



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Transforming the Commercial Building Operations

Building Re-tuning Training

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Presentation Outline

- Background on Re-tuning
- Large Commercial Building Re-tuning Training (buildings with Building Automation Systems)
- Small/Medium-Sized Building Re-tuning Training (buildings *without* Building Automation Systems)
- Train-the-Trainer

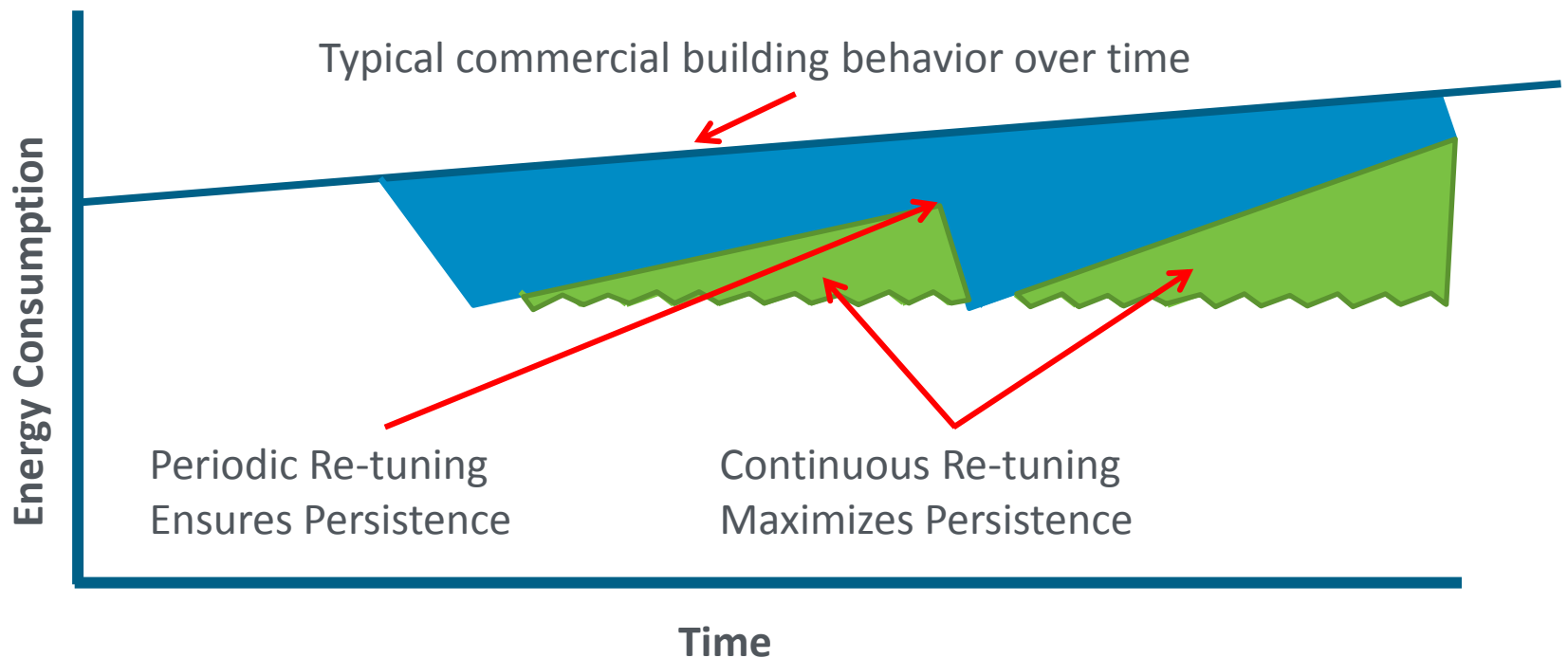


Why is Building Retro-commissioning Important?

- A number of studies have shown that retro-commissioning (RCx) buildings can lead to significant energy savings – 5 to 30%
- Cost of RCx varies between \$0.10/sf to \$0.60/sf
- Cost savings can range between \$0.10/sf to \$0.75/sf
- Simple payback ranges from 3 months to 3 years
- A number of the measures addressed by RCx relate to our inability to control the building operations
- Perceptions about RCx
 - **Expensive** – typically less than 3 year payback
 - **Results are not persistent** – last up to 6 months

What is Re-tuning?

- A systematic process to identify and correct building operational problems that lead to energy waste
- Includes small, low-cost repairs, such as replacing faulty sensors



Re-tuning can fill the Gap

- Re-tuning training is targeted at building operations staff
- Addresses the cost and persistence question
- Because re-tuning is implemented by leveraging information from building automation systems and targets operational problems, cost of implementing is significantly lower than retro-commissioning
- Can be periodically done to ensure persistence



Building Re-tuning Training Details

- Created by the DOE's Building Technologies Office through Pacific Northwest National Laboratory (PNNL)
- Initial training targeted buildings with building automation systems (BAS), "Large Buildings"
- PNNL developed an analysis tool which uses data directly exported from BAS system – Energy Charting and Metrics tool (ECAM)
- Currently developing trainings for buildings without BAS, "Small Buildings"



Pacific Northwest
NATIONAL LABORATORY

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Overview of Large *(buildings with building automation system)* Commercial Building Re-tuning Training

Six Primary Steps of Large Commercial Building Re-tuning

1. **Collecting Initial Building Information** – Basic building information
2. **Pre-Re-tuning Phase** – Trend data collection and analysis
3. **Building Walk Down** – Getting to know the building
4. **Re-tuning** – Identifying and correcting operations problems
5. **Post Re-tuning** – Reporting re-tuning findings
6. **Savings Analysis** – Determining and reporting the impacts

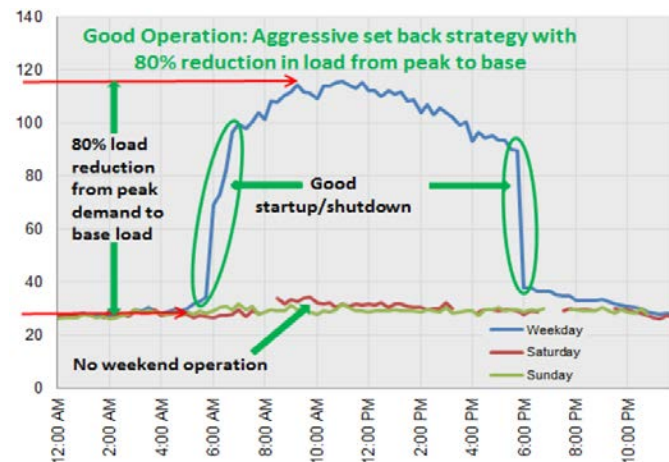
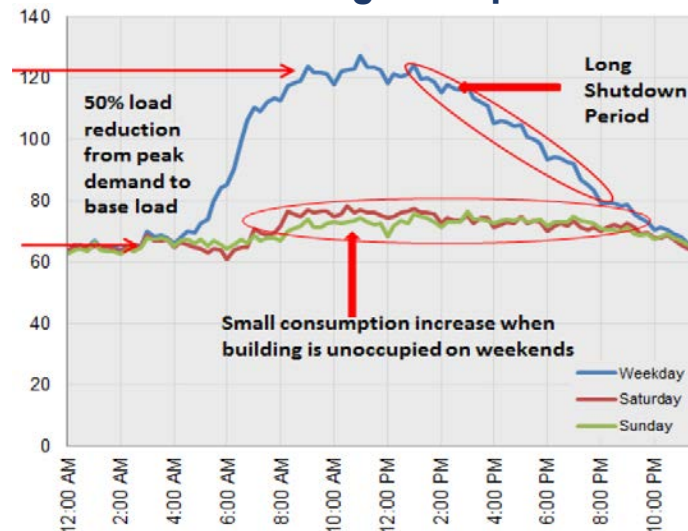


Large Commercial Re-Tuning Training Details

Major focus areas

- Occupancy scheduling
- Discharge-air temperature and pressure control
- Air-handling unit (AHU)
- Zone conditioning
- Meter profiles
- Central plant

Occupancy Scheduling Re-tuning Example

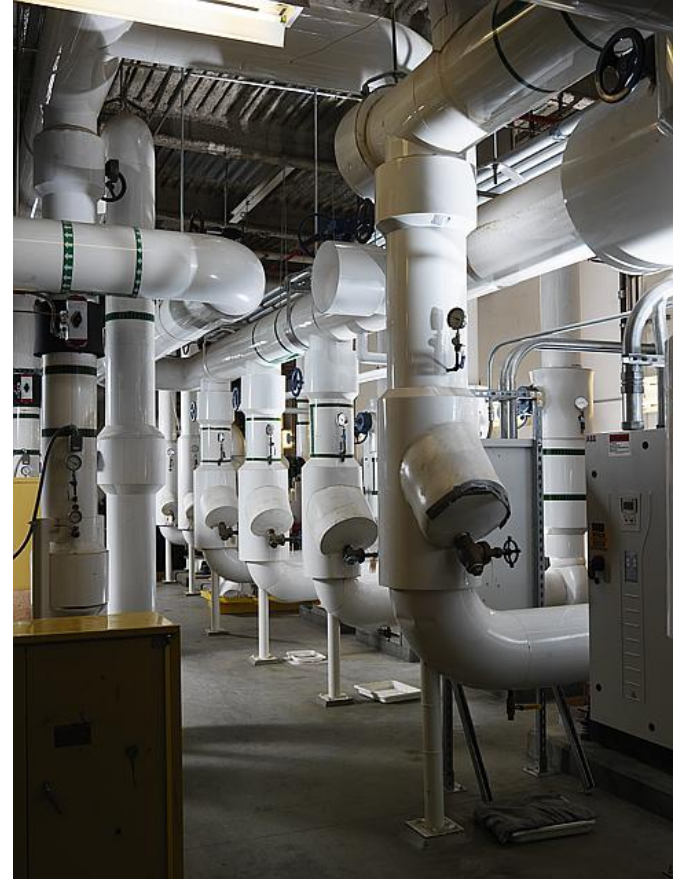


Large Commercial Common Problems Found

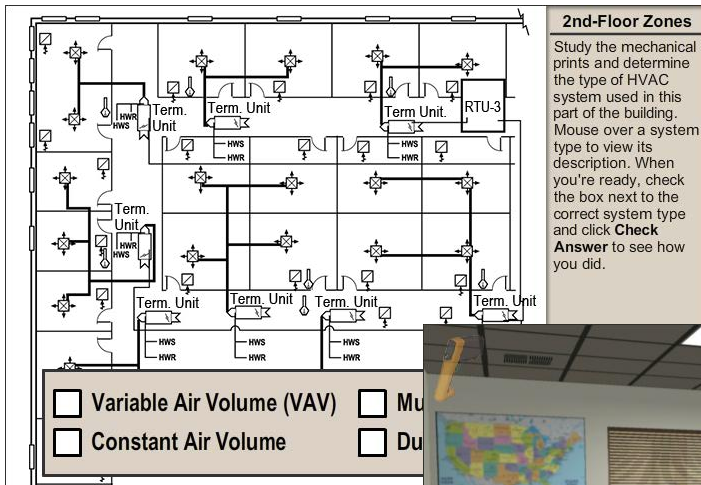
- Occupied Schedules longer than they need to be
- Equipment running during unoccupied periods (exhaust fans)
- Discharge-air set points too low
- Heating/cooling set points too close
- Static pressure too high (especially during partially occupied periods)
- No resets of either discharge-air set points or static pressure
- Economizer problems
- Lack of resets on distribution loops (both hot and chilled water)

Large Commercial Building Re-tuning e-Learning

- Available for free
- Provides learners:
 - A step-by-step walk through of the building re-tuning process
 - Opportunity to practice meaningful re-tuning activities in real-world contexts and situations
 - A variety of downloadable resources (checklists, templates, example plans, etc.) to use on the job
 - <http://retuningtraining.labworks.org/>



Large Commercial Building Re-tuning: Learn by Doing



Discharge Air Temperature Scenario 1
Field Inspection: Air Handler

Supply Fan Section

What would you like to do?

- Inspect supply fan
- Inspect VFD
- Check VFD belts
- Inspect motor sheaves
- Inspect ductwork

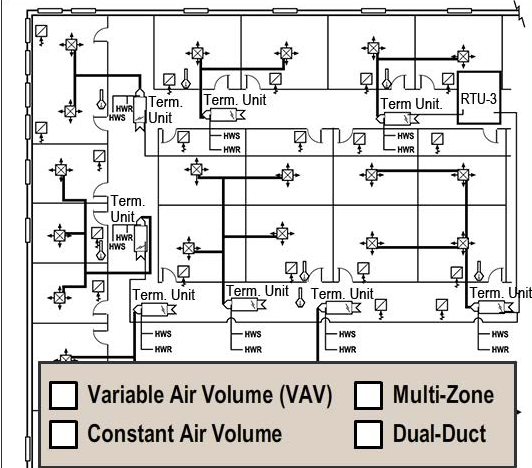
Return to Scene

Back Help Found Solution

- Work within a virtual, 3D commercial building
- Collect and analyze building prints and trend data
- Perform a virtual building walk down
- Interact with building occupants
- Work through a variety of interactive scenarios designed to target specific re-tuning issues throughout the building

Large Commercial Building Re-tuning e-Learning

- Currently over 550 registered users
- Transferred online training content to
 - Johnson Controls Inc.
 - Efficiency Vermont
 - Building Operator Certification®
 - A number of organizations interested in making the training a requirement for their facilities management staff



2nd-Floor Zones

Study the mechanical prints and determine the type of HVAC system used in this part of the building. Mouse over a system type to view its description. When you're ready, check the box next to the correct system type and click **Check**. **Answer** to see how you did.

Variable Air Volume (VAV) Multi-Zone
 Constant Air Volume Dual-Duct


Check Answer

Discharge Air Temperature Scenario 1
Field Inspection: Air Handler

Supply Fan Section

What would you like to do?

- Inspect supply fan
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Return to Scene

Back Help Found Solution

Large Building Re-tuning Online Resources

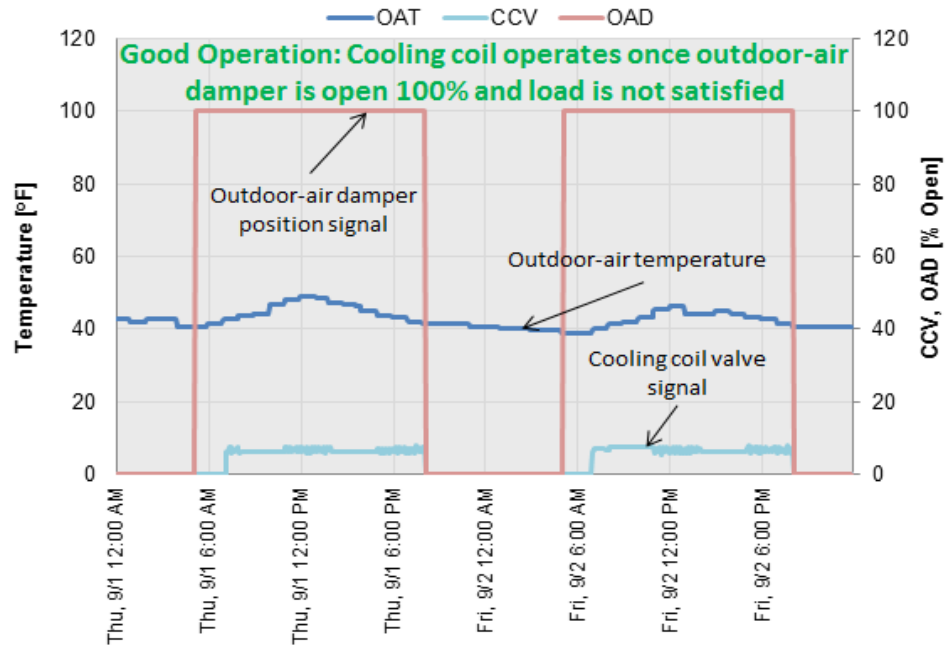
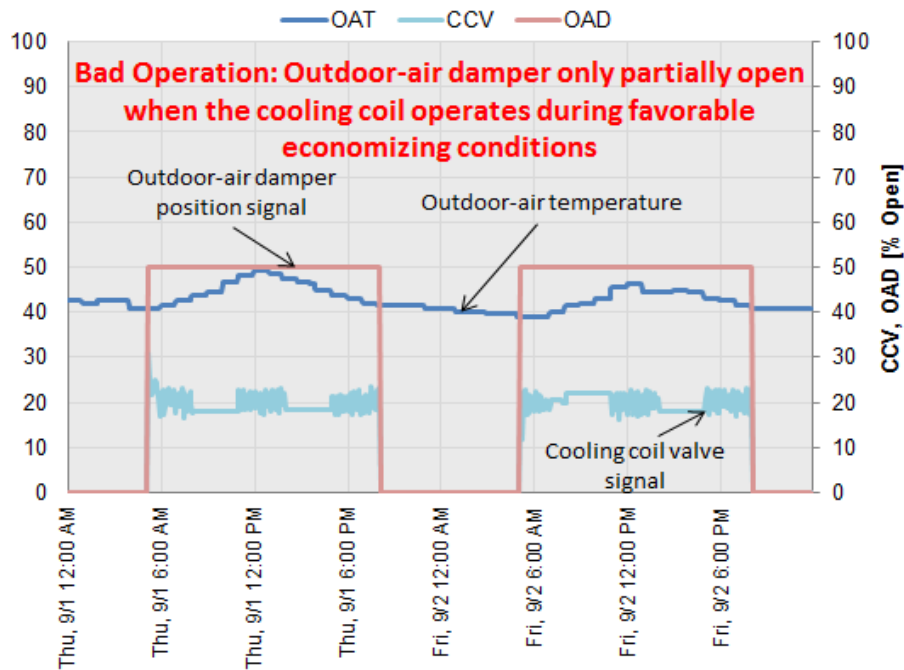
- All classroom re-tuning training material, including train-the-trainer instructor's manual
- Energy Charting and Metric tool (ECAM), a semi-automated Excel[®]-based trend data analysis tool
- Guides to re-tuning measures

The screenshot displays the Pacific Northwest National Laboratory (PNNL) website. At the top, the PNNL logo is visible, along with navigation links for Home, About, Research, Publications, Jobs, Newsroom, and Contacts. A search bar is located on the right. The main content area is titled "Re-tuning Commercial Buildings" and features a sidebar with "Focus Areas" (Re-tuning Home, Outreach, Resources, Training) and "Contacts" (Srinivas Katipamula, Energy and Environment Directorate). The main text includes sections for "Re-tuning Commercial Buildings Resources", "Re-tuning Classroom Training Material", "Re-tuning Training Instructor Manual", and "Energy Charting and Metrics Tool (ECAM)". A right-hand sidebar contains "Additional Information" with links to training materials, commercial building guides, and related web sites, as well as a "Website Contact" section for the WebMaster.

<http://www.pnl.gov/buildingretuning/resources.stm>

Example ECAM Chart

Visualizing Economizer Operation



Overview of Small/Medium-Sized *(buildings without building automation system)* Commercial Building Re-tuning Training

Definition and Scope of Small Building Re-tuning

- *Systematic process to identify and correct operational problems that lead to energy waste* (same as large re-tuning)
- Re-tuning process for small/medium-sized will not rely on detailed monitoring data from a building automation system
- Small/medium-sized buildings mostly have packaged units for heating and air and are controlled by zone thermostats, many recommendations are **prescriptive**
- Some topics covered are often covered in training associated with energy auditing and retro-commissioning for small/medium-sized commercial buildings

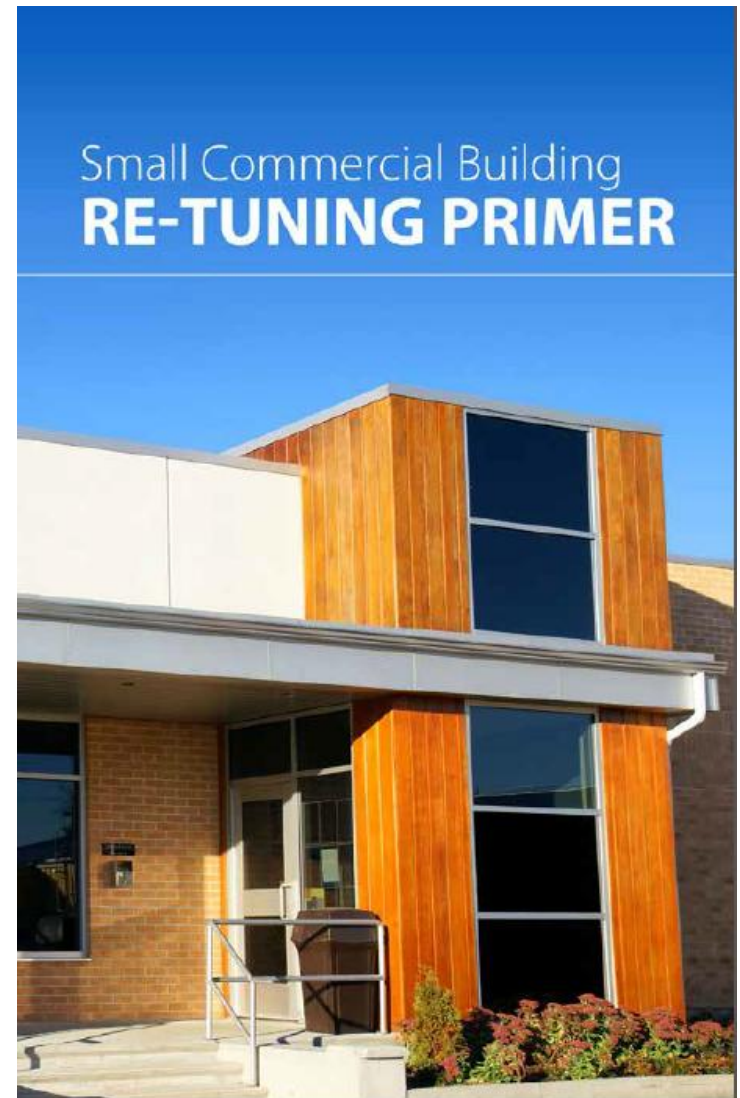
Small Building Re-tuning Training Intended Audience

- On-site employees (custodial staff) responsible for day-to-day building operations
- Off-site contractors (RCx agents, service providers or control vendors) hired to improve a building's energy efficiency
- Those interested in entering energy efficiency field, including college students and military veterans

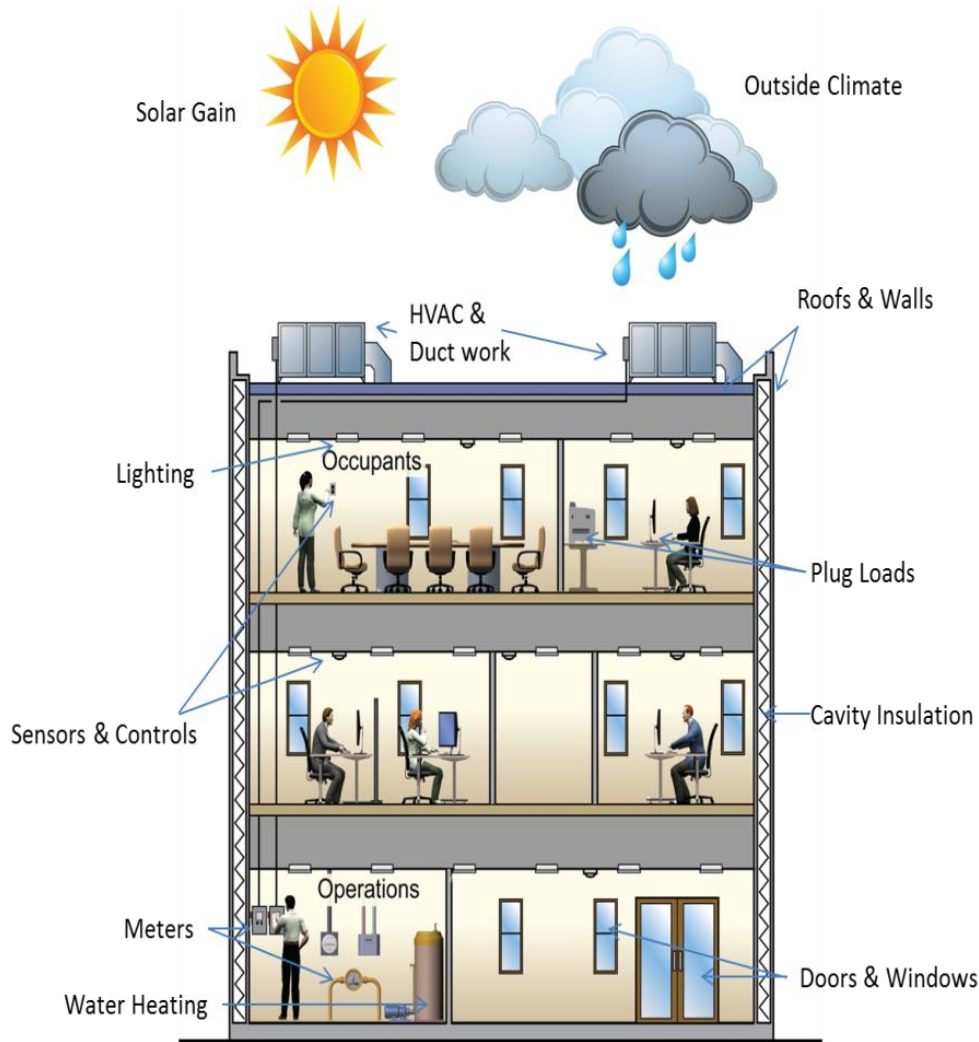


Small Building Re-tuning Primer

- Provides background information to help the audience prepare for the small building re-tuning training
- Contains basic building energy terminology associated with building energy use such as
 - *Plug loads*
 - *Solar gain*
 - *Sensors*
 - *Controls*



Topics covered in Primer

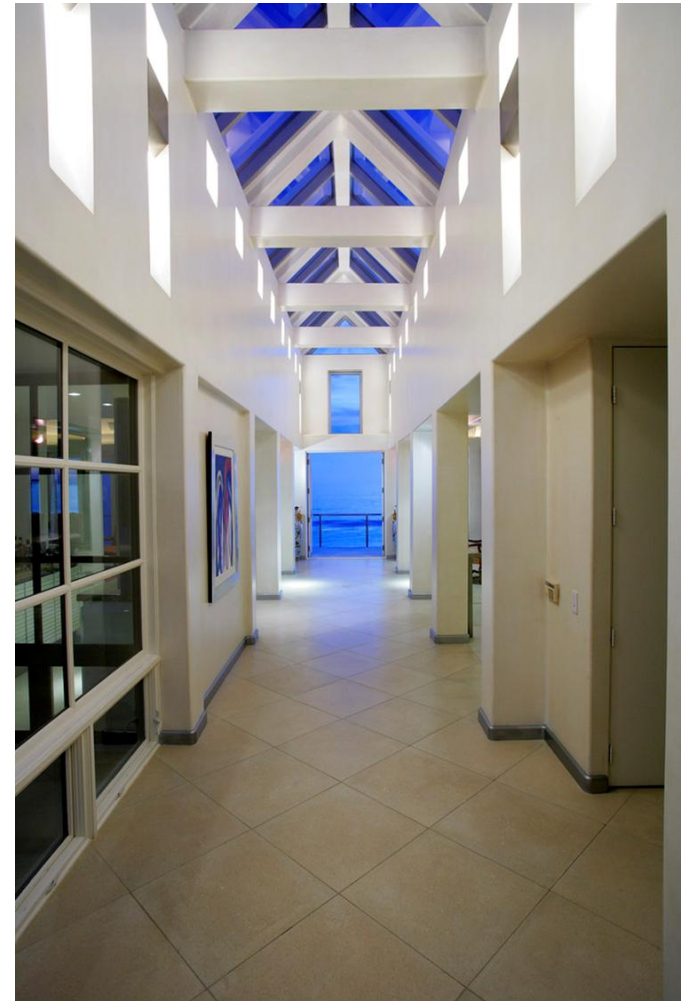


- Heating, Ventilation & Air Conditioning (HVAC)
- Building Envelope
- Meters, Sensors and Basic Controls
- Water Heating
- Lighting

Full of illustrative examples

Four Primary Steps of Small Building Re-tuning

1. **Initial Data Collection Phase** –
Collection of information about the building
2. **Investigation Phase** – Building
walk-down to identify and characterize the
building operations
3. **Implementation Phase** –
Application of prescriptive re-tuning
measures
4. **Documentation Phase** –
Reporting of measures implemented and
calculation of energy savings



Small Building Re-tuning Training

- Train students/technicians on efficient operations of small/medium-sized buildings leading to energy savings and reduced operating costs
- Knowledge and skills learned through training will be highly valued by companies and organizations seeking to improve performance of their smaller buildings
- Prepares students/technicians for hands-on field training



Current Re-tuning Trainings

Full Courses	Train-the-Trainer Courses
Laney College – Oakland, CA	PNNL
Energy Efficient Buildings Hub – Philadelphia, PA	Energy Efficient Buildings Hub
City University of New York (CUNY) Building Performance Lab	CUNY Building Performance Lab
Rochester Institute of Technology	Laney College

Key Lessons Learned

- Many commercial buildings have an array of operational problems
- Trained building operations staff can re-tune buildings, **if empowered** to do so
- Building re-tuning training can yield energy savings of 5-20% through implementation of no-cost and low-cost measures
- The human factor is a **real** issue in realizing re-tuning benefits in practice
- In the long run, automation is key to persistence of “optimal” building operations

Vornado Realty Trust Re-tunes

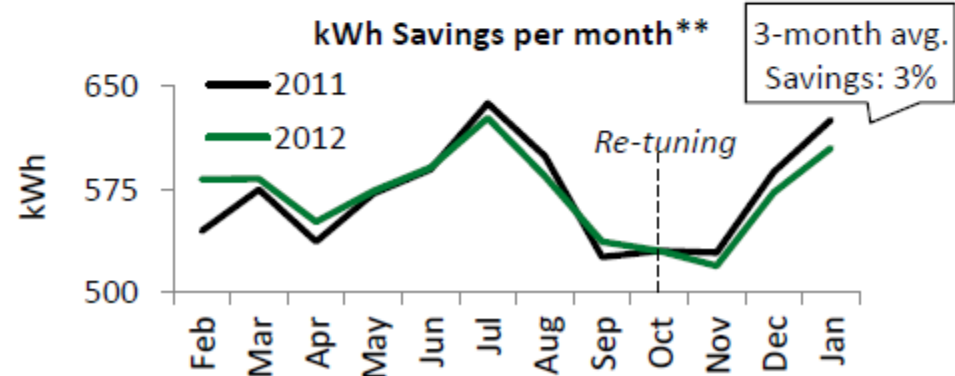
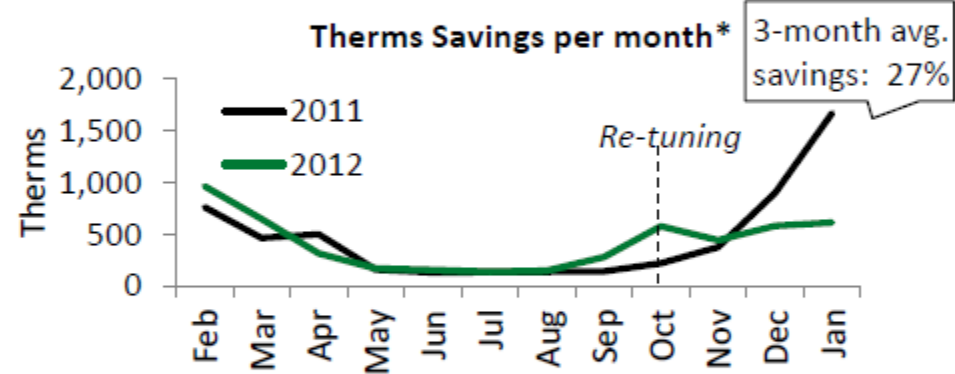


Address: 2100 Crystal Drive, Arlington VA
Owner: Vornado Realty Trust
Size: 250,000 square feet

Vornado Realty Trust is one of the nation's largest owners and managers of commercial real estate. Over 20 million square feet of Vornado's 100 million square foot portfolio has earned the Energy Star label.

In October 2012, Vornado trained building operators to re-tune one of its buildings and within 3 months saved an average 27% on its heating bill and 3% on electric by implementing 5 measures identified during the re-tuning process.

1. Lowering the boiler hot water supply temperature set point
2. Lowering the static pressure on the main duct and branches
3. Changing the set points on fan discharge temperature and chilled water supply temperature
4. Lowering condenser water temperature supply
5. Using motion sensors for the conference rooms to set VAV boxes to night mode



*Both Therm and kWh usage were normalized by degree days

**Fan and cooling kWh savings are most significant during the Spring and Fall months

Questions? Participate in a training?

General Questions

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Better Buildings Alliance Trainings

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Technical Re-tuning Questions

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