Introduction and Overview of Federal Building Energy Efficiency Mandates

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US Department of Energy
FEMP 7-Part Webcast Series

• Session 1, Overview of Federal Building Energy Efficiency Mandates/An Introduction to Building Life-Cycle Costing
• Session 2, Overview of the Requirements of ANSI/ASHRAE/IESNA Standard 90.1-2004
• Session 3, Appendix G of 90.1-2004
• Session 4, Integrated Building Design: Bringing the Pieces Together to Unleash the Power of Teamwork
• Session 5, Sustainable Design
• Session 6, Advanced Energy Design Guides
• Session 7, How to Build 30% Better
For more information on webcasts

http://www.energycodes.gov/federal/webcast_federal_series.stm
Outline of Presentation

• Legislative Drivers
• Federal Rulemakings
• Executive Orders
US Congress Legislation

- New legislation expected in 2009
Energy Policy Act of 2005

Section 102 – Energy Management Requirements
Section 103 – Energy Use Measurement and Accountability
Section 104 – Procurement of Energy Efficient Products
Section 109 – Federal Building Performance Standards

- Mandate:
  - New Federal buildings must achieve savings of at least 30% below ASHRAE Standard 90.1-2004 or the 2004 IECC if cost-effective.
  - Buildings must also use sustainable design principles for siting, design, and construction, if cost-effective.
  - If water is used to achieve energy efficiency, water conservation technologies shall be applied, if cost-effective.

- Section 431 – Energy Reduction Goals for Federal Buildings
- Section 432 – Management of Energy and Water Efficiency in Federal Buildings
- Section 433 – Federal Building Energy Efficiency Performance Standards
  - Requires steep reduction in fossil fuel energy relative to usage in DOE’s Commercial Building Energy Consumption Survey (CBECS) or Residential Energy Consumption Survey (RECS)
  - Applies only to public buildings, buildings with $2.5 million in annual costs, or buildings for which GSA must file a prospectus to Congress
  - New construction and major renovations
- Section 434 – Management of Federal Building Efficiency
Energy Independence and Security Act of 2007 (cont’d)

• Section 435 – Leasing
• Section 436 – High Performance Green Federal Buildings
• Section 437 – Federal Green Building Performance
• Section 441 – Public-Building Life Cycle Costs
  – Changes life-cycle cost period from 25 to 40 years – expands number of measures that are cost-effective
• Section 523 – Standard Relating to Solar Hot Water
  – If life cycle cost-effective, as compared to other reasonably available technologies, not less than 30 percent of the hot water demand for each new Federal building or Federal building undergoing a major renovation be met through the installation and use of solar hot water heaters.
DOE’s role in Congressional Legislation

• Many items in Congressional legislation direct DOE to develop formal rules to implement mandates in legislation
• For those mandates that involve Federal buildings, FEMP develops those rules
Federal Rulemakings

- Notice of Proposed Rulemaking on sustainable design requirements and water conservation in Section 109 of EPACT 2005 – Summer/Fall 2008
- Notice of Proposed Rulemaking on fossil fuel reduction requirements in Section 433 of EISA 2007 – Fall/winter 2008
Executive Orders

• The US President can issue executive orders that directly impact all Federal agencies.

• The latest executive order is EO 13423 - Strengthening Federal Environmental, Energy, and Transportation Management.
Executive Order 13423

- Reduce greenhouse gas emissions
- Increase renewable energy usage
- Reduce water consumption
- Procure sustainable and efficient products
- Ensure new construction follows Guiding Principles
  - Employ Integrated Design Principles
  - Optimize Energy Performance
  - Protect and Conserve Water
  - Enhance Indoor Environmental Quality
  - Reduce Environmental Impact of Materials
Specific Details on Federal Energy Efficiency Design Standards

- Based on Section 109 of EPAct 2005 only at this time
- Found in 10 CFR Part 433 for commercial and high-rise multi-family residential buildings
- Currently only cover energy efficiency and not sustainable design
- Will be updated over coming months to include sustainable design and also to include fossil-fuel reductions required in Section 433 of EISA 2007
Section 109 – Federal Building Performance Standards

• Mandate –
  – New Federal buildings must achieve savings of at least 30% below ASHRAE Standard 90.1-2004 or the 2004 IECC if cost-effective.
  – Buildings must also use sustainable design principles for siting, design, and construction, if cost-effective.
  – If water is used to achieve energy efficiency, water conservation technologies shall be applied to the extent that is life-cycle cost-effective
DOE Rulemakings

• Found in
    • new commercial and high-rise multi-family residential buildings started after January 3, 2007
  – 10 CFR Part 435 Subpart A
    • new residential buildings started after January 3, 2007
Baseline Standards

• Called out in Section 109 of the Energy Policy Act of 2005
• Set the baseline for “at least 30% savings”
• Must be met as absolute minimum if no other improvements are cost effective
Baseline Standards

- ANSI/ASHRAE/ IESNA Standard 90.1-2004
  - Prevailing private sector standard for commercial and high-rise multi-family residential buildings
Baseline Standards

• Section 109 requires DOE to update the baseline standards as new versions of the prevailing private sector standards are released and are deemed cost-effective

• DOE will be evaluating the 2006 IECC and ASHRAE Standard 90.1-2007 for the next version of the rule
Energy Saving and Cost-Effectiveness Goal

• Federal building designs must be at least 30% more energy efficient than buildings built to the prevailing private sector standards, if cost-effective

• This is a “soft” goal, as the energy savings must be “at least 30%” but also “cost-effective”
Energy Saving and Cost-Effectiveness Goal

- If 30% savings cannot be achieved, you must try backing off to lesser savings, until cost-effectiveness is achieved.
Energy Saving Metrics

• For commercial and high-rise multi-family residential buildings
  – Performance Rating Method in Appendix G of ASHRAE Standard 90.1-2004
Energy Saving Metrics

- Appendix G is performance-based
  - it requires the use of building simulation software to determine if the proposed design achieves the desired energy savings
- Appendix G requires simulation of a baseline building (that just meets the baseline standard) and a proposed building (that exceeds the baseline standard)
Energy Saving Metrics

• Appendix G relies on *energy cost* as the comparison, as opposed to site or source energy

• *Energy cost* is the metric used in the prevailing private sector standards

• *Energy cost* is also the metric underlying EO 13423
Cost-Effectiveness Metrics

• Life-cycle costing must be performed in accordance with 10 CFR Part 436

• Building Life Cycle-Cost (BLCC) software is available from National Institute of Standard and Technology (NIST)
Allowable Cost-Effectiveness Metrics

- Lower life-cycle cost
- Positive estimated net savings
- Savings-to-investment ratio greater than 1
- Adjusted internal rate of return estimated to be greater than Federal discount rate in OMB Circular A-94
Thank-You
An Introduction to Building Life-Cycle Costing

Building and Fire Research Laboratory
National Institute of Standards and Technology (NIST)
U.S. Department of Commerce

Barbara C. Lippiatt
Jennifer F. Helgeson

FEMP Webcast Series on Federal Commercial Buildings
Session 1
August 19, 2008
Objectives

- Rationale for Life-Cycle Cost (LCC) Analysis
- Basic LCC Methodology
- Requirements of a LCC Analysis
- BLCC5.3 computer program
LCC Legislation

- Executive Order 13423, 2007
- 10 CFR 436A, 1990
- OMB Circular A-94, 1992
Life-Cycle Cost Analysis

- a method of economic analysis that sums all relevant project costs over a given study period in present-value terms.

- most relevant when selecting among mutually exclusive project alternatives that meet minimum functional performance requirements but have different initial costs, OM&R costs, and/or expected lives.
Types of Decisions

- Accept/Reject Projects/Alternatives
- Optimal System Size
- Optimal Combination of Interdependent Systems
- Ranking Independent Projects
LCC Analysis Method

- evaluates costs of acquisition, ownership & disposal
- compares initial investment with future savings
- includes financing costs
- includes FEMP, OMB, MILCON criteria
- consistent with ASTM Standards
Relevant Project Costs

- **Investment-related**
  - First costs
  - Replacement costs
  - Salvage value (resale or disposal cost)

- **Operation-related**
  - Operation, maintenance, and repair costs
  - Energy and water costs
  - Contract-related costs (for financed projects)
LCC Analysis requires

- dollar amounts as of today
- no sunk costs
- non-tangibles in narrative form

Generally, only amounts that are different need to be considered when comparing mutually exclusive alternatives.
Study Period

- Length of time over which an investment is analyzed
- Study period must be equal for all alternatives, depending on:
  - the expected life of the project and/or
  - the investor’s time horizon
- Base Year: analysis date to which all cash flows are discounted
- Base Case: alternative with lowest first cost
Study Period

- Key dates
  - Base Date: beginning of study period
  - Service Date: beginning of operational period
  - End Date: end of study period

- Planning/Construction/Implementation Period

- Contract Period
Present Value & Discounting

Present-Value amount

is the equivalent value to an investor, as of the Base Year, of a cash amount paid (received) at a future date

Present-Value of a Future amount

is found by discounting

Discounting

adjusts for the investor’s time-value of money
Discount Rate

- the interest rate that makes an investor indifferent between cash amounts paid (received) at different points in time
- set by FEMP for energy and water conservation projects
- set by OMB for non-energy projects
Discounting Investment Costs

- PV Investment Costs

- First Cost

- Annual Operating Costs

- Replacement

- Salvage Value

Study Period
Discounting Operating Costs

PV Operating Costs

PV Investment Costs

Annual Operating Costs

Study Period
LCC of Alternatives

Alternative A

Alternative B

PV Operating Costs

PV Investment Costs
Discount Formula

\[ PV = C_t \times \frac{1}{(1 + d)^t} \]

\[ LCC = \sum_{t=0}^{n} \frac{C_t}{(1 + d)^t} \]

where \( n \) = length of study period

\( t \) = time of cost occurrence
Discount Factors

SPV – Single Present Value Factor
for one time amounts or non-annually recurring amounts

UPV – Uniform Present Value Factor
for uniform annual amounts

UPV* – Modified UPV Factor
for non-uniform annual amounts
Present Value Factors

Summary

Single future amount (year t) \( PV = F_t \times SPV_{(t,d)} \)

Recurring annual amount (over n years) \( PV = A_o \times UPV_{(n,d)} \)

Constantly escalating annual amount (over n years) \( PV = A_o \times UPV^*_{(n,d,e)} \)
Discount Factor Sources

- Annual Supplement to Handbook 135
- NIST BLCC computer programs
- NIST DISCOUNT computer program
**Inflation Adjustments**

**Inflation**
rate of increase of the general level of prices

**Escalation**
rate of differential increase in the price of a particular commodity
Two Approaches to dealing with inflation:

**Constant** dollars (excluding inflation)
- a real discount rate
- a real escalation rate

**Current** dollars (including inflation)
- a nominal discount rate
- a nominal escalation rate
Constant vs. Current dollars

Given:
Real Discount rate: 3.0%  
Inflation rate: 1.75%
Base Date amount: $500  
Time period: 1 year

Constant dollars, with real discount rate:

\[
PV = \frac{\$500}{(1+0.030)} = $485.44
\]

Current dollars, with nominal discount rate:

\[
PV = \frac{\$500 (1+0.0175)}{(1+0.030)(1+0.0175)} = $485.44
\]
Differential Escalation Rate

- Difference between the rate of a good’s annual price change and general inflation
- Due to causes other than loss of purchasing power of the dollar
- Relevant to energy pricing
Federal Criteria – FEMP Analyses

Energy and water conservation projects, 10 CFR 436/Handbook 135

- DOE/FEMP discount rate (updated annually)
- Maximum 40-year service period
- Local energy prices
- DOE energy price escalation rates
- Agency-Funded Projects: Constant-Dollar Analysis
- Financed Projects: Current-Dollar Analysis
Federal Criteria – Non-FEMP Analyses

Other federal projects

(non-energy or non-water conservation)

- OMB Circular A-94
- OMB discount rates (updated annually)

MILCON analyses (energy and non-energy)

- FEMP discount rates for energy conservation
- OMB discount rates for non-energy projects
An example

- **Base Case:** Existing Baseboard Heating System with Window AC
- **Alternative:** Heat Pump

- **Location:** Maryland
- **Discount Rate:** 3.0% *real*; 5.0% *nominal*
- **Study Period:** 15 years
- **Base Date:** March 2008
Base Case Data

Baseboard Heat / Window AC

- Initial investment: $0
- Expected Life: 15 years
- Electricity: 16,000 kWh
  $0.08/kWh, commercial
- Annual O&M: $80
- AC repair: $400 in year 8
Cash-Flow Diagram

Base Case

- Initial Inv.: $0
- Electricity: $1,280 annually
- O&M: $80 annually
- AC Repair: $400
- Residual Value: $0

Base Date

Year 08 09 10 11 12 13 14 15 16 17 22
# Alternative System Data

**Heat Pump**

- **Initial investment:** $3,000
- **Expected Life:** 20 years
- **Residual Value:** $750 (25 % of initial cost)
- **Electricity:** 10,100 kWh
  - $0.08/kWh, commercial
- **Annual O&M:** $100
- **Compressor repair:** $600 in year 8
$3,000 Initial Inv.

$808 annually Electricity

$100 annually O&M

Compressor Repair $600

Year 08 09 10 11 12 13 14 15 16 17 22

$750 Residual Value
## LCC Calculation

### Base Case

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>Base Date Cost</th>
<th>Year of Occurrence</th>
<th>Discount Factor</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Investment</strong></td>
<td>$ 0</td>
<td>Base date</td>
<td>Already PV</td>
<td>$ 0</td>
</tr>
<tr>
<td><strong>Electricity</strong></td>
<td>$ 1,280</td>
<td>Annual</td>
<td>UPV(_{15}^{*}) 11.73</td>
<td>$ 15,014</td>
</tr>
<tr>
<td><strong>O&amp;M Cost</strong></td>
<td>$ 80</td>
<td>Annual</td>
<td>UPV(_{15}) 11.94</td>
<td>$ 955</td>
</tr>
<tr>
<td><strong>AC Repair</strong></td>
<td>$ 400</td>
<td>8</td>
<td>SPV(_{8}) 0.789</td>
<td>$ 316</td>
</tr>
</tbody>
</table>

Total PV LCC costs = $16,285
## LCC Calculation

**Alternative**

<table>
<thead>
<tr>
<th>Cost Items (1)</th>
<th>Base Date Cost (2)</th>
<th>Year of Occurrence (3)</th>
<th>Discount Factor (4)</th>
<th>Present Value (5) = (2)X(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Cost</td>
<td>$ 3,000</td>
<td>Base date</td>
<td>Already PV</td>
<td>$ 3,000</td>
</tr>
<tr>
<td>Residual Value</td>
<td>$ 750</td>
<td>15</td>
<td><strong>SPV\textsubscript{15}</strong> 0.642</td>
<td>-$ 482</td>
</tr>
<tr>
<td>Electricity</td>
<td>$ 808</td>
<td>Annual</td>
<td>*<em>UPV\textsuperscript{<em>15}</em></em> 11.73</td>
<td>$ 9,478</td>
</tr>
<tr>
<td>O&amp;M Cost</td>
<td>$ 100</td>
<td>Annual</td>
<td><strong>UPV\textsubscript{15}</strong> 11.94</td>
<td>$ 1,194</td>
</tr>
<tr>
<td>Comp. Repair</td>
<td>$ 600</td>
<td>8</td>
<td><strong>SPV\textsubscript{8}</strong> 0.789</td>
<td>$ 473</td>
</tr>
</tbody>
</table>

Total PV LCC costs = $13,663
Base Case: $\text{LCC}_{BB} = $16,285

Alternative: $\text{LCC}_{HP} = $13,663*
Additional Measures of Worth

**Net Savings (NS)**

difference in LCCs of Base Case and Alternative

**Savings-to-Investment Ratio (SIR)**

Ratio of PV operational savings to PV additional investment costs
Net Savings

An example

NS for heat pump

- Net Savings = LCC_{BB} - LCC_{HP}

- NS = $16,285 - $13,663 = $2,622
Savings-to-Investment Ratio

An example

SIR for heat pump

\[ \frac{\text{operation-related savings}}{\text{additional investment costs}} = \frac{\$16,285 - \$11,145}{($3,000 - $482) - $0} \]

\[ = \frac{\$5,140}{\$2,518} \]

\[ SIR_{HP} = 2.04 \]
Steps in an LCC Analysis

Summary

- Identify feasible project alternatives
- Establish common assumptions
  - Base Year
  - Study period
  - Discount rate (real vs. nominal)
  - Inflation assumption (constant $ vs. current $)
- Identify relevant project costs
- Convert all $-amounts to present value
- Compute and compare LCCs of alternatives
- Interpret results
Alternative Financing

- Compare LCCs of
  - agency-funded and financed projects
  - individual ECMs or in combination
- Inclusion of contract costs
- Phasing-in of ECMs over study period
- Comparison of contract payments and savings
NIST LCC Support Software

BLCC5

- FEMP
- MILCON
  - FEMP criteria
  - ECIP criteria and report
- OMB – Non-energy projects
- Alternative Financing
  - Energy Savings Performance Contract
  - Utility Energy Services Contract
BLCC 5.3

- Java-programmed
- Platform-independent
- XML file format
- Familiar, windowed user interface
- Program-integrated help
- Downloadable from DOE web site
Replace existing lighting system in a federal office building in Arizona with a new system financed through an ESPC (Energy Savings Performance Contract)

- Amount financed: $380,560
- Contract payments: $58,000
- Study period: 20 years
- Contract period: 10 years
- Implementation period: 1 year

Determine whether the proposed system is cost-effective and whether the expected savings cover the contract payments.
General Project Information

Name: ESPC Example
Location: Arizona
Analyst: JFH
Comment: Replace existing lighting system with new lighting/daylighting system.

Discounting Convention

- End-of-Year Discounting
- Mid-Year Discounting

Analysis Information

- Constant Dollar Analysis
- Current Dollar Analysis

Nominal Discount Rate: 5.0%
Project: ESPC Example

Alternative: Base Case - Existing System

Alternative: Lighting/Daylighting System

- Contract Costs - Annually Recurring
  - Cost: Annual Contract Payment

- Contract Costs - Non-Annually Recurring

- Energy Costs
  - Cost: Electricity - New System

- Cost: Electricity - Old System

- Water Costs

- Capital Component:
### Energy Usage

<table>
<thead>
<tr>
<th>Name: Electricity - New System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Consumption: 363,000.00 kWh</td>
</tr>
</tbody>
</table>

### Energy Usage Indices

<table>
<thead>
<tr>
<th>From Date</th>
<th>Duration</th>
<th>Usage Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1, 2007</td>
<td>1 year 0 months</td>
<td>0.0%</td>
</tr>
<tr>
<td>April 1, 2008</td>
<td>Remaining</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Changing usage pattern**

**Customized emissions calculations**

### Emissions

**Location:** Arizona

### Tips

- Enter the base-year annual energy consumption of the specified energy type.
- Use Usage Indices to specify variable energy usage pattern.
- Enter region, state or end-use for emissions calculation.
## DOE Price Escalation Rates (Electricity)

<table>
<thead>
<tr>
<th>From Date</th>
<th>Duration</th>
<th>Escalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1, 2007</td>
<td>1 year 0 months</td>
<td>2.55%</td>
</tr>
<tr>
<td>April 1, 2008</td>
<td>1 year 0 months</td>
<td>0.62%</td>
</tr>
<tr>
<td>April 1, 2009</td>
<td>1 year 0 months</td>
<td>-0.10%</td>
</tr>
<tr>
<td>April 1, 2010</td>
<td>1 year 0 months</td>
<td>-1.14%</td>
</tr>
<tr>
<td>April 1, 2011</td>
<td>1 year 0 months</td>
<td>-0.49%</td>
</tr>
<tr>
<td>April 1, 2012</td>
<td>1 year 0 months</td>
<td>0.97%</td>
</tr>
<tr>
<td>April 1, 2013</td>
<td>1 year 0 months</td>
<td>1.37%</td>
</tr>
<tr>
<td>April 1, 2014</td>
<td>1 year 0 months</td>
<td>2.02%</td>
</tr>
</tbody>
</table>

**Tips**
- Enter all dollar amounts in base-year dollars.
- Energy Usage Indices also apply to demand charges and utility rebates.
- If applicable, edit DOE price escalation rates.
- Use real rates of price escalation in constant-dollar analysis, nominal rates in current-dollar analysis.
Project: ESPC Example

- Alternative: Base Case - Existing System
- Alternative: Lighting/Daylighting System
  - Contract Costs - Annually Recurring
    - Cost: Annual Contract Payment
  - Contract Costs - Non-Annually Recurring
- Energy Costs
- Water Costs
- Capital Costs
The ESPC increases at an average escalation rate. The annual contract payment is $58,000.00, starting April 1, 2007.

### Tips
- Enter amount in base-year dollars.
- Use real rates of escalation in constant-dollar analysis, nominal rates in current-dollar analysis.
- Use Usage Indices to specify variable pattern of occurrence.
- Use the Energy Escalation Rate Calculator (EERC) if you need to compute an average annual contract escalation rate based on DOE energy price forecasts.
The Energy Escalation Rate Calculator (EERC) computes an average annual escalation rate for fuel prices.

EERC is updated annually; available on the DOE website.

The rate is used to escalate the contract payments in ESPCs when payments are based on the projected annual energy cost savings.

Based on a LCC methodology; uses rates projected by EIA.
Energy Escalation Rate Calculator (EERC)

Fuel Type
- Weight (%)
  - Coal: 0
  - Distillate Oil: 0
  - Electricity: 100
  - Natural Gas: 0
  - Residual: 0
  - Total: 100

Fuel Rate Information
- Location: AR
- Sector: Commercial

Performance Period
- Start Date: 2008
- Duration: 10

Annual Energy Escalation Rate
- Inflation Rate (%): 1.9
  - Real: -0.80
  - Nominal: 1.081

Weighted average rates
Region specific
Sector specific
<table>
<thead>
<tr>
<th>From Date</th>
<th>Duration</th>
<th>Usage Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 1, 2007</td>
<td>1 year 0 months</td>
<td>0.00%</td>
</tr>
<tr>
<td>April 1, 2008</td>
<td>10 years 0 months</td>
<td>100.00%</td>
</tr>
<tr>
<td>April 1, 2018</td>
<td>Remaining</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

**Contract period**
Escalation Rate of Contract Payments from EERC

Contract payments negotiated with Energy Services Companies (ESCO) are often based on projected energy cost savings. The contract payments may be fixed from year to year or may include an escalation clause that increases them annually over the duration of the contract term (performance period). The portion of the contract payments that is based on projected energy savings should be escalated at the energy price escalation rates projected by the Energy Information Administration (EIA) of the U.S. Department of Energy. A DOE/NIST computer program, Energy Escalation Rate Calculator (EERC), calculates an average annual escalation rate based on the EIA projections and weighted by the proportion of energy savings coming from each of the fuels used in the project. The calculator is updated annually with the latest EIA energy price projections, which are also embedded in the BLCC programs and in the discount factor tables of the Annual Supplement to Handbook 135. EERC can be accessed from the DOE/FEMP web site at http://www.eere.energy.gov/femp/information/download_blcc.html.
Reports

- Input
- Detailed LCC
- Cash Flow
- Summary LCC
- Lowest LCC
- Comparative Analysis
- ECIP
# NIST BLCC 5.3-07: Lowest LCC

Consistent with Federal Life Cycle Cost Methodology and Procedures, 10 CFR, Part 436, Subpart A

## General Information

- **File Name:** C:\BLCCExample08.xml
- **Date of Study:** Fri Apr 18 16:04:11 EDT 2008
- **Analysis Type:** Federal Analysis, Financed Project
- **Project Name:** ESPC Example
- **Project Location:** Arizona
- **Analyst:** JFH
- **Comment:** Replace existing lighting system with new lighting/daylighting system.
- **Base Date:** April 1, 2007
- **Study Period:** 20 years 0 months (April 1, 2007 through March 31, 2027)
- **Discount Rate:** 5%
- **Discounting Convention:** End-of-Year

## Lowest LCC

### Comparative Present-Value Costs of Alternatives

*(Shown in Ascending Order of Initial Cost, * = Lowest LCC)*

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Initial Cost (PV)</th>
<th>Life Cycle Cost (PV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case - Existing System</td>
<td>$0</td>
<td>$1,203,400</td>
</tr>
<tr>
<td>Lighting/Daylighting System</td>
<td>$0</td>
<td>$772,284 *</td>
</tr>
</tbody>
</table>
## Comparison of Present-Value Costs

### PV Life-Cycle Cost

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>Alternative</th>
<th>Savings from Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial Investment Costs Paid By Agency:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital Requirements as of Base Date</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Future Costs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recurring and Non-Recurring Contract Costs</td>
<td>$0</td>
<td>$455,659</td>
<td>-$455,659</td>
</tr>
<tr>
<td>Energy Consumption Costs</td>
<td>$953,938</td>
<td>$264,908</td>
<td>$689,029</td>
</tr>
<tr>
<td>Energy Demand Charges</td>
<td>$163,532</td>
<td>$50,415</td>
<td>$113,117</td>
</tr>
<tr>
<td>Energy Utility Rebates</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Water Costs</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Recurring and Non-Recurring OM&amp;R Costs</td>
<td>$85,930</td>
<td>$22,202</td>
<td>$63,729</td>
</tr>
<tr>
<td>Capital Replacements</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Residual Value at End of Study Period</td>
<td>$0</td>
<td>-$20,900</td>
<td>$20,900</td>
</tr>
<tr>
<td><strong>Subtotal (for Future Cost Items)</strong></td>
<td>$1,203,400</td>
<td>$772,284</td>
<td>$431,116</td>
</tr>
<tr>
<td><strong>Total PV Life-Cycle Cost</strong></td>
<td>$1,203,400</td>
<td>$772,284</td>
<td>$431,116</td>
</tr>
</tbody>
</table>

### Net Savings from Alternative Compared with Base Case

- **PV of Operational Savings:** $865,875
- **PV of Differential Costs:** $434,759

**Net Savings:** $431,116
### Comparative Analysis Report

#### Comparison of Contract Payments and Savings from Alternative (undiscounted)

<table>
<thead>
<tr>
<th>Year Beginning</th>
<th>Contract Costs</th>
<th>Savings in Energy Costs</th>
<th>Savings in Total Operational Costs</th>
<th>Savings in Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr 2007</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Apr 2008</td>
<td>-$59,259</td>
<td>$64,424</td>
<td>$70,239</td>
<td>$10,980</td>
</tr>
<tr>
<td>Apr 2009</td>
<td>-$59,898</td>
<td>$64,094</td>
<td>$70,019</td>
<td>$10,121</td>
</tr>
<tr>
<td>Apr 2010</td>
<td>-$60,545</td>
<td>$63,397</td>
<td>$69,435</td>
<td>$8,890</td>
</tr>
<tr>
<td>Apr 2011</td>
<td>-$61,200</td>
<td>$63,249</td>
<td>$69,401</td>
<td>$8,201</td>
</tr>
<tr>
<td>Apr 2012</td>
<td>-$61,860</td>
<td>$63,939</td>
<td>$70,208</td>
<td>$8,347</td>
</tr>
<tr>
<td>Apr 2013</td>
<td>-$62,528</td>
<td>$64,885</td>
<td>$71,274</td>
<td>$8,746</td>
</tr>
<tr>
<td>Apr 2014</td>
<td>-$63,203</td>
<td>$66,057</td>
<td>$74,849</td>
<td>$11,646</td>
</tr>
<tr>
<td>Apr 2015</td>
<td>-$63,887</td>
<td>$67,766</td>
<td>$74,399</td>
<td>$10,512</td>
</tr>
<tr>
<td>Apr 2016</td>
<td>-$64,576</td>
<td>$69,643</td>
<td>$76,402</td>
<td>$11,826</td>
</tr>
<tr>
<td>Apr 2017</td>
<td>-$65,273</td>
<td>$70,853</td>
<td>$77,741</td>
<td>$12,467</td>
</tr>
<tr>
<td>Apr 2018</td>
<td>$0</td>
<td>$71,458</td>
<td>$74,716</td>
<td>$74,716</td>
</tr>
<tr>
<td>Apr 2019</td>
<td>$0</td>
<td>$72,730</td>
<td>$76,051</td>
<td>$76,051</td>
</tr>
<tr>
<td>Apr 2020</td>
<td>$0</td>
<td>$74,302</td>
<td>$77,686</td>
<td>$77,686</td>
</tr>
<tr>
<td>Apr 2021</td>
<td>$0</td>
<td>$75,950</td>
<td>$82,001</td>
<td>$82,001</td>
</tr>
<tr>
<td>Apr 2022</td>
<td>$0</td>
<td>$77,423</td>
<td>$80,937</td>
<td>$80,937</td>
</tr>
</tbody>
</table>
### Energy Savings Summary

**Energy Savings Summary (in stated units)**

<table>
<thead>
<tr>
<th>Energy</th>
<th>Type</th>
<th>Base Case</th>
<th>Alternative</th>
<th>Consumption Savings</th>
<th>Life-Cycle Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>1,250,000.0 kWh</td>
<td>407,447.2 kWh</td>
<td>842,552.8 kWh</td>
<td>16,848,750.2 kWh</td>
<td></td>
</tr>
</tbody>
</table>

**Energy Savings Summary (in MBtu)**

<table>
<thead>
<tr>
<th>Energy</th>
<th>Type</th>
<th>Base Case</th>
<th>Alternative</th>
<th>Savings</th>
<th>Life-Cycle Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>4,265.2 MBtu</td>
<td>1,390.3 MBtu</td>
<td>2,874.9 MBtu</td>
<td>57,490.3 MBtu</td>
<td></td>
</tr>
</tbody>
</table>

---
## Emissions Reduction Summary

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>----Average</th>
<th>Annual</th>
<th>Emissions----</th>
<th>Life-Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>Base Case</td>
<td>Alternative</td>
<td>Reduction</td>
<td>Reduction</td>
</tr>
<tr>
<td>CO2</td>
<td>1,187,150.01 kg</td>
<td>386,868.45 kg</td>
<td>800,281.57 kg</td>
<td>16,003,440.27 kg</td>
</tr>
<tr>
<td>SO2</td>
<td>820.54 kg</td>
<td>271.51 kg</td>
<td>549.03 kg</td>
<td>10,979.18 kg</td>
</tr>
<tr>
<td>NOx</td>
<td>2,367.32 kg</td>
<td>771.46 kg</td>
<td>1,595.86 kg</td>
<td>31,912.84 kg</td>
</tr>
</tbody>
</table>

**Emissions reductions for air pollutants by energy type**

**Totals**

| CO2         | 1,187,150.01 kg | 386,868.45 kg | 800,281.57 kg | 16,003,440.27 kg |
| SO2         | 820.54 kg | 271.51 kg | 549.03 kg | 10,979.18 kg |
| NOx         | 2,367.32 kg | 771.46 kg | 1,595.86 kg | 31,912.84 kg |

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Additional Resources

- NIST Handbook 135
- NIST Training Videos
- BLCC5 Support
- FEMP-Qualified Instructors
Contacts

- BLCC, associated programs and user guides:
  www.eere.energy.gov/femp/program/lifecycle.html

- Handbook 135 and Annual Supplement:
  1-800-DOE-EREC (1-800-363-3732)

- Technical Assistance:
  - NIST Office of Applied Economics:
    www.bfrl.nist.gov/oae
  - LCC Method: barbara.lippiatt@nist.gov
  - BLCC software: amy.rushing@nist.gov
Thank you

Questions?

Comments?