

Foamglas® Insulation, Sustainable Design, and the LEED™ Rating System

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Introduction

Sustainable design refers to the design and construction of buildings in a way that meets the needs of today without compromising the needs of the future. Often the focus is limited to environmental impacts, but true sustainable design considers the economic and social aspects of the design in addition to the environmental impacts and looks to balance this “triple bottom line.” Sustainable building design is a holistic look at the entire building process.

Determining exactly what qualifies as sustainable design is difficult and subjective, but many organizations have tried. The most widely used rating system in the U.S. is the LEED-NC (new construction) Rating System. However, sustainable design encompasses many elements not included in the LEED Rating Systems. A better tool for evaluating sustainable design can be found in the *Principles of High Performance School Buildings* developed by the Sustainable Buildings Industry Council. These principles of high performance, sustainable building design are:

- Environmentally responsive site planning
- Energy efficient building shell
- Thermal comfort
- Energy analysis
- Renewable energy
- Water efficiency
- Safety and security
- Daylighting
- Commissioning
- Environmentally preferable materials and products
- High performance HVAC
- High performance electric lighting
- Life cycle cost analysis
- Acoustic comfort
- Superior indoor air quality
- Visual comfort

This framework of principles of high performance buildings provides consideration of several elements not covered in LEED-NC that are key to sustainable design and masonry products. These include durability, efficient use of materials, avoidance of waste, life cycle costs, environmental life cycle assessment, and safety and security

Evaluating Sustainable Design

As mentioned earlier, the most widely used rating system in the U.S. is the LEED-NC Rating System. Other tools used to try to measure sustainable design include, but are not limited to, Green Globes™, BREEAM, and NAHB’s Green Homebuilding. In addition, LEED Canada has also developed a rating system that is slightly different from the U.S. version of LEED.

Green Globes is a building rating system promulgated by the Green Building Initiative (GBI). First developed in Canada and based on the U.K.'s BREEAM rating system, Green Globes is available in a U.S. version. Green Globes is an online building and management environmental audit. It allows for either self-assessment or third-party verification of a building's design and construction. Green Globes is in the process of developing their rating system into an ANSI-recognized consensus standard.

BREEAM is the green building rating system most widely used in the U.K. It was developed by BRE, a research and consulting company and has been in use for over a decade. BREEAM stands for BRE's Environmental Assessment Method. The BREEAM rating system can be used to evaluate new and existing construction, office, retail, residential and other types of construction.

The *Green Home Building Guidelines* were developed by the National Association of Home Builders (NAHB). The *Guidelines* are a checklist of items in seven categories that are designed to reward sustainable building practices in residential construction.

The *LEED Rating System* is a tool for assessing the energy and environmental impact of buildings that was developed by the U.S. Green Building Council (USGBC). LEED stands for Leadership in Energy and Environmental Design, and the purpose of the LEED Rating System is to lead market transformation in the building industry. The LEED Rating System is a voluntary rating system that provides a third-party certification to define what constitutes a "green" building. The USGBC, in conjunction with American Society of Heating, Refrigeration, Air-conditioning Engineers (ASHRAE), is pursuing development of an ANSI-recognized consensus minimum green building standard based on LEED-New Construction.

The *LEED-NC Canada* rating system is based on the U.S. version. Some of the most notable differences for building products are that LEED Canada-NC includes a credit for utilizing durable materials, recognizes differences in method of transport for building products, and uses a specific recycled content calculation for products utilizing cement replacements (supplementary cementing materials).

While each of these rating systems is slightly different in content and approach, there is general agreement on the importance of evaluating

- energy efficiency
- water efficiency
- land use (sites)
- materials and resources (resource efficiency)
- pollution (global impact)
- indoor environmental quality (health and well being)
- transport
- operations and maintenance

Each of the rating systems used in the U.S. is supported by a membership-based organization. Product manufacturers can become members of USGBC, NAHB, GBI, and numerous regional green building associations such as the Green Building Alliance in Pittsburgh, an affiliate of USGBC. Benefits of membership in each of the organizations vary considerably. In my experience, the most direct benefits come from individual sales staff joining regional or local chapters of green building organizations. Local membership allows for direct interaction with architects and other designers directly involved in product specification. Local chapters usually sponsor educational sessions that can also be of value to educate sales staff. Of the national organizations, my experience as a member of USGBC has provided fewer direct benefits. Opportunities to influence or participate in national USGBC committees are extremely limited. Members of USGBC do enjoy discounts on attendance at Greenbuild Expo, voting privileges on ballots such as that for LEED-Homes, and use of the USGBC member logo. Though I am not a member of NAHB, I believe national membership in NAHB may have more direct benefits. I would not recommend membership in GBI at this time because Green Globes is not widely used.

Foamglas® Insulation

This report evaluates the suitability of Foamglas® Insulation manufactured by Pittsburgh Corning (PCC) for use in sustainable commercial building designs. Though many of these strategies may also be appropriate for residential construction, the residential market has several unique aspects that are not covered here. Insights into the suitability of Foamglas® Insulation for sustainable design strategies are based on the information provided by PCC and information available online.

Evaluating the applicability to sustainable design strategies requires an understanding of the use of the product and its manufacture. Based on information received from PCC and that obtained online, the following generalizations can be made.

Foamglas® Insulation

Foamglas® Insulation is used primarily in industrial applications, such as pipe insulation, in the United States. It can also be used as roof, wall or slab insulation for buildings. Foamglas® is characterized by high compressive strength, resistance to moisture, resistance to fire, and lower initial insulating values (lower R-value) relative to other rigid insulations commonly used in buildings in the U.S. such as polystyrene. However the thermal properties of Foamglas® Insulation do not degrade with contact with moisture or with age. Other common building insulations can rapidly lose their insulating properties when subject to moisture or settling.

Foamglas® is manufactured from sand, limestone and soda ash. The raw materials are melted and the resulting glass is crushed to a fine powder with a cellulating agent. The powder is dispensed into molds, and sintered and cellulated (chemical reaction at high temperature) to form large buns. The buns are annealed to eliminate stress and potential breakage. The buns are trimmed into blocks of required size (18"x24"x thickness up to 6"), and then packaged using cardboard made from recycled materials. In this sheet form, Foamglas® Insulation can be used directly as wall or roof insulation. Fabrication of Foamglas® into pipe insulation or other shapes made from blocks produced at the manufacturing plant occurs at separate facilities not owned by PCC.

Melting furnace is fueled by natural gas and electricity. Waste heat is captured in the glass melting process and is reused to preheat combustion air for the melting oven. Cellulating furnaces and annealing ovens are fueled by natural gas. Water used in the process to cool equipment is recirculated and recycled. A minimal amount of fresh water is used to prepare molds. At present no post consumer recycled materials are used in manufacture of Foamglas® in the U.S., though European facilities use approximately 30% post-consumer recycled glass content in Foamglas®.

Foamglas® Insulation also markets adhesives, coatings and sealants made by others under the Pittsburgh Corning label for use in assembling Foamglas® Insulation pieces into piping insulation. Some of these adhesives and coatings are low-VOC.

Foamglas® Insulation and Sustainable Design Principles

As discussed earlier, the applicability of a product to a sustainable building design strategy depends both on its use and characteristics of its manufacture. This section describes each of the high performance sustainable design principles and its applicability to Foamglas® Insulation.

Environmentally Responsive Site Planning

Environmentally responsive site planning includes consideration of site selection, site disturbance, storm water management, and effect of the building on its surroundings. One area of interest is the use of vegetated (“green”) roofs. Vegetated roofs are increasingly used on sustainable building designs to reduce the heat island effect and reduce storm water runoff from the roof. The heat island effect is that effect whereby dark colored surfaces retain excess heat creating a microclimate. This is why oftentimes nighttime temperatures in the countryside are much cooler than in a city. The heat island effect can be reduced by shading of horizontal surfaces and by utilizing light-colored, reflective materials, or by introducing vegetation. Vegetation absorbs moisture and provides an evaporative cooling effect on the roof. Foamglas® Insulation is especially suited for use under a vegetated roof because of its high compressive strength and resistance to moisture.

Energy efficient building shell, Thermal Comfort, and Energy Analysis

An energy efficient building envelope is a key component in sustainable building design. Achieving an energy efficient building envelope includes consideration of both the insulating value of materials as well as the thermal mass of materials.

Foamglas® Insulation can be used to provide the necessary insulation for the building envelope, in both vertical (wall) applications and horizontal (roof) applications. Cavity wall applications for Foamglas® Insulation pose a challenge in that the required thickness to achieve the necessary R-value may exceed the allowable cavity width. Other applications, such as foundation insulation or exterior-applied wall insulation may be more suited to Foamglas® Insulation. As discussed previously, the high compressive strength of *Foamglas® Insulation* may provide an advantage in vegetated roof applications. The weight of vegetated roofs can be significant in some cases. *Foamglas® Insulation* may be especially appropriate in these cases.

Renewable energy

Incorporation of renewable energy sources into a building design can significantly reduce reliance on fossil fuels used by the building during operation. Renewable energy strategies used on sustainable buildings are most often active solar strategies such as photovoltaic panels.

However, passive solar energy can also be used.

Water efficiency

Water efficiency in sustainable buildings has two components: fixtures and landscaping. Low-flow fixtures and other water-saving devices are used to reduce water consumption by the building. Reduction in or elimination of landscape irrigation is the other aspect of achieving water efficiency.

Safety and security

Safety and security are two aspects of sustainable design that are not covered by the LEED-NC Rating System. Fire-resistant construction and resistance to impacts and wind-borne debris promotes occupant health and safety. *Foamglas® Insulation* is non-combustible. Resistance to impact as part of a building envelope may be something to further explore.

Daylighting

The introduction of daylight into the building spaces provides several benefits. Daylighting reduces the demand for electrical lighting. Daylighting can provide a more comfortable space if designed properly. Improvements in test scores and productivity have been documented for daylit space. Good daylighting allows for light penetration deep into the building space while avoiding glare and direct solar lighting on work planes. This is often achieved through the strategic use of overhangs and/or light shelves designed to reflect the light upward to the ceiling. See Figure 1.



Figure 1: School with light shelves (photo courtesy of Wake County Public School System, Raleigh, NC)

Commissioning

Commissioning refers to the process whereby the building systems, particularly the HVAC systems, are evaluated to ensure that they perform as intended.

High Performance HVAC and High Performance Electric Lighting

High performance HVAC and electric lighting systems are designed to respond to occupancy and environmental conditions. High performance HVAC systems may incorporate cooling by flushing with night air under appropriate environmental conditions, or the use of ground-source heat pumps. High performance HVAC also includes use of equipment that does not contain HCFC's and halons. Foamglas® Insulation is often used as piping or duct insulation in HVAC&R applications such as these. High performance electric lighting adjusts electrical light to the actual space needs. It is often sensor-controlled to dim or turn off when adequate daylight is provided.

Environmentally preferable materials and products

Consideration of the environmental impact of building materials and products is an important element in a sustainable design, though it is only one of several criteria to be considered for product selection. Materials should be evaluated over their entire life cycle, from raw material extraction to end of useful life. This life cycle assessment (LCA) of a building material or product must include accurate evaluation of product service life.

There are several aspects to consider in the environmental evaluation of building materials. Life cycle assessment allows for a complete examination of all aspects of building material manufacture and use. It includes all impacts from raw material acquisition to manufacturing to building maintenance and end of building life. This is often called "cradle to grave" for building materials. However in the U.S., life cycle assessment of building materials is often lacking. Few manufacturers can provide such robust information about their products. As a result, green building rating systems such as LEED-NC have developed surrogate measures of environmental impact, as well as measures that reflect on-site construction practices. Thus environmentally preferred products should incorporate one or more of the following strategies:

- Abundance of raw materials
- Efficient use of raw materials
- Use of bio-based or rapidly renewable materials
- Use of recycled materials
- Sustainable measures in acquisition or manufacture
- Use of regionally available materials (near to building project site)
- Regional manufacture or fabrication (near to building project site)
- Recyclable
- Salvageable
- Durable
- Non-toxic (not made of toxic materials)
- Avoidance of construction waste

Foamglas® Insulation may incorporate several of these sustainable strategies. Foamglas® Insulation is made in part from sand which might be considered an abundant raw material. Foamglas® Insulation manufacturing has little waste. Roughly 90% of raw materials are used in the final product. Opportunity exists for obtaining raw materials close to the manufacturing plant. The Sedalia plant sources approximately 75% (by weight) of its raw materials from within

500 miles of the factory, though the distance between raw materials and the factory is not a credit in the LEED-NC rating system.

Foamglas® Insulation is 100% glass and as such is recyclable as is its packaging (cardboard). Foamglas® Insulation is durable and requires no maintenance. Foamglas® Insulation is inert, is not made from toxic materials (no HCFC's), and retains its physical properties for its entire life span.

Foamglas® Insulation can be made of recycled materials, though it is not presently done in the U.S. European facilities use approximately 30% post consumer recycled glass content in the production of Foamglas® Insulation. Foamglas® Insulation is packaged with cardboard made from recycled materials (35-60%).

Life cycle cost analysis

Costs of building materials should be considered over the entire life span of the building. Durable materials like glass products generally have an advantage in that because of their long life and low maintenance, their life cycle costs are often low as compared with products that have a low initial cost but high life cycle cost.

Acoustic comfort

Acoustic comfort is another important element in sustainable designs. Walls with high Sound Transmission Class (STC) values provide superior acoustic insulation. Foamglas® Insulation used in a building envelope can nominally contribute to achieving the minimum STC for walls of 50 required by most rating systems with acoustic criteria. This is something that may warrant further investigation.

Superior indoor air quality

Superior indoor air quality encompasses both the reduction/elimination of pollutants in a building (i.e. tobacco smoke, chemical pollutants) as well as moisture control to avoid mold. *Foamglas® Insulation* is inert, is not food for mold, does not produce volatile organic compounds (no VOCs) and is not made from HCFC's. Low-VOC sealants and adhesives sold by Foamglas® Insulation also help to improve indoor air quality. Though test data is not a necessity, claims regarding resistance to moisture and mold, and lack of VOCs that are supported by test data are often seen as more authoritative. The test methods used most commonly for VOC content testing are ASTM D5116-06 and D6670-01.

Visual comfort

Visual comfort can include both views to outdoor spaces as well as avoidance of glare.

The LEED™ Rating System

The most widely used rating system in the U.S. is currently LEED-NC for New Construction and Major Renovations. Version 2.2 is organized into five environmental categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality; plus an innovation and design category to recognize exceptional performance or areas not covered in the other categories. Each category may contain mandatory prerequisites as well

as voluntary credits that are worth points toward a building project's certification. Figure 2 shows the percentage of points in each of the five environmental categories.

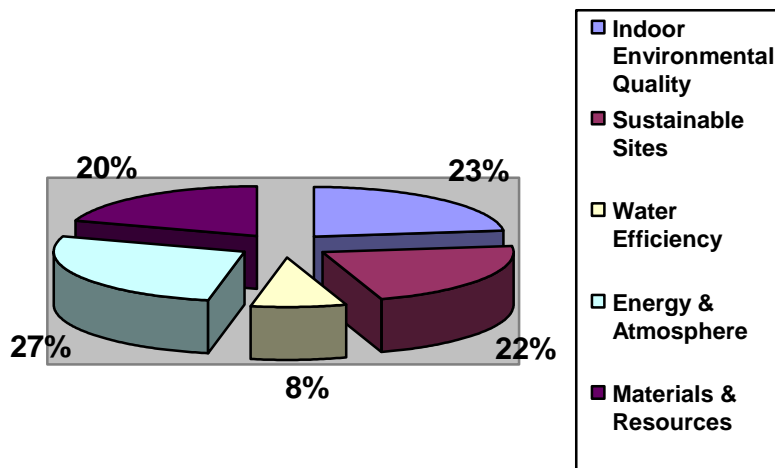


Figure 2: LEED Categories

Certification

A building project must earn at least 26 points out of a possible 69 to be LEED certified. In the LEED Rating System, the more points a building project earns, the “greener” the building (or the smaller the negative impact of the building on the environment). The USGBC recognizes four levels of LEED certification (Figure 3).

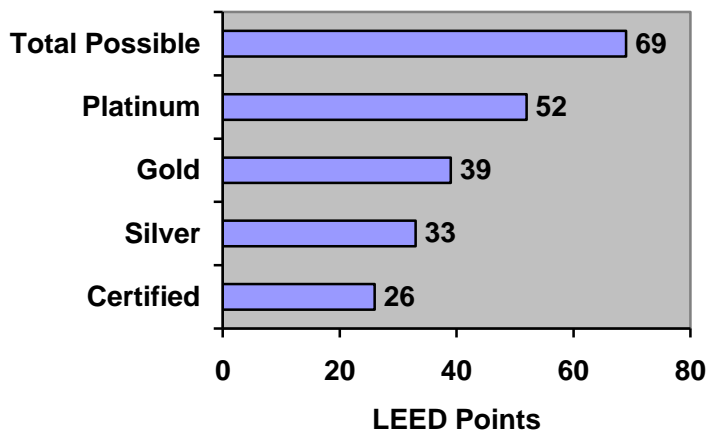


Figure 3: LEED certification levels

Earning LEED Points

Foamglas® Insulation can contribute toward earning LEED points on a project. While no one product or material alone can earn LEED credit points¹, Foamglas® Insulation can be used as part of a strategy to earn points in several credit categories.

¹ Certified wood is the only product that can earn 1 point under Materials & Resource Credit 7.

Sustainable Sites

Credit 6 – storm water management

Credit 7.1 – roof heat island effect

Foamglas® Insulation can be part of a vegetated roof design which is one sustainable strategy that can be used to earn both of these Sustainable Sites credits.

Water Efficiency

It is unlikely that *Foamglas® Insulation* would be part of a strategy for any of the Water Efficiency credits.

Energy & Atmosphere

Prerequisite 2 – minimum energy performance

Credit 1 - Optimize energy performance

Foamglas® Insulation can be used as part of strategies to help achieve the required energy performance and to further reduce the amount of energy consumed by the building.

Prerequisite 3 – fundamental refrigerant management

Credit 4 – enhanced refrigerant management

Foamglas® Insulation is often used as part of HVAC&R systems that do not use HCFC's. *Foamglas® Insulation* has a long life span and does not deteriorate in place.

Materials & Resources

Credits 2.1 and 2.2 – construction waste management – *Foamglas® Insulation* scrap construction waste can be recycled.

Credits 4.1 and 4.2 – recycled content – *Foamglas® Insulation* that incorporates recycled materials can be included in this calculation of the total recycled content in all building materials.

Credits 5.1 and 5.2 – regional materials – this credit recognizes that portion of materials that have both a raw material source and manufacturing facility within 500 miles of the building project site. *Foamglas® Insulation* manufactured in a facility that is within 500 miles of a building project site can include that percent (by weight) of the raw materials that are also within 500 miles of the project site toward the calculation of the total regionally located content in all building materials.

Indoor Environmental Quality

Credit 4 – low-emitting materials – Though insulation is not considered in this section, *Foamglas® Insulation* would also eliminate another potential source of VOC's in a building. Low-VOC sealants and adhesives sold by *Foamglas® Insulation* could be used as part of this strategy.

Innovation and Design

up to 3 points: *Foamglas® Insulation* can help earn points for use of durable materials and good indoor environmental quality (no-VOC; no mold), though to my knowledge the indoor

environmental quality (no mold, etc) credit has not yet been recognized on a LEED-certified project. LEED-Canada does have a credit for durable buildings.

Summary of LEED credits for Foamglas® Insulation

I believe *Foamglas® Insulation* as currently manufactured can be part of a strategy to earn points in the following LEED credits.

- Sustainable Sites
 - Credit 6 – storm water management
 - Credit 7.1 – roof heat island effect
- Energy and Atmosphere
 - Prerequisite 2 – minimum energy performance
 - Credit 1 – optimize energy performance
 - Prerequisite 3 – fundamental refrigerant management
 - Credit 4 – enhanced refrigerant management
- Materials and Resources
 - Credit 2 – construction waste management
 - Credit 4 – recycled content
 - To a lesser extent, possibility for
 - Credit 5 – regional materials
- Indoor Environmental Quality
 - Credit 4 – low-emitting materials
- Innovation and Design
 - Credit 1.1 – durable materials
 - To a lesser extent, possibility for
 - Credit 1.2 – good indoor environmental quality

Summary

Foamglas® Insulation can contribute to a sustainable building design. It is important to recognize the value of the holistic approach taken by the principles of high performance design to achieve a truly sustainable building that considers social and economic impacts as well as environmental ones. Issues such as durability and life cycle cost are not part of the LEED-NC rating system criteria but are important issues for sustainable design.