A Cool New Savings Calc Tool from the CCC

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Learning Objectives

1. Understand the applicability and capabilities of the California Commissioning Collaborative’s (CCC) new energy and demand savings calculation tool, including how the tool can utilize spot-measured values and trend data as inputs.

2. Recognize how the CCC’s new tool fits in to the suite of EBCx measure calculation tools currently available for use by EBCx providers and industry practitioners.
Agenda

• The current state of EBCx measure energy savings calcs
• Description of the CCC’s new tool
• How the new tool fits in with other tools
• Status of the tool
• Questions / discussion
An informal poll

Do you calculate energy and demand savings for retrofits / measures?

What tools do you use?

• Whole building analysis
• Custom spreadsheets
• Back-of-the-envelope
• Results from past projects
• Other tools
Calculating savings takes some effort

- Gather baseline data
  - Observations, spot measurements, trend data
- Estimate post-implementation performance
- Determine utility energy and demand rates
- Calculate savings
  - A variety of methods
Sometimes there’s more effort

Utility EBCx programs may require more effort

- Higher level of rigor and accuracy needed in the savings estimates
- Process evaluation of California’s recent EBCx programs indicated that:
  - Calc review process is burdensome
  - There’s a need to make the process easier
Where do you like to spend your time?

In buildings? Or doing savings calcs?

• Most Cx providers I know like to be in buildings
  ○ Identifying opportunities
  ○ Working with building operators
  ○ Helping optimize building performance
A solution

Develop standardized calculation tools

- To increase confidence in savings calculations
- To reduce time/money spent on creating and reviewing these calculations
  - Keep it simple, maintain accuracy

![Diagram showing ease of use and complexity]

- Deemed savings – enter equipment details only
- Simpler spreadsheets not based on trends
- Spreadsheet BIN models – inputs derived from system trends
- DOE 2 – calibrated against system trends and utility usage
CCC’s Approach

Spreadsheet-based calculation tool

• The California Commissioning Collaborative (CCC) is developing a tool
• Calculates energy and demand savings for common EBCx (“O&M”) measures

www.cacx.org
Development Team

Funded under PIER program
- California Energy Commission’s Public Interest Energy Research

Team made up of industry experts
- Architectural Energy Corporation (AEC)
  - Developing tool
- PECI
  - Project management, helped develop tool spec, involved in tool testing
- EMC
  - Tool testing
Technical Advisory Group

Other industry experts providing input and feedback

• Utility representatives
• Cx provider firms
• Building owners
• Research labs
About the tool

Five airside HVAC measures

○ Optimize economizer performance
○ Optimize air handler scheduling
○ Optimize or reset supply air temperature
○ Optimize or reset discharge static pressure setpoint
○ Add or optimize VFD on supply fan
About the tool

Four waterside HVAC

- Add or optimize VFD on chilled water pump
- Optimize or reset chilled water supply temperature
- Optimize or reset condenser water supply temperature
- Add or optimize VFD on cooling tower fans
<table>
<thead>
<tr>
<th>Energy Savings (kWh)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>4,000,000</td>
<td>40</td>
</tr>
<tr>
<td>5,000,000</td>
<td>50</td>
</tr>
<tr>
<td>6,000,000</td>
<td>60</td>
</tr>
<tr>
<td>7,000,000</td>
<td>70</td>
</tr>
</tbody>
</table>

Reducing equipment runtime, adding VFD to pumps, reducing DSP setpoint, and relocating sensors can significantly increase energy savings. Adding VFD to fans, chillers, and pumps can also reduce energy consumption. Other measures, such as revising AH control sequences and replacing flow sensors, can also contribute to energy savings.
Fundamental engineering formulas

• $Q = m \times C_p \times \Delta T$

Empirically derived equations

• From published literature.
  ○ E.g., DOE-2 chiller performance curves.

Bin temperature-based calculations

• Based on 8,760 weather data
Tool look and feel

Excel® spreadsheet

- Tool makes extensive use of macros and VBA code

Intuitive interface

- Help menu for each screen
- Pull-down menus for some inputs
Tool Format Overview

Enter inputs …

• General project information
  ○ E.g., climate zone
• Operating schedule
• Utility rate information
• Central plant general information
• AHU, chiller, and cooling tower information
• Measure information

… then click Calculate
Inputs are color-coded

- Inputs are highlighted yellow and red
  - These inputs vary depending on the equipment and measures selected
- Input cells will “grey out” if they do not apply to a certain situation

![Chilled Water Supply Information Table]
User inputs

- Some can use either spot measurements or data for calculation by tool
  - E.g., fan kW:
    - Spot measurements
      - Supply Fan Information
        - Capacity (CFM): 60000
        - Max Fan Power (kW): Set Operating kW
        - Operating kW: 52
        - Motor Size (HP):
        - Motor Efficiency (%):
        - Load Factor (%):
    - Tool calculates
      - Supply Fan Information
        - Capacity (CFM): 60000
        - Max Fan Power (kW): Calculate
        - Operating kW: 75
        - Motor Size (HP):
        - Motor Efficiency (%): 94%
        - Load Factor (%): 85%

- Others require trend data analysis results
  - E.g., supply fan airflow:
    - Supply Air Flow Regression (%)
      - OAT: 0
        - Air Flow (%): 0.5
      - OAT: 40
        - Air Flow (%): 0.5
      - OAT: 60
        - Air Flow (%): 0.7
      - OAT: 90
        - Air Flow (%): 1
Tool output

- Results are presented in tabular format for each measure selected

<table>
<thead>
<tr>
<th>Electric Savings (kWh)</th>
<th>Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Peak</td>
<td>Summer Mid-Peak</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Savings</th>
<th>User Specified Costs</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric ($)</td>
<td>Summer Demand ($)</td>
<td>Winter Demand ($)</td>
</tr>
</tbody>
</table>


Measure interactions

Measures can be ‘stacked’

• To avoid double counting of savings
  ○ The ECM of one measure becomes the baseline condition of the next measure

• Load- and schedule-based measures first, then efficiency measures
  ○ E.g., “Optimize air handler scheduling” measure is evaluated before “Reset static pressure setpoint”

• May not want them stacked, if multiple competing measures
  ○ Stacking is an option
Beware GIGO
Garbage in, Garbage out

The tool is not a Cx provider

• The results are only as good as the inputs
• Fundamental understanding of HVAC system operation is required
  ○ To ensure accuracy of tool inputs
  ○ To evaluate results from tool for reasonableness
How does this tool fit in?

This ain’t the only tool in town

- Whole building energy modeling
  - E.g., eQUEST. [http://doe2.com/equest/](http://doe2.com/equest/)

- Simplified calculators
  - E.g., BOA Tool. [http://www.cacx.org/resources/rcxtools/](http://www.cacx.org/resources/rcxtools/)

- Utility calculators and deemed savings
  - E.g., Xcel’s Recommissioning Calculator Tool

- Custom spreadsheet calcs

- Others
How does this tool fit in?

In short:

- **New CCC tool**: Simplified calculators. Enter equipment details only.

- **Custom calcs.**: Based on measured / trended data.

- **Whole building modeling.**: Calibrated to system trends and utility usage.
Tool strengths

- Inputs are based on actual operating conditions
  - Spot-measured values
  - Trend data analysis results
- Can use with any building type

![Graph showing relationship between OAT and Supply fan VFD speed, Hz.](image)
Tool strengths, cont’d.

• Measures selected are well-suited for tool
  ○ Most common
  ○ Most problematic / difficult savings calcs
  ○ Highest energy savings

• Tool helps meet an identified need
  ○ Simplify and streamline the savings calculation process
Tool limitations

• Applies to California only
  ○ Future version may allow for other climate zones
  ○ Utility rate structure in tool is based on California utilities’ rate structures
    - E.g., no demand ratcheting

• Outside air temperature-based correlations
  ○ Tool does not allow for other types of correlations, e.g., seasonal, time of day
Tool limitations, cont’d.

- Measure-to-measure interactions are not completely accounted for by the tool
  - But most are
- Tool does not apply to all EBCx measures
  - Future versions of the tool could include more measures
Tool status

Tool is currently in development

- Will be released this year
- Outreach component
  - Conference presentations
  - Post on CCC website: http://www.cacx.org/resources/rcxtools/
  - Demonstration workshops
  - Short online tutorials
  - Ongoing tech support
  - Pilot
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Thank you!

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