Environmental Product Declaration

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:

MAXWELL™ W

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
EPD registration number:	S-P-11974
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An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

General Information

Programme Information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
E-mail:	info@environdec.com

Accountabilities for PCR, LCA and independent, third-party, verification

Product Category Rules (PCR)	CEN standard EN 15804 serves as the Core Product Category Rules (PCR) PCR 2019:14 Being updated - Construction products (EN 15804+A2) (1.3.4) The International EPD System
Life Cycle Assessment (LCA)	LCA accountability: Callum Hill, JCH Industrial Ecology Ltd
Third-party verification	Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☒ EPD verification by individual verifier Third-party verifier: Andrew Norton, Renuables Ltd Approved by: The International EPD® System Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☒ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

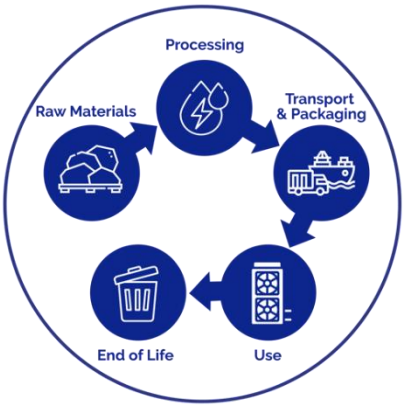
Company Information

Owner of the EPD	HT Materials Science Ltd
Contact	Thomas Grizzetti
Description of the organisation	HT Materials Science Ltd ('HTMS') was founded in 2018 to develop heat transfer fluids for commercial and industrial HVAC markets. In 2020, HTMS introduced its first heat transfer fluid, Maxwell™, named after James Clerk Maxwell, the pioneering scientist who first developed the concept of nano fluids in the 19th century. HTMS has received patent approvals from the USPTO for both the formulation and manufacturing process of Maxwell™.
Name and location of production site(s):	HT Materials Science Italy srl, Strada Provinciale SP7, Lecce - Arnesano snc, 73010, Arnesano LE, Italy

Product Information

Product name:	Maxwell™ W
Product identification	Maxwell™ W
Product description:	Maxwell™ W is a patented engineered suspension of submicron aluminium oxide (Al_2O_3) particles in water. Maxwell™ W is produced in concentrated form (15%) and diluted on-site to 2% of system volume when added to the base fluid of a closed, hydronic, HVAC system or other water-based cooling process. Maxwell™ is installed while systems are in operational mode. At a final concentration of 2%, Maxwell™ W delivers an increase in thermal energy transfer of up to 15% and potentially more. It is safe for all typical components and materials in mechanical systems and will not reduce the life expectancy of the base fluid. Maxwell™ W has been evaluated for effects on corrosion, using ASTM guidelines, and for metals and synthetic materials commonly used in the construction of thermal systems. Because of its effectiveness, typical payback for installations of Maxwell™ is 2 to 4 years, depending on system volume, utilisation and power cost.
UN CPC code	35490 Other chemical products
Geographical scope	Global

LCA Information

Declared unit:	One litre of Maxwell™ W heat transfer fluid
Reference service life:	10 years
Time representativeness	2023
Database(s) and LCA software used:	Ecoinvent 3.9, SimaPro 9.5
Description of system boundaries:	Cradle to gate with options (A + B + C)
System Diagram	
More information	For more information regarding the Maxwell™ W product, please consult the HTMS website: [https://htmaterialsscience.com]
LCA practitioner	Callum Hill, JCH Industrial Ecology Ltd [www.jchie.co.uk]

Description of LCA model

A1 Raw materials: Raw bauxite is transported from Brazil, Greece and Spain to the alumina processing facility in France. The bauxite is converted to fine alumina suspension using a calcination and milling process and the inclusion of additives, such as surfactants. Following transportation to the HTMS production facility at Lecce in Italy, the suspension is further processed by fine milling and the addition of ingredients, such as surfactants, to yield the final product.

A2 Transport: Transport of bauxite from sources in Brazil, Greece and Spain is by truck and ship. Transport from the French alumina supplier to HTMS in Lecce is by truck, as are all other processing additives.

A3 Processing: The average French grid mix is used for processing at the supplier in France and the average Italian grid mix for processing at Lecce. Primary energy mix (%) of the French electricity grid (Nuclear 68.3, 11.7, 8.0, 7.3, 2.5, 2.0, 0.2) (0.078 kg CO2e/kWh). Primary energy mix (%) of the Italian electricity grid (40.5, 35.3, 10.2, 6.9, 5.4, 1.8) (0.401 kg CO2e/kWh).

A4 Transport to Site: Assume transport of 1 500 km by sea and 250 km by truck.

A5 Installation: Typical generic scenario for a 50 000 litres installation requires 7 700 litres of Maxwell™ W @ 15%, which requires 8 kWh over two days (1.04×10^{-3} kWh per litre). Global grid mix is assumed.

B1 Use: Not applicable.

B2 Maintenance: Not applicable.

B3 Repair: Not applicable.

B4 Replacement: Typically, 5% of the product is replaced per year, for each subsequent year after installation, due to system losses (generic scenario), therefore 0.45 litres / initial litre is replaced over 10 years. Replacement energy requirement is the same as in module A5. Global grid mix is assumed.

B5 Refurbishment: Not applicable.

B6 Operational energy use: This depends upon the system in which the product is installed. Savings of 12.5% are typical – see example given later.

B7 Operational water use: Assumed that losses replaced in module B4 is wastewater (0.05 litres / initial litre per year).

C1 Deconstruction/Demolition: Not applicable.

C2 Transport to waste facility: Not applicable.

C3 Waste-processing: Not applicable.

C4 Disposal: Disposal involves pumping out the waste HTMS fluid as part of the base fluid, with this fluid being treated as wastewater.

D Impacts outside of system boundary: Not applicable. Not declared.

Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results):

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ND
Geography	GLO	GLO	IT	GLO	GLO	GLO	GLO	GLO	GLO	GLO	GLO	GLO	GLO	GLO	GLO	GLO	-
Specific data used	>90%			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%					-	-	-	-	-	-	-	-	-	-	-	-

Content information: One litre of Maxwell™ W

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/kg
Aluminium oxide	0.45	0.0	0.0
Surfactants	<0.1	0.0	0.0
Water	1.00	0.0	0.0
TOTAL	**1.45**	**0.0**	**0.0**

Packaging materials	Weight, kg	Weight-% (versus the product)	Weight biogenic carbon, kg C/kg
HDPE	0.0325	2.2	0.0
Steel	0.0125	0.9	0.0
TOTAL	**0.0450**	**3.1**	**0.0**

Dangerous substances from the candidate list of SVHC for Authorisation	EC No.	CAS No.	Weight-% per functional or declared unit
N/A	N/A	N/A	N/A

Environmental information (1 litre Maxwell™ W plus packaging 10 yr. RSL)

This EPD contains information about environmental impact, use of resources and waste production in the form of quantitative indicators. The following abbreviations are used in the tables which quantify environmental performance:

Indicator	Abbreviation
Global warming potential (Fossil, biogenic, land use and transformation (LUT))	GWP
Depletion potential of the stratospheric ozone layer	ODP
Acidification potential	AP
Eutrophication potential	EP
Formation potential of tropospheric ozone	POCP
Abiotic depletion potential – Elements	ADPE
Abiotic depletion potential – Fossil resources	ADPF
Water scarcity potential	WSP
Primary energy resources – Renewable (use as energy carrier)	PERE
Primary energy resources – Renewable (use raw materials)	PERM
Primary energy resources – Renewable (total)	PERT
Primary energy resources – Non-renewable (use as energy carrier)	PENRE
Primary energy resources – Non-renewable (use raw materials)	PENRM
Primary energy resources – Non-renewable (total)	PENRT
Secondary material	SM
Renewable secondary fuels	RSF
Non-renewable secondary fuels	NRSF
Net use of fresh water	NUFW
Hazardous waste disposed	HWD
Non-hazardous waste disposed	NHWD
Radioactive waste disposed	RWD
Components for re-use	CRU
Material for recycling	MFR
Materials for energy recovery	MFER
Exported energy, electricity	EEE
Exported energy, thermal	EET
Particulate Matter emissions	PM
Ionizing radiation, human health	IRP
Eco-toxicity - freshwater	ETP-fw
Human toxicity, cancer effect	HTP-c
Human toxicity, non-cancer effects	HTP-nc
Land use related impacts/Soil quality	SQP

Results of the environmental performance indicators

Mandatory impact category indicators according to EN 15804

Indicator	Unit	A1-A3	A4	A5	B4	B7	C4
GWP-fossil	kg CO_2 eq.	2.03E+00	1.40E-01	9.84E-04	9.15E-01	1.09E-04	7.33E-04
GWP-biogenic	kg CO_2 eq.	1.14E-02	2.74E-05	3.30E-05	5.16E-03	1.37E-05	1.39E-06
GWP-luluc	kg CO_2 eq.	5.44E-03	1.03E-04	1.85E-06	2.45E-03	1.41E-07	1.53E-06
GWP-total	kg CO_2 eq.	2.05E+00	1.40E-01	1.02E-03	9.23E-01	1.22E-04	7.36E-04
ODP	kg CFC 11 eq.	1.01E-07	2.26E-09	7.37E-12	4.56E-08	1.13E-12	4.77E-12
AP	mol H^+ eq.	6.94E-03	3.68E-03	4.93E-06	3.13E-03	5.85E-07	3.58E-06
EP-freshwater	kg P eq.	3.75E-04	5.39E-06	3.86E-06	1.71E-04	1.53E-06	3.32E-07
EP-marine	kg N eq.	1.49E-03	9.20E-04	8.88E-06	6.73E-04	3.54E-06	7.15E-07
EP-terrestrial	mol N eq.	1.56E-02	1.02E-02	1.12E-05	7.02E-03	1.74E-06	7.17E-06
POCP	kg NMVOC eq.	6.37E-03	2.79E-03	3.08E-06	2.87E-03	4.12E-07	2.13E-06
ADP-minerals& metals*	kg Sb eq.	5.48E-06	1.68E-07	1.78E-09	2.47E-06	4.81E-10	6.67E-10
ADP-fossil*	MJ	3.82E+01	1.77E+00	1.23E-02	1.72E+01	1.21E-03	9.49E-03
WDP*	m^3	4.81E-01	3.97E-03	-8.46E-02	1.80E-01	-3.67E-02	1.24E-04

** Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.*

Additional mandatory and voluntary impact category indicators

Indicator	Unit	A1-A3	A4	A5	B4	B7	C4
GWP-GHG[1]	kg CO_2 eq.	2.04E+00	1.40E-01	9.85E-04	9.18E-01	1.09E-04	7.34E-04

[1] This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO_2 is set to zero.

Resource use indicators

Indicator	Unit	A1-A3	A4	A5	B4	B7	C4
PERE	MJ	3.86E+00	1.46E-02	1.37E-03	1.74E+00	9.13E-05	1.16E-03
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	3.86E+00	1.46E-02	1.37E-03	1.74E+00	9.13E-05	1.16E-03
PENRE	MJ	4.10E+01	1.79E+00	1.31E-02	1.84E+01	1.29E-03	1.01E-02
PENRM	MJ	1.33E+00	0.00E+00	0.00E+00	6.00E-01	0.00E+00	0.00E+00
PENRT	MJ	4.23E+01	1.79E+00	1.31E-02	1.90E+01	1.29E-03	1.01E-02
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NUFW	m^3	3.64E-01	0.00E+00	0.00E+00	1.64E-01	0.00E+00	0.00E+00

Waste indicators

Indicator	Unit	A1-A3	A4	A5	B4	B7	C4
HWD	kg	1.17E-04	9.11E-06	3.20E-06	5.40E-05	1.38E-06	1.45E-08
NHWD	kg	3.23E-01	2.78E-02	4.34E-05	1.45E-01	1.38E-09	4.34E-05
RWD	kg	1.04E-04	2.47E-07	1.06E-07	4.71E-05	3.47E-08	2.56E-08

Output flow indicators

Indicator	Unit	A1-A3	A4	A5	B4	B7	C4
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE-E	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EE-T	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: All modules A-C are declared, but where there is a nil entry, the data is not shown to improve clarity.

Additional environmental information

Maxwell™ W confers significant heat transfer improvement in cooling and heating systems, which results in:

- Substantial energy savings.
- Carbon emissions reduced proportionally to reductions in energy consumption.
- Reduced equipment load resulting in better performance and reduced maintenance.
- Expanded capacity of existing equipment can be used to increase performance and avoid the need for equipment upgrades.
- Less costly and more efficient equipment for new HVAC installations.
- Long useful life (10+ years), after which Maxwell™ is recoverable and can be recycled.
- Maxwell™ is non-corrosive and non-toxic.

The table below outlines a typical installation analysis for a 60 000 m² building, which uses a 2 700-ton chiller of total capacity 50,000 litres, and operates for ~ 2 900 equivalent full load hours (EFLH) p.a., The building system will initially be charged with ~7 700 litres Maxwell™ W. At an equivalent 3.5 KW / ton of cooling, this equates to 9 496 KW cooling for the building. Dividing this amount by an average Coefficient of Performance (COP) of 3.7, the equivalent electrical energy required is 2 550 KW. At 2 900 EFLH, this equates to 7 395 000 KWh/year or 73 950 000 KWh over the 10-year service life of the installation.

Using a conservative operational energy saving of 12.5 % p.a., annual energy savings of 924 375 KWh can be achieved, or 9 243 750 KWh over 10 years. Note that with a 5% system fluid annual top-up due to maintenance, the overall Maxwell™ use over 10 years is about 11 165 litres.

Operational GWP emission savings are calculated for the 12.5% energy reduction (9 243 750kWh) achieved with Maxwell™ W. Using the global average electricity grid mix, over the 10-year lifecycle, this equates to savings of 6 543 tonnes CO2e for the total 11 165 litres usage (a saving of 586 kg CO2e / litre of Maxwell™ W), as summarised in the table below. The amount of CO2e saved is significant when compared to the total GWP emissions of 3.12 kg CO2e /litre for production (or 34.8 tonnes CO2e for total Maxwell™ W usage) over the 10-year period.

Model for operational energy emissions for single building cooling system over 10-year reference service life

Scenario	Energy use kWh	Operational GWP emissions (kgCO2e)
Baseline 60 000 m² building	73 950 000	5.24E+07
With Maxwell™ W (11 165 litres)	64 706 250	4.58E+07
Difference	-9 243 750	-6.54E+06

Characterisation factors calculated according to TRACI 2.1 v 1.08

Indicator	Unit	A1-A3	A4	A5	B4	B7	C4
Global warming	kg CO_2 eq	2.01E+00	1.40E-01	9.89E-04	9.04E-01	1.19E-04	9.89E-04
Ozone depletion	kg CFC-11 eq	1.09E-07	2.71E-09	1.18E-11	4.90E-08	1.53E-12	1.18E-11
Acidification	kg SO_2 eq	5.97E-03	3.16E-03	4.15E-06	2.69E-03	4.87E-07	4.15E-06
Smog	kg O_3 eq	9.29E-02	5.94E-02	5.68E-05	4.18E-02	7.24E-06	5.68E-05
Eutrophication	kg N eq	3.27E-03	1.74E-04	5.56E-05	1.50E-03	2.39E-05	5.56E-05
Carcinogenics	CTUh	2.13E-07	9.28E-09	1.41E-10	9.59E-08	4.43E-11	1.41E-10
Non carcinogenics	CTUh	2.83E-07	1.10E-08	1.70E-09	1.28E-07	7.05E-10	1.70E-09
Respiratory effects	kg PM2.5 eq	9.52E-04	2.04E-04	1.26E-06	4.29E-04	1.24E-07	1.26E-06
Ecotoxicity	CTUe	1.79E+01	7.72E-01	1.74E-02	8.07E+00	5.56E-03	1.74E-02
Fossil fuel depletion	MJ surplus	4.41E+00	2.59E-01	7.72E-04	1.98E+00	1.09E-04	7.72E-04

Additional social and economic information

Through increased economic and environmental efficiency, Maxwell™ facilitates the availability of climate management and air-conditioning for the benefit of societies, particularly in warmer regions globally. This ties in with the HTMS mission to deliver substantial environmental and economic benefits to society and commerce by mainstreaming energy-reducing technologies within heating and cooling systems across non-profit, industrial, and commercial sectors worldwide.

Differences versus previous versions

N/A

References

General Programme Instructions of the International EPD® System. Version 4.0.

PCR 2019:14 version 1.3.2 Construction products. International EPD® System.

Chemical products for building and construction industry (NPCR009). EPD-Norge.

EN 15804:2012+A2:2019/AC:2021 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.

ISO 14025:2006 Environmental labels and declarations — Type III environmental declarations -Principles and procedures.

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