HI-MACS® and Viatera® | Countertops

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

LG Hausys is Korea's largest construction and decoration materials firm and has been an industry leader for the past half century. LG Hausys practices sustainable management, which protects the environment and promotes a future where communities coexist comfortably with economic development. LG Hausys became the first Korean company to satisfy the Voluntary Carbon Standard (VCS), demonstrating its responsiveness to climate change. LG Hausys is taking the lead in social contribution activities through involvement in the Dokdo Natural Protection Zone and the Creating Happy Spaces project, while practicing responsible management that promotes the mutual growth of its partner companies. With "creating customer value" as the first and foremost business goal, LG Hausys will continue to create enjoyable, eco-friendly, and people-oriented living spaces through boundless determination and innovation.

SUSTAINABILITY CERTIFIED NSF™ Environmental Product Declaration

EPD Program Operator
NSF International
789 N. Dixboro Rd.
Ann Arbor, MI 48105 USA
www.nsf.org

Date of Issue: April 7, 2017
Period of Validity: 5 years
Declaration#: EPD10096

Alivar WAVY with HI-MACS®

ENVIRONMENTAL PRODUCT DECLARATION VERIFICATION

EPD Information			
Program Operator		NSF International	
Declaration Holder		LG Hausys Ltd.	
Product HI-MACS and Viatera	Date of Issue April 17, 2017	Period of Validity 5 Years	Declaration Number EPD10096
This EPD was independently verified by NSF International in accordance with ISO 14025: ☐ Internal ☒ External		[signature] Jenny Oorbeck joorbeck@nsf.org	
This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR:		[signature] Jack Geibig, EcoForm, LLC jgeibig@ecoform.com	
LCA Information			
Basis LCA		LG Hausys Countertop LCA February 2017	
LCA Preparer		Jeremy Rafter Sustainable Solutions Corporation jeremy@sustainablesolutionscorporation.com	
This life cycle assessment was critically reviewed in accordance with ISO 14044 by:		Jack Geibig EcoForm, LLC jgeibig@ecoform.com	
PCR Information			
Program Operator		NSF International	
Reference PCR		Residential Countertops	
Date of Issue		September 17, 2013	
PCR review was conducted by:		Steve Lubowinski NSF International ncss@nsf.org	

Environmental Product Declaration

LG Hausys HI-MACS® and Viatera® Surfaces

Alivar WAVY with HI-MACS®

Product Description

For both HI-MACS® and Viatera® product lines, the results contained within this declaration represent the worst case scenario in terms of life cycle impacts. Specific variations and product thicknesses within each product line have been analyzed, and life cycle impact assessment results for any given variation of either the HI-MACS® or Viatera® products are equal to or less than the results presented in this declaration.

<u>HI-MACS®</u>

HI-MACS® surfaces are laminate acrylic countertop surfaces. This material is a seamless, non-porous surface that without crevices or surface irregularities where harmful bacteria and mold may reside, and as such, requires no sealing. Additionally, the HI-MACS® product can be thermoformed to produce an unlimited variety of shapes, allowing it to be used for vertical and other applications beyond countertops. Within the HI-MACS® product line, there are several variations, each of which has a slightly different pattern, and each of these patterns is available in a number of color options. The maximum available thickness of HI-MACS is 12mm, however, thinner profiles are available. With durability similar to that of natural stone, HI-MACS® stands up to everyday scratches and endures its everyday wear and tear with higher resistance to stains, chemical and heat. This Environmental Product Declaration covers all product lines in the HI-MACS® collection.

Product Classification: 06 61 00.00 Wood, Plastics, and Composites (Framing): Simulated Stone Fabrications

<u>Viatera®</u>

Viatera® surfaces are engineered stone quartz countertop surfaces. Silica is combined with polyester resin and pigment to create a non-porous surface that requires no sealing. Each variation of the Viatera® product contains different ratios of various silica sizes, used to create a unique pattern. Similar to HI-MACS®, each available pattern has a variety of color options achieved through the use of differently colored pigments. The maximum available thickness of the Viatera® product is 30mm, however, thinner profiles are available. This Evironmental Product Declaration covers all product lines in the Viatera® collection.

Product Classification: 12 36 61.00 Furnishing: Simulated Stone Countertops

Manufacturing Location

HI-MACS surfaces are manufactured in both Adairsville, GA, USA and Cheongju, South Korea, while Viatera surfaces are manufactured exclusively in Adairsville, GA. Data was collected from both facilities, and the results presented here are representative of the production processes in both locations.

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Recycled Content

Within the HI-MACS product line, the Eden Collection offers surfaces that contain pre-consumer recycled content. The exact amount of pre-consumer recycled content ranges from 6% to 35% depending on product color: For more information on the recycled content of the HI-MACS Eden Collection, please view the following certification documents:

https://www.scscertified.com/products/cert_pdfs/LGHausys_2017_SCS-MC-02807_s.pdf

https://www.scscertified.com/products/cert_pdfs/LGHausys_2017_SCS-MC-01491_s.pdf

https://www.scscertified.com/products/cert_pdfs/LGHausys_2017_SCS-MC-02322_s.pdf

Viatera products contain no recycled content.

Alivar WAVY with HI-MACS®

Product Characteristics

The specific product characteristics / technical data for HI-MACS and Viatera products are presented below in Tables 1 and 2 respectively.

Table 1 – HI-MACS Technical Data

Property	Typical Result	Test
Thickness	12 mm	-
Density	1.65 g/cm^3	-
Substrate Type	Laminate	-
Tensile Strength	6,000 psi	ASTM D 638
Tensile Modulus	1.35 x 10^6 / in^2 (850 kg / m^2)	ASTM D 638 Nominal
Tensile Elongation	0.5% min	ASTM D 638
Flexuarl Strength	57.96 Mpa (8,407 psi)	ASTM D 790
Tensile Modulus	1.34 x 10^6 / in^2	ASTM D 790
Hardness	60 Pass	ASTM D 2583
Thermal Expansion	0.000018 in / in / degrees F	ASTM D 696
Deflection Temperature (under load)	90 degrees C (194 degrees F)	ASTM D 648
Light Resistance	No Effect - Pass	NEMA LD 3-3.03 ISSFA SST 7.1
Wear and Cleanability	Pass	ANSI Z-124.3 ISSFA SST 3.1-00
Stain Resistance	No Effect - Pass	ANSI Z-124.3 Modified; 3.4 & 11
Fungus and Bacterial Resistance	No Effect - Pass Approved for use in all food zones	ASTM G 21 / ASTM G 22 ANSI / NSF Standard 51
Boiling Water Resistance	No Effect - Pass	NEMA LD 3-3.05 ISSFA SST 8.1-00
High Temperature Resistance	No Effect - Pass	NEMA LD 3-3.06 ISSFA SST 9.1-00
Radiant Heat Resistance	No Effect - Pass	NEMA LD 3-3.10
Izod Impact	0.3 ft-lb / in (0.016 joules / mm)	ASTM D 256, Method A
Ball Impact Resistance	0.5 lbs (0.23 kg) ball 1/4" slab - 36" drop 1/2" slab - 144" drop	NEMA LD 3-3.08
Weatherability	Pass (1000 hr test)	ASTM D 2565 / ASTM D-1499
Water Absorption	1/4" slab - 0.07% 1/2" slab - 0.4%	ISO 4586-2 / ASTM D570
Toxicity	66.9 grams (2.36 oz)	Pittsburgh Protocol
Flammability - Flame Spread Index	<25	ASTM E84: Class I or A
Flammability - Smoke Development Index	<25	ASTM E84: Class I or A
Consistency of Color	Pass	ISSFA SST 2.10 Pass
Visual Defects	Pass	ISSFA SST 5.1 Pass
Flatness of Sheets	Pass	ISSFA SST 4.1

Table 2 – Viatera Technical Data

Property	Typical Result	Test
Thickness	3 cm	-
Density	2.37 g/cm^3	-
Substrate Type	Engineered Stone	-
Point Impact	Pass	ANSI Z124.6.4.2.1
Colorfastness	Pass	ANSI Z124.6.5.1
Stain Resistance	Pass	ANSI Z124.6.4.2
Wear and Cleanability	Pass	ANSI Z124.6.4.3
Cigarette Test	Pass	ANSI Z124.6.4.4
Chemical Resistance	Pass	ANSI Z124.6.4.5
Freeze / Thaw Cycling	No Loss / Damage	ASTM C1026
Coefficient of Friction	Dry: 0.86, Wet: 0.51	ASTM C1028
Compressive Strength	42,230 psi	ASTM C170
Water Absorption	0.0004	ASTM C97
Izod Impact Resistance	0.3468 ft-lb / in	ASTM D256
Barcol Hardness	94	ASTM D2583
Abrasion Resistance	40 mg (weight loss)	ASTM D4060
Bond Strength	164.9 psi	ASTM D482
Tensile Strength	1,007.25 psi	ASTM D638
Deflection Temperature	279 degrees C	ASTM D648
Thermal Expansion	1.55 - 1.83 (unit 10^{-5} in / in / degree C)	ASTM D696
Flexural Strength	4,114 psi	ASTM D790
Surface Burning Characteristic	Class A	ASTM E84
Fungal and Bacteria Resistance	No Growth	ASTM G21
Boiling Water Resistance	No Effect	NEMA LD3 3.5
High Temperature Resistance	No Effect	NEMA LD3 3.6

Functional Unit

The functional unit utilized for this study is one square meter of countertop surface area with a service life of 10 years, including end-of-life disposition. Table 3 below summarizes the functional unit for both HI-MACS and Viatera products and provides a scaling factor to one kilogram:

Table 3 – HI-MACS and Viatera Functional Unit

Parameter	HI-MACS	Viatera
Functional Unit (m^2)	1	1
Service Life (years)	10	10
Weight per Functional Unit (kg)	19.8	71.1
Ratio to 1 kg	0.051	0.014

System Boundaries

The system boundary of the LG Hausys Countertop LCA is presented below in Figure 1.

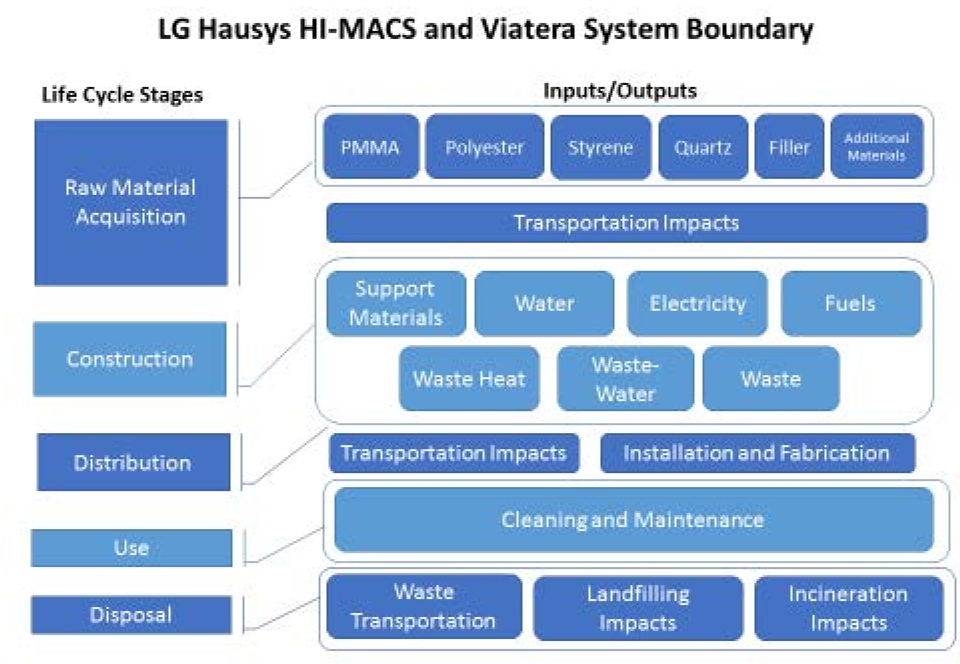

Figure 1 – HI-MACS and Viatera System Boundary

Waste Management

The treatment of waste throughout this study follows the most current version of the USEPA WARM Model. According to this model, the average municipal solid waste disposition is 80% landfill and 20% incineration. This assumption is followed throughout this study in the absence of primary disposal data, with the exception of the manufacturing stage where primary data was available.

Allocation Rules

A manufacturing facility in Adairsville, GA produces both HI-MACS and Viatera countertops for LG Hausys. In addition, HI-MACS surfaces are also produced in a facility located in Cheongju, South Korea. Both the Adairsville, GA and Cheongju, South Korea facilities produce surfaces of variable thickness, so allocation was conducted based on a mass basis to capture variations in product size. In the Adairsville facility, the HI-MACS and Viatera production lines are metered separately; therefore, no allocation was required to separate the production of the two product types.

For recycled materials, the Recycled Content Methodology was applied.

Calculation Rules and Data Quality Requirements

SimaPro v8.02 Software System for Life Cycle Engineering, an internationally recognized LCA modeling software program, was used for life cycle impact assessment modeling. In the absence of primary data, representative secondary datasets were utilized. The two datasets used in this study were the ecoinvent Version 3 recycled content methodology database and the USLCI database. The data used in this study meets all data quality requirements as outlined in the PCR. Secondary data was evaluated with regards to precision, completeness, consistency, reproducibility, representativeness and uncertaintly. Based on these criteria, the data quality used throughout this study is considered high.

Cut-off rules were followed as definied by ISO 14044. All known flows were included in the system boundary, and no more than 5% of the inputs by mass, energy, or environmental relevance were excluded. All hazardous and toxic materials and substances were included in the life cycle inventory.

Life Cycle Assessment Stages

The following life cycle assessment stages were considered in this study:

- Raw Material Acquisition
- Construction
- Installation
- Use
- Disposal

The following sections provide a more detailed description of each considered life cycle stage.

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Raw Material Acquisition Stage

The raw material acquisition stage considers the upstream production and sourcing of raw materials used in the countertops. This stage begins when the material is extracted from nature, and ends when the material reaches the gate of the countertop construction facility. The material content of the HI-MACS and Viatera products are presented below, using generalized names and percent ranges to protect proprietary information.

Table 4 – HI-MACS Material Composition

HI-MACS Raw Material	Percent Composition by Weight
Methyl Methacrylate (MMA)	20% - 30%
Methacrylic Polymer (PMMA)	5% - 10%
Aluminum Hydroxide	50% - 60%
Initiators, Pigments and Other Additives	0% - 10%

Table 5 – Viatera Material Composition

Viatera Raw Material	Percent Composition by Weight
Crystalline Silica (Quartz)	80% - 95%
Polyester Resin Solution	5% - 15%
Initiators, Pigments and Other Additives	0% - 5%

In addition to the upstream production of these materials, this life cycle stage also considers the transportation of the raw materials to the LG Hausys facility. Propriatary supplier data was collected to facilitate these freight calculations.

Construction Stage

Both HI-MACS and Viatera surfaces are manufactured using processes such as mixing of raw ingredients, heat curing, cutting of the surface to shape, and sanding and polishing of the surface. Primary data was used from the 2015 calendar year to determine the inputs and outputs to the manufacturing process. All transport of support materials to the manufacturing facility and transport of waste to its disposal site is considered in the construction stage. Disposal impacts from manufacturing waste are also considered in the construction stage.

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Installation Stage

The installation stage starts with the product leaving the production facility and ends when the product reaches the consumer. Included in this stage are the distribution and warehousing, along with the installation of the product. Primary data was provided regarding product warehousing and distribution, and this data is proprietary and undisclosed in this EPD. All transport of the product between the manufacturing site, warehousing locations, and final installation site are considered in this stage, along with the inbound transport of raw materials used and scrap created during the installation process.

Along with the warehousing and distribution, this stage also considers the installation of the countertop product. Installation involves cutting, sanding, and securing the surface in place with adhesive and caulk, along with the disposal of any scrap created during installation. For Viatera products, a 30% scrap rate was utilized, while for HI-MACS, a 10% scrap rate was utilized. The 10% scrap rate for HI-MACS was chosen based on data from and conversations with LG Hausys personnel. Based on these assumptions, the following installation inventories were used for HI-MACS and Viatera products respectively:

Table 6 – HI-MACS Installation Inventory

Input	Quantity	Unit (per m^2)
Silicone Adhesive	0.1	kg
Silicone Caulk	0.25	kg
Electricity	0.05	kWh
Install Scrap Disposal	2.2	kg

Table 7 – Viatera Installation Inventory

Input	Quantity	Unit (per m^2)
Silicone Adhesive	0.1	kg
Silicone Caulk	0.25	kg
Electricity	0.05	kWh
Install Scrap Disposal	7.9	kg

Use Stage

Considered in the use stage of the countertop products is the daily maintenance of the countertop across the 10 year service life. Identical maintenance assumptions are used for HI-MACS and Viatera products. Table 8 below details the assumed maintenance inventory for one square meter of installed countertop over a period of 10 years.

Table 8 – HI-MACS and Viatera Maintenance Inventory

Input	Quantity	Unit (per m^2)
Water	109.56	kg
Detergent	2.91	kg

Disposal Stage

HI-MACS and Viatera surfaces are not typically recycled or resused at the end of life. As such, disposal was modeled as 80% landfill and 20% incineration, according to the most current version of the USEPA WARM Model.

Life Cycle Assessment (LCA)

This section presents the life cycle impact assessment (LCIA) results for both HI-MACS and Viatera surfaces across the full cradle to grave life cycle of these products. All results presented in this section are impacts per functional unit: 1 square meter of countertop over a period of 10 years.

TRACI 2.1

Tables 9 and 10 below represent the cradle to grave life cycle impacts assessment results for the HI-MACS and Viatera products according to the TRACI 2.1 impact assessment methodology.

Table 9 – HI-MACS TRACI 2.1 Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	7.2E+01	5.8E+00	1.1E+01	4.3E+01	2.4E+00	**1.3E+02**
Acidification	kg SO_2 eq	4.1E-01	3.5E-02	7.3E-02	7.8E-02	3.7E-03	**6.0E-01**
Smog	kg O_3 eq	5.6E+00	2.3E-01	1.1E+00	8.4E-01	9.6E-02	**7.8E+00**
Eutrophication	kg N eq	1.0E-01	3.8E-02	2.7E-02	1.4E-01	3.0E-03	**3.1E-01**
Ozone Depletion	kg CFC_{-11} eq	2.0E-06	6.6E-07	3.0E-06	5.6E-07	5.5E-08	**6.3E-06**
Fossil Fuel Depletion*	MJ surplus	1.5E+02	5.5E+00	2.1E+01	4.2E+00	9.7E-01	**1.8E+02**

Table 10 – Viatera TRACI 2.1 Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	1.1E+02	1.7E+01	1.5E+01	4.3E+01	8.6E+00	**2.0E+02**
Acidification	kg SO_2 eq	4.8E-01	1.4E-01	7.3E-02	7.8E-02	1.3E-02	**7.9E-01**
Smog	kg O_3 eq	8.4E+00	1.1E+00	1.7E+00	8.4E-01	3.5E-01	**1.2E+01**
Eutrophication	kg N eq	2.3E-01	9.4E-03	5.1E-02	1.4E-01	1.1E-02	**4.5E-01**
Ozone Depletion	kg CFC_{-11} eq	9.2E-06	5.3E-07	7.4E-07	5.6E-07	2.0E-07	**1.1E-05**
Fossil Fuel Depletion*	MJ surplus	1.8E+02	1.6E+01	2.0E+01	4.2E+00	3.5E+00	**2.2E+02**

* TRACI 2.1 methodology does not currently contain a comprehensive Abiotic Depletion Potential category. Instead, impacts are reported using the Fossil Fuel Depletion impact category, which assesses the use of non-renewable fuel resources throughout the product life cycle.

Interpretation

The TRACI 2.1 results presented above were analyzed to understand the trends across the full cradle to grave life cycle of both the HI-MACS and Viatera products. Figure 2 below shows the contribution of each HI-MACS life cycle stage to the overall impacts in each of the considered TRACI 2.1 impact categories, while Figure 3 shows an equivalent analysis for the Viatera product.

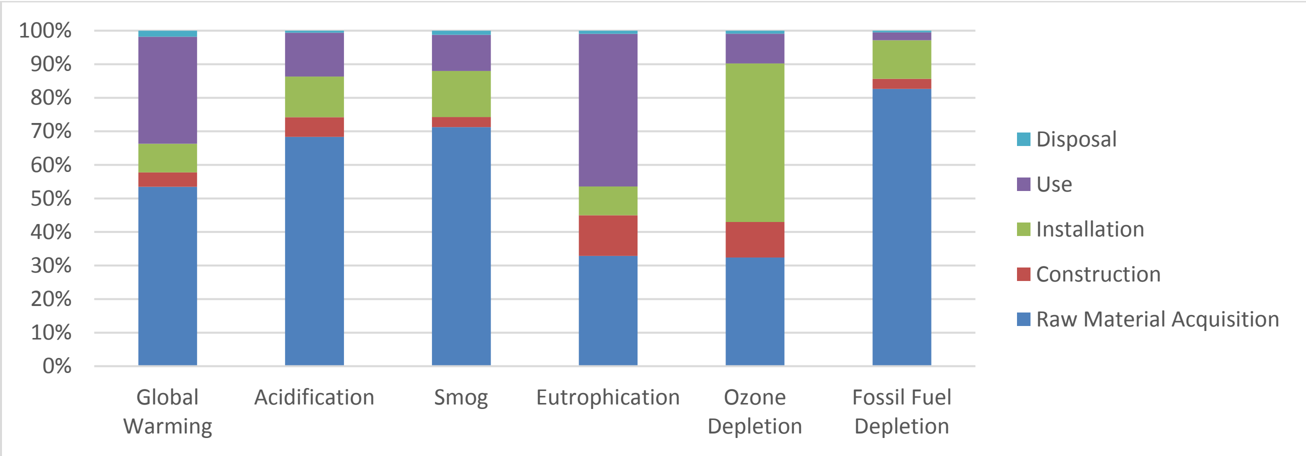

Figure 2 – HI-MACS TRACI 2.1 Impact Analysis

For the HI-MACS product, raw material acquisition is the primary driver of environmental impacts in all considered impact categories with two exceptions. In the eutrophication impact category, product use is the dominant contributor, while in the ozone depletion category, results are driven by the installation stage.

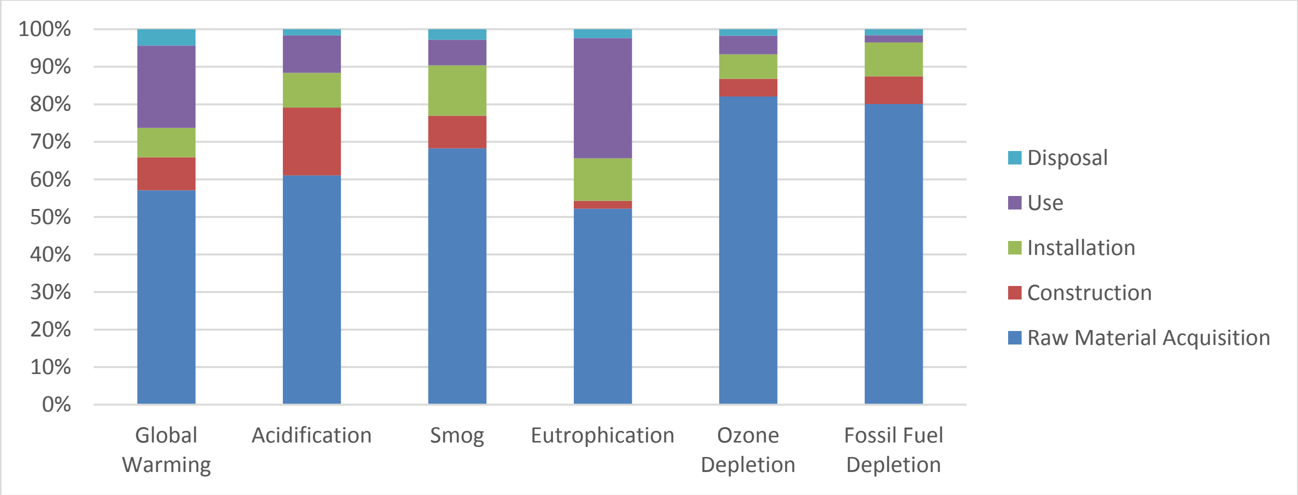

Figure 3 – Viatera TRACI 2.1 Impact Analysis

For the Viatera product, raw material acquisition is the primary driver of environmental impact in all considered impact categories. The use stage is the secondary driver of impacts in the global warming and eutrophication categories, while the installation stage is the secondary contributor in the ozone depletion and fossil fuel depletion categories, and the construction stage is the secondary contributor in the acidification category.

CML

In addition to the LCIA results reported above using the TRACI 2.1 methodology, LCIA results were also calculated using CML impact assessment methodology. Tables 11 and 12 below represent the cradle to grave life cycle impact assessment results for the HI-MACS and Viatera products according to the CML impact assessment methodology.

Table 11 – HI-MACS CML Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	7.2E+01	5.8E+00	1.1E+01	4.3E+01	2.4E+00	**1.3E+02**
Acidification	kg SO_2 eq	4.1E-01	3.8E-02	7.2E-02	6.8E-02	3.0E-03	**5.9E-01**
Photochemical Ozone Creation	kg C_2H_4 eq	2.0E-02	1.9E-03	3.2E-03	2.2E-02	1.3E-04	**4.7E-02**
Eutrophication	kg PO_4 eq	6.7E-02	1.7E-02	1.5E-02	7.2E-02	1.6E-03	**1.7E-01**
Ozone Depletion	kg CFC_{-11} eq	1.7E-06	6.0E-07	2.4E-06	4.7E-07	4.2E-08	**5.2E-06**
Abiotic Depletion	kg Sb eq	8.9E-05	1.1E-05	1.6E-05	2.5E-05	2.6E-07	**1.4E-04**

Table 12 – Viatera CML Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	1.1E+02	1.7E+01	1.5E+01	4.3E+01	8.6E+00	**2.0E+02**
Acidification	kg SO_2 eq	4.5E-01	1.5E-01	6.4E-02	6.8E-02	1.1E-02	**7.5E-01**
Photochemical Ozone Creation	kg C_2H_4 eq	3.5E-02	6.8E-03	3.8E-03	2.2E-02	4.7E-04	**6.8E-02**
Eutrophication	kg PO_4 eq	1.5E-01	8.2E-03	2.7E-02	7.2E-02	5.7E-03	**2.6E-01**
Ozone Depletion	kg CFC_{-11} eq	8.4E-06	4.7E-07	7.1E-07	4.7E-07	1.5E-07	**1.0E-05**
Abiotic Depletion	kg Sb eq	2.2E-04	2.4E-05	2.7E-06	2.5E-05	9.4E-07	**2.7E-04**

Material Resources

This section presents the material resource use for both HI-MACS and Viatera surfaces across the full cradle to grave life cycle of these products. All resource use results presented in this section per functional unit: 1 square meter of countertop over a period of 10 years. These numbers representative of the most impactful product variation in each product line.

Table 13 – HI-MACS Material Resource Use

Material Resource Category	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Virgin Renewable Resources (kg)	0.0E+00	1.0E+00	0.0E+00	1.1E+02	0.0E+00	1.1E+02
Recycled Resources (kg)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Virgin Non-renewable Resources (kg)	2.4E+01	9.0E-03	4.0E-01	3.0E+00	0.0E+00	2.7E+01

Table 14 – Viatera Material Resource Use

Material Resource Category	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Virgin Renewable Resources (kg)	0.0E+00	1.0E+00	0.0E+00	1.1E+02	0.0E+00	1.1E+02
Recycled Resources (kg)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Virgin Non-renewable Resources (kg)	8.1E+01	2.5E-03	4.0E-01	3.0E+00	0.0E+00	8.5E+01

Parameters to be Declared in the EPD

The following life cycing inventory (LCI) data is included, highlighting the material and energy flows throughout the product life cycle of both the HI-MACS and Viatera products. These numbers representative of the most impactful product variation in each product line.

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Table 15 – HI-MACS LCI Parameters

Inventory Assessment Category Emissions to Air (kg)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
SO_X	2.4E-01	2.8E-02	4.1E-02	1.4E-02	6.7E-04	3.2E-01
NO_X	1.9E-07	0.0E+00	1.4E-05	0.0E+00	1.2E-04	1.3E-04
CO_2	6.2E+01	5.3E+00	1.0E+01	3.4E+00	2.3E+00	8.3E+01
CH_4	3.7E-01	1.5E-02	1.6E-02	1.0E-02	6.9E-04	4.1E-01
N_2O	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
CO	1.3E-01	6.4E-03	1.9E-02	1.4E-02	2.3E-03	1.7E-01
Water Usage and Emissions to Water (kg)						
Phosphates	2.1E-02	1.5E-02	3.8E-03	5.1E-03	5.0E-04	4.6E-02
Nitrates	1.2E-02	5.0E-03	6.4E-03	4.1E-01	6.4E-04	4.3E-01
Dioxin	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Arsenic	2.5E-04	2.6E-05	9.9E-06	1.2E-05	6.1E-06	3.0E-04
Lead	5.4E-05	1.3E-05	1.1E-03	3.2E-05	1.1E-03	2.3E-03
Mercury	1.8E-06	1.1E-06	3.0E-06	5.2E-07	2.0E-07	6.6E-06
Cadmium	1.3E-05	8.7E-06	2.5E-05	6.2E-06	2.8E-06	5.6E-05
Chromium	1.6E-03	3.4E-05	3.1E-05	4.9E-05	1.7E-05	1.7E-03
Water Consumption	3.1E+02	4.1E+02	-5.3E+00	1.1E+03	6.3E+00	1.8E+03
Energy Type and Usages (MJ)						
Primary Energy Demand	1.3E+03	1.3E+02	1.8E+02	6.8E+02	7.8E+00	2.3E+03
Fossil Fuel Based Energy	1.3E+03	1.2E+02	1.8E+02	5.3E+02	7.7E+00	2.1E+03
Nuclear Energy	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Solar Energy	7.0E-06	4.7E-01	1.3E-05	5.8E-05	2.5E-07	4.7E-01
Wind Energy	5.1E-01	2.3E-01	2.5E-01	2.8E-01	3.9E-03	1.3E+00
Hydro Energy	3.4E+00	3.5E+00	1.9E+00	1.9E+00	3.4E-02	1.1E+01
Biomass Energy	9.9E+00	3.6E+00	1.5E+00	1.4E+02	6.2E-02	1.6E+02
Waste Management (kg)						
Incineration Without Energy Recovery	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Incineration With Energy Recovery	0.0E+00	0.0E+00	4.6E-01	0.0E+00	4.0E+00	4.4E+00
Landfill (non-hazardous)	1.8E+01	2.3E+00	2.4E+01	5.5E+00	1.6E+01	6.7E+01
Hazardous Waste	0.0E+00	3.9E-02	0.0E+00	0.0E+00	0.0E+00	3.9E-02
Landfill Avoidance (recycling)	0.0E+00	5.6E+00	0.0E+00	0.0E+00	0.0E+00	5.6E+00

Table 16 – Viatera LCI Parameters

Inventory Assessment Category Emissions to Air (kg)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
SO_X	2.1E-01	1.1E-01	1.7E-02	1.4E-02	2.4E-03	**3.5E-01**
NO_X	0.0E+00	0.0E+00	4.8E-05	0.0E+00	4.3E-04	**4.8E-04**
CO_2	7.3E+01	1.6E+01	1.2E+01	3.4E+00	8.3E+00	**1.1E+02**
CH_4	2.2E-02	3.5E-02	1.3E-02	5.4E-08	1.1E-03	**7.2E-02**
N_2O	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
CO	2.4E-01	1.4E-02	5.0E-02	1.4E-02	8.4E-03	**3.3E-01**
Water Usage and Emissions to Water (kg)						
Phosphates	5.9E-02	1.9E-03	1.6E-03	5.1E-03	1.8E-03	**6.9E-02**
Nitrates	2.0E-02	9.3E-04	1.9E-02	4.1E-01	2.3E-03	**4.5E-01**
Dioxin	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
Arsenic	1.4E-04	5.8E-06	1.1E-05	1.2E-05	2.2E-05	**2.0E-04**
Lead	1.5E-04	7.2E-06	3.7E-03	3.2E-05	4.0E-03	**7.9E-03**
Mercury	4.5E-06	1.5E-07	9.4E-06	5.2E-07	7.2E-07	**1.5E-05**
Cadmium	6.2E-05	1.9E-06	7.7E-05	6.2E-06	1.0E-05	**1.6E-04**
Chromium	2.9E-04	1.6E-05	4.5E-05	4.9E-05	6.0E-05	**4.7E-04**
Water Consumption	4.2E+05	1.0E+04	2.1E+04	1.1E+06	2.3E+04	**1.6E+06**
Energy Type and Usages (MJ)						
Primary Energy Demand	1.6E+03	2.6E+02	1.7E+02	1.9E+02	2.8E+01	**2.3E+03**
Fossil Fuel Based Energy	1.6E+03	2.6E+02	1.7E+02	-1.5E+02	2.7E+01	**1.9E+03**
Nuclear Energy	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
Solar Energy	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
Wind Energy	3.9E+00	6.0E-02	9.5E-02	3.1E-01	1.6E-02	**4.4E+00**
Hydro Energy	1.4E+01	3.6E-01	8.2E-01	1.9E+00	1.2E-01	**1.8E+01**
Biomass Energy	2.1E+01	3.8E-01	8.3E-01	3.4E+02	2.2E-01	**3.6E+02**
Waste Management (kg)						
Incineration Without Energy Recovery	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	**0.0E+00**
Incineration With Energy Recovery	0.0E+00	0.0E+00	1.6E+00	0.0E+00	1.4E+01	**1.6E+01**
Landfill (non-hazardous)	4.6E+01	3.4E+01	1.1E+00	4.9E+00	5.7E+01	**1.4E+02**
Hazardous Waste	0.0E+00	5.0E-02	0.0E+00	0.0E+00	0.0E+00	**5.0E-02**
Landfill Avoidance (recycling)	0.0E+00	6.0E-02	0.0E+00	0.0E+00	0.0E+00	**6.0E-02**

Alivar WAVY with HI-MACS®

Other Environmental Information

Material Ingredient Reporting

In addition to the environmental impact data contained within the declaration, LG Hausys has also published Health Product Declarations (HPD) for both HI-MACS and Viatera surfaces. The declarations can be accessed via the HPD Public Repository at the following link: http://www.hpd-collaborative.org/hpd-public-repository.

Disclaimer

This EPD was not written to support comparative assertions. Even for similar products, differences in functional unit, use and end-of-life stage assumptions, and data quality may produce incomparable results. It is not recommended to compare EPDs with another organization as there may be differences in methodology, assumptions, allocation methods, data quality such as variability in datasets, and results of variability in assessment software tools used. This declaration represents an average performance based on production values for a calendar year.

Contact Information

For additional information, please visit www.lghausys.com. To contact LG Hausys, please visit http://www.lghimacsusa.com/contactUs, or http://www.lgviaterausa.com/contactUs.

References

The following references were used in the publication of this EPD:

- (ILCD, 2010) Joint Research Commission, 2010, ILCD Handbook: General Guide for Life Cycle Assessment
- Intergovernmental Panel on Climate Change (IPCC)
- ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and Procedures
- ISO 14040:2006 *Environmental management - Life cycle assessment – Principles and framework*
- ISO 14044:2006 *Environmental management - Life cycle assessment – Requirements and guidelines*
- ISO 9001 *Quality Management System*
- ISO 14001 *Environmental Management System*
- ISO 21930 *Sustainability in building contruction – Environmental declaration of building products.*
- Product Category Rule for Environmental Product Declaration – PCR for Residential Countertops. NSF International. Valid through September 17, 2018
- ASTM D638 – Standard Test Method for Tensile Properties of Plastics
- ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- ASTM D2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

- ASTM D696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
- ASTM D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
- ASTM G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
- ASTM G22 – Standard Practice for Determining Resistance of Plastics to Bacteria
- ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- ASTM C1026 – Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling
- ASTM C1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method (Withdrawn 2014)
- ASTM C170 – Standard Test Method for Compressive Strength of Dimension Stone
- ASTM C97 – Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone
- ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- ASTM D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- ASTM D482 – Standard Test Method for Ash from Petroleum Products
- NEMA LD 3 – High-Pressure Decorative Laminates (HPDL)
- ANSI/NSF Standard 51 (National Sanitation Foundation – Food Equipment Materials)
- ANSI Z124.6 – Plastic Sinks
- Product Life Cycle Accouting and Reporting Standard, Greenhouse Gas Protocol, World Business Council for Sustainable Development and World Resources Institue.
- Countertop Life Cycle Assessment. LG Hausys / Sustainable Solutions Corporation. February 2017

Appendix: ISO 21930 Analysis

In order to meet ISO 21930 criteria, this EPD includes supplemental information in addition to the scope of the NSF Countertop PCR as presented in this section. The system boundary and life cycle stages mandated by ISO 21930 closely follow the system boundary presented above with one difference: ISO 21930 groups the Raw Material Acquisition and Construction Stages together under the Product Stage. All other life cycle stages are consistent between the two standards. Table 17 below shows how the life cycle stages match-up between ISO 21930 and the NSF Countertop PCR.

Table 17 – System Boundary Comparison

System Boundary					
ISO 21930 Life Cycle Stage	I - Product		II - Design and Construction Process	III - Use	IIII - End of Life
Countertop PCR Life Cycle Stage	Raw Material Acquisition	Construction	Install	Use	Disposal
Included in System Boundary	Yes	Yes	Yes	Yes	Yes

All assumptions and included flows and processes remain identical between the two system boundaries. All results are presented including the distinction between the Raw Material Acquisition and Construction Stage to show greater transparency and to meet the requirements of both standards.

ISO 21930 also requires additional inventory data to be reported. Tables 18 and 19 show the use of resources and renewable primary energy across the life cycle of the HI-MACS and Viatera products, respectively. All figures presented in this section are representative of the most impactful product variation in each product line per functional unit.

Table 18 – HI-MACS Use of Resources and Renewable Primary Energy

Use of Resources Category	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Depletion of Non-renewable Energy Resources (MJ)	1.3E+03	1.2E+02	1.7E+02	1.9E+02	7.7E+00	1.8E+03
Depletion of Non-renewable Material Resources (kg)	2.4E+01	9.0E-03	4.0E-01	3.0E+00	0.0E+00	2.7E+01
Use of Renewable Material Resources (kg)	0.0E+00	1.0E+00	0.0E+00	1.1E+02	0.0E+00	1.1E+02
Use of Renewable Primary Energy (MJ)	2.1E+01	7.8E+00	4.0E+00	4.8E+02	1.0E-01	5.2E+02
Consumption of Freshwater (m3)	3.1E-01	4.1E-01	3.9E-01	-5.3E-03	1.1E+00	1.1E+00

Table 19 – Viatera Use of Resources and Renewable Primary Energy

Use of Resources Category	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Depletion of Non-renewable Energy Resources (MJ)	1.6E+03	2.6E+02	1.7E+02	1.9E+02	2.8E+01	2.3E+03
Depletion of Non-renewable Material Resources (kg)	8.1E+01	2.5E-03	4.0E-01	3.0E+00	0.0E+00	8.5E+01
Use of Renewable Material Resources (kg)	0.0E+00	1.0E+00	0.0E+00	1.1E+02	0.0E+00	1.1E+02
Use of Renewable Primary Energy (MJ)	5.2E+01	2.0E+00	1.8E+00	4.8E+02	3.7E-01	5.4E+02
Consumption of Freshwater (m3)	4.2E-01	1.0E-02	1.0E-02	2.1E-02	1.1E+00	1.1E+00

Additionally, the resource use for all stages of the life cycle of the HI-MACS and Viatera products were differentiated by resources type, as shown below in Tables 20 and 21.

Table 20 – HI-MACS Differentiation of Material and Energy Resource Use

Energy / Resource Use Category	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Hydro/Wind Power (MJ)	4.0E+00	3.8E+00	2.1E+00	2.2E+00	3.8E-02	1.2E+01
Fossil Energy (MJ)	1.3E+03	1.2E+02	1.8E+02	5.3E+02	7.7E+00	2.1E+03
Bio-energy (MJ)	9.9E+00	3.6E+00	1.5E+00	1.4E+02	6.2E-02	1.6E+02
Nuclear Energy (MJ)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Other Energy (MJ)	7.0E-06	4.7E-01	1.3E-05	5.8E-05	2.5E-07	4.7E-01
Secondary Fuels (MJ)	4.0E-01	2.6E-02	3.4E-03	0.0E+00	3.8E-03	4.3E-01
Non-renewable Resources (kg)	2.4E+01	9.0E-03	4.0E-01	3.0E+00	0.0E+00	2.7E+01
Renewable Resources (kg)	0.0E+00	1.0E+00	0.0E+00	1.1E+02	0.0E+00	1.1E+02
Recycled Materials (kg)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Secondary Raw Materials (kg)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Land (m^2a)	9.2E-01	5.0E-01	9.7E-01	1.7E+01	3.4E-02	1.9E+01
Water (m^3)	3.1E-01	4.1E-01	3.9E-01	-5.3E-03	1.1E+00	2.2E+00
Hazardous Substances (kg)	0.0E+00	3.9E-02	0.0E+00	0.0E+00	0.0E+00	3.9E-02

Table 21 – Viatera Differentiation of Material and Energy Resource Use

Energy / Resource Use Category	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Hydro/Wind Power (MJ)	1.8E+01	4.2E-01	9.1E-01	2.2E+00	1.4E-01	2.2E+01
Fossil Energy (MJ)	1.6E+03	2.6E+02	1.7E+02	-1.5E+02	2.7E+01	1.9E+03
Bio-energy (MJ)	2.1E+01	3.8E-01	8.3E-01	3.4E+02	2.2E-01	3.6E+02
Nuclear Energy (MJ)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Other Energy (MJ)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Secondary Fuels (MJ)	2.7E+00	3.4E+00	2.2E+00	7.8E-05	1.4E-01	8.3E+00
Non-renewable Resources (kg)	8.1E+01	2.5E-03	4.0E-01	3.0E+00	0.0E+00	8.5E+01
Renewable Resources (kg)	0.0E+00	1.0E+00	0.0E+00	1.1E+02	0.0E+00	1.1E+02
Recycled Materials (kg)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Secondary Raw Materials (kg)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Land (m^2a)	3.9E+00	1.6E-01	1.5E-01	1.7E+01	1.2E-01	2.1E+01
Water (m^3)	4.2E-01	1.0E-02	1.0E-02	2.1E-02	1.1E+00	1.6E+00
Hazardous Substances (kg)	0.0E+00	5.0E-02	0.0E+00	0.0E+00	0.0E+00	5.0E-02

The disposal of waste throughout the product life cycle is classified as either hazardous or non-hazardous waste. This inventory data for both HI-MACS and Viatera product lines is included in Tables 22 and 23 below. This data is expressed in mass per functional unit.

Table 22 – HI-MACS Waste to Disposal

Waste to Disposal	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Hazardous Waste Disposed (kg)	7.4E-04	5.8E-05	9.6E-05	8.2E-05	5.4E-06	9.8E-04
Non-Hazardous Waste Disposed (kg)	8.4E+00	4.5E-01	1.1E+01	2.6E+00	1.6E+01	3.9E+01

Table 23 – Viatera Waste to Disposal

Waste to Disposal	Raw Material Acquisition	Construction	Install	Use	Disposal	Total
Hazardous Waste Disposed (kg)	9.1E-04	3.9E-05	2.1E-05	8.2E-05	1.9E-05	1.1E-03
Non-Hazardous Waste Disposed (kg)	4.2E+00	3.4E+01	6.5E+00	2.6E+00	5.8E+01	1.0E+02

Lastly, ISO 21930 requires life cycle impact assessment data to be presented. LCIA data using both TRACI 2.1 and CML methodologies are presented below.

TRACI 2.1

Tables 24 and 25 below represent the cradle to grave life cycle impact assessment results for the HI-MACS and Viatera products according to the TRACI 2.1 impact assessment methodology.

Table 24 – HI-MACS TRACI 2.1 Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	7.2E+01	5.8E+00	1.1E+01	4.3E+01	2.4E+00	**1.3E+02**
Acidification	kg SO_2 eq	4.1E-01	3.5E-02	7.3E-02	7.8E-02	3.7E-03	**6.0E-01**
Smog	kg O_3 eq	5.6E+00	2.3E-01	1.1E+00	8.4E-01	9.6E-02	**7.8E+00**
Eutrophication	kg N eq	1.0E-01	3.8E-02	2.7E-02	1.4E-01	3.0E-03	**3.1E-01**
Ozone Depletion	kg CFC_{-11} eq	2.0E-06	6.6E-07	3.0E-06	5.6E-07	5.5E-08	**6.3E-06**

Table 25 – Viatera TRACI 2.1 Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	1.1E+02	1.7E+01	1.5E+01	4.3E+01	8.6E+00	**2.0E+02**
Acidification	kg SO_2 eq	4.8E-01	1.4E-01	7.3E-02	7.8E-02	1.3E-02	**7.9E-01**
Smog	kg O_3 eq	8.4E+00	1.1E+00	1.7E+00	8.4E-01	3.5E-01	**1.2E+01**
Eutrophication	kg N eq	2.3E-01	9.4E-03	5.1E-02	1.4E-01	1.1E-02	**4.5E-01**
Ozone Depletion	kg CFC_{-11} eq	9.2E-06	5.3E-07	7.4E-07	5.6E-07	2.0E-07	**1.1E-05**

CML

In addition to the LCIA results reported above using the TRACI 2.1 methodology, LCIA results were also calculated using CML impact assessment methodology. Tables 25 and 26 below represent the cradle to grave life cycle impact assessment results for the HI-MACS and Viatera products according to the CML impact assessment methodology.

Table 26 – HI-MACS CML Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	7.2E+01	5.8E+00	1.1E+01	4.3E+01	2.4E+00	**1.3E+02**
Acidification	kg SO_2 eq	4.1E-01	3.8E-02	7.2E-02	6.8E-02	3.0E-03	**5.9E-01**
Photochemical Ozone Creation	kg C_2H_4 eq	2.0E-02	1.9E-03	3.2E-03	2.2E-02	1.3E-04	**4.7E-02**
Eutrophication	kg PO_4 eq	6.7E-02	1.7E-02	1.5E-02	7.2E-02	1.6E-03	**1.7E-01**
Ozone Depletion	kg CFC_{-11} eq	1.7E-06	6.0E-07	2.4E-06	4.7E-07	4.2E-08	**5.2E-06**

Table 27 – Viatera CML Cradle to Grave LCIA

Impact Category	Unit (per m^2)	Raw Material Acquisition	Construction	Installation	Use	Disposal	Total
Global Warming	kg CO_2 eq	1.1E+02	1.7E+01	1.5E+01	4.3E+01	8.6E+00	**2.0E+02**
Acidification	kg SO_2 eq	4.5E-01	1.5E-01	6.4E-02	6.8E-02	1.1E-02	**7.5E-01**
Photochemical Ozone Creation	kg C_2H_4 eq	3.5E-02	6.8E-03	3.8E-03	2.2E-02	4.7E-04	**6.8E-02**
Eutrophication	kg PO_4 eq	1.5E-01	8.2E-03	2.7E-02	7.2E-02	5.7E-03	**2.6E-01**
Ozone Depletion	kg CFC_{-11} eq	8.4E-06	4.7E-07	7.1E-07	4.7E-07	1.5E-07	**1.0E-05**

For additional information about the HI-MACS and Viatera product lines, please visit www.lghausys.com. To contact LG Hausys, please visit http://www.lghimacsusa.com/contactUs, or http://www.lgviaterausa.com/contactUs.