Cost-Effectiveness of Green Home Programs

Jay Hall, PhD
Sept 17, 2008
How to Measure Cost Effectiveness?

• Incremental First Cost
  • Monthly / Amortized Cost

• Monthly Savings

• Net Cost of Ownership
  = Monthly Cost - Monthly Savings
Example #1
Reduce Infiltration to 6.0 ACH50

Monthly Incremental First Cost: $250 ($1 / Month)

Monthly Operational Savings: $4 / Month

Net Cost of Ownership: $3 / Month
Example #1b
Construction Waste Reduction

Monthly Incremental First Cost

$ 100 ($1 / Month) (Create Plan)

Monthly Operational Savings

$ 400 ($4 / Month) (Reduce Hauling Charges)

Net Cost of Ownership

$ 3 / Month
Example #2
No Garage

Monthly Incremental First Cost
$0 / Month

Monthly Operational Savings

Net Cost of Ownership

Cost

Savings

$0 / Month

$0 / Month
Example #2b
High Efficiency Appliances

- Monthly Incremental First Cost: $450 ($2.50 / Month)
- Monthly Operational Savings: $2.50 / Month
- Net Cost of Ownership: $0 / Month

Cost

Savings
Example #3
CO Combustion Venting

- Monthly Incremental First Cost: $450 ($3 / Month)
- Monthly Operational Savings: $0 / Month
- Net Cost of Ownership: $3 / Month

Cost

Savings

$0 / Month
Example #3b
High Efficiency & Rightsized HVAC

Monthly Incremental First Cost

$ 1,000
($5 / Month)

Monthly Operational Savings

$200
($1 / Month)

Net Cost of Ownership

$3 / Month

(Rightsizing)

$1 / Month
Relative Cost Effectiveness of Green Measures
(Individual Measures)

Net Monthly Cost of Ownership

Green Measures

IEQ Measures

($140 / Mo.)
Relative Cost Effectiveness of Green Measures (All Measures Combined)

Net Monthly Cost of Ownership

Green Measures

IEQ Measures

($500/ Mo)
## List of Cost-Effective Measures

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Description of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Water Heating</td>
<td>Efficient Distribution System</td>
</tr>
<tr>
<td>2. Air Infiltration</td>
<td>Good Envelope</td>
</tr>
<tr>
<td>3. Water Heating</td>
<td>Efficient Water Heating Equipment</td>
</tr>
<tr>
<td>4. Waste Management</td>
<td>Construction Waste Reduction</td>
</tr>
<tr>
<td>5. Air Infiltration</td>
<td>Better Envelope</td>
</tr>
<tr>
<td>6. Air Infiltration</td>
<td>Best Envelope</td>
</tr>
<tr>
<td>7. Integrated Project Planning</td>
<td>Preliminary Rating</td>
</tr>
<tr>
<td>8. Insulation</td>
<td>Basic Insulation</td>
</tr>
<tr>
<td>9. Insulation</td>
<td>Enhanced Insulation</td>
</tr>
<tr>
<td>10. Duct Tightness</td>
<td>Reduced Distribution Losses</td>
</tr>
<tr>
<td>11. Landscaping</td>
<td>Limit Conventional Turf</td>
</tr>
<tr>
<td>12. Material Efficient Framing</td>
<td>Framing Efficiencies</td>
</tr>
<tr>
<td>13. Refrigerant Management</td>
<td>Refrigerant Charge Test (Prereq)</td>
</tr>
<tr>
<td>14. Irrigation System</td>
<td>Select High Efficiency Measures from List</td>
</tr>
<tr>
<td>15. Waste Management</td>
<td>Construction Waste Management Plan</td>
</tr>
</tbody>
</table>
## Method for Comparing Programs

<table>
<thead>
<tr>
<th>Type of Measure</th>
<th>Actual Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure #1</td>
<td>Program A</td>
</tr>
<tr>
<td></td>
<td>Mandatory</td>
</tr>
<tr>
<td>Measure #2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure #3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|               | Program A     | Program B     |
|---------------|---------------|
| Measure #1    | 10 pts        |               |
| Measure #2    |               |               |
| Measure #3    |               |               |
|               |               |               |

|               | Program A     | Program B     |
|---------------|---------------|
| Total         | 100 pts       | 400 pts       |
|               | 100 %         | 100 %         |
Comparison of Green Building Rating Systems

- LEED Platinum
- LEED Gold
- LEED Silver
- LEED Certified
- Green Communities
- NAHB Gold
- Built Green Tier III
- NAHB Silver
- EFL Diamond
- Built Green Tier II
- ALA Health House
- CA Green Builder
- EarthCraft House
- Green Point Rated
- NAHB Bronze
- Built Green Tier 1

Percent of Total Points (Increasing level of green performance)

75% of Market
Top 25% of Market
Summary

• It is difficult to compare cost of green measures
  • Limited cost and savings data available
  • How to calculate “cost-effectiveness”?  
  • Should account for interactions (integrative design)

• It is difficult to compare programs
  • Should be an apples-to-apples comparison

building a sustainable future…
BUILDING A FRAMEWORK FOR HEALTHY HOUSING

How Healthy are National Green Building Programs?

Presented by Jill Breysse, CIH
National Center for Healthy Housing

2008 National Healthy Homes Conference  September 15-17, 2008 in Baltimore, MD
Background

Increased Consumer Demand for Homes that are:

- Healthier for families
- Better for the environment
- Less expensive to operate
Background, cont’d

New Construction and Rehab help to:
- Prevent moisture intrusion
- Provide easily cleanable surface and systems to reduce tracking of contaminants into home
- Reduce and eliminate entryways for pests
- Provide sufficient ventilation
- Reduce likelihood of injuries
- Reduce exposure to toxins (radon, VOCs, lead)
Purpose of NCHH Report

- Compare Green Programs to core set of Healthy Homes criteria
- Identify programs offering greatest protection of resident health
- Help gov’t agencies, builders, architects, and homeowners make informed decisions
NCHH Healthy Housing Criteria

- Dry
- Clean
- Ventilated
- Pest-Free
- Contaminant-Free
- Safe
- Maintained
DRY
CLEAN

Cleanable Floors

Walk-Off Mats
VENTILATED

Exhaust fan working?

Hot, humid air—into the attic?
SAFE

Handrails

Locking drawers & cabinets

CO & Smoke Alarms

Temperature settings
CONTAMINANT-FREE

Radon Testing

Radon Mitigation
CONTAMINANT-FREE, continued

ETS

Deteriorated Lead-Based Paint

Vented combustion appliances

Low-VOC materials
PEST-FREE
**Healthy Homes Maintenance Checklist**

The following checklist was developed for the Healthy Homes Training Center and Network as a tool for healthy homes maintenance. A healthy home is one that is constructed, maintained, and installed in a manner that is conducive to good occupant health.

To maintain a healthy home, occupants should keep it dry, clean, and pest-free, and prevent injury and control chemicals/contaminants both indoors and outdoors. Good home maintenance can aid in reducing allergies, prevent illnesses, and reduce injury from accidents. This checklist provides basic guidelines; it may need to be checked more often depending on local conditions and maintenance suggestions.

Developed for the National Healthy Homes Training Center by Tony Bertaina, Coordinator Associate and Ellen Trien, MPH Associate.

<table>
<thead>
<tr>
<th>Indoor/Outdoor</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yard &amp; Exterior</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water share away from house</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fix Trip, falling, clear edge hazards</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Fix around pool leak</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check for signs of rodents, bats, roaches, termites</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check outdoor fixtures and frames</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Clean windows and check drainage</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Clean gutters and downspouts</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Exterior Roof, Walls, Windows - check for leaks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shingles in good condition</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check chimneys, valley, flashing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Make sure gutters drainage water away from building</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check attic vents</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check attic for signs of roof leaks</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check for siding and roof drains</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Look for peeling paint, efflorescence</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Look for signs of leaks where door attaches to frame</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Check for signs of moisture, dampness</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Porch, balcony, cracked glass</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Look for signs of leaks at window and door sites</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Clean exterior drains</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Clean exterior doors are clear</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Building a healthy and safe environment for all children - 11237 Wapner Commons, Suite 200, Columbia, MO 65202 - www.centre.org
Public and Private Sector Building Guidelines

- Enterprise Community Partners Green Communities Criteria
- USGBC LEED for Homes
- NAHB Green Home Building Guidelines
- US EPA Energy Star with Indoor Air Package
Enterprise Community Partners
Green Communities Criteria

- Integrated design process
- Site, location, and neighborhood fabric
- Site improvements
- Water conservation
- Energy efficiency
- Materials beneficial to the environment
- Healthy living environment
- Operations and maintenance
US EPA Energy Star with Indoor Air Package (IAP) Pilot Specifications

- Moisture control
- Radon control
- Pest control
- HVAC systems
- Combustion safety
- Building materials
- Home commissioning
USGBC LEED for Homes

- Awareness and education
- Location and linkages
- Energy and atmosphere
- Sustainable sites
- Water efficiency
- Indoor environmental quality
- Materials and resources
- Innovation and design processes
Resource efficiency
Energy efficiency
Water efficiency
Indoor environmental quality
Ops, maintenance, & homeowner educ.
Global impact
Site planning & land development
## Method of Analysis - Scoring System

<table>
<thead>
<tr>
<th>Score</th>
<th>Green Program Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Includes <em>mandatory</em> criterion equivalent to NCHH criterion</td>
</tr>
<tr>
<td>2</td>
<td>Includes <em>mandatory</em> criterion similar to NCHH criterion</td>
</tr>
<tr>
<td>1</td>
<td>Includes <em>optional</em> criterion that is similar to NCHH criterion</td>
</tr>
<tr>
<td>0</td>
<td>Does not include similar criterion</td>
</tr>
</tbody>
</table>
## Grading Key

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>&gt;100% of target score, <em>all</em> NCHH criteria included</td>
</tr>
<tr>
<td>A</td>
<td>90-100% of target score</td>
</tr>
<tr>
<td>B</td>
<td>80-89% of target score</td>
</tr>
<tr>
<td>C</td>
<td>70-79% of target score</td>
</tr>
<tr>
<td>D</td>
<td>&lt;70% of target score</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th></th>
<th>Enterprise Green Commun.</th>
<th>ENERGY STAR Indoor Air Pkg</th>
<th>USGBC LEED Homes</th>
<th>NAHB Green Building Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry (10 criteria-25 pts)</td>
<td>24 (96%)</td>
<td>24 (96%)</td>
<td>22 (88%)</td>
<td>12 (48%)</td>
</tr>
<tr>
<td>Clean (2 criteria-5 pts)</td>
<td>1 (20%)</td>
<td>0 (0%)</td>
<td>1 (20%)</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Ventilated (7 criteria-17.5 pts)</td>
<td>17 (97%)</td>
<td>21 (120%)</td>
<td>17 (97%)</td>
<td>8 (46%)</td>
</tr>
<tr>
<td>Safe (5 criteria-12.5 pts)</td>
<td>5 (40%)</td>
<td>5 (40%)</td>
<td>5 (40%)</td>
<td>3 (24%)</td>
</tr>
<tr>
<td>Contaminant-Free (7 criteria-17.5 pts)</td>
<td>18 (103%)</td>
<td>17 (97%)</td>
<td>10 (57%)</td>
<td>9 (51%)</td>
</tr>
<tr>
<td>Pest-Free (1 criterion-2.5 pts)</td>
<td>3 (120%)</td>
<td>3 (120%)</td>
<td>2 (80%)</td>
<td>1 (40%)</td>
</tr>
<tr>
<td>Maintained (2 criteria-5 pts)</td>
<td>6 (120%)</td>
<td>5 (100%)</td>
<td>6 (120%)</td>
<td>5 (100%)</td>
</tr>
</tbody>
</table>
# National Green Programs Health Grades

<table>
<thead>
<tr>
<th>Health Principles</th>
<th>Green Communities</th>
<th>Energy Star IAP</th>
<th>USGBC LEED-H</th>
<th>NAHB Bldg Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRY</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>CLEAN</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>WELL VENTILATED</td>
<td>A</td>
<td>A+</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>SAFE</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>CONTAMINANT-FREE</td>
<td>A</td>
<td>A</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>PEST-FREE</td>
<td>A+</td>
<td>A+</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>MAINTAINED</td>
<td>A+</td>
<td>A</td>
<td>A+</td>
<td>A</td>
</tr>
<tr>
<td>OVERALL GRADE</td>
<td>B+</td>
<td>B+</td>
<td>B-</td>
<td>D+</td>
</tr>
</tbody>
</table>
Conclusions

- All green programs not created equal
- Ventilation & pest mgmt addressed by most programs
- Greater focus needed on safety and cleanability
Recommendations

- **Overall**: More focus on affordable housing
- **Dry**:  
  - Landscaping away from building foundations  
  - Avoid use of mold-susceptible materials in wet areas
- **Safe**:  
  - Lockable chemical storage cabinets  
  - Bathroom grab bars  
  - Water heater temp 120 degrees
- **Contaminant-Free & Clean**:  
  - Active sub-slab depressurization new construction  
  - Options for multi-family smoke-free properties  
  - Smooth and cleanable flooring & walk-off mats  
  - Optional central vacuum
- **Ventilation**: ASHRAE 62.2
Full Report Available at: