THAILAND ENVIRONMENT INSTITUTE

Product Category Rules (PCR):

LCA of Gypsum Plasterboard materials

Effective date 12 April 2024

Specific terms for the evaluation of life cycle gypsum sheet products.

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1. Scope

This document provides specific guidelines for conducting a Life Cycle Assessment (LCA) to produce Environmental Product Declarations (EPDs) for semiconductor products. It details the methodology for conducting the life cycle assessment, Conforms to international standards ISO 14040 and EN 15804.

Specific requirements for this life cycle assessment cover the semiconductor product category, including wall panels and ceiling tiles used for external applications in areas not directly exposed to water.

The reference documents used to develop specific guidelines for conducting a Life Cycle Assessment include.

- ISO 14040:2006 Environmental management - Life Cycle Assessment (Principle and Framework)
- ISO 14044:2006 Environmental management - Life Cycle Assessment (Requirements and Guideline)
- ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations - Principles and procedures
- BS EN 15804:2012+A2:2019
- Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products
- The service organization managing greenhouse gases (public organization) Specific requirements for product-specific carbon footprint assessments. Semiconductor sheet material
- International standard ASTM and industrial standard MOC for semiconductor sheet material

2. Content, structure, and accessibility of the life cycle assessment methodology report

Environmental information of a product must be presented alongside a life cycle assessment (LCA) report, which provides fundamental data and details about the methodology used for the assessment.

The life cycle assessment methodology report is a systematically prepared document that organizes and summarizes comprehensive details of the life cycle assessment methods used. Its objective is to facilitate the review and verification of the assessment results referenced in Environmental Product Declarations (EPDs). The methodology report must include specific details

The life cycle assessment methodology report can be accessed by auditors under a confidentiality agreement and is not intended for public communication.

3. General information in a life cycle assessment (LCA) methodology report typically includes:

A life cycle assessment (LCA) methodology report should include the following information.

- Name of the applicant for review, specifying whether the assessment was conducted internally or contracted to an external party.
- Report date
- Declaration of compliance with specific requirements for life cycle assessment

4. Objectives of the life cycle assessment

The objectives of conducting a life cycle assessment (LCA) should be explained in the methodology report as follows

- Source of the life cycle assessment
- Application of the life cycle assessment results.
- Target audience
- Communication between manufacturing organizations and business partners (B2B) or between manufacturing organizations and consumers (B2C)

5. Scope of the life cycle assessment

5.1 Functional/Declared unit

Life cycle assessment (LCA) requires calculating environmental impact indicators per Functional Unit (FU) or Declared Unit of gypsum board products. For example, this could be defined as 1 square meter of gypsum board covering an area as specified throughout its life cycle (from cradle-to-grave), and usable for the building's lifespan of 50 years.

5.2 Declaration of construction product classes

Life Cycle Assessment (LCA) of multiple products and presenting the environmental impact index as an average help streamline calculations but requires displaying the data with a range or variability.

5.2.1 Presentation of Information by Single Manufacturer

- Presentation of information for 1 product from 1 manufacturing facility of 1 manufacturer.
- Presentation of information for 1 product by using the average values of several products produced by multiple manufacturing facilities of 1 manufacturer.
- Presentation of information using the average values of several products from 1 manufacturer, produced by multiple manufacturing facilities.
- Presentation of information using the average values of products produced by multiple manufacturing facilities of 1 manufacturer.

5.2.2 Displaying information by manufacturer groups (more than 1 entity)

- Displaying information for 1 product using the average values of products from multiple factories of multiple manufacturers.
- Displaying information using the average values of products calculated from emissions of multiple manufacturers.
- Displaying information using standard products or reference products to represent a representative product.

- When displaying information using the average values of products, the functional unit or declared unit must be specified to align with the environmental information of the product. For example, similar products with different densities or products with the highest impact values representing the product class should be specified as the representative. In this case, the method for calculating the average values in the life cycle assessment report and the representativeness of the representative product must be explained in detail.

5.3 Product Description

Technical description and functions of the packaging product. Instructions for use. Product service life, referencing relevant international or national standards.

5.4 Area of Application

Specify whether the product is intended for indoor or outdoor use.

5.5 Study Scope (System boundary)

Specify the study scope for conducting a life cycle assessment of the product, whether it covers a cradle-to-grave approach.

5.5.1 Product Life Cycle Stages

The steps in the life cycle of the product (As shown in Figure 1) include:

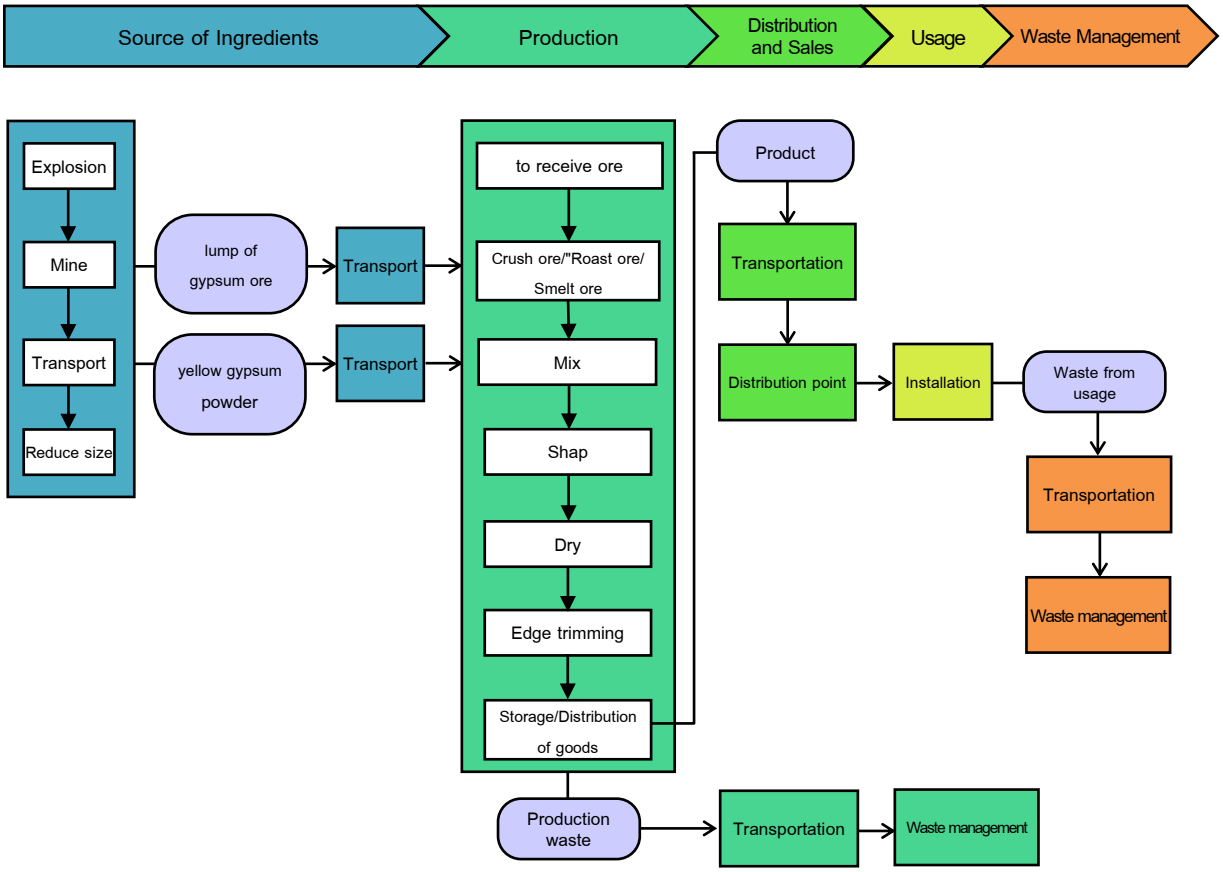
1) The raw material acquisition stage involves the extraction and transportation of raw materials and chemicals used in production from suppliers to gypsum board manufacturing plants via road, water, and air transport, excluding pipeline transport.

2) The manufacturing stage encompasses resource extraction, raw material storage, preparation, blending, chemical melting or mixing, component molding or shaping into gypsum boards, packaging, water quality adjustment, wastewater treatment, product quality enhancement, storage, and waste management within the manufacturing facility.

3) Distribution and sales stage involves the transportation of gypsum boards from the manufacturing plant to distribution points, and storage before sale.

4) The use stage involves the installation and use of gypsum boards indoors, such as for wall and ceiling finishes within buildings, and specific outdoor applications like non-directly exposed roof ceilings or office spaces, depending on the type of gypsum board installation method.

5) Waste management involves considering the transportation of waste generated after production and during the product's use, such as packaging scraps, waste from the product itself, packaging waste, and waste from usage points to disposal facilities via landfill disposal methods (both inbound and outbound transport).



"Figure 1: Life cycle diagram of gypsum board product"

6. Life Cycle Inventory (LCI) Analysis

6.1 Data Collection and Sources Gathering

6.1.1 The process of obtaining raw materials

6.1.1.1 Scope of data collection

Consideration of manufacturing and procurement of raw materials entering the factory includes both primary raw materials and other components such as production aids, as well as transportation of raw materials to the factory, data collection, and management of inputs and outputs during the procurement process specific to the product's requirements. Data can be either primary or secondary, with preference given to primary data collection unless it's impractical, in which case secondary data may be used.

6.1.1.2 The list of data to be collected

1) Input and output materials for the following activities:

- Electricity generation (if electricity is generated at the manufacturing company)
- Steam generation (if steam is generated at the manufacturing company)
- Water production (if water is produced at the manufacturing company)
- Wastewater treatment (if there is a wastewater treatment system at the manufacturing company)
- Cleaning of work areas
- Lighting systems
- Chemical production
- Packaging production
- Production of other related raw materials
- Various transportation activities within the factory

2) Data on inputs and outputs to be collected includes:

- List and quantity of raw materials used in production.
- List and quantity of chemicals used in production.
- List and quantity of packaging materials used in production.
- List and quantity of other related materials or substances.
- Quantity of energy used in production, including electricity, steam, fuel, as well as alternative and renewable energy sources.
- Quantity of water used in the production process.
- Fuel for transporting raw materials or vehicles used for transportation, including distance and loading rates

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6.1.1.3 Fundamental data items

1) Raw materials that are primary ingredients must be sourced as basic data items.
2) Inputs and outputs for other activities where the company has its own manufacturing processes or access to production data must be collected as basic data items. For instance, in cases where packaging materials are either produced or sourced internally from affiliated companies, data on inputs and outputs for the production of those packaging materials must be collected and used to calculate Characterization Factors (CFs) for those packaging materials, including internal support systems, considering the entire life cycle.
3) Inputs and outputs of other activities can be either primary data or proxy data. However, primary data should be prioritized as the main data source, except in cases where it is not possible to collect primary data, then proxy data may be used.
4) Energy consumption data within the factory.

6.1.1.4 the conditions for preparing primary data:

1) For input and output substances for various activities, use the latest data from the past 1 year. If necessary, data up to 3 years old may be used, provided it covers a continuous 12-month period. Reasons must be specified for not using data within the past 1 year, covering all activities related to production and support systems.
2) In cases where there are multiple suppliers for the same type of raw material, use primary data from every supplier. Alternatively, if data collection is not feasible, use data from the supplier with the highest shipment volume.
3) Use the mass-based allocation method for apportioning processes.

4) Regarding raw material transportation, consider two scenarios: international transportation from the sending country's port to Thailand's port, including domestic transportation.
5) Actual data from the factory can be used to calculate assessment quantities, such as electricity consumption calculations.
6) Utilizing recyclable materials like glass fragments as production materials incurs zero environmental impact (Characterization Factors = 0).

6.1.1.5 the conditions for preparing characterization factors (CFs) data:

Characterization factors (CFs) data for environmental impact potentials of raw materials and general production resources such as water, electricity, and fuel should be referenced from the CF list detailed in the relevant Product Category Rules (PCR).

If specific CF data is not provided, select from credible databases known for their representativeness and high accuracy, or those widely accepted in academia, in the following order of importance:

1) Environmental databases of basic materials and energy in Thailand.
2) Data from theses and relevant research conducted in Thailand, which have been peer-reviewed.
3) General public databases like LCA Software and specific industry group databases from different countries.
4) Published data from international organizations such as the IPCC (Intergovernmental Panel on Climate Change).

If there are multiple entries conforming to the data from the same source, select the highest value. In the case of imported raw materials, use the proxy data that best matches the actual production process.

6.1.1.6 Scenario Setting:

1) Transportation data of raw materials.

If the factory does not have specific transportation data, the following parameters will be used: a distance of 700 kilometers per trip and the use of an articulated truck with 18 wheels and a carrying capacity of 32 tons. This considers round trips where the outbound trip is fully loaded (100% loading) and the return trip is empty (0% loading).

6.1.1.7 Other Conditions

1) Data Collection Period:

Data will be collected continuously over a period of 1 year during regular operations to ensure consistency and to mitigate seasonal and weather-related data variations. If complete data cannot be collected over the full 1-year period, clear reasons, scope, and conditions for data collection must be specified.

2) Allocation:

Allocation will be based on weight.

3) Cut-off Criteria:

Environmental inventory items that contribute less than 1% to the total environmental impact throughout the life cycle can be considered for cut-off, provided they do not exceed 5% of the total impact.

6.1.2 Production Process

6.1.2.1 Scope of Data Collection

Consider the production processes of the gypsum board manufacturing group, including raw material preparation, shaping, storage, and product distribution, as well as all related support systems such as steam production, electricity generation, water production, wastewater treatment, and disposal of waste generated from production.

6.1.2.2 List of Data to be Collected

1) Input and Output Substance Data, covering the following activities

- Raw material preparation and main chemical substances
- Shaping processes
- Raw material mixing processes

- Shaping processes
- Packaging processes
- Electricity generation (if produced at the manufacturing site)
- Steam production (if produced at the manufacturing site)
- Water production (if produced at the manufacturing site)
- Wastewater treatment (if wastewater treatment system is available at the manufacturing site)
- Cleaning/sanitation of work areas
- Lighting systems
- Chemical usage
- Use of fuels, alternative energies, or renewable energies
- Packaging materials
- Other relevant materials
- Internal transportation processes within the factory
- Management of waste and unused materials from production processes

2) Input and Output Substance Data must include

- Main raw materials, alternative raw materials used in the factory.
- Chemicals and additives.
- Packaging.
- Products of gypsum boards that are manufactured and ready for sale within the reporting period.
- Other related materials and by-products obtained during production.
- Energy, including electricity, steam, fuels, alternative energy, and renewable energy.
- Water used in the production process.
- Wastewater from the production process.
- Waste generated and removed from the production process.

- Pollutants released into the environment.
- Fuel for transportation or vehicles used in transportation, distances, and transportation rates.

6.1.2.3 Fundamental data items

- Inputs and outputs for all activities related to product manufacturing and related support systems must consist of fundamental data items only.
- Inputs and outputs for other activities where the company has its own manufacturing processes or has access to production data must be collected in a basic data format. For instance, in cases where electricity or energy is produced or used internally or received from affiliated companies, quantities of fuel used to produce electricity or that specific type of energy must be recorded. These data are then used to calculate the environmental impact characterization factors (CFs) for electricity or that type of energy, considering comprehensive coverage of all upstream processes.

6.1.2.4 Conditions for preparing fundamental data include

- Use data from the past year to cover all activities related to manufacturing and supporting systems. If it's not possible to gather data from the past year, reasons must be explained.
- In cases where there are multiple production bases for the same product type, data must be collected from every production source or from primary production sources with clear and specific location identification.
- Proportional sharing methods should be used based on weight. If weight-based sharing is not feasible, appropriate proportional methods must be used, clearly specifying the method used, such as economic value sharing.
- For internal electricity generation, the quantity of fuel used must be evaluated and used to calculate the environmental impact characterization factors (CFs).
- When materials are discarded from other production processes and/or used waste materials no longer needed from internal manufacturing

processes to serve as primary materials for manufacturing gypsum board products, only consider the Global Warming Potential (GWP) impact factors from transportation and incineration.

- Regarding non-standard or discarded products that can be sold as raw materials for other product manufacturing, the environmental burden must be allocated to the products that do not meet standards.
- Waste generated from the production process must consider its final destination, managed by the factory, such as incineration, and calculate the environmental impact characterization factors (CFs) accordingly.

6.1.2.5 Conditions for preparing inventory data include

When selecting Characterization Factors (CFs) for environmental impact potentials of raw materials and general production resources such as water, electricity, and fuels, refer to the CFs listed in the relevant Product Category Rules (PCRs) that detail these impacts.

If the required CFs are not specified, choose data from reliable databases recognized for their representativeness and high accuracy, or are academically accepted. The selection of CF data should follow these prioritized criteria:

1) Environmental databases of basic materials and energy in Thailand.
2) Data from theses and relevant research conducted in Thailand that have been peer-reviewed.
3) General publicly available databases, including LCA software programs, industry-specific databases, and country-specific databases.
4) Published data from international organizations such as the IPCC (Intergovernmental Panel on Climate Change).

6.1.3 Scenario setting

1) Waste transportation data from production:

If the factory lacks data on fuel consumption for waste transportation, vehicle type, distance, and loading rates, use the following assessment methods:

1.1. For waste managed by contracted disposal companies: Assume a hypothetical scenario for transportation with a distance of 700 kilometers per trip (estimated from Bangkok to Chiang Mai). The vehicle used is a semi-trailer truck with 18 wheels and a capacity of 32 tons, running normally. Consider both one-way and return trips with a full loading rate (100% loading) for trips to the destination and no loading (0% loading) for return trips.

1.2. For waste disposed of as community landfill waste: Assume a hypothetical scenario for transportation with a distance of 40 kilometers per trip. The vehicle used is a 10-wheel garbage truck with a capacity of 16 tons, running normally. Consider both one-way and return trips with no loading (0% loading) for trips to the landfill and full loading (100% loading) for return trips.

Regarding recycling of products not included in this calculation step, if data completeness is less than 100%.

6.1.4 Other conditions include

1) Data collection period

Collect data continuously over a 12-month period for stable production processes.

2) Allocation

Use weight-based allocation principles.

3) Cut-off criteria

Exclude environmental inventory items with life cycle environmental impacts less than 1% of the total impact size, but not exceeding 5%.

4) Multiple sourcing

For multiple producers of materials and products, calculate weighted averages for material quantities and transportation units specified in section 3.6.2.2.

5) Reuse and recycling

When using recycled materials or engaging in reuse Calculate greenhouse gas emissions specifically attributable to processes of remanufacturing or preparation for reuse, such as remixing for reuse.

6.2 The process of distributing products and sales involves several steps:

6.2.1 Scope of Data Collection

Considering the transportation of products to distribution points, storage, and maintenance before they reach consumers.

6.2.2 Data Collection Requirements

1) Data on inbound and outbound materials for the following activities:
   - Transporting products from manufacturers to distribution points
   - Storing and maintaining products while awaiting distribution
2) Data on inbound and outbound materials must include:
   - Products transported and distributed
   - Energy sources including electricity, steam, and fuel
   - Solid waste
   - Fuel for transportation or vehicles used, distance, and loading rates
   - For international routes, consider transporting by sea from the factory to the user's country port.

6.2.3 fundamental geographic data.

1) Product weight
2) Location data of distribution points or main sales points (referencing points covering approximately 50% of annual production)
3) Location data of large-scale project sites (referencing points covering approximately 50% of annual production)

4) Fuel for transportation or vehicles used, distance, and loading rates
5) Energy used for storing products at distribution points (if applicable)

6.2.4 Conditions for preparing geographical data typically include.

In the case of assessing using fuel quantity, gather the following information:

1) Type of fuel
2) Quantity of fuel
3) Quantity of transported products
4) When assessing with transportation units (ton-kilometers), collect the following data:
   - Distance from production site to distribution or main sales point, using distances between provinces from the Department of Highways, Thailand (http://gisweb.doh.go.th/doh/download/index.php) for domestic road transport.
   - For data on transport between domestic and international ports, refer to www.searates.com.
5) Type of transport vehicle used
6) Loading capacity and loading proportion
7) Return transport (transport of other goods or empty trucks)

6.2.5 Conditions for preparing spatial data.

Characterization Factors (CFs) for the environmental impact potential of raw materials and general production resources such as water, electricity, and fuels should be referenced from the CF datasets specified in the relevant Product Category Rules (PCR).

If the specified characterization factors (CFs) are not available, select data from reliable databases that are representative and highly accurate, or academically accepted. Prioritize the selection of CF data in the following order:

1) Environmental databases of basic materials and energy of Thailand.
2) Theses and research works conducted in Thailand that have undergone peer review.
3) Widely recognized LCA software databases, industry-specific databases, and national databases.

4) Publications by international organizations such as the IPCC.

When multiple sources are available within the same ranking, choose the data with the highest representation and accuracy. For imported raw materials, use CF data that best matches the actual production circumstances.

6.2.6 Scenario setting

If the factory lacks fuel data for transporting products or information regarding the types of vehicles used, distances, and loading rates, the assessment is conducted using the following transportation units:

- Transport distance: 700 kilometers per trip (estimated from Bangkok to Chiang Mai).
- Vehicle type: Semi-trailer truck, 18 wheels, 32 tons, operating normally.
- Consider both inbound trips at full capacity (100% loading) and return trips with no loading (0% loading).
- For international transport, route planning considers road or rail transport from Thai ports to foreign ports.

6.2.7 Other conditions include.

1) Data Collection Period

Data is collected consistently over a one-year period during the shipment-receiving process, or as per fixed production data.

2) Allocation Method

The mass allocation method is utilized, requiring knowledge of the weight of each product.

6.3 Operation steps or Usage procedure.

Due to the installation of gypsum board, which integrates with other structural components of the building such as ceilings and walls, and involves minimal use of equipment, materials, and energy compared to other lifecycle stages of the product, there is no need to consider impacts during the usage phase.

6.4 The process of managing waste:

6.4.1 Scope of data collection

Post-expiry waste management steps for gypsum board products typically involve a hypothetical assumption of landfill disposal.

6.4.2 The list of data to be collected.

1) Data on Inputs and Outputs for the Following Activities:

- Transportation of Waste Materials No Longer in Use from the Production Process
- Transportation of Waste Materials No Longer in Use from the Production Process
- Management of Residual Waste after Use

2) Data on Inputs and Outputs to be Collected Include:

- Unused Material Waste from the Production Process
- Residual Waste after Use
- Methods for Managing Residual Waste after Use and Components Used in Other Activities Related to the Product (if applicable)
- Transportation of Residual Waste and Components Used in Other Activities Related to the Product (if applicable)

6.4.3 List of Primary Data to Collect.

- Weight of waste materials no longer used from the production process.
- Weight of waste generated during dismantling.
- Quantity of components used in other activities related to the product (if applicable).

6.4.4 Conditions for Generating Primary Data.

Primary data collection will involve actual measurement of waste quantities.

6.4.5 Conditions for Generating Characterization Factors (CFs) Data.

Characterization factors for environmental impact potentials (CFs) of raw materials and general production resources such as water, electricity, and fuel should be referenced from the detailed lists provided in relevant PCR documents.

If no predefined CF data is available, select data from reliable sources with high representativeness and academic acceptance. Priority for selecting CF data should be in the following order:

1) Environmental database of basic materials and energy in Thailand.
2) Research papers and studies conducted in Thailand that have been peer-reviewed.
3) Widely published databases such as LCA software programs and specific databases from industrial groups and individual countries.
4) Data published by international organizations like the IPCC (Intergovernmental Panel on Climate Change).

In cases where multiple data sources conform to the same tier, prioritize the highest value. For imported raw materials, use CF data that most closely aligns with actual production scenarios.

6.4.6 Scenario Setting.

1) Transportation Scenario for Product Waste.

   Set hypothetical scenarios for transportation as follows.

   - Transportation distance: 40 kilometers per trip
   - Vehicle used: 10-wheel garbage truck, 16-ton capacity, normal operation.
   - Consider both inbound trips with no loading (0% loading) and return trips fully loaded (100% loading).

7. Environmental Impact Assessment Throughout the Life Cycle.

7.1 Selection of Impact Assessment Indicators Throughout the Life Cycle.

The report must specify impact assessment indicators throughout the life cycle for the following environmental impacts.

- Global warming potential (carbon footprint), in kg CO2e
- Depletion of the stratospheric ozone layer, in kg CFC-11
- Acidification of land and water sources, in in moles H+ or kg SO2
- Eutrophication, in kg phosphate
- Photochemical ozone formation, in kg O3 eq.
- Abiotic depletion for fossil resources potential, in MJ

and additional impacts can be added as needed according to requirements.

7.2 Calculation of Environmental Impact Indicators Throughout the Product Life Cycle.

The assessment of environmental impacts throughout the product life cycle can be achieved through the following steps.

7.2.1 Classification of Potential Environmental Impacts from Input and Output Substances

It involves categorizing data on input and output substances in the environmental inventory of a product, examining their relationship with environmental impact categories of interest. Some substances can cause multiple environmental impacts, which are considered to occur simultaneously. This is because it evaluates the potential to cause impacts on the environment throughout its lifecycle. For example, the release of chlorofluorocarbons (CFCs) contributes to global warming and also affects the ozone layer.

7.2.2 Characterization of environmental impact indices

Characterization is the process of translating data on the quantities of input and output substances within the same environmental impact category into impact indicators. This is achieved by multiplying the quantities of input or output substances by their respective characterization factors, which represent their potential to cause environmental impacts. However, because each substance has varying potentials to affect the environment at different levels, they must be compared against reference substances based on these characterization

factors. These factors are calculated using models that describe the physical-chemical mechanisms and toxicity pathways in the environment, representing globally accepted scientific knowledge. Therefore, data on the quantities of input or output substances are multiplied by their respective potential to cause environmental impact:

7.2.2.1 Global Warming Potential (GWP) is an index used to measure the potential of greenhouse gases to cause global warming. This is calculated based on their ability to absorb and emit infrared radiation, thereby contributing to the greenhouse effect. Common gases considered in GWP calculations include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases. By using the following calculation equation

$$GWP = \sum_{i=1}^{n} GWP(i)\ x\ A(i)$$

GWP	is	the sum of the index measuring the potential to cause global warming.
GWP (i)	is	the index measuring the potential to cause global warming of that substance compared to the characterization factor of CO2.
A (i)	is	the quantity of substance obtained from environmental accounting analysis.

7.2.2.2 The depletion of the stratospheric ozone layer is measured using the Ozone Depletion Potential (ODP). Substances such as chlorofluorocarbons (CFCs) like CFC-11 (Trichlorofluoromethane), HCFCs (Hydrochlorofluorocarbons), and methyl bromide are evaluated for their impact on ozone depletion. The ODP is calculated relative to CFC-11, which serves as the reference substance. The calculation involves a specific formula tailored to quantify the potential of substances to deplete ozone in the atmosphere.

$$ODP = \sum_{i=1}^{n} ODP(i)\ x\ A(i)$$

ODP	is	the sum of the index measuring the potential to deplete ozone in the atmosphere.
ODP (i)	is	the index measuring the potential to deplete ozone in the atmosphere for that substance compared to the characterization factor of CFC-11.
A(i)	is	The quantity of substance obtained from environmental accounting analysis.

7.2.2.3 Acidification: Acidification Potential (AP) is the measurement of acidity in nature by assessing the quantities of substances that contribute to acidity, such as sulfur dioxide, nitrogen dioxide, ammonia, and hydrochloric acid. The impact is calculated relative to sulfur dioxide (1 g SO2 equivalent). Calculate the Acidification Potential using the following equation.

$$AP = \sum_{i=1}^{n} AP(i)\ x\ A(i)$$

AP	is	the sum of the acidification potential index of a substance compared to the characterization factor of SO2.
AP (i)	is	the acidification potential index of that substance compared to the characterization factor of SO2.
A (i)	is	the quantity of substance obtained from environmental accounting analysis.

7.2.2.4 Eutrophication: Eutrophication Potential (EP) is the measurement of the increase of nutrient elements in water bodies. It assesses the rise of nutrients such as nitrogen and phosphorus, which cause changes in aquatic life and a rapid decrease in oxygen levels in water bodies. The impact is calculated relative to phosphorus (1 g PO4 equivalent). Calculate the Eutrophication Potential using the following equation.

$$EP = \sum_{i=1}^{n} EP(i)x\ A(i)$$

EP	is	the index measuring nutrient enrichment potential in water bodies.
EP (i)	is	the index measuring the potential increase in nutrient minerals of that substance compared to the characterization factor of PO4 (phosphate).
A (i)	is	the quantity of substance obtained from environmental accounting analysis.

7.2.2.5 Formation of Tropospheric Ozone: The Photochemical Ozone Creation Potential (POCP) measures the formation of ozone in the troposphere, leading to the phenomenon of Photochemical Smog. Tropospheric ozone is primarily formed from natural reactions between sunlight and oxygen, and sunlight and nitrogen oxides (NOx). Nitrogen oxides are released into the atmosphere predominantly from combustion sources such as vehicles, trucks, coal, power plants, and other industrial facilities. The unit of measurement is kilograms of Ethene equivalent (kg Ethene e) or kilograms of nitrogen oxides equivalent (kg NOx e). Calculate the formation of tropospheric ozone using the following equation.

$$POCP = \sum_{i=1}^{n} POCP(i)x\ A(i)$$

POCP	is	the index measuring the potential to create ozone in the tropospheric atmosphere.
POCP (i)	is	the index measuring the potential to create ozone in the tropospheric atmosphere for that substance compared to the characterization factors of Ethene and NOx.
A (i)	is	the quantity of substance obtained from environmental accounting analysis.

7.2.2.6 Depletion of Non-Renewable Energy Resources: The Abiotic Depletion Potential for Fossil Resources (ADP fossil fuels) measures the depletion of non-renewable energy resources such as oil, natural gas, and coal. The unit of measurement is megajoules (MJ), or depends on the type of energy resource used. Calculate the depletion of non-renewable energy resources using the following equation.

$$ADP = \sum_{i=1}^{n} ADP(i)x\ A(i)$$

ADP	is	the index measuring the potential depletion of non-renewable energy resources.
ADP (i)	is	the index measuring the potential depletion of non-renewable energy resources for that substance.
A (i)	is	the quantity of substance obtained from environmental accounting analysis.

8. Characterization factors database (CFs).

Life cycle stages	Data list	LCIA Method	Reference
Sourcing of raw materials	Natural Gypsum	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6, (Gypsum, mineral {RoW}| gypsum quarry operation)
	External waste	CML-IA baseline V3.06 / World 2000	
	Internal waste	CML-IA baseline V3.06 / World 2000	
	General additives	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Acrylic binder, without water, in 34% solution state {RoW})

Life cycle stages	Data list	LCIA Method	Reference
	Moisture resisatnce additives	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Epoxy resin {RoW}| epoxy resin production)
	Fire resistance additives	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Triphenyl phosphate {GLO})
	Paper	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Kraft paper, unbleached {RoW}| production)
	End tap	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Kraft paper, unbleached {RoW}| production)
Production process.	Natural Gas	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Natural gas, low pressure (28.7 MMBTU/M3)
	Electricity energy	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Electricity, Power plant,120MW, NG)
	Diesel oil	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Diesel (36.42MJ/L)
	water	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Tap water {RoW}| tap water production, conventional treatment)
	Steam	CML-IA baseline V3.06 / World 2000	Ecoinvent 3.6 (Electricity, Power plant,120MW, NG (2.83GJ/ton)
Waste disposal	Gypsum board	CML-IA baseline V3.05/World 2000	Ecoinvent 3.6 (Waste gypsum {RoW}| treatment of waste gypsum, sanitary landfill)
	End tap	CML-IA baseline V3.05/World 2000	Ecoinvent 3.6 (Landfill of municipal solid waste, ES, GR, PT technology mix, EU-27 (of project ELCD)

9. Reference

1. Product Category Rule for Environmental Product Declarations, PCR for Gypsum Panel Products, NSF International, National Center for Sustainability Standards, Valid through July 17, 2024
2. PRODUCT CATEGORY RULES FOR PREPARING AN ENVIRONMENTAL PRODUCT DECLARATION FOR NORTH AMERICAN GLASS MAT GYPSUM PANELS, ASTM International, VERSION ADOPTION AUG. 2016
3. Product Category Rules for North American Gypsum Boards FP Innovations – Gypsum PCR-2013: v1, PCR Program Operator: FP Innovations