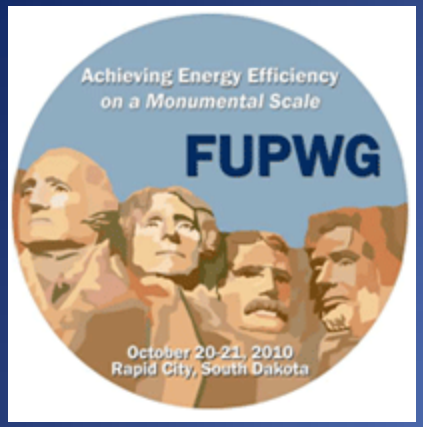


Best Practices in Existing Building Commissioning

Carl E. Lundstrom, P. E., CCP

Federal Solutions Manager

E M C Engineers, Inc. – Subsidiary of Eaton Corporation

FEDERAL UTILITY PARTNERSHIP WORKING GROUP MEETING
OCTOBER 20-21, 2010
RAPID CITY, SD

Presentation Agenda

- The Purpose & Benefits of Existing Building Commissioning (EBCx)
- The Building Commissioning Association (BCA) & “Best Practices”
- Contracting & Hiring Qualified Providers
- Typical Measures & Ideal Facilities
- Success Factors

What is The Building Commissioning Association?

- International non-profit organization (founded in 1998)
- Recognized commissioning authority and resource
- Commissioning providers, building owners, energy companies, facility managers, architects, engineers, and contractors
- Founded and supported by Northwest Energy Efficiency Alliance
- Website - www.bcxa.org

MISSION: To guide the building commissioning industry through advancing best practices and education, and promoting the benefits of building commissioning.

Integrity Leadership Expertise Quality

Purpose of Existing Building Commissioning

Improve Building Systems Performance To Meet Current Facility Needs

- Improve building performance by saving energy and reducing operational costs
- Identify and resolve building system operation, control and maintenance problems
- Reduce or eliminate occupant complaints and increase tenant satisfaction
- Improve indoor environmental comfort and quality and reduce associated liability
- Document system operation
- Identify the O&M staff training needs and provide such training
- Minimize operational risk and increase asset value
- Extend equipment life-cycle
- Ensure the persistence of improvements over the building's life
- Assist in achieving LEED™ for Existing Buildings
- Improve the building's ENERGY STAR rating

Source: Building Commissioning Association – Existing Building Commissioning Best Practices

The Benefits of Existing Building Commissioning

THE SAVINGS*

- National $30 Billion Savings Potential by 2030 (equivalent of 340 megatons CO2 emission savings)
- Building Metrics (from 332 projects/90 million square feet)
  - Median energy payback of 1.1 years
  - Median energy savings of 16%
- ***"The results demonstrate that commissioning is arguably the single-most cost-effective strategy for reducing energy, costs, and greenhouse-gas emissions in buildings today."***

***Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions" – Lawrence Berkeley National Laboratory July 2009**

Creating “Best Practices”

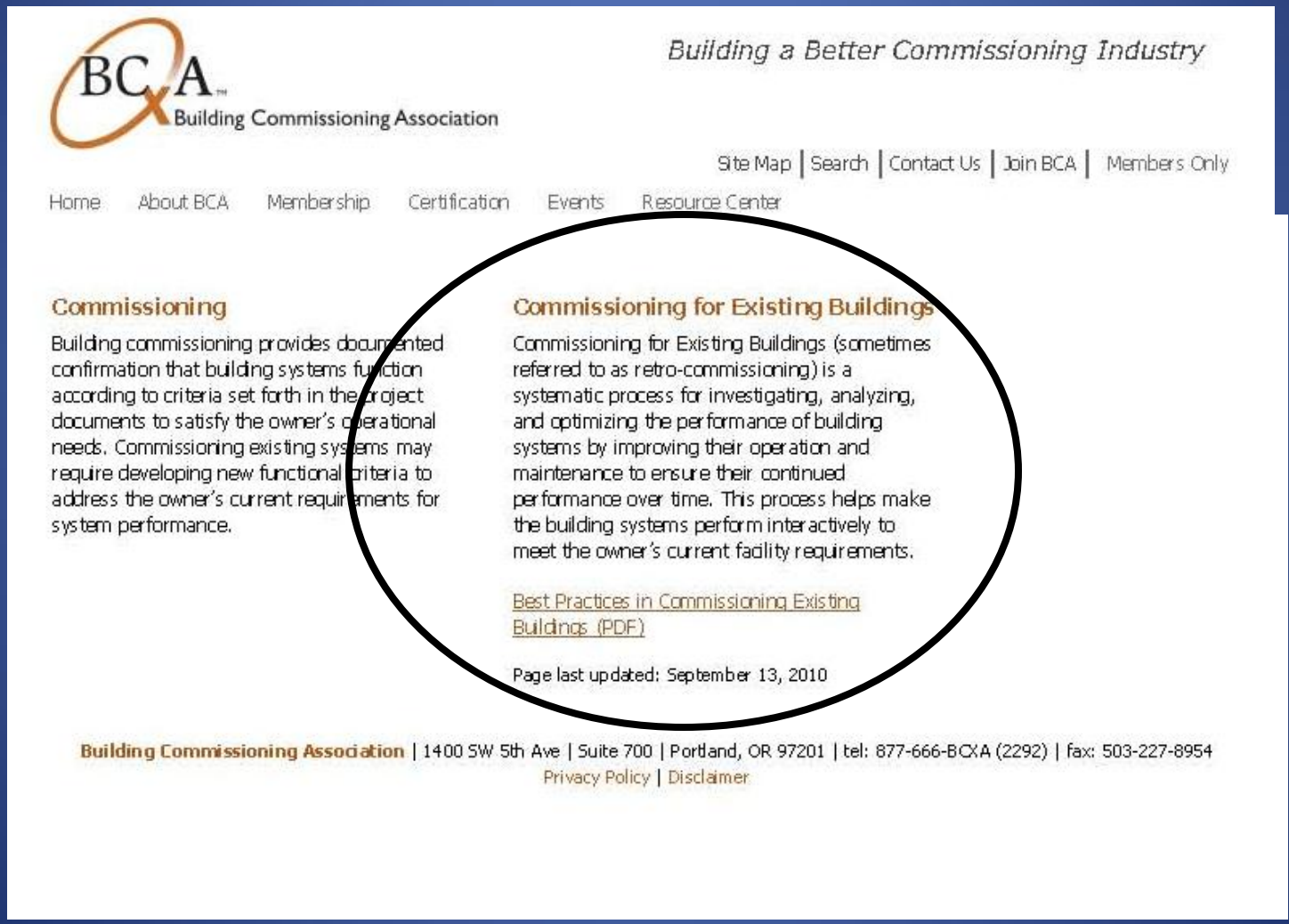
Existing EBCx Guides & Programs Reviewed

- LEED™ for Existing Buildings: Operations & Maintenance (USGBC)
- ENERGY STAR “A RCx Guide for Building Owners” (EPA)
- California Commissioning Collaborative Guide for Existing Buildings
- Building Commissioning Association’s Building Commissioning Handbook
- National Environmental Balancing Bureau (NEBB) Retro-Commissioning Process
- Associated Air Balance Council Commissioning Group (ACG) Commissioning Guidelines
- ASHRAE Guideline 0-2005; input from ASHRAE GPC 1.2
- Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

“Real World Experience” from a committee of 20+ commissioning professionals

EBCx "Best Practices": Where To Find It

http://www.bcxa.org/index.htm



What is Existing Building Commissioning?

A systematic process for investigating, analyzing, and optimizing the performance of building systems through the identification and implementation of **low/no cost and capital intensive Facility Improvement Measures (FIMs)** and ensuring their continued performance. The Existing Building Commissioning process assists in making the building systems **perform interactively to meet the Current Facility Requirements (CFR)** and provides the tools to support the **continuous improvement** of system performance over time.

The term *Existing Building Commissioning* is intended to be a **comprehensive term** and process that encompasses the more narrowly focused process variations such as retro-commissioning, re-commissioning and ongoing commissioning that are commonly used in the industry.

Source: Building Commissioning Association – Existing Building Commissioning Best Practices

Commissioning Terms Used

Retro-Commissioning The application of the commissioning process to an existing building that has not previously undergone the commissioning process. It commonly has a primary focus on reducing energy consumption and costs.

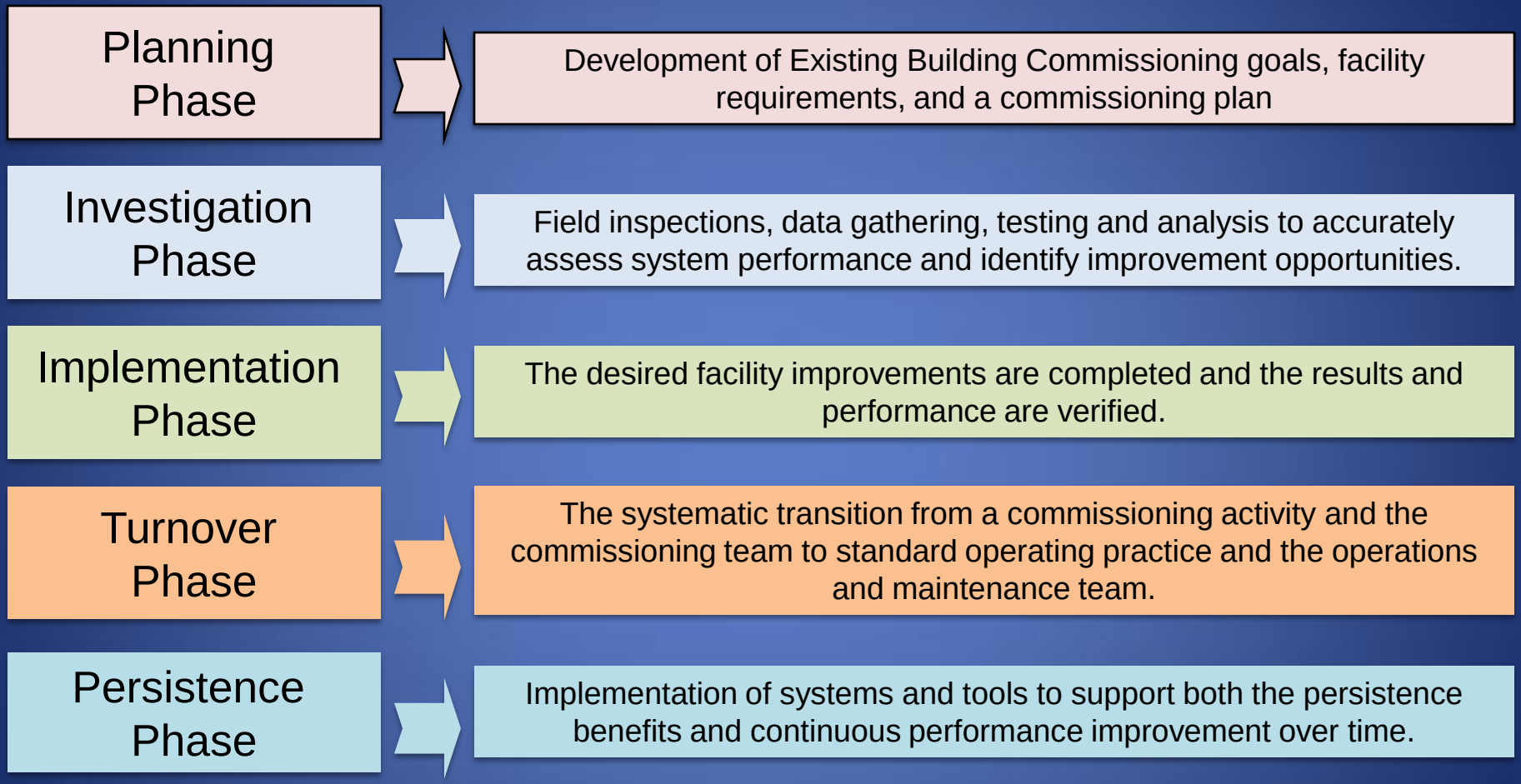
Re-Commissioning The periodic re-implementation of the commissioning process, either on a regularly occurring schedule (every 3 to 5 years is typical), or if building performance degrades, or if the building occupancy or usage changes significantly.

Ongoing Commissioning Commissioning activities that follow a commissioning event to addresses the issue of persistence. Includes ongoing energy monitoring, benchmarking and continuous trend data collection and analysis and periodic re-implementation of commissioning activities.

Continuous Commissioning® Refers to a commissioning approach that is integrated into a facility's standard O&M program developed by the Energy Sciences Laboratory at Texas A&M. Activities in support of the continuous commissioning effort are completed on a regular basis, compared with re-commissioning approaches that tend to be distinct events.

Monitoring Based Commissioning Monitoring Based Commissioning employs permanent remote energy system metering, bench marking and trend log capability to identify inefficiencies in energy system operations, facilitate diagnostics, document energy savings, and ensure persistence of savings through ongoing commissioning.

Existing Building Commissioning Phases & Key Steps



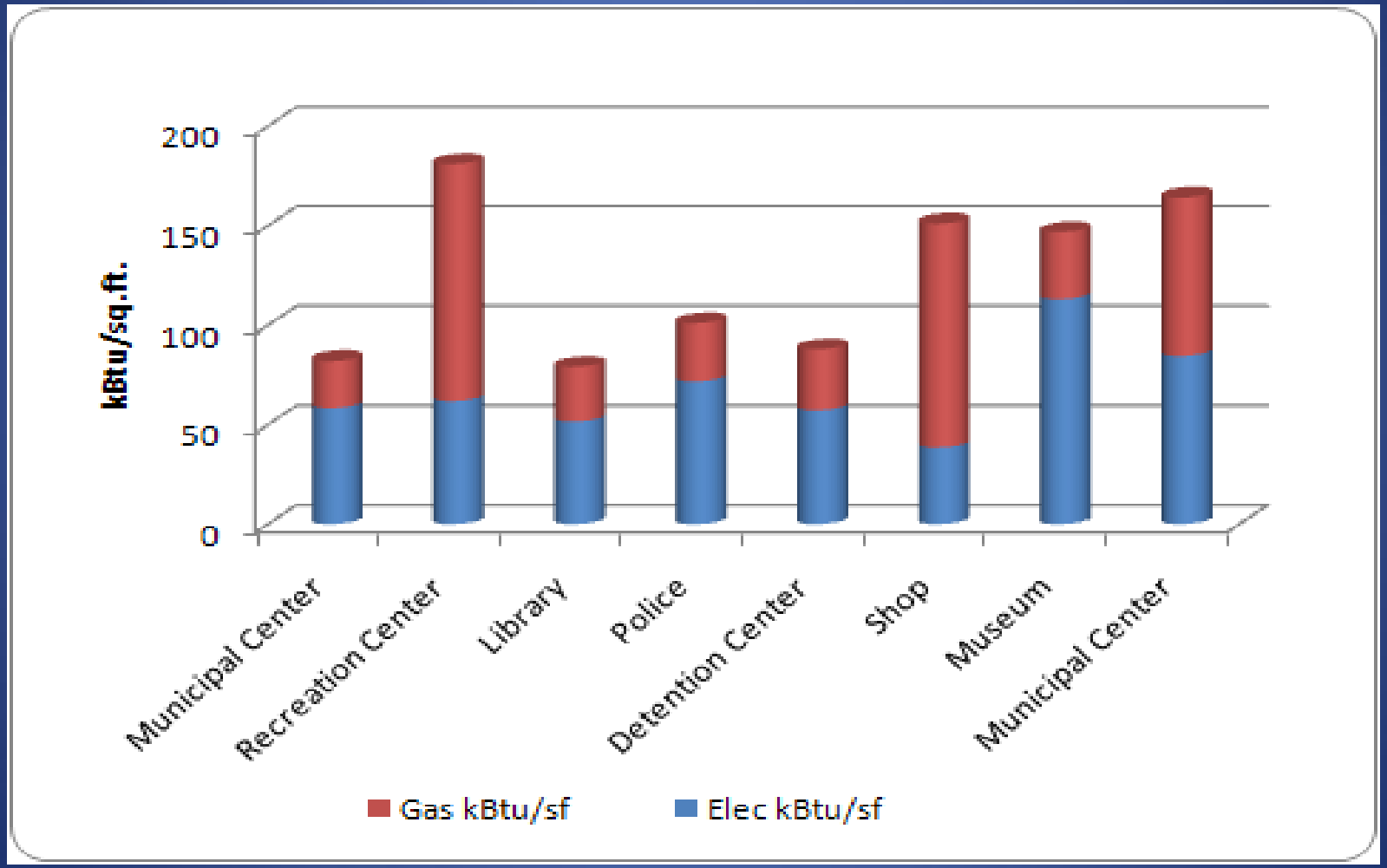
Source: Building Commissioning Association – Existing Building Commissioning Best Practices

Planning Phase

Establish Goals, Owner Needs & EBCx Plan

- Define Roles & Responsibilities
- Define Scope of Work
- Define Existing Building Commissioning Goals
- Define Current Facility Requirements
- Preliminary Building Benchmarking
- Review Existing Building Documentation
- Interview Key O&M Staff Members
- Perform Cursory Walk-Through
- Develop Existing Building Commissioning Plan
- Develop Customized Building Operation Plan

Benchmarking



EBCx “Best Practices” Phases & Steps

Investigation Phase

Evaluate Current System Performance with Owner Needs & Identify Improvements

- Documentation Review
- Site Review/Survey
- Building Occupant Interviews
- Systems Diagnostic Monitoring
- Test Development
- System Testing
- Master List of Findings & Facility Improvement Measures (FIM’s)
- Facility Performance Analysis & Performance Baseline Establishment
- Analyze Facility Improvement Measures (FIM’s)

Investigation

Site Observations

The “Wall of Shame”

Implementation Phase

Implement Recommended Improvements and Verify Performance

- Prioritize and Select Facility Improvement Measures (FIM’s)
- Prepare an Implementation Plan
- Implement Selected FIMs
- Verify Successful FIM Implementation
- Execute the Measurement and Verification (M&V) Plan
- Plan for Ongoing Commissioning

Turnover Phase

Establish Smooth Transition & Hand-Off to O&M Staff

- Update O&M Manuals and As-Built Documentation
- Develop Final Report & Update Documentation
- Compile or Update a Systems Manual
- Establish a Plan for Operational Sustainability, Ongoing Commissioning, and Continuous Improvement
- Develop Training Plan
- Hold a “Lessons Learned” Meeting

EBCx “Best Practices” Phases & Steps

Persistence Phase

Ensure Continuous System Performance Improvement

- Implement Operational Sustainability & Ongoing Cx Plan
- Benchmark the Building Energy Use & Monitor and Track
- Monitor and Track Non-Energy Building Performance Metrics
- Trend Key System Parameters
- Document Changes with an Operator’s Log
- Implement Persistence Strategies with BAS & Work Order
- Use Fault Detection & Diagnostic (FDD) Tools (Ongoing Cx Tools)
- Implement Staff Training Plan
- Implement the Commissioning Process Again (Re-Commission)

Typical EBCx Measures – EMS Driven

- Improve Scheduling of Lighting & HVAC Equipment
- Enable or Enhance Economizer Controls
- Optimum Start Function with Warm Up & Cool Down
- AHU Supply Fan Static Pressure Optimization & Reset
- Simultaneous Heating & Cooling
- CHW System Low Temperature Differential and CHW System By-passes
- VFDs Issues on Fans & Pumps
- VAV Box Minimum Flows and Setpoints
- Add BAS Control Scheme to Electric Unit Heaters & Reheats
- Improve Airflow Management and Setpoints in Data Centers
- Improve and Validate Demand Based Ventilation Systems
- Confirm Sequence of Operations for EMS Equipment

Characteristics of “Ideal” EBCx Candidate

- An energy management system (DDC)
- Mechanical equipment < 12 years old; good condition and no major renovations planned
- Higher than expected energy use
- Mechanical cooling and complex HVAC systems
- Greater than 75,000 gsf
- Individually metered or sub-metered
- Available/up-to-date building documentation
- Known building operational or comfort problems
- History of efficiency investments
- Workable relationships with established contractors
- VFDs installed on major systems and equipment
- Knowledgeable and available building staff

Key EBCx Success Factors

1. EBCx Should Save Energy and Solve Problems
2. Financial Requirements and Implementation Commitment Before Investigation
3. Qualified EBCx Service Provider (look at BCxA.org)
4. Emphasize O&M Staff Involvement and Buy In
5. EBCx Training & Documentation
6. Verify Energy Savings Through Appropriate M&V Methods
7. Establish Benchmarks and Ongoing Monitoring and Verification

Contracting and Hiring Qualified Providers

- Various Federal Agencies have contracted EBCx projects direct to firm in 2008-2010, many ARRA related
- Some Federal contracts were qualifications based selections, some were combinations of qualifications and price quotes

- Commissioning Provider qualifications should include:
  - Past experience in EBCx for similar type of buildings & systems (not just Cx for new construction)
  - Specialized skills-capabilities:
    - Controls testing and HVAC troubleshooting
    - TAB of air/water
    - Metering and data logging
    - Energy analysis
  - Capacity and experience of staff to handle size of project (Cx certifications)
  - Experience in O&M training

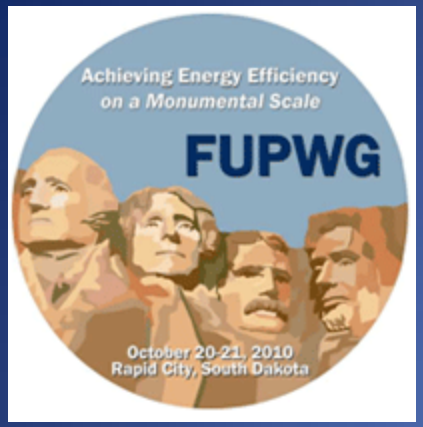
Contracting and Hiring Qualified Providers

- Strong EBCx scope of work with details on investigation phase requirements
  - DDC system checkout
  - Functional testing
  - TAB validations
  - Sampling strategies
  - Level of analysis
  - Repairs to minor problems (indicate an allowance amount)
- Providing building information:
  - Building size, function
  - Equipment take-off information
  - Building automation and HVAC control info
  - How much support will owner staff provide?

References

- Building Commissioning Association (BCA)
  www.bcxa.org
- ASHRAE Commissioning Guidelines
  www.ashrae.org
- GSA CX guidelines
  http://www.wfbg.org/pfds/building commissioningguide.pdf
- FEMP Operations & Maintenance Best Practices, Release 3.0, 8/2010
  http://www1.eere.energy.gov/femp/pdfs/om guide_complete.pdf
- White Paper - Building Commissioning - A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions
  http://cx.lbl.gov/2009-assessment.html
- Whole Building Design Guide (WBDG) – www.wbdg.org
- Portland Energy Conservation, Inc.
  www.peci.org

- **Carl Lundstrom, P.E., CCP**
- **E M C Engineers, Inc.**
- Eaton's Energy Solutions Group
  4550 North Point Parkway, S. 300
  Alpharetta, GA 30022
  tel: 678 254-1221
- cell: 770-329-3625
  fax: 678 254-1239
  www.carlelundstrom@eaton.com
- www.emcengineers.com
- www.eaton.com



Questions & Answers

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Case Study
GSA Region 4, 6 and 10

Retro-commissioning Project Scope

- Building systems affecting energy use and indoor environment
- Assist with ARRA project selection (go/no-go)
- Evaluate system operation
  - Equipment condition
  - Setpoints and control sequences
  - Trend data analysis
  - Functional testing for sampling of equipment
  - Identify detailed opportunities
- Testing again after ARRA project upgrades

Case Study
GSA Region 4, 6 and 10

RCx ECMs

- Equipment run time
- Optimize OSA damper control (econo)
- Chilled water/condenser water reset
- AHU supply temp/static pressure reset
- Upgrade building controls
- Optimize lighting schedules

Larger Capital ECMs

- Install variable frequency drives
- Upgrade building controls
- Replace/upgrade AHUs, boilers, CTs, chillers
- Upgrade lighting systems
- Install water-saving plumbing fixtures

Case Study
GSA Region 4, 6 and 10

Project Name	Total Square Feet	Estimated Annual Savings	Savings % of Utility Bill
Baker Federal Building - Baker City, OR	58,600	$31,920	Electrical: 24% Natural gas: 43%
Denney Federal Bldg - Lincoln, NE	508,000	$130,207	Electrical: 18% Natural gas: 39%
Eagleton Courthouse - St. Louis, MO	1,310,874	$140,420	Electrical: 13%
Goodfellow Complex - St. Louis, MO	1,633,496	485,5889	Electrical: 21% Natural Gas: 33%
North Platte Federal Building - North Platte, NE	76,791	$14,027	Electrical: 13.2% Natural Gas: 47.2%
Richland Federal Building - Richland, WA	386,585	$48,285	Electrical: 12 % Natural gas: 18 %
Spokane Federal Building - Spokane, WA	125,275	$66,381	Electrical (demand): 36% Natural Gas : 54% Water Usage: 11%
Whittaker Courthouse - Kansas City, MO	753,510	$130,750	Electrical: 16% District Steam: 38%
Richard B. Russell Federal Building – Atlanta, GA	1,315,210	$356,932	Electrical: 30%
Frank M. Johnson Federal Complex - Montgomery, AL	425,035	$47,992	Electrical: 8%