Certified Environmental Product Declaration

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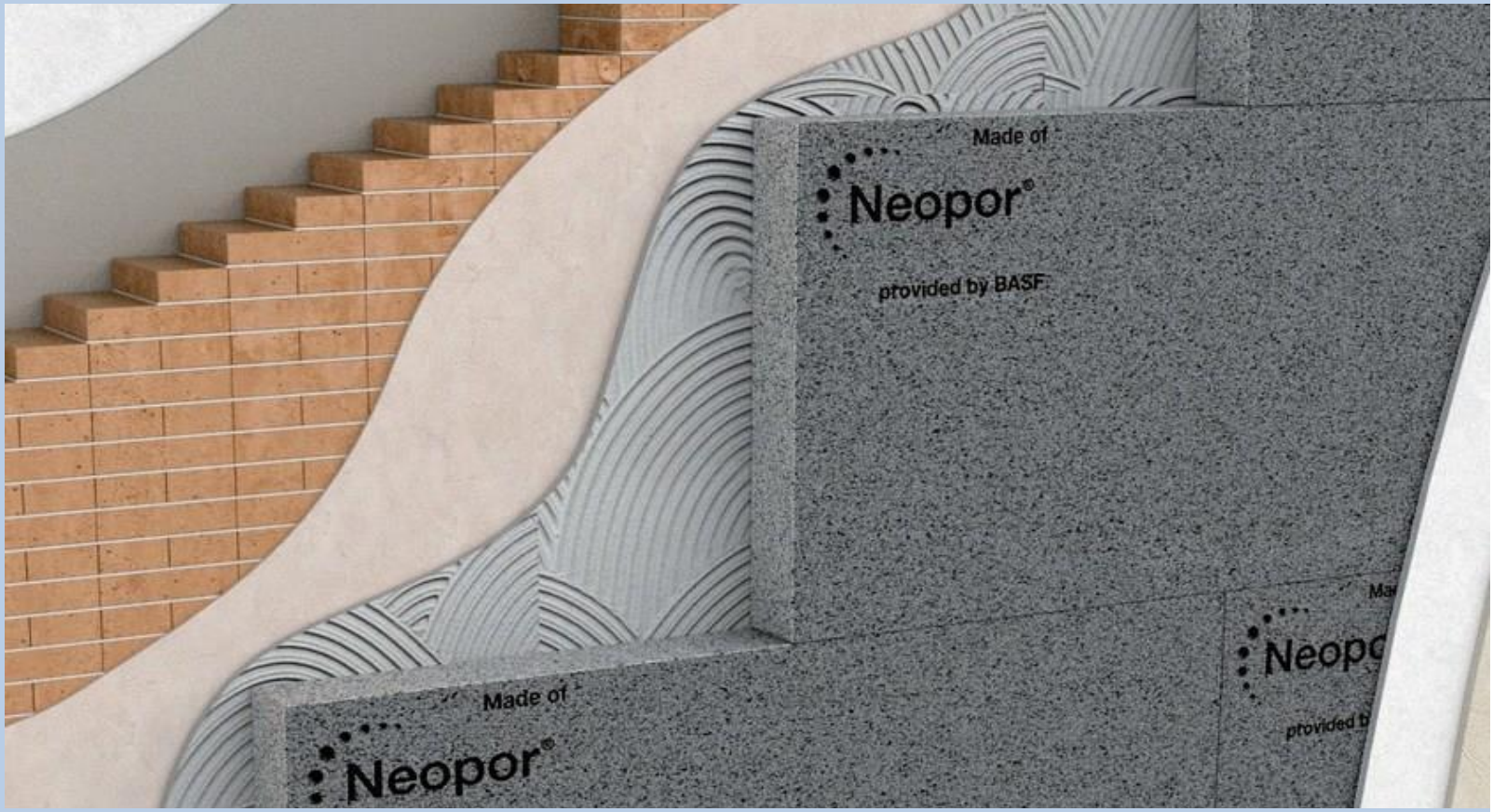
ENVIRONMENTAL PRODUCT DECLARATION

Owner of the Declaration	**BASF Corporation**
EPD Program Operator	NSF Certification LLC
PCR Program Operator	UL Environment
Declaration number	EPD10327
Issue date	February 14, 2020
Period of Validity	5 years

Neopor® Plus Graphite Polystyrene Insulation

BASF
We create chemistry

Neopor®
Innovation in Insulation
provided by BASF



1.0 General Information

EPD Program Operator	NSF Certification LLC 789 N. Dixboro Road. Ann Arbor Michigan 48105 USA www.nsf.org
General Program Instructions & version number	Part A: Life Cycle Assessment Calculations and Report Requirements, Version 3.1
Declaration Holder	BASF Corporation 100 Park Avenue Florham Park, New Jersey 07932
LCA and Declaration Prepared by	Bruce Uhlman, LCACP BASF Corporation 100 Park Avenue Florham Park, NJ 07932
Declaration Number	EPD10327
Declared Product and Declared Unit	1 m^2 of installed Neopor® Plus Graphite Polystyrene Type I insulation material with a thickness that gives an avg. thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 yrs. (packaging included).
Product Category and Subcategory	(category) Building Related Products and Services (subcategory) Building Envelope Thermal Insulation
PCR Program Operator	UL Environment 333 Pfingsten Road Northbrook, IL 60062 https://industries.**ul**.com/**environment**
Reference PCRs	ISO 21930:2017 and EN 15804:2012-04 serve as the core PCR along with Product Category Rules for Building-Related Products and Services; Part A (Standard 10010 version 3.1 4th edition, May 2, 2018) and Product Catgory Rule (PCR) Guidance for Building-Related Products and Services; Part B: Building Thermal Insulation EPD Requirements UL 10010-1 (2nd edition, April 10, 2018). Sub-category PCR was reviewed by Thomas Gloria, Phd (Chair), Industrial Ecology Consultants; Christoph Koffler, Phd, thinkstep and Andre Desjarlais, Oak Ridge National Laboratory.

Date of Issue	February 14, 2020
Period of Validity	5 years from date of issue

Contents of the Declaration	– Product definition and material characteristics – Overview of manufacturing process – Information about in-use conditions – Life cycle assessment results – Testing verifications
This EPD was independently verified by NSF Certification, LLC in accordance with ISO 21930:2017, EN 15804, UL Part A and ISO 14025. **☐ Internal ☒ External**	Jenny Oorbeck, joorbeck@nsf.org
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by	Jack Geibig – EcoForm, jgeibig@ecoform.com

Product's intended application and use and markets of applicability	The performance properties of Neopor® Plus Graphite Polystyrene (GPS) insulation boards make them suitable for use in many applications. The product described in this document is used in applications such as wall insulation, pitched roof insulation, External Insulation and Finish System (EIFS), cavity wall insulation, ceiling insulation, insulation for building equipment and industrial installations.
Product RSL	75 years
EPD Type	Product specific
Range of data set variability	Manufacturer-average
EPD Scope	Cradle to Gate (installation) with options (end of life)
Years of reported Mfg primary data	2014, 2017
LCA Software & Version number	Gabi ts 9.2.0.58
LCI Database & Version number	Gabi ts 9.2.0.58
LCIA Methodology & Version number	TRACI v2.1 and CML 2001 (2016)
Limitations	Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance of Building Envelope Thermal Insulation using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR. Full conformance with the PCR for Building Envelope Thermal Insulation allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

2.0 Product

2.1 Description of Companies

Neopor® Plus GPS (**G**raphite **P**oly**S**tyrene) resin is produced by BASF in Ludwigshafen, Germany. The Neopor® Plus GPS resin is then further processed at various manufacturing plants into insulation boards at one of twenty six North American manufacturing locations.

Atlas Molded Products (1-11): (1) Byron Center, Michigan 8240 Byron Center Ave SW Byron Center, MI 49315; (2) 445 Industrial Park Drive Ridgeway, Martinsville, Virginia 24148 (3) 911 Industrial Drive Perryville, Perryville, Missouri 63775 (4) Privada Misiones No. 1108 Tijuana, Mexico ;Baja California 22244 (5) 1739 Fox Ridge Dr., Fond du Lac, Wisconsin, 54937 (6) 111 West Fireclay Ave., Murray Utah 84107 (7) 809 E. 15th St. Washington, Iowa 52353 (8) 2731 White Sulphur Road, Gainesville, Georgia 30501 (9) 5250 N. Sherman St., Denver, Colorado 80216 (10) 1400 N. 3rd St., Kansas City, Kansas 66101 (11) 13695 Mt. Anderson St., Reno Nevada 89506

Insulfoam (12-19): (12) 628 Western Drive, Anchorage, Alaska 99501 (13) 19727 57th Avenue East, Puyallup, Washington 98387 (14) 1155 Business Park Drive Building A, Dixon, California 95620-4303 (15) 5635 Schaefer Avenue, Chino, California 91710 (16) 1057 Sunburst Lane, Mead, Nebraska 68041 (17) 12601 East 33rd Avenue, Unit 119 Aurora, Colorado 80011 (18) 3401 West Cocopah Street, Phoenix, Arizona 85009 (19) 4500 South Frontage Road, Lakeland, Florida 33815

Plasti-Fab (13-26): (20) 679 Aldford Avenue, Annacis Ind. Est. Delta, British Columbia V3M 5P5 (21) 16135 - 114th Avenue, Edmonton, Alberta T5M 2Z3 (22) 859 – 57th Street East, Saskatoon, Saskatchewan S7K 5Z2 (23) 2485 Day Street, Winnipeg, Manitoba R2C 5G2 (24) 1214 Union Street, Kitchener, Ontario N2G 4G1 (25) 2725 Henkle Drive, Lebanon, Ohio 45036 (26) 40 Mills Road Ajax, Ontario L1S 2H1

2.2 Product description

Neopor® Plus (GPS) insulation boards are graphite polystyrene (GPS) with a polymeric flame retardant in uniform distribution (blowing agent: pentane).

2.3 Application

The performance properties of Neopor® Plus (GPS) insulation boards make them suitable for use in many applications. The product described in this document is used in applications such as wall insulation, roof insulation, External Insulation and Finish System (EIFS), cavity wall insulation, interior insulation, insulation for building equipment and industrial installations.

2.4 Technical Data

Performance data of the product in accordance with the declaration of performance with respect to its essential characteristics according to ASTM C578 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

Name	Value	Value	Value	Value	Unit
ASTM C578 Classification	Type I	Type VIII	Type II	Type IX	
Density ASTM C303	0.90	1.15	1.45	1.80	lbs. / ft^3
Thermal Conductivity (lambda) ASTM C518	0.18	0.18	0.18	0.18	BTU*ft/hr.*ft^2*F
Thermal Resistance ASTM C518	4.7	4.7	4.7	4.7	ft^2*hr.*F/BTU/in
Compressive Resistance ASTM D1621	10	14	20	25	At yield of 10% deformation in psi (min)
Water Absorption by Total Immersion ASTM C272	1.1	1.1	1.1	1.1	Max volume % absorbed

Overall, Neopor® Plus (GPS) insulation boards were evaluated for the following properties:

- Surface Burning Characteristics (ANSI/UL723, ASTM E84)
- Physical Properties (ASTM C578)
- Roofing Systems for Exterior Fire Exposure (ANSI/UL790, ASTM E108)
- Roof Deck Construction Material with Resistance to Internal Fire Exposure (ANSI/UL1256)
- Flammability Testing for Use in Attics and Crawl Spaces (AC12, App. A and B)
- For Use on Exterior Commercial Walls (NFPA 285)
- Material Emissions (UL2818 and California Department of Public Health, CDPH/EHLB/Standard Method

2.5 Delivery status

Neopor® F5300 Plus GPS resin is supplied to various manufacturing locations listed in section 2.1 as lens-shaped granules. Manufacturers provide insulation boards at various densities and shapes to the construction industry. Manufacturing locations noted in section 2.1 are verified molders under the BASF Neopor® Brand Marketing Agreement that utilize BASF Neopor® resins in their UL certified end-use products.

2.6 Base materials / Ancillary materials

Neopor® Plus (GPS) insulation boards are made from the expansion of Neopor® resin through the use of a blowing agent. The Neopor® F5300 Plus GPS resin consists of polystyrene, a blowing agent, graphite and a flame retardant. The composition range for the resin is: polystyrene (85% - 90% by weight), pentane/isopentane (3% - 7% by weight), graphite (3% - 7% by weight) and a polymeric flame retardant (0.5% - 2.0% by weight).

For the preparation of flame-retardant polystyrene granules, a polymeric flame retardant (polymer FR) with about 1.1% by mass is added. Polymer-FR is a brominated styrene-butadiene copolymer (CAS No 1195978-93-8) that is not subject to the REACH Regulation for Substances of Very High Concern. To improve the insulation performance, graphite is added. As a result, the reflection and absorption behavior of heat radiation is changed, whereby the insulating performance of the product is improved with low layer thickness and density. The pentane assists in the expansion process and is released partly during and shortly after production (ageing process).

In addition to the basic materials, the manufacturer does not use any secondary polystyrene material that is reused during the production process. No other additives are used in relevant amounts. Polystyrene and pentane are produced from oil and natural gas, and therefore linked to the availability of these raw materials.

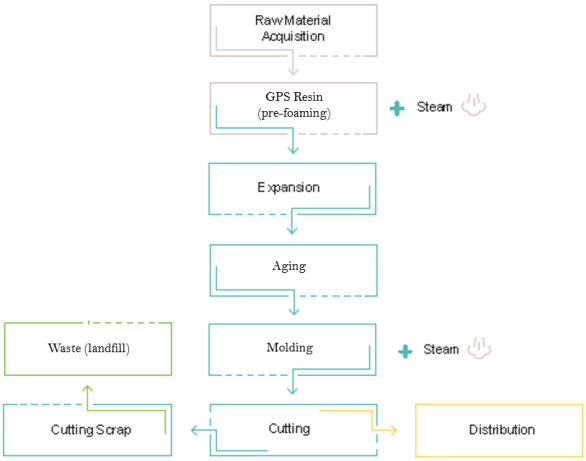
2.7 Manufacture

For the production of Neopor® Plus (GPS) insulation boards, a multi-stage process is carried out. At the beginning Neopor® Plus GPS resin is produced by BASF SE at their Verbund site in Ludwigshafen, Germany followed by the foaming and molding processes at various sites across North America. The conversion process of GPS granules to foamed insulation boards consists of the following manufacturing stages: pre-foaming, conditioning, block molding and finally cutting into the desired sizes.

During the pre-foaming stage, the resin is foamed with the aid of steam and the blowing agent pentane. Subsequently, the expanded granules are stored in air-permeable silos. Due to the diffusing air, the GPS foam particles receive the necessary stability for further processing.

The most commonly used method of producing GPS insulation boards is block molding followed by cutting. In this process, the GPS foam particles are filled into large block-shaped forms and foamed with steam. Then the blocks are cut into boards using mechanical or thermal cutting equipment. Additional edge profiling (tongue and groove or shiplap) can be added through milling machining.

Cut offs are disposed of as waste to landfill.



2.8 Environment and health during manufacturing

During the storage (aging) and processing of Neopor® Plus (GPS) insulation boards, pentane escapes the panels. Especially when cutting the foam with heated wires, good ventilation in the working area is necessary. This is because the vapor contains pentane and small amounts of styrene. Therefore, manufacturing areas should be well-ventilated and maximum workplace concentrations for styrene and pentane must be considered.

No ozone depleting substances as regulated by the EPA, such as CFC or HCFCs, are used as blowing agents for the production of Neopor® Plus Graphite Polystyrene (GPS) insulation materials.

This product contains styrene, which is listed as a hazardous air pollutant (Clean Air Act). This product contains pentane and residual styrene monomer, which OSHA defines as a hazardous chemical (SARA Title III Regulations). This product may be portable under SARA sections 311 and 312, depending on the maximum on-site storage volumes. This product contains a substance subject to a Significant New Use Rule (SNUR) or consent order restriction: TSCA § 5(a) final Significant New Use Restriction (SNUR) 40 CFR 721.10280. Pentane has a CERCLA recordable quantity (RQ) of 100 pounds. All ingredients are listed on the TSCA inventory. This material contains detectable amounts of some chemicals known to the State of California to cause cancer. Styrene oxide is listed as known to the State of California to cause cancer. Styrene oxide is a metabolite of styrene monomer. Pentane, isopentane and graphite are covered by PA, MA and NJ Right To Know (RTK) acts.

2.9 Product processing/Installation

Thermally insulating a building with Neopor® Plus (GPS) insulation boards products is an effective path toward sustainable energy savings. Additionally, Neopor® Plus (GPS) insulation boards are relatively light weight making them easy to process and to work with.

The insulation boards are dimensionally stable and absorb virtually no moisture. This is not only of great

importance for the entire life cycle of the building but also for the construction phase.

For all applications, the relevant standards and building codes as well as manufacturer instructions must be observed. Compliance with model building codes does not always ensure compliance with state or local building codes, which may be amended versions of these model codes. Always check with local building code officials to confirm compliance

Depending on the application, Neopor® Plus (GPS) insulation panels can be adhered to a wall with system approved adhesives or can be mechanically fastened. Different systems require different fastening requirements so consult your system supplier guidelines. Installation does not require any energy or water usage.

2.10 Packaging

External factors, such as solar energy conveyed via reflective surfaces, can create excessive heat build-up within insulation products made of Neopor® GPS foam. Excessive heat-build-up can damage insulation products made of Neopor® GPS foam. Precautionary measures taken in the packaging, storage, transportation and installation of insulation products made of Neopor® GPS foam can help minimize the potential for damage. Insulation products and foam surfaces should be protected at all times from reflected sunlight and prolonged solar exposure. Neopor® Plus (GPS) insulation boards should be packed in white opaque polyethylene plastic bags. Finally, this opaque film packaging is recyclable and can be recycled where suitable return systems exist. However, the recycling of the packaging film is not considered in this EPD.

2.11 Condition of use

Water pick up by capillarity does not occur with Neopor® Plus (GPS) insulation foams, due to the closed cell structure. The thermal insulation performance of Neopor® Plus (GPS) insulation foams is practically unaffected by exposure to water or water vapor due to its drying capability should it ever become wet.

Properly installed Neopor® Plus (GPS) insulation boards are durable with respect to their insulation, structural and dimensional properties. They are water resistant, resistant against microorganisms and against most chemical substances. It should not, however, be brought into contact with organic solvents.

The application of insulation material has a positive impact on energy efficiency of buildings. Quantification is only possible in context with the construction system of the building.

Dependent on the specific material and the frame conditions of installation, residual pentane may diffuse. Quantified measurements and release profiles cannot be declared.

2.12 Environment and health during use

Neopor® Plus (GPS) insulation boards in most applications are neither in direct contact with the environment nor with indoor air. However, when naked EPS/GPS products were tested for VOC emissions, the emissions proved to be below the limit values in countries with such regulation (see section 6.1). Neopor® Plus (GPS) insulation boards have also achieved GREENGUARD Gold certification to UL 2818, product certification for low chemical emissions for building materials, finishes and furnishings.

2.13 Reference service life

If applied correctly, the lifetime of Neopor® Plus (GPS) insulation boards is equal to the building life time, usually without requiring any maintenance. The reference service life considered is 75 years.

2.14 Extraordinary effects

The following is a listing of the standards required for the testing, evaluation and approval of Neopor® Plus (GPS) insulation boards for use in the intended applications and markets as identified in this document.

Fire

Neopor® Plus (GPS) insulation boards are fire and code approved by UL and ICC for ASTM E84, NFPA 285 and NFPA 286 for use in commercial cavity wall with a wide range of cladding approvals.

Finished Neopor® Plus Graphite Polystyrene (GPS) insulation boards manufactured from Neopor® F5300 Plus GPS resins up to a maximum density of 2.0 lbs./ft^3 and a maximum thickness of 6 ins. are qualified to bear a label with a flame-spread index of 25 or less and a smoke-developed index of 450 or less when tested in accordance with ANSI/UL723 (ASTM E84), provided the finished boards are listed and labeled by an approved agency.

Neopor® F5300 Plus GPS granules achieve the fire classification Euroclass E according to [DIN EN 13501-1] and according to B1 [DIN 4102-1].

Water

Neopor® Plus (GPS) insulation boards are chemically neutral and not water soluble. No water-soluble substances are released, which could lead to pollution of ground water, rivers or lakes. Because of the closed cell structure, Neopor® Plus (GPS) insulation boards can be used even under moist conditions. In the case of unintended water ingress, e.g. through leakage, there is normally no need for replacement of the insulation board. The insulation value of the board remains almost unchanged in moist conditions and the insulation will dry when the source of moisture is removed.

Mechanical destruction

Not relevant for Neopor® Plus GPS based products that have superior mechanical properties.

In summary, a listing of all standards required for testing, evaluation and approval of Neopor® Plus

(GPS) insulation boards for use in the applications and markets identified are:

- ICC-ES Acceptance Criteria for Foam Plastic Insulation (AC12), dated June 2012
- ICC-ES Acceptance Criteria for Quality Documentation (AC10), dated June 2014
- ANSI/UL723 (ASTM E84), Test for Surface Burning Characteristics of Building Materials
- ANSI/UL790 (ASTM E108), Standard Test Methods for Fire Tests of Roof Coverings
- ANSI/UL1256, Standard for Fire Test of Roof Deck Constructions
- ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- UL2818, GREENGUARD Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishings
- NFPA 285, Standard Fire Test for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Assemblies Containing Combustible Components
- California Department of Public Health, CDPH/EHLB/Standard Method V.1.1

2.15 Re-use phase

The reuse of GPS foam from production waste has been working for many years and has proven itself very well. Production residues due to cut-outs or edge profiles can be reused in the production plants. However, for this analysis, re-use of GPS scrap was not included in the calculation of the LCA results. For End-of-Life options, construction techniques can be employed to maximize the separation of GPS insulation boards at the end of life of a building to maximize the potential for re-use. Another option for re-use is to leave the GPS insulation boards in place when the existing construction is thermally upgraded.

2.16 Disposal

Finished insulation boards are not regulated by either RCRA or CERCLA. Disposal of Neopor® Plus (GPS) insulation boards should be in accordance with national, state and local regulations. Product should not be discharged into waterways or sewer systems without proper authorization.

The recycling of GPS waste to produce new GPS insulating materials is possible if a separation of building materials by type is guaranteed. Ground recycled material can easily be used as a lightweight aggregate for mortar and concrete. It is also used as an additive for PS-light concrete, plaster for containment and light plaster as well as in the clay industry.

Recycling of GPS though has not been included in the calculation of the LCA or this EPD.

At the end of its life cycle, Neopor® Plus (GPS) insulation boards can be disposed of to landfill or thermally incinerated. Embedded energy in GPS insulation boards can be recovered in municipal waste incinerators equipped with energy recovery units for steam and electricity generation and for district heating where available.

In this EPD EoL is considered with 100% landfill disposal which is currently the most common practice. Within the landfill modeling, a portion of the landfill gas is collected for combustion via flare or for direct use as steam and/or electricity production.

For domestic transportation purposes, this product is not regulated as a hazardous material by the US Department of Transportation (DOT) under Title 49 of the Code of Federal Regulations.

2.17 Further information

Additional information can be found at http://www.neopor.basf.us/

3.0 LCA: Calculation rules

3.1 Declared Unit

The declared unit calculated in the LCA is in conformance with EN 15804 and the relevant sub-category PCR (Part B) for Building Envelope Thermal Insulation and is defined as 1 m^2 of installed Neopor® Plus (GPS) Type I insulation board with a thickness that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years (packaging included). Relative to this declared unit, the mass of the described insulation board is 0.433 kg (0.98 lbs.).

Conversion factors are listed in the table below to convert the declared unit to 1 kg and 1 m^3 of material.

Name	Value	Unit
Declared Unit	0.98 (0.43)	lbs. (kgs.)
Declared Unit	1.21 (0.0307)	ins. (m)
Gross density	0.9	lbs./ft^3
Conversion factor to 1 m^3	32.6	-
Conversion factor to 1 kg	2.3	-

3.2 System boundary

Type of EPD: Cradle-to-gate (installation) - with options (end-of-life).

The modules considered in the Life Cycle Assessment are:

- A1: Raw materials supply
- A2: Transport to manufacturer
- A3: Manufacturing
- A4: Transport to construction site
- A5: Assembly
- C1: Demolition
- C2: Transport to waste treatment
- C3: Waste processing
- C4: Disposal
- D: Reuse, recovery or recycling potential

The analysis of the product life cycle includes production of the basic materials, transport of the basic materials, manufacture of the product and the packaging materials and is declared in module A1-A3. Transport of the product is declared in module A4, and disposal of the packaging materials and any insulation trim in module A5. The use stage is not considered in the LCA calculations. The end-of-life scenarios include the transport to end-of-life stage (C2), effort of material treatment (C3) and emissions of landfilling of waste (C4). Due to a non-existing separation of C3 and C4 in the background data, the environmental impacts are shown in sum in module C3/C4. For waste disposal, gained energy from any recovery of landfill gas and subsequent use in generating thermal energy or electricity are declared in module D, beyond the system boundary.

3.3 Estimates and assumptions

All inputs and outputs of the production of Neopor® F5300 Plus GPS resin in Ludwigshafen, Germany by

BASF and the production of thermal insulation boards by Atlas EPS in North America, were considered in the calculation. Generic data were used for externally purchased raw materials from suppliers as these materials are not produced by BASF SE. Assumptions were made for modules A2, A5, C2 and D. Transport distances of key raw materials to the manufacturing site (A2) were determined using the supplier's postal addresses. For A5 (assembly) around 1.5% installation/construction trim waste was assumed and a distance of 175 miles by diesel truck with an adjusted utilization ratio of 6.7% was used. Credits for the avoided production of electricity and steam in another product system, due to landfill gas recovery, were considered for manufacturing trim waste (A3) and construction waste (A5).

3.4 Cut-off criteria

All major inputs and outputs to processes where data was available related to the scope defined by this assessment were included in the analysis. There was coverage of at least 95 % of mass and energy of the input and output flows, and 98 % of their environmental relevance. There were no critical uncertainties or gaps in the data collection or assessment process. Primary data of the production processes were considered. In the case of module C1 (deconstruction), insufficient data for the process was available but expert opinion felt the impacts during this module would fall under the cut off criteria of 1% of the total energy or total mass input assessed in this LCA. No known flows were deliberately excluded from the LCA and subsequent EPD.

3.5 Period under review

The period under review for the BASF primary data related to the production of the Neopor® F5300 PLUS GPS resin, was 2017. For the production of Neopor® Plus (GPS) insulation boards, the period under review was 2014 for the twenty six manufacturing locations listed in section 2.1.

3.6 Allocation

During the production of Neopor® Plus (GPS) insulation boards no co-products are produced therefore, no allocation was necessary for the processes under the manufacturers control. All credits from exported thermal energy or electricity generated at the landfill sites containing packaging or product waste are allocated to module D.

3.7 Comparability

Environmental declarations from different programs (ISO 14025) many not be comparable. Comparison of the environmental performance of thermal insulation using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building energy use phase as instructed under this PCR.

EPD comparability is only possible when all stages of a life cycle have been considered, when they comply with all referenced standards, use the same sub-category PCR, and use equivalent scenarios with respect to construction works. However, some deviations and variations are possible. Example of

variations could be different LCA software and background LCI datasets which may lead to different results for upstream or downstream life cycle stages declared.

3.8 Background data

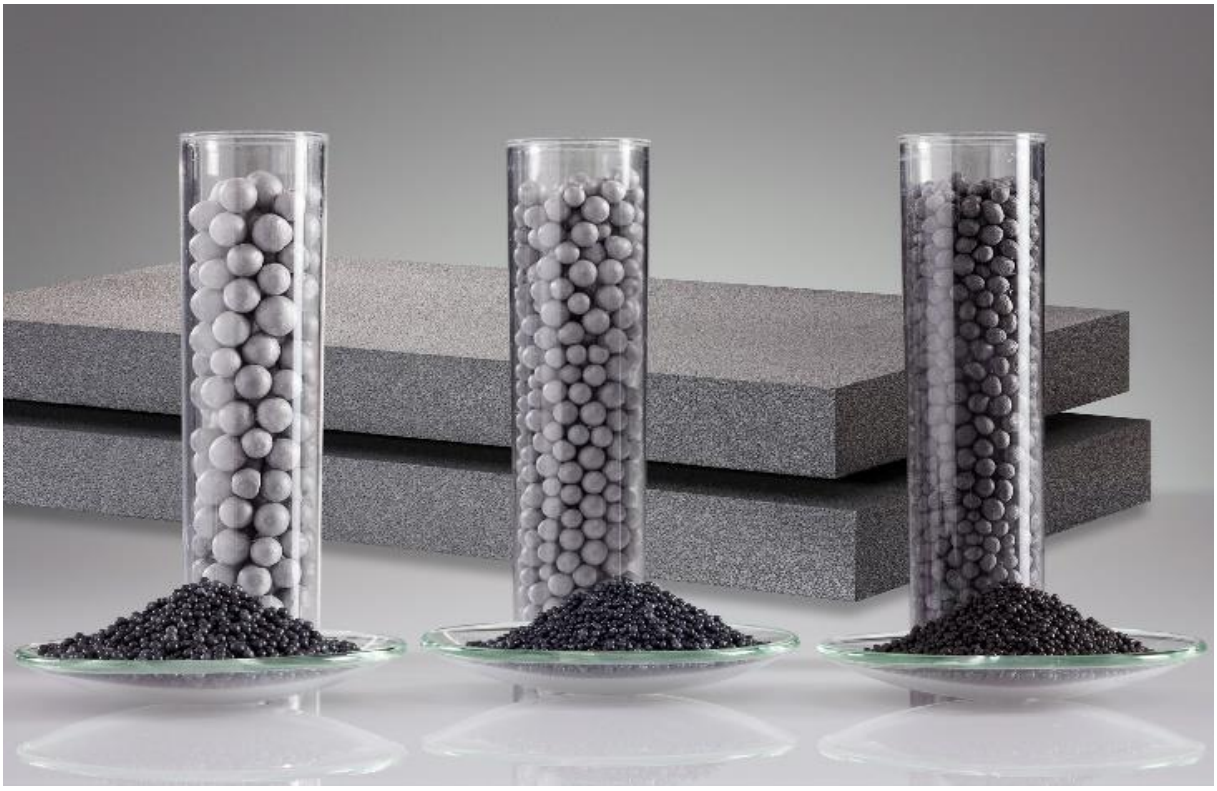
For life cycle modelling of the declared Neopor® Plus (GPS) insulation boards, the software solution GaBi ts 9.2 of thinkstep AG was used. Only background data from the GaBi ts 9.2 software were considered in the calculation to ensure the comparability of the results.

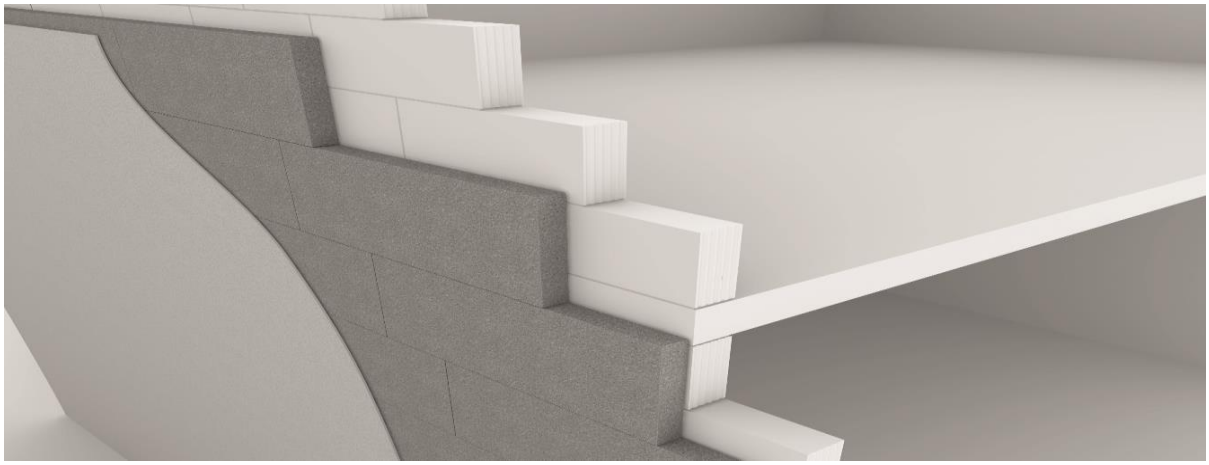
3.9 Data quality

For life cycle assessment of the considered products, the GaBi ts Software System for Life Cycle Engineering and GaBi ts database were used. An overall data quality assessment is provided in the table below.

Data Quality Assessment

Name of data set	unit	Source	Reference year	Region	Technological Representativeness	Overall Quality Assessment Score	Plant	comment
Energy Carriers - Electricity								
Heavy fuel oil at refinery from crude oil (1.0wt.% S)	kg	Gabi thinkstep	2014	EU-27	Very Good	Good	All	
Diesel mix at filling station from crude oil and biocomponent	kg	Gabi thinkstep	2014	US	Very Good	Good	All	
Mexico Electricity grid mix AC, technology mix consumption mix, to consumer <1kV	MJ	Gabi thinkstep	2014	Mexico	Good	Good	Mexico	
Electricity grid mix – SRMV	MJ	Gabi thinkstep	2016	SRMV, eGrid	Excellent	Good	Mississippi Valley	consumption mix, to consumer
Electricity grid mix – RFCM	MJ	Gabi thinkstep	2016	RFCM, eGrid	Excellent	Good	Michigan	consumption mix, to consumer
Electricity grid mix – SRVC (without PJM)	MJ	Gabi thinkstep	2016	SRVC, eGrid	Excellent	Good	Virginia, Carolinas	consumption mix, to consumer
Electricity grid mix (production mix, US eGRID)	MJ	Gabi thinkstep	2016	US	Excellent	Good	All	
Electricity grid mix - CA	MJ	Gabi thinkstep	2016	Canada	Excellent	Good	Canadian mfg.	consumption mix, to consumer
Thermal energy from natural gas (eGrid)	MJ	Gabi thinkstep	2014	US	Excellent	Good	All	technology mix regarding firing and flue gas cleaning
wood chips, from industry, mixed, burned in furnace	MJ	ecoinvent	2000	Switzerland	Good	Good	Mississippi Valley	best available data set
Thermal energy from LPG technology mix production mix, at heat plant	kg	Gabi thinkstep	2014	US	Good	Good	Mexico	
Transport								
Heavy Heavy-duty Diesel Truck / 53,333 lb payload - 8b	kg	Gabi thinkstep	2017	US	Very Good	Good	All	
Container ship, 27500 dwt payload capacity, ocean going	kg	Gabi thinkstep	2017	Global	Good	Good	All	consumption mix
Rail transport cargo - average, average train, gross tonne weight 1000t / 726t payload capacity	kg	Gabi thinkstep	2018	Global	Good	Good	All	consumption mix
Material Inputs								
Neopor F 5300 Base Plus resin with additives	kg	BASF	2017	Germany	Excellent	Very Good	Ludwigshafen	primary data from site
Neopor F 5300 Base Plus resin	kg	BASF	2017	Germany	Excellent	Very Good	Ludwigshafen	primary data from site; extrusion route in X Neopor Plant L930
Packaging								
Polyethylene Film (PE-HD) without additives technology mix	kg	Gabi thinkstep	2014	Germany	Very Good	Good	BASF, All	Polymerization of ethylene, extruding and calendering
Corrugated board (2012) technology mix	kg	Gabi thinkstep, FEFCO	2017	EU-27	Good	Good	All	
wooden pallet	kg	BASF	2016	Global	Good	Good	All	
Utility Inputs								
Tap water from groundwater (for regionalization)	kg	Gabi thinkstep	2014	global	Very Good	Good	All	regionalized with electricity and water
Ground water, input regionalization dummy	kg	Gabi thinkstep	2017	global	Very Good	Good	All	parameterized for region (national level)
Compressed air 10 bar (medium power consumption) 10 bar, medium efficiency	Nm3	Gabi thinkstep	2014	Global	Good	Good	All	electricity usage regionalized
Lubricants at refinery from crude oil production mix, at refinery	kg	Gabi thinkstep	2014	US	Good	Good	All	38 MJ/kg net calorific value
Disposal								
Landfill, wet climate treatment of leachate, production of electricity	kg	Gabi thinkstep	2017	US	Very Good	Good	Tijuana, Mx	production of electricity from percentage of landfill gas captured
Plastic waste on landfill, post-consumer	kg	Gabi thinkstep	2017	US	Very Good	Good	All	treatment of leachate, no landfill gas for energy use
Landfill, moderate climate treatment of leachate, production of electricity	kg	Gabi thinkstep	2017	US	Very Good	Good	All	production of electricity from percentage of landfill gas captured





4.0 LCA: Scenarios and additional technical information

The following technical information is a basis for the declared modules or can be used for developing specific scenarios in the context of a building assessment if modules are not declared (MND). The values refer to the declared unit of 1 m^2 of Neopor® Plus (GPS) insulation materials with a thickness that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years (packaging included).

Transport to the construction site (A4) - by truck

Name	Value	Unit
Truck Type	Heavy Duty Diesel 8b	
Fuel Type	Diesel	
Liters of Fuel	5.6	Miles/gallon
Transport distance	175	miles
Capacity utilization (including empty runs)	6.7*	%
Gross density of products transported	0.9	lbs/ft^3
Capacity utilisation volume factor	1	-

* Adapted according to density of Neopor® Plus (GPS) insulation boards

Installation in the building (A5)
The amount of installation trim waste varies. For the calculation of the environmental impacts of Neopor® Plus (GPS) insulation boards around 1.5% installation waste was considered. Ancillary materials did not contribute significantly and installation does not require an appreciable amount of freshwater, electricity or other resources and energy carriers.

End of life (C1-C4)
Waste disposal for this assessment was determined to be 100% to landfill, per regional practice and PCR Part A guidance. The transport distance to the disposal site is around 100 miles. Some percentage of landfills in the United States, capture a portion of the landfill gas (methane) and produce steam and/or electricity. This results in benefits, beyond the system boundary and is capture in module D.

Reuse, recovery and/or recycling potentials (D),
Module D includes the benefits of the landfill gas capture process.

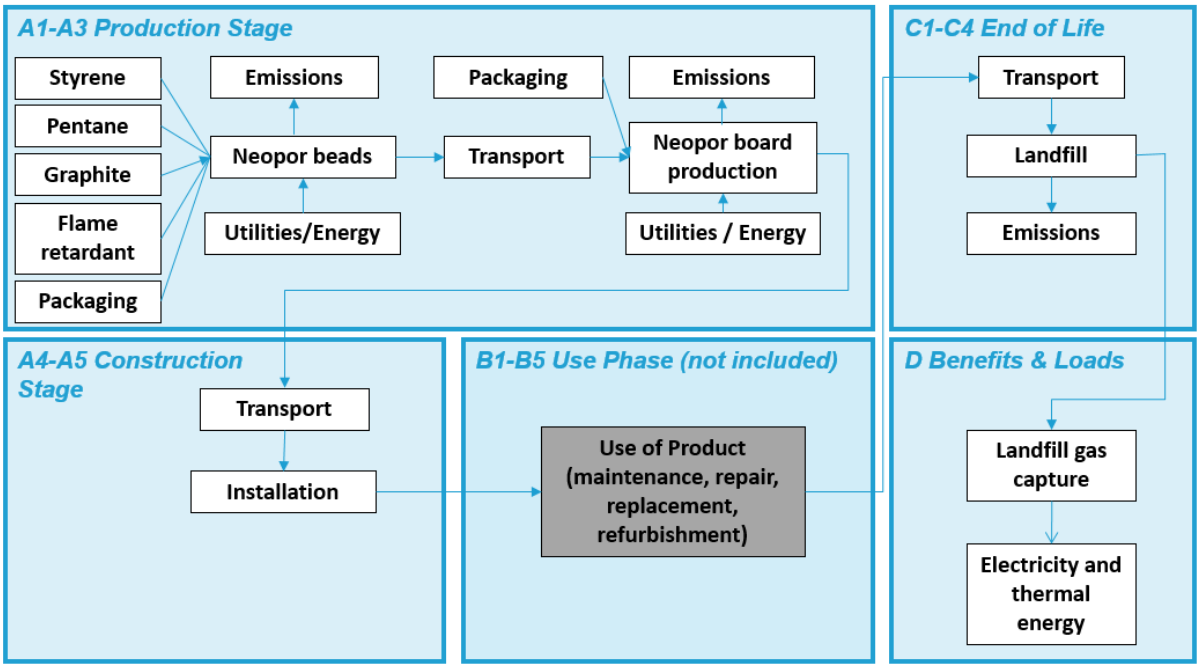
5.0 LCA: Results

The following tables display the environmental relevant results according to /EN 15804/ for the assessed base case declared unit of: 1 m^2 of installed Neopor® Plus (GPS) Type I insulation material with a thickness that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years (packaging included).

The environmental impact categories reported below are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development, however the EPD users shall not use additional measures for comparative purposes. Additionally, LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. Finally, many factors affect the comparability of EPDs. End users should be extremely cautious when comparing or evaluating EPD data of different EPD publishers. Such comparison or evaluation is only possible if all conditions for comparability listed in ISO 14025 (Section 6.7.2) are met.

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse- Recovery- Recycling- potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X



Base Case LCA results for Environmental Impacts, Resource Use, Waste categories, and Output flows for 1 m^2 of installed Type I Neopor® Plus GPS thermal insulation material with a thickness of 1.21 inches that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years.

Results of the LCA – ENVIRONMENTAL IMPACT (CML)										
CML 2001 (2016)		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demoliton	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	1.18E+00	1.12E-01	4.67E-01	7.99E-02	6.68E-03	0.00E+00	2.24E-02	1.96E-02	-6.71E-04
ODP	[kg CFC11-eq.]	7.49E-11	6.89E-17	5.86E-10	7.57E-18	2.20E-18	0.00E+00	2.12E-18	7.10E-17	-4.84E-15
AP	[kg SO2-eq.]	2.61E-03	1.97E-03	7.45E-04	2.14E-04	1.45E-05	0.00E+00	6.00E-05	2.67E-04	-1.34E-06
EP	[kg PO_4^{3-}-eq.]	2.64E-04	2.33E-04	1.27E-04	6.02E-05	1.61E-05	0.00E+00	1.69E-05	1.20E-04	-1.07E-07
POCP	[kg ethene-eq.]	5.99E-04	5.89E-05	6.52E-03	-7.44E-05	1.19E-03	0.00E+00	-2.09E-05	1.23E-04	-1.01E-07
ADPE	[kg Sb-eq.]	2.87E-07	1.27E-08	2.10E-07	1.52E-08	2.62E-10	0.00E+00	4.27E-09	8.04E-09	-2.12E-10
ADPF	[MJ]	4.03E+01	1.44E+00	6.85E+00	1.13E+00	1.05E-02	0.00E+00	3.16E-01	3.03E-01	-9.13E-03
Caption		GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources								

Results of the LCA – ENVIRONMENTAL IMPACT (TRACI)										
TRACI 2.1		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	1.17E+00	1.11E-01	4.63E-01	7.97E-02	6.21E-03	0.00E+00	2.24E-02	1.94E-02	-6.66E-04
AP	[kg SO2-eq.]	2.65E-03	2.14E-03	8.26E-04	2.88E-04	3.65E-05	0.00E+00	8.08E-05	3.07E-04	-1.33E-06
EP	[kg N-eq.]	1.63E-04	8.31E-05	8.50E-05	2.56E-05	1.33E-05	0.00E+00	7.19E-06	1.18E-04	-6.94E-08
ODP	[kg CFC11-eq.]	9.63E-11	-1.24E-15	7.10E-10	-4.29E-16	-3.11E-17	0.00E+00	-1.20E-16	-1.02E-15	-5.10E-15
POCP	[kg O_3-eq.]	4.20E-02	4.16E-02	3.56E-02	6.48E-03	4.04E-03	0.00E+00	1.82E-03	2.58E-03	-1.71E-05
ADP_{Fossil}	[MJ, LHV]	5.62E+00	1.89E-01	8.97E-01	1.51E-01	1.36E-03	0.00E+00	4.23E-02	3.90E-02	-9.25E-04
Caption		GWP = Global warming potential; ODP = Ozone depletion potential; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADP_{Fossil} Abiotic Depletion Potential of Non-renewable (fossil) energy resources								

Environmental Parameters from LCA – RESOURCE USE										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
PERE	[MJ]	5.06E-01	7.47E-02	6.36E-01	3.51E-02	7.69E-04	0.00E+00	9.84E-03	2.37E-02	-1.12E-03
PERM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	5.06E-01	7.47E-02	6.36E-01	3.51E-02	7.69E-04	0.00E+00	9.84E-03	2.37E-02	-1.12E-03
PENRE	[MJ]	2.17E+01	1.51E+00	7.23E+00	1.13E+00	1.07E-02	0.00E+00	3.18E-01	3.11E-01	-1.09E-02
PENRM	[MJ]	1.89E+01	0.00E+00	1.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	4.06E+01	1.51E+00	7.36E+00	1.13E+00	1.07E-02	0.00E+00	3.18E-01	3.11E-01	-1.09E-02
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	[MJ]	2.18E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	2.56E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m³]	3.72E-03	2.13E-04	2.56E-03	1.36E-04	1.97E-06	0.00E+00	3.81E-05	3.69E-05	-2.80E-06
Caption		PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilization; PERT = Total renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilization; PENRT = Total non-renewable primary energy resources; SM = Use of secondary material; RSF = Renewable secondary fuels; NRSF = Non-renewable secondary fuels; FW = Use of net fresh water								

Environmental Parameters from LCA – OUTPUT FLOWS & WASTE CATEGORIES										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
HWD	[kg]	7.89E-09	4.64E-09	3.14E-09	9.18E-09	4.37E-11	0.00E+00	2.58E-09	1.09E-09	-4.54E-12
NHWD	[kg]	8.23E-02	1.06E-04	4.42E-02	4.27E-05	1.19E-02	0.00E+00	1.20E-05	4.41E-01	-3.01E-06
RWD	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	7.21E-04	0.00E+00	1.15E-03	0.00E+00	0.00E+00	3.98E-03	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	4.33E-04	0.00E+00	1.27E-03	0.00E+00	0.00E+00	3.53E-03	0.00E+00
Caption		HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy								

Besides Type I insluation boards, Neopor® can also be molded into Type VIII, Type II and Type IX insulation boards. The environmental relevant results for these insulation boards are provided below. Conversion factors are listed in the table below to convert the declared and functional unit described in Section 3.1 to 1 kg and 1 m^3 of material for additional insulation types (Type VII, II and IX).

	Type I Insulation		Type VII Insulation		Type II Insulation		Type IX Insulation	
Name	**Value**	**Unit**	**Value**	**Unit**	**Value**	**Unit**	**Value**	**Unit**
Declared Unit	0.98 (0.43)	lbs. (kgs.)	1.25 (0.57)	lbs. (kgs.)	1.58 (0.72)	lbs. (kgs.)	1.96 (0.86)	lbs. (kgs.)
Declared Unit	1.21 (0.0307)	ins. (m)	1.21 (0.0307)	ins. (m)	1.21 (0.0307)	ins. (m)	1.21 (0.0307)	ins. (m)
Functional Unit	1.21 (0.0307)	ins. (m)	1.21 (0.0307)	ins. (m)	1.21 (0.0307)	ins. (m)	1.21 (0.0307)	ins. (m)
Gross density	0.9	lbs./ft³	1.15	lbs./ft³	1.35	lbs./ft³	1.8	lbs./ft³
Gross density	14.4	kg/m³	18.4	kg/m³	21.6	kg/m³	28.8	kg/m³
Conversion factor to 1 m³	32.6	-	32.6	-	32.6	-	32.6	-
Conversion factor to 1 kg	2.3	-	1.75	-	1.4	-	1.16	-

LCA results for Environmental Impacts, Resource Use, Waste categories, and Output flows for 1 m^2 of installed Type VIII Neopor® Plus GPS thermal insulation material with a thickness of 1.21 inches that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years.

Results of the LCA – ENVIRONMENTAL IMPACT (CML)										
CML 2001 (2016)		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demoliton	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	1.51E+00	1.43E-01	5.98E-01	1.02E-01	8.55E-03	0.00E+00	2.87E-02	2.50E-02	-8.59E-04
ODP	[kg CFC11-eq.]	9.59E-11	8.82E-17	7.50E-10	9.69E-18	2.82E-18	0.00E+00	2.71E-18	9.09E-17	-6.20E-15
AP	[kg SO2-eq.]	3.34E-03	2.52E-03	9.54E-04	2.74E-04	1.85E-05	0.00E+00	7.68E-05	3.42E-04	-1.72E-06
EP	[kg PO_4^{3-}-eq.]	3.38E-04	2.98E-04	1.63E-04	7.71E-05	2.06E-05	0.00E+00	2.16E-05	1.54E-04	-1.38E-07
POCP	[kg ethene-eq.]	7.67E-04	7.54E-05	8.35E-03	-9.52E-05	1.52E-03	0.00E+00	-2.67E-05	1.58E-04	-1.29E-07
ADPE	[kg Sb-eq.]	3.68E-07	1.62E-08	2.69E-07	1.95E-08	3.36E-10	0.00E+00	5.47E-09	1.03E-08	-2.71E-10
ADPF	[MJ]	5.16E+01	1.85E+00	8.76E+00	1.44E+00	1.34E-02	0.00E+00	4.05E-01	3.88E-01	-1.17E-02
Caption		GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources								

Results of the LCA – ENVIRONMENTAL IMPACT (TRACI)										
TRACI 2.1		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	1.50E+00	1.43E-01	5.92E-01	1.02E-01	7.95E-03	0.00E+00	2.86E-02	2.49E-02	-8.53E-04
AP	[kg SO2-eq.]	3.40E-03	2.73E-03	1.06E-03	3.69E-04	4.68E-05	0.00E+00	1.03E-04	3.93E-04	-1.70E-06
EP	[kg N-eq.]	2.09E-04	1.06E-04	1.09E-04	3.28E-05	1.70E-05	0.00E+00	9.20E-06	1.50E-04	-8.89E-08
ODP	[kg CFC11-eq.]	1.23E-10	-1.59E-15	9.08E-10	-5.50E-16	-3.98E-17	0.00E+00	-1.54E-16	-1.31E-15	-6.52E-15
POCP	[kg O_3-eq.]	5.38E-02	5.32E-02	4.56E-02	8.29E-03	5.17E-03	0.00E+00	2.33E-03	3.31E-03	-2.19E-05
ADPF	[MJ, LHV]	7.19E+00	2.42E-01	1.15E+00	1.93E-01	1.74E-03	0.00E+00	5.41E-02	4.99E-02	-1.18E-03
Caption		GWP = Global warming potential; ODP = Ozone depletion potential; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADP_{Fossil} Abiotic Depletion Potential of Non-renewable (fossil) energy resources								

Environmental Parameters from LCA – RESOURCE USE										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
PERE	[MJ]	6.48E-01	9.56E-02	8.14E-01	4.49E-02	9.84E-04	0.00E+00	1.26E-02	3.03E-02	-1.43E-03
PERM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	6.48E-01	9.56E-02	8.14E-01	4.49E-02	9.84E-04	0.00E+00	1.26E-02	3.03E-02	-1.43E-03
PENRE	[MJ]	2.77E+01	1.93E+00	9.26E+00	1.45E+00	1.37E-02	0.00E+00	4.07E-01	3.98E-01	-1.40E-02
PENRM	[MJ]	2.42E+01	0.00E+00	1.62E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	5.19E+01	1.93E+00	9.42E+00	1.45E+00	1.37E-02	0.00E+00	4.07E-01	3.98E-01	-1.40E-02
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	[MJ]	2.79E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	3.28E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m^3]	4.76E-03	2.72E-04	3.28E-03	1.74E-04	2.52E-06	0.00E+00	4.88E-05	4.72E-05	-3.58E-06
Caption		PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilization; PERT = Total renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilization; PENRT = Total non-renewable primary energy resources; SM = Use of secondary material; RSF = Renewable secondary fuels; NRSF = Non-renewable secondary fuels; FW = Use of net fresh water								

Environmental Parameters from LCA – OUTPUT FLOWS & WASTE CATEGORIES										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
HWD	[kg]	1.01E-08	5.94E-09	4.02E-09	1.18E-08	5.60E-11	0.00E+00	3.30E-09	1.39E-09	-5.81E-12
NHWD	[kg]	1.05E-01	1.36E-04	5.66E-02	5.47E-05	1.52E-02	0.00E+00	1.53E-05	5.65E-01	-3.85E-06
RWD	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	9.22E-04	0.00E+00	1.48E-03	0.00E+00	0.00E+00	5.09E-03	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	5.54E-04	0.00E+00	1.62E-03	0.00E+00	0.00E+00	4.51E-03	0.00E+00
Caption		HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy								

LCA results for Environmental Impacts, Resource Use, Waste categories, and Output flows for 1 m^2 of installed Type II Neopor® Plus GPS thermal insulation material with a thickness of 1.21 inches that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years.

Results of the LCA – ENVIRONMENTAL IMPACT (CML)										
CML 2001 (2016)		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demoliton	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	1.90E+00	1.80E-01	7.52E-01	1.29E-01	1.08E-02	0.00E+00	3.61E-02	3.15E-02	-1.08E-03
ODP	[kg CFC11-eq.]	1.21E-10	1.11E-16	9.43E-10	1.22E-17	3.54E-18	0.00E+00	3.41E-18	1.14E-16	-7.79E-15
AP	[kg SO2-eq.]	4.20E-03	3.17E-03	1.20E-03	3.44E-04	2.33E-05	0.00E+00	9.66E-05	4.31E-04	-2.16E-06
EP	[kg PO_4^{3-}-eq.]	4.25E-04	3.75E-04	2.05E-04	9.70E-05	2.60E-05	0.00E+00	2.72E-05	1.94E-04	-1.73E-07
POCP	[kg ethene-eq.]	9.64E-04	9.48E-05	1.05E-02	-1.20E-04	1.91E-03	0.00E+00	-3.36E-05	1.98E-04	-1.63E-07
ADPE	[kg Sb-eq.]	4.62E-07	2.04E-08	3.38E-07	2.45E-08	4.23E-10	0.00E+00	6.88E-09	1.30E-08	-3.41E-10
ADPF	[MJ]	6.48E+01	2.32E+00	1.10E+01	1.81E+00	1.69E-02	0.00E+00	5.09E-01	4.88E-01	-1.47E-02
Caption		GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources								

Results of the LCA – ENVIRONMENTAL IMPACT (TRACI)										
TRACI 2.1		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	1.88E+00	1.79E-01	7.45E-01	1.28E-01	1.00E-02	0.00E+00	3.60E-02	3.13E-02	-1.07E-03
AP	[kg SO2-eq.]	4.27E-03	3.44E-03	1.33E-03	4.64E-04	5.88E-05	0.00E+00	1.30E-04	4.94E-04	-2.14E-06
EP	[kg N-eq.]	2.63E-04	1.34E-04	1.37E-04	4.12E-05	2.14E-05	0.00E+00	1.16E-05	1.89E-04	-1.12E-07
ODP	[kg CFC11-eq.]	1.55E-10	-2.00E-15	1.14E-09	-6.91E-16	-5.01E-17	0.00E+00	-1.94E-16	-1.64E-15	-8.20E-15
POCP	[kg O_3-eq.]	6.76E-02	6.70E-02	5.73E-02	1.04E-02	6.50E-03	0.00E+00	2.93E-03	4.16E-03	-2.75E-05
ADP_{Fossil}	[MJ, LHV]	9.04E+00	3.04E-01	1.44E+00	2.43E-01	2.18E-03	0.00E+00	6.81E-02	6.28E-02	-1.49E-03
Caption		GWP = Global warming potential; ODP = Ozone depletion potential; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADP_{Fossil}, Abiotic Depletion Potential of Non-renewable (fossil) energy resources								

Environmental Parameters from LCA – RESOURCE USE										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
PERE	[MJ]	8.15E-01	1.20E-01	1.02E+00	5.65E-02	1.24E-03	0.00E+00	1.58E-02	3.82E-02	-1.80E-03
PERM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	8.15E-01	1.20E-01	1.02E+00	5.65E-02	1.24E-03	0.00E+00	1.58E-02	3.82E-02	-1.80E-03
PENRE	[MJ]	3.49E+01	2.43E+00	1.16E+01	1.82E+00	1.73E-02	0.00E+00	5.12E-01	5.00E-01	-1.75E-02
PENRM	[MJ]	3.05E+01	0.00E+00	2.04E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	6.53E+01	2.43E+00	1.18E+01	1.82E+00	1.73E-02	0.00E+00	5.12E-01	5.00E-01	-1.75E-02
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	[MJ]	3.51E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	4.12E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m^3]	5.99E-03	3.42E-04	4.12E-03	2.19E-04	3.17E-06	0.00E+00	6.14E-05	5.94E-05	-4.51E-06
Caption		PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilization; PERT = Total renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilization; PENRT = Total non-renewable primary energy resources; SM = Use of secondary material; RSF = Renewable secondary fuels; NRSF = Non-renewable secondary fuels; FW = Use of net fresh water								

Environmental Parameters from LCA – OUTPUT FLOWS & WASTE CATEGORIES										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
HWD	[kg]	1.27E-08	7.48E-09	5.06E-09	1.48E-08	7.04E-11	0.00E+00	4.15E-09	1.75E-09	-7.31E-12
NHWD	[kg]	1.33E-01	1.71E-04	7.12E-02	6.87E-05	1.92E-02	0.00E+00	1.93E-05	7.11E-01	-4.85E-06
RWD	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	1.16E-03	0.00E+00	1.86E-03	0.00E+00	0.00E+00	6.40E-03	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	6.97E-04	0.00E+00	2.04E-03	0.00E+00	0.00E+00	5.68E-03	0.00E+00
Caption		HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy								

LCA results for Environmental Impacts, Resource Use, Waste categories, and Output flows for 1 m^2 of installed Type IX Neopor® Plus GPS thermal insulation material with a thickness of 1.21 inches that gives an average thermal resistance (RSI) of 1 m^2*K/W (5.68 ft^2*hr.*F/BTU per inch) with a building service life of 75 years.

Results of the LCA – ENVIRONMENTAL IMPACT (CML)										
CML 2001 (2016)		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demoliton	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	2.36E+00	2.23E-01	9.35E-01	1.60E-01	1.34E-02	0.00E+00	4.48E-02	3.91E-02	-1.34E-03
ODP	[kg CFC11-eq.]	1.50E-10	1.38E-16	1.17E-09	1.51E-17	4.40E-18	0.00E+00	4.24E-18	1.42E-16	-9.68E-15
AP	[kg SO2-eq.]	5.22E-03	3.94E-03	1.49E-03	4.28E-04	2.89E-05	0.00E+00	1.20E-04	5.35E-04	-2.68E-06
EP	[kg PO_4^{3-}-eq.]	5.28E-04	4.66E-04	2.55E-04	1.20E-04	3.23E-05	0.00E+00	3.38E-05	2.41E-04	-2.15E-07
POCP	[kg ethene-eq.]	1.20E-03	1.18E-04	1.30E-02	-1.49E-04	2.38E-03	0.00E+00	-4.18E-05	2.46E-04	-2.02E-07
ADPE	[kg Sb-eq.]	5.75E-07	2.53E-08	4.20E-07	3.04E-08	5.25E-10	0.00E+00	8.54E-09	1.61E-08	-4.23E-10
ADPF	[MJ]	8.05E+01	2.88E+00	1.37E+01	2.25E+00	2.10E-02	0.00E+00	6.32E-01	6.06E-01	-1.83E-02
Caption		GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources								

Results of the LCA – ENVIRONMENTAL IMPACT (TRACI)										
TRACI 2.1		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
GWP	[kg CO_2-eq.]	2.34E+00	2.23E-01	9.26E-01	1.59E-01	1.24E-02	0.00E+00	4.47E-02	3.89E-02	-1.33E-03
AP	[kg SO2-eq.]	5.31E-03	4.27E-03	1.65E-03	5.76E-04	7.31E-05	0.00E+00	1.62E-04	6.14E-04	-2.65E-06
EP	[kg N-eq.]	3.27E-04	1.66E-04	1.70E-04	5.12E-05	2.66E-05	0.00E+00	1.44E-05	2.35E-04	-1.39E-07
ODP	[kg CFC11-eq.]	1.93E-10	-2.48E-15	1.42E-09	-8.59E-16	-6.22E-17	0.00E+00	-2.41E-16	-2.04E-15	-1.02E-14
POCP	[kg O_3-eq.]	8.40E-02	8.32E-02	7.12E-02	1.30E-02	8.08E-03	0.00E+00	3.64E-03	5.17E-03	-3.42E-05
ADP_{Fossil}	[MJ, LHV]	1.12E+01	3.78E-01	1.79E+00	3.02E-01	2.71E-03	0.00E+00	8.46E-02	7.80E-02	-1.85E-03
Caption		GWP = Global warming potential; ODP = Ozone depletion potential; AP = Acidification potential; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADP_{Fossil} Abiotic Depletion Potential of Non-renewable (fossil) energy resources								

Environmental Parameters from LCA – RESOURCE USE										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
PERE	[MJ]	1.01E+00	1.49E-01	1.27E+00	7.02E-02	1.54E-03	0.00E+00	1.97E-02	4.74E-02	-2.24E-03
PERM	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	1.01E+00	1.49E-01	1.27E+00	7.02E-02	1.54E-03	0.00E+00	1.97E-02	4.74E-02	-2.24E-03
PENRE	[MJ]	4.33E+01	3.02E+00	1.45E+01	2.27E+00	2.15E-02	0.00E+00	6.36E-01	6.21E-01	-2.18E-02
PENRM	[MJ]	3.78E+01	0.00E+00	2.54E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	8.12E+01	3.02E+00	1.47E+01	2.27E+00	2.15E-02	0.00E+00	6.36E-01	6.21E-01	-2.18E-02
SM	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	[MJ]	4.36E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	5.12E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m^3]	7.44E-03	4.25E-04	5.12E-03	2.72E-04	3.94E-06	0.00E+00	7.62E-05	7.38E-05	-5.60E-06
Caption		PERE = Renewable primary energy as energy carrier; PERM = Renewable primary energy as material utilization; PERT = Total renewable primary energy resources; PENRE = Non-renewable primary energy as energy carrier; PENRM = Non-renewable primary energy as material utilization; PENRT = Total non-renewable primary energy resources; SM = Use of secondary material; RSF = Renewable secondary fuels; NRSF = Non-renewable secondary fuels; FW = Use of net fresh water								

Environmental Parameters from LCA – OUTPUT FLOWS & WASTE CATEGORIES										
		Raw material supply	Transport	Manufacturing	Transport	Construction – Installation	Demolition	Transport	Disposal	Benefits and Loads beyond system boundary
Parameter	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**C1**	**C2**	**C3/C4**	**D**
HWD	[kg]	1.58E-08	9.29E-09	6.28E-09	1.84E-08	8.74E-11	0.00E+00	5.15E-09	2.18E-09	-9.08E-12
NHWD	[kg]	1.65E-01	2.12E-04	8.84E-02	8.54E-05	2.38E-02	0.00E+00	2.40E-05	8.83E-01	-6.02E-06
RWD	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	1.44E-03	0.00E+00	2.31E-03	0.00E+00	0.00E+00	7.95E-03	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	8.66E-04	0.00E+00	2.54E-03	0.00E+00	0.00E+00	7.05E-03	0.00E+00
Caption		HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy								

6.0 LCA: Interpretation

All environmental impact categories are significantly influenced by the provision of raw materials and the production process. The polystyrene used in the production process already contains a large part of the environmental burden. For the impact categories GWP, EP, AP, ADP (element & fossil) and POCP the granule production and transport is responsible for about 55% to 85% of the impact. Manufacturing of the insulation board (A3) also contributes significantly to GWP due to the energy requirements during production and POCP due to the pentane emissions during the product foaming and aging processes. The ozone depletion potential (ODP) is largely caused by the production of polystyrene granules and the production of the insulation board (> 95% of the impact). Transport of the Neopor® F5300 Plus GPS resin from BASF's Ludwigshafen, Germany plant to the various North American manufacturing locations contributes appreciably to the impact categories of AP, EP, GWP and POCP.

The effort (input of additional energy and material) for the end-of-life scenario (C3/C4) and the resulting credits in form of electricity and steam due to the capture and utilization of landfill gas are considered separately. Any benefits result in negative values in module D. Though no appreciable benefits are realized in this assessment.

Transports other than A2, (A4 and C2) have a minor influence on all impact categories compared to the contributions from the other areas.

6.1 VOC emissions

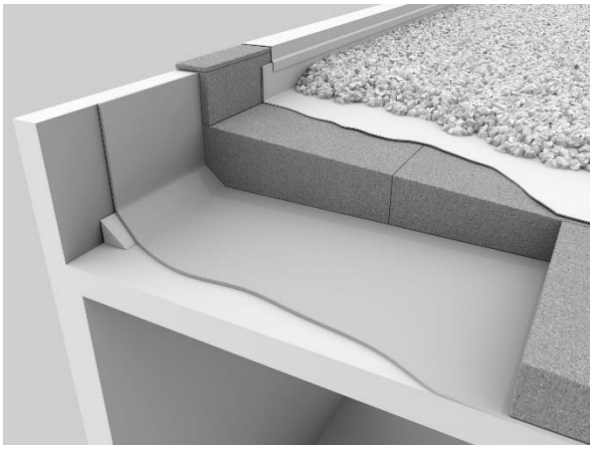
Like it is the case for all EPS products insulation boards, Neopor® Plus (GPS) can be used for indoor applications, however they typically are not directly exposed to the indoor air but covered by some kind of covering layer such as gypsum board.

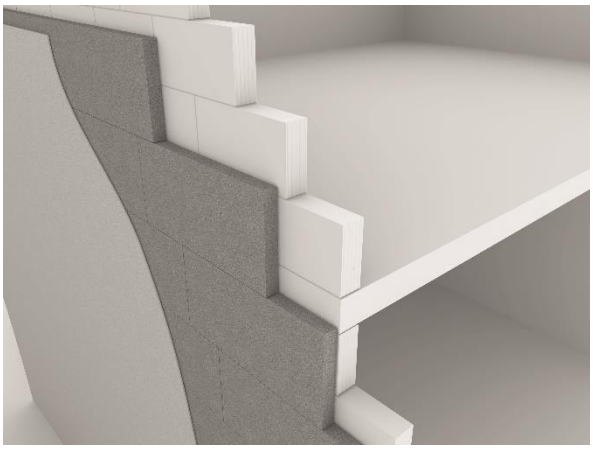
To make it easier for architects and developers to find low-emission materials, the Greenguard label indicates products that meet the strict emissions limits for Volatile Organic Compounds (VOCs). There are limits for over 360 VOCs. All insulation boards with Neopor® PLUS GPS meet not only the demanding criteria of the Greenguard certificate, but also the requirements of the Californian Department of Public Health Services. As a result, the raw material has been given the Greenguard Gold label, which means it may also be used in schools and health facilities accommodating children or elderly people, in addition to commercial buildings.

Manufacturers producing Neopor® Plus GPS insulation boards can also benefit from the certification of the raw material; by applying for an extended license from UL (Underwriter Laboratories), they can have their product labeled as protective of health for indoor spaces.

6.2 Leaching performance

Leaching behavior is not relevant for Neopor® Plus GPS insulation board.





7.0 References

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Standard Test Method for Surface Burning Characteristics of Building Materials.

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Eurofins
Eurofins Produkt Testing A/S, Smedeskovvej 38, 8464 Galten, Denmark; Prüfbericht 392-2016-004 18900

GaBi ts 9.2
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Greenguard
UL 2818 - 2013 Standard for Chemical Emissions for Building Materials, Finishes and Furnishings

Greenguard Gold
UL 2818 - 2013 Gold Standard for Chemical Emissions for Building Materials, Finishes and Furnishings

ISO 14025
DIN EN ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures

ISO 14040 – 14044
ISO 14040:2006, Environmental management – LCA – Principles and framework

ISO 21930
ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services.

NFPA 285
Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

NFPA 286
Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth

Neopor® Picture Front Page and Page 3
BASF Wohnen + Bauen GmbH

Neopor® Plus GPS Manufacturing process schematic (page 4)
Adapted form EPS IA EPS Insulation EPD Declaration No. 4787238561.101.1 8/10/2017

PCR Guidance-Texts for Building-Related Products and Services Part B
UL 10010-1 2.0 (issued 04/10/2018) Product Category Rules for Building-Related Products and Services. Part B: Building Envelope Thermal Insulation EPD Requirements

Product Category Rules for Building-Related Products and Services Part A
UL 10010 version 3.1 (issued 05/02/2018) Product Category Rules for Building-Related Products and Services. Part A: Life Cycle Assessment Calculation Rules and Report Requirements

Neopor® GPS Insulation and Construction Photos
BASF Corporation
BASF SE