# Environmental impact of EV chargers

Screening LCA for EVBox

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## Screening LCA for EVBox

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# Content

# Summary

In this study the carbon footprints of three chargers for electrical vehicles, produced and sold by EVBox were calculated and assessed. The analysis concerns a screening carbon footprint based on the ISO 14040-44 LCA guidelines. For this assessment, primary data was provided by EVBox, but no deep analysis of data quality was performed. Data gaps were filled in with proxy-data based on own expertise. Since this concerns a screening carbon footprint, the study has not been externally reviewed.

The goal of the analysis is to provide EVBox with insights into the climate change impacts of three EV charging solutions. The results of the analysis provides a substantiated estimate of the environmental performance of the three EV chargers and provides insights in data gaps and uncertainties that could be dealt with to improve the analysis. An additional aim is to share the outcomes of the study with potential customers and in tenders to demonstrate EVBox its commitment to sustainability.

**Table 1 – Main characteristics and calculated carbon footprints of the chargers assessed in this study**

| | EVBox Livo (AC) | EVBox Liviqo (AC) | EVBox Troniq Modular 180kW (DC) |
|---|---|---|---|
| |  |  |  |
| Weight (kg) | 6.6 | 9.0 | 541 |
| Country of assembly | Poland | Poland | France |
| Country of use | Benelux | Benelux | France |
| Country for End-of-Life | France | France | France |
| Energy demand charging (kWh/charge), excl. losses | 28.1 | 20.1 | 25.8 |
| Energy losses | 5% | 5% | 5% |
| Standby energy per year (kWh/year) | 6.7 | 36.2 | 4,615 |
| Charges per year | 240 | 408 | 2,780 |
| Life time (year) | 8 | 8 | 10 |
| | | | |
| FU1 (kg $CO_2$-eq./charger) | 47 | 54 | 12,090 |
| FU2 (kg $CO_2$-eq./kWh charged) | 0.41 (NL e-mix)<br>0.22 (LUX e-mix) | 0.41 (NL e-mix)<br>0.22 (LUX e-mix) | 0.11 (FR e-mix) |

* The assessment for EVBox Troniq Modular 180kW is based on a bill of materials that composes 85% of the total weight. Results for EVBox Troniq Modular 180kW should therefore be communicated with this limitation in mind.

The three chargers assessed in this study and their carbon footprints are shown in Table 1. The carbon footprints are provided per charger (FU1) and per kWh charged (FU2). The main contributor in the carbon footprint for all chargers (FU1) are the materials and components. When aiming to reduce the carbon footprint, first efforts should therefor focus on using materials and components with lower carbon footprints. When looking at the carbon footprint per kWh charged (FU2), the analysis shows that the contribution of the charger itself is minimal in comparison to the GHG emissions of the electricity used for charging. Therefore, the carbon footprint during use is dependent on where the charger is installed and used and the carbon footprint of the energy mix used for charging.

The outcomes of this study are also intended to be shared with potential customers and in tenders to demonstrate EVBox' commitment to sustainability.

Based on this study performed we have the following recommendations:
- When communicating the carbon footprint for EVBox Livo, EVBox Liviqo and EVBox Troniq Modular 180kW externally, make sure that limitations of the study are also communicated.
- If EVBox aims at lowering the carbon footprint of the charger itself, the main focus should be on using materials and components with a lower carbon footprint. The data provided for the analysis mainly concerned materials and not components. Reducing the carbon footprint would be more practical however, if the components with the highest impact could be identified (which was not possible with the data provided).
- We recommend to improve the carbon footprint analysis of EVBox Livo, EVBox Liviqo, and EVBox Troniq Modular 180KW when more detailed (environmental) data on the components used is available. Therefor it would be beneficial to start asking suppliers for their LCA's or carbon footprints of the components they provide. This would also open up the possibility to analyse the contribution of different components to the carbon footprint.
- An intended update of this study would, next to obtaining environmental impact data for components instead of materials, benefit from obtaining certificates of origin of the energy used in the assembly. Insights in the LCA report concerning Makrolon® RE would also be beneficial. When an externally reviewed carbon footprint or LCA is required, this information is crucial.

# 1 Introduction

## 1.1 Background

EVBox develops electric vehicle (EV) charging solutions for businesses and households. Because of upcoming sustainability regulations and increasing demands from customers and tenders that require substantiated environmental statements about their products. EVBox has asked CE Delft to evaluate the carbon footprint of three of their products; EVBox Livo (AC home charger), EVBox Liviqo (AC business charger), and EVBox Troniq Modular 180kW (high power DC Charger).

## 1.2 Goal and scope of the study

The goal of this project is to provide EVBox insights into the impact on climate change (via a screening LCA/carbon footprint analysis) of the three EV charging solutions above. The outcomes of a screening LCA provide an estimate of, and insights in, the environmental performance of a product. These insights can be used to improve the environmental performance of EVBox' products and in reaching their sustainability goals. Furthermore, the screening LCA also provide insights in potential data gaps and uncertainties that could be dealt with as a follow-up of the analysis. In addition the aim is to share the outcomes of the study with potential customers and in tenders to demonstrate EVBox' commitment to sustainability.

Table 2 provides an overview of the characteristics of the three chargers which are the starting point for the assessment. The data is based on data provided by EVBox.

**Table 2 - Main assumption for modelling the EV chargers in this study**

| | EVBox Livo (AC) | EVBox Liviqo (AC) | EVBox Troniq Modular 180kW (DC) |
|---|---|---|---|
| |  |  |  |
| Weight (kg) | 6.6 | 9.0 | 541 |
| Country of assembly | Poland | Poland | France |
| Country of use | Benelux | Benelux | France |
| Country for End-of-Life[1] | Benelux | Benelux | France |
| Energy demand charging (kWh/charge), excl. losses | 28.1 | 20.1 | 25.8 |
| Energy losses | 5% | 5% | 5% |
| Standby energy per year | 6.7 | 36.2 | 4,615 |
| Charges per year | 240 | 408 | 2,780 |
| Lifetime (year) | 8 | 8 | 10 |

[1] For simplicity it is assumed that the end-of-life treatment practice of electronic waste in the Benelux is similar to the practice in France.

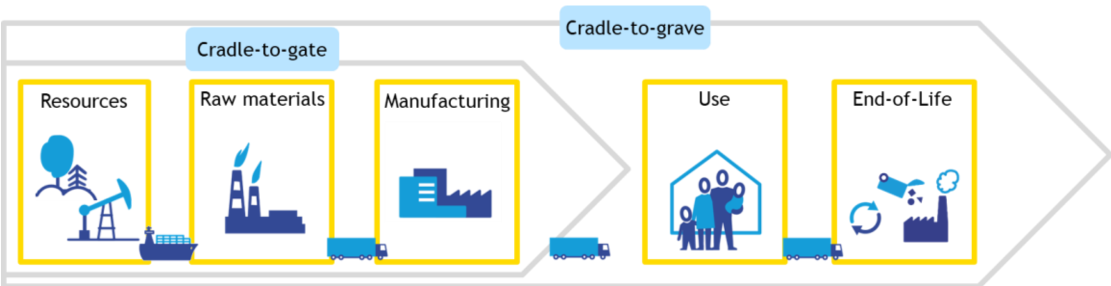
# 2 Carbon footprint analyses

## 2.1 Approach and method

The analysis here concerns a screening life cycle assessment (LCA) to obtain the carbon footprint of three different EV charger solutions produced by EVBox. A screening LCA is often a first form of LCA that follows the structure prescribed in the ISO 14040-44 LCA guidelines and indicates the climate change impacts (carbon footprint expressed in kg $CO_2$-eq). In addition, the analysis is based on readily available information provided by the commissioner, in this case EVBox. Where data gaps exist, these are filled in with proxy-data based on common logic. The set-up of the study will be described in the following paragraph using the four (ISO) phases of LCA; goal and scope definition, inventory analysis, impact assessment, and interpretation.

For the LCA modeling we use Simapro 9.6 LCA software in combination with the ecoinvent 3.10 (cut-off) background database (Ecoinvent, 2023). For modelling the end-of-life of the charging station we use the WEEE LCI database ((ESR), 2017) that covers all emissions from waste collection to final destination. Both databases follow the ‘polluter pays’ principle, where environmental impact from waste is the producer’s responsibility. When waste material is available for recycling, it is no longer considered as waste and the emissions from further processing beyond the collection of the waste are attributed to the user of recycled material. To avoid double counting of benefits from recycling over different stakeholders in the life cycle, no substitution benefits are included at end-of-life.

**Figure 1 – Generic life cycle stages in a LCA**




## 2.2 Goal and scope

The goal of this study has already been defined under Section 1.2. The scope of this study concerns the carbon footprint for three EV charging stations as described in Table 2 and is assumed to be representative for 2024. The study concerns a cradle-to-grave analysis (see Figure 1), meaning that all greenhouse gas emissions expressed in kg $CO_2$-eq. according to the IPCC 2021 method[2] that are emitted over the different life cycle phases are modelled and calculated.

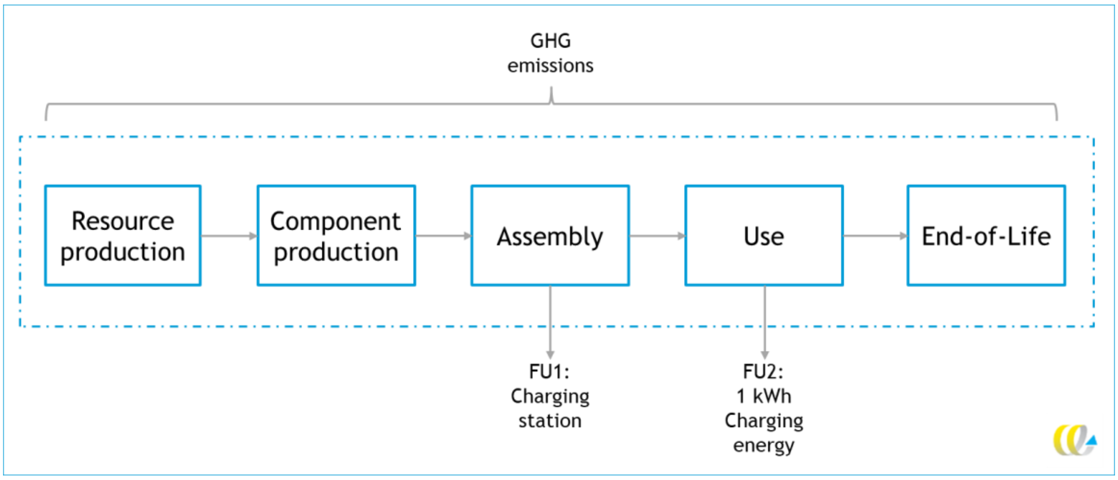
[2] Calculation method based on the Sixth Assessment Report (AR6) developed by the International Panel on Climate Change (IPCC, 2023). This report contains the Global Warming Potential (GWP) climate change factors of the IPCC.

### Functional unit

In an LCA, it is crucial to define a reference for the impacts calculated, called the functional unit. Following LCA theory, defining the functional unit is done in at least two steps. First, the function of a system (as close as possible to its end use) is defined. In the case of EVBox the function is *to provide an electric car with electricity for charging*. The second step is to quantify the function, which in this case would be *to provide a BEV with 1 kWh electricity for charging*. Defining the functional unit in this way would potentially allow comparison with other studies on EV chargers with similar functionality.

In this study we define the carbon footprint of three physical chargers first (excluding GHG emissions from the use phase) and by adding data on its operation we will define the carbon footprint per functional unit as described above (including the GHG emissions from the use phase). These are FU1 and FU2 respectively in Figure 2.

**Figure 2 – System under study**




## 2.3 Inventory analysis (data)

For all three chargers the primary data has been provided by EVBox. This data concerns the total bills of materials per charger (BOM in Annex A) and energy use for production, charging and standby energy in the use phase. Because specific LCA data per component was not available it was decided to base this assessment on the Greenhouse Gas (GHG) emissions of materials and generic processing used to make the components.

Upstream GHG emissions for material production, material treatment and energy production were taken from ecoinvent 3.10 – Cut-off. Emissions from the end-of-life treatment of the chargers were taken from the WEEE database (substitution benefits not included).

The following sections provide background information on modeling the different life cycle stages as displayed in Figure 2.

### 2.3.1 Transportation

Transportation is modelled as an integral part of the different life cycle phases and not shown in Figure 2. The ecoinvent database that provides the GHG emissions for market mixes of different materials includes emissions of transport from mine to 'market.'

Transport from *material production* to *component production* is therefor implicitly included in the data because market mixes are used. The climate change impact for transportation between these phases cannot be reported. GHG emissions for the transportation between *component production* and *assembly* are specifically modelled by using transportation distances and transportation modes provided by EVBox (Table 3). Transport between assembly and use was estimated by assuming 1,000 km transport by truck to a distribution center and 1,000 km by truck to use. GHG emissions from transport between the *use* and *end-of-life* phase are covered by using the WEEE database (see Section 2.3.5).

**Table 3 - Transport between component production and assembly in tonkm per charger[3]**

| Mode | EVBox Livo | EVBox Liviqo | EVBox Troniq modular 180kW | Unit |
|---|---|---|---|---|
| Truck | 2.8 | 2.8 | 2,099.0 | Tonkm |
| Van | 0.6 | 0.6 | 14.8 | Tonkm |
| Air | 3.5 | 3.5 | | Tonkm |
| Ocean | 75.3 | 75.3 | | Tonkm |

The contribution analysis (see Figure 3 and Figure 4) shows that the impact of transportation has a limited contribution to the total footprint. 1,000 km distance is chosen as a close to real life estimate, any changes in distance will most probably not influence the outcomes of this analysis.

### 2.3.2 Resource production and component production

Data to perform the analysis was provided directly by EVBox and consisted of the different bills of materials (BOMs) for the three chargers. The BOMs provided by EVBox covered 99% of the total weight of EVBox Livo, 93% of the total weight of EVBox Liviqo, and 85% of the total weight of EVBox Troniq Modular 180kW.[4] The data used in the assessment was scaled to 100% according to the material shares in the provided data. It is highly recommended to use a more complete dataset when any future analyses need to be performed.

3 For EVBox Livo and EVBox Liviqo we received transportation data for all components in 2024-Q1 divided in total weight per transport mode and distance. Weights and distances were multiplied to obtain a total (tonkm) which was then divided through the total amount of EVBox Livo and EVBox Liviqo chargers produced in that period to determine a (tonkm) per charger. For EVBox Troniq Modular 180kW we used the number of trucks/vans assuming 15.7 ton capacity and a 52% load rate for trucks and 1.2 ton capacity and a 41% load rate for vans (CE Delft, 2016) Number of trucks, vans and distances were provided by EVBox.

4 Given the 15% gap to full-weight coverage on the EVBox Troniq Modular 180kW, the current result should be used with caution when communicated to outside parties.

The upstream GHG emissions for resource production and component production are directly taken from the ecoinvent database. When a material was not available in the ecoinvent database, a representative proxy was used. Since it is unclear where the different components are produced, market mixes for materials are used. Market mix data already includes an assumed emission for transport from mine to market. A list of materials per charger can be found in Annex A.

The covers of EVBox Livo and EVBox Liviqo are manufactured from Makrolon®RE, which is produced by Covestro as polycarbonate resin. On its website Covestro claims that the production of Makrolon®RE is carbon neutral from cradle to factory gate.[5] This claim is based on an LCA study in which renewable materials and renewable energy are allocated to the production of Makrolon®RE resin. We do not have access to the full LCA, but included Makrolon®RE as having a net carbon footprint of zero (biogenic carbon is taken up at the start of the life cycle; -1 and emitted in the EoL phase;+1). At end-of-life this material is considered regular polycarbonate where emissions from incineration are included.

In addition, the GHG emissions from component production are modelled by using generic processing/manufacturing technologies from the ecoinvent database (see Table 4).
For metals average processes for metal working are used to convert for example aluminium to an aluminium (containing) product. For all plastics, it was assumed that injection moulding was needed for to convert granulates to components.

The BOMs provided a mix of materials and components (for example electronic components, PCB, cables and the LCD screen). Where components were provided rather than materials, these components have been modelled using comparable products in the ecoinvent database as a proxy. As most of the weight of electronic component in the EVBox Troniq Modular 180kW was the power unit module, this component has been modelled using an EV converter which has similar functionally, this proxy component has a carbon footprint of 41.5 kg $CO_2$-eq. per kg component. As with the missing data, this introduces another uncertainty in the results for the EVBox Troniq Modular 180 KW.

**Table 4 - Manufacturing data used to model component production**

| Material | Manufacturing process ecoinvent |
|---|---|
| Aluminium | Metal working aluminium |
| Copper | Wire drawing copper |
| Steel | Metal working steel |
| Other metals | Metal working average |
| All plastics | Injection moulding plastics |

### 2.3.3 Assembly

The data required for modelling the assembly was provided by EVBox and can be found in Table 5. EVBox Livo and EVBox Liviqo are assumed to be assembled in Poland.
The electricity used is based on the electricity mix provided by EVBox's supplier and has been modelled to have a carbon footprint in 0.537 kg $CO_2$-eq./kWh. EVBox Troniq Modular 180kW is assembled in France. EVBox' supplier in France claims to use 100% renewable energy with a carbon footprint of 0.012 kg $CO_2$-eq./kWh.

[5] Makrolon®RE for a more circular and sustainable future | Covestro

The claims for using green electricity in the assembly have not been verified in this study. The total contribution of emissions from assembly are around 10% (see Figure 3), so a change in carbon footprint of the energy used in the assembly is not expected to change the outcomes. If in the future an externally reviewed LCA study is required, it is recommended to provide proof to substantiate these green claims and perform an additional analysis to investigate the difference when grid electricity is used.

**Table 5 - Assembly data for EVBox Livo, EVBox Liviqo and EVBox Troniq Modular 180kW (excluding the components)**

| Resource required per charger | Amount EVBox Livo | Amount EVBox Liviqo | Amount EVBox Troniq Modular 180kW | Unit |
|---|---|---|---|---|
| Electricity | 3.272 | 3.276 | 738.217 | kWh |
| Heat | 29.965 | 29.965 | 366.831 | MJ |
| Water | 0.015 | 0.016 | 0.789 | $m^3$ |
| Recycling of cardboard waste | 0.297 | 0.297 | 29.716 | kg |
| Recycling of foil | 0.010 | 0.010 | | kg |
| Incineration of mixed packaging | 0.167 | 0.167 | | kg |
| Recycling of packaging of hazardous materials | 0.005 | 0.005 | | kg |
| Incineration of pressure packaging for hazardous materials | 0.000 | 0.000 | | kg |
| Incineration of contaminated cleaning wipes | 0.022 | 0.022 | | kg |
| Recycling of pcb with components | 0.002 | 0.002 | | kg |
| Recycling of cables | 0.003 | 0.003 | | kg |
| Recycling of metal waste | 0.013 | 0.013 | | kg |
| Recycling of electronic waste | | | 47.804 | kg |
| Recycling of iron waste | | | 18.088 | kg |
| Recycling of copper waste | | | 5.168 | kg |
| Incineration of unsorted waste | | | 38.760 | kg |

### 2.3.4 Use

Based on the current markets in which EVBox is active, this assessment assumes EVBox Livo and EVBox Liviqo to be used in the Benelux and EVBox Troniq Modular 180kW to be used in France. The energy required is divided in charging and in standby energy. For charging a loss of 5%[6] is assumed, making that 1.05 kWh/kWh charged is required. Charger and stand-by energy use can be found in Table 2.

Because the market for EVBox Livo and EVBox Liviqo is the Benelux and no generic emission factor for the electricity grid mix in the Benelux exist, the GHG emissions from charges are calculated using the best (Luxembourg - 0.206 kg $CO_2$-eq./kWh) and worst (Netherlands – 0.387 kg $CO_2$-eq./kWh) performing grid mix in the Benelux.

6 EVBox Branding

### 2.3.5 End-of-life

At end-of-life all chargers are assumed to be treated as electronic waste (WEEE - Waste Electrical and Electronic Equipment). For simplicity it is assumed here that GHG emissions from WEEE treatment in France are similar to the emissions in Benelux countries.
The contribution analysis shows that the impact of WEEE treatment is limited (10-15%) in comparison with the other life cycle stages (see Figure 3) and it can be expected that if any differences exist in the impact of WEEE treatment, these will be minor and will not influence the general outcomes of this analysis.

For modelling the GHG emissions from WEEE treatment, the WEEE database was used.
The WEEE database covers emissions from all the operations for waste collection to final destinations of the (re)processed fractions. Benefits from recycling (avoided emissions because no virgin material needs to be produced) are not allocated to EVBox, but to the recycling party. The current modelling allocates the direct emissions from waste collection (including transport from consumer to WEEE treatment facility) and WEEE treatment to EVBox' chargers (polluter pays principle) while emissions from recycling materials or the production of secondary materials, will be allocated to the recycler.

## 2.4 Impact assessment (results)

This section presents the results of the analysis. Since the analysis is a screening LCA for which several assumptions had to be made the results should be used while taking into account the limitations of these assumptions. Section 2.5.1 provides additional information on the limitations of the analysis.

**Figure 3 - Climate change impact per charger EVBox Livo/EVBox Liviqo - FU1: Use phase excluded**

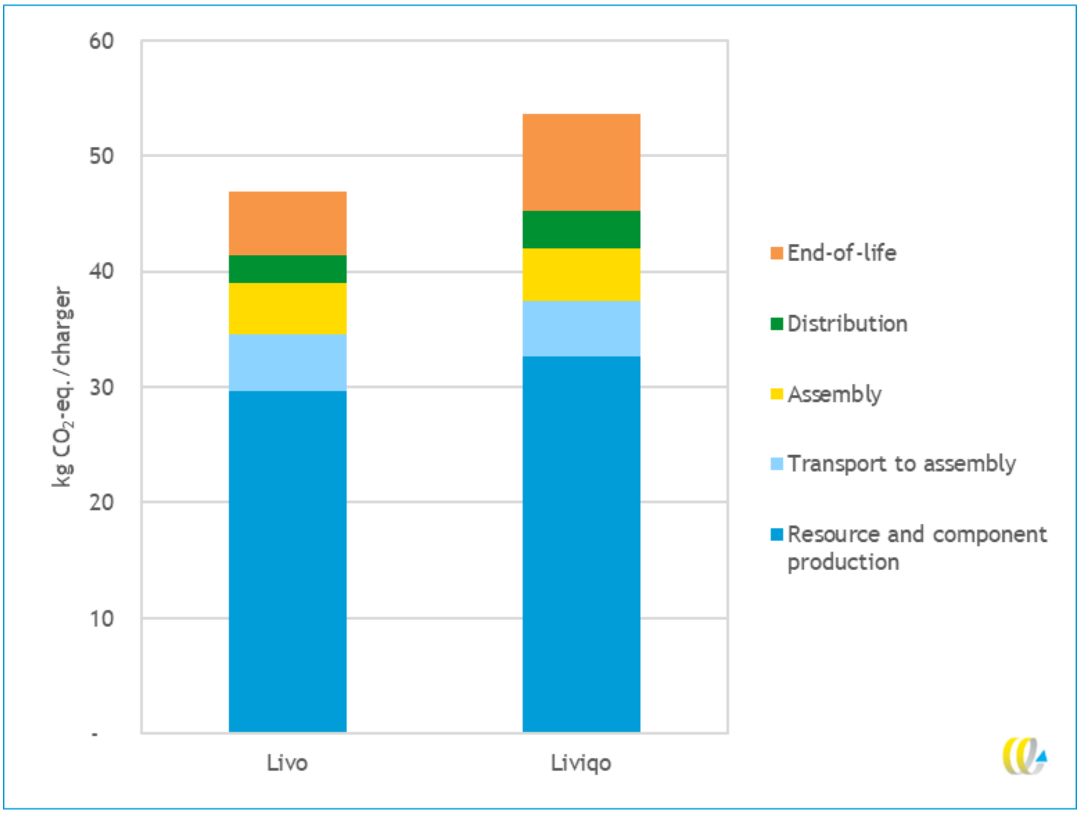


Figure 3 shows the carbon footprints (CF) of EVBox Livo and EVBox Liviqo when emissions from the use phase are excluded. EVBox Livo shows a CFP of 47 kg $CO_2$-eq./charger and EVBox Liviqo of 53 kg $CO_2$-eq./charger. The biggest contributor to the CFP's is clearly the resource and component production (~60-65% for both chargers). This category is further broken down in Figure 7. Figure 6 shows that EVBox Troniq Modular 180kW has a CFP of 0.11 kg $CO_2$-eq./kWh charged. Here the charging is responsible for more than 90% of the GHG emissions.

**Figure 4 - Climate change impact per charger EVBox Troniq Modular 180kW - FU1: Use phase excluded**

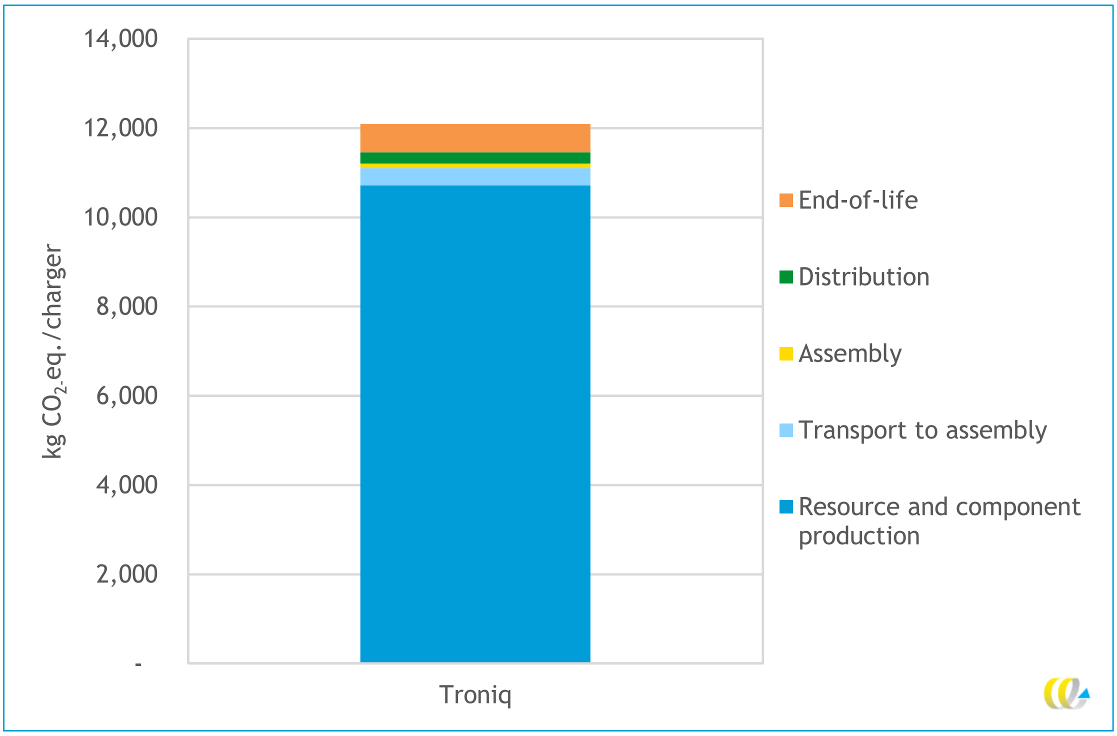



Figure 4 shows that EVBox Troniq Modular 180kW has a CFP of just over 12,000 kg $CO_2$-eq./charger when emissions from the use phase are excluded (EVBox Troniq Modular 180kW is a much bigger charger than the other two chargers). Also here the biggest contributors to the CFP is resource and component production (~89%). This category is further broken down in Figure 8.

The lower coverage of the total weight of EVBox Troniq Modular 180kW makes that the results for EVBox Troniq Modular 180kW have a higher degree of uncertainty but we expect that the crucial elements are included in the analyses. More data will probably not significantly change the final result.

**Figure 5 - Climate change impact per kWh charged EVBox Livo/EVBox Liviqo - FU2: Use phase included**

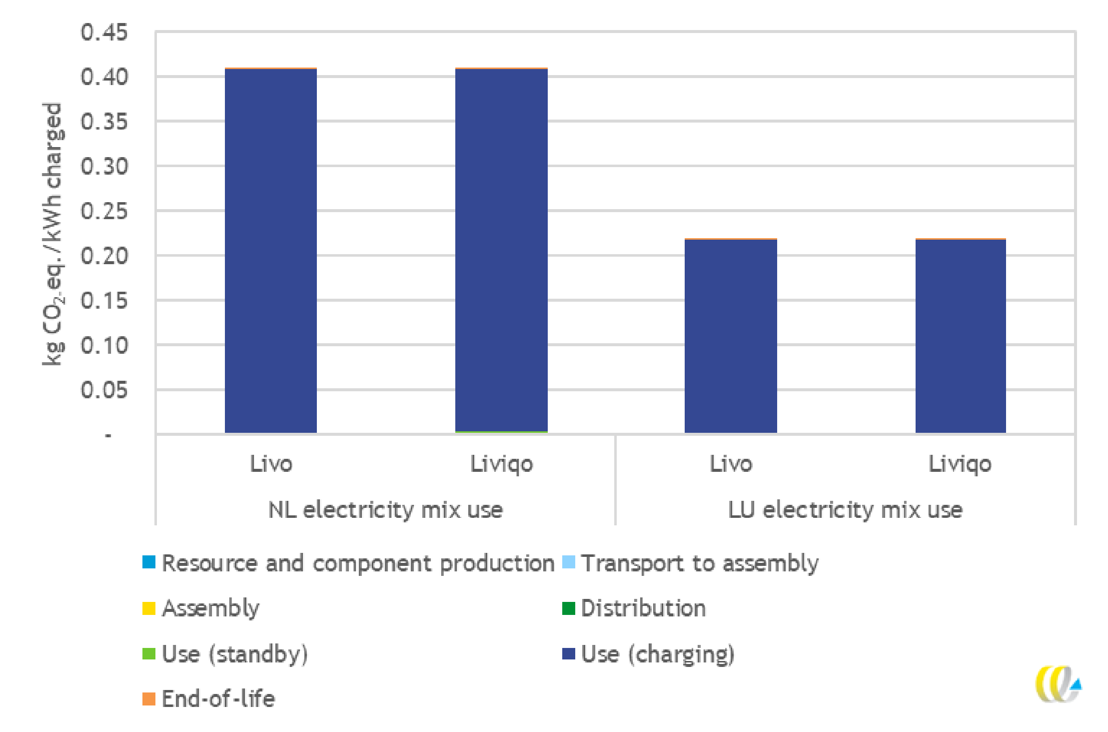



Figure 5 shows the carbon footprints (CFP) of EVBox Livo and EVBox Liviqo when GHG emissions from the use phase are included. This shows that the emissions from production, distribution and end-of-life of the charger itself is completely overshadowed by the GHG emissions from charging electric vehicles and that the CFP for both chargers is highly comparable (both 0.41 kg $CO_2$-eq./kWh charged in the Netherlands and 0.22 kg $CO_2$-eq./kWh charged in Luxemburg). It is also clear that this CFP strongly depends on the location where the charger is used.

**Figure 6 - Climate change impact per kWh charged EVBox Troniq Modular 180kW – FU2: Use phase included**

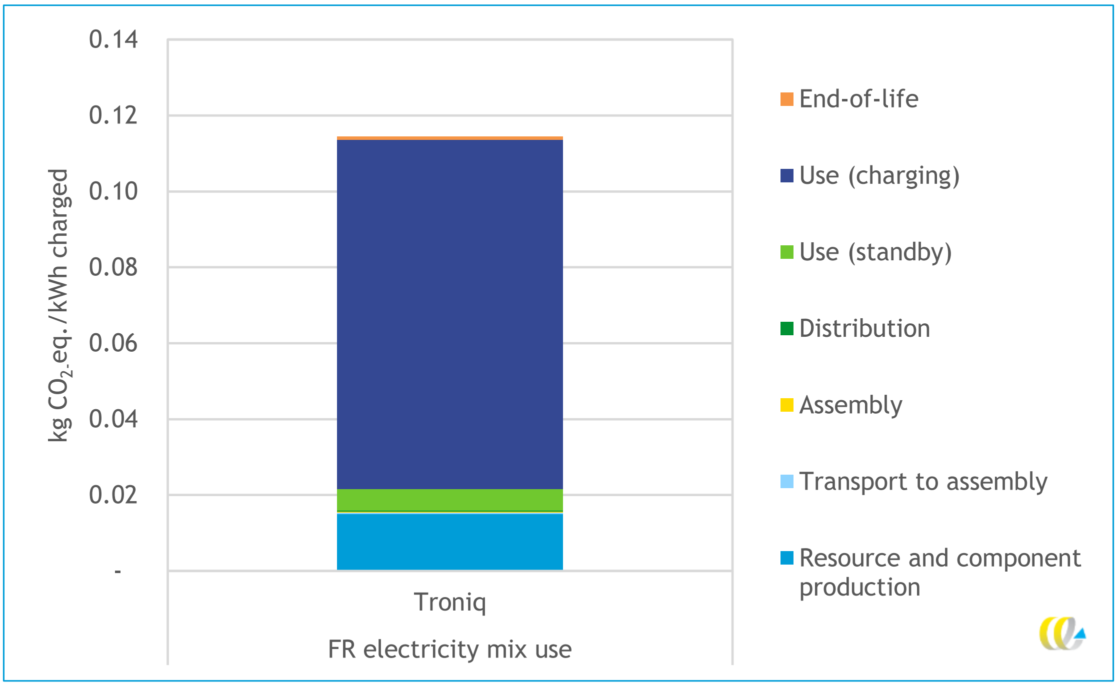
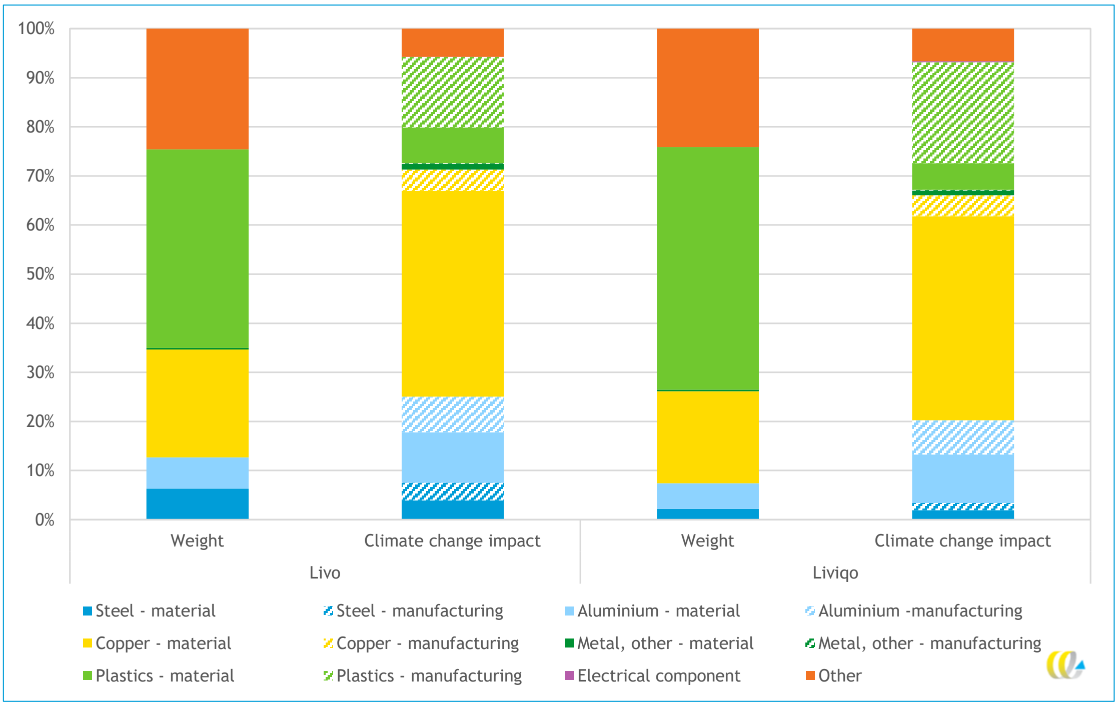


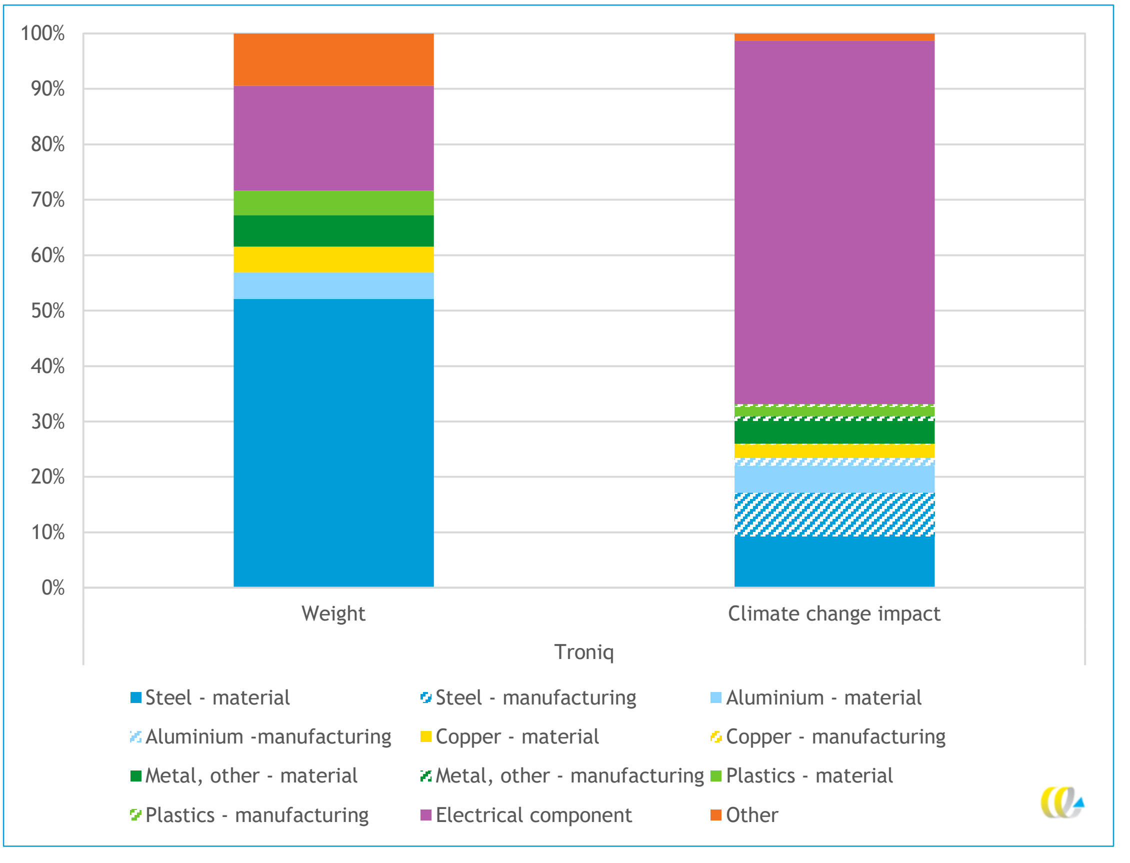

Figure 6 shows that EVBox Troniq Modular 180kW has a CFP of 0.11 kg $CO_2$-eq./kWh charged. Here the charging is responsible for more than 80% of the GHG emissions.

**Figure 7 - Contribution of materials to weight and component manufacturing impacts – EVBox Livo and EVBox Liviqo**



In Figure 7 the contribution of GHG emissions from materials and manufacturing components for EVBox Livo and EVBox Liviqo are presented. It is clear that plastics are the biggest contributor in weight. GHG emissions related to plastic are minor because Makrolon®RE is used in a large part of the plastics (covers). Copper is lower in contribution to the weight, however its related GHG emissions are the biggest contributor to the GHG emission of materials.

**Figure 8 - Contribution of materials to weight and component manufacturing impacts – EVBox Troniq Modular 180kW**




In Figure 8 the contribution of GHG emissions from materials and manufacturing components for EVBox Troniq Modular 180kW are presented. Regarding weight, EVBox Troniq Modular 180kW consists for more than 50% of steel, which has only a small contribution to the total GHG emissions. Electrical components make up 19% of the weight but show a contribution to the total GHG emissions of 66%. As a proxy is used for the modelling of the power unit, this adds uncertainty to the results.

## 2.5 Further interpretation of results

### 2.5.1 Limitations of the analysis and suggestions for improvement

Since the current analysis concerns a screening assessment, several assumptions had to be made. Hereafter we shortly discuss the limitations of this study:

- This study is a screening assessment, making that the analysis is performed by using available data from EVBox without thoroughly checking the correctness of the data and making generic assumptions where detailed data was missing. This study and report however make clear where data improvements are needed to improve the analysis.
- This study only considers a carbon footprint analysis and is not suitable to draw any conclusions on other impact categories than impacts on climate change. This study, however, provides a basis for extending to other impact categories.
- The analyses were based on available data provided by EVBox which covered the materials used in the different chargers. The analysis based on these data provides a good indication for a first carbon footprint calculation. The analysis however could be improved for EVBox' aim to improve the environmental performance of their products. The use of more detailed (environmental impact) data per component instead of per material used, allows a breakdown of the carbon footprint in different components and to identify the components that contribute most to the carbon footprint, for which then can be investigated if these components are available with a lower carbon footprint. A recommendation is to request environmental impact data or carbon footprint from the suppliers of different components.
- A significant limitation factor in the analysis is the BOM of EVBox Troniq Modular 180kW that only covers 85% of its weight. Therefore, the current result should be used with caution when communicated to outside parties.
- Further knowledge on the exact composition of the power modules would reduce the uncertainty of the results for the EVBox Troniq Modular 180kW.
- The assumption that the energy used in the assembly is of green origin has not been checked or substantiated with certificates of origin. Although the emissions for the assembly of the EV chargers is limited to 10-15% of the total carbon footprint it is possible that the results are slightly underestimated. If the assembly is not performed by using green energy but generic grid energy the carbon footprint could be slightly higher than shown here.

### 2.5.2 Additional sensitivity analyses

In this section we provide two sensitivity analysis to provide additional insights. First we performed an analysis in which we investigate how the use of Makrolon®RE influences the carbon footprint. Second we investigate the influence of using the Dutch energy mix has on the impact when EVBox Troniq Modular 180kW provides charger energy.

Figure 9 shows that the carbon footprint for EVBox Livo and EVBox Liviqo increases with ~45% and ~85% respectively when regular polycarbonate is used instead of Makrolon®RE. This also show the importance and dependency of the carbon footprint on the use of Makrolon®RE.

**Figure 9 - Sensitivity analysis – using regular PC instead of Makrolon® RE**

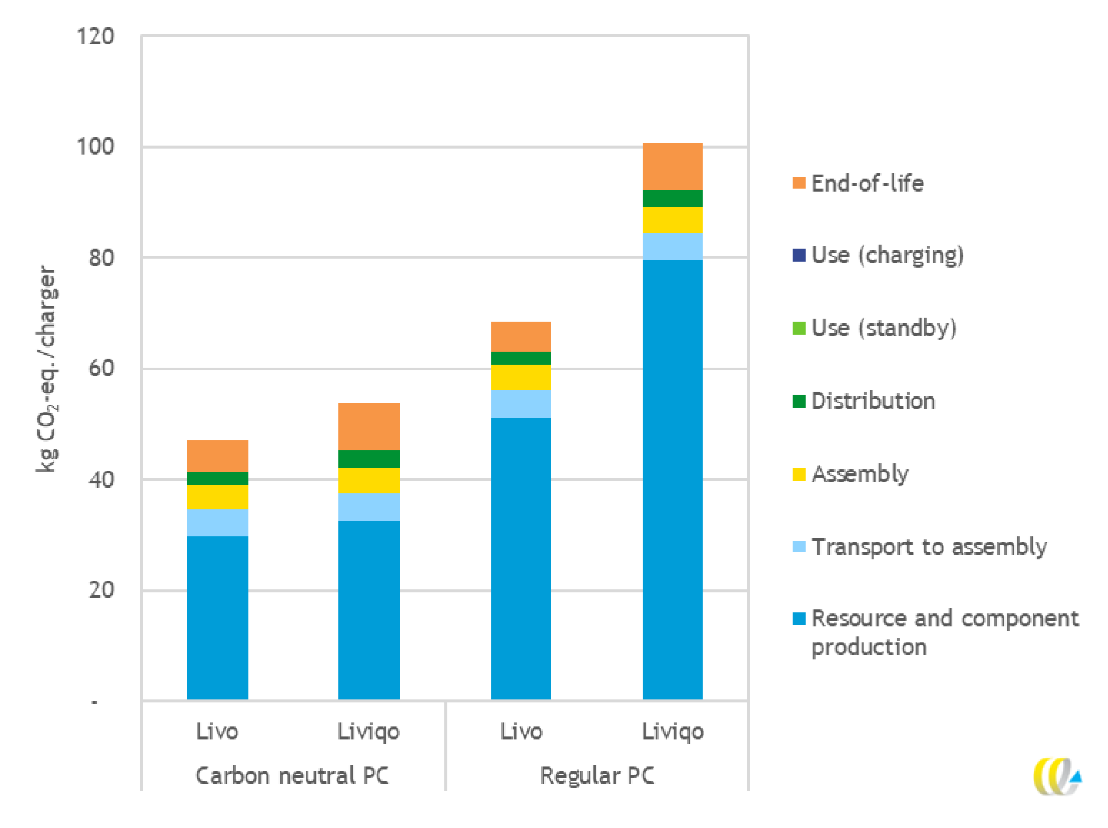
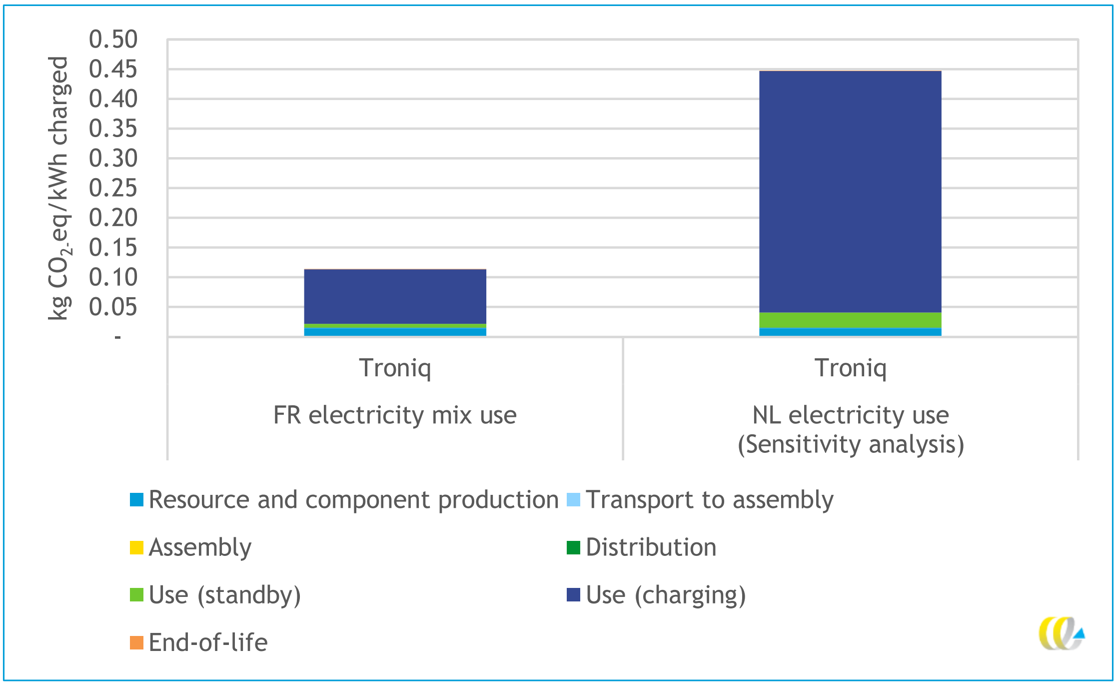



Figure 10 shows that the carbon footprint of charging 1 kWh of electricity strongly depends on where the charger is located. Because the GHG emissions of the French grid electricity mix are so much lower than the Dutch mix the carbon footprint of charging 1 kWh is more than tripled when the charger is located in the Netherlands instead of France.

**Figure 10 - Sensitivity analysis - using NL electricity mix instead of FR for EVBox Troniq Modular 180kW**



# 3 Conclusion and recommendations

In this study the carbon footprints for three chargers produced and sold by EVBox were calculated and assessed. The analyses here concerned a screening life cycle assessment (LCA) meaning that the structure and guidelines prescribed in the ISO 14040-44 LCA guidelines were used but only a carbon footprint was calculated and readily available information provided by EVBox was used. Where data gaps existed these were filled in with proxy-data based on common logic.

The goal of the analysis is to provide EVBox insights into the climate change impacts of three EV charging solutions to improve the environmental performance of EVBox' products and in reaching their sustainability goals. The outcomes of provide a solid estimate of the environmental performance of the three EV chargers and provides insights in data gaps and uncertainties that could be dealt with to improve the analysis. An additional aim was to share the outcomes of the study with potential customers and in tenders to demonstrate EVBox' commitment to sustainability.

## 3.1 Conclusion

Table 6 summarises the carbon footprint results for all three charging solutions.
These results are provided as carbon footprint per charger (FU1) and per kWh charged (FU2). The main contributor in the carbon footprint for all chargers are the materials and components that build the chargers. When looking at the carbon footprint per kWh charged, it is clear that the contribution of the charger itself is minimal in comparison to the GHG emissions of the electricity used for charging and therefore dependent on where the charger is installed and used.

**Table 6 - Overview of carbon footprints assessed in this study**

| | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW |
|---|---|---|---|
| FU1 (kg $CO_2$-eq./charger) | 47 | 54 | 12,090* |
| FU2 (kg $CO_2$-eq./kWh charged) | 0.41 (NL e-mix)<br>0.22 (LUX e-mix) | 0.41 (NL e-mix)<br>0.22 (LUX e-mix) | 0.12 (FR e-mix) |

* The assessment for EVBox Troniq Modular 180kW is based on a bill of materials that composes only 85% of the total weight. Results for EVBox Troniq Modular 180kW should therefor only be communicated with this limitation in mind.

A secondary aim was sharing the outcomes of the study with potential customers and in tenders to demonstrate EVBox' commitment to sustainability. Due to 15% gap to full-weight coverage for EVBox Troniq Modular 180kW (only 85% of the weight was covered by the BOM) the analysis performed only provides a very rough estimate of the carbon footprint for EVBox Troniq Modular 180kW.

## 3.2 Recommendations

Based on this study performed and conclusion drawn we have the following recommendations:

- When communicating the carbon footprint for EVBox Livo, EVBox Liviqo and EVBox Troniq Modular 180kW externally, make sure that limitations of the study are also communicated.
- If EVBox aims at lowering the carbon footprint of the charger itself, the main focus should be on using materials and components with a lower carbon footprint. The data provided for the analysis mainly concerned materials and not components. Reducing the carbon footprint would be more practical however if the components with the highest impact could be identified (which was not possible with the data provided).
- We recommend improving the carbon footprint analysis of EVBox Livo, EVBox Liviqo and EVBox Troniq Modular 180kW when more detailed (environmental) data on the components used is available. Therefor it would be beneficial to start asking suppliers for their LCA's or carbon footprints of the components they provide. This would also open up the possibility to analyse the contribution of different components to the carbon footprint.
- An intended update of this study would, next to obtaining environmental impact data for components instead of materials, benefit from obtaining certificates of origin of the energy used in the assembly. Insights in the LCA report concerning Makrolon® RE would also be beneficial. When an externally reviewed carbon footprint or LCA is required, this information is crucial.

# References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# A Bill of materials (BOM)

The BOMs provided covered 99% of the total weight of EVBox Livo, 93% of the total weight of EVBox Liviqo, and only 85% of the total weight of EVBox Troniq Modular 180kW. The data used in the assessment was scaled to 100% according to the material shares in the provides data. Due to the 15% gap to full-weight coverage for the EVBox Troniq Modular 180kW the results for this charger build in a higher degree of uncertainty and should be used with caution when made available to outside parties.

**Table 7 - Bill om materials of different chargers and upscaling to 100% weight**

| | Modelled as component | Materials reported by EVBox (grams) | | | Corrected materials (grams) | | |
|---|---|---|---|---|---|---|---|
| | | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW Modular | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW |
| Percentage of weight declared | | 99% | 93% | 85% | 100% | 100% | 100% |
| ABS | | | | 40.0 | | | 46.9 |
| Adhesives, sealants | | 2.0 | 7.3 | 4.3 | 2.0 | 7.8 | 5.1 |
| Aluminium | | | | 32,209.6 | | | 37,799.5 |
| Aluminium and aluminium alloys | | 2.0 | 2.0 | | 2.0 | 2.2 | |
| Battery | Yes | | | 0.8 | | | 0.9 |
| Brass | | | | 710.7 | | | 834.1 |
| Cable | Yes | | | 5,333.4 | | | 6,259.0 |
| Cardboard | Yes | 1,080.0 | 1,080.0 | 279.6 | 1,090.4 | 1,160.0 | 328.2 |
| Cast aluminium alloys | | 543.4 | 541.1 | | 548.7 | 581.1 | |
| Cement | | | | 41.6 | | | 48.8 |
| Ceramics/glass | | 47.4 | 434.5 | | 47.8 | 466.7 | |
| Copper | | 1,766.4 | 1,787.9 | 30,308.0 | 1,783.5 | 1,920.3 | 35,567.9 |
| Copper alloys | | 140.7 | 169.5 | | 142.0 | 182.1 | |
| Elastomers/ elastomeric compounds | | 354.5 | 27.6 | | 357.9 | 29.7 | |
| Electrical components | Yes | 0.0 | 0.3 | 124,585.3 | 0.0 | 0.3 | 146,206.6 |
| EPDM | | | | 331.0 | | | 388.4 |
| Filled Thermoplastics (Makrolon RE) | | 202.0 | 308.1 | | 203.9 | 330.9 | |
| GF Polyester | | | | 78.0 | | | 91.5 |
| Glass fibre | | | | 31.8 | | | 37.3 |
| Steel, highly alloyed | | 40.2 | 56.4 | | 40.6 | 60.6 | |
| Lacquers | | 18.8 | 2.6 | | 19.0 | 2.7 | |

| | Modelled as component | Materials reported by EVBox (grams) | | | Corrected materials (grams) | | |
|---|---|---|---|---|---|---|---|
| | | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW Modular | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW |
| Percentage of weight declared | | 99% | 93% | 85% | 100% | 100% | 100% |
| LCD | Yes | | | 920.0 | | | 1,079.7 |
| Lead | | 0.1 | 0.2 | | 0.1 | 0.2 | |
| Lithium grease | Yes | | | 20.0 | | | 23.5 |
| Lubricants | Yes | 0.1 | 0.1 | | 0.1 | 0.1 | |
| Melamine cyanurate | | | | 8.3 | | | 9.8 |
| Metals (mix) | | | | 38,494.0 | | | 45,174.5 |
| Mixed materials | | | | 56.0 | | | 65.7 |
| Nickel alloys | Yes | 8.1 | 4.4 | | 8.2 | 4.7 | |
| Nylon | | | | 19.0 | | | 22.3 |
| Other compounds (e.g. friction linings) | | 4.8 | 10.4 | | 4.8 | 11.2 | |
| Other duromers | Yes | 221.6 | 288.4 | | 223.8 | 309.7 | |
| Other fuels and auxiliary means | | 20.2 | 16.6 | | 20.4 | 17.8 | |
| Other special metals | Yes | 20.7 | 21.3 | | 20.9 | 22.9 | |
| PA | | | | 1,998.8 | | | 2,345.6 |
| PA 6.6 | | | | 1,209.1 | | | 1,419.0 |
| PA GF | | | | 454.4 | | | 533.3 |
| Paper | | 960.0 | 960.0 | 15.7 | 969.3 | 1031.1 | 18.5 |
| PBT | Yes | | | 59.3 | | | 69.6 |
| PC | | | | 1,004.0 | | | 1,178.2 |
| PCB | | | | 3,090.4 | | | 3,626.7 |
| PE | Yes | | | 705.2 | | | 827.6 |
| PET | | | | 4.0 | | | 4.7 |
| Plastic | | | | 1,260.0 | | | 1,478.7 |
| PMMA | | | | 9,487.5 | | | 11,134.1 |
| Polyolefin | | | | 898.1 | | | 1,053.9 |
| Polyurethane | | 6.3 | 25.7 | 197.2 | 6.4 | 27.6 | 231.4 |
| PPSP | | | | 4.0 | | | 4.7 |
| Preservative | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| PUR | | | | 80.0 | | | 93.9 |
| PVC | | | | 4,715.8 | | | 5,534.3 |
| Rubber | | | | 532.7 | | | 625.1 |
| SEBS | | | | 252.8 | | | 296.7 |
| Stainless steel | | | | 50,960.4 | | | 59,804.4 |
| Steel | | | | 237,173.5 | | | 278,334.2 |
| Steel, galvanized | | | | 44,143.6 | | | 51,804.6 |
| Steel, zinc plated | | | | 18,945.6 | | | 22,233.6 |

| | Modelled as component | Materials reported by EVBox (grams) | | | Corrected materials (grams) | | |
|---|---|---|---|---|---|---|---|
| | | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW Modular | EVBox Livo | EVBox Liviqo | EVBox Troniq Modular 180kW |
| Percentage of weight declared | | 99% | 93% | 85% | 100% | 100% | 100% |
| Steels/cast steel/sintered steel | | 24.8 | 82.3 | | 25.0 | 88.4 | |
| Textiles (in polymeric compounds) | | | 3.9 | | | 4.2 | |
| Thermoplastic | Yes | | | 4,224.6 | | | 4,957.8 |
| Thermoplastic elastomers (Makrolon RE) | | 117.4 | 1,041.7 | | 118.5 | 1,118.9 | |
| Unalloyed, low alloyed | | 483.4 | 89.9 | | 488.1 | 96.6 | |
| Underseal | | | 0.0 | | | 0.0 | |
| Unfilled thermoplastics (Makrolon RE) | | 2,605.8 | 3,472.7 | | 2,631.0 | 3,729.9 | |
| Unsaturated polyester | | 0.0 | 0.0 | | 0.0 | 0.0 | |
| UP polyester | | | | 1,965.4 | | | 2,306.5 |
| Washing water, battery acids | | 0.1 | | | 0.1 | | |
| Wood | | | | 56,692.0 | | | 66,530.7 |
| Wrought aluminium alloys | Yes | 3.4 | 3.1 | | 3.4 | 3.3 | |
| Zamak | | | | 10.5 | | | 12.3 |
| Zinc alloys | | 1.0 | 3.0 | | 1.0 | 3.2 | |
| ABS | | | | 40.0 | | | 46.9 |