Overview of the CCC
Retrocommissioning Toolkit

Presented by:
Hannah Friedman, PECI
ICEBO – San Francisco

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California Commissioning Collaborative’s Retrocommissioning Toolkit

- **RCx Toolkit** is part of the *Commercial Commissioning: Research and Development Program*, funded by the CEC Public Interest Energy Research (PIER) Program.

- **Goal:** Help practitioners provide consistent, effective, and cost-effective service through development of:
  - Templates and sample documents
  - RCx energy savings calculation spreadsheets
  - Data analysis tools

- Tools, templates, and sample documents on CCC website ([www.cacx.org](http://www.cacx.org))
Project Advisory Committee Members

- Norm Bourassa, CEC Program Manager
- Ken Gillespie, PG&E
- Reinhard Seidl, Taylor Engineering
- Glen Thieszen, Farnsworth Group
- Mark Case, ETC Group
- Tracy Phillips, AEC
- Len Beyea, RetroCom Energy Strategies, Inc.
- Patrick O’Neill, Northwrite
- Terry Egnor, New Buildings Institute
RCx Toolkit Overview

1. Templates and Sample Documents
2. Energy Savings Calculation Spreadsheets
3. Additional Tools
   – Utility Bill Analysis Tool
   – RCx Findings Workbook
   – Energy Charting and Metrics (ECAM) Tool
RCx Toolkit: Templates & Sample Documents

Goals:

- Facilitate information gathering
- Help commissioning providers streamline processes to reduce report writing time
- Increase information transfer to the owner’s team
Templates & Sample Document Development

- Analysis of existing publicly available templates and sample documents
- Online Cx Provider (CxP) survey:
  1) most value to CxPs
  2) perceived availability in the market
- Selected five templates for development that ranked highest
Templates & Sample Documents Selected

- Building Staff Interview Form (Template)
- Owner’s Operating Requirements (Template and Sample Document)
- List of Preferred Building Characteristics (Sample)
- Diagnostic Monitoring Plan (Template and Sample Document)
- Ongoing Commissioning Plan (Template and Sample Documents Package)
California Commissioning Collaborative

About the CCC

Library
- Tools and Templates
- Case Studies
- Certification Programs
- Cx Assistant
- Cx Database
- Functional Testing Guide
- Provider Qualifications

Resources for Providers

Resources for Building Owners

CaCx News

Calendar

Login

Oakland Federal Office Building
Oakland, CA

Read more about the success story

43 more case studies

The CCC develops cost effective programs, tools, techniques and a service delivery infrastructure to encourage the use of the building commissioning process in new and existing buildings.

Recent Publications

- CCC Commissioning Guides for new and existing buildings
- Roadmap for Achieving the Commissioning Costs of California's Green Building Executive Order.
- Summary of Market Research Findings on commercial office building and hospital commissioning.

CCC Mailing List

Email:  
Go
**Retrocommissioning Tools and Templates**

**Retrocommissioning Toolkit**

The RCx Toolkit provides concrete tools to assist RCx practitioners in providing consistent, effective, and cost-efficient services. These tools are designed to complement the California Commissioning Guide for Existing Buildings.

This Toolkit and the Commissioning Guide for Existing Buildings were developed with funding from the California Energy Commission.

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List of Preferred Building Characteristics

• Characteristics to consider when developing the scope and budget for a RCx project

• Checklist includes:
  – Mechanical equipment age and condition
  – Building staff participation
  – Control system trending attributes
  – List of building documentation
  – Future building projects
Diagnostic Monitoring Plan

- Helps CxP plan for the level and rigor involved in the diagnostic portion of RCx process
- Template and sample plans developed for portable dataloggers and EMCS trend logs
- EMCS Examples
  - Chilled water distribution loop pumping control
  - Condenser water temperature control
  - VAV box control
Ongoing Commissioning Plan (OCP)

• Develop an OCP in RCx Hand-off phase
• OCP assists the building staff in maintaining RCx benefits
• Four major sections:
  – Understanding the Implemented Measures
  – Performing O&M Persistence Activities (best practices in addressing operational issues and maintaining sensor calibration)
  – Tracking Building Energy Performance (benchmarking, energy use tracking)
  – Reviewing Training Needs
Ongoing Commissioning Plan Appendices

• RCx Implementation Summary Report
• Updated Sequence of Operations
• Monitoring Action Plan
• Calibration Plan
• Training Plan
**Monitoring Action Plan Template**

**[Insert Equipment or System Name and Number]**

<table>
<thead>
<tr>
<th>Control Strategy and Reference #:</th>
<th>Discharge air temperature reset</th>
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</thead>
<tbody>
<tr>
<td>Sequence of Operation:</td>
<td>Detailed sequence narrative here</td>
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</tbody>
</table>

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<th>What to look for…</th>
<th>What to look at (verify)…</th>
<th>What to do (action)…</th>
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<tbody>
<tr>
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*The min and max duct static pressure setpoints are correct (no overrides or changes)*
## Monitoring Action Plan Template

### [INSERT EQUIPMENT OR SYSTEM NAME AND NUMBER]

<table>
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<th>Control Strategy and Reference #:</th>
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**Note desired static pressure setpoints**
### Monitoring Action Plan Template

**[INSERT EQUIPMENT OR SYSTEM NAME AND NUMBER]**

<table>
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</table>

| What to look for... | What to look at (verify)... | What to do (action)...
<table>
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<tr>
<th></th>
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**Troubleshooting assistance**

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RCx Tools Currently Available on CCC Website

- Building Staff Interview Form
- List of Preferred Building Characteristics
- Owners Operating Requirements
- Diagnostic Monitoring Plan (Template & Sample)
- Ongoing Cx Plan (Template & Sample)
  - Implementation Summary Report (Template & Sample)
  - Sequence of Operation (Template & Sample)
  - Monitoring Action Plan (Template & Sample)
  - Calibration Plan (Template & Sample)
  - Training Plan (Template & Sample)
- Existing Building Commissioning Plan
- Design Intent Documentation
- Final RCx Report examples
- Systems Manual
- Request for Proposal Checklist
RCx Toolkit: Energy Savings Calculation Spreadsheets

Goals:
• Assist providers in completing energy savings calculations for RCx
• Streamline and standardize calculation methods
• Consistency with flexibility (Excel)
Spreadsheet Calcs: Criteria for Need

• How prevalent is the measure?
• Is the savings potential significant?
• Is there external demand for the calculation?
• How big is the typical calculation error?
• Is the calculation needed to increase investigation of, or to optimize the measure?
• Will the calculation significantly reduce utility program review time?
Spreadsheet Calcs: Specific Objectives

- Standardize energy savings calculations
- Include comparisons with Title 24 requirements
- The calculations are:
  - building-specific
  - easy-to-use
  - use information and data commonly available to RCx providers
  - not a black box – all formulas listed
- Include details to improve savings estimates
  - fan curves, pump curves
  - system pressure drops
  - location of the static pressure sensor
  - motor and VFD efficiency vs. speed
Spreadsheet Calcs Developed

• Pumping System Energy Savings Workbook
  – Change pumping system flow
  – Reduce differential pressure setpoint
  – Reset differential pressure setpoint

• Fan System Energy Savings Workbook
  – Reset supply air temperature
  – Change VAV box minimum flow setpoint
  – Reduce duct static pressure setpoint
  – Reset duct static pressure setpoint
## Example: Fan System Workbook

### Calculation Inputs

Typical calculation time may be ~1 minute, but may be notably slower on older computers.

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Total Hours: 5,138

### Calculate Energy Use and Savings

- Copy Flows from Baseline
- Copy Hours from Baseline
- Use Optimum Reset
**Savings Summary**

<table>
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<tr>
<th>Energy Use</th>
<th>Description</th>
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<tr>
<td>48,923 kWh/yr</td>
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<td>37,638 kWh/yr</td>
<td>Reduced flow scenario energy use</td>
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<tr>
<td>11,285 kWh/yr</td>
<td>Savings</td>
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<tr>
<td>17,078 kWh/yr</td>
<td>Adding/improving variable speed operation energy use</td>
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<tr>
<td>20,560 kWh/yr</td>
<td>Additional savings to the reduced flow scenario</td>
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<tr>
<td>11,829 kWh/yr</td>
<td>Resetting the pressure differential setpoint energy use</td>
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<tr>
<td>5,248 kWh/yr</td>
<td>Additional savings to improved variable speed scenario</td>
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<tr>
<td>37,094 kWh/yr</td>
<td>Total Annual Savings</td>
</tr>
</tbody>
</table>

**Electrical Power vs. Flow for Three Types of Flow Control**

- Baseline: Fixed speed or high static setpt.
- Improved: VAV box controls flow, VFD controls static press.
- With reset of static press, setpt.

**Fan Energy vs. Ambient Temperature for Three Types of Flow**

- Baseline: Fixed speed or high static setpt.
- Reduced Flows:
- Improved: VAV box controls flow, VFD controls static press.
- With reset of static press, setpt.

**Fan Performance and System Curves**

- Pressure Rise at 100% Speed
- Pressure Rise at 50% Speed
- Baseline System Curve
- Improved System Curve
- Improved with Reset
- Efficiency at 100% Speed
- Efficiency at 50% Speed
## Fan System Scenario Analysis

### Savings Summary

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</table>
RCx Toolkit: Additional Tools

- Utility Bill Analysis Tool
  - Goal: Ease of analysis of average daily consumption

- RCx Findings Workbook
  - Goal: Consistency in tracking and automated summary tables for reporting

- Energy Charting and Metrics (ECAM)
  - Tool Partnership between Northwest Energy Efficiency Alliance, CEC PIER, and NBI
  - Goal: Reduce time spent manipulating data
Utility Bill Analysis Tool – Average Daily Consumption

The graph shows the average daily natural gas use in therms for each month from January to December, with two sets of data: Heating degree-hours divided by 24 and the actual therms used.

- 2005 therms
- 2004 therms
- 2003 therms
- 2002 therms
- HDH ÷ 24

The graph indicates a decrease in gas use from January to August, followed by an increase in September and October, and a peak in November and December.
Findings Workbook

- Project information
  - bldg size, annual energy use, energy cost, savings potential, benchmarking score
- Investigation checklist
  - 21 most common findings
- Helps track
  - measure savings, costs, recommendations for implementation, source of savings calculations
- Data input sheet that feeds into standard reporting for owners
ECAM (Energy Charting and Metrics) Tool

Goals:

• Assist RCx providers and building operators with data analysis
  – Quickly provide useful summary metrics and charts
  – Provide easy but powerful ways to “drill-down” for additional analyses
  – Flexibility (Excel add-in)
Charting and Metrics Capabilities

- Can be normalized by another parameter:
  - Building area (e.g. kWh/sq.ft.)
  - Cooling tons (e.g. kW/ton, gpm/ton)
  - CFM (e.g. Watts/CFM)
  - gpm (e.g. Watts/gpm)

- Can be filtered by:
  - Year, Month
  - Pre/Post time periods
  - Daytype
  - Time of day
  - Occupancy
  - Weather conditions
  - Combinations
Four Simple Steps

1. Select data from existing spreadsheet
2. Map points
3. Create schedules
4. Create metrics and charts
Output Metrics - Filtering

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Load Profile Charting by Daytype

- Weekday
- Saturday
- Sunday
- Holiday

Average Electric Meters Watts per SF
Scatter Plot Charts
Summary

• CCC RCx Toolkit helps address need to streamline and provide consistency
• Spreadsheet tools could be developed to cover all common finding types
  – pre-approved for utility incentive programs
• ECAM used to streamline data analysis
  – Enhancements planned based on Fall 2007 pilot
RCx Toolkit on the CCC website

- All templates and sample documents currently available
- Tools will be available December 2007

http://www.cacx.org/resources/rcxtools/
Funding Acknowledgements:

California Energy Commission
Norman Bourassa, PIER Buildings

Northwest Energy Efficiency Alliance (for ECAM Tool support)
Janice Peterson, Market Manager

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