

Federal Utility Partnership for Data Centers

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September 14, 2017

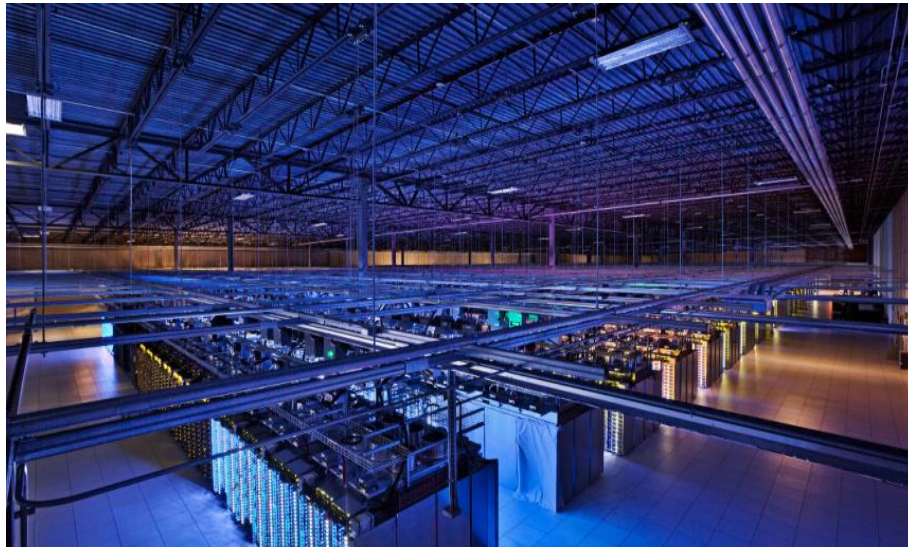


Before We Begin

- Please do NOT put the call on hold.
- All lines have been muted, to be unmuted or to ask a question, please go to your meeting controls panel and raise your hand.
- To submit questions through the chat box, click the chat button and type in the dialogue box at the bottom right. Please, select if you want your comment to go to the entire group or to Elena Meehan to prompt a question to the presenter.
- Slides will be posted at datacenterworkshop.lbl.gov.
- Attendees can receive a certificate of completion by filling out an evaluation form; link provided at the end of the presentation.

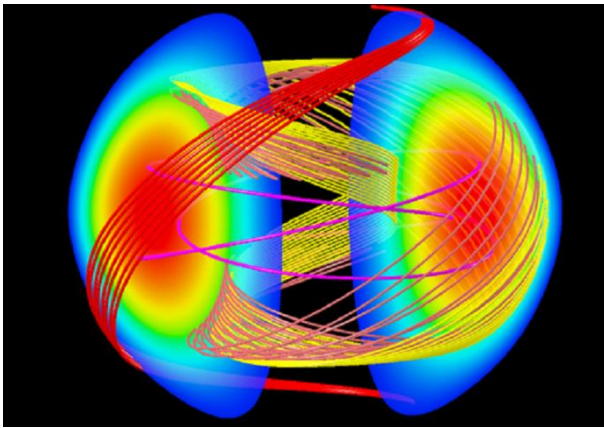
Agenda

- Data Center Energy Context, Federal Drivers, Performance metrics and Best Practices
- DOE and Utility Collaboration Strategy
- Example Collaboration - Current Demo Project
- CoE Resources to Help



Lawrence Berkeley National Laboratory (LBNL)

- Operates large systems along with legacy equipment



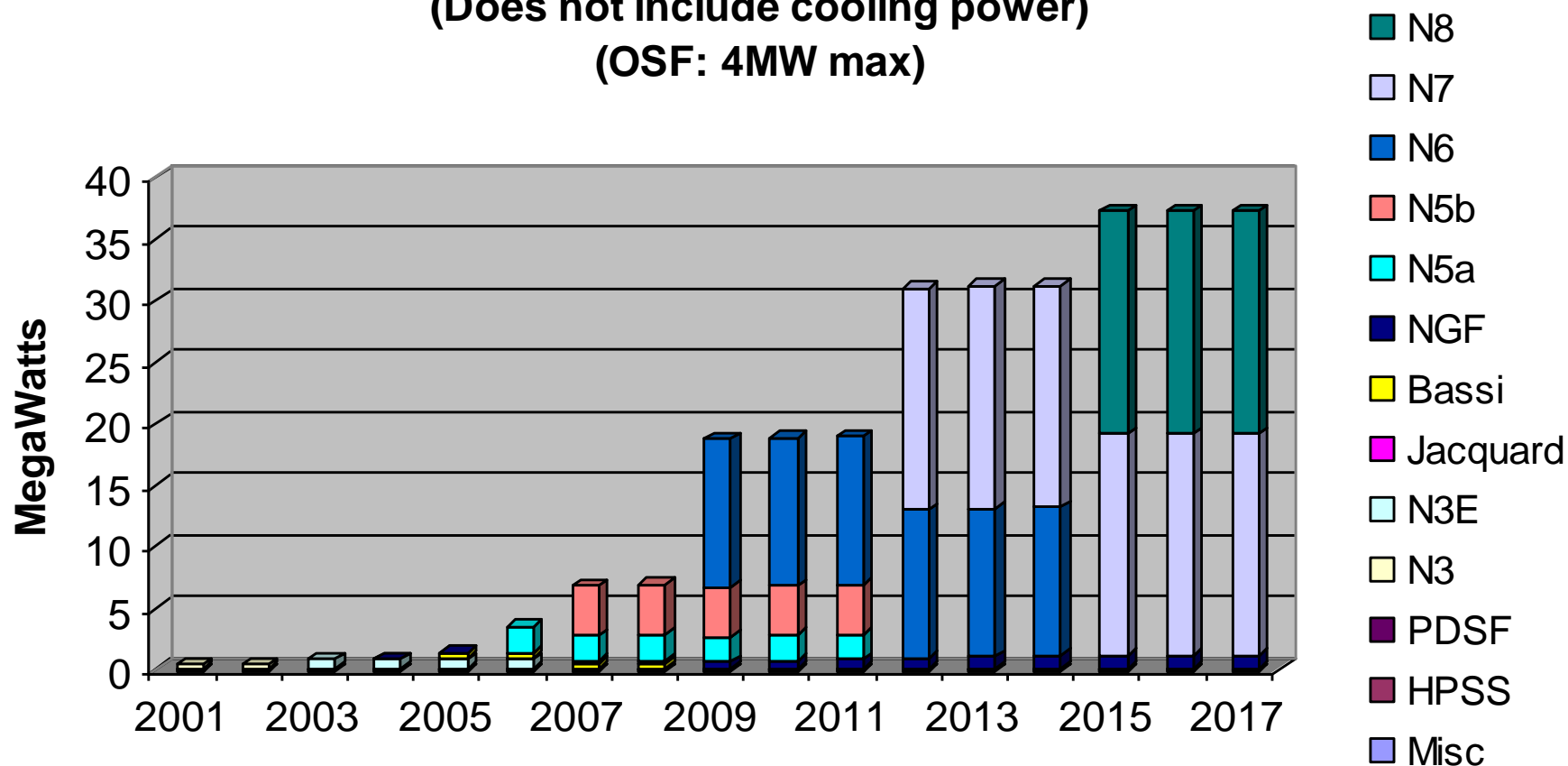
- We also research energy-efficiency opportunities and work on various deployment programs

LBNL Feels the Pain!



LBNL Super Computer Systems Power

NERSC Computer Systems Power
(Does not include cooling power)
(OSF: 4MW max)



Energy Use in Data Centers

Data centers are energy intensive facilities

- 10 to 100+ times more energy intensive than an office
- Server racks now designed for more than 25+ kW
- Surging demand for data storage
- 2% of US electricity consumption
- Power and cooling constraints in existing facilities

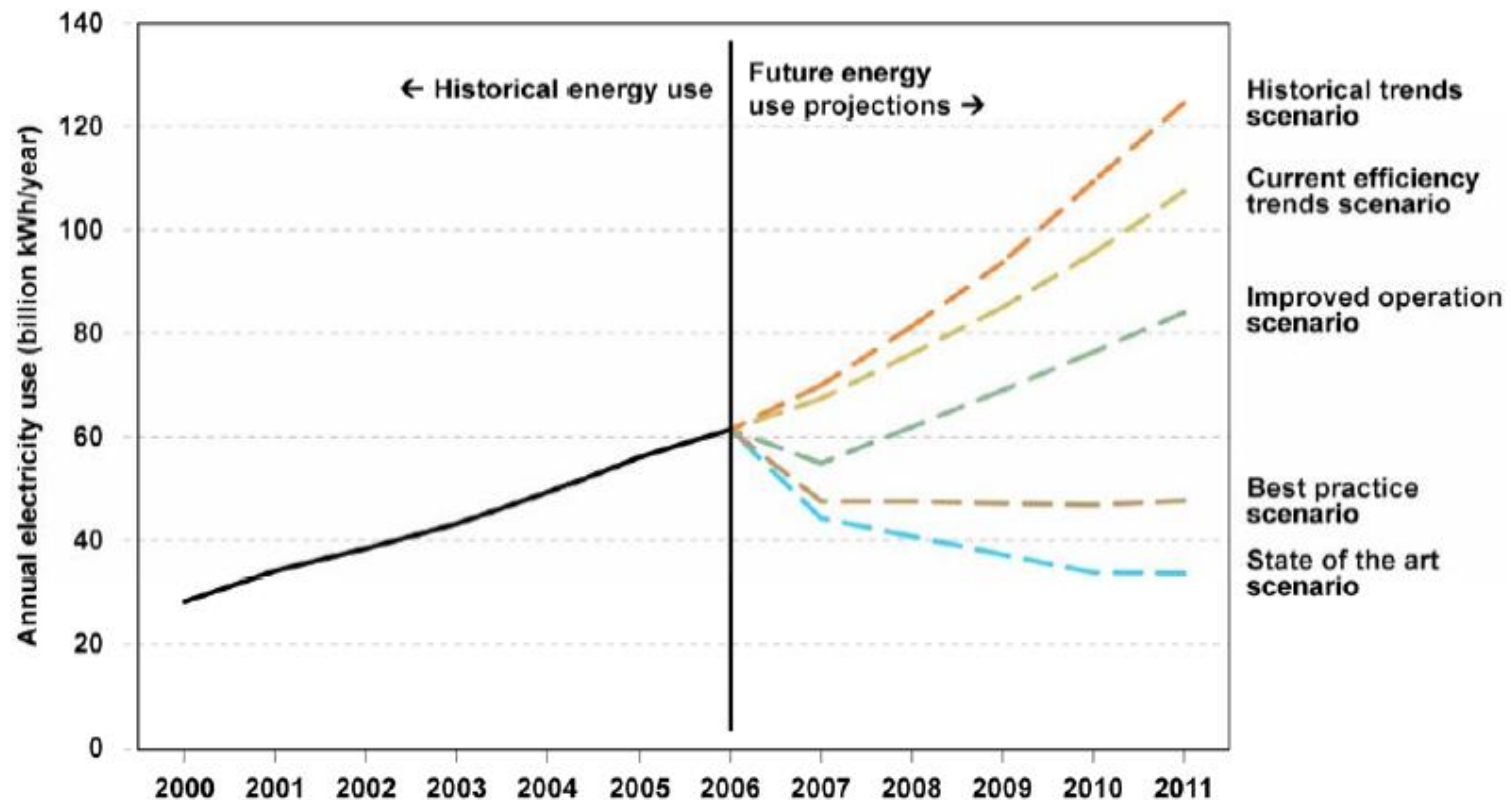
Potential Benefits of Energy Efficiency

- 20-40% savings & high ROI typical
- Aggressive strategies can yield 50+% savings
- Extend life and capacity of infrastructures



Data Center Energy Projections in 2007

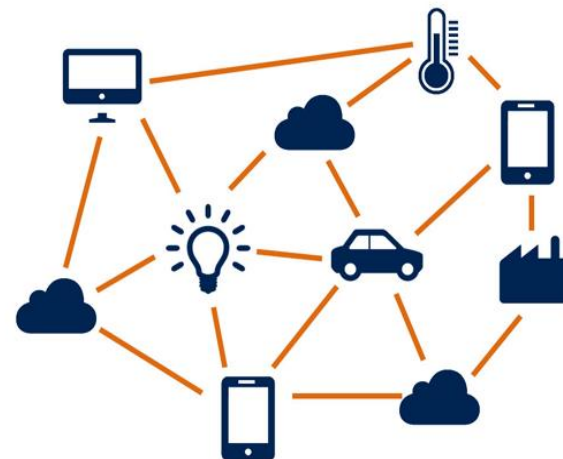
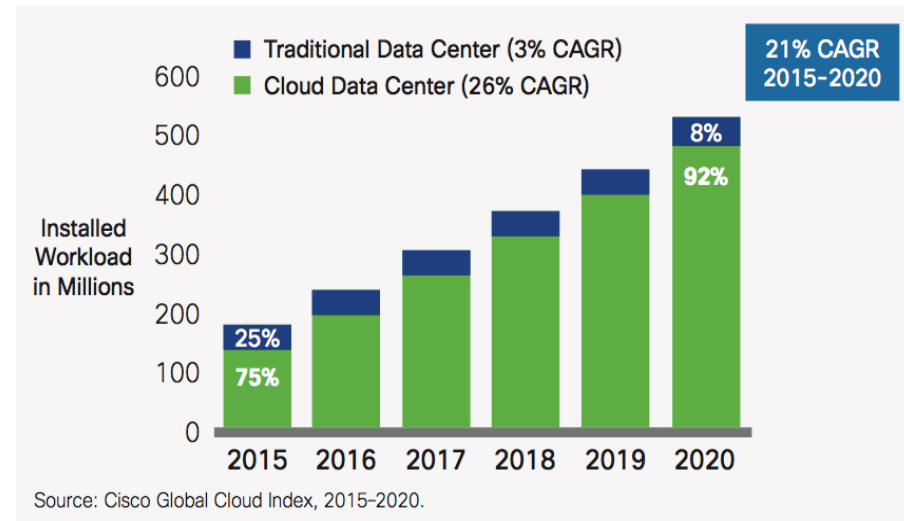
Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431



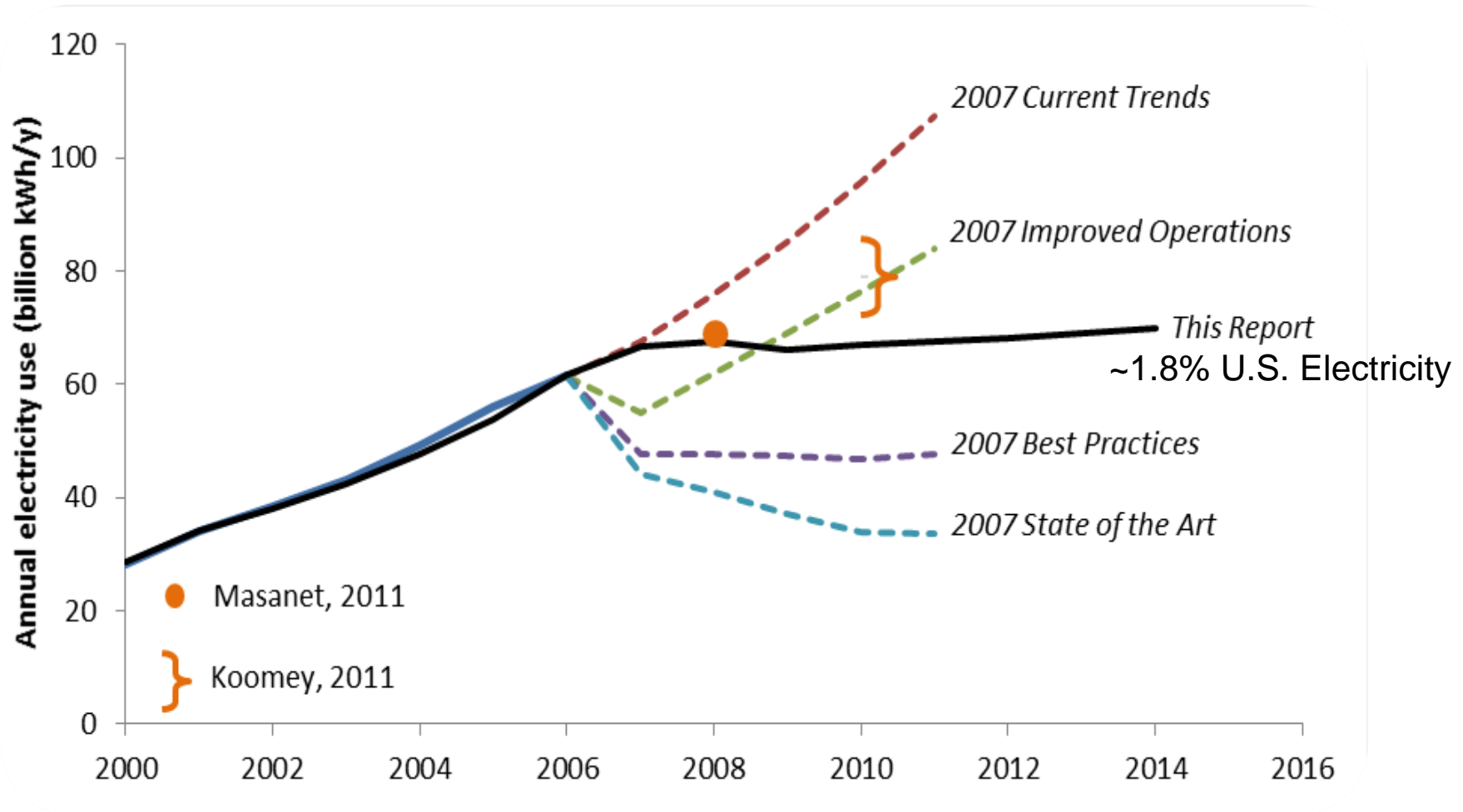
Brown et al., 2007, *Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431*

Data Center Landscape has Evolved Since 2007

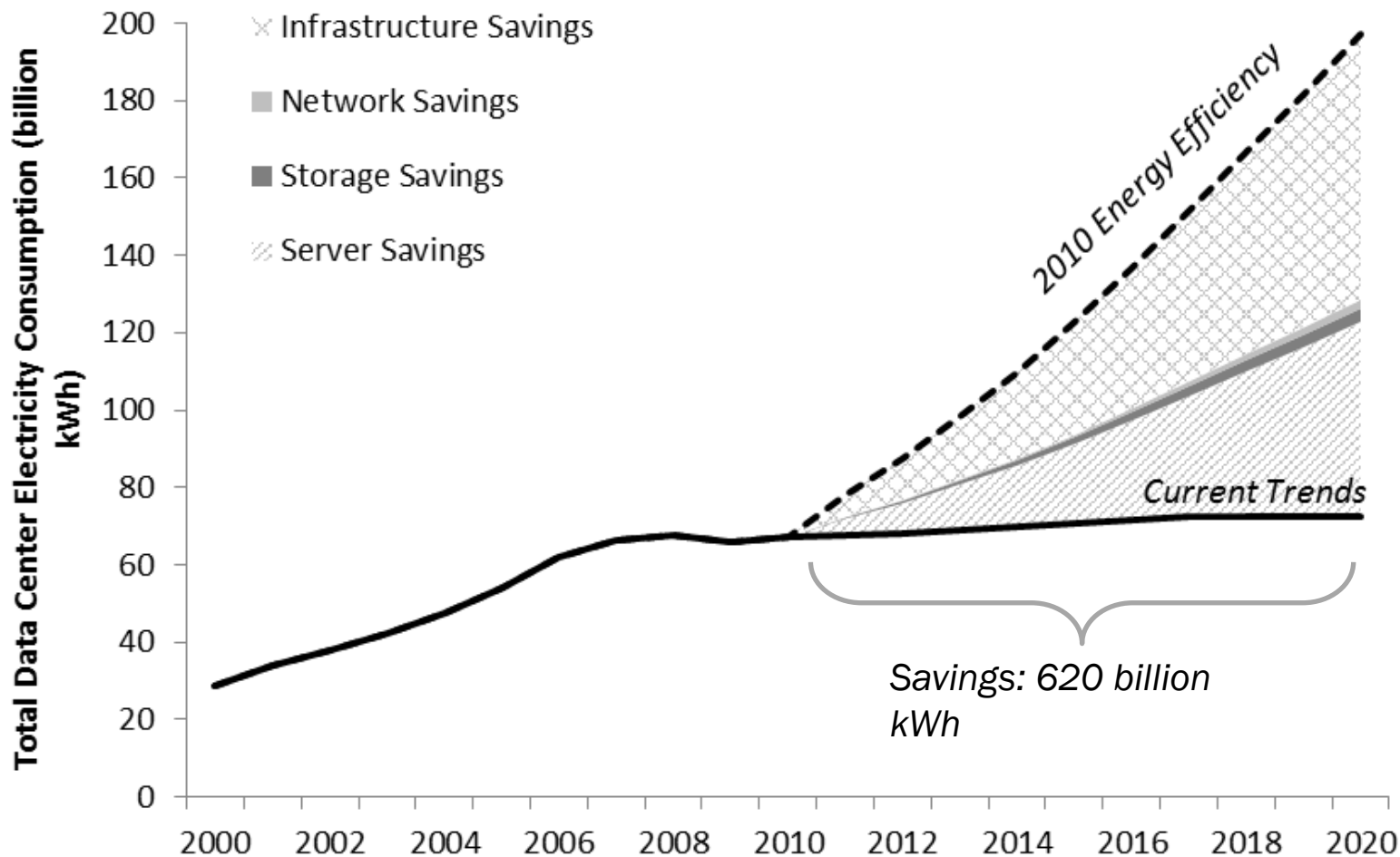
- Emergence of cloud computing and social media
 - IP traffic increasing 20% annually
- “Hyperscale” data centers
- Growth in data storage
 - 20x increase since 2007
- “Internet of Things” capabilities
- New IT equipment
 - “Unbranded” ODM servers
 - Solid state hard drives
 - Faster network ports



US Data Center Energy Usage Reports (2007 & 2016)

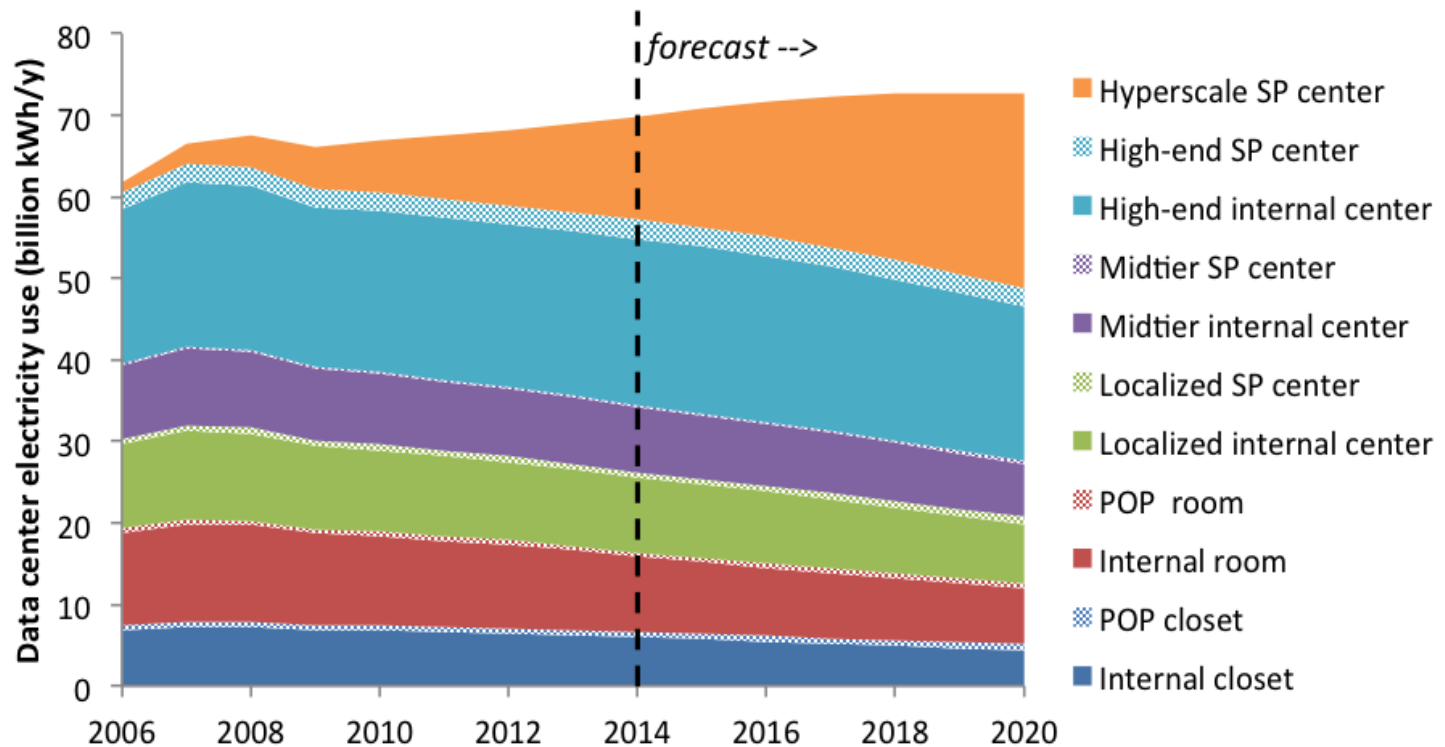


Results: Energy Use Projections and Counterfactual



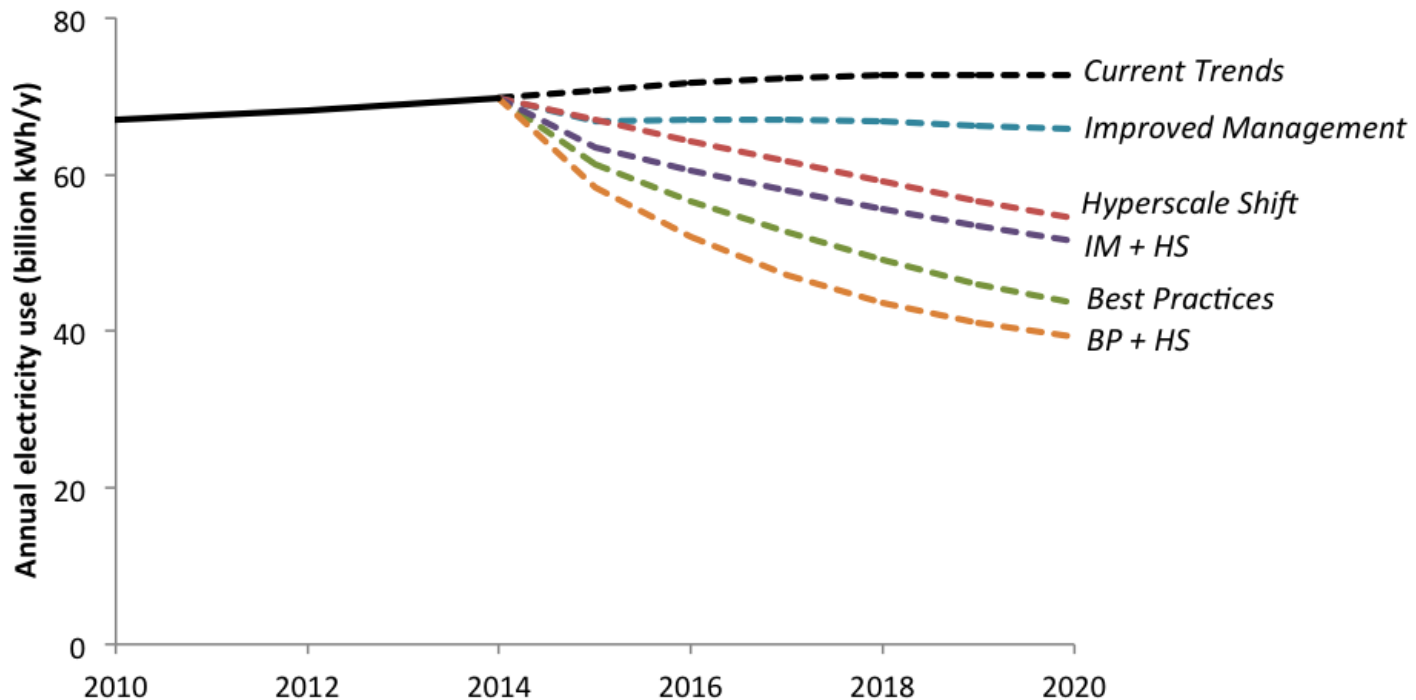
Energy Use Estimates by Data Center Type

- Hyperscale is a growing percentage of data center energy use

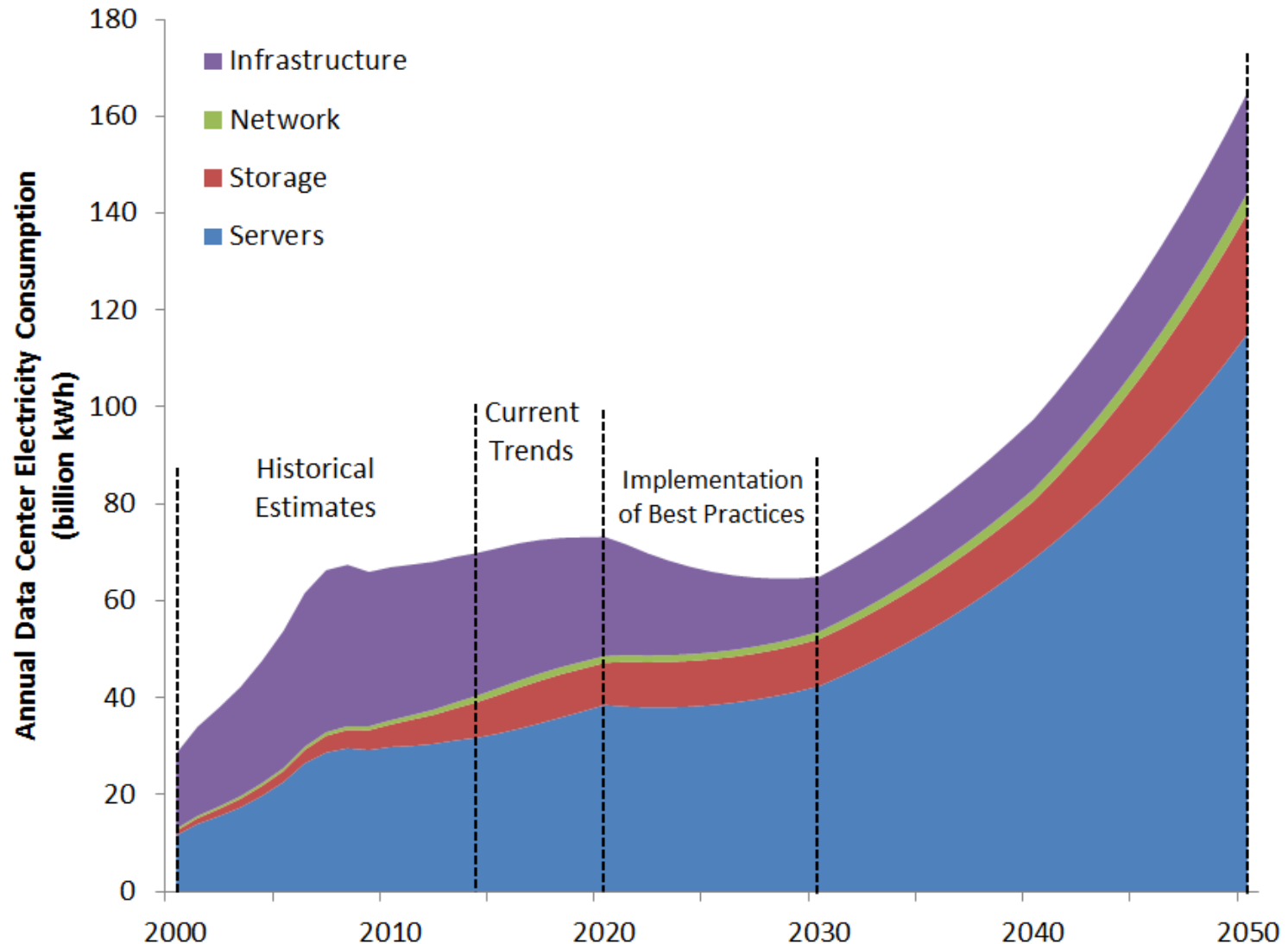


More Savings Available through Efficiency

- Annual saving in 2020 up to 33 billion kWh
- Represents a 45% reduction in electricity demand over current trends



2050 Projections



In Conclusion...

- **Data center energy use has approximately plateaued since 2008**
 - Expected to continue through 2020
- **Further efficiency improvements possible, but will eventually run out**
- **Next-generation computing technologies and innovative data center business models will be needed to keep energy consumption down over the next 20-30 years**

Fed Driver: Executive Order 13693

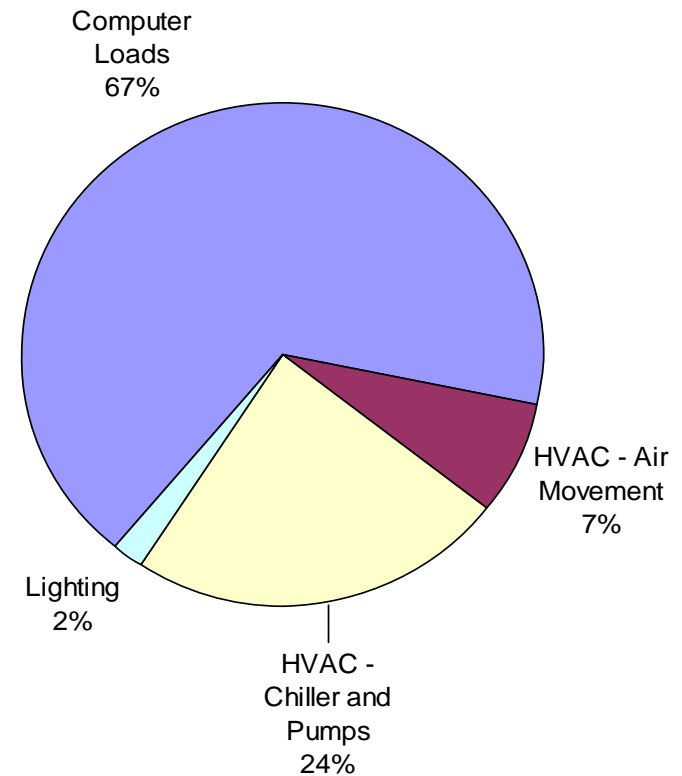
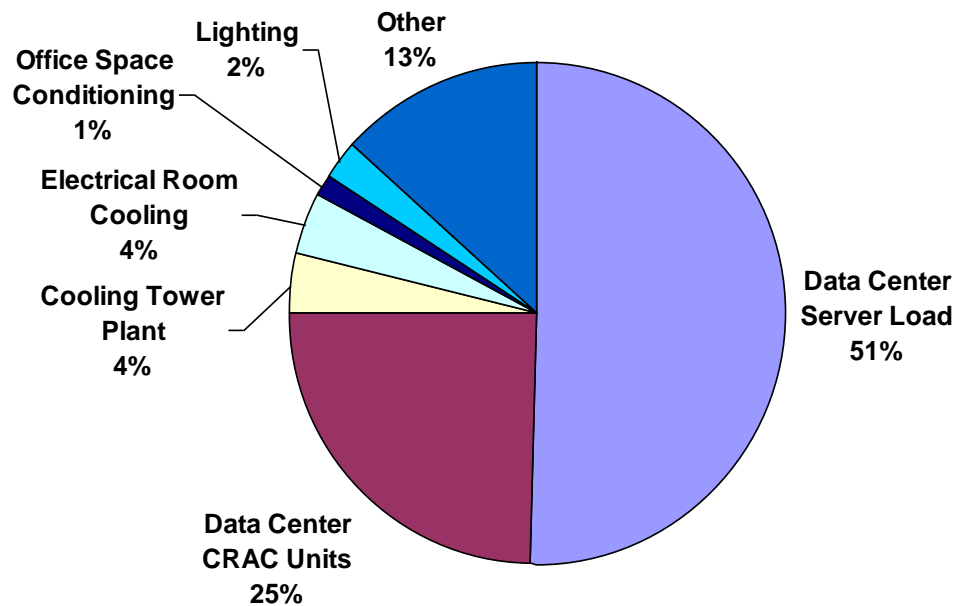
Specific goals for data centers

- Promote energy optimization, efficiency, and performance
- Install/monitor advanced energy meters in all data centers by FY2018
- Assign a Data Center Energy Practitioner (DCEP)
- Establish a Power Usage Effectiveness (PUE) target
 - between 1.2 and 1.4 for new data centers
 - less than 1.5 for existing data centers

Other related goals

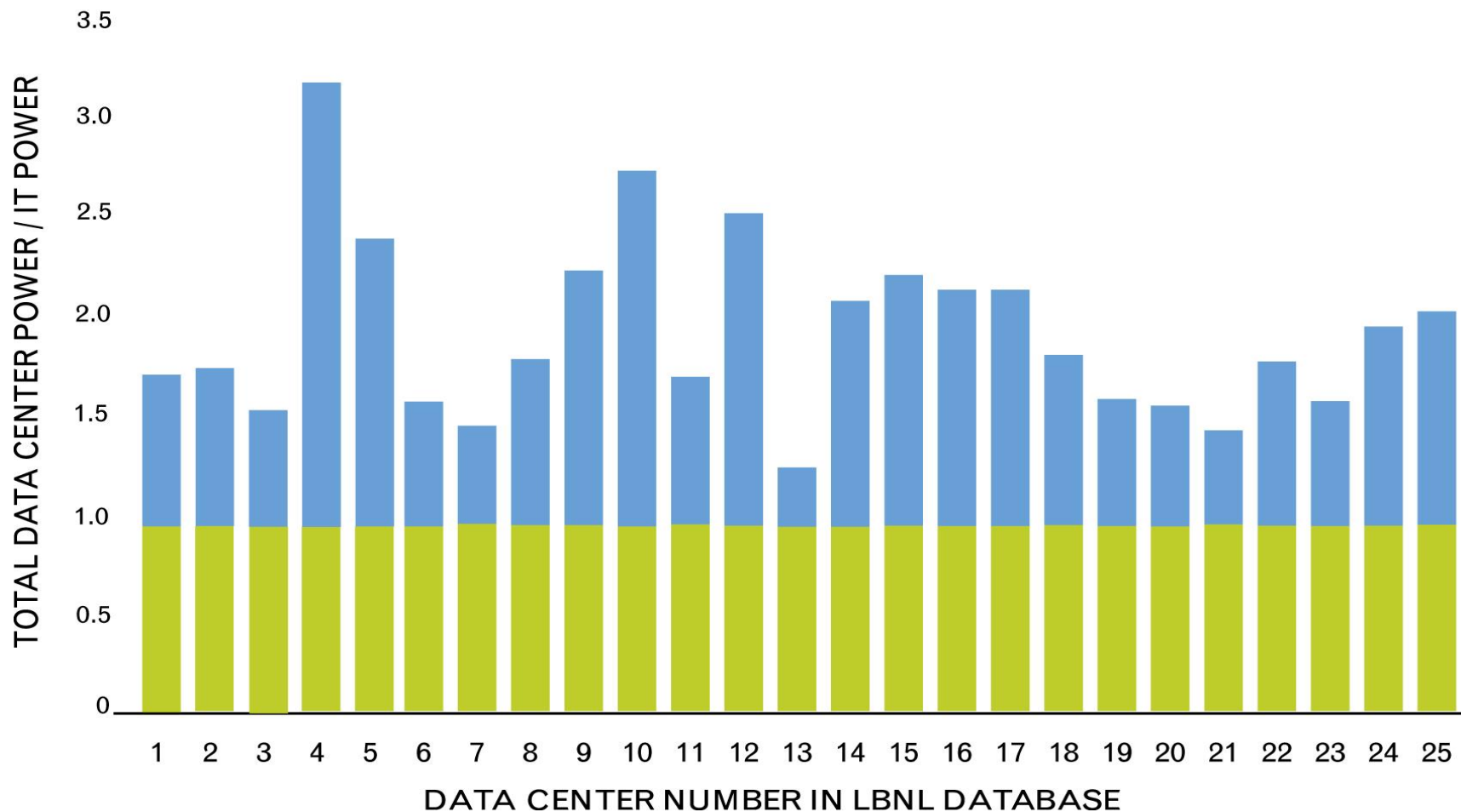
- Reduce building energy 2.5% per year per sq. ft. thru 2025
- Increase clean and renewable energy – to 25% & 30% by 2020 & 2025
- Reduce water consumption 2% per year per sq. ft. thru 2025
- Make ENERGY STAR or FEMP designated acquisitions

Benchmarking Energy Performance: So What is PUE?



High Level Metric: PUE

Power Utilization Effectiveness (PUE) = Total Power/IT Power



Sample PUEs

PUEs: Reported & Calculated	PUE
EPA ENERGY STAR Average	1.91
Intel Jones Farm, Hillsboro	1.41
T-Systems & Intel DC2020 Test Lab, Munich	1.24
Google	1.16
Leibniz Supercomputing Centre (LRZ)	1.15
National Center for Atmospheric Research (NCAR)	1.10
Yahoo, Lockport	1.08
Facebook, Prineville	1.07
National Renewable Energy Laboratory (NREL)	1.06

Source: Mike Patterson, Intel

Data Center Best Practices

1. Measure and Benchmark Energy Use
2. Identify IT Opportunities, and modify procurement processes to align with the procurement policy
3. Optimize Environmental Conditions
4. Manage Airflow (Air Management)
5. Evaluate Cooling Options
6. Improve Electrical Efficiency
7. Use IT to Control IT Energy

DOE and Utility Collaboration

- Federal efforts are resource constrained and cannot achieve significant market penetration on their own
 - ➔ Key goal: leverage DOE and utility resources
- Initiated Strategic Plan in FY16
- FY17-18 activities:
 - Utility webinar on resources and partnering opportunities
 - Cost-sharing demonstration projects (targeting 2-3) for prescriptive air management “packages” for small data centers
 - White paper on demand response in data centers

Utilities

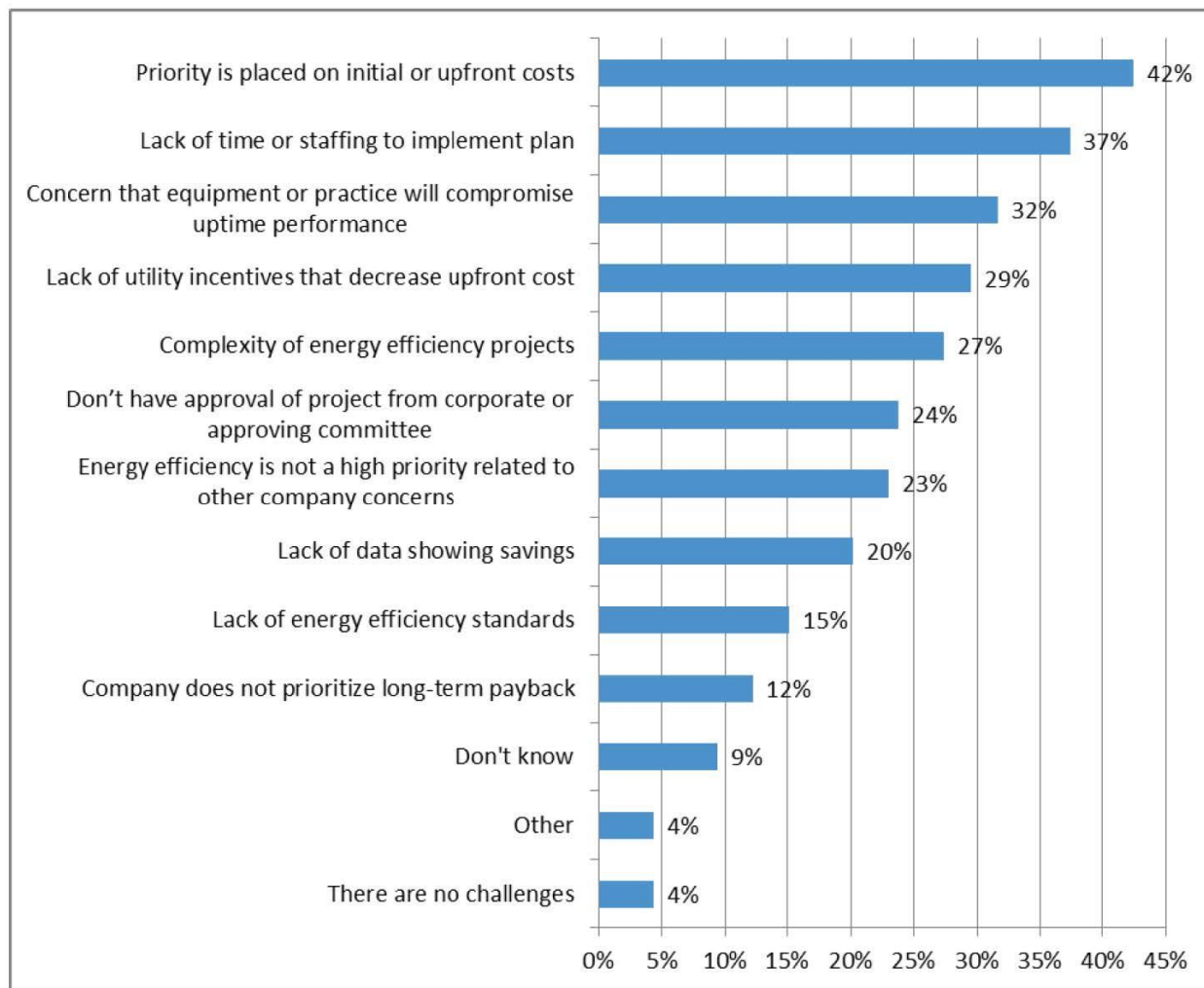
- Customer-facing efficiency programs
- A number of measures targeted through existing programs

Virtualization	ENERGY STAR Server	Massive Array of Idle Disks	Uninterruptible Power Supply	Chillers/Cooling Towers	Thermal Energy Storage	Storage Consolidation	Airflow
Airflow	Variable Frequency Drive	Air-Side Economizer	Water-Side Economizer	Pumps/Motors	HVAC/CRAC	DC Power	

Source: Environmental Protection Agency. 2012.

- Existing efforts often have low market penetration and savings- Federal data centers appear to be particularly under-served.
- Utility efforts are embedded in the marketplace but require technical resources and independent expertise.
- Utilities often find the existing technical information and literature complicated for their customers and “C-suite” audiences.

Barriers to Data Center Energy Efficiency Projects



By working more closely, Department of Energy (DOE) and utilities can be more responsive to the barriers perceived by data center managers.

Source: Cadmus, et al. 2015 for NYSERDA.

Strategy Overview

- *DOE/LBNL and utilities can act as “honest brokers,” providing credible third-party expertise. DOE efforts to-date have not focused on utility needs.*

- **2016 report prepared by LBNL**
 - Interviews with representatives from 16 utilities
 - Literature review and applied knowledge from LBNL’s related work
- **Seven strategies identified for DOE/LBNL and utilities to raise the energy efficiency of data centers. Goals:**
 - More accessible information and tools
 - Reach broader audience, including less-sophisticated users
 - Expand scope to include “softer” topics such as business-case analysis
 - Positive influence on regulatory process and decisionmaking (e.g. technologies allowable in programs).
- **Can formalize strategy through a collaborative framework**
 - Freestanding consortium or integrate efforts within an existing group

1. Expand audience of the Center of Expertise

Challenge: Strategic utility personnel often unaware of resources available from the Center of Expertise (CoE)

DOE/LBNL

- Tailor tools, best practices, and training for underserved groups such as small data center operators, utility customer representatives, senior managers, and others lacking deep background in data centers
- Reach broader audiences by publishing material in new places (e.g. business press)

Utilities

- Send staff to CoE trainings
- Incorporate pointers to CoE resources in customer-facing communications
- Provide view of market segmentation
- Customize CoE material to individual target audiences

2. Shift from emphasis on information “pull” to “push”

Challenge: Few people visit websites unprompted.

DOE/LBNL

- “Push” users to visit the CoE through email, social media, newsletters, and/or webinars
- Give more frequent and targeted presentations through:
 - Utilities
 - Consortium for Energy Efficiency (CEE)
 - Federal Utility Partnership Working Group (FUPWG)
 - Trade associations such as the Green Grid and ASHRAE

Utilities

- Engage customers in CoE’s information streams

3. Support DOE deployment programs

Challenge: Limited utility awareness of DOE's programs.

DOE/LBNL

- Further promote DOE deployment programs (e.g. the Better Buildings Challenge and the Data Center Accelerator)
- Further promote the Federal Utility Partnership Working Group (FUPWG)

Utilities

- Engage the CoE to identify and approach promising data centers in service territory
- Provide support to partners/customers (measure identification, metering plans, reporting, etc.)

4. Help utilities make the case for robust market interventions

Challenge: Low market penetration of existing programs and under- or misinformed regulators.

DOE/LBNL

- Leverage recent national market assessment and tailor to local conditions
- Ensure proper treatment of retrofit as well as new-construction applications
- Act as an “honest broker” to increase regulators’ level of competence including tailored trainings, state-level market assessments, and technical “White Papers” used to vet program proposals:
 - National regulatory entities such as National Association of Regulatory Utility Commissioners (NARUC)
 - FERC
 - NERC
 - ISOs
 - State/regional energy offices (individually and/or via NASEO)

Utilities

- Identify needs, helping DOE/LBNL establish priorities
- Share successes via CoE, FUPWG, and CEE
- Promote utility-branded versions of DOE resources
- Focus on new-construction in relevant markets (e.g., Northwest)
- Increase competency of non-datacenter account managers to address datacenters embedded in a diversity of “ordinary” buildings

5. Provide more comprehensive and relevant characterization of benefits

Challenge: Current efforts emphasize energy benefits while bigger drivers may be non-energy benefits.

DOE/LBNL

- Emphasize economics and non-energy benefits such as reliability (both within facilities and at the grid level) in CoE projects
- Address institutional barriers (e.g. IT staff vs. Facility staff needs)

Utilities

- Educate customers (end-users) with the goal of increasing perceived value of data center energy efficiency and program participation

6. Keep up with a changing technical landscape

Challenge: Emerging issues and opportunities such as demand response, smaller embedded data centers, liquid cooling, retro-commissioning, and waste-heat recovery need to be addressed.

DOE/LBNL

- Ensure core work on best practices, trainings, and tools keep pace, including updating already produced material
- Expand definition of best practices beyond technologies to management practices, standardized savings-calculation methods, downsized/partially-loaded datacenters, project quality assurance, financial analysis, etc.

Utilities

- Identify gaps in the existing CoE offerings
- Help set priorities for the targeting of existing federal resources

7. Address practical aspects of implementation

Challenge: Utilities seek to go beyond defining idealized outcomes, i.e., to help customers in implementation in the context of practical constraints and challenges.

DOE/LBNL

- Help utilities address challenges, such as:
 - Harmonizing energy efficiency with fire codes
 - Coping with downsizing
 - Practical issues of metering and collecting data for computing PUEs
 - Helping customers perform cost-benefit analyses
 - Educating regulators.

Utilities

- Promulgate new guidelines related to challenges

Next Steps: Utilities

- **Encourage data center customers to participate in DOE & EPA programs**
- **Create forums for customers to share best practices and lessons learned**
- **Utilize CoE tools and resources with customers to improve efficiency**
 - Assist customers to benchmark energy performance of their data centers
- **Sponsor training opportunities**
 - Data Center Energy Practitioner (DCEP) training and certification
 - Awareness workshops
 - Webinars
- **Support demonstration/showcase projects**
 - Retrofit their own data centers – lead by example
- **Target federal data center customers with Utility Energy Service Contacts (UESCs)**
- **Fund efforts through a collaborative framework**

Next Steps: DOE/LBNL

- **Initiate 2-3 demonstrations of prescriptive retrofit packages for small data centers.**
 - Cost sharing with 1-3 utilities (and their customers).
 - Federal customers will be targeted, but there may be a mix
 - Builds on work underway with PG&E
- **Develop and host an annual webinar targeting utilities**
 - Describe overall opportunities and trends in the rapidly changing data center industry
 - Describe current projects and resources
- **Develop data center demand response white paper**

Example: Prescriptive Air Management “Packages” for Small Data Centers

- “Small” data centers (<5,000 ft²) use ~50% of all energy used in data centers¹
- Majority of energy saving potential, best opportunity
- ... but a number of barriers:
 - Difficult to find (embedded)
 - Difficult to engage
 - Limited expertise
 - Limited resources
 - Limited savings for each individual data center.

•1) Shehabi, A. et al, 2016. U.S. Data Center Energy Usage Report.

Current Work at PG&E

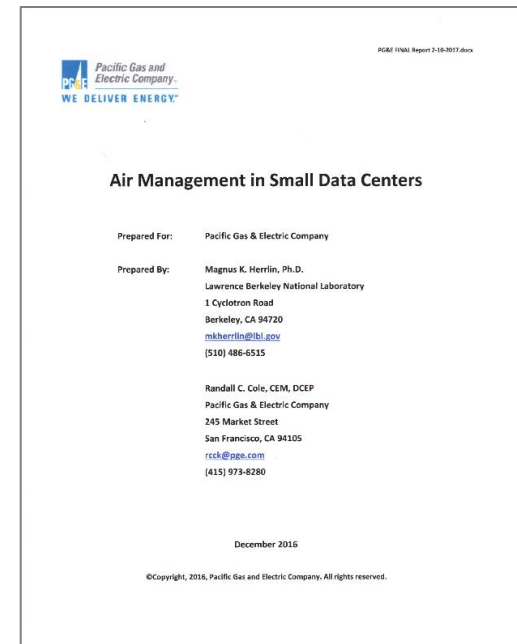
- Virtually all data center energy savings incentives currently offered to PG&E customers are using custom new construction or retrofit calculated programs
- Custom calculations are costly and not feasible to reach small imbedded data center market
- Focus on air management as a potential deemed opportunity for small data centers at reasonable program implementation cost.

Current Work at LBNL

- Focus on saving energy in small data centers
- Focus on air management
- Survey of portable air management monitoring tools
- Developing “packages” of air management measures.
- Center of Expertise for Energy Efficiency in Data Centers: <http://datacenters.lbl.gov>
- Reports, software, training,...

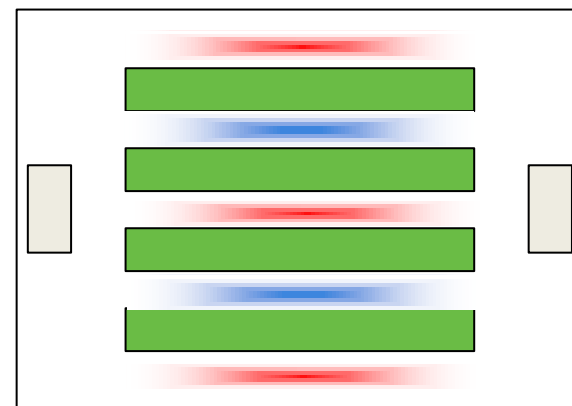
Potential Solution

- Develop prescriptive “packages” of air management measures through modeling.
- Methodology:
 - Select typical small data center
 - Select simulation tool
 - Select packages
 - Determine energy savings.



Selection of “Typical” Small Data Center

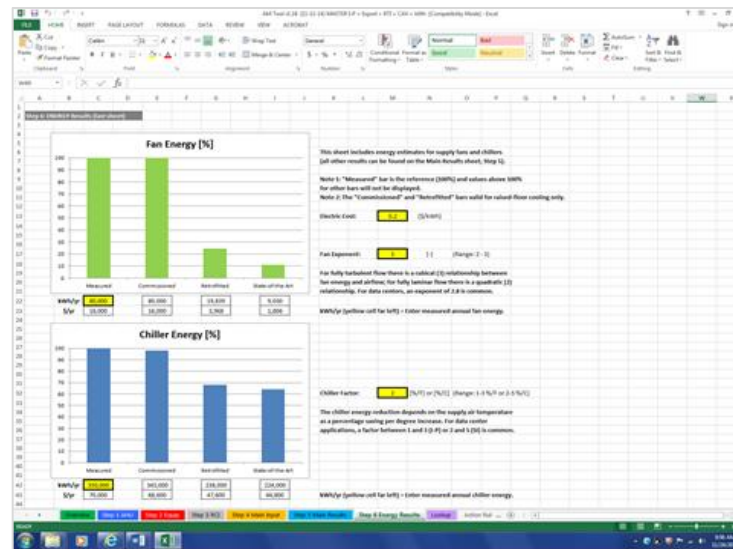
- 2000 ft²
- 60 IT racks in 4 rows
- Raised floor, hot and cold aisles
- Two 30-ton CRACs or three 20-ton CRACs
- CAV or VAV fans
- 82 kW IT equipment power
- 25F temperature rise
- Embedded.



Plan view of data center with four rows of IT racks

Selection of Simulation Tool

- Reviewed two tools: The DOE Air Management Tool and the Airflow Management Calculator.
- Both have pros and cons; quite complementary
- The DOE Air Management Tool allows manipulation of individual air management measures.



Selection of Packages

- Addressed most common individual measures
- Start with inexpensive, but effective measures

AM-Measure (AM Tool)	Reference	P1	P2	P3	P4	P5
#1: Recommended Range ¹	65-80°F	65-80°F	65-80°F	65-80°F	65-80°F	65-80°F
#2: Allowable Range ²	N/A	N/A	N/A	N/A	N/A	N/A
#3: Aisle Containment	L	L	L	M	M	H
#4: Blanking Panels	L	M	M	M	H	H
#5: Floor Leakage	L	M	M	M	M	H
#6: Tile Placement	L	M	H	H	H	H
#7: EC-Class	H	H	H	H	H	H
#8: CAV/VAV (CRAC)	CAV	CAV	VAV	CAV	VAV	VAV
#9: CRAC Modularity	M (2) or H (3)	M (2) or H (3)	M (2) or H (3)	M (2) or H (3)	M (2) or H (3)	M (2) or H (3)
#10: Cable Management	L	L	L	L	M	M

¹ The ASHRAE Recommended Range is used throughout.

² The ASHRAE Allowable Range does not enter the energy calculations.

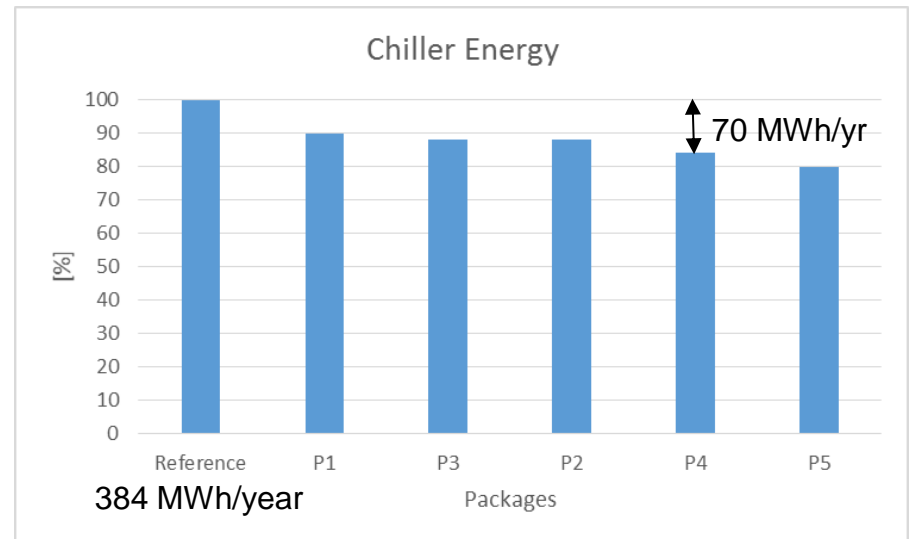
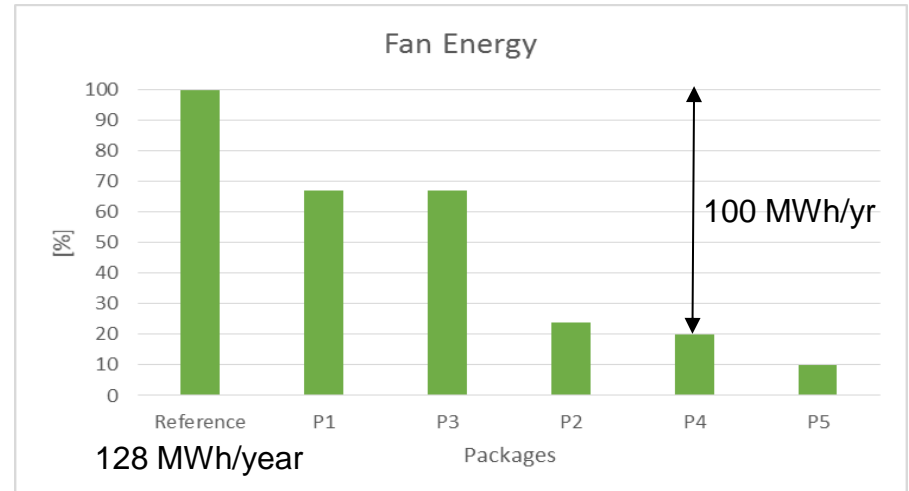
Level of quality/implementation: L: Low, M: Mid, H: High.

Determine Energy Savings

- Run each package through the simulation tool
 - Determine the increase in supply temperature
 - Determine the decrease in supply airflow
 - Determine chiller energy savings
 - Determine the supply fan savings.

Results

- Developed 6 packages
- Estimated savings
- Roadmap for selecting:
 - Matched data center
 - Target data center
 - Rebates.



Need for Simple, Inexpensive Air Management Monitoring Tools

- Access to simple, inexpensive tools for tracking air management is imperative. Many advanced monitoring systems are often too complex and expensive for small data centers.
- We looked at three portable tools that can be brought into the data center for checking the thermal conditions. We will demonstrate all three in a live data center in 2017 with funds from the Federal Energy Management Program (FEMP).

Selected Portable Air Management Monitoring Tools



Purkey Labs,
Audit-Buddy



Geist, Watchdog 15



PacketPower

Next Steps

- **Demonstration project for the packages (2017/18)**
- **Demonstration project for the portable tools (2017)**
- **Methodology to find & engage the small data center**
- **Determine the generalized costs for the packages**
- **Develop deemed savings**

DOE's Center of Expertise

Datacenters.lbl.gov

Navigation

Search

Featured Resources

Featured Activities



CENTER OF EXPERTISE
FOR ENERGY EFFICIENCY IN DATA CENTERS

SEARCH



U.S. DEPARTMENT OF ENERGY



FEMP
Federal Energy Management Program



BERKELEY LAB

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FEATURED RESOURCES:

- [NEW Air Management Estimator](#)
- [NEW Energy Assessment Worksheet](#)
- [Data Center Metering & Resource Guide](#)
- [Master List of Efficiency Actions](#)
- [DC Pro Tools](#)



The Department of Energy-led Center of Expertise for Energy Efficiency in Data Centers (CoE) demonstrates national leadership in decreasing the energy use of data centers. Through the supply of technical support, tools, best practices, analyses, and the introduction of technologies, CoE assists federal agencies and other organizations implement data center energy efficiency projects. The CoE, located at the Lawrence Berkeley National Lab, partners with key public and private stakeholders to further efficiency efforts.

Data Center Optimization Initiative (DCOI)

DCOI was established in the Office of Management and Budget (OMB) memorandum M-16-19 dated August 1, 2016, and includes a number of energy efficiency requirements for federal data centers. The Center of Expertise is here to help.

Data Center Energy Practitioner (DCEP) Training

The data center industry and DOE partnered to develop the DCEP training program that certifies energy practitioners qualified to evaluate the energy status and efficiency opportunities in data centers. Course content was updated June 2016.

Technologies

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Cooling Air / Air Management

Technologies

Reducing energy consumption in data centers relies on the use of energy-efficient technologies and systems. Click the technologies listed below for tips on improving performance and purchasing new.

Cooling Air / Air Management

In most cases, air distribution in data centers involves mixing of cooled air with air that has been heated by the IT equipment making it difficult to supply the cool air to where it is needed and resulting in inefficient heat transfer to the cooling system.

IT Equipment

Computations per watt is improving, but computation demand is increasing even faster, so overall energy use is increasing. The lifetime electrical cost will soon exceed cost of IT equipment. However, IT equipment load can be controlled.

Power

UPS, Front-end AC-DC power supplies, and DC-DC converters are three important conversion processes for powering of servers and other IT loads. Improving the efficiency of these processes can significantly improve the overall energy efficiency of a data center. Storage is a parallel area of importance.

Cooling Plant

Many opportunities exist to reduce energy consumption of cooling equipment including raising the chilled water temperature; air, water, or refrigerant-based economizers, and all-variable-speed plants.

Monitoring and Controls

Monitoring and controls are essential to effective energy management. Data center infrastructure management (DCIM) is a comprehensive approach that has received increasing attention in the last few years.

Liquid Cooling

Liquid cooling is valuable in reducing energy consumption because the heat capacity of liquids is orders of magnitude larger than that of air and once heat has been transferred to a liquid, it can be removed from the datacenter efficiently.

Environmental Conditions

Most data centers are overcooled and have humidity control issues, which is a valid concern as room temperature and humidity are two of the main HVAC energy drivers.

Lighting

Lighting controls, efficient lighting, and use of task lighting are all widely deployed in commercial buildings and can easily result in savings for the data center.

Technologies, example

Cooling Air / Air Management

In most cases, air distribution in data centers involves mixing of cooled air with air that has been heated by the IT equipment making it difficult to supply the cool air to where it is needed and resulting in inefficient heat transfer to the cooling system.

Poor air management leads to more air being circulated than required, which leads to air mixing and short circuiting. It also results in recirculated hot air, which is the cause of most hot spots.

HIGH-LEVEL BEST PRACTICES

- Install the Racks in Rows
- Implement Hot and Cold Aisles
- Preserve Any Hot-Aisle/Cold-Aisle Arrangements
- Rearrange Perforated Floor Tiles, Locating Them Only in Cold Aisles and Matching the Tile Flow Rate with the IT Equipment Airflow Rate
- Cover Openings Within and Between Racks
- Evaluate the Air Path (Under the raised floor or in the ceiling space) and Rearrange the Cables, Wires, and Pipes to Address Possible Congestion in the Cooling Air Path
- Seal the Remainder of the Cable Penetrations
- Separate Cold Air and Hot Air
- Shut Off Extra CRAC/CRAH/AHU
- Reset Each CRAC/CRAH/AHU Chilled Water Valve Setpoint with the Highest Air Intake Temperature at the Racks in that Zone
- Convert the Data Center CRAC/CRAH/AHU Air Temperature Control to the Rack Inlet Air Temperature Control
- Use Modeling Tools such as CFD or Thermal Imaging Install Variable Frequency Drives (VFDs) on CRAC/CRAH/AHU Fans with Advanced Control

FEATURED RESOURCES

- [Data Center Master List of Efficiency Actions](#) provides more information on the high-level best practices outlined above as well as a more detailed list of best practices related to cooling air and air management.
- The excel-based [Data Center Air Management Tool](#) provides air management recommendations (actions) and the potential for reducing the supply airflow rate and increasing the supply air temperature without affecting the thermal equipment environment. The Tool also estimates % energy reduction, kWh reduction, and associated \$ savings for fans and chillers. It is based on user input. An accompanying [Data Collection Guide](#) is also available.

Links:

[Data Center Master List of Efficiency Actions](#)
[Data Center Air Management Tool](#)
[Datacenter Air Management Tool Data Collection Guide](#)
[All Air Cooling / Air Management Resources](#)

Activities

[HOME](#)[ABOUT](#)[TECHNOLOGIES](#)[ACTIVITIES](#)[TOOLS](#)[NEWS & TRAINING](#)[RESOURCES](#)[CONTACT US](#)

**Data Center
Energy
Practitioner
(DCEP)
Training**

[All Activities](#)[DCEP Training](#)[DCOI](#)[Tools](#)[Small Data Centers](#)[India](#)[China](#)[Better Buildings](#)[High Performance
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Collaboration](#)[Related FEMP Activities](#)

Activities

CoE facilitates activities that range from training sessions and webinars, to the creation of tools, to specialized programs.

Data Center Energy Practitioner (DCEP) Training

The DCEP training program certifies energy practitioners qualified to evaluate the energy status and efficiency opportunities in data centers. A list of DCEP Program Developers, Instructors, and Practitioners is also maintained and available here.

[\[Edit\]](#)

Training

List of upcoming and on-demand training events and news via our Twitter feed. Content is focused on information and opportunities to facilitate energy efficiency projects in data centers with special attention paid to resources for federal agencies.

[\[Edit\]](#)

Small Data Centers

Energy efficiency efforts and attention for data centers have historically focused on larger data centers. Despite their comparatively small size, small data centers (defined as server closets, rooms, and localized data centers under 5,000 square feet of computer floor) have significant energy savings potential.

[\[Edit\]](#)

China

Unprecedented demand and policies are driving rampant growth in data centers throughout China. Asia is experiencing 27% data center growth- which is expected to last through 2020. This is over two times the growth rate of other regions, and is dominated by China (Data Center Dynamics, Shanghai 2017). DOE and LBNL are working with China's Ministry of Industry and Information Technology (MIIT) and industry to promote open standards, test procedures, specifications, and evaluation metrics for U.S. and Chinese data centers.

[\[Edit\]](#)

High Performance Computing

Demand for High Performance Computing (HPC) is growing in both the public and private sectors. It is also highly energy-intensive. LBNL has organized a HPC Working Group to address the energy-efficiency issues related to these technologies and provides guidance and resources tailored to HPC.

[\[Edit\]](#)

Partnerships & Collaboration

Utilities and state energy offices are critical partners in disseminating energy efficiency information, opportunities, and incentives for the marketplace.

[\[Edit\]](#)

Data Center Optimization Initiative (DCOI)

The Data Center Optimization Initiative (DCOI) requires federal agencies to develop and report on data center strategies to consolidate inefficient infrastructure, optimize existing facilities, improve security posture, achieve cost savings, and transition to more efficient infrastructure, such as cloud services and inter-agency shared services.

[\[Edit\]](#)

Tools

Toolkits and calculators are available to support the implementation of best practices. Tools cover areas such "early stage" data center profiling to establish a baseline and efficiency potential, and more detailed sub-system assessments to identify opportunities.

[\[Edit\]](#)

India

The energy intensity of data centers, the growth of data center infrastructure in India, and the existing power deficit in the country calls for increased energy efficiency in Indian data centers. A public-private partnership is working to increase the energy efficiency of data centers in India.

[\[Edit\]](#)

Better Buildings Data Center Partners (Challenge or Accelerator)

DOE is working with public and private building owners to reduce energy use in data centers. There are over 34 partners committed to date through the Better Buildings Challenge and Data Center Accelerator programs.

[\[Edit\]](#)

Related FEMP Activities

A number of activities supported by the Federal Energy Management Program (FEMP) assist in making data centers more energy efficient. These activities and accompanying resources include the purchase of energy- and water-efficient products, project financing, and institutional change for sustainability.

[\[Edit\]](#)

**Partnerships &
Collaboration
Page with
resources
geared towards
utilities**



Activities, example: DCEP Program



**CENTER OF
EXPERTISE**
FOR ENERGY EFFICIENCY IN DATA CENTERS

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All ActivitiesDCEP TrainingBetter Buildings Data Center PartnersMeasure and ManageHigh Performance ComputingIndiaChinaTools

Data Center Energy Practitioner (DCEP) Training

Program Description

Data centers are energy-intensive and opportunities exist to reduce energy use, but significant knowledge, training, and skills are required to perform accurate data center energy assessments. In order to accelerate energy savings, the data center industry and DOE partnered to develop the Data Center Energy Practitioner (DCEP) Program. The DCEP training program certifies energy practitioners qualified to evaluate the energy status and efficiency opportunities in data centers.

The entire DCEP course curriculum was updated in 2016 in collaboration with the industry to reinforce proven best practices as well as introduce new tools and techniques in key areas such as IT equipment, air management, cooling systems, and electrical systems.

DCEPs will:

- Be qualified to identify and evaluate energy efficiency opportunities in data centers;
- Demonstrate proficiency in the use of the [Data Center Profiler \(DC Pro\)](#) and [select Assessment Tools](#)
- Address energy opportunities in electrical systems, air management, HVAC, and IT equipment;
- Meet academic/work experience requirements (pre-qualifications);
- Receive training on conducting data center assessments;
- Be required to pass one or two exams.

Property management companies, engineering consulting firms, service companies, data center operators, state energy agencies, and utilities will benefit from the expertise provided by DCEPs. Executive Order 13693 "Planning for Federal Sustainability in the Next Decade" states that all core (Federal) data centers shall have at least one certified DCEP assigned to manage data center performance and continued optimization. This Order will increase the demand for DCEPs and not just in the Federal sector.

Training Calendar and Pricing

The DCEP Program is delivered by two Professional Training Organizations (PTOs): DC-Professional and CNet Training. The Program is also delivered by the DCEP Program Administrator: ANCIS Incorporated. All currently scheduled training events are listed below. If you are interested in participating in one of these events, please contact the individual or organization listed in the last column.

<http://datacenters.lbl.gov/dcep>

Activities, example: Partnerships & Collaboration



The screenshot shows the homepage of the Center of Expertise for Energy Efficiency in Data Centers. The header features the Center's logo, a search bar, and logos for the U.S. Department of Energy, FEMP (Federal Energy Management Program), and Berkeley Lab. A navigation menu includes links for HOME, ABOUT, TECHNOLOGIES, ACTIVITIES, TOOLS, ALL RESOURCES, TRAININGS, CONTACT US, and ADMIN. Below the menu, there are tabs for View, Edit, Webform, and Results. The main content area is titled "Partnerships & Collaboration" and contains a paragraph about the importance of utilities and state energy offices as partners. It lists four bullet points: Educating customers on energy savings opportunities, Providing implementation assistance, Understanding & designing effective customer-facing energy efficiency programs, and Case studies and success stories. A "Resources" section follows, listing four links: Energy Star: Understanding and Designing Energy Efficiency Programs for Data Centers, NRDC: Utility Energy Efficiency Program Design: Server Room Assessments and Retrofits, DC Pro, Best Practices Guide, and Database of State Incentives.

CENTER OF EXPERTISE
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View Edit Webform Results

Partnerships & Collaboration

Utilities and state energy offices are critical partners in disseminating energy efficiency information, opportunities, and incentives for the marketplace. Utilities are well positioned to help data center customers realize significant energy and cost savings through the pursuit of energy efficient opportunities. This page provides resources on data center energy efficiency geared specifically towards utilities. It also provides as well as high level documents that can serve as a helpful starting point for utility management and data center operators alike. Resources include guidance on:

- Educating customers on the vast energy savings opportunities in data centers
- Providing implementation assistance
- Understanding & designing effective customer-facing energy efficiency programs for data centers
- Case studies and success stories

Resources

- [Energy Star: Understanding and Designing Energy Efficiency Programs for Data Centers](#)
- [NRDC: Utility Energy Efficiency Program Design: Server Room Assessments and Retrofits](#)
- [DC Pro](#)
- [Best Practices Guide](#)
- [Database of State Incentives](#)

<https://datacenters.lbl.gov/partnerships-collaboration>

DCEP Federal Requirements

Memorandum M-16-19 (OMB and DCOI) states:

Implementing Instructions [for Executive Order 13693] advise that **“all existing and new data centers shall have at least one certified Data Center Energy Practitioner (DCEP) assigned to manage its performance.”**

Tools

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Tools

Tools presented here can be used sequentially to move from a basic understanding of how energy is used in your data center to identifying opportunities and implementing best practices.

Data Center Profiler (DC Pro) Tools

1. Data Center Profiler (DC Pro) Tools (Featured)

The DC Pro tools, DC Pro and the PUE Estimator are two "early stage" profiling tools designed for data center owners and operators to diagnose how energy is being used by their data centers and determine ways to save energy and money.

3. Energy Assessment Worksheets

Excel-based worksheet to document metrics, actions, and measurements from data center assessments. It is recommended that users first use the DC Pro tool before using this worksheet.

5. Air Management Tools

Two Excel-based tools designed to optimize air management in data centers while enhancing energy efficiency. Both tools were intended to help users accelerate the energy savings in data centers without affecting the thermal IT equipment environment.

7. Energy Efficiency Assessment Report Template (Featured)

Microsoft Word template for qualified assessors to report data center energy efficiency assessment findings. The document can easily be filled in with site data. An example assessment report using the template is also available here.

Third-Party Tools & Incentives

The Data Center Maturity Model, ENERGY STAR Portfolio Manager, the Free Cooling Calculator, and financial incentives are also available to help improve energy efficiency in data centers.

2. Energy Assessment Process Manual

Manual that provides administrative step by step instructions for conducting an energy assessment (before, during, and after the assessment).

4. Energy Assessment Kit Guide and Specification

Guide that covers how a portable and temporary wireless mesh assessment kit can be used to speed up the energy assessment process, reduce the costs, and overcome the issues with respect to shutdowns.

6. Data Center Electrical Power Chain Tool

Excel-based tool designed to help datacenter owners assess the potential savings from efficiency actions in the electrical power chain of a data center (transformers, generators, UPSs, PDUs, power supplies).

8. Data Center Master List of Efficiency Actions (Featured)

Comprehensive list of both high-level and detailed best practices. It is recommended to utilize this list of best practices within an energy assessment report.

Air Management Tools

Tools, example 1: DC Pro Tool

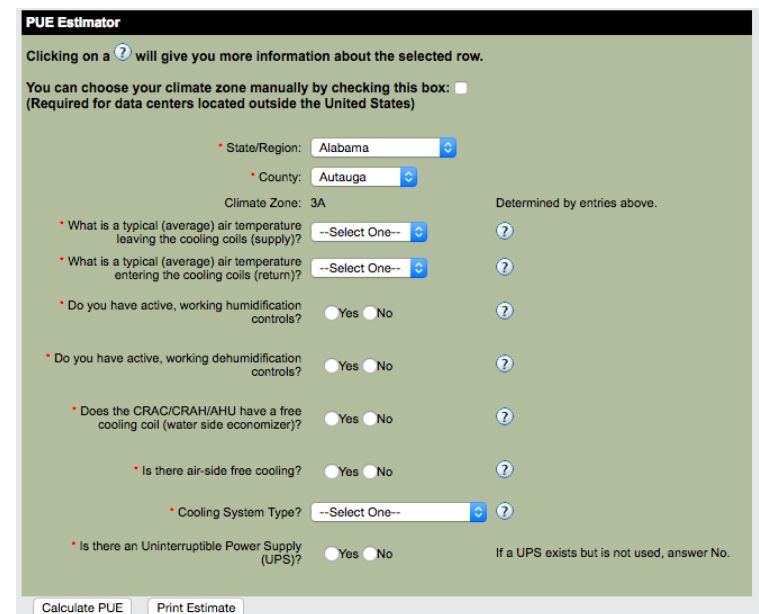
DC Pro Tools estimate PUE without sub-metering

DC Pro

DC Pro estimates current and potential PUE and energy use distribution. DC Pro also provides tailored recommended actions to start improvement process.

PUE Estimator, simplified DC Pro

PUE Estimator only asks questions that affect current PUE and does NOT provide potential PUE or recommended actions.



The screenshot shows the 'PUE Estimator' tool interface. It features a header with the title 'PUE Estimator' and a note: 'Clicking on a ? will give you more information about the selected row.' Below this, a checkbox allows users to 'choose your climate zone manually by checking this box: [] (Required for data centers located outside the United States)'. The form includes dropdown menus for 'State/Region' (Alabama) and 'County' (Autauga), which determine the 'Climate Zone' as '3A'. A series of questions follow, each with a dropdown or radio button and a help icon (?). The questions are: 'What is a typical (average) air temperature leaving the cooling coils (supply)?', 'What is a typical (average) air temperature entering the cooling coils (return)?', 'Do you have active, working humidification controls?', 'Do you have active, working dehumidification controls?', 'Does the CRAC/CRAH/AHU have a free cooling coil (water side economizer)?', 'Is there air-side free cooling?', 'Cooling System Type?', and 'Is there an Uninterruptible Power Supply (UPS)?'. The last question has a note: 'If a UPS exists but is not used, answer No.' At the bottom, there are two buttons: 'Calculate PUE' and 'Print Estimate'.

PUE Estimator tool input screen

<http://datacenters.lbl.gov/dcpro>

Tools, example 2: Air Management Tool

5. Air Management Tools

Data Center Air Management Tool: The Air Management Tool was developed to accelerate energy savings in data centers without affecting the thermal IT equipment environment by assessing the data center air-management status.

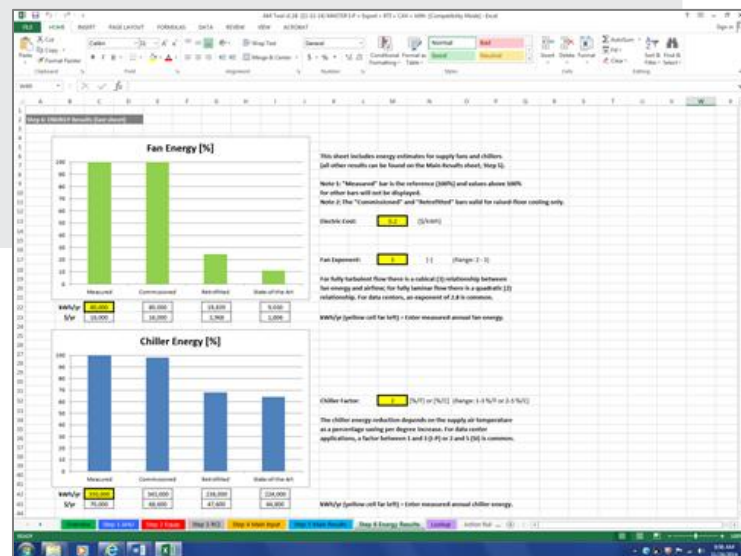
- Data Center Air Management Tool User Manual
- Data Center Air Management Tool Engineering Reference
- Data Center Air Management Tool Data Collection Guide

NEW Data Center Air Management Estimator: The Air Management Estimator is a simplified version of the Air Management Tool that uses the same engine. The input options in this tool have been reduced in favor of increased clarity.

- Data Center Air Management Estimator Tool User Guide

Files:

- Air Management Tool v1.18.xls
- AM Estimator Version 1-0.xls



Tool output with fan and chiller energy savings

News and Training

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News & Training

Training (webinars, on-demand courses, and in-person events)

Webinars

- 10/6/2016 "For Utilities: Designing and Implementing Successful Data Center Efficiency Programs" via ENERGY STAR -[registration](#)
- 10/13/2016 "Data Center Energy Efficiency Opportunities: What Managers Should Know" via ENERGY STAR - [registration](#)
- 12/2016 webinar on the U.S. Data Center Energy Usage Report - date and time TBD
- FY 2017 webinars on guidance for small data centers, the DCEP program, resources for utilities, and more - dates and times TBD

On-demand, web-based courses

- "Data Center Energy Efficiency Best Practices" - [registration](#)
- "FEMP16 Advanced HVAC In High-Tech Buildings: Data Centers" - [registration](#)
- "FEMP Training Certificate Series: Data Center Energy Efficiency" - Available November 2016

In-person training events

- 12/2016 "Data Center Energy Practitioner (DCEP) training" scheduled in San Francisco, California - see our dedicated DCEP [page](#) for more information

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Date	Title	Files and Links
08/16/2016	DCEP Program Developers, Instructors, and Practitioners Featured List of developers, instructors, and generalists for the DCEP program.	 DCEP_LIST_Updated 08162016.pdf
07/27/2016	Data Center Metering and Resource Guide Featured Guide is intended to help data center owners and operators gather the necessary data to participate in the Better Buildings Challenge (BBC). The BBC process includes supplying data that is at least partially metered.	 DataCenterMeteringandResourceGuide_07272016.pdf
06/01/2016	United States Data Center Energy Usage Report Featured This report estimates historical data center electricity consumption back to 2000, relying on previous studies and historical shipment data, and forecasts consumption out to 2020 based on new trends and the most recent data available.	 DataCenterEnergyReport2016.pdf

Questions

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Certificate of Completion

Attention Participants

In order to receive a certificate of completion, you **must** fill out the FEMP workshop evaluation form.

Access the FEMP workshop ***evaluation form*** and ***certificate of completion*** using this link:

<https://fempcentral.energy.gov/Training/EventRegistration/EvaluationForm.aspx>