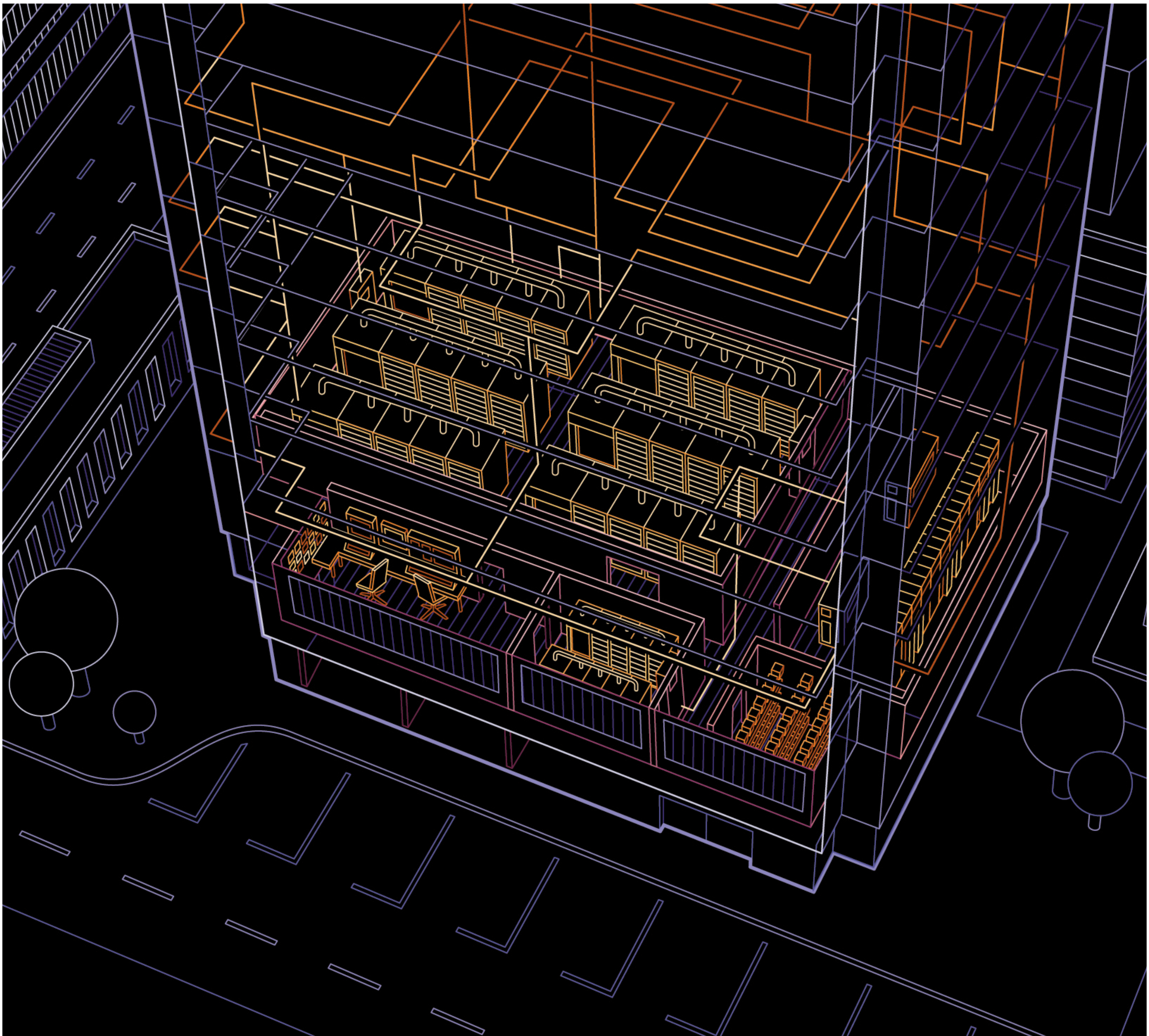

White Paper

Data Center Modernization: From Smart Data Centers to Enterprise Smart Grids

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This paper provides a primer of the grid, identifies an energy management paradigm shift with distributed energy sources and energy trading that impacts the data center, and introduces capabilities an enterprise needs to be successfully poised with the smart grid to achieve the anticipated benefits of a more energy-efficient, sustainable and nimble enterprise.

The Opportunity – Data Center Modernization

The common thread in a patchwork of global markets is energy. Irrespective of the market, enterprises rely on trade, and trade is enabled globally by web services hosted by efficient and reliable data centers. In the last five years, the underpinning factor determining data center efficiency and reliability has been energy.

Energy is becoming substantially more strategic to data centers and the enterprises they support. Especially now, with the modernization of America's electrical infrastructure underway, the same innovations that are being applied to the smart grid are finding their way into the enterprise to improve energy intensive operations like data centers. These innovations are shaping a new classification of smart grid called the "enterprise smart grid." With the advent of the enterprise smart grid, energy becomes the common currency of data centers in a borderless world.

These are interesting times for data center professionals. Many face the challenge of finding ways to generate more business with less capital—and the data center is not immune to these economic pressures. For instance, the uncertainty of an anemic global economy curbs commerce and hinders budgets. Despite the inescapable tangle of economic constraints, resolute and measured steps toward corporate sustainability initiatives have fostered new behaviors to incredible effect. New energy efficiency practices and innovative technologies enable optimal performance gains now—when the impact seems to matter most.

There has been no better time to capitalize on corporate financial incentives for modernizing data centers. In the United States, for example, government, utilities, commercial and non-profit organizations are enacting policies and providing incentives for new behaviors that will achieve a cleaner environment and a stronger and more secure economy through energy independence. These incentives include energy efficient commercial building tax deductions, bonus depreciations to assist with cost-recovery on eligible renewable technologies, and even commercial energy efficiency rebate programs from utilities.

The incentives are working. Industry reports, such as BP Energy Outlook 2030, show energy consumption per capita is on a declining trend[1] and global energy efficiency continues to improve at an accelerating rate.[2] Empirically, it is no longer uncommon for discussions about data center power usage effectiveness (PUE) to hover just above 1.0 instead of north of 2.0, and data center case studies are emerging that show an evolution to distributed energy resource integration, such as Project Quick Silver[3], eBay's new data center design that incorporates Bloom Energy fuel cells.

In addition to financial incentives and behavioral changes, technology innovations enable a strategic leap forward in achieving optimal efficiencies. This paper introduces these innovations. It provides a primer of the grid, identifies an energy management paradigm shift with distributed energy sources and energy trading that impacts the data center, and introduces capabilities an enterprise needs to be successfully poised with the smart grid to achieve the anticipated benefits of a more energy-efficient, sustainable and nimble enterprise.

The Cost – Lessons from the Grid: "No Change" Is Costly

Question: What is the estimated cost over the next two decades to dramatically revamp America's electrical power infrastructure to a fully functioning smart grid?

Answer: $476 billion.

The Electric Power Research Institute (EPRI) estimates that overhauling the grid will cost about $24 billion annually over 20 years, or $476 billion.[4]

To appreciate this estimate, consider the magnitude of the job that lies ahead. In an assessment report[5] prepared for the Department of Energy (DOE), we are reminded that this infrastructure is "the largest interconnected machine on Earth" with more than 9,200 electric generating units, more than 1,000,000 megawatts of generating capability, and more than 300,000 miles of transmission lines. Moreover, the grid is about 100 years old and performs at 99.97 percent reliability. In spite of its impressive historical performance, there is tremendous cost associated with the support and maintenance of a century-old behemoth that has not evolved to meet modern needs, such as expanding demand and new services. Consequently, some wonder if $476 billion is enough.

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[1] BP Energy Outlook 2030, p.11, reports OCED energy consumption per capital is on a declining trend with a projected average of -0.2% from 2010 to 2030.
[2] Again, according to BP Energy Outlook 20120, p.10, energy efficiency—measured broadly as energy per unit of GDP—will continue to improve globally, an accelerating rate of 2% p.a., vs 1.2% p.a. over the past 20 years.
[3] Serena Devito, "PUE Is Just the Beginning," October 23, 2012: 14. Presentation available at http://svlg.org/wp-content/uploads/2012/10/eBay-Serena-Devito-WEBSITE.pdf
[4] The actual estimate is reported as a range between $338 and $476 billion. This is a revised estimate, up from $165 billion reported in 2004. The increase is attributed to a better comprehension of what a fully functioning grid entails. For more information, refer to EPRI, "Estimating the Cost and Benefits of the Smart Grid: A Preliminary Estimate of the Investment Required and the Resultant Benefits of a Fully Functioning Smart Grid," March 2011.
[5] Litos Strategy Communications, "The Smart Grid: An Introduction," a report prepared for the DOE (2008): 5. See www.oe.energy.gov/SmartGridIntroduction.htm.

Deferred maintenance is another cost consideration. Even with 99.97 percent reliability, the few unplanned outages that occur are extremely costly. The 2011 EPRI report[6] on Estimating the Cost and Benefits of the Smart Grid cites five major blackouts in the last 40 years, three of which occurred in the last decade. The average cost of a massive blackout is estimated at $10 billion per event, and the additional cost impact from all business sectors in the US as a consequence of power disturbances, including problems with power quality, is estimated to be at least $150 billion[7] per year.

The lesson learned is glaringly obvious: When there is so much at stake, upgrades in phased increments are a less costly and less risky option than tackling a major overhaul. Nearly 100 years of safely and reliably delivering electric power is deserving of much acclaim. Not surprisingly, however, power outages have become more frequent and costly due to physical degradation from years of service, the direct and indirect costs of preserving outmoded technology and the growing demand for power per capita. For these reasons, continuing the “break-fix” approach is no longer a viable option.

Consequently, the United States has embarked on a forward-looking approach to electrical power delivery. Unlike the break-fix approach, the next generation of the grid is being designed to anticipate changing end-user requirements and identify potential issues with the power delivery network before they become problems. This condition-based maintenance approach is one example of game-changing energy management capabilities that will improve the reliability and efficiency of the smart grid and data centers alike.

The Approach – Radical but Not Revolutionary

Among the hurricane of differences swirling around about how the next version of the grid should be designed, which standards should be adopted, and how it should perform, one data point draws ready agreement: the smart grid will be a radical step forward in technological advancements and the benefits wrought, but it won’t be a revolutionary customer experience. It will take decades of iterative planning, development and testing. And, like any mission-critical deployment, upgrades will be executed in phased implementations for the life of its use.

[6] EPRI, “Estimating the Cost and Benefits of the Smart Grid: A Preliminary Estimate of the Investment Required and the Resultant Benefits of a Fully Functioning Smart Grid,” March 2011: pp. 1-3 and 2-13.

[7] According to The Smart Grid: An Introduction, pages 5-6, even today the grid performs at 99.97 percent reliability. Yet, power outages cost Americans at least $150 billion each year

To discern why its changes are considered a radical departure, consider first what the grid looks like today. With few exceptions, and aside from its sprawl, it appears quite similar to the simple electric power delivery system that was envisioned by Thomas Edison nearly a century ago. It comprises a power generation plant, transmission cables, a substation and a distribution system. These four key components[8] of the grid furnish power as follows:

- **Power generation** – Electricity is created at an electrical generation plant, typically using coal or natural gas but also from other energy sources like nuclear plants.
- **Transmission** – The electricity is transmitted "in bulk" at a high voltage via transmission cables to a substation.
- **Substation** – A substation is a subsidiary electrical generation plant where voltage is transformed from high to low, or the reverse, using transformers. Usually the voltage is lowered for use in homes and businesses.
- **Distribution** – This is the final stage (before retail) in the delivery of electricity to the consumer. It begins when the primary circuit leaves the substation and ends when it arrives at the customer's meter socket.

The electrical infrastructure, as described above, next takes a giant leap forward to the digital era. Modernizing the grid shares many similarities with how data centers are evolving to meet energy demands. Crucial for the success of the new paradigm of power distribution and energy management is identifying which capabilities are needed to deliver strategic improvements in reliability and operating efficiency. Following are three game-changing capabilities that are the cornerstones of the smart grid:

- **Two-way distributed generation (DG)** makes it possible for customers to interconnect their renewable energy systems (e.g., solar and fuel cells) to the grid so they can reduce their power bills by using "free" energy. Furthermore, using DG to replenish capacity to the grid can reduce (or even obviate) costly demand response practices during peak periods. Yet another benefit of DG, by virtue of "decentralizing" electric power generation, is improved security preparedness with regard to natural disasters and national defense.
- **Advanced telemetry** enables autonomous services that can detect issues before they turn into problems and either send an alert or automatically remedy issues. Autonomous services lower operating costs while improving the quality of service to customers. The proper design and implementation of telemetry, that is, of accurately and consistently connecting to and transmitting from innumerable devices, including distributed power generation systems, is the underpinning technology for nearly all services delivered remotely over the smart grid and smart data center operations.

[8] Wikipedia, www.en.wikipedia.org/wiki/Electric_power_generation

- **New services** from third parties provide additional value by optimizing the energy value chain. For example, a new data center service called Global Energy Intelligence® by Power Assure is a subscription service for PAR4 server metrics, IT analytics and forecasting, worldwide energy market integration supporting OpenADR, demand response, ancillary services, energy pricing and forecasts, and buy/sell trading aggregation. Essentially, this service enables data center professionals to gain a better understanding of their energy consumption, and actively participate in the energy market.

The above examples illustrate a paradigm shift made possible by the technological advancements converging from the utility, industrial monitoring and control systems, and data center operations. Comparatively, capabilities enabled by a full-suite data center infrastructure management system allow an enterprise to be successfully poised with the smart grid to achieve the benefits of a more energy-efficient, sustainable and nimble enterprise. These capabilities include:

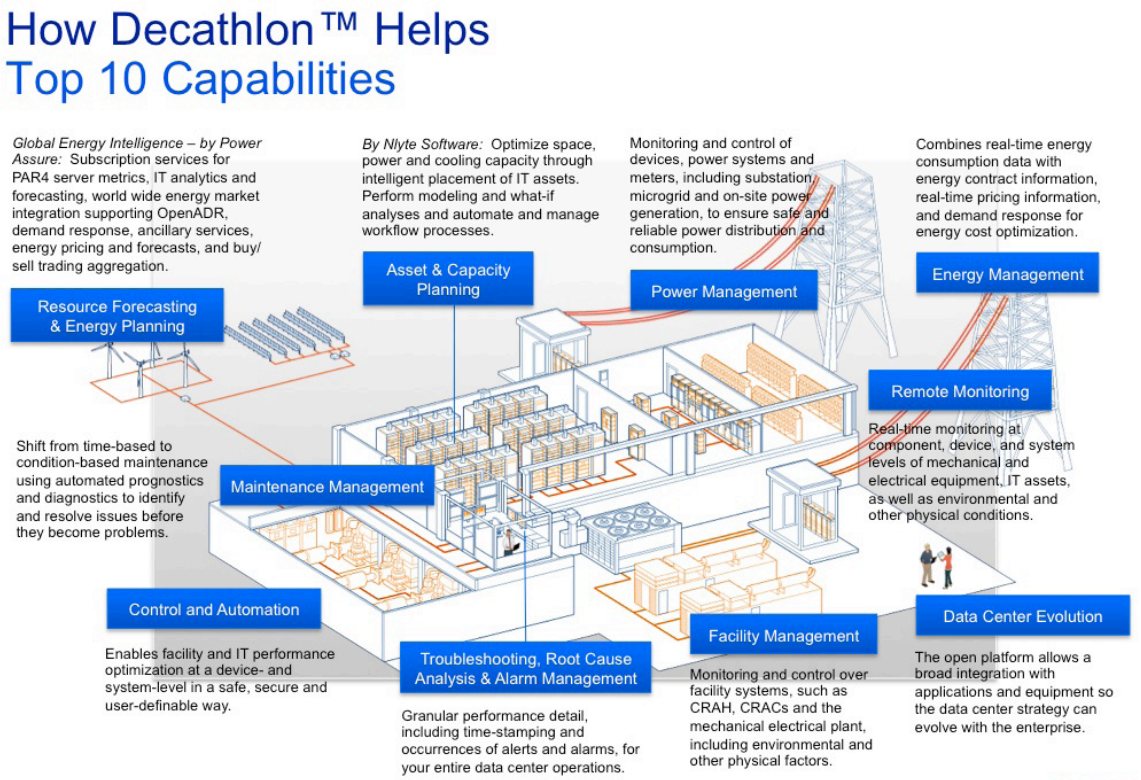
- **Energy management** – combines real-time energy consumption data with energy contract information, real-time pricing information, and demand response for energy cost optimization.
- **Power management** – real-time monitoring and centralized control of devices, power systems, and meters, including substation, microgrid and on-site power generation, to ensure safer and reliable power distribution and consumption.
- **Facility management** – real-time monitoring and centralized control of facility and environmental systems, such as CRAHs, CRACs, and the mechanical electrical plant, including weather and physical factors.
- **Maintenance management** – condition-based (versus time-based) maintenance using automated prognostics and diagnostics to identify and resolve issues before they become problems.

With these real-time monitoring and centralized control capabilities, data center professionals are able to manage their multi-site operations as a network, rather than isolated islands of equipment. Industrial-class visibility and performance metering of both IT and facility systems, including status change, energy consumption and environmental data for any location provide the insight required for optimal performance management. Because the tonnage of data can be overwhelming, the quality of decision support—including analytics, market intelligence and workflow—displayed on at-a-glance dashboards and available on more detailed reports is critical for enabling faster time to decision that help deploy new Web services and applications faster. Control technologies enable automation and distributed generations for a truly agile data center.

The Benefit – What Makes a Data Center Smart?

What makes the next-generation data center smart? The intelligence is realized from the benefits made possible by the visibility, decision support, and control technologies that enable renewable power, highly efficient systems, and other related services at a price at or below today's electrical power costs. Taken one step further, a full suite data center infrastructure management system that also enables two-way distributed generation becomes an enterprise smart grid.

The following illustration shows the Top 10 capabilities of an enterprise smart grid, made available by ABB Decathlon™, a data center infrastructure management system.



In summary, there has been no better time for data center modernization. Energy is becoming substantially more strategic to data centers and the enterprises they support. Innovations that are being applied to the smart grid are finding their way into the enterprise to improve energy intensive operations like data centers. Capabilities enabled by a full-suite data center infrastructure management system allow an enterprise to be successfully poised with the smart grid to achieve the benefits of a more energy-efficient, sustainable and nimble enterprise. These innovations are shaping a new classification of smart grid called the "enterprise smart grid." With the advent of the enterprise smart grid, energy becomes the common currency of data centers in a borderless world.

For more information

ABB is a global leader in power and automation technologies that enable utility, industrial and enterprise customers to improve performance while lowering environmental impact. To learn more about how ABB can help you take a strategic leap forward to the "future state" of your data center operations, contact your ABB representative, or visit http://www.abb.com/decathlon.

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