RACKWISE

Measuring Efficiency and Going Green with Rackwise DCM 3.5

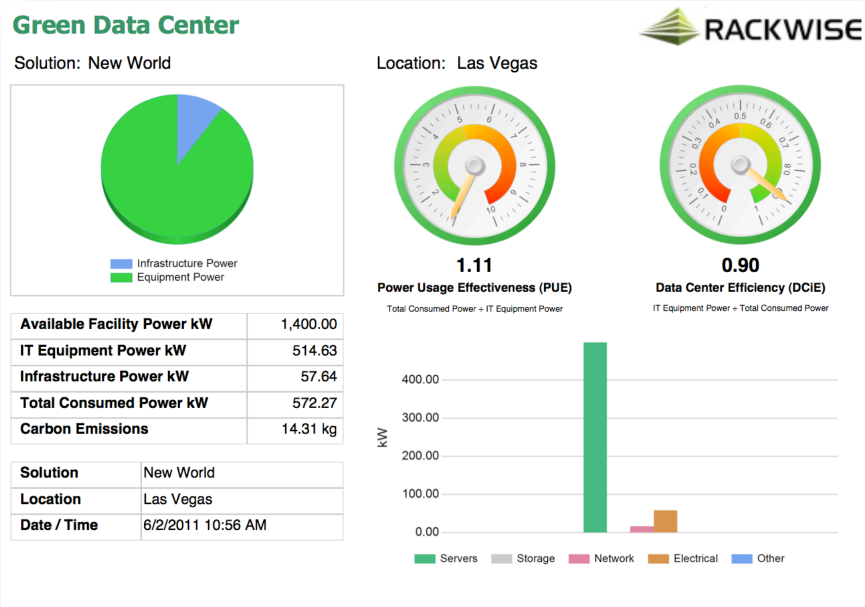
WHITE PAPER

Introduction

Energy has become a major factor in terms of costs associated with operating the data center today. A typical cost for electrical power is $0.12 per kWh (**kilowatt hour**). Given this cost, the annualized cost per kW of IT load is approximately $1,051 (per year). Over a 10-year life span of the average data center, this translates to approximately $10,000 per kW of load [1].

Driving more efficiency into the data center is a paramount objective for successful IT operations supporting the business. To that end, Rackwise has created an innovative and powerful Data Center Infrastructure Management (DCIM) solution that was designed with purpose to help business leaders evaluate their data centers' efficiency, pinpoint areas of inefficiency, analyze optimization "what-if" scenarios and simulate the impact on the infrastructure prior to making any changes, and to visualize the short and long-term financial and physical impact on data center power, cooling, space and weight capacity.

Rackwise DCM provides built-in analysis and presentation-quality Green Report metrics related to the selected data center. Rackwise DCM analyzes the data center model as well as any real-time metrics collected using industry-proven formulas for calculating data center efficiency, such as *The Green Grid's* PUE and DCiE [1].



Green Data Center

Solution: New World

Location: Las Vegas

Available Facility Power kW	1,400.00
IT Equipment Power kW	514.63
Infrastructure Power kW	57.64
Total Consumed Power kW	572.27
Carbon Emissions	14.31 kg

Solution	New World
Location	Las Vegas
Date / Time	6/2/2011 10:56 AM

1.11
Power Usage Effectiveness (PUE)
Total Consumed Power ÷ IT Equipment Power

0.90
Data Center Efficiency (DCiE)
IT Equipment Power ÷ Total Consumed Power

Figure 1. Rackwise DCM Green Data Center Report

Using Power Usage Effectiveness (PUE)/ Data Center Infrastructure Efficiency (DCiE) metrics[1]

Power Usage Effectiveness (PUE) is a measure of how efficiently a data center uses its power; specifically, how much of the power is actually used by the computing equipment in contrast with cooling and other overhead.

PUE is mathematically defined as:

$$PUE = \frac{total\ facility\ power}{IT\ equipment\ power}$$

PUE is the ratio of "IT equipment power" to "total facility power". The most efficient data centers operate at a PUE of 1.5 or below.

As an example, if a data center has a PUE of 3.0, then 3,000 watts of power are consumed for every 1,000 watts of IT equipment. Therefore, a data center with a PUE of 1.5 would only consume 1,500 watts for every 1,000 watts of IT equipment.

Data Center Infrastructure Efficiency (DCiE) is a performance improvement metric used to calculate the energy efficiency of a data center. DCiE is the percentage value derived, by dividing information technology equipment power by total facility power. DCiE is the reciprocal of PUE.

DCiE is mathematically defined as:

$$DCiE = \frac{IT\ equipment\ power}{total\ facility\ power}$$

As an example, if a data center has a DCiE value of 0.33 (equivalent to a PUE of 3.0), the IT equipment is consuming 33% of the power in the data center.

Total Facility Power is defined as everything that supports the IT equipment load such as:

- Power delivery components including: UPS, switch gear, generators, PDUs, batteries, and distribution losses external to the IT equipment
- Cooling system components including: chillers, computer room air conditioning units (CRACs), direct expansion air handler (DX) units, pumps, and cooling towers
- Computers, network, appliances, monitoring devices, monitors/terminals and storage nodes
- Other miscellaneous component loads such as security cameras, data center lighting, etc.

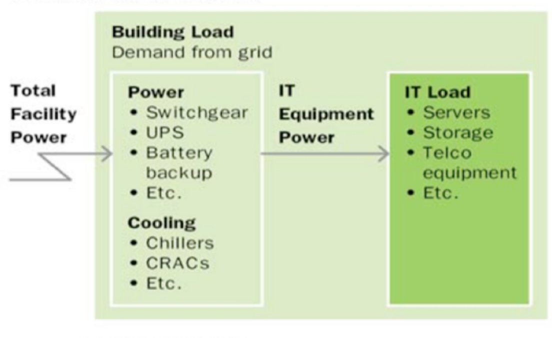


Figure 2. Relations between IT and Facility Power

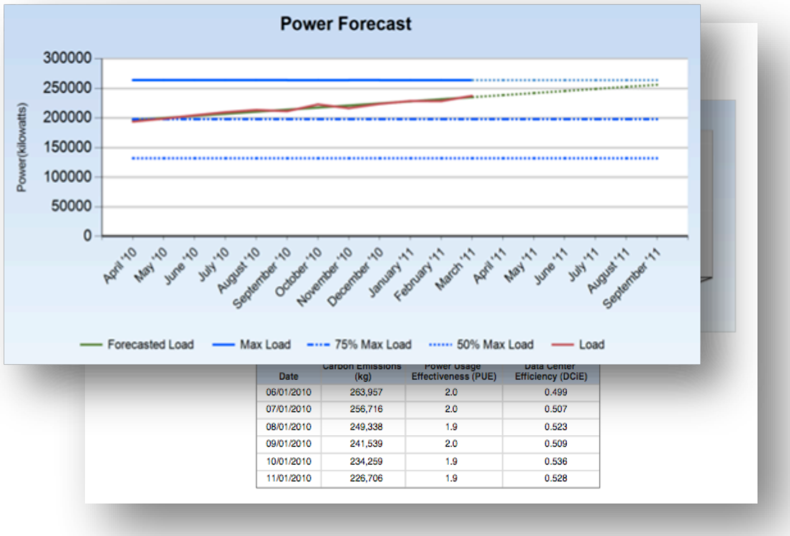
IT Equipment Power is defined as the load associated with all of the IT equipment, such as computers, storage, and network equipment, along with supplemental equipment such as KVM switches, monitors and workstations/laptops used to monitor or otherwise control the data center.

PUE and **DCiE**[1] are excellent metrics for understanding how well a data center is delivering power to its IT equipment. These metrics are best applied, however, to look at trends in an individual facility over time and to measure the effects of different design and operational decisions within a specific facility.

Rackwise DCM Green Reports provide a breakdown of power usage effectiveness by type including:

- Servers
- Storage
- Networking
- Electrical Switch Gear
- Other

Rackwise DCM provides incredibly powerful Green Trend Reports to view PUE and DCiE trends over any period of time.



Date	Carbon Emissions (kg)	Power Usage Effectiveness (PUE)	Data Center Efficiency (DCiE)
06/01/2010	263,957	2.0	0.499
07/01/2010	256,716	2.0	0.507
08/01/2010	249,338	1.9	0.523
09/01/2010	241,539	2.0	0.509
10/01/2010	234,259	1.9	0.536
11/01/2010	226,706	1.9	0.528

Figure 3. Rackwise DCM Green Data Center Trend Report and Power Capacity Forecasting with Real-Time Measurements

But, where does all the power go?

Less than half of the energy used in a data center goes to the IT loads. The other half goes to the critical physical infrastructure (CPI) equipment including power equipment, cooling equipment, and lighting. The figure below illustrates electrical power flow in a typical high availability data center. Note that all the energy consumed by the data center ends up as waste heat that is exhausted to the outdoors and into the atmosphere.

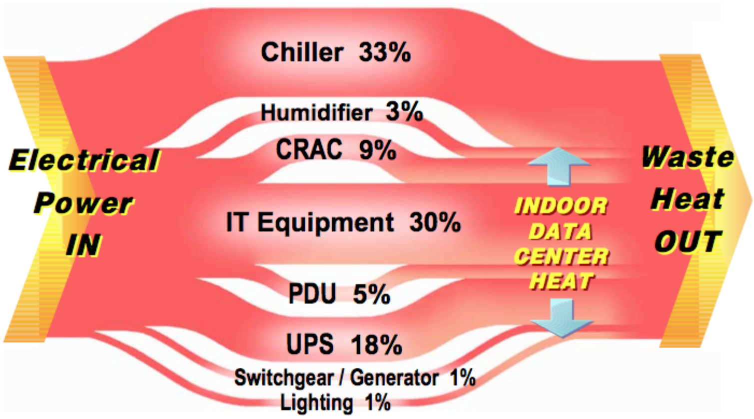


Figure 4. The data center depicted in this illustration is said to be 30% efficient, based on the fraction of the input power that actually gets to the IT load.

Improving PUE

There are various actions that can be taken to improve how “Green” a data center can become. According to The Green Grid[1] many current data centers have a PUE of 3.0 or greater, but with proper design and measurement, a PUE value of 1.6 can be readily achieved.

The following provides some methods and practices for improving your data center Power Usage Effectiveness (PUE):

Airflow and Cooling Coordination[3]

Airflow and cooling dynamics can be improved through a few simple efforts. These improvements decrease server inlet temperatures while increasing the CRAC return air temperature, which improves efficiency and reduces energy consumption.

Most data centers have multiple air conditioning systems. In some cases, these systems have set points that compete or conflict. One system may dehumidify while another humidifies, or some systems may actually be heating air. The various cooling technologies in the data center need to be coordinated. Expert analysis is often required to diagnose and remediate these types of conditions.

Employing basic airflow management best practices in data centers can yield up to 6% [4] annual savings. Closing holes in the raised floor, strategically locating perforated tiles and baffles and utilizing hot/cold aisles can be implemented at a low cost. It is estimated that a typical 25,000 square foot data center could save as much as $79,000[4] annually.

Tile Management and Floor Management [3]

Tile and floor management to produce efficiencies should be straight forward, but this is not often the case. Determining the right number, type and location of vented tiles in a data center requires specific ASHRAE expertise, computational fluid dynamics (CFD) software or some form of real- time instrumentation. New technologies do provide substantial help in this area. Investing time in this aspect of data center management ensures over-heated or under-cooled areas of the data center are corrected. Comprehensive tile analysis also allows CRAC location optimization.

How equipment is arranged on the floor has a major impact on energy efficiency in your data center. The most important aspect of this relates to cooling. A best-practice floor layout will improve the efficiency of airflow, which has a direct impact on the amount of fan energy needed to direct cooled air to the equipment.

Economizer Operation [3]

In many geographic locations, economizer technologies can realize substantial energy savings. Many air conditioner technologies offer economizer options, but this mode is often disabled or the equipment is not correctly configured to take advantage of this mode of operation.

Economizers leverage the outside ambient air conditions to reduce or eliminate mechanical cooling. There are two types of economizer technologies: air-side and water-side. Air-side economizer operations circulate outside air through the cooling system when the ambient air is at or below the CRAC outlet temperature setting.

Water-side economizers use ambient external air to chill water or coolant when the air temperature is low enough to chill the water to the target temperature, typically 45 degrees Fahrenheit.

Virtualization [2]

Virtualization of servers results in a dramatic reduction of IT power, cooling and space requirements. Virtualization is designed to reduce the number of physical servers while increasing the number of logical servers without increasing capacity requirements. Eliminating one physical server is a bottom-line cost avoidance of approximately 300 watts – 600 watts, depending on technology. Given the cost for electrical power is $0.12 per kWh, the average annual savings is over $500 per year per each eliminated server.

Summary

Measuring and understanding how your data center rates for PUE and DCiE are vital to developing improvements in your data center's efficiency.

"If you can't measure it, you can't improve it."

*Dr. H. James Harrington has been involved in quality and performance improvement projects since the 1950s. He taught us "*Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it.*"*

Rackwise DCM provides a powerful solution that provides detailed visualization of power, cooling, equipment, and space as well as comprehensive analysis, decision-making metrics, unlimited "what-if" scenarios, and superior reporting that in unison helps you measure, understand, control, and improve your data centers' performance.

Rackwise DCM provides you the power to proactively model and simulate potential changes in your data center and immediately see the impact of potential changes before ever implementing them.

Rackwise continues to provide innovation solutions surrounding "Green" data center metrics with support in the upcoming release of Rackwise DCM for the latest in industry standard PUE measurements.

Bibliography and Additional Resources

Certain materials and statistics referenced within this white paper were developed by Rackwise but also include information provided within the following works. We highly recommend you obtain and review these additional documents, white papers, books, and news outlets.

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