Transforming the Commercial Building Operations (subcontract of PNNL)

2014 Building Technologies Office Peer Review

Photo credit: Marta Milan

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Project Summary

Timeline:

Start date: Oct 1, 2011

Planned end date: Sept 30, 2014

Key Milestones

1. Coordinate up to 5 trainings; September 15, 2014
2. Develop up to 6 detailed case studies and outreach marketing materials; July 30, 2014

Budget:

Total DOE $ to date: $929K

Total future DOE $: TBD

Target Market/Audience:

Existing commercial buildings of all sizes and types across the nation with and without Building Automation Systems (BAS). Primary focus has been office buildings and higher ed.

Key Partners:

PNNL	GSA NCR
OWIP/SeeAction	State of Maryland
BOMA Philadelphia	NIST MEP – Manex
BOMA Minneapolis	NIST MEP – DVIRC
Parmenter Realty	NIST MEP – NY DED

Project Goal:

Develop, execute, and deploy a training program for building operators on "how to" operate buildings efficiently with re-tuning (RTx) practices. The re-tuning training is being piloted throughout 2013, and in 2014 the focus is on deployment of the training to the wider market to encourage more buildings to take advantage of this tremendous energy savings opportunity.

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Purpose and Objectives: Problem Statement

- A significant portion of the energy used in commercial buildings is wasted because of improper operations. The poorly operated and maintained buildings face significant energy wastes of 5 to 20%, even when they have building automation systems (BASs).
- The workforce is not often trained sufficiently to be proactive and efficient in O&M practices.
- Retro-commissioning (RCx), a common option for improving the efficiency of buildings, is perceived as costly and overly burdensome without delivering persistent savings.

Re-tuning addresses these challenges and gaps with a unique proactive approach to transform commercial building operations.

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Purpose and Objectives: Target Market and Audience

Target Market/Audience

Re-tuning Training focuses on two market sectors: Commercial Buildings with Building Automation Systems (BAS) and Commercial Buildings without BAS

Primary attention has been focused on office buildings and higher education, but re-tuning is applicable to all commercial buildings

Audience includes building engineers, operators, managers, and owners

Energy Usage/Impact

Currently, commercial buildings consume more than 18 quadrillion British thermal units (quads) of primary energy use annually, or about 18% of all the energy used in the nation in 2012

If 10% of commercial buildings were re-tuned, reducing their average energy consumption by 15%, this could save annually over 44 terawatt hours (TWh) and 30 trillion Btu's which would translate into savings of over $1.5 billion annually (*Source: DOE BTO Fact Book*)

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Purpose and Objectives: Impact of Project

Project Endpoints and Final Products
- Final products: Case Studies, Tracking of Trainees, Walkdown Reports, Energy Consumption results data, Training slides (BAS and non-BAS)
- Project endpoints (envisioned): Re-tuning becomes a common established practice in the building operator community and commercial buildings are regularly re-tuned for optimum operations and maintenance efficiencies

Measuring Achievement Towards Re-Tuning Goal
a. *Near-term (during or up to 1yr after project):*
   - Regular discussions with trainees to obtain qualitative comments/ feedback on training and how they are re-tuning their own buildings
   - Creation of documents with energy savings/case study materials to disperse to the public
b. *Intermediate-term (1-3yr after project):* Deploy (pass off) the training from the government to an outside organization (e.g. BOMA, IFMA, etc.) and keep re-tuning resources publicly available on CBRD/etc. from which the public can benefit
c. *Long-term (3yr+ after project):* Full re-tuning training deployment by an outside entity and continued training delivered to building operators

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Approach

Approach

- Unique Training: 2-day training (1 day Classroom, 1 day Field) with 2 expert trainers (1 academic, 1 field), and a "train-the-trainer" focus for re-tuning beyond the training

- Proactive Follow-Up Efforts: Pre-data analysis, Post-RTx Data Comparison, Trainee follow-up post training for comments/results

- Widespread Resource Deployment: Fact Sheet, Case Studies, Support Documents, Content shared with NIST MEPs to develop and deploy more broadly

Key Issues that Re-Tuning Addresses

- Building engineers are not proactive in their O&M practices
  - This training teaches building engineers to solve the root of the problem, not just respond to a hot/cold tenant call

- Building owners are not willing to undergo RetroCommissioning (RCx)
  - The no- and low-cost recommendations from building re-tuning provide a RCx-lite type of option for buildings to gain efficiencies with less effort

Distinctive Characteristics

- Unique training format & follow-up approach

- Resources such as case studies to share on CBRD and more widely

- Enhanced content deployment via NIST MEPs

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Progress and Accomplishments

| Lessons Learned	Accompanying Solution
Without setting clear trainee expectations, trainee follow-up participation is limited	Now during trainings the expectations are clear with agreement required in an application form for follow-up participation
The assumption is incorrect that large (>100,000sf) buildings have BAS and small (<100,000sf) do not	Changed nomenclature from Large/small to BAS/non-BAS to cover small buildings with BAS and large buildings without BAS
It is difficult to align specific energy savings with correlated re-tuning measures	Encouraging stronger M&V with sub-meters on specific pieces of equipment (e.g. AHUs) to quantify savings more accurately
BAS analysis tool "ECAM" is difficult for building engineers unfamiliar with MS Excel	Manex NIST MEP developing user-friend "ECAMplus" tool
Difficult to get management approval for the Building Engineer's time off to take the training and approval for the implementation of recommended (low-cost) measures	Case Studies on re-tuning with energy and cost savings encourage management approval

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Over FY14, conducted re-tuning trainings in four locations (Philadelphia, Minneapolis, Dallas, and Washington DC) for 70+ attendees

Captured data on actual realized re-tuning energy savings in 6+ commercial Field Training buildings, with case study development in progress

Photo credit: Marta Milan

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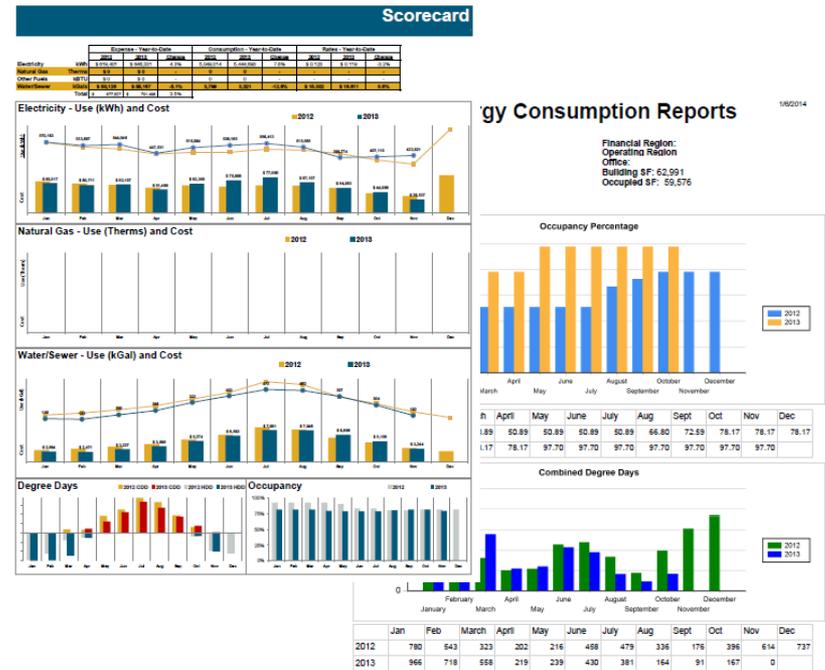
Re-Tuning Case Studies In Progress, Completion July 2014

DOE is in the process of creating case studies with energy savings information from Field Training buildings

Example: 2-page Re-Tuning Case Study of a large office building (with BAS)

Size (SF)	Building Type	Location
60,000	Business Center	Outside Philadelphia, PA
250,000	Office Building	Arlington, VA
270,000	Office Building	Bethesda, MD
440,000	Courthouse	Washington, DC
484,000	2-Tower Office Building	Outside Dallas, TX
550,000	Office Building	Washington, DC
1,285,000	Mixed-Use Building	Downtown Philadelphia, PA

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Example Re-Tuning Case Study: Vornado Energy Savings

In October 2012, Vornado trained building operators to re-tune one of its buildings in Arlington VA

In the 3 months following re-tuning training, Vornado has saved an average of 27% on its heating bill and 3% on its electricity bill due to the following 5 measures that were identified:

- Lowering the boiler hot water supply temperature set point

- Lowering the static pressure on the main duct and branches

- Changing the set points on fan discharge temperature and chilled water supply temperature

- Lowering condenser water temperature supply

- Using motion sensors for the conference rooms to set VAV boxes to night mode

Vornado Energy Consumption Re-Tuning Data

Therms Usage per month*

3-month avg. savings: 27%

kWh Usage per month**

3-month avg. Savings: 3%
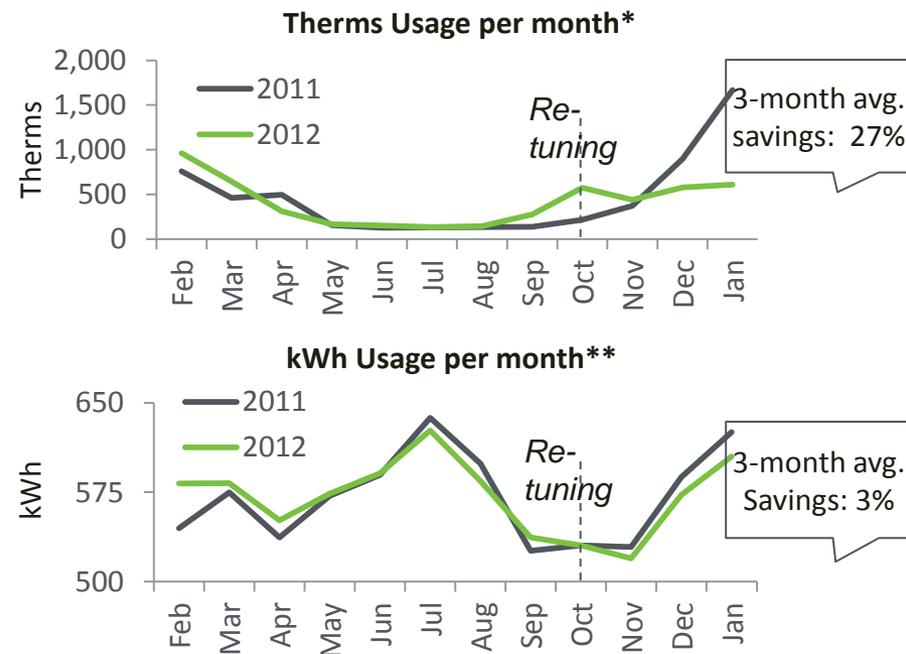
*Both Therm and kWh usage were normalized by degree days
**Fan and cooling kWh savings are most significant during the Spring and Fall months

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Re-Tuning Resources Online and more in Development

Re-Tuning Resources on CBRD and PNNL websites

Interested parties can visit the Commercial Buildings Resource Database (CBRD) for free Re-Tuning Resources such as:

- Re-Tuning Training: Instructors Manual
- Large Building Re-Tuning Training
- Small Building Re-Tuning Training
- ECAM User's Guide
- Interval Data Analysis
- Building Re-Tuning Case Study: Vornado
- Coming soon: Additional case studies

Online Re-Tuning Training Available

PNNL offers two free interactive Re-Tuning e-learning courses to anyone interested in improving a building's energy performance and the comfort of the building's occupants (http://retuningtraining.labworks.org/training/lms/)

- Re-tuning for Building with Building Automation Systems (CEUs available from the Building Operator Certification Program)
- Re-tuning for Buildings without Building Automation Systems

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PNNL Re-Tuning Training Website

The PNNL Re-Tuning website provides a wealth of information on the training as well as a link to the online interactive training system. It introduces the concept and benefits of re-tuning, and divides its information into categories for buildings with and without BAS.

Re-tuning Commercial Buildings

Focus Areas

Re-tuning Home

Re-tuning Outreach

Large Building Re-tuning Resources

Small Building Re-tuning Resources

Online Interactive Training

Contacts

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A Low-Cost Path to Energy Efficiency and Cost Savings

Commercial buildings account for almost 20% of the total U.S. energy consumption. A significant portion (up to 20%) of the energy used in commercial buildings is wasted because of improper operations. Today, large commercial buildings use sophisticated building automation systems (BASs) to manage a wide and varied range of building systems. Although the capabilities of the BASs have increased, many buildings still are not properly commissioned, operated, or maintained. Lack of proper maintenance leads to inefficient operation and reduced lifetimes of equipment. Re-tuning BASs ensures maximum energy efficiency and comfort for building occupants. Although a poorly tuned system can maintain comfort, it may do so at a high energy cost while compensating for undetected operational inefficiencies.

Pacific Northwest National Laboratory (PNNL) is changing the way heating, ventilating, and air conditioning (HVAC) systems in commercial buildings are operated, serviced, and maintained. PNNL trains building operators, managers, and businesses that install and service HVAC equipment to optimally re-tune large and small commercial buildings. Re-tuning commercial buildings can reduce energy use of buildings by 5 to 20%.

PNNL initiated the Commercial Building Re-tuning project for the U.S. Department of Energy's Building Technologies Office. The goal of this project is to improve building operations by

Additional Information

- Building Re-Tuning Training: Providing Energy Saving Solutions through Interactive e-Learning 📄

- Re-Tuning Commercial Buildings: A Low-Cost Path to Energy Efficiency and Cost Savings 📄

- Re-Tuning Training Guide: Trending Requirements for Re-Tuning 📄

- Related Web Sites

Website Contact

- ✉ WebMaster

http://buildingretuning.pnnl.gov/

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CBRD: Portal for Re-Tuning Documents, Results, and Tools

The Commercial Buildings Resource Database (CBRD) is a central location of resources to support the adoption of energy-saving building technologies – re-tuning training documents, case studies, videos, and analytical tools

https://buildingdata.energy.gov/cbrd/

Progress and Accomplishments, continued

Market Impact:

Efforts to ensure or accelerate impact
- Encourage past trainees to follow the "train the trainer" model and train others/colleagues with the PNNL material
- Create and Share case studies that capture energy savings and encourage re-tuning participants to M&V their activities
- Work with NIST MEPs to further develop PNNL curricula and deploy in different means to identify the best ways to reach the target market

How actual impacts measure up against planned impacts
- Final outputs: On track to complete all trainings and case studies, as well as additional resources to promote re-tuning
- Project endpoint: Our efforts to deploy RTx more broadly are in progress with the NIST MEPs collaborating with outside organizations

Awards/Recognition: Recognition in the form of case studies was provided to Vornado for their re-tuning efforts, and will be provided to organizations/buildings via promotion of future re-tuning case studies: JBG, Parmenter, GSA, BNY Mellon, Freedom Business Center

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Project Integration and Collaboration

Project Integration:
- BBA integration by inviting local members to nearby trainings
- BOMA integration to promote the training to more audiences
- NIST MEP collaboration to further develop curriculum

Communications:
- BOMA Philadelphia Pre-Re-Tuning Seminar
- Semi-annual NIST MEP Re-Tuning meeting
- 2014 DOE Better Buildings Summit

Partners, Subcontractors, and Collaborators

PNNL
- Develop training content and instruct the re-tuning trainings

NIST MEPs: Manex, DVIRC, NY DED
- Expand upon PNNL content to deploy re-tuning training to the broader market

DOE – BBA, OWIP, SeeAction
- Resource development to encourage accelerated adoption of re-tuning practices
- Training coordination and implementation
- Consideration of re-tuning within broader Workforce Development efforts

BOMA Philadelphia & Minneapolis, Parmenter Realty Trust, GSA, State of Maryland
- Provide buildings and audiences for trainings

DOE Re-Tuning Collaboration with NIST MEPs BCTEP

Funded by DOE in collaboration with NIST Manufacturing Extension Partnership (MEP), the Building Construction Technology Extension Program (BCTEP) pilot engages three MEP centers across the country to deliver re-tuning training using the extension program model, which has been tested and proven in the agricultural and manufacturing sectors. Each MEP center employed the core re-training material provided by DOE/PNNL and developed additional modules focused on the specific needs of their local market.

NIST MEP	Location	Partners
Manex	San Francisco	The Corporation for Manufacturing Excellence in California, partnering with Laney College and the International Union of Operating Engineers Local 39
DVIRC	Philadelphia	Delaware Valley Industrial Resource Center in Pennsylvania, partnering with Pennsylvania State University and Pennsylvania College of Technology
NY DED	NYC & Albany	New York State Department of Economic Development in New York, partnering with City University of New York and Rochester Institute of Technology

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Next Steps and Future Plans

Next Steps and Future Plans:

- Deployment (passing off) of re-tuning training from the DOE/government to the commercial building market (e.g. Service Providers or Training Organizations)
- Prepare re-tuning curricula to reach a broader market audience. Formulation of options in process
- Case Studies for long-term follow-up on energy savings and continued RTx
  - Did buildings continually re-tune?
  - What are long term, multi-year savings?
- Tie actual cost estimates and savings estimates to re-tuning measure recommendations
- "ECAMplus" usage testing and training with building operators
- Online re-tuning training deployment, expansion, improvement, etc.

The overall long-term goal is for the commercial buildings operations market to know, understand, and practice the benefits of building re-tuning and to obtain operational energy efficiency in buildings.

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REFERENCE SLIDES

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Project Budget

Project Budget: $205K carryover from FY13 funding ($75K – Waypoint Building; $130K – PNNL).

Variances: None to note.

FY14 Cost to Date: $96K through 3/21/2014.

Additional Funding: None to note.

Budget History					
FY2012– FY2013 (past)		FY2014 (current)		FY2015 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$929K	$100K	$205K (carryover)	$0	$TBD	$0

Project Plan and Schedule

Project Schedule														
Project Start: Oct 1, 2012	▮ (blue)	Completed Work												
Projected End: Sept 30, 2014	▮ (dark)	Active Task (in progress work)												
	◆ (red)	Milestone/Deliverable (Originally Planned) use for missed												
	◆ (black)	Milestone/Deliverable (Actual) use when met on time												
		FY2013				FY2014				FY2015				
Task	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)		
Past Work														
Q2 Milestone: Re-tuning Training for Small/Medium-sized Commercial Buildings		◆												
Q2 Milestone: Complete two small/medium building pilot re-tuning training sessions			◆											
Q3 Milestone: Re-tuning Training Train-the-Trainer Instructions for Small/Medium-Sized Commercial Buildings			◆											
Q3 Milestone: Update small/medium building re-tuning training and train-the-trainer material based on the pilot training feedback				◆										
Q4 Milestone: Provide technical leadership to setup the centers of excellence and input into development of enahncements to the re-tuning training					◆									
Q4 Milestone: Participate in meeting with NIST and MEPs					◆									

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Project Plan and Schedule

Project Schedule													
Project Start: Oct 1, 2012		Completed Work											
Projected End: Sept 30, 2014		Active Task (in progress work)											
	◆	Milestone/Deliverable (Originally Planned) use for missed											
	◆	Milestone/Deliverable (Actual) use when met on time											
		FY2013				FY2014				FY2015			
Task		Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Past Work													
Q4 Milestone: Provide 3 to 6 re-tuning train-the-trainer sessions for MEP and their partners. DVIRC Large 1/13; DVIRC Small 6/13; NY Small 5/13; CA Small 9/13					◆								
Q4 Milestone: Participate in meeting with NIST and MEPs					◆								
Q4 Milestone: Complete at least four additional small/medium building pilot re-tuning training sessions					◆								
Q4 Milestone: Handbook describing the terms and technology used in the small/medium-sized building re-tuning training.					◆								
Q4 Milestone: Deliver an online interactive re-tuning training for small/medium-sized buildings					◆								

Project Plan and Schedule

Project Schedule														
Project Start: Oct 1, 2013		▆ (light blue)	Completed Work											
Projected End: Sept 30, 2014		▆ (dark blue)	Active Task (in progress work)											
		◆ (red)	Milestone/Deliverable (Originally Planned) use for missed											
		◆ (black)	Milestone/Deliverable (Actual) use when met on time											

Task	FY2013				FY2014				FY2015			
	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Current/Future Work												
Q1 Deliverable: Management and Communication Plan					◆							
Q1 Deliverable: Recommendations on organization change strategies - Waypoint						◆						
Q3 Deliverable: Promotional and outreach materials including 1-page re-tuning fact sheets catered to key audiences from market analysis and other re-tuning tools for building operators based-on DOE-funded reference materials to be completed in October 2013 (Case Studies Database and Communication Outreach) - Waypoint							◆					
Q4 Milestone: 5 re-tuning train-the-trainer session complete - PNNL								◆				
Q4 Deliverable: Up to 6 Case studies (Case Studies Database) - Waypoint								◆				
Q1-Q4 Deliverable: Quarterly update on training sessions - PNNL						◆	◆	◆◆				
FY15 TBD Milestones												