Environmental Product Declaration

EcoBatt Unfaced Insulation

KNAUF INSULATION

KNAUFINSULATION
it's time to save energy

Knauf Insulation believes that it is in the best interest of public welfare and the environment to reduce the negative impacts associated with the entire life cycle of consumer products.

That's why we are very proud to be the first company in the U. S. to have a biobased binder for all of our insulation products.

At Knauf we understand that the average person spends up to 90% of their entire life indoors. According to the EPA, 72% of the total chemical exposure experienced in a lifetime comes from indoor sources. And, products that make-up a building's construction can be sources of that exposure. So why wouldn't people be interested in what goes into buildings?

At Knauf Insulation being open is part of our DNA.

Find out more at: www.knaufinsulation.us/product-stewardship

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
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ENVIRONMENTAL PRODUCT DECLARATION

KNAUF INSULATION
it's time to save energy

Knauf EcoBatt® Insulation *with ECOSE® Technology*

UNFACED AND KRAFT FACED BATTS AND ROLLS

According to ISO 14025

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Knauf Insulation
DECLARATION NUMBER	4786058564.101.1
DECLARED PRODUCT	Knauf EcoBatt® Insulation with ECOSE® Technology, Unfaced and Kraft Faced Batts and Rolls
REFERENCE PCR	PCR Building Envelope Thermal Insulation v1.2

DATE OF ISSUE	November 8, 2013
PERIOD OF VALIDITY	5 years

CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	UL Environment
	PCR was approved by Panel
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This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	
	Paul Firth
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	
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Environment

ECOBATT with ECOSE

Knauf EcoBatt® Insulation *with ECOSE® Technology*

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Product Definition

Company Description

Knauf Insulation North America is part of the Knauf Group, a large family owned business based in Iphofen, Germany. The insulation portion of the Knauf Group was founded in North America in Shelbyville, Indiana in 1978. All insulation products sold in North America are made in the United States.

Since 1978, the Knauf Insulation business has grown into a global entity, located in 36 countries and has become the second largest glasswool producer in the world today. Well known for its advocacy regarding the positive impact that insulation has on the potential of climate change started Knauf Insulation on a path of sustainable development. Most prevalent in this development began in 2008 when Knauf Insulation launched a green chemistry initiative known as Ecose® Technology whereas the traditional phenol/formaldhyde binders where replaced by a biobased based substitute. The entire glasswool insulation industry is following Knauf Insulation with similar biobased efforts.

By 2010 Knauf Insulation had implemented Ecose® Technology across all of it's insulation product lines and is the only company that offers formaldhyde free, biobased products for all traditonal glasswool applications. Today Ecose® Technology is a separate entity of the Knauf Group, sharing biobased application development with other industries. Knauf Insulation prides itself upon higher density, high quality products. For more information, see http://www.knaufinsulation.us/.

Knauf Insulation is an advocate for recycling and extracting the advantages of using recycled material from an energy reduction standpoint. Knauf Insulation uses approximately 5 railcars of crushed post consumer glass on a daily basis.

Product Description

Knauf Insulation's batts and rolls are glasswool thermal and acoustical products that have very high post-consumer glass content and a bio-based a thermosetting resin that gives the product shape. The products are available unfaced or with kraft, foil, or flame-rated FSK-25 (Foil-Scrim-Kraft) foil facings. Kraft-faced and unfaced batts and rolls, R-11 to R-49, are available.

Manufacturing Locations

This EPD represents the production volume weighted average for the production of kraft-faced and unfaced glasswool insulation at Knauf Insulation's facilities in Shelbyville, IN and Shasta Lake, CA.

Application and Uses

Knauf Insulation EcoBatt Insulation is a cost-effective thermal and acoustical barrier for energy-efficient and comfortable construction. Their consistent quality, low dust, and clean-cutting resilient fibers make fabrication easy and installation fast and friendlier to handle than traditional glasswool products. The products can be used in new and retrofit wood and metal frame applications in residential and commercial structures, as well as in manufactured housing applications. These applications include thermal and acoustical treatments to walls, ceilings, and floors.

In addition, **High Density (HD)** batts are available where optimal thermal performance is desired and space for insulation is limited. High Density Cathedral Ceiling Batts, for example, deliver greater R-value in less space, so builders can increase R-values and still maintain adequate space for ventilation.

Knauf Insulation EcoBatt **QuietTherm®** Insulation's excellent acoustical properties reduce sound transmission when

properly installed in partition walls, ceilings, and floor assemblies.

Knauf Insulation EcoBatt **Staple-Free** Batts are flange-less kraft-faced batts which friction fit between wood studs eliminating the need to staple in place. These batts are designed for use in standard 2" x 4" wood framed construction where the stud spacing is no more than 16" on center.

Installation

Vapor retarders

Kraft, foil, and FSK-25 foil facings applied to EcoBatt act as vapor retarders. The selection and positioning of faced batts should be in accordance with local codes and practices.

Provide heat source clearance:

- Install only non-combustible unfaced glasswool insulation around chimneys, flues and other heat sources.
- Do not install insulation within 3" of recessed electrical fixtures, lights, fans or other heat generating devices unless marked IC.

TIPS TO REMEMBER

- Do not take the insulation out of the packages until you are ready to install. Knauf Insulation's batts and rolls are compression-packed and will greatly expand to the labeled thickness when the package is opened.
- Watch out for nails—especially in attics where roofing nails may protrude through the sheathing.
- In attics place boards over the joists to make a path.
- Do not block attic vents—provide plenty of attic ventilation to prevent condensation.
- Fill in all cracks around windows and doors.
- Be sure the insulation fits well, but is not overly compressed.
- Seal and wrap heating and air conditioning vents, ducts and water pipes in unheated areas.
- Patch any vapor retarder tears.
- Try to fit insulation behind pipes or other obstructions unless this would compress the insulation. If so, cut the insulation to fit around objects, beams or other barriers.
- For additional installation information, see NAIMA literature BI402, "Recommendations for Installation in Residential and Other Light Frame Construction."

Health, Safety, and Environmental Aspects during Installation

Glasswool fibers are a potential mechanical irritant to skin. Long sleeves, gloves and goggles reduce dermal contact. OSHA regulations do not require respiratory protection as long as the exposure to glasswool does not exceed 1 fiber/cubic centimeter (f/cc) TWA (8-hour time weighted average). Installers and fabricators should be aware of their exposure levels and take appropriate actions if needed per recommended work practices. Guidance on typical fiber exposures for various applications can be obtained from the North American Insulation Manufacturers Association, www.NAIMA.org. Knauf Insulation recommends following all safe work practices while working with and/or installing glasswool products. The data from the exposure database relating to glasswool installation is as follows:

Table 1: Glasswool installation from exposure database

Job	Sample Size	Mean	Standard Deviation	Median	Range
Installers	65	0.16 fibers / cm^3	0.12	0.05	0.02 – 0.40

Potential Health Effects

- Acute: Mechanical irritation of the skin, eyes and upper respiratory system. Glasswool fibers are classified as a nuisance dust by OSHA.
- Chronic: None
- Skin Contact: There are confirmed reports of contact dermatitis.
- Eye Contact: A mechanical irritant which can cause moderate to severe eye irritation.
- Ingestion: Non-hazardous when ingested, but potentially a mild irritant to the GI tract if excessive quantity is ingested.

As a safety precaution, facing may be flammable. While glasswool insulation is non-combustible, kraft and non-fire-rated foil facings are combustible and should not be left exposed. Only FSK-25 foil facing is approved for exposed applications. Once installed, non fire-rated faced insulation should be covered with an approved interior finish as required by local codes.

Production

Material Content

Knauf Insulation glasswool is manufactured from two key components: the imorganic glass batch and the organic binder. The batch consists of inorganic minerals used to form the glass fibers. The binder, which holds the fibers together and gives the product shape, is manufactured from predominantly renewable sources (dextrose) and some non-renewable materials. EcoBatt contains recycled glass bottles, minerals, binder, mineral oil, and silicone. Insulation can also have facing, which provides a protective vapor retarder having a permeance rating of 1 perm.

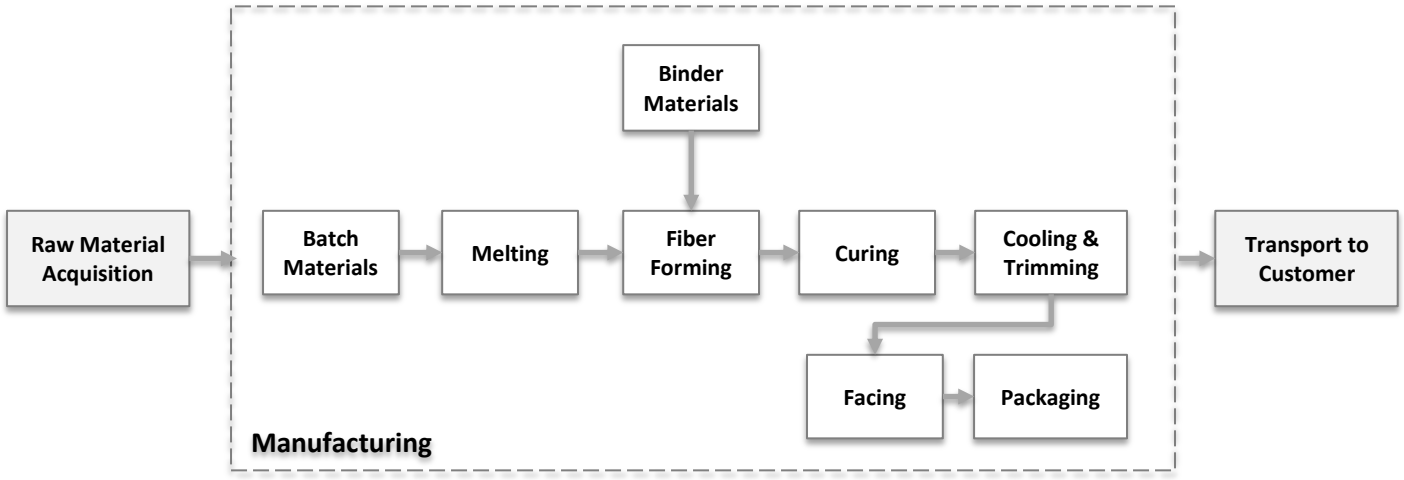
Table 2: Glasswool batts and rolls material content per functional unit

Component	Unfaced Weight Percent	Kraft-Faced Weight Percent	Recycled Resource	Mineral Resource	Renewable	Origin	Inbound Distance [mi]
Glass Batch							
Post-consumer cullet	59%	48%	x			North America	217
Sand	17%	13%		x		North America	236
Borax	9%	7%		x		North America	535
Soda ash	5%	4%		x		North America	886
Quicklime	3%	3%		x		North America	676
Manganese dioxide	< 1%	< 1%		x		North America	1,941
Binder							
Sugars	5%	4%			x	North America	216

Ammonia	< 1%	< 1%		x		North America	10
Ammonium sulfate	< 1%	< 1%		x		North America	2,740
Silane	< 1%	< 1%		x		North America	2,580
Facing							
Kraft/asphalt facing	N/A	19%		x	x	North America	500

Manufacturing Process

Figure 1: Glasswool batts and rolls manufacturing



Health, Safety, and Environmental Aspects during Production

Knauf Insulation management is committed to providing a safe work environment for all employees. To that end employee safety training is considered critical to achieving a safe working environment. Knauf Insulation management has charged the Corporate Environmental, Health and Safety group with the mission “to monitor specific business activities within Knauf Insulation and to provide advice and guidance to minimize the impact of those activities…” This includes our compliance with State and Federal OSHA standards, as well as our Best Practices. Knauf Insulation North America has environmental management and production certifications for ISO 14001:2004, ISO 50001:2011 and ISO 9001:2008.

Life Cycle Assessment – Product System and Modeling

A “cradle-to-grave” life cycle assessment (LCA) was conducted for this EPD. The analysis was done according to the product category rule (PCR) for building envelope thermal insulation and followed LCA principles, requirements, and guidelines laid out in the ISO 14040/14044 standards. As such, EPDs of construction products may not be comparable if they do not comply with the same PCR or if they are from different programs.

While the intent of the PCR is to increase comparability, there may still be differences among EPDs that comply with

the same PCR (e.g., due to differences in system boundaries, background data, etc.).

Functional Unit

Per the product category rules, the functional unit for this analysis is 1 m^2 of insulation material with a thickness that gives an average thermal resistance R_{SI} = 1 m^2K/W and a building service life of 60 years. In imperial units, the R_{SI} value is equivalent to R_{US} = 5.68.

Life Cycle Stages Assessed

A cradle-to-grave life cycle analysis was conducted, from extraction of natural resources to final disposal. Within these boundaries the following stages were included:

- **Raw materials acquisition:** Raw material supply (including virgin and recycled materials), inbound transport
- **Manufacturing:** Production of insulation, packaging of finished product, manufacturing waste, releases to the environment
- **Transportation:** Distribution of the insulation product from the manufacturer to a distributor (if applicable) and from there, to the building site
- **Installation and Maintenance:** Installation process, installation wastes and releases to the environment, maintenance under normal conditions
- **End-of-Life:** Dismantling/demolition, transport to final disposal site, final disposition

System Boundaries

This study covers the entire life cycle of the products, including raw material acquisition and manufacturing, transportation to the building site, installation and maintenance, and finally End-of-Life treatment. Additionally, transportation between stages has been accounted for, including raw material transport to the manufacturing facility and end-of-life transport to the landfill. Manufacturing facility overhead is included. Building operational energy and water use are considered outside of this study's scope: any impact that the use of insulation may have on a building's energy consumption is not calculated or incorporated into the analysis.

Assumptions

The analysis uses the following assumptions:

- Glasswool insulation is assumed to have a 60-year reference service life, equal to that of the building.
- Results represent a production volume weighted average of batts and rolls production at two of Knauf Insulation's facilities. Data, however, were primarily collected from the Shasta Lake facility as manufacturing technologies at the two locations are not materially different. Differences in electric grid mix and in distribution distances between the two facilities, however, are taken into account in the analysis.
- Installation is done by hand and assumed to have a negligible scrap rate (0%).

Cut-off Criteria

Processes or activities that contribute no more than 2% of the total mass and 1% of the total energy may be omitted under PCR cut-off criteria. If omitted material flows have relevant contributions to the selected impact categories, their exclusion must be justified by a sensitivity analysis.

Cut-off criteria were applied to capital equipment production and maintenance under the assumption that the impacts

associated with these aspects were sufficiently small to fall below cut-off when scaled down to the functional unit. Also, packaging for inbound raw materials was excluded from the analysis. Otherwise, all energy and material flow data available were included in the model.

Transportation

Average transportation distances via truck and rail are included for the transport of the raw materials to production facilities. Transport of the finished product to the construction site is also accounted for, along with the transport of construction wastes and the deconstructed product at end-of-life to disposal facilities. Distribution of the finished product is assumed to be volume-limited rather than mass-limited with a utilization rate of 27% of mass capacity.

Period under Consideration

Primary data were collected on insulation production for January 2011 to October 2012.

Background Data

The LCA model was created using the GaBi 6 Software system for life cycle engineering, developed by PE INTERNATIONAL. The GaBi 2012 LCI database provided the life cycle inventory data for upstream and downstream processes of the background system. Proxy data used in the LCA model were limited to background data for raw material production. US background data were used whenever possible, with European or global data substituted as proxies as necessary.

Data Quality

Data quality and representativeness are considered to be good to high. Foreground data were collected from Knauf Insulation's manufacturing facilities, with seasonal variations accounted for by collecting 22 months of data. Aside from capital equipment, no data were omitted under cut-off criteria. All primary data were collected with the same level of detail, while all background data were sourced from the GaBi databases. Allocation and other methodological choices were made consistently throughout the model.

Allocation

Knauf Insulation's facilities produce multiple products, including loose fill glasswool. Allocation of manufacturing material and energy inputs was done on a mass-basis—the one exception being facing, which was allocated based on product surface area. Allocation of transportation was based on mass while accounting for the utilization rate.

For recycled content and disposal at end-of-life, system boundaries were drawn consistent with the cut-off allocation approach. Post-consumer cullet (waste glass), which is used as part of Knauf Insulation's manufacturing process, is assumed to enter the system burden-free in that burden associated with the production of virgin glass is not allocated to the glasswool life cycle. Likewise, the system boundary was drawn to include landfilling of glasswool at end-of-life (following the polluter-pays principle), but exclude any avoided burdens from material or energy recovery.

Use

Glasswool insulation is assumed to have a reference service life of 60 years, equal to that of the building. Once installed, insulation does not directly consume energy, and

requires no maintenance. There are no parts to repair or refurbish. Any reduction in building operational energy consumption associated with insulation use need to be considered on the level of the individual building and are considered outside the scope of the LCA.

End-of-Life

At the end-of-life, insulation is removed from the deconstructed building. Wastes are then transported 20 miles and disposed in a landfill. While batt insulation is commonly reused and recycling is feasible, there are minimal recycling programs and infrastructure; therefore, current practice is to send the waste to a landfill at this time.

Life Cycle Assessment Results and Analysis

Use of Material and Energy Resources

Tables 3 and 4 show the primary energy demands per functional unit. Energy resource consumption is broken down by type and by resource. Figures 2 and 3 illustrate the results graphically.

Table 3: Primary energy demand per functional unit (by type)

Total Primary Energy	Unit	Unfaced Batts & Rolls	Kraft-Faced Batts & Rolls
Non-renewable, oil, coal, natural gas	MJ	9.3	12
Non-renewable, nuclear (uranium)	MJ	0.82	1.0
Renewable, biomass	MJ	0.003	0.003
Renewable, wind, solar, geothermal	MJ	1.0	2.7
Renewable, hydro	MJ	0.41	0.44
Total	**MJ**	**11.6**	**16.5**

Table 4: Primary energy demand per functional unit (by resource)

Total Primary Energy	Unit	Unfaced Batts & Rolls	Kraft-Faced Batts & Rolls
Non-renewable resources			
Fossil oil	MJ	1.8	4.0
Coal	MJ	3.1	3.4
Natural gas	MJ	4.5	4.9
Uranium	MJ	0.82	1.0
Renewable resources			
Biomass	MJ	0.0026	0.0026
Geothermal	MJ	0.0027	0.0039
Hydropower	MJ	0.41	0.44
Solar power	MJ	0.88	2.6
Wind power	MJ	0.12	0.16
Total	**MJ**	**11.6**	**16.5**

Figure 2: Non-renewable primary energy resources

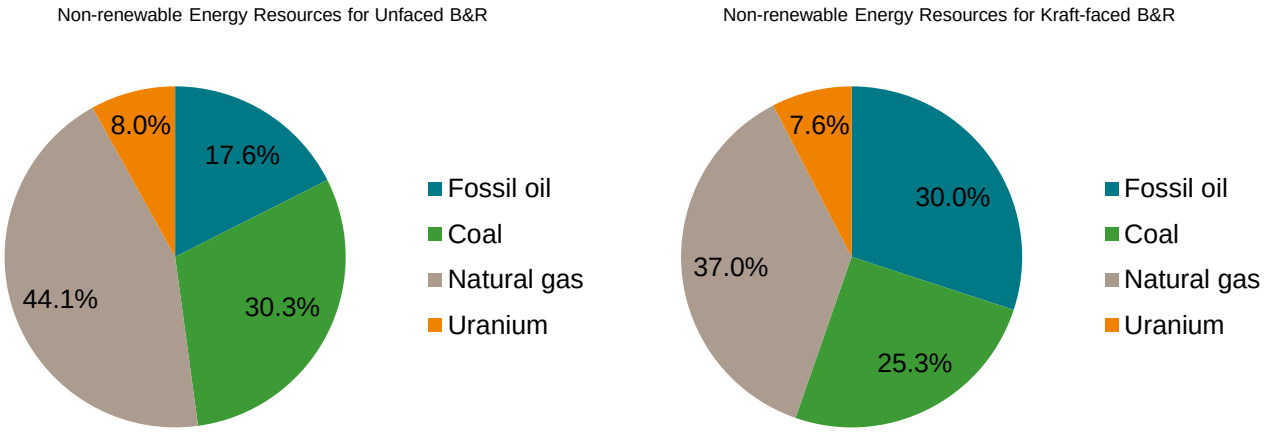
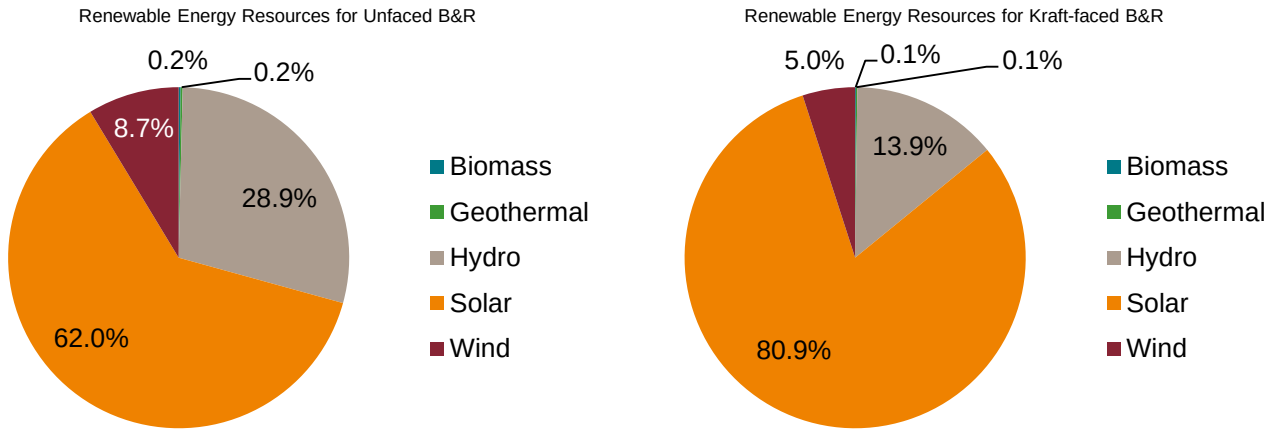


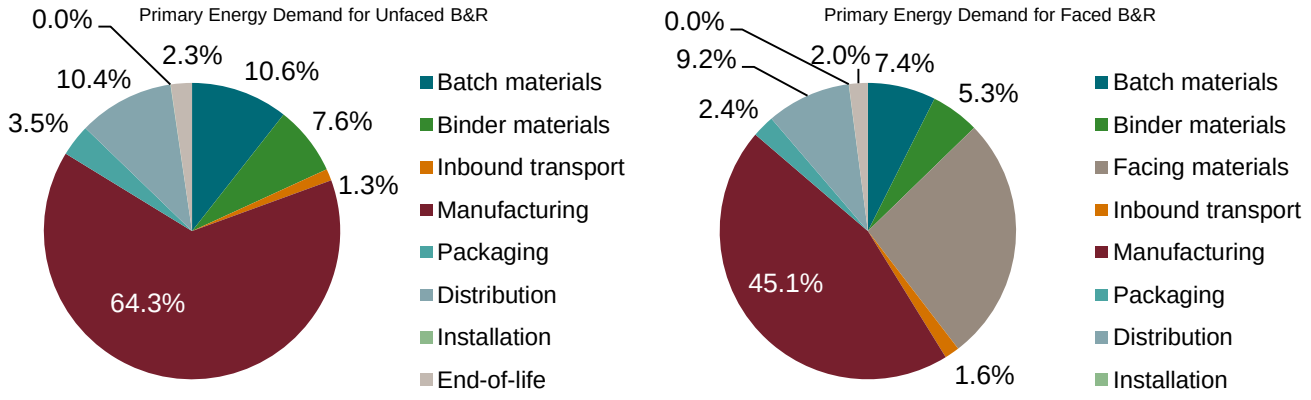
Figure 3: Renewable primary energy resources



Primary Energy by Life Cycle Stage

A breakdown of non-renewable primary energy demand by life cycle stage is shown in Figure 4. The majority of primary energy consumption is attributed to energy consumed during raw materials production and manufacturing. More energy is required to for distribution than for inbound transport of materials due to longer shipping distances as well as lower capacity utilization.

Figure 4: Primary energy demand breakdown by life cycle stage



Life Cycle Impact Assessment

Table 5 contains life cycle impact assessment results per functional unit. Impact results were calculated using the TRACI 2.0 methodology.

Table 5: Life cycle impact category results per functional unit (TRACI 2.0)

Impact Category	Units	Raw Materials	Production	Transport	Installation	End-of-Life	Total
Unfaced							
Global Warming	kg CO_2 eq	1.10E-01	4.58E-01	8.08E-02	2.12E-04	1.61E-02	**6.65E-01**
Acidification	kg mol H^+ eq	4.05E-02	1.15E-01	5.97E-03	2.05E-04	3.43E-03	**1.66E-01**
Eutrophication	kg N eq	7.94E-05	1.27E-04	6.66E-06	1.09E-06	2.34E-06	**2.16E-04**
Smog Creation	kg O_3 eq	8.88E-03	1.33E-02	1.83E-03	2.46E-05	9.84E-04	**2.50E-02**
Ozone Depletion	kg CFC-11 eq	1.64E-11	1.16E-10	2.80E-12	2.47E-14	1.88E-12	**1.37E-10**
Waste to Landfill	kg	–	6.18E-03	–	4.57E-03	3.48E-01	**3.59E-01**
Metered Water	L	–	1.23E+00	–	–	–	**1.23E+00**
Primary Energy	MJ	2.25E+00	7.84E+00	1.20E+00	3.49E-03	2.66E-01	**1.16E+01**
Kraft-Faced							
Global Warming	kg CO_2 eq	1.25E-01	4.58E-01	1.02E-01	2.12E-04	1.64E-01	**8.49E-01**
Acidification	kg mol H^+ eq	6.07E-02	1.15E-01	7.56E-03	2.05E-04	1.26E-02	**1.97E-01**
Eutrophication	kg N eq	1.67E-04	1.27E-04	8.44E-06	1.09E-06	3.68E-05	**3.40E-04**
Smog Creation	kg O_3 eq	1.55E-02	1.33E-02	2.32E-03	2.46E-05	1.83E-03	**3.29E-02**
Ozone Depletion	kg CFC-11 eq	9.23E-11	1.16E-10	3.55E-12	2.47E-14	2.39E-12	**2.14E-10**
Waste to Landfill	kg	–	7.17E-03	–	4.57E-03	4.42E-01	**4.54E-01**
Metered Water	L	–	1.23E+00	–	–	–	**1.23E+00**
Primary Energy	MJ	6.80E+00	7.84E+00	1.52E+00	3.49E-03	3.38E-01	**1.65E+01**

Waste to Disposal

Non-hazardous waste generated from production and at end-of-life is shown in Table 6, along with metered water consumption results per functional unit. There is no hazardous waste associated with this product.

Table 6: Non-hazardous waste and water usage per functional unit

Impact Category	Units	Raw Materials	Production	Transport	Installation	End-of-Life	Total
Unfaced							
Non-Hazardous Waste	kg	–	0.006	–	0.005	0.35	0.36
Water Consumption	gal	–	0.32	–	–	–	0.32
Kraft-Faced							
Non-Hazardous Waste	kg	–	0.007	–	0.005	0.44	0.45
Water Consumption	gal	–	0.32	–	–	–	0.32

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Scaling to Other R-Values

Environmental performance results are presented per functional unit, defined as 1 m^2 of R_{SI} = 1 m^2K/W insulation. In the US and Canada however, insulation is typically purchased based on R-value stated in units of $ft^2 \cdot °F \cdot hr/Btu$. Environmental impacts per square meter of these alternative R-values can be calculated by multiplying the above results for unfaced insulation by scaling factors presented in Table 7. Since facing weight does not scale with R-value, the impacts associated with facing (Table 8) must be added separately.

Table 7: Scaling factors to other R-values

Customary US R-value	Scaling factor per 1 m^2 of R_{SI} = 1	Customary Canadian R-value (R_{SI})	Scaling factor per 1 m^2 of R_{SI} = 1
R-11	1.88	R-8 (1.4)	1.61
R-13	3.05	R-12 (2.1)	2.92
R-15HD	6.13	R-14 (2.5)	4.51
R-19	3.10	R-20 (3.5)	4.60
R-21HD	5.74	R-22 (3.9)	7.09
R-22	4.23	R-24 (4.2)	11.57
R-23HD	8.58	R-28 (4.9)	6.18
R-25	4.61	R-28 HD (4.9)	9.02
R-26	3.98	R-31 (5.5)	6.01
R-30	5.16	R-35 (6.2)	7.72
R-30	4.81	R-40 (7.0)	8.71
R-30HD	7.20	R-49 (8.6)	12.0
R-38	6.56		
R-38HD	9.57		
R-49	12.0		

Table 8: Facing impact per square meter

Impact Category	Units	Facing Impact
Global Warming	kg CO_2 eq	1.85E-01
Acidification	kg mol H^+ eq	3.10E-02
Eutrophication	kg N eq	1.24E-04
Smog Creation	kg O_3 eq	7.92E-03
Ozone Depletion	kg CFC-11 eq	7.71E-11
Waste to Landfill	kg	9.52E-02
Metered Water	L	–
Primary Energy	MJ	4.95E+00

$$\text{Unfaced impact per m}^2\text{ (R-xx)} = \text{Impact scaling factor (R-xx)} \times \text{Unfaced impact per m}^2\text{ } (R_{SI} = 1)$$

$$\text{Kraft-faced impact per m}^2\text{ (R-xx)} = \text{Impact scaling factor (R-xx)} \times \text{Unfaced impact per m}^2\text{ } (R_{SI} = 1) + \text{Facing impact}$$

Additional Environmental Information

Indoor Environment

EcoBatt Insulation products are interior friendly. They are certified to strict indoor air quality standards such as UL Environment's GREENGUARD Gold, and are certified to meet CHPS Low-Emitting Materials criteria section 01350 and are validated to be formaldehyde free. They also meet or exceed all applicable industry performance specifications and standards.

Building Use Stage Benefits

In the following building use phase example, REM/Design™ v-14.0 energy modeling software was used to model the same building with and without insulation to determine the time that the insulation must be in service to recover the life cycle energy (primary energy demand, PED) and the life cycle global warming potential (GWP) that is required throughout the model home design's products' life cycles.

Table 9: Primary energy demand (PED) comparison of a building with and without insulation*

Wall Insulation R-value	Ceiling Insulation R-value	Total annual PED for the home from heating and cooling [MJ]	Total annual energy saved via insulation [MJ]	Insulation life cycle PED [MJ]	Time to recover PED of insulation [days]
None	None	203,000	None	N/A	N/A
R-13	R-38	105,000	97,400	12,700	47
R-15 HD	R-38	103,000	100,000	17,900	65
R-19	R-38	96,500	106,000	12,700	44

Table 10: Global warming potential (GWP) comparison of a building with and without insulation*

Wall Insulation R-value	Ceiling Insulation R-value	Total annual GWP for the home from heating and cooling [kg CO_2 eq]	Total annual energy saved via insulation [kg CO2 eq]	Insulation life cycle GWP [MJ]	Time to recover GWP of insulation [days]
None	None	12,200	None	N/A	N/A
R-13	R-38	6,370	5,840	733	46
R-15 HD	R-38	6,210	6,000	1,030	63
R-19	R-38	5,840	6,370	728	42

* Numbers may not match exactly due to rounding

Analysis assumptions included:

- A 2,115-ft^2 (195-m^2) home from actual builder plans was used for this use stage analysis
- The location for climate considerations was Indianapolis, Indiana
- Cavity insulation only was considered to eliminate influences of exterior insulation
- Wall insulation was increased in R-Value while ceiling insulation was fixed at R-38
- The window area of the home was 15% and the framing factor used was 15% for all scenarios
- The actual R-Value for R-19 is R-16.7 when compressed in a 5½ inch wall cavity
- None of the scenarios provided are intended to represent energy code
- The addition of facing would extend the payback period for PED by 7 to 14% but has a less significant effect on GWP recovery times
- R-15 HD has significantly greater density and that is why it takes longer to recover PED and GWP

Table 11: Home energy impact factors from GaBi 6

Metric	Electricity	Natural Gas
PED, total	10.7 MJ / kWh	1.15 MJ / MJ
GWP	0.667 kg CO_2 eq / kWh	0.0689 kg CO_2 eq / MJ

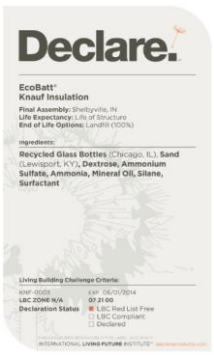
Other Relevant Information

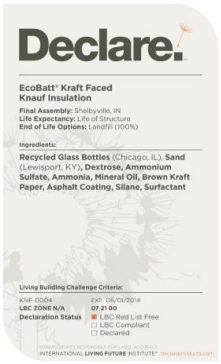
- ASTM C 665; Type I, Class A (unfaced)
- ASTM C 665; Type II, Class C (Kraft faced)
- ASTM C 665; Type III, Class A (FSK-25 foil faced)
- ASTM C 665; Type III, Class B (foil faced)
- Verified formaldehyde-free by GREENGUARD Environmental Institute
- GREENGUARD Certified
- GREENGUARD Gold Certified
- California Energy Commission
- MEA #498-90-M
- State of Minnesota
- EUCEB Certified for Biosolubility of Formulation

Knauf EcoBatt® Insulation *with ECOSE® Technology*

UNFACED AND KRAFT FACED BATTS AND ROLLS

According to ISO 14025





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ISO 14025	ISO 14025:2011-10, Environmental labels and declarations — Type III environmental declarations — Principles and procedures.
ISO 14040	ISO 14040:2009-11, Environmental management — Life cycle assessment — Principles and framework.
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LCA Development

The EPD and background LCA were prepared with support from PE INTERNATIONAL, Inc.

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