

## Data Driven Innovation

### *Boosting Performance, Reducing GHG Emissions at Citi's Data Centers*

Citi, a financial services company operating across more than 100 countries, is taking important steps to minimize its global footprint. The company has targeted to spend \$10 billion through 2017 to reduce the environmental impact of its operations and technology,<sup>1</sup> building on previous success in realizing the bottom line benefits of GHG reductions.<sup>2</sup> Citi is on track to reduce its GHG emissions 10 percent by 2011 from a 2005 base year (measured in absolute terms).

Citi Realty Services (CRS) is the division with responsibility for sustainable building management at Citi, focused on reducing the environmental impacts of facilities through high-performance building construction and renovation, energy saving retrofits, green power purchases, and space reduction programs. Using guidance in the Greenhouse Gas Protocol,<sup>3</sup> Citi tracks and reports its annual GHG emissions and has estimated that its data processing operations, though representing only a small portion of the company's overall building portfolio, are responsible for 20-25 percent of total corporate GHG emissions.

In 2008, the company created a real estate sustainability team composed of regional energy managers and senior executives to

lead GHG emission reduction initiatives, including efforts to reduce Citi's data center footprint. A data center consolidation initiative seeks to reduce the total number of data centers from approximately 50 in 2006 to 24 in 2010 while still supporting the company's growing need for data processing.

A recent sign of Citi's investment in data center efficiency is its pioneering 232,000-square-foot data center in Frankfurt, Germany. As the first data center to receive the a LEED-NC<sup>4</sup> Platinum certification, the facility's electricity and cooling infrastructure requires just 30 percent of the power consumed by a conventional data center. Most importantly, the project "provided the model for the way in which Citi will design its future facilities," notes John Killey, who heads CRS in Europe, the Middle East, and Africa.

#### *The Business Case for Green Data Centers*

- *Energy performance, security, & reliability*
- *Greenhouse gas reductions*
- *Competitive positioning*
- *Brand enhancement*
- *Expense management*

<sup>1</sup> This is part of Citi's broader 10-year, \$50 billion commitment to reduce climate pollution and advance clean technology markets.

<sup>2</sup> See

[http://www.climatenortheast.org/pdfs/01\\_CNE\\_CS\\_2005\\_Citigroup1.pdf](http://www.climatenortheast.org/pdfs/01_CNE_CS_2005_Citigroup1.pdf).

<sup>3</sup> See [www.ghgprotocol.org](http://www.ghgprotocol.org).

<sup>4</sup> LEED, or Leadership in Energy and Environmental Design, is the building rating system developed by the U.S. Green Building Council (USGBC). The system includes ratings for new construction (NC), existing buildings (EB) and commercial interiors (CI), among others.

### Box 1. IT's Energy and Cost Implications

With growing demand for data processing, data centers are putting an increasing strain on the U.S. electric grid and adding to corporate energy costs. The average power consumption per server quadrupled from 2001 to 2006, while the average number of servers doubled and is expected to grow another 50 percent by 2010. Data centers can consume up to 100 times more energy per square foot than a typical office building, and energy usage in data centers has been growing at approximately 12 percent per year.<sup>5</sup> Increased power demand in turn puts upward pressure on energy costs. Meanwhile, survey results released in 2009 show expectations of increasing energy prices<sup>6</sup> and GHG regulations bring increasing prices for GHG-intensive energy. Energy efficiency in data centers will be critical for information-intensive businesses such as investment banks, telecoms, and business analytics firms seeking to insulate themselves from rising energy costs.

Data centers and information technology (IT) in general can be significant sources of energy use, but also energy savings. Improved data center efficiency could save 20 billion kWh per year by 2015, and potentially defer the need to build an additional 2,300 MW of new generating capacity.<sup>7</sup> The Environmental Protection Agency (EPA) estimates that for every dollar spent on IT, companies spend 50 cents on related energy costs. Some studies predict that by 2011, businesses will spend as much on energy as they do on hardware.<sup>8</sup>

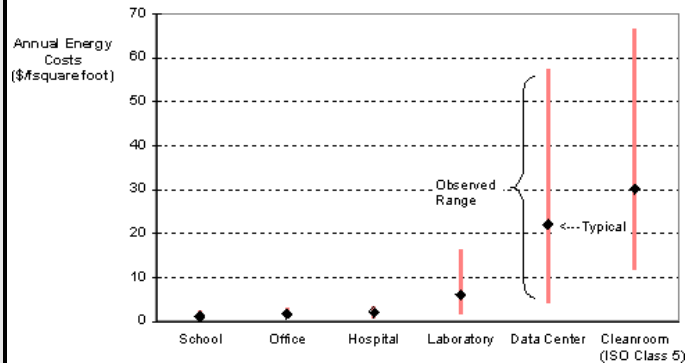
<sup>5</sup> See: "Gartner Survey Suggests Extensive Data Center Expansion Plans Are on the Horizon" *Gartner*, February 2008.

<sup>6</sup> See 2009 Energy Efficiency Indicator, *Johnson Controls*, May 2009.

<sup>7</sup> See "Revolutionizing Data Center Energy Efficiency" *McKinsey & Company*, July 2008.

<sup>8</sup> See EPA 2007 Report to Congress on Server and Data Center Energy Efficiency.

### Comparative Energy Costs High-Tech Facilities vs. Standard Buildings



**Data centers are extremely energy intensive and typically use 20 times (and up to 100 times) as much energy per square foot as other commercial buildings.**

Source: Lawrence Berkeley National Laboratory

### STARTING EARLY: IDENTIFYING CARBON REDUCTION OPPORTUNITIES

In 2000, Citi began collecting data on the energy consumed by its 14,000 buildings so that managers could track and manage GHG emissions. The portfolio included approximately 50 data centers across global operations. These energy-intensive facilities represented a significant portion of the company's GHG emissions and energy costs. Citi initiated cost-reduction efforts to consolidate to a target of 14 primary facilities and 10 secondary satellite centers by 2010. Citi has gone from 52 data centers in 2006 to 32 in 2008 (and is on pace to achieve its consolidation target of 24 by 2010).

Citi began work on its Frankfurt data center while developing two other data centers that also achieved LEED Gold certifications in Texas (new construction) and Singapore (commercial interior). Citi's new data center in Georgetown, Texas, was one of the first new designs to receive LEED-NC Gold certification. The location includes energy controls that alert technicians if systems fall

short of their optimal efficiency, as well as pollution controls that remove 90 percent of the nitrogen oxides from generator exhaust. Landscaping and irrigation systems cut facility water consumption by 50 percent.

The renovation of Citi's Singapore data center achieved LEED-CI Gold with features that included state-of-the-art air conditioning and efficiency lighting systems. The Singapore data center also borrowed lessons and ideas from Citi's data center project in Frankfurt, including energy-efficient designs for power and backup power that led to performance improvements and cost savings.<sup>9</sup>

Citi's facilities fall within a small but growing set of LEED-certified data centers. Currently, Citi and several of the nation's most data-intensive companies, from Google and Yahoo! to IBM and HP, are seeking to consolidate and upgrade data centers to capitalize on energy, water, and cost efficiencies, among other benefits. Although the USGBC's LEED standard was initially designed for commercial office buildings, data centers are able to achieve certification under the LEED-NC standard. To help create customized benchmarking tools for data center projects, EPA and the U.S. Department of Energy are working and collaborating with Citi and others to develop data center metrics for the ENERGY STAR program.

### **A HUB FOR DATA CENTER EFFICIENCY, A BLUEPRINT FOR SUSTAINABLE DESIGN**

In April 2009, Citi announced that its Frankfurt Data Center earned a LEED Platinum rating from the U.S. Green Building Council—the highest rating and

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<sup>9</sup> See "Arup's low energy Citi data centre" *Building Sustainable Design*, January 2009.

the first LEED Platinum data center certification in the world. Citi's Frankfurt facility will become the firm's IT hub for Europe, the Middle East and Africa, and its largest data center outside of the United States.

To achieve the highest level of building performance, Citi Realty Services emphasized sustainability at the outset as an equally important decision factor along with performance, reliability, and cost. Sustainability became a key performance metric monitored at Frankfurt and now at all Citi projects. This ensured that sustainability would be a part of decision-making, from procurement to design to construction:

#### ***Procurement***

Successful procurement for Citi's Frankfurt facility was contingent on joint commitments to LEED accreditation by Citi's senior management and its contracting parties. Citi embedded a unified project vision, including environmental requirements, in all documentation to consultants, designers, and contractors, which guided partner and vendor selection.

#### ***Design***

Design innovation was executed with no increased cost over more conventional data centers. Citi invested in new technologies that enhanced overall performance and reworked existing infrastructure to make it more efficient.

Cost and quality factors in the context of LEED requirements helped align objectives; however Citi and its design team at Arup Associates did not simply seek to check off boxes on the LEED checklist. Design features were selected according to the needs of the facility with the goal of maximizing sustainability and performances as the driving decision factors. The team identified and integrated several innovative design features (see below) and reaped the

benefits of major reductions in capital cost, physical footprint, and GHG emissions.

### ***Innovative Design Features***

- For cooling, the facility maximizes use of outside air to provide free pre-cooling approximately 80 percent of the time.
- Water-efficient fixtures reduce potable water use by 41 percent.<sup>10</sup>
- Citi and its construction team focused on recycling materials and were able to divert 100 percent of the waste from landfills.
- The recycled content of project materials reached 27 percent, with local sourcing of materials exceeding 40 percent.
- A combination of standby energy systems allows the facility to operate continuously, yet only use 30 percent of the power required by a conventional data center and only 40 percent of the heating energy.
- The facility's 1500 square-meter office building is naturally ventilated with a fresh air supply and uses heat recovered from the data center to warm the office.
- Additional features, including innovative technologies, helped achieve additional energy savings. Virtualized technology, which makes it possible to consolidate several operating systems onto a single server, helps the data center consume far less power. Virtualization allows Citi to use one server to replace multiple machines and reduces the amount of hardware, physical space, and energy required. In

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<sup>10</sup> The design team also recognized that the cooling towers could potentially have a large impact on water consumption and contaminated discharge. A reverse osmosis water treatment system solved both issues. The system filters the water and eliminates the need for chemicals and softeners. Because the quality of the make-up water is improved, the quantity required is reduced, providing savings of 13,208,602 gallons of water per year.

North America, each virtualized server represents an approximate 70 percent reduction in energy used for power and cooling.

### ***Coordination and Engagement***

Identifying sustainability and performance goals up front, and communicating these goals to all involved throughout the process, was a major factor in the project's success. Citi took pains to include LEED language in each of its contractor specifications and carve out a specific role for contractors in LEED credits. Internal collaboration was just as critical. Citi Realty Services worked closely with Citi Technology Infrastructure as well as project partners at Arup Associates, an integrated architecture and mechanical/engineering firm, to develop a shared vision and implementation plan for the project. Arup, as an integrated architectural and engineering firm, helped create consistency and facilitated coordination across the various project stages.

Upon completion, Citi's John Killey noted the commitment to sustainability not only drove innovation, but it also was a large part of the project's overall success. As he explains:

The key to the success of Frankfurt was the way in which we included sustainability as a key selection criterion with equal importance to the more traditional criteria of performance, reliability, maintainability, constructability and cost. In many cases the selection of the sustainable solution improved both performance and reliability and, taken across the whole life cycle of the building, improved facility costs.

## AN EXAMPLE FOR FUTURE DATA CENTERS

Killey notes that this approach will serve as a model for future facilities, which will help further advance Citi's efforts to reduce GHG emissions.

In 2008, Citi achieved an overall absolute emissions reduction of two percent from the previous year and stayed on track to meet its 2011 GHG reduction target in large part thanks to its data center consolidation and efficiency initiatives.

Citi's success has not gone unnoticed. The company was named Overall Winner at the 2008 Financial Services Technology (FST) Magazine Awards and became a finalist in the Department of Energy's Green Enterprise IT Award. Innovation in data centers can be a strategic opportunity as more companies look to curb the growth of data processing energy demand and meet GHG reduction goals.

As in the Citi example, companies that emphasize sustainability objectives and take an integrated approach to data center management can maximize performance, reliability, and efficiency. Implementation requires innovations beyond technology. Successful projects rely on early engagement and consistency drive toward efficiency and sustainability throughout the decision making process.

## Additional Data Center Resources

- Greener Computing:  
<http://www.greenercomputing.com/>
- "Green Data Centers Bring Environmental Financial Gains," FacilitiesNet  
<http://www.facilitiesnet.com/datacenters/article/Green-Data-Centers-Bring-Environmental-Financial-Gains--10459>
- Companion to the EU Code of Conduct on Data Centres v0.9:  
<http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoC%20data%20centres%20nov2008/Best%20Practices%20v1.0.0%20-%20Release.pdf>
- EPA 2007 Report to Congress on Server and Data Center Energy Efficiency Public Law:  
[http://www.energystar.gov/ia/partners/production/downloads/EPA\\_Datacenter\\_Report\\_Congress\\_Final1.pdf](http://www.energystar.gov/ia/partners/production/downloads/EPA_Datacenter_Report_Congress_Final1.pdf)
- Enterprise Server and Data Center Energy Efficiency Initiatives:  
[http://www.energystar.gov/index.cfm?c=production.development.server\\_efficiency](http://www.energystar.gov/index.cfm?c=production.development.server_efficiency)
- EU Code of Conduct for Data Centers:  
<http://re.jrc.ec.europa.eu/energyefficiency/pdf/CoC%20data%20centres%20nov2008/Best%20Practices%20v1.0.0%20-%20Release.pdf>
- Fact sheet on ENERGY STAR's National Data Center EE Information Program:  
<http://www.energystar.gov/ia/partners/production/downloads/NDCFactSheet.pdf>
- "Going Green in the Data Center," Cisco Press:  
<http://www.networkworld.com/subnets/cisco/063009-ch1-going-green-in-the-data-center.html>
- The Green Grid:  
<http://www.thegreengrid.org/home>
- Lawrence Berkeley National Laboratories areas of research and compilation of best practices:  
<http://hightech.lbl.gov/datacenters.html>
- McKinsey Corporate Average Data Center Efficiency (CADE):  
[www.mckinsey.com/client\\_service/bto/point\\_of\\_view/pdf/Revolutionizing\\_Data\\_Center\\_Efficiency.pdf](http://www.mckinsey.com/client_service/bto/point_of_view/pdf/Revolutionizing_Data_Center_Efficiency.pdf)
- Uptime Institute:  
[www.uptimeinstitute.org](http://www.uptimeinstitute.org)