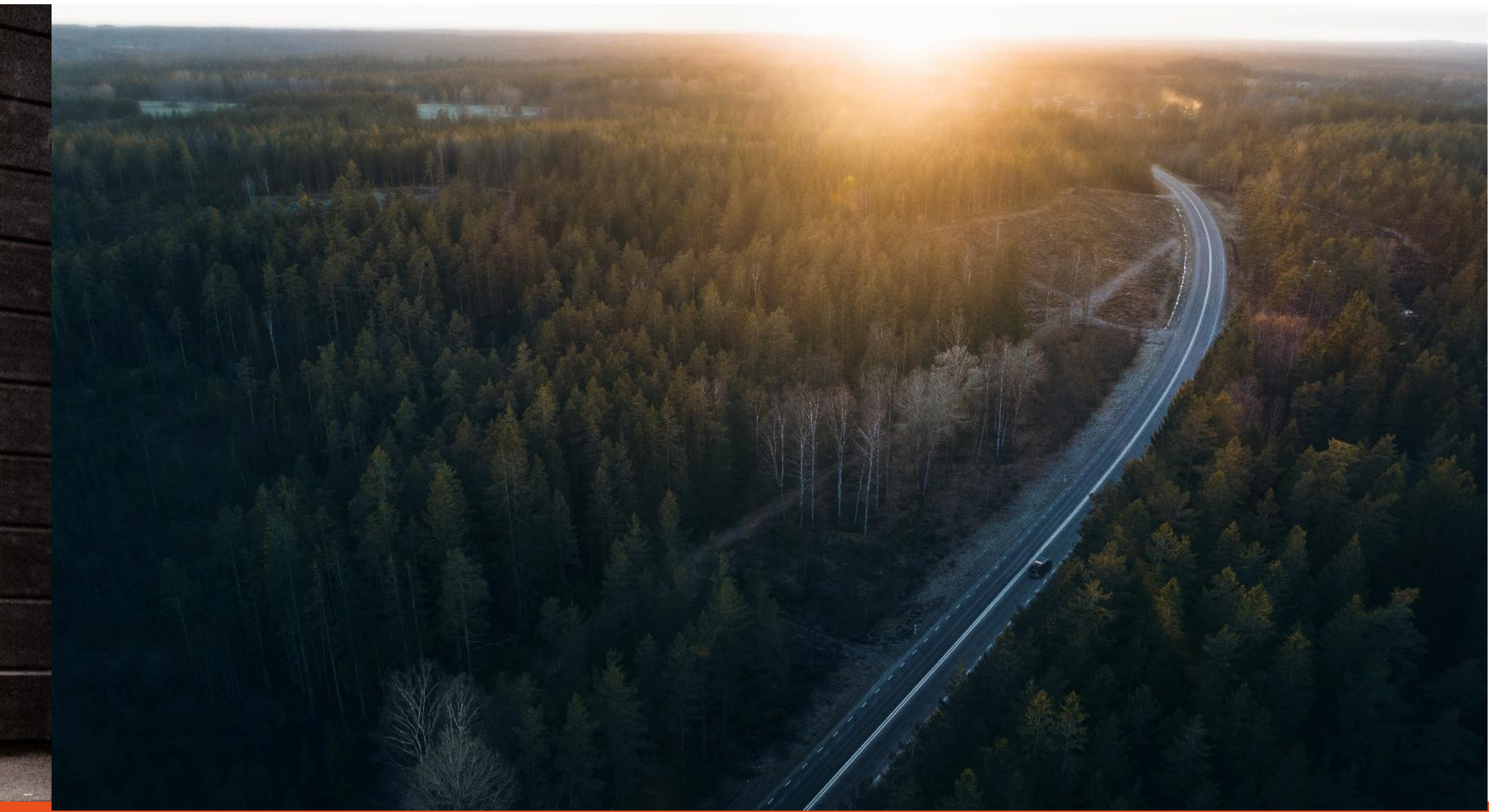
Life Cycle Assessment of the charging station GARO LS4



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Fast Forward to a Greener Future

Introduction

This report presents the result of the Life Cycle Assessment (LCA) that has been carried out during the spring 2021 by GARO AB, with assistance from the climate consultant, 2050 Consulting. The LCA has evaluated the climate impact from one of GAROs most popular charging stations GARO LS4.

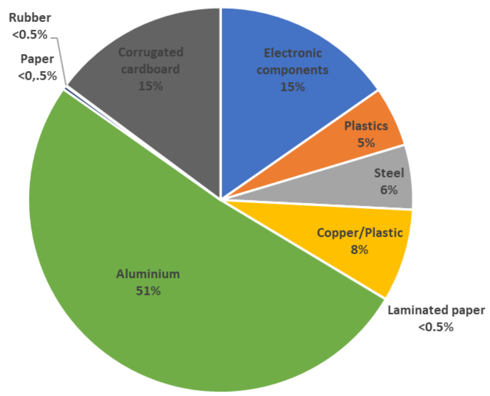
Process description and methodology

All GAROs suppliers have been asked to deliver product specific data about the offered component or material. However, there have been difficulties for the suppliers to obtain this kind of data. Therefore, the LCA also had to rely on generic data. A detailed description of the methodology, calculations and references are provided further down in this document.

The climate impact of the products is assessed through a life cycle assessment methodology which is inspired by ISO 14025.

The GARO LS4

The GARO LS4 is a ground mounted charging station and an important cog in the expanding charging infrastructure network for electric vehicles. The LS4 is assembled at GARO AB's manufacturing plant in Gnosjö, however the product is a result of a complex value chain with components and materials from all over the world. In terms of weight the largest share of the GARO LS4 consist of aluminium. The second largest share of the LS4 is the electronic components, which consist of a mixture of materials. Also, the corrugated cardboard in the packaging is a large share of the total weight.



Material distribution in GARO LS4

Functional unit (FU)

The evaluated product, GARO LS4, has an official total weight of 24.5 kg. However, the bill of materials which includes packaging, specifies components and materials with a total weight of 29.7 kg. The technical lifetime of the LS4 is estimated to 15 years. Thus, the functional unit of the LCA is one unit of packaged LS4, with a total weight of 29.7 kg and an operating lifetime of 15 years.

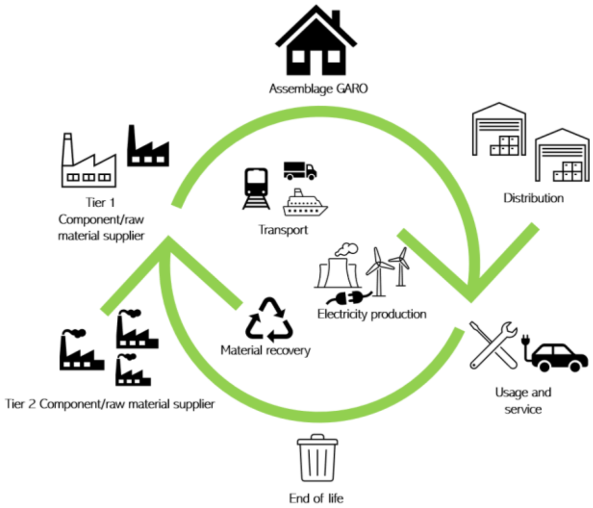
Allocation method

In processes where several outputs are generated, emissions must be allocated between all outputs. The ambition has been to primarily avoid allocation of emissions, secondly base it on physical properties, and lastly base it on other properties of the system, such as economic value. However, the best suited allocation method differs depending on the type of product, processes, or available data. In this LCA, allocation of emissions has been done for GAROs use of electricity and biogas in production. The allocation has been done with the physical property allocation method, where the emissions are divided per production unit.

System boundary

The system boundary of the LCA is set on such level that it includes the relevant life cycle phases with the largest emissions. The LCA includes the following life cycle phases; raw material and component production, energy emissions from GARO Gnosjö, transport between suppliers, transport to GARO, transport from GARO to distributor, usage and service, and end-of-life.

Further information about the methodology for the calculation of each life cycle phase can be seen in the detailed process description further down.



Data collection method

The activity data used in the LCA comes from the following sources, with the resulting emissions distributed according to the heading. More detailed information about each data collection method can be found in the detailed process description:

- **Collected data from suppliers – 31% of the total emissions**
  Data about components have been collected with supplier declaration, where the tier 1 suppliers were asked to list: the materials in the component; quantity of process energy; transportation distance and mode from tier 2 supplier; transportation distance and mode from tier 1 supplier to GARO Gnosjö.
- **Data from GARO AB – 43% of the total emissions**
  GARO has supplied the LCA with activity data regarding the production energy in Gnosjö. GARO has also provided the bill of material (BOM) list. The BOM list specifies weight, supplier location and main material type, of each component. This activity data has been used for the components where no supplier specific data has been possible to obtain.
- **Interpolation – 20% of the total emissions**
  Interpolation has been used for the calculations of raw material and component production, as well as for the energy for tier 1 production.
- **Assumptions – 6% of the total emissions**
  Where activity data have been missing, assumptions have been made in discussion with GARO.

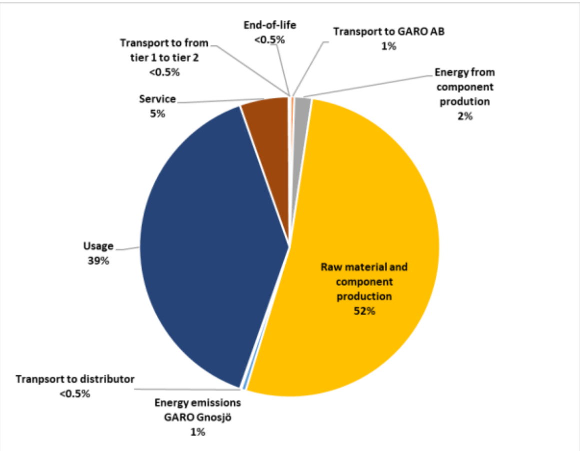
Result

The result of the LCA shows that the largest share of emissions comes from the production of the LS4 charging station. The single largest source of emission is the raw material and component production with just above 52% of the emissions. The second largest source of emission is the standby energy usage of the LS4.

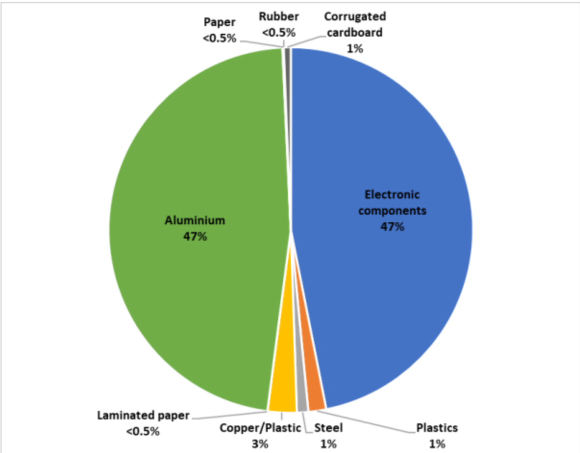
Life cycle phase		**kgCO_2e/LS4**	**Share**
Production	*Transport to tier 2 and from tier 2 to tier 1*	0.7	0.1%
	Transport to GARO AB	2.3	0.4%
	Energy from component production	11.4	2%
	Raw material and component production	314.2	52%
	Energy emissions GARO Gnosjö	2.9	0.5%
	Sum	**331.5**	**55.5%**
Distribution	*Transport to distributor*	0.9	0.1%
	Sum	**0.9**	**0.1%**
Usage and service	*Usage*	235.6	39%
	Service	31.7	5%
	End-of-life	0.6	0.1%
	Sum	**267.9**	**44.4%**
	Total emissions	**600**	**100%**

The total emissions of the GARO LS4 sums up to just above 600 kg of CO_2e. The GARO LS4 has a total weight of 29.7 kg, this means about 20 kg CO_2e per kg. One LS4 is estimated to be used for 20 000 charges per 15-year lifetime, this means about 30 g of CO_2e per charging occasion. The left chart below shows the CO_2e emission distribution during the lifetime.

Looking more closely on the raw material and component production in the right chart below, it is clear that two material groups are significant contributors of emissions. Aluminium and Electronic components stand for about 47% of the total emissions each. These two materials are also the ones with the highest emissions factors per kg.



Emissions distribution of the life cycle

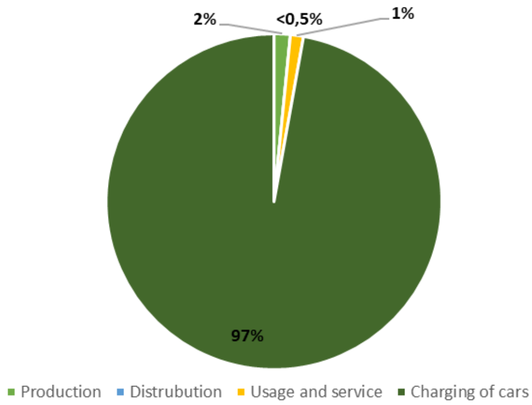


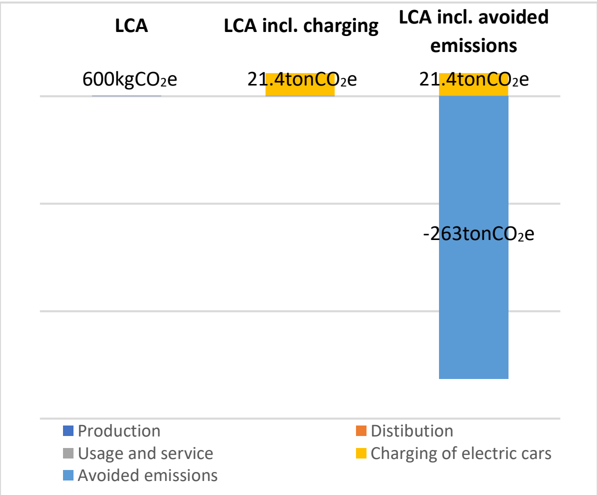
Emissions distribution between materials

Analysis

Charging of cars

To give a more holistic view on what the result means in a more wide-ranging system boundary, the analysis includes emissions from electricity used for car charging. For this calculation, a Volvo V60 Twin Engine with a charging capacity of 11.6 kWh has been used as an example. It is assumed that the car is fully charged at every charging occasion. With about 20 000 charges per lifetime this means about 232 000 kWh or 20.8 tons of CO_2e. This equals to about 97% of the lifetime emissions***.





Avoided emissions

Meanwhile, charging stations like the GARO LS4, enables the transition from combustion-based technology to electric. In a comparison between an electric car* and a fossil fuel powered car**, the charging capacity that the LS4 enables during a lifetime helps to reduce about 240 tons of CO_2e.

The same comparison in a global context, results in an emissions reduction of 150 tons of CO_2e.***

100% Renewable energy

According to the "Fossilfritt Sverige" road map, Sweden will have exclusively renewable energy in the grid mix by 2030. This would mean that the result of the LCA would be lower, but most importantly that the CO_2e reduction from electricity charging, would be even greater.

LCA result with only renewable energy in the grid mix	
LCA of GARO LS4 (kg CO2e)	392
Avoided emissions during use (tCO2e)	263

* Consumption of 0.15 kWh per km

** Consumption of 170g CO_2e per km

*** Calculated with Nordic energy mix, specified in the appendix.

**** Calculated with global energy mix, specified in the appendix.

Detailed process description

Tier 2 Component/raw material supplier

Transport

Emissions from the tier 2 suppliers include the emissions from transport between tier 2 supplier and tier 1 supplier. Where supplier specific data have been missing, following assumptions have been made.

- For transports in Europe, the transports are assumed to be performed with a truck without trailer.
- Transports from non-Europe countries, are assumed to be carried out with ship.
- Distribution between transport modes.
- Transportation distance in the same country has been estimated with available data in supplier declarations as benchmark.

Tier 1 Component/raw material supplier

Process energy

For the calculation of raw material and component production emissions – the supplier declaration data from one component supplier, have been used for interpolation on other products. The same supplier also declared that they use renewable energy. For the other suppliers that have not specified the energy type, the country specific energy mix have been used for the emissions calculations. Only electricity usage has been included in the calculations.

Emissions from raw materials and components

These emissions have been calculated with help of supplier declarations and the BOM list from GARO. The emissions data from one of the electric device suppliers have been used to calculate an average value of kg CO_2e per kg for electronic components. This emissions factor has been used on the remaining electronic components. For some components where supplier specific data is missing, the production only regards the primary raw material and not refinement processes.

Transport from tier 1 supplier to GARO Gnosjö

When supplier specific data has been missing, the following assumptions have been made:

- For transports in Europe, the transports are assumed to be performed with 75% truck without trailer and 25% truck with trailer.
- Transports from non-European countries are assumed to be carried out with ship.
- Distribution between transport modes.
- Transportation distance have been estimated with google maps.
- Transportation distance in the same country have been estimated with available data in supplier declarations as benchmark.

Assemblage GARO

Production energy at GARO Gnosjö

The calculations of emissions from energy used for production, are based on the energy specifications of GAROs use of electricity and biogas. The energy emissions have been allocated with a physical property allocation method, where the emissions have been distributed with respect to production volume.

Distribution

The distribution system boundary has been limited to include the transport to the main distributors, who are located within 300 km from Gnosjö. The transport is assumed to be performed with 25% truck without trailer and 75% truck with trailer.

Usage

The LS4 is equipped with a heater that is used when the temperature falls below minus 5 degrees Celsius. In the LCA the LS4 is assumed to be used in an environment where the heater is not needed. Therefore, the energy uses during the lifetime only considers the standby energy, not the mounted heater. The LS4 is assumed to be mounted in Sweden and therefore the calculations have been made with the Nordic average energy mix.

The lifetime of the LS4 is set to the technical lifetime of the components. According to GARO, an LS4 with proper service has an operating lifetime of about 25 years. The needed service of the LS4 is based on assumptions made by GARO and includes 10km transport per year and one residual current device.

End-of-life

It is assumed that all components and packaging of the LS4 are material recycled.

Appendix – Emission factors and distance estimations

Distances

Route	Distance (km)
China - Gnosjö	6754
Bremen-Karlstad-Gnosjö	570
Czech Republic - Gnosjö	812
Czech Republic - Slovenia	607
Poland - Gnosjö	1029
Germany - Gnosjö	900
Denmark-Gnosjö	435
Italy - Gnosjö	2330
Turkey-Gnosjö	3600
Poland- Slovenia	980
Slovenia - Gnosjö	1660
Finland - Sweden	650

Source: Google maps

Materials

Material	gCO2e/kg
Copper	840
High Density Polyethylene (HDPE)	1930
Low Density Polyethylene (LDPE)	2080
Iron	2030
General plastic	3310
Zinc	4180
Aluminium	13056
Aluminium	13187
Silica (silicone dioxide), Production mix, at plant, Technology mix, calcinated and precipitated,	4277,9
Iron	2030
Copper	3810
Manganese	3500
magnesium hydroxide production, production mix, at plant, technology mix, 100% active substance	1875
Nickel	12400
Zinc	4180
Tin, production mix, at plant, sand extraction and processing, reduction, 118.71 g/mol	5788
Lead	3370
6 Polymers	9140
Steel	1727
Steel	577
Copper/plastic	3560
Rubber	2850
Paper	320

Source: ICE V.3.0, Pence European EF-database, Livsmedelsverket

Energy

Energy type	gCO2e/kWh
Renewable energy from hydro power	10.5
Biogas (kWh)	12.0
Nordic average mix 2019	89.6
DE average mix 2019	255.2
FI average mix 2019	89.6
PL average mix 2019	788.0
CN average mix 2017	657.0
SE average mix 2019	89.6
Czech Republic average mix 2019	583.9
TUR average mix 2019	441.0
SLO average mix 2019	318.6
TW average mix 2019	537.0
DK average mix 2019	89.6
IT average mix 2019	388.3
Global energy mix 2019	475.0

Sources: AIB, IEA, Vattenfall, www.worldbenchmarkingalliance.org