Environmental Product Declaration

In accordance with ISO 14025 and EN 15804

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Jolywood

N-type Bifacial Double Glass Photovoltaic Modules

Programme information

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

Product category rules (PCR):	*PCR 2007:08 Electricity, steam and hot water generation and distribution (Version 4.0)*
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Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification	
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Company information

Owner of the EPD:
Jolywood (Taizhou) Solar Technology Co., Ltd
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Description of the organisation:
Founded in 2008, Jolywood (Taizhou) Solar Technology Co., Ltd is the world's largest manufacturer of NTOPCon (N-type) bifacial solar panel, with a registered capital of 1.5 billion RMB, N-type bifacial solar panel of more than 3GW capacity. In the N-type bifacial solar panel field, Jolywood has complete independent intellectual property rights. It has applied for 99 related patents, including 58 granted patents and PCT5 items.

Up to now, Jolywood has established strategic partnerships with a number of large-scale industry groups such as the National Power Investment Yellow River Hydropower and Shanghai Electric. In overseas markets, the high efficiency N-type bifacial panels have been used in the largest solar project in Oman, Middle East. The company focuses on innovative R&D and high-quality manufacturing of photovoltaic auxiliary materials, solar cells and modules, system integration and other products. Jolywood was awarded financial health Top3 by Photon.


Figure 1 Jolywood (Taizhou) Solar Technology Co., Ltd

Product information

Product name:
Jolywood N-type Bifacial Double Glass Photovoltaic Modules

UN CPC code:
171 Electrical Energy

Geographical scope: Global

Product description:
Jolywood produces more than a dozen series of mono-crystalline silicon PV modules. With higher efficiency, higher bifaciality (up to 85%), lower degradation, and lower temperature co-efficiency (≤0.32%), the N-Type solar systems can generate extra power, therefore reducing solar projects' levelized cost of energy (LCOE), and bringing better investment return for customers. Combined with Jolywood's leading technologies of NTOPCon bifacial, 9BB, and half-cell, the Jolywood N-type bifacial modules can reach power output up to 420W, long lifetime, no light-induced degradation (LID), and higher bifaciality.

Within this project, in total there are 12 models of double glass PV modules that were analyzed:

- JW-HD144N-158.75 with frame
- JW-HD144N-158.75 without frame

- JW-HD156N-158.75 with frame
- JW-HD156N-158.75 without frame

- JW-HD120N-158.75 with frame
- JW-HD120N-158.75 without frame

- JW-D60N-158.75 with frame
- JW-D60N-158.75 without frame

- JW-D72N-158.75 with frame
- JW-D72N-158.75 without frame

- JW-HD120N-166 with frame
- JW-HD144N-166 with frame

Note: H: Half-cells; D: Double glass; N: N-type cells; 60/72/120/144/156: Number of cells ; 158.75/166: side length (mm) of cells.

Product Application:

Jolywood N-Type bifacial modules can be widely used in rooftop and ground solar farms. Also, the products have wider application areas, such as high temperature regions, heavy snow regions, water surface systems, agriculture greenhouses, etc..

Product identification:

Table 1 Product technical specifications

Double Glass Modules		Peak Power/W	Module efficiency/%
With frame	JW-HD144N-158.75	420	20.92
	JW-HD156N-158.75	455	20.96
	JW-HD120N-158.75	350	20.79
	JW-D60N-158.75	345	20.74
	JW-D72N-158.75	415	20.92
	JW-HD120N-166	390	21.17
	JW-HD144N-166	470	21.39
Without frame	JW-HD144N-158.75	420	20.92
	JW-HD156N-158.75	455	20.96
	JW-HD120N-158.75	350	20.79
	JW-D60N-158.75	345	20.74
	JW-D72N-158.75	415	20.92

Manufacturing Process:

The manufacturing process of PV modules includes solar cells production and PV modules production. Figure 2 and Figure 3 below are flowcharts depicting the production process stages of the declared products. For simplification purpose, only main stages of manufacturing are presented. Raw material, auxiliary processes that were considered in the LCA but not shown in the flowcharts include:

- Raw and auxiliary material production and transportation
- Recycling of waste materials;
- Waste water and off-gas treatment;
- Water recycling and reuse system;
- Supply of natural gas/water/electricity

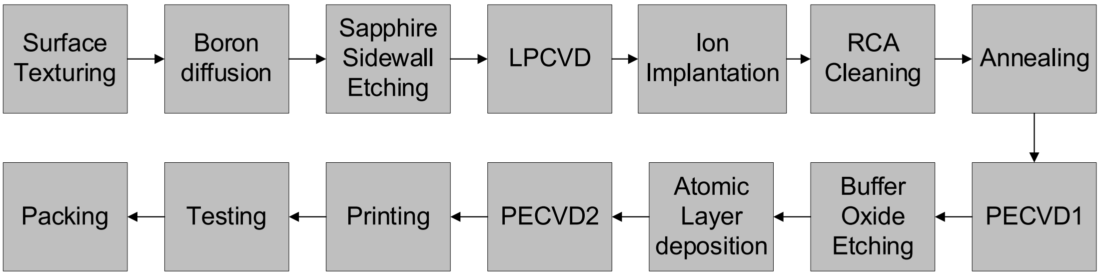

Figure 2 Manufacturing process flowchart of solar cells

Solar cells production

Step 1: Surface Texturing
In order to reduce the reflection of incident light for enhancing the conversion efficiency of solar cells, a texturing structure needs to be formed at the surface of the wafer by using chemical etching processing.

Step 2: Boron diffusion
Boron gases are introduced into the tube and pass through the wafers so that a layer of boron doped layer is formed on the wafer surfaces. The following high temperature process drives the boron into the surface areas of the wafers and a P-N junction is formed at the surface region.

Step 3: Sapphire Sidewall Etching
During the Boron diffusion for P-N junction formation, a layer of silicate glass is coated at the surface of the wafers. It is necessary to remove the silicate glass before further processing for solar cells. The removal processing is composed of diluted hydrofluoric (HF) etching and rinse.

Step 4: Low pressure chemical vapor deposition (LPCVD)
Silicon nitride films were prepared by low pressure chemical vapor deposition (LPCVD) at 800 ℃ with different process gas flow ratios.

Step 5: Ion Implantation
The doping of N + and P + region is realized by boron ion implantation.

Step 6: RCA Cleaning
Removal of particulate matter and metal ions from the surface of silicon wafer by multi-channel cleaning.

Step 7: Annealing
By heating and drying the back passivated silicon wafer, the water vapor can be completely removed through negative pressure ventilation, and the impurities in the silicon wafer can be more fully separated out and defects can be reduced by gradient cooling.

Step 8: Plasma enhanced chemical vapor deposition 1 (PECVD1)
The plasma enhanced chemical vapor deposition (PECVD) method was used to coat the surface of silicon wafer with a layer of SixNy by conducting the graphite boat at 480 ℃ in vacuum.

Step 9: Buffer Oxide Etching (BOE)
BOE solution, namely buffer oxide etching solution, is a mixture of hydrofluoric acid and ammonium fluoride. The volume ratio of hydrofluoric acid and ammonium fluoride in the mixed solution is 1:6 to clean the secondary suede.

Step 10: Atomic Layer deposition
Advanced atomic layer deposition (ALD) aluminum oxide (Al_2O_3) method was used to passivate the front surface of battery.

Step 11: Plasma enhanced chemical vapor deposition 2 (PECVD2)
The plasma enhanced chemical vapor deposition (PECVD) method was used to coat the surface of silicon wafer with a layer of SixNy by conducting the graphite boat at 480 ℃ in vacuum.

Step 12: Printing
The printing process is based on the principle that the part of the screen pattern is permeated with the paste through the mesh and the non-permeable part is impervious to the paste. Using screen printing process, the corresponding metal electrodes are printed on the upper and lower surfaces of the fabricated P-N junction silicon wafer to collect and conduct the photocurrent generated by illumination.

Step13: Testing
Under standard test condition (STC), test the solar cells by sunlight simulator after production completed, and then sort them into varied class.

Step 14: Packing
Pack the tested cells according to different grades and efficiencies.

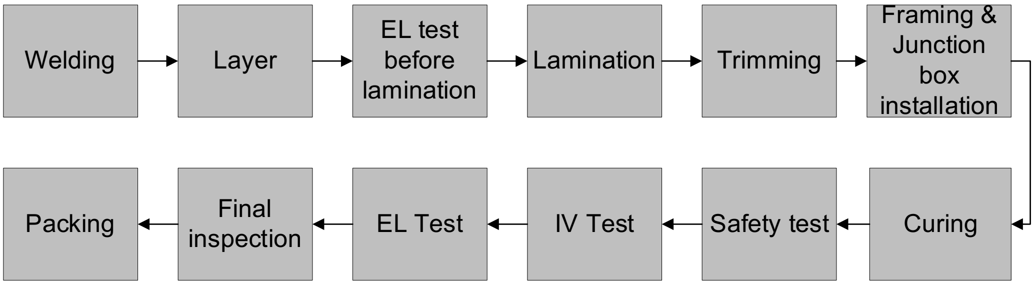

Figure 3 Manufacturing process flowchart for PV modules

PV modules production

Step 1: Welding
The bus bar is welded to the main grid line on the front and back of the cell. The bus bar is tinned copper strip. The welding machine can spot-weld the strip on the main grid line in the form of multiple points.

Step 2: Layer
Connect the cells in series to form a PV layer. The positioning of the cell mainly depends on the template.

Step 3: Electroluminescent (EL) Imaging test before lamination
Conduct appearance and EL imaging inspection on the PV modules before lamination.

Step 4: Lamination
The assembled PV modules are put into the laminating machine, the air in the modules is extracted by vacuuming, and then the Ethylene Vinyl Acetate (EVA)/ Polyolefin Encapsulant (POE) is melted by heating, and the battery, glass and backplane are bonded together.

Step 5: Trimming
During lamination, EVA melts and extends outward due to pressure to form burr, so it should be cut off after lamination.

Step 6: Framing & junction box installation
Aluminum frame is installed on the glass module to increase the strength of the module, further seal the battery module and prolong the service life of the Cell. Weld a box at the back lead of the module to facilitate the connection between the battery and other devices or batteries.

Step 7: Curing
Under the condition of 25 ± 5 ℃ and more than 60% humidity, curing the PV Modules frame glue and junction box glue.

Step 8: Safety test
A certain voltage is applied between the frame and the electrode lead to test the withstand voltage and insulation strength of the module to ensure that the module will not be damaged under adverse natural conditions (such as lightning strike). Test the grounding performance of modules to ensure the safety of modules.

Step 9: IV Test
standard test condition (STC), the output power of the module is calibrated and its output characteristics are tested.

Step 10: EL Test
Electroluminescent imaging technology is used to detect the potential defects and control the product quality.

Step 11: Final inspection
Inspect the appearance of the modules and judge its grade.

Step 12: Packing
Package the modules after testing according to the standard.

Content declaration

Raw materials of the different PV modules are mostly the same, including solar cells, solar glass, aluminum frame, silica gel, junction box and packaging etc. The type and ratio of raw materials per 1000 pcs PV modules are listed in Table 2.

Table 2 Raw materials of double glass PV modules

Materials	**Units**	**JW-HD144N-158.75-with frame**	**JW-HD144N-158.75-without frame**	**JW-HD156N-158.75-with frame**	**JW-HD156N-158.75-without frame**	**JW-HD120N-158.75-with frame**	**JW-HD120N-158.75-without frame**	**JW-D60N-158.75-with frame**	**JW-D60N-158.75-without frame**	**JW-D72N-158.75-with frame**	**JW-D72N-158.75-without frame**	**JW-HD120N-166-with frame**	**JW-HD144N-166-with frame**
Solar cells	kg	658.80	658.80	713.70	713.70	549.00	549.00	549.00	549.00	658.80	658.80	592.92	711.50
Glass	kg	24,873.75	24,873.75	26,903.25	26,903.25	20,839.50	20,839.50	20,592.00	20,592.00	24,576.75	24,576.75	18,254.32	21,776.70
POE film	kg	2,080.00	2,080.00	2,243.44	2,243.44	1,741.00	1,741.00	1,853.00	1,853.00	2,208.60	2,208.60	1,883.17	2,247.40
Frame	kg	1,800.00	0	1,921.00	0	1,500.00	0	1,488.80	0	1,730.00	0	1,569.20	1,759.10
Silica gel	kg	300.82	64.00	309.00	64.00	275.82	64.00	266.00	64.00	291.83	64.00	285.50	311.59
Ribbon-Cu	kg	214.40	214.40	227.20	227.20	178.66	178.66	246.40	246.40	295.68	295.68	192.95	231.54
Ribbon-Sn/Pb	kg	53.60	53.60	56.80	56.80	44.66	44.66	61.60	61.60	73.92	73.92	48.23	57.88
Junction Box-PPO	kg	21.54	21.54	21.54	21.54	21.54	21.54	21.54	21.54	21.54	21.54	21.54	21.54
Junction Box-Diode	kg	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09	4.09
Junction Box-Connector	kg	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67	24.67
Junction Box-Copper Plate	kg	15.69	15.69	15.69	15.69	15.69	15.69	15.69	15.69	15.69	15.69	15.69	15.69
Junction Box-Cable	kg	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00	39.00
Cardboard	kg	671.43	671.43	771.43	771.43	571.43	571.43	485.71	485.71	571.43	571.43	600.00	640.00
Wood board	kg	1,205.00	1,205.00	1,285.71	1,285.71	1,142.86	1,142.86	1,085.71	1,085.71	1,171.43	1,171.43	1,200.00	1,660.00
PET belt	kg	58.60	58.60	61.52	61.52	54.42	54.42	47.20	47.20	58.79	58.79	56.42	59.42
PE film sleeve	kg	6.57	6.57	8.57	8.57	5.71	5.71	5.71	5.71	6.57	6.57	5.92	7.06
PE stretch film	kg	13.50	13.50	17.14	17.14	10.64	10.64	10.00	10.00	12.14	12.14	11.01	13.13
Isopropanol	kg	25.84	25.84	27.99	27.99	21.53	21.53	12.54	12.54	15.04	15.04	23.25	27.90
Active agent	kg	1.36	1.36	1.47	1.47	1.13	1.13	0.66	0.66	0.79	0.79	1.22	1.47

Transportation

The transportation mainly takes place on the upstream of raw material supply and downstream of PV modules and other equipment delivery to the solar PV plant.

According to Jolywood, the production site is in Taizhou, Jiangsu Province. The raw materials are mainly sourced from Jiangsu and Zhejiang Province, and delivered by lorry. As it was not possible to define specific distances, justified estimates and web map service according to the suppliers' locations provided by Jolywood were used. For all transportation vehicles, since it was not specified, unspecified EURO 4 lorry was used for LCA modelling for simplification purpose.

Product Installation

The specific data regarding PV modules installation was taken from a real PV plant in Guangxi Province in China. The PV plant with energy yield capacity at 60MW was constructed with Jolywood JW-D72N-158.75 (with frame) PV modules. The detailed information about the PV plant is listed in Table 3. After the PV modules are manufactured, the PV modules, along with other materials, such as brackets, cable, inverters are transported to the installation site. During the construction, construction materials like concrete, tape are needed, and the construction process consumes mainly electricity.

Table 3 PV plant information

Parameters	Value		Source
	Amount	Unit	
Peak power of the plant	60,000	KW	Jolywood
Plant latitude and longitude	N24°44, E 108°46	°	Jolywood
Plant altitude	21	m	Jolywood
Nominal solar irradiance	1,467,300	Wh/m²/year	Jolywood

Use, Maintenance, and Reference Service Life

In terms of electricity generation during RSL (30 years), as provided by Jolywood, the electricity generation in the first year is based on the real monitoring data, total electricity generation during RSL can be calculated with following equation:

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

where E_{RSL} is electricity generation during RSL, E_1 is electricity generation for the first year of operation, deg is yearly degradation rate (%), 0.3% in this study. n (n=30) is RSL. Table 4 listed electricity generation for the first year of operation and the electricity generation during RSL for all modules.

Table 4 Electricity generation during RSL for all PV modules

Electricity generation	Unit	Value
E_1	kWh	74,065,250
E_{RSL}	kWh	2,127,954,734

Reuse, Recycling, Energy Recovery, and Disposal

According to Jolywood, the products reuse & recycling rate has been tested by TÜV SÜD Greater China, proved that all the components (including glass, frame etc.) of PV module have a recycling rate of higher than 95%. The evaluation was carried out following the rules of 2012/19/EU-Article 11 & ANNEX V issued by Waste Electrical and Electronic Equipment (WEEE), and the recycling and recovery weight results complying with the legal requirements. The disposal of other components including inverters was regarded as 100% recyclable and following the end-of-life load and benefit allocation approach, was then cut off from the analysis. Therefore, only 5% mass of glass will end up with waste disposal according to the WEEE assessment report. For the waste scenario, De-construction (C1) of the PV plant during the disposal stage was assumed to consume mainly electricity, and the electricity consumption was assumed the same as the construction stage (A5). 100km of road transportation (C2) from the plant site to waste treatment site was assumed. For end-of-life disposal treatment process (C4), waste management scenario of 20% landfill and 80% incineration was adopted.

LCA information

Functional unit:
In this report, the functional unit is defined as 1 kWh net of electricity generated by PV modules and thereafter distributed to the customer.

Time representativeness:
The study used primary data collected from January 2019 to December 2019.

Database(s) and LCA software used:
Generic data including material, energy as well as waste disposal and transportation are taken from the LCI-database Ecoinvent 3.4 with regional energy and material mix data coming from adapted China local LCI data (1mi1,2020). For the modeling and calculation, the LCA-software SimaPro version 9.1 was used.

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 calculated and submitted by Jolywood. Emission data was taken from the greenhouse gas inventory report in 2019 of Jolywood;
- *Generic data* related to the life cycle impacts of the material or energy flows that enter the production system. These data were sourced from the databases in SimaPro 9.1;
- Existing LCI data were, at most, 10 years old. Newly collected LCI data were current or up to 3 years old;
- The LCI data related to the geographical locations where the processes took place, e.g. electricity and transportation data from China, disposal data from China and Europe were utilized;
- The scenarios represented the average technologies at the time of data collection.

System diagram:

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

Manufacturing Stage			**Distribution stage**	**Installation Stage**	**Use Stage**							**De-Installation Stage**	**End-of-life Stage**			**Resource recovery stage**
Raw Material	Transport	Manufacturing	Transport	Assembly / Install	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction and demolition	Transport	Waste processing	disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	MND

The system boundary considered in this LCA study is from cradle to grave, except use by end consumer. According to the PCR, the life cycle stage must refer to segmentation in the following three processes:

1. *Upstream process*: which includes all the processes upstream of the production of the PV modules and distribution to the solar PV plant. According to the PCR, the gate in this study is defined as the fence of solar PV plant. The upstream includes extraction and processing of raw materials (A1), transportation of the raw material to the factory (A2), manufacturing of the solar cells and PV modules (A3) with the supply of the energy and auxiliary material inputs, emissions, and distribution of PV modules to solar PV plant (A4). The upstream ends at the beginning of PV plant construction;

2. *Core process*: which includes all the relevant processes managed by the Organization proposing the EPD. The core module in this study includes the 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. However, considering that the installation and operation is beyond the control of Jolywood, for simplification purpose, assumption was made on the life cycle inventory (LCI) data during the modeling of core modules;

3. *Downstream process*: which includes all the relevant processes that take place outside of the control of the Organization proposing the EPD. In this study, the downstream module includes de-construction and demolition of the solar plant (C1), transport to waste processing (C2), waste processing (C3) and disposal (C4). 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. Due to the fact that it will take 30 years to enter the end-of-life stage for the PV modules, scenarios have to be developed for end-of-life treatment. For simplification purpose, assumption was made during the modeling of downstream modules.

Figure 4 below illustrates the system boundaries for Jolywood's PV module products, including raw material production and transportation, manufacture, delivery, solar plant installation and End-of-life.

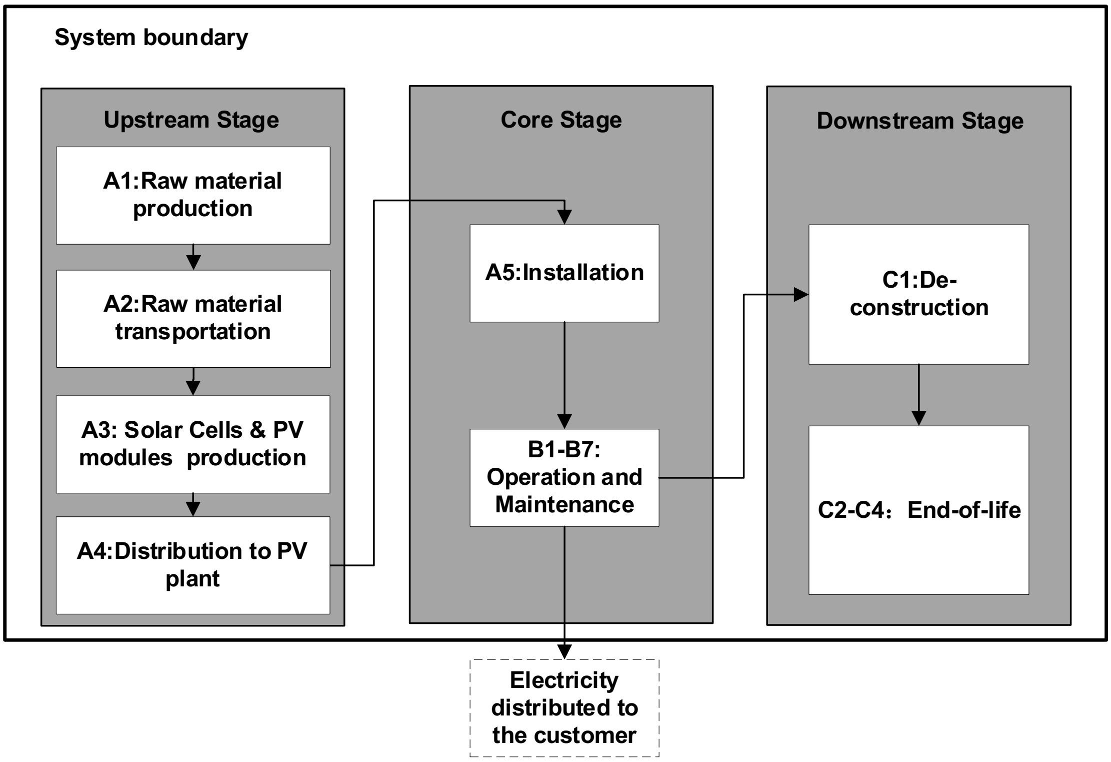

Figure 4 System boundary of PV module products

<u>Excluded Processes:</u>
The following steps/stages were not included in the system boundary due to the reason that the elements below are considered irrelevant or not within the boundary to the LCA study of PV module products：

- Production and disposal of the infrastructure and capital equipment (buildings, machines, transport media, roads, etc.) during PV modules manufacturing and solar plant construction and maintenance.
- The load and benefit of recycling waste solar module as well as waste equipment from solar plant were excluded from the analysis.
- The packaging for silicon wafer and solar cells is reused internally and its impact was excluded from the system;
- Emissions during the solar PV plant construction and operation due to no obvious emission observation.
- Storage phases and sales of PV products due to no observable impact;
- Product losses due to abnormal damage such as natural disaster or fire accident. These losses would mostly be accidental;
- Recycling process of defective products;
- Handling operations at the distribution center and retail outlet due to small contribution and negligible impact;
- Electricity loss during transmission of electricity from the plant distributed to the grid or the customer and usage of electricity.

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

- For missing background data, substitution of missing data using similar background data approach was taken to shorten the gap. A sensitivity analysis was conducted.
- According to Jolywood, the production of 158.75 mm solar cells and 166 mm solar cells are same, materials inputs of 166 mm solar cells is 1.08 times that of 158.75 mm cells based on cells area ratio (1662/158.752=1.08). While energy consumption and emissions per cell are the same.
- According to Jolywood, the reference PV plant (60MW) is built with JW-D72N-158.75 (with frame) PV modules. Electricity generation during RSL of other PV module models analysed in this study was assumed the same due to the same installation capacity (60MW) of the plant.
- Water for cleaning the PV modules during the PV plant operation and maintenance was assumed done by rainfall as the region is rich in precipitation.
- De-construction (C1) of the PV plant during the disposal stage consumes mainly electricity, and the electricity consumption was assumed the same as the electricity consumption in PV plant construction stage (A5).
- 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 was assumed to be 100 km for simplification purposes. A sensitivity analysis was conducted.

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 was generally carried out via the mass. The consumption of raw materials and the transportation of raw materials was allocated by mass ratio.

Multi-output processes

During the production of Solar Cells and PV modules, the total consumption of energy and water during manufacturing was equally allocated to per unit mass. There are no by-products that need to be allocated.

Allocation for recovery processes

For the allocation of residuals, the model “allocation cut-off by classification (ISO standard) (called “Allocation Recycled Content”, alloc rec, by Ecoinvent) was used. 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 was 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 and etc., was also allocated to the next life cycle of substituted products, but not the primary producers, hence no burden or benefit was allocated to the primary producer of the PV module or solar PV plant (cut-off approach).

Cut-off rules:
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;
- According to PCR, data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts shall be included. Therefore, the cut off criteria was set to 1% in this study. The neglected flows are demonstrated in Table 5 below.

Table 5 Cut-off flows

Flow name	**Process stage**	**Mass %**	**Reason to cut off**
Additive-Potassium Sorbate	A1	0.01%	<1%
Additive-Sodium Acetate	A1	0.02%	<1%
Additive-Defoamer	A1	0.03%	<1%
Additive-Surfactant	A1	0.08%	<1%
Boron tribromide	A1	0.01%	<1%
Phosphine	A1	0.0003%	<1%
TMA	A1	0.0008%	<1%
Screen (photosensitive adhesive)	A1	4E-05%	<1%
Hollow partition (EPE)	A1	0.02%	<1%
Foam body (EPE)	A1	0.02%	<1%
Potassium Dihydrogen Phosphate	A1	0.17%	<1%
Total cut off mass % estimated		0.36%	<1%

Environmental performance

To analysis the contribution of different life stages to the environmental impacts, a LCIA was conducted using EN 15804 method. The result was allocated by stages, as shown in tables below.

Table 6 Environmental impacts of JW-HD144N-158.75-with frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,43E-03	5,79E-03	2,16E-04	1,54E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,08E-03	-2,13E-05	-1,30E-06	-1,10E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,57E-05	4,89E-06	2,13E-08	2,06E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,37E-03	5,78E-03	2,15E-04	1,44E-02
Acidification potential (AP)	Kg SO_2 eq.	6,42E-05	1,11E-04	1,10E-06	1,76E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,33E-06	2,07E-05	2,34E-08	2,91E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,55E-05	3,66E-05	7,24E-07	7,28E-05
Particulate matter	kg PM2.5 eq.	6,10E-06	1,15E-05	7,84E-08	1,76E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,09E-06	4,42E-07	1,61E-10	1,53E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,92E-02	6,42E-02	2,22E-03	1,66E-01
Water scarcity footprint	m^3 H_2O eq.	8,07E-02	1,08E+00	1,12E-05	1,16E+00

Table 7 Environmental impacts of JW-HD144N-158.75-without frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,15E-03	5,79E-03	2,15E-04	1,52E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,07E-03	-2,13E-05	-1,30E-06	-1,09E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,45E-05	4,89E-06	2,06E-08	1,94E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,09E-03	5,78E-03	2,13E-04	1,41E-02
Acidification potential (AP)	Kg SO_2 eq.	6,18E-05	1,11E-04	1,09E-06	1,74E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,04E-06	2,07E-05	2,33E-08	2,88E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,37E-05	3,66E-05	7,15E-07	7,11E-05
Particulate matter	kg PM2.5 eq.	5,85E-06	1,15E-05	7,74E-08	1,74E-05
Abiotic depletion potential – Elements	Kg Sb eq.	8,89E-07	4,42E-07	1,56E-10	1,33E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,52E-02	6,42E-02	2,20E-03	1,62E-01
Water scarcity footprint	m^3 H_2O eq.	8,05E-02	1,08E+00	1,10E-05	1,16E+00

Table 8 Environmental impacts of JW-HD156N-158.75-with frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,43E-03	5,53E-03	2,16E-04	1,52E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,08E-03	-2,10E-05	-1,30E-06	-1,10E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,58E-05	4,88E-06	2,11E-08	2,07E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,37E-03	5,51E-03	2,15E-04	1,41E-02
Acidification potential (AP)	Kg SO_2 eq.	6,42E-05	1,06E-04	1,10E-06	1,72E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,32E-06	1,99E-05	2,34E-08	2,83E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,56E-05	3,51E-05	7,22E-07	7,13E-05
Particulate matter	kg PM2.5 eq.	6,11E-06	1,10E-05	7,81E-08	1,72E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,10E-06	4,26E-07	1,59E-10	1,52E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,93E-02	6,16E-02	2,22E-03	1,63E-01
Water scarcity footprint	m^3 H_2O eq.	8,13E-02	1,02E+00	1,12E-05	1,10E+00

Table 9 Environmental impacts of JW-HD156N-158.75-without frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,15E-03	5,53E-03	2,14E-04	1,49E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,07E-03	-2,10E-05	-1,30E-06	-1,09E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,46E-05	4,88E-06	2,04E-08	1,95E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,10E-03	5,51E-03	2,13E-04	1,38E-02
Acidification potential (AP)	Kg SO_2 eq.	6,18E-05	1,06E-04	1,09E-06	1,69E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,04E-06	1,99E-05	2,33E-08	2,80E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,38E-05	3,51E-05	7,13E-07	6,96E-05
Particulate matter	kg PM2.5 eq.	5,87E-06	1,10E-05	7,72E-08	1,69E-05
Abiotic depletion potential – Elements	Kg Sb eq.	8,96E-07	4,26E-07	1,55E-10	1,32E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,54E-02	6,16E-02	2,19E-03	1,59E-01
Water scarcity footprint	m^3 H_2O eq.	8,12E-02	1,02E+00	1,10E-05	1,10E+00

Table 10 Environmental impacts of JW-HD120N-158.75-with frame

Parameter	**Unit**	**Upstream**	**Core**	**Downstream**	**Total**
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	1,01E-02	6,76E-03	2,23E-04	1,70E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,25E-03	-2,24E-05	-1,30E-06	-1,28E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,64E-05	4,93E-06	2,38E-08	2,13E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,81E-03	6,74E-03	2,21E-04	1,58E-02
Acidification potential (AP)	Kg SO_2 eq.	6,81E-05	1,27E-04	1,13E-06	1,96E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,73E-06	2,36E-05	2,39E-08	3,23E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,76E-05	4,23E-05	7,59E-07	8,07E-05
Particulate matter	kg PM2.5 eq.	6,44E-06	1,33E-05	8,18E-08	1,98E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,13E-06	5,00E-07	1,77E-10	1,63E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	1,06E-01	7,35E-02	2,32E-03	1,81E-01
Water scarcity footprint	m^3 H_2O eq.	8,36E-02	1,32E+00	1,18E-05	1,40E+00

Table 11 Environmental impacts of JW-HD120N-158.75-without frame

Parameter	**Unit**	**Upstream**	**Core**	**Downstream**	**Total**
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,74E-03	6,76E-03	2,20E-04	1,67E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,25E-03	-2,24E-05	-1,30E-06	-1,27E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,51E-05	4,93E-06	2,27E-08	2,00E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,51E-03	6,74E-03	2,19E-04	1,55E-02
Acidification potential (AP)	Kg SO_2 eq.	6,55E-05	1,27E-04	1,12E-06	1,94E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,43E-06	2,36E-05	2,37E-08	3,20E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,57E-05	4,23E-05	7,44E-07	7,87E-05
Particulate matter	kg PM2.5 eq.	6,18E-06	1,33E-05	8,03E-08	1,96E-05
Abiotic depletion potential – Elements	Kg Sb eq.	9,23E-07	5,00E-07	1,70E-10	1,42E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	1,01E-01	7,35E-02	2,28E-03	1,77E-01
Water scarcity footprint	m^3 H_2O eq.	8,34E-02	1,32E+00	1,15E-05	1,40E+00

Table 12 Environmental impacts of JW-D60N-158.75-with frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	1,04E-02	6,60E-03	2,22E-04	1,72E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,22E-03	-2,22E-05	-1,30E-06	-1,25E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,68E-05	4,92E-06	2,37E-08	2,18E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	9,16E-03	6,58E-03	2,21E-04	1,60E-02
Acidification potential (AP)	Kg SO_2 eq.	7,31E-05	1,24E-04	1,13E-06	1,99E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	9,86E-06	2,31E-05	2,39E-08	3,30E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,93E-05	4,14E-05	7,56E-07	8,14E-05
Particulate matter	kg PM2.5 eq.	6,88E-06	1,30E-05	8,16E-08	2,00E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,19E-06	4,90E-07	1,76E-10	1,68E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	1,09E-01	7,19E-02	2,32E-03	1,84E-01
Water scarcity footprint	m^3 H_2O eq.	8,83E-02	1,28E+00	1,18E-05	1,36E+00

Table 13 Environmental impacts of JW-D60N-158.75-without frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	1,01E-02	6,60E-03	2,21E-04	1,69E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,21E-03	-2,22E-05	-1,30E-06	-1,24E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,55E-05	4,92E-06	2,30E-08	2,05E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,87E-03	6,58E-03	2,19E-04	1,57E-02
Acidification potential (AP)	Kg SO_2 eq.	7,06E-05	1,24E-04	1,12E-06	1,96E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	9,56E-06	2,31E-05	2,38E-08	3,27E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,74E-05	4,14E-05	7,47E-07	7,96E-05
Particulate matter	kg PM2.5 eq.	6,62E-06	1,30E-05	8,07E-08	1,97E-05
Abiotic depletion potential – Elements	Kg Sb eq.	9,75E-07	4,90E-07	1,71E-10	1,47E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	1,05E-01	7,19E-02	2,29E-03	1,79E-01
Water scarcity footprint	m^3 H_2O eq.	8,82E-02	1,28E+00	1,16E-05	1,36E+00

Table 14 Environmental impacts of JW-D72N-158.75-with frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,43E-03	5,79E-03	2,16E-04	1,54E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,04E-03	-2,13E-05	-1,30E-06	-1,06E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,57E-05	4,89E-06	2,11E-08	2,06E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,41E-03	5,78E-03	2,15E-04	1,44E-02
Acidification potential (AP)	Kg SO_2 eq.	6,69E-05	1,11E-04	1,10E-06	1,79E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	9,13E-06	2,07E-05	2,34E-08	2,98E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,60E-05	3,66E-05	7,22E-07	7,33E-05
Particulate matter	kg PM2.5 eq.	6,32E-06	1,15E-05	7,81E-08	1,79E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,11E-06	4,42E-07	1,59E-10	1,55E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,95E-02	6,42E-02	2,22E-03	1,66E-01
Water scarcity footprint	m^3 H_2O eq.	8,27E-02	1,08E+00	1,12E-05	1,16E+00

Table 15 Environmental impacts of JW-D72N-158.75-without frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,16E-03	5,79E-03	2,14E-04	1,52E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,03E-03	-2,13E-05	-1,30E-06	-1,05E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,45E-05	4,89E-06	2,04E-08	1,94E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,14E-03	5,78E-03	2,13E-04	1,41E-02
Acidification potential (AP)	Kg SO_2 eq.	6,46E-05	1,11E-04	1,09E-06	1,76E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,85E-06	2,07E-05	2,33E-08	2,96E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,43E-05	3,66E-05	7,13E-07	7,16E-05
Particulate matter	kg PM2.5 eq.	6,08E-06	1,15E-05	7,72E-08	1,76E-05
Abiotic depletion potential – Elements	Kg Sb eq.	9,12E-07	4,42E-07	1,55E-10	1,35E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,56E-02	6,42E-02	2,19E-03	1,62E-01
Water scarcity footprint	m^3 H_2O eq.	8,26E-02	1,08E+00	1,10E-05	1,16E+00

Table 16 Environmental impacts of JW-HD120N-166-with frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	9,26E-03	6,36E-03	2,19E-04	1,58E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,21E-03	-2,19E-05	-1,30E-06	-1,23E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,59E-05	4,91E-06	2,21E-08	2,09E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	8,07E-03	6,34E-03	2,17E-04	1,46E-02
Acidification potential (AP)	Kg SO_2 eq.	6,25E-05	1,20E-04	1,11E-06	1,84E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,52E-06	2,24E-05	2,36E-08	3,09E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,45E-05	3,99E-05	7,36E-07	7,52E-05
Particulate matter	kg PM2.5 eq.	5,97E-06	1,25E-05	7,95E-08	1,86E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,11E-06	4,76E-07	1,66E-10	1,59E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,75E-02	6,96E-02	2,26E-03	1,69E-01
Water scarcity footprint	m^3 H_2O eq.	8,27E-02	1,22E+00	1,14E-05	1,30E+00

Table 17 Environmental impacts of JW-HD144N-166-with frame

Parameter	Unit	Upstream	Core	Downstream	Total
Global warming potential – Fossil (GWP-fossil)	kg CO_2 eq.	8,80E-03	5,53E-03	2,11E-04	1,45E-02
Global warming potential – Biogenic (GWP-biogenic)	kg CO_2 eq.	-1,33E-03	-2,10E-05	-1,30E-06	-1,36E-03
Global warming potential - Land use and Land transformation (GWP-luluc)	kg CO_2 eq.	1,55E-05	4,88E-06	1,91E-08	2,04E-05
Global warming potential (GWP) - Total	kg CO_2 eq.	7,48E-03	5,51E-03	2,10E-04	1,32E-02
Acidification potential (AP)	Kg SO_2 eq.	5,98E-05	1,06E-04	1,08E-06	1,67E-04
Eutrophication potential (EP)	kg PO_4^{3-} eq.	8,25E-06	1,99E-05	2,30E-08	2,82E-05
Photochemical oxidant formation potential (POFP)	kg di NMVOC eq.	3,29E-05	3,51E-05	6,95E-07	6,86E-05
Particulate matter	kg PM2.5 eq.	5,74E-06	1,10E-05	7,55E-08	1,68E-05
Abiotic depletion potential – Elements	Kg Sb eq.	1,08E-06	4,26E-07	1,47E-10	1,50E-06
Abiotic depletion potential – Fossil fuels	MJ, net calorific value	9,25E-02	6,16E-02	2,14E-03	1,56E-01
Water scarcity footprint	m^3 H_2O eq.	8,11E-02	1,02E+00	1,07E-05	1,10E+00

Use of resources

Table 18 Resource use of JW-HD144N-158.75-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	2,95E-02	2,97E-03	5,07E-04	3,30E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	2,95E-02	2,97E-03	5,07E-04	3,30E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,20E-01	7,65E-02	2,76E-03	1,99E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,20E-01	7,65E-02	2,76E-03	1,99E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,16E-01	2,81E-02	1,31E-05	1,44E-01

Table 19 Resource use of JW-HD144N-158.75-without frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	2,92E-02	2,97E-03	5,07E-04	3,27E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	2,92E-02	2,97E-03	5,07E-04	3,27E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,16E-01	7,65E-02	2,73E-03	1,95E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,16E-01	7,65E-02	2,73E-03	1,95E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,15E-01	2,81E-02	1,28E-05	1,43E-01

Table 20 Resource use of JW-HD156N-158.75-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	2,96E-02	2,93E-03	5,07E-04	3,30E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	2,96E-02	2,93E-03	5,07E-04	3,30E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,20E-01	7,31E-02	2,75E-03	1,96E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,20E-01	7,31E-02	2,75E-03	1,96E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,17E-01	2,68E-02	1,30E-05	1,44E-01

Table 21 Resource use of JW-HD156N-158.75-without frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	2,94E-02	2,93E-03	5,07E-04	3,28E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	2,94E-02	2,93E-03	5,07E-04	3,28E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,16E-01	7,31E-02	2,73E-03	1,91E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,16E-01	7,31E-02	2,73E-03	1,91E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,16E-01	2,68E-02	1,27E-05	1,43E-01

Table 22 Resource use of JW-HD120N-158.75-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,22E-02	3,11E-03	5,09E-04	3,58E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	3,22E-02	3,11E-03	5,09E-04	3,58E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,28E-01	8,89E-02	2,85E-03	2,20E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,28E-01	8,89E-02	2,85E-03	2,20E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,20E-01	3,27E-02	1,42E-05	1,53E-01

Table 23 Resource use of JW-HD120N-158.75-without frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,19E-02	3,11E-03	5,08E-04	3,55E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	3,19E-02	3,11E-03	5,08E-04	3,55E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,23E-01	8,89E-02	2,81E-03	2,15E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,23E-01	8,89E-02	2,81E-03	2,15E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,19E-01	3,27E-02	1,37E-05	1,52E-01

Table 24 Resource use of JW-D60N-158.75-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,24E-02	3,09E-03	5,08E-04	3,60E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	3,24E-02	3,09E-03	5,08E-04	3,60E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,32E-01	8,69E-02	2,85E-03	2,22E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,32E-01	8,69E-02	2,85E-03	2,22E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,24E-01	3,19E-02	1,42E-05	1,56E-01

Table 25 Resource use of JW-D60N-158.75-without frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,21E-02	3,09E-03	5,08E-04	3,57E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	3,21E-02	3,09E-03	5,08E-04	3,57E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,28E-01	8,69E-02	2,82E-03	2,17E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,28E-01	8,69E-02	2,82E-03	2,17E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,23E-01	3,19E-02	1,39E-05	1,55E-01

Table 26 Resource use of JW-D72N-158.75-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	2,90E-02	2,97E-03	5,07E-04	3,25E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	2,90E-02	2,97E-03	5,07E-04	3,25E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,20E-01	7,65E-02	2,75E-03	1,99E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,20E-01	7,65E-02	2,75E-03	1,99E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,16E-01	2,81E-02	1,30E-05	1,44E-01

Table 27 Resource use of JW-D72N-158.75-without frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	2,88E-02	2,97E-03	5,07E-04	3,23E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	2,88E-02	2,97E-03	5,07E-04	3,23E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,16E-01	7,65E-02	2,73E-03	1,95E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,16E-01	7,65E-02	2,73E-03	1,95E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,15E-01	2,81E-02	1,27E-05	1,44E-01

Table 28 Resource use of JW-HD120N-166-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,11E-02	3,05E-03	5,08E-04	3,47E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	3,11E-02	3,05E-03	5,08E-04	3,47E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,18E-01	8,37E-02	2,79E-03	2,05E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,18E-01	8,37E-02	2,79E-03	2,05E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,19E-01	3,08E-02	1,35E-05	1,49E-01

Table 29 Resource use of JW-HD144N-166-with frame

PARAMETER		UNIT	Upstream	Core	Downstream	Total
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value	3,20E-02	2,93E-03	5,06E-04	3,54E-02
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	3,20E-02	2,93E-03	5,06E-04	3,54E-02
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value	1,12E-01	7,31E-02	2,68E-03	1,88E-01
	Used as raw materials	MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	TOTAL	MJ, net calorific value	1,12E-01	7,31E-02	2,68E-03	1,88E-01
Secondary material		kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Non-renewable secondary fuels		MJ, net calorific value	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water		m^3	1,16E-01	2,68E-02	1,21E-05	1,43E-01

Waste production and output flows

Table 30 Waste production of JW-HD144N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.34E-04	0.00E+00	3.68E-03	3.81E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 31 Output flows of JW-HD144N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 32 Waste production of JW-HD144N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.34E-04	0.00E+00	3.54E-03	3.67E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 33 Output flows of JW-HD144N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 34 Waste production of JW-HD156N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.37E-04	0.00E+00	3.64E-03	3.78E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 35 Output flows of JW-HD156N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 36 Waste production of JW-HD156N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.37E-04	0.00E+00	3.51E-03	3.65E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 37 Output flows of JW-HD156N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 38 Waste production of JW-HD120N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.53E-04	0.00E+00	4.17E-03	4.32E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 39 Output flows of JW-HD120N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 40 Waste production of JW-HD120N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.53E-04	0.00E+00	3.96E-03	4.11E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 41 Output flows of JW-HD120N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 42 Waste production of JW-D60N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.44E-04	0.00E+00	4.14E-03	4.28E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 43 Output flows of JW-D60N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 44 Waste production of JW-D60N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.44E-04	0.00E+00	4.01E-03	4.15E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 45 Output flows of JW-D60N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 46 Waste production of JW-D72N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.25E-04	0.00E+00	3.64E-03	3.77E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 47 Output flows of JW-D72N-158.75 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 48 Waste production of JW-D72N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.25E-04	0.00E+00	3.51E-03	3.63E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 49 Output flows of JW-D72N-158.75 without frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 50 Waste production of JW-HD120N-166 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.47E-04	0.00E+00	3.85E-03	3.99E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 51 Output flows of JW-HD120N-166 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 52 Waste production of JW-HD144N-166 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Hazardous waste disposed	kg	3.65E-07	0.00E+00	0.00E+00	3.65E-07
Non-hazardous waste disposed	kg	1.52E-04	0.00E+00	3.25E-03	3.41E-03
Radioactive waste disposed	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table 53 Output flows of JW-HD144N-166 with frame

PARAMETER	UNIT	Upstream	Core	Downstream	Total
Components for reuse	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Additional environmental information

Radiology, Electro Magnetic Fields and Noise

The impact of photovoltaic power generation is mainly the noise of power generation equipment such as inverters and transformers, the low-level radiation generated by photovoltaic cells, and electromagnetism. The noise is within a controllable range and below the legally set limits. The radiation has little impact on the human body and the environment, similar to the battery of mobile phones and cameras. The electromagnetic field and the radio and TV interferences that will be generated by the operation of the connection line will not exceed the recommended limits. For the end-of-life stage of the photovoltaic power station, the battery components need to be recycled. In China, crystalline silicon battery components are widely used, therefore producing very little pollution.

Environmental risks

The manufacturing of silicon material and silicon wafer is the most energy-consuming part in the production process of the entire industrial chain. During the production of crystalline silicon, a large amount of silicon tetrachloride ($SiCl_4$) and dichloro-dihydro silicon (SiH_2Cl_2) are produced, and these by-products can be treated through resource reuse. The recycling process is strictly controlled.

During the manufacturing of solar cells and photovoltaic modules. The pollution comes mainly from the cell production process. Chemicals like hydrofluoric, hydrochloric acid, isopropanol, hydrogen peroxide, etc. are used, and the discharge of exhaust gas will also affect the environment. Jolywood strictly controls the discharge of waste water and exhaust gas, and has been awarded the “National green factory” title by the Ministry of Industry and Information Technology of the Chinese government.. Assembling the solar cells into photovoltaic modules does not consume chemicals and basically does not cause pollution to the environment.

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ISO 21930:2017 Environmental declaration of building products

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

ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework

ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines

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