Cisco Energy Management: A Case Study in Implementing Energy as a Service

Cisco Labs Save US$1 Million in One Year Using Energy Management Technologies

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Summary

Managing energy costs has become a corporate-level priority for many organizations. There are many opportunities to achieve significant energy reductions, not only in the data center, but across the organization. By taking an iterative approach to energy management for the enterprise, users can set practical goals for improving energy efficiency across facilities and IT assets. The approach detailed in this paper brings together Cisco emerging energy technologies within an extensible framework being used today by Cisco Services. In this paper, you will learn:

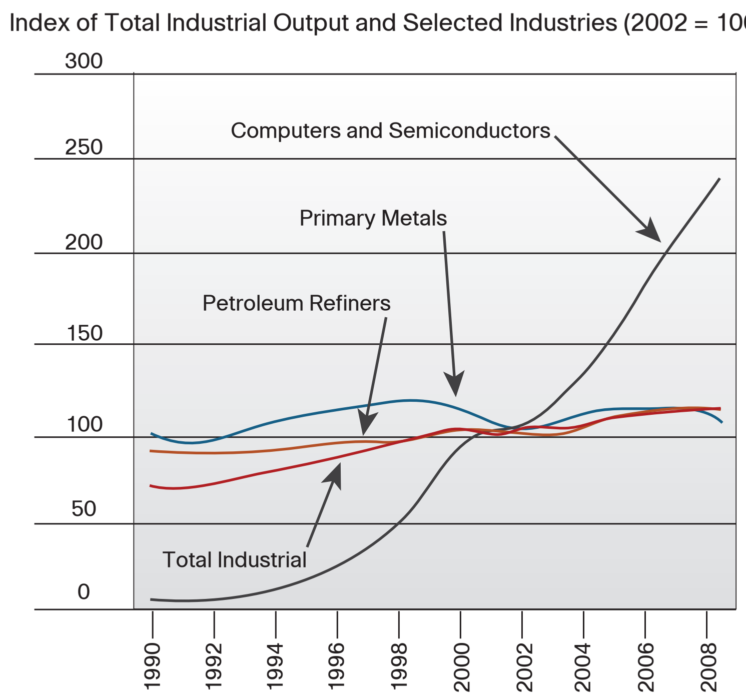
- How a Cisco lab organization solved capacity challenges using innovative network-based tools and reduced total energy costs by 33 percent
- Functional elements of IP-enabled energy management
- How Cisco Services can help in the next step of an organization's energy management strategy

Introduction

Electricity is the largest unmanaged cost for many enterprises today. However, attempts to manage electricity to date have been largely static and reactive. Drivers such as global climate change, data center capacity constraints, and shrinking budgets have spurred new innovation in IP-enabled energy management technologies. These technologies allow resilient and secure transport of two-way diagnostics and control communications to create a more reliable and manageable infrastructure.

According to a Forrester study (*IT's Role in Reducing Corporate Environmental Impact*, January 2009), reducing energy-related operating expenses is by far the top green priority for the companies interviewed, followed by other sustainability objectives, such as complying with environmental regulations and maintaining a brand image of a socially responsible company. Some estimates for energy used by enterprise information and communication technology (ICT) equipment range from as low as 10 percent to as high as 40 percent of the total energy used. Not only is ICT in most buildings the second-largest consumer of energy behind heating and cooling, it is also the fastest growing segment of electrical usage worldwide (see Figure 1). To date, ICT electrical load has been operated in an always-on state, with no active management in place.

Figure 1 Energy usage related to the ICT industry is the fastest growing segment among all industries in the last 30 years



Source: US Environmental Protection Agency
Reference URL:
http://www.eia.doe.gov/oiaf/1605/flash/flash.html

In addition to electrical loads being unmanaged, the electrical supply is reactive. Today's energy grids lack the ability to communicate and lack awareness of user preferences for price, time of use, reliability, and visibility into greenhouse gas emissions. As a result, energy is wasted, and businesses spend more than necessary.

Because energy management systems have historically been static, a growing number of companies are identifying a need for intelligent, IP-enabled systems to compile, manage, and track data relating to enterprisewide environmental initiatives. Businesses want to track and justify their efforts and report progress to regulators, investors, customers, and employees. Energy management represents a new, crucial role for IT organizations as the central repository, manager, and reporter of corporatewide energy and greenhouse gas emission data.

Cisco's Commitment to Energy Management

As a leading ICT company and as an enterprise seeking to improve its sustainability progress, Cisco has been developing new energy management technologies since late 2006. In 2007, Cisco announced a corporate commitment to reduce greenhouse gas emissions 25 percent by 2012. The company has also committed to achieving the majority of these savings using its own technology. Cisco has identified key elements of a strategy, and these elements in turn have led to the development of a range of energy management solutions and services that also benefit Cisco customers.

The Cisco Energy Management Approach

The Cisco strategy is to develop cross-platform, network-based energy management systems. These systems include:

- Energy discovery capabilities for devices attached to Cisco networks
- A common platform and simplified domain management structure for managing energy across IT and facilities assets
- An ability to associate IT assets with critical facility assets through Cisco building mediation technologies
- Monitoring and management of IP-enabled devices to provide cloud-based power-savings policy automation and reporting

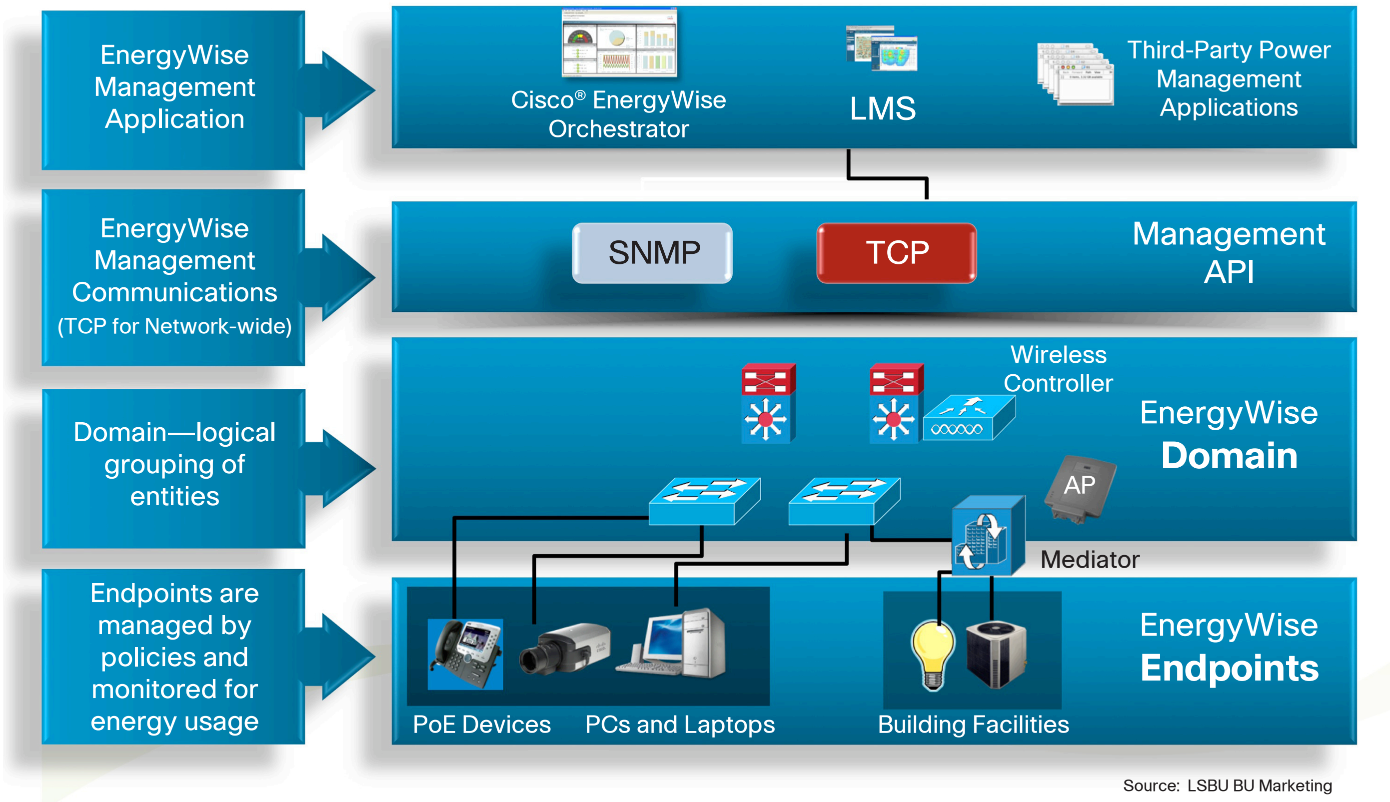
"Our approach to developing energy management solutions at Cisco is to play to our core strengths as the networking leader and use the network as the monitoring and management platform for energy," says Rob Aldrich, principal architect, Energy Management Services. "In order to realize big savings, it is clear that an energy management platform has to be based on IP and has to be as ubiquitous as possible."

The Cisco platform is based on existing Cisco operating systems to help ensure backward compatibility. The next generation of energy management will be built on solutions that are here today, such as Cisco EnergyWise, Cisco Network Building Mediator, and new innovations from Cisco and its partners. Future solutions will include end-to-end, IP-based, highly secure communications infrastructures for utility grids.

EnergyWise: A Logical Approach

Cisco EnergyWise is an energy management architecture that allows IT and facilities operations to measure, monitor, and manage power usage to realize significant cost and greenhouse gas savings. EnergyWise provides for intelligent electrical consumption policies and practices that automate and extend the control of electrical power to millions of devices that lack energy intelligence. It helps reduce the amount of power used by networked devices, from Power over Ethernet (PoE) devices, IP phones, and wireless access points, to IP-enabled building and lighting controllers (see Figure 2).

Figure 2 Cisco EnergyWise is a non-disruptive, cross-platform capability that allows for common monitoring and control of facilities and IT assets

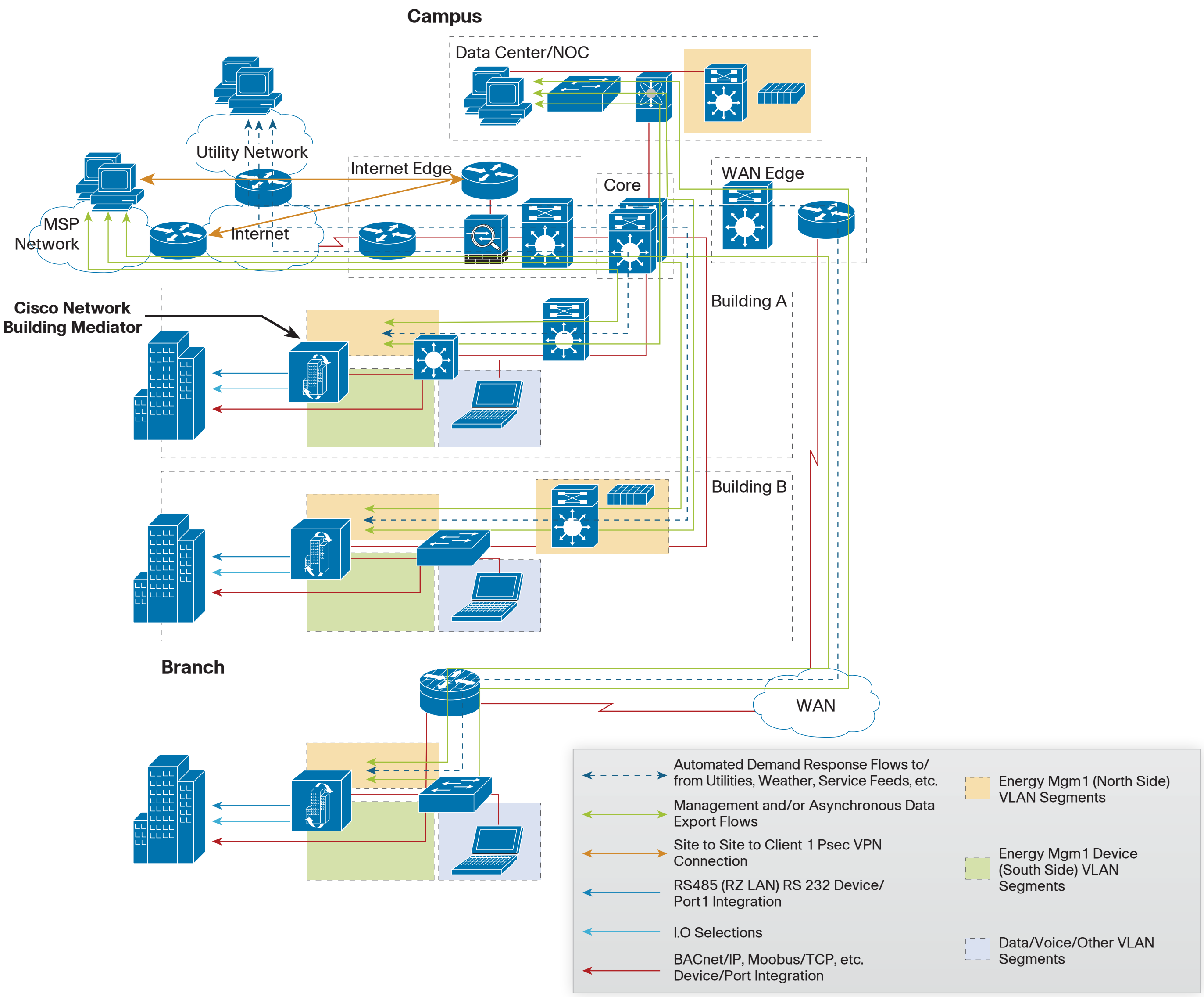


Together with the Cisco EnergyWise Orchestrator, a power management solution for IT assets, EnergyWise allows IT to begin to manage energy as a service. It enables IT to administer the energy requirements of IT assets, gain visibility into unit-per-watt, and extend enterprise power management to desktop and laptop PCs to increase energy cost savings. In some EnergyWise pilot deployments, Cisco has seen a 20 percent reduction in energy use.

Cisco Network Building Mediation Technology

The Cisco Network Building Mediator is one of the industry's first solutions to converge IP networks with building management networks. The Mediator provides an interface between these networks that connects and collects data on mechanical and electrical systems. Through the Mediator, power data is converted into actionable information, enabling users to monitor a converged view of building and IT assets and to target energy savings across labs, data centers, and office spaces. The broader context for deploying the Mediator is shown in Figure 3.

Figure 3 Building mediation allows for the extension of logical EnergyWise domains into the facilities assets that often support IT deployments



Source: Cisco Systems, 2009
Reference URL:
http://www.cisco.com/en/US/docs/solutions/Verticals/Government/mediator-AAG.html

Smart Grid-Readiness

A smart grid is an electrical grid where electrical generation and consumption are synchronized through a mix of IP enablement and network convergence. A smart grid inherently assumes the development of “smart loads,” or consumer systems that possess the intelligence needed to optimize electrical supply for usage requirements. When combined with EnergyWise and Cisco building mediation technology, a robust energy management solution will deliver a smart load solution that can take advantage of emerging smart grid technologies.

The Cisco Connected Grid portfolio of smart grid communications solutions helps utilities reliably and efficiently deliver electric power from generation facilities to businesses and homes, resulting in better energy management, as well as economic and environmental benefits. The first products introduced include the Cisco 2010 Connected Grid Router and Cisco 2520 Connected Grid Switch. These ruggedized routers and switches form a resilient, manageable, and highly secure network solution for the substation to integrate IP-based communications with the power grid for intelligent grid monitoring and control.

Energy Savings at Cisco

Cisco faces many of the same energy management challenges that its customers face. Cisco labs around the world account for approximately two-thirds of Cisco's electricity consumption. The Cisco Customer Advocacy Lab Operations (CALO) group maintains the labs used to recreate customer network environments for solution testing. CALO labs represent approximately 4 percent of Cisco's worldwide lab footprint. With 11 locations across North America, Europe, and Asia Pacific regions, these labs occupy 90,000 square feet and contain roughly 2900 racks of equipment, more than 18,000 IP-based devices that include servers, routers, switches, storage arrays, and testing devices.

In 2008, CALO manager Dave Katz and his team were faced with the challenge of consolidating available lab space to open up new power capacity, while simultaneously addressing the company's energy management targets. Katz and his team assessed possible solutions, including virtualization and deploying active energy management technologies.

Virtualization Makes an Impact

Virtualization delivers energy savings by consolidating servers, and the team believed that virtualization would be an important first step. The team used virtualization to consolidate computing and server resources across the lab environment.

"We estimated that virtualization could gain us approximately 17 percent in savings on average across our computing and storage environments," says Katz. "This could translate roughly into a 6.8 percentage reduction in lab electrical costs. Energy management, by contrast, could save up to 33 percent of our total lab electrical usage. We are using both technologies to meet operative constraints while driving down costs."

Making Energy Use Easier to Manage

Shutting down the lab equipment when not in use offered the largest opportunity to reduce wasted watts. The goal was to move equipment to a powered-off state when idle or unused. However, achieving the goal was going to be difficult with so many devices and no common management, monitoring, and reporting capabilities. The team needed an easy-to-manage system with scalable IP address management to minimize administrative costs, automate power management policies, and track power usage and costs on a per-use, per-device, and per-site basis.

In addition, the solution had to support the ability to shut down assets by authorized users only and to assign a default policy rule to each component to enable on-demand power. Part of the solution would include in-rack, IP-enabled, "smart" Power Distribution Units (PDUs) that were deployed to automate power usage by mapping all assets, including servers, switching and routing devices, storage arrays, appliances, and test tools, to an outlet. Finally, with more than 18,000 IP-addressable devices, the solution had to be robust.

"The challenge of relying on PDUs for control is scalability," says Katz. "PDU deployments must scale to address a very real day-to-day IP address management problem, to maintain a consistent mapping of power policies at the chassis level, and to develop and maintain a power management maintenance and governance process that can be used by IT operations staff worldwide."

Solution: IP-Enabled Energy Management

To meet these requirements, the CALO lab team built a web-based asset management tool, Omni, which mapped the entire inventory of lab components to logical energy domains and enabled default power policies to be assigned to each asset. Next, the team integrated Omni with a scheduling and reservation check-out system. This approach enabled them to associate each asset with a user who is authorized to activate the default policy and provide a control point for policy automation and administrative control. Now the team could easily map devices, assign default power settings, and schedule shutdown commands, thereby automating user-aware policies for thousands of devices that lack native energy control capabilities.

The team fitted each lab equipment rack with one IP-addressed PDU, which was attached to the Cisco network. To simplify IP address management, controllers were connected to blocks of 48 PDUs. Every chassis was assigned a default power setting, allowing the execution of orderly shutdown scripts using standard Simple Network Management Protocol (SNMP). Using a series of energy dashboards that gather data from the smart PDUs, the team was able to track the amount of energy used and to report on cost savings. Reporting is based on calculations that incorporate the number of power off/on days, the power draw by device, time, the cost of power, and a cooling multiplier to determine overall cost savings (refer to Appendix A). Metrics gathered for reporting include:

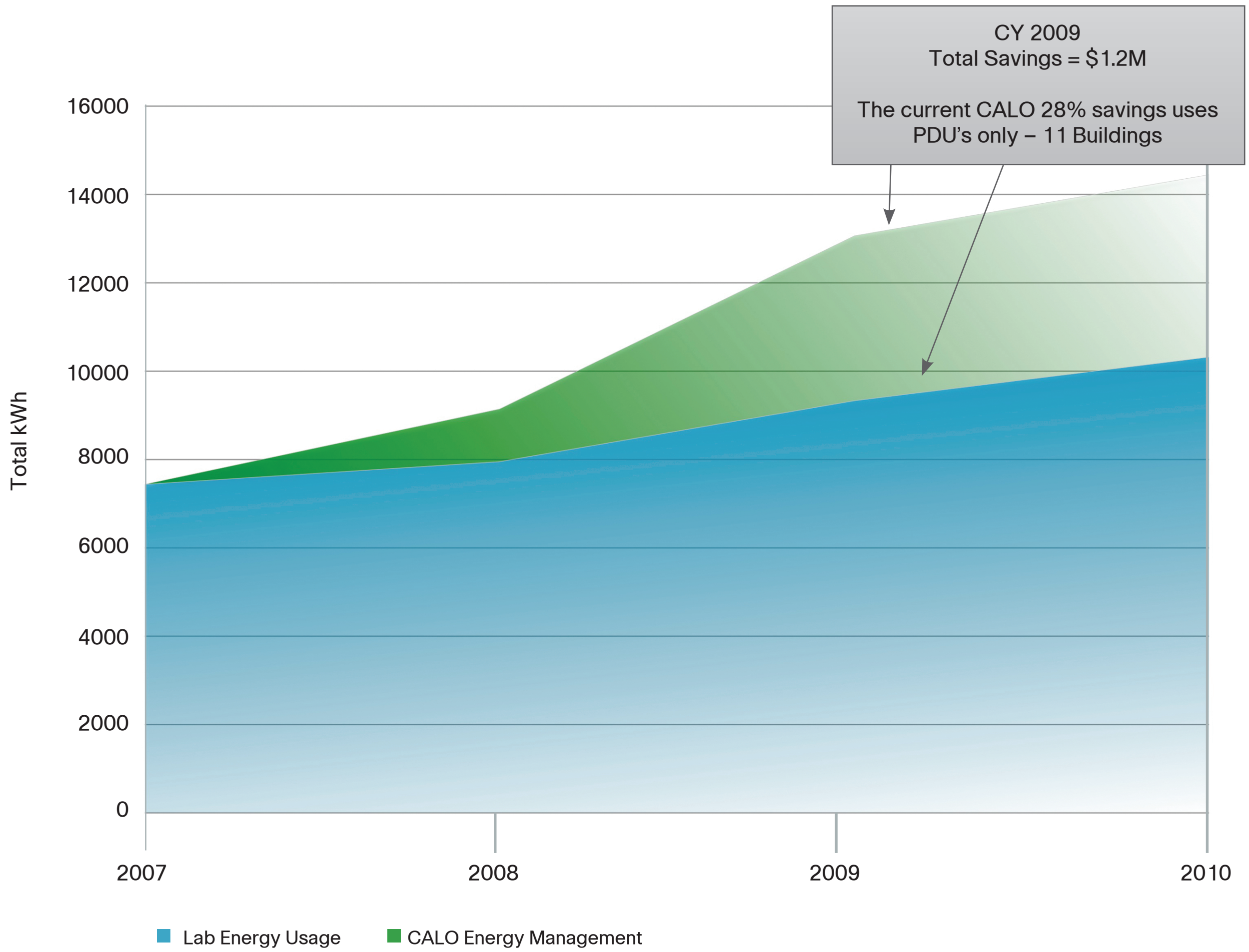
- Energy usage by product family
- Real-time power draw by product
- Energy consumption by device
- Total electrical costs by IP address
- Estimated total cooling costs
- Power consumption curves throughout the year
- Carbon dioxide equivalency (CO_2e) savings
- Total savings derived from automated shutdown policies

"By enabling intelligent power automation with a formal check-out and scheduling system, we maximize user input and have a full view of energy efficiency data," says Katz. "Users create their own unique energy shut-off policies, and our energy portal enables real-time monitoring and control and analysis, which delivers significant savings. Our goal is to bring over 18,000 devices under power management, across 90,000 square feet of lab space, which will result in an estimated $1.3 million in electrical cost savings annually."

Generating Significant Savings

As of June 2010, Cisco's CALO teams have reduced electricity consumption by an average of 33 percent, saving US$1.0M in annual electricity costs and achieving a 1.6 year payback through a pilot of Cisco Energy Management solutions (Figure 4). This equates to 1.2 megawatt savings across 11 buildings by simply automating shutdown of assets when not in use. Once it was clear that significant cost savings could be achieved through real-time energy automation, the CALO lab team was asked to enable energy management in CALO labs in Europe, Australia, China, Korea, and Japan.

Figure 4 Cisco CALO labs have been able to significantly trim wasted wattage by turning off assets when not in use



Results

- Reduced lab energy usage by 33 percent through energy management
- Virtualized servers for 17 percent savings
- Saved $1 million in annual electricity costs for CALO labs
- Mapped 18,000 assets to authorized contact for administrative control
- Developed management dashboards for tracking energy use

Extending the Savings

This deployment represents an example of Cisco's efforts to incorporate energy as another network-based service. CALO labs represent only 4 percent of Cisco's total lab space. When expanded to Cisco lab environments worldwide, the estimated power cost savings is projected to reach $20M as similar results are achieved in other lab environments. When implemented globally, systems like these will enable Cisco to use its own energy management technology to help achieve a 25 percent reduction in greenhouse gas emissions by 2012. The CALO team tools, process, and governance will be deployed across all CALO labs by the first quarter of FY2011.

To maximize savings and mitigate IP address management challenges associated with using PDUs for control, CALO is now working with Cisco Energy Management Service teams. This partnership is focused on developing Cisco energy management capabilities and bringing new solutions through the labs and into customer environments.

"The next phase of development is a software-based solution that is backward-compatible," says Aldrich. "For the first time, our clients will be able to directly manage their IT energy use at a low price point, with very little disruption to their current business model."

Solution Attributes	Benefits
Asset mapping and management tools by user, device, and energy domain	Significant energy cost and greenhouse gas savings
IP-enabled, in-rack power distribution units	Operative flexibility in the face of power and cooling constraints
Assignment of device-specific default power policies by level of criticality	Integration into an existing system that is already broadly adopted
Integration with device checkout and reservation system	Correlation of energy use by user, asset, and physical location
Power management tools enabling orderly remote power on/off by energy domain and power policy	Proof of concept that greenhouse gas emissions can be reduced using internal technologies at low price points
Dashboard reports on power usage by device and the cost of power by user, asset, and site	IP-address management mitigation using aggregators

Best Practices

Cisco customers can draw on Cisco IT's real-world experience to determine how they might benefit from this proven approach.

- **Adopt an enterprise approach:** Opportunities for energy management exist both inside and outside of the data center. Significant payoffs result when technology is applied to business processes. Capitalizing on opportunities in facilities management, conferencing and collaboration, and supply chain optimization will account for a larger share of most companies' greenhouse gas emissions than do the IT operations themselves.
- **Expand the role of corporate networks:** The corporate voice and data networks play a crucial role in enabling greener business processes. The network's reach, reliability, and bandwidth enable IT to connect thousands of sensor devices to management systems and dashboards. These capabilities also support collaboration across devices and locations.
- **Develop a strategy:** Identify all options for reducing energy use, including virtualization, critical facilities reconciliation, and consolidation, and plan to implement the options that deliver the highest efficiency gains.
- **Take an iterative approach:** Cisco CALO teams achieved their results through a phased approach. After planning, they implemented the solution in phases and were able to achieve their goals with minimal business disruption.
- **Inventory assets and identify baseline usage:** Inventory assets and IP addresses for connecting each to the energy management solution and enabling granular monitoring and tracking. Assessment is the first step, creating a baseline for measuring alternatives and improvements.
- **Begin with incremental, cost-effective solutions:** By focusing on green solutions that are incremental to existing systems, IT can begin to make improvements without high capital expense. Service-based offerings can offload some capital costs, and "thin" software layers for monitoring can be more affordable.
- **Look beyond the data center:** The data center is obviously a centralized target for savings, but just as much power is used outside of the data center. Steps such as introducing power management for desktop PCs, phones, branch servers, and branch switches can deliver savings that are as impressive as a major data center project.

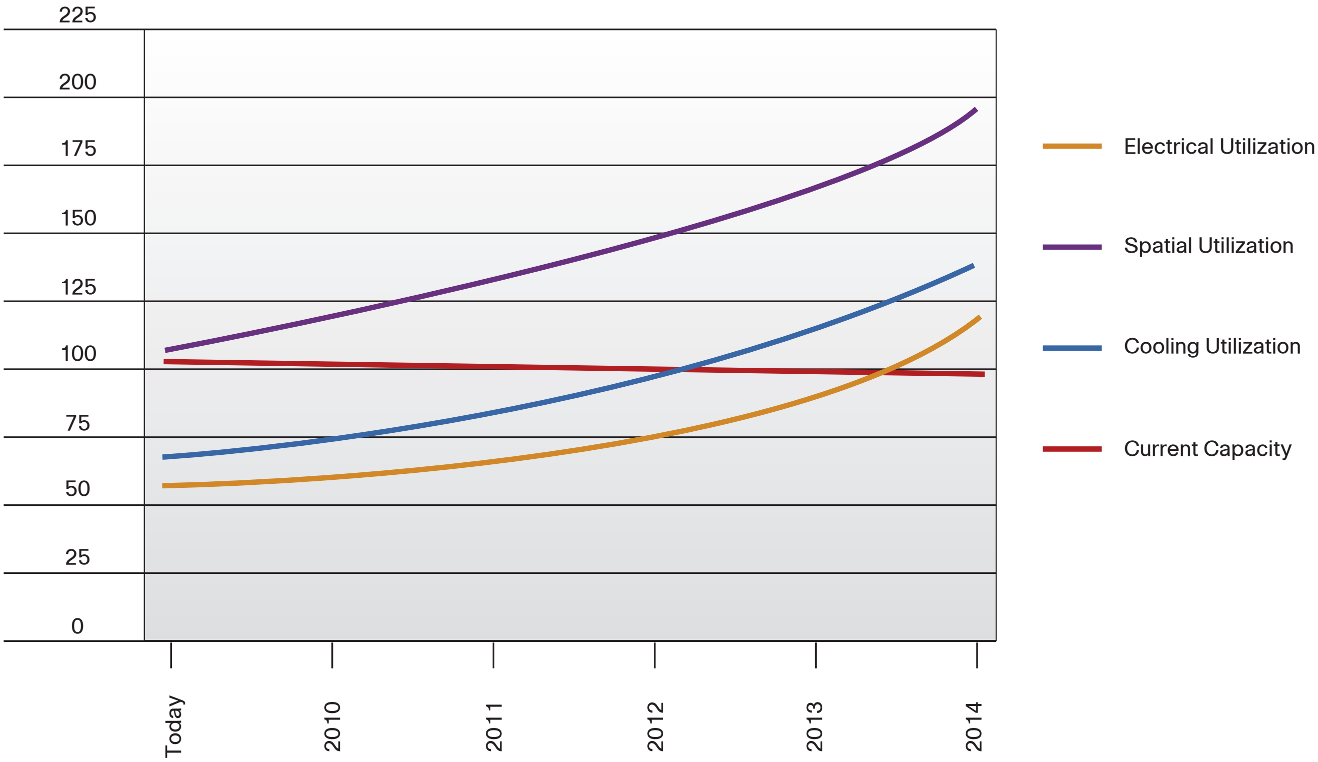
Services to Help Achieve Energy Efficiency

Cisco Services for Energy Management help organizations accelerate the adoption of IP-based energy management solutions to improve electrical efficiency across IT and facilities operations. Providing in-depth infrastructure efficiency expertise, Cisco Services offers a range of services to help customers virtualize infrastructure and perform energy efficiency benchmarking to effectively measure, monitor, and fine-tune energy usage. Sharing detailed analysis, recommendations, and design expertise, Cisco Services can help energy management staff better understand, optimize, and control power to achieve significant cost savings and lower greenhouse gas emissions.

Cisco Infrastructure Efficiency Assessment Service

The Cisco Infrastructure Efficiency Assessment Service is a critical first step in building an active IP-based energy management program using EnergyWise and other industry-leading energy management technologies. This service establishes energy efficiency benchmarks for a customer's physical infrastructure, identifies existing inefficiencies, provides analyses and recommendations to help customers effectively upgrade and expand their power, cooling, and space to support new equipment or design a new facility. In addition, the service helps develop the business case for virtualization, including analysis for facilities savings and deployment risks. The efficiency assessment service provides many aspects of the business case and architecture needed to launch a large consolidation initiative, including capacity analysis as shown in Figure 5.

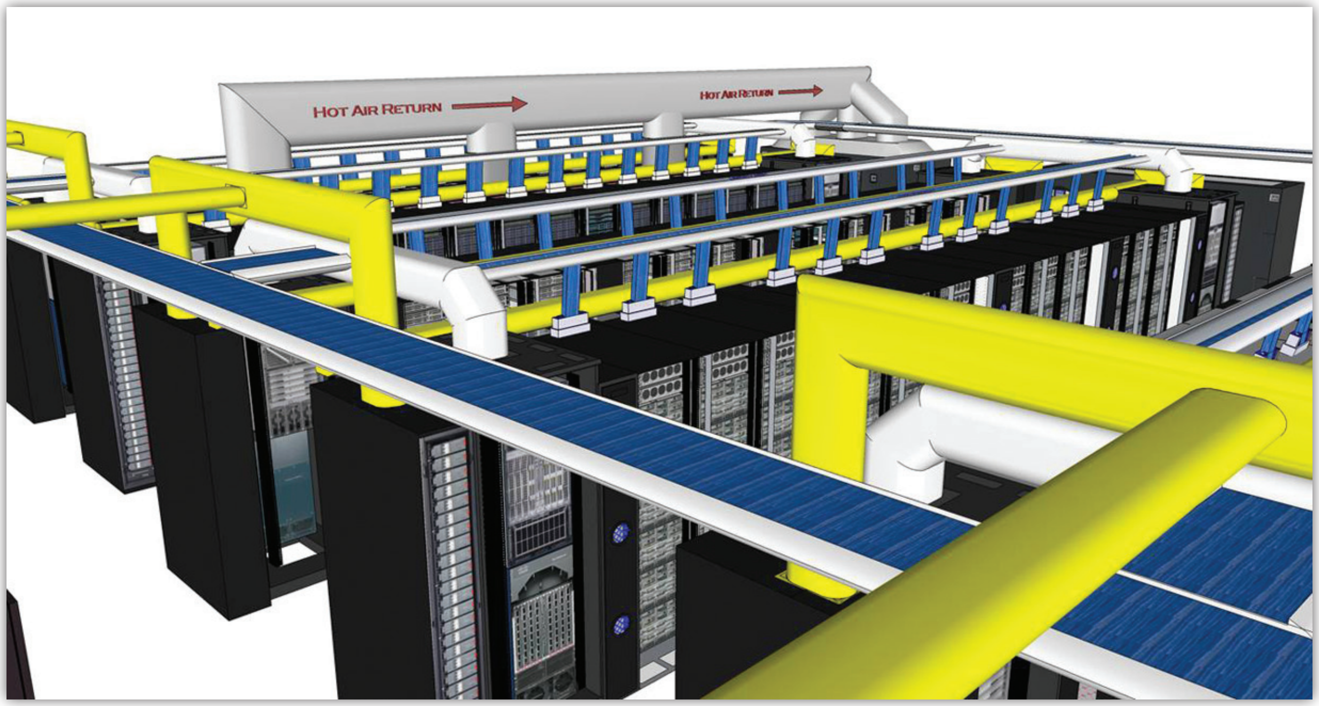
Figure 5 Capacity analysis, energy management technology recommendations, virtualization, and consolidation are all addressed through the efficiency assessment service framework



Cisco Data Center Efficiency and Facilities Services

Cisco Data Center Efficiency and Facilities Services help customers analyze power usage, establish energy benchmarks across facilities and infrastructure systems, and provide recommendations for improvements. These recommendations include a roadmap for adopting energy management technologies from Cisco and other providers. Through strategy, planning, and assessment services, Cisco experts use best-practice methodologies and advanced tools to identify sources of inefficiency. Customers receive recommendations for improving critical infrastructure, reducing energy consumption, aligning the IT infrastructure with business goals, helping plan for infrastructure growth, and creating a long-term architecture blueprint. These blueprints are intended to convey design intent and issued in three dimensional Collaborative Infrastructure Models (CIM) built using Google SketchUp freeware (see Figure 6).

Figure 6 CIM models provide a 3D wiki between Cisco and client IT and facilities operations to help ensure that new designs can be analyzed commonly



Cisco Services for the Cisco Network Building Mediator

Cisco Services delivers comprehensive assistance for enabling utilities to build mediation solutions that proactively measure, report, and optimize energy for commercial buildings. These services define energy usage requirements and develop customized energy management solutions to meet unique smart grid requirements, coordinate the deployment and integration of the solution, and then deliver support through ongoing optimization services.

For More Information

The path to IP-enabled energy management is easier with best practices, network management standards, and proven methodologies. For more information about Cisco Services and solutions for energy management, visit:

- Cisco Efficiency Assurance Program: www.cisco.com/go/efficiency
- Cisco Green Technologies (YouTube): www.youtube.com/greencisco
- Cisco Services for Energy Management: www.cisco.com/en/US/products/ps10944/serv_home.html

Appendix A

Calculating Usage

Table 1 summarizes the methodology that CALO used for calculating electrical savings, projected savings, and return on investment.

Table 1: Calculating Usage

	Data Points	Formula	Notes/Links
Electrical and cooling savings	· Total CALO Lab Electrical Cost = $3M USD annually · Estimated 33% reduction totaling $1.0M in electricity cost savings · Benchmark data has been normalized against new assets added – control group is 18,000 assets	Costs are measured through CALO energy tracking database and represent an aggregation of all IP-enabled assets that currently report into the CALO EMS system. 33% is the delta between total kWh usage against total benchmarked kWh usage over 1 year.	**CALO Labs Online** This is a basic percentage calculation set against benchmarked data across 18,000 IP-enabled assets over a 1-year period across 11 buildings. **Buildings:** RTP Bldg 12 SJ Bldgs K, J, & I Richardson Bldg 5 Boxborough Bldg 500 Brussels Pegasus Reading UK GreenPark Bldg 200 Bangalore India Bldg 14 Sydney Australia Chatswood Tokyo Shinjuku Seoul Korea Bejing China
	Current: 33% totaling $1.0M in electrical savings includes 33% cooling savings	Lab Cooling Burden Factor (Liquid Cooled Systems) = 0.8 Watts for every 1 Watt of IT load Lab Cooling Burden Factor (Air Cooled Systems) = 1.2 Watts for every 1 Watt of IT load	This is an estimation of the cooling savings that result and are compared Watt to Watt. Cooling systems currently do not report into CALO EMS.
	Projected $20M/per year electrical costs savings when deployed across all Cisco labs	A 25% reduction projected out an electrical bill of $80M totally $20M in costs savings. Total Electrical Costs for Cisco labs = $80M USD according to Cisco Work Place Resources (WPR). This estimation assumes an expanded adoption of Cisco EMS by Cisco labs worldwide and a target for total Cisco lab electrical power of 25%.	This is an estimation of what savings could be garnered by the remaining 96% of lab electrical use by Cisco WW. A 25% conservative estimate was chosen as the CALO operation attained 33% in their full year but less than 20% for the 6 months that preceded June 2009–June 2010.
	Total Implementation Cost	APAC: $260k Europe: $250k Boxborough: $136k RTP: $700k Richardson: $245k San Jose: $297k Japan: $150k Total: $2.0M	Costs come from CALO operations and include total costs of In-rack IP-enabled PDUs. Does not account for staffing costs.

	Data Points	Formula	Notes/Links
	Projected $20M/per year electrical costs savings when deployed across all Cisco labs	A 25% reduction projected out an electrical bill of $80M totally $20M in costs savings. Total Electrical Costs for Cisco labs = $80M USD according to Cisco WPR. This estimation assumes an expanded adoption of Cisco EMS by Cisco labs worldwide and a target for total Cisco lab electrical power of 25%.	This is an estimation of what savings could be garnered by the remaining 96% of lab electrical use by Cisco worldwide. A 25% conservative estimate was chosen as the CALO operation attained 33% in their full year but less than 20% for the 6 months that preceded June 2009-June 2010.
	Payback achieved in 1.6 years	**$2.0M/$1.3M = 1.6 years**	Payback period is not a fully reconciled return on investment.
	6.8% total estimated lab electrical savings from virtualization	**17% x 40%** 17% savings of total IT load from virtualization coming from compute and storage infrastructure only. 40% estimated CALO compute and storage load vs. total IT load allocation.	This estimation by Cisco Data Center Services is of the total possible electrical savings that would result from a virtualization deployment within CALO across compute and storage infrastructure. This estimation was completed by reviewing asset/inventory lists to profile total deployed asset and grouping them by compute, network, storage, and other. Other includes appliances, firewalls, and specialized equipment. CALO is disproportionately high when compared to data centers within Cisco and the industry where compute and storage will typically require 75–85% of total IT load.
Global Lab Scope	11 CALO Labs across US/Canada, Europe, APAC, Japan	Each labs savings are being reported on assets within each lab that are plugged into an IP-enabled PDU.	Lab energy use only focused on the electrical consumption of the assets that are connected via IP-enabled PDUs and reported over the network. Lab energy use has yet to be contrasted against WPR building meter data to provide an estimated power usage effectiveness.
Devices Currently Under Energy Management	18,000 IP-addressable devices including servers, Cisco switching and routing equipment, storage arrays, appliances, and test tools	Total number of assets plugged into and IP-enabled PDUs. This translates into 18,000 power outlets reporting current draw per outlet at a set voltage. This VoltAmps (VA) is being translated into watts.	For these assets, the VA that is being reported via PDU's is assumed as watts given the unity power factor of the power supplies in each asset.

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