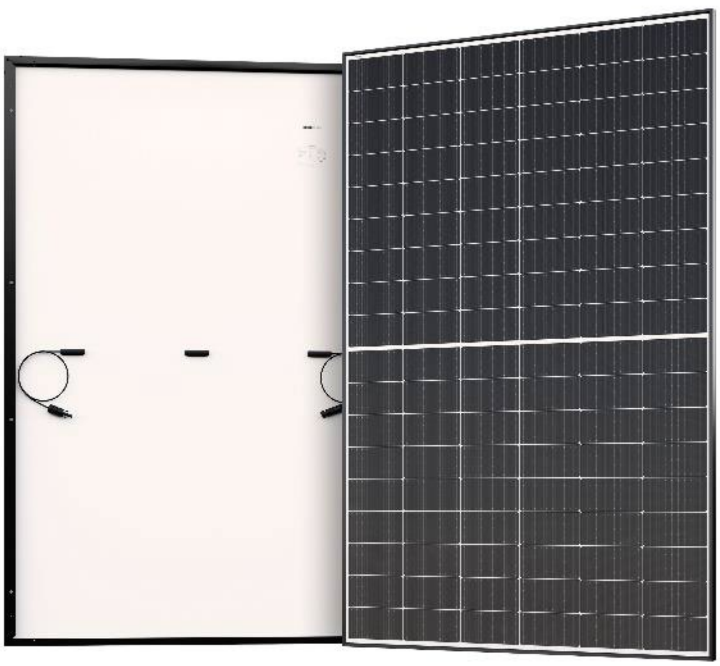
Environmental Product Declaration

MXXXP54LM-SF/BF/BB-F3, MXXXP54LB-SF/BF/BB-F3, MXXXP72LM-SF/BF/BB-F3, MXXXP72LB-SF/BF/BB-F3, MXXXP60UM-SF/BF/BB-F3, MXXXP60UB-SF/BF/BB-F3, MXXXP66UM-SF/BF/BB-F3, MXXXP66UB-SF/BF/BB-F3, MXXXN54LM-SF/BF/BB-F3, MXXXN54LB-SF/BF/BB-F3, MXXXN72LM-SF/BF/BB-F3, MXXXN72LB-SF/BF/BB-F3

PHOTOVOLTAIC MODULES
LEDVANCE GmbH



Our photovoltaic panels are engineered to meet all your requirements, from residential to commercial applications. Choose from a wide range of options, including power ratings between 405W and 660W, available in both monofacial and bifacial designs.

LEDVANCE RE NEW ABLES

LEDVANCE is one of the world's leading providers of general lighting and has an innovative and comprehensive portfolio of luminaires, advanced LED lamps, intelligent and networked products and solutions in the areas of SMART Home and SMART Building, as well as traditional light sources. In addition to this, the company is working to leverage its existing market presence and supply chain expertise to expand its existing portfolio to include products from the renewable energy sector.

At LEDVANCE, sustainability is not a destination but a continuous journey. It's about reshaping our practices, reducing our carbon footprint, creating collaborative spaces, and promoting ethical business conduct. This includes creating new product ranges, minimizing CO2 emissions through efficient transport facilities, improving demand planning with AI and optimizing our headquarters to reflect our sustainability principles.

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION
UL.COM/EPD

ENVIRONMENTAL PRODUCT DECLARATION

LEDVANCE RE NEW ABLES

MxxxP54LM-SF/BF/BB-F3, MxxxP54LB-SF/BF/BB-F3, MxxxP72LM-SF/BF/BB-F3, MxxxP72LB-SF/BF/BB-F3, MxxxP60UM-SF/BF/BB-F3, MxxxP60UB-SF/BF/BB-F3, MxxxP66UM-SF/BF/BB-F3, MxxxP66UB-SF/BF/BB-F3, MxxxN54LM-SF/BF/BB-F3, MxxxN54LB-SF/BF/BB-F3, MxxxN72LM-SF/BF/BB-F3, MxxxN72LB-SF/BF/BB-F3

PHOTOVOLTAIC MODULES

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

According to ISO 14025, EN 15804:2012+A2:2019/AC:2021

EPD Program and Program Operator Name, Address, Logo, and Website	UL Solutions 333 Pfingsten Road Northbrook, IL 60611	HTTPS://WWW.UL.COM/ HTTPS://SPOT.UL.COM/
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	PROGRAM OPERATOR RULES V2.7 2022	
MANUFACTURER NAME AND ADDRESS	LEDVANCE GmbH, Parkring 1-5, 85748 Garching, Germany Website: www.ledvance.com E-Mail: LCA@ledvance.com	
DECLARATION NUMBER	4791425933.101.1	
DECLARED PRODUCT & FUNCTIONAL UNIT	MxxxP54LM-SF/BF/BB-F3, MxxxP54LB-SF/BF/BB-F3, MxxxP72LM-SF/BF/BB-F3, MxxxP72LB-SF/BF/BB-F3, MxxxP60UM-SF/BF/BB-F3, MxxxP60UB-SF/BF/BB-F3, MxxxP66UM-SF/BF/BB-F3, MxxxP66UB-SF/BF/BB-F3, MxxxN54LM-SF/BF/BB-F3, MxxxN54LB-SF/BF/BB-F3, MxxxN72LM-SF/BF/BB-F3, MxxxN72LB-SF/BF/BB-F3 1 kWh of electricity generated as output from the solar photovoltaic plant	
REFERENCE PCR AND VERSION NUMBER	PCR EPDItaly014: Electricity Produced by Photovoltaic Modules.	
DESCRIPTION OF PRODUCT APPLICATION/USE	LEDVANCE solar monocrystalline silicon PV modules are widely used to generate electricity on rooftop and ground solar farms	
PRODUCT RSL DESCRIPTION (IF APPL.)	30 Years	
MARKETS OF APPLICABILITY	Europe	
DATE OF ISSUE	April 1, 2024	
PERIOD OF VALIDITY	5 years	
EPD TYPE	Product-specific	
RANGE OF DATASET VARIABILITY	N/A	
EPD SCOPE	Cradle to grave	
YEAR(S) OF REPORTED PRIMARY DATA	2022.7-2023.7	
LCA SOFTWARE & VERSION NUMBER	eFootprint online software	
LCI DATABASE(S) & VERSION NUMBER	Ecoinvent 3.9.1 and CLCD 0.9	
LCIA METHODOLOGY & VERSION NUMBER	EN 15804+A2 Method V1.03	

The PCR review was conducted by:	EPDItaly Program PCR Moderator & PCR Committee info@epditaly.it
This declaration was independently verified in accordance with ISO 14025: 2006. ☐ INTERNAL ☒ EXTERNAL	Cooper McCollum, UL Solutions
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Sung Mo Yeon, H.I.P. Pathway

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible". Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

1. Product Definition and Information

1.1. Description of Company/Organization

LEDVANCE is one of the world's leading providers of general lighting and has an innovative and comprehensive portfolio of luminaires, advanced LED lamps, intelligent and networked products and solutions in the areas of SMART Home and SMART Building, as well as traditional light sources. In addition to this, the company is working to leverage its existing market presence and supply chain expertise to expand its existing portfolio to include products from the renewable energy sector.

LEDVANCE offers unique, vertically-integrated solutions for the building sector covering energy supply, energy storage, energy use, and integration with power systems. Sunlight becomes the source of energy that we harvest and store. We fuel people's lives with smart energy.

1.2. Product Description

Product Identification

LEDVANCE Photovoltaic modules under analysis integrate various advanced technologies like multi-busbar and Gallium-doped wager, with the highest power up tp 670W and up to 21.6% module efficiency. Besides, the Gallium-doped technology overcomes the light attenuation of the module and ensures the long-term power generation and stability of the module. Application of these modules can remarkably 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.

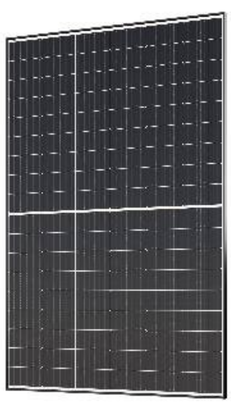


Figure 1: LEDVANCE Photovoltaic module

Product Specification

- Panel size below 2 m2
- Durable anodized aluminium frame
- 3.2 mm tempered glass
- IP68 junction box
- Wide operating temperature: -40 - +85° C
- Maximum static load up 5400 Pa

- MC4 EVO2 connectors
- Multi Bus Bar (MBB) technology
- Also available in shorter cable length 0.3 m

Product Benefits

- Durable design and highest quality component selection for long lasting performance
- Better weak illumination response
- Low light induced degradation for N-TOPCon Types
- Resistance to potential induced degradation
- Resistant to difficult weather conditions
- 12 years product guarantee for P-Type panels
- 15 years product guarantee for N-Type panels
- 25 years linear power guarantee for P-Type panels
- 30 years linear power guarantee for N-Type panels

Table 1. Different PV module products models

SERIES (BRAND NAME)	POWER OUTPUT RANGE(W)	DIMENSIONS(MM*MM)	MODULE EFFICIENCY (%)
MxxxP54LM-SF/BF/BB-F3	400~415	1722*1134*30	21.25
MxxxP54LB-SF/BF/BB-F3	400~415	1722*1134*30	21.25
MxxxP72LM-SF/BF/BB-F3	530~550	2278*1134*30	21.29
MxxxP72LB-SF/BF/BB-F3	530~550	2278*1134*30	21.29
MxxxP60UM-SF/BF/BB-F3	585~605	2172*1303*35	21.37
MxxxP60UB-SF/BF/BB-F3	585~605	2172*1303*33	21.37
MxxxP66UM-SF/BF/BB-F3	650~670	2384*1303*35	21.56
MxxxP66UB-SF/BF/BB-F3	650~670	2384*1303*33	21.56
MxxxN54LM-SF/BF/BB-F3	420~440	1722*1134*30	22.53
MxxxN54LB-SF/BF/BB-F3	420~440	1722*1134*30	22.53
MxxxN72LM-SF/BF/BB-F3	560~580	2278*1134*30	22.45
MxxxN72LB-SF/BF/BB-F3	560~580	2278*1134*30	22.45

1.3. Application

LEDVANCE Solar PV modules are widely used to generate electricity on ultra-large ground power station.

1.4. Declaration of Methodological Framework

In this project, a full LCA approach was considered with some simplification on data modeling using generic data for most background systems. The EPD analysis uses a cradle-to-grave system boundary. No known flows are deliberately excluded from this EPD.

To calculate the LCA results for the product maintenance stage, a 30-year reference service life (RSL) was assumed for the declared products.

Additional details on assumptions, cut-offs and allocation procedures can be found in section 2.3\ 2.4\ 2.8 respectively.

1.5. Technical Requirements

The chart below lists all standards required for LEDVANCE PV modules

Table 2. Standards required for LEDVANCE PV modules

PRODUCT	STANDARDS
MxxxP54LM-SF/BF/BB-F3	IEC 61215, IEC 61730, ISO50001, IECQ QC 080000 ISO9001:2015: ISO Quality Management System ISO14001:2015: ISO Environment Management System ISO45001:2018: Occupational Health and Safety IEC 62941:2019: Guideline for module design qualification and type approval
MxxxP54LB-SF/BF/BB-F3	
MxxxP72LM-SF/BF/BB-F3	
MxxxP72LB-SF/BF/BB-F3	
MxxxP60UM-SF/BF/BB-F3	
MxxxP60UB-SF/BF/BB-F3	
MxxxP66UM-SF/BF/BB-F3	
MxxxP66UB-SF/BF/BB-F3	
MxxxN54LM-SF/BF/BB-F3	
MxxxN54LB-SF/BF/BB-F3	
MxxxN72LM-SF/BF/BB-F3	
MxxxN72LB-SF/BF/BB-F3	

1.6. Material Composition

Table 3 contains a list of materials and substances in different modules.

Table 3. Components in different modules

MATERIALS	MAIN SUBSTANCE	UNITS	MxxxP54LM-SF/BF/BB-F3	MxxxP54LB-SF/BF/BB-F3	MxxxP72LM-SF/BF/BB-F3	MxxxP72LB-SF/BF/BB-F3	MxxxP60UM-SF/BF/BB-F3	MxxxP60UB-SF/BF/BB-F3	MxxxP66UM-SF/BF/BB-F3	MxxxP66UB-SF/BF/BB-F3	MxxxN54LM-SF/BF/BB-F3	MxxxN54LB-SF/BF/BB-F3	MxxxN72LM-SF/BF/BB-F3	MxxxN72LB-SF/BF/BB-F3
Cell	**Single-crystal silicon**	kg/pcs	0.61	0.61	0.81	0.81	0.84	0.84	0.93	0.93	0.60	0.60	0.80	0.80
Solar glass	**SiO2**	kg/pcs	15.49	9.68	11.48	7.17	22.47	14.05	24.67	15.42	15.49	9.68	20.50	12.81
EVA	**EVA**	kg/pcs	1.70	1.85	2.20	1.15	2.69	1.30	2.95	1.40	2.02	1.85	1.09	2.46
POE	**POE**	kg/pcs	/	/	/	1.17	/	1.29	/	1.43	/	/	0.98	/
Back sheet	**FPF**	kg/pcs	0.85	/	1.15	/	1.02	/	1.12	/	0.70	/	1.18	/
Frame	**Al**	kg/pcs	2.22	2.22	2.54	2.40	2.89	2.88	3.01	3.04	2.22	2.05	2.56	2.45
Interconnection bar	**Cu**	kg/pcs	0.11	0.11	0.15	0.14	0.17	0.17	0.16	0.18	0.14	0.14	0.18	0.18
Bus bar	**Cu**	kg/pcs	0.040	0.041	0.040	0.041	0.036	0.038	0.037	0.037	0.031	0.032	0.041	0.03
Junction box	**PP**	kg/pcs	0.10	0.10	0.12	0.10	0.10	0.12	0.10	0.12	0.10	0.10	0.10	0.10
Flux for soldering	**Flux**	kg/pcs	0.0082	0.012	0.017	0.0092	0.010	0.0089	0.0092	0.0096	0.011	0.011	0.014	0.014
Silica gel	**SiO2**	kg/pcs	0.28	0.013	0.29	0.28	0.29	0.28	0.30	0.28	0.28	0.22	0.27	0.27
Potting adhesive	**PU**	kg/pcs	0.025	0.040	0.024	0.024	0.024	0.024	0.026	0.025	0.025	0.025	0.025	0.024
Packing film	**PE**	kg/pcs	0.013	0.012	0.014	0.011	0.011	0.011	0.013	0.010	0.018	0.011	0.0092	0.012
Packaging strip	**Steel**	kg/pcs	0.042	0.050	0.048	0.046	0.052	0.047	0.065	0.054	0.048	0.056	0.042	0.052
Paper corner	**Paper**	kg/pcs	0.0089	0.0072	0.0117	0.0086	0.0084	0.0086	0.0080	0.0086	0.0086	0.0086	0.0076	0.009
Paper box	**Corrugated paper**	kg/pcs	0.25	0.23	0.27	0.27	0.33	0.31	0.33	0.38	0.25	0.25	0.27	0.27
Wooden pallet	**Plywood**	kg/pcs	0.63	0.63	0.79	0.79	0.75	0.75	1.10	1.10	0.63	0.63	0.79	0.79

2. Life Cycle Assessment Background Information

2.1. Functional Unit

In this report, the functional unit is defined as 1 kWh of electricity generated as output from the solar photovoltaic plant, as determined by the PCR.

2.2. System Boundary

The system boundary of this evaluation is cradle-to-grave. Figure 2 below illustrates the system boundaries for the LEDVANCE Solar product, including raw material production and transportation, manufacture, delivery, solar plant installation and waste disposal.

According to the PCR, the life cycle stage must refer to segmentation in the following three processes:

Upstream Stage for module: which includes extraction and processing of raw materials (A1), transportation of the raw material to the factory (A2);

Core Stage for module: which includes all the relevant processes managed by the Organization proposing the EPD. The core stage in this study includes manufacturing of solar cells and PV modules (A3) with the supply of the energy and water input, and gaseous emissions, wastewater and solid wastes; distribution of PV modules to solar PV plant(A4); construction of the solar plant (A5), the use (B1), maintenance (B2), repair (B3), replacement (B4), refurbishment(B5) and the operational energy use (B6) and water use (B7) during the RSL (30 years) period; disassembled and demolition of the solar plant (C1), transport to waste processing (C2). However, considering that the installation and operation is beyond the control of LEDVANCE, therefore the construction of the solar plant (A5) base on the data from Ecoinvent database value.

Downstream Stage for module: which includes waste processing (C3) and disposal (C4). Dissipation related to voltage drop operations before feeding electricity into the grid, and environmental impacts of using booster station. According to the PCR, the benefit and avoided loads beyond the product system boundary are not reported in module D separately within this study, neither will the benefit and loads be reported in other stages by following a cut off allocation approach.

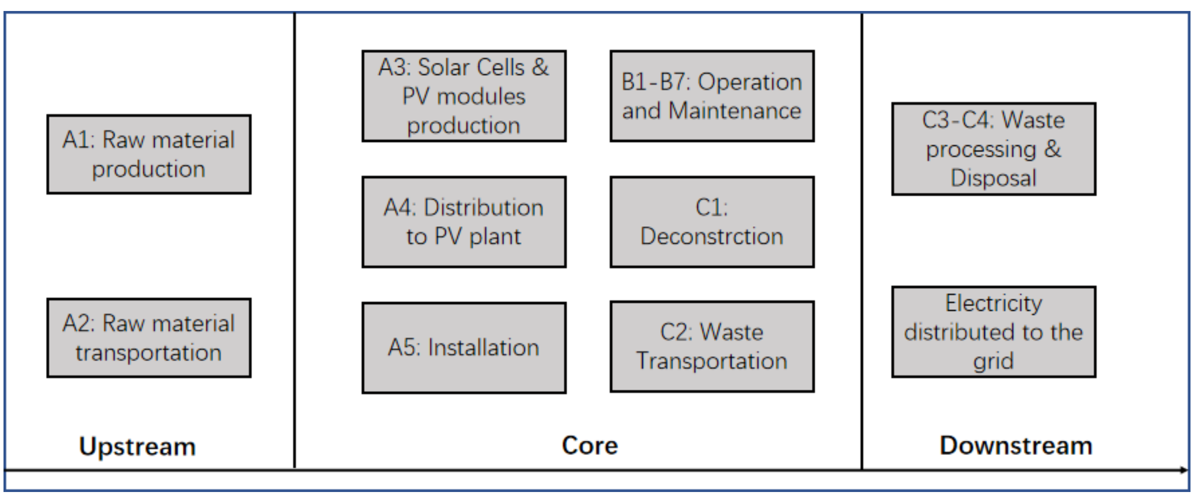


Figure 2. System boundary of PV modules

2.3. Estimates and Assumptions

In order to carry out the LCA study, the following main assumptions were made:

- All products are modeled using the same assumptions.

- The transportation distance of some raw material suppliers not provided by LEDVANCE is estimated according to the average road transportation distance of 177km in China Statistical Yearbook 2022

- For missing background data, substitution of missing data using similar background data approach was taken to shorten the gap.

- The number of PV module employed in PV plant construction (A5) was calculated by dividing the peak power of the PV plant (570kWp) by the peak power output of each PV module;

- The electricity consumption during PV plant construction stage is scaled up based on the data from Ecoinvent database value (36.03 kWh/570kWp) according to the power capacity;

- Electricity used during the PV plant operation is assumed to be powered by the plant itself, water used for cleaning the PV panels is assumed 0.23L (source: www.polywater.com) per module per time and two times per year. The service life of the inverter is 15years.

- Materials consumption during PV plants construction is scaled up based on the data from Ecoinvent database value according to the power capacity. Secondary data from Ecoinvent 3.9.1 (photovoltaics, electricity installation for 570kWp modules, open ground GLO);

- The electricity consumption during deconstruction of PV plant (C1) is assumed same to the electricity consumption of construction stage (A5), and electricity consumption for PV module demolition at waste processing stage (C3) is assumed same to the electricity consumption of PV module assembling;

- During the end of life stage, the transportation of the waste PV modules and other equipment from the solar PV plant to treatment facilities including recycling, landfill or incineration center is assumed to be 100 km for simplification purposes.

- The transportation distance of the two raw materials of unknown origin is based on the average distance of 177Km for road transportation in the China Statistical Yearbook (2022) as an assumption.

- The wastewater generated from the used water is divided into two parts, one part needs to be discharged after wastewater treatment, and the other part is directly discharged into the municipal wastewater system, therefore this part is not included in the inventory.

2.4. Cut-off Criteria

The following procedure was followed for the exclusion of inputs and outputs:

- All inputs and outputs to a (unit) process will be included in the calculation for which data is available. Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices will be documented;

- In case of insufficient input data or data gaps for a unit process, according to the PCR requirement, the cut-off criteria chosen is 2% of the total mass and energy of that unit process. (respectively, of the photovoltaic module's unit weight and the energy needed to produce and assemble it). The neglected flow is demonstrated in table 4.

Table 4. Cut off flows

FLOW NAME	PROCESS STAGE	MASS%	REASON TO CUT OFF
Production, use, and disposal of the packaging of components and semi-finished intermediates;	Upstream	＜0.1%	Specified in PCR
Transportation of waste from the A3 production phase	Corestream	N/A	Transportation distances of around 100km and very small quantities of waste
Inspection during operation of solar plant	B	N/A	Cut off due to small impact according to PCR
Total cut off mass % estimated		＜2%	＜2%

2.5. Reference Service Life

Reference Service life is assumed to be 30 years based on EPDItaly014 PCR.

2.6. Data Sources

In this EPD, both primary and secondary data are used. Site specific foreground data have been provided by LEDVANCE. Main data sources are the bill of materials available on the enterprise resource planning. For all processes for which primary are not available, generic data originating from the ecoinvent v3.9.1 and CLCD v0.9 databases, allocation cut- off by classification, are used.

2.7. Data Quality

The data quality requirements for this study were as follows:

- Foreground data of the considered system: such as materials or energy flows that enter the production system. These data were directly extracted from ERP or calculated and submitted by LEDVANCE.

- Technological representativeness: For the most part, data is representative of the actual technologies used for processing, transportation, and manufacturing operations. Representative fabrication datasets, specific to the type of material, are used to represent the actual processes, as appropriate.

- Geographical representativeness: Background data may be global data. LCI data linked to the geographical locations of the processes, such as electricity and transport data from China and Global, were used.

- Time-related representativeness: The most recent available data are used, based on other considerations such as data quality and similarity to the actual operations. Typically, these LCI data are less than 3 years old (typically 2022 and 2021). Manufacturer-supplied data (primary data) are based on annualized production for 2023.

- Completeness: The LCA model included all known mass and energy flows for production of these PV modules. No known processes or activities contributing to more than 2% of the total environmental impact for each indicator are excluded.

- Precision/uncertainty: Data collected for operations were typically averaged for one year, which is expected to reduce the variability of results.

- Methodological appropriateness and consistency: The consistency of the assessment is considered to be high. Different portions of the product life cycle are equally considered; however, it must be noted that final disposition of the product is based on assumptions of current practices in Italy.

2.8. Allocation

Allocation refers to partitioning of input or output flows of a process or a product system between the product systems under study and one or more other product systems. In this study, there are three types of allocation procedures considered:

Multi-input processes

For data sets in this study, the allocation of the inputs from coupled processes is generally carried out via the mass. The consumption of raw materials is allocated by mass ratio. The transportation of raw materials is allocated by mass ratio.

Multi-output processes

In the production of PV modules, the total consumption of energy and water during manufacturing is equally allocated to per unit mass. No other by products are produced from the production, hence there is no production of by products that need to be used to allocate the situation.

Allocation for recovery processes

The model used for the allocation for recovery processes is the Ecoinvent cut-off system model (Allocation, cut-off by classification). According to this approach, wastes are the producer's responsibility, and there is an to use recyclable products, that are available burden-free (cut-off). The underlying philosophy of this approach is that primary (first) production of materials is always allocated to the primary user of a material. If a material is recycled, the primary producer does not receive any credit for the provision of any recyclable materials. Consequently, recyclable materials are available burden-free for recycling processes, and secondary (recycled) materials bear only the impacts of the recycling processes.

During the end of life stage of the solar plant, the extra benefit of recycling the waste modules as well as other equipment is cut off from the boundary, following the PCR's recommendation on end of life scenario. Along with the benefit, the load from waste treatment for recycling purpose such as de-pollution and crushing, etc is also allocated to the next life cycle of substituted products, but not the primary producers of PV module, hence no burden or benefit will be allocated to the primary producer of the PV module or solar PV plant (cut off approach).

2.9. Comparability

No comparisons or benchmarking are included in this EPD. LCA results across EPDs can be calculated with different background databases, modeling assumptions, geographic scope and time periods, all of which are valid and acceptable according to the Product Category Rules (PCR) and ISO standards. The user of the EPD should take care when comparing EPDs from different companies. Assumptions, data sources, and assessment tools may all impact the uncertainty of the final results and make comparisons misleading.

2.10. Electricity power mix

In this EPD, different electricity mix data is taken where the process takes place. The electricity inventory is based on the year 2021 for Chinese electricity generation (China Energy Statistics Yearbook 2021). For the production of PV modules, it takes place in Jiangsu province, so China eastern grid mix electricity in CLCD 0.9 database is adopted. For PV plant construction and operation, it takes place at Italy, (market for electricity medium voltage Italy) in Ecoinvent 3.9.1 database is adopted.

3. Life Cycle Assessment Scenarios

3.1. Manufacturing

The PV module products under study includes one series covering 12 models (see Table 1). All the products share similar manufacturing processes and life cycle stages. A flowchart depicting the production process stages of LEDVANCE PV module products is shown in Figure 2 below. For simplification purpose, only main stages of manufacturing are presented, raw material, auxiliary processes considered in the LCA but not shown in the flowcharts, which include:

- Raw and auxiliary material production and transportation;
- Energy consumption;
- Tap water consumption;
- Waste (including transport to waste treatment plant);

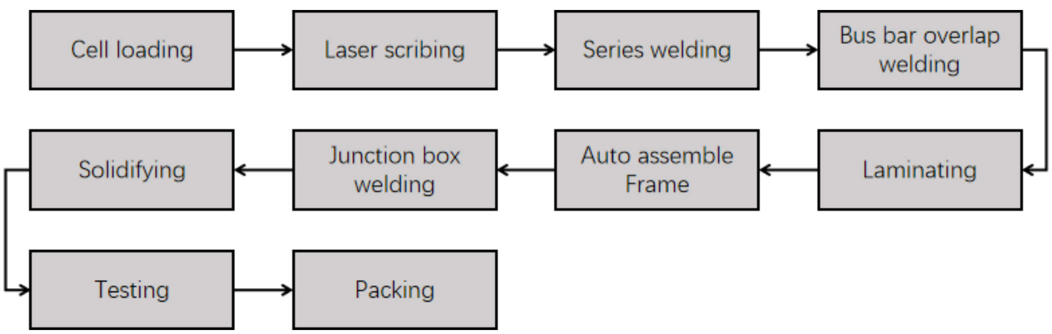


Figure 1. Production Process Flow Diagram

The raw materials are mainly sourced from Jiangsu Province & Zhejiang Province & Sichuan Province in China and delivered by lorry. Transportation information for individual raw materials and components is detailed in the LCA report.

3.2. Packaging

There are four main kinds of packaging materials: Paper board/Paper (corner protector, box, top cover, bottom cover); PE (Wrap film); Steel(Packaging strip); Wood (Pallet).Package composition can be found in the Table 3.

3.3. Transportation

According to LEDVANCE, the production site is in No. 18, Jinwu Road, Yaotang Town, Jintan District, Changzhou City, Jiangsu Province, P.R. China. After the PV module is manufactured, these modules are transported from the production plant in China to Netherlands, Italy and other countries. As it was not possible to define specific distances, justified estimates and web map service according to the agency's locations provided by LEDVANCE were used, see the table 5 below for detailed transport information.

Table 4. Transport to the building site (A4)

SERIES (BRAND NAME)	COUNTRY OF SALE	SEE TRANSPORT DISTANCE (KM)	VEHICLE TYPE	ROAD TRANSPORT DISTANCE (KM)	VEHICLE TYPE
MxxxP54LM-SF/BF/BB-F3	Netherlands	9000	Transoceanic Ship	220 (From the factory gate to the harbor)	Diesel lorry
MxxxP54LB-SF/BF/BB-F3	Australia	7000			
MxxxP72LM-SF/BF/BB-F3	Italy	9000			
MxxxP72LB-SF/BF/BB-F3	Brazil	17000			
MxxxP60UM-SF/BF/BB-F3	Netherlands	9000			
MxxxP60UB-SF/BF/BB-F3	Denmark	8500			
MxxxP66UM-SF/BF/BB-F3	Italy	9000			
MxxxP66UB-SF/BF/BB-F3	Denmark	8500			
MxxxN54LM-SF/BF/BB-F3	Italy	9000			
MxxxN54LB-SF/BF/BB-F3	Netherlands	9000			
MxxxN72LM-SF/BF/BB-F3	Netherlands	9000			
MxxxN72LB-SF/BF/BB-F3	Netherlands	9000			

3.4. Product Installation

After the PV modules are manufactured, the PV modules and other materials, such as brackets, cables, and inverters, are transported to the installation site. During the construction process, construction materials such as concrete and tape are used, and electricity is mainly consumed during the construction process. Since, the construction of PV parks is already very mature, the emissions involved in the construction can be borrowed from background data. Therefore, all installation data concerning the solar PV plant are based on data from the Ecoinvent 3.9.1 database values, and the assumed installation sites provide only nominal solar irradiance data, as well as the installed capacity, with all the PV modules installation site assumed to be Realmonte, Sicily, Italy. The detailed information about the PV plant is listed in Table 6.

Table 6. PV plant information

PARAMETERS	VALUE		SOURCE
	Amount	Unit	
Peak power of the plant	570	KW	Ecoinvent
Plant latitude and longitude	N37 ° 21'44.4", E13 ° 38'24.1"	°	LEDVANCE
Plant altitude	280	m	LEDVANCE
Nominal solar irradiance	1685400	Wh/m2/year	LEDVANCE

3.5. Use and maintenance

The energy produced by a photovoltaic module depends on the installed power peak [Wp] and the module efficiency, the latter decreases with time, due to performance changes during lifespan according to degradation rate.Linear annual degradation was assumed over reference service life (RSL). The table below presents the aggregate power output from power plants to the grid during RSL, based on LEDVANCE's simulation results utilizing Pvsyst software.

Table 7. Energy production over Reference service life

SERIEN (BRAND NAME)	PEAK POWER (KW)	REFERENCE SERVICE LIFE ELECTRICTY GENERATION (KWH)	REMARKS ON CALCULATION
MxxxP54LM-SF/BF/BB-F3	0.415	13499.4105	PERC modules attenuate 2% in the first year and 0.55% annually
MxxxP54LB-SF/BF/BB-F3	0.415	13499.4105	
MxxxP72LM-SF/BF/BB-F3	0.55	17890.785	
MxxxP72LB-SF/BF/BB-F3	0.55	17890.785	
MxxxP60UM-SF/BF/BB-F3	0.605	19679.8635	
MxxxP60UB-SF/BF/BB-F3	0.605	19679.8635	
MxxxP66UM-SF/BF/BB-F3	0.67	21794.229	
MxxxP66UB-SF/BF/BB-F3	0.67	21794.229	
MxxxN54LM-SF/BF/BB-F3	0.44	14798.784	TOP Con modules decay 1% in the first year and 0.4% annually
MxxxN54LB-SF/BF/BB-F3	0.44	14798.784	
MxxxN72LM-SF/BF/BB-F3	0.58	19507.488	
MxxxN72LB-SF/BF/BB-F3	0.58	19507.488	

As water used for cleaning the PV panels is assumed 0.23L per module per time and two times per year, over reference service life (RSL) the water consumption is 13.8L

3.6. Disposal

For the end-of-life stage, disassembled (C1) of the PV plant during the disposal stage is assumed only consumes electricity, and the electricity consumption is assumed the same as the construction stage (A5), 100km transportation distance from plant site to waste treatment site (C2) is assumed, electricity used for PV module demolition during waste processing stage is assumed the same as PV module manufacturing stage (A3). For end of life disposal treatment process (C4), the disposal of other components including inverters is regarded as 100% recyclable and following the end of life load and benefit allocation approach, is then cut off from the analysis. Since there is lack of existing data of recycling rate for PV module, this study refers to legal requirements issued by Waste Electrical and Electronic Equipment (WEEE). In 2012/19/EU-Article 11 & ANNEX V, the required recycling rate for waste PV module is 85%. Therefore, 15% of waste PV module end up with waste disposal, waste management scenario of 20% landfill and 80% incineration was adopted.

4. Life Cycle Assessment Results

Table 8. Description of the system boundary modules

	PRODUCT STAGE			CONSTRUCT-ION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
	Raw material supply	Transport	Manufacturing	Transport from gate to site	Assembly/Install	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste processing	Disposal	Reuse, Recovery, Recycling Potential
EPD Type	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	ND

4.1. Life Cycle Impact Assessment Results-Core environmental impact indicators

Based on the model of PV module products, the EN 15804 result is calculated and the tables below shows the results. Note that impact results are calculated based on 1 kWh electricity generated by the PV plant. The results have been demonstrated through different processes according to the PCR, namely upstream, core, and downstream processes.

Table 5. Core Environmental Impact Category Indicators Assessment Results - MXXXP54LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.76E-05	1.39E-05	1.36E-05	7.12E-08
Climate change ~total	kg $CO_{2\ eq}$	2.00E-02	1.27E-02	7.02E-03	2.75E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	6.24E-05	3.78E-05	2.22E-05	2.46E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.99E-02	1.26E-02	6.99E-03	2.72E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.45E-01	1.50E-01	9.17E-02	3.74E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	2.03E-06	4.25E-08	1.98E-06	2.55E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.65E-05	4.12E-06	1.20E-05	3.79E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	9.33E-05	4.36E-05	4.89E-05	8.58E-07
Acidification	mol $H^{+}{}_{eq}$	2.18E-04	7.36E-05	1.43E-04	1.11E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	1.11E-09	9.19E-10	1.81E-10	5.28E-12
Water use	m^3 world $_{eq}$. deprived	1.79E-02	1.48E-02	3.02E-03	1.20E-04

Table 10. Core Environmental Impact Category Indicators Assessment Results - MXXXP54LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.69E-05	1.32E-05	1.37E-05	7.61E-08
Climate change ~total	kg $CO_{2\ eq}$	1.91E-02	1.18E-02	7.03E-03	2.88E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	5.79E-05	3.32E-05	2.22E-05	2.47E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.90E-02	1.17E-02	7.00E-03	2.85E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.34E-01	1.38E-01	9.18E-02	3.82E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	2.02E-06	3.55E-08	1.98E-06	2.59E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.64E-05	3.94E-06	1.20E-05	4.45E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.94E-05	3.95E-05	4.90E-05	8.98E-07
Acidification	mol $H^{+}{}_{eq}$	2.11E-04	6.67E-05	1.43E-04	1.15E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	3.41E-10	1.55E-10	1.81E-10	5.35E-12
Water use	m^3 world $_{eq}$. deprived	1.76E-02	1.44E-02	3.02E-03	1.21E-04

Table 11. Core Environmental Impact Category Indicators Assessment Results- MXXXP72LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.08E-05	1.35E-05	7.20E-06	7.26E-08
Climate change ~total	kg $CO_{2\ eq}$	1.59E-02	1.16E-02	4.05E-03	2.78E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	4.80E-05	3.34E-05	1.21E-05	2.47E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.59E-02	1.16E-02	4.03E-03	2.76E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	1.96E-01	1.39E-01	5.35E-02	3.76E-03

Depletion of abiotic recourses--minerals and metals [2]	kg Sb_{eq}	1.18E-06	3.75E-08	1.14E-06	2.56E-09
Eutrophication aquatic freshwater	kg P_{eq}	1.13E-05	3.94E-06	6.95E-06	3.98E-07
Photochemcial ozone formation	Kg $NMVOC_{eq}$	6.80E-05	3.87E-05	2.84E-05	8.69E-07
Acidification	mol H^+_{eq}	1.51E-04	6.47E-05	8.54E-05	1.12E-06
Ozone Depletion	Kg CFC 11_{eq}	2.18E-04	1.27E-04	8.84E-05	2.31E-06
Water use	m^3 world $_{eq.}$ deprived	1.97E-05	1.22E-05	7.37E-06	2.04E-07

Table 12. Core Environmental Impact Category Indicators Assessment Results- MXXXP72LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.03E-05	1.29E-05	7.37E-06	7.58E-08
Climate change ~total	kg $CO_{2\ eq}$	1.53E-02	1.08E-02	4.27E-03	2.87E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	5.81E-05	4.35E-05	1.21E-05	2.47E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.52E-02	1.07E-02	4.25E-03	2.84E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	1.88E-01	1.28E-01	5.63E-02	3.81E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb_{eq}	1.17E-06	3.03E-08	1.14E-06	2.58E-09
Eutrophication aquatic freshwater	kg P_{eq}	1.11E-05	3.72E-06	6.96E-06	4.41E-07
Photochemcial ozone formation	Kg $NMVOC_{eq}$	6.94E-05	3.52E-05	3.33E-05	8.95E-07
Acidification	mol H^+_{eq}	1.52E-04	5.89E-05	9.19E-05	1.15E-06
Ozone Depletion	Kg CFC 11_{eq}	2.81E-10	1.76E-10	1.00E-10	5.35E-12
Water use	m^3 world $_{eq.}$ deprived	1.61E-02	1.43E-02	1.68E-03	1.20E-04

Table 13. Core Environmental Impact Category Indicators Assessment Results- MXXXP60UM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.67E-05	1.30E-05	1.36E-05	7.16E-08
Climate change ~total	kg $CO_{2\ eq}$	1.91E-02	1.18E-02	7.01E-03	2.76E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	6.03E-05	3.57E-05	2.22E-05	2.47E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.90E-02	1.17E-02	6.97E-03	2.74E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.35E-01	1.40E-01	9.15E-02	3.75E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb_{eq}	2.02E-06	3.99E-08	1.98E-06	2.56E-09
Eutrophication aquatic freshwater	kg P_{eq}	1.62E-05	3.84E-06	1.20E-05	3.84E-07
Photochemcial ozone formation	Kg $NMVOC_{eq}$	9.04E-05	4.05E-05	4.90E-05	8.62E-07
Acidification	mol H^+_{eq}	2.13E-04	6.85E-05	1.43E-04	1.11E-06
Ozone Depletion	Kg CFC 11_{eq}	9.58E-10	7.72E-10	1.80E-10	5.29E-12
Water use	m^3 world $_{eq.}$ deprived	1.71E-02	1.39E-02	3.02E-03	1.20E-04

Table 14. Core Environmental Impact Category Indicators Assessment Results- MXXXP60UB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.61E-05	1.23E-05	1.36E-05	7.57E-08
Climate change ~total	kg $CO_{2\ eq}$	1.83E-02	1.10E-02	7.03E-03	2.87E-04

Climate change ~biogenic	kg $CO_{2\ eq}$	6.93E-05	4.47E-05	2.22E-05	2.48E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.82E-02	1.10E-02	6.99E-03	2.84E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.24E-01	1.29E-01	9.17E-02	3.81E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	2.02E-06	3.29E-08	1.98E-06	2.59E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.61E-05	3.66E-06	1.20E-05	4.38E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.71E-05	3.69E-05	4.93E-05	8.95E-07
Acidification	mol H^+_{eq}	2.07E-04	6.23E-05	1.44E-04	1.15E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	3.60E-10	1.74E-10	1.81E-10	5.35E-12
Water use	m^3 world $_{eq.}$ deprived	1.67E-02	1.36E-02	3.02E-03	1.21E-04

Table 15. Core Environmental Impact Category Indicators Assessment Results- MXXXP66UM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.67E-05	1.30E-05	1.36E-05	7.15E-08
Climate change ~total	kg $CO_{2\ eq}$	1.89E-02	1.16E-02	7.01E-03	2.76E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	5.97E-05	3.51E-05	2.22E-05	2.47E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.88E-02	1.15E-02	6.98E-03	2.73E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.33E-01	1.38E-01	9.15E-02	3.75E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	2.02E-06	3.49E-08	1.98E-06	2.56E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.62E-05	3.76E-06	1.20E-05	3.82E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.96E-05	3.97E-05	4.90E-05	8.61E-07
Acidification	mol H^+_{eq}	2.11E-04	6.67E-05	1.43E-04	1.11E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	9.57E-10	7.72E-10	1.81E-10	5.30E-12
Water use	m^3 world $_{eq.}$ deprived	1.70E-02	1.39E-02	3.02E-03	1.20E-04

Table 16. Core Environmental Impact Category Indicators Assessment Results- MXXXP66UB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.61E-05	1.23E-05	1.37E-05	7.55E-08
Climate change ~total	kg $CO_{2\ eq}$	1.81E-02	1.08E-02	7.03E-03	2.86E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	6.88E-05	4.42E-05	2.22E-05	2.48E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.80E-02	1.08E-02	6.99E-03	2.84E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.23E-01	1.27E-01	9.17E-02	3.81E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	2.02E-06	2.94E-08	1.98E-06	2.59E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.61E-05	3.60E-06	1.20E-05	4.34E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.65E-05	3.62E-05	4.93E-05	8.93E-07
Acidification	mol H^+_{eq}	2.06E-04	6.09E-05	1.44E-04	1.14E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	3.58E-10	1.72E-10	1.81E-10	5.35E-12
Water use	m^3 world $_{eq.}$ deprived	1.67E-02	1.36E-02	3.02E-03	1.21E-04

Table 17. Core Environmental Impact Category Indicators Assessment Results - MXXXN54LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.56E-05	1.23E-05	1.32E-05	7.18E-08
Climate change ~total	kg $CO_{2\ eq}$	1.84E-02	1.13E-02	6.79E-03	2.73E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	5.83E-05	3.44E-05	2.15E-05	2.38E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.83E-02	1.12E-02	6.76E-03	2.70E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.26E-01	1.34E-01	8.86E-02	3.65E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	1.96E-06	3.61E-08	1.92E-06	2.48E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.57E-05	3.65E-06	1.16E-05	4.08E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.70E-05	3.88E-05	4.74E-05	8.52E-07
Acidification	mol $H^+_{\ eq}$	2.05E-04	6.55E-05	1.38E-04	1.09E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	1.06E-09	8.82E-10	1.75E-10	5.13E-12
Water use	m^3 world $_{eq}$. deprived	1.63E-02	1.32E-02	2.92E-03	1.16E-04

Table 18. Core Environmental Impact Category Indicators Assessment Results - MXXXN54LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.53E-05	1.20E-05	1.32E-05	7.16E-08
Climate change ~total	kg $CO_{2\ eq}$	1.75E-02	1.04E-02	6.82E-03	2.72E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	5.51E-05	3.13E-05	2.15E-05	2.38E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.74E-02	1.04E-02	6.79E-03	2.70E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.16E-01	1.23E-01	8.90E-02	3.65E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	1.95E-06	3.17E-08	1.92E-06	2.48E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.56E-05	3.51E-06	1.16E-05	4.05E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.38E-05	3.50E-05	4.79E-05	8.50E-07
Acidification	mol $H^+_{\ eq}$	1.99E-04	5.89E-05	1.39E-04	1.09E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	3.44E-10	1.63E-10	1.75E-10	5.13E-12
Water use	m^3 world $_{eq}$. deprived	1.61E-02	1.30E-02	2.92E-03	1.16E-04

Table 19. Core Environmental Impact Category Indicators Assessment Results - MXXXN72LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.55E-05	1.22E-05	1.32E-05	6.95E-08
Climate change ~total	kg $CO_{2\ eq}$	1.79E-02	1.09E-02	6.78E-03	2.68E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	6.72E-05	4.34E-05	2.14E-05	2.39E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.78E-02	1.08E-02	6.74E-03	2.65E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.21E-01	1.29E-01	8.84E-02	3.63E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	1.96E-06	3.47E-08	1.92E-06	2.48E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.56E-05	3.55E-06	1.16E-05	3.76E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.55E-05	3.74E-05	4.72E-05	8.36E-07
Acidification	mol $H^+_{\ eq}$	2.02E-04	6.29E-05	1.38E-04	1.08E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	1.26E-09	1.08E-09	1.75E-10	5.12E-12

Water use	m^3 world $_{eq.}$ deprived	1.63E-02	1.32E-02	2.92E-03	1.16E-04

Table 20. Core Environmental Impact Category Indicators Assessment Results - MXXXN72LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
Climate change ~ land use and land use change	kg $CO_{2\ eq}$	2.52E-05	1.20E-05	1.32E-05	6.20E-08
Climate change ~total	kg $CO_{2\ eq}$	1.72E-02	1.02E-02	6.73E-03	2.48E-04
Climate change ~biogenic	kg $CO_{2\ eq}$	5.45E-05	3.07E-05	2.14E-05	2.37E-06
Climate change ~fossil	kg $CO_{2\ eq}$	1.71E-02	1.01E-02	6.70E-03	2.46E-04
Depletion of abiotic recourses-fossil fuels[2]	MJ, net calorific value	2.13E-01	1.21E-01	8.79E-02	3.51E-03
Depletion of abiotic recourses--minerals and metals [2]	kg Sb $_{eq}$	1.95E-06	3.11E-08	1.92E-06	2.43E-09
Eutrophication aquatic freshwater	kg P $_{eq}$	1.54E-05	3.47E-06	1.16E-05	2.76E-07
Photochemcial ozone formation	Kg NMVOC $_{eq}$	8.13E-05	3.41E-05	4.64E-05	7.75E-07
Acidification	mol $H^+{}_{eq}$	1.95E-04	5.72E-05	1.37E-04	1.01E-06
Ozone Depletion	Kg CFC 11 $_{eq}$	3.35E-10	1.56E-10	1.74E-10	5.02E-12
Water use	m^3 world $_{eq.}$ deprived	1.62E-02	1.31E-02	2.92E-03	1.15E-04

4.2. Life Cycle Inventory Results

Table 21. Resource Use- MXXXP54LM-SF/BF/BB-F3Table 21. Resource Use- MXXXP54LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ, LHV	1.55E-01	9.53E-02	5.74E-02	2.45E-03
PERE	MJ, LHV	2.31E-02	1.52E-02	7.22E-03	7.52E-04
PENRM	MJ, LHV	2.96E-02	1.75E-02	1.18E-02	3.68E-04
PERM	MJ, LHV	6.34E-03	4.19E-03	2.07E-03	7.27E-05
PENRT	MJ, LHV	1.85E-01	1.13E-01	6.92E-02	2.82E-03
PERT	MJ, LHV	2.95E-02	1.94E-02	9.30E-03	8.24E-04
FW	m^3	1.65E-04	1.09E-04	5.54E-05	6.17E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ, LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 22. Resource Use- MXXXP54LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	1.49E-01	8.91E-02	5.74E-02	2.48E-03
PERE	MJ,LHV	2.28E-02	1.48E-02	7.23E-03	7.53E-04
PENRM	MJ,LHV	2.72E-02	1.50E-02	1.18E-02	4.01E-04
PERM	MJ,LHV	6.14E-03	4.00E-03	2.07E-03	7.35E-05
PENRT	MJ,LHV	1.76E-01	1.04E-01	6.92E-02	2.88E-03
PERT	MJ,LHV	2.90E-02	1.88E-02	9.30E-03	8.27E-04

FW	m^3	1.63E-04	1.07E-04	5.54E-05	6.30E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 23. Resource Use- MXXXP72LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	1.65E-01	1.19E-01	4.37E-02	3.26E-03
PERE	MJ,LHV	2.61E-02	1.98E-02	5.29E-03	9.97E-04
PENRM	MJ,LHV	3.07E-02	2.03E-02	9.85E-03	5.01E-04
PERM	MJ,LHV	6.56E-03	5.00E-03	1.45E-03	9.66E-05
PENRT	MJ,LHV	1.96E-01	1.39E-01	5.35E-02	3.76E-03
PERT	MJ,LHV	3.27E-02	2.48E-02	6.75E-03	1.09E-03
FW	m^3	1.86E-04	1.42E-04	4.29E-05	8.23E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 24. Resource Use- MXXXP72LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	1.58E-01	1.11E-01	4.40E-02	3.28E-03
PERE	MJ,LHV	2.57E-02	1.94E-02	5.31E-03	9.98E-04
PENRM	MJ,LHV	2.96E-02	1.69E-02	1.23E-02	5.29E-04
PERM	MJ,LHV	6.35E-03	4.79E-03	1.46E-03	9.73E-05
PENRT	MJ,LHV	1.88E-01	1.28E-01	5.63E-02	3.81E-03
PERT	MJ,LHV	3.21E-02	2.42E-02	6.77E-03	1.10E-03
FW	m^3	1.83E-04	1.40E-04	4.29E-05	8.34E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 25. Resource Use- MXXXP60UM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	2.17E-01	1.30E-01	8.36E-02	3.58E-03
PERE	MJ,LHV	3.24E-02	2.08E-02	1.05E-02	1.10E-03
PENRM	MJ,LHV	4.18E-02	2.43E-02	1.71E-02	5.41E-04
PERM	MJ,LHV	8.55E-03	5.43E-03	3.01E-03	1.06E-04
PENRT	MJ,LHV	2.59E-01	1.54E-01	1.01E-01	4.12E-03
PERT	MJ,LHV	4.09E-02	2.62E-02	1.35E-02	1.20E-03

FW	m³	2.31E-04	1.50E-04	8.03E-05	9.03E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 26. Resource Use- MXXXP60UB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	2.09E-01	1.22E-01	8.36E-02	3.62E-03
PERE	MJ,LHV	3.20E-02	2.04E-02	1.05E-02	1.10E-03
PENRM	MJ,LHV	3.77E-02	1.99E-02	1.72E-02	5.81E-04
PERM	MJ,LHV	8.31E-03	5.19E-03	3.02E-03	1.07E-04
PENRT	MJ,LHV	2.47E-01	1.42E-01	1.01E-01	4.20E-03
PERT	MJ,LHV	4.03E-02	2.56E-02	1.35E-02	1.21E-03
FW	m³	2.29E-04	1.47E-04	8.03E-05	9.18E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 27. Resource Use- MXXXP66UM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	2.38E-01	1.41E-01	9.26E-02	3.97E-03
PERE	MJ,LHV	3.58E-02	2.29E-02	1.17E-02	1.22E-03
PENRM	MJ,LHV	4.58E-02	2.64E-02	1.88E-02	5.98E-04
PERM	MJ,LHV	1.01E-02	6.61E-03	3.34E-03	1.18E-04
PENRT	MJ,LHV	2.84E-01	1.68E-01	1.11E-01	4.57E-03
PERT	MJ,LHV	4.59E-02	2.95E-02	1.50E-02	1.34E-03
FW	m³	2.55E-04	1.65E-04	8.90E-05	1.00E-06
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 28. Resource Use- MXXXP66UB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	2.30E-01	1.33E-01	9.27E-02	4.01E-03
PERE	MJ,LHV	3.54E-02	2.25E-02	1.17E-02	1.22E-03
PENRM	MJ,LHV	4.12E-02	2.16E-02	1.90E-02	6.40E-04
PERM	MJ,LHV	9.81E-03	6.34E-03	3.34E-03	1.19E-04

PENRT	MJ,LHV	2.71E-01	1.55E-01	1.12E-01	4.65E-03
PERT	MJ,LHV	4.52E-02	2.89E-02	1.50E-02	1.34E-03
FW	m^3	2.52E-04	1.62E-04	8.90E-05	1.02E-06
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 29. Resource Use- MXXXN54LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	1.56E-01	9.30E-02	6.08E-02	2.61E-03
PERE	MJ,LHV	2.33E-02	1.48E-02	7.66E-03	7.94E-04
PENRM	MJ,LHV	3.09E-02	1.80E-02	1.25E-02	4.12E-04
PERM	MJ,LHV	6.46E-03	4.19E-03	2.20E-03	7.73E-05
PENRT	MJ,LHV	1.87E-01	1.11E-01	7.33E-02	3.02E-03
PERT	MJ,LHV	2.97E-02	1.90E-02	9.86E-03	8.72E-04
FW	m^3	1.66E-04	1.07E-04	5.87E-05	6.61E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 30. Resource Use- MXXXN54LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	1.51E-01	8.71E-02	6.09E-02	2.63E-03
PERE	MJ,LHV	2.31E-02	1.46E-02	7.66E-03	7.95E-04
PENRM	MJ,LHV	2.80E-02	1.48E-02	1.27E-02	4.36E-04
PERM	MJ,LHV	6.32E-03	4.04E-03	2.20E-03	7.78E-05
PENRT	MJ,LHV	1.79E-01	1.02E-01	7.36E-02	3.06E-03
PERT	MJ,LHV	2.94E-02	1.86E-02	9.86E-03	8.73E-04
FW	m^3	1.65E-04	1.05E-04	5.87E-05	6.70E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 31. Resource Use- MXXXN72LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	2.03E-01	1.19E-01	8.01E-02	3.44E-03
PERE	MJ,LHV	3.07E-02	1.95E-02	1.01E-02	1.05E-03

PENRM	MJ,LHV	3.85E-02	2.17E-02	1.62E-02	5.21E-04
PERM	MJ,LHV	9.03E-03	6.03E-03	2.89E-03	1.02E-04
PENRT	MJ,LHV	2.41E-01	1.41E-01	9.64E-02	3.96E-03
PERT	MJ,LHV	3.97E-02	2.56E-02	1.30E-02	1.15E-03
FW	m^3	2.19E-04	1.41E-04	7.71E-05	8.66E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 32. Resource Use- MXXXN72LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
PENRE	MJ,LHV	1.97E-01	1.13E-01	8.01E-02	3.37E-03
PERE	MJ,LHV	3.05E-02	1.93E-02	1.01E-02	1.05E-03
PENRM	MJ,LHV	3.51E-02	1.90E-02	1.57E-02	4.48E-04
PERM	MJ,LHV	8.87E-03	5.88E-03	2.89E-03	1.00E-04
PENRT	MJ,LHV	2.32E-01	1.32E-01	9.58E-02	3.82E-03
PERT	MJ,LHV	3.93E-02	2.52E-02	1.30E-02	1.15E-03
FW	m^3	2.17E-04	1.39E-04	7.71E-05	8.37E-07
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ,LHV	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Acronyms: LHV PENRE = Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw material; PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; SM = Use of secondary materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; LVH=Lower Heating value

Table 33. Output Flows and Waste Categories- MXXXP54LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	4.95E-06	4.90E-06	5.30E-07	0.00E+00
NHWD	kg	3.08E-03	1.12E-03	3.03E-04	1.66E-03
RWD	kg	6.80E-07	4.00E-08	6.27E-07	1.31E-08
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.28E-03	0.00E+00	0.00E+00	1.12E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 34. Output Flows and Waste Categories- MXXXP54LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	3.16E-06	3.11E-06	5.309E-07	0.00E+00
NHWD	kg	1.25E-03	9.88E-04	8.96E-05	1.16E-03
RWD	kg	6.78E-06	3.58E-07	6.27E-06	1.55E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	7.81E-04	0.00E+00	0.00E+00	7.81E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 35. Output Flows and Waste Categories- MXXXP72LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	5.34E-06	4.81E-06	5.30E-07	0.00E+00
NHWD	kg	2.29E-03	8.66E-04	3.03E-04	1.12E-03
RWD	kg	5.48E-06	4.84E-07	4.81E-06	1.83E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.28E-03	0.00E+00	0.00E+00	1.01E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 36. Output Flows and Waste Categories- MXXXP72LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	3.21E-06	2.68E-06	5.30E-07	0.00E+00
NHWD	kg	1.54E-03	6.54E-04	8.11E-05	8.05E-04
RWD	kg	5.45E-06	4.22E-07	4.82E-06	2.04E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	7.21E-04	0.00E+00	0.00E+00	7.21E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 37. Output Flows and Waste Categories- MXXXP60UM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	6.64E-06	6.11E-06	5.31E-07	0.00E+00
NHWD	kg	3.16E-03	1.19E-03	3.63E-04	1.61E-03
RWD	kg	9.86E-06	5.39E-07	9.12E-06	1.94E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.59E-03	0.00E+00	0.00E+00	1.59E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 38. Output Flows and Waste Categories- MXXXP60UB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	5.32E-06	4.79E-06	5.31E-07	0.00E+00
NHWD	kg	2.53E-03	1.05E-03	3.55E-04	1.12E-03
RWD	kg	9.83E-06	4.81E-07	9.13E-06	2.23E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.11E-03	0.00E+00	0.00E+00	1.11E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 39. Output Flows and Waste Categories- MXXXP66UM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	7.26E-06	6.73E-06	5.32E-07	0.00E+00
NHWD	kg	3.54E-03	1.69E-03	2.53E-04	1.60E-03
RWD	kg	1.09E-05	5.61E-07	1.01E-05	2.14E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.74E-03	0.00E+00	0.00E+00	1.74E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 40. Output Flows and Waste Categories- MXXXP66UB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	5.51E-06	4.98E-06	5.32E-07	0.00E+00
NHWD	kg	2.59E-03	1.21E-03	2.55E-04	1.12E-03
RWD	kg	1.09E-05	5.07E-07	1.01E-05	2.44E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.22E-03	0.00E+00	0.00E+00	1.22E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 41. Output Flows and Waste Categories- MXXXN54LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	5.47E-06	4.91E-06	5.10E-07	0.00E+00

NHWD	kg	2.98E-03	1.14E-03	3.03E-04	1.53E-03
RWD	kg	7.18E-06	3.75E-07	6.65E-06	1.56E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.13E-03	0.00E+00	0.00E+00	1.13E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 42. Output Flows and Waste Categories- MXXXN54LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	3.65E-06	3.14E-06	5.10E-07	0.00E+00
NHWD	kg	2.35E-03	9.93E-04	3.01E-04	1.06E-03
RWD	kg	7.17E-06	3.46E-07	6.65E-06	1.73E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	7.86E-04	0.00E+00	0.00E+00	7.86E-04
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 43. Output Flows and Waste Categories-MXXXN72LM-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	5.89E-06	5.38E-06	5.13E-07	0.00E+00
NHWD	kg	3.13E-03	1.32E-03	3.33E-04	1.48E-03
RWD	kg	9.41E-06	4.71E-07	8.75E-06	1.88E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.45E-03	0.00E+00	0.00E+00	1.45E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 44. Output Flows and Waste Categories- MXXXN72LB-SF/BF/BB-F3

INDICATOR	UNIT	TOTAL	UPSTREAM	CORE STREAM	DOWNSTREAM
HWD	kg	5.33E-06	4.82E-06	5.13E-07	0.00E+00
NHWD	kg	2.41E-03	1.06E-03	3.03E-04	1.04E-03
RWD	kg	9.33E-06	4.44E-07	8.75E-06	1.36E-07
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MFR	kg	1.02E-03	0.00E+00	0.00E+00	1.02E-03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Acronyms: HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy

5. LCA Interpretation

The contribution analysis of the PV module products on core LCIA reveals that PV module including raw components production stage and PV plant construction stage are the main contributions to environmental impact categories.

In terms of upstream stage, cell and aluminum bezel are two key influencing components, and in the core stage of PV plant construction, the copper cable and inverters used for PV plant infrastructure are the two key influencing components.

For ADP minerals & metals this indicator is largely due to the use of various metal components (e.g., copper, aluminum, steel, etc.) in PV plant infrastructure, resulting in the vast majority of the contribution from the Core stage.

The LCA study has been carried out based on available information, regional and global database and experience to achieve more accuracy, completeness and representative of the results. The production stage data in this study are derived from the most recent ERP data, and due to the allocation principle, the LCA results can represent the company's average level of similar products.

6. Additional Environmental Information

Clean Solar Energy

LEDVANCE has always been committed to the research, development and promotion of high-efficiency photovoltaic products, making significant contributions to the global dual-carbon goal. We strive to use the clean solar energy to promote energy transformation. We are committed to systematically addressing the issues of economic development, environmental protection and energy security and providing the clean solar energy to the public. We not only conduct our operation in a responsible manner, but also contribute to meet the rising demand for clean energy by establishing Product Stewardship Policy, technological innovations, efficiency improvement, so as to actively respond to global climate change.

Sustainable Use of Water Resource

LEDVANCE regards protecting water resource as one of its important tasks, and strives to reduce the consumption of water resource per MW module production through sustainable use of water resource. Solar module production consumes a lot of water. To carry out water conservation management, we setup water saving goals for each workshops and implemented various of water saving projects, such as reuse of RO (Reverse Osmosis) rejected water, treat and reuse of wastewater, collection of condensated water from air conditioning system etc. We setup a strict maintenance scheme to clean RO membrane to increase DI(De-ionized) water yield. With business expanding, total amount of water consumption is in increasing trend. But as we continue to develop and implement water conservation projects, our water use efficiency continues to increase.

Certifications

Plants of LEDVANCE & suppliers 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

- ISO 45001: Occupational Health and Safety Management System
- IECQ QC 080000:2017 Hazardous Substances Management System

7. References

Additional information about LEDVANCE products can be found on the website: https://www.ledvance.com/

8. References

1) ISO 14067:2018 Carbon footprint of products —Requirements and guidelines for quantification and communication

2) ISO 14040:2006 Environmental management — Life cycle assessment —Principles and Framework

3) ISO 14044:2006 Environmental management- Life cycle assessment Principles and guidelines

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

5) EN 50693:2019 Product category rules for life cycle assessments of electronic and electrical products and systems

6) PCR EPDItaly014: Electricity Produced by Photovoltaic Modules.

7) ISO 14025: ISO14025:2011-10, Environmental labels and declarations - Type III environmental declarations - Principles and procedures.

8) www.polywater.com: Water Consumption in PV Panel Cleaning.

9) GB 50797-2012 Design specification for photovoltaic power station.