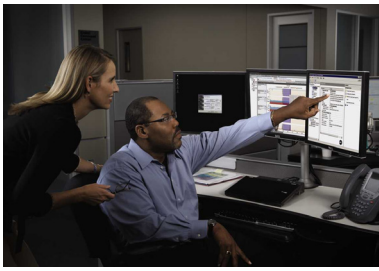
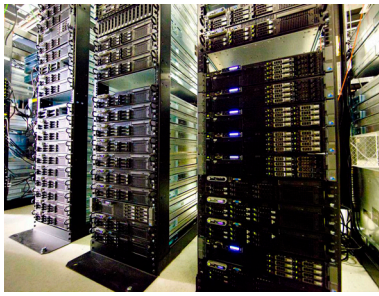
Power and Cooling
A Dell Point of View

From the utility to the chipset, Dell takes a holistic view of the data center, working to maximize performance while extracting maximum efficiency out of every component.





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The power to do more

The power and cooling challenge

The growing demand for lightning-fast performance, consistent availability, and the ability to deploy the newest applications and technologies is creating a generation of IT solutions that require increasingly more energy to operate. Today's servers, storage systems, and networking products are far more advanced than their counterparts from even five years ago.

The power-hungry nature of this generational advancement, coupled with skyrocketing energy costs and diminishing capacity within modern data centers, has brought power and cooling to the forefront of the IT discussion like never before. To meet the growing need for efficient power and cooling, Dell engages in these power and cooling discussions, and works diligently toward solving your power and cooling needs. We do this through innovative design approaches, constant focus on maximizing efficiency throughout our product portfolio, ongoing lab research and testing, and partnerships with some of the world's leading organizations.

This point-of-view brief provides high-level insight into how Dell is investing in solution-based approaches to solving our customers' key issues and delivering on expected future needs.

The rise of the power and cooling dilemma

Not long ago, power and cooling were simply an afterthought to many IT discussions. We are seeing a dramatic mind-shift in this respect. Increasingly, power and cooling are being included in every server conversation. Data center purchases are being looked at holistically, taking into account the impact on the entire ecosystem. How will this impact my utility bill? How will this affect my capacity and future growth scalability? How can I positively impact what I'm not consistently measuring? Am I leveraging the equipment I already own to its fullest potential? Driving this shift-change are several key factors:

- The energy use of U.S. servers and data centers in 2006 was estimated to be more than double the electricity consumed for this purpose in 2000. From 2005 to 2010, energy needs for data centers increased by another 56%.[1]
- The power and cooling infrastructure that supports IT equipment in data centers also uses significant energy, accounting for 50 percent of the total consumption of data centers.[2]

- Environmental concerns are causing many companies to take measures to reduce their carbon footprint by decreasing energy consumption.
- As IT environments grow ever denser, many traditional power and cooling philosophies are becoming less effective, leaving data center operators with less capacity than demand and increasing their scrutiny of every aspect of data center efficiency.

With power and cooling costs becoming a growing line item in IT budgets, often taking up a disproportionate percentage of the allocated resources, and with energy costs quickly rising, it becomes clearer each year just how crucial it is for your business to have the right power and cooling strategy.

An ideal world

In a perfect-world scenario, each aspect of the data center ecosystem would be running on all cylinders, working toward the common goal of maximizing performance to deliver against business and operational needs, while extracting every ounce of efficiency out of every component. This would include:

- Highest efficiency IT solutions, engineered from the ground up to optimize for highest performance per watt
- Effective deployment and design strategies, enabling operational efficiencies while ensuring maximum utilization of the equipment already owned
- Highly efficient power consumption from the utility through the chipset
- Complete visibility enabling robust power consumption measurement and the necessary management to maintain your ideal conditions

In this perfect situation, the disparate pieces work together to deliver the ideal power usage effectiveness (PUE) measurement. Essentially, the PUE of a data center is understood as the ratio of the total power being consumed to the power being consumed by the equipment itself. The perfect PUE would be 1.0, indicating there is no lost power and all power drawn is used only by the IT solutions. It is commonly espoused that the PUE for most data centers is between 1.5 and 3.0. Dell asserts that a PUE target of 1.6 is desirable, with 1.3 feasible for new data centers leveraging economizers. Recent Dell data center deployments have seen a PUE as low as 1.03, indicating how close we truly are to an ideal world.

Microsoft® Bing Maps reports 8x in cost savings with 5x the density than traditional computing models, and achieved a PUE of 1.03.

Closing the gap on power and cooling

To confidently meet your power and cooling challenges head-on, Dell can help you to better understand your unique business challenges, evaluate your current and expected future data center requirements, and help you leverage the world-class design and engineering precision that goes into every Dell offering. As a starting point, we have identified several key areas to consider and focus your energy on as you begin the journey toward the ideal data center strategy.

Measure, monitor, and manage

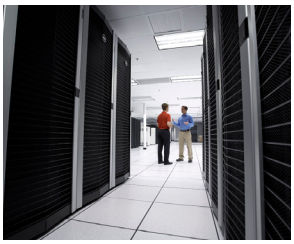
You cannot manage what you are not measuring. This is a basic business principle that is no less accurate in the data center. In discussions with customers, we find that many understand the potential value in gaining visibility at a granular level to what is being consumed, but in practice very few are actually measuring with any amount of consistency. Dell is innovating in each of these areas, and is delivering built-in mechanisms for quality power management into our IT solutions, including servers, power infrastructure, and systems management.

Right-sizing your data center

We believe in right-sizing. You should be able to purchase solutions that fit your needs exactly without wasted over-provisioning. Dell offers a comprehensive portfolio, and regardless of your business size or operational needs, it allows you to identify that perfect fit. From the power supply units inside our servers, to innovative containment options like our self-contained rack, to deployment methodologies that can leverage your square footage and current capacity to its fullest, Dell has full utilization in mind. This saves you operational expense (OpEx) and capital expenditures (CapEx), as well as ensuring you are meeting your energy-efficiency goals without sacrificing your high-performance needs.

Scaling capacity on demand

You are faced with having to do more with less and to maximize ROI by improving resource utilization. Traditional sizing for forecasted peak activity and the propensity to design for worst-case scenarios have resulted in resource under-utilization. We believe in grouping resources to create a highly efficient shared IT infrastructure that adjusts as your business needs do, while meeting your green IT objectives. Dell Advanced Infrastructure Manager (AIM) software creates a shared and dynamic IT infrastructure that can adjust capacity up and down, and can transition between different configurations to improve operational efficiencies and reduce your power footprint.



"Dell doubled our capacity, yet because it reduced the number of servers seven-fold—from 21 to 3—it consumes about 86 percent less power and cooling resources than our legacy system did." – Northern Arizona University, US

World-class energy efficiency

As demand for greater levels of performance escalates, Dell remains in the leader's pack in the race to deliver the best solutions, highest performance, and consistent reliability. On top of this furious pace of innovation, our engineers and researchers have a dedicated team working tirelessly to innovate and lead the way in the area of energy efficiency as well. We are proud to deliver solutions that not only meet industry guidelines and expectations, but often exceed those recommendations, as well as define new categories for the rest of the industry to follow. For example, we have been well ahead of the curve with IT solutions capable of operating at 45°C, a temperature range unheard of in non-custom solutions until very recently. You can deploy confidently knowing that we are doing everything we can to reduce your power consumption while maximizing performance.

Having a solution-oriented and customer-based approach allows us to help you work through your power and cooling challenges. Improving current products, generation after generation, and introducing innovative products and solutions to fill gaps in the market, Dell aspires to lower the PUE of every customer, thereby saving you OpEx and CapEx and freeing up resources to do more with what you already have.

The power to do more, the efficiency to keep it cool

Dell is intensely focused on driving energy efficiency into our products—it is a way of life for us, not a side project. We bring to the table our ability to architect end-to-end solutions to help solve your power and cooling challenges while meeting your business growth demands with standards-based solutions. We can help you look at your data center strategy holistically, and realize a comprehensive solution to help maximize IT productivity while significantly reducing energy consumption. We call this Energy Smart—our philosophy that is inherent in everything we do, from product design to consultative services.

Energy Smart Data Center Assessment

Right-size your data center investments, improve productivity, and minimize power and cooling costs with our Dell Energy Smart Data Center Assessment, which uses infrastructure and thermal analysis to help maximize data center efficiency. Whether you are changing platforms, creating a

new IT environment, or looking to explore new trends (such as fresh-air cooling), Dell's broad and customizable services portfolio can help simplify assessment, design, implementation, management, and support.

"We have reduced power consumption by up to 70 percent by following the recommendations of Dell infrastructure services. Our air conditioning unit is now running at about 65 per cent capacity when before it was running at 90 percent."
– John Brown Media (UK)

Energy Smart power supply units

Energy Smart power supply units (PSUs) are engineered to achieve some of the highest efficiencies in the industry. They have intelligent features, such as the ability to dynamically optimize efficiency while maintaining availability and redundancy. Also featured are enhanced power-consumption reduction technologies, such as high-efficiency power conversion and advanced thermal-management techniques, and embedded power-management features, including high-accuracy power monitoring.

Energy Smart power management

Dell power management inside each server includes energy-saving features such as power capping, advanced power policies, power scheduling, and device disablement. Our operating system-diagnostic power-management capability can save you money by lowering the system-level power draw at times of low utilization. PowerEdge servers equipped with the Dell Active Power Controller (DAPC), a Dell exclusive, can outperform other OS-based power management solutions head-to-head in PowerEdge servers with the widely used SPECpower benchmark.[3]

Our open-standards-based approach to power management outside of the server enables seamless plug-and-play in a heterogeneous environment. Dell's power management solutions enable:

- **Discovery:** Protocol-based discovery of servers, storage, and networking devices, tying your systems to applications and lines of business
- **Inventory and visualization:** Inventory of systems and mapping of the data center facility and device locations down to the rack level
- **Monitoring:** Server utilization, processor, memory, disk, and power draw
- **Reporting:** Exception reporting, workflow orders, and change management
- **Optimization and prediction:** Proactive preparation for refreshes or downtime, and leveraged trend analysis and capacity planning for optimized and intelligent utilization

Realize more than $100K of operational savings per megawatt of IT

Eliminate capital expenditures of approximately $3M per megawatt of IT

Reduce the risk of IT failures during facility cooling outages

Learn more at Dell.com/Freshair

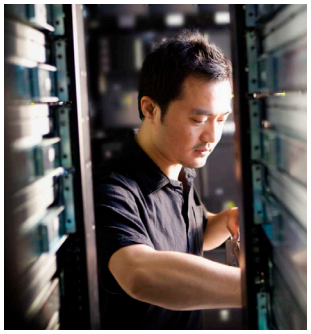
Energy Smart Solution Advisor

Understanding the need for accurate power and cooling data as you configure your data center, Dell created an online advisor console that enables easier and more meaningful estimates to help you determine the most efficient configuration possible. With Dell's Energy Smart Solution Advisor (ESSA), you can calculate the power consumption of your hardware, power infrastructure, and storage. Additionally, ESSA helps with the planning process so you can pursue the appropriate power and cooling infrastructure, as well as other facilities requirements with the comfort of knowing you can deploy right-sized equipment. Unique features allow you to include non-Dell configurations, as well as legacy hardware, for a more complete power consumption view of your data center needs.

Energy Smart servers

Lower overall system-level power draw of PowerEdge blade, rack, and tower servers is a result of Dell's breakthrough system design. Leveraging high-efficiency voltage regulators, greater venting and airflow, Dell's low-flow fan technology, and advanced resource management, PowerEdge servers are ready to help maximize performance per watt. You can expect:

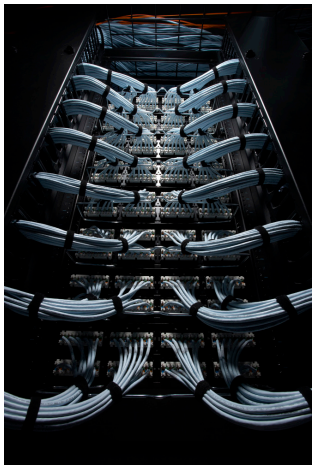
- **Thermal advantages:** An extensive collection of sensors automatically track thermal activity, helping regulate temperature and reduce energy consumption. With up to 44 sensors, Dell PowerEdge systems are capable of adjusting in real-time to reduce overall energy usage.
- **Intelligent performance:** Advantages of Dell's PSU portfolio include intelligent features, such as dynamically optimizing efficiency while maintaining availability and redundancy. They also include options for right-sized or dynamically-provisioned power supplies (for blades). Our right-sized power portfolio is optimized for value and performance, and includes customization choices for selecting input type (AC or DC) or defining redundancy.
- **High-efficiency fans and airflow management:** By effectively directing airflow only to where it is needed for cooling, we further enable today's technologies, such as Dell's 10Gb Select Network Adapter. Included in a rich feature set, an advanced thermal control minimizes system power by dynamically optimizing fan speeds and component power consumption.
- **Industry compliance:** Compliant with all relevant industry certifications and guidelines, including 80+ and Climate Savers, Dell has more ENERGY STAR compliant systems than any vendor on the market.



- **High-efficiency processors and memory:** Dell incorporates some of the latest processor and memory technologies to target the highest performance per watt for standards-based servers.
- **Higher-temperature or chiller-less operation:** Dell solutions offer the ability to confidently run your data center at higher temperatures or even chiller-less.[4] Select configurations of Dell mainstream servers are capable of excursion-based operation, reliably in temperatures up to 113°F (45°C). By leveraging the thermal and reliability advantages engineered into this portfolio of equipment, data centers can be run even warmer, reducing additional maintenance and infrastructure costs, while lowering overall energy consumption when compared to a using a chiller plant.

Energy Smart containment rack enclosure

In the pursuit of cost-efficient IT, improving the distribution of air to data center equipment can have a surprisingly favorable impact on energy costs and capital expenses. The Dell PowerEdge Energy Smart containment rack enclosure[5] provides a passive and effective way to manage the air consumption of IT equipment and lower the costs in a data center using raised-floor cooling. The sealed front plenum provides even distribution of airflow to all equipment installed in the rack. A tight, brush seal around its lower perimeter couples the rack to the floor, enabling the IT systems to control how much air comes out of the floor and reducing waste while ensuring density.



Rack infrastructure for the efficient enterprise

Dell offers some of the industry's highest-efficiency power infrastructure solutions with power distribution units and uninterruptible power supplies.

Power distribution unit

Reliable power distribution is a key part of data center design. Dell PDUs help provide reliable power distribution in a rack enclosure from low-amperage, single-phase circuits to high-power, three-phase solutions. PDUs support input voltages ranging from 100 V to 415 V, input currents ranging from 16 A to 63 A, and varying quantities of C13 and C19 outlet types with up to 48 receptacles. Intelligent PDUs can also report on temperature and humidity readings. Dell PDUs offer these options:

- **Basic:** Entry-level power distribution

- **Metered:** Enhanced power distribution enables network monitoring for aggregate power consumption. Offered in a range of models including those designed for high-density power distribution.
- **Managed:** Premium intelligent power distribution provides improved data center outlet- and device-level visibility and control, combining high-density power distribution with onsite or remote monitoring and management

Uninterruptible power supply

Dell's uninterruptible power supply (UPS) backup systems are available in line-interactive and online models, and in tower and rack-mount styles. These UPS models help protect equipment from downtime, damage, and data loss due to power problems. Dell's UPS backup systems maintain power during a power outage long enough for IT staff to save data and shut down equipment properly. Through strong partnerships, Dell offers additional options, such as the mid-size UPS, which leverages Softscale Technology to provide customers with the capability to right-size and use only what you need today, while enabling future growth.

Dell and the power of green

The Green Grid® is a non-profit, open industry consortium of end-users, policy-makers, technology providers, facility architects, and utility companies seeks to unite global industry efforts, create a common set of metrics, and develop technical resources and educational tools to further its goals.

As power and cooling continues to grow in importance, we anticipate it to be elevated in the overall data center strategy discussion. The right mix of tools, partnerships, and services can help you get more out of your infrastructure without the cost and hassle of retrofitting or expanding your data center. Achieving tangible gains in energy optimization depends on improving technology and the means to measure its results. To help you better evaluate, deploy, and manage power and cooling requirements, Dell works with world-class partners throughout the technology life cycle to drive innovation that delivers real, measurable results.

Dell has a long-standing commitment to promoting energy optimization throughout the industry. We are the first company to introduce energy-optimized 1U and 2U industry-standard servers. We are a founding member of The Green Grid, an association of technology vendors chartered to help lower overall power consumption in the global data center. Dell is also actively engaged with other industry-relevant bodies such as ASHRAE, the Technology CEO Council, Climate Savers Computing Initiative, and the Environmental Protection Agency.

Summary

Some may lose interest when the discussion turns from the exciting talk of blades, virtualization, and next-gen technologies, to the comparatively routine world of power and cooling. Dell has a different perspective. We get excited when we talk about power and cooling. We understand the potential our customers have to gain tremendous benefits and experience relevant business value through best practices in power and cooling. We also understand that no data center can survive, much less thrive, without a robust power and cooling strategy to support their IT systems.

As more data centers are realizing large financial benefits from their focus on improving their power and cooling deployments, we are seeing an uptick in power and cooling related questions, a greater desire to understand Dell's portfolio strength in this area, and an increased interest in exploring innovative deployment methodologies—strategies that require an increased knowledge of power and cooling to be achieved.

Today, you may be faced with a multitude of daily challenges:

- Constraints and limitations that impede future planning
- Capacity that is stretched to its limits
- Constrained resources with reduced budgets and escalating OpEx and CapEx
- Lack of measurement and under-utilization of resources already owned
- Rapid pace of technology and the need for in-house resources to focus on key business needs or technology trends
- Lack of high quality and real-time visibility to enable better decision making
- Increased demand for power-hungry IT solutions
- Skyrocketing energy costs—the utility bill that is quickly becoming everyone's problem

Considering these factors, Dell sees a huge opportunity to help you reduce waste, reduce cost, and improve your bottom line.

Power and Cooling—Additional Resources

We recommend you contact your account manager to learn more about how Dell can help with your power and cooling initiatives. Find additional information at Dell.com/PNC and Dell.com/FreshAir.

1. Jonathan Koomey, Stanford University, "Growth in Data Center Power Use 2005-2010," July 2011
2. U.S. Environmental Protection Agency, "Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431," August 2, 2007
3. Based on SPecpower_ssj2008 benchmark testing performed by Dell labs in February 2009 comparing the Dell PowerEdge R710 running Microsoft® Windows® 2008 Server SP1 with Dell Active Power Controller enabled versus Windows Balanced power management enabled.
4. David Moss, Jon Fitch, and Paul Artman, Dell Inc., "Chiller-less Facilities: They May be Closer than you Think," June 2011, available at http://www.dell.com/ie/enterprise/p/d/business~solutions~whitepapers~en/Documents~chillerless-facilities-white-paper.pdf.aspx
5. David Moss, Dell Inc., "Managing Data Center Costs with Dell PowerEdge Energy Smart Containment Rack Enclosures," May 2011, available at http://i.dell.com/sites/content/business/large-business/en/Documents/energy-smart-containment-rack.pdf.