

# **Case Study: Building Green with Insulated Vinyl Siding**

**Revised: July 2, 2009**



## Executive Summary

While the market share of “green” homes continues to grow, builders, contractors, and consumers are being inundated with “green” claims from manufacturers of residential building materials and systems. In an effort to separate fact from fiction, the Vinyl Siding Institute commissioned a study to evaluate the environmental performance of insulated vinyl siding. The study was conducted by Newport Ventures, a research and consulting firm with expertise in the housing industry. In investigating the environmental performance of insulated vinyl siding, the following metrics were assessed:

- Environmental life cycle analysis using software sourced from the National Institute of Science and Technology (NIST);
- Contribution to points achieved within nationally recognized green building standards and guidelines;
- Energy conservation potential as projected by building energy simulation software; and,
- Thermal performance as demonstrated by on-site thermal imaging.

Conducted over 2008 and 2009, the study involved two high-performance homes that were built to comply with the rigorous goals of the New York State Energy Research and Development Authority’s (NYSERDA) High Performance Residential Development Challenge, one in Saratoga Springs, NY, and one in Burnt Hills, NY. The Challenge was conceived to educate home builders on construction of cost effective, high performance homes designed to achieve 50 to 60 percent energy savings from typical homes built to New York’s stringent energy code. Additionally, the Saratoga Springs home achieved the first LEED® for Homes’ Gold rating issued for the Capital Region of New York. Insulated vinyl siding was specified as the cladding on both of the homes.

Grouped according to the metrics assessed in the study, key findings included:

### *Environmental Life Cycle Analysis*

Based on a fully developed environmental life cycle analysis generated by NIST’s Building for Environmental and Economic Sustainability software (BEES® 4.0), standard vinyl siding outperforms the market average environmental performance score of typical siding materials by 77 percent.

### *Green Building Standards and Guidelines*

Use of insulated vinyl siding can help achieve up to three points under the current LEED® for Homes point system. When combined with other environmentally preferable products, insulated vinyl siding can help achieve up to 205 points under the National Green Building Standard™.

### *Energy Conservation Potential*

Whole building energy simulation using REM/Rate 12.61 indicated that specification of insulated vinyl siding in lieu of fiber cement siding for a typical home in New York’s Capital Region results in projected annual savings of \$56 in natural gas and electric utility costs, 448 pounds of CO<sub>2</sub> and 3.2 million Btu. Across all climate zones, the average savings for specifying insulated vinyl siding in lieu of fiber cement siding were

projected to be \$47 in natural gas and electric utility costs, 497 pounds of CO<sub>2</sub>, and 3.3 million Btu.

#### *Thermal Performance and Imaging*

On the Burnt Hills, NY home, a side-by-side field test was conducted to compare the thermal performance of insulated vinyl siding with James Hardie fiber cement siding. Thermal imaging clearly indicated there was less heat loss from the home to outdoors with insulated vinyl siding compared to James Hardie fiber cement. The exterior surface temperature of the insulated vinyl siding section of the wall was colder, indicating there was more thermal bridging with the fiber cement.

#### *Consumer Perception*

While consumer perception is not typically regarded as a green building metric, it does provide a good litmus test for reception and integration potential of a green building material. In the case of the Saratoga Springs home, the study found that environmental performance and visual appeal can go hand-in-hand through the use of insulated vinyl siding. A survey conducted at the site revealed that 68 percent of visitors found the siding to be “very attractive” while 95 percent agreed that the visual appeal of the siding was “better than average.” The LEED® Gold certified home also was winner of the Best Exterior Award in the 2008 Saratoga Showcase of Homes.

Overall, the study provides documentation that insulated vinyl siding can outperform exterior cladding alternatives on environmental measures.

## Background

U.S. Census Bureau data has shown that vinyl siding is installed more often than any other exterior cladding in new housing construction. Builders and home owners have developed a preference for vinyl siding because of its affordability and durability. But as builders are learning more about building “green,” they’re also discovering that specifying insulated vinyl siding offers environmental and aesthetic benefits as well.

Insulated vinyl siding combines the environmentally preferable characteristics of vinyl with the energy savings benefit of expanded polystyrene (EPS) insulation to result in a product that saves on home energy costs while reducing environmental impact. Insulated vinyl siding can be installed as a two-step process, with vinyl siding installed over an EPS backer profile, or as an integral product, arriving at the site with EPS adhered to the back face of the siding.

To evaluate the specification and performance of insulated vinyl siding in residential construction, insulated vinyl siding was installed on two single family homes that were recently constructed in New York State. One of the homes was a single family ranch, built by Belmonte Builders in Saratoga Springs. The other was a two story colonial, built by Stewart Construction in Burnt Hills. The homes were constructed under the New York State Energy Research and Development Authority’s (NYSERDA) High Performance Residential Development Challenge program. The builders of these homes started with a goal of achieving 50-60 percent energy savings from typical homes built to the already stringent energy codes in New York. In achieving this goal, the builders showed preference for systems that offered both energy savings and affordability. Insulated vinyl siding was specified by both builders as a system to help them achieve their energy conservation and green building goals.

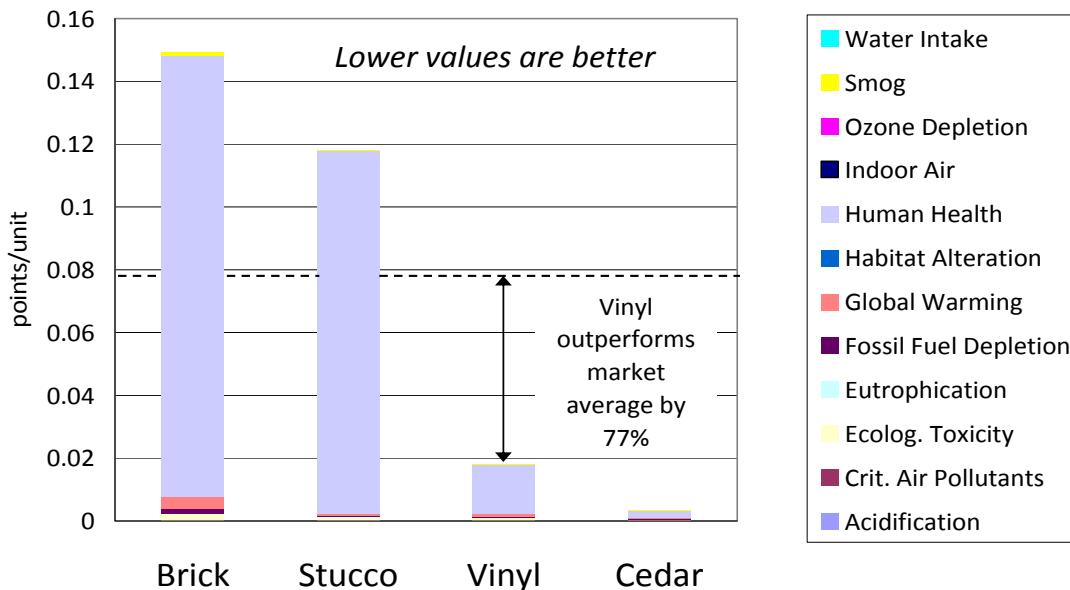


This insulated vinyl sided home by Belmonte Builders pursued LEED® certification and became the first home in the Capital Region of New York to achieve a LEED for Homes® Gold rating.

## Vinyl Siding, an Environmentally Preferred Cladding

In the selection of exterior cladding for single family dwellings, builders typically choose between standard vinyl siding (30% of new construction market share), brick (23%), and stucco (23%), with wood (8%) and “other” (16%) accounting for the remainder of the market share.<sup>1</sup> To determine environmental preference between these materials, a 100 percent environmental life cycle analysis was conducted using BEES<sup>®</sup> (Building for Environmental and Economic Sustainability) software<sup>2</sup>, developed by the National Institute of Science and Technology. Using significance weightings developed by the U.S. EPA across all twelve environmental categories available for analysis within BEES, standard vinyl siding was shown to have a better environmental score than brick or stucco. In fact, of the top four siding products by market share, vinyl siding outperforms the market average by 77 percent. This gives vinyl siding a clear advantage among conventional exterior cladding for achieving green building goals. Insulated vinyl siding is not currently available for analysis within BEES. The fiber cement siding industry has not submitted environmental impact data to BEES; therefore it could not be included in the analysis.

### Environmental Performance of Siding Alternatives



Output of 100 percent environmental performance LCA as conducted using BEES<sup>®</sup> software. Standard vinyl siding shows better performance than brick or stucco and is 77 percent better than the market average. All environmental factors tracked by BEES were considered in this analysis. Though cedar siding is the best performer among these choices in a 100 percent environmental LCA, a BEES economics performance LCA projects standard vinyl siding's life cycle costs to be less than half that of cedar. Life cycle costs for cedar siding would include maintenance costs associated with recurring painting or staining.

<sup>1</sup> U.S. Census Bureau Characteristics of New Housing, 2007 data, <http://www.census.gov/const/C25Ann/sftotalexwallmat.pdf>

<sup>2</sup> <http://www.bfrl.nist.gov/oe/software/bees/>

## Insulated Vinyl Siding and Green Building Certification Programs

“Green” is judged by many metrics, but the two most recognized systems of evaluating residential green building in the U.S. are LEED® for Homes and the recently completed, ANSI-approved ICC 700-2008 National Green Building Standard™ (NGBS). Because these programs are in their infancy, they have not yet developed the level of sophistication required to recognize environmental performance based on environmental life cycle assessments. Nonetheless, the insulated vinyl siding specified by the builders provided the opportunity to achieve points in the areas of energy efficiency and environmentally preferable materials under both LEED and the NGBS.

In determining the energy efficiency impact of insulated vinyl siding on the homes’ thermal performance, a thermal resistance value of R-2.6 was used for the siding. This value was based on the R-value obtained from testing a quad 4.5" insulated vinyl siding product using *ASTM C1363-05, Standard Test Method for the Thermal Performance of Building Assemblies by Means of Hot Box Apparatus*. The test was conducted on an unsealed insulated vinyl siding wall section with a 15 mph sustained wind on the surface, so this R-value is conservative and appropriate to use for typical insulated vinyl siding configurations.

Based on the process of the two New York homes pursuing green certifications, the project team learned the following about how insulated vinyl siding can help a home achieve a green building rating under LEED for Homes and the NGBS.

Under the LEED for Homes criteria, insulated vinyl siding can help earn points in the following categories:

**EA 1.2 – Exceptional Energy Performance.** Credit is given for expected energy savings as demonstrated by the home’s Home Energy Rating System (HERS) Index. Up to 0.5 points can be attributed to the insulated vinyl siding for typical homes in Climate Zone 5, based on whole building energy simulations (no points for standard vinyl siding).

**EA 2.2 – Enhanced Insulation.** This credit may be claimed as an alternate path to EA 1.2. Insulated vinyl siding can assist in achieving 2 points for enhanced insulation. This credit is given for “insulation that exceeds the R-value requirements of Chapter 4 of the *2004 International Energy Conservation Code (IECC)* by at least 5 percent.” A wood-framed wall with R-13 cavity insulation that uses R-2.6 of insulated vinyl siding has a 23 percent higher whole-wall R-value than the same wall without insulated vinyl siding. Similarly, a wood-framed wall with R-19 cavity insulation that uses R-2.6 of insulated vinyl siding has a 17 percent higher whole-wall R-value than the same wall without insulated vinyl siding.<sup>3</sup> No points are available under this credit for standard vinyl siding.

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<sup>3</sup> Calculated using REM/Rate’s parallel path calculator. Assumptions include: R-0.17 outdoor air film, R-0.68 indoor air film, R-0.45 gypsum, 23% framing factor, R-0.17 fiber cement, R-0.83 plywood sheathing (full), and R-2.6 insulated vinyl siding.



**MR 2.2 – Environmentally Preferable Products.** 0.5 points are awarded if the product contains at least 25 percent post-consumer recycled content. Half the value of the post-industrial recycled content can be applied towards the post-consumer recycled content requirement. Vinyl siding with significant percentages of post-consumer content is becoming available. For example, for their two story colonial, Stewart Construction specified insulated vinyl siding with 60 percent recycled content, 40 percent of which was post-consumer and 60 percent of which was post-industrial. The post-consumer recycled content was valued at  $60\% \times (40\% + [60\%/2]) = 42\%$ , which qualified for 0.5 points under this credit. Another 0.5 points are available if the insulated vinyl siding or standard vinyl siding is “extracted, processed, and manufactured within 500 miles of the home.” This information can be sourced from the manufacturer.

Under the ICC 700-2008 National Green Building Standard™ insulated vinyl siding can contribute to points in the following categories:

**601.7: Site-applied Finishing Material.** Building materials or assemblies are utilized that do not require additional site-applied material for finishing. Both insulated vinyl siding and standard vinyl siding are eligible for up to 5 points in this category.

**602.8: Termite-resistant Materials.** When combined with other termite-resistant materials (e.g. structural walls, floors, decks, etc.), both insulated vinyl siding and standard vinyl siding may help builders achieve up to 6 points.

**604.1: Recycled Content.** When at least one other building material with recycled content is used in a building, both insulated vinyl siding and standard vinyl siding with recycled content will help builders qualify for 1-6 points, depending on the percent of recycled material. Vinyl siding products with significant percentages of post-consumer content are becoming available. As an example, the insulated vinyl siding used in Stewart Construction’s two story colonial in Burnt Hills had 60 percent recycled content, which was eligible for four points in this category.

**608.1: Indigenous Materials.** Depending on the proximity of the building site to the manufacturing facility, both insulated vinyl siding and standard vinyl siding may qualify for 2 points.

**609.1: Life Cycle Analysis.** “A more environmentally preferable product or assembly is selected for an application based upon the use of a Life Cycle Assessment (LCA) tool compliant with ISO 14044 or other recognized standards that compare the environmental impact of building materials, assemblies, or the whole building.” Vinyl siding has been shown in LCAs to be more environmentally preferable than other exterior cladding, and as such is eligible for 3 points. If a whole-building LCA is completed, both insulated vinyl siding and standard vinyl siding can help contribute 15 points.

**610.1: Innovative Practices: Manufacturer’s Environmental Management System Concepts.** Check with your insulated vinyl siding or standard vinyl siding manufacturer to see if their production facility is ISO 14001 certified. If it is, and at least 1 percent of the estimated total cost of building materials is sourced from such manufacturers, then 1 point is awarded for each 1percent specified, to a maximum of 10 points.

**700: Energy Efficiency.** Builders may choose from the performance or prescriptive path to achieve points for insulated vinyl siding (no points are available for standard vinyl siding).

**702.2: Energy Cost Performance Levels (Energy Performance Path).** Energy efficiency features are implemented to achieve energy cost performance that exceeds the ICC IECC by the following: (1) 15 percent = 30 points; (2) 30 percent = 60 points; (3) 50 percent = 100 points; (4) 60 percent = 120 points

Energy simulations of a typical home<sup>4</sup> showed that insulated vinyl siding can be expected to save 1-5 percent of the home’s IECC compliant energy cost budget, regardless of the home’s geographic location. Specifying insulated vinyl siding in tandem with other energy conservation measures will help builders achieve points under this credit.

**703.1.1: Building Envelope UA (Energy Prescriptive Path).** Where the total building thermal envelope UA outperforms code minimum values, it is eligible for the following points:

Table 703.1.1	Total Building Thermal Envelope UA				
	Climate Zone				
	2	3	4	5-6	7-8
	Points				
<b>10% UA improvement</b>	10	12	14	16	18
<b>20% UA improvement</b>	20	24	28	32	36

To gauge the impact that insulated vinyl siding can have on achieving points under this credit, REM/Rate v.12.61 software was used to model the total UA of a typical<sup>4</sup> home with and without insulated vinyl siding. Based on this analysis, specification of insulated vinyl siding resulted in an improvement in the home’s UA of 5-8 percent across all climate zones. Combined with other improvements in the building envelope, insulated vinyl siding can be used to achieve points under this category.

## Insulated Vinyl Siding: Performance and Benefits

REM/Rate, the most widely used whole-building energy simulation tool, was used to simulate the anticipated energy, environmental, and economic benefits expected from the specification of insulated vinyl siding. This analysis was performed on Stewart Construction’s two story colonial home located in Burnt Hills, NY, first with James Hardie fiber cement siding and then with insulated vinyl siding. Improvements based on specifying insulated vinyl siding instead of fiber cement siding were then recorded and summarized. Expected annual savings based on this analysis included \$56 in natural gas and electric utility costs, 448 pounds of CO<sub>2</sub>, and 3.2 million Btu of energy consumed at the home.

Because benefits of increasing insulation vary by climate zone, simulations were conducted on this same “typical”<sup>4</sup> two story colonial home across the eight IECC climate zones. Based on the study of this specific home in these locations, specification of

<sup>4</sup> Assumptions for “typical” home include: two story, 2280 sq. ft., minimum efficiency equipment, compliance with minimum prescriptive path of 2006 IECC except for vinyl windows (U=0.35, SHGC=0.30) and basement insulation (R-11 instead of R-10). Foundation and mechanical equipment assumed are typical for climate zone (e.g. basements and furnaces/central AC for cold climates, slab on grade and heat pumps for warm climates).



insulated vinyl siding in lieu of fiber cement siding can be expected to result in the following improvements or annual savings across climate zones:

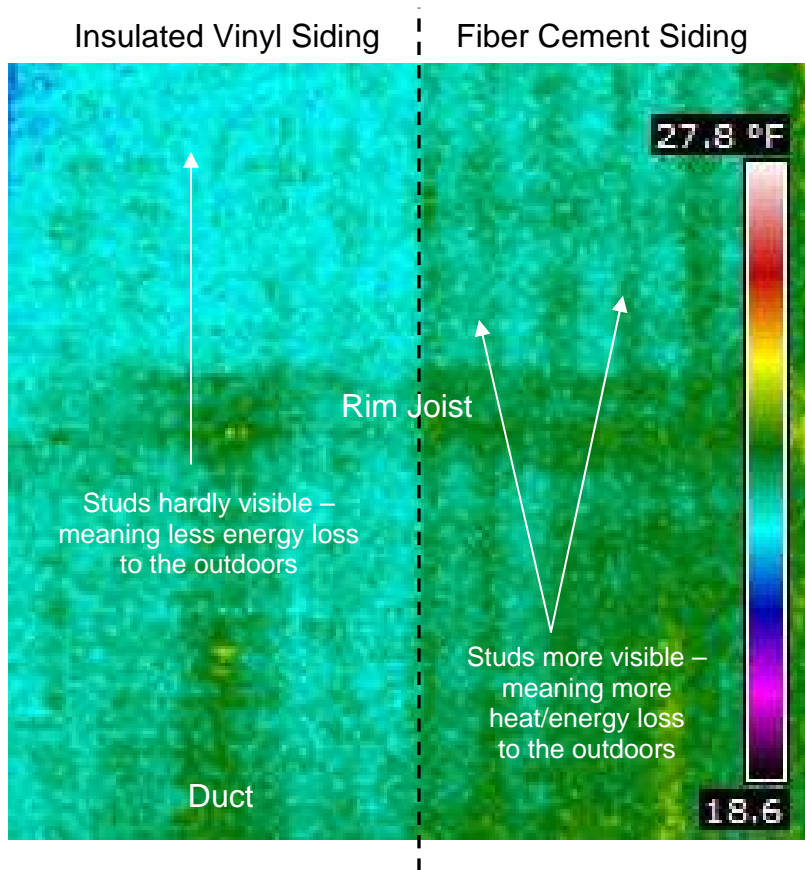
- Energy Savings: 0.6-6.2 MM Btu (average of 3.3)
- HERS Index Improvement: 1-2 points (average of 1.9)
- CO<sub>2</sub> Emissions Savings: 167-755 lbs (average of 497)
- Utility Cost Savings: \$14-\$80 (average of \$47)
- Percent Utility Cost Savings: 2-5% (average of 3%) based on total heating, cooling, and water heating costs

Climate Zone	Representative City	HERS Index Improvement	SAVINGS			
			Energy (MM Btu)	Emissions (lbs CO <sub>2</sub> )	Utility Cost (\$)	Utility Cost (%)
N/A	Albany, NY	1	3.2	448	\$56	3%
1	Miami, FL	1	0.6	167	\$14	2%
2	Phoenix, AZ	2	1.0	336	\$27	3%
3	Memphis, TN	2	1.6	583	\$40	4%
4	Baltimore, MD	2	4.5	581	\$80	5%
5	Chicago, IL	2	3.4	427	\$43	3%
6	Helena, MT	2	4.3	538	\$58	3%
7	Duluth, MN	2	4.8	589	\$57	3%
8	Fairbanks, AK	2	6.2	755	\$57	2%
	<b>Avg</b>	1.9	3.3	497	\$47	3%
	<b>Min</b>	1.0	0.6	167	\$14	2%
	<b>Max</b>	2.0	6.2	755	\$80	5%

To gauge the thermal performance of the insulated vinyl siding as installed, a field test was conducted to offer a comparison between the insulated vinyl siding and James Hardie fiber cement siding on the two story colonial in Burnt Hills. A two story section of a south-facing, above-grade wall was outfitted with both insulated vinyl siding and James Hardie fiber cement siding. This particular section of wall was selected because of its uniform nature (i.e., no openings) to permit a better comparison between the siding systems. The siding products were installed by a contractor who was certified through the Vinyl Siding Institute, Inc. (*VSI Certified Installer Program*) and who also received training on the installation of fiber cement from a fiber cement manufacturer. Cavity insulation was provided with low density spray polyurethane foam to minimize any thermal effects that could be caused by air leakage through the wall sections. To approach steady-state conditions of heat transfer across the wall sections, the indoor



temperature was maintained at 68°F for one day prior to taking readings. Infrared images were taken prior to sunrise to minimize any solar radiation effects, with an inside-to-outside temperature differential of 41°F across the wall. Infrared imagery measures the surface temperatures of components, and when there is a heat flow across an assembly, these temperatures provide a signature of where an assembly is losing the most heat. The image below shows that the insulated vinyl siding minimizes heat loss through the wall assembly, especially through the studs (which have the lowest R-value in the overall assembly). This is evident by the fact that the studs are barely visible behind the insulated vinyl siding, while they are clearly visible behind the fiber cement siding.

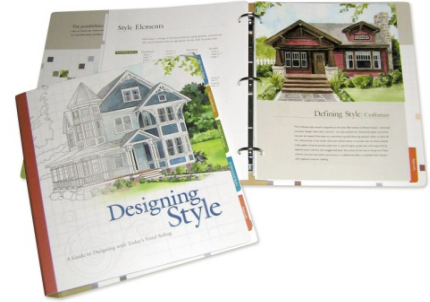


Overall, the exterior surface temperature of the insulated vinyl siding section of wall is colder, indicating less heat/energy loss from the house to outdoors.

## Vinyl Siding and Aesthetics

Energy efficiency advocates have been known to lament that home buyers are more likely to choose granite countertops over a high efficiency furnace. But with insulated vinyl siding, builders can offer prospective buyers a more aesthetically pleasing product that also helps to save energy. An insulated vinyl siding package can be enhanced with architectural design modifications to provide period-appropriate details. Stewart Construction's two story colonial home in Burnt Hills was completed with shutters, door surrounds, crown frieze, window mantels, and return cornices that reflect the Georgian

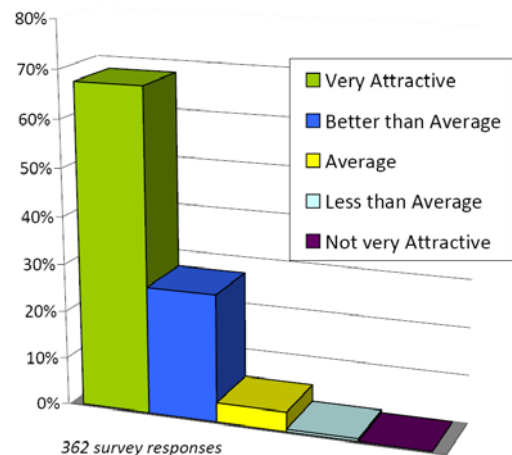
style. The Vinyl Siding Institute's *Designing Style, A Guide to Designing with Today's Vinyl Siding* (pictured at right) served as a resource for selection of these elements and provided key information on Georgian design related to profiles, accents, shapes, color and architectural trim. The guide provides an overview of how a variety of architectural styles can be achieved using vinyl siding, architectural trim and accessories, and is rich in illustrations that are helpful in visualizing the final product.



Designer's illustration of the two story colonial home with Georgian details. Illustration by Georgia Toney of Builder Plan Works.

The deep red vinyl siding with white trim and accessories used by Belmonte Builders on the Saratoga Springs home was well received with groups that toured the home. A survey conducted at the site revealed that 95 percent of the visitors ranked the visual appeal of the vinyl siding as "Better than Average" or above. In fact, 68 percent of visitors gave the insulated vinyl siding the highest rank of "very attractive." This LEED® Gold certified home was also winner of the "Best Exterior" award in the 2008 Saratoga Showcase of Homes.

Consumer Perception of Visual Appeal of Insulated Vinyl Siding



## Findings

Insulated vinyl siding can be used to provide an affordable, aesthetically pleasing, and environmentally preferable siding system for homes. Further, insulated vinyl siding:

- Can help a builder achieve up to 3 points under LEED® for Homes current points system
- Can be combined with other environmentally preferable products to contribute to helping a builder achieve up to 205 points under the ICC 700-2008 National Green Building Standard™<sup>5</sup>
- Outperforms the market average environmental performance score of typical siding materials by 77 percent, based on a fully developed life cycle analysis<sup>6</sup>
- Minimizes thermal bridging as compared to fiber cement siding based on thermal imagery taken of an actual installation
- Provides a very attractive exterior that can be installed with period-appropriate details

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<sup>5</sup> Results will vary based on geographic location and package of energy efficiency and environmentally preferable products and measures specified.

<sup>6</sup> LCA performed using BEES software with EPA weightings, considering all environmental categories available for analysis. Study was conducted for standard vinyl siding and did not include an economic analysis.