THE INTERNATIONAL EPD® SYSTEM

ECO PLATFORM EPD VERIFIED

Environmental Product Declaration

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

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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.

LONGi

Product name:

Solar photovoltaic module

LR5-54HIH

LR5-54HPB

LR5-54HPH

LR5-54HTB

LR5-54HTH

LR5-66HIH

LR5-66HPH

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
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Accountabilities for PCR, LCA and independent, third-party verification
Product Category Rules (RCR)
CEN standard EN 15804 serves as the Core Product Category Rules (PCR)
Product Category Rules (PCR): PCR 2019:14 Construction products (EN 15804: A2) version1.2.5 NPCR Part A for Construction products and services, version2.0 PCR 2019:14-c-PCR-016 c-PCR-016 Photovoltaic modules and parts thereof PCR – Part B for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block, solar grade silicon, solar substrates, solar superstrates and other solar grade semiconductor materials" (NPCR 029 version 1.2)
PCR review was conducted by: The Technical Committee of the International EPD® System. See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.
Life Cycle Assessment (LCA)
LCA author: Harry LV, SGS-CSTC Standards Technical Services Co.,Ltd. Contact: Harry LV Harry.lv@sgs.com
Third-party verification Bill Kung, Independent third-party verifier approved by The International EPD®System Contact email: bill.k@1mi1.cn
Independent third-party verification of the declaration and data, according to ISO 14025:2006, via: ☒ EPD verification by individual verifier Third-party verifier: Approved by: The International EPD® System

Procedure for follow-up of data during EPD validity involves third party verifier:
☐ Yes ☒ No

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Contact information

EPD Owner	Company: LONGi Green Energy Technology Co., Ltd. Address: Block B, No.8989 Shangji Road, Economic & Technological Development Zone, Xi'an, Shaanxi, China Contact: market@longi.com
LCA Author	LCA author: Harry LV, SGS-CSTC Standards Technical Services Co.,Ltd. Contact: Harry.lv@sgs.com
Programme Operator	EPD International AB info@environdec.com

Description of the organization

LONGi is a world leader in the clean energy transition. We provide a comprehensive suite of solar PV solutions that can optimize a wide range of project applications. LONGi's technological and manufacturing leadership in solar wafers, cells and modules underscores our commitment to helping accelerate the clean energy transition. By offering high-quality, reliable products and systems, we provide holistic solutions for the solar and renewables industry.

In 2021. LONGi produce a total of about 38.69 GW modules. In addition, LONGi hopes to work jointly with partners inside and outside the global energy industry to innovate and continuously improve the technology of PV power generation. LONGi also hopes to continuously expand the scale of the global PV industry to maximize the value of the eternal gift from our Sun.

Plants of LONGi Solar comply with the following standards:

- ISO 9001-Quality Management System
- ISO 14001- Environmental Management System
- ISO 50001- Energy Management System
- ISO14064 - Organization Level for Quantification and Reporting of Greenhouse Gas Emission and Removals
- ISO45001: Occupational Health and Safety Management System

Name and location of production site(s).

Table1. location of production sites

Production sites name	location
LONGi Solar Technology (Chuzhou) Co., Ltd	No. 19 Huaian Road, Chuzhou City, Anhui Province, China
LONGi Solar Technology (Zhejiang) Co., Ltd	No.2 Bailing Middle Road, Donggang Industrial Functional Zone, Quzhou Economic Development Zone,Qujiang District,Quzhou City,Zhejiang Province, China
LONGi Solar Technology (Jiaxing) Co., Ltd	No.130 Ruifeng Street, Gaozhao Subdistrict, Xiuzhou District, Jiaxing City, Zhejiang Province, P. R. China
LONGi Solar Technology （Jiangsu）Co., Ltd.	No. 288 Yaojia Road, Jiulong Town, Hailing District, Taizhou City, Jiangsu Province, China
LONGi Solar Techology(Qinghai)Co.,Ltd	Hainan Green Industry Development Park (Building

	Materials Park) in Gonghe County, Hainan Tibetan Autonomous Prefecture, Qinghai Province, China
LONGi Photovoltaic Technology (Xianyang) Co., Ltd.	No.169,Wenxing Road, Qindu District, Shaanxi Province
LONGi Solar Techology(Datong)Co.,Ltd	Xinrong Economic and Technological Development Zone, Huayuantun Township, Xinrong District, Datong City, Shanxi Province, China
LONGi Solar Techology Co.,Ltd	No. 8369, Shangyuan Road, Economic and Technological Development Zone, Xi'an City, Shanxi Province, China
LONGi Solar Technology （Taizhou）Co., Ltd.	NO.8 Taikang Road, Hailing District, Taizhou City, Jiangsu Provice, China.

Product Identification

The LONGi Solar's PV modules under analysis integrate various advanced technologies like half-cut cells and Gallium doped wafer, with the highest power up to 560W and up to 21.8% module efficiency. Besides, the unique circuit design of half-cut cells can reduce temperature coefficient. Moreover, the gallium-doped technology overcomes the light attenuation of the module and ensures the long-term power generation stability of the module. Application of this modules can reduce the number of modules employed in a power station, thus lowering the corresponding cost of supports, cables, construction and land, improving the return on investment.

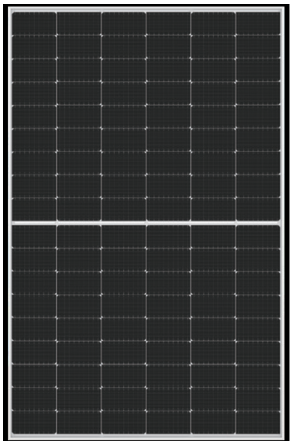


Figure 1. LONGi Solar PV modules

Product Specification

LONGi Solar produces more than a dozen series of mono-crystalline silicon PV modules. Within this project, LONGi Solar PV Bifacial double glass modules cover 7 PV modules that are analyzed, including LR5-54HIH, LR5-54HPB, LR5-54HPH, LR5-54HTB, LR5-54HTH, LR5-66HIH, LR5-66HPH. The full list of the modules under analysis is shown below.

Table 2. Different PV module products models

Serious (brand name)	Power output range (W)	Dimensions (mm)	Weight(KG)	Weight (KG) including package	Cell number
LR5-54HIH	400-420	1722 x1134 x 30	20.8	21.96	108
LR5-54HPB	400-420	1722 x1134 x 30	20.8	21.96	108
LR5-54HPH	405-425	1722 x1134 x 30	20.8	21.96	108
LR5-54HTB	410-440	1722 x1134 x 30	20.8	21.96	108
LR5-54HTH	415-450	1722 x1134 x 30	20.8	21.96	108
LR5-66HIH	490-510	2094x1134x35	26	27.26	132
LR5-66HPH	495-515	2094x1134x35	26	27.26	132

Application

LONGi Solar PV modules are widely used to generate electricity on ultra-large ground power station and Large-scale industrial and commercial projects.

Life cycle assessment basic information

Geographical scope

Modules A1-A3: China

Modules A4: China and European Union

Modules A5: European Union

Modules B: European Union

Modules C: European Union

Functional unit

1 Wp of manufactured photovoltaic module, from cradle-to-grave, with activities needed for a study period for a RSL of 25 years.

Reference service life (RSL)

25 Years

Factor for conversion to m^2

Table 3. Conversion factor list

Serious (brand name)	Maximum power output range (W)	Dimensions (m2)	Conversion factor (W/m2)
LR5-54HIH	420	1.95	215.08
LR5-54HPB	420	1.95	215.08
LR5-54HPH	425	1.95	217.64
LR5-54HTB	440	1.95	225.32
LR5-54HTH	450	1.95	230.44
LR5-66HIH	510	2.37	214.77
LR5-66HPH	515	2.37	216.88

Time representativeness

Data collection is between January 2020-September 2022, all used background datasets are valid for collection period.

Database(s) and LCA software used

Software: SimaPro 9.3.0.2

Database: ecoinvent 3.8, cut-off model

System boundaries

Cradle to grave and module D (A + B + C + D)

Modules B1 and B3-B5 contains no activities and are therefore not declared in the result tables.

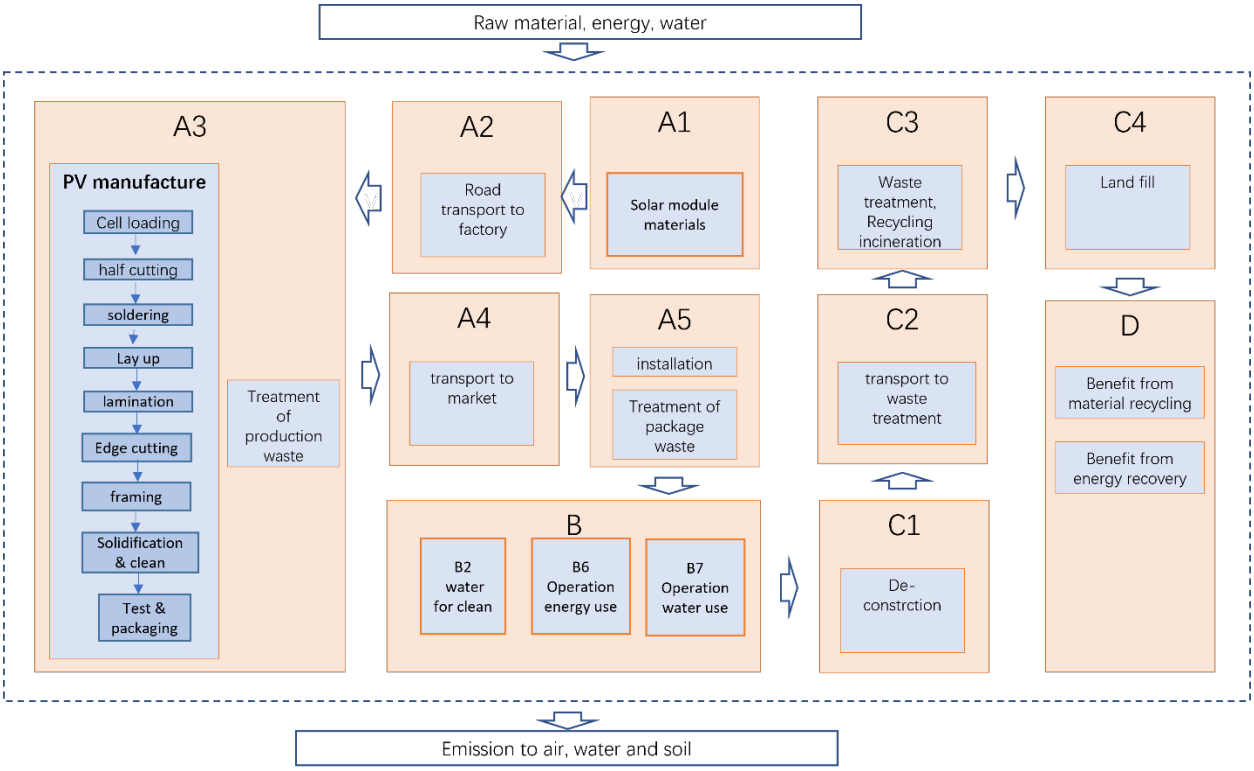


Figure 2. System diagram

As per PCR specifications, the following are not included in the system boundary:

- Materials for the mounting system of the module
- Microinverters
- Wiring
- Switches
- One or many solar inverters
- Battery bank
- Battery charger
- Other electrical components and systems necessary to connect the photovoltaic module to the
- electrical grid shall
- Personnel activities and transport of personnel
- Fasteners (screws) and other additional materials

Assumptions, scenarios and additional technical information

The most general assumptions of the LCA were:

- PV waste amount is assumed to be zero and waste package is recycled during construction stage A5.
- No energy is consumed for stage C1 dismantle of photovoltaic modules.
- The electricity mix is used for A3 production.
- During product transportation stage A4, due to no specific storage location is given, the real photovoltaic power station Albacete-Spain is chosen as representative for this study. And the maritime transport distance from Shanghai port to Cartagena port is 8883 n miles (source: www.SOL.com.cn) and convert to 16451 km, the lorry is used for domestic road transportation, and 2380 km is used from the farthest factory Qinghai to Shanghai port and 205km is used for road transportation distance from Cartagena port to Albacete. (Distance source: Gaode Map)

Scenario information	unit	Value
Fuel type and consumption of vehicle or vehicle type use for transport	L/tkm	Diesel, 10.83 L/tkm Freight, lorry 16-32 metric ton, euro5
Distance	km	2380km (China) 205km (Spain)
Capacity utilisation (including empty returns)	%	50%

Scenario information	unit	Value
Fuel type and consumption of vehicle or vehicle type use for transport	L/tkm	heavy fuel oil, 14.9 L/tkm Freight, sea, container ship
Distance	km	16451 km (8883 n miles)
Capacity utilisation (including empty returns)	%	50%

- The lorry is used for road transportation during stage C2 waste transferring to the waste treatment factory and 50km is assumed as the default transport distance as per PCR.
- PCR default plan is adopted as the waste treatment plan in C3 module in view of waste recovery rate of photovoltaic components shall be 85% which required in the WEEE2012/19/EU Article11& Annex V,

and the recycling materials are treated according to the following solutions. For non-recycling components, the European Union (28 countries) ‘s waste disposal strategy is adopted that the 45% waste will be treated by incineration and 55% by landfill, as per Annex C, V2.1 in the cyclic footprint formula of EU product environment footprint (PEF).

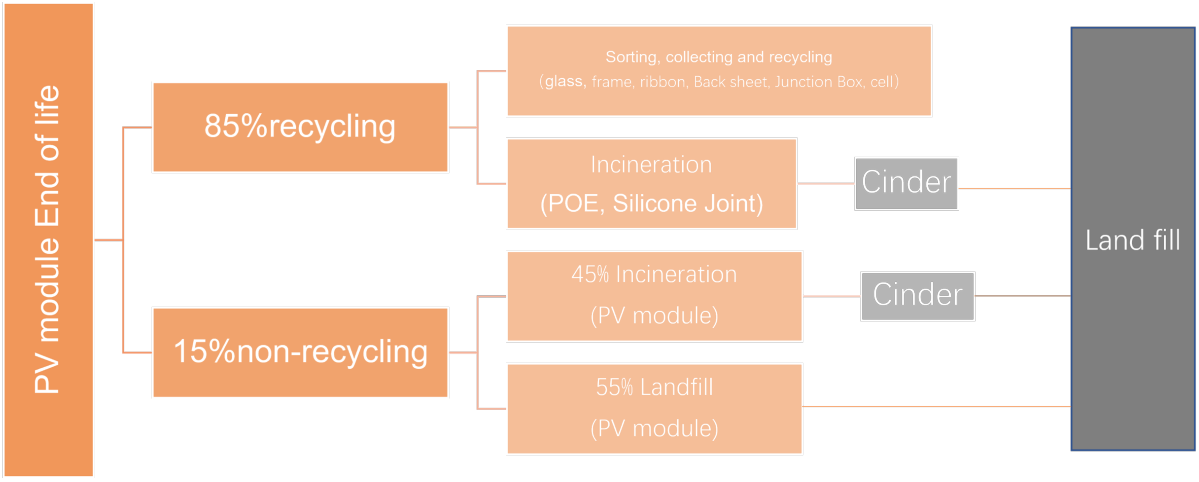


Figure 3. EoL waste disposal strategy

- Benefits and loads beyond the product system boundary in module D include benefits of secondary material from recycling material in C3 and package recycling in A5 and heat recovery from incineration power generation.

LR5-66HPH model is taken as an example in this study for sensitivity analysis.

For the assumption that the electricity mix is used for A3 production stage, this sensitivity analysis was carried out, and different power sources were used to compare, including Qinghai photovoltaic power generation, Qinghai wind power generation, Qinghai hydro power generation, and Zhejiang nuclear power, and the different environmental impact results and change rate of the A3 electricity consumption process were obtained. It can be seen that the usage of clean energy can significantly reduce the environmental impact from sensitivity analysis in LCA report.

For the assumption that product is transported by lorry from Qinghai factory to Shanghai port, by container ship from Shanghai port to Cartagena port and road transportation from Cartagena port to Albacete, different transportation scenarios are used for sensitivity analysis as below in A4.

Scenario A, product is transported by train from Qinghai factory to Shanghai port, by container ship from Shanghai port to Cartagena port and road transportation from Cartagena port to Albacete.

Scenario B, product is transported by lorry from Qinghai factory to Shanghai port, by aircraft from Shanghai port to Cartagena port (distance is 9849km source: Baidu Map) and road transportation from Cartagena port to Albacete.

It can be seen that transport by train can significantly reduce the environmental impact and transport by aircraft can remarkably increase environmental impact.

For the assumption that the lorry is used for road transportation during stage C2 waste transferring to the waste treatment factory. Sensitivity analysis is carried out and different modes of transportation are used to compare different environmental impact results as follows, including lorry 16-32 metric ton, euro6**,** freight train. It can be seen that the usage of train as transportation can significantly reduce the environmental impact.

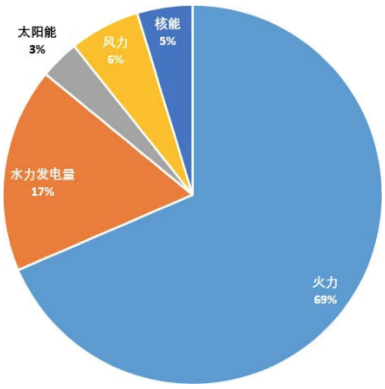
For the assumption that the European Union (28 countries) ‘s waste disposal strategy is adopted that the 55% waste will be treated by incineration and 45% by landfill for non-recycling components in C4 module, another waste treatment plan scenario is used for sensitivity analysis as below.

Scenario A, Spain ‘s waste disposal strategy is adopted that the 14% waste will be treated by incineration and 86% by landfill for non-recycling components in C4 module. It can be seen that scenario A can significantly increase the environmental impact of GWP, EP, aquatic marine and POCP, and reduce the other environmental impact.

See detail in LCA report.

The electricity mix is used for the manufacturing (A3):

the China average power mix in year 2020 （source: Statistical Yearbook of China’s Energy 2021）is 1.022684 kg CO2eq/kwh and shown below:



Allocation rules

For data sets in this study, the allocation of the material flow and energy flow is generally carried out via the amount.

Cut-off rules

The default cut-off criteria shall be set to 1% in accordance with the GENERAL PROGRAMME

INSTRUCTIONS FOR THE INTERNATIONAL EPD® SYSTEM (version 4.0) A3.3. However, the big environmental impact material shall not be allowed to be cut-off, such as a hazardous waste or precious metals. Capital goods and personnel activities shall be ignored

The total of neglected input flows per module, e.g. per module A1-A3, A4-A5, B2, B6-7, C1-C4 and module D is maximum 5% of energy usage and mass.

Data quality

The data quality assessment is divided by upstream (A1 & A2), core (A3) and downstream (A4-D).

The data quality assessment is based on the criteria of the UN Environment Global Guidance on LCA database development.

Table8. Data quality assessment

Data Quality	Data Quality Assessment
Time related coverage	Upstream: Good as all used datasets are currently valid, and the collected quantities are from 2020-2022. Core: Good as all used datasets are currently valid, and the collected quantities are from 2020-2022. Downstream: Good as all used datasets are currently valid, and the collected quantities are from 2020-2022.
Geographical coverage	Upstream: Good, datasets are from global average or European region Core: Good, quantities are from the area under study, datasets are from global average or European region, electricity mix data is taken where the process takes place based on grid mixes of China. Downstream: Good, datasets are from global average or European region
Technology coverage	Upstream: Good, all datasets are taken from the latest ecoinvent version (3.8). Datasets have been chosen to closely relate to the actual conditions. Core: Good, all datasets are taken from the latest ecoinvent version (3.8). Datasets have been chosen to closely relate to the actual conditions. Downstream: Good, all datasets are taken from the latest ecoinvent version (3.8). Datasets have been chosen to closely relate to the actual conditions.
Other Data Quality	
Precision	The variance is shown in the uncertainty analysis. The variance is calculated using the SimaPro pedigree matrix and lognormal uncertainty distribution analysis function.
Completeness	All known flows are accounted for.
Representativeness	The data has been chosen to specifically reflect the true conditions; it is not within the scope of the project to verify the upstream value chain, but the chosen datasets should reflect this as accurately as possible within the scope of the project.
Consistency	The same methodology has been uniformly used
Reproducibility	The LCA is reproducible with all data reported in this report. No other data was used then what is reported in this document.
Data sources	Data collection method is described in the LCI chapter, and all datasets are referenced.
Data uncertainty	Uncertainty has been assessed through a sensitivity analysis for the most relevant assumptions and an uncertainty analysis for the variance of the datasets.

Table9.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 demolition	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	ND	X	ND	ND	ND	X	X	X	X	X	X	X
Geography	GLO	GLO	CN	GLO	GLO	ND	EU	ND	ND	ND	EU	EU	GLO	GLO	EU	EU	GLO
Specific data used	0%	0%	>99%	0%	0%	ND	0%	ND	ND	ND	0%	0%	0%	0%	0%	0%	0%
Variation – products	0%																
Variation –sites	0%																

Note：

X--- module included

ND--- Module not declared

Module B1 & B3-B5 are marked as ND as they do not contain any activities.

Energy production during RSL in B6 module

Formula in PCR Part B：

Energy production in the first year of operation:

$$E1 = Srad * A * y * PR * (1- deg) \quad (1)$$

E1--- Energy produced in the first year of operation, kWh/year

Srad--- Site specific annual average solar radiation on module (shadings not included), kWh/kWp/year.

A--- Area of module, from functional unit (FU), m2

y--- Module yield: electrical power, kWp for standard test conditions (STC) of the module divided by the area of the module

PR--- Performance ratio, coefficient for losses.

deg--- yearly degradation rate

Energy production second year of operation:

$$E2 = E1 * (1 - deg) \quad (2)$$

Energy production n year of operation:

$$En = E1 * (1 - deg)^{n-1} \quad (3)$$

Energy production over reference service life of module, assuming linear annual degradation:

$$E_{RSL} = E_1 * \left(1 + \sum_{n=1}^{RSL-1}(1 - deg)^n\right) \quad (4)$$

Simulation calculation according to the below actual power station

Table 10. Power station information

Location：	Albacete-Spain	angle：	35°
Latitude：	38.75839°N	Azimuth：	0° south
Longitude：	-3.119985°W	system loss （PVGIS default）	14%
Annual solar radiation (kwh/m2)	2.1E+03	data from PVGIS-5 geo-temporal irradiation database	

Table 11. Total energy production in RSL

Serious (brand name)	Maximum power output range （W）	E1/kwh	deg-first year	deg-after first year	ERSL/kwh
LR5-54HIH	420	1.8E+03	2.00%	0.55%	4.2E+04
LR5-54HPB	420	1.8E+03	2.00%	0.55%	4.2E+04
LR5-54HPH	425	1.8E+03	2.00%	0.55%	4.2E+04
LR5-54HTB	440	1.8E+03	1.50%	0.40%	4.3E+04
LR5-54HTH	450	1.8E+03	1.50%	0.40%	4.3E+04
LR5-66HIH	510	1.8E+03	2.00%	0.55%	4.2E+04
LR5-66HPH	515	1.8E+03	2.00%	0.55%	4.2E+04

Content Declaration (including packaging)

Amounts are presented per Wp, for amounts per m2, multiply by transfer factor listed in table3.

Table12. Content information--- LR5-66HPH

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.7E-02	-	-
Frame	5.1E-03	-	-
Ribbon Interconnection	5.2E-04	-	-
Junction Box	4.7E-04	-	-
backsheet	2.1E-03	-	-
cells	1.6E-03	-	-
EVA	4.2E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	8.8E-05	-	-
Assembly - Silicone glue	6.1E-04	-	-
Insulating strip	2.9E-06	-	-
Soldering Flux	1.0E-04	-	-
Total	5.5E-02	-	-
Packaging materials	Weight, kg/Wp	Weight-% (versus the product)	Biogenic material, kg/Wp
pallet	1.4E-03	2.82%	5.7E-04
Paperboard corner	1.6E-05	0.03%	7.1E-06
Paperboard Carton	6.3E-04	1.24%	2.9E-04
Box cover	7.5E-05	0.15%	3.5E-05
paper floor	1.3E-04	0.25%	5.8E-05
Strips	1.0E-04	0.20%	-
PET film	0.0E+00	0.00%	-
lable	3.9E-06	0.01%	1.8E-06
A4 paper	6.3E-08	0.00%	2.9E-08
Wrap film	7.0E-05	0.14%	-
Total	2.4E-03	4.84%	9.6E-04
Dangerous substances from the candidate list of SVHC for Authorization	EC No.	CAS No.	Weight-% per functional or declared unit

No SVHC in product

Table13. Content information--- LR5-66HIH

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.8E-02	-	-
Frame	5.4E-03	-	-
Ribbon Interconnection	4.3E-04	-	-
Junction Box	5.9E-04	-	-
backsheet	2.0E-03	-	-
cells	1.4E-03	-	-
EVA	4.6E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	5.9E-05	-	-
Assembly - Silicone glue	5.9E-04	-	-
Insulating strip	7.8E-05	-	-
Soldering Flux	7.8E-05	-	-
Total	5.4E-02	-	-
Packaging materials	**Weight, kg/Wp**	**Weight-% (versus the product)**	**Biogenic material, kg/Wp**
pallet	1.4E-03	2.82%	5.7E-04
Paperboard corner	1.6E-05	0.03%	7.2E-06
Paperboard Carton	6.3E-04	1.24%	2.9E-04
Box cover	7.6E-05	0.15%	3.5E-05
paper floor	1.3E-04	0.25%	5.8E-05
Strips	1.0E-04	0.20%	-
PET film	0.0E+00	0.00%	-
lable	3.9E-06	0.01%	1.8E-06
A4 paper	6.3E-08	0.00%	2.9E-08
Wrap film	7.1E-05	0.14%	-
Total	2.5E-03	4.84%	9.7E-04
Dangerous substances from the candidate list of	**EC No.**	**CAS No.**	**Weight-% per functional or declared**

SVHC for Authorization			unit
No SVHC in product			

Table14. Content information--- LR5-54HTH

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.3E-02	-	-
Frame	4.6E-03	-	-
Ribbon Interconnection	5.0E-04	-	-
Junction Box	4.0E-04	-	-
backsheet	2.3E-03	-	-
cells	1.4E-03	-	-
EVA	5.1E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	8.2E-05	-	-
Assembly - Silicone glue	6.5E-04	-	-
Insulating strip	0.0E+00	-	-
Soldering Flux	6.6E-05	-	-
Total	5.4E-02	-	-
Packaging materials	**Weight, kg/Wp**	**Weight-% (versus the product)**	**Biogenic material, kg/Wp**
pallet	1.4E-03	3.03%	5.6E-04
Paperboard corner	1.8E-05	0.04%	8.2E-06
Paperboard Carton	7.2E-04	1.55%	3.3E-04
Box cover	8.6E-05	0.19%	4.0E-05
paper floor	1.4E-04	0.31%	6.6E-05
Strips	1.2E-04	0.25%	
PET film	0.0E+00	0.00%	
lable	4.4E-06	0.01%	2.0E-06
A4 paper	7.2E-08	0.00%	3.3E-08
Wrap film	8.0E-05	0.17%	

Total	2.6E-03	5.55%	1.0E-03
Dangerous substances from the candidate list of SVHC for Authorization	EC No.	CAS No.	Weight-% per functional or declared unit
No SVHC in product			

Table15. Content information--- LR5-54HTB

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.4E-02	-	-
Frame	4.7E-03	-	-
Ribbon Interconnection	5.1E-04	-	-
Junction Box	4.1E-04	-	-
backsheet	2.4E-03	-	-
cells	1.5E-03	-	-
EVA	5.2E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	8.3E-05	-	-
Assembly - Silicone glue	6.7E-04	-	-
Insulating strip	0.0E+00	-	-
Soldering Flux	6.8E-05	-	-
Total	4.9E-02	-	-
Packaging materials	Weight, kg/Wp	Weight-% (versus the product)	Biogenic material, kg/Wp
pallet	1.4E-03	3.03%	5.7E-04
Paperboard corner	1.8E-05	0.04%	8.4E-06
Paperboard Carton	7.3E-04	1.55%	3.4E-04
Box cover	8.8E-05	0.19%	4.0E-05
paper floor	1.5E-04	0.31%	6.7E-05
Strips	1.2E-04	0.25%	-
PET film	0.0E+00	0.00%	-
lable	4.5E-06	0.01%	2.1E-06

A4 paper	7.3E-08	0.00%	3.4E-08
Wrap film	8.2E-05	0.17%	-
Total	2.6E-03	5.55%	1.0E-03
Dangerous substances from the candidate list of SVHC for Authorization	EC No.	CAS No.	Weight-% per functional or declared unit
No SVHC in product			

Table16. Content information--- LR5-54HPH

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.5E-02	-	-
Frame	4.9E-03	-	-
Ribbon Interconnection	5.3E-04	-	-
Junction Box	4.2E-04	-	-
backsheet	2.4E-03	-	-
cells	1.5E-03	-	-
EVA	5.4E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	8.6E-05	-	-
Assembly - Silicone glue	6.9E-04	-	-
Insulating strip	0.0E+00	-	-
Soldering Flux	7.0E-05	-	-
Total	5.1E-02	-	-
Packaging materials	Weight, kg/Wp	Weight-% (versus the product)	Biogenic material, kg/Wp
pallet	1.5E-03	3.03%	5.9E-04
Paperboard corner	1.9E-05	0.04%	8.7E-06
Paperboard Carton	7.6E-04	1.55%	3.5E-04
Box cover	9.1E-05	0.19%	4.2E-05
paper floor	1.5E-04	0.31%	7.0E-05
Strips	1.2E-04	0.25%	-

PET film	0.0E+00	0.00%	-
lable	4.7E-06	0.01%	2.2E-06
A4 paper	7.6E-08	0.00%	3.5E-08
Wrap film	8.5E-05	0.17%	-
Total	2.7E-03	5.55%	1.1E-03
Dangerous substances from the candidate list of SVHC for Authorization	EC No.	CAS No.	Weight-% per functional or declared unit
No SVHC in product			

Table17. Content information--- LR5-54HPB

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.5E-02	-	-
Frame	4.9E-03	-	-
Ribbon Interconnection	5.4E-04	-	-
Junction Box	4.3E-04	-	-
backsheet	2.5E-03	-	-
cells	1.5E-03	-	-
EVA	5.5E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	8.7E-05	-	-
Assembly - Silicone glue	7.0E-04	-	-
Insulating strip	0.0E+00	-	-
Soldering Flux	7.1E-05	-	-
Total	5.2E-02	-	-
Packaging materials	Weight, kg/Wp	Weight-% (versus the product)	Biogenic material, kg/Wp
pallet	1.5E-03	3.03%	6.0E-04
Paperboard corner	1.9E-05	0.04%	8.8E-06
Paperboard Carton	7.6E-04	1.55%	3.5E-04
Box cover	9.1E-05	0.19%	4.2E-05

paper floor	1.5E-04	0.31%	7.1E-05
Strips	1.2E-04	0.25%	-
PET film	0.0E+00	0.00%	-
lable	4.7E-06	0.01%	2.2E-06
A4 paper	7.6E-08	0.00%	3.5E-08
Wrap film	8.5E-05	0.17%	-
Total	2.8E-03	5.55%	1.1E-03
Dangerous substances from the candidate list of SVHC for Authorization	EC No.	CAS No.	Weight-% per functional or declared unit
No SVHC in product			

Table18. Content information--- LR5-54HIH

Product components	Weight, kg/Wp	Post-consumer material, weight-%	Biogenic material, kg/Wp
glass	3.5E-02	-	-
Frame	4.9E-03	-	-
Ribbon Interconnection	5.4E-04	-	-
Junction Box	4.3E-04	-	-
backsheet	2.5E-03	-	-
cells	1.5E-03	-	-
EVA	5.5E-03	-	-
POE.	0.0E+00	-	-
Junction Box - Silicone join	8.7E-05	-	-
Assembly - Silicone glue	7.0E-04	-	-
Insulating strip	0.0E+00	-	-
Soldering Flux	7.1E-05	-	-
Total	5.2E-02	-	-
Packaging materials	Weight, kg/Wp	Weight-% (versus the product)	Biogenic material, kg/Wp
pallet	1.5E-03	3.03%	6.0E-04
Paperboard corner	1.9E-05	0.04%	8.8E-06

Paperboard Carton	7.7E-04	1.55%	3.5E-04
Box cover	9.2E-05	0.19%	4.2E-05
paper floor	1.5E-04	0.31%	7.1E-05
Strips	1.3E-04	0.25%	-
PET film	0.0E+00	0.00%	-
lable	4.8E-06	0.01%	2.2E-06
A4 paper	7.7E-08	0.00%	3.5E-08
Wrap film	8.6E-05	0.17%	-
Total	2.8E-03	5.55%	1.1E-03
Dangerous substances from the candidate list of SVHC for Authorization	EC No.	CAS No.	Weight-% per functional or declared unit
No SVHC in product			

Environmental Performance

The LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. All results are presented per Wp.

There are differences in the environmental performance of multiple product specifications, and this EPD discloses the worst environmental performance of each specification model, and the difference from the best environmental performance in some environmental indicators with other product specifications is more than 10%. The environmental performance of product LR5-54HIH is disclosed in the following context. It's environmental indicator that GWP-total is in the range 0%-11%, ODP is in the range 0%-15%, WDP is in the range 0%-20%, and Abiotic depletion potential (ADP) for fossil resources is in the range 0%-13%。

According to PCR 2019:14 ANNEX 2, biocarbon emissions need to consider the emission of biochar contained in products or packaging materials. GWP-biogenic (CO_2 for non-product/packaging content) is set as zero, GWP-biogenic (CO_2 for product content) is zero due to no biogenic carbon content in product, and the biogenic carbon of packaging material is emitted as biogenic CO_2 emissions in module A5, no packaging material is burn in C module. 1 kg biogenic carbon is equivalent to 44/12 kg of CO_2. The GWP-biogenic is calculated and listed in the chapter 4.2 of LCA report.

Potential environmental impact – mandatory indicators according to EN 15804

Acronyms

GWP-fossil = Global Warming Potential fossil fuels.

GWP-biogenic = Global Warming Potential biogenic.

GWP-luluc = Global Warming Potential land use and land use change.

ODP = Depletion potential of the stratospheric ozone layer.

AP =Acidification potential, Accumulated Exceedance.

EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment.

EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment.

EP-terrestrial = Eutrophication potential, Accumulated Exceedance.

POCP = Formation potential of tropospheric ozone.

ADP- minerals &metals = Abiotic depletion potential for non-fossil resources.

ADP-fossil = Abiotic depletion for fossil resources potential.

WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

Table 19. Core environmental impact indicators (MANDATORY)

Results per functional unit													
Indicator	unit	A1	A2	A3	A1-A3	A4	A5	B	C1	C2	C3	C4	D
GWP-fossil	kg CO2 eq	5.1E-01	4.4E-03	3.6E-02	5.5E-01	2.5E-02	1.7E-02	2.3E-01	0.0E+00	2.7E-04	6.7E-03	5.9E-04	-1.0E-01
GWP-biogenic	kg CO2 eq	1.6E-03	1.2E-05	3.1E-03	4.7E-03	4.6E-05	5.2E-03	1.1E-03	0.0E+00	7.3E-07	6.7E-03	5.8E-03	-1.4E-03
GWP-land use	kg CO2 eq	1.1E-03	3.1E-05	4.7E-06	1.2E-03	1.3E-04	2.2E-05	4.5E-04	0.0E+00	1.9E-06	8.7E-07	1.8E-07	-1.7E-04
GWP-total	kg CO2 eq	5.1E-01	4.5E-03	3.9E-02	5.5E-01	2.5E-02	2.3E-02	2.3E-01	0.0E+00	2.7E-04	1.3E-02	6.4E-03	-1.1E-01
ODP	kg CFC 11 eq.	1.3E-07	9.4E-10	2.5E-10	1.3E-07	5.3E-09	8.1E-10	2.6E-08	0.0E+00	5.7E-11	4.4E-11	2.1E-11	-6.4E-09
POCP	kg NMVOC eq.	2.5E-03	2.7E-05	1.2E-04	2.7E-03	2.9E-04	1.6E-04	9.1E-04	0.0E+00	1.6E-06	1.4E-05	2.8E-06	-2.7E-04
AP	mol H+ eq.	3.1E-03	2.4E-05	1.9E-04	3.3E-03	3.5E-04	8.0E-04	1.5E-03	0.0E+00	1.5E-06	6.0E-06	1.3E-06	-4.8E-04
EP, aquatic freshwater	kg P eq.	2.6E-04	3.7E-07	6.7E-06	2.7E-04	1.7E-06	6.2E-05	1.1E-04	0.0E+00	2.2E-08	3.2E-07	1.9E-06	-4.7E-05
EP, aquatic marine	kg N eq.	6.5E-04	8.7E-06	4.1E-05	7.0E-04	9.8E-05	4.2E-05	2.7E-04	0.0E+00	5.3E-07	7.6E-06	4.5E-06	-9.6E-05
EP,terrestrial	mol N eq.	5.7E-03	9.4E-05	4.3E-04	6.3E-03	1.1E-03	5.7E-04	2.7E-03	0.0E+00	5.7E-06	3.2E-05	4.0E-06	-9.6E-04
WDP	m3 world eq.	1.1E+00	2.6E-04	5.4E-03	1.1E+00	1.2E-03	1.7E-02	2.1E-01	0.0E+00	1.6E-05	3.4E-04	3.7E-05	-2.3E-01
Abiotic depletion potential (ADP) for fossil resources	MJ	7.1E+00	6.6E-02	3.1E-01	7.4E+00	3.6E-01	2.3E-01	2.8E+00	0.0E+00	4.0E-03	3.4E-03	2.1E-03	-1.3E+00
Abiotic depletion potential (ADP) for minerals and metals (non-fossil resources)	kg Sb eq.	4.3E-05	1.5E-08	1.1E-07	4.4E-05	7.0E-08	1.9E-05	1.3E-05	0.0E+00	9.1E-10	-1.3E-09	8.7E-10	-2.0E-07

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

Impact category	Indicator
Climate change	Global warming potential (GWP) including GWP-fossil, GWP-biogenic, GWP-land use and land use change (luluc), and GWP-total
Acidification	Acidification potential (AP)
Eutrophication	Eutrophication potential (EP), aquatic freshwater
Eutrophication	Eutrophication potential (EP), aquatic marine
Eutrophication	Eutrophication potential (EP), terrestrial
Photochemical pollution	Photochemical ozone creation potential (POCP)
Ozone depletion	Ozone depletion potential (ODP)
Resource depletion	Abiotic depletion potential for minerals and metals (non-fossil resources) (ADP-fossil)
Resource depletion	Abiotic depletion potential for fossil resources (ADP-mineral & metals)
Water deprivation	Water deprivation potential (WDP)

Potential environmental impact – additional indicators-GWP-GHG

Table 20. GWP-GHG

Results per functional unit													
Indicator	unit	A1	A2	A3	A1-A3	A4	A5	B	C1	C2	C3	C4	D
GWP-GHG	kg CO2 eq	5.0E-01	4.4E-03	3.6E-02	5.4E-01	2.5E-02	1.7E-02	2.2E-01	0.0E+00	2.7E-04	6.6E-03	4.9E-03	-1.0E-01

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 CO2 is set to zero.

Potential environmental impact – additional indicators-Resource Use

The resource consumption is demonstrated in tables below

Table 21. Resource Use

Results per functional unit														
Indicator		Unit	A1	A2	A3	**A1-A3**	A4	A5	B	C1	C2	C3	C4	D
Primary energy resources--Non--renewable	use as energy carrier	MJ	7.6E+00	7.1E-02	3.3E-01	8.0E+00	3.9E-01	2.4E-01	3.0E+00	0.0E+00	4.3E-03	3.7E-03	2.2E-03	-1.4E+00
	use as raw material	MJ	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Total	MJ	7.6E+00	7.1E-02	3.3E-01	8.0E+00	3.9E-01	2.4E-01	3.0E+00	0.0E+00	4.3E-03	3.7E-03	2.2E-03	-1.4E+00
Primary energy resources-renewable	use as energy carrier	MJ	3.9E+00	1.1E-03	3.2E-02	3.9E+00	5.2E-03	3.5E-02	1.4E+01	0.0E+00	6.9E-05	3.8E-05	8.1E-05	-4.7E-01
	use as raw material	MJ	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Total	MJ	3.9E+00	1.1E-03	3.2E-02	3.9E+00	5.2E-03	3.5E-02	1.4E+01	0.0E+00	6.9E-05	3.8E-05	8.1E-05	-4.7E-01
Secondary material		kg	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Renewable secondary fuels		MJ	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Non-renewable secondary fuels		MJ	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Net use of fresh water		m3	0.0E+00	0.0E+00	4.0E-05	4.0E-05	0.0E+00	0.0E+00	2.7E-08	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Potential environmental impact – additional indicators-Waste to disposal

Environment impact indicates for waste to disposal are studied and declared.

Table 22. Waste to disposal

Results per functional unit															
Indicator		Unit	A1	A2	A3	**A1-A3**	A4	A5	B2	B6	B7	C1	C2	C3	C4	D
Waste to disposal	Hazardous waste	kg	0.0E+00	0.0E+00	1.9E-04	1.9E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Non-hazardous waste	kg	0.0E+00	0.0E+00	2.0E-03	2.0E-03	0.0E+00	7.2E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Radioactive waste disposed (total low, intermediate and high level waste)	kg	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Radioactive waste disposed (high level waste)	kg	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Potential environmental impact – additional indicators-Other output flow

Environment impact indicates e.g. components for reuse, materials for recycling, materials for energy recovery and export energy are studied and declared.

Table 23. Other output flow

Results per functional unit															
Indicator		Unit	A1	A2	A3	**A1-A3**	A4	A5	B2	B6	B7	C1	C2	C3	C4	D
Other output flows	Components for reuse	kg	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-03	0.0E+00
	Materials for recycling	kg	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.9E-02	0.0E+00
	Materials for energy recovery	kg	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Export energy	MJ per energy carrier	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-02	0.0E+00

Differences Versus Previous Versions

2023-04-18 Version 1

2023-05-29 Version 2
Editorial change:

1. PCR description updated: PCR 2019: 14 Construction products (EN 15804: A2) version1.2.5
2. Only one representative EPD results instead of 7 results are included in the EPD.
3. Add the indicator GWP-GHG and the biogenic carbon checked in the EPD
4. The electricity mix for the manufacturing (A3) is to be added in the EPD.

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