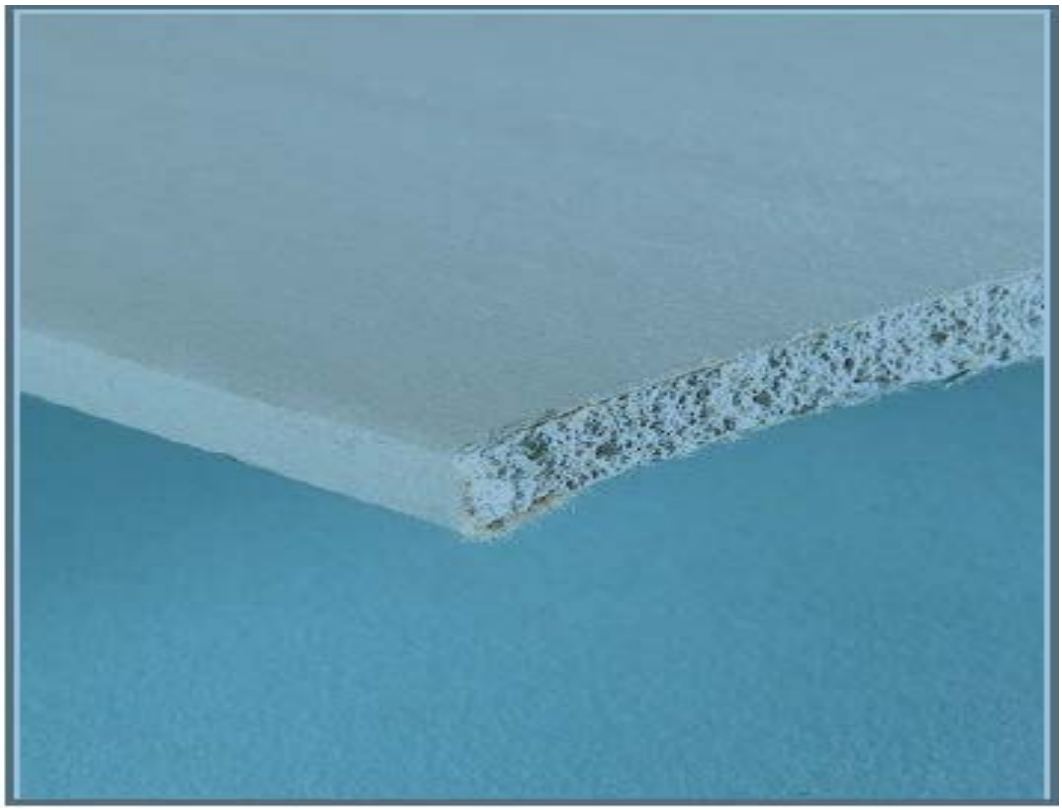
An Environmental Product Declaration

According to ISO 14025:2006 and ISO 21930:2017

An industry average cradle-to-gate EPD for $^{5}/_{8}$" Type X Conventional Gypsum Board produced by Gypsum Association member companies for the USA and Canadian Markets.



NSF Certification, LLC
Ann Arbor, MI
www.nsf.org

Date of issue: 28/04/2020
Period of validity: 5 years
Declaration No.: EPD 10270

NSF Certified Environmental Product Declaration

This is an industry average (also known as an "industry-wide" cradle-to-gate EPD) business-to-business Type III environmental product declaration for $^{5}/_{8}$" (15.9 mm) Type X conventional gypsum board as manufactured by the Gypsum Association (GA) member companies in the USA and Canada conforming to ASTM C1396, Standard Specification for Gypsum Board [1]. This declaration has been prepared in accordance with ISO 21930 [2], ISO 14025 [3], ISO 14040 [4], ISO 14044 [5] the governing NSF International product category rules (PCR) for preparing an environmental product declaration for gypsum panel products [6] and NSF International's EPD program operator rules [7].

The intent of this document is to further the development of environmentally compatible and more sustainable construction products by providing comprehensive environmental information related to potential environmental impacts of $^{5}/_{8}$" (15.9 mm) Type X conventional gypsum board available in the USA and Canada in accordance with international standards.

Environmental Product Declaration Summary

General Summary	
Owner of the EPD	
	Gypsum Association (GA) 6525 Belcrest Road, Suite 480 Hyattsville, MD 20782 Link (URL): www.gypsum.org info@gypsum.org The GA 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. To be eligible for membership in the Association, a firm or corporation must calcine gypsum and manufacture gypsum board under the provisions of ASTM Standard C1396.

General Summary	
	Each GA member company provided both LCI and meta-data for the reference year 2017. GA members, with the inclusion of their Canadian holdings and affiliates, produce and ship over 90% of the gypsum board 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
CONTINENTAL BUILDING PRODUCTS	Continental Building Products 12950 Worldgate Drive, Suite 700 Herndon, VA 20170, USA Member Link (URL): http://www.continental-bp.com/en/
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 Company 2001 Rexford Road Charlotte, North Carolina 28211, USA Member Link (URL): http://nationalgypsum.com/
	PABCO® Gypsum 10600 White Rock Road, Suite 100 Rancho Cordova, CA 95670, USA Member Link (URL): http://www.pabcogypsum.com/
	United States Gypsum Company 550 West Adams Street Chicago, IL 60661-3676, USA Member Link (URL): https://www.usg.com/content/usgcom/en.html 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	Gypsum board
Product Description	Gypsum board is the generic name for a family of sheet products consisting of a non-combustible core primarily of gypsum with a paper facing [5], [8] (UNCPC Code 3699, NAICS Code 327420).
Product Category Rules (PCR)	NSF International, Product Category Rule for Environmental Product Declarations, PCR for Gypsum Panel Products, April 2020 [5].
Certification Period	28.04.2020 - 27.04.2025
Declared Unit	92.9 m^2 (1,000 square feet) of $^{5}/_{8}$" (15.9 mm) Type X conventional gypsum board.
NSF Declaration Number	EPD 10270

EPD and Project Report Information			
Program Operator		NSF Certification, LLC	
Declaration Holder		Gypsum Association (GA)	
Product group	**Date of Issue**	**Period of Validity**	**Declaration Number**
Gypsum board	28.04.2020	5 years	EPD 10270

Declaration Type

A "cradle-to-gate" EPD for $^{5}/_{8}$" Type X conventional gypsum board 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

Gypsum board products are used extensively in building construction and renovation as an enclosing surface for interior walls and ceilings providing a finishing surface as well as mold and fire resistance.

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 NSF in accordance with ISO 14025 and the reference PCR: **Internal** **External** X	Jenny Oorbeck, joorbeck@nsf.org
The Project Report	An Industry Average Cradle-to-Gate Life Cycle Assessment of $^{1}/_{2}$" Lightweight and $^{5}/_{8}$" Type X conventional Gypsum Board for the USA and Canadian Markets, April 2020.
Prepared by	Lindita Bushi, Ph.D. and Mr. Jamie Meil Athena Sustainable Materials Institute info@athenasmi.org www.athenasmi.org

EPD and Project Report Information	
This EPD project report was independently verified by NSF in accordance with ISO 14025, ISO 14040/44 and the reference PCR:	 Jack Geibig – EcoForm jgeibig@ecoform.com
PCR Information	
Program Operator	NSF Certification, LLC
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

Gypsum board (UN CPC Code 3699, NAICS Code 327420), is manufactured to ASTM C1396 [1] and is designed to be used as an interior sheathing capable of supporting an array finishes and demonstrating various performance characteristics. Per NSF PCR [6], gypsum board is the generic name for a family of sheet products consisting of a non-combustible core primarily of gypsum with paper facing [8]. Gypsum board is ubiquitous in its use and naming – also called wallboard, drywall, plaster board, sheet rock and gypsum panel. Conventional $^{5}/_{8}$" (15.9 mm) Type X gypsum board, having additional fire rating characteristics, is used primarily in commercial applications. As calculated, the weighted average density of $^{5}/_{8}$" Type X conventional gypsum board (MC 0%) was 10.4 kg/m^2, with a minimum and maximum density value of 9.9 and 11.0 kg/m^2, respectively (less than +/-10% variation). The substrates consist of a noncombustible water-resistant gypsum core, sandwiched between two layers of paper. Typically, gypsum boards are 4' wide and 8' length panels (4'×8') produced with a beveled edge and are compatible with most interior wall and ceiling applications. Gypsum board may be available in other lengths and can vary in thickness and fire rating properties depending on additive types. It should be noted that $^{5}/_{8}$" Type X conventional gypsum board (type X core) does not cover $^{5}/_{8}$" Mold and Moisture Resistant (MMR), including paper faced abuse resistant, paper faced impact resistant (fiberglass mesh reinforcement embedded in the core) and paper faced plaster base gypsum board.

1.2 PRODUCT STANDARD

Applicable product standards for gypsum board include:

- ASTM C11–18b *Standard 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 C1396 / C1396M–17- *Standard Specification for Gypsum Board*.
- ASTM D3273–16 *Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber*.
- ASTM E84–19b *Standard Test Method for Surface Burning Characteristics of Building Materials*.
- ASTM E119–18ce1 *Standard 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 $^5/_8$" Type X conventional gypsum board (Table 1).

Table 1: Declared unit definition

Parameter	15.9mm $^5/_8$" Type X conventional	Units
Declared unit	92.9	m^2
Mass	991	kg
Thickness	15.9	mm
Core type	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 $^5/_8$" (15.9 mm) Type X conventional gypsum board as derived from the GA member facilities LCI data collection for the reference year 2017.

Table 2: Weighted average material content for 92.9 m^2 of 15.9 mm Type X conventional gypsum board

Inputs	Units	15.9 mm ($^5/_8$") Type X conventional
Natural gypsum ore	kg	359
FGD synthetic gypsum	kg	558
Post-consumer gypsum[1)]	kg	3.5
Facing paper	kg	19.2
Backing paper	kg	17.9
Starch	kg	3.8
Vermiculite	kg	0.55
Fiberglass	kg	2.65

Inputs	Units	15.9 mm (5/8") Type X conventional
Potash	kg	0.0041
Dextrose	kg	0.59
Dispersant	kg	1.63
Retarder	kg	0.22
Potassium Sulfate	kg	0.020
Clay, kaolin	kg	0.28
Boric Acid	kg	0.12
Foaming agent (soap)	kg	0.25
Ball mill accelerator, BMA	kg	2.4
Edge Paste	kg	0.20
Sodium Trimetaphosphate	kg	0.036
Shredded Paper	kg	0.029
Water	kg	610
Wet weight	kg	1461
Final weight, with MC	*kg*	*991*
Final MC	%	2.6%
Final weight, with 0% MC	*kg*	*964*

Note:
[1)] Post-consumer gypsum includes gypsum board on-site construction off-cuts and recovered gypsum material collected from demolition sites.

4 PRODUCT 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 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 1). Figure 2 illustrates the Production stage system boundary for the declared gypsum board product system.

Per ISO 21930, 7.1.7.2.1 [2], the system boundary with nature includes those technical processes that provide the material and energy inputs into the system and the subsequent manufacturing and transport processes up to the factory gate, as well as the processing of any waste arising from those processes

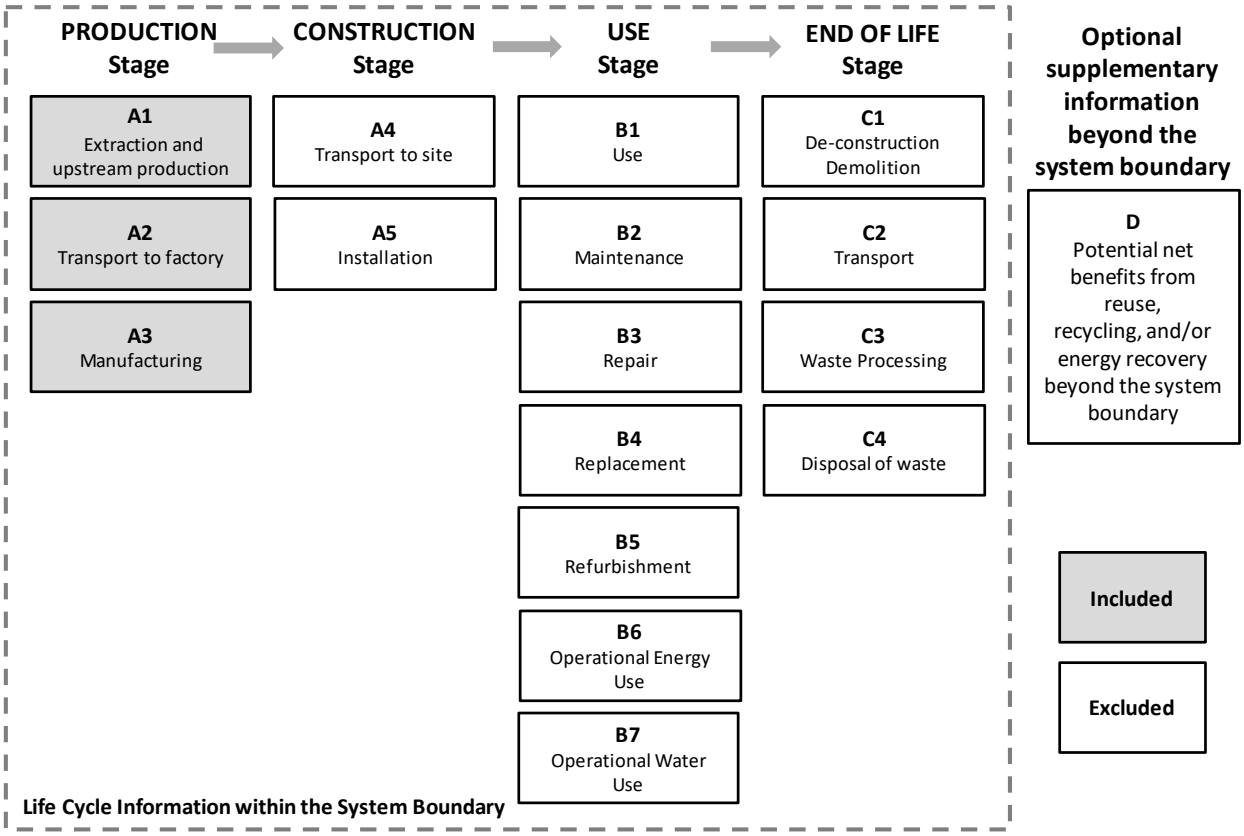


Figure 1 Common four life cycle stages and their information modules for construction products and the optional supplementary module [2]

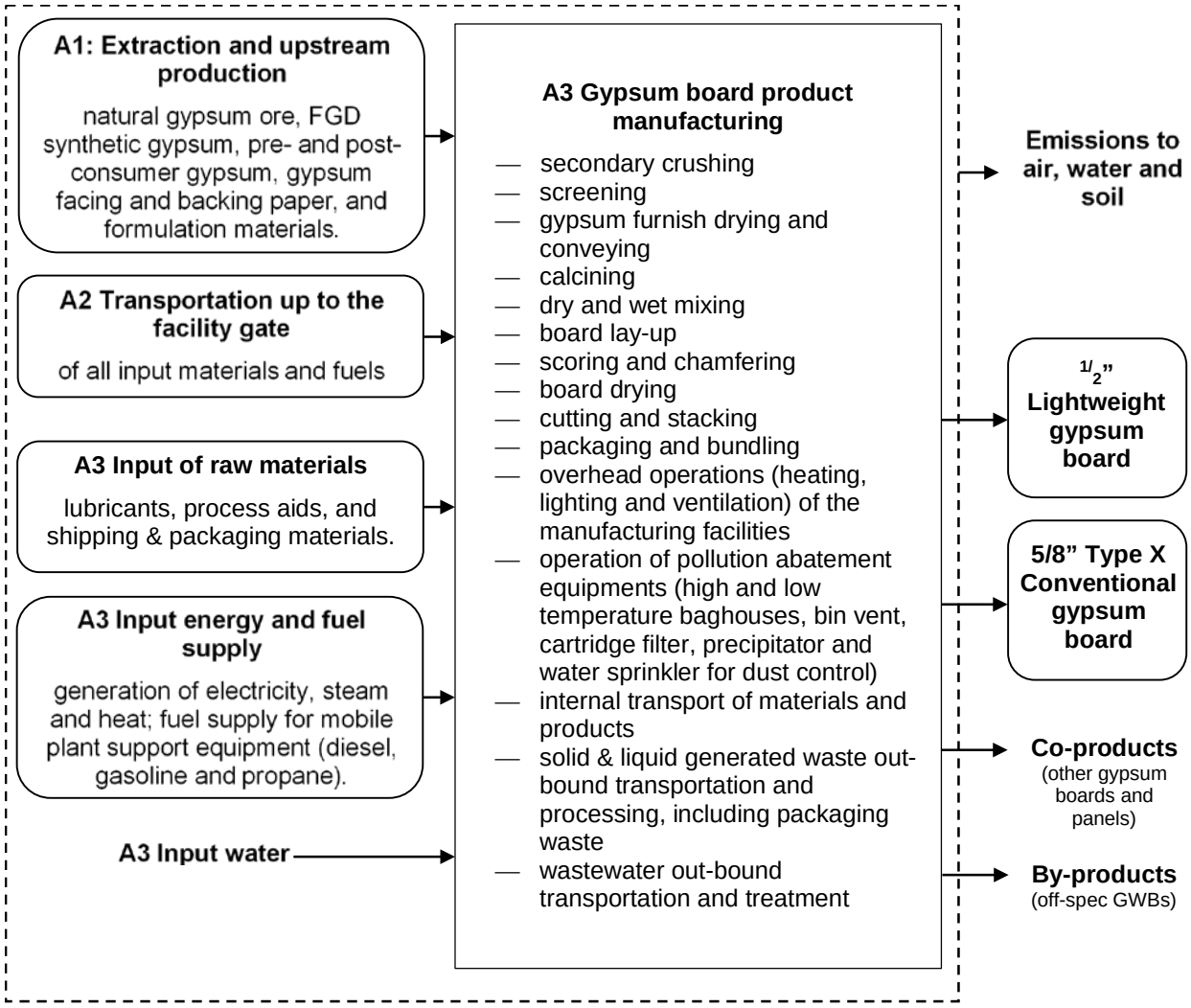


Figure 2 Production stage (modules A1 to A3) system boundary of gypsum board manufacturing

5 LIFE CYCLE INVENTORY

5.1 DATA COLLECTION, REPRESENTATIVENESS, SOURCES, 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 panel products. Some facilities are 100% dedicated to the production of gypsum boards while others may produce paper faced as well as other gypsum panel products. In total 17 facilities operated by the 7 GA company members (American Gypsum Company LLC, CertainTeed Gypsum, Inc., CertainTeed Gypsum Canada, Inc., Continental Building Products, Georgia-Pacific Gypsum LLC, National Gypsum Company, PABCO® Gypsum, United States Gypsum Company and CGC Inc.) completed LCI data collection questionnaires representing a third of all GA member facilities producing gypsum board. The gypsum board manufacturing plant study sample included all GA member companies and represented about 25% of all establishments producing gypsum and about 30% of all gypsum board produced in the N.A. To ensure representativeness, the gypsum board manufacturing plant study also considered the scale of operations including a mix of small, medium and large facilities, their geographical location in each US census region and their source of gypsum – adjacent quarry, mine, imported natural gypsum ore and their use of flue gas desulfurized (FGD) synthetic gypsum (both domestic and imported).

In addition, in the framework of this project, foreground gate-to-gate LCI data were collected for natural gypsum ore extraction (six quarries and one underground mining site) as well the manufacture of gypsum facing and backing papers (three plants) for the reference year 2017. LCI data collection was based on three customized LCI surveys for the GA natural gypsum ore extraction sites, gypsum paper production, and gypsum board manufacturing facilities. 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.

Per NSF PCR, Section 5.3 [6] and ISO 21930, 5.3 [2], all facility specific LCI data were weighted based on total annual production to calculate the weighted average LCI profile for the natural gypsum ore (in short ton), gypsum papers (per MSF) and gypsum boards (per MSF).

Data calculation procedures follow ISO 14044 [4], and NSF PCR for Gypsum Panel Products [6]. Per ISO 21930, 7.2.2 [2], when transforming the inputs and outputs of combustible material into inputs and outputs of energy, the net calorific value (lower heating value) of fuels is applied according to scientifically based and accepted values specific to the combustible material.

5.2 DATA QUALITY REQUIREMENTS AND ASSESSMENTS

A detailed description of collected data and the data quality assessment regarding the NSF PCR requirements [5] and ISO 14044 [4] 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 documented in the LCA report. *Geographical representativeness is characterized as "high".*
Time Coverage	Activity data are representative as of 2017. - Gypsum board manufacturing process- primary data collected from 17 facilities: reference year 2017 (12 months); - In-bound/ out-bound transportation data- primary data collected from 17 facilities: reference year 2017 (12 months); - Natural gypsum ore – primary data collected from six quarries and one gypsum ore underground mine: reference year 2017 (12 months); - Face and backing paper manufacturing- primary data collected from 3 facilities: reference year 2017 (12 months). - Generic data: North American and global LCI databases such as the U.S. National Renewable Energy Laboratory LCI database, September 2015 (http://www.nrel.gov/lci/), and ecoinvent 3.5, allocation, cut-off database, 2018 (http://www.ecoinvent.org/). Both are included in the LCA software SimaPro v.9.0.0.30, 2019. US LCI database "dummies" (empty/missing LCI datasets) are substituted with ecoinvent v3.5 LCI datasets. *Temporal representativeness is characterized as "high".*

Data Quality Requirements	Description
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 5/8" (15.9 mm) Type X conventional gypsum board. The completeness of the cradle-to-gate process chain in terms of process steps is rigorously assessed and documented in the LCA report.
Consistency	To ensure consistency, the LCI modeling of the production weighted input and output LCI data for the gypsum board product of interest used the same LCI modeling structure across the selected GA member facilities, which consisted of input raw, secondary, facing/backing, formulation, 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 GB LCI database* developed in SimaPro, 2019. A high level of transparency is provided throughout the project 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 summarized in the LCA report. GA industry internal reproducibility is also possible as a high level of transparency is provided throughout the LCA report.
Transparency	Activity and LCI datasets are transparently disclosed in the project 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 and is documented in the LCA report.

5.3 ALLOCATION RULES

Per NSF PCR, Section 7.2.3 and 7.2.6 [6], allocation, if required, shall follow the requirements and guidance of ISO 14044:2006, Section 4.3.4 and shall be based on the mass of gypsum panel products produced. Allocation related to transport shall be based on the mass of the transported product.

The GA gypsum board manufacturing facilities produce other co-products besides selected gypsum boards and as such allocation based on the mass of gypsum board products was necessary. Per ISO 21930, 3 [2], co-product is defined as any of one or more products from the same unit process, but which is not the object of the assessment. As a result, plant specific generic formulations for 1 MSF (92.9 m^2) of the two gypsum board products of interest were used to model and calculate the required input raw materials (both primary and secondary), facing/backing and formulation materials, and water input (see Table 2).

Per NSF PCR, Section 7.2.3 to 7.2.6 [6], "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. Similarly, plant specific generic formulations for 1 MSF (92.9 m^2) of gypsum paper and mass was used as the basis for allocating flows across products and co-products of gypsum paper manufacturing.

Per ISO 21930, 3 [2], by-product is defined as co-product from a process that is incidental or not intentionally produced and which cannot be avoided. 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); side rolls (recycled back into the gypsum paper production, or sold out to other converters to make tubes and cores); downgraded rolls (used as paper fiber in the wallboard, or sold out to other converters to make tubes and cores), or other rocks from gypsum ore extraction sites (sold to other industries).

Per NSF PCR 7.1.7.2.5 and 7.2.3 [6], flue gas desulfurized synthetic gypsum is considered a recovered "waste" material and is used burden free; other than those burdens necessary to use it as an input in the manufacture of gypsum boards. FGD synthetic gypsum is a by-product of coal-fired power generation process – a result of SO_2 scrubbing of stack emissions enforced by the US EPA Clean Air Act– and a major raw material used in the production of gypsum board products [9], [10]. For FGD synthetic gypsum to be a saleable product for use in gypsum board manufacturing it needs to undergo de-watering process to reduce the moisture content to around 10% [10], [11], [12], and transport to the gypsum board manufacturing facility. As a result, the dewatering of sludge by vacuum filtration and transport of FGD synthetic gypsum is included within the Production stage system boundary [11], [12]. It should be mentioned that saleable FGD synthetic gypsum has the same molecular composition as raw gypsum [10]. Typically, FGD synthetic gypsum undergoes additional secondary drying at the GWB plant; this drying is included in the A3 Manufacturing information module. In addition, per NSF PCR, Section 7.2.3 to 7.2.6 [6], allocation related to transport is based on the mass of transported inputs and outputs.

5.4 CUT OFF RULES

The cut-off criteria as per NSF PCR, Section 7.1.6 [6] and ISO 21930, 7.1.8 [2], were followed for this EPD. Per ISO 21930, 7.1.8 [2], 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 plant specific data gaps for the reference year 2017 e.g. input hydraulic fluids, lubricants, oils, or packaging materials were filled in with plant generic data from previous years or industry average data. Material Safety Data Sheet (MSDSs) are provided confidentially by GA plants per each chemical class e.g. sizing agents, retention 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, Section 7.1.6 [6], the Production Stage *excludes* the following processes:

- Capital goods and infrastructure;
- Human activity and personnel related activity (travel, furniture, office operations and supplies);
- 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 product 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 15.9 mm ($^5/_8$") Type X conventional gypsum board. (Table 3). *It should be 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].*

Per NSF PCR, Section 7.3 [6], the US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), version 2.1, 2012 impact categories are used as they provide a North American context for the mandatory category indicators to be included in this EPD. Per NSF PCR, Section 7.2.10, 7.2.13, 7.2.14 [6], the following mandatory resource use, waste categories and output flows are reported as described in Table 3.

Table 3 Product Stage (A1-A3) - EPD Results – 92.9 m² (1MSF) of 15.9 mm ($^{5}/_{8}$)" Type X conventional gypsum board

Impact categories and inventory indicators	Unit	A1, Extraction and upstream production	A2, Transport to factory	A3, Manufacturing	Total
Global warming potential, GWP 100[1)]	kg CO_2 eq	55.5	9.9	211.6	**277**
Ozone depletion potential, ODP[1)]	kg CFC-11 eq	6.0E-06	8.0E-10	2.8E-05	**3.4E-05**
Smog formation potential, SFP[1)]	kg O_3 eq	2.91	3.71	5.15	**11.8**
Acidification potential, AP[1)]	kg SO_2 eq	0.189	0.14	0.35	**0.67**
Eutrophication potential, EP[1)]	kg N eq	0.250	0.0079	0.34	**0.60**
Abiotic depletion potential, ADP surplus, TRACI[1)]	MJ surplus	97.6	19.9	457.4	**575**
ADP LHV, CML[2)]	MJ LHV	697.1	134.4	3,014	**3,845**
Renewable primary energy carrier used as energy, RPR_E	MJ LHV	129.2	0	55	**184**
Renewable primary energy carrier used as material, RPR_M[3)]	MJ LHV	0	0	0	**0**
Non-renewable primary energy carrier used as energy, $NRPR_E$	MJ LHV	770.8	135.8	3194	**4,100**
Non-Renewable primary energy carrier used as material, $NRPR_M$[3)]	MJ LHV	0	0	0	**0**
Secondary material, SM[3)]	kg	608	0	0	**608**
Renewable secondary fuel, RSF[3)]	MJ LHV	0	0	0	**0**
Non-renewable secondary fuel, NRSF[3)]	MJ LHV	0	0	0	**0**
Recovered energy, RE[3)]	MJ LHV	0	0	0	**0**
Consumption of fresh water[3)]	m^3	0.443	0	0.78	**1.22**
Hazardous waste disposed, HWD[3)]	kg	0	0	0	**0**
Non-hazardous waste disposed, NHWD[3)]	kg	4.7349	0	5.9	**10.6**
High-level radioactive waste, conditioned, to final repository, HLRW[3)]	m^3	4.1E-08	1.3E-11	1.1E-07	**1.5E-07**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW[3)]	m^3	4.3E-07	1.0E-10	9.1E-07	**1.3E-06**
Components for re-use, CRU[3)]	kg	0	0	0	**0**
Materials for recycling, MR[3)]	kg	0	0	28.3	**28.3**

Impact categories and inventory indicators	Unit	A1, Extraction and upstream production	A2, Transport to factory	A3, Manufacturing	Total
Materials for energy recovery, MER[3)]	kg	0	0	0	0
Recovered energy exported from the product system, EE[3)]	MJ LHV	0	0	0	0

Notes to Table 3:
[1)] Calculated as per U.S EPA TRACI 2.1, v1.05, SimaPro v 9. GWP 100, excludes biogenic CO_2 removals and emissions associated with biobased products such as starch and dextrose (see Table 4 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 [13]. ADP surplus, TRACI v2.1 (also known as Fossil fuel depletion, FFD) is required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations [14].
[2)] Calculated as per CML-IA Baseline V3.05, SimaPro v 9. ADP LHV, CML is also required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations [14].
[3)] Calculated as per ACLCA ISO 21930 Guidance [15], respective sections 6.2 to 10.8.

Per NSF PCR, 7.2.7 [5], for the gypsum panel products, recycled raw materials used to produce paper are not counted as biogenic carbon whereas starch and dextrose are counted. Table 4 shows the cradle-to-gate biogenic CO_2 removals associated with bio-based products used in the gypsum board system.

Table 4 Production Stage (A1-A3), Biogenic CO_2 removals – 92.9 m^2 (1 MSF) of 5/8" Type X conventional

Inputs	Chemical formula	C-Content	Biogenic CO_2 removals (in kg CO_2/ MSF)
Starch	$(C_6H_{10}O_5)_n$	44%	**- 6.1** = -3.8 kg×0.44×44/12
Dextrose	$C_6H_{12}O_6$	40%	**- 1.4** =-(0.59+0.36) 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 that is applied directly to the board (not part of BMA, Table 2), and the amount of dextrose mixed with landplaster to produce BMA (also known as heat resistant accelerator, HRA). The weighted average amount of dextrose in BMA resulted to 15%.

6.2 INTERPRETATION

The cradle-to-gate manufacture of 92.9 m^2 of 15.9 mm (1 MSF of 5/8") Type X conventional gypsum board embodies about 4.3 GJ of primary energy (LHV) and emits in the order of 277 kg CO_2 eq of greenhouse gases. Over 95% of the total primary energy is derived from non-renewable primary energy resources. On-site energy use at the plant (*natural gas* and *purchased electricity*) and the *paper input* were the major contributing sources to total primary energy use. Figure 3 presents the impact assessment and energy indicator results for 92.9 m^2 (1 MSF) of $^{5}/_{8}$" Type X conventional gypsum boards, by information module, percent contribution basis.

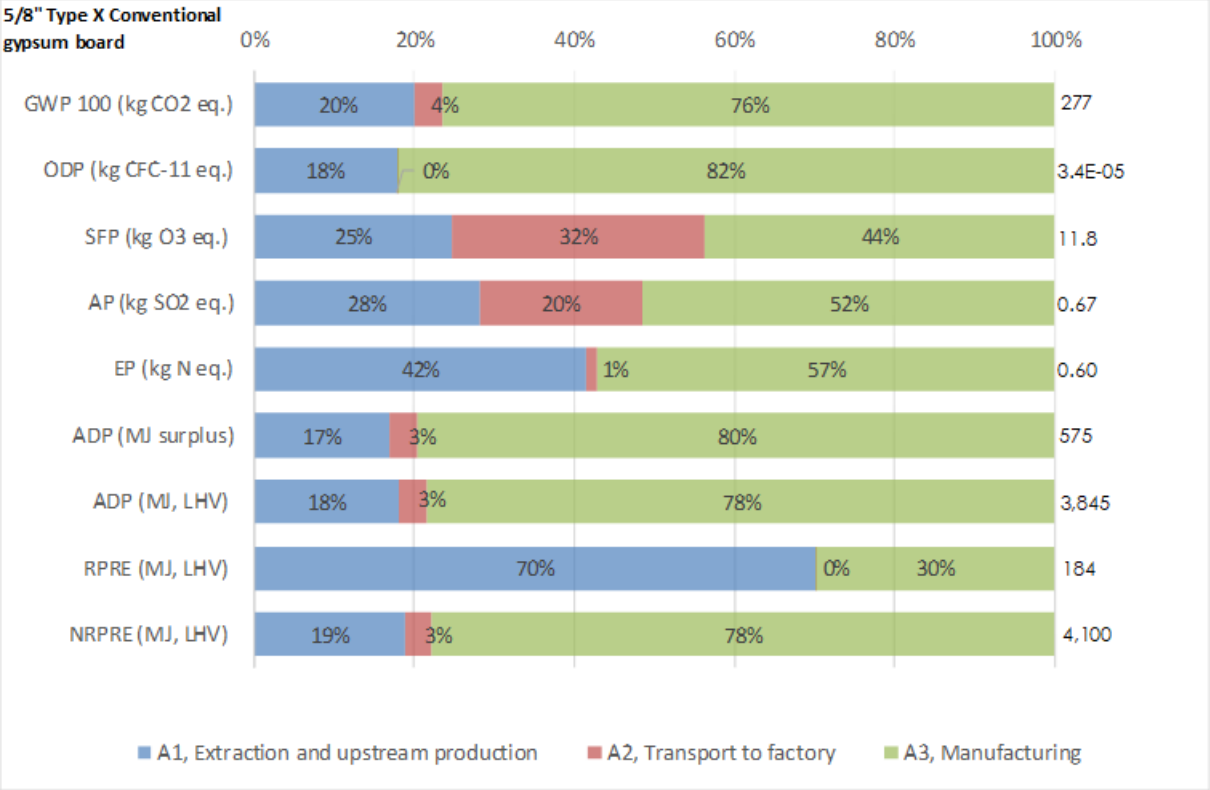


Figure 3 Impact assessment and energy indicator results by information module – 92.9 m^2 (1 MSF) of 15.9 mm ($^{5}/_{8}$") Type X conventional gypsum board – % Basis

Across the three-gypsum board production information modules, *Module A3 Manufacturing*, contributes the largest share of the LCIA and energy indicator results – accounting for between 44% (smog) and 82% (ozone depletion) of the potential environmental burdens. *Module A1*

Extraction and upstream production is the second largest contributor (<42%) to the overall potential environmental impacts of ½" Lightweight gypsum board manufacture. Except for acidification (20%) and smog potential impacts (32%), *Module A2 Transportation* is generally a minor contributor (<4%) to the overall impact of 5/8" Type X gypsum board manufacture.

The use of FGD synthetic gypsum and post-consumer paper is beneficial for the gypsum board industry as it reduces the dependency on primary material resources (natural gypsum ore and virgin paper stock).

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 15-04-2020.

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

- *Environmental Protection Manufacture and Equipment*

  The GA member manufacturing facilities comply with the regional (US and Canadian) 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 15-04-2020.

  - The Canadian National Pollutant Release Inventory (NPRI) reporting http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=4A577BB9-1, accessed 15-04-2020.

Pollution abatement equipment typically used in the gypsum board manufacturing facilities consist of high and low temperature baghouses, bin vent filter, cartridge filter, precipitator and water sprinklers for dust control.

8 DECLARATION TYPE AND PRODUCT AVERAGE DECLARATION

The type of EPD is defined as:

- A "Cradle-to-gate" EPD for $^{5}/_{8}$" Type X conventional gypsum board covering the *Production stage* (information modules A1 to A3) and is intended for use in Business-to-Business communication.

This industry average EPD for $^{5}/_{8}$" Type X conventional gypsum board (UNCPC Code 3699, NAICS Code 327420) 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", *see General Summary section*).

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 [6]:

- *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, please contact the program operator.

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