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Best Practices in Energy and Water Auditing and Existing Building Commissioning

Presented by:

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Presentation Agenda

- The Purpose & Definition of EBCx
- BCA EBCx Best Practices Phases & Steps
- Typical Measures & Ideal Facilities
- Case Studies
- What is Happening in Industry
- 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

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

Integrity Leadership Expertise Quality

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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.

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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.

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

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Source: Building Commissioning Association – Existing Building Commissioning Best Practices

Climate Change & Energy Efficiency

Buildings contribute **40%** of total CO_2 emissions

- 50% of all electricity consumed in commercial buildings
- 3% of all water consumed in commercial buildings

"Modest investments in **energy-saving** and other climate-friendly technologies can yield buildings and communities that are **environmentally responsible**, **profitable** and **healthier** places to live and work, and that **contribute to reducing CO_2 emissions**."

SOURCE: U.S. Green Building Council

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Options for Energy Reduction

Guaranteed Savings w/ Energy Service Co.

- Capital intensive
- Can include savings financing (performance contracting funding mechanism)
- Detailed savings guarantee
- New equipment, systems and retrofits
- Turnkey projects
- Ongoing maintenance
- 7 - 10 year total payback
- Older buildings with deferred maintenance

Limited Resources

Need New Equipment

Energy Audit w/ Consulting Engineer

- Capital intensive
- Owner typically provides funding
- Detailed savings estimates
- New equipment, redesigned systems and retrofits
- Owner involvement varies
- Owner maintains
- 3 – 7 year payback
- Older buildings, inefficient system designs or deferred maintenance

Need Retrofits or New Equipment

O & M Initiatives & Retro-Commissioning

- Lower cost
- Owner funds
- Detail of savings vary
- Optimize system operation or "tune up"
- Collaborative with O&M staff
- Owner maintains
- ½ – 2 year payback
- Enhanced O&M/RCx works for ALL buildings, Ideal for newer buildings with efficient systems

Newer Facilities with Energy Features Exist Already

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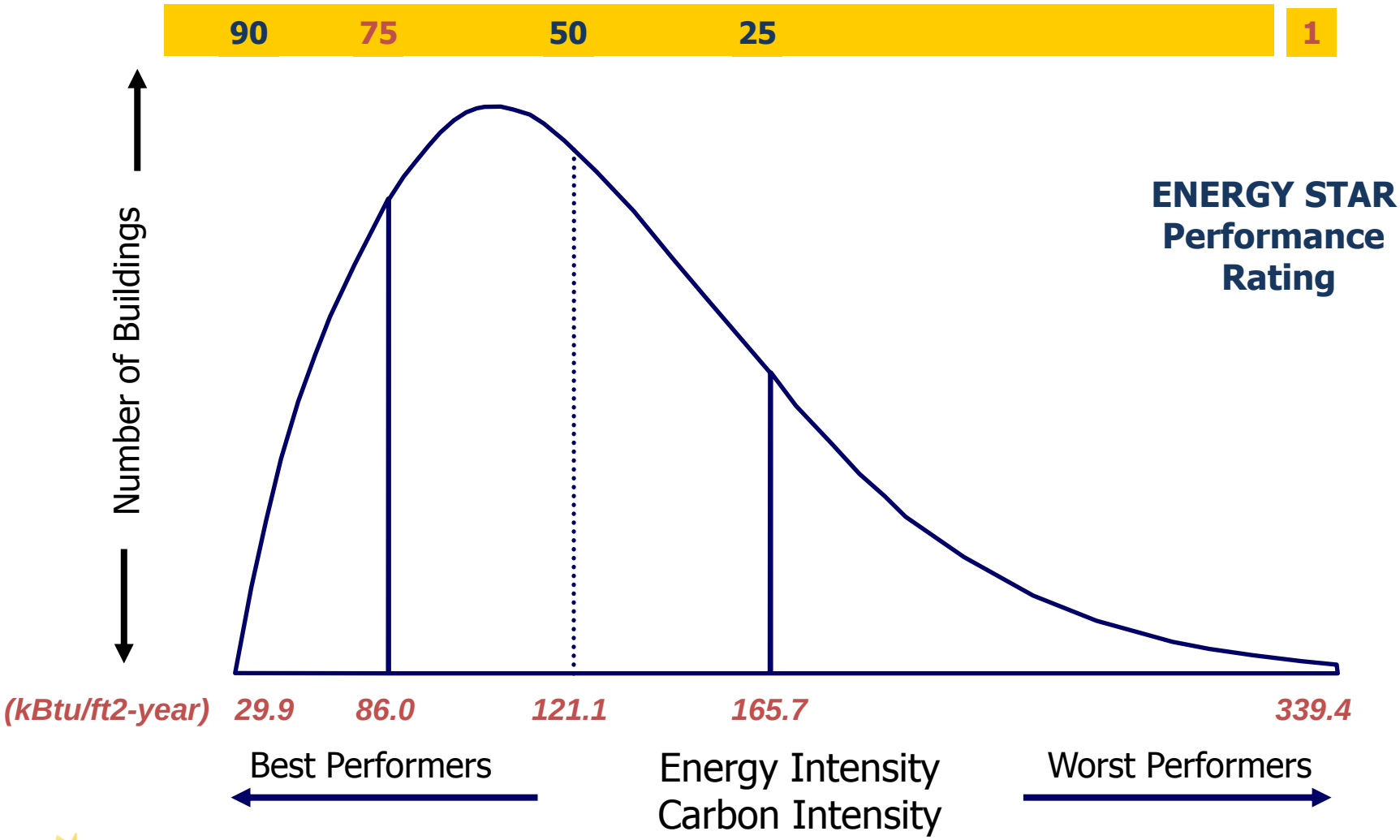
Energy Performance Gap In Existing Stock of U.S. Buildings



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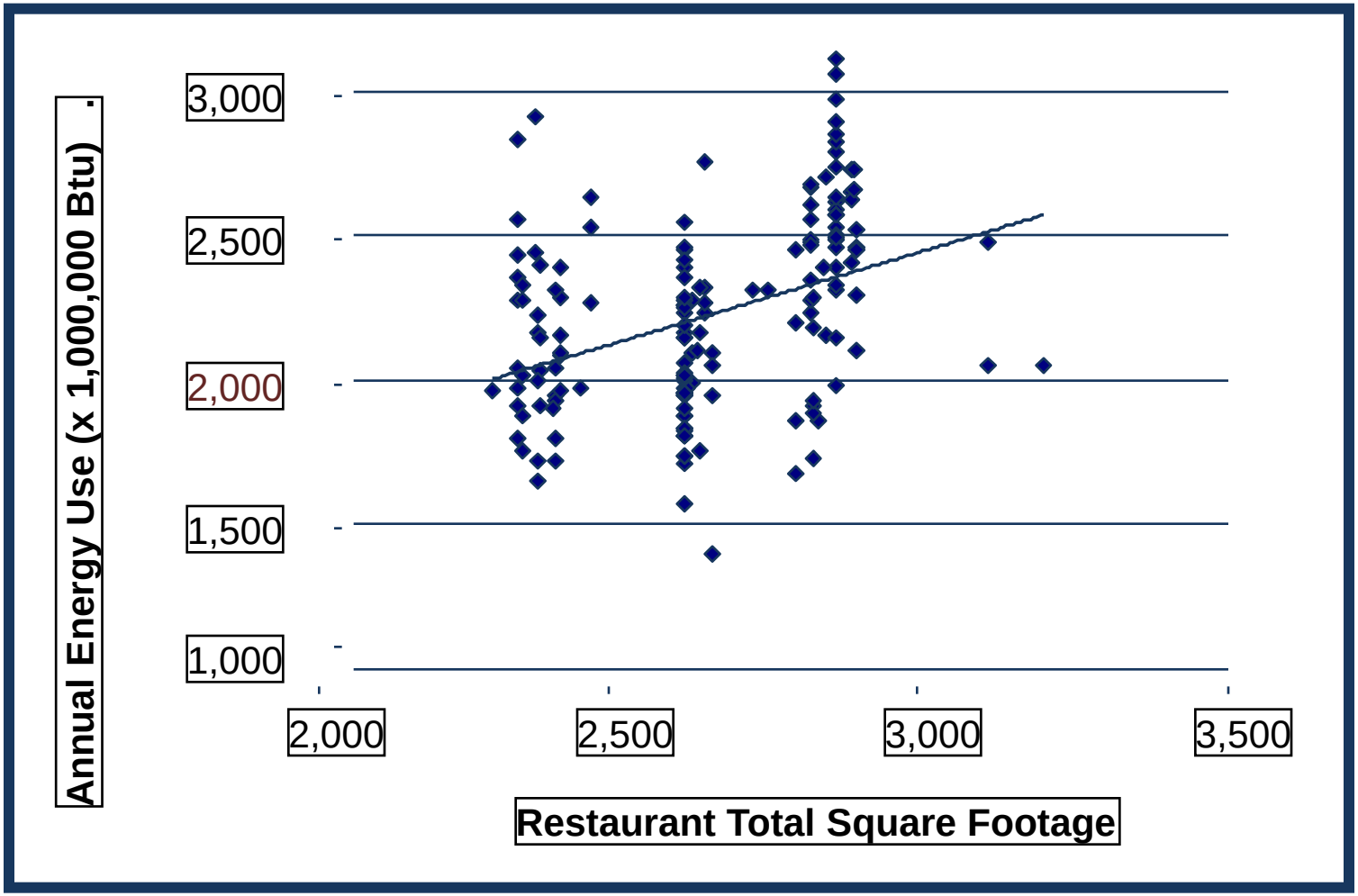
Within a Single Property Portfolio, Performance Varies Greatly



Source: Energy Star

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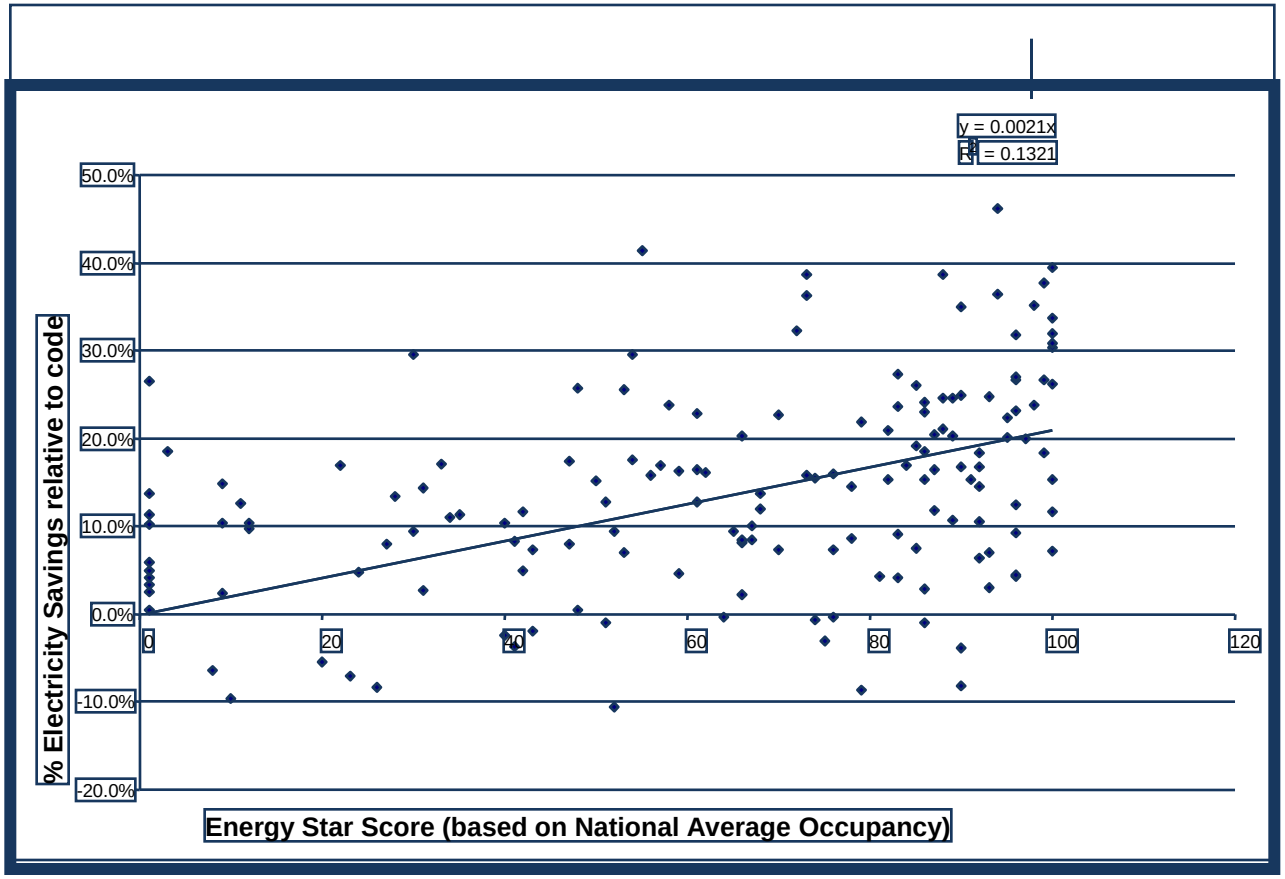
What Makes a Building Efficient?

Better than code buildings are weakly-correlated to actual performance



Source: Energy Star

Buildings designed to be 20% better than code are seen to have an energy performance rating ranging from 1-100.

"Design to exceed code" approach is not sending right market signal.

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Existing Building Commissioning (Retro-Commissioning) is the Solution

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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%
- Non-Energy Benefits
  - Improved thermal comfort, profitability, and
  - indoor air quality
  - Extended life of equipment
  - Compliance with LEED requirements
  - Qualification for rebate financing

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

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Existing Building Commissioning Phases & Key Steps

Planning Phase	Development of Existing Building Commissioning goals, facility requirements, and a commissioning plan
Investigation Phase	Field inspections, data gathering, testing and analysis to accurately assess system performance and identify improvement opportunities.
Implementation Phase	The desired facility improvements are completed and the results and performance are verified.
Turnover Phase	The systematic transition from a commissioning activity and the commissioning team to standard operating practice and the operations and maintenance team.
Persistence Phase	Implementation of systems and tools to support both the persistence benefits and continuous performance improvement over time.

Source: Building Commissioning Association – Existing Building Commissioning Best Practices

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EBCx "Best Practices" Phases & Steps

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

Investigation Phase

Evaluate Current System Performance with Owner Needs & Identify Improvements

- Documentation Review
- Site Review/Survey
- Building Occupant Interviews
- Facility Performance Analysis & Performance Baseline Establishment
- Systems Diagnostic Monitoring
- Test Development
- System Testing
- Master List of Findings
- Performance Assurance

Implementation Phase

Implement Recommended Improvements and Verify Performance

- Analyze, 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 & Begin Training Implementation
- Hold a Lessons Learned Meeting

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 Bypasses
- 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 Base 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 100,000 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

EBCx Case Study 1 - State Courthouse

Existing Building Commissioning with Comprehensive Testing

- Bring equipment to its proper operational state
- Implement only low/no cost projects
- Capital projects to be rolled into ESCO contract

COURTHOUSE

- 427,300 gsf municipal courthouse
- Constructed in 1999
- Includes 28 courtrooms, computer data center and underground parking facility

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Opportunities Identified

Low/No Cost Opportunities:

- Minor Calibrations & Repairs
- Reduce Simultaneous Heating/Cooling
- HVAC Scheduling Improvements
- Lighting Scheduling Improvements
- Some Lighting De-Lamping

Capital Opportunities (17 ECMs):

- Boiler & Hot Water System Optimization
- Chiller Plant & Cooling Tower Upgrades
- Upgrade of building lighting control system and add day lighting control
- Upgrade and Expand the building management system (BMS) & Sequence of Operation Modifications

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17 Capital Opportunities (ECMs)

Estimated Cost	$400k
Estimated Annual Savings	$395k

Simple Payback 1 Year

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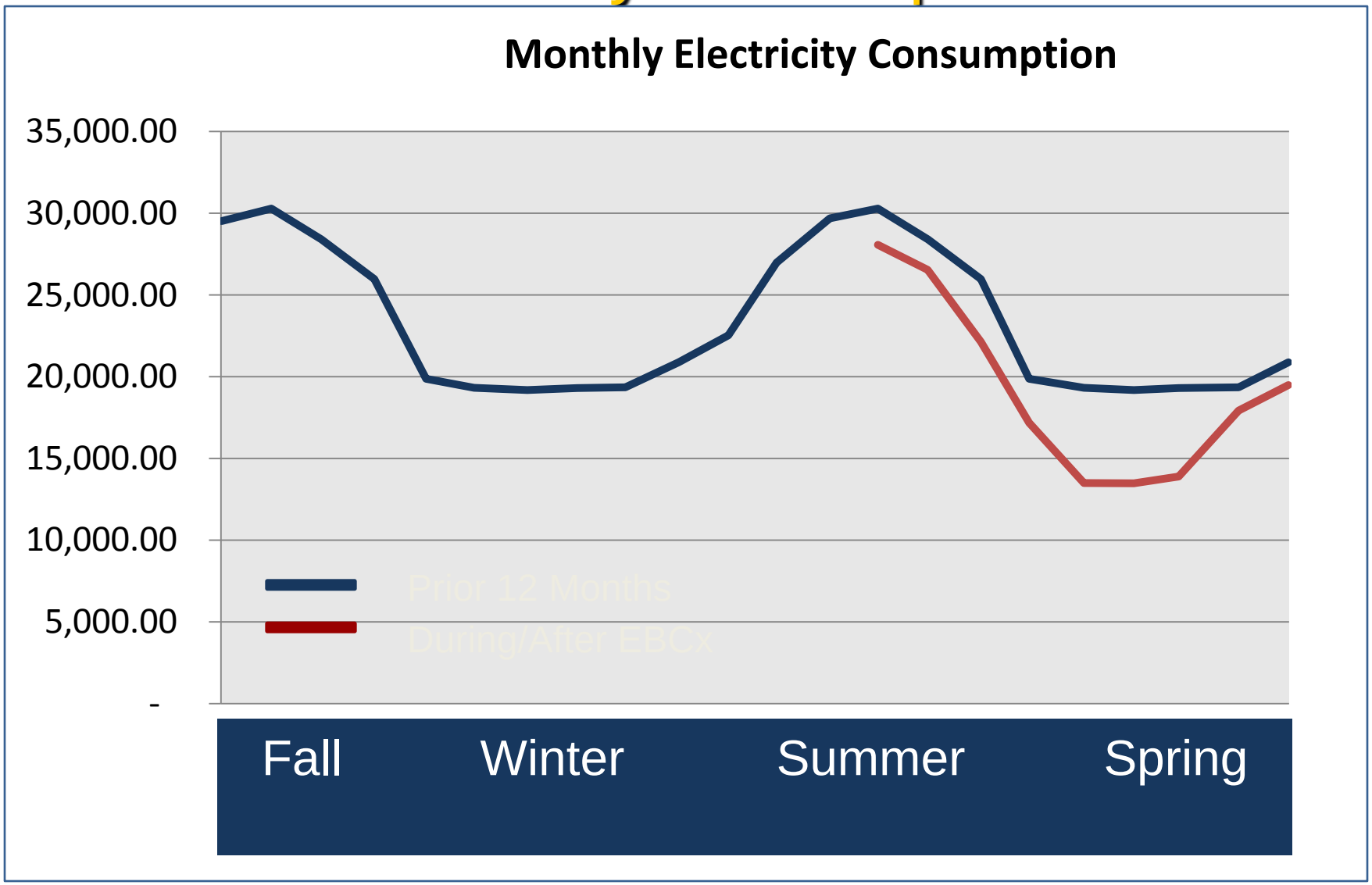
Courthouse Electricity Consumption



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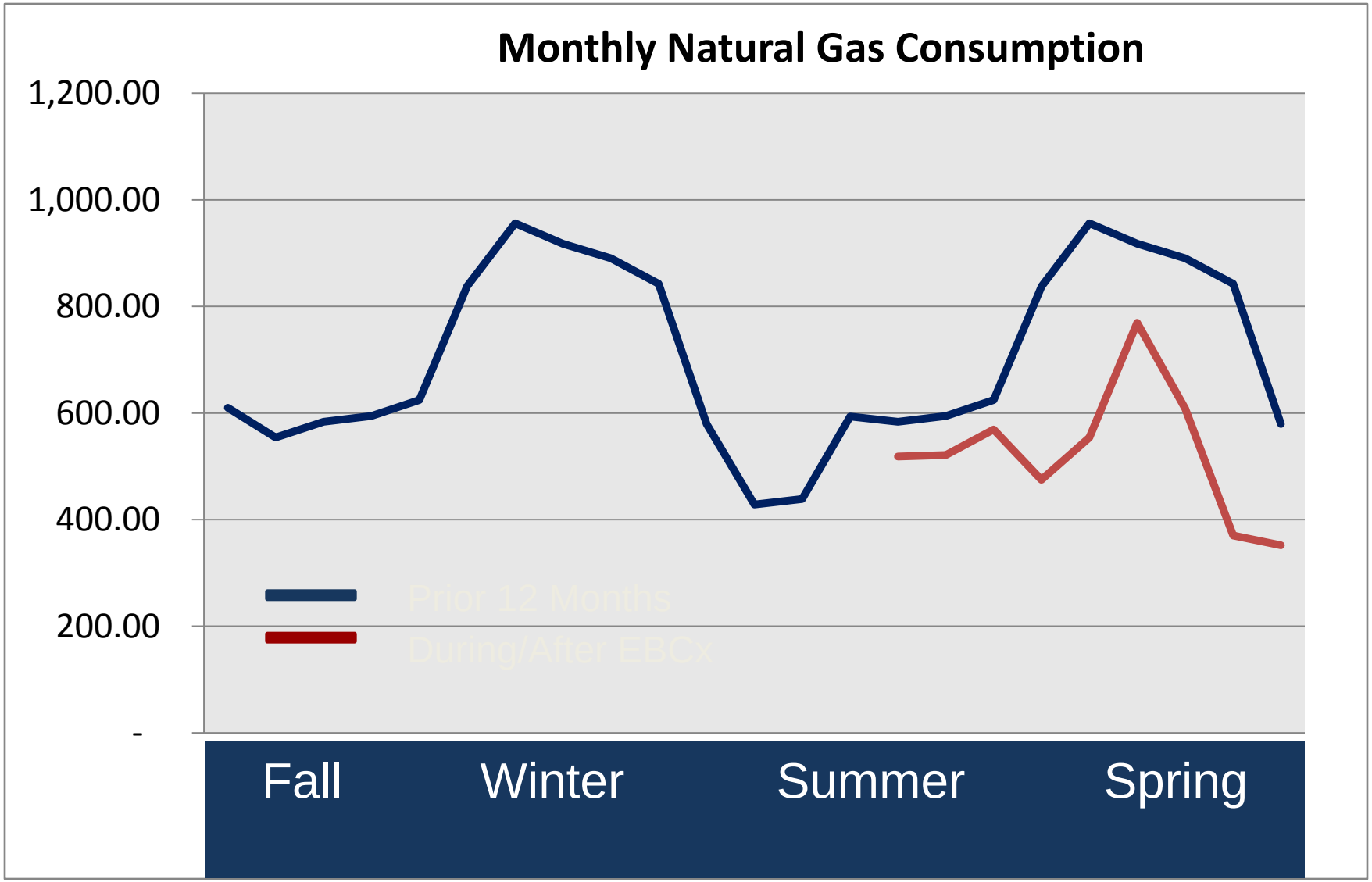
Courthouse Natural Gas Consumption



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EBCx Case Study 2 – LEED EB O&M

400,000 Square Feet

57% of waste stream recycled

854,470 pounds of carbon emissions reduced since November 2007

779,701 kWh saved YTD compared to same period in prior year

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EBCx Case Study 2 – LEED EB O&M

"Best Practices" applied to **10** LEED-OM Existing Building Credits

- WE Credit 1.1: Water Performance Measurement – Whole Building Metering
- WE Credit 1.2: Water Performance Measurement – Submetering
- EA Prerequisite 1: Energy Efficiency Best Management Practices
- EA Prerequisite 2: Minimum Energy Efficiency Performance
- EA Prerequisite 3: Refrigerant Management
- EA Credit 1: Optimize Energy Efficiency Performance
- EA Credit 2.1: Existing Building Commissioning – Investigation & Analysis
- EA Credit 2.2: Existing Building Commissioning – Implementation
- EA Credit 5: Refrigerant Management
- EA Credit 6: Emissions Reduction Reporting

ENERGY STAR Rating
Soared from 66 to 80 in 12 months

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EBCx Case Study 2 – LEED EB O&M

Sample ECM's

Expand metering throughout BAS

Change static pressure setpoint on AHU's

Install VFD's on chiller compressors

Link chiller BTU metering to BAS

Update software/hardware for web-based BAS monitoring

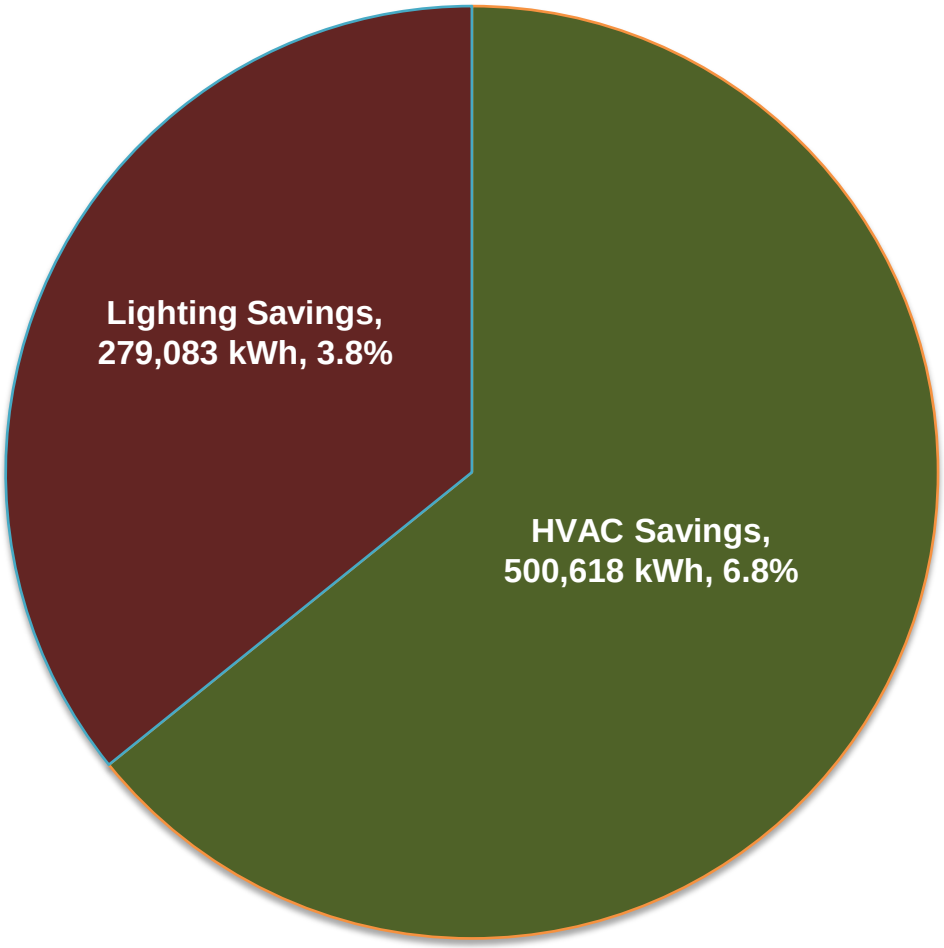
Repair/calibrate thermostats throughout the building

VFD's for condenser water pumping system

Conduct heat recovery system repair

Adjust VAV setpoints

Implement employee/tenant energy education program



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EBCx Case Study 3 – Portfolio Financial Services

ENERGY & FINANCIAL ANALYSIS

Site	Number of Projects	Annual Energy Savings (KWH)	Demand Savings (KW)	Implementation Cost	Annual Energy Savings	Potential Utility RCx Incentive	Simple Payback Without Incentive
Commercial Bldg 1	40	5,865,630	268	$1,682,604	$1,329,387	$221,264	1.3
Commercial Bldg 2	40	2,720,159	410	$749,308	$764,811	$118,500	1.0
Commercial Bldg 3	50	2,916,300	300	$506,890	$463,328	$18,323	1.1
Commercial Bldg 4	29	1,016,022	131	$500,621	$227,614	TBD	2.2
Totals	**159**	**9,918,111**	**1,109**	**$3,439,423**	**$2,785,140**	**$358,087**	**1.2**

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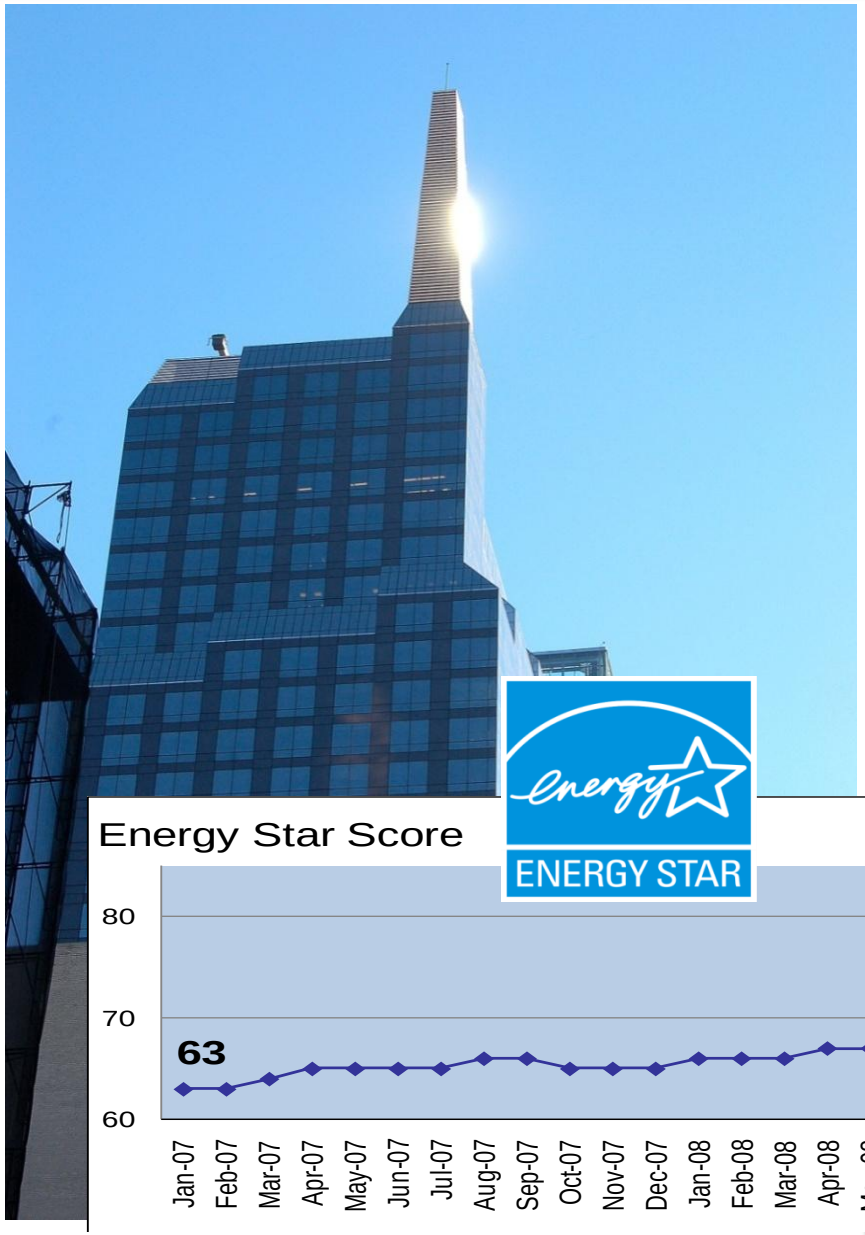


High Rise Office, NYC Landlord and Major Tenant

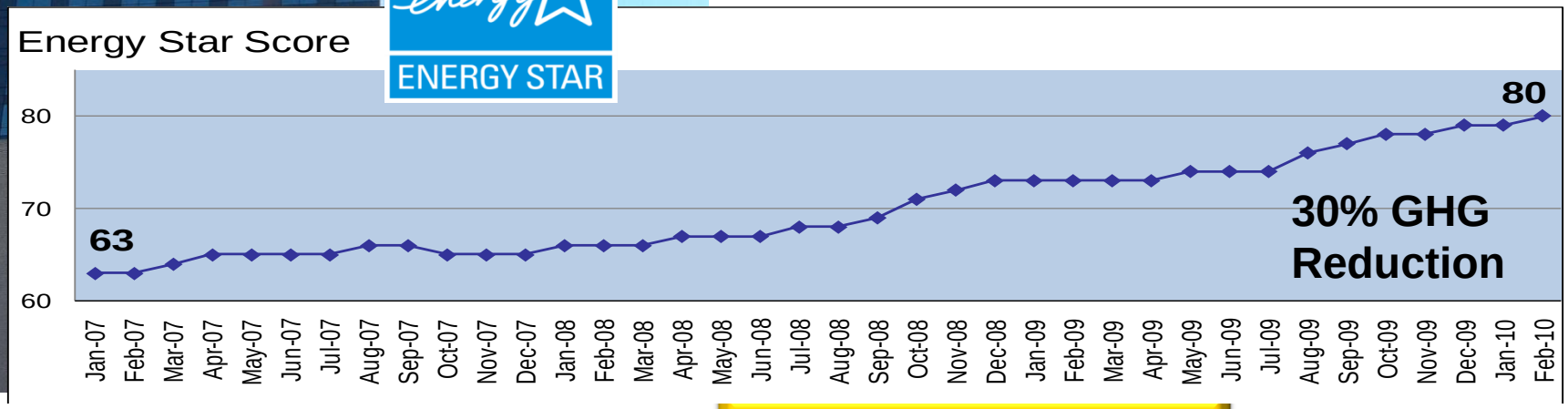
Utility Funded RCx

\+ More than 50

Energy Conservation
Measures Identified & 38 implemented

= Savings of nearly

3,000,000 kWh per year



Payback less than 2 years

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EBCx Programs, Incentives & Legislation

http://www.dsireusa.org/

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Industry Resources & Guidelines

Guides & Standards

- BCA's Best Practice for Commissioning Existing Buildings

  http://www.bcxa.org/

- LEED for Existing Buildings High Performance Operations
- ASHRAE GPC 1.2 "The Commissioning Process for Existing HVAC & R Systems"
- "An RCx Guide for Building Owners" - EPA Energy Star
- "California Commissioning Guide: Existing Buildings" - CA CX

BCxA™ Building Commissioning Association

ASHRAE Commissioning Guidelines

ASHRAE Guideline 0-2005: The Commissioning Process

(To be used as the foundation of ASHRAE Guideline 1 and the NIBS Total Building Commissioning Process technical guidelines)

ASHRAE Guideline 0.2P
Existing Building Commissioning

ASHRAE Guideline 1.2P
Existing Building Commissioning

Others

Guideline 1 – ASHRAE, HVAC&R System
Guideline 2 – ASCE, Structural Systems
Guideline 3 – BETEC, Exterior Envelope Systems
Guideline 4 – NRCA, Roofing Systems
Guideline 5 – AWCI, Interior Systems
Guideline 6 – NEII, Elevator Systems
Guideline 7 – ASPE, Plumbing Systems
Guideline 8 – IES, Lighting Systems
Guideline 9 – IEEE, Electrical Systems
Guideline 10 – NFPA, Fire Protection Systems
Guideline 11 – TIA, Telecommunications Systems

ASHRAE Guideline 1.1-2007
HVAC&R Technical Requirements for The Commissioning Process

ASHRAE/NIBS Guidelines 3-2006
Technical commissioning guidelines dealing with lighting, fire, interiors, envelopes, plumbing, etc.

Others

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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
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