Product Carbon Footprint Report

Product Name : SOLAR INVERTER

Product Model : SUN2000-30KTL-M3

Report Number : SYBH(G-L)10216403-01

Reliability Laboratory of Huawei Technologies Co., Ltd.

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General information	
Report Number	SYBH(G-L)10216403-01
Report Traceability	First report
Applicant	Huawei Technologies Co., Ltd.
Address	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C
Reference Standards	ISO 14040 Life Cycle Assessment (LCA) –Principle and Framework ISO 14044 Life Cycle Assessment (LCA) –Requirements and Guidelines ETSI ES 203 199 V1.2.1 (2014-10) Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services
Product Name	SOLAR INVERTER
Product Model	SUN2000-30KTL-M3
Product Description	The product is a three-phase grid-tied PV string inverter that converts the DC power generated by PV strings into AC power and feeds the power into the power grid.
Output Power	30 kW (on mode)
Power Consumption	6 W (standby mode)
Efficiency	European Efficiency : 98.4% (400 V) , 98.45% (480 V) *Note: The following calculations are based on the minimum efficiency.*
Weight	64.3 kg (with packaging 21.3 kg)
Dimension	640*530*270 mm
Product picture	
Boundary	Cradle to grave
Functional Unit	The usage of one product for 25 years
Environmental Impact Categories	Climate Change (CC)

Cut off Criteria	Raw Materials which constitute <1% of product weight and >95% of product weight included
Software Tool	SimaPro 9.4
Database	ecoinvent 3.8
Assessment Method	IPCC 2021 GWP 100a
Abbreviations	PV: Photovoltaic AC: Alternating Current DC: Direct Current CC: Climate Change GHG: Greenhouse Gas GWP: Global Warming Potential IPCC: Intergovernmental Panel on Climate Change RMA: Raw Material Acquisition EU: European Union PCB: Printed Circuit Board PCBA: Printed Circuit Board Assembly IC: Integrated Circuit EoL: End-of-Life RSL: Reference Service Life IRM: Royal Meteorological Institute IEA: International Energy Agency PVPS: Photovoltaic Power Systems Programme
Reason for Carrying The Study	Market requirements
Target Audience(s)	Client
Results and Interpretations	
GHG Emissions	2401.0 kg $CO_{2\ eq}$
Identify Hot Spot	RMA and production stage and use stage
Conclusion	RMA and production stage and use stage contribute 54.1% and 44.7% of CC, respectively. (Please see Chapter 4 for more details)

Approved by Senior Engineer:	2023-02-06	Zhang Jiaojiao	Zhang Jiaojiao
	Date	Name	Signature
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	Date	Name	Signature

Content

1 GOAL AND SCOPE DEFINITION

1.1 Goal Definition

Huawei Technologies Co., Ltd. aims to carry out a carbon footprint assessment on SUN2000-30KTL-M3. Through this Carbon Footprint assessment, Huawei can use the results to find out what the most important contributors are within the upstreaming, manufacturing and downstreaming process chain of SUN2000-30KTL-M3.

Furthermore, the parameters of the process chain that can potentially be improved in the future can be identified through this investigation.

The goal of this report is to estimate an indicator for Climate Change (CC) mid-point impact category of SUN2000-30KTL-M3 used in Belgium during its lifetime.

1.2 Scope Definition

1.2.1 Functional Unit

The applicable functional unit is the usage of one SUN2000-30KTL-M3 for 25 years. All results below are based on an estimated lifetime of 25 years.

1.2.2 System Boundary

This studied product system is one SUN2000-30KTL-M3 used in Belgium. To evaluate the life cycle greenhouse gas (GHG) emissions in relative scale to Global warming potential (GWP100), in kilograms (kg) of carbon dioxide equivalents ($CO_{2\ eq}$) of SUN2000-30KTL-M3. The lifetime of the product is assumed to be 25 years. The product is transported from Dongguan, China to Belgium.

The system boundary of this evaluation is set to include following life cycle stages:
– Raw Material Acquisition (RMA) and Production
– Distribution
– Use
– End of Life

The system boundary is shown in Figure 1.

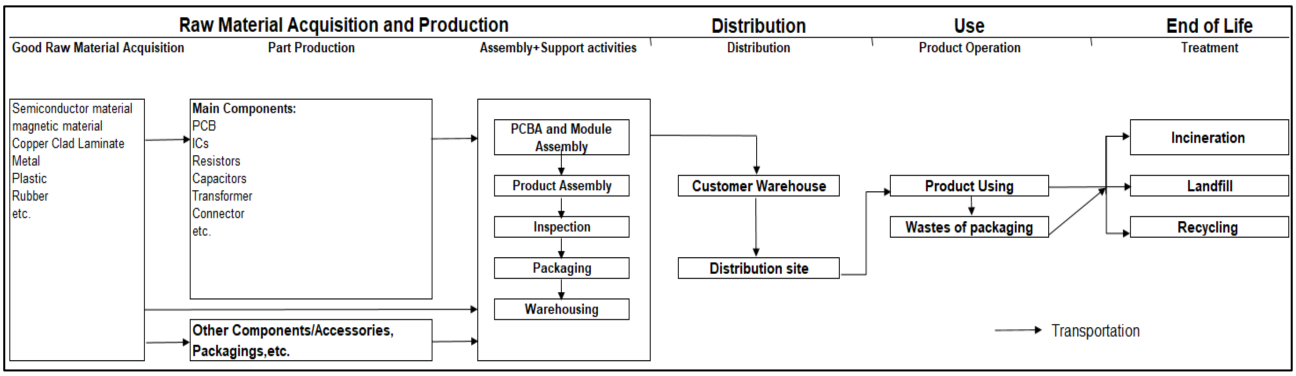

Figure 1 The Life Cycle Process Map of SUN2000-30KTL-M3

This product system boundary includes all of the life cycle stages of the product, including raw material acquisition (RMA), part production, assembly and support activities (including testing, packaging, etc.), main distribution processes, use stage and end of life (recycling/ disposal) stage.

The capital goods (e.g. machinery equipment and buildings, used in the life cycle of products) that are not directly associated with the production of this product are excluded.

2 LIFE CYCLE INVENTORY

2.1 Data collection

2.1.1 Raw Material Acquisition and Production

The raw material acquisition and production stage mainly includes the acquisition of raw materials, production of parts/components, assembling and support activities of finished products, as follows.

The raw materials stage includes:
- Raw material (e.g. semiconductor material, magnetic material, copper clad laminate, metal, plastic, etc.) extraction of product component/part.
- Production/generation of energy used for raw materials manufacturing.

The packaging of raw materials is not included in the system boundary.

The production of component/part includes:
-Transportation of raw materials to manufacturing sites of component/part (e.g. electronic components, cable, etc.).
- Manufacturing of product component/part and the generation of associated process waste and its treatment.
- Production/generation of energy used for component/part manufacturing.

The packaging material of component/part is not included in the system boundary.

The assembling and support activities stage includes:
- Transportation of product component/part to product assembly.
- PCBA and Modules assembly, final product assembly, final product packaging and the generation of associated process waste and its treatment.
- Production/generation of energy used for product manufacturing.

The internal transportation is not included in the system boundary.

Most of the basic data required for the development of the assessment for the product were obtained from direct measurement of the size and mass of each component or technical data sheets of each component of the system. For the final product assembly processes, site-specific data (primary data) is collected from the relevant processes. Secondary data is used where primary data is not available, or may exist quality issues (e.g. when appropriate measurement are not available).

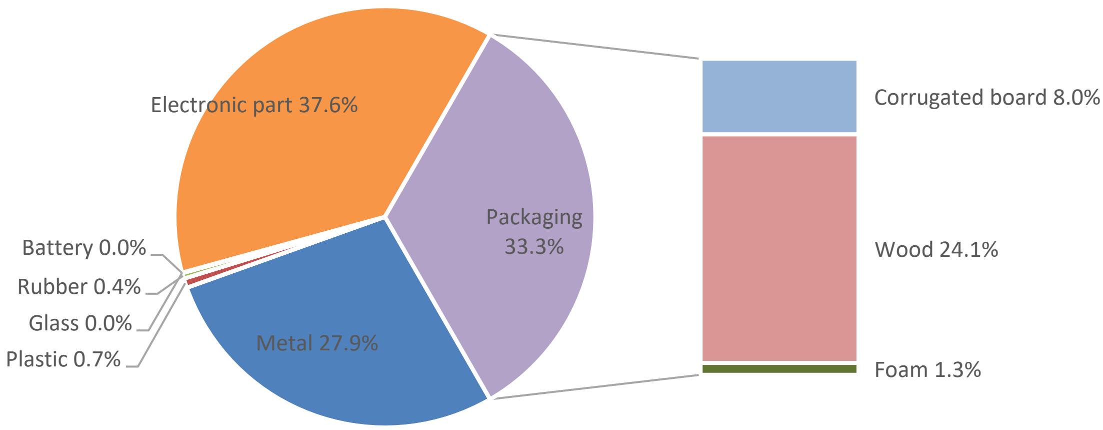

Figure 2 Main constitutive raw materials and parts of SUN2000-30KTL-M3

Note: "0.0%" indicates that the percentage is less than "0.1%".

Raw material GHG emission data for all electronic parts and electrical components, structural parts, including their packaging material, the process energy, waste treatment and transportation GHG emission data are collected from the latest applicable ecoinvent database.

2.1.2 Distribution

The distribution stages include:
- The transportation process from the Dongguan assembly factory to the Shenzhen port. The distance is about 70 km by truck.
- The transportation process from Shenzhen port to Trieste port, Italy. The distance is about 14150 km by ship.
- The transportation process from Trieste port to the Budapest, Hungary. The distance is about 550 km by truck.
- The transportation process from Budapest to Brussels (representative of Belgium). The distance is about 1350 km by truck.
- The transportation process from Brussels to customer location. The average distance in France is assumed to be 250 km by truck, as defined in section 7.14 of the EU Product Environmental Footprint Category Rules Guidance.

Secondary data collected from the latest applicable ecoinvent database embedded an average load factor and empty return trips is used for the transportation distance and the calculation of the GHG emissions. Land transportation distances data is from Google Maps. Maritime transportation distances data is obtained from http://www.searates.com/services/.

2.1.3 Use

This section refers to the use of SUN2000-30KTL-M3 by customers, excluding installation, commissioning, and maintenance processes. The activity data of these processes having a negligible contribution of environmental impacts is difficult to obtain and are then cut off.

This solar inverter is a three-phase grid-tied PV string inverter that converts the DC power generated by PV strings into AC power and feeds the power into the power grid. The impacts related to the energy consumed by the inverter to operate during its entire reference service life is considered here, assuming that the electricity loss of solar inverter in the electricity energy conversion process as the electricity consumption during use stage.

The modelling of electricity amount is established based on the use stage modelling requirements of EU Product Environmental Footprint Category Rules Guidance. The amount of electricity used by SUN2000-30KTL-M3 is calculated by the following equation:

$$E_{tot} = E_{on} + E_{standby}$$

The total energy consumed by the product is the result of two parameters: the former describes the electricity dissipated by the power inverter to keep converting electricity from DC to AC frequency, which is related to the sunshine duration of the location where the product is used, while the latter considers the energy consumption in standby mode for the rest of the time. And the energy consumption can be calculated respectively by the following equations:

$$\mathrm{E}_{on} = P_{out} * \frac{1-\eta}{\eta} * T_{on} * RSL = 30\mathrm{kW} * \frac{1-98.4\%}{98.4\%} * 1966\mathrm{h} * 25\mathrm{years} = 23975.6\ \mathrm{kWh}$$

Where,

P_{out} is the output rated AC active power which means the degree of the active power during a demand period in kW.

η is the energy efficiency, more details can be found in the product manual.

T_{on} is the average local annual sunshine duration which means the number of average annual sunshine in country where the inverter is installed, it is expressed in hours per year.

RSL is the service life of the product (details please see section 1.2.1).

$$\mathrm{E}_{standby} = P_{standby} * T_{standby} * RSL = 6\mathrm{W} * (24\mathrm{h} * 365\mathrm{days} - 1966\mathrm{h}) * 25\mathrm{years} = 1019.1\ \mathrm{kWh}$$

Where,

$P_{standby}$ is power in standby mode in kW.

η is the energy efficiency, more details can be found in the product manual.

$T_{standby}$ is the time when the product is in standby mode, which can be assumed to be the rest of sunshine duration, it is expressed in hours per year.

The evaluation model of the use stage is based on the assumption that the product is used in Belgium. T_{on} is the latest published data obtained from Royal Meteorological Institute (IRM) of Belgium, 1966 hours per year. The electricity emission factor of EU photovoltaic plant is obtained from the International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS), 42.9 g $CO_{2\ eq}$/kWh.

2.1.4 End-of-Life

The assumptions of waste treatment modes at EoL stage are as below:

- 90% of the metal parts of the product can be recycled and 10% are sent to landfills (Refer to IEC/TR 62635:2012 Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment).
- 60% of plastic parts can be recycled, and 40% incinerated (Refer to IEC/TR 62635:2012 Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment).
- 65% of the electronic parts (cable, etc.) are recycled, 10% are incinerated, and 25% are sent to landfills (This assumption is based on the minimum recovery targets referred to the directive 2012/19/EU (WEEE)).
- 100% of rubber is incinerated. (Refer to IEC/TR 62635:2012 Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment).
- 70% of batteries of the product can be recycled and 30% are sent to landfills (This assumption is based on the median recycling targets which is considering the diversity of batteries and referred to the directive 2013/56/EU on batteries).
- 64% of packaging are recycled, 16% are incinerated, and 20% are sent to landfills (Refer to EU recovery and recycling rate of packaging waste, 2019, obtained from Eurostat, Packaging waste statistics).
- 65% of other materials are recycled, 10% are incinerated, and 25% are sent to landfills (This assumption is based on the minimum recovery targets referred to the directive 2012/19/EU (WEEE)).

The secondary data of the recycling, landfill and incineration models in ecoinvent are used to calculate the GHG emissions at EoL stage.

The mass of individual raw material (mentioned above) of EoL product under the corresponding treatment mode (recycling/landfill/incineration) is calculated by following formula in SimaPro, and then the environmental impact of EoL scenarios are assigned to for each material categories automatically.

$$M_{ij}=R_{ij} * M_i$$

Where,

M_{ij} is the mass of the i^{th} raw material disposed by the j^{th} waste treatment method.

R_{ij} is the proportion of the i^{th} raw material disposed by the j^{th} waste treatment method.

M_i is the mass of the i^{th} raw material.

i represents the raw material categories of EoL product.

j represents the treatment method (recycling/landfill/incineration).

Note：The combined masses of materials are equal to the total mass of the product.

The cut-off approach in the database is used. All incineration processes are calculated without energy recovery. All recoverable wastes are disposed of through external company. For the material recycling in the end of life and manufacturing process, the scrap don’t be considered as an input, all recyclable waste is disposed through open-loop recycling, and the recycling benefit is allocated to the production as recycled materials which may use produce other products instead of SUN2000-30KTL-M3 inverter.

2.2 Product Carbon Footprint Data Calculation

The collected primary data of the manufacturing of SUN2000-30KTL-M3 includes raw material consumption, process energy consumption, transportation information, use stage power consumption and total processes output flows. Most of the process data were collected in the year 2023 with geographically representative and time-sensitive data in the database selected as far as possible. The secondary data used in the SimaPro 9.4 for the GHG emission calculation is from the ecoinvent database. The used datasets are selected timely and reflect consistent production data.

The life cycle model of the GHG emissions in SimaPro 9.4 and the calculation result are as follows.

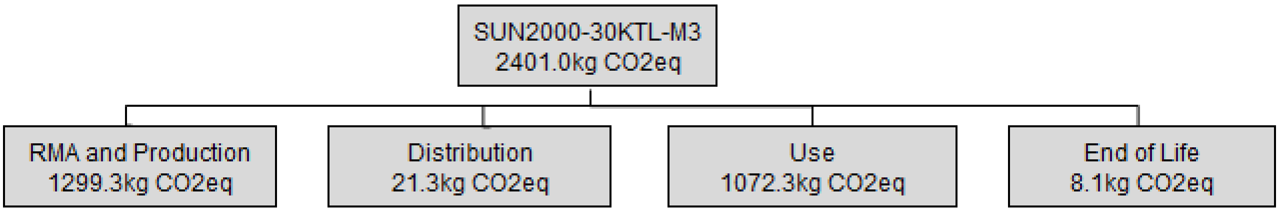

Figure 3 Life cycle model of the GHG emission calculation in SimaPro

3 LIFE CYCLE IMPACT ASSESSMENT

Based on the methodology, assumptions and model described in this report, the result of GHG emissions in relative scale to GWP 100a for SUN2000-30KTL-M3 is 2401.0 kg $CO_{2\,eq}$.

In terms of life cycle stages, the result can be shown as Figure 4. It shows that the major emission stages are RMA and production stage and use stage.

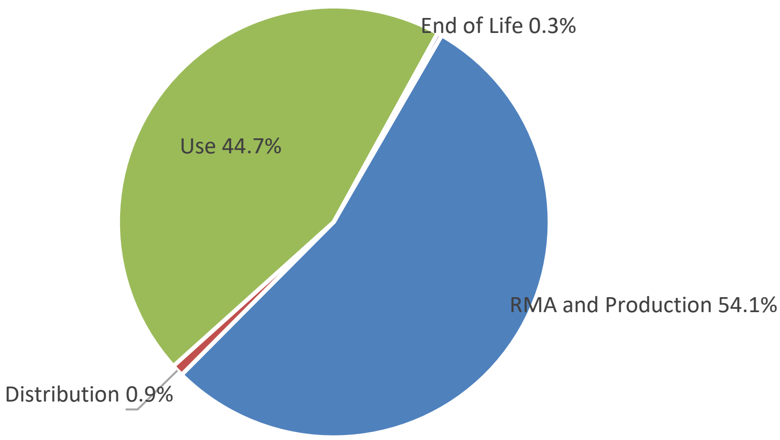

Figure 4 Product Carbon footprint analysis by all life stages

Figure 5 shows the shares of total $CO_{2\,eq}$ emissions for different parts or processes of RMA and production stage. Electronic parts have the largest share at 75.7%.

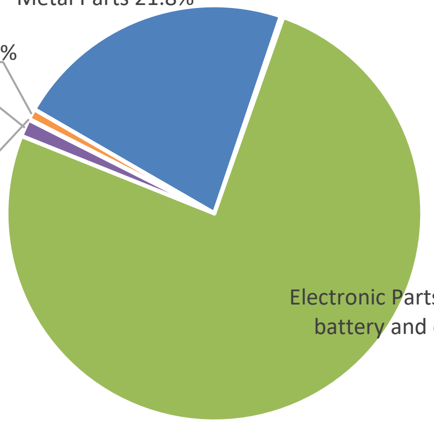

Figure 5 Product Carbon footprint analysis by manufacturing process

4 LIFE CYCLE INTERPRETATION

The main interpretations and conclusions of this evaluation are described hereinafter:

The results for different stages and manufacturing process, please see section 3.

The highest impact of SUN2000-30KTL-M3 GHG emissions occurs from the RMA and production stage (54.1% of the resulting life cycle GHG emissions). As shown in figure 5, the GHG emissions of electronic parts and metal parts account for the major proportion in this stage due to their high percentage by weight. Meanwhile, the impact per unit masses of electronic parts is relatively high due to the high energy consumption, waste and emission in the manufacturing process to produce raw materials such as PCB, IC, etc. The GHG emissions related to these parts can be reduced by using recycled materials or low-carbon materials and optimizing manufacturing processes when design those parts.

The second impact occurs from the use stage (44.7% of the resulting life cycle GHG emissions). For this stage, the GHG emissions are mainly caused by the electric energy consumption of product (details please see section 2.1.3), which is mainly affected by the electric power consumption of product and the energy resources of electricity. The GHG emissions can be reduced by improving the product energy efficiency.

The distribution stage and end of life stage have no significant impacts on total GHG emissions.