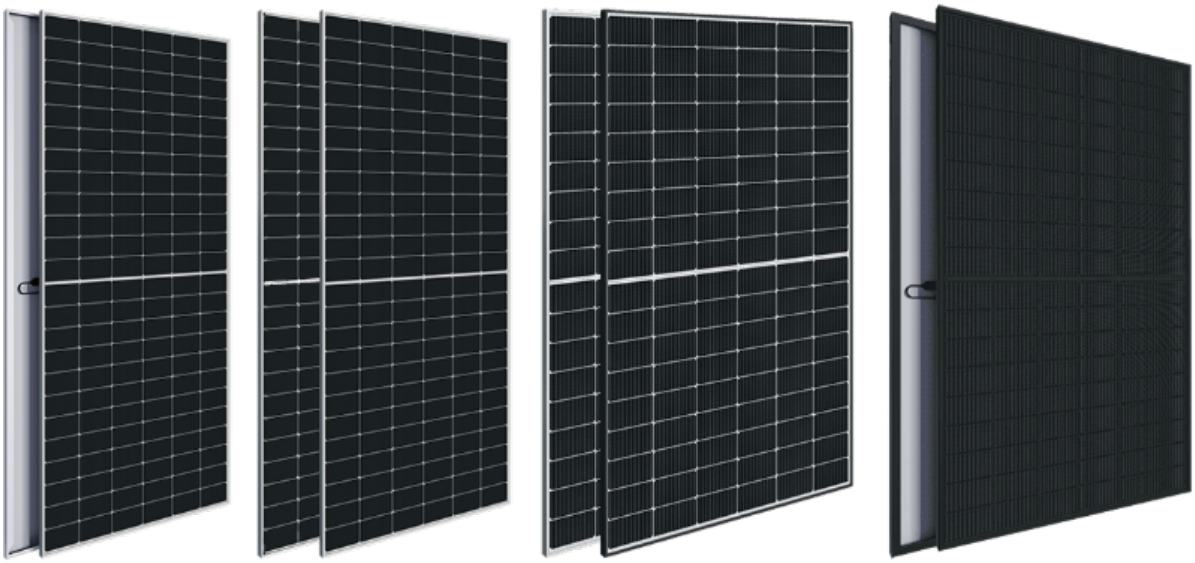
epd-norway
Global Program Operator

# Environmental Product Declaration

In accordance with ISO14025:2006 and EN15804:2012+A2:2019/AC: 2021

## ASTRONERGY MONOCRYSTALLINE PHOTOVOLTAIC MODULES



ASTRONERGY

**Owner of the declaration:**
Chint New Energy Technology Co., Ltd.

**Product name:**
Astronergy monocrystalline photovoltaic modules

**Functional unit:**
1Wp

**Product category /PCR:**
[NPCR 029 Version 1.2]

**Program holder and publisher:**
The Norwegian EPD foundation

**Declaration number:**
NEPD-6420-5635-EN

**Registration number:**
NEPD-6420-5635-EN

**Issue date:**

16.04.2024

**Valid to:**

16.04.2029

The Norwegian
EPD Foundation

# General information

## Product:
CHSM72N(DG)/F-HC, CHSM72N(DG)/F-BH

CHSM54N-HC, CHSM54N(BL)-HC

CHSM54N(BLH)-HC, CHSM54N(DG)/F-HC

CHSM54N(DGT)/F-BH, CHSM54N(DGT)(BLH)/F-BH

## Program operator:
The Norwegian EPD Foundation
Post Box 5250 Majorstuen, 0303 Oslo, Norway
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## Declaration number:
NEPD-6420-5635-EN

## This declaration is based on Product Category Rules:
NPCR 029 version 1.2

This EPD follows additional requirements for construction products considered as Electronic or Electric Equipment.

## Statement of liability:
The owner of the declaration shall be liable for the underlying information and evidence. EPD Norway shall not be liable with respect to manufacturer, life cycle assessment data and evidences.

## Functional unit:
1 Wp

## Verification:
Independent verification of the declaration and data, according to ISO14025:2010

internal ☐ external √

Lucas Pedro Berman

Independent verifier approved by EPD Norway

## Owner of the declaration:
Chint New Energy Technology Co., Ltd.
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## Manufacturer:
Chint New Energy Technology Co., Ltd.
Address: No.1 Jisheng Road, Jianshan New District, Haining, P.R. China

Chint Solar (Haining) Co., Ltd
Address: No.2 Jisheng Road, Jianshan New District, Haining, P.R. China

## Place of production:
Haining, P.R. China

## Management system:
ISO 9001, ISO 14001, ISO 45001

## Organisation no:
913304813502083466

## Issue date:
16.04.2024

## Valid to:
16.04.2029

## Year of study:
2022.11-2023.10

## Comparability:
EPD of construction products may not be able to compare if they do not comply with EN 15804 and are seen in a building context.

## The EPD has been worked out by:
Star Talers Environmental Technology

Approved

Manager of EPD Norway

# Product

## Product description:

Astronergy places a strong emphasis on technological innovation and substantial investments in research and development. Astronergy has consistently introduced the ASTRO series of high-efficiency modules, including the ASTRO monocrystalline bifacial series and the ASTRO monocrystalline mono-facial series. These modules leverage cutting-edge photovoltaic technologies such as large-format silicon wafers, half-cutting, MBB (Multi Busbar), non-destructive cutting, and high-density design to maximize module power and efficiency. These innovations have earned the company certifications in numerous mainstream markets worldwide, including China, Europe, Australia, Japan, South Korea, Israel, Brazil, and the United States, with performance metrics that meet international first-class standards.

Astronergy's commitment to excellence and technological leadership is evident in its recognition as a seven-time "Top Performer" by PVEL/DNV GL, a top module manufacturer, and its consistent inclusion in Bloomberg's prestigious list of world-class Tier 1 suppliers of photovoltaic modules. These accolades underscore the company's reliability and position as a market leader in the solar energy industry.

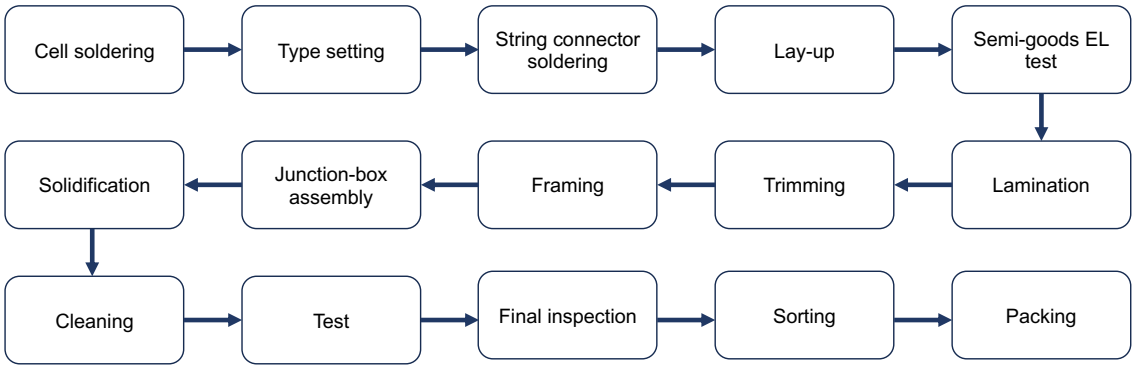
Astronergy remains unwavering in its dedication to an innovation-driven, high-quality development approach, consistently delivering superior-quality, highly reliable, and long-term stable module products to its customers. The company spares no effort in advancing the photovoltaic industry and empowering the world with sustainable and efficient green energy solutions.

## Product specification:

Materials compositions and technical data for the declared product are shown below.

| Materials | CHSM72N(DG)/F-HC<br>CHSM72N(DG)/F-BH | | CHSM54N-HC<br>CHSM54N(BL)-HC<br>CHSM54N(BLH)-HC | | CHSM54N(DG)/F-HC<br>CHSM54N(DGT)/F-BH<br>CHSM54N(DGT)(BLH)/F-BH | |
|---|---|---|---|---|---|---|
| | kg/FU | % | kg/FU | % | kg/FU | % |
| Frame | 3.90E-03 | 7.1% | 4.36E-03 | 8.9% | 4.47E-03 | 9.1% |
| Backsheet | 0.00E+00 | 0.0% | 1.93E-03 | 3.9% | 0.00E+00 | 0.0% |
| Glass | 4.21E-02 | 77.1% | 3.39E-02 | 69.1% | 3.55E-02 | 72.7% |
| Cell | 1.14E-03 | 2.1% | 1.16E-03 | 2.4% | 1.21E-03 | 2.5% |
| Solder | 2.69E-04 | 0.5% | 2.73E-04 | 0.6% | 3.49E-04 | 0.7% |
| Busbar | 6.72E-05 | 0.1% | 9.09E-05 | 0.2% | 1.16E-04 | 0.2% |
| EVA | 1.94E-03 | 3.6% | 1.90E-03 | 3.9% | 2.05E-03 | 4.2% |
| POE | 3.18E-04 | 0.6% | 1.71E-03 | 3.5% | 0.00E+00 | 0.0% |
| EPE | 1.61E-03 | 2.9% | 0.00E+00 | 0.0% | 2.04E-03 | 4.2% |
| Junction box | 2.12E-04 | 0.4% | 5.30E-04 | 1.1% | 5.42E-04 | 1.1% |
| Flux | 1.68E-05 | <0.01% | 2.27E-05 | <0.01% | 2.33E-05 | <0.01% |
| Silicone | 6.72E-04 | 1.2% | 8.41E-04 | 1.7% | 9.30E-05 | 0.2% |
| Packaging film (PE) | 3.36E-05 | 0.1% | 2.27E-05 | <0.01% | 4.65E-05 | 0.1% |
| Packaging bag (PVC) | 8.40E-05 | 0.2% | 9.09E-05 | 0.2% | 1.40E-04 | 0.3% |
| Pallet | 1.70E-03 | 3.1% | 1.61E-03 | 3.3% | 1.65E-03 | 3.4% |
| Corrugated board box | 5.04E-05 | 0.1% | 6.82E-05 | 0.1% | 6.98E-05 | 0.1% |
| Paper Bead | 2.02E-05 | <0.01% | 3.18E-05 | 0.1% | 3.95E-05 | 0.1% |
| Paper Cover | 6.72E-05 | 0.1% | 6.82E-05 | 0.1% | 6.98E-05 | 0.1% |
| Packaging frame (Paper) | 3.70E-04 | 0.7% | 4.09E-04 | 0.8% | 4.19E-04 | 0.9% |

## Description of production processes:




*Step 1: Cell soldering*

Cells prepared on the feed port are heated by infrared tubes. Transmit the heat to ribbons to fusing the stannum on the cells.

*Step 2: Typesetting/ soldering/ lay up*

Lay up glass, EVA, cell strings automatically, use tape to fix the cell strings, solder cross connectors to form a circuitry, meanwhile lay up EVA, back sheet, paste the SN label. At last record information into AMES system.

*Step 3: Semi-goods EL Test*

Scan SN label and take photos automatically. Operators inspect the EL pictures according the EL standard. AI intelligent judgment.

*Step 4: Lamination*

The semi-goods flow to laminator automatically. Put 4 pieces of semi-goods once regardless of 72pcs or 54pcs cells.

*Step 5: Trimming*

Trimming the edge of semi-goods automatically to ensure the edge is smooth.

*Step 6: Framing*

Put Aluminum rails on the feed port, inject silicone gel into the groove. Then mechanical arm grabs glued frames and compresses to the module automatically.

*Step 7: J-Box Assemble*

Fix junction box to glue machine, glue silicone to cover the bottom of J-box. Its appearance should be smooth.

*Step 8: J-Box glue*

Fill the AB gel to the J-Box. After solidifying it can protect the metal component from the humidity to ensure electrical function.

*Step 9: Solidification*

The modules are placed on the conveyor by mechanical arm, and then transferred into the solidification room.

*Step 10: Module Cleaning*

Operators use 99% industrial alcohol to clean the module. And assemble the J-Box lid.

*Step 11: Power Test*

Simulate outside light, guarantee the consistency of result under a series of standard condition. Use xenon light as source, and the light shapes as pulse to decrease the power loss as much as possible. Specific data is pasted on the label of back sheet.

*Step 12: Final EL Test*

Utilize electroluminescence technology to detect a number of defects, such as micro cracks, grain boundaries, broken contacts and shunts.

*Step13: Final Inspection*

Modules enter final inspection where inspectors check for visual defects, EL pictures and related module size and so on. AI intelligent assisted judgment.

*Step 14: Sorting*

According to different power, currents, colors and ranks, modules are distinguished automatically.

*Step 15: Packing*

Modules which have passed the final inspection are transported to packing area, each module of pallets turns over of 90° and 180° in order, and then cover the box, strap and wrap automatically. Present packing type is vertical.

*Step 16: Entering warehouse*

Transport the packaged modules to the warehouse and get prepared for delivery to customers.

## Technical data:

| Series (model name) | Power output range (Wp) | Dimensions ($mm^3$) | Area ($m^2$) | Module efficiency (%) | Weight (kg) | 1st year degradation (%) | Annual degradation (%) |
|---|---|---|---|---|---|---|---|
| CHSM72N(DG)/F-HC | 570-595 | 2278*1134*30 | 2.58 | 22.1~23.0 | 32.1 | 1 | 0.4 |
| CHSM72N(DG)/F-BH | 570-595 | 2278*1134*30 | 2.58 | 22.1~23.0 | 32.1 | 1 | 0.4 |
| CHSM54N-HC | 425-445 | 1722*1134*30 | 1.95 | 21.8~22.8 | 21.3 | 1 | 0.4 |
| CHSM54N(BL)-HC | 420-440 | 1722*1134*30 | 1.95 | 21.5~22.5 | 21.3 | 1 | 0.4 |
| CHSM54N(BLH)-HC | 420-440 | 1722*1134*30 | 1.95 | 21.5~22.5 | 21.3 | 1 | 0.4 |
| CHSM54N(DG)/F-HC | 425-440 | 1722*1134*30 | 1.95 | 21.8~22.5 | 20.8 | 1 | 0.4 |
| CHSM54N(DGT)/F-BH | 415-430 | 1722*1134*30 | 1.95 | 21.3~22.0 | 20.8 | 1 | 0.4 |
| CHSM54N(DGT)(BLH)/F-BH | 415-430 | 1722*1134*30 | 1.95 | 21.3~22.0 | 20.8 | 1 | 0.4 |

### Geographical area:
The products are produced and manufactured in China, and the evaluation incorporated the current market scenario in China. End-of-life scenario are based on EU regulation. The products are intended for global distribution and application.

### Reference service life, product:
25 years

### Type of EPD
This declaration is a specific EPD using a representative power output for each product. LCA Results of various power output ranges could be obtained using the conversion factors presented in the Chapter "additional requirements".

## LCA: Calculation rules

### Functional unit:
Functional unit is 1 Wp of manufactured photovoltaic module, with activities needed for a study period for a defined reference service life (≥80% of the labelled power output).

### Cut-off criteria:
For the processes within the system boundary, all available energy and material flow data have been included in the model. In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts. The following steps/stages are not included in the system boundary due to the reason that the elements below are considered irrelevant or not within the boundary:

• Impacts related to the production, transportation and installation of capital goods (buildings, infrastructure, machinery, internal transport packaging) and general operations (staff travel, marketing and communication actions) that cannot be directly allocated to products are excluded from the LCA study;

• The packaging for silicon wafer and solar cells is reused internally and its impact was excluded from the system;

• Emissions during the PV module installation and operation due to no obvious emission observable;

• Storage phases and sales of PV products due to no observable impact. Product losses due to abnormal damage such as natural disasters or fire accidents would occur at a rather low frequency;

• Handling operations at the distribution center and retail outlet due to small contribution and negligible impact;

• Research and development activities;

• Long-term emissions.

## Allocation:

The allocation is made in accordance with the provisions of EN 15804. Incoming energy and water and waste production in-house is allocated equally among all products through power output allocation. For the end-of-life allocation of background data (energy and materials), the model "allocation cut-off by classification (ISO standard) is used. As for the end-of-life stage of the solar PV modules, the load and benefit of reuse, recycling, and recovery processes is reported separately following the PCR's recommendation.

## Data quality:

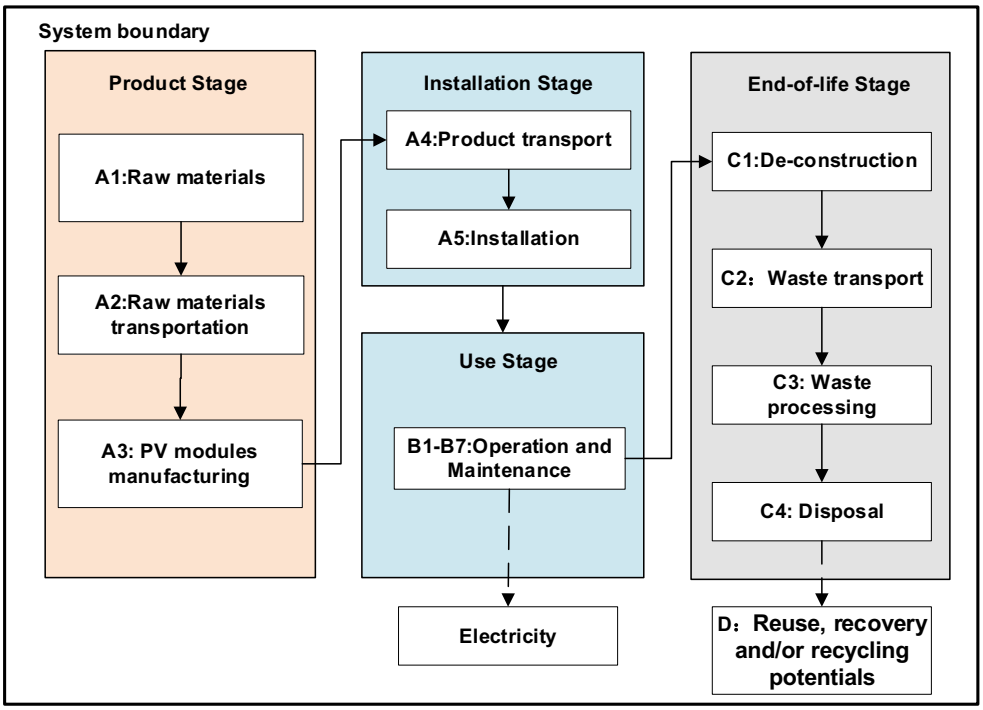
Primary data (such as materials or energy flows that enter and leave the production system) is from Astronergy manufacturing facilities for the period spanning from Nov. 2022 to Oct. 2023 (annual average). Generic data related to the life cycle impacts of the material or energy flows that enter and leave the production system is sourced from Ecoinvent 3.9 "allocation, cut-off by classification - unit" database.

System boundaries (X=included, MND=module not declared, MNR=module not relevant)

| Product stage | | | Assembly stage | | Use stage | | | | | | | End of life stage | | | | Benefits & loads beyond system boundary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Raw materials | Transport | Manufacturing | Transport | Assembly | Use | Maintenance | Repair | Replacement | Refurbishment | Operational energy use | Operational water use | De-construction 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 | X |

## System boundary:

The system boundary for this LCA study of PV modules encompasses product stage, installation stage, use stage, and end-of-life stage, from cradle to grave and module D.


System boundary
Product Stage
A1:Raw materials
A2:Raw materials transportation
A3: PV modules manufacturing
Installation Stage
A4:Product transport
A5:Installation
Use Stage
B1-B7:Operation and Maintenance
Electricity
End-of-life Stage
C1:De-construction
C2：Waste transport
C3: Waste processing
C4: Disposal
D：Reuse, recovery and/or recycling potentials

# LCA: Scenarios and additional technical information

The following information describe the scenarios in the different modules of the EPD.

## Transport from production place to assembly/user (A4)

| Transport from production place to assembly/user (A4) | Capacity utilisation (incl. return) % | Distance (km) | Fuel/Energy consumption | Unit | Value |
|---|---|---|---|---|---|
| Truck | 36.7 | 1151.26 | Diesel | kg/tkm | 0.0366 |

For all products, domestic market of China applies, transportation distances are calculated as an aggregate of distances to each respective region, weighted by their market ratio.

## Assembly (A5)

| | Unit | Value |
|---|---|---|
| Water consumption | $m^3$/FU | - |
| Electricity consumption | kWh/FU | 6.32E-5 |
| Other energy carriers | MJ/FU | Diesel: 1.35E-2 |
| Material loss | kg/FU | - |
| Output materials from waste treatment | kg/FU | 1.21E-3~1.27E-3 |

According to PCR, mounting structures and electrical components will not be included in this stage, only energy consumption, waste generation and treatment of packaging materials will be considered. The waste from the products' packaging is considered in this stage, and waste treatment of wood pallet is modeled as 75% recycling and 25% incineration. Other packaging materials including paper and plastic film are modeled with 100% incineration.

## Use (B1)

There are no material or energy inputs, nor emissions during the use phase (B1) of the PV module.

## Maintenance (B2)/Repair (B3)

| | Unit | Value |
|---|---|---|
| Water consumption | $m^3$/FU | 1.93E-5~2.67E-5 |

As for the maintenance stage (B2), water used for cleaning to maintain the performance is considered, 0.23L water used per module each time, and 2 times in a year are assumed. During the operation of PV module, no repair (B3) is required.

## Replacement (B4)/Refurbishment (B5)

It is assumed that the PV module itself does not require replacement and refurbishment during its RSL.

## Operational energy (B6) and water consumption (B7)

It is assumed that there is no operational electricity (B6) or water consumption (B7). To calculate the expected energy production over the lifetime of the panels, the following formula may be used:

$$E_1 = S_{\text{rad}} * A * y * PR * (1 - \deg)$$

Where:

$E_1$= Energy produced in the first year of operation, kWh/year

$S_{rad}$ = Site specific annual average solar radiation on module (shadings not included), kWh/kWp/year. The annual radiation must take into consideration the specific inclination (slope, tilt) and orientation.

A = Area of module, $m^2$.

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

STC: The ratio is given for standard test conditions: irradiance 1000 $W/m^2$, cell temperature 25 °C, wind speed 1 m/s, AM1.5.

PR = Performance ratio, coefficient for losses. Site specific performance ratio can be modelled with PV simulation software tools, such as PVSYST or similar.

Energy production second year of operation:

$$E_2 = E_1 * (1 - \deg)$$

Energy production n year of operation:

$$E_n = E_1 * (1 - \deg)^{n-1}$$

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

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

## Operational energy (B6) and water consumption (B7)

No inputs and outputs during operation stage.

## End of Life (C1, C3, C4)

| | Unit | CHSM72N(DG)/F-HC CHSM72N(DG)/F-BH | CHSM54N-HC CHSM54N(BL)-HC CHSM54N(BLH)-HC | CHSM54N(DG)/F-HC CHSM54N(DGT)/F-BH CHSM54N(DGT)(BLH)/F-BH |
|---|---|---|---|---|
| Hazardous waste disposed | kg/FU | - | - | - |
| Collected as mixed construction waste | kg/FU | 5.39E-02 | 4.84E-02 | 4.84E-02 |
| Reuse | kg/FU | - | - | - |
| Recycling | kg/FU | 4.22E-02 | 3.56E-02 | 3.67E-02 |
| Energy recovery | kg/FU | 4.29E-03 | 6.60E-03 | 5.18E-03 |
| To landfill | kg/FU | 7.45E-03 | 6.24E-03 | 6.54E-03 |

Assumptions are made for C1, C3 and C4 stage. Decommissioning stage (C1) of PV modules is assumed to be taken with same energy and fuel consumption as for installation stage. Waste processing (C3) stage is assumed to be mechanically treated to yield the bulk materials. Modelling

of disposal stage (C4) refers to legal requirements issued by Waste Electrical and Electronic Equipment (WEEE) under the EU scenario.

## Transport to waste processing (C2)

| Transport from production place to assembly/user (C2) | Capacity utilisation (incl. return) % | Distance (km) | Fuel/Energy consumption | Unit | Value |
|---|---|---|---|---|---|
| Truck | 36.7 | 50 | Diesel | kg/tkm | 0.036 |

50km transportation distance from the plant site to waste treatment site (C2) is assumed according to PCR.

## Benefits and loads beyond the system boundaries (D)

| Benefits and loads beyond the system boundaries (D) | Unit | CHSM72N(DG)/F-HC CHSM72N(DG)/F-BH | CHSM54N-HC CHSM54N(BL)-HC CHSM54N(BLH)-HC | CHSM54N(DG)/F-HC CHSM54N(DGT)/F-BH CHSM54N(DGT)(BLH)/ F-BH |
|---|---|---|---|---|
| Substitution of electricity | MJ/FU | 2.79E-02 | 3.48E-02 | 3.12E-02 |
| Substitution of thermal energy, district heating | MJ/FU | 5.28E-02 | 6.53E-02 | 5.92E-02 |
| Substitution of converter aluminum with net scrap | kg/FU | 1.01E-03 | 1.13E-03 | 1.16E-03 |
| Substitution of primary silver with net scrap | kg/FU | 8.40E-06 | 9.09E-06 | 9.30E-06 |
| Substitution of primary copper with net scrap | kg/FU | 7.06E-05 | 9.32E-05 | 1.19E-04 |
| Substitution of primary glass with glass gullets | kg/FU | 3.04E-02 | 2.45E-02 | 2.57E-02 |
| Substitution of primary wood pallet with recycled wood | kg/FU | 1.27E-03 | 1.21E-03 | 1.24E-03 |

# LCA: Results

The LCA results show the environmental impacts and resource input and output flows calculated according to EN 15804:2012+A2. The results are shown per functional unit (1Wp). The LCA results have been calculated using the LCA software SimaPro 9.5.

## Core environmental impact indicators

CHSM72N(DG)/F-HC and CHSM72N(DG)/F-BH (595Wp)

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GWP - total | kg $CO_2$ eq | 3.83E-01 | 1.22E-02 | 4.98E-03 | 0.00E+00 | 2.39E-05 | 0.00E+00 | 1.40E-03 | 5.09E-04 | 1.42E-02 | 9.78E-03 | -1.82E-01 |
| GWP - fossil | kg $CO_2$ eq | 3.84E-01 | 1.22E-02 | 1.80E-03 | 0.00E+00 | 2.39E-05 | 0.00E+00 | 1.40E-03 | 5.08E-04 | 1.42E-02 | 9.78E-03 | -1.81E-01 |
| GWP - biogenic | kg $CO_2$ eq | -1.48E-03 | 3.23E-06 | 3.19E-03 | 0.00E+00 | 3.78E-08 | 0.00E+00 | 1.77E-07 | 1.34E-07 | 2.05E-06 | 9.63E-07 | -7.07E-04 |
| GWP - luluc | kg $CO_2$ eq | 4.09E-04 | 6.43E-06 | 3.29E-07 | 0.00E+00 | 3.16E-08 | 0.00E+00 | 1.74E-07 | 2.68E-07 | 5.62E-06 | 1.24E-07 | -2.03E-04 |
| ODP | kg CFC11 eq | 7.23E-09 | 1.92E-10 | 5.48E-11 | 0.00E+00 | 3.70E-13 | 0.00E+00 | 2.14E-11 | 8.01E-12 | 2.51E-11 | 1.20E-11 | -1.15E-08 |
| AP | molc H+ eq | 2.31E-03 | 3.02E-05 | 1.35E-05 | 0.00E+00 | 1.27E-07 | 0.00E+00 | 1.27E-05 | 1.26E-06 | 7.53E-05 | 2.80E-06 | -1.34E-03 |
| EP- freshwater | kg P eq | 1.25E-05 | 1.16E-07 | 1.03E-08 | 0.00E+00 | 9.57E-10 | 0.00E+00 | 6.10E-09 | 4.84E-09 | 3.01E-07 | 3.62E-09 | -1.99E-05 |
| EP -marine | kg N eq | 4.94E-04 | 7.19E-06 | 6.05E-06 | 0.00E+00 | 2.37E-08 | 0.00E+00 | 5.80E-06 | 2.99E-07 | 1.55E-05 | 1.27E-06 | -3.62E-04 |
| EP - terrestrial | molc N eq | 4.98E-03 | 7.57E-05 | 6.58E-05 | 0.00E+00 | 2.63E-07 | 0.00E+00 | 6.31E-05 | 3.15E-06 | 1.71E-04 | 1.32E-05 | -4.19E-03 |
| POCP | kg NMVOC eq | 1.46E-03 | 4.03E-05 | 1.96E-05 | 0.00E+00 | 8.47E-08 | 0.00E+00 | 1.87E-05 | 1.68E-06 | 4.51E-05 | 3.52E-06 | -9.84E-04 |
| ADP-M&M[2] | kg Sb-Eq | 4.51E+00 | 1.72E-01 | 2.02E-02 | 0.00E+00 | 2.87E-04 | 0.00E+00 | 1.81E-02 | 7.16E-03 | 1.38E-01 | 3.58E-03 | -2.45E+00 |
| ADP-fossil[2] | MJ | 1.59E-05 | 3.97E-08 | 1.32E-09 | 0.00E+00 | 1.09E-10 | 0.00E+00 | 5.05E-10 | 1.65E-09 | 9.08E-09 | 6.25E-10 | -3.99E-04 |
| WDP[2] | $m^3$ | 4.41E-01 | 7.66E-04 | 1.04E-04 | 0.00E+00 | 7.89E-04 | 0.00E+00 | 4.43E-05 | 3.19E-05 | 1.57E-03 | 5.19E-04 | 1.45E-01 |

CHSM54N-HC, CHSM54N(BL)-HC, and CHSM54N(BLH)-HC (440Wp)

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GWP - total | kg $CO_2$ eq | 3.94E-01 | 1.10E-02 | 4.96E-03 | 0.00E+00 | 3.24E-05 | 0.00E+00 | 1.40E-03 | 4.56E-04 | 1.28E-02 | 1.45E-02 | -9.66E-02 |
| GWP - fossil | kg $CO_2$ eq | 3.95E-01 | 1.10E-02 | 1.79E-03 | 0.00E+00 | 3.23E-05 | 0.00E+00 | 1.40E-03 | 4.56E-04 | 1.28E-02 | 1.45E-02 | -9.61E-02 |
| GWP - biogenic | kg $CO_2$ eq | -1.55E-03 | 2.91E-06 | 3.17E-03 | 0.00E+00 | 5.11E-08 | 0.00E+00 | 1.77E-07 | 1.21E-07 | 1.84E-06 | 1.19E-06 | -3.92E-04 |
| GWP - luluc | kg $CO_2$ eq | 4.31E-04 | 5.79E-06 | 3.43E-07 | 0.00E+00 | 4.28E-08 | 0.00E+00 | 1.74E-07 | 2.40E-07 | 5.04E-06 | 1.52E-07 | -1.45E-04 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ODP | kg CFC11 eq | 3.66E-08 | 1.73E-10 | 5.82E-11 | 0.00E+00 | 5.01E-13 | 0.00E+00 | 2.14E-11 | 7.18E-12 | 2.25E-11 | 1.65E-11 | -2.14E-09 |
| AP | molc H+ eq | 2.33E-03 | 2.72E-05 | 1.36E-05 | 0.00E+00 | 1.71E-07 | 0.00E+00 | 1.27E-05 | 1.13E-06 | 6.76E-05 | 3.79E-06 | -6.35E-04 |
| EP- freshwater | kg P eq | 1.31E-05 | 1.05E-07 | 1.06E-08 | 0.00E+00 | 1.29E-09 | 0.00E+00 | 6.10E-09 | 4.34E-09 | 2.70E-07 | 4.82E-09 | -5.23E-06 |
| EP -marine | kg N eq | 5.00E-04 | 6.48E-06 | 6.08E-06 | 0.00E+00 | 3.21E-08 | 0.00E+00 | 5.80E-06 | 2.68E-07 | 1.39E-05 | 1.75E-06 | -1.23E-04 |
| EP - terrestrial | molc N eq | 5.01E-03 | 6.82E-05 | 6.62E-05 | 0.00E+00 | 3.56E-07 | 0.00E+00 | 6.31E-05 | 2.83E-06 | 1.53E-04 | 1.81E-05 | -1.42E-03 |
| POCP | kg NMVOC eq | 1.48E-03 | 3.63E-05 | 1.97E-05 | 0.00E+00 | 1.15E-07 | 0.00E+00 | 1.87E-05 | 1.51E-06 | 4.05E-05 | 4.72E-06 | -3.89E-04 |
| ADP-M&M[2] | kg Sb-Eq | 4.78E+00 | 1.55E-01 | 2.03E-02 | 0.00E+00 | 3.88E-04 | 0.00E+00 | 1.81E-02 | 6.43E-03 | 1.24E-01 | 4.17E-03 | -1.17E+00 |
| ADP-fossil[2] | MJ | 1.63E-05 | 3.58E-08 | 1.39E-09 | 0.00E+00 | 1.47E-10 | 0.00E+00 | 5.05E-10 | 1.48E-09 | 8.15E-09 | 8.28E-10 | -4.66E-05 |
| WDP[2] | m³ | 4.52E-01 | 6.90E-04 | 1.10E-04 | 0.00E+00 | 1.07E-03 | 0.00E+00 | 4.43E-05 | 2.86E-05 | 1.41E-03 | 7.22E-04 | -1.05E-02 |

CHSM54N(DG)/F-HC, CHSM54N(DGT)/F-BH, and CHSM54N(DGT)(BLH)/F-BH (430Wp)

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GWP - total | kg $CO_2$ eq | 4.03E-01 | 1.10E-02 | 5.23E-03 | 0.00E+00 | 3.31E-05 | 0.00E+00 | 1.40E-03 | 4.56E-04 | 1.28E-02 | 1.11E-02 | -9.82E-02 |
| GWP - fossil | kg $CO_2$ eq | 4.04E-01 | 1.10E-02 | 1.98E-03 | 0.00E+00 | 3.30E-05 | 0.00E+00 | 1.40E-03 | 4.56E-04 | 1.28E-02 | 1.11E-02 | -9.77E-02 |
| GWP - biogenic | kg $CO_2$ eq | -1.41E-03 | 2.92E-06 | 3.25E-03 | 0.00E+00 | 5.23E-08 | 0.00E+00 | 1.77E-07 | 1.21E-07 | 1.84E-06 | 9.98E-07 | -4.10E-04 |
| GWP - luluc | kg $CO_2$ eq | 4.44E-04 | 5.80E-06 | 4.02E-07 | 0.00E+00 | 4.38E-08 | 0.00E+00 | 1.74E-07 | 2.40E-07 | 5.04E-06 | 1.28E-07 | -1.51E-04 |
| ODP | kg CFC11 eq | 8.58E-09 | 1.74E-10 | 7.51E-11 | 0.00E+00 | 5.12E-13 | 0.00E+00 | 2.14E-11 | 7.18E-12 | 2.25E-11 | 1.31E-11 | -2.20E-09 |
| AP | molc H+ eq | 2.42E-03 | 2.73E-05 | 1.38E-05 | 0.00E+00 | 1.75E-07 | 0.00E+00 | 1.27E-05 | 1.13E-06 | 6.75E-05 | 3.03E-06 | -6.49E-04 |
| EP- freshwater | kg P eq | 1.35E-05 | 1.05E-07 | 1.24E-08 | 0.00E+00 | 1.32E-09 | 0.00E+00 | 6.10E-09 | 4.34E-09 | 2.70E-07 | 3.89E-09 | -5.36E-06 |
| EP -marine | kg N eq | 5.18E-04 | 6.49E-06 | 6.13E-06 | 0.00E+00 | 3.28E-08 | 0.00E+00 | 5.80E-06 | 2.68E-07 | 1.39E-05 | 1.39E-06 | -1.25E-04 |
| EP - terrestrial | molc N eq | 5.19E-03 | 6.84E-05 | 6.68E-05 | 0.00E+00 | 3.64E-07 | 0.00E+00 | 6.31E-05 | 2.83E-06 | 1.53E-04 | 1.44E-05 | -1.45E-03 |
| POCP | kg NMVOC eq | 1.52E-03 | 3.64E-05 | 1.98E-05 | 0.00E+00 | 1.17E-07 | 0.00E+00 | 1.87E-05 | 1.51E-06 | 4.04E-05 | 3.79E-06 | -3.99E-04 |
| ADP-M&M[2] | kg Sb-Eq | 4.76E+00 | 1.55E-01 | 2.08E-02 | 0.00E+00 | 3.97E-04 | 0.00E+00 | 1.81E-02 | 6.42E-03 | 1.24E-01 | 3.61E-03 | -1.20E+00 |
| ADP-fossil[2] | MJ | 1.86E-05 | 3.59E-08 | 1.67E-09 | 0.00E+00 | 1.51E-10 | 0.00E+00 | 5.05E-10 | 1.48E-09 | 8.14E-09 | 6.70E-10 | -4.78E-05 |
| WDP[2] | m³ | 4.71E-01 | 6.92E-04 | 1.38E-04 | 0.00E+00 | 1.09E-03 | 0.00E+00 | 4.43E-05 | 2.86E-05 | 1.41E-03 | 5.69E-04 | -7.89E-03 |

***GWP-total:*** *Global Warming Potential;* ***GWP-fossil:*** *Global Warming Potential fossil fuels;* ***GWP-biogenic:*** *Global Warming Potential biogenic;* ***GWP-LULUC:*** *Global Warming Potential land use and land use change;* ***ODP:*** *Depletion potential of the stratospheric ozone layer;* ***AP:*** *Acidification potential, Accumulated Exceedance;* ***EP-freshwater:*** *Eutrophication potential, fraction of nutrients reaching freshwater end compartment; See "additional Norwegian requirements" for indicator given as PO4 eq.* ***EP-marine:*** *Eutrophication potential, fraction of nutrients reaching freshwater end compartment;* ***EP-terrestrial:*** *Eutrophication potential, Accumulated Exceedance;* ***POCP****: Formation potential of tropospheric ozone;* ***ADP-M&M****: Abiotic depletion potential for non-fossil resources (minerals and metals);* ***ADP-fossil:*** *Abiotic depletion potential for fossil resources;* ***WDP:*** *Water deprivation potential, deprivation weighted water consumption*

Reading example: 9.0 E-03 = $9.0*10^{-3}$ = 0.009

## Additional environmental impact indicators

### CHSM72N(DG)/F-HC and CHSM72N(DG)/F-BH (595Wp)

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM | Disease incidence | 2.81E-08 | 9.07E-10 | 3.61E-10 | 0.00E+00 | 1.56E-12 | 0.00E+00 | 3.50E-10 | 3.78E-11 | 1.05E-09 | 2.41E-11 | -1.26E-08 |
| IRP[1] | kBq U235 eq. | 8.62E-03 | 6.13E-05 | 7.66E-06 | 0.00E+00 | 8.35E-07 | 0.00E+00 | 4.39E-06 | 2.55E-06 | 1.91E-04 | 1.97E-06 | -3.26E-03 |
| ETP-fw[2] | CTUe | 2.34E+00 | 9.45E-02 | 2.25E-02 | 0.00E+00 | 1.05E-04 | 0.00E+00 | 8.52E-03 | 3.93E-03 | 3.85E-02 | 2.00E-02 | -5.20E+00 |
| HTP-c[2] | CTUh | 2.28E-10 | 5.54E-12 | 7.16E-13 | 0.00E+00 | 5.65E-14 | 0.00E+00 | 4.21E-13 | 2.31E-13 | 2.91E-12 | 8.90E-13 | -7.49E-10 |
| HTP-nc[2] | CTUh | 4.82E-09 | 1.24E-10 | 7.10E-12 | 0.00E+00 | 7.99E-13 | 0.00E+00 | 3.41E-12 | 5.18E-12 | 1.33E-10 | 3.03E-11 | -2.23E-07 |
| SQP[2] | Dimensionless | 1.53E+00 | 1.04E-01 | 2.27E-03 | 0.00E+00 | 5.96E-05 | 0.00E+00 | 1.29E-03 | 4.33E-03 | 2.68E-02 | 4.83E-03 | -2.52E+00 |

### CHSM54N-HC, CHSM54N(BL)-HC, and CHSM54N(BLH)-HC (440Wp)

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM | Disease incidence | 2.85E-08 | 8.17E-10 | 3.62E-10 | 0.00E+00 | 2.12E-12 | 0.00E+00 | 3.50E-10 | 3.39E-11 | 9.44E-10 | 2.73E-11 | -5.45E-09 |
| IRP[1] | kBq U235 eq. | 8.96E-03 | 5.53E-05 | 7.98E-06 | 0.00E+00 | 1.13E-06 | 0.00E+00 | 4.39E-06 | 2.29E-06 | 1.72E-04 | 2.55E-06 | -1.99E-03 |
| ETP-fw[2] | CTUe | 2.34E+00 | 8.51E-02 | 2.39E-02 | 0.00E+00 | 1.42E-04 | 0.00E+00 | 8.52E-03 | 3.53E-03 | 3.46E-02 | 2.92E-02 | -8.02E-01 |
| HTP-c[2] | CTUh | 2.41E-10 | 4.99E-12 | 7.82E-13 | 0.00E+00 | 7.64E-14 | 0.00E+00 | 4.21E-13 | 2.07E-13 | 2.61E-12 | 1.30E-12 | -1.30E-10 |
| HTP-nc[2] | CTUh | 5.16E-09 | 1.12E-10 | 7.45E-12 | 0.00E+00 | 1.08E-12 | 0.00E+00 | 3.41E-12 | 4.64E-12 | 1.19E-10 | 4.48E-11 | -2.68E-08 |
| SQP[2] | Dimensionless | 1.56E+00 | 9.38E-02 | 2.33E-03 | 0.00E+00 | 8.06E-05 | 0.00E+00 | 1.29E-03 | 3.89E-03 | 2.41E-02 | 4.39E-03 | -1.13E+00 |

### CHSM54N(DG)/F-HC, CHSM54N(DGT)/F-BH, and CHSM54N(DGT)(BLH)/F-BH (430Wp)

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM | Disease incidence | 2.95E-08 | 8.19E-10 | 3.64E-10 | 0.00E+00 | 2.16E-12 | 0.00E+00 | 3.50E-10 | 3.38E-11 | 9.44E-10 | 2.40E-11 | -5.56E-09 |
| IRP[1] | kBq U235 eq. | 9.20E-03 | 5.54E-05 | 9.46E-06 | 0.00E+00 | 1.16E-06 | 0.00E+00 | 4.39E-06 | 2.29E-06 | 1.72E-04 | 2.10E-06 | -2.09E-03 |
| ETP-fw[2] | CTUe | 2.48E+00 | 8.53E-02 | 3.10E-02 | 0.00E+00 | 1.45E-04 | 0.00E+00 | 8.52E-03 | 3.53E-03 | 3.46E-02 | 2.25E-02 | -8.34E-01 |
| HTP-c[2] | CTUh | 2.54E-10 | 5.00E-12 | 8.29E-13 | 0.00E+00 | 7.82E-14 | 0.00E+00 | 4.21E-13 | 2.07E-13 | 2.61E-12 | 1.00E-12 | -1.35E-10 |
| HTP-nc[2] | CTUh | 5.56E-09 | 1.12E-10 | 8.30E-12 | 0.00E+00 | 1.10E-12 | 0.00E+00 | 3.41E-12 | 4.64E-12 | 1.19E-10 | 3.43E-11 | -2.75E-08 |
| SQP[2] | Dimensionless | 1.63E+00 | 9.40E-02 | 2.48E-03 | 0.00E+00 | 8.25E-05 | 0.00E+00 | 1.29E-03 | 3.88E-03 | 2.41E-02 | 4.38E-03 | -1.17E+00 |

*PM: Particulate matter emissions; IRP: Ionising radiation, human health; ETP-fw: Ecotoxicity (freshwater); ETP-c: Human toxicity, cancer effects; HTP-nc: Human toxicity, non-cancer effects; SQP: Land use related impacts / soil quality*

[1] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

[2] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator

## Resource use

### CHSM72N(DG)/F-HC and CHSM72N(DG)/F-BH (595Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RPEE | MJ | 8.95E-01 | 2.22E-03 | 2.74E-04 | 0.00E+00 | 2.74E-05 | 0.00E+00 | 1.62E-04 | 9.26E-05 | 1.47E-02 | 2.96E-02 | -4.67E-01 |
| RPEM | MJ | 2.95E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -2.95E-02 | 0.00E+00 |
| TPE | MJ | 9.25E-01 | 2.22E-03 | 2.74E-04 | 0.00E+00 | 2.74E-05 | 0.00E+00 | 1.62E-04 | 9.26E-05 | 1.47E-02 | 9.57E-05 | -4.67E-01 |
| NRPE | MJ | 5.20E+00 | 1.71E-01 | 1.84E-01 | 0.00E+00 | 3.31E-04 | 0.00E+00 | 1.78E-02 | 7.11E-03 | 2.05E-01 | 3.68E-03 | -2.67E+00 |
| NRPM | MJ | 1.64E-01 | 0.00E+00 | -1.64E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| TRPE | MJ | 5.37E+00 | 1.71E-01 | 1.99E-02 | 0.00E+00 | 3.31E-04 | 0.00E+00 | 1.78E-02 | 7.11E-03 | 2.05E-01 | 3.68E-03 | -2.67E+00 |
| SM | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| RSF | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRSF | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| W | $m^3$ | 1.16E-02 | 2.47E-05 | 3.46E-06 | 0.00E+00 | 1.84E-05 | 0.00E+00 | 1.53E-06 | 1.03E-06 | 3.76E-05 | 1.58E-05 | -2.25E-03 |

### CHSM54N-HC, CHSM54N(BL)-HC, and CHSM54N(BLH)-HC (440Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RPEE | MJ | 9.22E-01 | 2.00E-03 | 2.85E-04 | 0.00E+00 | 3.71E-05 | 0.00E+00 | 1.62E-04 | 8.31E-05 | 1.32E-02 | 2.95E-02 | -2.58E-01 |
| RPEM | MJ | 2.93E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -2.93E-02 | 0.00E+00 |
| TPE | MJ | 9.52E-01 | 2.00E-03 | 2.85E-04 | 0.00E+00 | 3.71E-05 | 0.00E+00 | 1.62E-04 | 8.31E-05 | 1.32E-02 | 1.28E-04 | -2.58E-01 |
| NRPE | MJ | 5.46E+00 | 1.54E-01 | 2.28E-01 | 0.00E+00 | 4.48E-04 | 0.00E+00 | 1.78E-02 | 6.38E-03 | 1.84E-01 | 4.34E-03 | -1.37E+00 |
| NRPM | MJ | 2.07E-01 | 0.00E+00 | -2.07E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRPE | MJ | 5.66E+00 | 1.54E-01 | 2.00E-02 | 0.00E+00 | 4.48E-04 | 0.00E+00 | 1.78E-02 | 6.38E-03 | 1.84E-01 | 4.34E-03 | -1.37E+00 |
| SM | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| RSF | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRSF | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| W | $m^3$ | 1.19E-02 | 2.23E-05 | 3.69E-06 | 0.00E+00 | 2.49E-05 | 0.00E+00 | 1.53E-06 | 9.24E-07 | 3.38E-05 | 2.23E-05 | -1.04E-03 |

### CHSM54N(DG)/F-HC, CHSM54N(DGT)/F-BH, and CHSM54N(DGT)(BLH)/F-BH (430Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RPEE | MJ | 9.58E-01 | 2.01E-03 | 3.35E-04 | 0.00E+00 | 3.79E-05 | 0.00E+00 | 1.62E-04 | 8.30E-05 | 1.32E-02 | 3.02E-02 | -2.68E-01 |
| RPEM | MJ | 3.01E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -3.01E-02 | 0.00E+00 |
| TPE | MJ | 9.88E-01 | 2.01E-03 | 3.35E-04 | 0.00E+00 | 3.79E-05 | 0.00E+00 | 1.62E-04 | 8.30E-05 | 1.32E-02 | 1.03E-04 | -2.68E-01 |
| NRPE | MJ | 5.49E+00 | 1.54E-01 | 2.05E-01 | 0.00E+00 | 4.58E-04 | 0.00E+00 | 1.78E-02 | 6.37E-03 | 1.84E-01 | 3.73E-03 | -1.39E+00 |
| NRPM | MJ | 1.85E-01 | 0.00E+00 | -1.85E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| TRPE | MJ | 5.67E+00 | 1.54E-01 | 2.05E-02 | 0.00E+00 | 4.58E-04 | 0.00E+00 | 1.78E-02 | 6.37E-03 | 1.84E-01 | 3.73E-03 | -1.39E+00 |
| SM | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| RSF | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| NRSF | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| W | $m^3$ | 1.24E-02 | 2.23E-05 | 4.46E-06 | 0.00E+00 | 2.55E-05 | 0.00E+00 | 1.53E-06 | 9.23E-07 | 3.37E-05 | 1.75E-05 | -9.94E-04 |

***RPEE*** *Renewable primary energy resources used as energy carrier;* ***RPEM*** *Renewable primary energy resources used as raw materials;* ***TPE*** *Total use of renewable primary energy resources;* ***NRPE*** *Nonrenewable primary energy resources used as energy carrier;* ***NRPM*** *Nonrenewable primary energy resources used as materials;* ***TRPE*** *Total use of non-renewable primary energy resources;* ***SM*** *Use of secondary materials;* ***RSF*** *Use of renewable secondary fuels;* ***NRSF*** *Use of non-renewable secondary fuels;* ***W*** *Use of net fresh water.*

## End of life – Waste

### CHSM72N(DG)/F-HC and CHSM72N(DG)/F-BH (595Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HW | kg | 6.78E-04 | 1.11E-06 | 1.30E-07 | 0.00E+00 | 8.16E-10 | 0.00E+00 | 1.18E-07 | 4.63E-08 | 7.14E-08 | 2.00E-08 | 2.27E-05 |
| NHW | kg | 3.60E-02 | 8.49E-03 | 1.11E-04 | 0.00E+00 | 3.32E-06 | 0.00E+00 | 2.95E-05 | 3.53E-04 | 4.23E-02 | 1.16E-02 | -2.13E-02 |
| RW | kg | 5.73E-06 | 3.52E-08 | 4.78E-09 | 0.00E+00 | 5.06E-10 | 0.00E+00 | 2.54E-09 | 1.47E-09 | 1.46E-07 | 1.27E-09 | -2.14E-06 |

CHSM54N-HC, CHSM54N(BL)-HC, and CHSM54N(BLH)-HC (440Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HW | kg | 6.89E-04 | 1.00E-06 | 1.30E-07 | 0.00E+00 | 1.10E-09 | 0.00E+00 | 1.18E-07 | 4.15E-08 | 6.41E-08 | 2.38E-08 | 3.02E-05 |
| NHW | kg | 3.63E-02 | 7.65E-03 | 1.16E-04 | 0.00E+00 | 4.49E-06 | 0.00E+00 | 2.95E-05 | 3.17E-04 | 3.60E-02 | 1.24E-02 | -1.14E-02 |
| RW | kg | 5.95E-06 | 3.17E-08 | 5.00E-09 | 0.00E+00 | 6.85E-10 | 0.00E+00 | 2.54E-09 | 1.32E-09 | 1.31E-07 | 1.66E-09 | -1.29E-06 |

CHSM54N(DG)/F-HC, CHSM54N(DGT)/F-BH, and CHSM54N(DGT)(BLH)/F-BH (430Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HW | kg | 7.19E-04 | 1.00E-06 | 1.32E-07 | 0.00E+00 | 1.13E-09 | 0.00E+00 | 1.18E-07 | 4.15E-08 | 6.41E-08 | 2.04E-08 | 3.08E-05 |
| NHW | kg | 3.81E-02 | 7.66E-03 | 1.26E-04 | 0.00E+00 | 4.59E-06 | 0.00E+00 | 2.95E-05 | 3.17E-04 | 3.70E-02 | 1.14E-02 | -1.17E-02 |
| RW | kg | 6.12E-06 | 3.18E-08 | 6.04E-09 | 0.00E+00 | 7.01E-10 | 0.00E+00 | 2.54E-09 | 1.31E-09 | 1.31E-07 | 1.35E-09 | -1.35E-06 |

***HW*** *Hazardous waste disposed;* ***NHW*** *Non-hazardous waste disposed;* ***RW*** *Radioactive waste disposed.*

## End of life – output flow

CHSM72N(DG)/F-HC and CHSM72N(DG)/F-BH (595Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CR | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| MR | kg | 0.00E+00 | 0.00E+00 | 1.27E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.23E-02 | 0.00E+00 |
| MER | kg | 0.00E+00 | 0.00E+00 | 9.32E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EEE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.79E-02 | 0.00E+00 |
| ETE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.28E-02 | 0.00E+00 |

CHSM54N-HC, CHSM54N(BL)-HC, and CHSM54N(BLH)-HC (440Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CR | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| MR | kg | 0.00E+00 | 0.00E+00 | 1.21E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.60E-02 | 0.00E+00 |
| MER | kg | 0.00E+00 | 0.00E+00 | 9.81E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EEE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.48E-02 | 0.00E+00 |
| ETE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.53E-02 | 0.00E+00 |

CHSM54N(DG)/F-HC, CHSM54N(DGT)/F-BH, and CHSM54N(DGT)(BLH)/F-BH (430Wp)

| Parameter | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CR | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| MR | kg | 0.00E+00 | 0.00E+00 | 1.24E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.70E-02 | 0.00E+00 |
| MER | kg | 0.00E+00 | 0.00E+00 | 1.01E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EEE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.12E-02 | 0.00E+00 |
| ETE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.92E-02 | 0.00E+00 |

***CR*** *Components for reuse;* ***MR*** *Materials for recycling;* ***MER*** *Materials for energy recovery;* ***EEE*** *Exported electric energy;* ***ETE*** *Exported thermal energy.*

## Information describing the biogenic carbon content at the factory gate

| **Biogenic carbon content** | **Unit** | CHSM72N(DG)/F-HC<br>CHSM72N(DG)/F-BH | CHSM54N-HC<br>CHSM54N(BL)-HC<br>CHSM54N(BLH)-HC | CHSM54N(DG)/ F-HC<br>CHSM54N(DGT)/F-BH<br>CHSM54N(DGT)(BLH)/F-BH |
|---|---|---|---|---|
| Biogenic carbon content in product | kg C/FU | 0 | 0 | 0 |
| Biogenic carbon content in the accompanying packaging | kg C/FU | 8.69E-04 | 8.64E-04 | 8.87E-04 |

Note: 1 kg biogenic carbon is equivalent to 44/12 kg $CO_2$

# Additional requirements

## Location based electricity mix from the use of electricity in manufacturing

In the context of China, a market-based approach is not applicable due to the absence of a Guarantee of Origin system. Therefore, a location-based approach is employed to assess the environmental impact of electricity in this EPD. Regional production mix from medium voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing process (A3).

| Regional electricity grid | Data source | Foreground / core [kWh] | $GWP_{total}$ [kg $CO_2$ -eq/kWh] | SUM [kg $CO_2$ -eq] |
|---|---|---|---|---|
| *Electricity, medium voltage {CN-ECGC}\| market for electricity, medium voltage \| Cut-off, U* | ecoinvent 3.9 | 1.14E-2 | 0.857 | 9.77E-3 |

## Additional environmental impact indicators required for construction products

In order to increase the transparency of biogenic carbon contribution to climate impact, the indicator GWP-IOBC is required as it declares climate impacts calculated according to the principle of instantaneous oxidation. GWP-IOBC is also referred to as GWP-GHG in context to Swedish public procurement legislation.

| | Unit | A1-A3 | A4 | A5 | B1 | B2 | B3-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHSM72N(DG)/F-HC (595Wp)<br>CHSM72N(DG)/F-BH (595Wp) | kg $CO_2$ eq | 3.84E-01 | 1.22E-02 | 1.79E-03 | 0.00E+00 | 2.39E-05 | 0.00E+00 | 1.40E-03 | 5.09E-04 | 1.42E-02 | 9.78E-03 | -1.81E-01 |
| CHSM54N-HC (440Wp)<br>CHSM54N(BL)-HC (440Wp)<br>CHSM54N(BLH)-HC (440Wp) | kg $CO_2$ eq | 3.96E-01 | 1.10E-02 | 1.79E-03 | 0.00E+00 | 3.23E-05 | 0.00E+00 | 1.40E-03 | 4.56E-04 | 1.28E-02 | 1.45E-02 | -9.62E-02 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHSM54N(DG)/F-HC (430Wp)<br>CHSM54N(DGT)/F-BH (430Wp)<br>CHSM54N(DGT)(BLH)/F-BH (430Wp) | kg $CO_2$ eq | 4.04E-01 | 1.10E-02 | 1.98E-03 | 0.00E+00 | 3.30E-05 | 0.00E+00 | 1.40E-03 | 4.56E-04 | 1.28E-02 | 1.11E-02 | -9.78E-02 |

***GWP-IOBC*** *Global warming potential calculated according to the principle of instantaneous oxidation.*

## Hazardous substances

The declaration is based upon reference to threshold values and/or test results and/or material safety data sheets provided to EPD verifiers. Documentation available upon request to EPD owner.

- ☐ The product contains no substances given by the REACH Candidate list.
- ✓ The product contains substances given by the REACH Candidate list that are less than 0,1 % by weight.
- ☐ The product contains dangerous substances, more than 0,1% by weight, given by the REACH Candidate List, see table.
- ☐ The product contains no substances given by the REACH Candidate list.
- ☐ The product is classified as hazardous waste, see table.

## Indoor environment

This is not relevant to the product under study.

## Carbon footprint (A1-C4)

The carbon footprint (per Wp) for CHSM72N(DG)/F-HC (595Wp) and CHSM72N(DG)/F-BH (595Wp) is 4.24E-01kg $CO_2$ eq./Wp.

The carbon footprint (per Wp) for CHSM54N-HC (440Wp), CHSM54N(BL)-HC (440Wp), CHSM54N(BLH)-HC (440Wp) is 4.38E-01kg $CO_2$ eq./Wp.

The carbon footprint (per Wp) for CHSM54N(DG)/F-HC (430Wp), CHSM54N(DGT)/F-BH (430Wp), CHSM54N(DGT)(BLH)/F-BH (430Wp) is 4.43E-01kg $CO_2$ eq./Wp.

## EPD results conversion factors of various power output ranges

CHSM72N(DG)/F-HC and CHSM72N(DG)/F-BH

| Rated power output range (Wp) | 570 | 575 | 580 | 585 | 590 | 595 |
|---|---|---|---|---|---|---|
| Conversion factor* | 1.044 | 1.035 | 1.026 | 1.017 | 1.008 | 1 |

*Note: Environmental impacts of other power outputs are determined by multiplying the results for 595 Wp by relevant conversion factors.

CHSM54N-HC, CHSM54N(BL)-HC, and CHSM54N(BLH)-HC

| Rated power output range (Wp) | 420 | 425 | 430 | 435 | 440 | 445 |
|---|---|---|---|---|---|---|
| Conversion factor* | 1.048 | 1.035 | 1.023 | 1.011 | 1 | 0.989 |

*Note: Environmental impacts of other power outputs are determined by multiplying the results for 440 Wp by relevant conversion factors.

CHSM54N(DG)/F-HC, CHSM54N(DGT)/F-BH, and CHSM54N(DGT)(BLH)/F-BH

| Rated power output range (Wp) | 415 | 420 | 425 | 430 | 435 | 440 |
|---|---|---|---|---|---|---|
| Conversion factor* | 1.036 | 1.024 | 1.012 | 1 | 0.989 | 0.977 |

*Note: Environmental impacts of other power outputs are determined by multiplying the results for 430 Wp by relevant conversion factors.

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| | |
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