

# The Value of O&M Training

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# Operations & Maintenance (O&M)

*'...even when staff meticulously maintain equipment, operation that relies on inadequate control strategies or improper scheduling can result in significant energy waste, higher energy bills, reduction equipment life, and poor indoor environmental quality.' – PECI*

- O&M is more than maintenance and repair
- Analyzing operations for efficiency is a skill
- Energy equipment, commissioned, retro-commissioned—now what?
- NYC is considering making O&M certification mandatory for operators who manage larger buildings because...

# Beyond the O&M Assessment

To achieve savings, we need to go beyond the O&M assessment:

- Challenges going from recommendations to implementation
- Persistence of Savings  
(One-time O&M consultants vs. training long-term personnel)
- Knowledge Diffusion

# O&M Training Programs in NYC

- BPI      Multifamily Energy Efficient Building Operator      XX Hr
- BOC      Building Operator Certification      60-90 Hr
- BRT      Building Re-Tuning      15 Hr
- GPRO      Green PROfessionals      12 Hr

# Topics in O&M Training

BOC Level I	BOC Level II
Building Systems Overview	Preventative Maintenance & Operations
Energy Conservation Techniques	Advanced Electrical Diagnosis
HVAC Systems and Controls	HVAC Troubleshooting & Maintenance
Efficient Lighting Fundamentals	HVAC Controls and Optimization
Maintenance and Related Codes	Advanced Indoor Air Quality
Indoor Air Quality	Energy Audit
Facility Electrical Systems	Advanced Lighting Applications

# O&M Training – Results & Benefits

## Facilities Personnel<sup>1</sup>

- Familiar with the baseline performance of the building systems
- Track building performance
- Monitor/maintain equipment efficiency
- Optimize equipment operations
- Specify energy and environmental goals with suppliers and contractors
- Familiarity with local utility energy and water efficiency programs/requirements

## Building Performance

- Energy and demand Savings
- Persistence in savings from commissioning activities
- Improved Indoor Environmental Quality (IEQ)
- Increase equipment life

Performance improvement by:

- Better scheduling
- Equipment performance tracking
- Diagnosing inefficiencies (ex. simultaneous heating and cooling)

<sup>1</sup>Adapted from Cynthia Putnam and Stan Price's The Right Stuff: Preparing the Facilities Engineering Workforce for the Sustainable Workplace

# O&M Training

Methods for Achieving Better Performance

# O&M Training: Learning Tools of the Trade



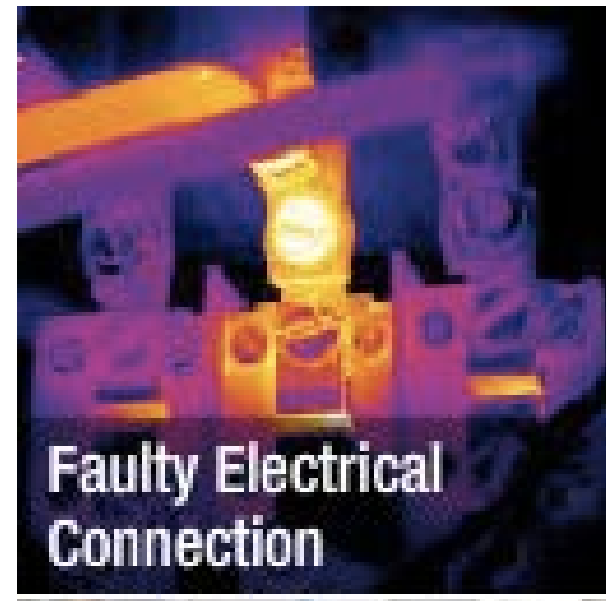
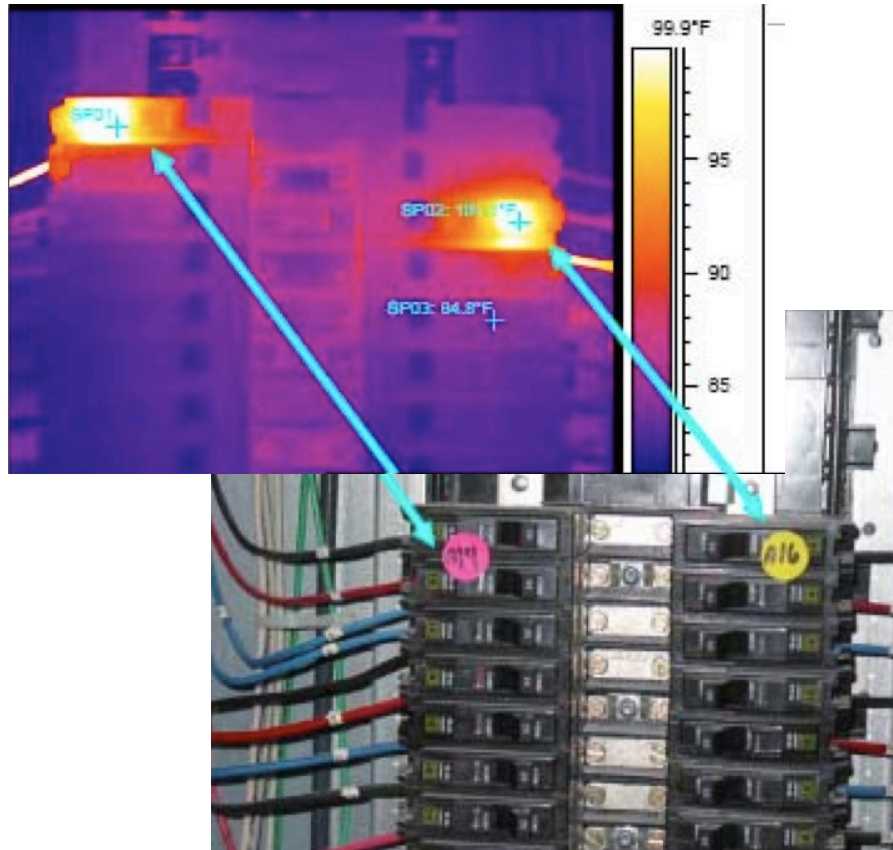
- All stocked in BPL's Field Equipment Lending Library!



# O&M Training: Energy Efficient Motors

- Even a seemingly modest (small) **increase in motor efficiency** can lead to measurable (often large) reductions in energy use and costs.
- Electrical should be inspected with a thermographic scan to ensure that connections at the motor and starter are clean and tight.
- Provide good ventilation to dissipate heat.  
**For every 20° F increase in motor operating temperature, motor life is estimated to be halved!**

# O&M Training: Identifying Equipment Operation Issues



# O&M Training: Managing Oversized Equipment

- Buildings always **designed for peak conditions** (winter/summer).
- Equipment operates most efficiently at designed load.
- Most of the year the **equipment is oversized!** (Operates at partial load.)
- O&M can address by: Load Matching – Partial Load Management
  - **Modulation**  
Control of the capacity of the equipment over a range. Ex. 25%-100%.
  - **Lead-lag Adjustment**  
Control capacity by controlling the number of boilers on-line.
  - **Temperature Reset**  
Change the set point of the system's working fluid based on outdoor temperature.  
Applies well to hot water but not to steam.
  - **Variable Drives**  
Variable speed/frequency drives for pumps and fans

# O&M Training: Addressing Simultaneous Heating/Cooling

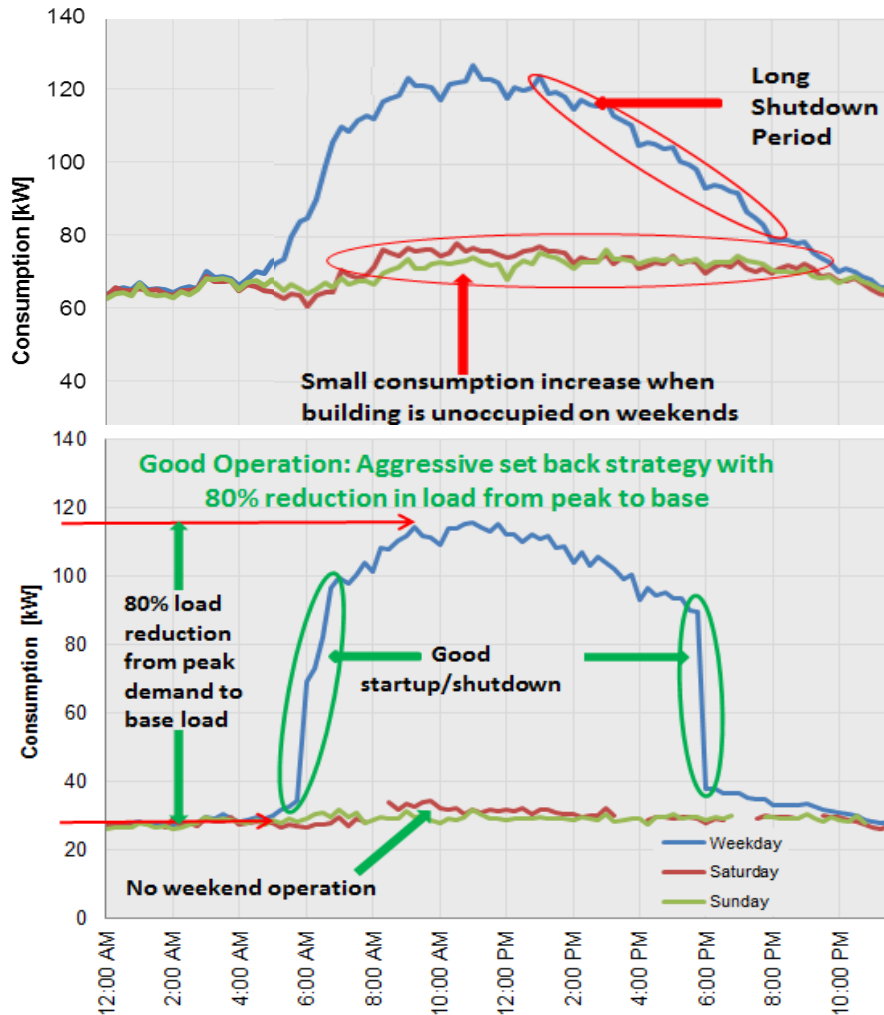


- Often significant energy savings comes from reducing energy use in the shoulder months.
- Cold mornings + warm afternoons = buildings prone to simultaneous heating and cooling.
- Can be identified with close monitoring and addressed through operations.

# O&M Training: Optimizing Heating and Cooling

- *Loads are not steady over the course of a day or in all areas of a building*
- **Morning start-up issues**
  - How long does it take the building to come up to temperature?
  - Demand prices vary by time of day
- **Thermal momentum**
  - The difference of “heavy” vs “light” construction
  - Dealing with “control overshoot”
  - Identifying opportunities for early shut-down?
- **Varying solar gains and activities**
  - Heightening awareness and perception
- *Data loggers can help identify solutions!*

# O&M Training: Optimizing Scheduling



## Results

- Optimized for occupancy
- Reduced energy demand (kW)
- Reduces energy use (kWh)

# Energy Savings from O&M

## O&M Training Evaluation Results

# Energy Savings from O&M

## Summary of Commercial Building O&M-Related Energy Savings Studies

Estimated Savings, %	Date of Study	Information Source	Notes
5 to 10	1986	Thompson, T. A. "Preventive Maintenance Saves Energy and Dollars," Engineered Systems.	Well-developed O&M program savings.
15.4	1992	Herzog, P., and L. LaVine, "Identification and Quantification of the Impact of Improper Operation..." ACEEE.	3-year study of seven office buildings to quantify improved operations potential
15 to 30	1992	Piette, M. A. "Diagnostics for Building Commissioning and Operation." LBNL.	Savings through improved operations and maintenance.
23	1994	Liu, M., et al., "Identifying and Implementing Improved Operation and Maintenance Measures..." ACEEE.	35-building and 104- school summary of energy cost savings from improved O&M.
15 to 25	1994	Szydowski, R. F., et al., "No Maintenance - No Energy Efficiency." PNNL.	Savings identified through O&M measure case studies.
5 to 15	1997	Gregerson, J. "Commissioning Existing Buildings." E-Source.	44-building study of whole-building energy savings.
12	1997	Portland Energy Conservation Inc.(PECI). "What Can Commissioning Do for Your Building."	175-building study of savings
12 to 30	1998	Claridge, D., et al., "Implementation of Continuous Commissioning..." ACEEE.	Continuous commissioning savings range.

Source: Opinion Dynamics



# Energy Savings from O&M | Heating

## Savings Associated with Specific O&M Heating System Efficiency Measures

Efficiency Measure	Approximate Fuel Savings	Related O&M Behaviors in Building w/o BMS
Keep heating and hot water systems well maintained with regular boiler tube cleanings and yearly combustion efficiency tests. Adjust air/fuel ratio for increased efficiency. Maintain well-functioning steam traps, air valves and shutoff valves on all radiators [4].	20% or more	<ul style="list-style-type: none"><li>• Identify and promptly repair system leakage.</li><li>• Maintain boiler efficiency.</li></ul>
Install an energy or building management system (EMS/BMS) that takes indoor air temperature into account for heating control [4].	15-25%	<ul style="list-style-type: none"><li>• Reduce unnecessary heating</li><li>• Optimize boiler and/or RTU start and stop.</li><li>• Adjust temperatures and/or flow resets on hot water systems</li></ul>
Use an EMS/BMS and zoning system to create different heating zones in a building [4].	20% or more	<ul style="list-style-type: none"><li>• Identify and reduce unnecessary heating</li></ul>

Source: Adapted from Urban Green Council & EDF

# Savings from BOC

Evaluation of BOC Savings Results (Units / Participant / Sq. Ft.)

Area Served	Electric (kWh)	Gas (Therms)	Annual Energy (MMBtu)	Water (Gal)	Rebates	Source
Northeast	0.18	-	0.71	0.14	No	1
Northeast	0.35	-	0.74	0.14	Yes	1
Kansas City	0.02	0.52	-	-	?	2
Minnesota						

Adapted from RLW Analytics and Opinion Dynamics

# Savings Evaluation Factors

**Table 3. Basis of Savings Quantified by Program**

Measures Installed and O&M Changes	BOC Programs					Other Programs	
	NEEA	MN MEEA	KCP&L	NEEP	APS	CA SEE	TOSER <sup>a</sup>
Lighting Controls	X	X	X (I, O&M)	X		X (I, O&M)	
Lighting Equipment	X	X	X	X		X (I, O&M)	X
Efficient Motors	X	X	X (I, O&M)	X (O&M)	X (O&M)	X (I, O&M)	
VFDs	X	X	X	X (O&M)		X	
HVAC	X (I, O&M)	X (I, O&M)	X (I, O&M)	X (I, O&M)	X (I, O&M)	X (I, O&M)	X (I, O&M)
Domestic Hot Water	X	X				X (I, O&M)	

# Case Studies in O&M Savings



# Case Studies in O&M | PECl



# Case Studies in O&M | Raytheon



# Case Studies in O&M | Atlanta Federal Center

- ❑ 1.8 million square feet; 2 city blocks
- ❑ 10 MW feeder to the building
- ❑ All electric, perimeter box reheat
- ❑ 4 chillers, 3 1500-ton, 1 500-ton
- ❑ Variable chilled water flow
- ❑ Paired VAV air handler for each floor
- ❑ Mostly glass all sides
- ❑ True VAV facility
- ❑ ~ 100 air handlers total



# Atlanta Federal Center - Before & After BRT

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- Re-commission unoccupied modes.
- Re-commission variable chilled water pumping and chillers.

Before	After
Three 150 HP secondary chilled water pumps running 100% 24/7.	One, sometimes two, pumps most days. One pump 50% at night.
Chilled water temperature: 42°F.	Reset to 48°F based on humidity and load at coils .
Two 1,500 ton chillers run all night to cool 2-250 SF server rooms. This 500 SF space out of 1.8 million SF was driving the cost of the building.	Forced the engineers to fix the smaller chiller at 500 ton and made it run all night, to save energy.

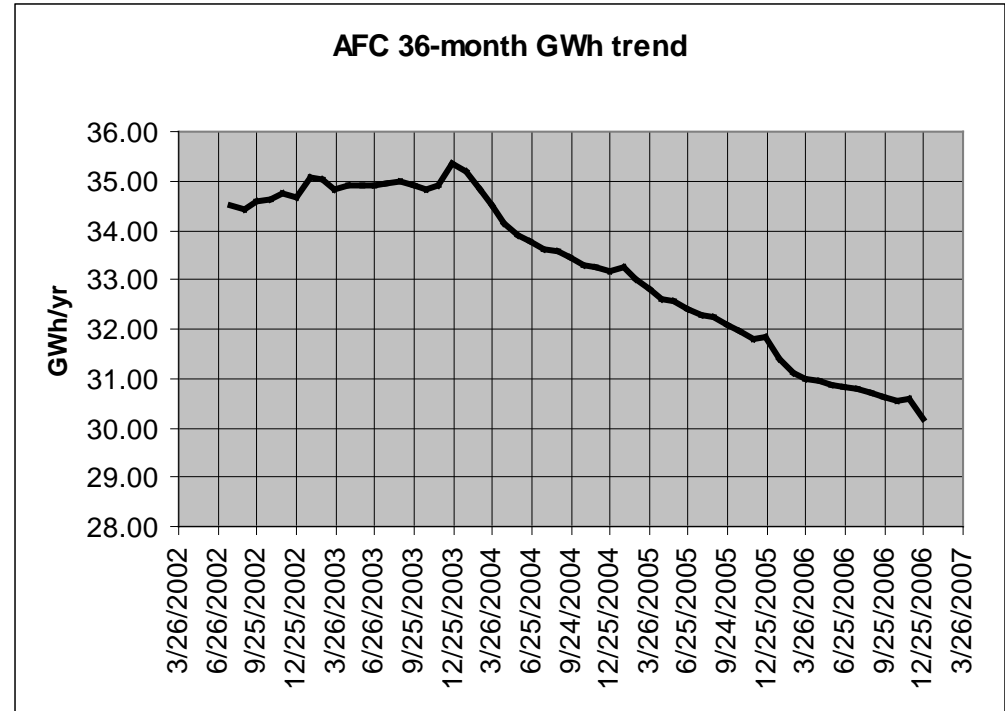


# Atlanta Federal Center - More Re-Tunes

- Installed **discharge air temperature resets** based on warmest interior & coolest exterior zones.
- **Locked out outside air** during morning warm-up/cool-down.
- Installed **discharge air pressure resets** based on VAV box damper positions. Run at 75% open. Now 3 identical floors will run from 0.5" to 1.5" of static pressure.
- Changed dead bands on interior and exterior to allow for **floating temperature**. Open bays with set points as much as 5 degrees difference from zone to zone.

# Atlanta Federal Center - Impact

- Received Energy Star rating.
- Energy down 15% to 20%.
- Peak down on shoulder months.
- **Tenant complaints down 35%.**



QUESTIONS?

Thanks!