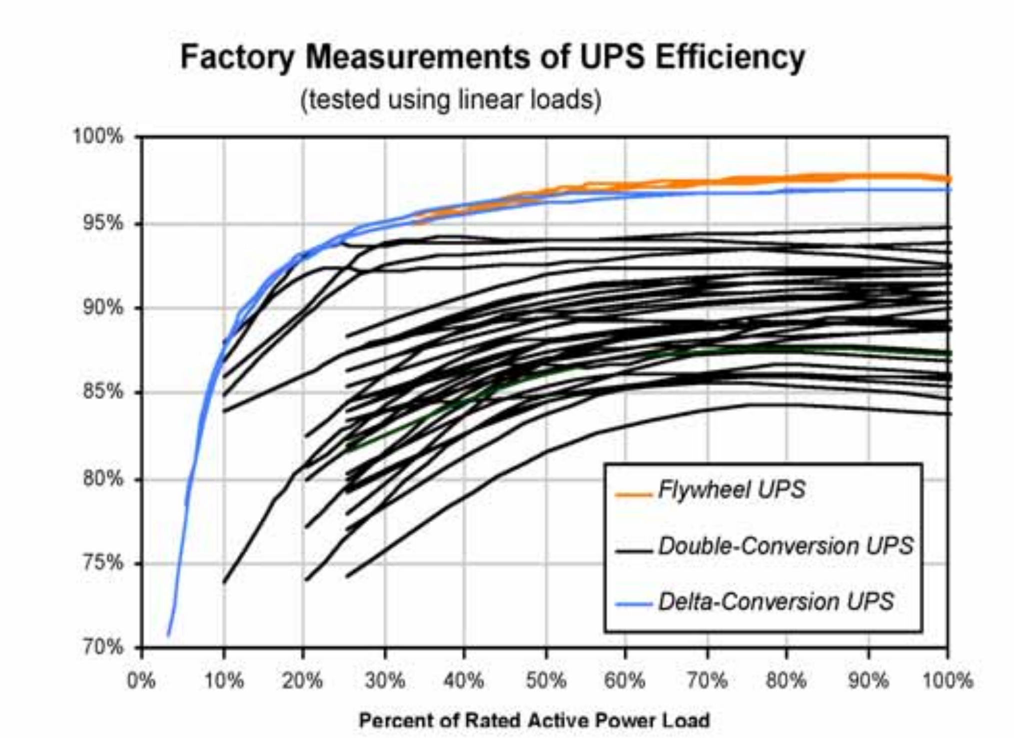

Figure 12.   Range of UPS system efficiencies for factory measurements of different topologies

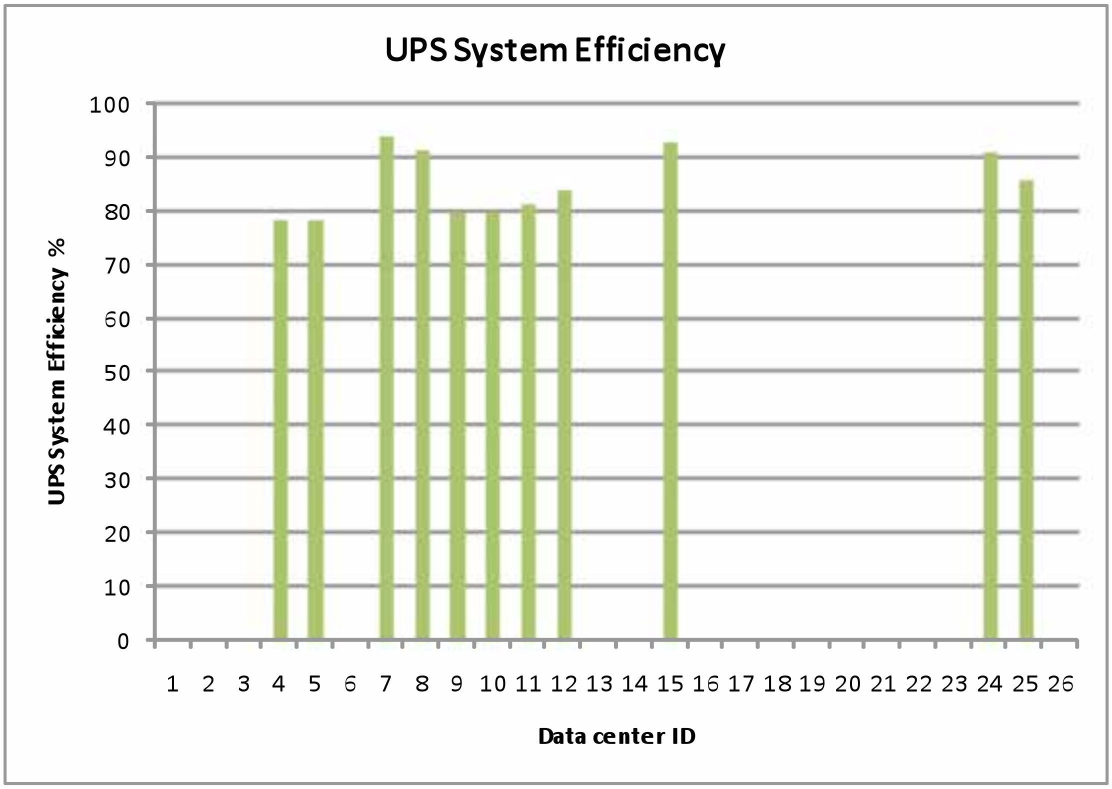

Figure 13. UPS efficiency for data centers in the LBNL database

Actions Inferred:

Selection of more efficient UPS systems, especially the ones that perform well at load factors below 40% improves energy savings. For non-critical IT work by-passing the UPS system using factory-supplied hardware and controls may be an option. Reducing the level of redundancy by using modular UPS systems also improves the efficiency.

Special Considerations:

In addition to improving the efficiency of the UPS system, efficient transformers and power supplies provide energy saving. Placing the power distribution units and transformers outside the data center room is a strategy that helps reduce the cooling load of the HVAC system.

P3: IT or Server Equipment Load Density

Description:

This metric is the ratio of the average IT or server power to the electrically active data center area. This metric provides a measure of the power consumed by the servers.

Units: W/ft^2

$P3 = dP5 \times 1000 \div dB1$
where:
dP5: Average IT or server power (kW)

dB1: Electrically active area of the data center (ft^2)

See section 7 for more information on the data items

Benchmarks:

The LBNL data center benchmarking studies were started in 2001, and according to this study the typical value of IT load density in 2003 was 25 W/ft^2. By 2005 the typical value had jumped to 52 W/ft^2 and was hovering around 80 W/ft^2 by 2006.

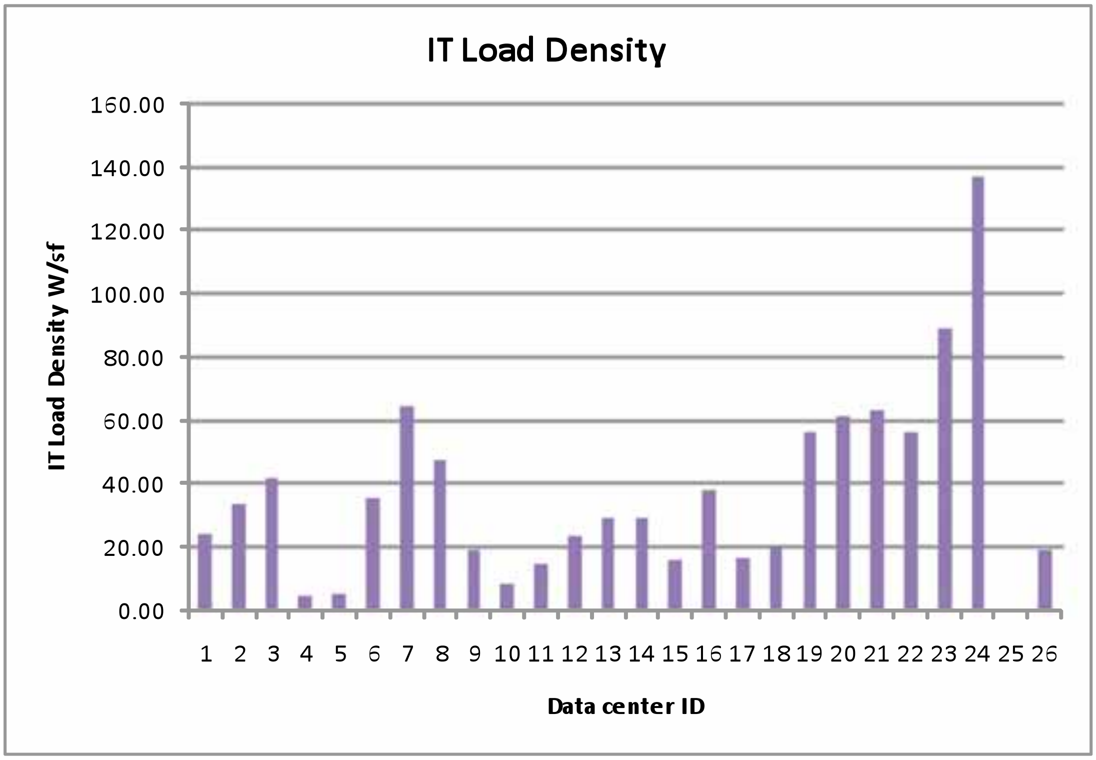

Figure 14. IT load density for data centers in the LBNL database

Actions Inferred:

Benchmarking of the IT load density can help prevent over-sizing during the planning phase for a new data center. The IT load can be reduced by using efficient servers and software methodologies like virtualization. Switching off or transition to low power modes for servers that are not in use provide significant energy savings. Reducing the IT load has a multiplier effect on the HVAC and power chain systems.

P4: Data Center Lighting Density

Description:

This metric is the ratio of the data center lighting power consumption to the data center area.

Units: W/ft^2

$$P4 = dP4 \times 1000 \div dB1$$

where:
dI4: Data center lighting power (kW)
dB1: Data center area (ft^2)

See section 7 for more information on the data items

Benchmarks:

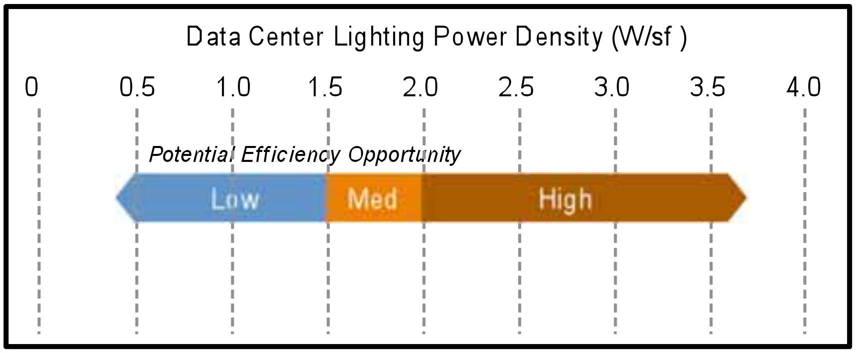

Figure 15. Benchmarks for lighting power density in data centers

Actions Inferred:

The efficiency of the lighting system can be improved by using efficient lamps and ballasts. The use of occupancy sensors to turn off lights in unoccupied aisles can also reduce the overall lighting energy use.

7. Data Required for Performance Metrics

The table below lists the data required for the performance metrics described in sections 3-6.

ID	Data Item	Measurement/Calculation Guidance
General Data Center Data		
dB1	Data Center Area (electrically active)	
dB2	Data Center Location	
dB3	Data Center Type	
dB4	Year of Construction (or major renovation)	
Data Center Energy Data		
dE1	Annual Electrical Energy Use	Meter data or Utility bills.
dE2	Annual IT Electrical Energy Use	Measured downstream from PDUs.
dE3	Annual HVAC Electrical Energy Use	Includes cooling system and air handling energy use.
dE4	Annual Fuel Energy Use	Meter data or Utility bills.
dE5	Annual District Steam Energy Use	Meter data or Utility bills.
dE6	Annual District Chilled Water Energy Use	Meter data or Utility bills.
Air Management		
dA1	Supply Air Temperature	Measured at supply diffuser/outlet.
dA2	Return Air Temperature	Measured at return grille/inlet.
dA3	Supply Air Relative Humidity	Measured at supply diffuser/outlet.
dA4	Return Air Relative Humidity	Measured at return grille/inlet.
dA5	Rack Inlet Mean Temperature	Average of measurements at different heights and multiple racks.
dA6	Rack Outlet Mean Temperature	Average of measurements at different heights and multiple racks.
dA7	Total Fan Power (Supply and Return)	Use design values if measured values not available.
dA8	Total Fan Airflow rate (Supply and Return)	Use design values if measured values not available.
Cooling		
dC1	Average Cooling System Power Consumption	Average power during the time that chiller is on.
dC2	Average Cooling Load	Average load during the time chiller is on. If load is not directly measured, it can be calculated from flow rate and supply and return temperatures.
dC3	Installed Chiller Capacity (w/o backup)	Rated capacity.
dC4	Peak Chiller Load	Peak over one year.
dC5	Air Economizer Hours (full cooling)	Hours without compressor-based cooling.
dC6	Water Economizer Hours (full cooling)	Hours without compressor-based cooling.
Electrical Power Chain		
dP1	UPS Peak Load	Peak over one year.
dP2	UPS Load Capacity	Rated capacity.
dP3	UPS Input Power	Average over one year or representative time period.
dP4	UPS Output Power	Average over one year or representative time period.
dP5	Average IT or Server Power	Average over one year or representative time period. Power measured downstream from PDUs.
dP6	Average Lighting Power	Average over one year or representative time period.

8. References & Resources

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