Optimizing Energy use in Buildings

By: Tim Peckham

ACS
Design · Construction · Integration
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Learning Objectives

• Apply specific methods to reduce energy consumption in buildings.

• Understand the impact on reduced energy consumption on the initial building cost.

• Understand the economics of energy usage in a building.
Agenda

- Energy history
- Background of USGBC and LEED
- Basic Cost Data related to Green buildings
- Process for evaluating energy reduction options
- Simulation programs
- Optimizing systems
- Project examples
Energy History
Figure 2. Primary Energy Consumption and Gross Domestic Product, 1970-1998

Energy Information Administration, Annual Energy Review 1998, Table 1.5
Figure 1. Total Primary Energy Use in the U.S. by Sector, 1998

- **Transportation** 27%
- **Buildings** 39%
- **Industrial** 37%

Figure 4. Energy Consumption in the Buildings Sector by Energy Source, 1970-1998

Energy Information Administration, Annual Energy Review 1999, Table 2.1
Figure 3. Consumer Price Estimates for Energy, 1970-1995

Note: Real price estimates were derived using the Consumer Price Index (1982-1984 = 100)
Energy Information Administration, Annual Energy Review 1998, Table 3.3
Energy Costs

Wisconsin Natural Gas Prices 1995-2005

Note: Prices are calculated to account for the effects of general price inflation.

Source: State of Wisconsin - Department of Administration
Wisconsin Electricity Prices 1995-2005

Note: Prices are calculated to account for the effects of general price inflation.

Source: State of Wisconsin - Department of Administration
Background of USGBC and LEED
LEED was developed by the U.S. Green Building Council (USGBC) as a unique rating system for designing, constructing and certifying “green” buildings worldwide.

USGBC is a national coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work.
**LEED-NC Version 2.2 Project Checklist**

**Project Name**

**Project Location**

---

<table>
<thead>
<tr>
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<tr>
<td>Credit 2</td>
<td>Development Density &amp; Community Connectivity</td>
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</tr>
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<td>Credit 3</td>
<td>Brownfield Redevelopment</td>
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<tr>
<td>Credit 4</td>
<td>Alternative Transportation: Public Transportation Access</td>
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<tr>
<td>Credit 5</td>
<td>Alternative Transportation: Bicycle Storage &amp; Changing Rooms</td>
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<td>Alternative Transportation: Low Emitting &amp; Fuel Efficient Vehicles</td>
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<td>Credit 7</td>
<td>Alternative Transportation: Parking Capacity</td>
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<tr>
<td>Credit 8</td>
<td>Site Development: Protect or Restore Habitat</td>
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<tr>
<td>Credit 9</td>
<td>Site Development: Maximize Open Space</td>
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<tr>
<td>Credit 10</td>
<td>Stormwater Management: Quantity Control</td>
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<tr>
<td>Credit 11</td>
<td>Stormwater Management: Quality Control</td>
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<td>0</td>
</tr>
<tr>
<td>Credit 12</td>
<td>Heat Island Effect: Non-Roof</td>
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<tr>
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<td>Heat Island Effect: Roof</td>
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<tr>
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<tbody>
<tr>
<td>Credit 1</td>
<td>Water Efficient Landscaping: Reduce by 50%</td>
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<td>Credit 2</td>
<td>Water Efficient Landscaping: No Potable Use or No Irrigation</td>
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<td>Innovative Wastewater Technologies</td>
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<td>Water Use Reduction: 20% Reduction</td>
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<td>Water Use Reduction: 30% Reduction</td>
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<td>Fundamental Refrigerant Management</td>
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<td>On-Site Renewable Energy: 2.5%</td>
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<tr>
<td>Credit 6</td>
<td>On-Site Renewable Energy: 5%</td>
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<td>On-Site Renewable Energy: 7.5%</td>
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<td>0</td>
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<tr>
<td>Credit 8</td>
<td>On-Site Renewable Energy: 12.5%</td>
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<td>Credit 9</td>
<td>Enhanced Commissioning</td>
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<td>Enhanced Refrigerant Management</td>
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<td>Measurement &amp; Verification</td>
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<td>Credit 12</td>
<td>Green Power</td>
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<table>
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<td>Credit 2</td>
<td>Innovation in Design: Provide Specific Title</td>
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<td>Innovation in Design: Provide Specific Title</td>
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<td>Credit 4</td>
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<table>
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<tr>
<td>Credit 1</td>
<td>Storage &amp; Collection of Recyclables</td>
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<td>0</td>
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<tr>
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<td>Building Reuse: Maintain 75% of Existing Walls, Floors &amp; Roof</td>
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<td>Building Reuse: Maintain 95% of Existing Walls, Floors &amp; Roof</td>
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<tr>
<td>Credit 4</td>
<td>Building Reuse: Maintain 50% of Interior Non-Structural Elements</td>
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<td>0</td>
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<tr>
<td>Credit 5</td>
<td>Construction Waste Management: Divert 50%</td>
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<td>0</td>
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<tr>
<td>Credit 6</td>
<td>Construction Waste Management: Divert 75%</td>
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<tr>
<td>Credit 7</td>
<td>Resource Reuse: 5%</td>
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<td>Credit 8</td>
<td>Resource Reuse: 10%</td>
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<tr>
<td>Credit 9</td>
<td>Recycled Content: 10% (post-consumer + 1/2 pre-consumer)</td>
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<td>0</td>
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<tr>
<td>Credit 10</td>
<td>Recycled Content: 20% (post-consumer + 1/2 pre-consumer)</td>
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<td>Credit 11</td>
<td>Regional Materials: 10% Extracted, Processed &amp; Mfr. Regionally</td>
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<td>0</td>
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<tr>
<td>Credit 12</td>
<td>Regional Materials: 20% Extracted, Processed &amp; Mfr. Regionally</td>
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<tr>
<td>Credit 13</td>
<td>Rapidly Renewable Materials</td>
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<td>0</td>
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<tr>
<td>Credit 14</td>
<td>Certified Wood</td>
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<table>
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<th>Indoor Environmental Quality</th>
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<tr>
<td>Credit 1</td>
<td>Minimum IAQ Performance</td>
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<tr>
<td>Credit 2</td>
<td>Environmental Tobacco Smoke (ETS) Control</td>
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<tr>
<td>Credit 3</td>
<td>Outdoor Air Delivery Monitoring</td>
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<tr>
<td>Credit 4</td>
<td>Increased Ventilation</td>
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<td>0</td>
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<tr>
<td>Credit 5</td>
<td>Construction IAQ Management Plan: During Construction</td>
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<tr>
<td>Credit 6</td>
<td>Construction IAQ Management Plan: Before Occupancy</td>
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</tr>
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<td>Credit 7</td>
<td>Low-Emitting Materials: Adhesives &amp; Sealants</td>
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<td>Credit 8</td>
<td>Low-Emitting Materials: Paints &amp; Coatings</td>
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<td>Credit 9</td>
<td>Low-Emitting Materials: Carpet Systems</td>
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<td>Credit 10</td>
<td>Low-Emitting Materials: Composite Wood &amp; Ag/Ag Products</td>
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<td>Credit 11</td>
<td>Indoor Chemical &amp; Pollutant Source Control</td>
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<td>Credit 12</td>
<td>Controllability of Systems: Lighting</td>
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<td>Credit 13</td>
<td>Controllability of Systems: Thermal Comfort</td>
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<tr>
<td>Credit 14</td>
<td>Thermal Comfort: Design</td>
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<td>0</td>
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<tr>
<td>Credit 15</td>
<td>Thermal Comfort: Verification</td>
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<td>Credit 16</td>
<td>Daylight &amp; Views: Daylight 75% of Spaces</td>
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<tr>
<td>Credit 17</td>
<td>Daylight &amp; Views: Views for 90% of Spaces</td>
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</table>

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**Date**
SCORECARD AND STATUS

MY ACTION ITEMS
Displays the next steps for the project. Depending on your project role, the project status and number of points anticipated or awarded; different action items will appear.

Please provide documentation for any Credits or Prerequisites as directed by your Project Administrator.

POTENTIAL LEED RATING
Displays LEED level which is based on number of points attempted. Actual Certification Level will be based on the number of points awarded and successful completion of all Prerequisites.

This Project has attempted enough points for Gold Rating.

ATTEMPTED CREDIT SUMMARY
Displays attempted points for the project by status.

<table>
<thead>
<tr>
<th>Status</th>
<th>Design</th>
<th>Construction</th>
<th>Total</th>
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<tbody>
<tr>
<td>Pending:</td>
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<td>14</td>
<td>46</td>
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<tr>
<td>Total Attempted:</td>
<td>32</td>
<td>14</td>
<td>46</td>
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</table>

APPEALED CREDIT SUMMARY
Displays your appealed Credits.
This Project is not currently under appeal.

CREDIT SCORECARD
Displays all credits and points per LEED sections. Depending on project access, one can attach team members, view attempted credits or click credits to display template.
<table>
<thead>
<tr>
<th>Points Documented</th>
<th>Points Available: 69</th>
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<tbody>
<tr>
<td>Sustainable Sites</td>
<td></td>
</tr>
<tr>
<td>SS Prerequisite 1</td>
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</tr>
<tr>
<td>SS Credit 1</td>
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<tr>
<td>SS Credit 2</td>
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<tr>
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<td>SS Credit 4.1</td>
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<tr>
<td>SS Credit 4.2</td>
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<td>SS Credit 4.3</td>
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<td>SS Credit 4.4</td>
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<td>SS Credit 7.1</td>
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<td>Water Efficiency</td>
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<td>WE Credit 1.1-1.2</td>
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<td>WE Credit 2</td>
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<tr>
<td>WE Credit 3.1-3.2</td>
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</table>

- **Construction Activity Pollution Prevention**: Civil Engineer, Attempted: 0
- **Site Selection**: Architect, Attempted: 1
- **Development Density & Community Connectivity**: 1
- **Brownfield Redevelopment**: 1
- **Alternative Transportation: Public Transportation Access**: 1
- **Alternative Transportation: Bicycle Storage & Changing Rooms**: Architect, Attempted: 1
- **Alternative Transportation: Low-Emitting & Fuel Efficient Vehicles**: Landscape Architect, Attempted: 1
- **Alternative Transportation: Parking Capacity**: Landscape Architect, Attempted: 1
- **Site Development: Protect or Restore Habitat**: Landscape Architect, Attempted: 1
- **Site Development: Maximize Open Space**: Landscape Architect, Attempted: 1
- **Stormwater Management: Quantity Control**: Civil Engineer, Attempted: 1
- **Stormwater Management: Quality Control**: 1
- **Heat Island Effect: Non-Roof**: Architect, Attempted: 1
- **Heat Island Effect: Roof**: Lighting Designer, Attempted: 1
- **Light Pollution Reduction**: Possible Points: 5
- **Water Efficient Landscaping**: Landscape Architect, Attempted: 2
- **Innovative Wastewater Technologies**: Project Team Administrator, Attempted: 1
- **Water Use Reduction**: Project Team Administrator, Attempted: 2
ENERGY & ATMOSPHERE: OPTIMIZE ENERGY PERFORMANCE (CREDIT 1)

CLAIM OF CREDIT STATUS
Displays status information and team member assigned to credit. A project administrator can also unattempt a credit in this section.

Attempted On: 7/12/2006

- Credit 1.1 Optimize Energy Performance, 10.5% New / 3.5% Existing, Attempted
- Credit 1.2 Optimize Energy Performance, 14% New / 7% Existing, Attempted
- Credit 1.3 Optimize Energy Performance, 17.5% New / 10.5% Existing, Attempted
- Credit 1.4 Optimize Energy Performance, 21% New / 14% Existing, Attempted
- Credit 1.5 Optimize Energy Performance, 24.5% New / 17.5% Existing, Attempted
- Credit 1.6 Optimize Energy Performance, 28% New / 21% Existing, Attempted
- Credit 1.7 Optimize Energy Performance, 31.5% New / 24.5% Existing, Attempted
- Credit 1.8 Optimize Energy Performance, 35% New / 28% Existing, Attempted
- Credit 1.9 Optimize Energy Performance, 38.5% New / 31.5% Existing, Attempted
- Credit 1.10 Optimize Energy Performance, 42% New / 35% Existing, Attempted

Is Clarification Needed for this Credit?: No

Assigned Team Role: HVAC Engineer
Basic Cost Data related to Green buildings
Initial Cost of Code vs. LEED Buildings

For a typical office building

<table>
<thead>
<tr>
<th>Certification Level</th>
<th>Initial Cost per Sq. Ft.</th>
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<tr>
<td>Code Building</td>
<td>$95</td>
</tr>
<tr>
<td>LEED Certified</td>
<td>$95.63</td>
</tr>
<tr>
<td>LEED Silver</td>
<td>$97.00</td>
</tr>
<tr>
<td>LEED Gold</td>
<td>$96.73</td>
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</tbody>
</table>

Source: USGBC
Initial Cost of Code vs. LEED Buildings

Source: USGBC
Cost of LEED Buildings
Annual Energy Costs

Source: USGBC
Energy Reduction in LEED Rated Buildings

![Bar Chart]

Energy Reduction Beyond Code

- Certified: 18%
- Silver: 37%
- Gold: 30%
- Average: 28%

Source: USGBC
Impact of LEED on Heating

Boiler Equipment Size vs LEED Rating

Source: Sample LEED Buildings/USGBC
Impact of LEED on Cooling

Cooling Equip. Size vs LEED Rating

Source: Sample LEED Buildings/USGBC
## Simple Payback of LEED Buildings

### Supporting Data
Cost Breakdown by Sq. Ft.

<table>
<thead>
<tr>
<th></th>
<th>Code Building</th>
<th>Certified</th>
<th>Silver</th>
<th>Gold</th>
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<tbody>
<tr>
<td><strong>Building First Cost</strong></td>
<td>$95.00</td>
<td>$95.63</td>
<td>$97.00</td>
<td>$96.73</td>
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<td><strong>Rooftop Replacement</strong></td>
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<tr>
<td><em>(15 yrs. +)</em></td>
<td>$4.19</td>
<td>$4.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chiller/Tower Replacement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(20 yrs. +)</em></td>
<td></td>
<td></td>
<td>$3.92</td>
<td>$3.92</td>
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<tr>
<td><strong>Operating Cost</strong></td>
<td>$2.22/SF/YR</td>
<td>$1.79/SF/YR</td>
<td>$1.60/SF/YR</td>
<td>$1.44/SF/YR</td>
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<tr>
<td>Maintenance</td>
<td>.30 / SF / YR</td>
<td>.25 / SF / YR</td>
<td>.20 / SF / YR</td>
<td>.18 / SF / YR</td>
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<tr>
<td>Electric</td>
<td>1.70 / SF / YR</td>
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<td>1.24 / SF / YR</td>
<td>1.11 / SF / YR</td>
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<tr>
<td>Gas</td>
<td>.22 / SF / YR</td>
<td>.20 / SF / YR</td>
<td>.16 / SF / YR</td>
<td>.15 / SF / YR</td>
</tr>
</tbody>
</table>

Source: USGBC and ASHRAE
Simple Payback of LEED Buildings

Simple Payback:
1 year, 6 months
Simple Payback of LEED Buildings

Simple Payback:
4 years, 3 months
Simple Payback of LEED Buildings

Simple Payback:
3 years, 3 months
Process for evaluating energy reduction options
Energy Use

Issue: Energy Efficiency

Achieve increased level of energy performance above the minimum energy performance baseline. Executive Order 111 requires new buildings owned, leased or operated by State agencies to achieve at least a 20% improvement in energy efficiency levels as prescribed by the New York State Energy Conservation Construction Code.

Performance Criteria


Benchmark

ASHRAE 90.1-2004; Labs21 Laboratory Modeling Guidelines Using ASHRAE 90.1-2004

Applicable LEED Credit

<table>
<thead>
<tr>
<th>EA 1</th>
<th>Optimize Energy Performance</th>
<th>Point Probability</th>
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<td></td>
<td>Y</td>
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</table>

Demonstrate a percentage improvement in the energy performance for regulated energy components described in the requirements of ASHRAE/IESNA Standard 90.1-2004, as demonstrated by a whole building simulation using the Building Performance Rating Method in Appendix G of the Standard.

Design Team Action

<table>
<thead>
<tr>
<th>Design Team Action</th>
<th>O</th>
<th>A</th>
<th>LA</th>
<th>ID</th>
<th>SE</th>
<th>CE</th>
<th>ME</th>
<th>EE</th>
<th>C1</th>
<th>CM</th>
<th>C</th>
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</thead>
<tbody>
<tr>
<td>Define base energy performance using code minimum model augmented by selected laboratory performance benchmarks</td>
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<tr>
<td>Analyze availability of on-site renewable resources and identify governmental and/or utility-based incentive programs for renewable energy</td>
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<tr>
<td>Identify and evaluate performance of energy design alternatives for building envelope, lighting and mechanical systems. Reduce energy requirements through passive site and architectural design strategies first.</td>
<td></td>
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<tr>
<td>Perform comparative evaluation of individual and combined strategies</td>
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<td></td>
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<tr>
<td>Evaluate performance of renewable energy system strategies.</td>
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<tr>
<td>Perform LCC analysis of each strategy</td>
<td></td>
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<tr>
<td>Affirm or modify energy performance goals</td>
<td></td>
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## Options Check List

<table>
<thead>
<tr>
<th>1. Architectural</th>
<th>First Cost</th>
<th>4. Systems</th>
<th>First Cost</th>
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<tbody>
<tr>
<td>Shading Devices</td>
<td>M</td>
<td>Standing column heat pump</td>
<td>M</td>
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<tr>
<td>High Reflectance/vegetated roof</td>
<td>H</td>
<td>Vertical borefield heat pump</td>
<td>H</td>
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<tr>
<td>Glazing area reduction</td>
<td>L</td>
<td>Solar assisted heat pump</td>
<td>H</td>
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<tr>
<td>Solar Orientation</td>
<td>L</td>
<td>Underfloor air dist. at office space</td>
<td>M</td>
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<tr>
<td>Glazing performance</td>
<td>M</td>
<td>Radiant heating</td>
<td>M</td>
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<tr>
<td>Increased envelope R-value</td>
<td>L</td>
<td>Static pressure reduction</td>
<td>H</td>
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<tr>
<td>Evaporative-cooled roof</td>
<td>M</td>
<td>Electrostatic filtration</td>
<td>L</td>
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<tr>
<td></td>
<td></td>
<td>Fan walls</td>
<td>L</td>
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</table>

<table>
<thead>
<tr>
<th>2. Loads</th>
<th>First Cost</th>
<th>5. Misc.</th>
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<tbody>
<tr>
<td>Airflow management</td>
<td>L</td>
<td>Auxiliary cooling-chilled beam</td>
<td>M</td>
</tr>
<tr>
<td>Low ambient/task lighting</td>
<td>L</td>
<td>Auxiliary cooling-fan coil</td>
<td>L</td>
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<tr>
<td>Multilevel lighting control</td>
<td>M</td>
<td>Airflow monitoring (Optinet or Aircuity)</td>
<td>H</td>
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<tr>
<td>Space occupancy sensors</td>
<td>M</td>
<td>Variable velocity exhaust</td>
<td>M</td>
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<tr>
<td>Night setback controls for HVAC &amp;</td>
<td>L</td>
<td>VFD Motors</td>
<td>M</td>
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<tr>
<td>light</td>
<td></td>
<td>Thermal storage</td>
<td>H</td>
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<td></td>
<td></td>
<td>Load shifting/shredding</td>
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<table>
<thead>
<tr>
<th>3. Energy Recovery</th>
<th>First Cost</th>
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<th>First Cost</th>
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</thead>
<tbody>
<tr>
<td>Heat wheel</td>
<td>L</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Run around coil</td>
<td>M</td>
<td></td>
<td>M</td>
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<tr>
<td>Heat pipe</td>
<td>M</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Air-to-air heat exchanger</td>
<td>M</td>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Domestic water</td>
<td>M</td>
<td></td>
<td>M</td>
</tr>
</tbody>
</table>
Simulation programs
Programs

- Transys
- DOE 2
- Energy 10
- eQUEST
Optimizing systems
Boilers

- Use water tube versus fire tube. Flue gas can be colder than entering hot water temperature.
- Use sealed combustion boilers. Condensing still have new product development issues.
Chillers

- Use chilled water with variable speed compressors (screw, scroll, rotary) with cooling tower. Up to 18% savings.
- Second choice use packaged chiller with evaporative spray condenser.
 Cooling Towers

- Allow temperature to float. Reset to 5 degrees F below wet bulb. Each 1 degree F offers approximately 1% energy savings. Saves chiller horsepower and tower fan horsepower.

- Run all multiple towers at part load first. Two tower fans at ½ speed consumes ¼ of the power of one fan at full speed.
Hot Water

- Use variable flow with variable pressure reset.
- Use constant volume primary, variable volume secondary, pumped coils, reheat off secondary.
- Centrally locate equipment horizontally and vertically. Lower first cost and operating cost.
HOT WATER PIPING SYSTEM

Energy Efficient HW System
Central Equipment Location
Remote Equipment Location
Chilled Water

- Keep supply temperature as high as practical. Approximately 1% savings in operating cost for each 1 degree F.
- Select coils with maximum water temperature drop.
Air Systems

- Use variable air volume with variable static reset.
- Use exhaust heat recovery.
- Transfer air for double use where possible.
- Centrally locate equipment horizontally and vertically. Lower first cost, lower operating cost, quieter system.
Project examples
Harley-Davidson

- Product Development Center
- Wauwatosa, WI
## Sustainable Sites

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
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<tbody>
<tr>
<td>Prereq</td>
<td>Erosion &amp; Sedimentation Control</td>
<td>Required</td>
</tr>
<tr>
<td>Credit 1</td>
<td>Site Selection</td>
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<tr>
<td>Credit 2</td>
<td>Urban Redevelopment</td>
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<tr>
<td>Credit 3</td>
<td>Brownfield Redevelopment</td>
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</tr>
<tr>
<td>Credit 4</td>
<td>Alternative Transportation, Public Transportation Access</td>
<td>1</td>
</tr>
<tr>
<td>Credit 4.1</td>
<td>Alternative Transportation, Bicycle Storage &amp; Changing Rooms</td>
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<tr>
<td>Credit 4.3</td>
<td>Alternative Transportation, Alternative Fuel Vehicles</td>
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<tr>
<td>Credit 4.4</td>
<td>Alternative Transportation, Parking Capacity</td>
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<tr>
<td>Credit 5</td>
<td>Reduced Site Disturbance, Protect or Restore Open Space</td>
<td>1</td>
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<tr>
<td>Credit 5.2</td>
<td>Reduced Site Disturbance, Development Footprint</td>
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</tr>
<tr>
<td>Credit 6</td>
<td>Stormwater Management, Rate or Quantity</td>
<td>1</td>
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<tr>
<td>Credit 6.2</td>
<td>Stormwater Management, Treatment</td>
<td>1</td>
</tr>
<tr>
<td>Credit 7.1</td>
<td>Landscape &amp; Exterior Design to Reduce Heat Islands, Non-Roof</td>
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</tr>
<tr>
<td>Credit 7.2</td>
<td>Landscape &amp; Exterior Design to Reduce Heat Islands, Roof</td>
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<tr>
<td>Credit 8</td>
<td>Light Pollution Reduction</td>
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## Water Efficiency

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<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit 1.1</td>
<td>Water Efficient Landscaping, Reduce by 50%</td>
<td>1</td>
</tr>
<tr>
<td>Credit 1.2</td>
<td>Water Efficient Landscaping, No Potable Use or No Irrigation</td>
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<tr>
<td>Credit 2</td>
<td>Innovative Wastewater Technologies</td>
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<tr>
<td>Credit 3.1</td>
<td>Water Use Reduction, 20% Reduction</td>
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<tr>
<td>Credit 3.2</td>
<td>Water Use Reduction, 30% Reduction</td>
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## Energy & Atmosphere

<table>
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<tr>
<th>Credit</th>
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<tbody>
<tr>
<td>Prereq 1</td>
<td>Fundamental Building Systems Commissioning</td>
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<tr>
<td>Prereq 2</td>
<td>Minimum Energy Performance</td>
<td>Required</td>
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<tr>
<td>Prereq 3</td>
<td>CFC Reduction in HVAC&amp;R Equipment</td>
<td>Required</td>
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<tr>
<td>Credit 1</td>
<td>Optimize Energy Performance</td>
<td>1 to 10</td>
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<tr>
<td>Credit 2.1</td>
<td>Renewable Energy, 5%</td>
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<tr>
<td>Credit 2.2</td>
<td>Renewable Energy, 10%</td>
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<tr>
<td>Credit 2.3</td>
<td>Renewable Energy, 20%</td>
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<tr>
<td>Credit 3</td>
<td>Additional Commissioning</td>
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<td>Credit 4</td>
<td>Ozone Depletion</td>
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<tr>
<td>Credit 5</td>
<td>Measurement &amp; Verification</td>
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<tr>
<td>Credit 6</td>
<td>Green Power</td>
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### Materials & Resources

<table>
<thead>
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<th>Credit</th>
<th>Description</th>
<th>Points</th>
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<tbody>
<tr>
<td>1.1</td>
<td>Building Reuse, Maintain 75% of Existing Shell</td>
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<tr>
<td>1.2</td>
<td>Building Reuse, Maintain 100% of Shell</td>
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<tr>
<td>1.3</td>
<td>Building Reuse, Maintain 100% Shell &amp; 50% Non-Shell</td>
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<tr>
<td>2.1</td>
<td>Construction Waste Management, Divert 50%</td>
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</tr>
<tr>
<td>2.2</td>
<td>Construction Waste Management, Divert 75%</td>
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</tr>
<tr>
<td>3.1</td>
<td>Resource Reuse, Specify 5%</td>
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<tr>
<td>3.2</td>
<td>Resource Reuse, Specify 10%</td>
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<td>4.1</td>
<td>Recycled Content, Specify 5% p.c. or 10% (p.c. + 1/2 p.i.) - Version 2.0</td>
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<tr>
<td>4.2</td>
<td>Recycled Content, Specify 10% p.c. or 20% (p.c. + 1/2 p.i.) - Version 2.0</td>
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<tr>
<td>5.1</td>
<td>Local/Regional Materials, 20% Manufactured Locally</td>
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<tr>
<td>5.2</td>
<td>Local/Regional Materials, of 20% Above, 50% Harvested Locally</td>
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<tr>
<td>6</td>
<td>Rapidly Renewable Materials</td>
<td>1</td>
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<tr>
<td>7</td>
<td>Certified Wood</td>
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### Indoor Environmental Quality

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<th>Description</th>
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<tr>
<td>1.1</td>
<td>Minimum IAQ Performance</td>
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<tr>
<td>2.1</td>
<td>Environmental Tobacco Smoke (ETS) Control</td>
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</tr>
<tr>
<td>2.2</td>
<td>Carbon Dioxide (CO₂) Monitoring</td>
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<tr>
<td>3.1</td>
<td>Ventilation Effectiveness</td>
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<tr>
<td>3.2</td>
<td>Construction IAQ Management Plan, During Construction</td>
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<tr>
<td>3.3</td>
<td>Construction IAQ Management Plan, Before Occupancy</td>
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<tr>
<td>4.1</td>
<td>Low-Emitting Materials, Adhesives &amp; Sealants</td>
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<td>4.2</td>
<td>Low-Emitting Materials, Paints</td>
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<td>4.3</td>
<td>Low-Emitting Materials, Carpet</td>
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<td>4.4</td>
<td>Low-Emitting Materials, Composite Wood</td>
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<td>5.1</td>
<td>Indoor Chemical &amp; Pollutant Source Control</td>
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<tr>
<td>6.1</td>
<td>Controllability of Systems, Perimeter</td>
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<tr>
<td>6.2</td>
<td>Controllability of Systems, Non-Perimeter</td>
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<tr>
<td>7.1</td>
<td>Thermal Comfort, Comply with ASHRAE 55-1992</td>
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<tr>
<td>7.2</td>
<td>Thermal Comfort, Permanent Monitoring System</td>
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<tr>
<td>8.1</td>
<td>Daylight &amp; Views, Daylight 75% of Spaces</td>
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<tr>
<td>8.2</td>
<td>Daylight &amp; Views, Views for 90% of Spaces</td>
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### Innovation & Design Process

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<th>Description</th>
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<tr>
<td>1.1</td>
<td>Innovation in Design: Exemplary Performance: Credits MR 4.1/4.2</td>
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<tr>
<td>1.2</td>
<td>Innovation in Design: Provide Specific Title</td>
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<tr>
<td>1.3</td>
<td>Innovation in Design: Provide Specific Title</td>
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<td>1.4</td>
<td>Innovation in Design: Provide Specific Title</td>
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<tr>
<td>2</td>
<td>LEED™ Accredited Professional</td>
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### Project Totals

- Certified: 25-32 points
- Silver: 33-38 points
- Gold: 39-51 points
- Platinum: 52-69 points

U.S. Green Building Council
LEED Checklist
LEED™ Green Building Rating System 2.0
### Energy Summary by End Use

<table>
<thead>
<tr>
<th>End Use</th>
<th>Energy Type</th>
<th>Proposed Building Energy [10^6 Btu/hr]</th>
<th>Budget Building Energy [10^6 Btu/hr]</th>
<th>Optimized Energy Performance</th>
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</thead>
<tbody>
<tr>
<td>Lighting - Conditioned</td>
<td>Electricity</td>
<td>823</td>
<td>1,335</td>
<td>62%</td>
</tr>
<tr>
<td>Lighting - Unconditioned</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Space Heating</td>
<td>Electricity</td>
<td>87</td>
<td>114</td>
<td>76%</td>
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<tr>
<td>Space Heating</td>
<td>Gas</td>
<td>4,578</td>
<td>6,371</td>
<td>72%</td>
</tr>
<tr>
<td>Space Cooling</td>
<td>Electricity</td>
<td>392</td>
<td>373</td>
<td>105%</td>
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<tr>
<td>Pumps</td>
<td>Electricity</td>
<td>228</td>
<td>286</td>
<td>80%</td>
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<tr>
<td>Heat Rejection</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Fans - Interior Ventilation</td>
<td>Electricity</td>
<td>972</td>
<td>1,085</td>
<td>90%</td>
</tr>
<tr>
<td>Fans - Interior Exhaust</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Fans - Parking Garage</td>
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<tr>
<td>Service Water Heating</td>
<td>Gas</td>
<td>138</td>
<td>138</td>
<td>100%</td>
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<tr>
<td>Office Equipment</td>
<td>Nonregulated</td>
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<td></td>
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<tr>
<td>Elevators &amp; Escalators</td>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Refrigeration (food, etc.)</td>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking (commercial)</td>
<td>Electricity</td>
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</table>

**TOTAL BUILDING CONSUMPTION:**

<table>
<thead>
<tr>
<th>Proposed Building Consumption</th>
<th>Budget Building Consumption</th>
<th>Optimized Energy Performance</th>
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<tbody>
<tr>
<td>7,217.4</td>
<td>9,702.9</td>
<td>74%</td>
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</table>

### Energy and Cost Summary by Fuel Type

<table>
<thead>
<tr>
<th>Type</th>
<th>DEC&lt;sup&gt;'&lt;/sup&gt; Use [10^6 Btu/hr]</th>
<th>DEC&lt;sup&gt;'&lt;/sup&gt; Cost [$]</th>
<th>ECB&lt;sup&gt;'&lt;/sup&gt; Use [10^6 Btu/hr]</th>
<th>ECB&lt;sup&gt;'&lt;/sup&gt; Cost [$]</th>
<th>DEC&lt;sup&gt;'&lt;/sup&gt; / ECB&lt;sup&gt;'&lt;/sup&gt; Energy %</th>
<th>DEC&lt;sup&gt;'&lt;/sup&gt; / ECB&lt;sup&gt;'&lt;/sup&gt; Cost %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>2,273</td>
<td>$35,488</td>
<td>3,193</td>
<td>$45,286</td>
<td>71%</td>
<td>78%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>4,945</td>
<td>$29,382</td>
<td>6,510</td>
<td>$40,554</td>
<td>76%</td>
<td>72%</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>$0</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Total Nonrenewable</td>
<td>7,218</td>
<td>$64,850</td>
<td>9,703</td>
<td>$85,840</td>
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<tr>
<td>Renewable</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total including Renewable</td>
<td>14,436</td>
<td>$64,850</td>
<td>19,406</td>
<td>$85,840</td>
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</table>

Percent Savings = (ECB<sup>'</sup> $ - DEC<sup>'</sup> $) / ECB<sup>'</sup> $ = 24%
<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Lighting</td>
<td>12</td>
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<tr>
<td>Heating</td>
<td>65</td>
</tr>
<tr>
<td>Cooling</td>
<td>5</td>
</tr>
<tr>
<td>Pumps</td>
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<td>Fans</td>
<td>13</td>
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<td>Dom. Wtr Heat</td>
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<tr>
<td><strong>Total</strong></td>
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# Harley-Davidson PDC Office

## Energy/Cost Distribution %

<table>
<thead>
<tr>
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<tr>
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<td>69</td>
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|        | 100    | 100  |

---
Kettle Foods

- Chip Manufacturing Plant
- Beloit, WI
### Sustainable Sites

<table>
<thead>
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<th>Credit Title</th>
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<tbody>
<tr>
<td>1</td>
<td>Construction Activity Pollution Prevention</td>
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<td>2</td>
<td>Site Selection</td>
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<td>Development Density &amp; Community Connectivity</td>
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<td>Alternative Transportation: Public Transportation Access</td>
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<td>Alternative Transportation: Bicycle Storage &amp; Changing Rooms</td>
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<td>Alternative Transportation: Parking Capacity</td>
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<td>5</td>
<td>Site Development: Protect or Restore Habitat</td>
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<td>Stormwater Management: Quantity Control</td>
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<td>6.2</td>
<td>Stormwater Management: Quality Control</td>
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<td>7.1</td>
<td>Heat Island Effect: Non-Roof</td>
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<td>7.2</td>
<td>Heat Island Effect: Roof</td>
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<td>8</td>
<td>Light Pollution Reduction</td>
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### Water Efficiency

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<tr>
<td>1</td>
<td>Water Efficient Landscaping: Reduce by 50%</td>
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<tr>
<td>1.2</td>
<td>Water Efficient Landscaping: No Potable Use or No Irrigation</td>
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<tr>
<td>2</td>
<td>Innovative Wastewater Technologies</td>
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<tr>
<td>3</td>
<td>Water Use Reduction: 20% Reduction</td>
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<tr>
<td>3.2</td>
<td>Water Use Reduction: 33% Reduction</td>
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### Energy & Atmosphere

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<td>Fundamental Commissioning of the Building Energy Systems</td>
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<td>2</td>
<td>Minimum Energy Performance</td>
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<td>3</td>
<td>Fundamental Refrigerant Management</td>
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<tr>
<td>1</td>
<td>Optimize Energy Performance</td>
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<td>1 to 10</td>
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<td>2.1</td>
<td>On-Site Renewable Energy: 2.5%</td>
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<td>2.2</td>
<td>On-Site Renewable Energy: 7.5%</td>
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<td>2.3</td>
<td>On-Site Renewable Energy: 12.5%</td>
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<tr>
<td>3</td>
<td>Enhanced Commissioning</td>
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<tr>
<td>4</td>
<td>Enhanced Refrigerant Management</td>
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<tr>
<td>5</td>
<td>Measurement &amp; Verification</td>
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<td>6</td>
<td>Green Power</td>
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### Innovation & Design Process

<table>
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<th>Credit Title</th>
<th>Point Value</th>
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<tbody>
<tr>
<td>1</td>
<td>Innovation in Design: Exemplary regional materials</td>
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</tr>
<tr>
<td>1.2</td>
<td>Innovation in Design: Exemplary water use reduction</td>
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<tr>
<td>1.5</td>
<td>Innovation in Design: Public education program to promote sustainability</td>
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<tr>
<td>1.4</td>
<td>Innovation in Design: Process water efficiency</td>
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<tr>
<td>2</td>
<td>LEED™ Accredited Professional</td>
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# Energy Cost Budget

**2007**

**Project Name:** Kettle Foods  
**Date:** May 02, 2007  
**City:** Beloit  
**Weather Data:** Rockford, IL TMY2

<table>
<thead>
<tr>
<th>Source of Energy</th>
<th>Alt-1 Base Case</th>
<th>Alt-2 Envelope - 1st Estimate</th>
<th>Alt-3 Envelope - 1st Estimate</th>
<th>Alt-4 Envlp-AEI light-AAON ERV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proposed</td>
<td>Base %</td>
<td>Peak kBTuh</td>
<td>Proposed</td>
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<tr>
<td><strong>Lighting - Conditioned</strong></td>
<td>Electricity</td>
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<td><strong>Space Heating</strong></td>
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<td>Gas</td>
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<td><strong>Space Cooling</strong></td>
<td>Electricity</td>
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<td>568</td>
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<td><strong>Heat Rejection</strong></td>
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<td><strong>Fans - Conditioned</strong></td>
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<td><strong>Receptacles - Conditioned</strong></td>
<td>Electricity</td>
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<td><strong>Stand-alone Base Utilities</strong></td>
<td>Electricity</td>
<td>6228.8</td>
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<td>Gas</td>
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<td>4830</td>
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<td>4854.5</td>
<td>4446.9</td>
<td>58862.8</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Energy</th>
<th>Alt-1 Base Case</th>
<th>Alt-2 Envelope - 1st Estimate</th>
<th>Alt-3 Envelope - 1st Estimate</th>
<th>Alt-4 Envlp-AEI light-AAON ERV</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Energy 10^6 Btu/yr</td>
<td>Cost/yr $/yr</td>
<td>Energy 10^6 Btu/yr</td>
<td>Cost/yr $/yr</td>
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<tr>
<td><strong>Electricity</strong></td>
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<td>173512</td>
<td>3841.9</td>
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<td><strong>Gas</strong></td>
<td>49536.9</td>
<td>549859</td>
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<td>11240</td>
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<td><strong>Total</strong></td>
<td>60862</td>
<td>723371</td>
<td>4854</td>
<td>70478</td>
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</table>
# Kettle Foods

## Energy Distribution ($10^6$ BTU/YR)

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<tr>
<td>Fuel</td>
<td>3,724 39%</td>
<td>5,097 45%</td>
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<tr>
<td>Gas</td>
<td>4,959 10%</td>
<td>7,227 65%</td>
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<tr>
<td></td>
<td>8,683 100%</td>
<td>12,324 100%</td>
</tr>
</tbody>
</table>

Building Energy Reduction = 30%

Building and Process Energy Reduction = 6.6%
Lab Building

- Heavy-Duty Diesel Lab
- Auburn Hills, MI
# Auburn Hills HDD Expansion

**Estimate Issue Date: 1/10/2007**

## Estimate of Cost for Phase I

<table>
<thead>
<tr>
<th>Item</th>
<th>Title</th>
<th>Cost</th>
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<tbody>
<tr>
<td>1 - Site Work</td>
<td>Demolition &amp; Relocations</td>
<td>$ 46,870</td>
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<tr>
<td></td>
<td>Excavation/Grading, Paving, Fence, Landscaping</td>
<td>$ 33,700</td>
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<td></td>
<td>Site Utilities</td>
<td>$ 252,850</td>
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<td>Site Lighting</td>
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<td><strong>Subtotal</strong></td>
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<td><strong>$ 881,990</strong></td>
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<tr>
<td>2 - General Trades</td>
<td>Demolition</td>
<td>$ 87,000</td>
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<tr>
<td></td>
<td>Substructure</td>
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<tr>
<td></td>
<td>Superstructure</td>
<td>$ 1,207,100</td>
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<td></td>
<td>Roofing Enclosure</td>
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<td></td>
<td>Building Enclosure</td>
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<td>Finishes</td>
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<td>Specialties</td>
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<tr>
<td>3 - Mechanical - Central Systems</td>
<td>Chilled Water</td>
<td>$ 378,050</td>
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<td>Cooling Tower Water</td>
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<td>Process Cooling Water</td>
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<td>Cooling Cell Condensate</td>
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<tr>
<td></td>
<td>Heating Hot Water</td>
<td>$ 298,680</td>
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<td></td>
<td>Humidification Steam &amp; Condensate Drain</td>
<td>$ 62,190</td>
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<td>Insulation for All Central Systems</td>
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<tr>
<td><strong>Subtotal</strong></td>
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<td><strong>$ 1,426,090</strong></td>
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<tr>
<td>4 - Mechanical - Test Cell Support Systems</td>
<td>Cell Ventilation/ Cooling - Cells 5, 6, &amp; 7</td>
<td>$ 325,510</td>
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<tr>
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<td>Combustion Air - Cells 5, 6, &amp; 7</td>
<td>$ 97,310</td>
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<tr>
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<td>Engine Exhaust - Cells 5, 6, &amp; 7</td>
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<td>Scavenge Air System</td>
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<td>Insulation for Above Systems</td>
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<td>Fire Suppression - CO2 Systems</td>
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<td>System Test &amp; Balance</td>
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<td>5 - Mechanical - Building Systems</td>
<td>Piping/Plumbing</td>
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<td>Fire Protection</td>
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<td>HVAC - Office/Labs/Storage/ Mezz/Prep/ Mech &amp; Elec</td>
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<td>6 - Fuel Systems</td>
<td>Engine Lab Fuel Storage</td>
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<td>Engine Lab Fuel Supply &amp; Distribution</td>
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<td>Vehicle Lab - Fueling Station and Drum Storage System</td>
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<td><strong>Subtotal</strong></td>
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<td>7 - Electrical Systems</td>
<td>Service &amp; Distribution</td>
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<td>Grounding</td>
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<td>Motor Control</td>
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<td></td>
<td>Branch Lighting</td>
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<td>Branch Power</td>
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<td></td>
<td>Fire Alarm</td>
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<td>Paving</td>
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<td>Tele/Data Raceway</td>
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<td>Security Access Control</td>
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<td>Testing</td>
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<td><strong>Subtotal</strong></td>
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<td><strong>$ 2,547,860</strong></td>
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# Auburn Hills HDD Expansion

**ESTIMATE OF COST FOR PHASE 1**

**Estimate Issue Date:** 1/10/2007

<p>| | | |</p>
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<tr>
<td>8</td>
<td><strong>Control Systems</strong></td>
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<td>9</td>
<td><strong>Test &amp; Emissions Equipment/Systems</strong></td>
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<td>Test Cell 1 - Transient</td>
<td>$2,969,800</td>
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<td>Test Cell 2 - Transient</td>
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<td>Test Cell 3 - Aging</td>
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<td>Bottled Gas</td>
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<td>Gas Detection System</td>
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<td>MEP Contractor Installation (Dyno, DAS, Emissions)</td>
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<td>ACS Integration &amp; Vendor Management</td>
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<td><strong>Construction Phase Mgmt/Services/Cost</strong></td>
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<td>Construction Mgmt, Design &amp; Const &amp; Comm Phases</td>
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<td><strong>Totals (rounded to nearest $100)</strong></td>
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<td>Direct Costs - Facility</td>
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<td></td>
<td>Direct Costs - Test Equipment</td>
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<td>Indirect Costs</td>
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<td><strong>TOTAL ESTIMATE OF PROJECT COST</strong></td>
<td>$21,191,000</td>
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Lab Building

- Alternate Energy Research Building
LEED-NC Version 2.2 Project Checklist
Project Name AERTC Baseline [Silver Rating]

### Sustainable Sites

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
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<tbody>
<tr>
<td>1</td>
<td>Construction Activity Pollution Prevention</td>
<td>Y</td>
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<tr>
<td>1</td>
<td>Site Selection</td>
<td>Y</td>
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<tr>
<td>1</td>
<td>Development Density &amp; Community Connectivity</td>
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<tr>
<td>1</td>
<td>Brownfield Redevelopment</td>
<td>Y</td>
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<tr>
<td>1</td>
<td>Alternative Transportation: Public Transportation Access</td>
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<td>Alternative Transportation: Bicycle Storage &amp; Changing Rooms</td>
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<td>1</td>
<td>Alternative Transportation: Low Emitting &amp; Fuel Efficient Vehicles</td>
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<td>1</td>
<td>Alternative Transportation: Parking Capacity</td>
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<td>Site Development: Maximize Open Space</td>
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<tr>
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**Total Points:** 5

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**Total Points:** 17

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**Total Points:** 5
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### LEED-NC Version 2.2 Project Checklist

**Project Name: AERTC Gold Rating**

#### Project Totals (pre-certification estimates)
Certified 26-32 points  Silver 33-38 points  Gold 39-51 points  Platinum 52-69 points

#### Sustainable Sites 14 Points

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**Total Points:** 5

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**Total Points:** 13

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**Total Points:** 15
## LEED-NC Version 2.2 Project Checklist

Project Name: AERTC Platinum Rating

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### Energy & Atmosphere

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<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Optimize Energy Performance</td>
<td>1</td>
</tr>
<tr>
<td>2.1</td>
<td>On-Site Renewable Energy: 2.5%</td>
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</tr>
<tr>
<td>2.2</td>
<td>On-Site Renewable Energy: 7.5%</td>
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<tr>
<td>2.3</td>
<td>On-Site Renewable Energy: 12.5%</td>
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<tr>
<td>3</td>
<td>Enhanced Commission</td>
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<tr>
<td>4</td>
<td>Enhanced Refrigerant Management</td>
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</tr>
<tr>
<td>5</td>
<td>Measurement &amp; Verification</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Green Power</td>
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### Innovation & Design Process

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
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<tbody>
<tr>
<td>1.1</td>
<td>Innovation in Design: Exemplary Recycled Content</td>
<td>1</td>
</tr>
<tr>
<td>1.2</td>
<td>Innovation in Design: Green Housekeeping Program</td>
<td>1</td>
</tr>
<tr>
<td>1.3</td>
<td>Innovation in Design: Exemplary Water Use Reduction</td>
<td>1</td>
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<tr>
<td>1.4</td>
<td>Innovation in Design: Process Water Reduction</td>
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<table>
<thead>
<tr>
<th>Credit</th>
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<tbody>
<tr>
<td>2</td>
<td>LEED™ Accredited Professional</td>
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### Materials & Resources

<table>
<thead>
<tr>
<th>Prereq</th>
<th>Description</th>
<th>Required</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Storage &amp; Collection of Recyclables</td>
<td>Required</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Building Reuse: Maintain 75% of Existing Walls, Floors &amp; Roof</td>
<td>1</td>
</tr>
<tr>
<td>1.2</td>
<td>Building Reuse: Maintain 95% of Existing Walls, Floors &amp; Roof</td>
<td>1</td>
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<tr>
<td>1.3</td>
<td>Building Reuse: Maintain 50% of Interior Non-Structural Elements</td>
<td>1</td>
</tr>
<tr>
<td>2.1</td>
<td>Construction Waste Management: Divert 50%</td>
<td>1</td>
</tr>
<tr>
<td>2.2</td>
<td>Construction Waste Management: Divert 75%</td>
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<tr>
<td>3.1</td>
<td>Resource Reuse: 5%</td>
<td>1</td>
</tr>
<tr>
<td>3.2</td>
<td>Resource Reuse: 10%</td>
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<tr>
<td>4.1</td>
<td>Recycled Content: 10% (post-consumer + ½ pre-consumer)</td>
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</tr>
<tr>
<td>4.2</td>
<td>Recycled Content: 20% (post-consumer + ½ pre-consumer)</td>
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<tr>
<td>5.1</td>
<td>Regional Materials: 10% Extracted, Processed &amp; Mfr. Regionally</td>
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<tr>
<td>5.2</td>
<td>Regional Materials: 20% Extracted, Processed &amp; Mfr. Regionally</td>
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<tr>
<td>6</td>
<td>Rapidly Renewable Materials</td>
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<tr>
<td>7</td>
<td>Certified Wood</td>
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### Indoor Environmental Quality

<table>
<thead>
<tr>
<th>Prereq</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Minimum IAQ Performance</td>
<td>Required</td>
</tr>
<tr>
<td>2</td>
<td>Environmental Tobacco Smoke (ETS) Control</td>
<td>Required</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Outdoor Air Delivery Monitoring</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Increased Ventilation</td>
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<tr>
<td>3.1</td>
<td>Construction IAQ Management Plan: During Construction</td>
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</tr>
<tr>
<td>3.2</td>
<td>Construction IAQ Management Plan: Before Occupancy</td>
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<tr>
<td>4.1</td>
<td>Low-Emitting Materials: Adhesives &amp; Sealants</td>
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</tr>
<tr>
<td>4.2</td>
<td>Low-Emitting Materials: Paints &amp; Coatings</td>
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</tr>
<tr>
<td>4.3</td>
<td>Low-Emitting Materials: Carpet Systems</td>
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<tr>
<td>4.4</td>
<td>Low-Emitting Materials: Composite Wood &amp; Agrifiber Products</td>
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<tr>
<td>5</td>
<td>Indoor Chemical &amp; Pollutant Source Control</td>
<td>1</td>
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<tr>
<td>6.1</td>
<td>Controllability of Systems: Lighting</td>
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<tr>
<td>6.2</td>
<td>Controllability of Systems: Thermal Comfort</td>
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<tr>
<td>7.1</td>
<td>Thermal Comfort: Design</td>
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<tr>
<td>7.2</td>
<td>Thermal Comfort: Verification</td>
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<tr>
<td>8.1</td>
<td>Daylight &amp; Views: Daylight 75% of Spaces</td>
<td>1</td>
</tr>
<tr>
<td>8.2</td>
<td>Daylight &amp; Views: Views for 90% of Spaces</td>
<td>1</td>
</tr>
</tbody>
</table>
THANK YOU

This concludes the ASHRAE & AIA Continuing Education Systems Program

Please visit the website
www.ashraemadison.org/crc2007

Questions or Comments??
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