California Commissioning Collaborative

Overview of the CCC Retrocommissioning Toolkit

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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)

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)

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]		
Control Strategy and Reference #:	*Discharge air temperature reset*	
Sequence of Operation:	*Detailed sequence narrative here*	
What to look for…	**What to look at (verify)…**	**What to do (action)…**

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]		
Control Strategy and Reference #:	*Discharge air temperature reset*	
Sequence of Operation:	*Detailed sequence narrative here…*	
What to look for…	**What to look at (verify)…**	**What to do (action)…**

Note desired static pressure setpoints

Monitoring Action Plan Template

[INSERT EQUIPMENT OR SYSTEM NAME AND NUMBER]		
Control Strategy and Reference #:	*Discharge air temperature reset*	
Sequence of Operation:	*Detailed sequence narrative here…*	
What to look for…	**What to look at (verify)…**	**What to do (action)…**

Troubleshooting assistance

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.

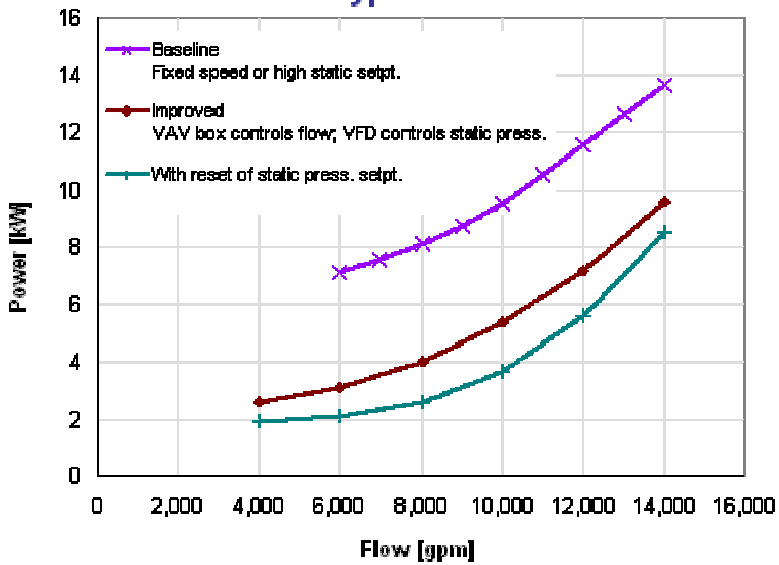
Calculate Energy Use and Savings

	Baseline		Change Flows		Add VFD or Reduce Static Press. SetPt.		Reset Static Pressure Setpoint		
	Static pressure **setpoint**:	5	Static pressure setpoint:	5	Static pressure setpoint:	1.6	Static pressure setpoint:	1.6	
			Copy Flows from Baseline	Copy Hours from Baseline					Use Optimum Reset
Ambient Temp, °F	Flow, CFM	Hours at Flow	Flow, CFM	Hours at Flow	Flow, CFM	Hours at Flow	Flow, CFM	Hours at Flow	Static Pressure Setpoint
102.5	14,000	53	14,000	53	14,000	53	14,000	53	1.09
97.5	13,000	53	12,000	53	12,000	53	12,000	53	0.80
92.5	12,000	257	10,000	257	10,000	257	10,000	257	0.55
87.5	11,000	1,026	8,000	1,026	8,000	1,026	8,000	1,026	0.35
82.5	10,000	2,054	6,000	2,054	6,000	2,054	6,000	2,054	0.20
77.5	9,000	1,026	4,000	1,026	4,000	1,026	4,000	1,026	0.09
72.5	8,000	512	4,000	512	4,000	512	4,000	512	0.09
67.5	7,000	105	4,000	105	4,000	105	4,000	105	0.09
62.5	6,000	53	4,000	53	4,000	53	4,000	53	0.09
57.5	6,000		4,000	0	4,000	0	4,000	0	0.09
52.5	6,000		4,000	0	4,000	0	4,000	0	0.09
47.5	6,000		4,000	0	4,000	0	4,000	0	0.09
42.5	6,000		4,000	0	4,000	0	4,000	0	0.09
37.5	6,000		4,000	0	4,000	0	4,000	0	0.09
32.5	6,000		4,000		4,000	0	4,000	0	0.09
27.5	6,000		4,000		4,000	0	4,000	0	0.09
22.5	6,000		4,000		4,000	0	4,000	0	0.09
17.5	6,000		4,000		4,000	0	4,000	0	0.09
12.5	6,000		4,000		4,000	0	4,000	0	0.09
7.5	6,000		4,000		4,000	0	4,000	0	0.09
	Total Hours:	5,138		5,138		5,138		5,138	

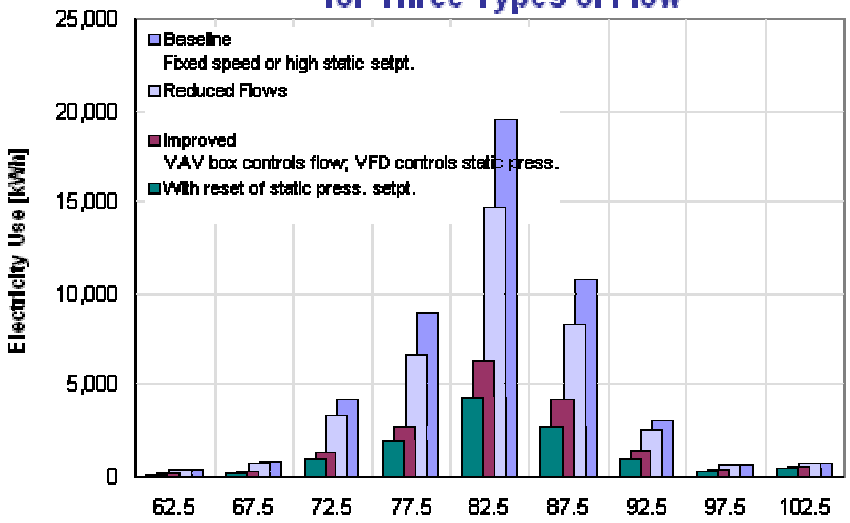
Savings Summary

48,923 kWh/yr	Baseline scenario energy use
37,638 kWh/yr	Reduced flow scenario energy use
11,285 kWh/yr	Savings
17,078 kWh/yr	Adding/improving variable speed operation energy use
20,560 kWh/yr	Additional savings to the reduced flow scenario
11,829 kWh/yr	Resetting the pressure differential setpoint energy use
5,249 kWh/yr	Additional savings to improved variable speed scenario
37,094 kWh/yr	Total Annual Savings

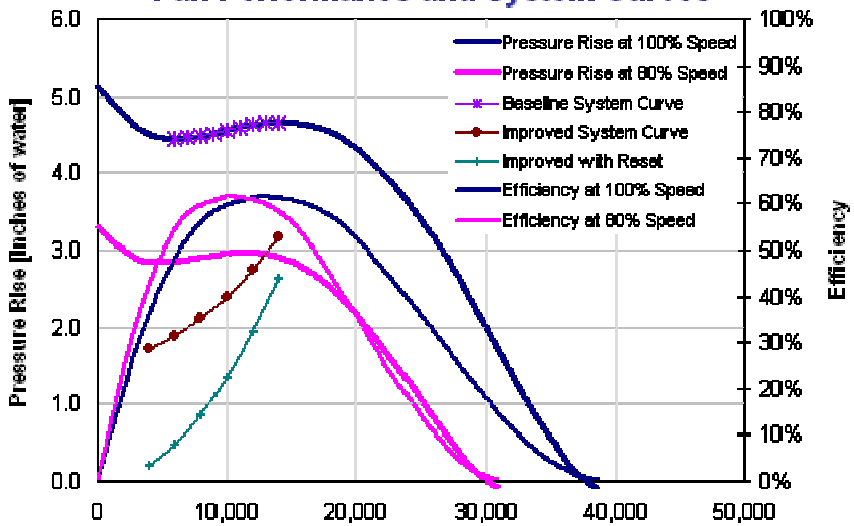
Electrical Power vs. Flow for Three Types of Flow Control



Fan Energy vs. Ambient Temperature for Three Types of Flow



Fan Performance and System Curves



Fan System Scenario Analysis

Savings Summary

48,923 kWh/yr	Baseline scenario energy use
37,638 kWh/yr	Reduced flow scenario energy use
11,285 kWh/yr	Savings
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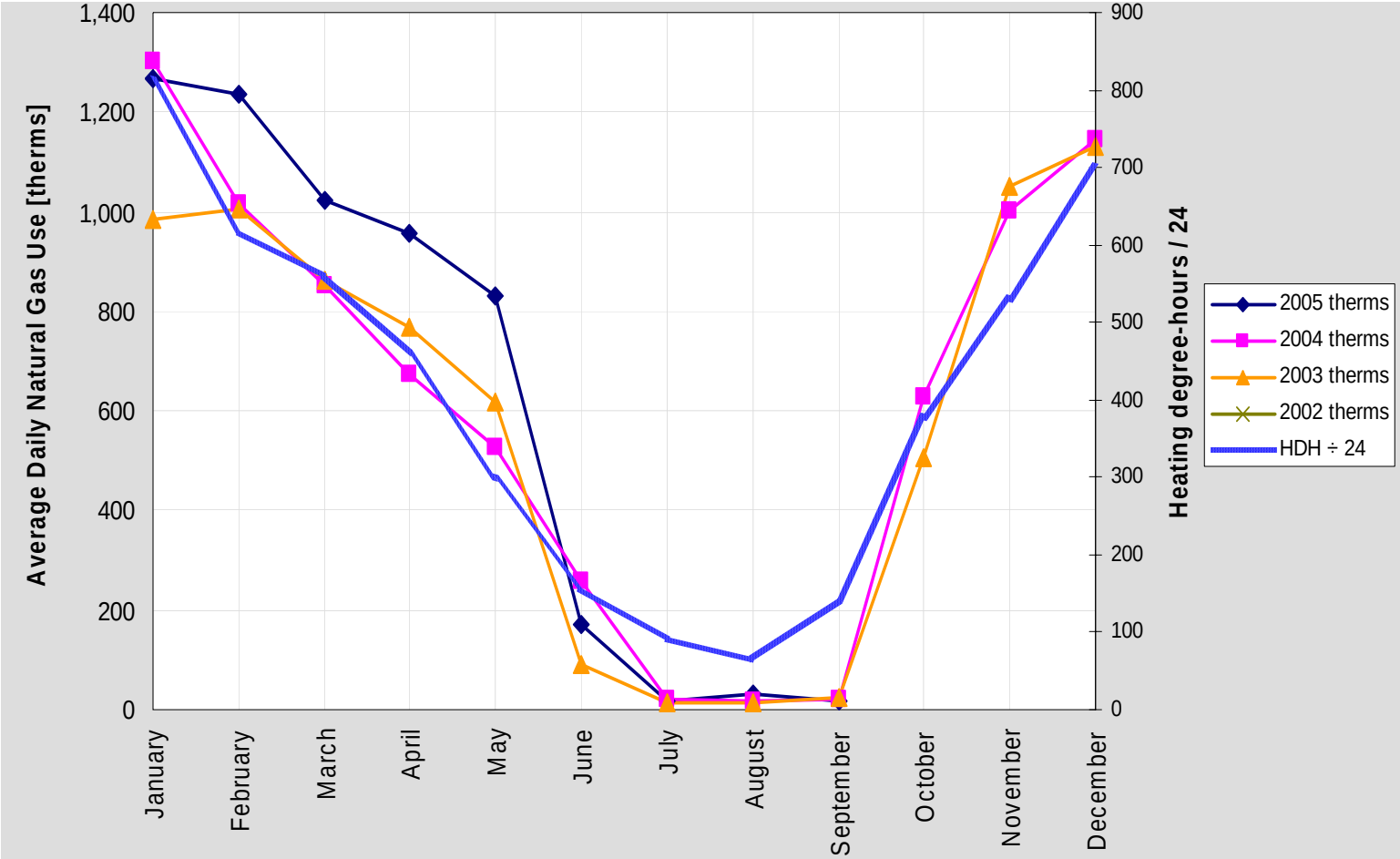
37,094 kWh/yr	Total Annual Savings

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



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)

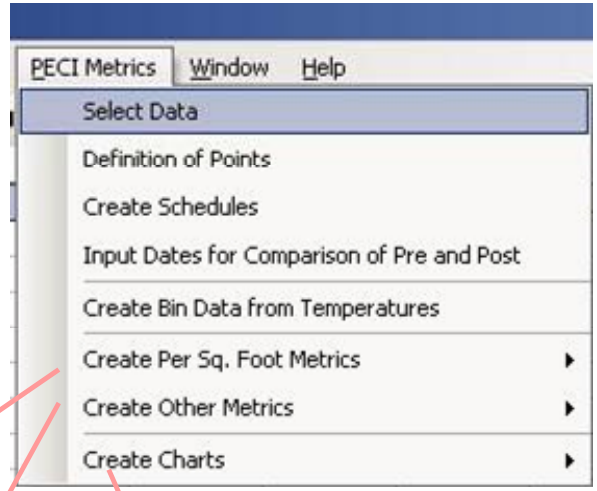
Charting and Metrics Capabilities

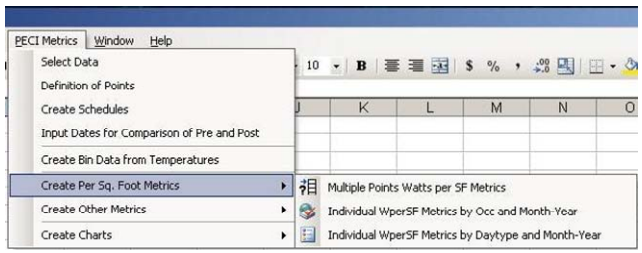
- Can be normalized by another parameter:
  - Building area (e.g. kWh/sq.ft.)
  - Cooling tons (e.g. kW/ton, gpm/ton)
  - CFM (e.g. Watts/CFM)
  - gpm (e.g. Watts/gpm)

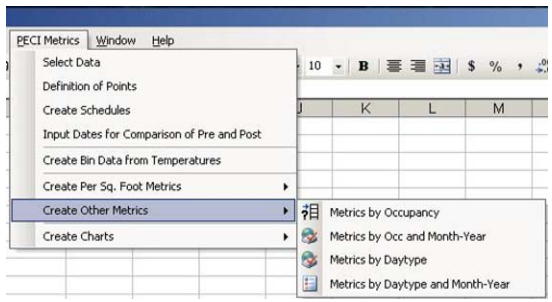
- Can be filtered by:
  - Year, Month
  - Pre/Post time periods
  - Daytype
  - Time of day
  - Occupancy
  - Weather conditions
  - Combinations

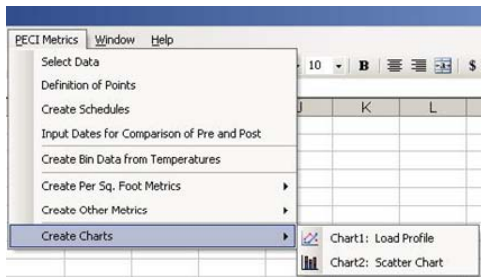
Four Simple Steps

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







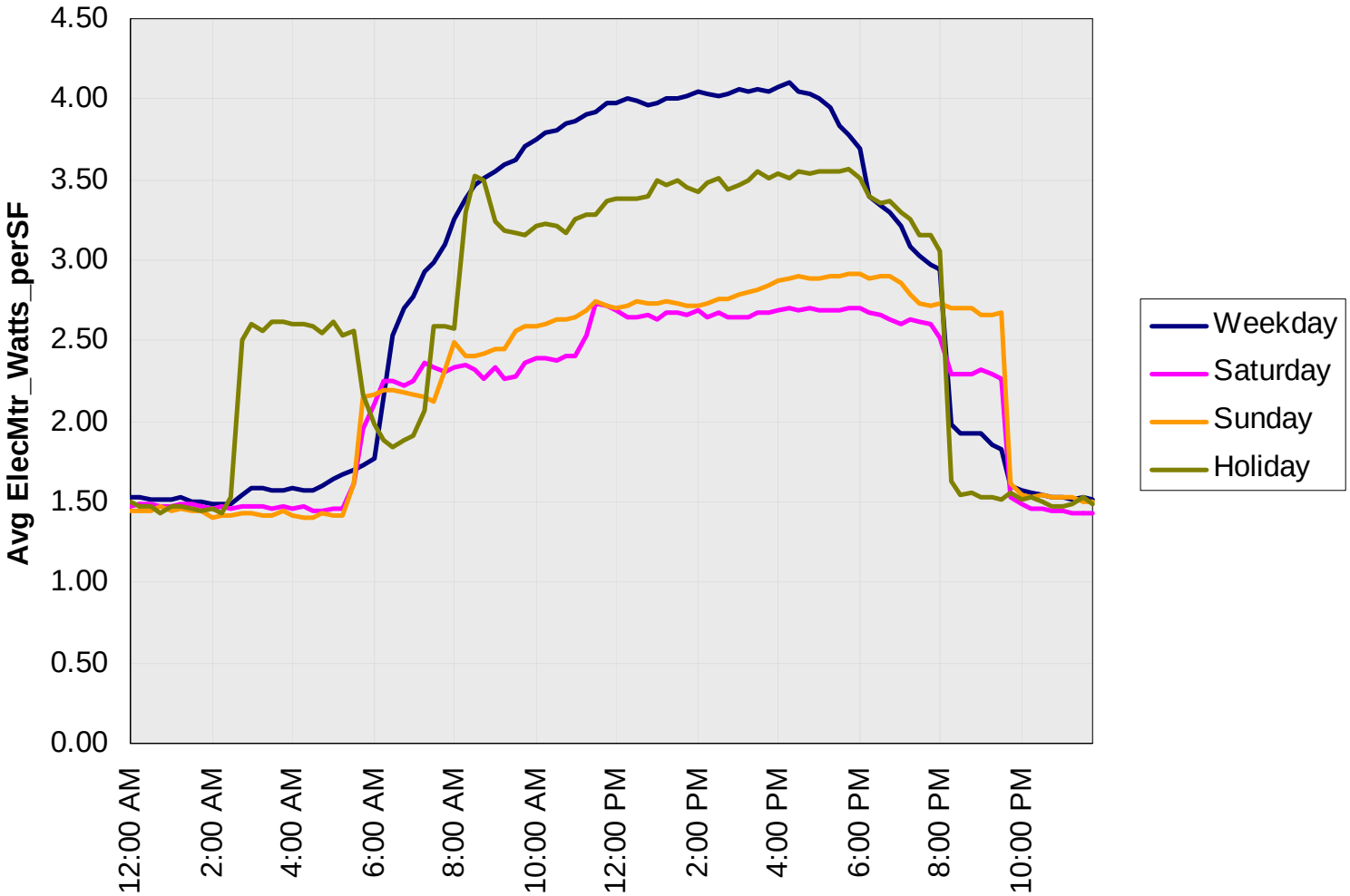


Output Metrics - Filtering

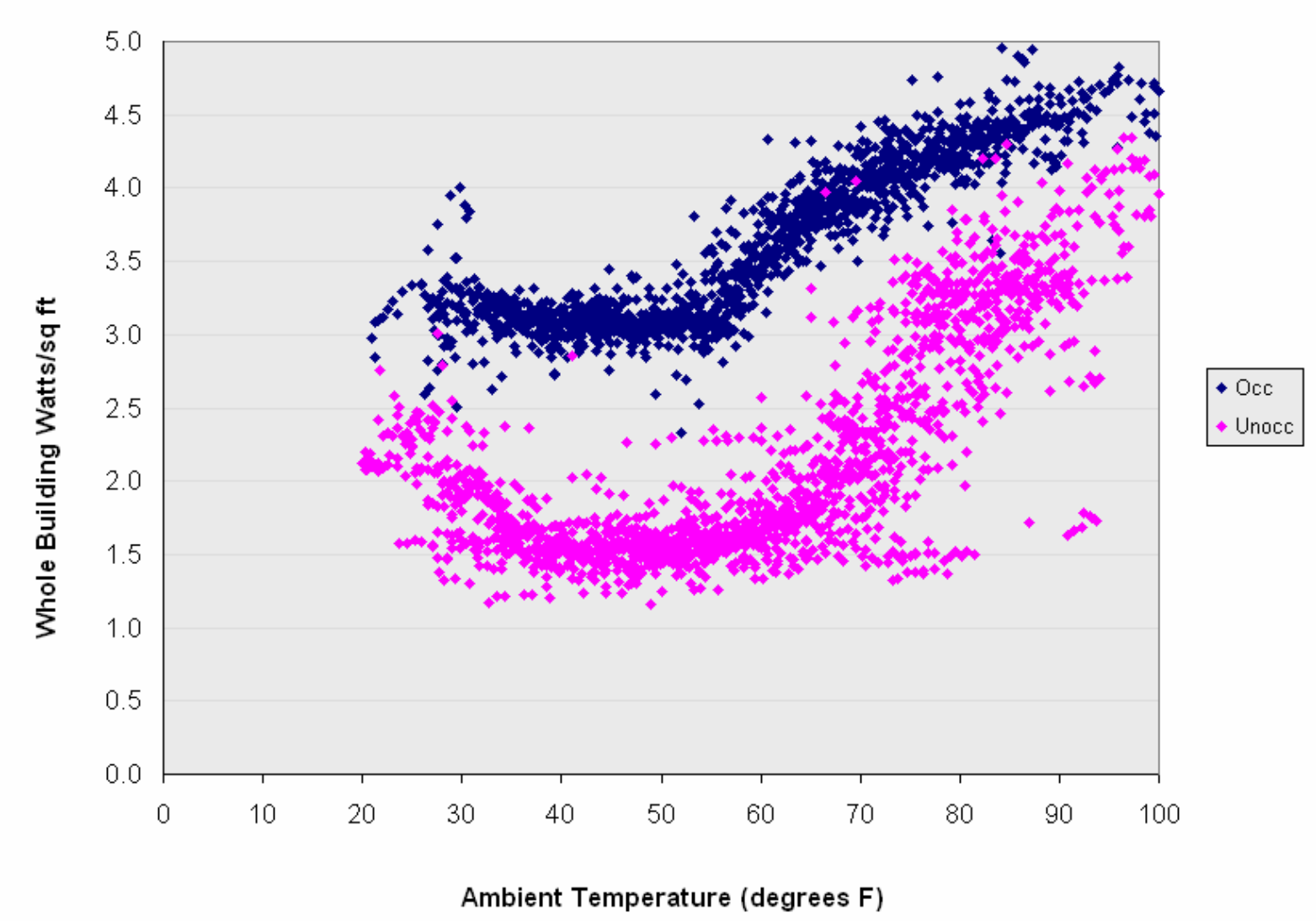
Year	(All)
Month	(All)
MonthYr	Sep 2006
Weekday	(All)
Day	(All)
Holiday	(All)
5degBin	(All)
1degBin	(All)
TempRng	(All)

Avg ElecMtr_Watts_perSF	Daytype			
Time	Weekday	Saturday	Sunday	Holiday
12:00 AM	1.52	1.47	1.45	1.50
12:15 AM	1.53	1.49	1.45	1.47
12:30 AM	1.52	1.48	1.45	1.47
12:45 AM	1.51	1.48	1.47	1.43
1:00 AM	1.51	1.48	1.44	1.47
1:15 AM	1.52	1.49	1.45	1.47
1:30 AM	1.50	1.48	1.45	1.46
1:45 AM	1.50	1.47	1.44	1.45
2:00 AM	1.48	1.46	1.41	1.46
2:15 AM	1.48	1.47	1.42	1.43
2:30 AM	1.49	1.46	1.41	1.53

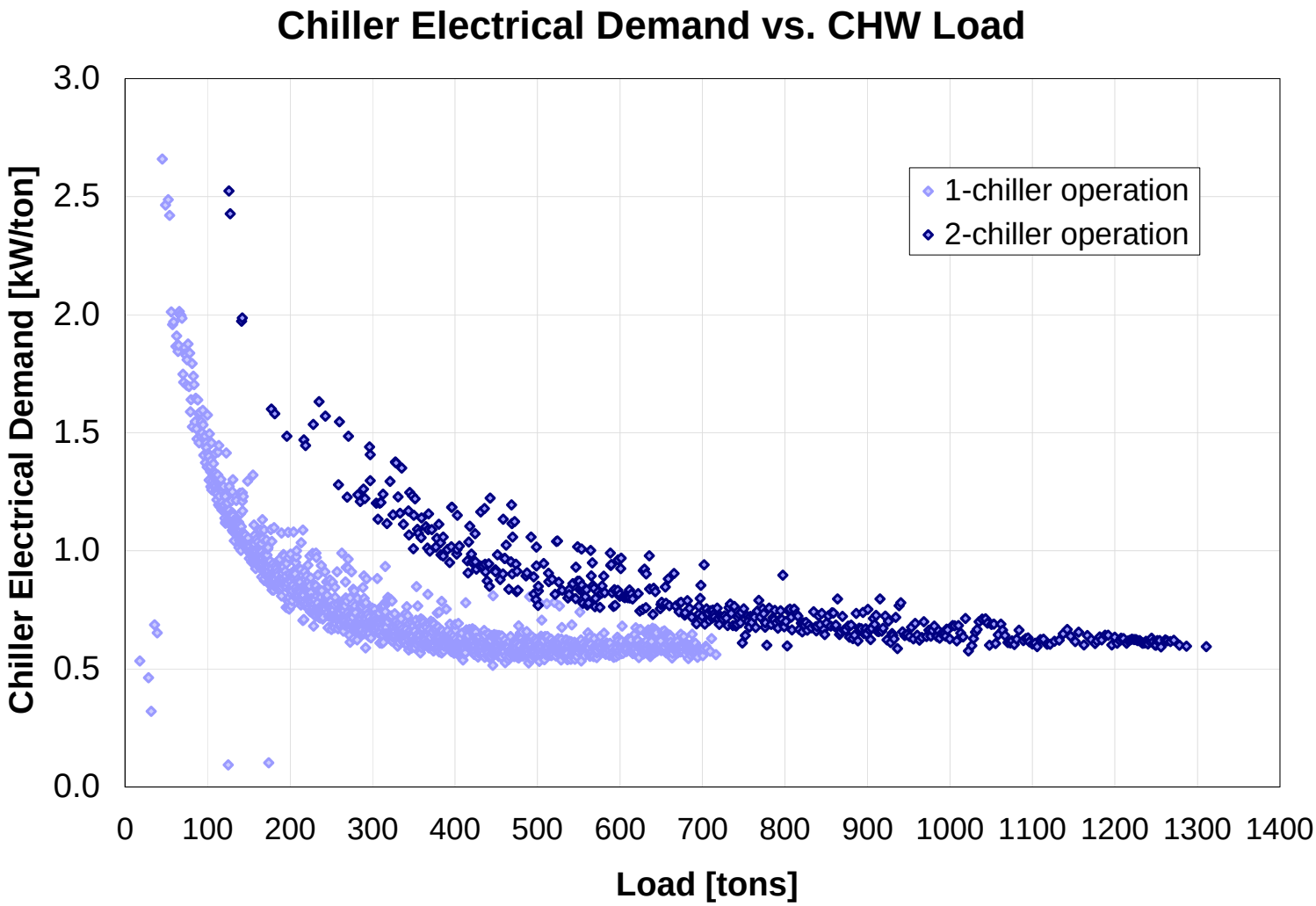
Load Profile Charting by Daytype



Scatter Plot Charts



System-level charting



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 in 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/

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California Energy Commission
Norman Bourassa, PIER Buildings

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Janice Peterson, Market Manager

New Buildings Institute
Mark Cherniak, Program Manager

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Spreadsheet and ECAM Tools
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For more information on the RCx Toolkit, contact
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