Product Carbon Footprint Report

Product Name	:	Solar inverter
Product Model	:	SUN2000-4KTL-M1
Report Number	:	SYBH(G-L)07250643-02

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General information	
Report Number	SYBH(G-L)07250643-02
Date of Issue	2020-12-2
Report Traceability	First report
Company Name	Huawei Technologies Co., Ltd.
Address	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C
Standard	ISO 14040 Life Cycle Assessment (LCA) –Principle and Framework ISO 14044 Life Cycle Assessment (LCA) –Requirements and Guidelines PAS 2050 Specification for The Assessment of The Life Cycle Green House Gas Emissions of Goods and Services
Software tool used	SimaPro 9.0.0.49
Product Description	Solar inverter, converting solar power to electrical energy
Product Model	SUN2000-4KTL-M1
Power Consumption(W)	Rated active power: 4kW European Efficiency: 97.1%
Weight	17kg without the package
Functional Unit	25 years (lifetime of use)
Boundary	Cradle to grave
Environmental Impact Categories	CC according to “Climate change from ReCiPe Midpoint (H) V1,05”
Cut off Criteria	Less than 10% off mass, 10% addition to the first iteration LCA score for CC (Climate Change).
Abbreviations	GHG: Greenhouse Gas PCB: Printed Circuit Board PCBA: Printed Circuit Board Assembly
Reason for Carrying The Study	market requirement
Target Audience(S)	Customer

Result and Interpretation	
GWP Emission	1502.72kg CO_2 e
Identify Hot Spot	Use phase
Conclusion	Use Phase is 70.73% of CC
Product picture	

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	Date	Name	Signature

Content

1 GOAL AND SCOPE DEFINITION

1.1 Goal definition

HUAWEI aimed to carry out a Carbon Footprint assessment on the solar inverter SUN2000-4KTL-M1. 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 the solar inverter.
Furthermore, element of the process chain that can potentially be improved in the future can be identified though this investigation.
The goal of this report is to estimate an indicator for Climate Change (CC) mid-point impact category of the solar inverter during its lifetime.

1.2 Scope definition

1.2.1 Function Unit

The applicable functional unit is the product lifetime of use. All results below will therefore be expressed per 25 years of use. The reference flow is 25 years of usage.

1.2.2 System Boundary

The studied product system is one solar inverter used in solar power station. 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_2e) of the Multi-service Access Module. The lifetime of the product is 25 years. The product is transported from Shenzhen, China to German.
The system boundary of this evaluation is set to include following life cycle stages:
– Raw Materials Extraction & Manufacturing
– Distribution
– Use
– End of Life
The system boundary can be showed as the following Figure 1 Life Cycle Process Map of the solar inverter.

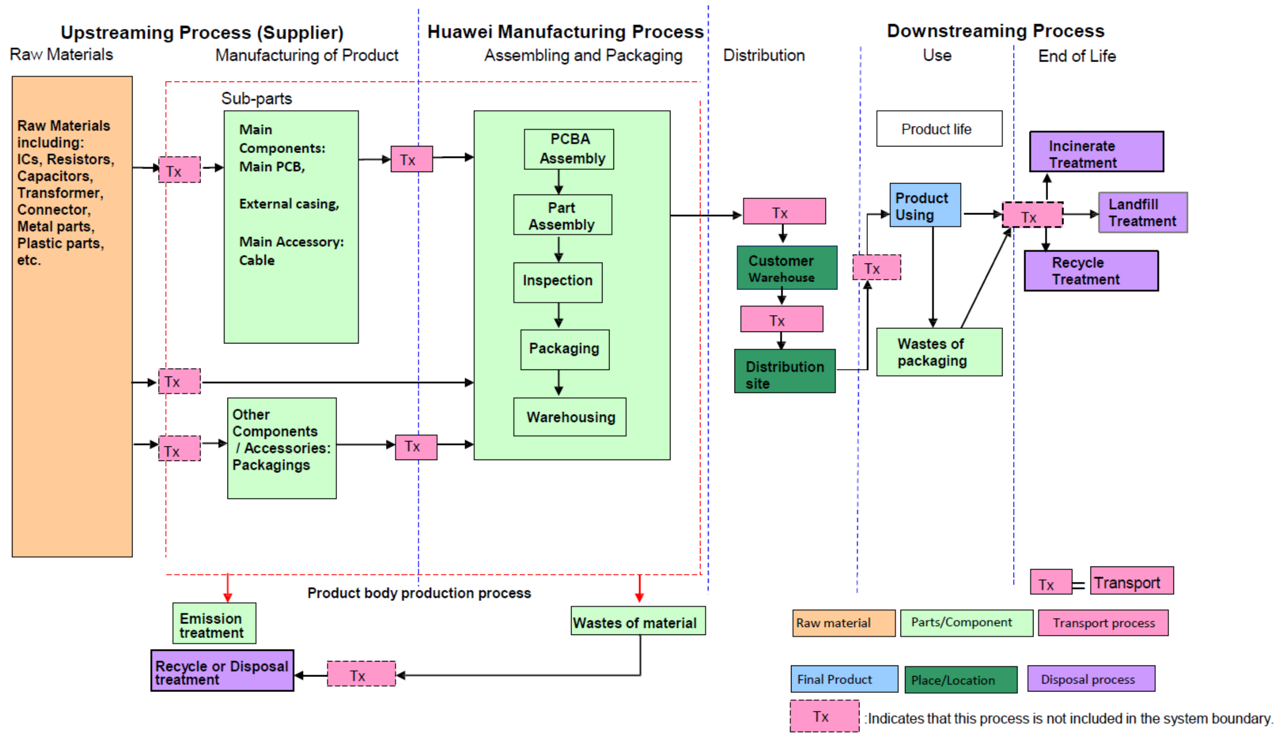

Figure 1 The Life Cycle Process Map of SUN2000-4KTL-M1

This solar inverter system boundary includes all of the life cycle stages of the product, including raw material, product sub-part manufacturing and transportation, the solar inverter assembling and packaging, main distribution steps, use phase and end of life (disposal/recycling) phase.

The capital goods (e.g. subsidiaries, buildings, etc.) 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 materials phase includes:

- Material extraction and manufacturing of electronic components (e.g. resistors, capacitors, etc.), plastics, metals, etc.
- Production/generation of energy used for raw material manufacturing;

The packaging material of raw material/components is not included in the system boundary.

The manufacturing of product sub-parts includes:

- Transportation of raw materials to product main components manufacturing;
- Manufacturing of product sub-parts and the generation of associated process waste and its treatment;

- Transportation of product sub-parts to product assembly and packaging plant.

Transportation of raw materials to the manufacturing process of other components, accessories and packaging materials were excluded.

The assembling and packaging phase includes:

- PCBA assembly, final product assembly, final product packaging and the generation of associated process waste and its treatment;
- The generation of associated process waste and its treatment. The internal transportation is not included in the system boundary.

Transportation of raw materials to the product assembling/packaging process was also excluded.

For the components/final product manufacturing and assembly process, site-specific data (primary data) was collected from the relevant processes. Where primary data are not available, or is of questionable quality (e.g. when appropriate measurement are not available), secondary data were used.

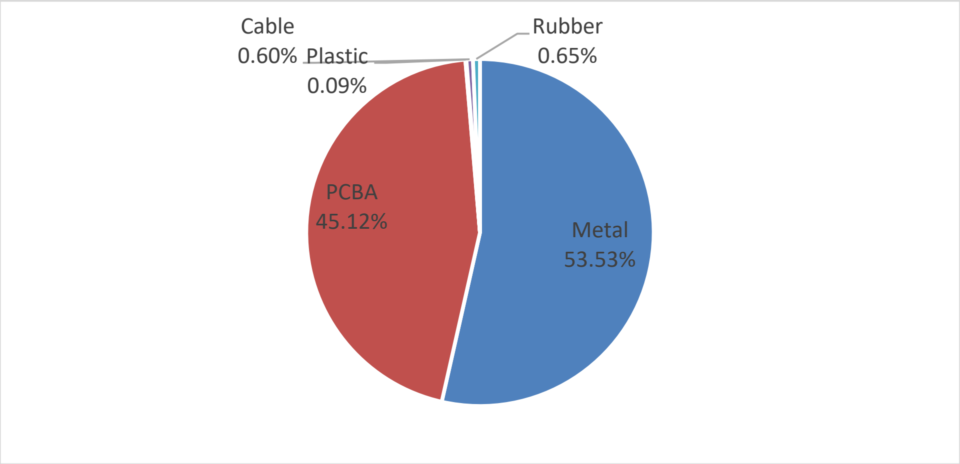

Figure 2 Main constitutive materials for SUN2000-4KTL-M1

Raw material GHG emission data for all electronic components, other components and ancillary materials, including their packaging material were collected from secondary data. The process energy, waste treatment and transportation GHG emission data were collected from secondary data.

2.1.2 Distribution

The distribution phase includes:

- The transportation process from the manufacturing factory to the Shenzhen port.
- The transportation process from Shenzhen port to Trieste port, Italy.
- The transportation process from Rijeka Bakar port to the Budapest, Hungary.
- The transportation process from Budapest to the distribution site.

The transportation distance from the manufacturing factory to the Shenzhen port is about 70 km by truck, the transportation distance from Shenzhen port to Trieste port is about 14150 km by seaway, the distance from the Trieste port to Budapest is about 550km by truck, and the distance from Budapest to the distribution site (assuming Berlin here) is about 1000km. Generic data (secondary data) was used for the transportation distance and the calculation of the GHG emission.

Data on the distance from the manufacturing factory to the Shenzhen port, Trieste port to Budapest, and Budapest to Berlin are from Google Maps.

Data on maritime transport distances are obtained from http://www.searates.com/services/.

2.1.3 Use

The function of solar inverter is to convert the variable DC voltage generated by a photovoltaic (PV) solar panel into a commercial frequency alternating current (AC). The power generated by solar panels is related to the light intensity and the effective light time. It is assumed that the loss of photovoltaic inverter in the process of electric energy conversion can be taken as the electric energy used in its work.

$$\begin{aligned}\text{The Energy consumption} &= \text{the output Rated active power} \times \text{average annual sunshine time} \\ &\times \frac{1-\text{European Efficiency}}{\text{Eruopean Efficiency}} = 4\text{kW} \times 1625\text{h} \times \frac{1-97.1\%}{97.1\%} \times 25\text{years} \\ &= 4853.24\text{kWh}\end{aligned}$$

The product is produced for use in the German Market.

Average annual sunshine time in Berlin, Germany is 1625h. This Data is obtained from Deutscher Wetterdienst (DWD). Germany has around 1600 hours of sunshine throughout the country, and data of Berlin is used here as a representation.

The output rated active power: 4kW

European Efficiency: 97.1%

According to the known data of SUN2000-4KTL-M1, its whole life cycle energy consumption is 4853.24kWh based on the assumption of 25-year lifetime. According to the calculation result released by German Environment Agency (UBA), 219g of CO_2 were emitted per kilowatt hour of electricity generated in German in 2019. Based on this data, it can be calculated that the emission of CO_2 in the use phase is 1062.86kg.

2.1.4 End-of-life phase

The GHG calculation is based on databases, and the assumed waste treatment mode is as below:

– 90% of the metal parts of the product can be recycled and 10% can be disposed of by landfill

– 80% of the paper material of the product can be recycled, and 20% can be disposed of by incineration

– Rubber and plastic mixtures cannot be recycled, but they can be 100% disposed of by incineration.

– 60% of single plastic can be recycled, and 40% disposed of by incineration

– 65% of the Electronic parts/components (PCBA, cable) can be disposed of by recycling, 10% can be disposed of by incineration, and 25% can be disposed of by landfill.
– Other metal content such as tin solder is very small, can be ignored.

All recoverable waste was disposed of through external company, and the recycling benefit, including material and energy recycling, is allocated to the production of the recycled materials, which may be used to produce other company's product. It will not be allocated to the SUN2000-4KTL-M1.

According to the assumption described, 76.88% of the product can be recycled, 6.02% can be disposed of by incineration, and 17.70% can be disposed of by landfill.

Table1 the detail waste treatment mode of material and component

Material / Component	Weight percent (%)	Dispose mode
Plastic	0.09	60% is disposed of by recycling, 40% is disposed of by incineration
Metal	53.53	90% is disposed of by recycling, 10% is disposed of by landfill
PCBA	45.12	65% is disposed of by recycling, 10% is disposed of by incineration, and 25% is disposed of by landfill
Cable	0.60	
Rubber	0.65	100 is disposed of by incineration

NOTE: all the incineration processes are calculated without energy recovery.

Secondary data was used for the calculation of the GHG emission directly. The database uses a cut-off approach. All incineration processes were calculated without energy recovery. For the material recycling in the end-of life and manufacturing process, we do not consider scrap as an input, all recyclable waste were disposed of through open-loop recycling, and the recycling benefit are allocated to the production of the recycled materials which may use to produce other company's product. The GHG emission is calculated with the secondary data and the database has a default allocation method: cut-off approach.

2.2 Product Carbon Footprint Data Calculation

The collected primary data of the manufacturing of SUN2000-4KTL-M1 product including raw material consumption, process energy consumption, transportation information, use phase power consumption and total processes output flows. Most of the process data were collected in the year 2019. All data reflects the state of art production processes in Asia.

The generic data (secondary data) used in the SimaPro 9.0.0.49 software for the GHG emission calculation is from the databases Ecoinvent. The used datasets were selected closed to the year 2020 and reflects also state of the art production data.

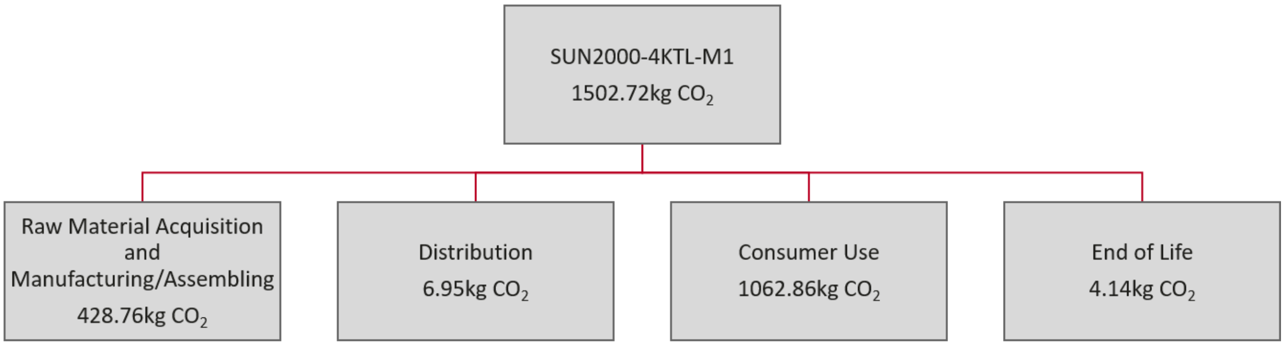

Figure 3 Life cycle model of the GHG emission calculation in Simapro

3 Life Cycle Impact Assessment

The growing concerns of global warming draws particular attentions of HUAWEI to GHG (Greenhouse Gases) emission along all the whole life cycle of the SUN2000-4KTL-M1.

Based on the methodology, assumptions and modeling described in this report, the resulting greenhouse gas (GHG) emissions in relative scale to Global warming potential (GWP100), in kilograms (kg) of carbon dioxide equivalents (CO_2e) of the SUN2000-4KTL-M1 is 1502.72kg.

In terms of life cycle phases, the result can be shown as Figure 4. It shows that the highest emission phase is consumer use, which is 70.73% of the whole life cycle GHG emissions.

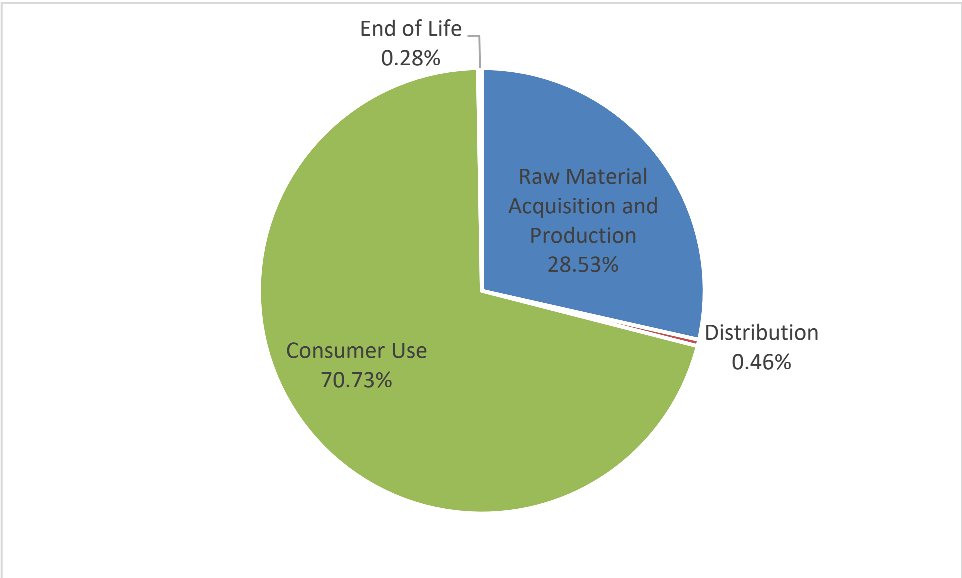

Figure 4 Product Carbon footprint analysis by all life phase

The following picture shows the CO2e emission of different components or manufacturing process for the raw material and manufacturing phase. We can see that the highest emission is from PCBA production, which is 74.51% of the whole raw material and manufacturing/assembling phase.

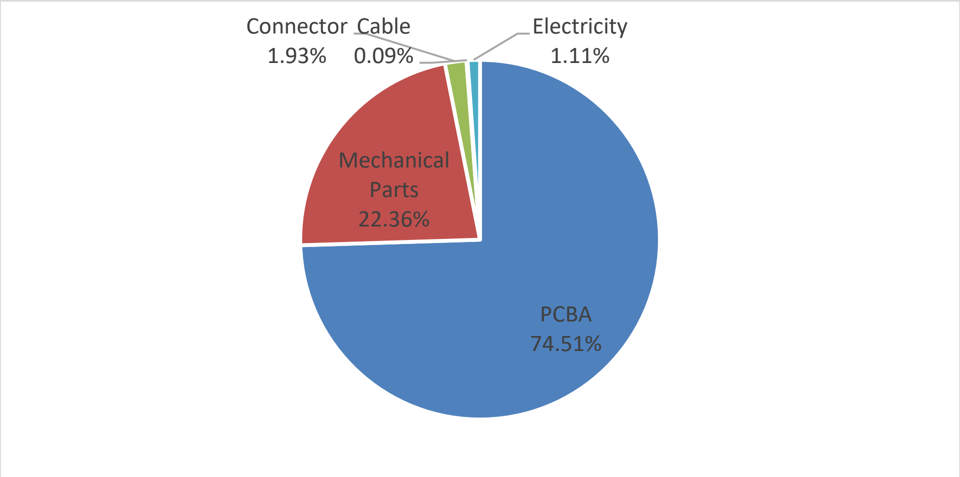

Figure 5 Product Carbon footprint analysis by manufacturing process

4 Life Cycle Interpretation

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

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

- The highest impact of the solar inverter GHG (Greenhouse Gases) emission occurs from the use phase (70.73% of the resulting life cycle GHG emission). The GHG emission of use phase occurs from the loss of electric power (details please see section 3). It can be noticed that the second most important contribution is the raw material acquisition and production phase (28.53% of the anticipated life cycle GHG emissions associated).

- The end of life phase and distribution have no significant impacts on GHG emission.

- Considering the conversion power of the inverter, the use of the inverter will generate 1062.86kg CO2-equiv carbon emissions during the 25 years of life, but the output electrical energy can reduce 34555.46kg CO2-equiv carbon emissions.

- The growing concerns of global warming draws particular attentions of HUAWEI to GHG emission along all the whole life cycle of solar inverter.