Corporate value chain analysis Alfen Charging Equipment

CO_2 Performance Ladder and GHG Protocol

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ALFEN
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Revision	**Section**	**Change**
0	Initial version	7-1-2019
1	1.6, 2, 3, 6.7, 7, 8, Appendix F	Update format; Correction CO_2 emission end-of-life treatment, included appendix F; Update chapter 7 and 8 to advancing insights.

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1 Introduction

1.1 Scope of the report

This is Alfen's first corporate value chain report for Alfen Charging Equipment. It focuses on the Green House Gas (GHG) impact across its value chain on an example of an Eve charging station.

Eve charging station is the most popular Electric Vehicle (EV) charging station among Alfen's clients. Its design, technical characteristics and performance is optimally suited for the broad market range. This report provides the Scope 3 GHG inventory of the charging stations Eve and shows the corporate value chain and indirect emissions produced during the product's life cycle. Indirect emissions are emissions that are a consequence of Alfen's activities, but occur at sources owned or controlled by another company [202].

To optimise the accuracy of the impact calculations it was decided to select a project with Stedin as a baseline. The project covers a reasonable amount of EV charging stations, has different locations and external media recognition which allowed Alfen to obtain the most complete picture of the corporate value chain.

1.2 Main objective

The objective of the document is to understand the full value chain emissions impact of Alfen Charging Equipment in order to focus company's efforts on its potential to reduce its carbon footprint, leading to more sustainable decisions regarding companies' activities and products. Determining most significant emissions will help communicate the potential risks of the emissions to stakeholders and engage them in planning actions to mitigate the associated risks.

By providing partners with the results of the corporate value chain inventory and its "hot spots" Alfen wants to increase its transparency and environmental management in the supply chain. Also, costs can be reduced through improved supply chain efficiency and reduction of material, resource, and energy use.

1.3 Structure of the report

First chapter 2 gives the abbreviations and definitions and chapter 3 gives the references used in this document. Chapter 4 outlines the history and the main product types of Alfen Charging Equipment. Chapter 5 describes the corporate value chain of Eve charging station and provides the reader with an insight on the quantitative information around the value chain. Chapter 6 focuses on each of the components of the corporate value chain and presents a short overview of the carbon dioxide emissions. Chapter 7 builds a synthesis of the key findings and identifies improvement opportunities. Finally, chapter 8 sets main objectives and action plan for further development. The results of the calculations and other sources are included in the appendices.

1.4 Calculation methods

The Stedin project served as a framework for the analysis of the most significant emissions in Alfen's corporate value chain. As the installation of the charging stations took place between May and November 2018, mostly data from 2017 and some available data from 2018 were used. Main databases for calculating CO_2 emissions are CCaLC2 [209], Ecoinvent [210] and DCF Carbon Factors 2018 [211].

1.5 Reporting Principles

Corporate value chain report is based on the requirements of CO_2 Performance Ladder [201] and GHG The Corporate Value Chain (Scope 3) Accounting and Reporting Standard [202]. The following reporting principles were applied in this paper:

- Relevance
- Completeness
- Transparency
- Consistency
- Accuracy

1.6 Update of the report

In this document revision the original data have been retained, including the emission factors used. Reason is that the study is based on a specific project with Stedin in 2017/ 2018. Due to advancing insight goals and actions have been adjusted. The Eve charging station is currently known as the Eve Double Pro-line.

2 Abbreviations & Definitions

2.1 Abbreviations

Abbreviation	Definition
ACE	Alfen Charging Equipment
AIM	Alfen Integrated Management system
CO_2	Carbon dioxide
EU	European Union
H-SMC	Hemp fibre
GHG	Green House Gas
IEA	International Energy Agency
ISO	International Organization for Standardization
LiDS	Lifecycle Design Strategy
PCB	Printed circuit board
(PH)EV	(Plug-in Hybrid) Electric Vehicle.
QHSE	Quality Health Safety Environment
R&D	Research & Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
SCN	Smart Charging Network
SMC	Sheet Moulding Compound
WEEE	Waste Electrical and Electronic Equipment

Table 1 - Abbreviations

2.2 Definitions

Definition	Description
Direct emissions	Emissions emitted by installations that are owed or controlled by Alfen.
EcoDesign	Development that focusses on meeting the needs of the present without compromising the ability of future generations to meet their own needs.
Indirect emissions	Emissions that are a consequence of Alfen's activities, but occur at sources owned or controlled by another company.
Open Charge Point Protocol	An application protocol for communication between Electric Vehicle charging stations and a central management system, also known as a charging station network.

Table 2 - Definitions

3 References

3.1 AIM Documents

Ref.	Document Title	AIM Document Number	External Document Number
[101]	Alfen Supplier Code of Conduct	AIM-QHSE-GEN-2.02-02-POL-14	https://alfen.com/sites/alfen.com/files/downloads/AIM-QHSE-GEN-2.02-03-POL-14%20Supplier%20Code%20of%20Conduct_EN%20publicatieversie_4.pdf
[102]	EcoDesign analysis Eve Double Pro-line	AIM-QHSE-GEN-0.00-02-RP-01	

Table 3 - AIM Documents

3.2 External Documents

Ref.	Document Title	Alfen Document Number	External Document Number
[201]	CO_2 Performance Ladder Handbook		Version 3.1
[202]	Corporate Value Chain (Scope 3) Accounting and Reporting Standard		GHG Protocol, 2011: https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf
[203]	Stedins Wagenpark wordt volledig elektrisch		Stedin press release 13-Ot-2017: https://www.stedin.net/over-stedin/pers-en-media/persberichten/stedins-wagenpark-wordt-volledig-elektrisch
[204]	Ecodesign your future		Rijkswaterstaat brochure: https://www.afvalcirculair.nl/onderwerpen/beleid-circulaire/europese-richtlijn/ecodesign/downloads/ecodesign-your/
[205]	Printed circuit board		Wikipedia: https://en.wikipedia.org/wiki/Printed_circuit_board#Materials
[206]	Environmental Management Systems -Requirements with guidance to use		ISO 14001: 2015
[207]	MVO article Technische Unie		Technische Unie: https://www.technischeunie.nl/portal/themas/duurzaamheid/mvo-technischeunie/
[208]	Global EV Outlook 2018, Technology Report May 2018		International Energy Agency: https://www.iea.org/reports/global-ev-outlook-2018
[209]	Carbon Footprinting Tool CCaLC2		Build 1.700: http://www.ccalc.org.uk/

Ref.	Document Title	Alfen Document Number	External Document Number
[210]	Ecoinvent life cycle inventory database		Integrated in Carbon Footprinting Tool CCalC2.
[211]	DCF Carbon Factors		2018
[212]	CO_2 emissiefactoren 2018		2018, https://www.co2emissiefactoren.nl/wp-content/uploads/2019/01/co2emissiefactoren-2018.pdf
[213]	European directive on Waste Electrical and Electronic Equipment (WEEE)		2002/96/EC
[214]	European directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)		2002/95/EC
[215]	European Directive for Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)		1907/2006/EC

Table 4 - External Documents

4 Information about Alfen Charging Equipment

4.1 History

Alfen Charging Equipment (ACE) is a trading name of Alfen ICU B.V., which is a subsidiary of Alfen NV, an international organisation focusing on the development and delivery of innovative products and projects in the world of electric energy. The company brings together areas of expertise such as smart grids, energy storage systems and EV charging equipment.
As one of the founding fathers of EV charging solutions in the Netherlands, in 2018 ACE realised over 40,000 charge points worldwide, and plays a leading role in development and standardisation of the industry.

Important milestones in the history of ACE:

2008: Development and production of first charging stations for the Electric Vehicles (EV) market in the Netherlands

2011: Delivery of the 1000th public charge point in the Netherlands
Company take-over of EXENDIS, an expert in the field of converters and chargers

2014: Alfen expands to the United Kingdom, France and Germany

2016: Alfen introduces Eve Mini, the latest charging station for electric cars in the Eve range
ICU Charging Equipment selected as supplier for the world's largest electric vehicle smart charging project
Alfen is nominated as a finalist for the eCarTec Award in the Energy Infrastructure category

2017: Introduction of the new Eve
Alfen supplies the European Commission with Charging Infrastructure for Electric Vehicles

2018: Launch of the new integrated energy storage solution (fast EV charging system)
Alfen has been selected by Jaguar Land Rover to supply its EV charging equipment, covering the Netherlands, Belgium, Luxembourg, Switzerland, Portugal and Spain.

4.2 Product types

Alfen offers a full range of charging stations suitable for every Plug-in Hybrid and Electric Vehicle for use at home, work or public areas and are available in a variety of power capacities and functionalities. With the help of its in-house products and services Alfen is connecting the megatrends in the energy sector. The product types illustrated in Figure 1 are explained in the following sections.

	Eve Mini	Eve	Twin
Material	Polycarbonate	Sheet Moulding Compound	Stainless Steel
Size	S	M	L
Outlets	1	2 in same direction	2, back to back
Available outlet options	Type 2 socket (with and without shutter), fixed cable (type 1 and type 2)	Type 2 socket	Type 2 socket
Authorization	Plug & Charge or RFID	Plug & Charge or RFID	Plug & Charge or RFID
Safety related components: installation flexibility	Full flexibility: MCBs and RCDs installed outside	Partial flexibility: MCBs (RCDs installed inside)	Flexibility determined by product configuration: Residual current and over current (short circuit) Type A protection fully on board
User Interface	Single LED or display	Display & authorization status indicator	Authorization status indicator. Language independent, pictograms showing user steps

Figure 1 - Alfen product types

4.2.1 Eve Mini

The Eve Mini is the most compact charge point in the Alfen product range. It offers charging speeds of 3.7kW up to 22kW, as well as all smart features that are also integrated in Alfen's other charge points. The Eve Mini features all elements needed for automated clearing of electricity consumption costs, and can easily be managed remotely.

Based on the smart technology integrated by Alfen, the Eve Mini autonomously carries out the local management of the installation. If more advanced options such as load balancing or the Alfen Smart Charging Network are used, the charge points always charges with the optimum output. Users have a comfortable experience too, as the bright colour display provides clear insights in the status of the charging process.

4.2.2 Eve

The Eve is Alfen's smart charging solution with two sockets and is optimally suited for private and semi-public locations. In 2017, Alfen has redesigned the Eve from the ground up taking into account the latest in charging technology and needs of EV drivers. With its large display and improved user interface, and a new high-tech and ultimately reliable hardware platform and several features allowing for easy configuration and operation.
The Eve is equipped with a DC sensor against hazardous electrical faults which allows a more cost-efficient installation. An externally accessible Ethernet Port makes it easy to connect the Eve to a PC and configure the charge point with the user friendly Installer.
With its redesigned soft- and hardware, the Eve supports various features such as smart charging networks, load balancing and Open Charge Point Protocol 1.6.

4.2.3 Twin

The Twin is Alfen's robust and smart charging solution with two sockets. It is perfectly suitable for semi-public and public locations. Alfen completely redesigned the Twin in 2017 and renewed its interior with state of the art charging technology based on the preferences of EV drivers. With its clear user interface and highly reliable hardware platform, the Twin offers unparalleled user-friendliness and integrates advanced smart charging features.

5 Corporate value chain

Main objective of the Scope 3 inventory analysis is gaining insight into the overall emissions profile of Alfen's upstream and downstream activities on the example of Eve charging station. This information helps to clarify where potential emissions and associated risks lie in the value chain. Additionally, the relative risks and opportunities of the scope 3 emissions in comparison with the company's direct emissions are identified.

The corporate value chain of Alfen Charging Equipment starts with Purchased goods and services and deliberately doesn't include raw materials. The reason for this is that Alfen has very limited knowledge of the supply chains of its suppliers and that's why it was agreed to see raw materials and suppliers under one category of Purchased goods and services.

Alfen traditionally operates its manufacturing of the EV charging stations using a linear value chain: make, use, dispose. Standing in the middle of the energy transition it is important for Alfen to focus on the transformation of linear value chain to a circular ecosystem business.

Research & Development (R&D) is one of the key enablers of this transition as it requires better knowledge about value of the product, components and materials at their highest level. That's why R&D is included in the value chain.

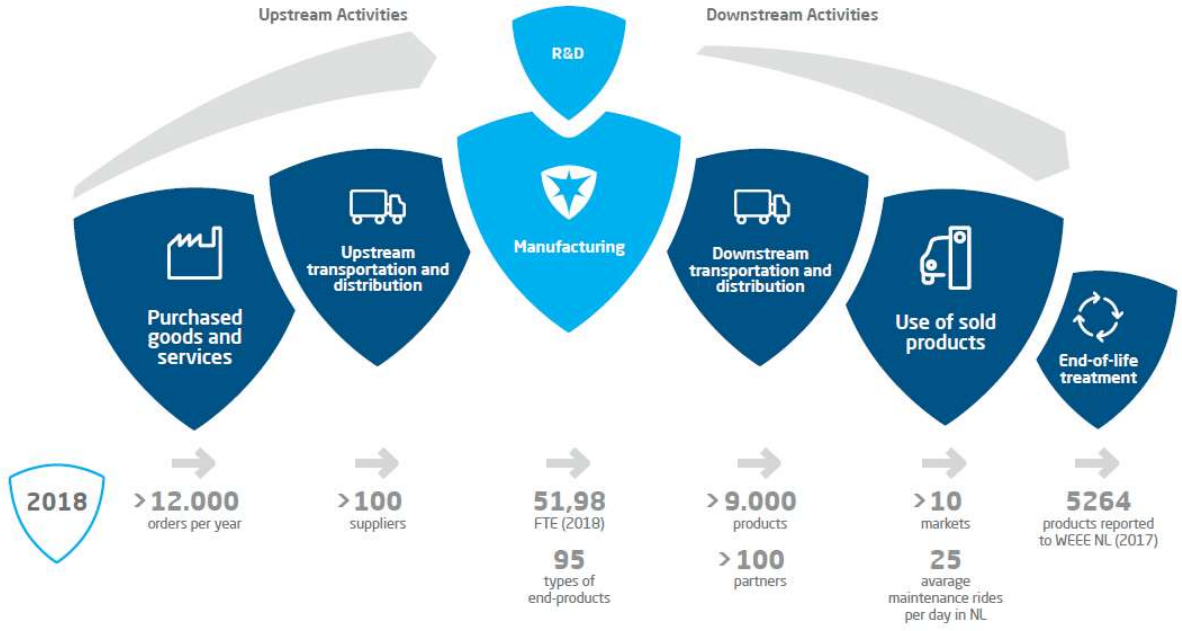

Figure 2 - Corporate value chain Alfen charging stations

6 Project analysis baseline description “Energy transition at Stedin”

As part of its program to electrify the fleet, Stedin is installing charging stations for electric cars at various Stedin locations throughout The Netherlands. During the year 2018 a number of 84 Eves were installed at five different Stedin locations across the country. These charging points are all branded with the Stedin logo and equipped with Alfen's Smart Charging Network for simultaneously charging a large number of cars.

With approximately 2,100 company cars, Stedin has one of the largest fleet in the Randstad.
In 2017 the organisation announced to bring its fleet to zero-emissions in the coming years. By changing the company’s cars to fully electrical, Stedin wants to make a significant contribution to reducing CO_2 emissions and improving air quality in the Randstad [203].

Alfen and Stedin are working together in the field of medium voltage grid solutions and energy storage projects for decades. This experience gives both parties the confidence that Alfen can roll-out a charging infrastructure at Stedin’s locations. The ambitions of Stedin and a good knowledge of internal processes of this project allowed to evaluate the most significant impact of the Eve charging station on the environment and achieve objective of the research.

6.1 Research & Development

Obviously, manufacturing of a charging station has an impact on the environment during its complete life-cycle, such as use of raw materials and natural resources, manufacturing, packaging, transport, disposal and recycling. However, more than 80% of the environmental impact of a product is determined at the development stage [204].

A good product design takes into account all its environmental impacts, where uncoordinated product planning is avoided, energy consumption is minimised and quantities of recycled materials are increased. Alfen has an ambitious goal to facilitate a positive environmental impact in the energy transition and makes first steps towards circularity. The Eve charging station is designed in such a way that the product can be taken apart effortlessly and the necessary parts can be easily replaced.

6.2 Materials and suppliers

A sustainable environment is an essential value of Alfen. Environment not only in the sense of legal responsibilities, national and international law and guidelines, but also taking care of current and future generations. To meet this value, the development and production of sustainable products is a mission.

6.2.1 RoHS/REACH declaration of conformity

Alfen takes great responsibility for the quality of its products and services as well as for the prevention of environmental pollution. This affects the choice of materials and product manufacturing. Regarding the protection of the environment, amongst others, the following regulations and directives have been drawn up within the European Union (EU).

Alfen does not produce nor import chemical materials into the EU and that's why the registration obligations under the REACH directive [215] are not directly applicable to Alfen. However, Alfen fully supports the objective of REACH to advance public health and safety and protect the environment by informing its suppliers about their obligations in this regard.

The European Restriction of Hazardous Substances (RoHS) directive [214] restricts the possibility of using certain hazardous substances in electric and electronic equipment. In addition to reducing harmful effects on people and the environment, legislation aims to improve recycling options. Alfen closely monitors the development of RoHS and immediately responds to specifications. All Alfen charging stations including Eve meet the material requirements of RoHS.

6.2.2 Alfen Supplier code of conduct

Environment and corporate social responsibility run like a thread not only through the operations and daily activities at Alfen. They also play an important role with regard to business relations. That is why suppliers are informed about the standards applicable to the entire supply chain.

Together with the suppliers Alfen continuously works on sustainable developments in the areas of company management, human rights, fair operational and business practices, health, safety & environment. Alfen Supplier Code of Conduct [101] describes these principles. The document provides a framework for the suppliers in which Alfen wants to operate.

The Code of Conduct introduction helps Alfen to create an honest ecosystem for coexistent cooperation with partners. Protecting the environment, recycling and conservation of natural resources are of the highest priority to Alfen. Partners violating these regulations are requested to rectify the situations; furthermore, if violations continue, limitations are imposed on future transactions.

6.2.3 Emissions from the purchased goods and services

Part of the scope 3 inventory is an analysis of the purchased goods and services necessary for the production of Eve, or in other words - main components. Table 5 provides a list of the Eve's main components, which are comprised of roughly 78 subcomponents.

Component	Material	kg CO_2/ Eve
Casing	Fibre-reinforced polyester (Sheet Moulding Compound - SMC)	50.6
Electronic Components: • Residual Current Devices • Load switch • kWh meter • Fuses • PCB (Printed Circuit Board)	Plastic Fiberglass & aluminium [205]	12.7
Fixing components	Pressed steel	7.7
Wiring components	Copper	26.5

Table 5 - Main Components of Eve charging station

The total carbon footprint of this category is 97.5 kg CO_2 or 0.098 ton CO_2 per Eve. The measurement is based on the CO_2 emission factors of each subcomponent of the product.
Figure 3 shows the ratio of the emissions. The detailed information is provided in Appendix A, CO2 emissions components Eve Charging stations.

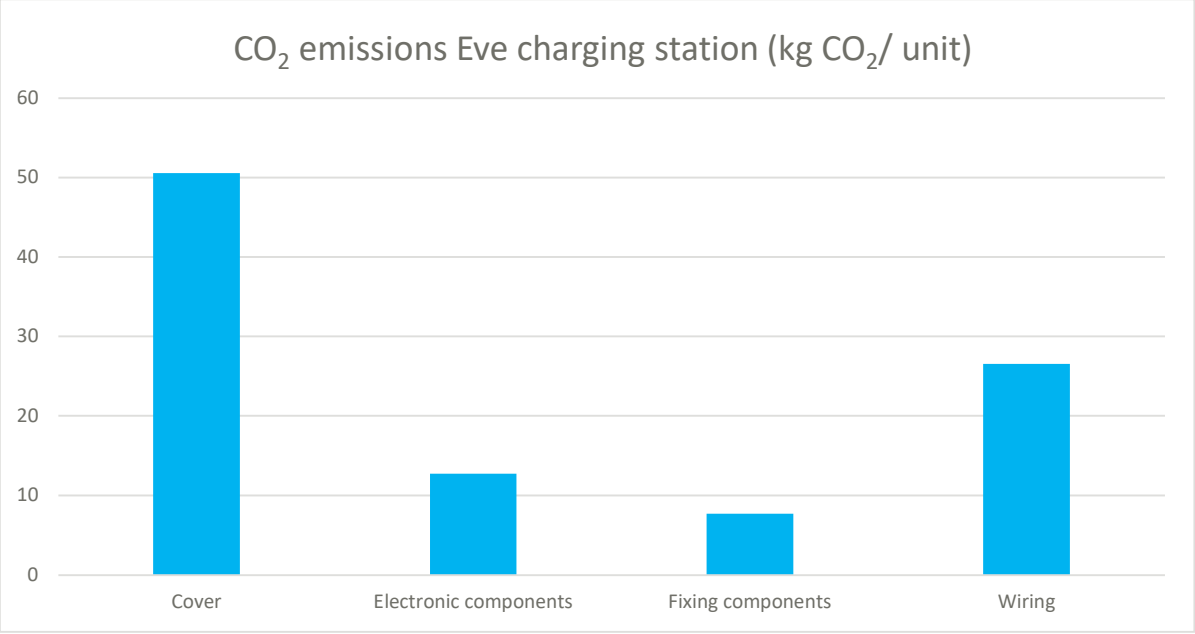

Figure 3 - CO_2 emissions main components Eve Charging station

6.3 Logistics

Alfen Charging Equipment works with about 100 suppliers from the Netherlands and Europe, of which about 50 are active suppliers. Appendix B provides an overview of the top ten suppliers with the highest turnover.

In order to reduce the environmental impact of logistic activities, orders are planned depending on their stock availability, delivery time and volumes. Efficient planning contributes to efficient delivery with more pallets dispatched on the same day. Also, many deliveries are combined with the shipments to another neighbouring location of Alfen at Hefbrugweg 28.

In order to measure the impact of the upstream transportation and distribution the whole list of suppliers is analysed. As it wasn't possible to identify the exact logistics of the product's components with regard to the Stedin project, the average CO_2 emission per charging station produced in 2017 is calculated. A starting point for the measurement is the quantity and traffic of transportation consisting of two parameters: ton amount and distance in kilometres. Assumption is that every delivery contains one ton of cargo transported by a gasoline truck using the shortest route from supplier's main office in the Netherlands to Alfen at Vlotbrugweg 24 in Almere.

In the end the results are as follows:

Total kilometres	: 18,865
Total amount of ACE products:	: 5,264
CO_2 emission factor for a truck, a type of a gasoline is unknown:	: 0.259 kg CO_2/km
Emission per charging station	**: 0.928 kg CO_2/Eve**

In the circular economy a close cooperation throughout the value chain has a lot of value. A good example of such partnership is cooperation with a supplier of Eve's casing. The supplier delivers casings for the charging stations in cardboard boxes which are being reused for shipments to Alfen's clients.

6.4 Manufacturing

The Eve charging station is not manufactured in a single process but assembled after its various components have been produced and delivered to Alfen.
According to the CO_2 Performance Ladder the environmental impact of direct manufacturing falls under the scope 1 and 2.
However, some other activities are related to indirect emissions in the manufacturing process. These activities are employee commuting and waste generated in operations.

6.4.1 Employee commuting

Employee commuting between their homes and worksites are considered as a part of Manufacturing processes. Therefore, a survey is conducted among 54 employees of Alfen ICU B.V. on how they usually commute to work.
From the respondent group nine people use a lease car and therefore fall under scope 1 and are not considered in the outcome of the questionnaire. In total 31 people responded to the survey, which

allows to make an assumption of the total emissions of all 45 employees commuting by their own cars or public transportation.
The total emissions from the transportation of the employees between their homes and the worksite in 2018 is 74.51 ton CO_2 (Appendix C, Table 12). As the amount of the staff members is increased with 68% in 2018 (from 32 in 2017 to 54 in 2018) the forecasted amount of the charging points in 2018 (9,000) is used, which results in 8.28 kg CO_2 per Eve.

6.4.2 Waste generated in operations

Waste avoidance, separation and recycling is one of the ambitions of Alfen to become a sustainable company. Waste streams generated during the manufacturing processes are closely monitored and regularly reported under the Environmental Management System [206]. The main waste streams are:

- Paper
- Cardboard
- Wood
- Metal
- E-waste
- Chemical waste

To measure the waste produced per charging station the financial results consolidation approach is used. Alfen Charging Equipment has 12% in the turn-over of Alfen group of companies in 2017, therefore the same 12% is used to calculate the waste ratio from the total waste generated (Appendix C, Table 13). E-waste and chemical waste are not considered due to insignificant amounts.
The total carbon dioxide emissions from waste resulted in 391 kg CO_2 per year and 0.07 kg CO_2 per Eve.

6.5 Distribution

Alfen Charging Equipment works with more than 800 clients across the Netherlands and other European countries. With nearly 120 of them ACE has a service agreement. Together with them Alfen makes it possible that EV charging stations are available anywhere, anytime for anyone.

Below is a brief overview of some distribution partners with which Alfen has an agreement.

Allego
The Netherlands, Belgium, Germany

Van Leeuwen Oplaad
The Netherlands

Technische Unie
The Netherlands

NewMotion
The Netherlands, United Kingdom, Germany, France

GreenFlux
United Kingdom, the Netherlands, Germany, Norway

Efimob
Portugal, Spain

This chapter focusses on downstream transportation and distribution of the charging stations, specifically on the Stedin project where Technische Unie and WL Techniek acted as Alfen's partners. The details of the distribution are presented in Figure 4.

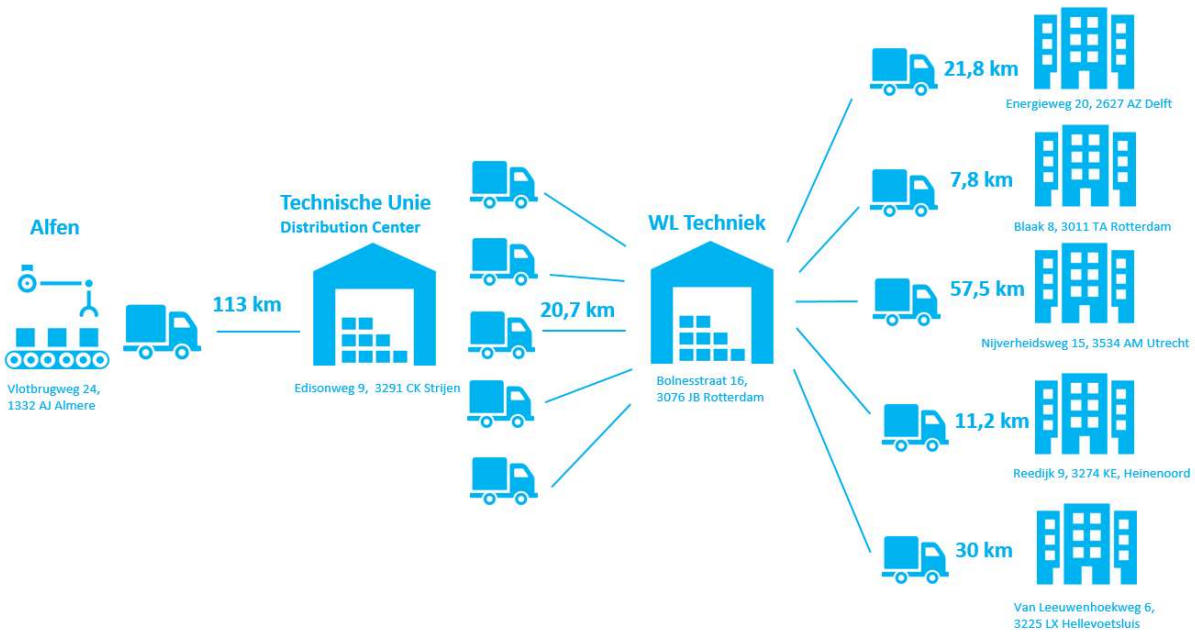

Figure 4 - Distribution charging stations Stedin project

All Eves are transported to the distribution centre of Technische Unie at Edisonweg 9 in Strijen located at a distance of 113 km from Alfen. By driving smart routes Technische Unie decreases the amount of empty trucks [207]. The route for this particular project is not known, therefore the shortest distance to the distribution centre is calculated via the website https://www.anwb.nl/verkeer/routeplanner.
From the distribution centre the charging stations were delivered to WL Techniek separately for every location of Stedin according to the installation schedule.
For calculating the average CO_2 emission per charging station the same calculation method as in the Chapter 6.3 is used. According to the measurement the average CO_2 emission per Eve charging station results in 1.06 kg (Appendix D).

6.6 Use of sold products

Alfen's greatest impact is through its products. Products and services are continuously improved to shape the energy transition and the experience of driving electrical vehicles. All products are approved by the Office for Low Emission Vehicles. Moreover, the chargers are tested by all major electric car manufacturers and have been approved by notified certifying bodies such as DEKRA.
Alfen's decade-long experience ensures that our products including Eve are easy to install and configure, contain clear user-interfaces and realise high uptimes. This high-tech robust charging station comes with many functionalities and meets the latest technical standards and innovations.

For example, Alfen introduced the Smart Charging Network (SCN) which is the most advanced charging station technology on the market. It operates as a social charging network and aligns the charging speed among electrical vehicles. With the SCN, the available power capacity is evenly distributed among the users. When a vehicle is fully charged, other connected vehicles will automatically be supplied with more power.
However, as any other electrical appliance the charging station has an impact on the distribution network. To determine the impact during the Stedin project the carbon emissions of electric power distribution losses of the Eve charging station is calculated.
Stedin's energy network is not 100 % fossil fuel energy free. Therefore, the assumption is that in the worst case scenario the charging infrastructure at all Stedin locations is powered by non-renewable energy. The average energy consumption of the Eve is 9.3 Watt. This is based on measurements in 2018. The consumption resulted in 81,468 kWh and 0.0529 ton of CO_2 per year or 0.529 ton CO_2 per the life cycle of ten years (Appendix E).

6.7 End-of-life treatment

Alfen Charging Equipment is classified as a producer of electrical/ electronic equipment and in this respect falls under European directive Waste Electrical and Electronic Equipment (WEEE) [213]. This legislation entails a take-back obligation of discarded electrical equipment, batteries and packaging material on basis of a producer responsibility.
Electrical and electronic equipment (anything that uses a plug or battery) can contain materials that can be harmful if released into our environment. In addition, such equipment contains valuable materials that can be recycled and used again in the manufacture of new items of equipment.

Alfen makes sure that the organisation is WEEE compliant and regularly reports to the relevant authorities on the amount products entering the market. Figure 5 shows the amounts of the reported charging equipment for the past two years.

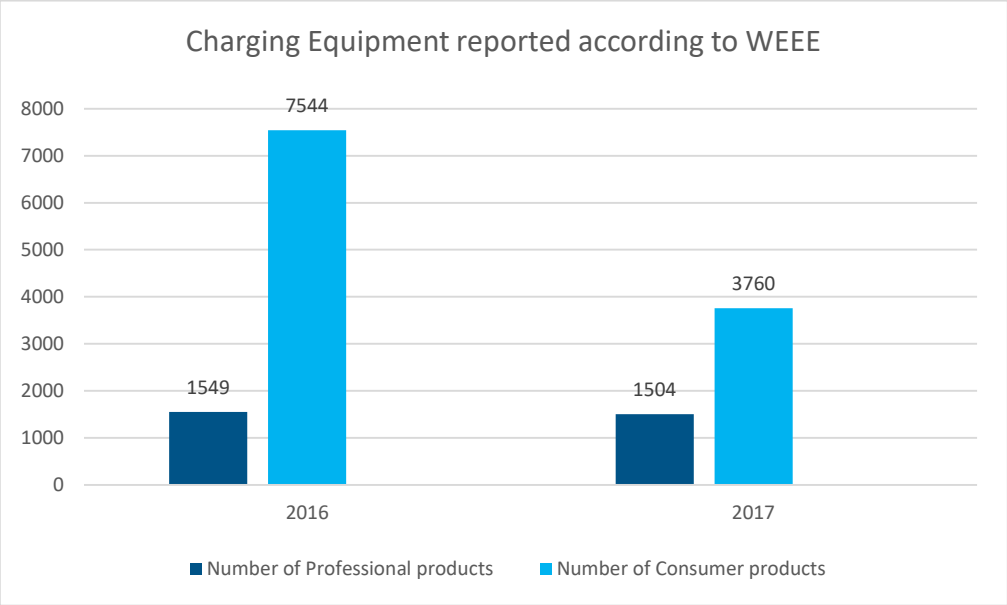

Figure 5 - Charging Equipment reported according to the WEEE Regulation

After expected lifetime of ten years Eve charging stations enter the phase of the end of their useful life. It means that Alfen has right to stop providing any technical support, service and updates of the product's software. It also means that the product can be treated as waste.
To gain an optimal benefit for the environment, Alfen always encourages its clients to bring the EV charge equipment to recycling stations where the products will be dissembled and recycled.
Knowing that Stedin is an environmentally aware organisation, the assumption is that all 84 charging stations will be recycled at the end-of-life stage. In this case the CO_2 emissions will be *0.5* kg CO_2 per Eve charging station or *42* kg CO_2 per 84 stations (Appendix F).

7 Key findings and opportunities for improvement and update

The world of electrical vehicles and charging infrastructure is rapidly growing and polices are changing along. According to International Energy Agency (IEA) only 35% of the publicly accessible charging points required by 2020 have been deployed in the EU [208]. These developments provide a strong outlook for Alfen in the coming years.
The organisation certainly contributes to decarbonisation in the area of electric mobility. However, the environmental footprint across the corporate value chain remains negative. Alfen is committed to reduce its negative footprint by setting up specific targets and an action plan included in Chapter 8.

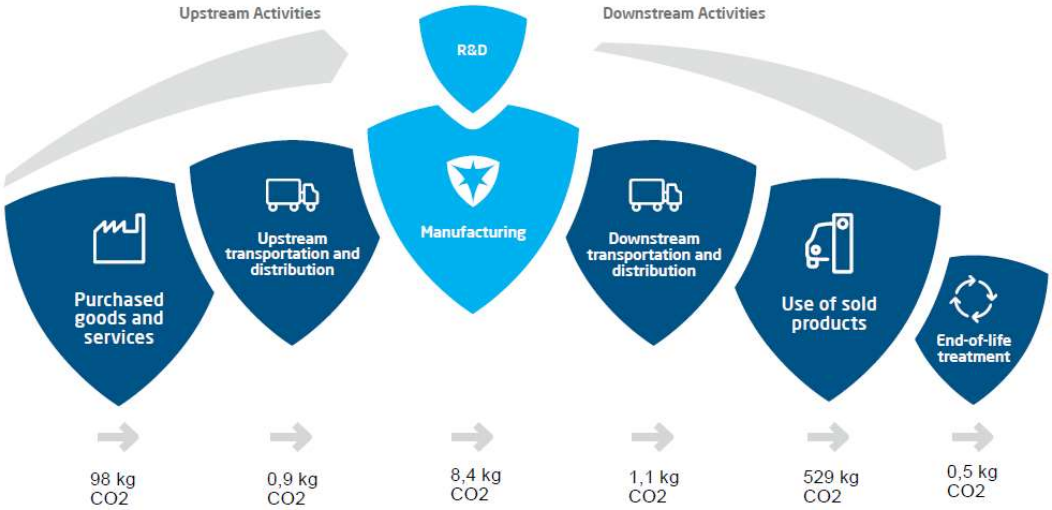

Figure 6 - Carbon footprint Alfen Eve charging station

The total CO_2 emission per Eve charging station is 0.64 ton CO_2. The study shows that the most significant environmental impacts of the Eve lie outside of Alfen's direct operational control - at the stage of use of manufactured products (83%) and in the materials (15%). See Appendix G for further information.
Based on these findings, the next recommendations for improvement were determined.

Impact 1: Material use
Key findings:

- The information on the use of raw materials is not available.
- Eve's casing made of Sheet Moulding Compound produces 52% of the total CO_2 emissions originated in Purchased goods and services, followed by wiring with 27%.

Recommendations for improvement:

- Search for light weighted and/or natural fibre reinforced polyester alternatives to glass-fibre, for example hemp fibre (H-SMC). Additionally, Alfen's R&D specialists could investigate a possibility to minimise the weight of the charging station and to reuse some parts of the product.
- Create a handbook for developers including list of materials according to REACH and RoHS requirements, list of critical raw materials - to make a deeper analysis of the suppliers Tier 2 category.

Challenges:

The quality of the product may be negatively influenced if the material structure will be changed. Also, products are produced with specially developed moulds. And finally, Alfen's clients may demand a specific design of the product which limits the company to implement any changes.

Update 2021:

- See impact 6 on the update on design and the adopted Lifecycle Design Strategy (LiDS) Wheel method .
- The LiDS wheel method is used to analyse the Eve Double Pro-line [102]. It turned out that SMC is a material with an average eco-score that provides the necessary weather resistance to maintain intended lifespan.
- Recycled plastics are currently not desirable due to the presence of silicones, which complicate the application of the desired paint color.

Impact 2: Employee commuting

Key findings:

- At least 42% of the respondents travel to work by car, which brings the average carbon dioxide emissions to 8.28 kg per charging station.
- The company is not very easily accessible by a public transportation and many people come to work faster by car.

Recommendations for improvement:

Alfen does not have any direct influence on the employee commuting besides providing lease electrical vehicles to a number of employees. Economically it will be quite a challenge to provide every employee with the possibility to lease a car and therefore this option is not considered a solution. Nevertheless, to bring the carbon dioxide emissions of the employee commuting to a minimum, Alfen can use the following options:

- Stimulating carpooling among the employees. For example via the platform https://www.carpoolworld.com.
- Additional public transportation coverage such as NS Business cards and OV-chip cards.
- Work from home policy for office employees.
- Provide employees who live in Almere with an e-bike.

Challenges:
To implement these solutions, Alfen should reconsider its travel and reimbursing policy and therefore strategic decisions have to be made.

Update 2021:
Alfen has developed a working from home policy for office employees.

Impact 3: End-of-life treatment
Key findings:

- No trace of the products at the end of their useful life.
- No reporting from WEEE NL.
- No information on the recyclability rate.

Recommendations for improvement:
Alfen can tremendously improve its performance in end-of-life treatment after the product's useful life if more information is collected and processed at the design development stage. For instance, the knowledge about inactive charging stations and detailed reports from the recycling centre will help to determine an approximate amount of recovered raw materials.
It is important to mention that Alfen can develop and communicate Product End-of-life instructions to the clients. These instructions will identify the components that optimise the recycling performances of the product, contact details of recycling centres and any other special recommendations concerning the product.
Another option is the establishment of a take-back procedure which will make it possible to reuse and remanufacture parts of the products.

Challenges:
There is no additional agreement with WEEE NL about the reporting processes and the received information is not sufficient. New arrangements have to be made.
A take-bake procedure can only be implemented if the management will include it into the company's business model.

Update 2021:

- With a considered life time of ten years, the first products are expected to enter the end-of-life phase. Currently, Alfen is performing feasibility studies for second life of chargers.
- In the Netherlands the WEEE agreements are taken over by "Stichting OPEN" in 2021. This party ensures sustainable and environmentally conscious processing of collected waste electrical appliances. After collection, the electrical appliances are sorted. Some devices are dismantled manually so that reuse or better recycling (up to 95%) can be achieved. This activity takes place, where possible, with people who are at a distance from the labor market. The e-waste is then processed in the best possible way into raw materials by CENELEC-certified processors.
- In 2021 Alfen found a customer for the reuse of the cover materials. It will be used as a filler material for concrete. This means the material is downgraded to a lower quality. However, this is much better than ending up in landfill or an incinerator.

Impact 4: Distribution and transportation

Key findings:

- Distribution and transportation of the products is not efficient.
- At the moment Alfen has limited influence on the logistics of the partners.

Recommendations for improvement:

To reduce greenhouse gas emissions in the distribution and transportation sector, Alfen will need to work closer with the partners and logistics companies for more efficient distribution planning. For example, products can be transported by smaller tracks or by electrical trucks. Also, transportation of the charging stations can be done directly to an end-client or an installing company.

Challenges:

Partners may need to switch to another type of transportation which could be economically not possible for them. Additionally, new arrangements have to made in order to change delivery schemes.

Impact 5: Energy consumption during stand-by mode

Key findings:

- Electric power distribution loss during the stand-by mode negatively influences the environment

Recommendations for improvement:

Investigate energy losses and the possibility to minimise it from 9,3 to 5 Watt/hour.

Challenges:

At the moment there are higher priority topics. This means that ambitions on design shall be determined and prioritised by the management.

Update 2021:

- See impact 6 on update on design.
- In the period 2020-2021 Alfen developed a new software platform, including new possibilities for eco-friendlier use. For example, the idle time is reduced by adding a proximity sensor. When there is no activity in front of the charger, the screen turns off and internal processes are minimised. Estimated is that this results in a stand-by reduction of nearly 50%, to 5 Watt.
- The new software platform is backwards compatible and therefore can be installed on older systems, making a longer initial lifetime.

Impact 6: Design

Key findings:

- Lack of circular design approach has a negative impact on other aspects in the corporate value chain.

Recommendations for improvement:

Define goals, boundaries for life cycle impact assessment and action planning and inform suppliers and encourage them to participate.

A close cooperation between the Alfen departments QHSE, R&D and Purchase and Alfen suppliers is vital here.

Challenges:
At the moment there are higher priority topics. This means that ambitions on design shall be determined and prioritised by the management.

Update 2021:
Alfen adopted Eco-design method Lifecycle Design Strategy (LiDS) Wheel described by Brezet and Van Hemel. For future designs this method is used for environmental improvement. First analysis is performed for the Eve Double Pro-line [102]. Reference is made to the update mentioned under impact 1 and 5.

8 Targets and action plan

The overview of the key findings and challenges shows that are several opportunities to reduce the emissions that contribute to climate change.
To reduce the environmental impact, the focus should preferably be on the most material emissions in the corporate value chain, the materials used and the use of sold products. For this purpose two main reduction goals are determined. Table 6 gives an overview of the goals and related actions.

Most significant emission category	Reduction goal	Action	Schedule	Responsible person or department
Use of sold product	2022: 30% reduction in energy consumption (standby) compared with 2017.	1. Research on possibilities for reduction of energy consumption	2019	Research & Development
		2. Management decision on scope implementation plan	2020-Q1	
		3. Execution of the implementation plan during regular product update process	2020-2021	
Purchased goods and services	5% reduction in CO_2 emissions of the components in product update or new design compared with the Eve Double in 2017	1. Investigation on alternative materials for the casing	2019	Research & Development ACE Production
		2. Management decision on scope implementation plan	2019	
		3. Execution of Implementation plan during regular product update or design process	According to design schedule	

Table 6 - Targets and Action plan

Appendices

Number	Title
Appendix A	CO_2 emissions components Eve Charging stations
Appendix B	Emissions from upstream transportation
Appendix C	Emissions from manufacturing, scope 3
Appendix D	Emissions from the distribution
Appendix E	Emissions from the use of sold products
Appendix F	Emissions from the End of life treatment
Appendix G	The carbon footprint of the Eve charging station

The appendices are only available to chain partners and can be requested via the e-mail address qhse@alfen.com.