FEMP Re-tuning Challenge Webinar

Nael Nmair – Federal Energy Management Program (FEMP)
Jay Wrobel – Federal Energy Management Program (FEMP)
Anne Wagner – Pacific Northwest National Laboratory (PNNL)
Nick Fernandez – Pacific Northwest National Laboratory (PNNL)
Dave Hunt – Pacific Northwest National Laboratory (PNNL)

DATE 4/4/2019
Introduction to the FEMP Re-tuning Challenge Webinar

• The objective of the FEMP Re-tuning Challenge is to demonstrate
  – How re-tuning is done
  – Help you build your capability to complete re-tuning on your own
  – Ultimate goal is to train the trainer

• Today we will discuss
  – Why FEMP is sponsoring the Re-tuning Challenge
  – What the Re-tuning Challenge is
  – What re-tuning is
  – Next steps for interested sites

• O&M Working Group – Request Participation
Why FEMP is Sponsoring the Re-tuning Challenge?

• Building re-tuning is an effective, low-cost method for reducing building energy use.

• Building re-tuning identifies opportunities primarily through Building Automation System (BAS).

• Re-tuning federal buildings, to date, has resulted in savings that typically range from 5 – 25% with a simple payback of 0.3 – 3.5 years.

• Re-tuning is a contributing approach to overall energy management program (i.e. ISO 50001).
DOE Recognition for 50001 Conformance

- DOE program offers a **no-cost** way to receive **DOE recognition** for establishing a business practice around the management of energy
- Not a certification program and **no third-party audits** or verification
- DOE provides **free tools and technical assistance** to implement and maintain 50001

**Key Actions in a 50001 Ready EnMS**
- Set an Energy Policy
- Have management commitment
- Empower an energy team
- Identify where energy is used
- Create plans to improve energy use
- Management approval of plans
- Track progress and reassess energy action plans

**Key Benefits of a 50001 Ready EnMS**
- Manage risk associated with energy performance and projects
- Reduce energy-related costs
- Develop pipeline of vetted and prioritized energy projects
- Dedicate more resources to energy improvement opportunities
- Demonstrate leadership and compliance with federal requirements

**Energy Manager Note**
50001 does not necessarily mean you need to do something NEW. It is often a reorganization of existing activities and commitments in a streamlined and replicable architecture
Field Validation of ISO 50001 Savings

Proven data around typical US energy savings over time.

- Business-as-Usual [EIA] ~1% per year
- Industry Leaders [Better Plants] ~2.5% per year
- ISO 50001 facilities [DOE] ~4% per year
- Enterprise-Wide Approach [DOE] ~5% per year

Energy Manager Note
Within the companies’ own facilities they found a doubling of energy performance. They also had robust EnMS in place already so it started (like federal sites) with existing energy mgmt
“The strength of our [ISO 50001] Continuous Energy Improvement program is that we get the people who understand each operation to think about how to do things a little differently – to change their processes in some way to save energy.”

“Energy Improvement is precisely the kind of operational discipline we are good at. We’re just applying that skill in a new way.”

Joseph Cercle
OC-ALC Energy Manager

Contact Jay.Wrobel@ee.doe.gov or Brad.Gustafson@ee.doe.gov
Or visit energy.gov/50001Ready for more info or to get started
What is the Re-tuning Challenge?

• Re-tuning Challenge is to provide agencies with training and apply learned methods to building in their portfolio.
• Sites can still participate in training even if not selected.
• FEMP will provide the following support:
  – Selected sites (3 – 5 sites):
    • Completed re-tuning of one building
    • Re-tuning training for site staff
    • Technical support for a site staff re-tuning effort
    • Results monitoring and presentation
• Site participation
  – Interested sites will be screened for re-tuning applicability (details later in the webinar)
  – Sites will be selected by June 27, 2019
Re-tuning is a process of improving control of existing building energy systems, centered on the BAS of centrally controlled buildings through:

- The application of the sidebar principles on the right, embodied in a few dozen best-practice re-tuning measures
- Identification and correction of faulty control infrastructure
- Adopting strategies for better monitoring and control into the culture and mindset of the building operators (e.g. use of trend data and training on how to manipulate reset parameters for “tuning”)

Benefits of re-tuning are:

- **Energy savings** typically range from 5 – 25%*
- **Cost savings and cost effectiveness** average $0.185/sf-year and show a simple payback of 0.3 – 3.5 years*
- **Thermal comfort**, through correction of faults, and making airside systems responsive to specific zone demands.

* Based on PNNL experience with GSA buildings
Re-tuning Methodology for Identifying Opportunities

Investigation

...AND Problem Solving

- Interval-Metered Data
- Trend Data
- BAS Graphics
- Sequence of Operations

VS.

Best Practice Checklist

<table>
<thead>
<tr>
<th>Control Type</th>
<th>Baseline Observations</th>
<th>Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHU Duct Static Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHU Supply Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAV Minimum Airflow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimal Start/Stop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHU Schedules</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHU Economizers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Outdoor Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chiller Lockouts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VFD Pump DP Control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Re-tuning Checklist: Re-tuning Principles

1. Boiler and Chiller OAT Lockouts
2. Lighting Schedules
3. “Turn it Off”
4. AHU and Exhaust Fan Scheduling
5. Snowmelt and Garage Systems

Optimal Start/Stop
Re-tuning Checklist: Re-tuning Principles

- Hot Water Temperature Reset
- Chilled Water Temperature Reset
- Night Setbacks
- Condenser Water Temperature Reset
- Pump Differential Pressure Resets
- Fan Static Pressure Reset

“Turn it Down”
Re-tuning Checklist: Re-tuning Principles

- Widen Thermostat Deadbands
- Minimum VAV Airflow Setpoint Reductions
- DOAS Supply Air Temperature Reset
- Economizer Control
- AHU Supply Air Temperature Reset
- Enthalpy Wheel Control

Mitigate Simultaneous Heating + Cooling
Re-tuning Checklist: Re-tuning Principles

- Demand Control Ventilation
- Exhaust Fan Control
- Building Pressure Control
- Minimum OA Damper Schedule

Reduce Infiltration and Outdoor Air

House icon with equal sign
Re-tuning Principles for Formulating Recommendations

• Stick to “tried-and-true” methodologies and best practices
  – ASHRAE-Approved strategies
  – Standard minimum and maximum setpoints for resets
  – Choose common feedback variables
  – Trim-and-respond versus linear span resets

• Take the path of least resistance
  – Make use of control points that are already being calculated
  – Make use of existing resets, evaluate performance and tune, rather than re-inventing resets
  – Take an appropriate sample, if the number of points required for the programming becomes excessive.

• Take into account observations about the baseline state

• Talk-through with building operators and identify limitations and consequences.

• Perform demonstration on one system first
Re-tuning; Sample Recommendation

Measure 1: Supply-Air Temperature Reset

Observation:
- The east and west AHUs on all 10 floors have constant year-round supply-air temperature (SAT) set points of 52ºF.
- These set points are extremely low, and cause the following:
  - In winter: excess use of waterside economizer followed by excess use of reheat at the terminal boxes,
  - In shoulder seasons: excess use of chillers followed by excess use of reheat at the terminal boxes,
  - In summer: exacerbation of use of reheat coils (the ultimate cause for their use is high terminal box airflow set points).

Recommendation:
- **January 2016:** SAT reset, based on Stephen Taylor’s (PE, ASHRAE) SAT reset strategy.
  - SAT reset based on average zone temperature (corridors and mechanical spaces excluded) with outdoor-air temperature (OAT) based limits imposed.
    - First step: Find average deviation from zone temperature set point
    - Second step: Reset from 65ºF at -0.5ºF deviation to 55ºF at 0.5ºF deviation
    - Third step: Impose maximum set point of 65ºF at 35ºF OAT, reset down to 55ºF at 70ºF OAT
    - Fourth step: Impose minimum set point of 58ºF at 35ºF OAT, reset down to 55ºF at 70ºF OAT
- The reset strategy is shown graphically in Figure 1.
- **February 2016:** It was observed after implementation that the solar load on the perimeter zones was causing localized overheated zones that were not being adequately captured by the averages along the entire floor. The reset should be modified to be based on the maximum of perimeter (by façade) and interior zone thermostat deviations, rather than a single overall average deviation. The current reset programming can be found for each AHU in WorkPlace Pro under MNB_XX_AH_YY→DA_T_Reset, where XX and YY vary by AHU. A sample block diagram of

- Investigation and Problem Solving
- Take Into Account Observations about the Baseline State
- Stick to “Tried-and-True” Methodologies and Best Practices
GSA Energy Savings and Its Persistence (3-Year Cohort)

- 42-Building Cohort with at least 3-Years Post-Site Visit
- Two sites with major occupancy reductions removed
- Additional 3.7% Savings Year 1 to Year 2 (Completion of implementation may be 6-months to 18 months after site visit)
- -0.8% Savings Year 2 to Year 3
GSA Energy Savings and Its Persistence (4-Year Cohort)

- 25-Building Cohort with at least 4-Years Post-Site Visit
- Increase in savings year 3 to year 4
- Big electricity savings increase suggests another systemic cause (e.g. widespread LED lighting upgrades or more teleworking)
• Overall simple payback based on Year 2 savings: 0.51 years
• 75% of sites below 3-year payback
• Includes total contracted cost but does not include additional costs borne by GSA (control contractor retention, any capital projects that were funded)
Re-tuning Challenge Steps and Timeline

**Screening**
- Screening Questionnaire: 4/22/2019
- Evaluation Questionnaire: 5/28/2019
- Site Selection: 6/27/2019

**Pre- Site Visit**
- Pre-visit call
- Download interval-metered data
- Trend data and BAS access or screenshots → PNNL

**PNNL Re-tuning Site Visit**
- Re-tuning Training Session(s)
- Identification of measures
- Implementation of select measures
- 7/29/2019 to 12/20/2019
Re-tuning Challenge Steps and Timeline (Cont’d)

Implement and M&V

- Complete measure implementation
- Complete documentation of findings, recommendations and implementations
- Initiate monitoring and verification

Internal Re-tuning Effort

- Agency takes lead to initiate internal site visit
- Makes use of training and lessons from PNNL site visit
- 1/24/2020

Final Report

- Compile site feedback
- Analyze data
- Report savings, overall outcomes and lessons learned
PNNL Site Visit

3 to 4 day site visit

• Day 1
  – Presentation training session for agency representatives who will be involved in a future internal re-tuning effort
  – Building walk-through with O&M staff, building management, and agency reps
• Day 2
  – BAS review and interactive training session. Identification of measures and formulation of recommendations.
  – Requires O&M staff to be present and discuss measures and any conflicts/limitations
  – Potential demonstration/testing of some measures
• Day 3/4
  – Implementation of agreed-upon re-tuning measures
  – In some cases, this may require retention of a controls contractor (paid for by the agency) who is familiar with the building and BAS programming,

After visit
  – The controls contractor (paid for by the agency) may need to return to complete measures.
Characteristics of Good Re-tuning Candidate Buildings

- Large Buildings (at least 100,000 sf; 300,000+ sf ideal)
  - The re-tuning process scales well
  - Cost savings improves with higher baseline energy cost
- High Baseline energy consumption relative to similar buildings in similar climates
- Digital controllers, actuators, thermostats
- Modern BAS (updated within the last 5-8 years)
- Control of systems like Chiller, Boiler, Lighting via BAS
- Variable speed pumps and fans
- Single-Duct AHUs
- Presence of dedicated outdoor air-handling systems (DOAS)
- Not a “mission critical” building
- Little to no previous attempt at re-tuning or control-centered energy savings projects
Next Steps:

• Sites determine interest to participate.

• Submit completed Screening Questionnaire no later than April 22, 2019 for consideration.

• Sites meeting the criteria as established in Screening Questionnaire will be asked to complete an Evaluation Questionnaire no later than May 28, 2019 on site attributes affecting re-tuning.
Site Selection Screening

Screening Questionnaire addresses:

1) Building HVAC systems that are controlled by a centralized Building Automation System.

2) Buildings must be metered with advanced meters and have access to this data.

3) Sites participating in the Challenge must commit to:
   a. Work with the PNNL team to implement agreed upon measures during the Challenge period.
   b. Send site and/or agency staff to the onsite re-tuning training conducted by PNNL.
   c. Use trained staff to attempt re-tuning based on the principles and methods demonstrated during the training session.

4) Site ability to host other agency staff participation in the onsite re-tuning training
## Re-tuning Challenge Timeline

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Date/Deadline</th>
</tr>
</thead>
</table>
| FEMP conference call with interested candidate sites  
- Detailed re-tuning presentation  
- Review site qualifications information | Today – 4/4/2019 |
| Site screening questionnaire submissions to FEMP | Screening Questionnaire: Due no later than 4/22/2019 |
| Site evaluation questionnaire submissions to FEMP (for notified sites) | Evaluation Questionnaire (for qualifying sites): No later than 5/28/2019 |
| Site selection by FEMP | 6/27/2019 |
| Sites host re-tuning | 7/29/2019 – 12/20/2019 |
| Site staff complete building re-tuning | 1/24/2020 |
Re-tuning Challenge
Next Steps for Interested Agencies/Site

Action items:

- Interested sites self-assess using Screening Questionnaire criteria
- Submit completed Screening Questionnaire by 4/22/2019
- Optional: Additional information on the Re-tuning process
  https://buildingretuning.pnnl.gov/

Direct questions to the Re-tuning Challenge at
FEMPRetuningChallenge@pnnl.gov

FEMP O&M Program Manager - Nael Nmair
Nael.Nmair@ee.doe.gov
202-586-8827
QUESTIONS/DISCUSSION?
FEMP Re-tuning Challenge Supplemental Slides
Screening Questionnaire

• Include building information – agency, building name, location, utility energy sources, and square footage.
• Are most HVAC systems in the building controlled by a centralized Building Automation System (BAS)?
• Building Automation System (BAS) vendor and version (or date of last upgrade).
• Please note if boilers, chillers, and/or lighting are controlled via the BAS.
• List the utilities for which there is a reliable building-level interval meter or meters that report consumption at least at the hourly level, if not sub-hourly and for which at least 12 months of data prior to the site visit is available.
• Will the site or agency commit to attempt re-tuning based upon the principles and methods demonstrated in that session and in the PNNL site visit at a different building owned or leased by the agency (Internal Re-tuning Effort) prior to January 24, 2020?

• Please name, title, and contact information for a point of contact within the agency/at the site that will serve as a “champion” for this Re-tuning Challenge. This person will be responsible for controlling the internal agency and building-level logistics for all three tasks, keeping the project on-schedule, and overseeing the team that will lead the internal re-tuning effort.
• Will the site or agency commit to the PNNL Re-tuning Site Visit taking place before December 20, 2019?

• Will the site or agency commit that they will complete implementation of all identified measures that are agreed upon by site staff by January 24, 2020, under the assumption that the site visit occurs prior to December 20, 2019 (this may require the assistance of a local controls contractor)?

• Will the site or agency commit to sending representatives to the Re-tuning Training conducted during the PNNL Re-tuning Site Visit?
Re-tuning Site Selection

• The Re-tuning Challenge site selection is comprised of the following 4 steps:
  – **Step 1.** Agency submits at least one Screening Questionnaire. *(Due 4/22/2019)*
  – **Step 2.** Screening Questionnaires are reviewed and agency point of contact is advised if the building is eligible for the next step. If a building is eligible to continue, an Evaluation Questionnaire will be provided. *(5/6/2019)*
  – **Step 3.** Agency point of contact submits Evaluation Questionnaire. *(Due 5/28/2019)*
  – **Step 4.** Evaluation Questionnaires are reviewed and agency point of contact is advised if the building is selected to participate in the Re-tuning Challenge. *(6/27/2019)*
Estimated Site Time Requirements

- **PNNL re-tuning and training**
  - Building-level management – 6 hours
  - Building-level O&M staff/contractor (1 person) – 16 hours
  - BAS technician (site staff and/or contractor) – 0 to 12 hours (to be determined during site visit prep)
  - 2 Agency representatives – 8 hours+ each

- **Agency- re-tuned building**
  - 2+ trained staff from PNNL Re-tuning training: 3-4 days
  - Building-level management – 6 hours
  - Building-level O&M staff/contractor – 16 hours
  - BAS technician – 0 to 12 hours (to be determined during site visit prep)