The webinar will start momentarily....

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Opportunities for ESPCs in Data Centers

Rachel Shepherd (FEMP), Dale Sartor (LBL), Tom Hattery (ORNL),
Meghann Ison (Schneider Electric), R.J. Dyrdek (Army)

May 21, 2020

FEMP Federal Energy Management Program

Webinar Logistics

- This webinar is being recorded. The Q&A portion will not be made publically available.
- Your phone will be muted throughout the webinar.
- Enter any questions in the Question Box throughout the webinar.
- Instructions to take the quiz will be provided at the end of webinar.
- Slides will be sent out afterwards to those who attend the entire webinar

Webinar Overview

Agenda	
I.	Introduction to Opportunities for ESPCs in Data Centers
II.	Case Study – ESCO Perspective
III.	Case Study – Federal Agency Perspective
III.	Resources and Q&A

Learning Objectives

- Understand why data center efficiency improvements are well-suited for inclusion in ESPCs
- Know practical steps to be take to determine the value of including your data center in an ESPC project
- Have lessons learned from agencies that have successfully incorporated data centers into their ESPC projects
- Have relevant resources to assist the federal project executive and agencies in conducting additional preliminary work to further assess the potential of ESPC in their data center

Webinar Team

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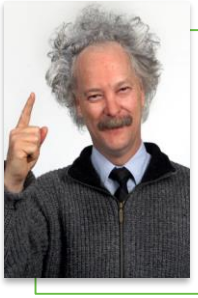

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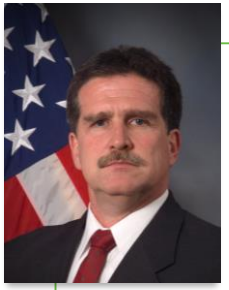

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Dale Sartor & Tom Hattery

Introduction to Opportunities for ESPCs in Data Centers

Why the Need for Data Center Energy Efficiency?

Data Centers are energy intensive facilities

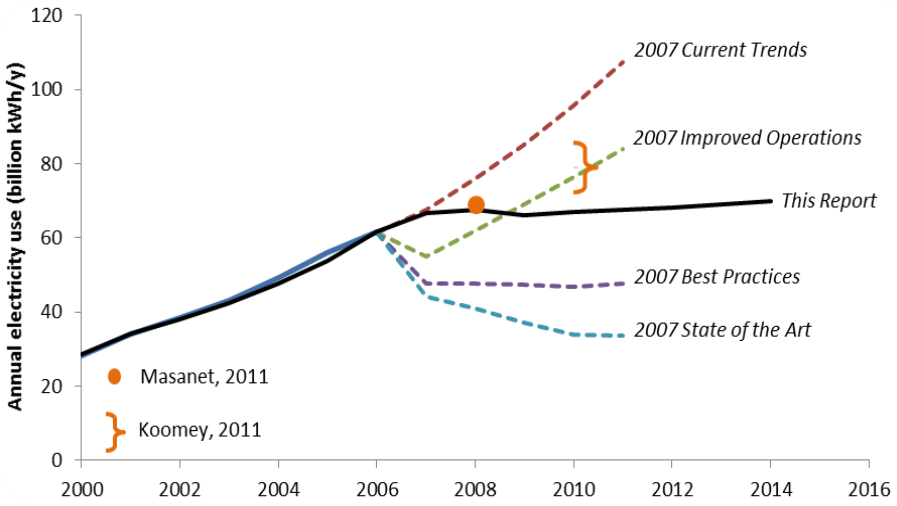
Data Centers are **10 to 100+** times more energy intensive than an office, and represent approximately 2% of *all* U.S. electricity consumption.

No slowdown in sight

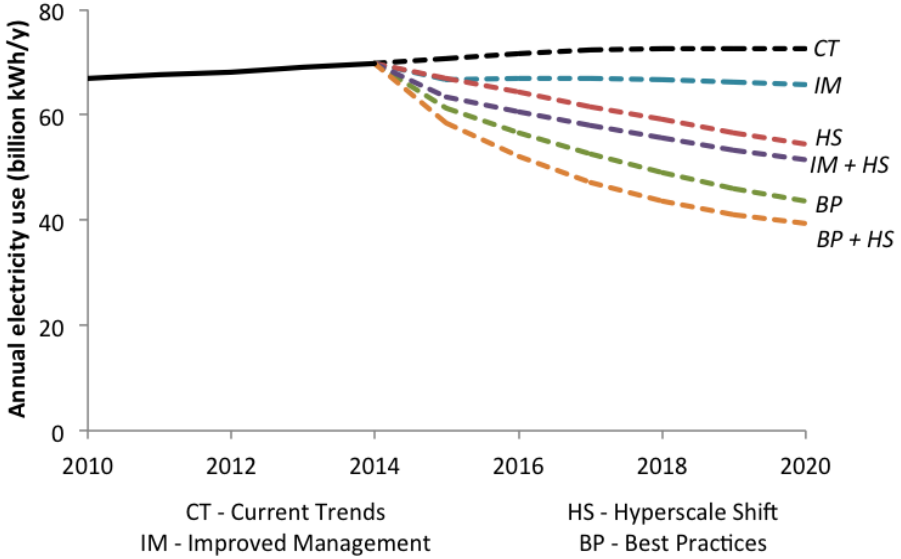
There is surging demand for data storage. Some server racks are now designed for more than 30 kW each. Energy cost, once in the noise, is now often the highest operating cost.

US Data Center Energy Usage (2007 & 2016 Reports)

2007 US Data Center Energy Usage Report



2016 US Data Center Energy Usage Report



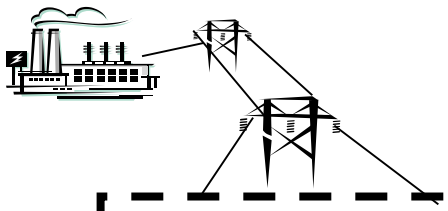
- 20-40% energy savings & high ROI typical
- Aggressive efficiency strategies can yield 50+% savings
- Efficiency can extend life and capacity of infrastructures and improve resiliency

Policy Drivers for Federal Data Center Optimization

- **Federal Information Technology Acquisition Reform Act (FITARA) (2014)**
  - Agency annual reports (inventories, strategies, timeline, savings)
  - OMB sets targets and collects agency performance
- **Data Center Optimization Initiative (DCOI)**
  - OMB requires federal agencies to consolidate, optimize, and modernize IT / data centers (OMB Memo M-19-19)
  - Performance metrics include Virtualization, Advanced Energy Metering, Server Utilization, and Availability
  - Aligning energy-related strategies/activities with DCOI requirements is a win-win for agencies
  - See the Center of Expertise's DCOI factsheet
- **Modernizing Government Technology (MGT) Act (Dec 2017)**
  - Establishes Technology Modernization Fund (TMF)

"Agencies are also encouraged to use performance contracting including Energy Savings Performance Contracts and Utility Energy Service Contracts to finance energy improvements when cost-effective."
– OMB Memo M-19-19

Data Center Energy Efficiency Opportunities



- IT innovation
- Virtualization
- High-efficiency power supplies
- Load management

- Better air management
- Move to liquid cooling
- Optimized chilled-water plants
- Use of free cooling
- Heat recovery

Power Conversion & Distribution

IT Load/ Computing Operations

Cooling Equipment

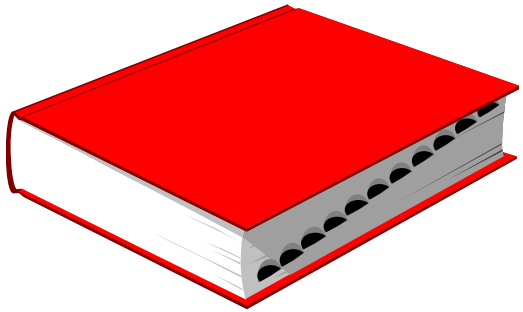
- High-voltage distribution
- High-efficiency UPS
- Efficient redundancy strategies
- Use of DC power

Alternative Power Generation

- On-site generation Including fuel cells and renewable sources
- CHP applications (waste heat for cooling)

Definition of ESPC

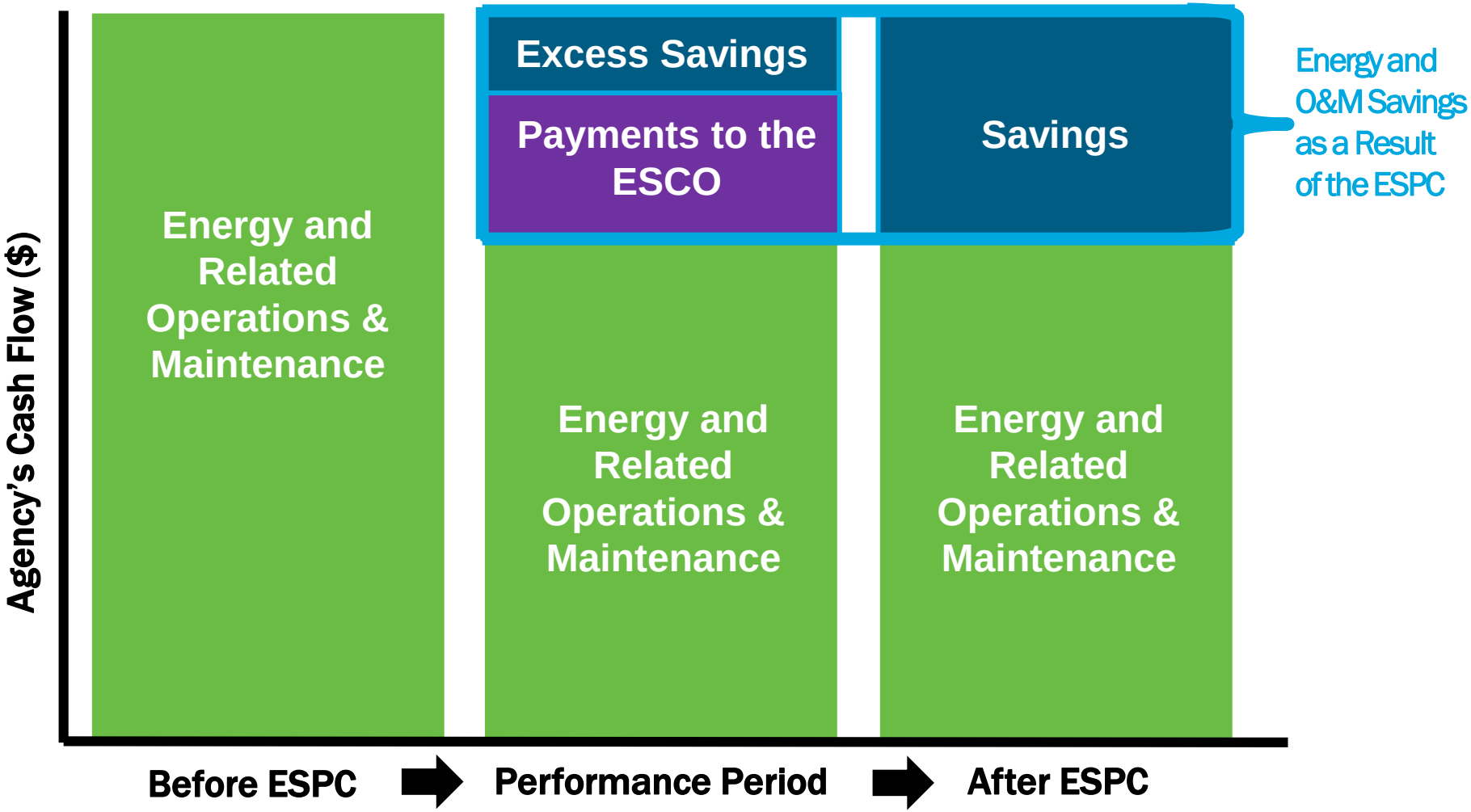
Energy savings performance contract (ESPC) is a no-upfront-capital-cost contracting method. The contractor incurs the cost of implementing energy conservation measures (ECM) and is paid from the energy, water, wastewater and operations savings resulting from these ECMs. An ESPC is a partnership between an agency and an energy service company (ESCO).



ESPCs Are a Budget-Neutral Solution to Infrastructure Backlog

Reallocate the Government's Utility Bill

Stop paying for waste and pollution ♦ Start paying for efficiency



Savings Must Exceed Payments

Two types of savings may be used to pay the ESCO

Energy cost savings

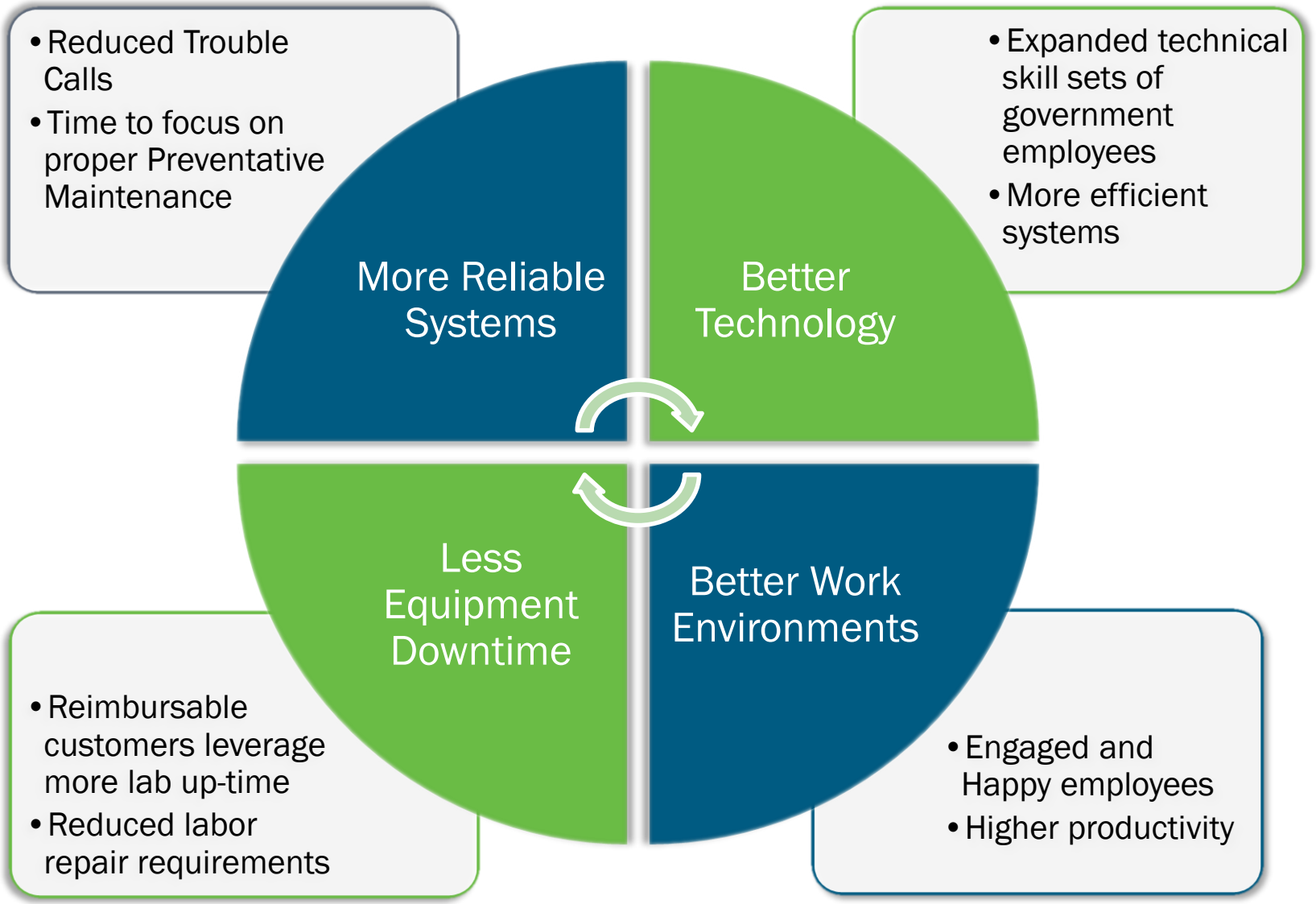
Example: Less energy use due to more efficient HVAC equipment

Energy-related cost savings

Example: Reduced operation and maintenance expenses

Critical for IT/data center modernization and consolidation

Ancillary Benefits of ESPC



ESPC Project with IT

- ~$11 million project
- 21 year contract term
- roughly half the total investment for the IT ECM

ECM	Mbtu savings
Ice storage & chiller upgrade	1,800
HVAC controls	2,540
Lighting	4,603
IT	18,757 (over 90% savings)

FEMP ESPC Team - Helping Agencies Succeed with ESPC

FEMP Headquarters

- Program and policy support

FEMP Federal Project Executive (FPE)

- Your first point of contact
- Coordinates FEMP ESPC assistance for agencies

FEMP Project Facilitators (PFs)

- Hands-on technical project support

DOE Golden Field Office

- DOE-FEMP ESPC IDIQ contract administration
- Procurement guidance

National Lab SME

- Technologies
- Pricing (ECM benchmarking, finance rates)
- Utility tariffs and escalation
- General ESPC expertise

Legal counsel

- ESPC guidance to agency GC

Financing IT/Data Center Projects with ESPCs

- **IT/data center ESPC projects can stand alone or be part of a comprehensive project including other building systems**
- **High cost of consolidation and modernization strategies can be too high to be financed by energy savings alone:**
  - O&M savings and/or appropriations may be needed to make a project viable
  - Technology Modernization Fund (TMF) and IT Working Capital Funds (WCF) are opportunities for leverage
- **Considerations for data center ESPC project scope:**
  - Data center size, energy use, energy intensity, etc.
  - Data center configuration.
  - Plans for growth or consolidation.

Why are there so few IT/Data Center ESPCs

- **Organizational Inertia, conflicting goals, and risk aversion**
  - ESPCs traditionally used by Building and Public Works departments (facilities), while IT managers are the key decision maker.
  - Split Incentives - Energy cost savings typically accrue outside the IT department.
  - High levels of coordination and communication needed on critical facilities.
  - Data centers also have customers and other stakeholders that want control.
  - Integrity of IT - Criticality raises concerns with risk adverse staff that any change or work in the data center could compromise operations.
- **Lack of Manpower/Expertise**
  - Organizations may not be familiar with ESPC model and benefits.
  - Some ESCOs lack a credible IT team.
- **Unique implementation challenges**
  - Data centers are constantly changing, multiple refresh cycles (3-5 years) during typical contract term.
  - Unique contract mechanism requires ongoing contract management effort

How can ESPCs help overcome barriers?

- FEMP and ESPCs can help solve and overcome barriers!
- Team building and communication - Project Facilitators can help improve organizational communication.
- IT Performance should be enhanced and security/resiliency increased (non-energy benefits can “sell” the project).
- Augment manpower and expertise - Bring in outside experts where needed (on IT and facilities side).
- solution must be developed by data center experts and decisions made by the agency IT departments.
- Provide alternative source of funding for high cost of consolidation and optimization strategies.

Data Center ESPC Best Practices

Most importantly: Get IT and Facilities people talking and working together as a team!!!

Introduction Takeaways

1. There are a lot of energy and cost-savings opportunities in data centers both in the facilities and with the IT.
2. ESPCs are a procurement mechanism to finance IT and data center projects with no upfront cost.
3. Solution must be developed by data center experts with full "buy in" from the agency's IT departments.
4. Budget impacted by savings (utility, building maintenance, IT) requires cooperation
5. Term length, refresh need special consideration for IT ECMs
6. Your requirements hard to meet without these tools

Meghann Ison

Case Study – ESCO Perspective

ESPCs for Data Centers

Schneider Electric

Presented by: Meghann Ison

Scope Opportunities

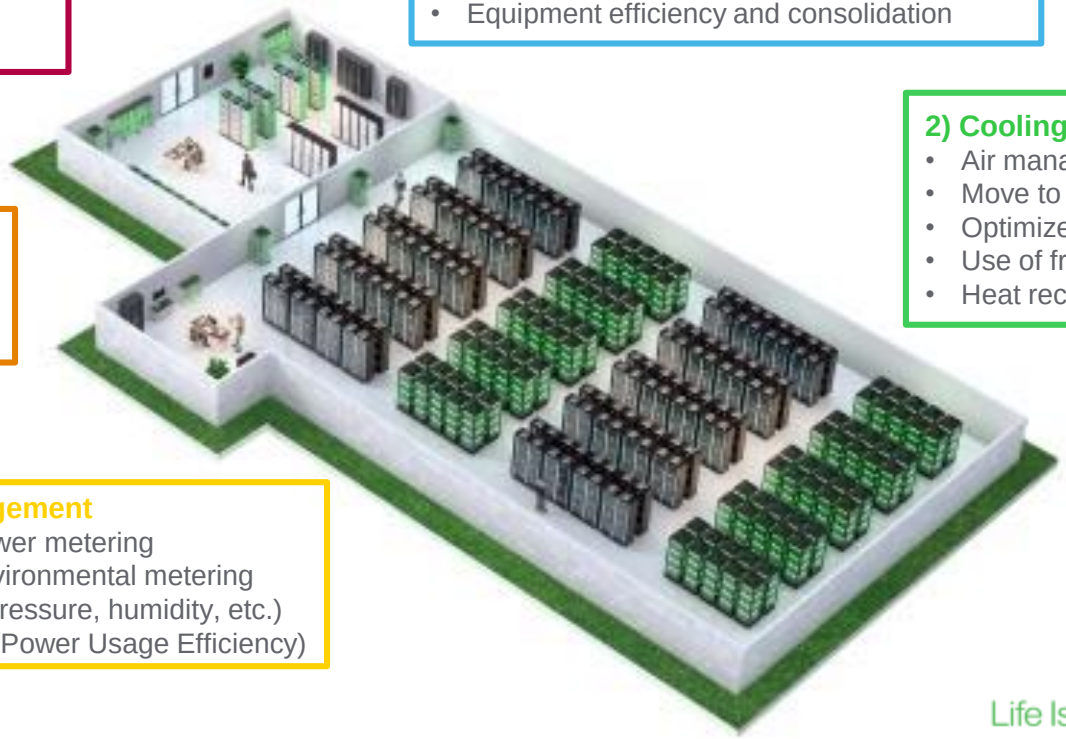
1) Server Load / Computing Operations
- Virtualization
- Network storage optimization
- Overhead structured cable and network
- Power management software
- Equipment efficiency and consolidation

2) Cooling Equipment
- Air management
- Move to liquid cooling
- Optimized chilled-water plants
- Use of free cooling
- Heat recovery

3) Energy Management
- Data center power metering
- Data center environmental metering (temperature, pressure, humidity, etc.)
- Trending PUE (Power Usage Efficiency)

4) Power Security & Distribution
- High voltage distribution
- High efficiency UPS systems
- Efficient redundancy strategies

5) On-site Generation
- Fuel cells, micro-turbines, renewable sources, etc.
- CHP applications



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Case Studies - U.S. Naval Base

Data Center ESPC Overview

- **The ESPC Addresses the Navy's Mission Critical Goals** - reliability, sustainability, resiliency, and efficiency for this mission critical data center.
- **The TO was awarded Feb 2016 with a value of $114 M**
  - Construction is 100% complete and we're in the 2nd year of long-term services
  - Guaranteed savings are **$4.4 million/year**
- **Results**
  - Upgrade of all cooling, heating, primary & emergency power, and controls
  - Conversion from mixed/open floor cooling & dehumidification to controlled POD environment – hot/cold aisle configuration w/ integrated cooling
  - PUE (Power Usage Effectiveness) reduced from **2.5 to 1.2**
  - Consumption of server floor area reduced from **60% to 20%**
  - **N+1** cooling redundancy
  - **N+1** heating redundancy
  - **N+1** emergency power redundancy
  - **2N** primary power redundancy
  - **40 hour/week on site energy manager**
  - Control Panel relaying specific equipment failures
  - **1 hour response time** for any equipment failures
  - Project meets the ("five nines") **99.999% availability** requirement for mission critical facilities

$$\text{PUE} = \frac{\text{Power Usage Effectiveness}}{} = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

ESPC Project's Performance Guarantees

Efficiency - HVAC equipment installed under the ESPC will be maintained to operate within 4% of the installed efficiency

Resiliency and Availability - HVAC equipment serving the facility will have N+1 redundancy throughout the performance period. Equipment serving the data center will be maintained in a state of operational readiness. Timeframes for loss of N+1 redundancy will be reported. Loss of N+1 redundancy beyond 14 days in a performance period will result in a financial penalty of $50,000.

Replacement - the equipment serving the facility will be replaced within the performance period resulting in significant remaining equipment life at the end of the performance period.

M&V - Equipment performance, including efficiencies, power, temperatures, delivered tonnage of cooling, and run times will be monitored and reported

Staffing and Response - an onsite FTE will be provided during normal working hours and a one hour response will be provided at all other times.

This ESPC meets the Navy's needs today and positions them well for the future. It builds the platform for consolidation and enables the Navy to meet their reliability and sustainability requirements and provides the platform of scalability for future needs.

Case Studies - U.S. Air Force Base

Data Center Investment Grade Audit Overview

- **The IGA addressed AF Mission Critical Goals** – consolidation, virtualization, reliability, sustainability, resiliency, and efficiency for this mission critical data center.
- **The IGA performed 2015 with a value of $24M**
  - 12 year contract proposed
  - Guaranteed savings **$2 million/year**
- **Results**
  - Consolidate and Upgrade Data Center infrastructure and HW/SW in both **primary data center and back-up data center**
  - Modernize IT equipment and platforms by increasing the virtual to physical servers from **1.3:1 to 6:1**.
  - Create a **virtualized computing HW** and centralized storage / backup HW
  - Reduce servers, storage, and networking equipment
  - Consolidate existing oversized Uninterruptible Power Supplies (UPSs)
  - Reduce energy usage by **27%**.
  - Convert from mixed/open floor cooling & dehumidification to controlled **POD environment** – hot/cold aisle configuration w/ integrated cooling
  - Implement a **comprehensive Operations and Maintenance** (O&M) approach that will ensure the long-term sustainability of their facilities – renewal of licenses, applications, and IT Refresh of equipment infrastructure as well as IT HW / SW.

Lessons Learned

1. Connecting with Stakeholders – tenants and IT Management
   - Increased reliability, i.e. replacing old substations
   - Increased capacity, i.e.- increased electrical load capacity, available floor space
2. Getting ahead of break/fix – look into IT expenses, end use devices and applications
3. Buy-in for reallocating funds to accommodate a proactive approach – IT Refresh
   - O&M of Computing Equipment
   - O&M of Infrastructure Equipment (HVAC)
   - O&M of Power Distribution Equipment

Additional resources are available

- White Papers – Data Center Optimization Cybersecurity DC Life Cycle Mgmt
- Q&A – Meghann.ison@se.com

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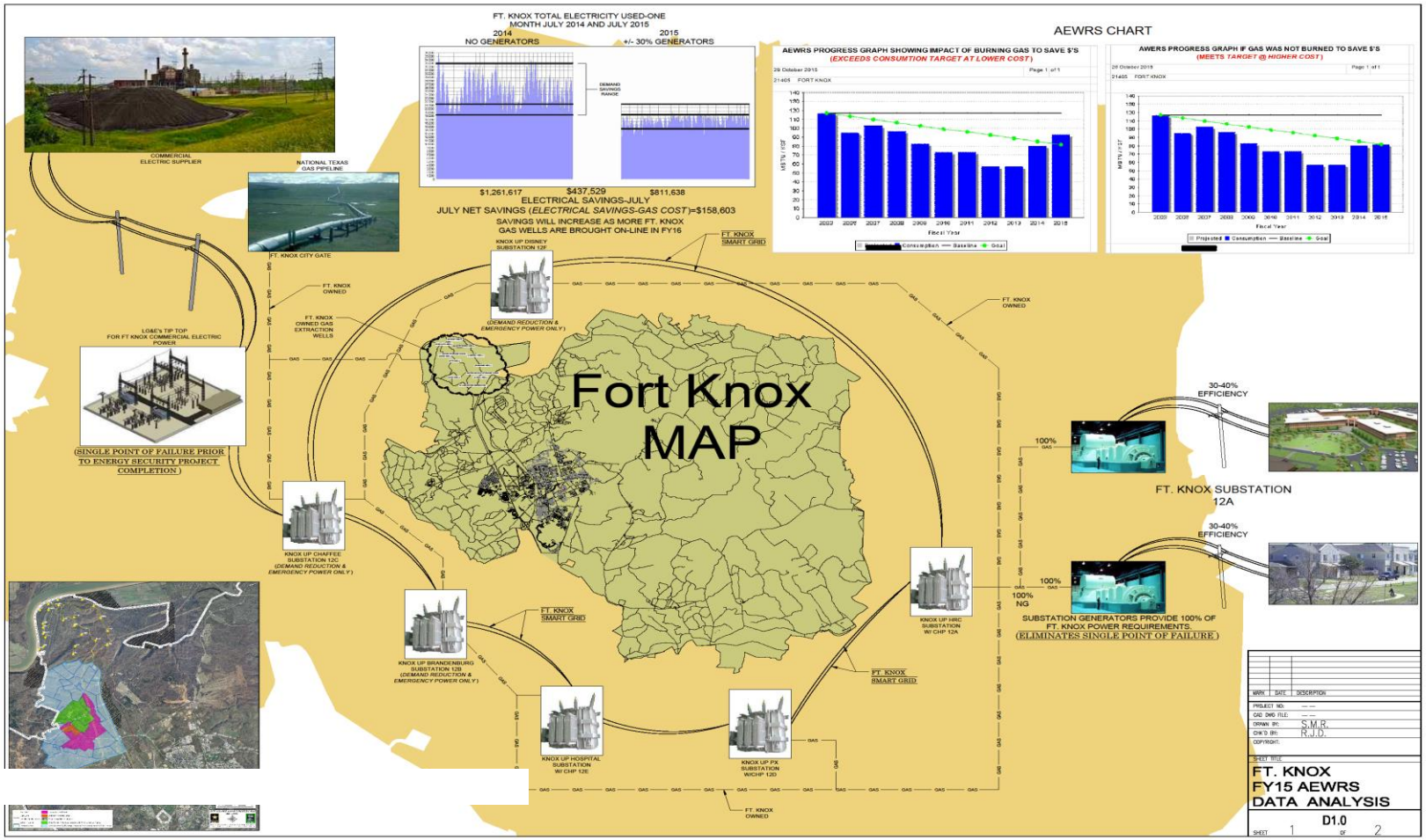
R.J. Dyrdek

Case Study – Agency Perspective

Fort Knox Energy Program is Complete Team Effort

REACTION TO THE 2009 ICE STORM:
Sitewide Upgrades Continuing Today



“OFF THE GRID”
ENERGY SECURITY

Central Water Plant

Waste Water Treatment Plant

Natural Gas Compression

Energy Security Project

2.1 Megawatt Solar Array

Daily Baseline Power Generation:	**14 MW**
Additional Local Utility Power Reduction Due To Cogeneration:	**2 MW**
Peak Power Generation To Reduce Demand Charge:	**16 MW**
Peak Demand Last 12 Months:	**38.2 MW**

Maude Complex: Home of Human Resources Command

Data Center – Attributes are ALWAYS changing

- 18K sq ft facility
- Hosts ~200 applications
- Hosts 2700+ servers (~70% virtual)
- 60% Capacity (300+ Racks In Use; Capacity For 500+ Racks)
- Exceeds federal energy efficiency mandates and Data Center Optimization Initiative requirements
- ~30% power capacity (2,725 kW available)
- ~35% cooling capacity (1140 tons available)

Air Management Enabler – Variable Speed Fans

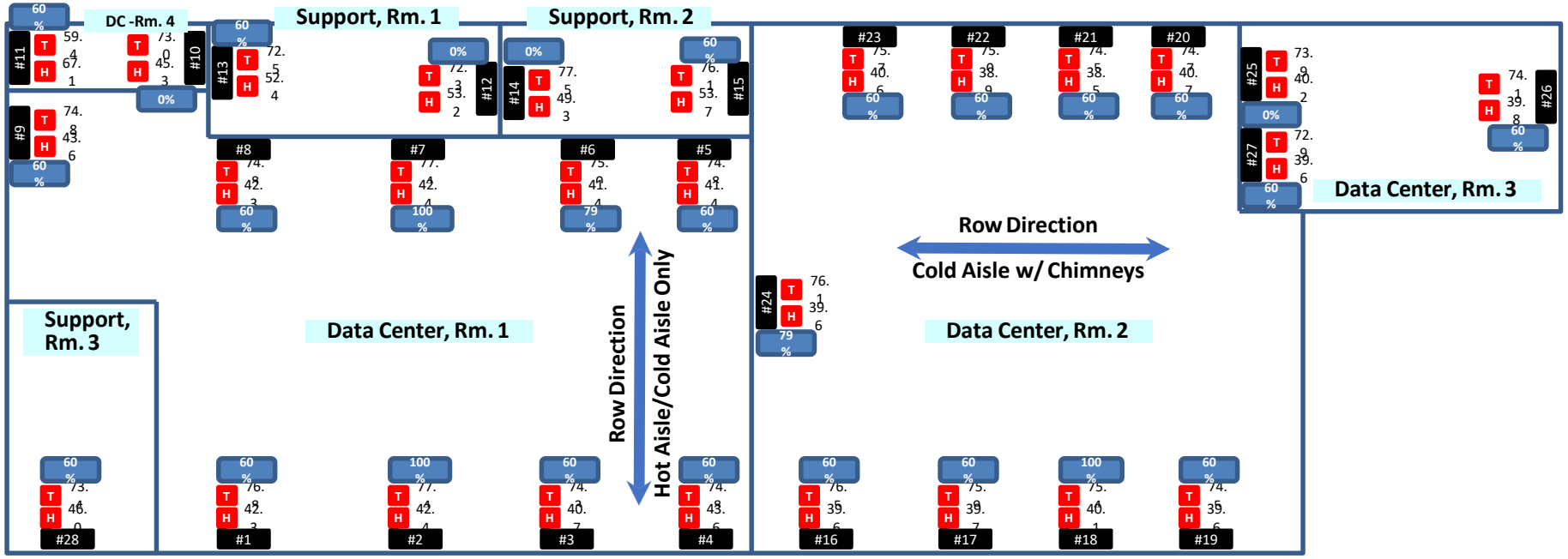
AFTER

- 2/3 of Air Handler Units Converted to Plug Fans w/ Electrically Commutated (EC) Variable Speed Motors (below)
- 1/3 of Air Handler Units Converted to Variable Frequency Drives With Original Fans

ESPC vehicle allows "bundling" of projects for cost effectiveness and access to financing:

- **Sitewide LEDs help pay for data center-specific measures**

Fan Retrofit Map & Performance Observations



T = Return Temp, °F

H = Humidity, %RH

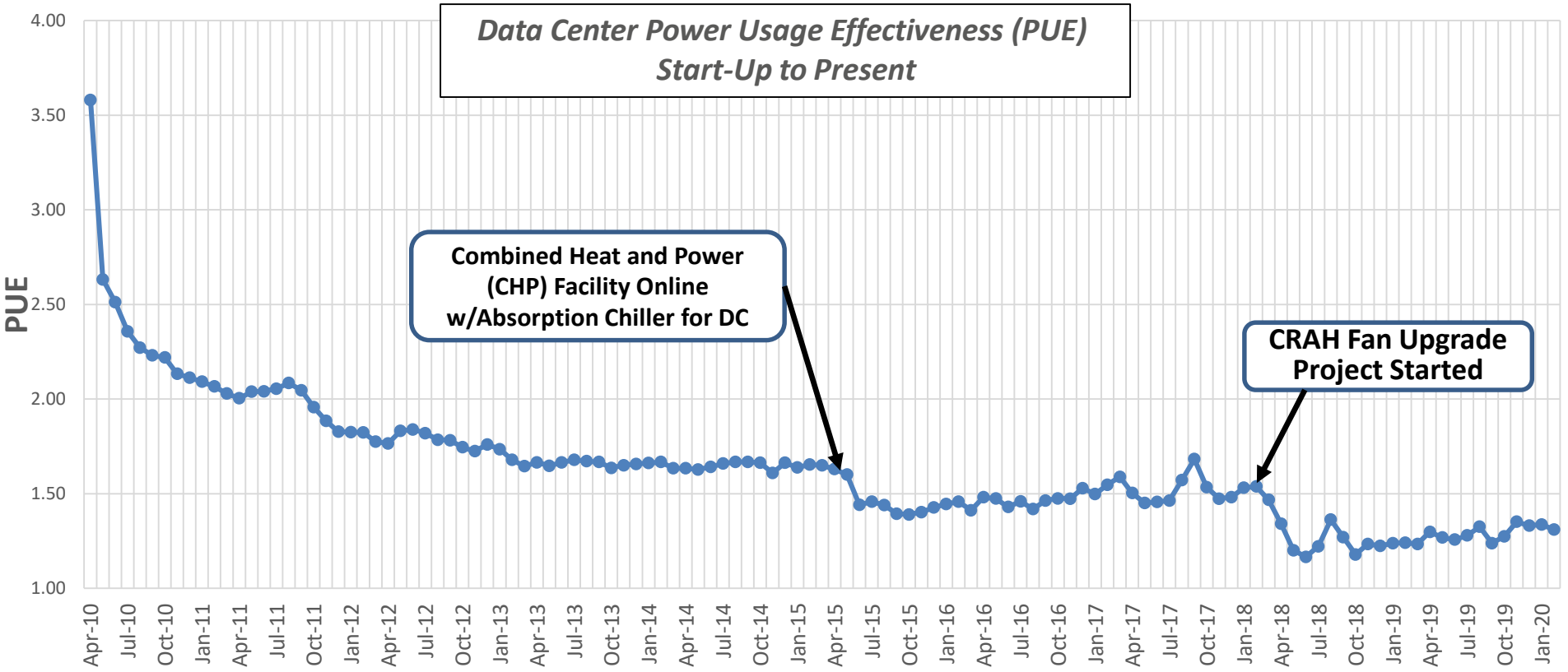
Fan Speed, %

Computer Room Air Handlers (CRAH)

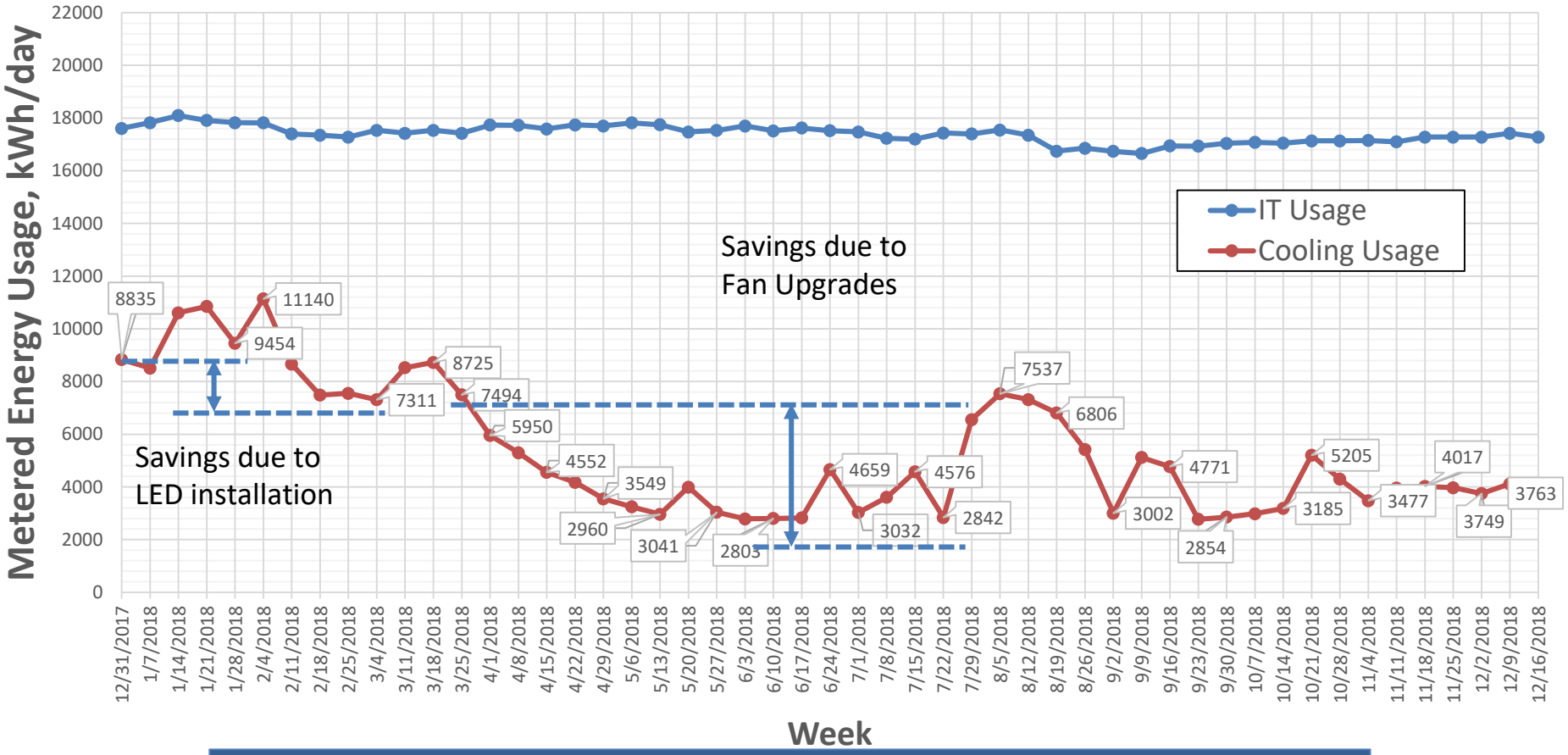
- At 60% fan speed, 81% reduction in power for fans
- At 79% fan speed, 75% reduction in power for fans
- At 100% fan speed, 35% reduction in power for fans

Compared to original drive/fan configuration

Better Air Management Impacts on Data Center Efficiency

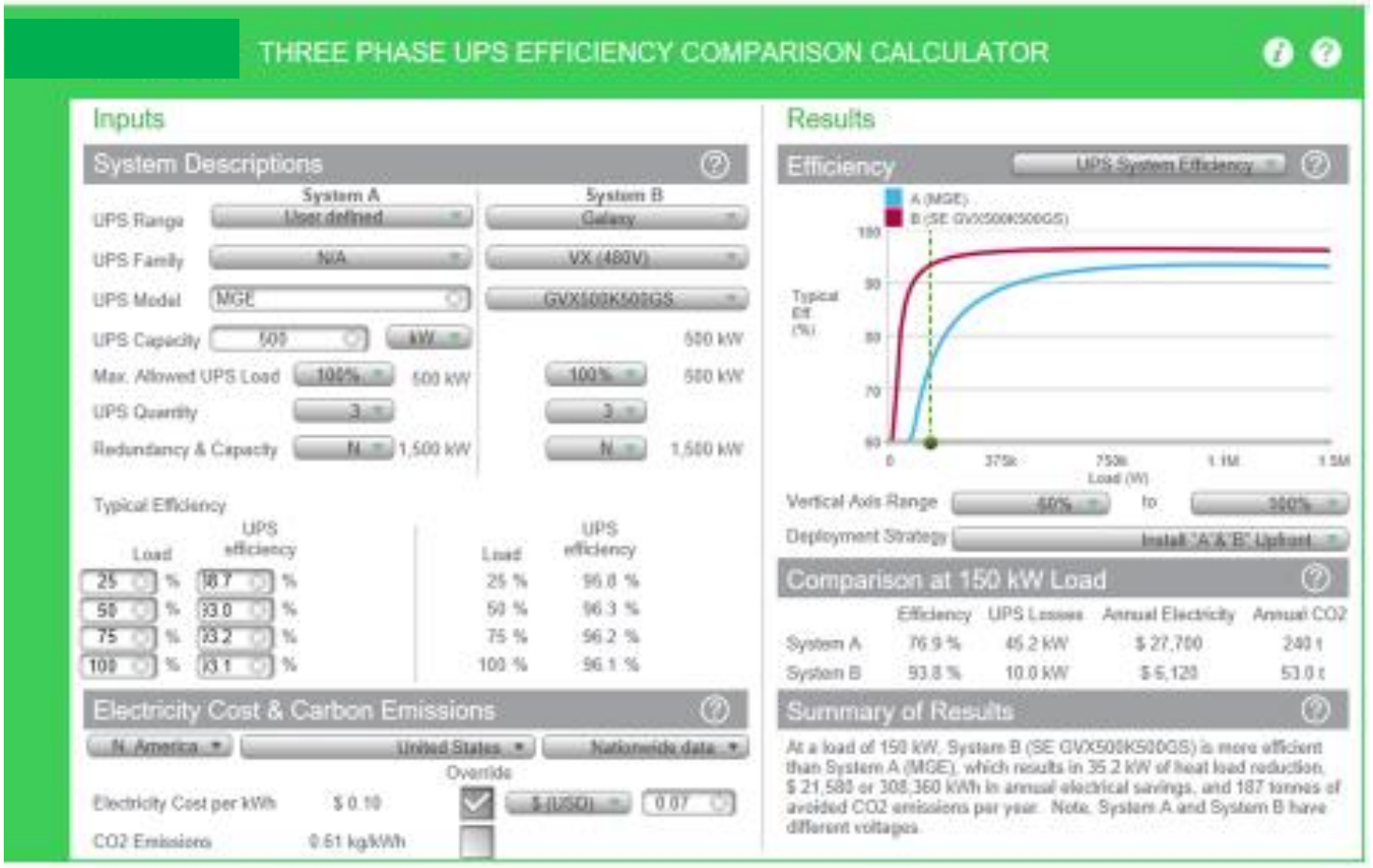


Data Center Energy Usage



NOTE: Peaks in Cooling Usage line are primarily due to use of in-house cooling equipmen

What efficiency is left for Fort Knox's Data Center?



Ft. Knox Now Has a High-Performing Data Center

(At Zero Upfront Cost)

Energy Efficiency Upgrades Sitewide

- $26.4MM in upgrades across 452 buildings as part of ESPC project
- $2.3MM in annual energy and related savings
  - Reduced total energy consumption by 8%
  - Reduced grid electricity usage by 25.9MM kWh/yr (20% reduction)

ECM 4.2- Data Center HVAC

Substantially Complete

- 32 out of 32 CRACs completely renovated
- All units networked together with firmware updates
- Temp increases and commissioning on hold until direction to proceed
  - Critical to get a notice to proceed with commissioning to ensure that project is completed on schedule

After agreement on higher temperature set points than planned, commissioning was successful

Rachel Shepherd

Resources and Q&A

FEMP's Data Center Program

FEMP's Data Center program assists federal agencies and other organizations with optimizing the design and operation of data centers. design and operation of energy and water systems in data centers to enhance agency's mission.

Assistance

- Project and technical assistance from the Center of Expertise including identifying and evaluating ECMs, M&V plan review, and project design review.
- Support agencies in meeting OMB's Data Center Optimization Initiative requirements

Tools

- Data Center Profiler (DC Pro) Tools, including PUE Estimator
- Air Management Tools
- Energy Assessment Worksheets

Key Resources

- The Energy Assessment Process Manual
- Data Center Master List of Energy Efficiency Actions
- Small Data Centers, Big Energy Savings: An Introduction for Owners and Operators

Training

- Better Buildings webinar series
- Nine on-demand FEMP data center trainings
- Center of Expertise Webinars
- Data Center Energy Practitioner Trainings

LBL's Center of Expertise (CoE)

Use CoE's Energy Efficiency Toolkit

Filter CoE's many resources by type and topic.

Choose from upcoming live webinars, pre-recorded trainings, and in-person Data Center Energy Practitioner (DCEP) trainings.

Search resources by topics of interest.

Explore the diverse activities that CoE is engaged in.

Visit us at datacenters.lbl.gov

Webinar for Feds – Next Tues. at 1:00 pm EST

Getting IT and Facilities Managers Talking and Working Together as a Team!

Tuesday, May 26 from 1:00 – 2:00 pm EST

- Part of the Cloud & Infrastructure Community of Practice hosted by GSA.
- IT Deputy for Operations and a Chief Sustainability Officer share their experience working together to make continual improvements of energy and water performance
- Report on the process and progress that yields tangible results
- Presentation on tools and resources for teams and project champions for planning and implementing energy efficiency measures

Email rachel.shepherd@ee.doe.gov if interested in attending

Better Buildings Summit

Date	Time (EST)	Virtual Session
Monday, June 8	1:00 – 2:30 pm	Data Centers Sector Meet-Up
Monday, June 8	3:00 – 4:30 pm	DOE Fireside Chat with the National Labs: Trends and Emerging Technologies
Tuesday, June 9	3:00 – 4:30 pm	What's New in Energy Efficiency Finance?
Wednesday, June 10	3:00 – 4:30 pm	Stump the Chumps: How to Optimize Critical Facilities

Visit the Better Buildings website for more information and register for virtual sessions here.

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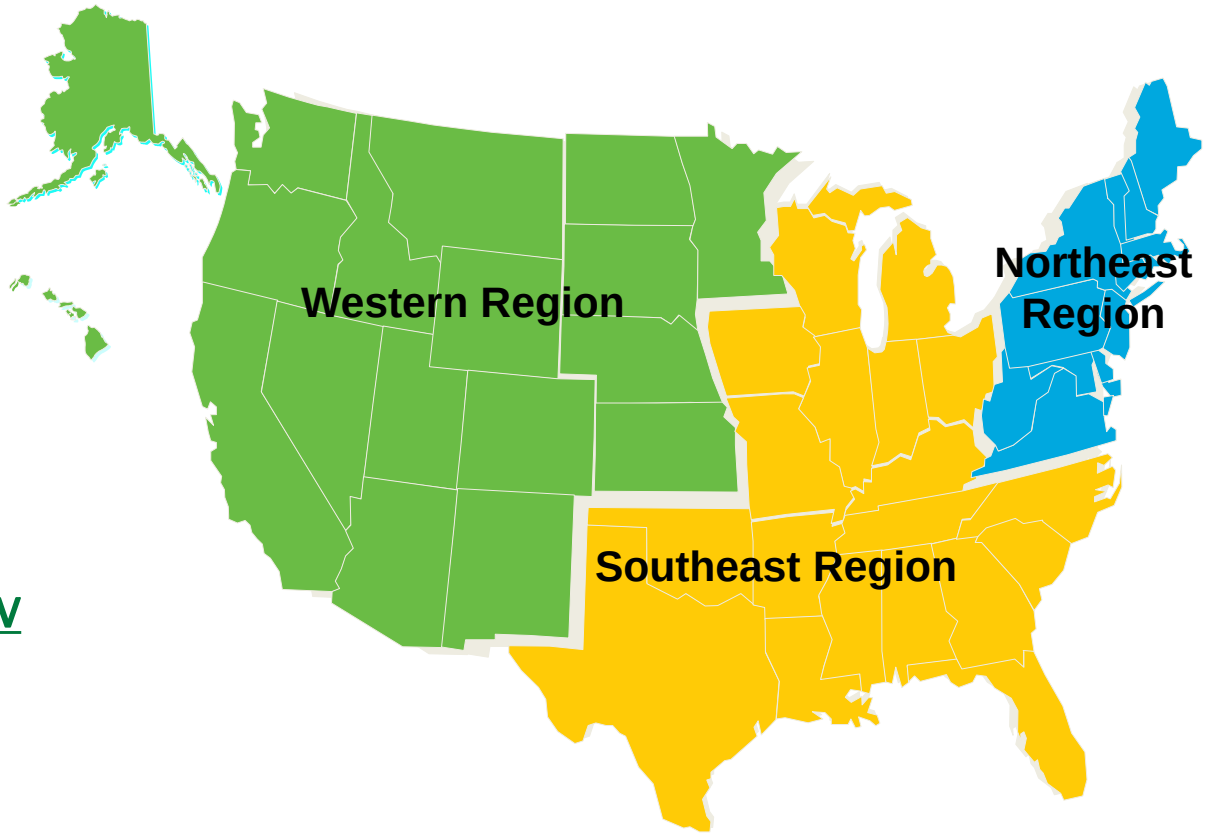

FEMP ESPC Team - Helping Agencies Succeed with ESPC

Visit FEMP's ESPC for Federal Agencies website

Contact FPEs for help with ESPCs or any questions

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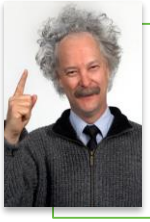

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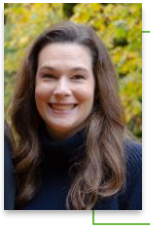

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IACET Credit for Webinar

WBDG WHOLE BUILDING DESIGN GUIDE a program of the National Institute of Building Sciences

ACCREDITED IACET PROVIDER

The National Institute of Building Sciences' (NIBS) Whole Building Design Guide (WBDG) hosts the FEMP training program's learning management system (LMS).

The WBDG LMS:

- Allows for taking multiple trainings from multiple organizations through one platform.
- Houses the assessments and evaluations for all accredited courses.
- Allows you to:
  - Track all of your trainings in one place.
  - Download your training certificates of completion.
- Eases the CEU-achievement process.

Visit the WBDG at www.wbdg.org to view courses and create an account

IACET Credit for Webinar

To receive IACET-Certified CEUs, attendees must:

- Attend the training in full (no exceptions).
  - If you are sharing a web connection during the training, you must send an e-mail to Elena Meehan (elena.meehan@ee.doe.gov) and indicate who was on the connection and who showed as connected (will reflect in the WebEx roster).
- Complete an assessment demonstrating knowledge of course learning objectives and an evaluation **within six weeks of the training**. A minimum of 80% correct answers are required for the assessment.

To access the webinar assessment and evaluation, visit:

https://www.wbdg.org/continuing-education/femp-courses/femplw05212020

If you have a WBDG account and enrolled previously, simply log in and click the *Continuing Education* tab on the user account page. Click *Proceed to Course* next to the course title.