BUILD GREEN WITH BORAL® BRICKS

Boral® bricks are natural products that are extremely well-suited for construction projects planned with the principals of sustainable design. Boral's fundamental objectives of sustainable design, sometimes described as green building, include:

- **Reducing the negative effects of building on the environment**
- **Reducing the consumption of non-renewable resources**
- **Minimizing waste**
- **Creating healthy, productive environments**
- **Contributing to the health and comfort of building occupants**
- **Improving building performance overall**

According to the U.S. General Services Administration, sustainable design principles include the ability to:

- Optimize site potential
- Minimize non-renewable energy consumption
- Use environmentally preferable products
- Protect and conserve water
- Enhance indoor environmental quality
- Optimize operational and maintenance practices

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BORAL® BRICKS MEETS SUSTAINABLE DESIGN GOALS

Selecting natural materials, such as Boral® brick products, provides environmental advantages for virtually any building project. Brick is composed of mineral elements that stand the test of time without harming the environment as they age. Brick is an ideal choice for architects and builders working to achieve the goals of sustainable design.

Brick meets the following standards incorporated in the philosophy of sustainable design:

- Brick does not emit volatile organic compounds (VOCs) or formaldehyde.
- It is a durable, low-maintenance material.
- It can be salvaged from existing or demolished buildings for re-use.
- Brick is made using natural resources.
- Brick has low "embodied energy" (the energy required to produce and transport materials).
- Brick does not contain CFCs, HCFCs, or other ozone-depleting substances.
- Brick does not contain highly toxic compounds, and the production of brick does not result in highly toxic by-products.
- Brick creates very little waste when it is manufactured or recycled.
- Brick can be obtained from local resources and manufacturers, which means less energy is consumed to transport materials to the job site.
- Brick is completely recyclable, either whole for re-use in new projects, or crushed for roadway sub-base or permanent mulch in landscaping. Brick can also be ground to manufacture new brick.

A Clemson University analysis of the life cycle and sustainability of exterior cladding materials suggests that greener buildings can be achieved by, among other things:

- The adoption of load-bearing masonry when possible.
- The use of hollow clay brick veneer applications as a means of taking advantage of lower energy consumption in the production and transport of lighter weight brick.
- Designing structures to last beyond a single lifetime, which includes minimizing the use of wood as structural elements.

*Life Cycle Analysis and Sustainability of Modern Building Cladding Materials by Denis A. Brosnan, Ph.D. PE, professor of ceramic and materials engineering at Clemson University, Clemson, SC, USA © 2001, D. A. Brosnan.

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ENERGY ADVANTAGES OF BRICK CONSTRUCTION

As an exterior cladding material, brick offers energy advantages on several fronts. Not only is it a green material that requires comparatively little energy to manufacture, but building with brick also results in structures that have greater energy efficiency than structures built with many other exterior cladding materials, providing long-term energy conservation and savings.

From production to recycling, brick provides greater energy advantages than virtually any other type of exterior cladding:

- Brick construction provides the advantages of thermal mass, holding temperatures constant longer than other materials, resulting in more comfortable interior environments with greater energy efficiency during both cold and warm weather.
- The insulating air space in brick cavity wall construction enhances the advantages of the thermal mass properties of brick.
- When compared to double-reflective glass often used in commercial construction, insulated brick cavity wall construction resists heat gain approximately 50 times better.
- When compared to an insulated metal sandwich panel wall commonly used in commercial construction, insulated brick cavity wall construction resists heat gain approximately nine times better.
- The amount of energy needed to produce brick is lower than most building materials designed for comparable use.
- Virtually all brick used in construction in the U.S. is manufactured in the U.S. with domestically sourced materials, which results in lower transportation costs and energy expenditure for the shipment of raw materials.
- An abundance of brick manufacturing facilities located throughout the U.S. essentially ensures that less energy is used to transport brick to construction sites than to transport other materials, such as aluminum or steel.

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ENVIRONMENTALLY FRIENDLY MANUFACTURING

Beyond compliance, Boral® embraces the principles of sustainable development for continued success and growth. To Boral, sustainable development in the environmental sense means:

- The non-wasteful use of resources, including energy and water, along with the development of processes to reduce the amount of energy required to manufacture each unit of brick.
- Minimizing any adverse impact on the environment at extraction and manufacturing locations and exercising the same level of care and responsibility in the rehabilitation and, where required, remediation of sites.
- Taking into account community needs and expectations, as well as financial considerations, in all operations.
- Non-renewable resources utilized on the basis of competent and cost-effective extraction, optimal recycling and reuse, and progressive development and reuse of alternative materials and energy.

USING NATURAL MATERIALS

Boral® brick products are manufactured from two of the most abundant natural materials on the planet – clay and shale.

The raw materials that Boral uses to produce brick are surface-mined in a way that causes minimal long-term impact to the environment. These are materials that, over the course of centuries, can be used again and again, or can be broken down without harm and returned to the earth. There is effectively no waste and the land at extraction locations is reclaimed according to federal and state guidelines, which often includes replanting with trees or lake development.

And, unlike other building materials, brick creates little waste when it is manufactured. Mining one pound of clay produces nearly one pound of brick with only slight moisture and mineral loss.

Additionally, at some Boral facilities, brick is produced with a combination of clay, shale and recycled wood waste materials. The wood waste is burned away during the firing process, which results in lighter weight brick that can be as much as 20 percent lighter than traditional brick, without sacrificing the integrity of the brick. These lighter brick have enhanced insulating properties and are also more fuel-efficient to transport.

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ALTERNATIVE FUEL SOURCES FOR MANUFACTURING

Respect is a Boral® core value, which includes respect for the environment and the communities in which Boral operates. As part of that respect for the environment, Boral Bricks is at the forefront of exploring and implementing the use of alternative fuel sources for the manufacturing and firing of brick.

METHANE GAS

The U.S. Environmental Protection Agency requires large landfills to capture their methane emissions and either burn them off in a safe, environmentally responsible way, or find alternative uses for these emissions. Many scientists believe that methane emissions contribute to man-made global warming. If not burned as fuel, methane is four times more problematic as a greenhouse gas than when used as fuel.

In March of 2008, Boral Bricks opened its second U.S. facility designed to use methane gas as a fuel source for brick manufacturing in Terre Haute, Indiana. Methane is a clean-burning gas that is produced during the natural decomposition of plant, animal waste and garbage. The Terre Haute plant is the largest brick manufacturing facility in the country, producing approximately 120 million bricks per year.

The plant location was selected for it's proximity to the Victory landfill. Prior to the opening of the Boral facility, the methane from the landfill was being flared off to control the levels of methane entering the atmosphere. The gas is now tapped and piped to the Boral plant for use as an energy source in firing and drying brick. In addition to using landfill methane for power, the facility is a zero waste plant where nearly all materials used are recycled in new batches.

The first Boral Brick facility to use methane gas in brick production was opened in March of 2006, in Union City, Oklahoma. The 165,000-square-foot plant is fueled using a combination of methane and natural gas.

The methane used to fuel the Union City plant is captured from a landfill managed by the Oklahoma Environmental Management Authority. Boral made a substantial investment to develop wells at the landfill to collect the methane gas. The methane is then piped two miles to the brick manufacturing facility, where it is used as an energy source for the production of Boral Bricks. By using methane as an energy resource, Boral has relieved the Union City landfill of the challenging responsibility of methane gas disposal.

Boral is a company committed to cutting-edge, energy-conscience fuel alternatives for manufacturing. By using methane to fuel these plants, an otherwise precarious gas is safely consumed in the production of a usable product. The methane produced by these landfills can provide enough fuel to power these brick manufacturing facilities for more than 25 years.

WOOD WASTE & RECLAIMED MATERIALS

Boral uses sawdust-fired kilns at several manufacturing locations and is exploring the use of forest residuals and reclaimed landfill materials as additional fuel sources. These innovative practices are part of an ongoing corporate mandate to investigate and develop alternative fuel sources, as well as reduce the energy invested in the production of Boral brick products.

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BRICK AND EMBODIED ENERGY

Embodied energy refers to the energy required to extract raw materials, manufacture and transport the materials required to build a structure, as well as the energy that is required to assemble and construct the building.

From the perspective of embodied energy, there is a large amount of energy embedded in every structure. Because of this, other factors become increasingly important when considering embodied energy, such as the life expectancy of the materials. Since brick can have a life expectancy of 100 years or more, the embodied energy required to manufacture brick, spread over the life of a building, can be as little as pennies per year. When compared based on life expectancy, the energy used to produce brick is lower than most commonly used building materials, including concrete, glass, steel and aluminum (AIA Environmental Resource Guide – embodied energy). Because brick is also a natural material that can be re-used as well as recycled in whole or in part, the use of brick in construction provides additional positive contributions to sustainable design.

EMBODIED ENERGY ANALYSIS OF BRICK

MATERIAL	WOOD	BRICK	FIBER CEMENT	CONCRETE	VINYL
kWh/PER TON	640	1240	2060	3200	3840
ADDITIONAL ENERGY REQUIREMENTS	REQUIRES REPEATED PAINTING, STAINING AND/OR SEALING OVER LIFE OF STRUCTURE*	OTHER THAN CLEANING, NO MAINTENANCE OR ADDITIONAL TREATMENT IS REQUIRED	REQUIRES REPEATED PAINTING OVER LIFE OF STRUCTURE*	REQUIRES REPEATED PAINTING OVER LIFE OF STRUCTURE*	OTHER THAN CLEANING, NO MAINTENANCE OR ADDITIONAL TREATMENT IS REQUIRED
PRODUCT LIFE	20–25 YEARS**	100 YEARS	50 YEARS	50 YEARS	50 YEARS
EMBODIED ENERGY/LIFETIME***	25.6 kWh PER TON PER YEAR	12.4 kWh PER TON PER YEAR	41.20 kWh PER TON PER YEAR	64.0 kWh PER TON PER YEAR	76.8 kWh PER TON PER YEAR

* The manufacturing processes used to produce paint, stain and sealers are energy intensive, contributing to the embodied energy in the structure calculated over the life of the structure.

** Life expectancy depends on quality of maintenance.

*** Embodied energy calculated over the life of the structure.

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LEED CERTIFICATION AND THE NAHB NATIONAL GREEN BUILDING STANDARD

These rating systems, which encompass both commercial and residential construction practices, focus on sustainable design principals. These principals consider how the materials used in construction are manufactured, used and disposed of, including recyclability. The application of materials in sustainable design also takes into consideration the energy efficiency and use of resources in the completed building or home.

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, established by the U.S. Green Building Council (USGBC), promotes a whole-building approach to sustainability. LEED Certification is based on a point system as defined in the LEED for New Construction Reference Guide and the LEED for Homes program. Brick offers many advantages for both commercial and residential projects eligible for LEED certification.

The NAHB Green Building Program is a system developed by the National Association of Home Builders that evaluates green standards for residential projects. Homes built to residential green building standards focus attention on energy efficiency, water and resource conservation, the use of sustainable or recycled products, and incorporate measures to protect indoor air quality.

Clay brick products that meet or exceed ASTM C216 and/or C652 standards are applicable for both the LEED and Green Building rating systems.

The chart on the following pages illustrates how brick can play a role in the sustainable design process for all of these programs, whether commercial or residential.

LEED certification provides an opportunity to demonstrate that environmental goals have been met. For more information about LEED, or to register a project for LEED certification, please visit www.usgbc.org. For more information about the NAHB Green Building program, visit www.nahbgreen.org.

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POTENTIAL SUSTAINABLE DESIGN CONTRIBUTIONS FROM BRICKWORK

	LEED-NC[1]	LEED FOR HOMES[2]	NAHB NATIONAL GREEN BUILDING STANDARD[3]
ENVIRONMENTALLY RESPONSIVE SITES			
REUSE EXISTING BUILDINGS Brick masonry buildings can be renovated and reused.	MATERIALS & RESOURCES (MR) CREDIT 1 **3 POINTS**		SITE DESIGN & DEVELOPMENT (SD) 403.9 **6 POINTS** RESOURCE EFFICIENCY (RE) **UP TO 12 POINTS**
URBAN DEVELOPMENT Brick masonry is suitable and highly adaptable to urban infill projects.	SUSTAINABLE SITES (SS) CREDIT 2 **1 POINT**	LOCATION & LINKAGE (LL) CREDIT 3.1 OR 3.2 **1 POINT**	SD 401.1 **4 POINTS** LOT DESIGN, PREPARATION & DEVELOPMENT (LD) 501.1 **4 POINTS**
LOCATION ON SITE Site building to optimize solar radiation (passive solar heating and cooling possible). Maintain open space (brick construction requires minimal disruption of site).	SS CREDIT 5.2 **1 POINT**	INNOVATION & DESIGN (ID) CREDIT 1.5 **1 POINT**	SD 403.2 **6 POINTS**
STORM WATER DESIGN Reduce quantity and improve quality of runoff with permeable brick pavements.	SS CREDIT 6 **2 POINTS**	SS CREDIT 4.1 **4 POINTS**	SD 403.5 **5 POINTS** LD 503.4 **UP TO 5 POINTS**
HEAT ISLAND EFFECT Light-colored pavers can help reduce heat build-up.	SS CREDIT 7 **2 POINTS**	SS CREDIT 3 **1 POINT**	LD 505.2 **4 POINTS**
ENERGY EFFICIENCY, THERMAL COMFORT AND ENERGY ANALYSIS			
IMPROVED ENERGY PERFORMANCE Thermal mass of brick helps reduce heat transfer; pressure-equal-ized brick rain screen walls.	ENERGY & ATMOSPHERE (EA) CREDIT 1 **UP TO 10 POINTS**	EA CREDIT 1 **UP TO 34 POINTS**	ENERGY EFFICIENCY (EE) 703.1.3 **UP TO 6 POINTS** EE 704.3.1 **UP TO 7 POINTS**
THERMAL COMFORT Thermal mass of brick helps reduce indoor temperature swings.	EA CREDIT 1 **UP TO 10 POINTS**	EA CREDIT 1 **UP TO 34 POINTS**	EE 703.1.3 **UP TO 6 POINTS** EE 704.3.1 **UP TO 7 POINTS**
ENERGY ANALYSIS Energy modeling reflects ben-efits of thermal mass of brick.	EA CREDIT 1 **UP TO 10 POINTS**	EA CREDIT 1 **UP TO 34 POINTS**	EE 703.1.3 **UP TO 6 POINTS** EE 704.3.1 **UP TO 7 POINTS**
RENEWABLE ENERGY			
RENEWABLE ENERGY Thermal mass of brick walls and floors can be used in passive solar designs.	EA CREDIT 1 **UP TO 10 POINTS**		EE 3.3.5.1 B **10 POINTS**

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POTENTIAL SUSTAINABLE DESIGN CONTRIBUTIONS FROM BRICKWORK

	LEED-NC[1]	LEED FOR HOMES[2]	NAHB NATIONAL GREEN BUILDING STANDARD[3]
ENVIRONMENTALLY PREFERABLE MATERIALS			
LIFE CYCLE ASSESSMENT	ID CREDIT 1 **1 POINT**	MR CREDIT 2.2 **UP TO 8 POINTS**	RE 609.1 PER PRODUCT: **3 POINTS**
AVOIDANCE OF CONSTRUCTION WASTE Use modular designs to avoid waste.			RE 601.3 **3 POINTS**
RECYCLING OF CONSTRUCTION WASTE Brick and packaging are 100% recyclable.	MR CREDIT 2 **2 POINTS**	MR CREDIT 3.2 **3 POINTS**	RE 605.1 **6 POINTS**
SALVAGED MATERIALS Salvaged brick and pavers can be reused.	MR CREDIT 3 **2 POINTS**	MR CREDIT 2.2 PER PRODUCT: **1/2 POINT**	RE 603.2 **3 POINTS**
RECYCLED CONTENT Brick may contain recycled sawdust, sludge, metallic oxides. Mortar/grout may use fly ash.	MR CREDIT 4 **2 POINTS**	MR CREDIT 2.2 PER PRODUCT: **1/2 POINT**	RE 604.1 **UP TO 6 POINTS**
REGIONAL MATERIALS Brick manufacturing plants are located near raw materials and available throughout the United States.	MR CREDIT 5 **2 POINTS**	MR CREDIT 2.2 PER PRODUCT: **1/2 POINT**	RE 608.1 PER MATERIAL: **2 POINTS**
MATERIALS THAT DO NOT REQUIRE ON-SITE FINISHES No finishes are required of brickwork, can be used inside as well.			RE 601.7 PER MATERIAL: **2** OR **5 POINTS**
MATERIALS MADE WITH RENEWABLE ENERGY Several brick manufacturers use landfill gas or sawdust to fire their brick.			RE 606.3 PER MATERIAL: **2 POINTS**
DURABILITY AND DESIGN FOR SERVICE LIFE			
DURABILITY Brick has a useful life of more than 100 years.			
TERMITE RESISTANT MATERIALS IN AREAS OF TERMITE INFESTATION Insects do not eat brick.		SS CREDIT 5 **UP TO 1 POINT**	RE 602.8 **UP TO 6 POINTS**
WEATHER-RESISTANT BARRIER OR DRAINAGE PLANE INSIDE SIDING OR VENEER Brick veneer introduced the drainage wall.			RE 2.2.9 **8 POINTS**
FLASHING Flashing is always present in well-detailed brick buildings.			RE 602.12 **6 POINTS**
ACOUSTIC COMFORT			
ACOUSTIC COMFORT Brick walls provide an STC of 45 or higher.			

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POTENTIAL SUSTAINABLE DESIGN CONTRIBUTIONS FROM BRICKWORK

	LEED-NC[1]	LEED FOR HOMES[2]	NAHB NATIONAL GREEN BUILDING STANDARD[3]
SAFETY & SECURITY			
FIRE-RESISTANT CONSTRUCTION Brick will not burn or emit toxic fumes.			
IMPACT-RESISTANT CONSTRUCTION Brick masonry resists damage from wind-borne debris and other impacts.			
EFFICIENT USE OF MATERIALS			
MATERIALS WITH MULTIPLE FUNCTIONS Brick walls can serve as structure and finish, provide acoustic separation, and provide thermal mass.			RE 601.9 **4 POINTS**
USE PRODUCTS THAT CONTAIN FEWER RESOURCES THAN TRADITIONAL PRODUCTS Thinner brick units use less material and weigh less; hollow brick units use less material and can be reinforced.			RE 607.1 PER MATERIAL: **3 POINTS**
FOUNDATIONS THAT REQUIRE LESS MATERIAL Pier and panel foundations of brick meet this practice.			RE 601.8 **3 POINTS**
STRUCTURAL SYSTEMS THAT OPTIMIZE MATERIAL USE Engineering design, rather than empirical design, of brick walls provides better utilization of materials.			RE 601.2 **3 POINTS**
SUPERIOR INDOOR AIR QUALITY			
AVOID VOCs Interior brick walls avoid paints.	INDOOR ENVIRONMENTAL QUALITY (EQ) CREDIT 4.2 **1 POINT**	MR CREDIT 2.2 PER PRODUCT: **1/2 POINT**	IE 901.8 **POINTS DEPEND ON APPLICATION**
Interior brick floors avoid carpets and adhesives.	EQ CREDIT 4.3 **1 POINT**	MR CREDIT 2.2 PER PRODUCT: **1/2 POINT**	IE 901.8 **POINTS DEPEND ON APPLICATION**
MOLD With moisture-tolerant materials and finishes, brick is not a food source for mold and can be easily cleaned.			
MISCELLANEOUS			
PRODUCT MANUFACTURER IS ISO 14001 CERTIFIED			RE 610.1 PER PERCENT: **1 POINT**

[1] LEED-NC version 2.2 – Total possible points = 69
[2] LEED for Homes (January 2008) – Total possible points = 136
[3] NAHB National Green Building Standard, Draft 2 (2008) – Total possible points = approximately 2000

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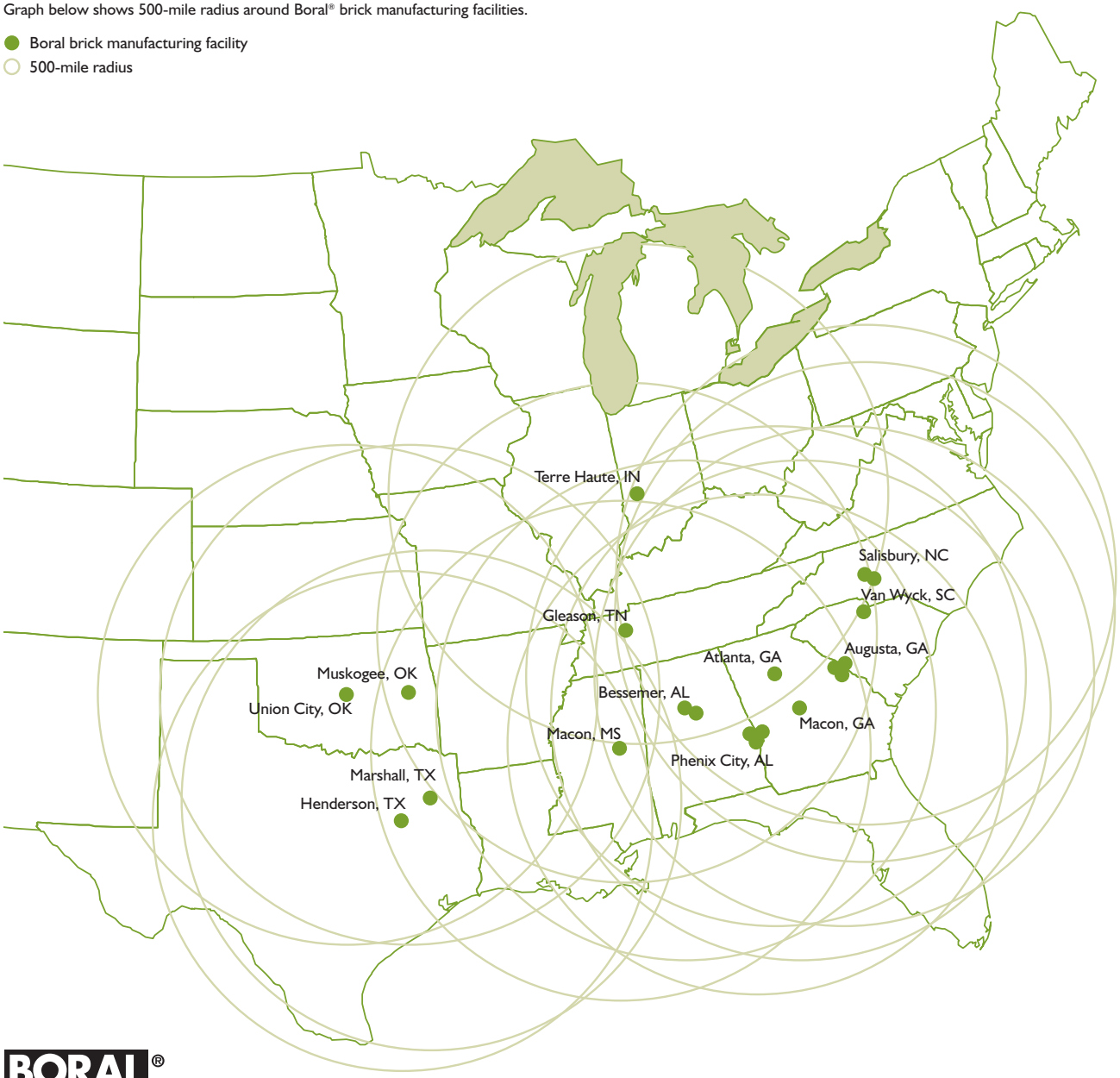
SOURCING FROM REGIONAL MATERIALS

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ offers points in the certification system in the Materials and Resources category under credit 5 for purchasing materials sourced, recycled or manufactured within a 500-mile radius of the project site. Using regional materials reduces the use of fossil fuels for transporting materials.

Graph below shows 500-mile radius around Boral® brick manufacturing facilities.

- Boral brick manufacturing facility
- 500-mile radius



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LIFE CYCLE ANALYSIS OF BRICK

The chart below provides an across-the-board comparison of brick to block masonry, EIFS, fiber cement and vinyl siding. The comparisons in the chart are based on the energy used to manufacture and ship each of these products, as well as other environmental factors to consider when choosing exterior cladding. The figures are determined based on the total life span or "life cycle" of the structure; for example, the total amount of energy required to produce the product averaged over the anticipated life cycle of the product. The life cycle is established as the length of warranty for each product.

CLADDING / LIFE CYCLE ANALYSIS

BASIC DATA	BRICK MASONRY	BLOCK MASONRY	FIBER CEMENT	VINYL SIDING	EIFS
WARRANTY	100 YEARS	50 YEARS	50 YEARS	50 YEARS	5 YEARS
WEIGHT / FT^2	35.5 LB.	42.8 LB.	2.3 LB.	0.5 LB.	1.24 LB.
ENERGY, MINING AND MANUFACTURING	RECYCLING: BRICK 100% MORTAR 40%	RECYCLING: 80%	RECYCLING: 0%	RECYCLING: 80%	RECYCLING: 0%
RECYCLING AND ENERGY KWH / FT^2 / YR	ENERGY: 0.252	ENERGY: 0.228	ENERGY: 0.328	ENERGY: 0.210	ENERGY: 5.48
POLLUTION WATER AND AIR EMISSIONS LB / FT^2 / YR	0.011	0.005	0.026	0.001	0.023
DISTRIBUTION ENERGY AVG / DISTANCE, MILES AND NET ENERGY KWH / FT^2 / YR	175 MILES 0.004	100 MILES 0.004	365 MILES 0.146	310 MILES 0.001	300 MILES 0.189[3]
WASTE AND DEPLETION LB / FT^2 / YR	0.108	0.203	0.048	0.460[4]	0.828
TOTALS					
ENERGY	0.256	0.232	0.474	0.211	5.669
POLLUTION	0.011	0.005	0.026	0.001	0.023
WASTE AND DEPLETION	0.108	0.203	0.048	0.460	0.828

Research data in chart is generated by the National Brick Research Center, Clemson University.
1 There is no proven method of recycling available for fiber cement siding or EIFS.
2 Used the maximum allowed in this analysis (80%). According to the Vinyl Siding Institute, 100% of vinyl siding is recyclable. Some environmental groups claim recycling of vinyl siding results in dioxin emissions.
3 Low weight per truckload influenced results.
4 Depletion of salt in processing PVC influenced results.

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