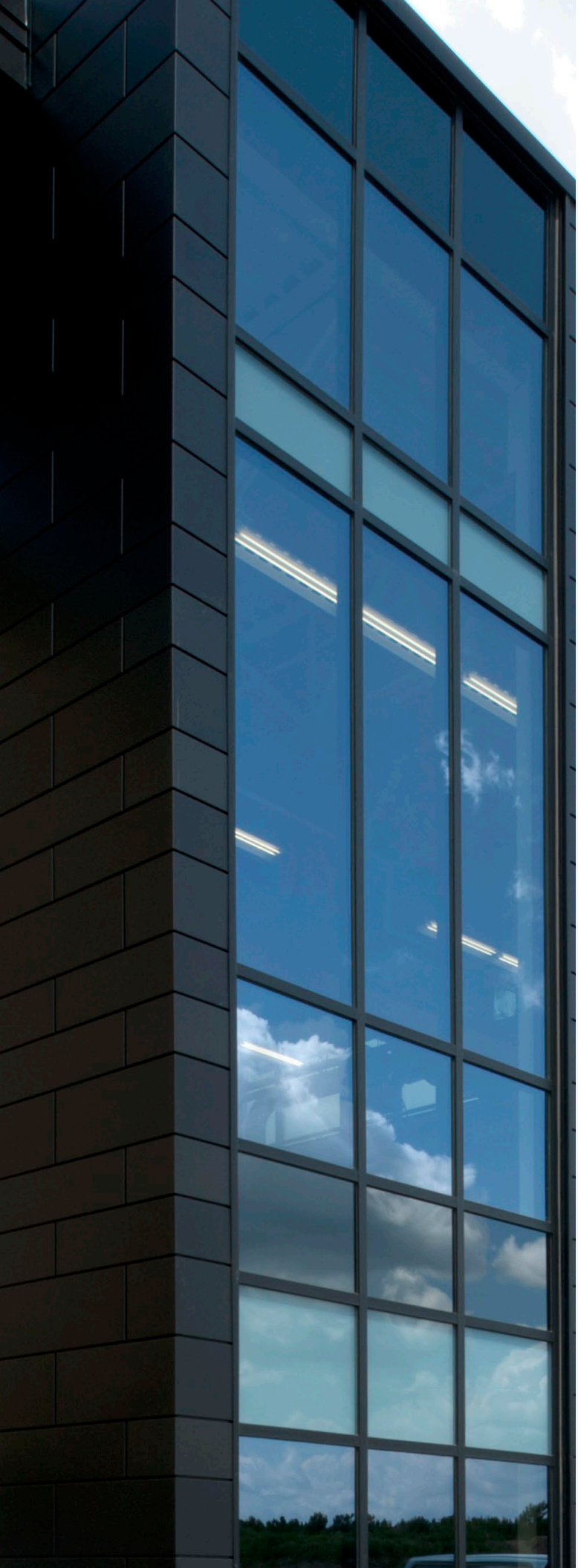


Environmental Product Declaration

Dri-Design | Anodized Aluminum Panel

dri-design® A Kingspan Group Company

VERIFIED by SCS Global Services ENVIRONMENTAL PRODUCT DECLARATION BASED ON LCA

Declaration Owner

Dri-Design
12480 Superior Ct #1
Holland, MI 49424
(616) 355-2970
www.dri-design.com

Product

Anodized Aluminum Panels

Functional Unit

The functional unit is 100 m^2 of anodized aluminum panel

EPD Number and Period of Validity

SCS-EPD-10200
EPD Valid July 2, 2024 through July 1, 2029

Product Category Rule

Product Category Rules for Building-Related Products and Services. Part A, Version 4.0. UL Environment. March 2022.

Product Category Rules for Building-Related Products and Services, Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels. Version 2.0. UL Environment. October 2018. Expiration date Dec 31, 2024

Program Operator

SCS Global Services
2000 Powell Street, Ste. 600, Emeryville, CA 94608
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SCSglobal SERVICES

Declaration Owner:	Dri-Design
Address:	12480 Superior Ct #1, Holland, MI 49424 USA
Declaration Number:	SCS-EPD-10200
Declaration Validity Period:	July 2, 2024 through July 1, 2029
Program Operator:	SCS Global Services
Declaration URL Link:	https://www.scsglobalservices.com/certified-green-products-guide
LCA Practitioner:	Tess Garvey, Ph.D., SCS Global Services
LCA Software and LCI database:	OpenLCA v2.0 software and the Ecoinvent v3.10 database
Product RSL:	n/a
Markets of Applicability:	North America
EPD Type:	Product-Specific
EPD Scope:	Cradle-to-Grave
LCIA Method and Version:	TRACI 2.1 and IPCC AR5
Independent critical review of the LCA and data, according to ISO 14044 and ISO 14071	☐ internal ☒ external
LCA Reviewer:	Lindita Bushi, PhD, Athena Sustainable Materials Insitute
Part A Product Category Rule:	PCR Guidance for Building-Related Products and Services Part A: Life Cycle Assessment Calculation Rules and Report Requirements. Version 4.0. UL Environment. March 2022.
Part A PCR Review conducted by:	Lindita Bushi, PhD (Chair); Hugues Imbeault-Tétreault, ing., M.Sc.A.; Jack Geibig
Part B Product Category Rule:	PCR Guidance for Building-Related Products and Services. Part B: Insulated Metal Panels, Metal Composite Panels, and Metal Cladding: Roof and Wall Panels. Version 2.0. UL Environment. October 2018. Expiration date Dec 31, 2024
Part B PCR Review conducted by:	Thomas Gloria, PhD (chair); Lindita Bushi, PhD; Bob Zabcik, P.E., LEED AP BD+C
Independent verification of the declaration and data, according to ISO 14025 and the PCR	☐ internal ☒ external
EPD Verifier:	Lindita Bushi, PhD, Athena Sustainable Materials Insitute
Declaration Contents:	1. Dri-Design....2 2. Product....2 3. LCA: Calculation Rules....5 4. LCA: Scenarios and Additional Technical Information....10 5. LCA: Results....12 6. LCA: Interpretation....14 7. Additional Environmental Information....15 8. References....16

Disclaimers: *This EPD conforms to ISO 14025, 14040, 14044, and ISO 21930.*

Scope of Results Reported: *The PCR requirements limit the scope of the LCA metrics such that the results exclude environmental and social performance benchmarks and thresholds, and exclude impacts from the depletion of natural resources, land use ecological impacts, ocean impacts related to greenhouse gas emissions, risks from hazardous wastes and impacts linked to hazardous chemical emissions.*

Accuracy of Results: *Due to PCR constraints, this EPD provides estimations of potential impacts that are inherently limited in terms of accuracy.*

Comparability: *The PCR this EPD was based on was not written to support comparative assertions. EPDs based on different PCRs, or different calculation models, may not be comparable. When attempting to compare EPDs or life cycle impacts of products from different companies, the user should be aware of the uncertainty in the final results, due to and not limited to, the practitioner's assumptions, the source of the data used in the study, and the specifics of the product modeled.*

In accordance with ISO 21930:2017, EPDs are comparable only if they comply with the core PCR, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

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1. Dri-Design

Dri-Design is a metal wall system that provides endless design possibilities, with an unlimited palette of colors, finishes, materials, and textures, including custom perforations. Dri-Design is a 100 percent recyclable pressure equalized rain-screen that attaches to nearly any substrate without the use of clips or extrusions. A leader in the architectural metal panel industry, Dri-Design's unique architectural cladding system offers design flexibility, superior testing, and ease of installation. With a commitment to sustainability, design excellence, and advanced manufacturing processes, they provide customers with high-quality metal panels that deliver both aesthetic appeal and exceptional performance.

Dri-Design's offerings deliver both performance and sustainability advantages to noteworthy structures across various sectors worldwide. As an employer, a substantial landholder, and as a key member of our neighboring communities, Dri-Design aims to adopt and apply best practice sustainability principles by ensuring environmental, social, and economic parameters are considered in an integrated way in the operation of its business.

2. Product

2.1 PRODUCT DESCRIPTION

Dri-Design anodized aluminum wall panels created by using the natural oxidation process, adding electricity and chemicals, to produce a dense surface that is integral with the aluminum. Due to the oxidation process, there is a natural color variation in the aluminum.

The anodized aluminum panels are available in a thickness of 2.03 mm (0.080 inch), with an average weight per area of 5.57 kg/m^2.



2.2 PRODUCT FLOW DIAGRAM

The flow diagram below illustrates the production processes and the life cycle phases included in the scope of the EPD.

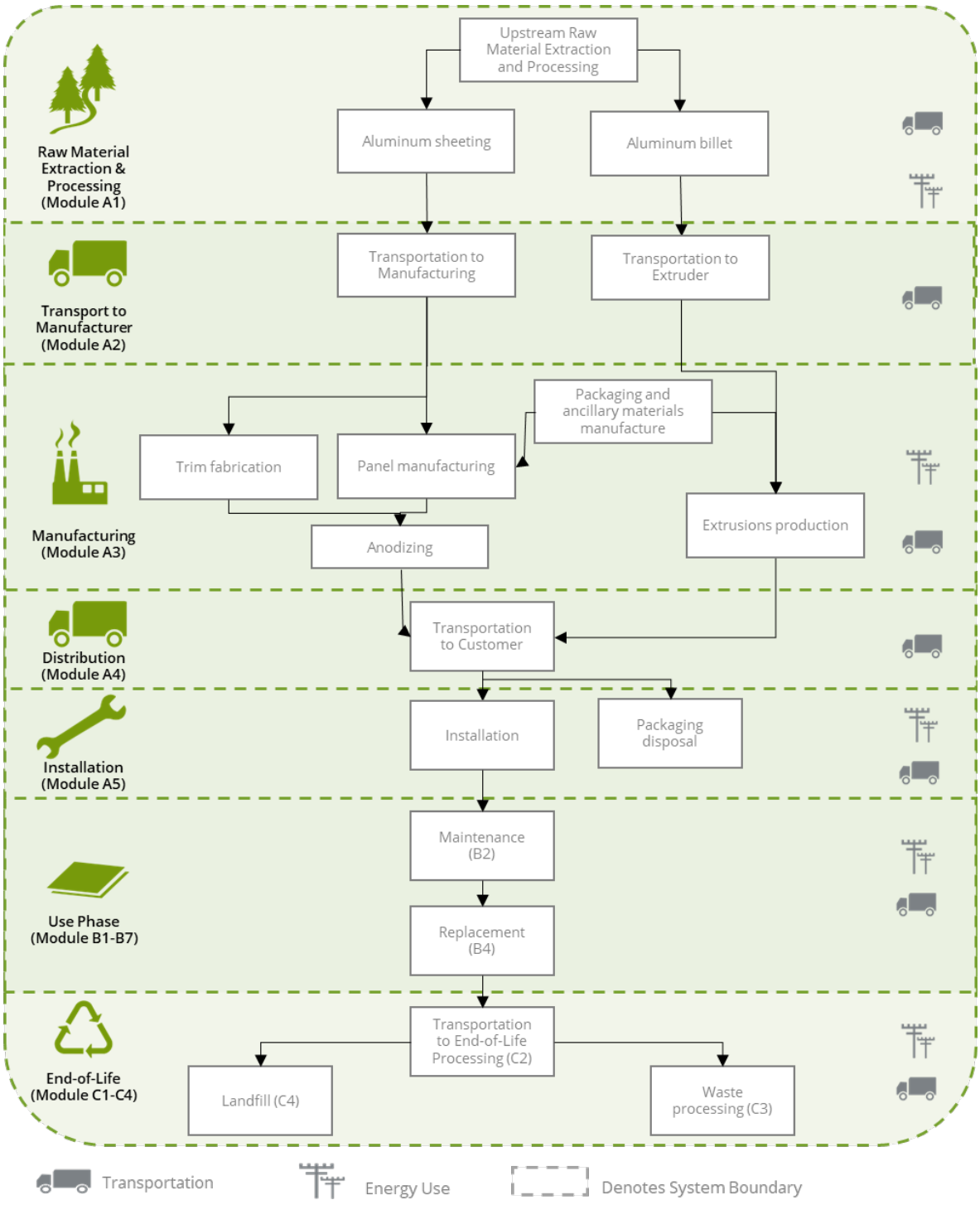


Figure 1. *Flow diagram for the life cycle of the Dri-Design anodized aluminum panels.*

2.3 INTENDED APPLICATION

The Dri-Design anodized aluminum panels are used as metal wall panels.

2.4 DECLARATION OF METHODOLOGICAL FRAMEWORK

The scope of the EPD is cradle-to-grave, including raw material extraction and processing, transportation, product manufacture, product use and end-of-life. The life cycle phases included in the product system boundary are shown below.

Cut-off and allocation procedures are described below and conform to the PCR and ISO standards.

Table 1. *Life cycle phases included in the product system boundary.*

Product			Construction Process		Use							End-of-life				Benefits and loads beyond the system boundary
A1	A2	A3	A4	A5	B1	B1	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material extraction and processing	Transport to manufacturer	Manufacturing	Transport	Construction - installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse, recovery and/or recycling potential
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND

X = Module Included | MND = Module Not Declared

2.5 TECHNICAL DATA

A summary of technical specifications for the anodized aluminum panels in this EPD include CSI 07 42 13.24. Other technical specifications across Dri-Design products include those listed in Section 7, Additional Environmental Information.

2.6 PROPERTIES OF PRODUCT AS DELIVERED

The final products are delivered in thickness of 2.03 mm (0.080 inch) in wood crates.

2.7 MATERIAL COMPOSITION

The anodized aluminum panels are composed of 100% aluminum.

In conformance with the PCR, product materials were reviewed for the presence of any toxic or hazardous chemicals. Based on a review of the product components provided by the manufacturer, no regulated chemicals are expected to be released.

2.8 MANUFACTURING

The anodized aluminum panels are manufactured from aluminum sheet at the panel manufacturing facility in Wausau, WI. Trims for the panels system are fabricated at the facility in Holland, MI. Additional finishing occurs at one of Dri-Design's partner facilities within 20 miles of the panel manufacturing facility.

The manufacturer provided primary data for their annual production, resource use and electricity consumption and waste generation at the panel manufacturing and trim fabrication facilities. Primary data from upstream supplier for aluminum sheeting were also collected. Dri-Design's partners provided primary data for anodizing operations. One of Dri-Design's finishing partners additionally produces the aluminum extrusions used in the aluminum panel systems, for which primary

data were also provided. The electricity supply mix for each facility is modeled using Ecoinvent electricity grid supply mix for the applicable NERC region and tailored to the eGRID subregion. No CO2 certificates are included in this LCA.

2.9 PACKAGING

Packaging for the panels includes wood crates at the manufacturing facilities, and fiberboards for the aluminum extrusions.

2.10 INSTALLATION

Installation is modeled based on PCR requirements where 5% of the product is lost to scrap during installation. Packaging disposal is also contained within this module.

2.11 USE CONDITIONS

Per the PCR, maintenance activities (B2) consist of twice yearly cleaning with a sodium lauryl sulfate solution. The panels are expected to be replaced every 30 years, requiring 1.5 replacements (B4) over the estimated service life of the building, 75 years. Modules B1, B3, B5, B6, and B7 are assumed to be null.

2.12 DISPOSAL

Disposal is comprised of truck transportation to end-of-life disposal, scrap treatment for recycling and landfilling, according to the PCR. Module C1 is assumed to be null.

2.13 FURTHER INFORMATION

Further information on the product can be found on the manufacturer's website https://www.dri-design.com/

3. LCA: Calculation Rules

3.1 FUNCTIONAL UNIT

In accordance with the PCR, the functional unit is coverage of 100 square meters (1076.4 square feet) of building area for 75 years. The reference flow for the modeling of this system is listed in Table 1. Per the PCR, the reference service lifetime (RSL) for the panel products is 30 years, while the estimated service lifetime (ESL) of the building is 75 years. The number of replacements required to fulfill the ESL is 1.5.

Table 1. Reference parameters for the assessed products.

Parameter	Value	Unit
Functional unit	100	m^2
Thickness	0.080	inches
Reference flow (Average weight per area of panel)	557	$kg/100m^2$
Packaging per FU	315	kg
Product lifetime (RSL)	30	years
Building lifetime (ESL)	75	years
Replacements	1.5	--

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3.2 SYSTEM BOUNDARY

The scope of the EPD is cradle-to-grave, including raw material extraction and processing, transportation, and product manufacture, product use, and end-of-life. The life cycle phases included in the EPD scope are described in Table 2.

Table 2. *The modules and unit processes included in the scope for the Dri-Design anodized aluminum panels.*

Module	Module Description	Unit Processes Included in Scope
A1	Extraction and processing of raw materials; any reuse of products or materials from previous product systems; processing of secondary materials; generation of electricity from primary energy resources; energy, or other, recovery processes from secondary fuels	Raw material extraction and processing for the materials upstream of the Dri-Design facilities. Metal extraction, processing and rolling the intermediate panels, as well as any processes done upstream of Dri-Design operations
A2	Transport (to the manufacturer)	Transportation of metals from upstream manufacture to the Dri-Design facilities
A3	Manufacturing, including packaging and ancillary material production	Panel and trim manufacture at the Holland, MI and Wausau, WI facilities**,** aluminum panels are additionally finished at external partner facility
A4	Transport (to the building site)	Distribution to customer by truck
A5	Construction-installation process	Scrap loss of 5% during installation. Packaging disposal and transport to disposal facility.
B1	Product use	None
B2	Product maintenance	Twice yearly cleaning of panels
B3	Product repair	None
B4	Product replacement	1.5 replacements required over product lifetime
B5	Product refurbishment	None required
B6	Operational energy use by technical building systems	None required
B7	Operational water uses by technical building systems	None required
C1	Deconstruction, demolition	No significant impacts
C2	Transport (to waste processing)	Truck transport to end-of-life processing
C3	Waste processing for reuse, recovery and/or recycling	Recycling of panels
C4	Disposal	Landfilling of panels
D	Reuse-recovery-recycling potential	Module Not Declared

3.3 UNITS

All data and results are presented using SI units.

3.4 ESTIMATES AND ASSUMPTIONS

The assessment relied on several assumptions. The major assumptions used in the assessment are described below.

- The aluminum sheet supplier provided confidential primary data on aluminum sheeting, including suppliers, recycled content, waste production, and upstream transport. Representative inventory data for other raw materials were modeled with unit process data taken from Ecoinvent.
- The amount of average trims and extrusions used for aluminum panels per product system were estimated using the ratio of production of all three components.
- Primary data for resource use (e.g., electricity, natural gas, water), waste/byproducts, and emissions released, were allocated on a mass-basis as a fraction of total annual production across the panel products, due to data availability, except for one partner finishing facility. Data related to finishing operations were provided and allocated based on surface area.
- Representative inventory data for electricity use were modified to reflect the eGRID subregion electricity supply mixes at each of the facilities which provided primary data.
- Transportation for manufacturing wastes were modeled using the assumption from the US EPA WARM model of 20 miles (~32 km), from the point of product use to a landfill, material recovery center, or waste incinerator. Ecoinvent datasets are used to model the impacts associated with incineration and landfilling, which does not include energy recovery from landfill gas.
- Transportation for installation and product end-of-life wastes were modeled using the PCR assumption of 100km, per the PCR.

3.5 CUT-OFF RULES

According to the PCR, processes contributing greater than 1% of the total environmental impact indicator for each impact must be included in the inventory. No data gaps were allowed which were expected to significantly affect the outcome of the indicator results. No known flows are deliberately excluded from this EPD.

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3.6 DATA SOURCES

Primary data were provided by Dri-Design, supplier, and partner finishing facility. The sources of secondary LCI data are the Ecoinvent database.

Table 3. *LCI datasets and associated databases used to model material production and processing for the Dri-Design anodized aluminum panels.*

Flow	Dataset	Data Source	Publication Date
Metal			
Aluminum	market for aluminium, wrought alloy | aluminium, wrought alloy | Cutoff, U – GLO* modified to match recycled content provided by supplier	Ecoinvent 3.10	2023
Other raw materials and ancillary			
Lubricating oils	market for lubricating oil | lubricating oil | Cutoff, U - RER	Ecoinvent 3.10	2023
Crating for packaging	EUR-flat pallet production | EUR-flat pallet | Cutoff, U - RER	Ecoinvent 3.10	2023
Fiberboard packaging for extrusions	market for containerboard, unspecified | containerboard, unspecified | Cutoff, U – US	Ecoinvent 3.10	2023
Electricity and Fuel Use			
Electricity	market for electricity, medium voltage | electricity, medium voltage | Cutoff, U – *various (RFC, MRO)* modified for eGRID subregions (MROE, RFCM) as appropriate	Ecoinvent 3.10 eGRID 2022	2023 2024
Natural gas	market group for heat, district or industrial, natural gas | heat, district or industrial, natural gas | Cutoff, U - RER	Ecoinvent 3.10	2023
Propane	propane, burned in building machine | propane, burned in building machine | Cutoff, U - GLO	Ecoinvent 3.10	2023
Diesel	diesel, burned in building machine | diesel, burned in building machine | Cutoff, U - GLO	Ecoinvent 3.10	2023
Gasoline	petrol, unleaded, burned in machinery | petrol, unleaded, burned in machinery | Cutoff, U - GLO	Ecoinvent 3.10	2023
Other	heat production, light fuel oil, at boiler 10kW, non-modulating | heat, central or small-scale, other than natural gas | Cutoff, U - Europe without Switzerland	Ecoinvent 3.10	2023
Waste Disposal			
Non-hazardous wastes	process-specific burdens, inert material landfill | process-specific burdens, inert material landfill | Cutoff, U - RoW process-specific burdens, municipal waste incineration | process-specific burdens, municipal waste incineration | Cutoff, U - Europe without Switzerland	Ecoinvent 3.10	2023
Other hazardous wastes	process-specific burdens, hazardous waste incineration plant | process-specific burdens, hazardous waste incineration plant | Cutoff, U - RoW	Ecoinvent 3.10	2023
Water use at facility			
Water use	market for tap water | tap water | Cutoff, U - Europe without Switzerland	Ecoinvent 3.10	2023
Transportation			
Truck transport	transport, freight, lorry 16-32 metric ton, EURO4 | transport, freight, lorry 16-32 metric ton, EURO4 | Cutoff, U - RER	Ecoinvent 3.10	2023
Installation			
Installation fuel use	market group for electricity, medium voltage | electricity, medium voltage | Cutoff, U – US diesel, burned in building machine | diesel, burned in building machine | Cutoff, U - GLO	Ecoinvent 3.10	2023
Maintenance			
Soap	market for sodium sulfate, anhydrite | sodium sulfate, anhydrite | Cutoff, U – RER market for tap water | tap water | Cutoff, U - Europe without Switzerland	Ecoinvent 3.10	2023
End -of-Life			
Recycle	treatment of aluminium scrap, post-consumer, by collecting, sorting, cleaning, pressing | Cutoff, U - RER	Ecoinvent 3.10	2023
Landfill	treatment of scrap steel, inert material landfill | Cutoff, U - Europe without Switzerland	Ecoinvent 3.10	2023

3.7 DATA QUALITY

The data quality assessment addresses the following parameters: time-related coverage, geographical coverage, technological coverage, precision, completeness, representativeness, consistency, reproducibility, sources of data, and uncertainty.

Table 4. *Data quality assessment for the product system.*

Data Quality Parameter	Data Quality Discussion
Time-Related Coverage: Age of data and the minimum length of time over which data is collected	The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these data are less than 10 years old (typically 2019 or more recent). All of the data used represented an average of at least one year's worth of data collection. Manufacturer-supplied data (primary data) are based on a full year of operations from at each of the Dri-Design facilities from January 1- December 31, 2022.
Geographical Coverage: Geographical area from which data for unit processes is collected to satisfy the goal of the study	The data used in the analysis provide the best possible representation available with current data. Actual processes for upstream operations are primarily North American. Surrogate data used in the assessment are representative of North American operations. Data representative of European operations are considered sufficiently similar to actual processes. Data representing disposal practices are based on regional statistics.
Technology Coverage: Specific technology or technology mix	For the most part, data are representative of the actual technologies used for processing, transportation, and manufacturing operations.
Precision: Measure of the variability of the data values for each data expressed	Precision of results are not quantified due to a lack of data. Data collected for operations were typically averaged for one or more years and over multiple operations, which is expected to reduce the variability of results. Precise results would depend on the amount of trims and extrusions used in the final product system.
Completeness: Percentage of flow that is measured or estimated	The LCA model included all known mass and energy flows for production of panels. In some instances, surrogate data used to represent upstream and downstream operations may be missing some data which is propagated in the model. No known processes or activities contributing to more than 1% of the total environmental impact for each indicator are excluded. In total, these missing data represent less than 5% of the mass or energy flows.
Representativeness: Qualitative assessment of the degree to which the data set reflects the true population of interest	Data used in the assessment represent typical or average processes as currently reported from multiple data sources and are therefore generally representative of the range of actual processes and technologies for production of these materials. Considerable deviation may exist among actual processes on a site-specific basis; however, such a determination would require detailed data collection throughout the supply chain back to resource extraction. For supplier information, the most representative source of data possible was chosen or modeled.
Consistency: Qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The consistency of the assessment is considered to be high. Data sources of similar quality and age are used with a bias towards Ecoinvent v3.10 data. Different portions of the product life cycle are equally considered; however, it must be noted that final disposition of the product is based on assumptions of current average practices in Europe and North America.
Reproducibility: Qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Based on the description of data and assumptions used, this assessment would be reproducible by other practitioners with access to the primary data. All assumptions, models, and data sources are documented.
Sources of the Data: Description of all primary and secondary data sources	Data representing facility operations at the Dri-Design manufacturing facilities, as well as supplier and finishing partners, represent an annual average and are considered of high quality due to the length of time over which these data are collected, as compared to a snapshot that may not accurately reflect fluctuations in production. Other data are also considered high quality due to the fact that they similarly span a full calendar year and are representative of the materials. The Ecoinvent database is used for secondary LCI datasets.
Uncertainty of the Information: Uncertainty related to data, models, and assumptions	Uncertainty related to materials in the products is low. Actual supplier data for upstream operations was not available for all suppliers and the study relied upon the use of existing representative datasets. These datasets contained relatively recent data (<10 years) but lacked geographical representativeness. Uncertainty related to the impact assessment methods used in the study are high. The impact assessment method required by the PCR includes impact potentials, which lack characterization of providing and receiving environments or tipping points.

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3.8 PERIOD UNDER REVIEW

The period of review for Dri-Design anodized aluminum panels is from January 1- December 31, 2022.

3.9 ALLOCATION

This study follows the allocation guidelines of ISO 14044 and allocation rules specified in the PCR and minimized the use of allocation wherever possible. This LCA follows an attributional approach as outlined in ISO 21930 Section 7.1.1.

Mass allocation was deemed the most accurate and reproducible way of calculating the energy and material requirements for the manufacture of the panels within the facilities, with the exception of the panel finishing facilities. Primary data for resource use (e.g., electricity, natural gas, water), waste/byproducts, and emissions released, are allocated on a mass-basis as a fraction of total annual production across the panel products and then multiplied by the panel's surface density ($kg/100m^2$). For finishing operations, allocation was performed based on surface area.

The transportation from primary producer of material components to the manufacturing facilities is based on primary data provided by Dri-Design and others, including modes, distances, and amount of material transported. Transportation was allocated on the basis of the mass and distance the material was transported.

Modeling of recycled material follows the recycled content method (also known as 100-0 method or cut-off method) whereby only the burdens of reprocessing the waste material are allocated to the system from the use of the recycled material. No burdens are allocated across the system boundary with secondary material, secondary fuel, or recovered energy flows arising from waste.

3.10 COMPARABILITY

Environmental declarations from different programs (ISO 14025) may not be comparable.

Comparison of the environmental performance of metal panel and cladding products using EPD information shall be based on the product's use and impacts at the building level, and therefore EPDs may not be used for comparability purposes when not considering the building use phase as instructed under the PCR.

Full conformance with the PCR for metal panels and cladding allows EPD comparability only when all stages of a life cycle have been considered when they comply with all referenced standards, use the same sub-category PCR, and use equivalent scenarios with respect to construction works. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to different results for upstream and downstream of the life cycle stages declared.

4. LCA: Scenarios and Additional Technical Information

Manufacturing

The anodized aluminum panels are manufactured from aluminum sheet at the facility in Wausau, WI. Trims for the panels system are fabricated at the facility in Holland, MI. Additional finishing occurs at one of Dri-Design's partner facilities within 20 miles of the panel manufacturing facility.

Transportation for waste materials at manufacturing assumes a 20 miles (~32 km) average distance to disposal, consistent with assumptions used in the US EPA WARM model. Hazardous wastes are disposed by incineration.

Installation (A5) The energy and resources required for installation are estimated per PCR requirements. The PCR specifies that 1 kWh of electricity and 1 gallon of diesel are required per 100m^2 for installation. Additionally, the PCR specifies 5% scrap loss during product installation. Module A5 includes the upstream environmental burden of 5% installation scrap loss.

The A5 module includes the transport and treatment of waste product packaging at a waste disposal facility. The disposal rates of the waste product packaging are based on the US EPA Facts and Figures report[1], in which 58.8% of wood-based packaging waste generated is landfilled and 26.9% is recycled. Truck transport is modeled for packaging-based disposal with an assumed one-way distance of 100km (62mi) to the end-of-life facility, per the PCR.

Use Stage (B1) There are no resource requirements associated with use of the panel products. The default environmental impacts are assumed to be zero[2].

Maintenance (B2) The panel products may require some maintenance during use. The PCR specifies for cladding panels, panels should be cleaned with 500 ml of 1% (v/v) sodium lauryl sulfate solution, twice per year, over the 75 years of the building's lifetime.

Repair (B3), Refurbishment (B5) The panel products are not expected to require routine repair or refurbishment during use in standard conditions and if correctly applied. The default environmental impacts are assumed to be zero.

Replacement (B4) The panel products have a RSL of 30 years, per the PCR, and as such 1.5 replacements are required over the building's lifetime, 75 years. Module B4 includes the environmental burden, including the upstream (A1-A5) and end-of-life (C1-C4), of the replacements.

Building operation (B6-B7) The panel products require no energy use or water use during its operation and the environmental impact are assumed to be zero.

Disposal stage (C1-C4) This module includes the demolition of the products, including on-site sorting of the materials. The products are assumed to be retrieved from the construction site with negligible resource use. Hence, it is assumed that no resource use is required for this module. The C2 module includes an assumed 100 km (62mi), per the PCR, to transport the product to a landfill or recycling facility at its end-of-life by truck transport. The C3 module includes any collection of waste fraction and processing required before the product can be reused, recycled, or recovered for energy. The waste processing includes recycling operations for the metal panels where the recovery rates are taken from the UL PCR Part A, with the exception of the wood-based packaging.

Table 5. *Waste disposal pathways for each of the panel products per functional unit.*

Name	Product Aluminum	Packaging Fiberboard	Wood*
Recycling	95%	68%	58.8%
Incineration	0%	5%	14.3%
Landfilling	5%	20%	26.9%

The C4 module includes the impacts from landfilling of the panel products, per the disposal rates shown in Table 5.

[1] US EPA Facts and Figures report, 2018. https://www.epa.gov/sites/default/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf
[2] As per the PCR.

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5. LCA: Results

Results of the Life Cycle Assessment are presented below. It is noted that LCA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. All LCA results are stated to three significant figures in agreement with the PCR for this product and therefore the sum of the total values may not exactly equal 100%. Note that B1, B3, B5, B6, B7, and C1 are assumed to be null and excluded from result tables.

The following environmental impact category indicators are reported using characterization factors based on the U.S. EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts – TRACI 2.1 and IPCC AR5.

TRACI 2.1 Impact Category	Unit
Global Warming Potential **(GWP)**	kg CO_2 eq
Ozone Depletion Potential **(ODP)**	kg CFC 11 eq
Acidification Potential **(AP)**	kg SO_2 eq
Eutrophication Potential **(EP)**	kg N eq
Smog Formation Potential **(SFP)**	kg O_3 eq
Fossil Fuel Depletion Potential **(FFD)**	MJ Surplus, LHV

These impact categories are globally deemed mature enough to be included in Type III environmental declarations. Other categories are being developed and defined and LCA should continue making advances in their development. However, the EPD users shall not use additional measures for comparative purposes.

Table 6 summarizes the nomenclature and reporting units for the additional inventory parameters (energy and waste flows), as specified in the PCR, while Table 7 presents these results according to the life cycle module definitions for the Dri-Design anodized aluminum panels. Category indicator results for the product are summarized by life cycle phase in Table 8.

Table 6. *Nomenclature and reporting units for resource use and waste flows.*

Parameter	Units
RESOURCES	
Renewable primary resources used as energy carrier (RPR_E)	MJ, LHV
Renewable primary resources used as material (RPR_M)	MJ, LHV
Non-renewable primary resources used as an energy carrier ($NRPR_E$)	MJ, LHV
Non-renewable primary resources used as material ($NRPR_M$)	MJ, LHV
Secondary materials (SM)	kg
Renewable secondary fuels (RSF)	MJ, LHV
Non-renewable secondary fuels (NRSF)	MJ, LHV
Recovered energy (RE)	MJ, LHV
Use of net freshwater resources (FW)	m^3
WASTES	
Non-hazardous waste disposed (NHWD)	kg
Hazardous waste disposed (NWD)	kg
High-level radioactive waste (HLRW)	kg
Intermediate- and low-level radioactive waste (ILLRW)	kg
Components for re-use (CRU)	kg
Materials for recycling (MR)	kg
Materials for energy recovery (MER)	kg
Recovered energy exported from the product system (EE)	MJ

Table 7. *Resource use and waste flows for the functional unit of Dri-Design anodized aluminum panels, 2.03 mm (0.080 in) thick. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Parameter	Unit	A1	A2	A3	A4	A5	B2	B4	C2	C3	C4
Resource use											
Use of renewable primary energy excluding renewable primary energy resources used as raw materials (RPR_E)	MJ	11,000	24.4	7,860	19.1	952	$7.41x10^{-6}$	30,100	2.57	144	$3.96x10^{-2}$
Use of renewable primary energy resources used as raw materials (RPR_M)	MJ	0.00	0.00	2,130	0.00	106	0.00	3,350	0.00	0.00	0.00
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials ($NRPR_E$)	MJ	105,000	1,430	7,010	1,120	6,030	$5.56x10^{-5}$	184,000	150	1,190	4.24
Use of non-renewable primary energy resources used as raw materials ($NRPR_M$)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of secondary material (SM)	kg	95.3	0.00	0.00	0.00	4.76	0.00	150	0.00	0.00	0.00
Use of renewable secondary fuels (RSF)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered Energy (RE)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Use of net fresh water (FW)	m^3	60.4	0.197	6.88	0.154	3.42	$6.16x10^{-7}$	108	$2.07x10^{-2}$	0.638	$4.44x10^{-3}$
Waste and outflows											
Non-hazardous waste disposed (NHWD)	kg	4.96	0.00	3.56	0.00	130	0.00	250	0.00	0.00	27.8
Hazardous waste disposed (HWD)	kg	$4.36x10^{-4}$	0.00	4.17	0.00	0.208	0.00	6.56	0.00	0.00	0.00
High-level Radioactive waste disposed (HLRW)	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Radioactive waste disposed (ILLRW)	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Components for re-use (CRU)	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for recycling (MR)	kg	33.5	0.00	99.8	0.00	192	0.00	1,280	0.00	529	0.00
Materials for energy recovery (MER)	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Exported energy (EE)	MJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The PCR requires the calculation of biogenic carbon emissions and removals. No biogenic carbon is associated with the product. However, wood crates and fiberboards are used in packaging. Biogenic carbon uptake, removals and emissions are reported for the relevant modules in Table 8.

Table 8. *Biogenic carbon inventory parameters per functional unit, 100m²*

Product	Uptake A3	Uptake A5	Removals A5	Emissions A5	Uptake B4	Removals B4	Emissions B4
Aluminum panel, 0.080 inch	577	28.8	163	89.2	909	244	134

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Table 9. *Key Life Cycle Impact Assessment results by life cycle phase for the functional unit of anodized aluminum panels, 2.03 mm (0.080 in) thick. Results reported in MJ are calculated using lower heating values. All values are rounded to three significant digits.*

Impact Category	A1	A2	A3	A4	A5	B2	B4	C2	C3	C4
IPCC AR5										
GWP (kg CO_2 eq)	11,000	102	540	80.0	610	$5.54x10^{-4}$	18,800	10.7	162	0.175
TRACI 2.1										
GWP (kg CO_2 eq)	10,800	99.9	534	78.4	600	$4.57x10^{-7}$	18,500	10.5	160	0.170
ODP (kg CFC-11 eq)	$1.11x10^{-4}$	$2.17x10^{-6}$	$8.43x10^{-6}$	$1.70x10^{-6}$	$6.54x10^{-6}$	$1.22x10^{-11}$	$1.97x10^{-4}$	$2.29x10^{-7}$	$1.81x10^{-6}$	$5.38x10^{-9}$
AP (kg SO_2 eq)	62.1	0.363	1.84	0.285	3.38	$4.27x10^{-4}$	103	$3.82x10^{-2}$	0.538	$1.11x10^{-3}$
EP (kg N eq)	41.0	$9.42x10^{-2}$	5.00	$7.39x10^{-2}$	2.35	$5.93x10^{-7}$	73.4	$9.92x10^{-3}$	0.426	$2.54x10^{-4}$
SMOG (kg O_3 eq)	705	9.58	26.3	7.52	37.7	$3.11x10^{-5}$	1,190	1.01	7.06	$2.97x10^{-2}$
FFD (MJ surplus, LHV)	5,800	202	636	159	340	$7.69x10^{-4}$	10,900	21.3	135	0.614

Limitations

Primary data of material components was modeled with actual process information from the aluminum supplier. Secondary data consists of ecoinvent datasets.

The panel manufacture and fabrication facility, was not able to provide a panel-specific scrap rate. Preparing a material-specific scrap rate would improve the precision of results by material.

6. LCA: Interpretation

The primary contributor to indicator results for each of the metal panels is from the replacement phase (B4) due to the way impacts are allocated for replacements. When the B4 module is excluded, the Upstream Raw Material Production and Metalworking (A1) stage is the most impactful stage, while the Manufacturing processes within the A3 module make it the second-most impactful module for most other impact indicators. For the Acidification and Smog Formation indicators, Installation (A5) contributes slightly more impact than Manufacturing (A3).

The configuration of each panel system is dependent upon the final customer and application. The average amount of trims and extrusions used for aluminum panels per product system were estimated here based upon the annual production of trims and extrusions divided by the final panel production at the panel manufacturing facility. The results of an actual panel product system may depend upon the final use of trims and extrusions.

7. Additional Environmental Information

Below is a summary of the certifications and accreditations Dri-Design products hold:

- NFPA 285 compliant
- AAMA 508-21 Tested
- DADE NOA Tested
- CAN/ULC-S114-218 Tested
- Florda Product Approval Accredited
- Code Compliance Research Report Accredited
- Las Angeles Research Report Accredited
- Manufactured in an ISO 9001:2015 facility

Dri-Design is a Kingspan group company. Kingspan understands its impact on the environment, both in terms of the role its products can play in optimizing energy efficiency, and the responsibility the company has with a global footprint of over 159 manufacturing facilities and over 15,000 employees. Kingspan seeks to operate as sustainably as possible throughout its supply chain.

Planet Passionate is Kingspan's ambitious 10-year global sustainability strategy that will impact on three big global issues: climate change, circularity, and protection of our natural world. Through Planet Passionate Kingspan will contribute to the world's renewable energy mix, reduce carbon emissions, divert waste from landfill, conserve water, provide upcycling solutions for plastic waste and help clean the world's oceans and protect biodiversity.

The strategy is made up of 12 ambitious targets, addressing the impact of Kingspan's business operations and manufacturing on the four key areas of energy, carbon, circularity and water, with commitments by 2030 to include:

- Energy: powering 60% of all Kingspan operations directly from renewable energy with a minimum of 20% of this energy generated on manufacturing sites (up from 5.3% today). This will include install solar PV on all wholly owned facilities.
- Carbon: achieving net zero carbon manufacturing and a 50% reduction in product CO2 intensity from primary supply partners.
- Circularity: upcycling of 1 billion PET bottles per annum into insulation products plus zero company waste to landfill across all sites.
- Water: harvesting 100 million liters of Kingspan's water usage from rainwater with a goal of five active ocean clean-up projects by 2025.
- Waste: target of zero company waste sent to landfill.

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8. References

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