



California Commissioning Collaborative

## CCC PIER Research Program:

# ***“Building Commissioning: Strategies and Technologies for Energy Efficiency”***

*Program Advisory Committee (PAC) Meeting*

*June 10, 2010, SCE*

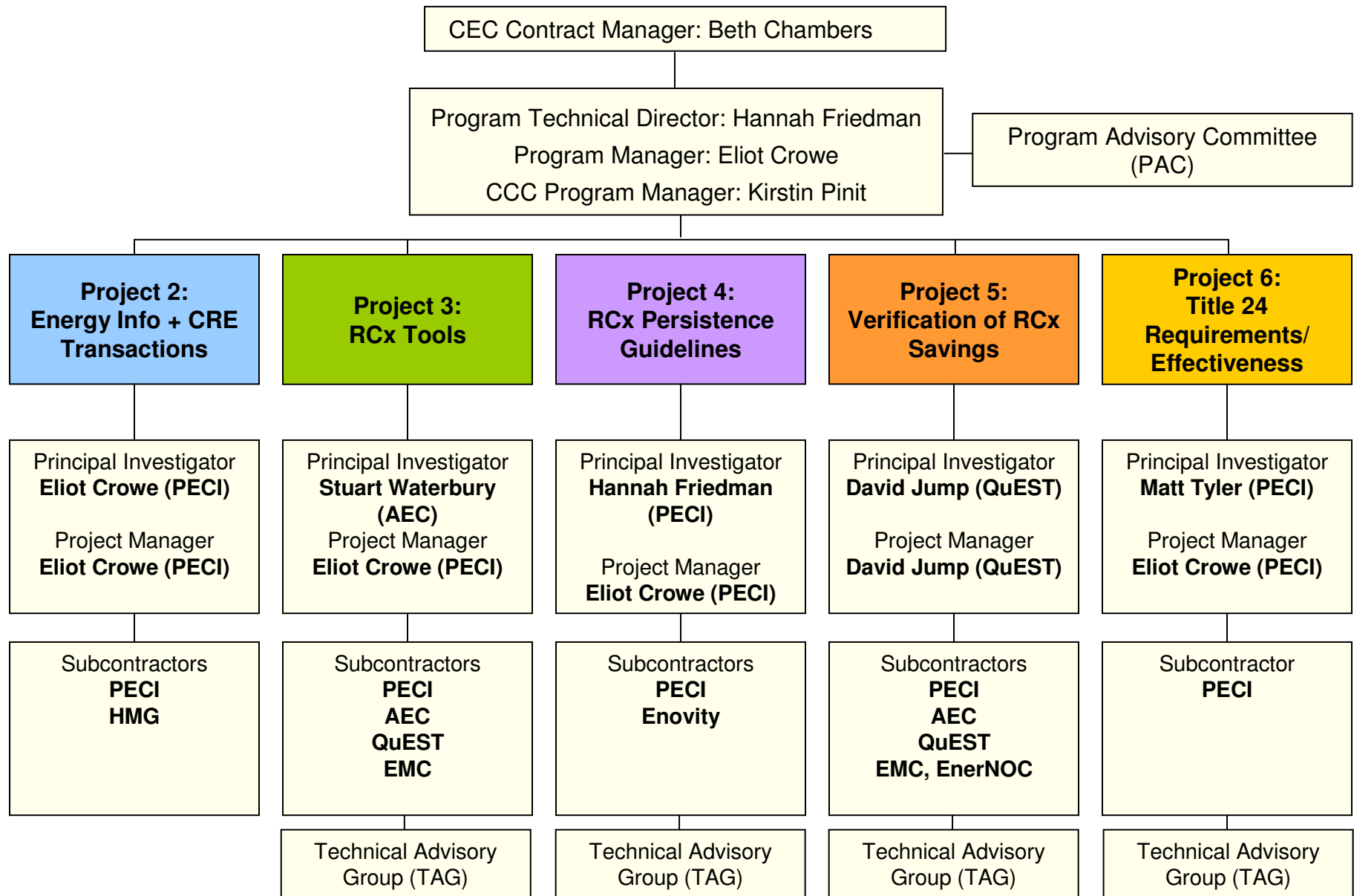


## AGENDA

- General update from the Energy Commission
- Program refresher
- Hot topics
- Project updates
- Q&A

# CALIFORNIA ENERGY COMMISSION UPDATE

- CEC relocation
- Funding questions from Senate



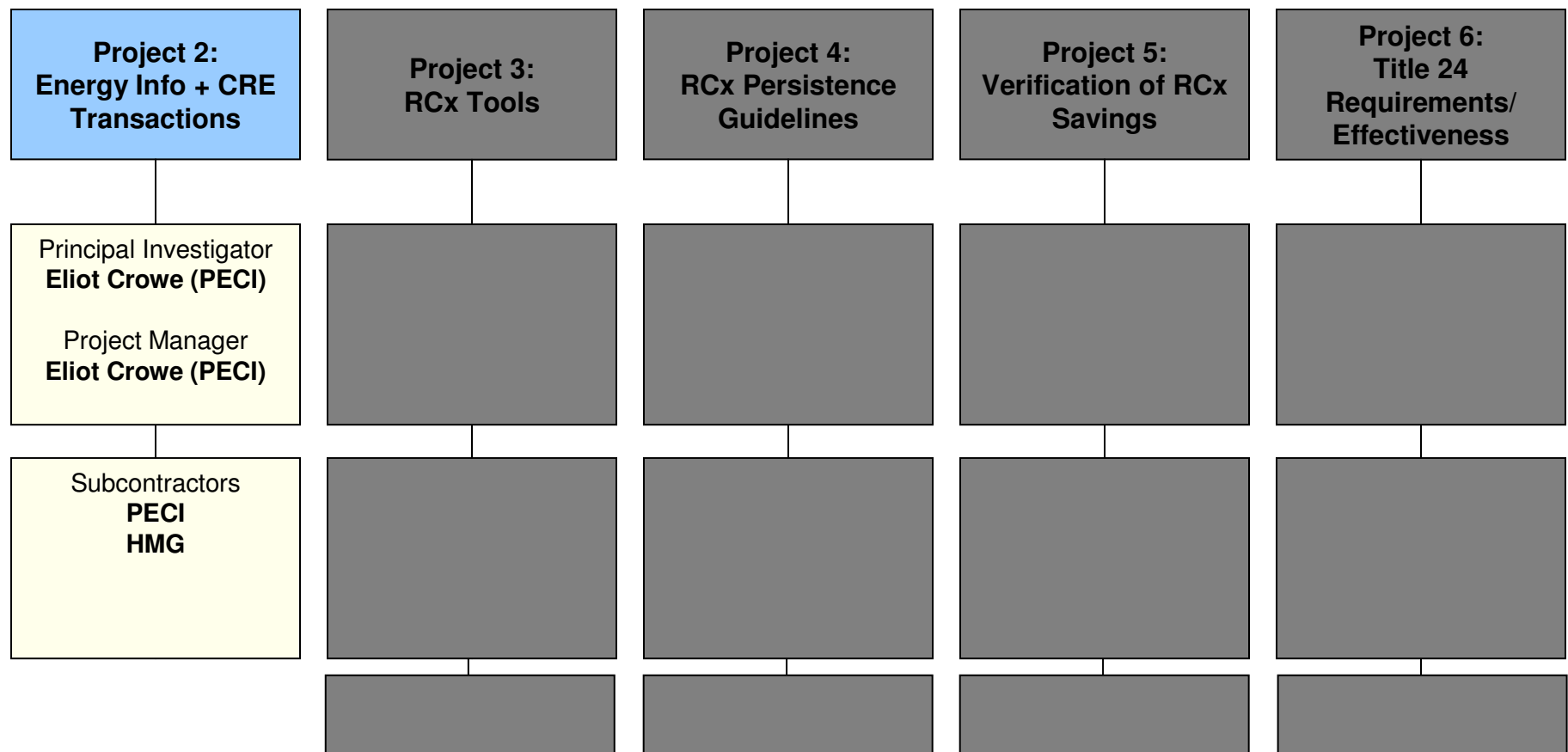
## Hot topics!

- Outreach
- Building performance metrics (Project 4)
- Title 24 project alignment with ongoing industry activity (Project 6)

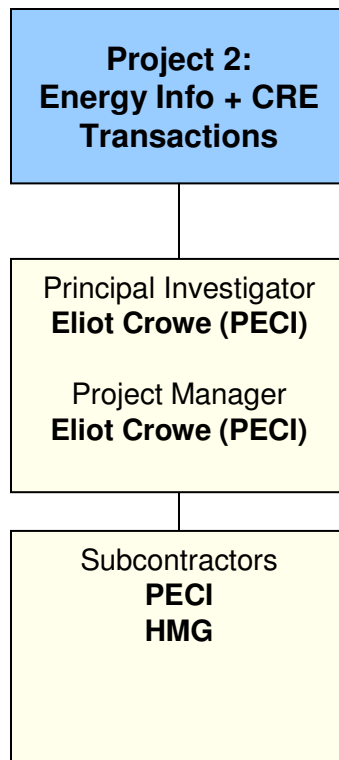
## Hot topic #1: Outreach

- Audiences: Owners, providers, contractors, utilities
- Some well-established methods:
  - Conference presentations
  - Printed publications
  - Posting to CCC website
- New media opportunities?
  - Industry webinars?
  - Blogs?
  - Youtube?
  - Facebook, LinkedIn?
  - Networking groups?
- Discussion: Positive experiences with delivering/receiving outreach?

# Progress Update: Project 2: “Integrating Energy Information into Commercial Real Estate Transactions”

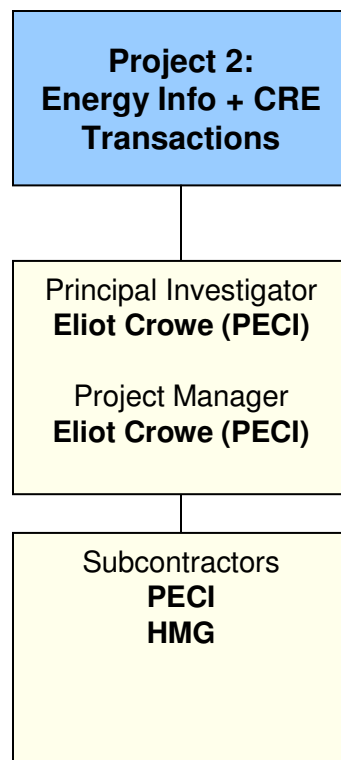


## Progress Update: Project 2: “Integrating Energy Information into Commercial Real Estate Transactions”



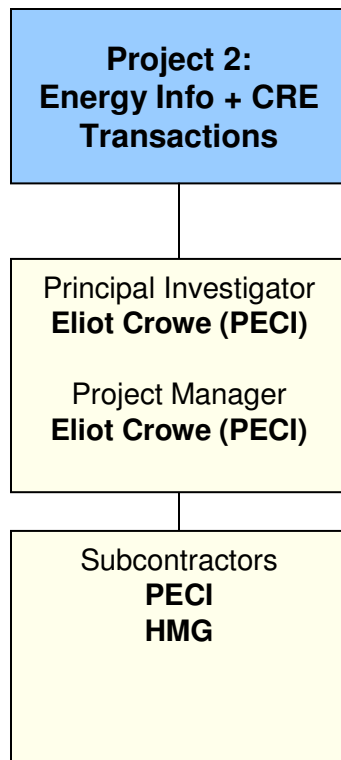
- Update
  - Joined ASTM
  - Completed templates for “Building Operations Survey” (BOS)
  - Conducted two pilot surveys in SF
  - 2 BOS reports and 1 scoping study
  - Ongoing recruitment

## Progress Update: Project 2: “Integrating Energy Information into Commercial Real Estate Transactions”



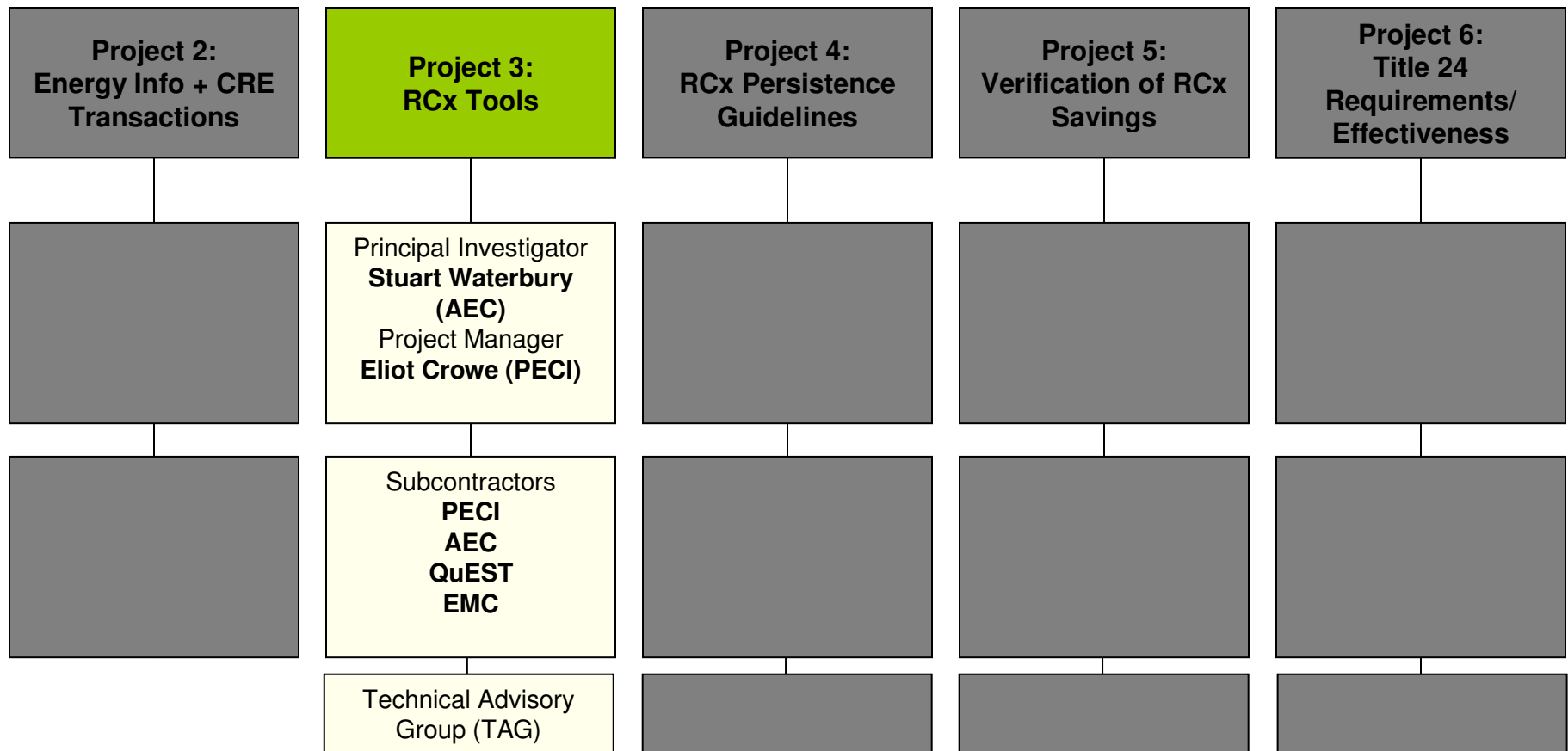
- Building Operations Survey
  - *Energy Star Benchmark*
  - *1-2 hour interview with building engineers*
  - *1-2 hour building walkthrough (all systems)*
  - *2-4 hours reporting and follow up*
  - *Cost target \$2,000 or less*
  - *Non-invasive, no trends, no costs/savings calcs*
  - *Output: list of observations that point to potential operational (EBCx) measures*
- *Scoping*
  - *Higher cost/rigor option*

## Progress Update: Project 2: *“Integrating Energy Information into Commercial Real Estate Transactions”*

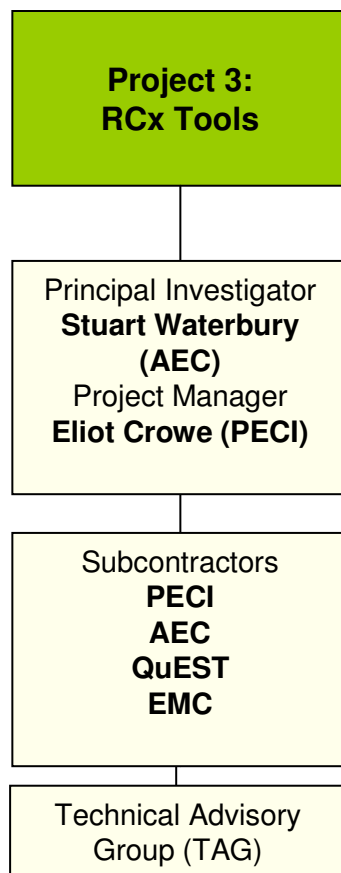


- Upcoming activities
  - Recruitment of PCA firms & building owners
  - 4 more pilots
  - Owner & PCA firm interviews
  - Refine process
  - Second round of pilots

# Progress Update: Project 3: “*EBCx Tools Development*”

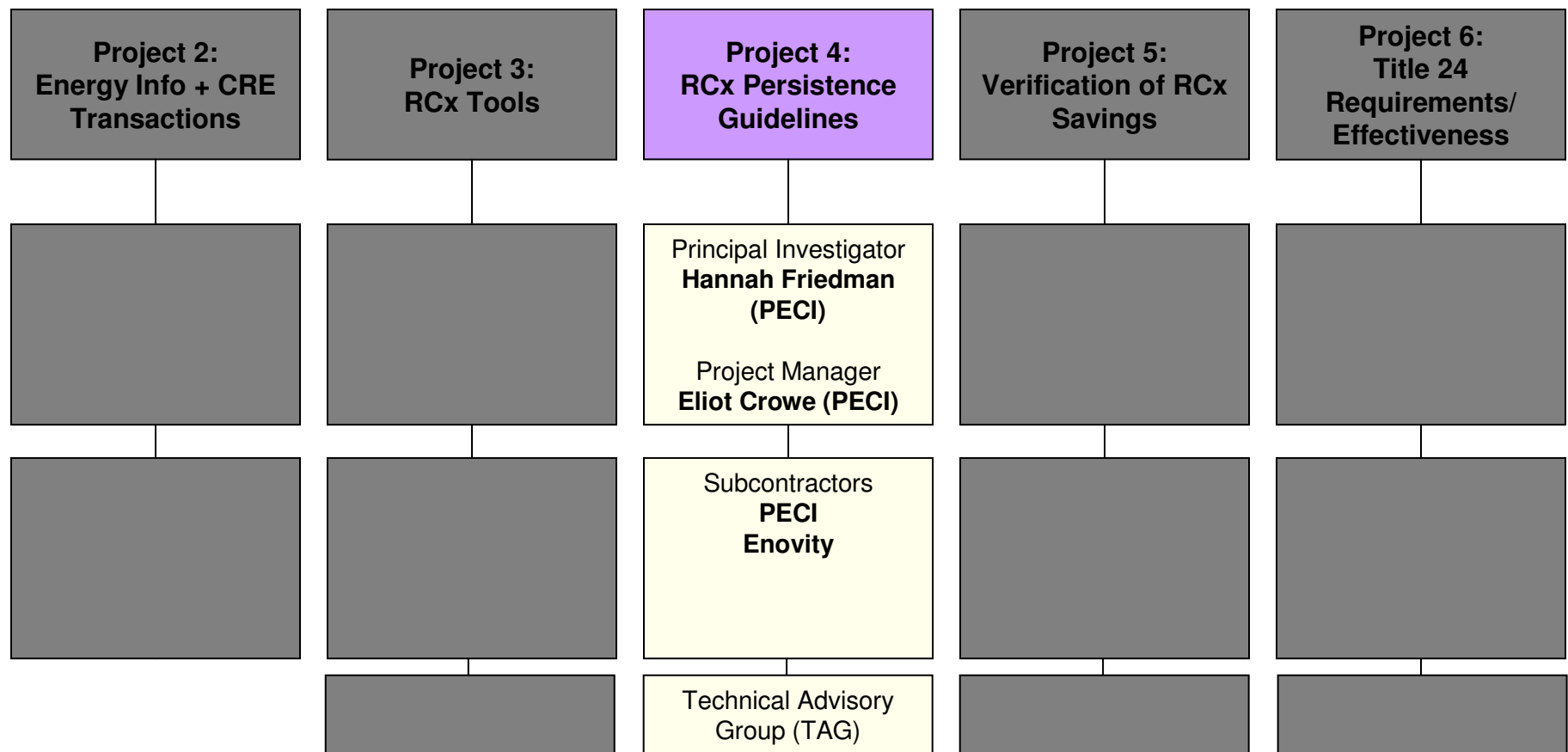


## Progress Update: Project 3: “*EBCx Tools Development*”

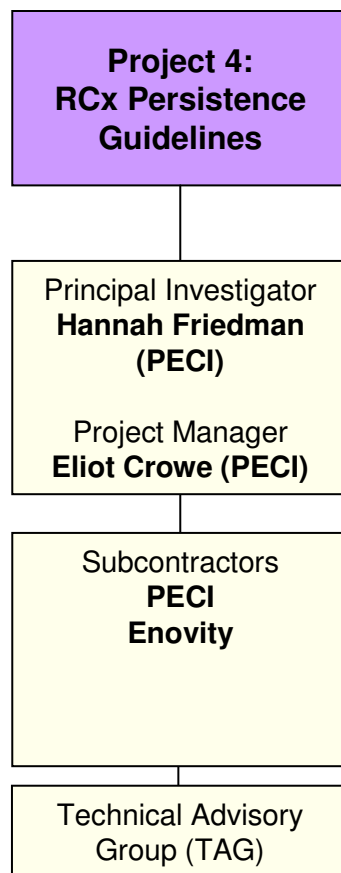


- Update
  - New Principal Investigator: Stuart Waterbury
  - Calc tool specifications being updated
  - ECAM updated (QuEST), beta testing commenced
- Upcoming Activities
  - Finalize calc tool specifications
  - Commence calc tool development
  - Finalize ECAM

# Progress Update: Project 4: “*EBCx Persistence Improvement*”



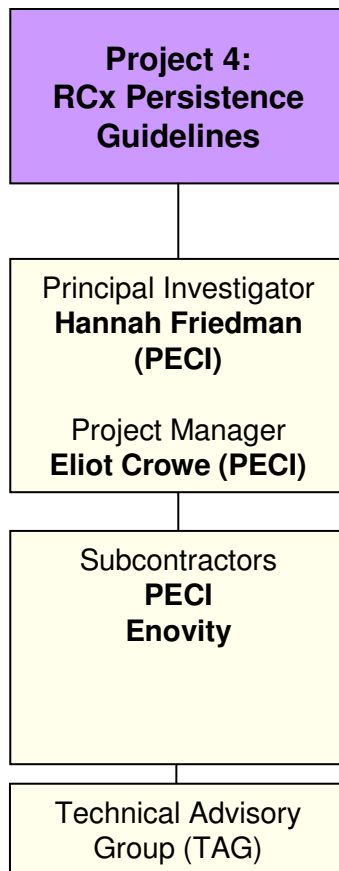
## Progress Update: Project 4: “*EBCx Persistence Improvement*”



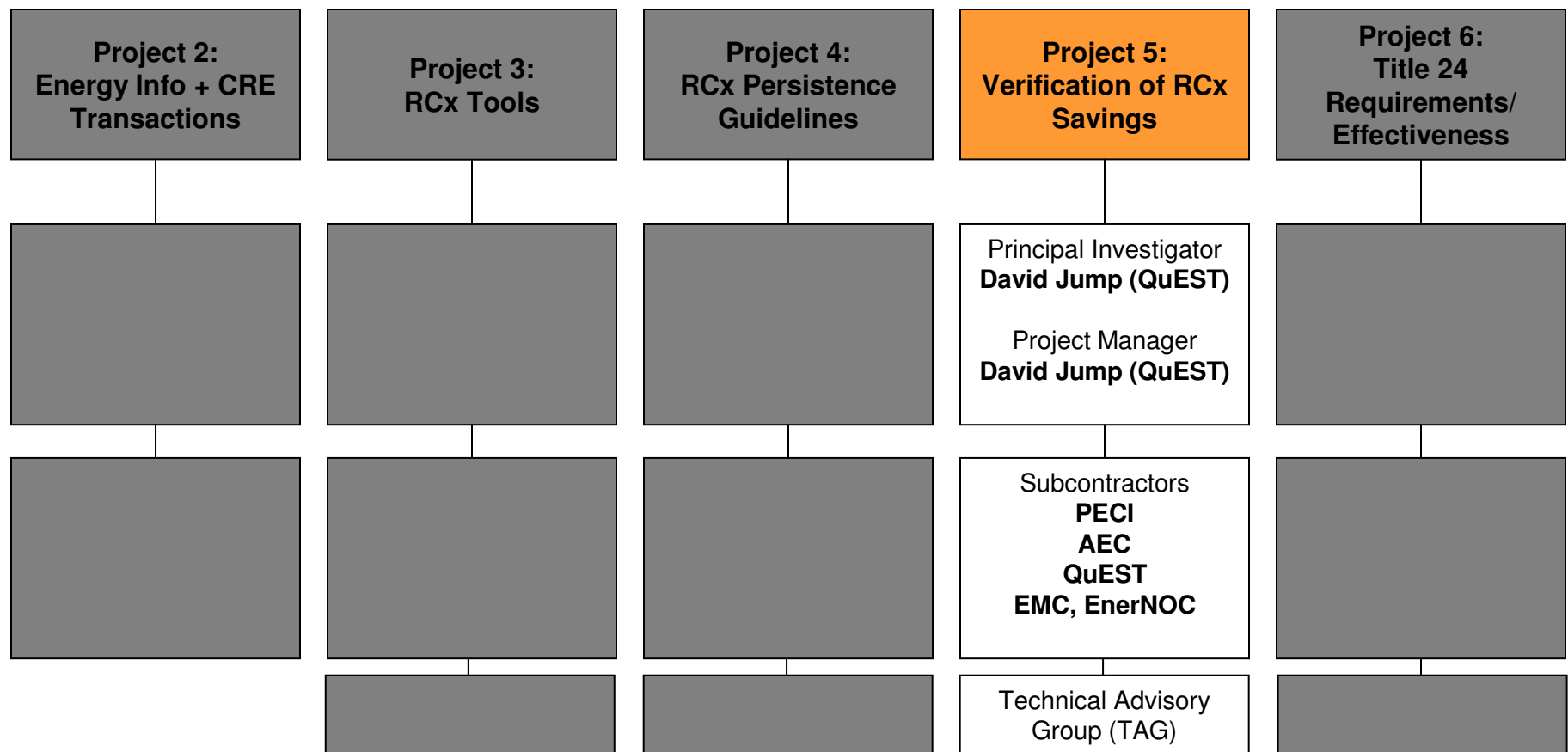
- Update
  - 19 phone interviews
  - 4 site visits (one more pending)
  - Completed literature search on best practice
  - Metrics research ongoing – **hot topic!**
  - FDD Tool characterization 90% complete
  - Guide outline evolving
  - Created case study template
  - NCBC presentation

# Progress Update: Project 4: “*EBCx Persistence Improvement*”

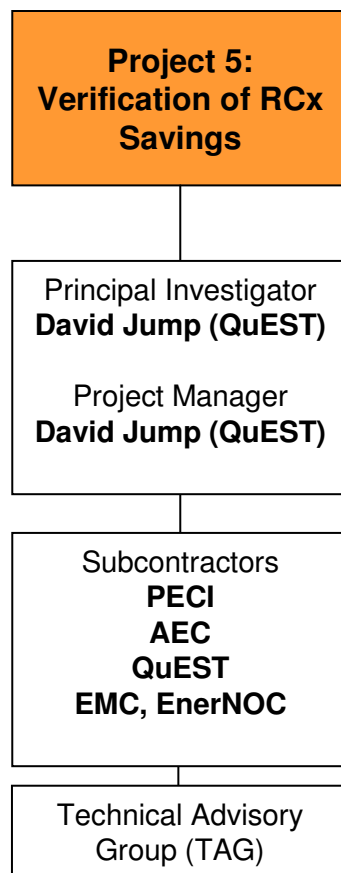
- Upcoming Activities
  - 1-2 more site visits
  - Finalize FDD Tool characterization
  - Finalize metrics research
  - Create 3-4 case studies
  - Commence writing Energy Performance Tracking Guide



# Progress Update: Project 5: “*Verification of Retrocommissioning Savings*”

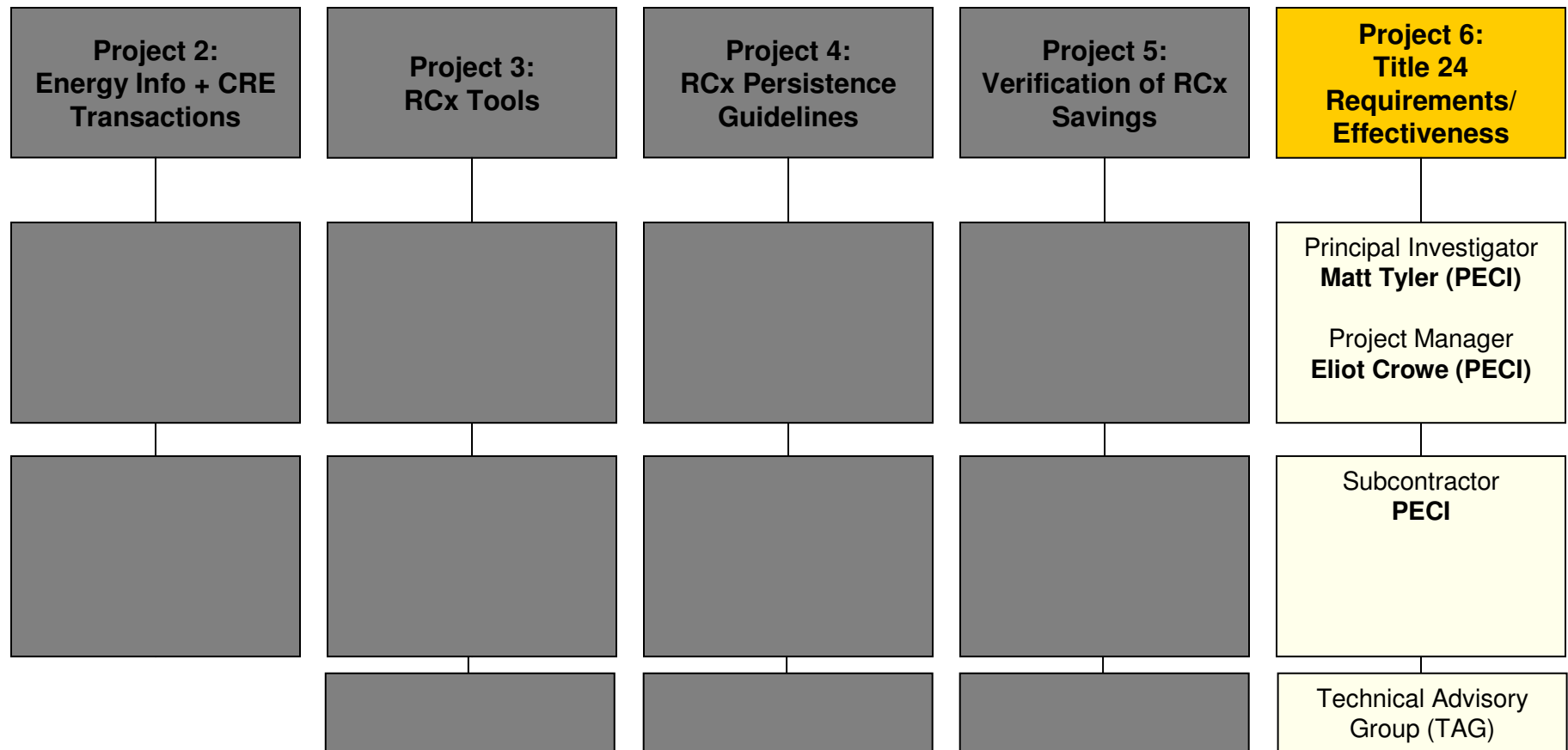


## Progress Update: Project 5: “*Verification of EBCx Savings*”

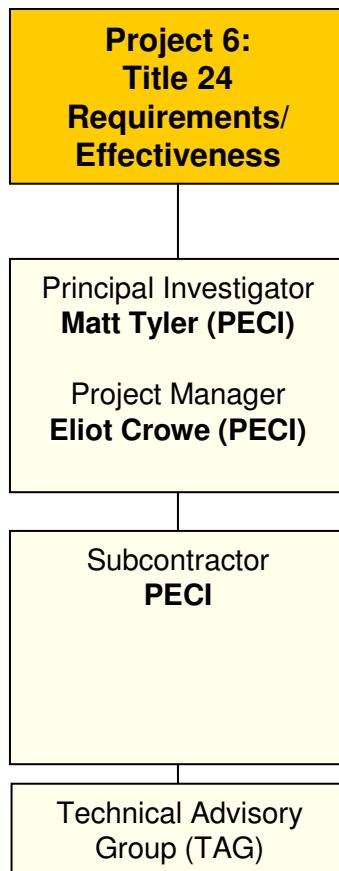


- Update
  - Commenced writing chapters
  - Pilot existing guideline: EnerNOC and EMC selected as participants
- Upcoming Activities
  - First draft of Guideline end June
  - Commence pilots
  - TAG meeting early July

# Progress Update: Project 6: “*Evaluation of Title 24 enforcement, and effectiveness of acceptance tests*”

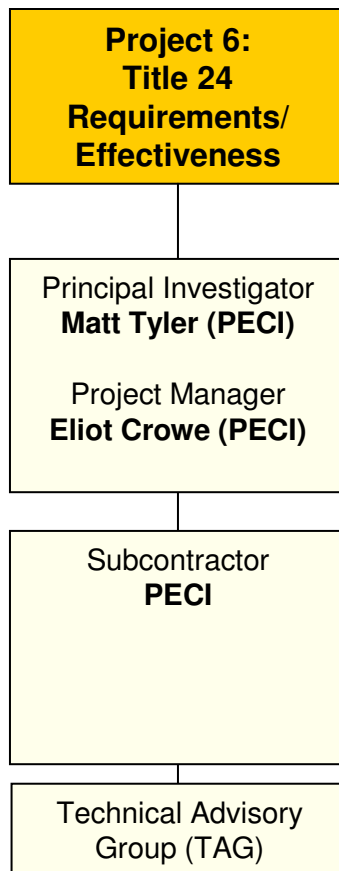


## Progress Update: Project 6: “*Evaluation of Title 24 enforcement, and effectiveness of acceptance tests*”



- Update
  - Created interview guides
  - 8 phone interviews with building department officials
  - 2 phone interviews with HVAC contractors
- Upcoming Activities
  - Complete phone interviews (contractors, MEP firms, building owners)
  - 6 in-person interviews (enforcement of code)
  - Recruitment for site visits to evaluate effectiveness of tests

## Progress Update: Project 6: “*Evaluation of Title 24 enforcement, and effectiveness of acceptance tests*”



- Initial findings from phone interviews with building department officials
  - 2008 forms are an improvement over 2005
  - Attended training, but still a lot to learn about forms & procedures
  - Need for guidance on how to review documentation
  - Resource limitations on performing site verification visits

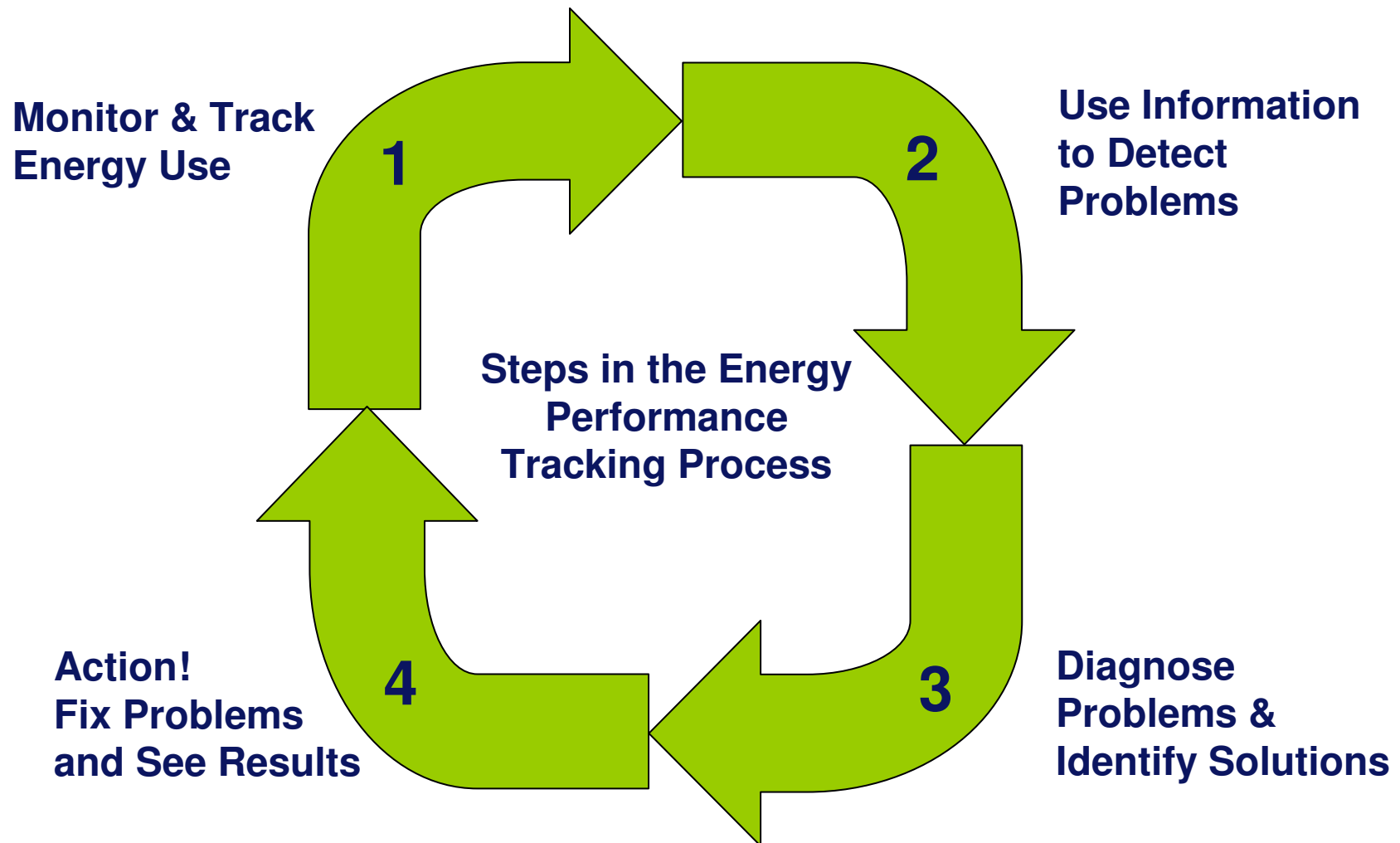
## Hot Topic – Title 24 project alignment

- Need to ensure that project takes account of ongoing roll-out of 2008 standard.
- Discussion points:
  - Evidence that Title 24 awareness is growing among industry stakeholders?
  - Any examples of acceptance testing performed to Title 24 2008?
  - Any building projects in planning/specification/design phase?

## Project 4 Highlight

- Improving the persistence of RCx savings
  - Research on best practice
  - Research on performance tracking tools
  - Develop Energy Performance Tracking Guide
  - Develop Case studies

# Energy Performance Tracking



# Types of Energy Performance Tracking

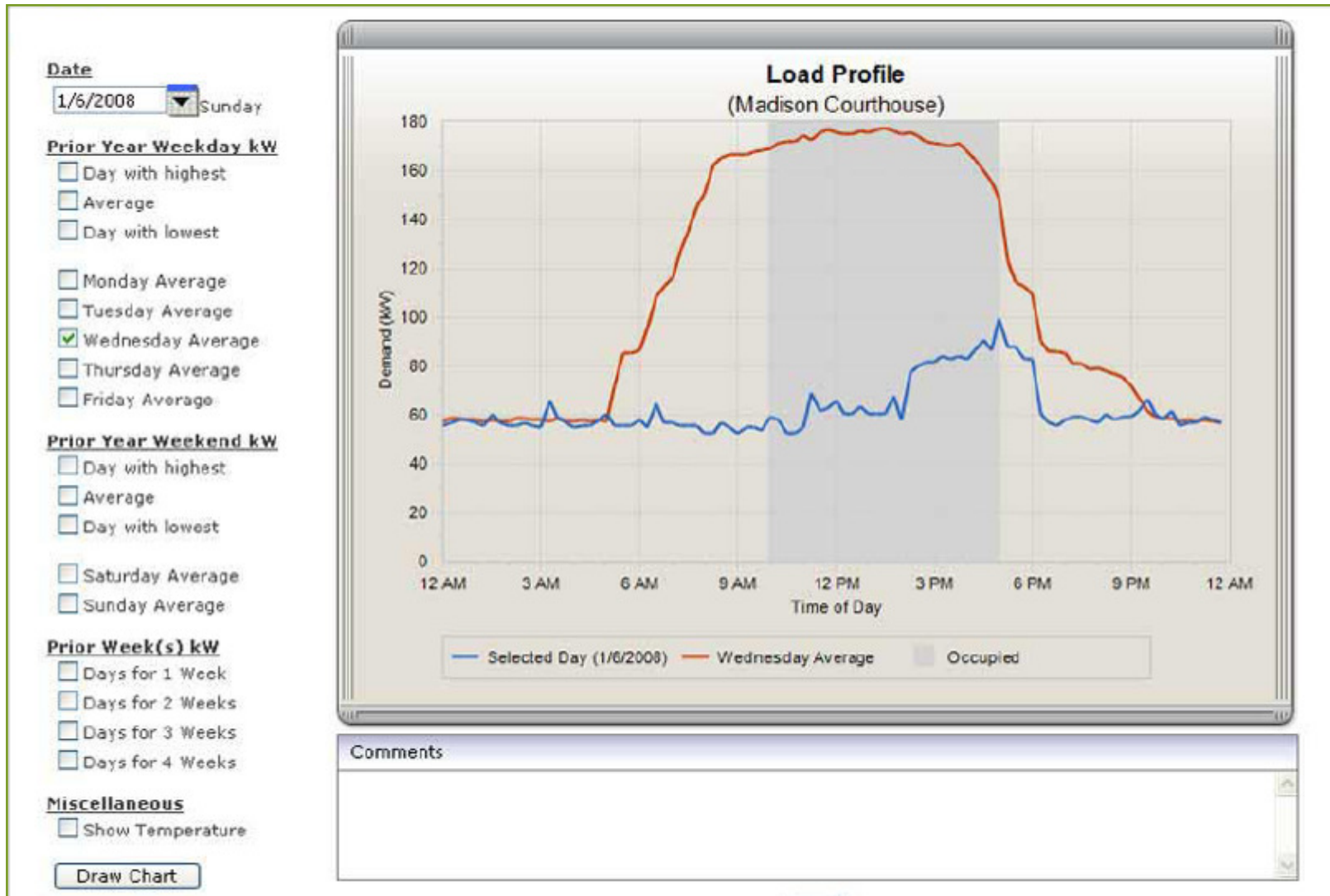
- Method 1: Benchmarking
- Method 2: Energy information systems (EIS)
- Method 3: Building Automation System (BAS/EMS/etc)
- Method 4: Automated fault detection and diagnostic tools (FDD)

Hybrid tools are available on the market

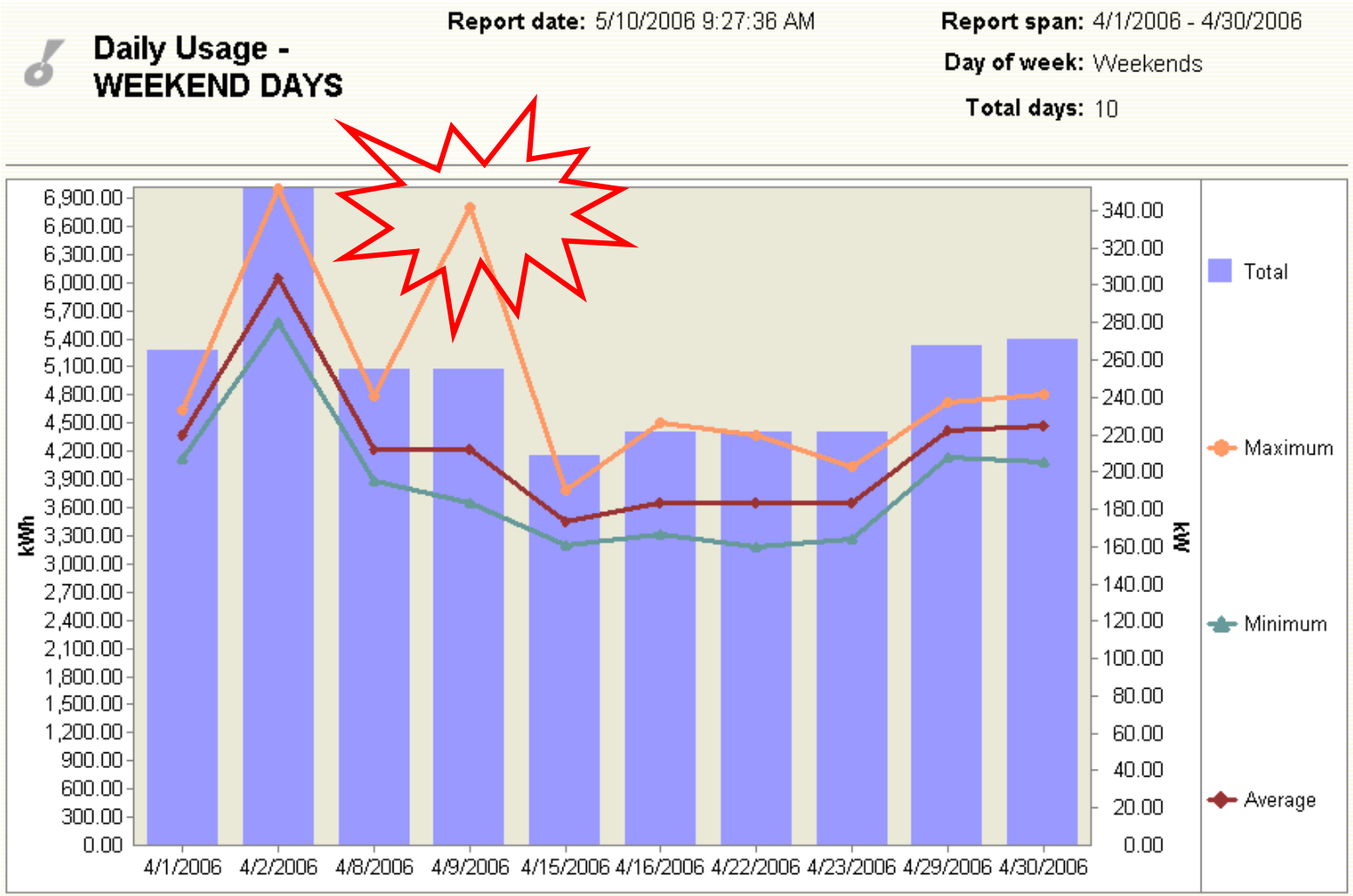
## Method 2: Energy Information Systems

- EIS Basic Features
  - Monitoring and collection of energy data
  - Utility bill analysis
  - Web browser interface
  - Often includes data filtering and benchmarking
  - See “Building Energy Information Systems: State of the Technology and User Case Studies”, Granderson, Piette, 2009

# Slice and Dice Energy Usage Data!



# Look for Outliers or Trends



## Method 2: Energy Information Systems

- Pros
  - Great for portfolio of buildings
  - Many EIS have ability to program custom alarms
  - Focus is giving energy managers the big picture on energy performance for drilling in using other ways
- Cons
  - Mainly only electric whole building and maybe gas meters
    - Submetering in more expensive systems
  - Usually a separate system from BAS

## Method 3: Using BAS for Energy Performance Tracking

- Typical BAS don't track energy usage
- Make a tracking tool by adding
  - Energy meter data
  - Calculate system metrics
  - “Smart alarms” to help detect problems
- BAS vendors starting to offer packaged solutions (eg. Building Logix)

# Example: BuildingLogix

## Electricity Summary

💡 Current Electric Usage:	1607.0 Kwh
💡 Target Electric Usage:	425.8 Kwh
💡 Predicted Electric Usage:	1871.9 Kwh

## Gas Summary

🔥 Current Gas Usage:	15.5 ccf
🔥 Target Gas Usage:	32.6 ccf
🔥 Predicted Gas Usage:	40.7 ccf

## KBTU Summary

💡 KBTU from Electric	5483.2 KBTU
🔥 KBTU from Gas:	1575.0 KBTU
📊 Current KBTU Usage:	7058.2 KBTU
📊 Target KBTU Usage:	4751.9 KBTU
📊 Predicted KBTU Usage	10417.2 KBTU
📊 Monthly KBTU Usage	107494.6 KBTU
📊 Monthly Target KBTU Usage:	142555.6 KBTU

## KBTU/ft2 Summary

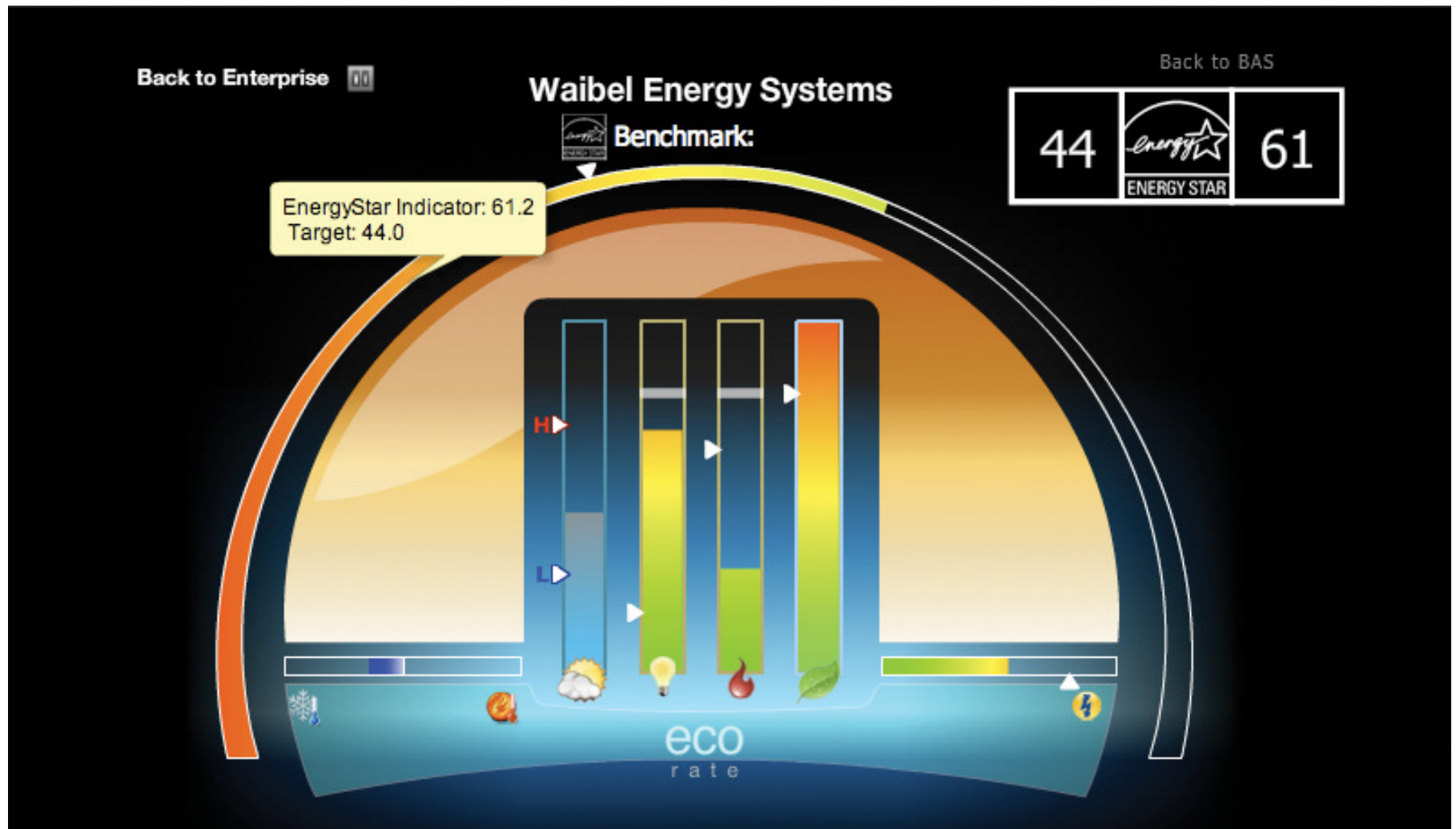
💡 KBTU/ft2 from Electric	0.4 KBTU/ft2
🔥 KBTU/ft2 from Gas:	0.1 KBTU/ft2
📊 Current KBTU/ft2 Usage:	0.5 KBTU/ft2
📊 Target KBTU/ft2 Usage:	0.3 KBTU/ft2
📊 Predicted KBTU/ft2 Usage	0.7 KBTU/ft2
📊 Monthly KBTU/ft2 Usage	22.3 KBTU/ft2
📊 Monthly Target KBTU/ft2 Usage:	10.2 KBTU/ft2

## Net Performance

👍 Current Streak:	14 Days
🕒 Current Month Days Above Target:	6 Days
🕒 Current Month Days Below Target:	20 Days
Total Days [MTD]: 26	

🕒 Current Year Days Above Target:	10 Days
🕒 Current Year Days Below Target:	23 Days
Total Days [YTD]: 33	

# Example: BuildingLogix



## Method 3: BAS for Performance Tracking

- Pros
  - Operators are familiar with BAS
  - Nice to have one front end, rather than EIS and BAS separate
  - Whatever energy tracking tool used, use BAS for troubleshooting
- Cons
  - Not many packaged solutions, but create custom system
  - Likely does not have as many EIS-like features for data visualization

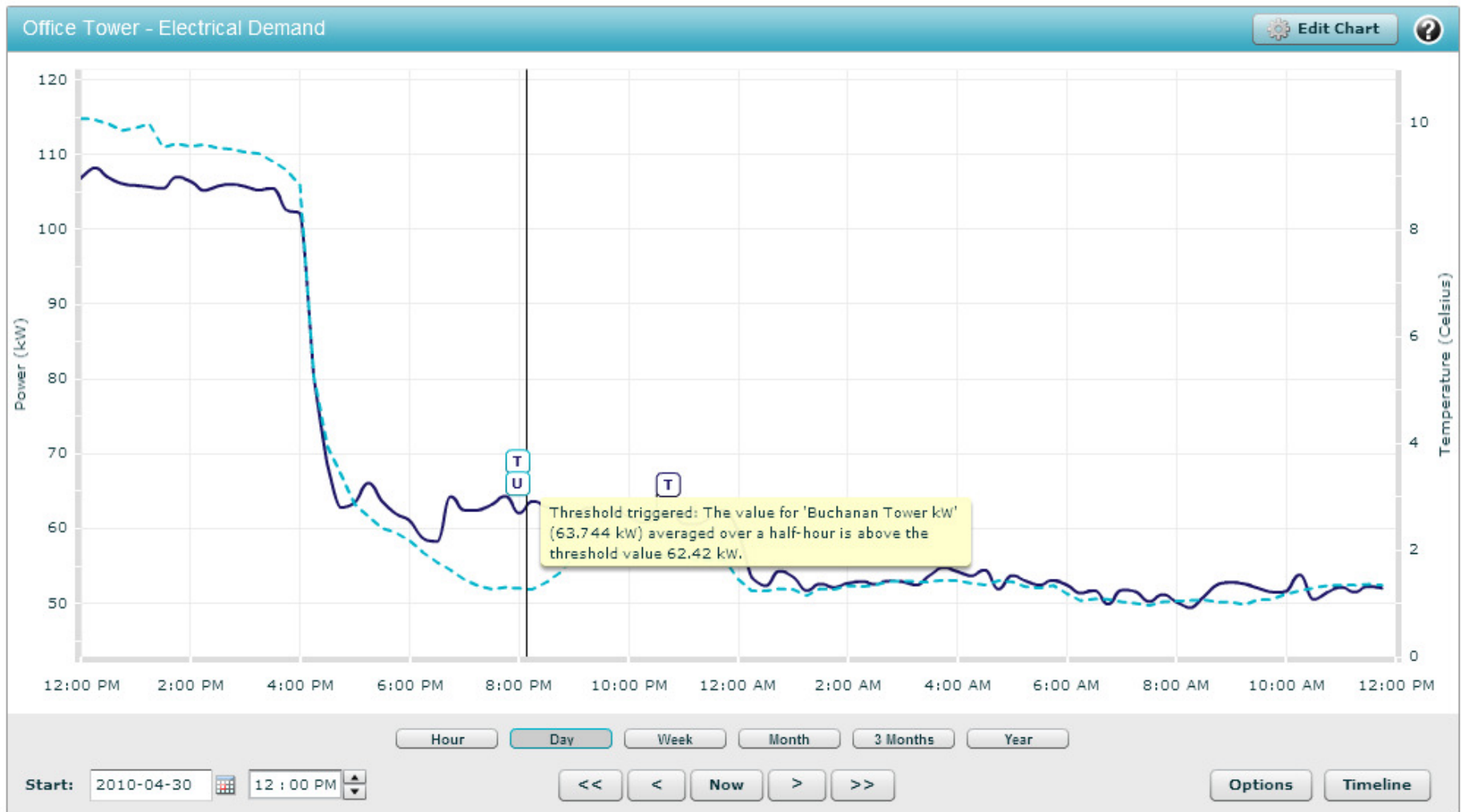
## Method 4: Fault Detection and Diagnostic (FDD) Tools

- **FD** Automated detection of faults
- **D** Diagnose of the cause of the fault

## Two Fault Detection Approaches

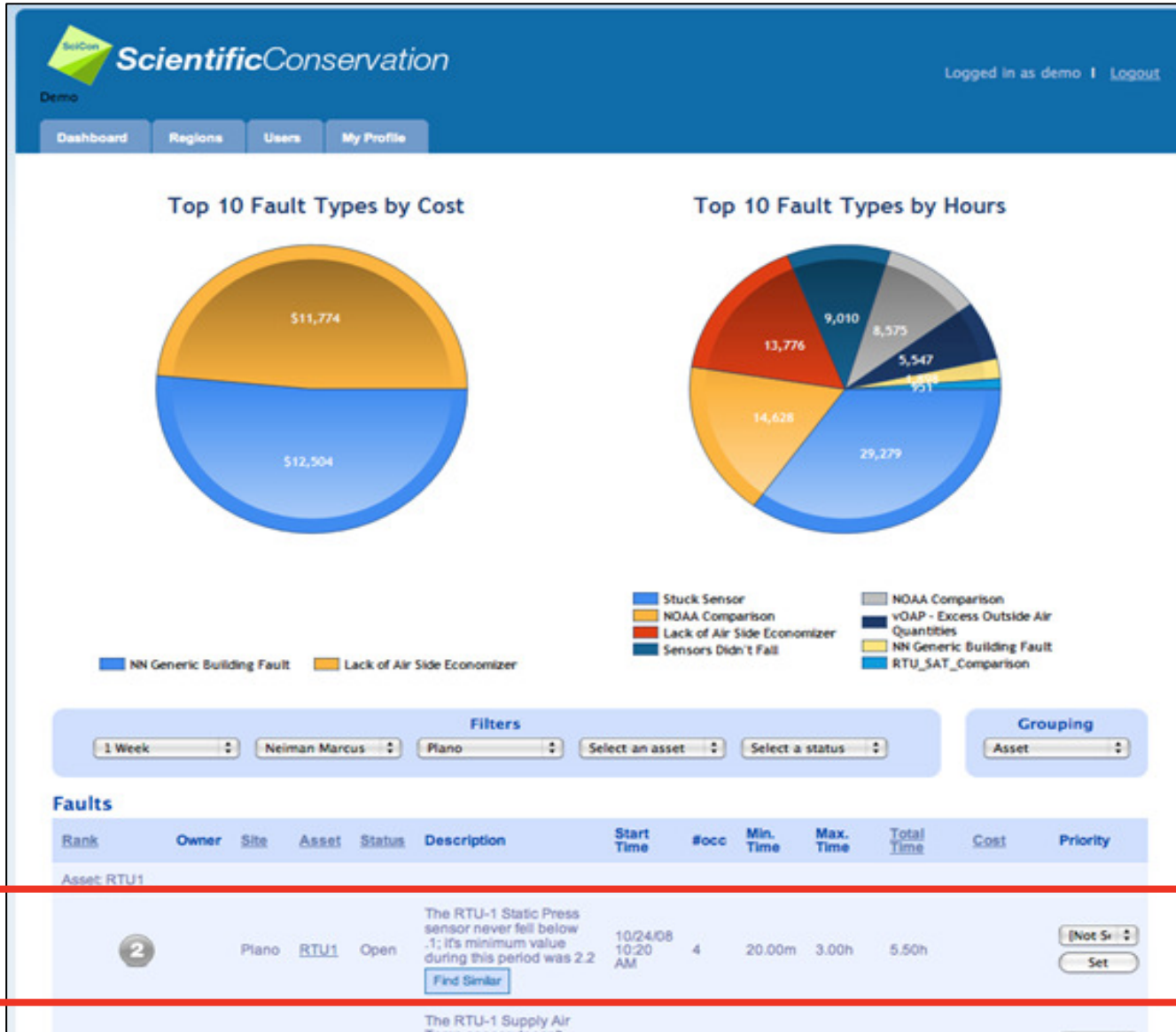
- Top-down approach: whole building / main meter level
  - Deviations from model of historical energy use
  - Generally preferred by energy managers
  - Can be used to track energy savings

# Top-Down Example: Pulse Energy



## Bottom-up FDD

- Bottom-up approach: equipment level
  - Monitors system data from BAS
  - System fault identification “rules-based”
    - Helps to diagnose possible causes of faults
    - “FDD Tools”
  - Generally preferred by facility engineers
  - Potential to reduce operational complaints



# Bottom-up Example: Metasys Sustainability Manager

Summary  
Energy Analyzer  
Time Series/Event Analysis

**Source Data**

Default Site | User Sites

- Prince Hall
- South Service Center
- Wainwright State Office Building
  - Billing
  - HVAC
    - AHU
      - AHU-1 
        - AHU-1 Carbon Dioxide Average
        - AHU-1 Carbon Dioxide High Set Point
        - AHU-1 Carbon Dioxide Low Set Point
        - AHU-1 Carbon Dioxide Level
        - AHU-1 Cooling Coil Valve
        - AHU-1 Economizer Status
        - AHU-1 Mixed Air Temp

Navigation Tree Controls

**Legend**

- AHU-1 Cooling Coil Valve %
- AHU-1 Supply Air Temp F
- AHU-1 Supply Air Temp Set Point F

Legend Controls

**Administration**

**Details**

Stats | Event Details | Event Detection | Date Range | Messages

No event selected.

Define Event | Create Event Table  
Delete Event | Work Request  Show Flags  
Event Reporting | Send Email

Zoom 1d 5d 1m 3m Max ± : Data Axis Scaling Restore Default Scale to Data

**Event: Alarm17**  
Tue Aug 7 2007 09:45:00 AM  
Value: 58.4099426269577

*Alarm Description: The Supply Air Temperature was greater than the Supply Set Point Temperature while the Cooling Control Valve was fully opened.*

*The Heating Control Valve is optional in this algorithm. It may be included to ensure that the proper algorithm is being implemented i.e. The Heating and Cooling Valves are in the correct position. If the point is not used the Heating Valve is defaulted to closed (0% open).*

**Diagnosis Possibilities:**

- Supply Air Temperature Sensor Error
- Caught Heating Coil Valve
- Leaking Heating Coil Valve
- Polluted Cooling Coil
- Undersized Cooling Coil
- Chilled Water Supply Temperature Too High
- Chilled Water Circulating Pump Problem

**Possible Implications:**

- Energy Consumption
- Occupant Comfort
- Maintenance Staff Productivity

eneti://EnNET-Logging/Groups/WainwrightS1-NIE02/Items/S1-NIE02+2FN1 Migration.NC2.AHU-1.DA.T.PresentValue/TrapValue

Event List

Click the graph icon to see the graph, the table icon to see the table

## Method 4: Fault Detection and Diagnostic (FDD) Tools

- Pros
  - Automated detection of faults saves time, finds hidden problems, calculate cost of energy waste
  - Top-down FD provides the big picture
  - Bottom-up FDD can give operators more information on problem and its potential cause
- Cons
  - Top-down FDD doesn't tell you where to look
  - Bottom-up FDD can be complex to implement; may be false alarms without customizing the system

## Examples of Fault Detection Tools

- Top-down Fault Detection
  - Pulse (Pulse Energy)
  - Energy Expert (Northwrite)
- Multiple Systems Bottom-up FDD
  - PACRAT (Facility Dynamics)
  - Infometrics (Cimetrics)
  - SCiWatch (Scientific Conservation, Inc.)
  - Metasys Sustainability Manager (JCI)
- System-specific Bottom-up FDD
  - Efftrack (Efftec) – chilled water systems
  - APAR (NIST) – air handlers
  - VPACC (NIST) – VAV boxes

## Market Penetration

### – Limited Market Penetration

- End users have the perception that there are few options
- Adoption rate highest at facilities where energy reduction has been mandated

### – Service Based Tools More Prevalent

- 80% of end users surveyed are using software as a service
  - Lower up-front cost
  - Ease of installation
  - External support

## What are building owners doing?

- Phone surveys and site visits
  - 19 interviews
    - large commercial, government, universities
  - 4 site visits
- Successful tracking
  - Best performing participants had defined:
    - Goals (what)
    - Policies (how, when)
    - Accountability (who)

## What are building owners doing?

- Phone survey and site visits
  - Key findings:
    - Simplistic methods can be effective
    - Internal champions required
    - Information transfer to all levels is critical

## Case Study: Glenborough Realty – “Aventine”, La Jolla, CA

- Large Office (217,000 ft<sup>2</sup> Rentable)
- Multi-tenant
- ENERGY STAR® 100
- LEED Platinum – soon
- Central Plant Retrofit
  - Turbocor® Compressors
  - OptimumLoop
- Energy Savings ~33%
- EUI = 26.7 kBtu/ft<sup>2</sup>

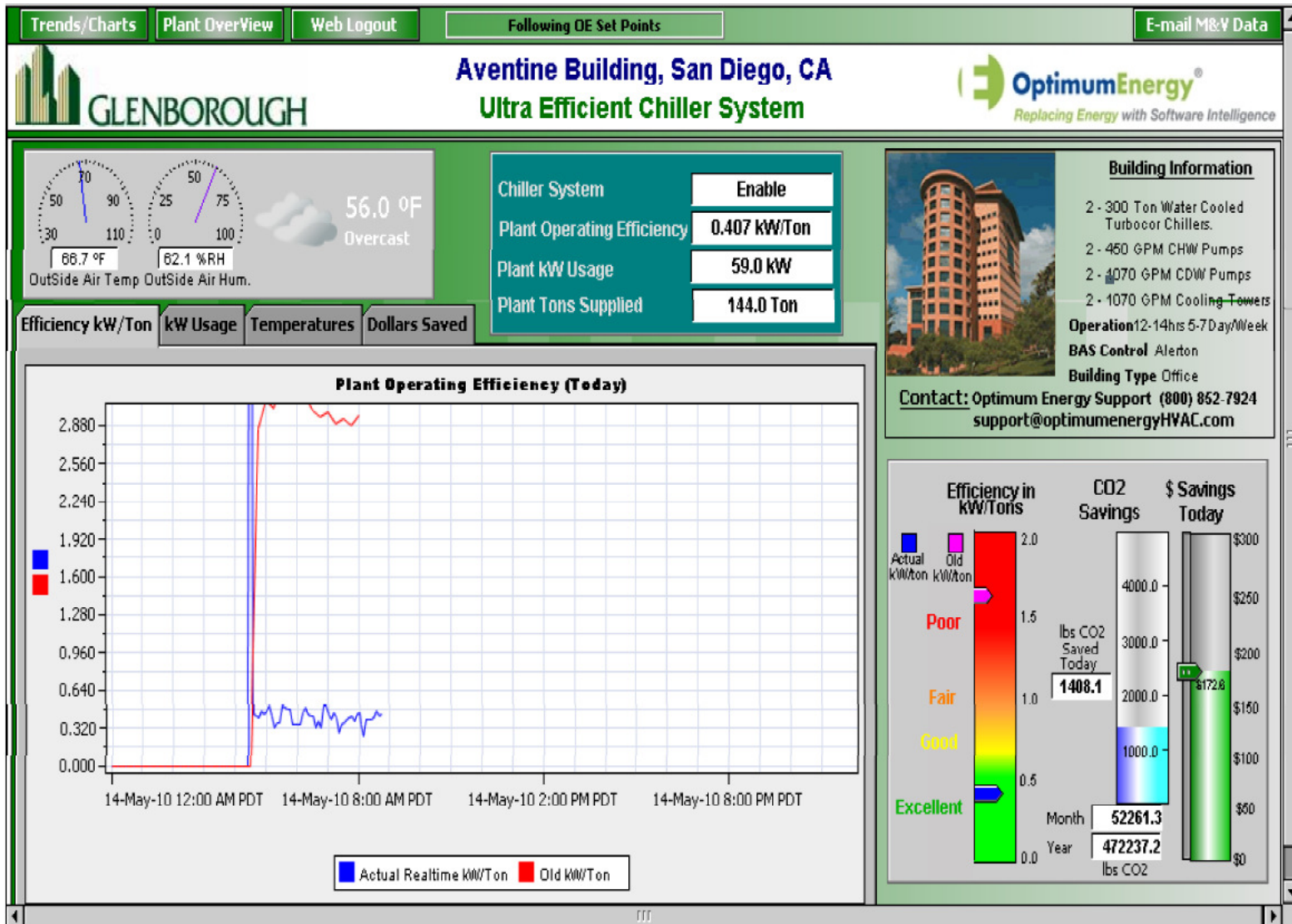


## Aventine: Tracking Strategies - “Software as a service”

- Constellation Energy Billing analysis
  - Automatic utility bill pay service
  - Data mining monthly consumption to identify anomalies
- OptimumMVM
  - 3<sup>rd</sup> party continual monitoring/optimization of central plant performance



# Aventine – tracking dashboard

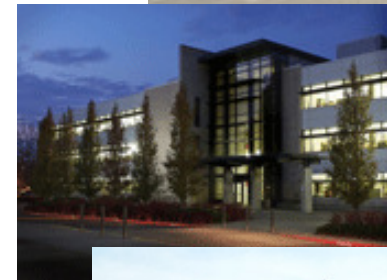


## Aventine – Successes

- Constellation
  - Identified improperly split meters after the property was subdivided
- OptimumMVM
  - Continual and automatic optimization (high level of trust)
  - Onsite staff responds quickly to high kW/ton
    - Persistence of energy savings is maintained

## Case Study: Oregon Department of Administrative Services (OR DAS)

- Portfolio of various buildings
  - Office
  - Lab
  - Data Centers
- State mandate to save
  - 20% of 2000 level by 2015
- 27% portfolio savings achieved by 2009

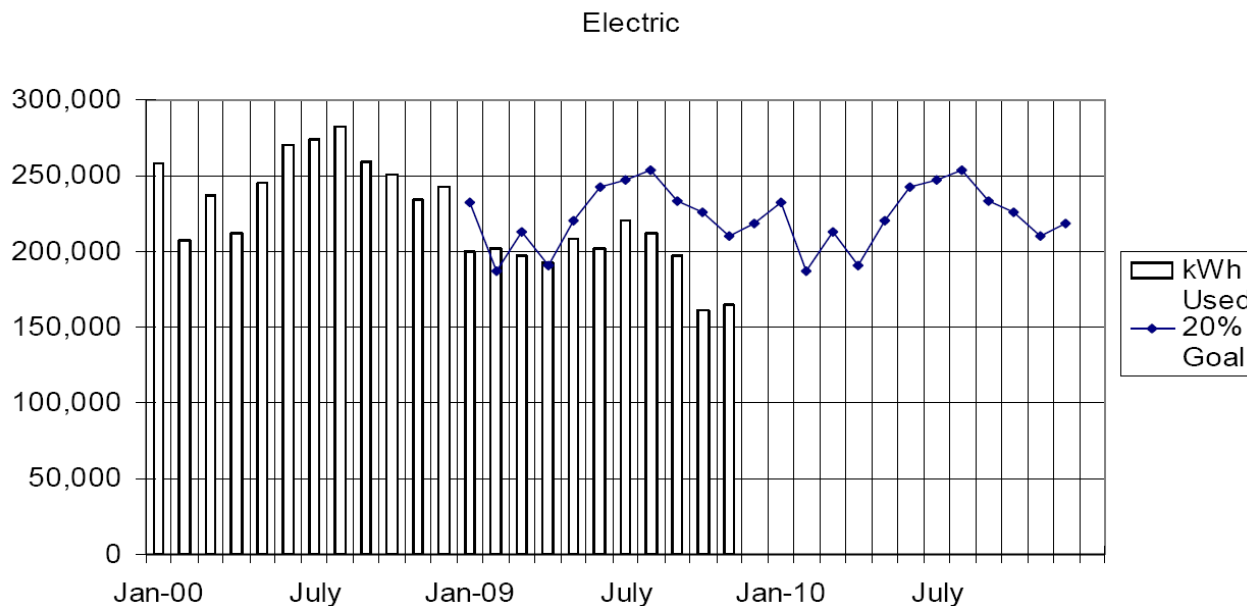


## Oregon DAS – Tracking Strategies

- Management level (EIS)
  - Utility Manager (Itron/McKinstry)
    - Used for long term tracking
    - Snapshots are communicated to tenants quarterly
- Operations level (Top-down FD)
  - Energy Expert (NorthWrite)
    - Used for day to day tracking
    - Daily energy reports are monitored

# Oregon DAS: Tracking report

- Management level: Utility Manager
  - Performance and progress to goal is tracked
  - Quarterly report cards used to communicate



STATUS

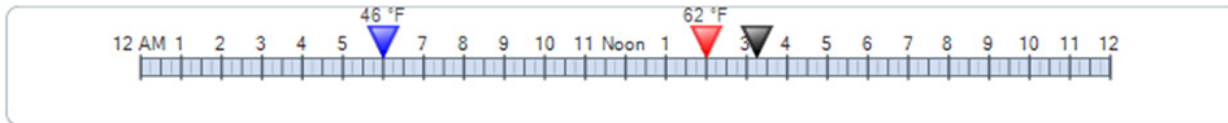
**SAVINGS = 19%**

Savings includes electricity and natural gas combined.

# Oregon DAS: Tracking Report (Northwrite Energy Expert)

Energy Expert ScoreCard for : Commerce Expert

Date: 4/26/2010

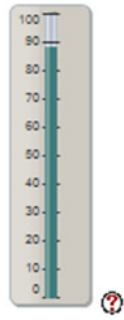


Calculated Savings / (Cost)

Monday, 04/26/2010: \$ 2  
Prior 30 Days: \$ 23

Year-To-Date: (\$ 53)  
Prior 12 Months: \$ 150

Consumption



Actual Use  
892

Expected Use  
911

Baseline 88%

Based on 24 hours

[What does this mean?](#)

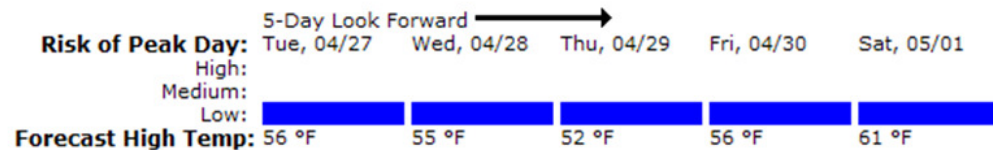
Load Profile

Peak of 72 at 3:15 PM

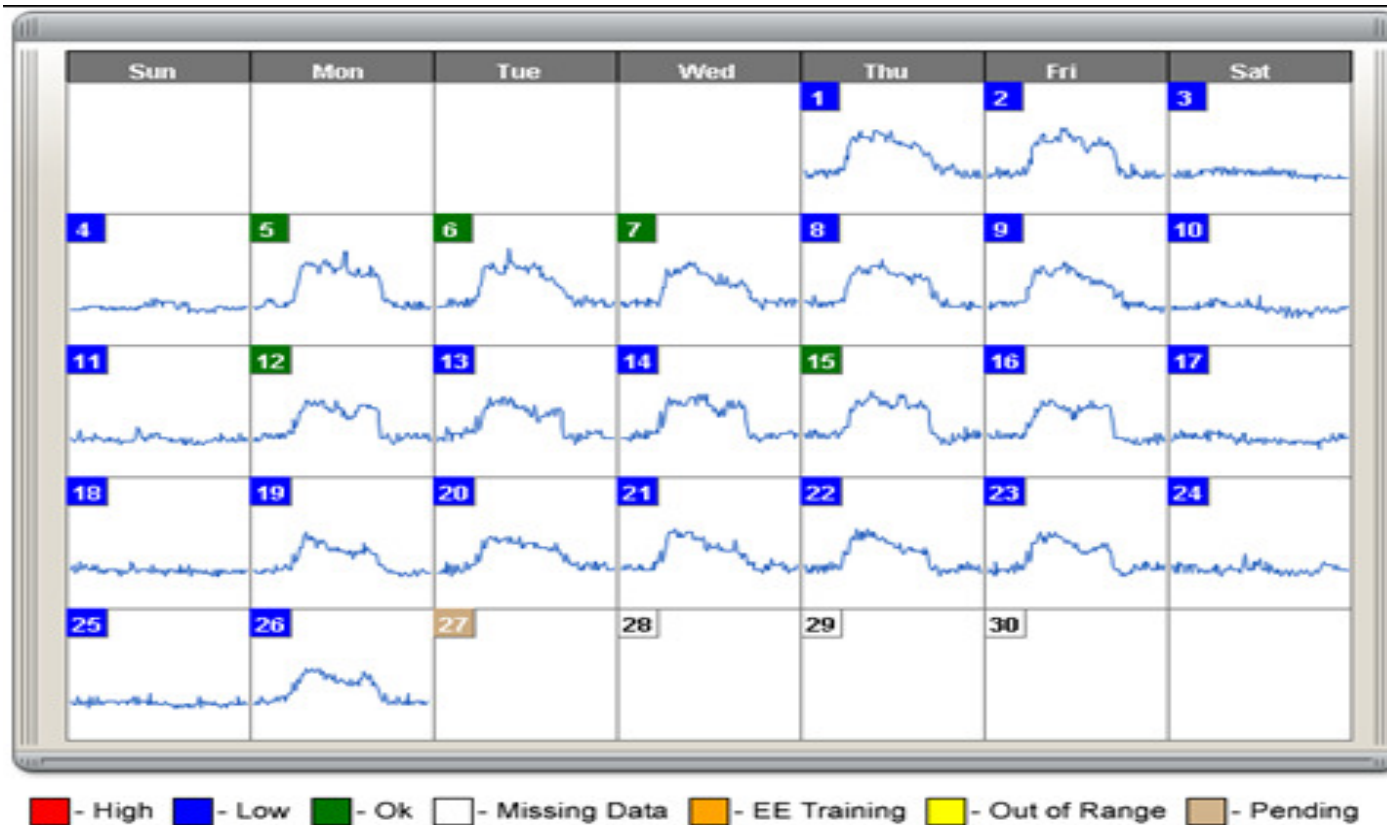


Load Profile

Potential Peak Days\*



# Oregon DAS: Energy Expert report



Operators eventually learned how each building’s load profile should look and can now diagnose issues more efficiently

## PAC Co-Chairs

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**ANY QUESTIONS?**