For Utilities: Understanding and Designing Energy-Efficiency Programs for Data Centers

- Participants will be muted throughout so please ask questions through chat window
- We will send you a presentation later in the week

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October 8, 2015

Overview

- In November 2012, EPA ENERGY STAR issued their utility program review document, “Understanding and Designing Energy Efficiency Programs for Data Centers.” Download at www.energystar.gov/lowcarbonit
- Based on this guidance, the webinar today will cover:
  - Understanding Data Centers
  - Efficiency Opportunities
  - Breaking Down Program Barriers
  - Project Planning and Rollout
  - Other ENERGY STAR Data Center Efforts

Data Center "Market" for Efficiency Programs

- Enormous energy use density: Consume 100-200x the electricity of standard office space (source FEMP)
- Energy use of data centers:
  - Growing 9.6% per year through 2020 (source McKinsey report)
  - Represents 1.1 to 1.5% of all global electricity (source Koomey)
- Function 24 hours/day, 365 days (high load factor)
- For every 1 watt used by a computer, est. 2 additional watts are used by its supporting data center (source DOE)
- **Efficient data centers have been shown to reduce consumption by up to 80%** (source DOE)

Understanding Data Centers

Server Rack vs. Barbecue

vs.

- Industrial Light & Magic deployed 84 blade servers/rack. Just 1 rack…
  - Uses 28 kW
  - Requires 8 tons of cooling per rack
  - Heat equivalent to 4 Weber Spirit gas grills

280 hamburgers per hour!

Understanding Data Centers

Data Center Types

(2009 estimates)

Type	Square footage	U.S. Facilities	Total servers	Average Servers per location
Utility scale	> 100,000	~7000	~3.6 million	~500
Enterprise	> 5000			
Localized	500-5000	~74,000	~4 million	~50
Server Rooms	200-500	~1.2 million	~ 3 million	3
Server Closets	<200	~1.3 million	~ 2 million	2

- Utility scale: may not need incentives (sophisticated and may implement on their own)
- Enterprise data centers best opportunity (programs have best addressed this market since few free ridership concerns)
- Localized, server rooms and server closets may be too small in terms of savings per project unless admin costs can be reduced.

Efficiency Opportunities

Many Ways to Improve Efficiency in Data Centers

- EPA's "Top 12 Ways to Decrease Energy Consumption in Your Data Center" provides user-friendly descriptions of:
  - IT Opportunities
    1. Server Virtualization
    2. Decommissioning of Unused Servers
    3. Consolidation of Lightly Utilized Servers
    4. Better Management of Data Storage
    5. Purchasing More Energy-Efficient Servers, UPSs, and PDUs
  - Airflow Management Strategies
    6. Hot Aisle/Cold Aisle Layout
    7. Containment/Enclosures
    8. Variable Speed Fan Drives
    9. Properly Deployed Airflow Management Devices
  - HVAC Adjustments
    10. Server Inlet Temperature and Humidity Adjustments
    11. Air-Side Economizer
    12. Water-Side Economizer

Efficiency Opportunities

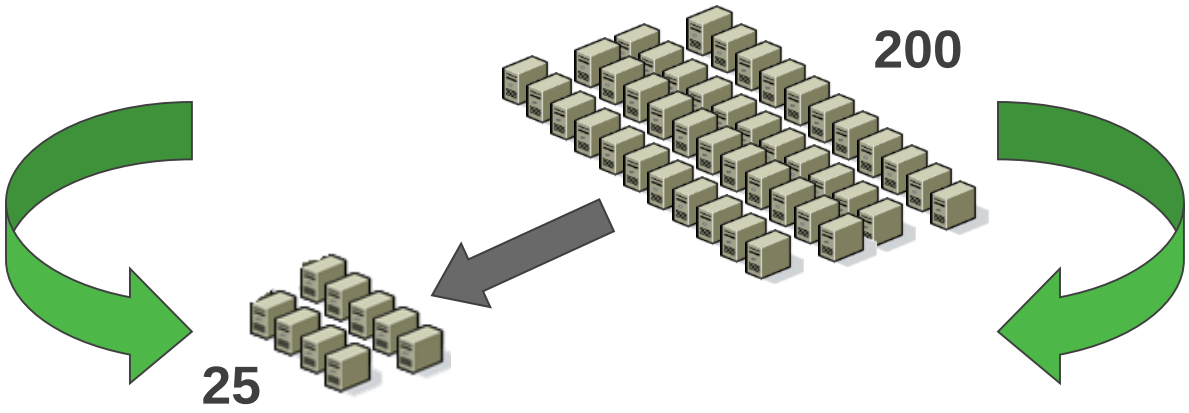
Virtualization – Takes Advantage of Powerful New Servers/Software

- Used to be one physical server box per application
- Allows for multiple virtual machines on one physical server (virtual host)

Source: VMWare.com
Note: EPA does not endorse any particular product or service.

Virtualization Can Cut Energy *and* Capital Costs

Example

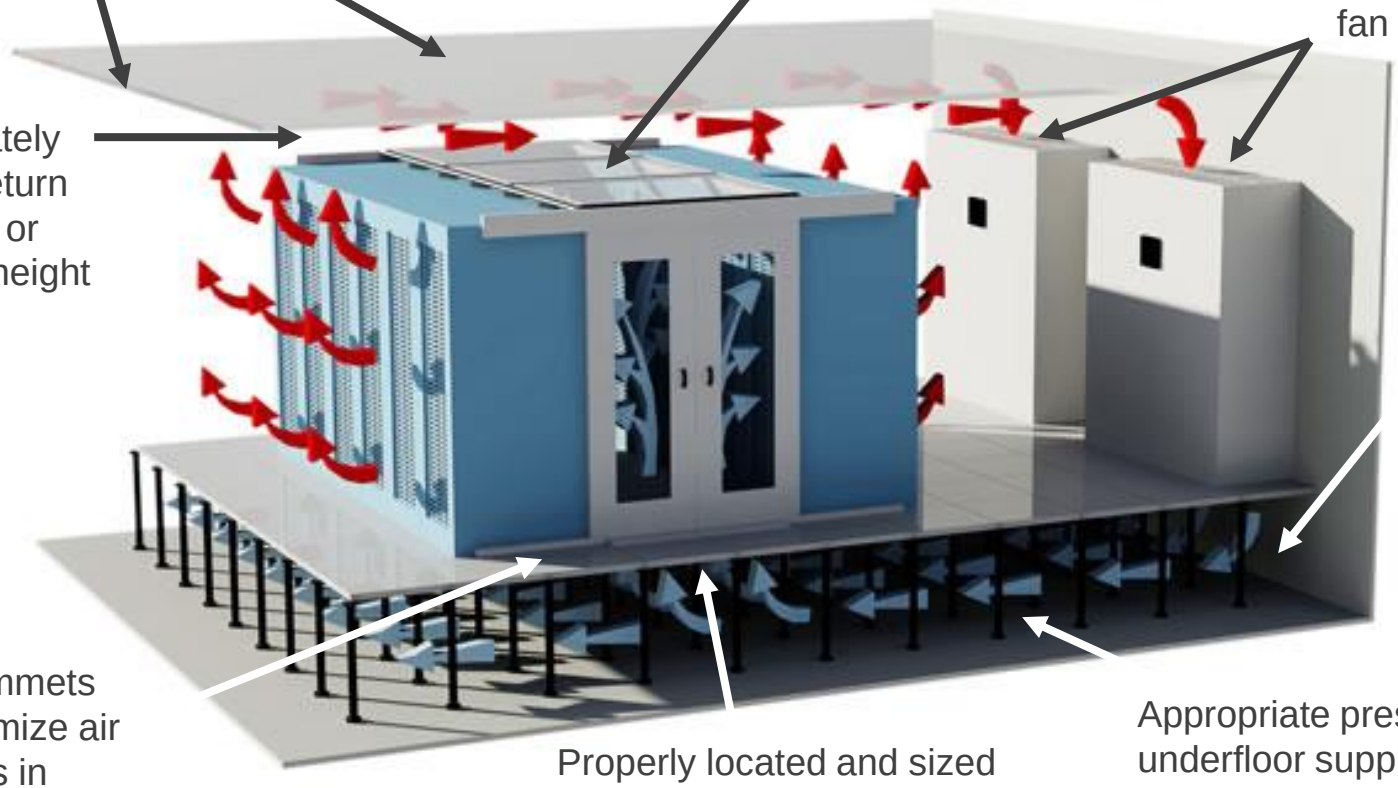


Source: BC Hydro

Note: Free ridership can be high for some customer segments

Efficiency Opportunities

Data Centers: Airflow Management Strategies



Sources: LBNL, Keyzone Computer Products, Ltd.

Efficiency Opportunities

Airside Economizers

Exhaust Air
85° F

Outside Air
65° F

In milder climates, cooling with 100% outside air can be used for most of the year (San Francisco: 8,500 out of 8,760 hours annually)

Efficiency Opportunities

Many Utility Programs are Incenting These Measures Now

Utility Programs	Virtualization	ENERGY STAR Server	Massive Array of Idle Disks	Uninterruptible Power Supply	Chillers/ Cooling Towers	Thermal Energy Storage	Storage Consolidation	Airflow	Variable Frequency Drive	Air-Side Economizer	Water-Side Economizer	Pumps/Motors	HVAC/ CRAC	DC Power
Arizona Public Service Company (APS)	C	C		C	C/P			C	P	P	C	P	P	
Austin Energy	C		C	C	C	C			P			P	C/P	
AVISTA Utilities					C				P			P	C/P	
British Colombia Hydro (BC Hydro)	C	C		C	C		C	C	C	C	C	C	C	C
Commonwealth Edison	C			C	C		C	C	C	C	C	P	C	
Duke Energy (NC, SC, OH)	C			C	C/P	C	C	C	C/P	C	C	P	P	C
Efficiency Vermont	C	C		C					P	C	C	P	P	
Energy Trust of Oregon	P			C	C			C		C	C		C/P	
Focus on Energy (WI)	C/P	C		C	P	C	C	C	P	C	C		P	C
Idaho Power									P			P	P	
Nevada Power									P				P	
New York State Energy Research and Development Authority (NYSERDA)	C			C	C		C	C	C/P	C	C	C/P	C/P	C
Pacific Gas & Electric Company (PG&E)	C	C		C	C		C	C	P	C	C	P	P	C
Puget Sound Energy (PSE)	C			C					C			C	C	
Sacrament Municipal Utility District (SMUD)	C				C/P			C	C/P	C	C	P	C/P	
Salt River Project					P				P				P	
San Diego Gas & Electric (SDG&E)	C								P		P	P		
Seattle City Light	P	C/P	C	C	C		C	C	P	C	C	C	C	C
Silicon Valley Power	C				C			C	P	C	C	P	P	
Snohomish County Public Utility District					C				C			C	C	
Southern California Edison (SCE)	C			C	C	C	C	C	C	C	C	C	C	

Note: "C" indicates a customized measure, and "P" indicates a prescriptive measure. Some programs also incentivize the removal of existing servers through a customized approach. (Data current as of April 2012).

Breaking Down Barriers

Barriers to Entering the Data Center Market

- Lack of knowledge and risk aversion:
  - IT manager worries about:
    - Enormous cost to data center downtime
    - Lack of cooling capacity or power delivery/conditioning
  - Misperception that energy efficiency can adversely affect reliability
- Disincentive for trade allies:
  - Server virtualization and consolidation may reduce future sales of servers.
- Higher first cost and split incentives:
  - Efficient equipment costs more to purchase.
  - IT manager purchasing the equipment not responsible for operating costs.
  - Facility manager responsible for power/cooling and operating budget.

Breaking Down Barriers

Educate the Market Place

- Emphasize increased reliability and reclaimed capacity through energy efficiency, for example:
  - Removing non-critical equipment
  - Ending overcooling of the data center
  - Virtualizing to consolidate IT workloads
- Implement comprehensive internal and external data center training programs that include:
  - Industry overview
  - Available efficiency measures
  - Call to action message

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Breaking Down Barriers

Examples of Training

- Internal Training:
  - Consolidated Edison of New York trained account managers about leading energy-efficiency measures for data centers and desktop IT equipment.
- External Training
  - SMUD has held an annual Business Computing showcase for the past five years, featuring a seven-hour training course and a show area for up to 30 vendors.
  - Pacific Gas and Electric Company (PG&E) has been holding two data center training courses each year since 2005, attended by IT professionals, facility managers and the design and engineering community.
  - Duke Energy has held five all-day Data Center Efficiency Summits since 2010. Over 350 customer representatives have attended.

Breaking Down Barriers

Structure Programs for Trade Allies

- Trade allies, who have established relationships with data center customers, include:
  - **IT Trade Allies:** Value-Added Resellers (VARs), System Integrators, IT Equipment Manufacturers
  - **Facilities Trade Allies:** Design and Engineering Firms, Electrical and Cooling System Contractors and Maintenance Firms, Data Center Cooling Equipment Manufacturers
- Structure programs to encourage trade ally participation
  - Structure incentives to reward participation (e.g., upstream incentives to manufacturers)
  - Offer subsidized or free data center efficiency assessments -- customers receive list retrofits that can be put out to bid

Breaking Down Barriers

Engage Trade Allies

- Identify trade allies
  - Work with utility customers to generate leads and contracts
  - Conduct outreach at regional data center conferences (e.g., Data Center Dynamics)
- Conduct outreach to trade allies
  - Invite vendors to customer education and training sessions
  - Co-brand program marketing material with trade ally information
  - Encourage vendors to invite efficiency program managers to their outreach events

Breaking Down Barriers

Split Incentives and High First Cost

- Cater outreach efforts to IT/Facilities -- promote benefits of lowering capital and operating costs
- Ensure both IT AND facilities personnel receive ALL correspondences and are present at ALL meetings/calls
- Design program incentives based on the different efficiency measure types:
  - Prescriptive: for measures that offer reliable per unit savings
  - Customized: based on engineering calculations and review of applications
  - Retro-Commissioning: examine before and after monitoring data to establish savings

Breaking Down Barriers

Guidance on Data Center Incentive Types

Measure		Program Model		
Measure or Technology	**Description**	**Prescriptive Incentive**	**Customized Incentive**	**Performance/RCx**
Data Center Cooling Systems				
Premium Efficiency Equipment	Premium efficiency chillers, pumps, fans, cooling towers, and other components; ultrasonic humidifiers.	Can use programs established for other markets (e.g., commercial offices), but will likely underestimate savings.	Preferred for retrofits to capture savings from high load factor use of equipment.	
Variable Speed Fans	Variable speed fans on computer room air conditioners/handlers.	Can use programs established for other markets (e.g., commercial offices), but will likely underestimate savings.	Preferred for retrofits to capture savings from high load factor use of equipment.	
Cooling System Controls	Upgrading controls, integrating controls of multiple cooling units, or installing metering and monitoring to improve control of system.		Generally must be undertaken with suitable airflow management upgrades and/or variable speed fans.	
Air-side and Water-side Economizers	Use of outside air or water-side cooling when environmental conditions are favorable.		Water-side retrofits are very attractive; air-side retrofits are more difficult.	
Airflow Management Upgrades	A set of no- and low-cost measures that ensure the proper delivery and return of cooling air, limiting mixing.			Ideal approach, with pre- and post-measurement of supply and return temperatures and calculation of achieved savings.
Power Delivery and Conditioning				
ENERGY STAR certified UPS and Premium Efficiency Distribution Transformers	Specification of premium-efficiency equipment.		Easily handled using standard calculation model; note that loading of equipment is crucial.	
Direct Current Power Systems	Use of high-voltage, direct current power delivery and conditioning schemes.			
Self Generation	Use of fuel cells, solar PV, or other generation.	Generally treated as a prescriptive incentive.		
Premium Efficiency IT Equipment				
Premium-Efficiency IT Equipment	Specification of premium-efficiency power supplies in IT equipment, including ENERGY STAR-certified equipment.	Applicable as a downstream, midstream, or upstream program.		
Virtualization and Consolidation	Software that allows for higher utilization of computing (server) and data storage equipment.	Can be delivered as a prescriptive rebate.	Most often handled using a standard calculation model.	
Data Storage Measures	Premium-efficiency equipment (power supplies), solid-state storage, thin provisioning, compression, de-duplication.		Some measures can be accurately assessed using calculation models (other technologies do not have predictable savings).	

Well designed incentives can address key barriers by improving cost-effectiveness and addressing split incentives

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Establishing Market Potential

Rules of thumb

- Estimate potential via national averages (1.6% of national energy use)
- Determine how many data centers in your territory are:
  - Greater than 10 MW
  - Between 1 and 10 MW;

  These represent roughly 40% of the data center load in your territory
- Develop baseline market assessment that incorporates:
  - More efficient popular technology that changes established baseline "available on the market" assumptions
  - Data center program evaluation information on free ridership, spillover, and savings
  - Changes in construction and efficiency standards (e.g., free cooling required in CA in 2013; new ES specifications)

Project Planning and Rollout

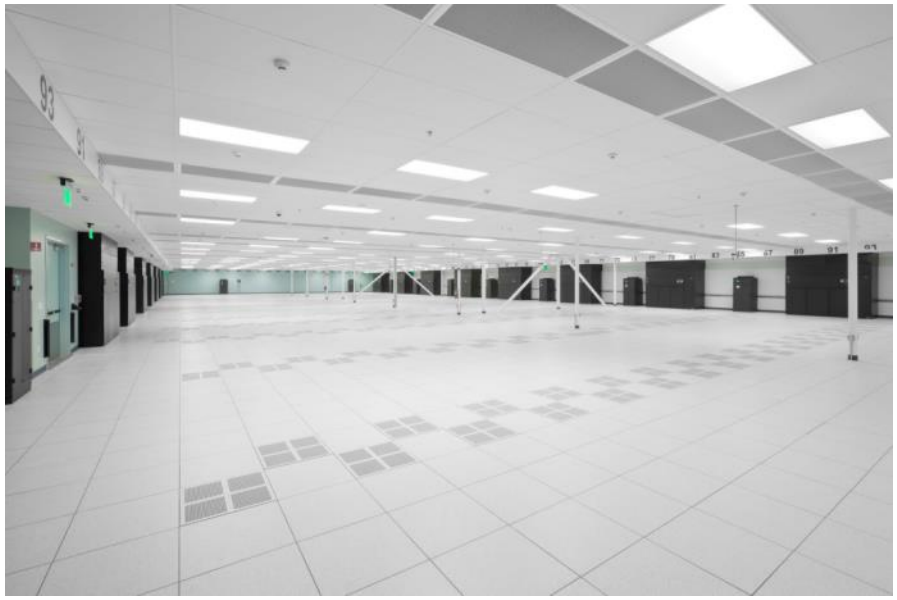
Addressing Technical Complexity

- In-house expertise may not be familiar with data center measures
- Technical service contractors or energy service providers with specific expertise in data centers can be sourced to run or support programs

Project Planning and Rollout

Addressing Lead Times/IT Growth

- Extended implementation periods lead to incentives not paid (and savings not counted) in program year committed
- Growth in IT workload can mask savings (e.g., air flow management, virtualization)
- *Programs should capture time-dependent energy savings based on load growth and accounting for lead time*



Addressing Prod. Cycles & Potential Free-ridership

- Production Cycles
  - Servers /IT equipment have 1-year production cycles and become antiquated quickly
  - *IT incentives might best be set by comparing savings to currently available equipment – not existing installed equipment.*
- Freeridership
  - Utility-scale data centers are more likely to undertake efficiency projects w/o utility incentives to remain competitive.
  - *Programs could set maximum incentives, preclude rate classes, or limit participation of utility-scale data centers.*

EM&V

- Program implementation challenges such as free ridership, load growth and production cycles complicate evaluations to verify savings and attribution.
- Program managers can:
  - Meet with evaluators before launch to discuss these issues and manage expectations.
  - Review latest evaluations. Early ones concluded that:
    - Utility managers may have difficulty growing data center programs quickly enough to meet demand.
    - The split incentive challenge is particularly acute for the data center market and associated decision makers, especially in co-location facilities.

Project Planning and Rollout

Go-To-Market Strategy

Activity/Program Element	Planning	Early Stage Program	Mid-Stage Program	Advanced Programs
Assess market baseline	✓			
Prepare work papers for prescriptive rebate measures and submit to regulators for approval	✓			
Hold internal stakeholder training (for account representatives, program managers, etc.)	✓			
Meet with program evaluators to review the design and implementation plan	✓			
Identify potential vendor partners	✓			
Prepare standard calculation models for selected measures	✓			
Identify technical support contractors and issue an RFP for technical support and/or program management and delivery services	✓			
Offer prescriptive rebate program		✓		
Hold customer and vendor training events		✓	✓	
Participate in vendor-sponsored outreach activities		✓	✓	
Conduct energy assessment services		✓	✓	✓
Offer customized incentives for selected measures and technologies		✓		
Expand customized incentive measure eligibility			✓	
Monitor program results		✓	✓	✓
Consider new construction program			✓	✓
Consider offering server room retro-commissioning program			✓	✓
Consider upstream/midstream rebate program for prescriptive measures (e.g., energy-efficient servers)			✓	✓

Wrap-Up

- Data centers are a worthy target for utility efficiency programs.
- However, unique and complex characteristics of data centers require that efficiency programs are carefully planned and implemented.
- This new ENERGY STAR guide:
  - Describes the barriers to successful data center efficiency program managers.
  - Proposes solutions that can lead to successful program implementation and evaluation.
  - Available for download at www.energystar.gov/lowcarbonit

Other ENERGY STAR Data Center Efforts

ENERGY STAR certified data center products

Uninterruptible Power Supplies (UPS)

Servers

Storage

COMING SOON!

Large network equipment

ENERGY STAR rating for Data Centers

- Portfolio Manager Tool for data center operators to benchmark energy performance and receive a 1 to 100 energy performance rating.
- Uses Power Usage Effectiveness (PUE) as performance metric (Total facility source energy/IT source energy)
- Created using a comparative data set of annual energy consumption data from 120 data centers of various size, type and location
- Data Centers receiving score of 75-100 eligible to apply for ENERGY STAR certification

First Data Center to Earn ES Label: NetApp

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NetApp Relied on Free Cooling

- Can house 277,000 terabytes of storage equal to:
  - 28,000 copies of the entire contents of the Library of Congress or
  - About 15.8 million HD movies
- Achieved a 99 score on the 100-point ES scale.
- Used free cooling 97% of the year under the operating parameters used by NetApp.
- Chilled water plant sole provider of cooling only three percent of the year.

ES certified data centers -- LCIT Champion PSAs

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