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Federal Buildings Overview from the O&M Perspective

(PNNL-SA-81102)

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Presentation Objectives

- Understand role of O&M in meeting goals *and* improving performance
- Describe Federal building inventory
- Characterize O&M needs and opportunities
- Locate resources that can help

Role of O&M

- Laws and mandates
- O&M benefits
- Definition and examples

Why Are We Here?

- Energy goals
- Want to improve facility operations
- O&M is cool!!!

Laws and Mandates

- Executive Order 13514 – Federal Leadership in Environmental, Energy and Economic Performance (2009)
- Energy Independence and Security Act of 2007
- Executive Order 13423 – Strengthening Federal Environmental, Energy, and Transportation Management (2007)
- Energy Policy Act of 2005

Key Goals and Requirements O&M Can Impact

- Reduce annual building energy use 30% through 2015
- Reduce annual water use
 - Potable water 26% through FY20
 - Industrial, landscaping and agricultural water 20% through FY20
- Meter
 - Building electric metering by 10/1/12
 - Building natural gas and steam by 10/1/16
- Audit each covered facility every 4 years
- And more!

O&M Benefits

- Energy
 - Reduces energy consumption and costs
- Operations
 - Ensures sufficient operations
 - Reduces unscheduled events
 - Extends equipment life
 - Improves safety and reliability
- Occupant satisfaction and health (indoor air quality)

O&M First! Philosophy

- O&M improvements should be the FIRST energy efficiency measure
- People, not equipment, are the key to success
- New equipment must be appropriate for the O&M environment it will operate in

Definition – What is O&M

The decisions and actions regarding the control and upkeep of property and equipment. These are inclusive, but not limited to the following:

- Actions focused on scheduling, procedures, and work/systems control and organization; and
- Performance of routine, preventive, predictive, scheduled and unscheduled actions to prevent equipment failure or decline with the goal of increasing energy efficiency, reliability, and safety.

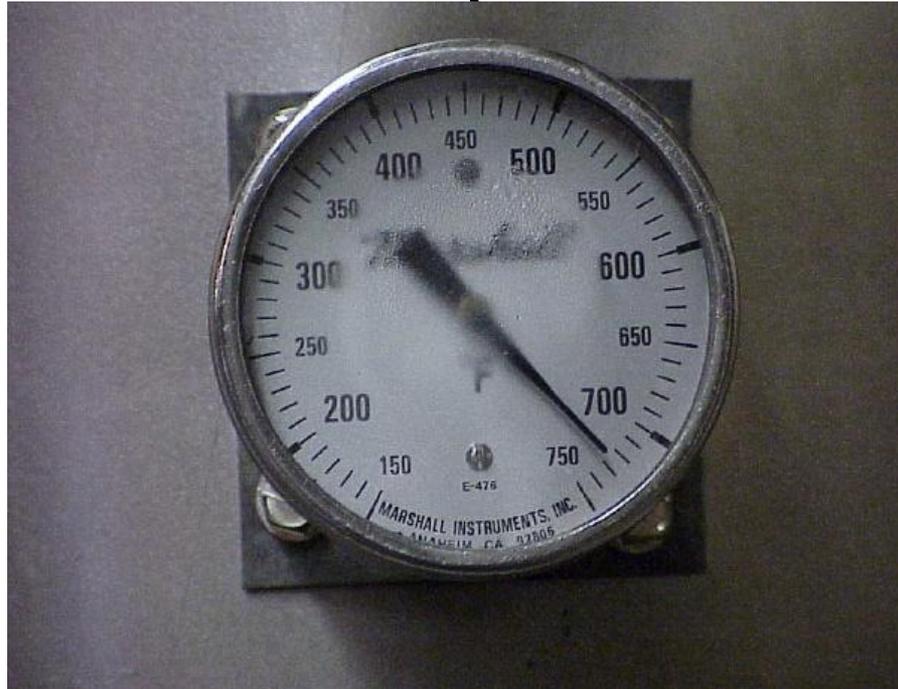
Operations Example 1

Simple Controls



Operations Example 2

Unsafe Operations



Boiler stack reading – dangerous condition!

Operations Example 3

Benefits of Metering

Before

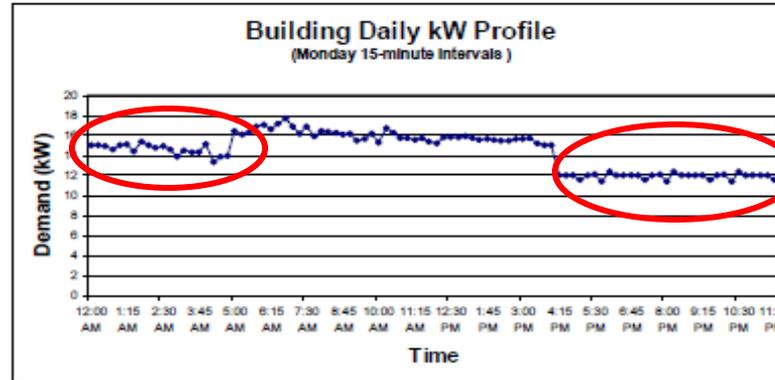


Figure 7.1. Daily Demand Profile – Nighttime Temperature Setback Disabled

After

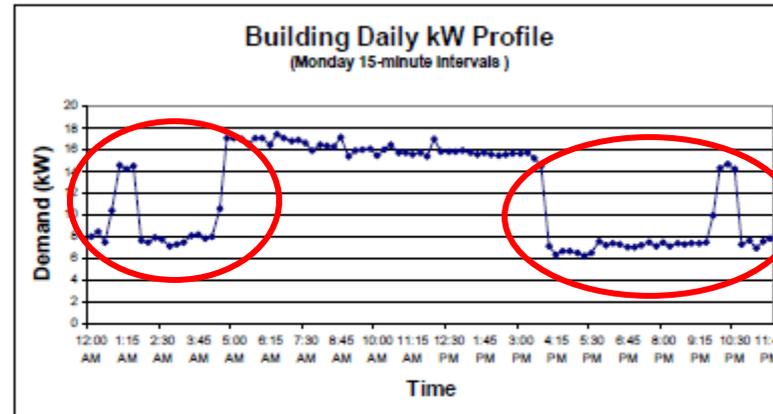


Figure 7.2. Daily Demand Profile – Nighttime Setback Enabled

Maintenance Example

Dirty Air Filter



O&M Approaches and Strategies

- Approaches – reactive, preventive, predictive, and reliability-centered
- Strategies
 - Re/Retrocommissioning and tune-ups
 - Metering
 - Contracting
 - Training
 - *Take action*

Federal Building Inventory

- Typical Federal buildings
- Uses of Federal buildings
- Square footage

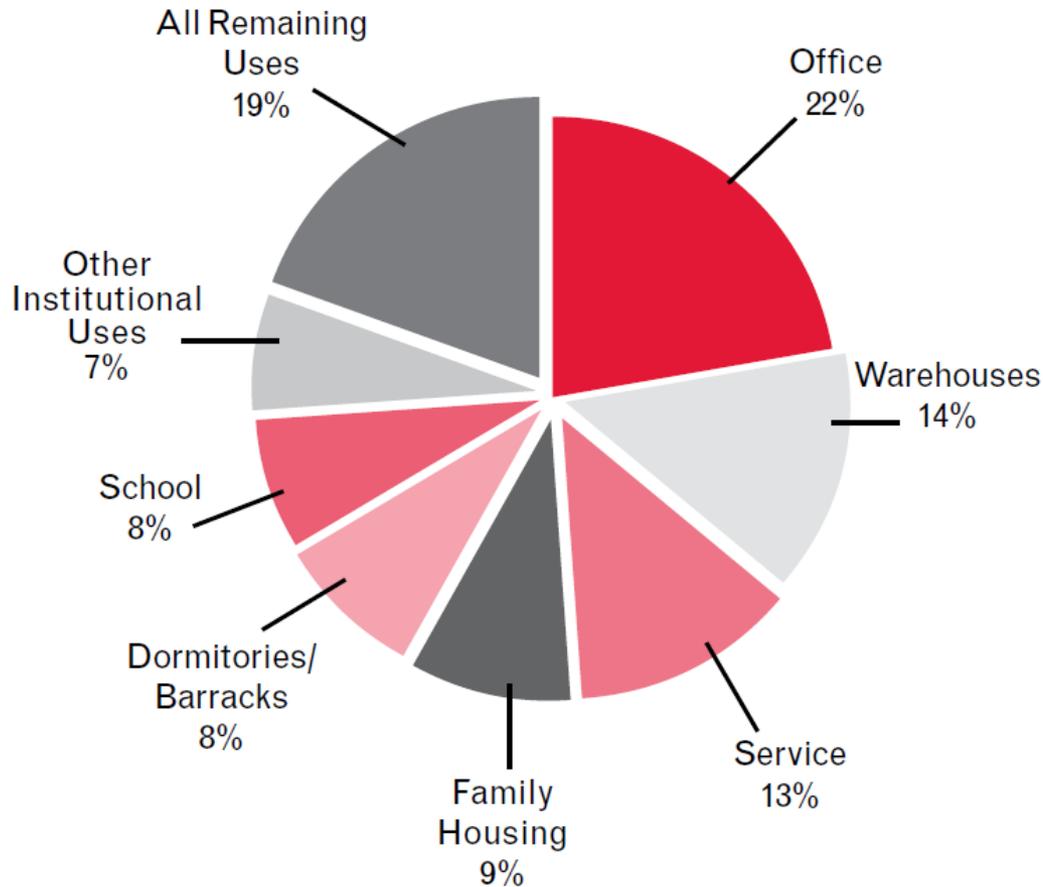
What is the “Typical” Federal Building?

- No such thing as a “typical” Federal building.
 - Age
 - Climate/location
 - Size, geometry, orientation, # of floors
 - Original use
 - Current use
 - # of occupants
 - Etc...

How are Federal Buildings Used

- Offices
- Post offices
- Hospitals and clinics
- Prisons and detention centers
- Schools/education
- Museum
- Family housing
- Dormitories
- Dormitories/barracks
- Warehouses
- Industrial
- Service
- Communications systems
- Laboratories
- Navigation and traffic aids
- All other

Use of Buildings by Square Footage



Source: The Federal Real Property Council's FY 2008 Federal Real Property Report (August 2009)

Summary of Total Federal Building Stock*

- DoD has most buildings and square footage

	DOD	Civilian	Total
Number of Sites/ (%)	2,588 (17)	12,273 (83)	14,861
Number of Buildings/ (%)	318,090 (78)	91,404 (22)	409,494
Total Floor Space (ft ²)/ (%)	1,993,480,978 (67)	987,594,647 (33)	2,981,075,625

* Loper and Sandusky. 2010. Attributes of the Federal Energy Management Program's Federal Site Building Characteristics Database. PNNL-20175

Summary of Total Federal Building Stock*

- Largest civilian agencies by square footage (000 sf)
 - General Services Administration – 296,213
 - U.S. Postal Service – 167,347
 - Veterans Affairs – 136,369
 - Department of Energy – 116,794

*Loper 2010

Facility Inventory by Size

Sorting facilities by square footage (sf) shows

- Most of Federal sf is housed at a few sites
- Many buildings are at small facilities or are stand-alone

Facility SF: Largest to Smallest by Bin (~600 msf/bin)	Number of Facilities	Approx. # of Buildings (000)
0 - 20%	44	95
20 - 40%	85	80
40 - 60%	157	90
60 - 80%	510	48
80 - 100%	14,065	96
Totals	14,861	409

Source: Data based on internal PNNL database of Federal buildings.

Annual Operating Costs* per Square Foot by Building Use

- Office • \$10.94/sf/yr
- Laboratories • \$10.31/sf/yr
- Hospitals • \$6.51/sf/yr
- Family Housing • \$3.17/sf/yr
- Warehouses • \$2.97/sf/yr

*Energy costs are not separated

Source: FY 2009 Federal Real Property Statistics/FY 2009 Federal Real Property Report

O&M Needs and Opportunities

- Magnitude of opportunities
- Typical opportunities

Magnitude of Federal Opportunities

- FEMP building assessments – ALERT, ESET, & E4
- General conclusions
 - Opportunities at all levels
 - Retrofit projects cost roughly **20x** more than O&M measures to achieve roughly the same energy savings!
 - Federal opportunities mirror non-Federal

Magnitude of Opportunities - All

- 2009 LBNL study (Mills)*
 - Median cost of \$0.30/sf (range of \$0.20/sf to \$0.60/sf)
 - 16% median whole building energy savings
 - Median benefit-cost ratio of 4.5
 - Savings tend to persist well over a 3-5 year timeframe

* Evan Mills. 2009. "Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse-gas Emissions"

<http://cx.lbl.gov/2009-assessment.html>

Top Reasons for Retrocommissioning*

- Obtain energy savings (~90%)
- Ensure or improve thermal comfort (~65%)
- Ensure adequate indoor air quality (~55%)
- Ensure system performance (energy and non-energy-related systems) (~45%)

* Mills

Typical RCx Opportunities Are ...

- Malfunctioning control systems
- Incorrect sequences of operation
- Energy management systems not updated
- Sensor out of calibration
- Overridden controls
- Simultaneous heating and cooling

More Typical RCx Opportunities

- Changed building uses affecting loading, air flow, schedules, etc.
- OSA dampers stuck in always closed or open position
- Adjustable speed drives no longer adjust properly
- Unconnected flexible ductwork
- Improperly placed control devices

Top Cumulative Saving Measures

Top Cumulative Saving Measures and % of Savings

Key Measure Mix	% of Total Savings
Revise control sequence	21%
Reduce equipment runtime	15%
Optimize airside economizer	12%
Add / optimize SAT reset	8%
Add VFD to pump	6%
Reduce coil leakage	4%
Reduce / reset DSP setpoint	4%
Add / optimize optimum start/stop	3%
Add / optimize CWST reset	2%

A Study on Energy Savings and Measure Cost Effectiveness of Existing Building Commissioning. Effinger, Friedman, Morales, Sibley, and Tingey. PECI (LBNL). 2009

http://www.peci.org/documents/annex_report.pdf

Metering Opportunities

- Reimbursable billing
- Utilities interaction
 - Time-of-use pricing
 - Real-time pricing
 - Load aggregation
- Efficiency opportunities identification
- Operational opportunities identification
- Benchmarking
- Emergency response
- Power quality applications

Lost Opportunity Equipment Change-Out

Equipment reaches end of useful life

- Typical approach:
 - Repair by replacement
 - Cut-and-paste
 - Lowest cost available unit
- Recommended approach: Evaluate to consider
 - Current system needs
 - Specify current best available, not lowest performing acceptable
- Difference:
 - Recommended costs more and takes longer
 - Recommended improves energy performance and still cost effective

Available Resources

- FEMP
- Outside FEMP

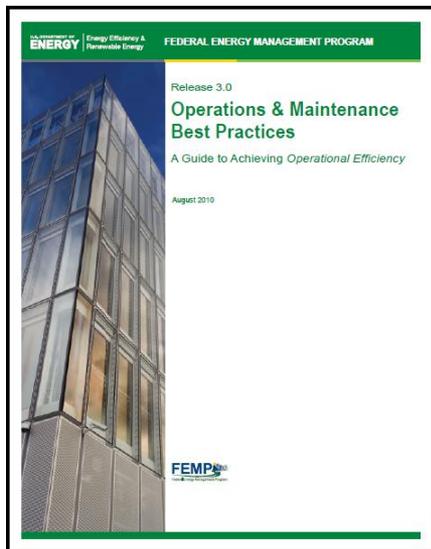
FEMP Resources

- O&M Best Practices Guide

http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf

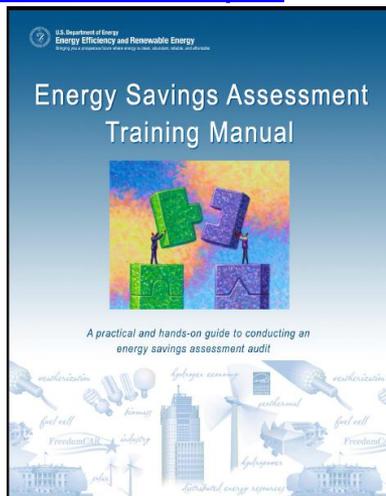
- Metering Best Practices Guide

[http://www1.eere.energy.gov/femp/pdfs/omguide_complete_complete.pdf](http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf)

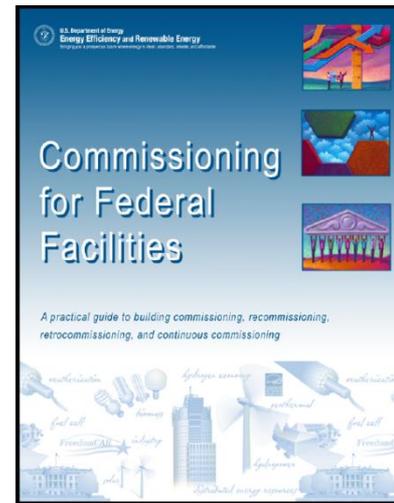


FEMP Resources

- Energy Savings Assessment Training Manual
http://www1.eere.energy.gov/femp/pdfs/esa_manual.pdf



- Commissioning for Federal Facilities
http://www1.eere.energy.gov/femp/pdfs/commissioning_fed_facilities.pdf



FEMP Resources

- FEMP O&M webpage

http://www1.eere.energy.gov/femp/program/operations_maintenance.html

- FEMP Training (on-demand)

<http://apps1.eere.energy.gov/femp/training/>

Other Resources

- Portland Energy Conservation, Inc. <http://www.peci.org/>
 - National Conference on Building Commissioning Aug 10-12, 2011 in Cincinnati, OH <http://www.peci.org/nbc/about/announcement.html>
 - Commissioning Resource Center <http://www.peci.org/resources/commissioning.html>
- Building Commissioning Association <http://www.bcxa.org/index.htm>
- California Commissioning Collaborative <http://www.cacx.org/>
- Battelle/Pacific Northwest National Laboratory – Improving Efficiency of Washington Commercial Buildings
<http://buildingefficiency.labworks.org/large.stm>