Utility Energy Efficiency Program Design: Server Room Assessments and Retrofits

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Executive Summary

Leading utilities in the United States are increasingly seeking opportunities to capture large energy savings through the delivery of energy efficiency programs and services for data centers and information technology (IT) infrastructure.

These programs, whether targeted or comprehensive, typically address desktop infrastructure at one end of the infrastructure spectrum and dedicated data centers at the other. Programs often fail to target a vast middle portion of the market: small server rooms and IT equipment closets.

This hidden infrastructure represents over half of the energy use attributed to data centers, and in fact can be a significant portion of total energy use in an office environment.

The Natural Resources Defense Council believes that utilities can deliver effective programs and services that increase the use of energy efficiency opportunities for small server rooms. Utility energy efficiency programs can begin to draw attention to server rooms and IT equipment closets with education and evaluation tools, and extend education programs with on-site efficiency evaluations. These tools and services could in turn support a select package of incentive programs to encourage the implementation of energy efficiency measures.

This paper presents a suite of programs and services to help utilities capture this market opportunity.

Hidden Energy Hog: IT Closets

What is lurking behind the door at the end of *your* hallway, the door labeled "Telecomm Room," or something equally innocuous, in most commercial office environments?

In many offices, IT equipment rooms have evolved into miniature data centers, filled with information and communication technology supporting the desktop computers and back office operations of modern businesses, and consuming a great deal of energy.

While businesses often make efforts to improve the energy efficiency of their operations – by replacing lighting and air conditioning systems for example – the information technology lurking in these rooms has largely escaped notice.

The information technology industry has made data center energy efficiency a major focus over the past half dozen years, but these efforts have been largely directed at purpose-built facilities with features such as raised floors and customized cooling systems, not at the distributed IT infrastructure lurking in your office closet.

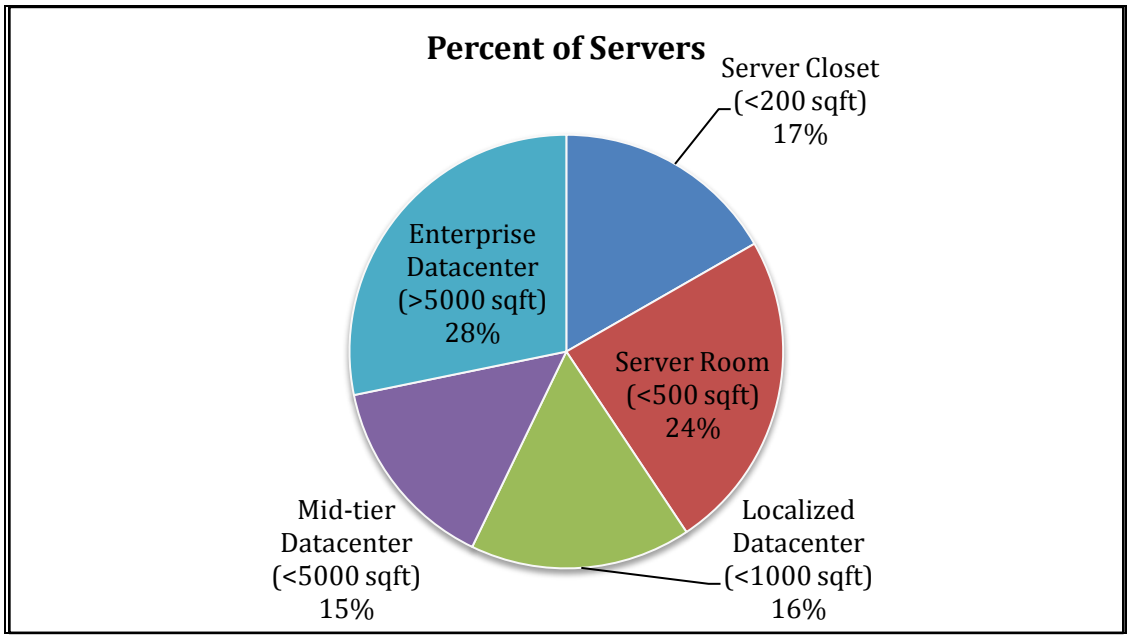
Companies that operate enterprise data centers do most of their IT heavy lifting in those data centers, so their telecomm rooms are still largely support spaces to run cable and power, and to locate telecommunications gear.

However, even major corporations with top notch IT organizations can be surprised by the sprawl of IT equipment accumulating outside of their data centers, with rogue equipment installed in closets or even hiding in employee work spaces, outside of Corporate IT's control and quietly gobbling energy.

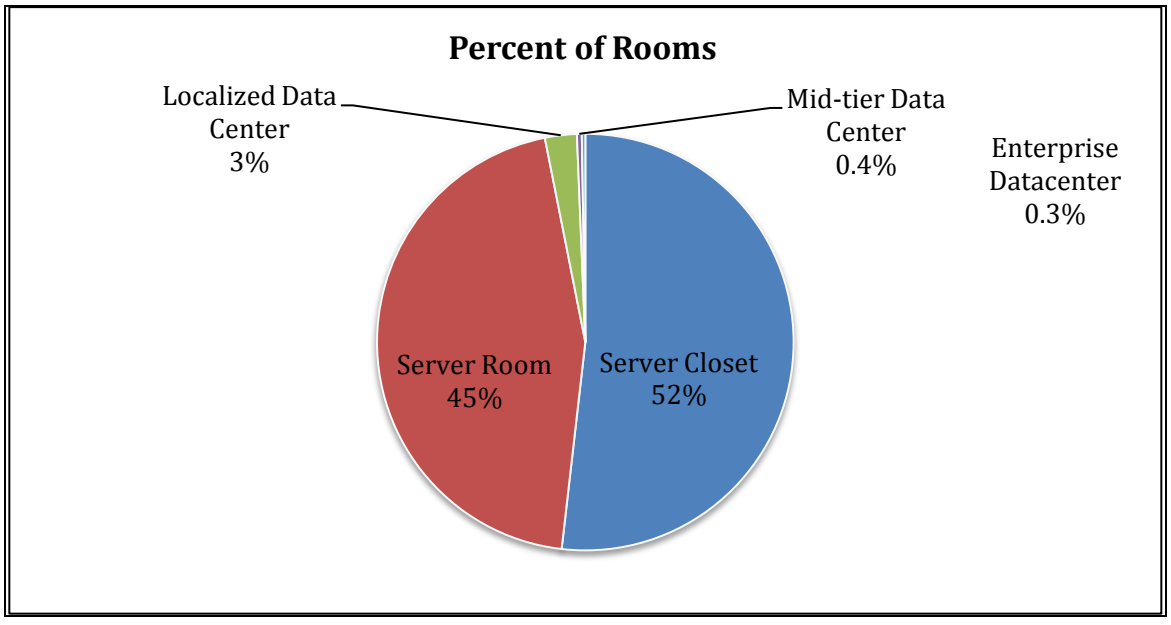
For the vast majority of small- and medium-sized businesses, closets are de facto data centers, holding servers, data storage equipment, switches, and routers, as well as telecommunications infrastructure.

Industry research undertaken by the International Data Corporation (IDC), a consulting and market research firm, indicates that half of all servers in use are not

in data centers, but rather in server closets, rooms and other localized data centers (less than a thousand square feet)[1].



The IDC study indicates that there are about two and a half million small and medium sized server rooms in the United States, vastly more than the 20,000 or so full-fledged data centers in the country.



[1] Michelle Bailey, et al., C, April 2006, IDC #06C4799

Utility Programs Can Increase Server Room and Server Closet Efficiency
Utilities have been successful at impacting energy use at the two extremes of information technology efficiency opportunities: full-fledged data centers and desktop IT infrastructure.

Programs that reward retrofits of existing data centers or improvements in new construction can be considered mature at utilities in some parts of the country, with most of the major energy saving strategies already in use. Efficiency programs are notably mature in California, the Pacific Northwest, Texas, and New York. Many utilities across the country are now debuting programs for this market, or have programs in effect.

These programs, directed toward smaller customers, deliver energy savings accomplishments on a par with programs directed at the industrial market sector. They require significant investments in customer outreach and technical support and evaluation, but deliver large energy and demand reductions per project.

Similarly, many utilities offer rebates for desktop IT efficiency measures, at the smallest end of the data management equipment spectrum. Desktop network power management software rebates are currently offered by over twenty utilities nationwide. These programs mirror mass-market programs that have been implemented in the commercial sector; since vendors market the program on behalf of the utility it is a low-cost, low-overhead program for a utility to try and drive adoption of energy efficiency best practices across many customer classes.

In short, there is every reason to believe that utilities, while addressing marketing and customer engagement challenges, can design and deliver effective energy efficiency programs that capture the energy savings opportunities in the middle of the market--in server rooms and closets--using strategies that have successfully delivered cost-effective savings to both the largest and smallest IT users.

Opportunities for Energy Efficiency

Even though server rooms and closets don't require the same level of cooling, power delivery, and air conditioning infrastructure as data centers, several energy efficiency opportunities can still deliver excellent financial returns.

Server Virtualization and Consolidation
Improving the utilization rate of equipment represents one of the largest opportunities for energy savings and capital cost avoidance in server rooms and closets.

The average utilization rate for servers is only 5 to 15 percent (Dietrich 2007, US EPA 2007), and is likely even lower for distributed equipment because it is not

managed to the same degree as data center-based infrastructure. The problem is that typical servers use 60 to 90 percent of their maximum power while running at such low utilization levels (AMD 2006, Bodik et al. 2006, Dietrich 2007), resulting in a large consumption of power for very limited work output.

Poor utilization rates occur for a number of reasons, but the primary driver is that servers are typically running a single application that is only used intermittently. In a distributed environment, a server might only run email software, for example.

ENERGY STAR® Servers

At the most basic level, energy efficiency gains are often available through improvements in IT equipment and technology.

The United States Environmental Protection Agency, through its ENERGY STAR® Program, has established high energy efficiency standards for several classes of IT equipment, including desktop computers, monitors, and servers.

Although the availability of ENERGY STAR®-rated servers is currently quite limited, it is worth educating customers about the standard and encouraging qualified equipment purchases as the number of certified models increases.

Manufacturers of all types of IT equipment, including servers, routers, and storage devices, are adding models to their lines that have the most energy efficient power supplies available. These power supplies can save 10-20 percent of total server energy use, while costing only a few dollars extra, paying back for themselves typically in less than 1 year. In the absence of ENERGY STAR®-rated equipment, customers should be encouraged to specify models with premium efficiency power supplies to reduce energy consumption.

Equipment Refresh

The well-known Moore's Law says that the number of transistors on a chip will double approximately every two years, setting the pace for computer performance. Some studies indicate that the energy efficiency of IT equipment has and will continue to follow a similar trend.[2] The latest generation of IT equipment, notably servers, is dramatically more energy efficient than equipment built just a few years ago.

This energy efficiency advantage is often not being captured, particularly in the distributed IT segments, because customers have extended their refresh rate, or the length of time they wait before purchasing new equipment.

[2] Koomey, Jonathan G., Stephen Berard, Marla Sanchez, and Henry Wong. 2011. *Implications of Historical Trends in The Electrical Efficiency of Computing*. IEEE Annals of the History of Computing. vol. 33, no. 3. July-September. pp. 46-54

Customers should be encouraged to consider replacing IT equipment that is five years older or more, an improvement that, with savings in energy costs, usually pays for itself. Sophisticated, large scale users of servers have shortened refresh rates to as low as two years in order to capture energy efficiency advantages.

Server Power Management

While effective power management of desktop IT infrastructure is a mature, proven technology, power management of servers and other distributed IT equipment, while available, has poor market penetration among smaller IT customers.

Future generations of power management software will offer features that can be tailored to individual applications, delivering just the right amount of server availability and resources for, say, accounting or email applications, which might have quite different needs. When this technology matures, customers will be able to dramatically reduce energy use by varying the power settings of equipment according to the needs of their specific programs. An IT or office manager could save additional energy by setting servers on low-power modes for periods of the day when use will be minimal, such as when the office is closed.

Use of Centralized or Cloud Services

Migrating IT workloads from equipment in server rooms to the cloud, or simply to a central data center environment, may in fact be an excellent strategy to lower energy use.

The primary advantages of centralized infrastructure are the ability to increase utilization rates of equipment, and the ability to specify and utilize more current equipment and infrastructure that is more energy efficient.

Quantifying the energy savings from moving to centralized infrastructure is not easy, but promoting the transition may be a worthwhile strategy to address energy costs and carbon footprint as well as other challenges, such as a lack of space or power capacity in a server closet.

Cooling and Power Conditioning

There are a host of energy efficiency measures related to cooling systems for server rooms and localized data centers. An example of such a measure is airflow management for localized data centers that feature raised floor environments, including low- and no-cost measures to isolate supply and return air streams in order to keep cooler air in and warmer air going out.

Similarly, there are cooling equipment upgrades, including the installation of variable speed drives for fans and economizers, which can save energy mostly in large server rooms and localized data centers (less applicable in server closets).

These cooling measures can be promoted as part of an airflow management retro-commissioning service program offered by utilities, with the understanding that they are best targeted to facilities in the five to ten thousand square foot range.

Power conditioning measures are also limited for server rooms. Operators should consider specifying high-efficiency UPS equipment and consider modular units so that loading of UPS equipment is maximized.

Program Design

Education Materials and Evaluation Tools
We recommend that utilities prepare simple marketing and outreach material that can primarily be distributed via an Internet page at the utility's energy efficiency web site. Customers and vendors in this market prefer electronic materials rather than printed ones.

The material should include a description of the program and how to participate, a guide for vendors who wish to participate in the program, and, after several successful engagements, a case study or two.

Intel has developed a server replacement energy savings calculation tool, and is making that tool available for use by utilities. In order to keep the tool current, Intel prefers that utilities refer customers to Intel's energy efficiency resource site (http://premierit.intel.com/community/ipip/energy) rather than posting it.

On-Site Evaluations
Evaluating the potential for energy efficiency projects directly affecting IT workloads and equipment is well beyond the expertise of most energy assessment professionals, and instead must be performed by IT specialists.

A customer could get information about the expected gains from a consolidation--a general cost and rebate estimate could be made, say, for an organization that had ten servers and could likely consolidate to two--but would still be likely to need expert IT advice before planning and carrying out such a project.

We recommend that utilities designing programs to increase server room and IT closet efficiency form partnerships with IT service companies that can not only recommend projects to the utility customers, but also help organizations to carry out the projects successfully.

Prescriptive Incentive Programs
Several of the energy efficiency measures applicable for server rooms and distributed IT infrastructure lend themselves to rebate or incentive program designs.

For desktop IT infrastructure, rebates for the purchase and use of power management software are already offered by more than twenty utilities in the U.S., with proven program performance and solid accomplishments.

For enterprise IT, a few utilities have transitioned server virtualization and consolidation programs from a calculated measure—in which a customer applies to implement a solution, calculates predicted savings and gets approval to make purchases that will be reimbursed when the results are proven—to a prescriptive one in which utilities choose which equipment qualifies for rebates. This approach is particularly appropriate for small projects undertaken in the small commercial customer class, customers with loads of no more than 100 or 200 kW.

If utilities are wary of evaluation management and verification (EM&V) risks from a prescriptive server virtualization and consolidation program, they might consider limiting applications to certain customer types. These could be based on number of employees, rate schedule, or type of company according to the standard industrial classification (SIC) code, for example. Another way of limiting rebates could be by project size, or capping the rebate amount allowed per project or location.

Finally, there are opportunities for delivering midstream or upstream prescriptive incentive programs that reward manufacturers, vendors, and/or IT service providers for the sale of qualifying equipment.

This type of program has proven successful for desktop IT measures, rewarding vendors for the sales of ENERGY STAR®-qualified desktop computers, and for monitors that exceed the current ENERGY STAR® standard.

Ecova[3], through their Plug Load Solutions program, offers a utility incentive clearinghouse service for information technology and consumer electronics equipment that meets ENERGY STAR standards, or that is equipped with premium efficiency power supplies. Servers are currently included in the program, and other IT equipment such as data storage and communications equipment can be included.

We strongly recommend that utilities consider offering a server virtualization and consolidation rebate program directed towards small- and medium-sized customers, perhaps with a project cap, as a vital means of capturing and documenting energy savings in the server room market.

[3] Formerly known as Ecos

We also recommend that utilities consider offering rebates for the purchase of premium efficiency servers, either using the ENERGY STAR standard or based on power supply specifications. This program can be directed to customers, or through mid- or upstream channels such as equipment manufacturers or vendors.

Program Delivery

Education and Evaluation Tools
We recommend that education materials and evaluation tools be predominantly distributed via utility web sites, as well as through IT service companies acting as partners.

Market actors in the IT field, whether they are IT managers or part of the vendor community (value-added resellers, system integrators, consultants, service providers) are likely to prefer using information technology for accessing information and training resources online, rather than more traditional channels such as printed marketing materials.

The vendor community should not be ignored as a productive channel for the delivery of education and evaluation tools. If these tools can both increase sales of vendors' services and reduce energy use, the utility programs will be successful. Utilities can reach and energize vendors through presentations (webinars are often a low-cost way to reach a large audience). When vendors understand that many energy efficiency measures will generate hardware, software, and service orders, they become part of the marketing force expanding the utility's energy efficiency program.

On-Site Evaluations
We recommend that utilities partner with vendors who have a deep understanding of IT infrastructure to perform energy efficiency assessments for organizations looking to make their distributed IT equipment more energy efficient, as well as to promote utility incentives or rebate programs.

Most small and medium businesses rely on contracted information technology support from IT service providers, who are often referred to as "value-added resellers" by the IT industry, or as "system integrators." These companies are typically local or at most regional players in their markets, so utilities may need to reach out to many vendors in order to cover the entire utility service area.

Service providers, who often have ongoing contracts with customers, are ideally positioned to assess the opportunities for projects that result in higher energy efficiency, as well as to actually implement these projects.

Some service providers may be interested in participating in a utility energy assessment program on a fee-per-assessment basis. Others may very well perform assessments at no charge, as part of their ongoing service offerings, with the intent of recouping costs for the assessments through the implementation of recommended projects.

We recommend that utilities engage with the local IT service provider community through a series of meetings and webinars. In these presentations, utilities can describe potential program offerings. Based on feedback from participants, utilities can then assess how IT service companies would assist in driving program participation, or whether the program offerings need to be adjusted.

Prescriptive Incentive Programs

Utilities' prescriptive rebate programs generally feature a set catalog of measures and are marketed to all classes of customers. If rebate programs exist that do not include rebates for server virtualization and consolidation (or other desktop IT measures), these can be added to program catalog offerings for small- and medium-sized businesses and institutions. In this case, marketing activity for server rooms, IT closets, and desktop IT measures can be leveraged off of existing energy efficiency efforts.

Launching Server-Room Efficiency Programs

Utilities might consider two avenues for launching an incentive program targeted at server rooms: a pilot program with limited funding and vendor participation, or a broader, well-funded program targeting a wide range of vendors and organizations throughout the utility's service area. For either type of program, we recommend identifying qualified IT service firms to participate. This will be important to a program's success. These firms, whether they are paid to do on-site evaluations or not, will be key marketing channels for the programs.

Some customers may help utilities to identify these firms. We recommend that utilities survey their customers, asking about IT energy efficiency needs, and at the same time ask who they use as IT service professionals.

For a limited pilot program, it may be sufficient to identify only one or a few IT service firms, perhaps through a request for qualifications process. For a broader program launch, a request for proposals, including bids for performing on-site evaluations, will likely be needed.

IT service providers should indicate their ability to survey server room IT systems, to recommend virtualization and consolidation strategies, and to accurately estimate both project costs and estimated energy savings. (Energy savings can be determined using the prescriptive levels associated with the rebate program.)

Program Design and Delivery Checklist

Activity	Planning	Launch	Delivery
Prepare work papers for server virtualization and consolidation and premium efficiency server rebate measures and submit to regulators for approval	☐		
Meet with program evaluators to review design and implementation plan	☐		
Identify potential vendor partners	☐		
Prepare education and marketing materials	☐		
Post marketing and education materials and evaluation tools to web site		☐	
Hold internal stakeholder (account representatives, program managers, etc.) training event		☐	
Hold vendor training event		☐	
Hold customer events (or integrate into other outreach activities)		☐	☐
Participate in vendor-sponsored outreach activities			☐
Monitor program results			☐

Evaluation, Measurement, and Verification

Validating the accomplishments of a mass-market energy efficiency program addressing the technology measures inherent in IT infrastructure is certain to be challenging. We recommend carefully reviewing program designs with your evaluation team prior to a program pilot or debut.

In some states, notably California, the EM&V community and regulators have allowed utilities to prescriptively claim modest energy savings from the performance of energy evaluations, even without any direct documentation of customers' implementation of recommendations.

Even if savings cannot be claimed to result from evaluations alone, evaluations do serve as strong evidence for attribution of savings from implemented projects. Some utilities regularly revisit customers to see if recommended actions have been taken,

and claim savings for actions that were undertaken without participation in financial incentive programs.

Prospective Valuations of Prescriptive Rebate Parameters
Most utilities that are offering incentives for server virtualization and consolidation projects are doing so using calculation models that either require research regarding the actual power draws of specific server models, or use a simple average assumed value that is likely to be reasonably accurate for the majority of servers currently in use.

A second approach essentially involves setting a prescriptive rebate value for each server removed, net of any remaining or new servers.

For a program limited to small-scale projects applicable in server rooms and closets, we recommend adopting a prescriptive rebate model. Silicon Valley Power, serving the City of Santa Clara in California, successfully ran a program offering a $225 rebate per server removed, with no limits on eligibility or project size.

However, given concerns about companies seeking free rides and accurate estimation of energy savings, we recommend limiting a server virtualization and consolidation rebate program to small-scale projects.

The scale of each project could be limited in one of two ways: by setting a maximum rebate amount, or by limiting the program to small and medium customer rate classes. We recommend the maximum rebate approach, setting a limit that covers projects where no more than a given number, perhaps twenty-five servers, are removed per project application.

This approach would allow even large businesses to improve energy efficiency in their server rooms and closets, with the restriction that larger projects in data centers would be covered separately, under a traditional calculated incentive program model.

The following chart presents reasonable and defensible valuations of a prescriptive rebate program design:

Essential Elements of a Prescriptive Rebate Program Design

Measure Name	Small-scale server virtualization and consolidation
Measure Description	Installation of software allowing consolidation of IT workloads on fewer physical servers, and removal of unneeded servers
Program Applicability	May be limited by project size or by customer class
Base Case Description	Servers dedicated to single IT workloads, typically at utilization rates below ten percent become more energy efficient when servers are virtualized and consolidated.
Base Case Energy Consumption	On average, "volume" servers (single or dual-core machines manufactured three to six years ago) draw 225 Watts with little or no power management based on IT workload variability, resulting in annual consumption of about 1,970 kWh. If a new replacement server is purchased, both demand and energy use would be lower, as the latest generation servers draw only about 125 to 150 Watts on average, corresponding to annual consumption of 1,100 to 1,300 kWh.
Energy Savings	Demand: 0.125-0.225 kW per server removed (net) Energy: 1100-1970 kWh/yr per server removed (net)
Base Case Equipment Cost	Not Applicable
Measure Cost	Approximately $2000 per server removed, including software license and services, and assuming new servers
Measure Incremental Cost	Same as above
Effective Useful Life	5 years (could be higher)
Net To Gross Ratio	0.8

At this time, we do not have comparable data for an ENERGY STAR®-rated server prescriptive rebate program, but one could be offered as a direct-to-customer

program as part of a server room and IT closet initiative. Such a program could direct rebates at customers themselves or midstream partners. Rebates would be relatively small, favoring rebates administered through partners.