U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Deep Energy Retrofits & State Applications

June 20th, 2013

DOE's State and Local Technical Assistance Program

DOE's Technical Assistance Program

Priority Areas

- Strategic Energy Planning
- Program & Policy Design and Implementation
- Financing Strategies
- Data Management and EM&V
- **EE & RE Technologies**

Resources

- General Education (e.g., fact sheets, 101s)
- **Case Studies**
- Tools for Decision-Making
- Protocols (e.g., how-to guides, model documents)

Peer Exchange & Trainings

- **Webinars**
- Conferences & in-person trainings
- Better Buildings Project Teams

One-on-One

- Level of effort will vary
- In-depth efforts will be focused on:
  - *High impact efforts*
  - *Opportunities for replicability*
  - *Filling gaps in the technical assistance marketplace*

Priority Area: EE & RE Technologies

- **Peer exchange & trainings**
  - *Past retrofit-related webinars* on the Federal Energy Management Program (FEMP) website: www.eere.energy.gov/femp/training/first_thursday_seminars.cfm
  - *Upcoming webinars* focused on technical topics and their state-specific applications – next session on CHP, Thursday, July 18th
- **Resources**
  - Buildings Technology Office and FEMP websites, including *Advanced Energy Retrofit Guides:* www.eere.energy.gov/buildings/commercial/aerg.html
  - Improved *Solution Center* portal for technology deployment resources live later this year
- Apply for **one-on-one assistance** and **peer matching**

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

How to Tap into These and Other TAP Offerings

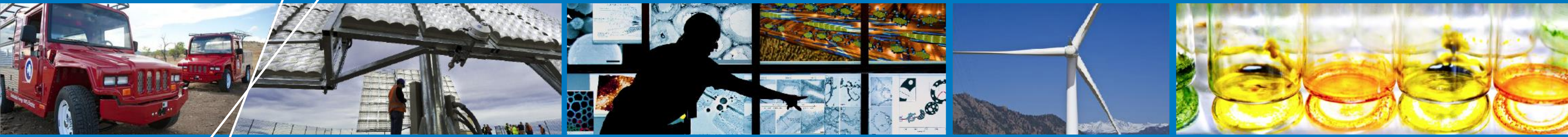
- Visit the ***Solution Center***
  www.eere.energy.gov/wip/solutioncenter/

- Submit an ***application*** for assistance
  www.eere.energy.gov/wip/solutioncenter/technical_assistance.html

- Sign up for ***TAP Alerts***, the TAP mailing list, for updates on our latest and greatest
  TechnicalAssistanceProgram@ee.doe.gov

NATIONAL RENEWABLE ENERGY LABORATORY

DOE TAP Webinar:
Deep Retrofits



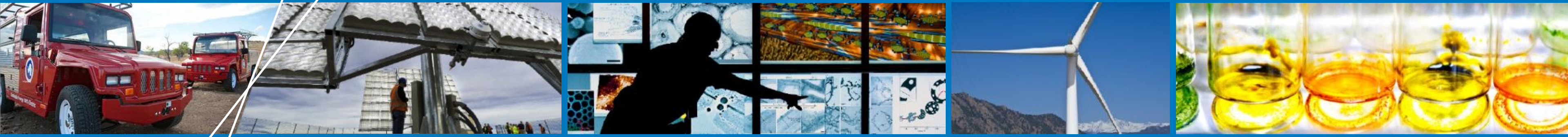
Matt Leach, National Renewable Energy Laboratory

Eric Friedman, Commonwealth of Massachusetts

6/20/13

Outline

- Definitions and Overview
- Process
- Economics
- Integrated Design
- Building Operation
- Case Studies



Deep Retrofit

Definitions and Overview

Definitions and Overview

- **What is a deep retrofit?**
  - Larger energy savings and improved economics through a holistic, integrated approach that leverages special opportunities in a building's lifecycle

- **Process differentiators**
  - Essential differentiators:
    - Prioritization of efficiency from the outset (goal setting)
    - Increased design team interaction
    - Integrated design
    - Improved economics (based on incremental rather than full costs)
  - Best practice differentiators:
    - Advanced auditing, energy modeling, and economic analysis
    - Verification of performance, ongoing Measurement and Verification (M&V)
    - Occupant education and engagement
    - Wider range of efficiency options

Advanced Energy Retrofit Guides

- **Purpose:** to provide energy managers with guidance for planning and executing successful commercial retrofits
- Five Advanced Energy Retrofit Guides (AERGs) completed or in development by NREL and PNNL
  - Grocery
  - Healthcare (in development)
  - K-12 Schools
  - Office
  - Retail

Retrofit Categorization

Advanced Energy Retrofit Guide (AERG) Approach

Retrocommisioning

Pros:
- Energy savings > 15%
- Quick payback
- Savings can be used to fund larger retrofit projects

Cons:
- Only takes advantage of most obvious savings opportunities
- Savings may be negated by equipment replacement as part of more comprehensive retrofit

Energy Retrofit

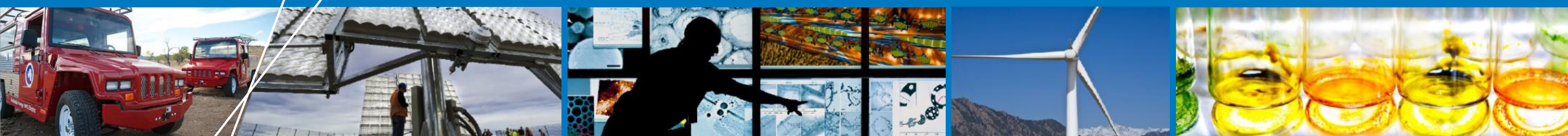
Pros:
- Energy savings > 30%
- Can leverage Energy Service Companies (ESCOs)
- Portfolio-wide implementation

Cons:
- Higher first costs
- Envelope measures not viable

Deep Retrofit

Pros:
- Energy savings > 50%
- Right-timed with other capital improvements
- Path to net zero
- Integrated design solutions – passive and mechanical

Cons:
- Highest first costs
- May require longer time horizon



Deep Retrofit Process

Considerations for Project Selection

Top indicators for deep retrofit opportunity:

1. Planned capital improvement
2. Major system replacement
3. Major envelope project
4. Code upgrades
5. New owner/refinancing
6. New use/occupancy type
7. Building "greening"
8. Large utility incentives/high energy costs
9. Noticeably poor energy performance
10. Portfolio prototype update

Barriers to Deep Retrofits

- **Lack of policy**
  - Lack of motivation to invest time and capital required for a deep retrofit
- **Lack of integrated design tools**
  - Tools that facilitate individual strategy evaluation exist
  - Tools that streamline the identification of integrated design packages are lacking
- **Analysis uncertainty**
  - Technical and economic performance uncertainty create real and perceived risk
  - Cost of efficiency can be difficult to isolate and track
  - Risk mitigation favors low-risk, low-reward retrofit packages
- **Complicated financing**
  - Deep retrofit projects can require coordination between multiple funding mechanisms (capital budget, ESCOs, etc.)

Deep Retrofit Project Team

- **Team assembly**
  - Engaged owner/building manager
  - Designers and engineers that understand the benefits of strategy integration
  - Maintenance and facility personnel who are invested in the energy performance of the building
- **Team responsibilities**
  - Gather all relevant building data
  - Specify project performance goal
  - Plan early and often to keep stakeholders engaged and promote interdisciplinary communication

Setting Performance Targets

- **Importance of having a clear goal**
  - Holistic, integrated approach to a deep retrofit is facilitated by setting a clear performance goal at the outset
- **Target specification**
  - Percent savings versus energy use intensity (EUI)
  - ASHRAE Standard 100 – Energy Efficiency in Existing Buildings
    - Targets based on top performing facilities (25^{th} percentile)
    - EUI targets for 48 building types in 16 climate zones

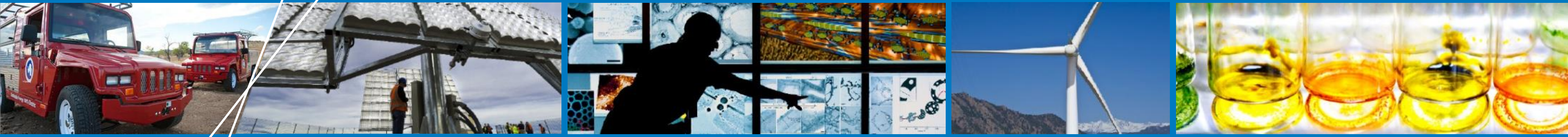
Retrofit Process Comparison

Typical Retrofit

1. **Identify the need for a building or equipment upgrade**
   - Equipment failure is a common motivator
2. **Get bids from individual contractors**
   - Each bid is component- or system-specific
   - For example, an HVAC contractors bids on a boiler upgrade
3. **Select upgrades according to capital cost requirements**
   - Strategies with high energy savings but high first costs are likely to be eliminated
4. **Implement selected retrofit package**
   - Project ends at occupancy

Deep Retrofit

1. **Assemble qualified project team**
   - Emphasize the importance of an integrated, whole-building approach
2. **Set project performance goal**
3. **Develop integrated design strategies**
4. **Evaluate design packages using energy modeling and economic analysis**
   - Such as lifecycle cost-based efficiency optimization
5. **Implement selected retrofit package**
6. **Educate occupants and operators**
7. **Ongoing system commissioning and occupant engagement adaptation**
   - Project continues into occupancy to ensure that performance goals are met

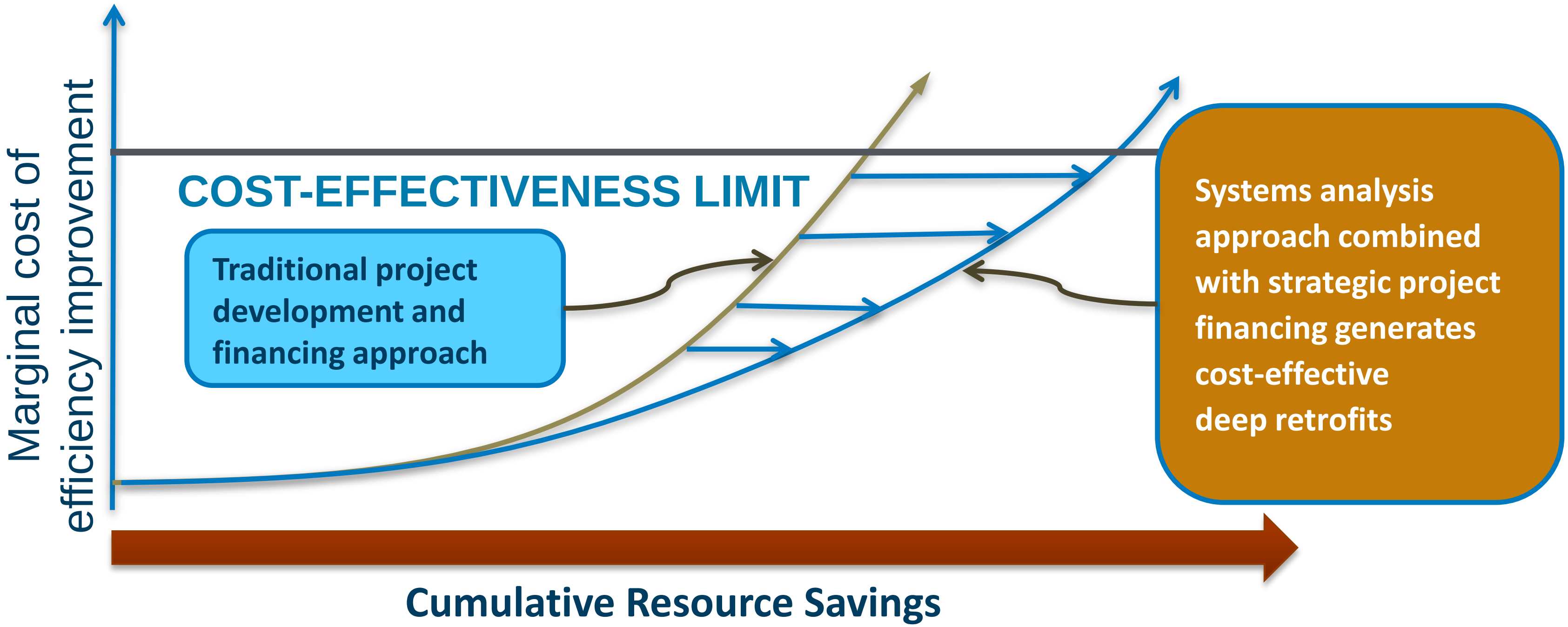


Deep Retrofit Economics

Factors for Economic Success

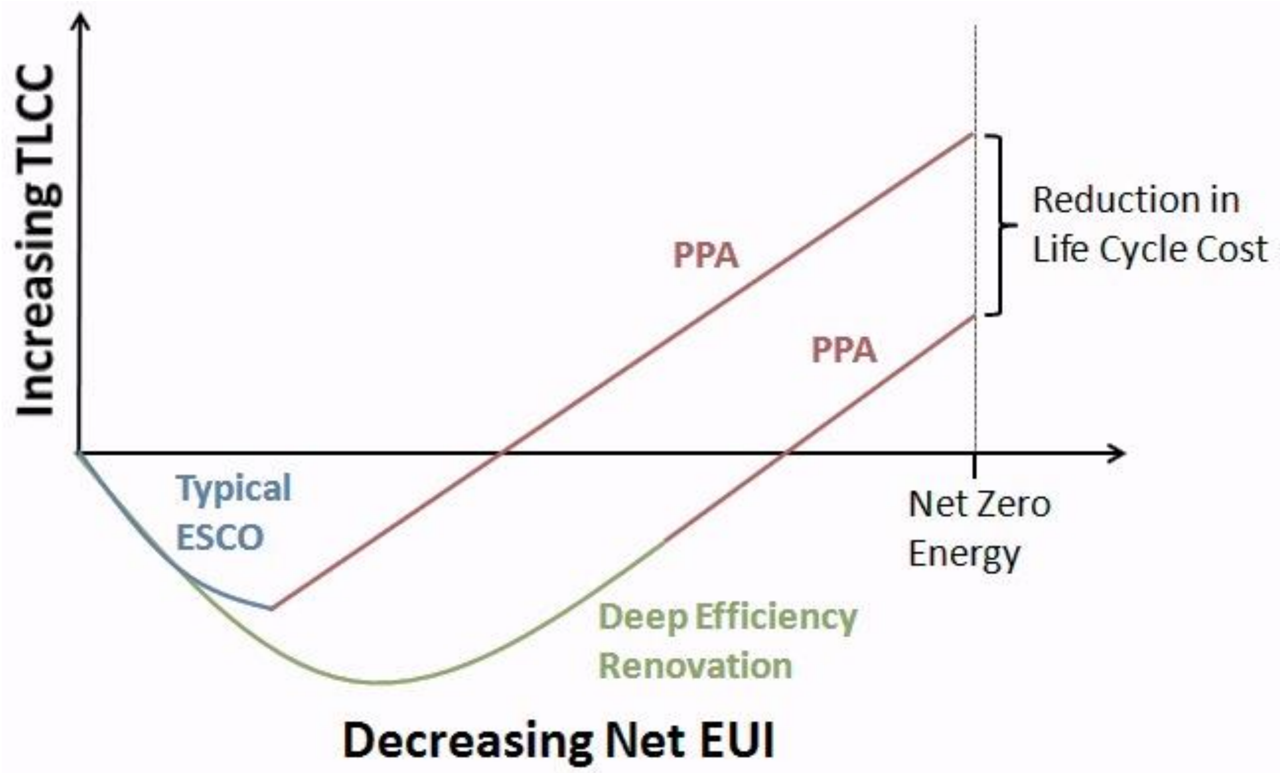
- **Facility**
  - Older facilities with pending, budgeted equipment replacements are good candidates
- **Energy costs**
  - Higher energy costs result in better return on investment
- **Mentality**
  - Owner and staff must be motivated to achieve larger than typical reductions in facility energy use (environmental benefits, Federal mandates, agency/corporate goals, etc.)
- **Finance strategy**
  - High first costs may require coordinated financing (capital budget, ESCOs, incentives, reallocation of utility costs)

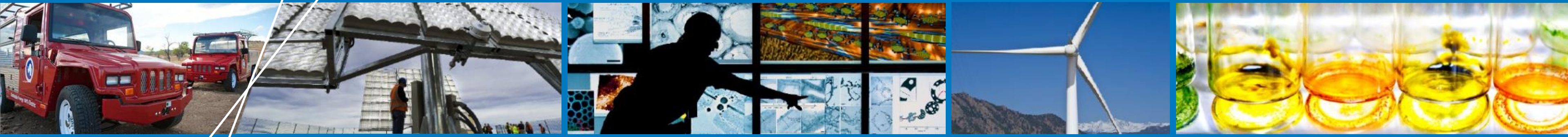
Cost Benefits of Integrated, Holistic Approach



Lifecycle Cost Implications of Deep Retrofits

- **Deep retrofit strategies reduce EUI more cost-effectively than a renewable power purchase agreement (PPA); resulting in a lower total lifecycle cost (TLCC)**
- **Reducing scope of PPA reduces amortized cost of achieving net zero energy**





Deep Retrofit
Integrated Design

Deep Retrofit Constraints

- **The deep retrofit design approach is similar to that for high performance new construction. However, deep retrofits often have constraints that new construction projects do not:**
  - Costs associated with replacement
    - New construction design tradeoffs are based on incremental costs
    - Retrofit analyses must consider useful life, disposal costs, replacement costs, etc.
  - Fixed building footprint limits strategies that depend on building shape and orientation
  - Envelope improvements may be cost-prohibitive
    - Exterior wall and roof constructions are difficult to replace
  - Retrofit strategies need to be compatible with the existing building

Strategies for Deep Retrofits

- **Strategies must account for project constraints**
  - Strategies need to be evaluated within the context of the specific retrofit project
  - Prescriptive strategies are not appropriate
- **Simple, passive strategies increase likelihood of project success**
  - Require limited facility manager or occupant intervention
  - Minimize long term maintenance requirements
  - Don’t rely on complicated controls
  - Example: electrochromic windows eliminate the need for operable shades and mitigate building orientation limitations

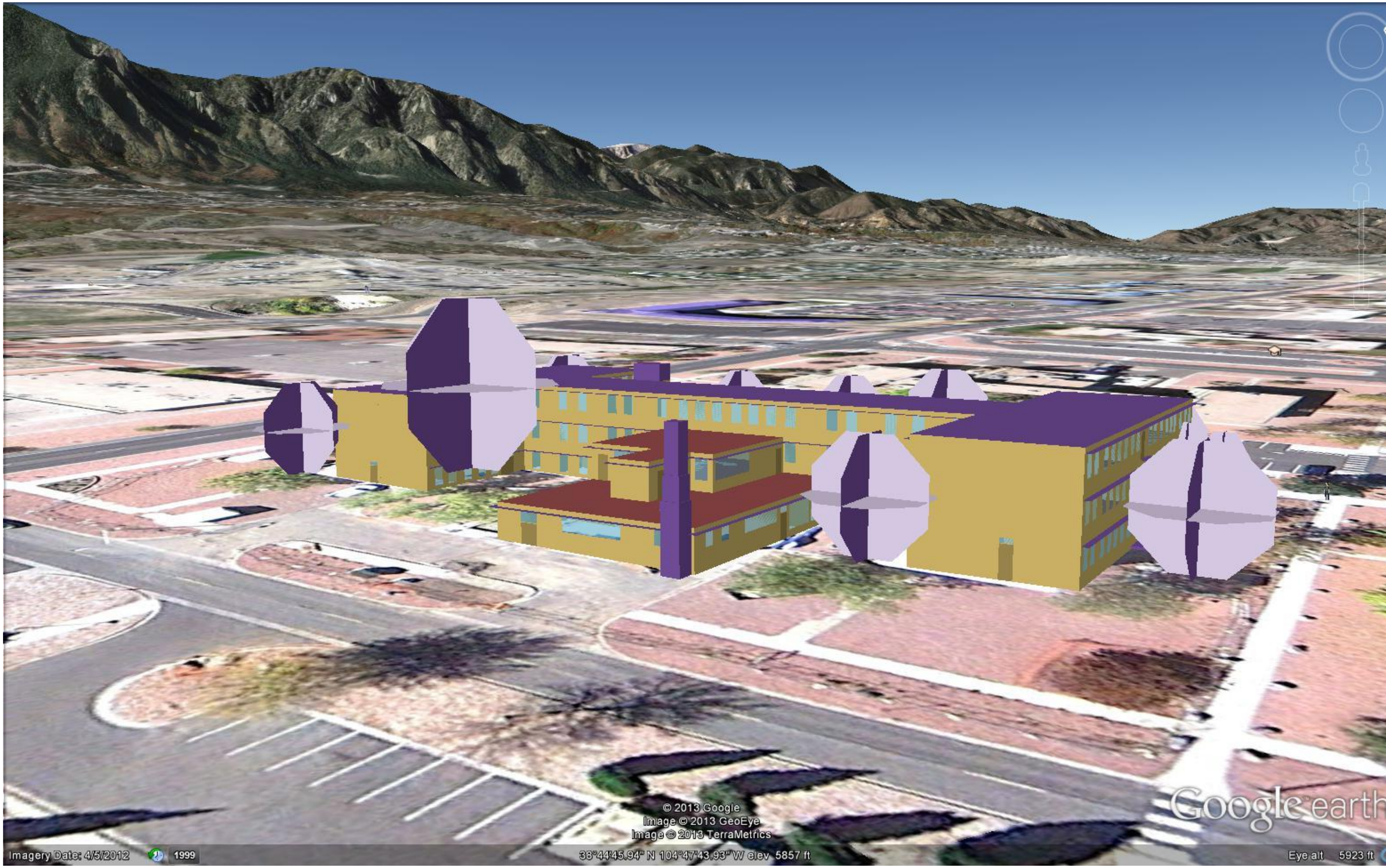
Role of Energy Modeling

- **Inform target-setting process**
  - Establish or evaluate potential energy performance targets, which are essential to a successful deep retrofit project workflow
- **Identify integrated design strategies**
  - Capture interactions between existing building systems/features and potential efficiency strategies
  - Recognize and exploit synergies between systems
- **Ensure economic requirements are met**
  - Evaluate lifecycle cost implications of design packages
  - Optimize design packages according to project-specific economic criteria

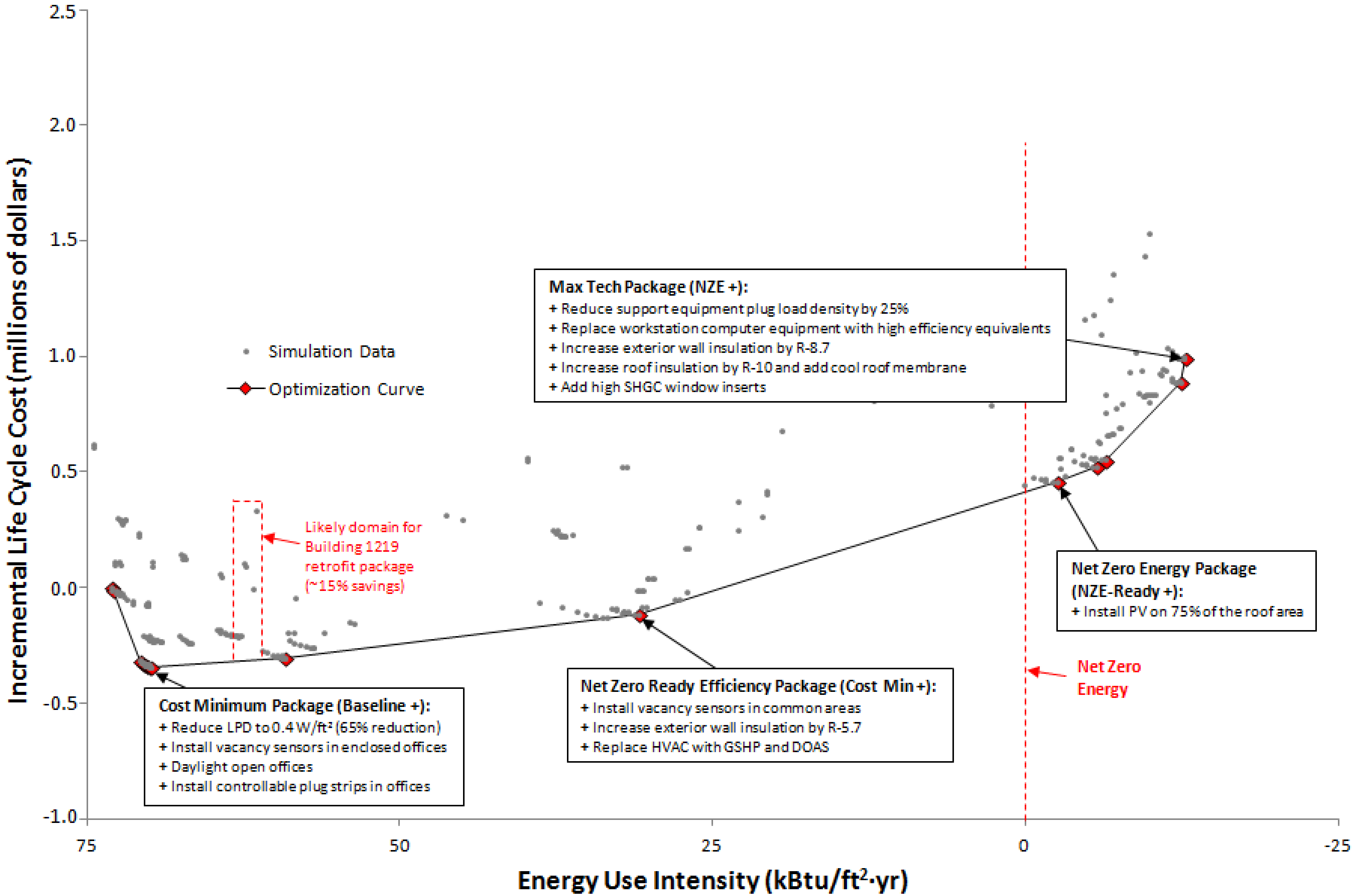
Fort Carson Net Zero Retrofit Optimization

- **Evaluate retrofit opportunities for a real building**
- **Assemble a list of candidate efficiency measures**
  - Defined in accordance with project constraints
  - Emphasizing simple, passive strategies likely to be compatible with the existing building
- **Build whole-building energy simulation framework with OpenStudio tool suite**
- **Optimize on lifecycle cost and energy use**
  - Identify design packages (efficiency strategies and renewable generation) that minimize lifecycle cost at each level of energy performance
  - Incorporate relevant economic criteria (analysis period, discount rate, utility tariffs)

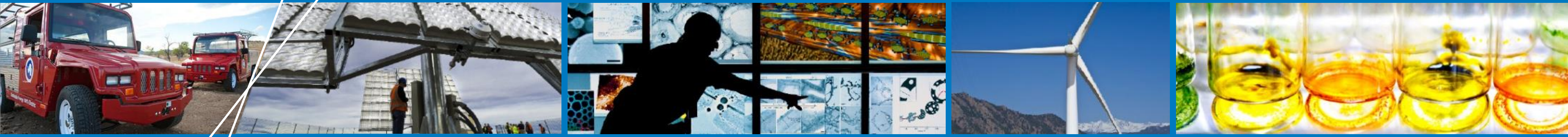
Ft Carson Net Zero Retrofit Optimization



Ft Carson Net Zero Retrofit Optimization



NREL
NATIONAL RENEWABLE ENERGY LABORATORY



Deep Retrofit

Building Operation

Performance Verification

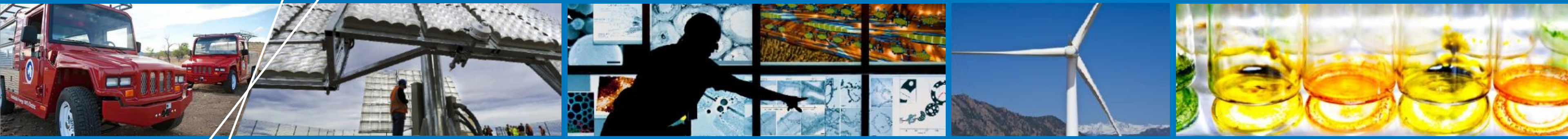
- **The project does not end after construction is complete**
  - Ongoing commissioning, operations and maintenance (O&M) and M&V are critical to ensuring long-term achievement of energy performance goals
  - Simple, passive retrofit strategies can reduce the complexity and cost of these efforts
- **Ongoing commissioning**
  - Typically very cost effective
  - Improves system performance and reduces the need for O&M
- **O&M**
  - Staff engagement is key. Maintenance efforts should be tied to energy performance goals
- **M&V**
  - Helps to identify opportunities to improve system performance through ongoing commissioning or updated O&M practices

Occupant Engagement

- **Education is Key**
  - Occupants need to be made aware of the changes that have been made to the building
  - Understanding the energy impact of occupant interaction can encourage responsible behavior
  - Where occupant engagement is required, protocol should be simple and clear
- **Behavior mitigation**
  - Design systems to minimize potential negative impacts of occupant behavior (prioritize simple, passive solutions)
  - Example: combining radiant space conditioning with manually operable natural ventilation

Key Resources

- **FEMP seminar – Implementing deep retrofits: a whole building approach**
  - Training session to foster competency in developing integrated, holistic retrofit solutions
  - http://apps1.eere.energy.gov/femp/training/course_detail_live.cfm/CourseDateId=387
- **AERGs**
  - Provide energy managers with guidance for planning and executing successful commercial retrofits
  - http://www1.eere.energy.gov/buildings/commercial/aerg.html
- **RMI/JCI net zero retrofit paper**
  - Defines eight steps along a holistic path to achieving net zero energy in an existing building
  - http://www.institutebe.com/InstituteBE/media/Library/Resources/Green%20Buildings/Reinventing-Existing-Buildings-8-Steps-to-Net-Zero-Energy_JCI-RMI.pdf



Thank you!

Creating A Cleaner Energy Future For the Commonwealth

DEEP ENERGY RETROFITS – LEARNING FROM EXPERIENCE:

THE MASSACHUSETTS STORY

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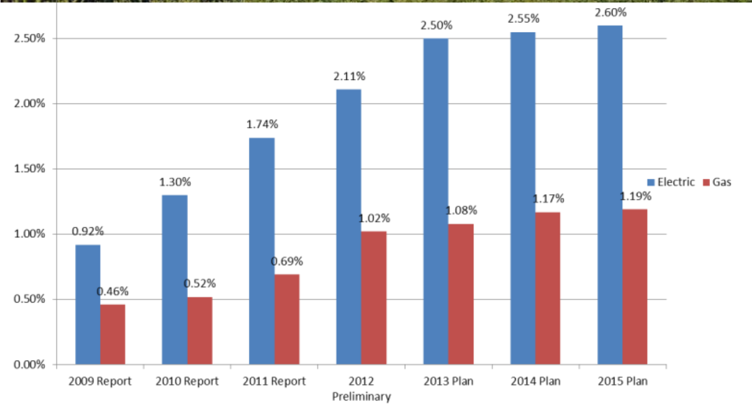
U.S. Department of Energy (DOE) Webinar
Deep Energy Retrofits and State Applications
June 20, 2013

DOER Mission

Creating a Cleaner Energy Future for the Commonwealth

- Develops and implements policies and programs aimed at ensuring the adequacy, security, diversity, and cost-effectiveness of the Commonwealth's energy supply while creating a cleaner energy future. DOER strives to:
  - Ensure deployment of all cost-effective **energy efficiency**
  - Maximize development of **clean energy resources**
  - Create and implement energy strategies to assure **reliable supplies** and **improve the cost** of clean energy relative to fossil-fuel based generation
  - Support Massachusetts' **clean energy companies** and spur Massachusetts' clean energy employment



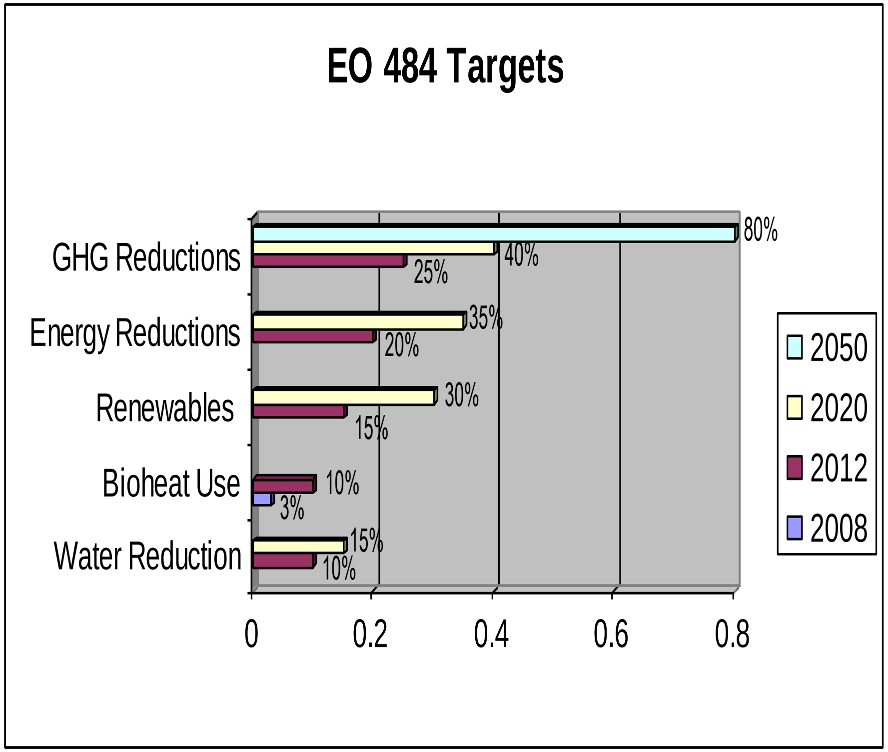
Discussion

1. Massachusetts building efficiency programs
   - Leading by Example (LBE)
   - American Recovery & Reinvestment Act (ARRA)
2. ARRA-funded case studies
   - Castle Square Tenant Organization
   - Center for Ecological Technology
   - United Teen Equality Center
   - Architectural Heritage Foundation
3. Leading by Example profiles
   - Developmental Services Hogan Wrentham
   - Department of Correction
4. Real-time metering and operations
5. Lessons learned

Leading by Example

Executive Order No. 484 for state government operations issued 2007

- 25% GHG reduction by 2012, 40% by 2020
- 20% Energy reduction by 2012, 35% by 2020
- 15% reliance on renewables by 2012, 30% by 2020



Creating A Cleaner Energy Future For the Commonwealth

Massachusetts Department of Energy Resources

Capital Improvements-ARRA Funds

Large Comprehensive

- Fund 18 employees, to oversee clean energy projects
- Leveraged **$120 million**
- Efforts at **22.4 million square feet/500 buildings**

- $50 million project @ UMass Dartmouth
- Natural gas Combined Heat & Power
- 600kW Wind Turbine
- 269kW Solar

Smaller Projects

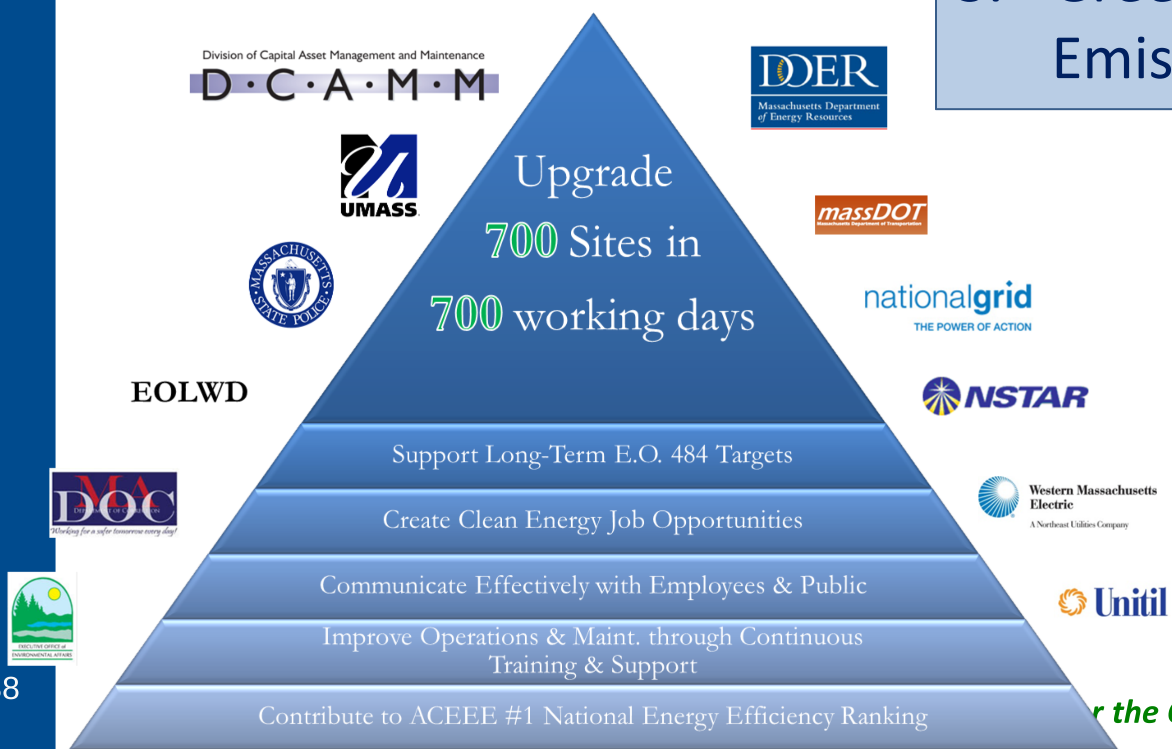
- 65 quick fix projects
- Indoor & outdoor lighting
- Utilities 43% in incentives
- 2.6 year simple payback
- $658,000 Annual savings

Accelerated Energy Program

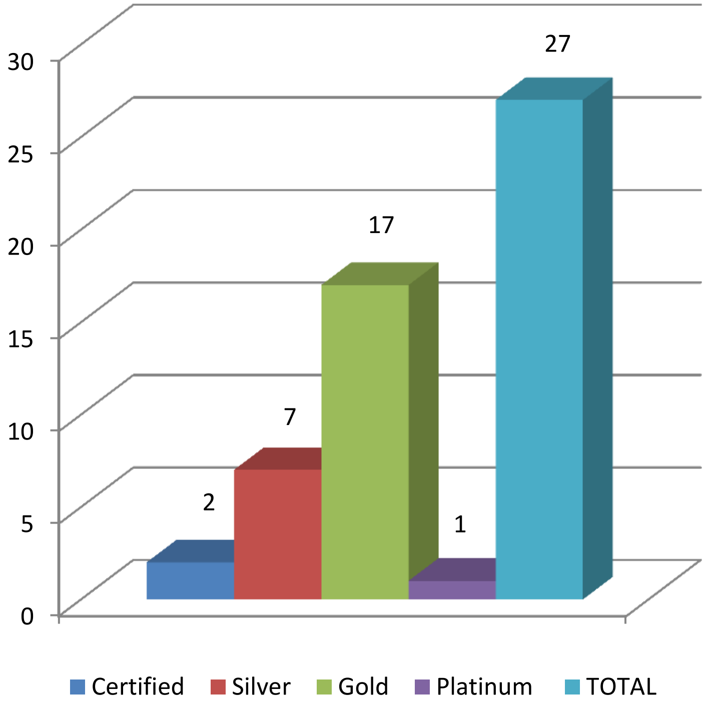
2012-2014 interagency effort to retrofit 700 sites/4,000 buildings

Portfolio-Wide Target of 25% reduction in 2 out of 3:

1. Energy Use
2. Energy Cost
3. Greenhouse Gas Emissions



New Construction



Mass. LEED Certified State Buildings 2006-2013

Zero Net Energy Buildings

1. **57,000 Sq. Ft. College Bldg**
2. **45,000 Sq. Ft. Fish & Game HQ**

- solar PV
- 60 percent energy reduction
- high-performance envelope
- geothermal
- radiant ceilings
- heat recovery ventilation

American Recovery and Reinvestment Act Summary

- ARRA passed and signed into law February of 2009
- DOER got $70 Million from the U.S. DOE
- $54.9 million for State Energy Program
- Projects all ended August 31, 2012

- Job Creation
- Economic Development
- Energy and Cost Reduction
- Greenhouse Gas Reduction
- New Technologies, Replicable & Scalable Projects
- Shovel-Ready
- Leverage Maximum Amount of Other Funding

SOLAR - $14.4m

- 9.5 MW installed
- Leveraged over $38 million

LEADING BY EXAMPLE - $16.2m

- Real-time energy management
- DCAM staff for energy projects
- Low-E Ceilings at state ice rinks
- Utility Incentives

HIGH PERFORMANCE BLDGS-$19.5m

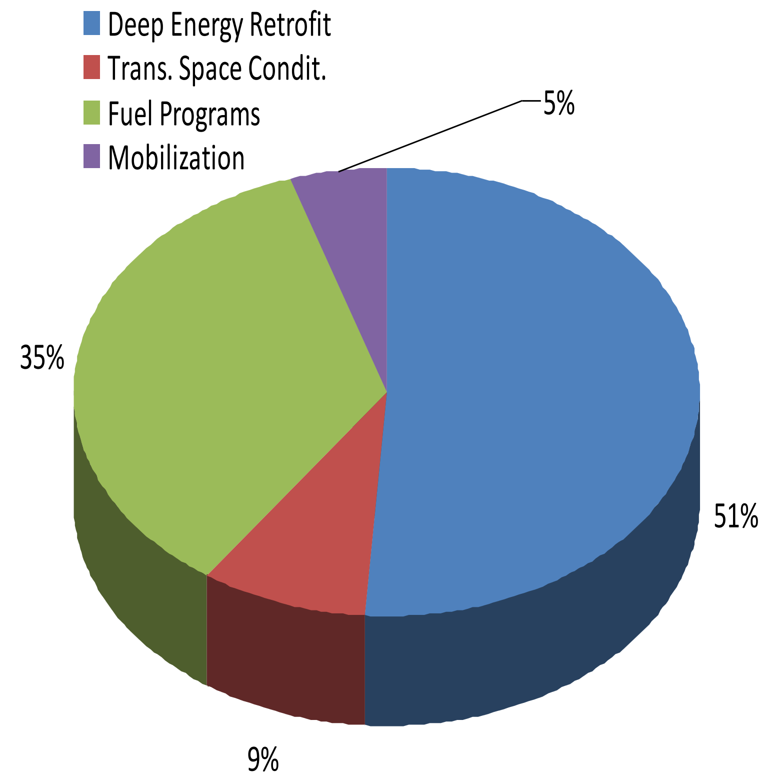
- Deep Energy Retrofits
- Transformative Technology
- Oil Heat Efficiency
- Community Mobilization
- Western Mass. Rebuild Prog

High Performance Building Overview: Goals

- Achieve scalable and dramatic improvements to energy performance in existing buildings.
- Provide demonstrations for Governor Patrick's Zero Net Energy Building Challenge.
- Recognize new technologies and market opportunities in the building conditioning tech.
- Encourage wider participation in MassSAVE (state energy efficiency program)

Funding Opportunities:

1. Deep Energy Retrofits: Reduce an existing building's energy consumption by 50% using comprehensive building modifications
2. High-Impact Fuel Program: Reduce energy use in buildings heated with fuel oil, propane, or other unregulated fuels.
3. Transformative Space Conditioning: Demonstrate effective use of new technology that leads to greater energy efficiency. Technology commercially viable.
4. Community Mobilization: Dramatically increase customer participation in existing statewide efficiency programs.



HPB Deep Energy Retrofit Approaches

- Historic buildings
- Passive strategies
- Exterior and/or interior envelope work
- Large comprehensive
- Various building types
  - Warehouse
  - Multi-family
  - Religious/community center
  - Historic

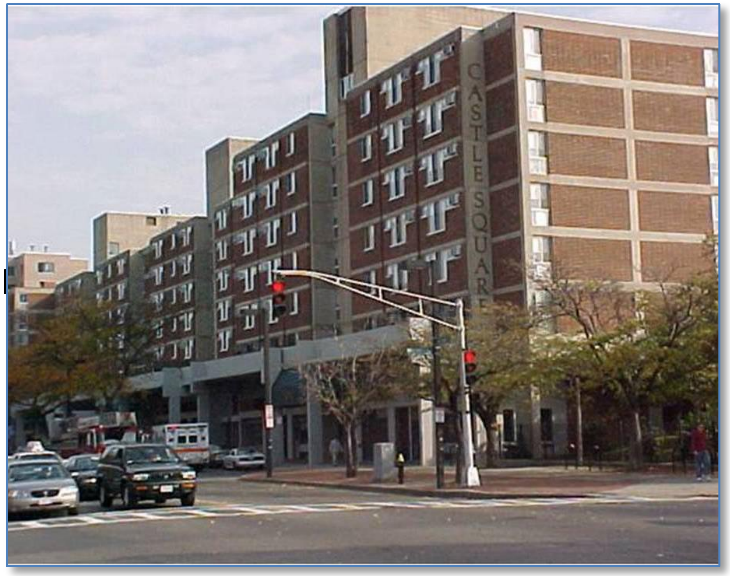
ARRA-Funded Deep Energy Retrofits

Castle Square Apartments - Boston

- Original 1960s construction with low- and moderate-income housing
- 540,000 square feet; 192 of 500 units were retrofitted
- Project costs: $50.5 million; retrofit was $11 million; $4.4 million from ARRA

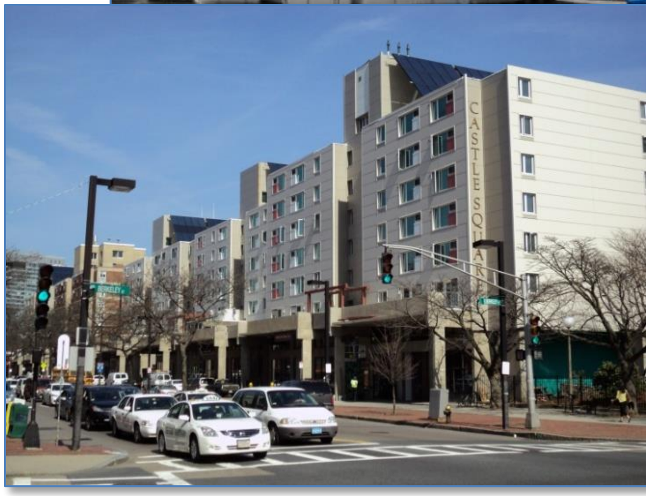
PROJECT FEATURES

- New 5-inch R-40 shell (from R-3)
- R-5 casement windows
- A super-insulated roof and reflective materials
- Extensive air sealing
- High-efficiency mechanical systems, appliances, and lighting
- Rooftop solar thermal energy panels
- Improved ventilation



ARRA-Funded Deep Energy Retrofits

Castle Square Apartments - Boston



RESULTS

- Designed for a 72% reduction in energy consumption
- Projected 71% decrease in fuels for heating
- $227,578 in projected annual utility savings for entire apartment complex; more than $3 million over lifetime
- Achieved LEED Platinum certification in December 2012

ARRA-Funded Deep Energy Retrofits

United Teen Equality Center - Lowell

- Original 1839 construction
- 29,000 square feet of office and education/programming space
- Project costs: $10 million; $4.6 million for retrofit; $1.9 million from ARRA

PROJECT FEATURES

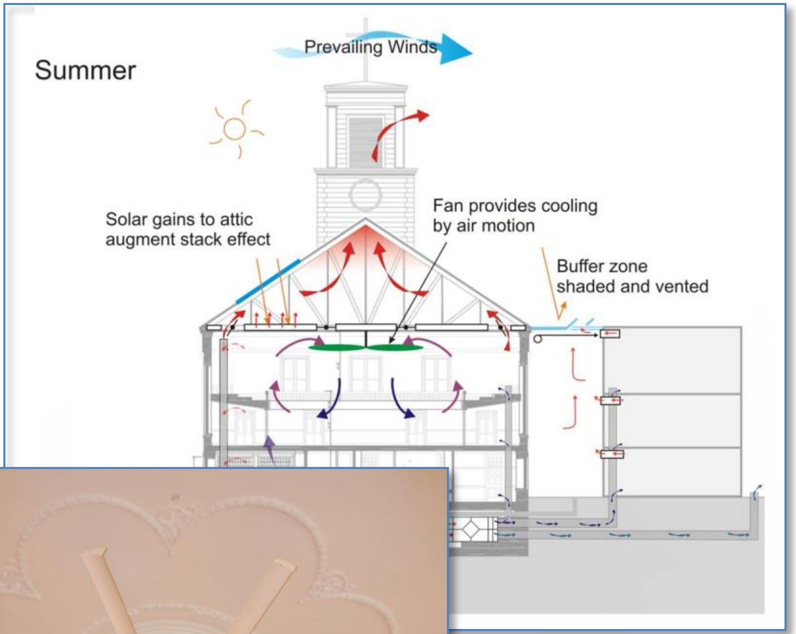
- 95%+ high efficiency gas boiler
- Conversion of the steeple into a solar chimney
- A passive cooling system, eliminating the need for air conditioning
- Natural daylighting
- Recycled materials- and soy-based insulation
- Energy-efficient appliances
- 34 kW Solar PV

ARRA-Funded Deep Energy Retrofits

United Teen Equality Center - Lowell

RESULTS

- Designed for a 68% decrease in energy consumption
- $19,209 in projected annual energy savings; $339,660 over its lifetime
- Achieved LEED Platinum certification in December 2012—the oldest LEED Platinum-certified structure in the U.S.



ARRA-Funded Deep Energy Retrofits

Center for Ecological Technology - Springfield

- Early 20th century original construction
- Contains EcoBuilding Bargains
- 60,000 square foot warehouse
- Project costs: \$3.5 million; \$1.16 million from ARRA

PROJECT FEATURES

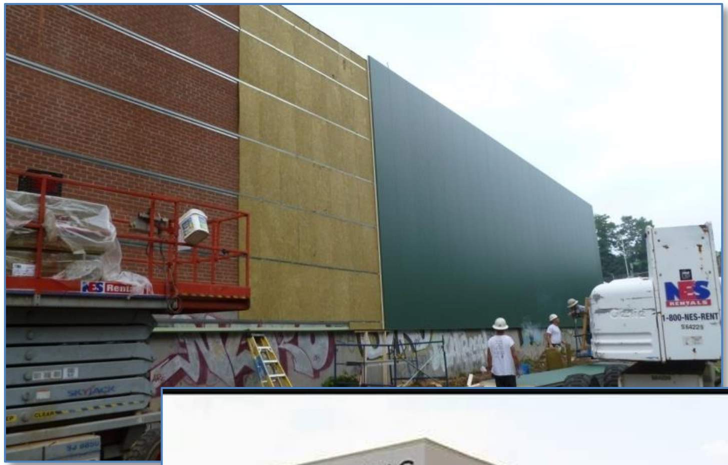
- Air sealing, exterior insulated metal panels and a new heavily insulated roof
- Air-source heat pumps
- Heat recovery ventilation and infrared heaters
- High-efficiency heat system for smaller spaces
- Energy-efficient lighting and controls
- Conversion from oil to natural gas

ARRA-Funded Deep Energy Retrofits

Center for Ecological Technology - Springfield

RESULTS

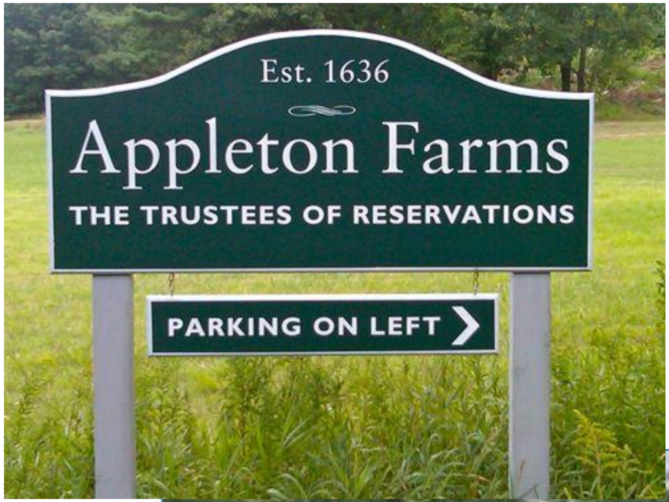
- Designed for a 57% energy reduction
- Actual energy use (from six-month data) is 72% lower than baseline
- $30,229 in projected annual energy savings; $798,385 over project lifetime; actual savings are $70,000 between November 2011 and May 2012
- Designed for LEED Platinum certification (in process)



ARRA-Funded Deep Energy Retrofits

Architectural Heritage Foundation: Appleton Farms - Ipswich

- Original 1680s construction; main part of house dates back to 1794
- Oldest continuously operating farm in the United States
- Contains 4,700 square feet of office and exhibit space for visitors
- Project costs: $1.1 million; $200,000 from ARRA



PROJECT FEATURES

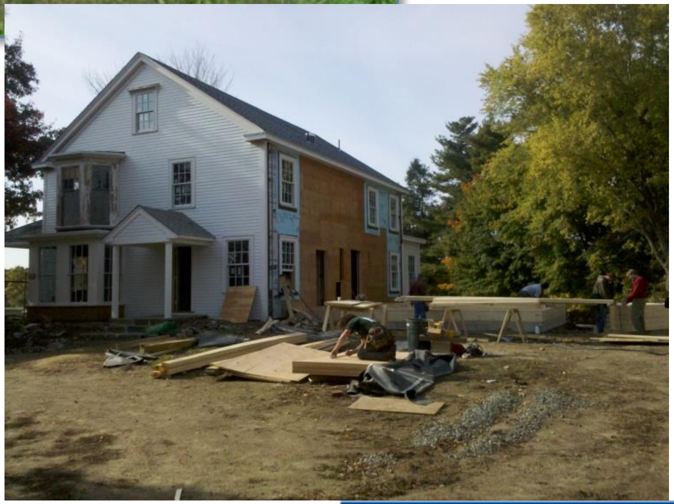
- A highly efficient biomass boiler
- Heat recovery ventilation
- Super-insulated floors, walls, ceilings & exterior envelope
- Solar-thermal hot water

ARRA-Funded Deep Energy Retrofits

Architectural Heritage Foundation: Appleton Farms - Ipswich

RESULTS

- Designed for a 55% decrease in energy consumption
- $3,929 in projected annual utility savings; $131,539 over lifetime
- Qualifies for LEED Platinum certification (in process)



Creating A Cleaner Energy Future For the Commonwealth

DOER
Massachusetts Department of Energy Resources

ARRA-Funded Deep Energy Retrofits

Architectural Heritage Foundation: Bullitt Reservation - Ashfield

- Original farmhouse from the 1840s
- 2,000 square feet of office and exhibit space
- Project costs: $576,950; $110,000 from ARRA

PROJECT FEATURES

- Structurally integrated panels (SIPs) installed on top of original roof
- Also installed light-colored metal roof
- Six-inch interior insulation
- Air source heating and cooling pumps
- 6 kW solar PV array on barn will power heat pumps, lights, computers and all electrical needs

ARRA-Funded Deep Energy Retrofits

Architectural Heritage Foundation: Bullitt Reservation - Ashfield

RESULTS

- Designed for a 50% decrease in energy consumption
- $1,633 in projected annual utility savings; $41,041 over lifetime
- Designed for LEED Platinum certification (in progress)

ARRA-Funded Deep Energy Retrofits

Architectural Heritage Foundation: Lyman Estate – Waltham

- Original 1793 construction
- On the National Register and designated as a National Historic Landmark
- 14,000 square feet for weddings, meetings, and private parties
- Project costs: $1.5 million, $348,000 from ARRA

PROJECT FEATURES

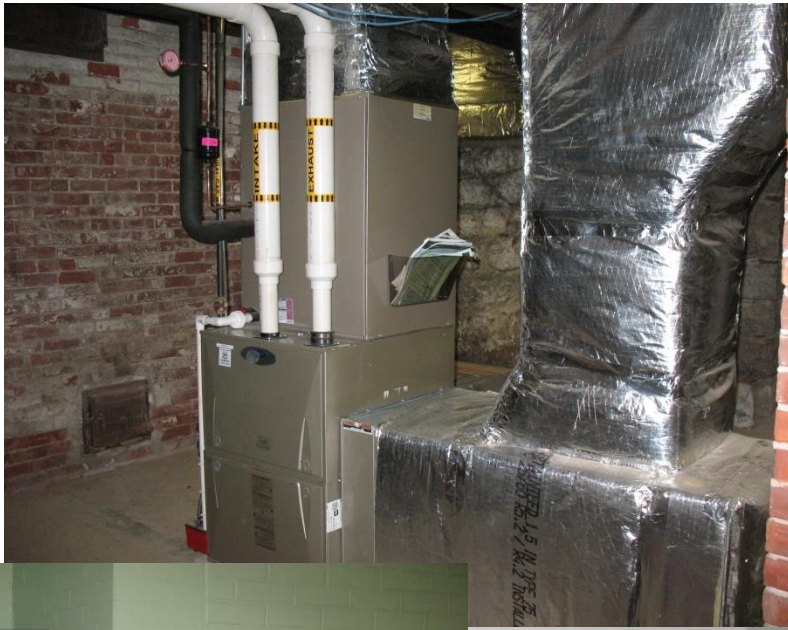
- Weather stripping
- Storm windows where necessary
- Air/duct sealing and attic space insulation
- New efficient furnace
- Conversion from fuel oil to natural gas
- Improved duct work
- Programmable thermostats
- Upgraded catering kitchen equipment

ARRA-Funded Deep Energy Retrofits

Architectural Heritage Foundation: Lyman Estate - Waltham

RESULTS

- Designed for at least 50% decrease in energy consumption
- $10,804 in estimated annual energy savings; $282,230 over lifetime

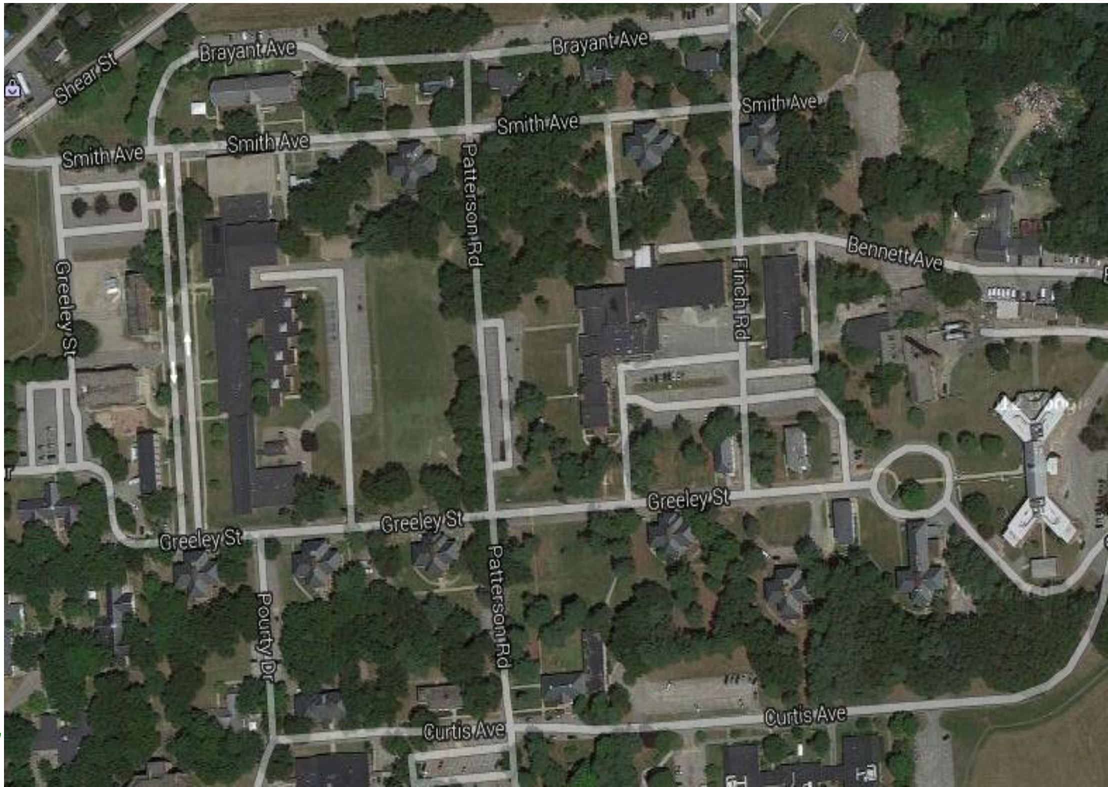


Leading by Example
"Deep Energy Retrofits"

LBE Project #1 – Hogan Regional and Wrentham Developmental Centers

- Centers for Developmentally Disabled
- 827,000 Square Feet Total
- 24 hour residential services & administrative, recreational, and medical facilities

- 50 year+ old oversized steam power plant
- Mile long steam runs from plant to facility
- Project Cost - $24 million

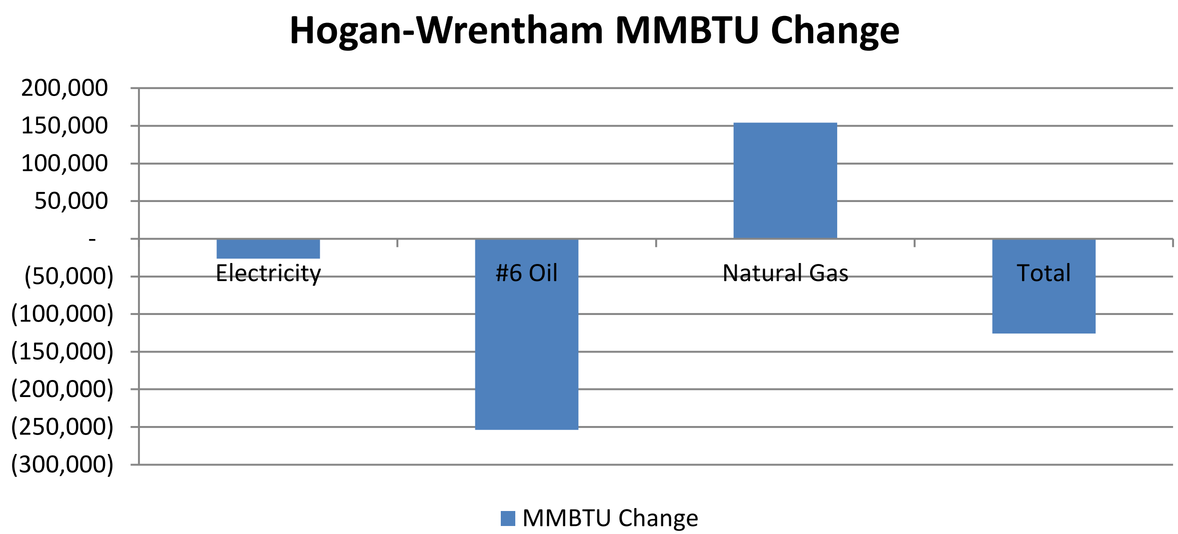


Creating

Hogan-Wrentham - Project

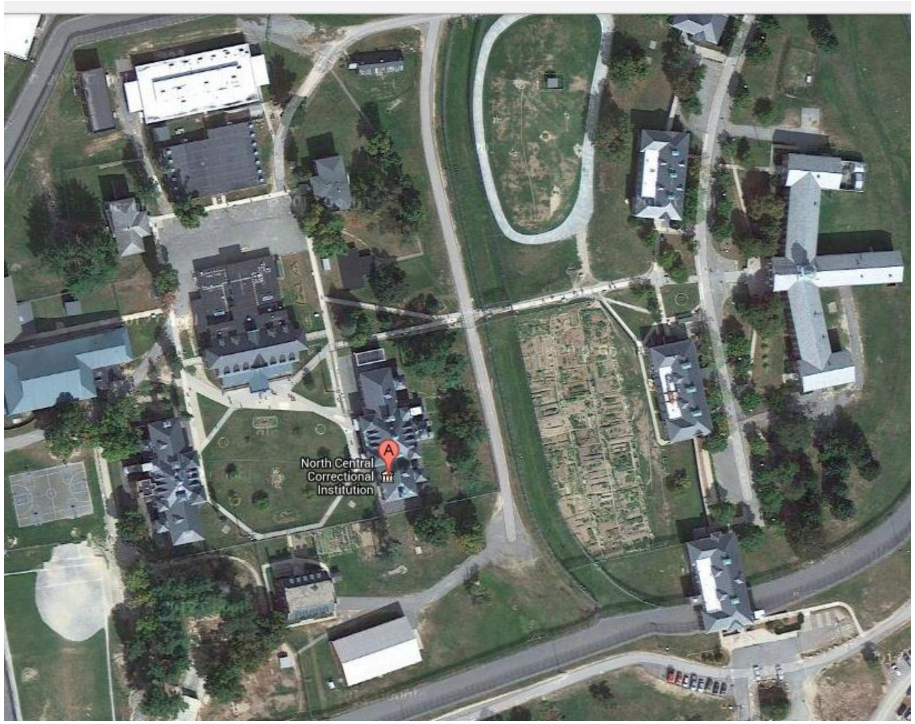
- Comprehensive lighting upgrades for more than 3,000 fixtures, including high efficiency T8s, LED exit signs and lighting controls
- High-efficiency motors
- Programmable thermostats and energy management systems
- Ext door weather stripping, pipe insulation, storm windows
- Steam trap repair & replacement
- Replacement of oil-fired equipment with gas boilers
- 522 kW cogeneration system
- Solar hot water system
- 500 kW solar PV

Hogan-Wrentham - Savings



- Reduction: 7 million+ kWh
- Reduction: 1.7 million gallons #6 oil
- Increase: 1.5 million therms natural gas
- 50% reduction over four-year average baseline
- 297 kBTU/Sq. Ft. EUI to projected 145 kBTU/Sq. Ft. EUI
- Energy Savings - $2.5 million annually

LBE Project #2 – NCCI Gardner



- 1,000 inmates
- 120 employees
- Fueled by #6 oil
- 808,374 square feet
- Opened 1981
- 18 buildings

NCCI Gardner – Project

- Cost - $13.4 million
- Replace high pressure steam oil boilers with low pressure steam natural gas boilers and condensing boilers
- Convert steam dryers to natural gas.
- Install attic insulation in 16 buildings.
- Water conserving faucets, toilets, showerheads throughout
- Window replacement
- Also two 1.65 Wind Turbines

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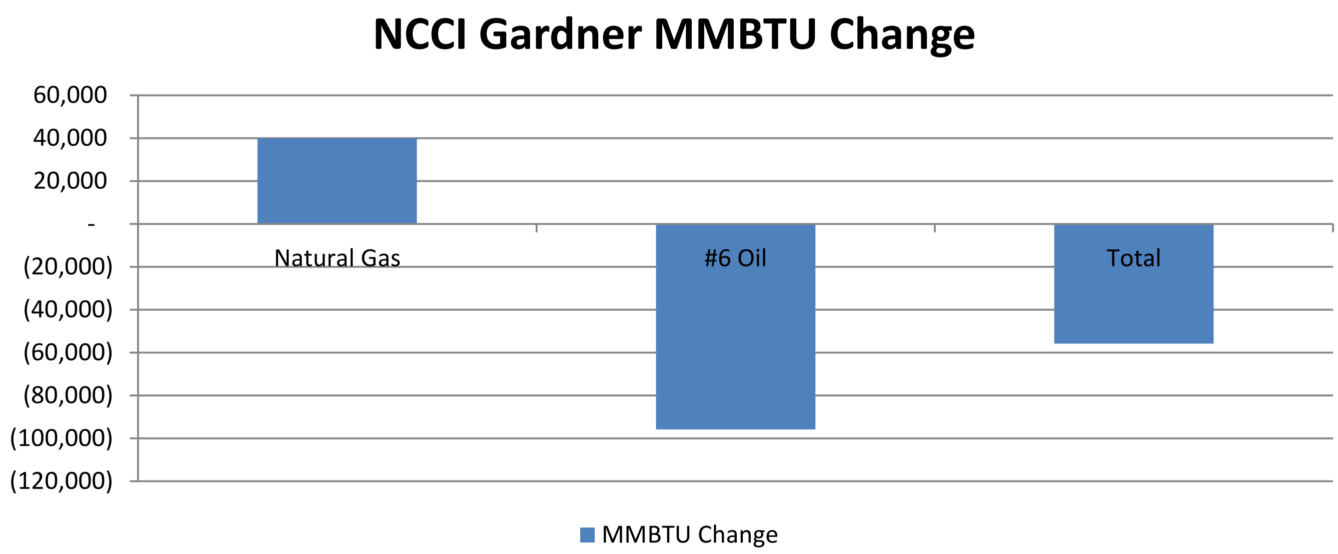
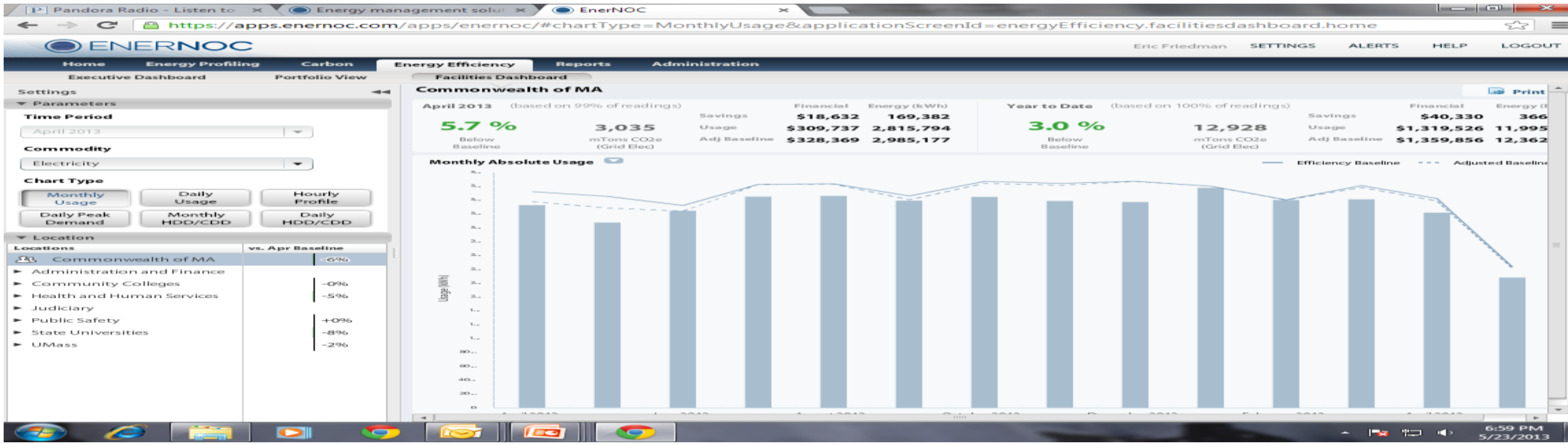
NCCI Gardner - Savings



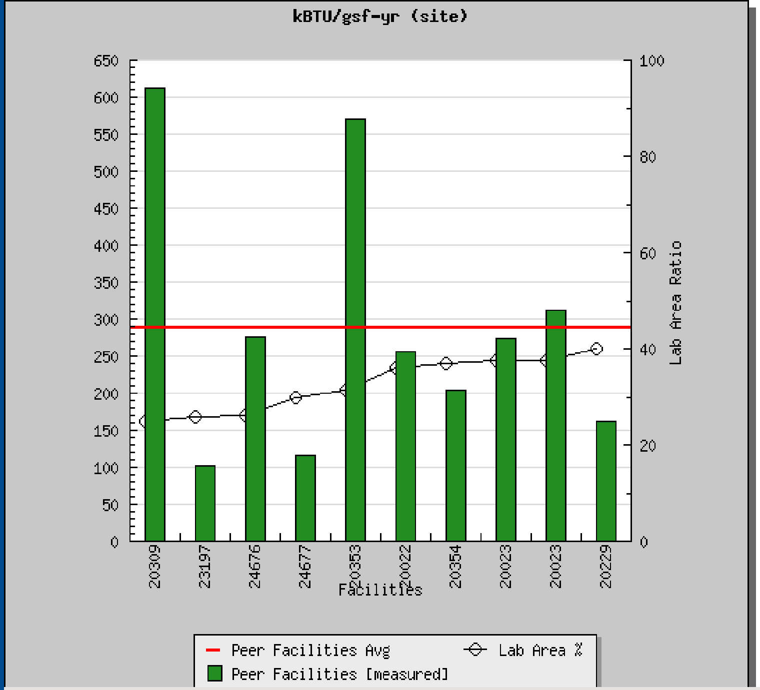
- Savings - $1.1 million annually
- Eliminate 640,000 gal of #6 fuel oil
- Increase of 400,000 Therms of natural gas
- Reduce GHG emissions 5422 metric tons
- 50% energy use reduction
- 57% reduction in GHG emissions

Real-Time Metering & Operations

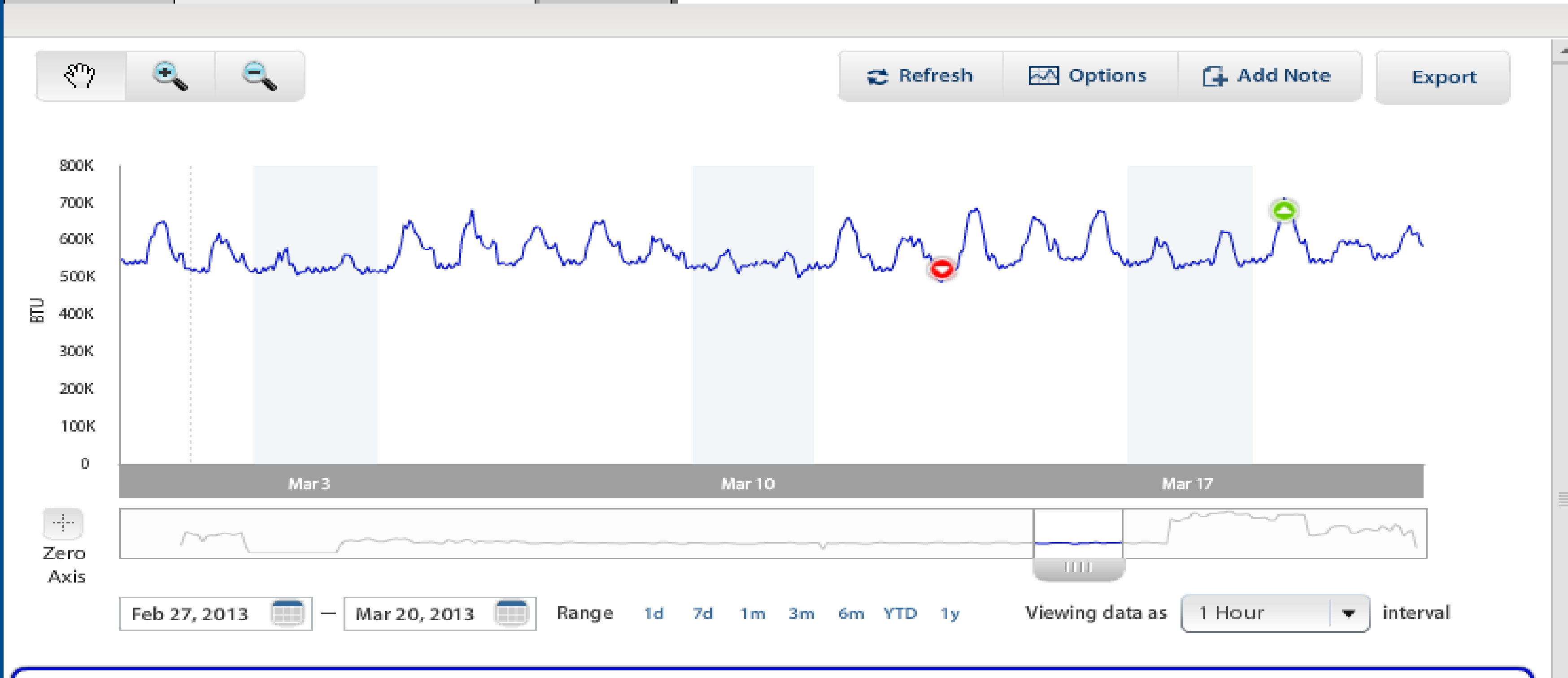


Enterprise Energy Management System (EEMS)

- Real-time metering across 25 million square feet of state buildings
- 18 colleges, all prisons, 4 hospitals, downtown offices, 5 courts,
- Provide actionable on-line building level information for all fuels
- Use daily energy information to make operational changes
- Compare building energy use

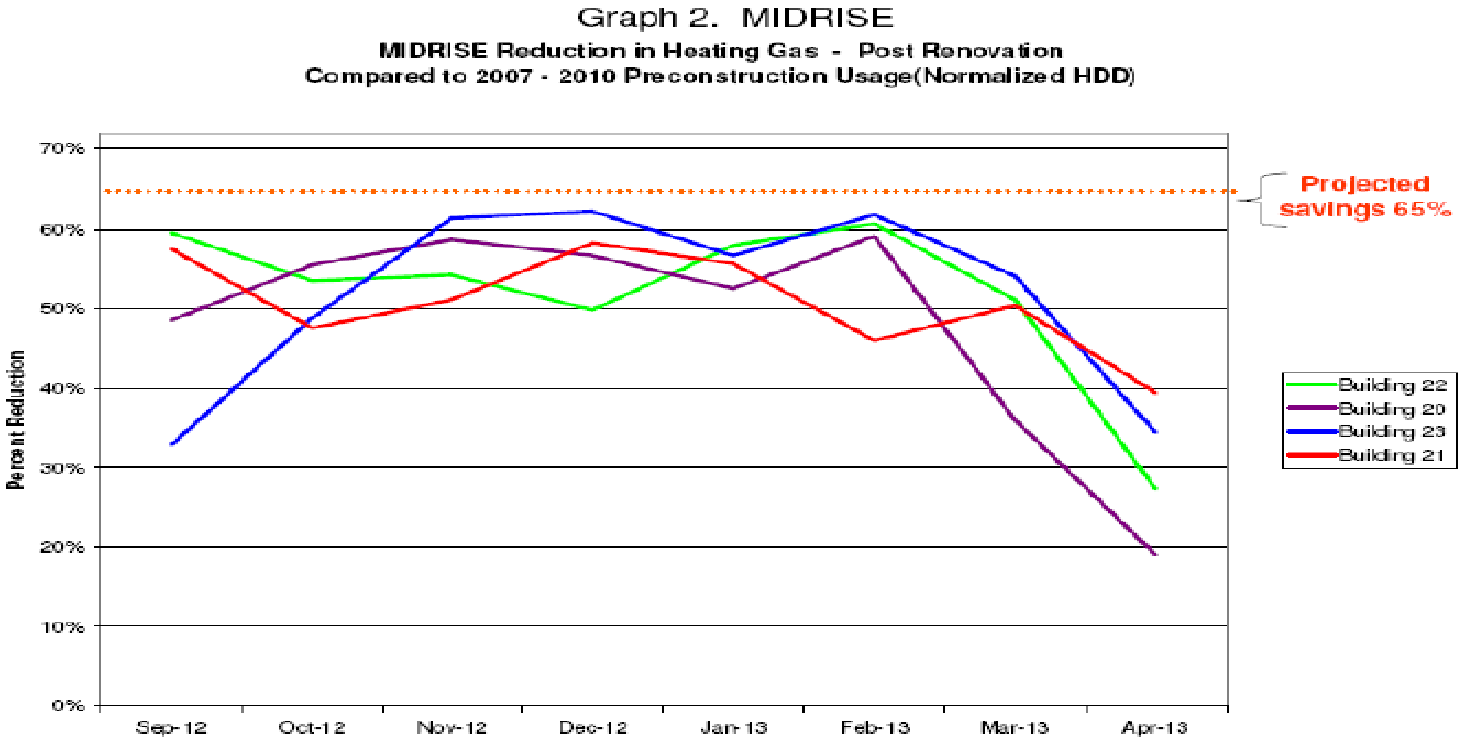


- Lab LEED Platinum bldg with average performance
- Bldg running all the time
- Ventilation design the key



Lessons Learned

- Still need to get actual consumption data to check against projected/modeled data



Castle Square Apartments

FINDINGS AFTER SEVEN MONTHS

Lessons Learned

- Most projects need building envelope improvements to achieve higher savings
- HPB projects did not pay for themselves-served as demonstrations
- Easier to get large savings with project starting from a “bad” place
- Many state projects do not get to 50% energy reduction
- Some strategies can significantly reduce GHG emissions but not the same level of energy reduction (e.g. electric heat to natural gas)
- Longer payback period (e.g. 20 years instead of 10) allow for greater savings

Lessons Learned

Innovative technologies/strategies can be key

- CET's use of a small low-cost Mitsubishi control system to schedule ventilation equipment and heat pumps, and reusing insulation and other materials lowered construction costs
- Castle Square unique design for the building envelope: (1) a liquid-applied air-and-water control membrane; then (2) a mineral-fiber air-flow suppression layer; then (3) insulated metal panels
- UTEC's passive cooling strategies reduced upfront and ongoing costs associated with A/C
- Design envelope improvements before HVAC systems
- Use small specialized HVAC components instead of a complex centralized system can help reduce construction costs and save energy while allowing for local control of comfort
- Reduce lighting needs by painting walls and ceilings white

Lessons Learned

- Signage and an interpretive display about the project, especially video, help to educate and inform visitors about deep energy retrofits.
- The term "deep energy retrofit" is not well known by the general public
- It can take a large number of third-party consultants to understand the full range of options for energy-efficient technologies, materials, appliances and techniques
- It is less expensive to piggyback a retrofit onto an existing renovation than to do a retrofit in isolation
- Operational actions can play a large role in actual results

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Thank you!