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# **Data Center Energy Management and Optimization**

**A Viridity White Paper**

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With Viridity Software organizations  
are immediately discovering  
**20–40 percent**  
improvements in data center  
energy efficiency.

## Executive summary

Advances in data center energy management and optimization can yield three distinct areas of improvement:

- Remove the risk of unknown power use and cooling capacity
- Reduce energy cost and optimize efficiency
- Support green initiatives with real data

To be actionable and effective, data center power optimization requires accurate measuring, modeling, trending, and analysis.

## Introduction

**“Insanity: doing the same thing over and over again and expecting different results.”**

– *Albert Einstein*

As energy prices rise, data centers must become more efficient. The mountain of digital information continues to grow as processing demands increase. Data centers are either going to run out of power or the cost of electricity is going to outstrip capital expenditures as the number one cost in the data center.<sup>1</sup>

How did this become such a problem? Because the industry has historically based its energy planning on fundamentally flawed power calculations — starting with vendor nameplate power specifications and fixed de-rating of these specifications. Or worse: no measurement at all. In addition, advances in server design and power settings have not been leveraged by existing energy measurement tools.

Data center managers need a window into data center energy efficiency. Legacy hardware-based solutions are intrusive and costly. Software is flexible, scalable, non-invasive, and less expensive to deploy and manage. A software solution allows provisioning and budgeting decisions to be made using real-world data.

## Improving data center energy management and optimization

Look around a data center and the view is hardware-centric: racks, servers, network cables, and power cables. What’s not readily visible are the CPUs running programs and the constant flow of information in and out. Rushing air, blinking LEDs, and a spinning electricity meter might be the only evidence of behind-the-scenes activity.

It is no surprise that typical solutions for measuring energy consumption — such as power meters — have been hardware-based.

Unfortunately, measuring energy with power meters or other installed devices is intrusive and expensive, adding another capital expense to already tight data center budgets.

Further, an evaluation of current offerings would lead you to believe that an extensive network of sensors is the only way to measure data center power consumption. Unfortunately the combined cost of hardware and software, time to implement, and ongoing maintenance eat into the potential savings. Sensor networks also fail to deliver the overlooked but most critical element of the energy consumption picture: how useful is the server to the business? So called bottom up solutions suffer from black box syndrome; they cannot determine if the server is doing useful work. Without that insight, sensor networks might as well be measuring power supplied to space heaters.

Data center power optimization software offers a non-intrusive and cost-effective approach by:

- Including a wide range of IT assets
- Applying the most accurate energy trending and analysis
- Capturing the largest possible volume historic of data
- Providing useful and actionable information

This modern heuristic approach provides a complete view of data center energy.

Using an intelligent software approach, measurements become granular down to the device and time. Knowing power consumption at any given moment is useful; having multiple power level snapshots at regular intervals is an improvement; and continuous trending of power consumption over time opens up new levels of data center optimization.

A state of the art software solution can apply the latest intelligence and best practices to the current knowledge base, recording and storing energy use levels as it learns about your data center. Software can also scale easily, from one asset and location to thousands of assets distributed in multiple data centers. The result is the most complete and accurate view of data center energy efficiency.

## Measuring and modeling

“You can only manage what you can measure.”

— Peter Drucker<sup>2</sup>

The first step to improving efficiency and controlling energy use is an accurate measurement of power consumption. Detailed measurement of real-world power use at the device level is more accurate than nameplate information. Data center managers need an accurate fine-grained view of kW use. Scaling precise kW use across the data center provides the big picture view managers need to make informed decisions.

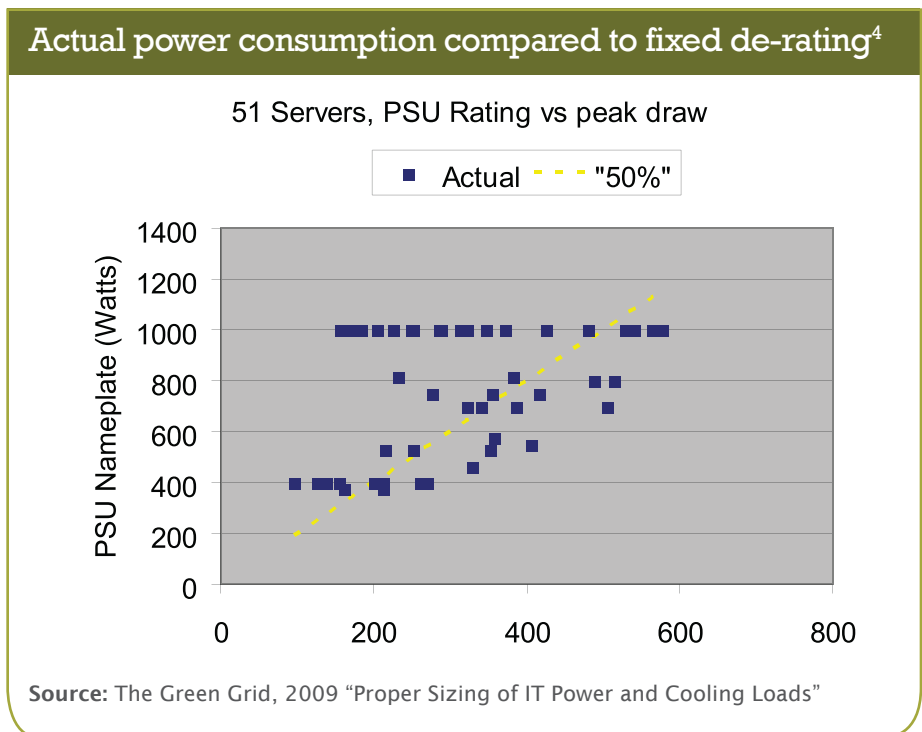
Older methods of measuring kW usage relied on nameplate numbers and fixed de-rating. Manufacturers must use worst-case scenario kW ratings on nameplates. Fixed de-rating only adds to the problem, as the name implies it subtracts a fixed number or percentage of kW use from the nameplate rating.

In practice, devices rarely if ever reach the nameplate kW consumption. De-rating is also a culprit as actual kW use does not always decrease predictably. Now scale these nameplate or de-rated values across the data center, and the total estimated kW use can be wrong by an order of magnitude.

The problem is twofold:

- Fixed nameplate de-rating is little more than a guess.
- De-rating overestimates actual consumption, particularly at low power levels.

An EPA EnergyStar test<sup>3</sup> shows that devices use an average of 50% less energy than predicted using fixed de-rating.



Given the level of error inherent in fixed de-rating and the difference in behavior per device, and it becomes impossible to predict asset behavior using traditional methods. Data centers need an accurate and easily deployed way to model Watts per device. With a model of energy use per device, business applications can be correlated directly to their data center cost.<sup>5</sup>

## Trending and analysis

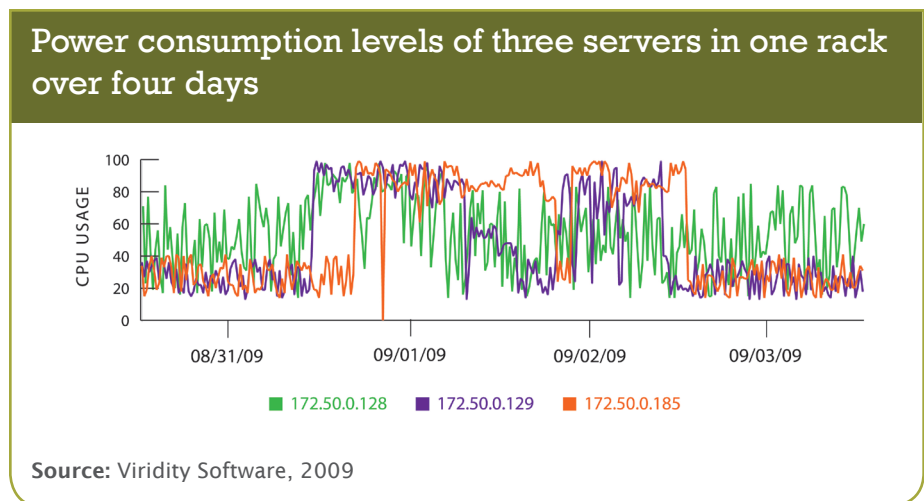
“There is no substitute for knowledge.”

— *W. Edwards Deming*<sup>6</sup>

The next step in data center optimization is trending and analysis of data. Time-based energy use adds a valuable level of detail that has been missing in energy management solutions. Power consumption can be viewed at any time for immediate feedback. Even more importantly, a track record of energy use creates an increasingly precise view of data center efficiency. The accuracy of the energy use model improves over time.

Long-term trending provides a detailed view of an asset, group, and data center over time. A history of energy utilization also enables advanced business functions such as comparing all instances of one device type to determine the accuracy of the current load distribution program.

Analyzing energy trends can lead to the discovery of less obvious asset use patterns such as a vital business activity that only occurs weekly, monthly, or yearly. *Figure 2* illustrates the wide variation in power consumption by showing empirical data for three servers in the same rack over a period of four days.



With this information, analyzing energy efficiency can now be based on actual use. Detailed and precise measurement of power consumption over time allows analysis of real data. Intelligent analytics can suggest changes to improve efficiency. Optimize the location of new devices. Relocate existing devices. Power off or remove unproductive assets. Power off under-productive assets as needed or aggregate their services in fewer devices.

Analytics can also uncover devices that are using more energy than expected. Overused assets that are located in hot spots due to poor cooling delivery can

have a higher likelihood of failure, resulting in lower availability. Data center managers can certainly capitalize on knowing which rack is about to overload a circuit before it happens.

In the dynamic setting of a data center, time-based trending captures the result of any change. The immediate impact can be viewed in real time. By creating a database of power utilization, the long-term impact can also be viewed and analyzed.

### Optimizing for action

**“You have these vampire machines that are drawing power, even though they’re no longer used. That creates a strain on every system, from cooling to electrical.”**

*– Ken Brill, Uptime Institute<sup>7</sup>*

Optimization analysis of data center energy use can reveal stranded power, unproductive assets, and under-utilized rack space. Inefficiencies can be discovered anywhere from an individual device up to the data center level. Detailed measurements allow drilling down through asset group and rack, to individual devices.

Database-driven analytics enable continuous optimization. Data center inefficiencies can be discovered and resolved almost immediately. Combine this level of detail with trending and analysis to optimize the data center. Eliminate the guesswork that plagued legacy power consumption and capacity planning to open up new levels of understanding and new courses of action.

For example, with detailed insight into usage levels, unproductive servers — sometimes called orphans — are often the first item on an action plan. According to the Uptime Institute “up to 30% of the servers running are really dead.” Patterns of power utilization over time provide a complete view that may include random and rare events. Managers can determine if an asset is unproductive, under-productive, or only productive on demand. Turning off unproductive servers yields immediate bottom-line savings and is one of the first steps in data center optimization.<sup>8</sup>

A second actionable strategy is to employ a technology refresh. Newer servers have built-in features that can be used to lower power consumption during periods of inactivity and limit highest power draw during peak activity.

#### Action Plan

- Power off unproductive assets
- Technology refresh
- Optimal placement of new equipment
- Server virtualization and consolidation

A third common action that improves energy consumption is the optimal placement of new equipment. The dynamic nature of today's data center makes it difficult to determine the best placement for new equipment. Managers need to balance rack space, available power, and adequate airflow. By discovering unused power or under-performing assets, placing new equipment becomes easier. The detailed view of power use by rack and device gives managers the option of re-arranging a rack or racks, replacing inefficient equipment, or just placing a new device where rack space was once left open unnecessarily.

A fourth optimization trend is server virtualization or consolidation. Unfortunately, virtualization without a fine-grained view of server power use and a corresponding optimization plan can result in little or no return on the investment. To date, most consolidation methods rely on broad assumptions about server usage that often result in under-consolidation or inaccurate consolidation. Recent field assessments show that many data centers barely reach 10% utilization even after 6 months of deploying virtualization software because of the lack of visibility into actual loads. Only with an accurate view of activity on the physical servers can virtualization work effectively to realize maximum reduction in the total number of servers, and therefore power consumption.

As the quality and amount of information about data center power use rises through an organization, decision-making improves at all levels. Executives and managers can compare power use to business services. Action plans can improve efficiency; saving money while maintaining or improving productivity. Capacity planning becomes easier for processing, cooling, and facilities. Green initiatives can be correlated to bottom line savings.

A well-executed optimization plan results in a more efficient data center that can readily adapt to change.

## Conclusion

Many data centers have run out of space. Some cannot draw any more power from the grid. Others cannot add cost-effective cooling. All have budgetary constraints. Historically, efforts to manage energy required intrusive and labor-intensive methods. Legacy data center management tools have failed to leverage new technologies and were difficult to scale for large data centers. They provided information about energy intake and use, but there has been little ability to analyze the data, and no way to discover the level of productivity inside assets.

Accurate energy measurement provides a quantum leap over current methods such as nameplate and fixed de-rating. New software methods provide completely non-intrusive, easy-to-deploy and manage solutions that can be used to quickly reduce operational expenses (OPEX).

Modeling actual server use and corresponding energy consumption delivers a clear picture of business value. This granular view reveals opportunities for consolidation and optimal placement of new equipment.

Calculated dynamically, trending and analysis delivers more than a static point-in-time measurement. Optimization analytics make it easy to identify under-productive IT equipment, make informed technology refresh decisions, and map power consumption to business needs.

Using software available today, data center managers can implement new strategies based on actionable information. The result is fast time-to-results and high return-on-investment (ROI).

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