An Environmental Product Declaration

According to ISO 14025:2006 and ISO 21930:2017

An industry-wide cradle-to-gate EPD for $^{1}/_{2}$" and $^{5}/_{8}$" Glass-mat Gypsum Boards

This EPD has been prepared in conformance with ISO 14040/44 standards and according to the requirements of ISO 21930:2017, NSF International product category rules (PCR) for preparing an environmental product declaration for gypsum panel products and ASTM International's EPD program operator rules. This EPD was commissioned by the Gypsum Association and is verified by ASTM International to conform to the requirements of ISO 14040, 14044,14025, and 21930.



ASTM International West Conshohocken, PA www.astm.org	Date of issue: May 1, 2021 Period of validity: 5 years (Extended to Nov. 1, 2026) Declaration No.: EPD 206

Environmental Product Declaration Summary

General Summary	
Owner of the EPD	
GYPSUM ASSOCIATION	**Gypsum Association (GA)** 962 Wayne Avenue, Suite 620 Silver Spring, MD 20910 Link (URL): www.gypsum.org The Gypsum Association is a not-for-profit trade association founded in 1930. Its mission is to promote the use of gypsum while advancing the development growth, and general welfare of the gypsum industry in the United States (U.S.) and Canada on behalf of its member companies. GA members include all the active gypsum panel product manufacturers in the U.S. and Canada. GA member companies provided both LCI and meta-data for the reference year 2019. GA members, with the inclusion of their Canadian holdings and affiliates, produce and ship over 95% of the glass mat panel sheathing consumed in the USA and Canada. The owner of the declaration is liable for the underlying information and evidence.
GA Member Companies Corporate Locations	
AMERICAN GYPSUM	American Gypsum Company LLC 3811 Turtle Creek Blvd., Suite 1200 Dallas, TX 75219, USA Member Link (URL): http://www.americangypsum.com/
CertainTeed SAINT-GOBAIN Gypsum	CertainTeed Gypsum, Inc. CertainTeed Gypsum Canada, Inc. 20 Moores Road Malvern, PA 19355, USA Member Link (URL): http://www.certainteed.com/gypsum *In the course of completing this EPD project Continental Building Products (CBP) was acquired by CertainTeed. CBP also provided operational data to support this project).*
GP Georgia-Pacific Gypsum	Georgia-Pacific Gypsum LLC 133 Peachtree Street NE Atlanta, GA 30303, USA Member Link (URL): http://www.buildgp.com/Georgia-Pacific-Gypsum

General Summary	
National Gypsum	National Gypsum Company 2001 Rexford Road Charlotte, North Carolina 28211, USA Member Link (URL): http://nationalgypsum.com/
PABCO Gypsum what the job demands	PABCO® Gypsum 10600 White Rock Road, Suite 100 Rancho Cordova, CA 95670, USA Member Link (URL): http://www.pabcogypsum.com/
USG	United States Gypsum Company 550 West Adams Street Chicago, IL 60661-3676, USA Member Link (URL): https://www.usg.com/content/usgcom/en.html
CGC IT'S YOUR WORLD. BUILD IT.™	Canadian Gypsum Company (CGC) Inc. 350 Burnhamthorpe Road West 5th Floor Mississauga, ON, L5B 3J1, Canada Member Link (URL): https://www.usg.com/content/usgcom/en_CA_east.html
Product Group and Name	Glass-mat gypsum board
Product Description	Glass-mat gypsum boards are designed to be used as exterior substrate or sheathing for weather barriers. The substrates consist of a non-combustible water-resistant gypsum core, surfaced with glass mat partially or completely embedded in the core.
Product Category Rules (PCR)	NSF International, Product Category Rule for Environmental Product Declarations, PCR for Gypsum Panel Products, April 2020 [5].
Certification Period	May 1, 2021 - May 1, 2026 (Extended to November 1, 2026)
Declared Unit	92.9 m^2 (1,000 square feet) of glass-mat gypsum board with a nominal finished thickness of 12.7 mm and 15.9 mm ($^1/_2$” and $^5/_8$”).
NSF Declaration Number	EPD 206

EPD and Project Report Information	
Program Operator	ASTM International
Declaration Holder	Gypsum Association (GA)

General Summary

Declaration Type

A “cradle-to-gate” EPD for glass-mat gypsum boards manufactured by GA members. Activity stages or information modules covered include production with the product ready for shipment at the manufacturing plant (modules A1 to A3). The declaration is intended for use in Business-to-Business (B-to-B) communication.

Applicable Countries

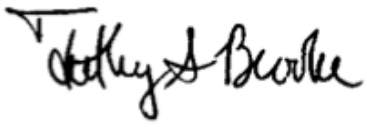
United States and Canada

Product Applicability

Glass-mat gypsum boards are typically used as exterior building envelope sheathing providing weather barriers, mold and fire resistance for new construction or renovation work.

Content of the Declaration

This declaration follows *Section 9*; *Content of an EPD*, NSF International, Product Category Rule for Environmental Product Declarations: PCR for Gypsum Panel Products, April 2020 [5].

This EPD was independently verified **by ASTM in accordance with ISO 14025 and the reference PCR:** **Internal** **External** X	 Tim Brooke, ASTM International
The Project Report *Note that this Project Report is not part of the public communication (ISO 21930, 10.1).*	An Industry Average Cradle-to-Gate Life Cycle Assessment of 1/2” Regular and 5/8” Type X Glass-mat Gypsum Board for the USA and Canadian Markets, April 2021.
Prepared by Athena Sustainable Materials Institute	Lindita Bushi, PhD, Mr. Jamie Meil and Mr. Grant Finlayson Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org
The EPD project report was independently verified in accordance with ISO 14025, ISO 14040/44, and the reference PCR:	Thomas P. Gloria, PhD Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA

PCR Information

Program Operator	ASTM International

General Summary	
Reference PCR	NSF International, Product Category Rule for Environmental Product Declarations: PCR for Gypsum Panel Products [5].
Date of Issue	April 2020
PCR review was conducted by:	Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants, t.gloria@industrial-ecology.com Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group

1 PRODUCT IDENTIFICATION

1.1 PRODUCT DEFINITION

Glass-mat gypsum boards UNSPSC Code 30161500, as defined in ASTM C1177 are designed to be used as an exterior substrate or sheathing for weather barriers [1]. The substrates consist of a non-combustible water-resistant gypsum core, surfaced with a glass mat partially or completely embedded in the core [1]. Typically, glass-mat gypsum boards are 4' wide and 8' length boards (4'×8') produced with a square edge but they may be available in other lengths and can vary in thickness depending on the application.

The focus of this industry average LCA study is on two glass-mat gypsum boards used for exterior sheathing applications (walls and soffits).

- $^{1}/_{2}$” (12.7 mm) glass-mat gypsum board (Regular core, ASTM C1177), and
- $^{5}/_{8}$” (15.9 mm) Type X glass-mat gypsum board (Type X core, ASTM C1177).

This study does not cover glass-mat gypsum panels used in interior wall and ceiling applications (ASTM C1658). In addition, this study does not cover glass-mat gypsum roof board (ASTM C1177), glass-mat gypsum panel abuse & impact resistant (ASTM C1629), and glass-mat gypsum tile backer (ASTM C1178). Figure 1 below provides a visual of a glass mat panel.



Figure 1 Generic glass-mat gypsum board

1.2 PRODUCT STANDARD

Applicable product standards for glass-mat gypsum boards include:

- *ASTM C1177/ C1177M-17 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing*
- *ASTM C11-18b Terminology Relating to Gypsum and Related Building Materials and Systems*
- *ASTM C22 / C22M-00(15) Standard Specification for Gypsum*
- *ASTM C473-17 Standard Test Methods for Physical Testing of Gypsum Panel Products*
- *ASTM C1264- 19Specification for Sampling, Inspection, Rejection, Certification, Packaging, Marking, Shipping, Handling, and Storage of Gypsum Panel Products*
- *ASTM E119-18ce1 Test Methods for Fire Tests of Building Construction and Materials*

- *ASTM E2921-16a Standard practice for minimum criteria for comparing whole building LCAs for use with building codes, standards, and rating systems.*

2 DECLARED UNIT

The declared unit is 92.9 m^2 (1,000 square feet, 1 MSF) of glass-mat gypsum boards with a nominal finished thickness of $^1/_2$" and $^5/_8$" (Table 1).

Table 1 Declared unit definition

Item	1/2" Regular glass-mat gypsum board	5/8" Type X glass-mat gypsum board	Units
Declared unit	92.9	92.9	m^2
Mass	943	1263	kg
Thickness	12.7	15.9	mm
Final MC	1.4	1.7	%
Core type	Regular	Type X	n/a

3 MATERIAL CONTENT

Table 2 below presents the weighted average composition by input material for 92.9 m^2 (1 MSF) of glass-mat gypsum boards as derived from the GA member facilities LCI data collection for the reference year 2019.

Table 2: Material content for 92.9 m^2 (1 MSF) of glass-mat gypsum boards by thickness

Inputs	1/2" Regular glass-mat gypsum board	5/8" Type X glass-mat gypsum board	Units
Natural gypsum ore	661.5	857.6	kg
FGD synthetic gypsum	161.2	231.3	kg
Post-consumer gypsum[1)]	1.47	0.93	kg
Glass matting	51.4	53.0	kg
Starch	0.72	0.48	kg
Continuous filament glass fiber	1.11	1.64	kg
Dispersant	1.81	2.68	kg
Retarder	0.07	0.20	kg

Inputs	1/2" Regular glass-mat gypsum board	5/8" Type X glass-mat gypsum board	Units
Potassium Sulfate	0.65	0.67	kg
Boric Acid	0.034	0.043	kg
Land Plaster	0.27	0.15	kg
Foaming agent (soap)	0.12	0.15	kg
Ball mill Accelerator (BMA)	1.80	1.28	kg
Edge Paste	1.21	1.66	kg
Fly ash	0.64	0.50	kg
Other Chemicals[2)]	1.12	3.08	kg
Silicone products	3.26	3.25	kg
Wax	3.29	5.18	kg
Other (MgO, Portland cement)	0.06	0.09	kg
Water	614.7	811.0	kg
Final weight, with MC%/ MSF	943.0	1,263.0	kg
Final moisture content	1.40%	1.66%	%
Final weight, with 0% MC/ MSF	929.3	1,241.0	kg

Notes:

[1)] Post-consumer gypsum includes on-site construction off-cuts and recovered gypsum material collected from demolition sites.
[2)] It consists of biocide, sodium omadine, sodium trimetaphosphate, barium metaborate monohydrate (Busan) and emulsion solids. LCI data have been rolled up to protect confidential/proprietary information.

4 PRODUCTION STAGE

For this EPD, the boundary is “cradle-to-gate” or the *Production stage*, which includes extraction of raw materials (cradle) through the manufacture of glass-mat gypsum boards ready for shipment (gate). Downstream activity stages - Construction, Use, End-of-life, and Optional supplementary information beyond the system boundary - are excluded from the system boundary (Figure 2). Figure 3 illustrates the Production stage system boundary for the declared unit.

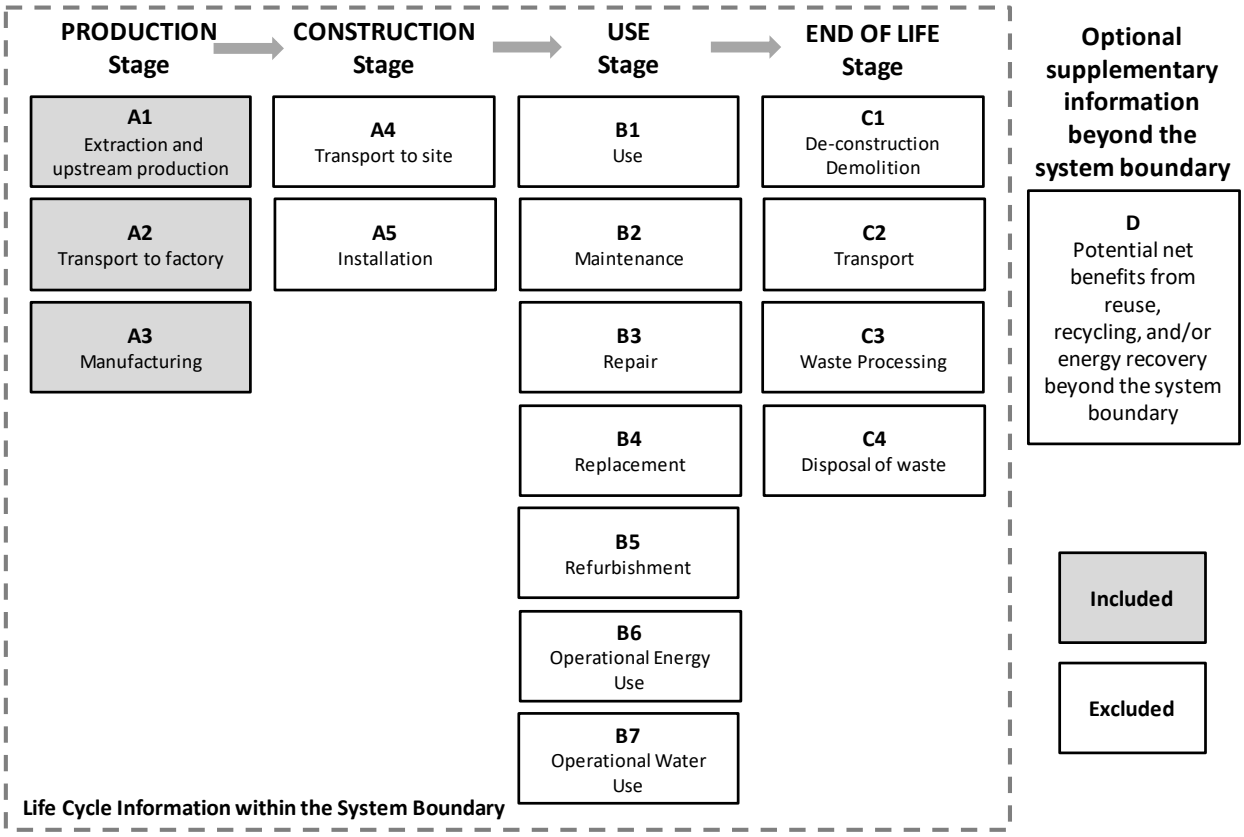


Figure 2 Common four life cycle stages and their information modules for construction products and the optional supplementary module [2]

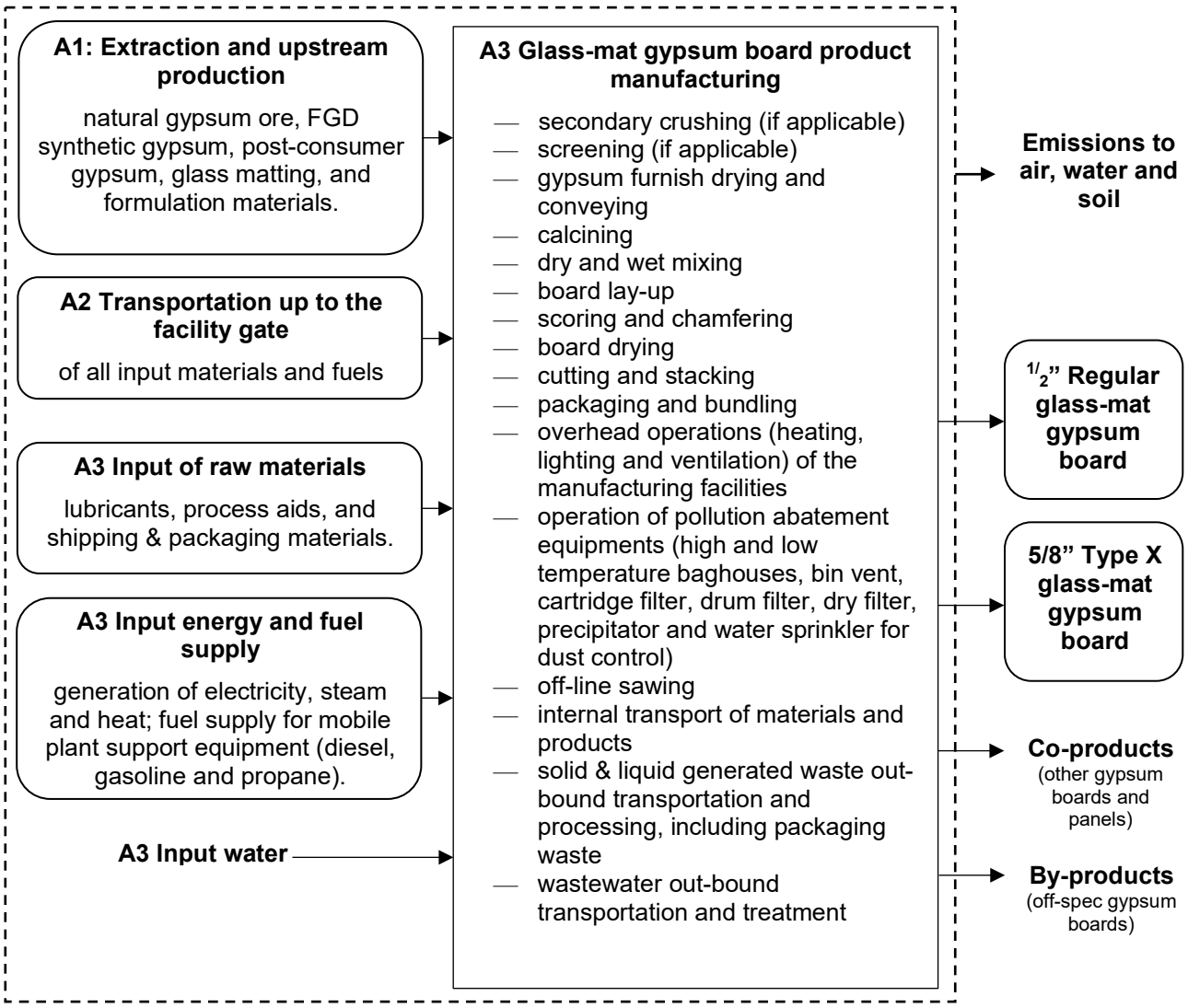


Figure 3 Production stage (modules A1 to A3) system boundary for glass-mat gypsum boards

5 LIFE CYCLE INVENTORY

5.1 DATA COLLECTION, SOURCE AND CALCULATIONS

Data collection was based on an initial survey of all GA member facility operations. GA members operate 51 facilities in the USA and Canada producing various gypsum board and panel products. Some facilities are 100% dedicated to the production of glass-mat gypsum boards while others may produce glass-mat gypsum boards as well as other gypsum panel products. In total 11 facilities operated by the seven (7) GA company members completed LCI data collection questionnaires representing 35% of all GA member facilities producing glass-mat gypsum boards. To ensure representativeness, the manufacturing plant sample also considered the scale of operations including a mix of small, medium, and large glass-mat gypsum board production volume facilities, their geographical location (East, Midwest and Western US) and their source of gypsum – adjacent quarry, mine, imported gypsum ore and their use of FGD synthetic gypsum. All LCI data were averaged on the annual production weighted basis across facilities.

This project draws on foreground gate-to-gate LCI data collected for natural gypsum ore extraction (six quarries and one underground mining site) for the reference year 2017. In addition, a major glass matting US manufacturer provided confidential LCIA and LCI indicator results for a typical glass mat product used in the manufacturing of glass-mat gypsum boards for production year 2017.

LCI data collection was based on a customized LCI survey developed for glass mat panel manufacturing.

Source of data is specified as: Direct, based on measurements or purchasing/selling records of the surveyed facilities; Indirect, based on calculations made by the personnel of the surveyed facilities; and Estimated, based on the industry average data and/or expert judgment. Key input flows driving the indicator results were either directly measured or indirectly calculated.

Data calculation procedures follow ISO 14044, and NSF PCR for Gypsum Panel Products. Per ISO 21930, 7.2.2 the net calorific value (lower heating value) of fuels is applied according to scientifically based and accepted values specific to the combustible material.

The cradle-to-gate LCI model for each product of interest considers the three modules: A1 Extraction and upstream production, A2 Transport to factory and A3 Manufacturing of glass-mat gypsum boards.

5.2 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

A detailed description of collected data and the data quality assessment regarding the NSF PCR requirements and ISO 14044 is provided in the LCA report. Data quality is assessed based on its representativeness (technology coverage, geographic coverage, time coverage). completeness, consistency, reproducibility, transparency and uncertainty (Table 3).

Table 3 Data Quality Requirements and Assessments

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology in use in U.S. and Canada. Whenever available, for all upstream and core material and processes, North American typical or average industry LCI datasets were utilized. Technological representativeness is characterized as “high”.
Geographic Coverage	The geographic region considered is U.S. and Canada. The geographic coverage of all LCI databases and datasets is provided in the LCA background report. Geographical representativeness is characterized as "high".
Time Coverage	Activity data are representative as of 2017-2019. - Glass-mat gypsum board manufacturing process - primary data collected from 11 facilities: reference year 2019 (12 months) - In-bound/ out-bound transportation data - primary data collected from 11 facilities: reference year 2019 (12 months) - Natural gypsum ore – primary data collected from six quarries and one gypsum ore underground mine: reference year 2017 (12 months) - Glass mat manufacturing- cradle-to-gate profile per ISO 21930:2017 provided by a major glass matting US manufacturer to support this project: reference year 2017 (12 months). - Generic data: the most appropriate LCI datasets were used as found in the US LCI Database, ecoinvent v.3.6 database for US, Canada and global, Dec 2019. Temporal representativeness is characterized as “high”.
Completeness	All relevant, specific processes, including inputs (raw materials, energy and ancillary materials) and outputs (emissions and production volume) were considered and modeled to provide an industry average for the glass-mat gypsum board products of interest. The relevant background materials and processes were taken from the US LCI Database, ecoinvent v 3.6 LCI database, and modeled in SimaPro v9.1.1.1, 2021. The completeness of the cradle-to-gate process chain in terms of process steps is rigorously assessed for both glass-mat gypsum boards and documented in the LCA background report.

Data Quality Requirements	Description
Consistency	To ensure consistency, the LCI modeling of the production weighted input and output LCI data for the glass-mat gypsum board product of interest used the same LCI modeling structure across the selected GA member facilities, which consisted of input raw, secondary, glass matting, ancillary and packaging materials, energy flows, water resource inputs, product outputs, co-products, by-products, emissions to air, water and soil, and solid and liquid waste disposal. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level and selected process levels to maintain a high level of consistency.
Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in GA Athena Glass-mat gypsum boards LCI database developed in SimaPro, 2021. A high level of transparency is provided throughout the LCA background report as the weighted average LCI profile is presented for each of the declared products as well as major upstream inputs. Key primary (manufacturer specific) and secondary (generic) LCI data sources are also summarized.
Transparency	Activity and LCI datasets are transparently disclosed in the LCA background report, including data sources.
Uncertainty	A sensitivity check was conducted to assess the reliability of the EPD results and conclusions by determining how they are affected by uncertainties in the data or assumptions on calculation of LCIA and energy indicator results. The sensitivity check includes the results of the sensitivity analysis and Monte Carlo uncertainty analysis both of which are summarized in the LCA report

5.3 ALLOCATION AND CUT-OFF RULES

The GA glass-mat gypsum board manufacturing facilities typically produce other co-products besides selected products of interest and as such allocation was necessary. As specified in the NSF PCR, “mass” was used as the physical parameter for allocating flows between the products of interest and other co-products to calculate the input energy flows (electricity, natural gas, propane, etc.), shipping and packaging materials, lubricants, hydraulic fluid, greases, and oils, total water consumption, process emissions to air, water and land and waste flows. No burden is allocated to any of the by-products of the selected product systems such as off-spec gypsum boards (used as dunnage/bunks/sleuters).

The cut-off criteria as per NSF PCR, and ISO 21930, were followed for this EPD. All input/output data required were collected and included in the LCI modelling. No substances with hazardous and toxic properties that pose a concern for human health and/or the environment were identified in the framework of this EPD. Any data gaps for the reference year 2019 e.g., input hydraulic fluids, lubricants, oils, packaging materials or transportation were filled with plant generic data from previous years or industry average data. GA members provided Material Safety Data Sheet (MSDSs) confidentially per each chemical class e.g., dispersant, retarder chemicals, etc. Any data gaps in the MSDS are filled in with two generic LCI datasets, as appropriate (conservative assumptions): *Chemical, organic {GLO}| production | Cut-off, U*; *Chemical, inorganic {GLO}| production | Cut-off, U*.

Per NSF PCR, the Production Stage *excludes* the following processes:

- Capital goods and infrastructure;
- Human activity and personnel related activity (travel, furniture, office operations and supplies); and
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

6 LIFE CYCLE ASSESSMENT

6.1 RESULTS OF THE LIFE CYCLE ASSESSMENT

This section summarizes the production stage life cycle impact assessment (LCIA) results including resource use and waste generated metrics based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated based on 92.9 m^2 (1 MSF) of $^1/_2$" and $^5/_8$" glass-mat gypsum boards (Tables 4 and 5). *It is noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks* [3], [4].

Table 4 Production Stage (A1-A3), EPD Results – 92.9 m^2 (1 MSF) for $^1/_2$" Regular glass-mat gypsum products

Impact category and inventory indicators	Unit	A1, Extraction and upstream production	A2, Transport to factory	A3, Manufacturing	Total
Global warming potential, GWP 100[1)], AR5	kg CO_2 eq	207.0	25.5	204.9	**437.4**
Ozone depletion potential, ODP[1)]	kg CFC-11 eq	0.0	0.0	0.0	**7.2E-05**
Smog formation potential, SFP[1)]	kg O_3 eq	12.6	10.9	6.4	**29.9**
Acidification potential, AP[1)]	kg SO_2 eq	0.8	0.5	0.3	**1.6**
Eutrophication potential, EP[1)]	kg N eq	0.7	0.0	0.3	**0.95**
ADP surplus, TRACI[1)]	MJ LHV	407.9	52.0	449.7	**910**
Renewable primary resources used as an energy carrier (fuel), RPR_E[2)]	MJ LHV	97.6	0.2	61.7	**160**
Renewable primary resources with energy content used as material, RPR_M[2)]	MJ LHV	0.0	0.0	0.0	**0**
Non-renewable primary resources used as an energy carrier (fuel), $NRPR_E$[2)]	MJ LHV	3,336	347.9	3,122	**6,806**
Non-renewable primary resources with energy content used as material, $NRPR_M$[2)]	MJ LHV	0.0	0	0.0	**0**
Secondary materials, SM[2)]	kg	162.5	0	0.0	**163**
Renewable secondary fuels, RSF[2)]	MJ LHV	0	0	0	**0**

Impact category and inventory indicators	Unit	A1, Extraction and upstream production	A2, Transport to factory	A3, Manufacturing	Total
Non-renewable secondary fuels, NRSF[2)]	MJ LHV	0	0	0	**0**
Recovered energy, RE[2)]	MJ LHV	0	0	0	**0**
Consumption of freshwater, FW[2)]	m^3	1.3	0	0.8	**2.1**
Hazardous waste disposed, HWD[2)]	kg	0.024	0	0.013	**0.037**
Non-hazardous waste disposed, NHWD[2)]	kg	8.3	0	11.1	**19.4**
High-level radioactive waste, conditioned, to final repository, HLRW[2)]	m^3	2.0E-08	1.7E-10	1.2E-07	**1.4E-07**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW[2)]	m^3	1.8E-06	1.1E-06	1.8E-06	**4.7E-06**
Components for re-use, CRU[2)]	kg	0	0	0	**0**
Materials for recycling, MR[2)]	kg	0	0	26.1	**26.1**
Materials for energy recovery, MER[2)]	kg	0	0	0.0	**0**
Recovered energy exported from the product system, EE[2)]	MJ LHV	0	0	0.0	**0**

Table 5 Production Stage (A1-A3), EPD Results – 92.9 m^2 (1 MSF) for $^5/_8$" Type X glass-mat gypsum boards

Impact category and inventory indicators	Unit	A1, Extraction and upstream production	A2, Transport to factory	A3, Manufacturing	Total
Global warming potential, GWP 100[1)], AR5	kg CO_2 eq	220.4	33.0	250.5	**503.9**
Ozone depletion potential, ODP[1)]	kg CFC-11 eq	0.0	0.0	0.0	**8.3E-05**
Smog formation potential, SFP[1)]	kg O_3 eq	13.9	14.4	7.4	**35.7**
Acidification potential, AP[1)]	kg SO_2 eq	0.9	0.7	0.4	**2.0**
Eutrophication potential, EP[1)]	kg N eq	0.7	0.0	0.3	**1.05**
ADP surplus, TRACI[1)]	MJ LHV	456.1	67.0	548.4	**1,072**
Renewable primary resources used as an energy carrier (fuel), RPR_E[2)]	MJ LHV	99.1	0.3	79.8	**179**
Renewable primary resources with energy content used as material, RPR_M[2)]	MJ LHV	0.0	0.0	0.0	**0**
Non-renewable primary resources used as an energy carrier (fuel), $NRPR_E$[2)]	MJ LHV	3,693	447.7	3,817	**7,958**
Non-renewable primary resources with energy content used as material, $NRPR_M$[2)]	MJ LHV	0.0	0	0.0	**0**
Secondary materials, SM[2)]	kg	232.3	0	0.0	**232**
Renewable secondary fuels, RSF[2)]	MJ LHV	0	0	0	**0**
Non-renewable secondary fuels, NRSF[2)]	MJ LHV	0	0	0	**0**
Recovered energy, RE[2)]	MJ LHV	0	0	0	**0**
Consumption of freshwater, FW[2)]	m^3	1.3	0	1.0	**2.3**
Hazardous waste disposed, HWD[2)]	kg	0.030	0	0.018	**0.048**
Non-hazardous waste disposed, NHWD[2)]	kg	8.6	0	14.0	**22.5**
High-level radioactive waste, conditioned, to final repository, HLRW[2)]	m^3	2.4E-08	2.4E-10	1.4E-07	**1.7E-07**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW[2)]	m^3	2.6E-06	1.5E-06	2.3E-06	**6.4E-06**
Components for re-use, CRU[2)]	kg	0	0	0	**0**
Materials for recycling, MR[2)]	kg	0	0	41.3	**41.3**
Materials for energy recovery, MER[2)]	kg	0	0	0.0	**0**

Impact category and inventory indicators	Unit	A1, Extraction and upstream production	A2, Transport to factory	A3, Manufacturing	Total
Recovered energy exported from the product system, EE[2)]	MJ LHV	0	0	0.0	**0**

Notes to Table 4 and 5:

[1)] Calculated as per U.S EPA TRACI 2.1, v1.05, SimaPro v 9.1.1.1. GWP_{100}, excludes biogenic CO_2 removals and emissions associated with biobased products such as starch and dextrose (see Table 6 for details); 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5), TRACI 2.1, with AR5, v1.05.
[2)] Calculated as per ACLCA ISO 21930 Guidance, respective sections 6.2 to 10.8.

Per NSF PCR [5], glass-mat gypsum board products contain starch and dextrose which have a biogenic carbon component. Table 6 shows the cradle-to-gate biogenic CO_2 removals associated with bio-based products used in the gypsum board system.

Table 6 Production Stage (A1-A3), Biogenic CO_2 removals – 92.9 m^2 (1 MSF) of 1/2" Regular and 5/8" Type X glass-mat gypsum boards

Inputs	Chemical formula	C-Content (in %)	Biogenic CO_2 removals (in kg CO_2/ MSF)	
			1/2" Regular glass-mat gypsum board	5/8" Type X glass-mat gypsum board
Starch	$(C_6H_{10}O_5)_n$	44%	**- 2.6** = -1.59 kg × 0.44 × (44/12)	**- 1.7** = -1.06 kg × 0.44 × (44/12)
Dextrose	$C_6H_{12}O_6$	40%	**- 0.87** = -0.60 kg × 0.40 × (44/12)	**- 0.62** = -0.42 kg × 0.40 × (44/12)

Notes:
[1)] 44 and 12 is the molar mass of CO_2 and C (in g/mol), respectively.
[2)] It includes the amount of dextrose mixed with landplaster to produce BMA (also known as heat resistant accelerator, HRA). The weighted average quantity of dextrose in BMA was calculated to be 15%.

6.2 INTERPRETATION

The cradle-to-gate manufacture of 92.9 m^2 of 12.7 mm (1 MSF of $^1/_2$") glass mat panel embodies about 7.0 GJ of primary energy (LHV) and emits 437 kg CO_2 eq of greenhouse gases. Around 98% of the total primary energy is derived from non-renewable primary energy resource.

Across the three production information modules, Module A1 extraction and upstream production contributes the largest share of the LCIA and energy indicator results – accounting for between 42% (smog) and 69% (eutrophication) of the potential environmental burdens. The glass matting production is the primary contributor to Module A1 Extraction and upstream production. Module A3 Manufacturing is the second largest contributor (<50%) to the overall potential environmental impacts of $^1/_2$" Regular glass-mat gypsum board manufacture. Except for acidification (31%) and smog potential impacts (37%), Module A2

Transportation is generally a minor contributor (<10%) to the overall potential environmental impacts of ½" Regular glass-mat gypsum board manufacture.

The cradle-to-gate manufacture of 92.9 m^2 of 15.9 mm (1 MSF of $^5/_8$") glass-mat gypsum board embodies about 8.1 GJ of primary energy (LHV) and emits 504 kg CO_2 eq of greenhouse gases. Around 98% of the total primary energy is derived from non-renewable primary energy resource.

Across the three production information modules, Module A1 extraction and upstream production contributes the largest share of the LCIA and energy indicator results – accounting for between 39% (smog) and 65% (eutrophication) of the potential environmental burdens. The glass matting production is the primary contributor to Module A1 Extraction and upstream production. Module A3 Manufacturing is the second largest contributor (<50%) to the overall potential environmental impacts of $^5/_8$" Type X glass-mat gypsum board manufacture. Except for acidification (35%) and smog potential impacts (40%), Module A2 Transportation is generally a minor contributor (<10%) to the overall potential environmental impacts of $^5/_8$" Type X glass-mat gypsum board manufacture.

7 ADDITIONAL ENVIRONMENTAL INFORMATION

- *Health Protection Manufacture*

  The OSHA standards are applicable and followed.

  - U.S. Department of Labor, Occupational Safety & Health Administration (OSHA), 29 CFR, PART 1910 Occupational Safety and Health Standards.

  https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=1910, accessed 03-2021.

  No additional health protection measures extending beyond mandatory occupational safety measures for commercial operations are required.

- *Environmental Protection Manufacture and Equipment*

  GA member manufacturing facilities comply with US regional environmental protection requirements, monitor and report the emissions to air during the manufacturing process as per the following:

  - EPCRA Section 313 Toxic Release Inventory Reporting (U.S)

  https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=1910, accessed 03-2021.

  - The Canadian National Pollutant Release Inventory (NPRI) reporting

  http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=4A577BB9-1, accessed 03-2021.

  Pollution abatement equipment typically used in the glass-mat gypsum board manufacturing facilities are as follows: fabric filter – high temperature (baghouse), fabric filter- low temperature (baghouse), bin vent filter, drum filter, dry filter, cartridge filter, precipitator and water sprinkler for dust control.

8 DECLARATION TYPE AND PRODUCT AVERAGE DECLARATION

This type of EPD is defined as:

A “*Cradle-to-gate*” EPD for $^{1}/_{2}$” Regular and $^{5}/_{8}$” Type X glass-mat gypsum boards covering the Production stage (information modules A1 to A3) and is intended for use in *Business-to-Business* communication

This Gypsum Association EPD for glass-mat gypsum boards (*NAICS Code 30161500)* falls under the description:

- An average product EPD, as an average from several GA manufacturers’ facilities (in this case, GA member manufacturers as listed under “GA Member Companies Corporate Locations”

9 DECLARATION COMPARABILITY LIMITATION STATEMENT

The following ISO 21930 statements indicate the EPD comparability limitations and intent to avoid any market distortions or misinterpretation of EPDs based on the NSF PCR for Gypsum Panel Products.

- *Only EPDs prepared from cradle-to-grave life cycle results and based on the same function, RSL, quantified by the same functional unit, and meeting all the conditions for comparability listed in ISO 14025:2006 and ISO 21930:2017 can be used to comparison between products*.

10 EPD EXPLANATORY MATERIAL

For any explanatory material, regarding this EPD for glass-mat gypsum boards, please contact the program operator.

ASTM International
Environmental Product Declarations
100 Barr Harbor Drive,
West Conshohocken,
PA 19428-2959, http://www.astm.org

11 REFERENCES

1. ASTM C1177/C1177M- 17 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

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

3. ISO 14040:2006/Amd 1:2020 Environmental management - Life cycle assessment - Principles and framework.

4. ISO 14044:2006/Amd1:2017/Amd2:2020 Environmental management - Life cycle assessment - Requirements and guidelines.

5 NSF International, Product Category Rule Environmental Product Declarations, PCR for Gypsum Panel Products, April 2020.

6 ASTM Program Operator Rules. Version: 8.0, Revised 04/29/20.

7 ISO 14025:2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

8. ASTM C11 – 18b Standard Terminology Relating to Gypsum and Related Building Materials and Systems.

9. ISO 14021:2016 Environmental labels and declarations -- Self-declared environmental claims (Type II environmental labelling).

10. PRé 2019.SimaPro LCA Software v9.1.1.1, 2021.
https://simapro.com/, accessed 03-2021.

11. ACLCA 2019, Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017. The American Centre for Life Cycle Assessment. May, 2019.
https://aclca.org/aclca-iso-21930-guidance/, accessed 03-2021.

12. LEED v4, *Building Design and Construction Guide (BD+C), MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations, Option 2 Multi-attribute optimization* (1 point).
https://www.usgbc.org/node/2616376?return=/credits/new-construction/v4/material-%26amp%3B-resources, accessed 08-2020,
accessed 03-2021.

13. LEED v4.1 July 2019, *Building Design and Construction Guide (BD+C), Getting started guide for beta participant, MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations, Option 2 Multi-attribute optimization (1 point), pg.170.*
https://new.usgbc.org/leed-v41, accessed 03-2021.