# A comparison Life Cycle Assessment between Razor Blade and Electric Shaver


**The Royal institute of technology**
AG 2800 Life Cycle Assessment
Project Work Group 2
**Andrea Lind Löv and Tigist Fetene**

Supervisor – Sofiia Miliutenko

December, 2012

## Abstract

Our daily life contributes to the energy consumption in one way or in another and it contributes to the various impacts on environment. We need to be aware on our choice for the type of product we used in order to be environmentally friendly. In this project a comparative life cycle analysis of razor blade and electric shaver were studied using SimaPro software. Both the electric shaver and razor blade are used to remove hairs from unwanted areas. Obviously it is important to understand that both razor blade and electric shaver is giving a very good shave. But if environmental consideration put forward which one is the best suited option is studied. The goal of this project is to find out which of the products: razor blade or electric shaver are the most environmentally friendly for shaving. The study is based on a comparative accounting LCA. The application of ReCiPe method was used for calculation of the environmental impact. The functional unit is shaving for three years that is throughout the life of the product.

The life cycle analysis from material extraction through the life of the product including waste treatment is analyzed. Both products have the same share of production process and production area, but the major focus was during the use phase of the product. The analysis using the SimaPro result showed that the electric shaver is the highest environmental impact than razor blade. This is due to the higher electric energy consumption during usage. Unlikely, razor blade has less environmental impact. Though some difference was observed when the level of water consumption during shaving is increased by 250 %. Even though consuming excess amount of water during the use phase of razor blade it is again more environmentally friendly than electric shaver.

# Table of Contents

# 1. Goal and scope

The first step of a LCA analysis is presented in this chapter. The goal and scope of the study is defined. This chapter sets the context of the study and explains who the intended audience is.

## 1.1. Goal of the study

***Background***

The environmental awareness is one of the major contributions in the society nowadays. More and more people are concerned with the environmental impact when they buy products and they want to know that they make good choices (they want to make sure that they are making the right choice). While customers are aware of which product is more preferable in the perspective of environment the companies need to be able to deliver the best choice. They have keenly interested to know either they make the right choices

The goal of this study is to compare the difference of the environmental impact between a razor blade and an electric shaver to help end users make good choices between products and to create awareness for the companies who produces the type of product with the worst environmental impact and to propose them to produce the product in an environmental friendly way.

***Research question***

The question to answer in this project is: *Which are the potential environmental impacts of using a razor blade and electric shaver and which one is best to use if you want to make a good environmental choice?*

- *Which one of these products has the highest environmental impact during their life cycle?*
- *Which stage of the product life cycle contributes the most environmental impact?*

***Type of LCA, intended audience and application***

The project is a comparative and accounting LCA and the intended audience is both the customers and companies. For the customers to raise awareness of the potential environmental consequences of choosing one product instead of the other and the companies that produces razor blades and electric shavers for them to being able to improve the product with the perspective of environmentally compatible. The whole life cycle is analyzed from cradle-to-grave. In this project SimaPro software was used for modeling of the process.

## 1.2. Functional unit

The function of both razor and shaver is to remove hairs from areas of the body where it is undesirable. The functional unit is the removing of hair throughout the life of the product (3 years). It is the average number of times a man shaves his beard (the average hours a man used to shave throughout the life of the product / the average electricity consumption throughout the life of the product) through the life of the product; compared with the corresponding number of times a blade is changed during the life period (3 years). From interview of friends, discussion forum, relevant data from internet, it is found out that a man spends 60 hrs per year to shave. The life of shaver is 3 years, so in total it uses 180 hrs. (Electricity consumption is 5 W / hr). The data shows that 90% of men shaves every day and changes the blade every two weeks (twice in a month), that is they change 24 times in a year (24*3=72 times per life of the product) For detail information about the data can be

found under section 1.4 Assumption and limitation below. ***Therefore the functional unit of a product is expected to be shaving in three years (throughout the use phase of the product per person)***.

### 1.3. System boundaries

In this research, it was not easy to decide which environmental impact is included in the process. Cradle-to cradle is not considered as the material extraction and production is taking place at China and the product assembled at Holland and it is used and the waste is treated in Stockholm. It is due to this reason that we are forced to consider the environmental impact from cradle-to-grave. The environmental impact from extraction of raw material, production, transportation and usage of the product is taken into account.

For both products the production and material extraction is taking place at the same place and through the same production processes, though the waste treatment is unlike. Since it is hard and possibly can hurt to separate the cutting blades from the razor head, most of waste parts are landfilled (disposed) and only plastic parts incinerated. While for electric shaver the waste is treated by recycling, incinerated and only very tiny scraps are discarded.

***Initial flow chart***

Figure 1 below shows the general simple flow chart that is considered in the life of the products.

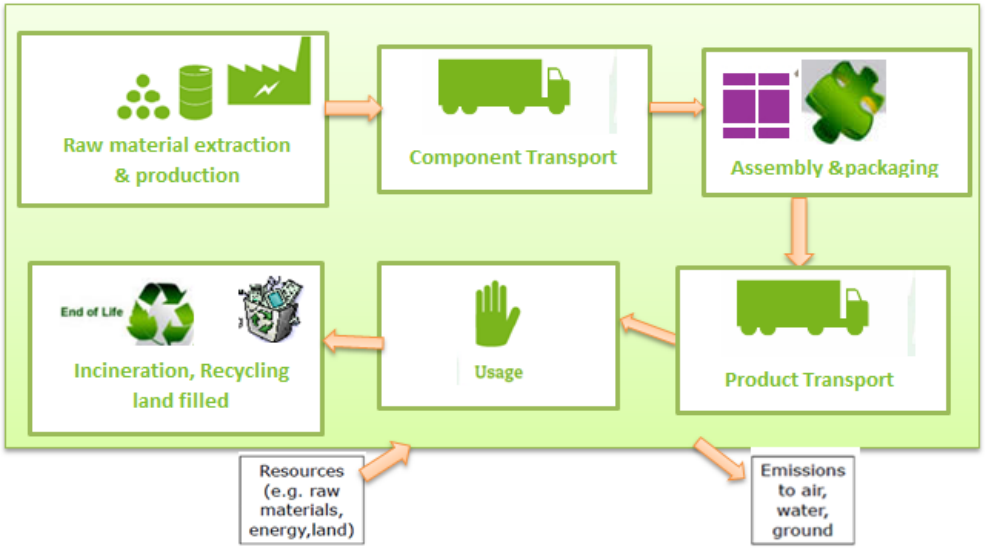



*Figure 1: Initial flow chart - manufacturing process of razor blade and electric shaver*

***Time horizon***

The LCA model for this project is based on usage of an electric shaver and a razor blade throughout the life of the product (that is 3 years usage). It can be applicable anytime unless the products are phased out (either if it is out of the market or terminate its production). To reduce the environmental impact, it is suggested that the raw material used might be substituted by other materials with similar functioning that have less impact to the environment and that consumes less amount of energy during production. Though keep customer satisfaction should be given priority. It is possibly to use old data unless the new suggested material are used for manufacturing, if so change only the type of material from the inventory library and can use the old model.

***Geographical boundaries***

The geographical boundaries of the product system are defined by the countries where the electric shaver and the razor blade are used in and the countries where it is produced and manufactured. The material extraction and components production of razor and shaver are assumed to be in China. The components are transported to Holland for assembly and packaging. It is assumed that products are sold, used and disposed in Stockholm, Sweden.


*Figure 2: The geographical boundaries*

***Cut-off criteria***

- The detailed production steps is excluded, only the inputs and outputs to the whole production system is taken into consideration
- The energy use for assembling the product is not conciderd
- Waste of hairs shaved is not taken into consideration
- Transport of the products from retailer to customer is not considered
- We considered only the product used in Stockholm, Sweden
- In the flow chart network from Sima Pro showing in figure 5, 6 and 15 cut offs have been done. Figure 5 and 15 shows 9% of the contribution from the life cycle of the razor and figure 6 shows 1% of the contribution from the life of the shaver.

***Allocation procedure***

The allocation problems in the system are encountered due to three basic cases: (1) process that results in several products (multi output), (2) waste treatment processes that have input consisting of many different products (multi input) and (3) open loop recycling is when a product is recycled into a different product. This allocation problem is solved by partitioning and system expansion.

One of the allocation problems in the system arises due to incineration of electric shaver and razor blade and due to the material that is recycled. It is solved by system expansion. The energy from incineration and the material that is recycled is presumed to use for other purposes, as the production and use phase of the product are not geographically close.

## 1.4. Assumptions and limitations

***Transportation***

It is assumed that the components for both razor blade and electric shaver are manufactured in China. Of course, all components are not manufactured in the same place in China, but the journey is not contributing enough to the total intercontinental transport. Then the components are

transported by ship to Holland where they are assembled and packed. Due to the unavailability of information about razor blade we assumed that both products are manufactured and assembled in the same place. We also assumed that the tagged on shaver and razor is made on "Made in Holland" but some parts are marked with "Made in China". Finally the products are transported by train - in this case, to Stockholm, Sweden. The distance between Hong Kong and Amsterdam are estimated at 9277 km and between Amsterdam and Stockholm to 1126km with the online service distance calculator (Distancecalculator, 2012). The assumptions about using boat and train for transportation have been made by discussing to a person responsible and working at transportvarlden.se

***Usage***

The assumption on the usage of shaver is depending on the study conducted by questionaries' made on men. It is found that 90% of men shave the grown up hair every day. By considering other factors (holly day, weekend …), in this research we assumed that the average number of times a man shaves is 328 days.

*Shaver* - On an average a person uses 60hrs per year for shaving. It is also assumed that they change the shaver head once in a year. In the waste management recycling and incineration were considered. Due to waste scenarios ass

*Razor*: - when using the razor it is estimated that a man consumes approximately 2 liter of water per shave for cleaning the face and the razor blade. That is approximately 1800 liter of water in three years (1,8 l/shave * 328 days/year*3years). The razor head is changed twice per month. They use liquid soap.

The Swedish electricity company Eon (Eon, 2012) webpage says that it is a myth that a shaver consumes more energy than a razor. This statement is built in comparison if a person left the water running (tab on) through the whole time of shaving. Therefore calculations have also been done assuming that if a person leaves the water running for five minutes per shaving (assume they shave 328 times per year). The water consumption per minute is 6 liter (that is the water consumption is increased by 250%). (LKF, 2012) That is 29520 liter in three years.

The razor head is assumed to be changed twice per month. There are exact statistics of how often a person should change the re-changeable razor blades because there are many different factors affecting how long it will function properly (Howstuffwork, 2012). In every package of re-changeable razor head there are 4 pieces. Therefore 18 packages are needed during three years. As very few of the material ingredients (Gilette, 2012) of a shaving gel are found in SimaPro, only liquid soap are assumed to be used. Consider that this will affect the results that are made.

It is also assumed that the products are functioning properly without broken or maintained throughout their life.

***Materials***

Since the unavailability of information about the product components, for an electric shaver data from a previous LCA project have been used. For razor blade, we bought the product and disassembled the parts and we differentiated the material and finally we scaled them.

***Waste treatment***

Information about waste treatment for the electric shaver and the razor blade are obtained from Stockholm city waste and recycling web page (City, 2012).

Shaver- Information about electrical waste was used and the shaver is collected at the closest recycling station. A valuable material such as metals is recycled into different purpose. Hazardous materials are managed so that they do not harm the environment. Combustible materials such as plastic are chipped and incinerated with energy recovery.

Razor- Since it is hurting the skin when we trying to disassemble different parts of the razor blade to recycle, so this is not considered to be done. Some plastic parts are incinerated and the rest of the product goes to landfill. Waste in Stockholm is incinerated in Högdalenverket south of the city and turned into heat and electricity.

As there is no unit of ''tonKm'' for personal car, it is on personKM, in both cases to buy and to return the product after useful life for waste management, we assumed that they use ¨Transport, van'' rather.

### 1.5. Impact categories and impact assessment method

ReCiPe Midpoint (Hierarchist) (ReCiPe, 2012) methodology is used for analyzing the impact of the modeled products. The method was selected and set as default in Sima Pro. When you are using a midpoint impact assessment you are looking at the environmental impacts in an early stage in the cause-effect chain. The setting hierarchist means that you are looking at long term damage that can be avoided in the future by good management. With this method you are able to see the potential impacts and there is also a possibility to avoid them by doing changes.

There are 18 different impact categories (ReCiPe, 2012) included in the ReCiPe Midpoint (H). These are all used in this LCA where the results are presented. When looking at these categories the comparison between the shaver and the razor can be done and hot spots showing the potential environmental impact will be indicated. The categories are (ReCiPe, 2012):

- Climate change
- Ozone depletion
- Human toxicity
- Photochemical oxidant formation
- Particulate matter formation
- Ionizing radiation
- Terrestrial acidification
- Freshwater eutrophication
- Marine eutrophication
- Terrestrial ecotoxicity
- Freshwater ecotoxicity
- Marine ecotoxicity
- Agricultural land occupation
- Urban land occupation
- Natural land transformation
- Water depletion
- Metal depletion
- Fossil depletion

### 1.6. Normalization and weighting

Normalization is used in this LCA to place the result in a context where the numbers and results are given common dimensions. The results obtained are evaluated with a reference value to help understand the magnitude of the environmental impact when using a shaver and a razor. As mentioned previously the impact assessment method ReCiPe Midpoint (H) was used (ReCiPe, 2012), to compare the environmental impact from using electricity shaver head and razor blade. The world normalization method in Recipe is used in this study. In the results you can see which categories have a large significance impact in the life cycle of the product by using this method.

Weighting is not included in this study. It is not allowed according to ISO for comparative assertions (Finnveden, 2012).

## 2. Life cycle inventory analysis

### 2.1 Process flowchart- razor blade

Figure 3 below shows the life cycle of razor blade from raw material extraction to the end of life of the product including the waste management. The flow chart illustrated in SimaPro is shown figure 5.

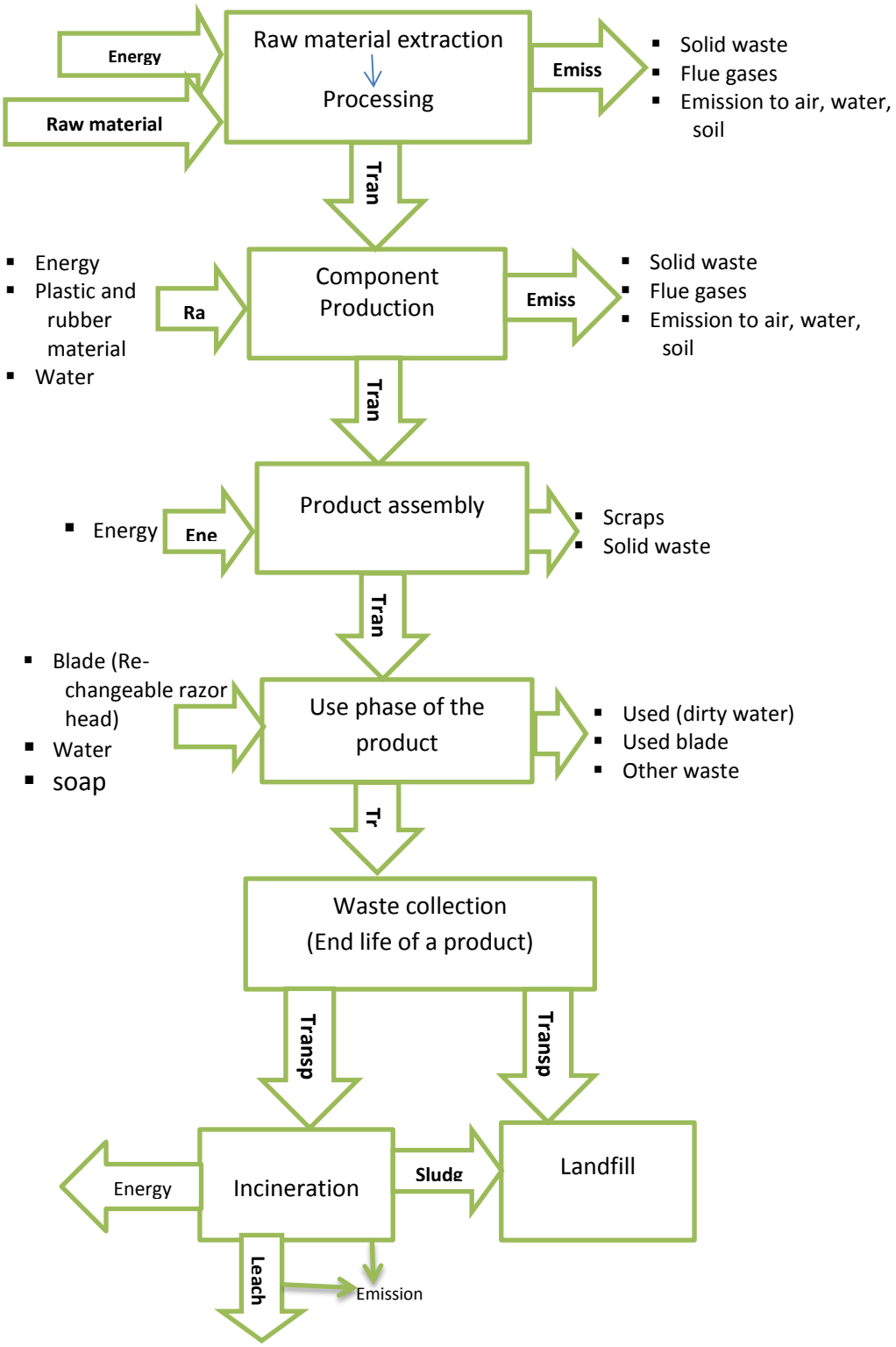



*Figure 3: Process flow chart of razor blade*

## 2.2 Process flowchart of electric shaver

The following figure 4 and 6 shows life cycle of electric shaver from raw material extraction to the end of life of a product including the waste treatment of the used product, the later shows the life cycle as depicted in SimaPro.

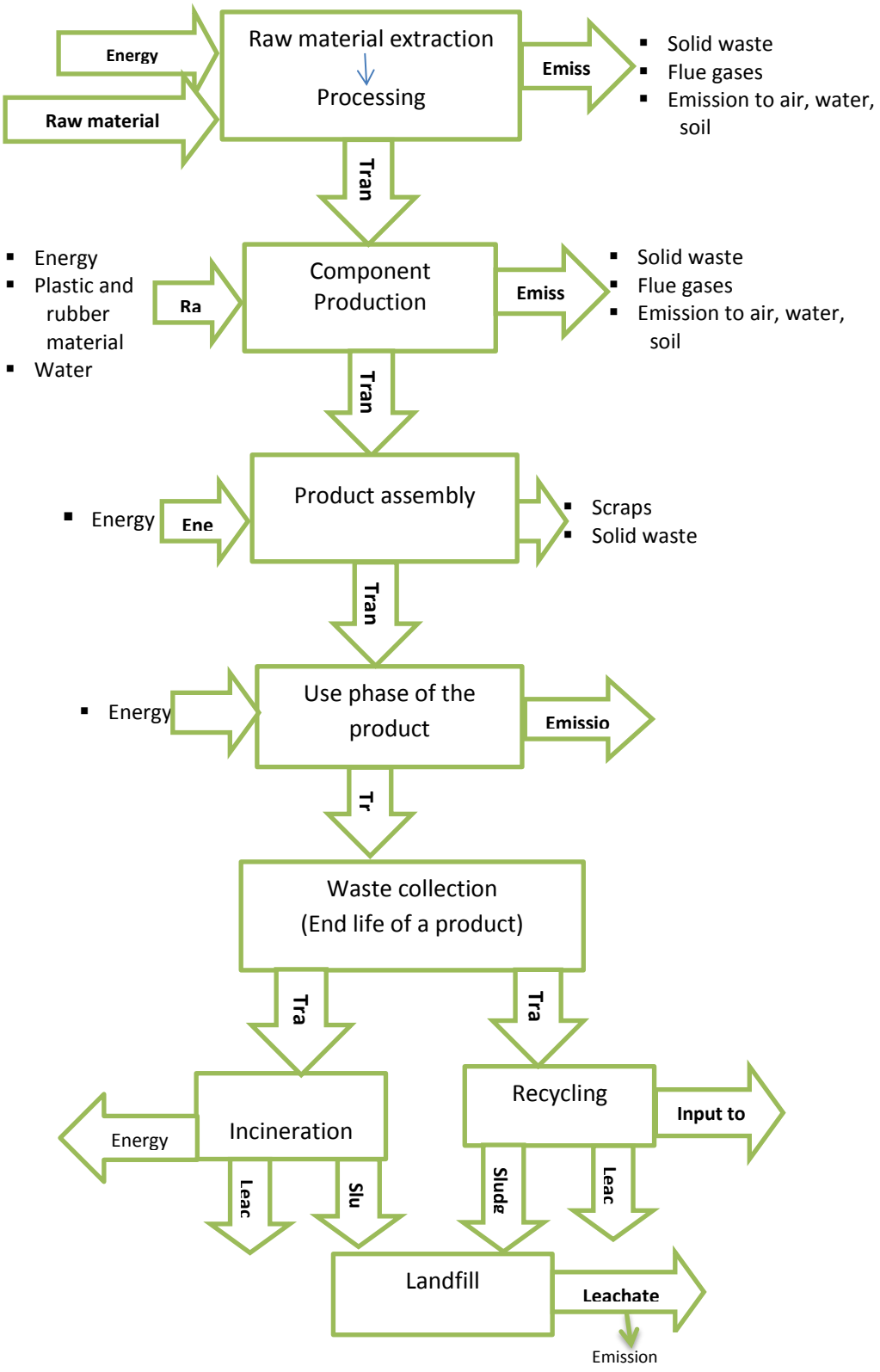



*Figure 4:– process flow chart of electric shaver*

The figure below shows the life cycle of razor blade as modeled in SimaPro.

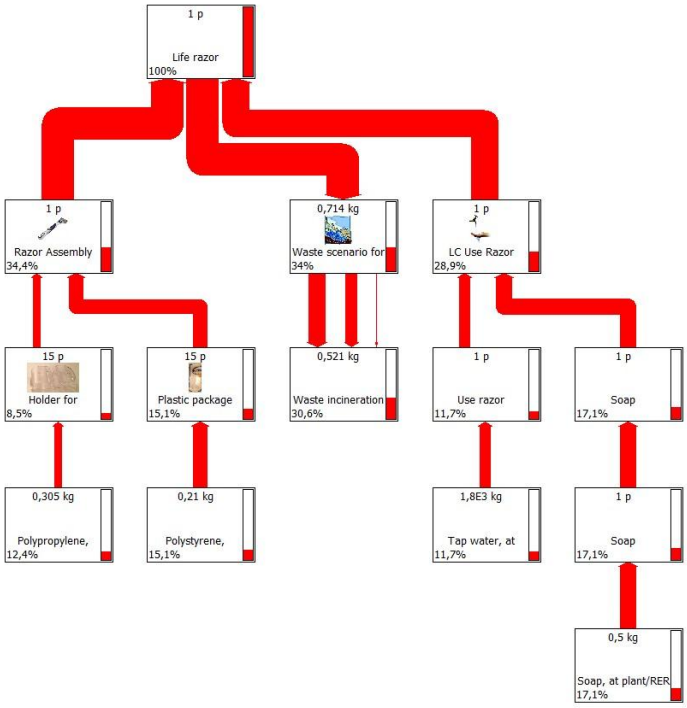



*Figure 5: flow chart showing the life cycle of razor blade as depicted in SimaPro*

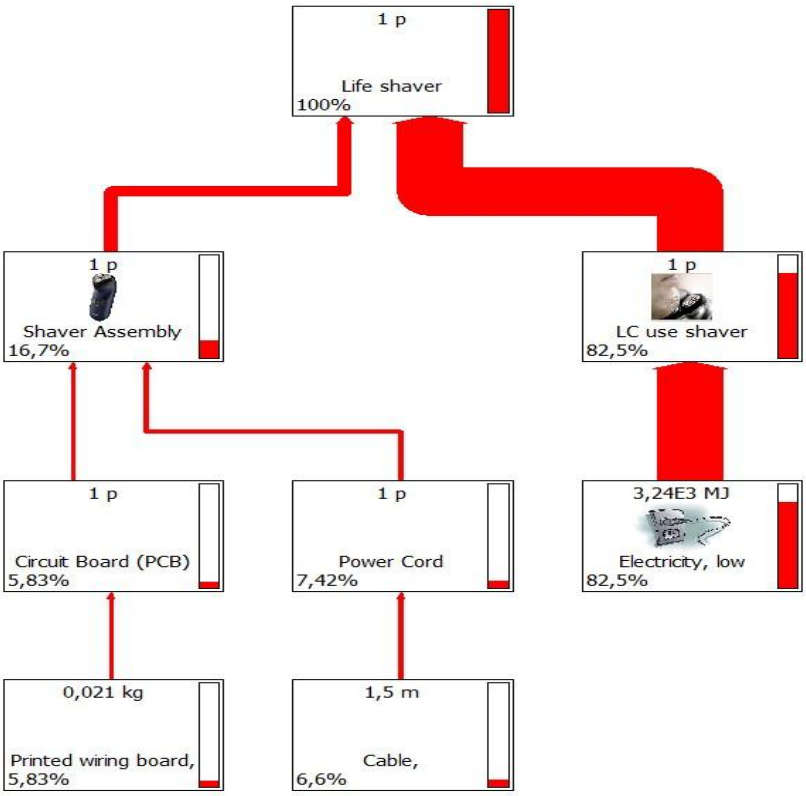



*Figure 6: flow chart of electric shaver showing the life cycle as modeled in SimaPro*

## 2.3 Data

### 2.3.1 Material data for razor blade

A safety razor is a device used to remove hair from areas of the body where it is undesirable such as the face for men and the legs and underarm regions. The modern blade razor consists of a specially designed blade mounted in a metal or plastic shell that is attached to a handle. Razor blade is exposed to moisture and therefore it should be made from a special corrosion resistance. This kind of razor can be designed as a refillable cartridge which can accept new blades or as a disposable unit which is intended to be thrown away after the blade becomes dull.

Razors are routinely packaged in clear plastic blister packs with a cardboard backing sheet that allow display of the razors design. Refill blade cartridges can be packaged in boxes, although most current designs require the cartridges to be held in a plastic tray that helps them to insert into the handle. The razor blade product and its disassembled parts are depicted below Figure 7.


*Figure 7: left-packed razor blade product and right – components of razor blade*

During modeling of electric shaver in simapro, there were different inputs of energy, material (plastic, metal, water), and output used. These input and output used during modeling of the electric shaver in Simapro is listed below.

The weight for each component and the material input (metal, plastic, rubber, paper, etc.) that is used for the production of razor blade for each component with the corresponding number is displayed below table 1.

***Table 1: Material Input for razor blade production*** [1]

| No | Component name | Amount (quantity) | Material input | Weight (g) | Total weight |
|---|---|---|---|---|---|
| 1 | Blade support member | 1 | Steel, low-alloyed, at plant/RER S | 0,3 | 0,3 |
| 2 | Cutting blade | 5 | Silicon, multi-Si, casted, at plant/RER S<br>Manganese, at regional storage/RER S<br>Chromium steel 18/8, at plant /RER S<br>Molybdenum, at regional storage/RER S<br>_12 Iron ores from mine, EU27<br>Carbon black, at plant/GLOS | 0,001<br>0,001<br>0,014<br>0,0016<br>0,0819<br>0,00055 | 0,5 |
| 3 | Handle | 1 | Steel, low-alloyed, at plant/RER S | 30 | 30 |
| 4 | Holder for razor | 1 | Polypropylene, granulate, at plant/RER S | 33 | 33 |
| 5 | Holder for re-changeable razor head | 15 | Polypropylene, granulate, at plant/RER S | 14 | 210 |
| 6 | Lubricating strip | 1 | Polyurethane, flexible foam, at plant/RER S | 0,1 | 0,1 |
| 7 | Other plastic part in the product | 6 | Polypropylene, granulate, at plant/RER S | 1 | 6 |
| 8 | Other rubber part in the product | 5 | Synthetic rubber, at plant/RER S | 1 | 5 |
| 9 | Package paper (instruction) | 15 | Packaging, corrugated board, mixed fibre, single wall, at plant/CH S | 5 | 75 |
| 10 | Plastic package | 15 | Polystyrene, general purpose, GPPS, at plant/RER S | 14 | 210 |
| 11 | Retaining clips | 2 | Steel, low-alloyed, at plant/RER S | 5 | 10 |
| 12 | Soft grip handles | 1 | Polypropylene, granulate, at plant/RER S<br>Synthetic rubber, at plant/RER S | 0,4<br>1,6 | 2 |
| 13 | Re-changeable razor head | 60 | See | 5 | 300 |

The Re-changeable razor head is a made up of the assembly of the following components. The part with the amount in quantity need is described table 2 below.

***Table 2: Re-changeable razor head components – taken from the model in SimaPro***

| | | |
|---|---|---|
| Cutting Blade | 5 | Quanti. |
| Lubricating Strip | 1 | Quant. |
| Retaining Clips | 2 | Quantit. |
| Blade support member | 1 | Quantit. |
| Polypropylene, granulate, at plant/RER S | 1 | g |
| Synthetic rubber, at plant/RER S | 0,4 | g |

[1] Some of the data for the material are retrieved from http://www.madehow.com/Volume-5/Safety-Razor.html Nov, 2012. --- and for the rest of the parts, we bought the product from Clas Ohlson, Stockholm. Then we disassembled, we scaled each part. Moreover, the type of material for each part that unable to get on is determined by the expert from material department, KTH.

The following are the inputs to the transportation used for razor blade from China, where the material extraction and production are taking place, to Holland, where parts are assembled and packed, and from Holland to Sweden, where products are distributed and used. Moreover the transportation to buy the product, soap and the water consumed is described below.

| Input | Amount (tkm) |
|---|---|
| Transport, transoceanic freight ship/OCE S | 9277*0,000861 = 7,99 |
| Transport, freight, rail/RER S | 1126*0,000861 = 0,969 |
| Transport, van <3.5t/RER S | 5*0,00086 = 0,0043 |
| Soap, at plant/RER S | 0,5kg |
| Tap water, at user/RER S | 1800 liter |

At the end of life of the product, the used products are returned to the waste collection center for waste treatment. The plastic parts are incinerated and the metal parts are landfilled. The transportation from the used place to the waste collection center and to the waste treatment is assumed to be 2Km.

| Input (waste treatment) | Amount |
|---|---|
| Waste incineration of plastics (PE, PP, PS, PB), EU-27- lca02 | 100% |
| Landfill of ferro metals EU-27 | 100% |
| Disposal, rubber, unspecified, 0% water, to municipal incineration/CH S | 100% |
| Landfill of paper waste EU-27 | 100% |
| Transport, van <3.5t/RER S | 2*0,000861 = 0,001720tkm |

All of the above data can be accessed through Ecoinvent v 2.2, in Simapro 7.3.3.

### 2.3.2 Material data for electric shaver

In this research work the product that is analyzed is Philishave (HS860/840). It is manufactured by Philips. The product and its parts are displayed in figure 8 & 9 respectively.

*Figure 8: Picture of the shaver from the product manual for Philishave HS860/840*

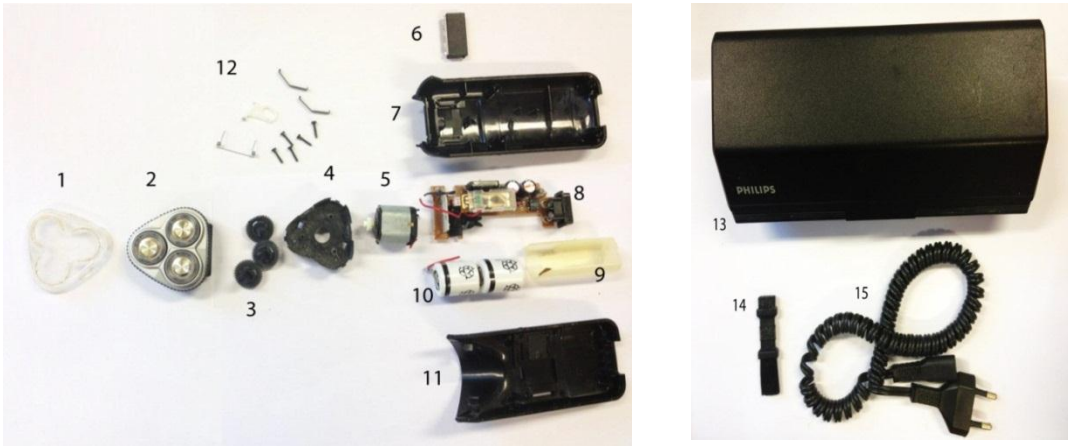



*Figure 9: shaver parts /or component*

***Table3 – material input and weight of each electric shaver parts***[2]

| Nr | Component | Amount | Material input | Weight (g) | Total weight (g) |
|---|---|---|---|---|---|
| 1 | Shaver Head Cover | 1 | Polystyrene, general purpose, GPPS, at plant/RER S | 7 | 7 |
| 2 | Shaving head | 1 | See below | 44 | 44 |
| 3 | Cogs | 3 | Acrylonitrile-butadiene-styrene copolymer, ABS, at plant/RER S | 1 | 3 |
| 4 | Shaving head attachment | 1 | Polypropylene, granulate, at plant/RER S | 3 | 3 |
| 5 | Motor | 1 | See below | 39 | 39 |
| 6 | Trimmer | 1 | | 4 | 4 |
| 7 | Half of the shell 1 | 1 | Polystyrene, general purpose, GPPS, at plant/RER S | 22 | 22 |
| 8 | Circuit Board (PCB) | 1 | Printed wiring board, mixed mounted, unspec., solder mix, at plant/GLO S | 21 | 21 |
| 9 | Battery cover | 1 | Nylon 6, glass-filled, at plant/RER S | 3 | 3 |
| 10 | Battery | 2 | Single cell, lithium-ion battery, lithium manganese oxide/graphite, at plant/CN U-waste type | 22,5 | 55 |
| 11 | Half of the shell 2 | 1 | Polystyrene, general purpose, GPPS, at plant/RER S | 23 | 23 |
| 12 | Screws, etc. | 7 | Iron and steel, production mix/US | 0 | 0 |
| 13, 14 | Storage box + brush | 2 | | 152 | 152 |
| 15 | Power cord | 1 | See below | 53 | 53 |
| - | Start button | 1 | Polypropylene, granulate, at plant/RER S | 0 | 0 |
| | Package paper | | Packaging, corrugated board, mixed fibre, single wall, at plant/CH S | | |
| | Re changeable shaver head | | See below | | |

1. The motor part is made up with different material, they are displayed below with the corresponding weight

| Materials/Assemblies | Amount |
|---|---|
| Copper wire, technology mix, consumption mix, at plant, cross | 5 |
| Magnetite, at plant/GLO S | 16 |
| Iron and steel, production mix/US | 11 |
| Polypropylene, granulate, at plant/RER S | 7 |

[2] The material data for this table has been taken from the previous research work (under the course Eco-design)

2. The power cord is made up of the combination of the following material

| Materials/Assemblies | Amount |
|---|---|
| Cable, three-conductor cable, at plant/GLO S | 1,5 |
| Plugs, inlet and outlet, for printer cable, at plant/GLO S | 1 |

3. The re-changeable electric shaver head is the assembly of the following component

| Materials/Assemblies | Amount |
|---|---|
| Cogs | 3 |
| Shaver Head Cover | 1 |
| Shaving head | 1 |
| Shaving Head Attachment | 1 |
| Packaging, corrugated board, mixed fibre, single wall, at plant/ | 75 |

4. Shaving head material includes

| Materials/Assemblies | Amount |
|---|---|
| Stainless steel hot rolled coil, annealed & pickled, elec. arc furn | 42 |
| Polypropylene, granulate, at plant/RER S | 2 |

5. Storage box and brush

| Materials/Assemblies | Amount |
|---|---|
| Polystyrene (general purpose) granulate (GPPS), prod. mix, RE | 151,5 |
| Nylon 6, at plant/RER S | 0,5 |

6. Trimmer

| Materials/Assemblies | Amount |
|---|---|
| Stainless steel hot rolled coil, annealed & pickled, elec. arc furn | 3 |
| Polystyrene, general purpose, GPPS, at plant/RER S | 1 |

The following are the inputs to the transportation used for electric shaver from China to Holland and from Holland to Sweden. Moreover the electricity used is described below.

| **Input** | **Amount (tkm)** |
|---|---|
| Transport, transoceanic freight ship/OCE S | 9277*0,000986=9,15 |
| Transport, freight, rail/RER S | 1126*0,000986=1,11 |
| Electricity, low voltage, production SE, at grid/SE S | 900 kwh |

At the end of life of the product, the used products are returned to the waste collection center for waste treatment. The plastic parts are incinerated and the metal parts are recycled. The transportation from the used place to the waste collection center and to the waste treatment is assumed to be 2km.

| **Input (disposal)** | **Amount** |
|---|---|
| Disposal, Li-ions batteries, hydrometallurgical/GLO S | 100% |
| Waste incineration of plastics (Nylon 6 GF 30, Nylon 66 GF 30), EU-27 S | 100% |
| Waste incineration of plastics (PE, PP, PS, PB), EU-27 S | 100% |
| Disposal, treatment of printed wiring boards/GLO S | 100% |
| Disposal, rubber, unspecified, 0% water, to municipal incineration/CH S | 100% |
| Disposal, treatment of cables/GLO S | 100% |
| Disposal, packaging paper, 13.7% water, to municipal incineration/CH S | 100% |
| Recycling steel and iron/RER S | 100% |
| Recycling non-ferro/RER S | 100% |
| Transport, van <3.5t/RER S | 2*0,000986 = 0,00197 tkm |

# 3. Life cycle interpretation

In this chapter the results are presented and analyzed and conclusions and recommendations based on the findings are also suggested.

## 3.1. Results

***Comparison between the electric shaver and the razor blade***

For interpretation of the results, the ReCiPe Midpoint (H) impact assessment method is used. The overall view of the environmental impact categories and the result in each category in the life cycle for the electric shaver and the razor blade is displayed in characterization figure 10 below. For larger pictures of the results, see Appendix 1. The red bars represent for the razor blade and the blue ones are for the electric shaver.

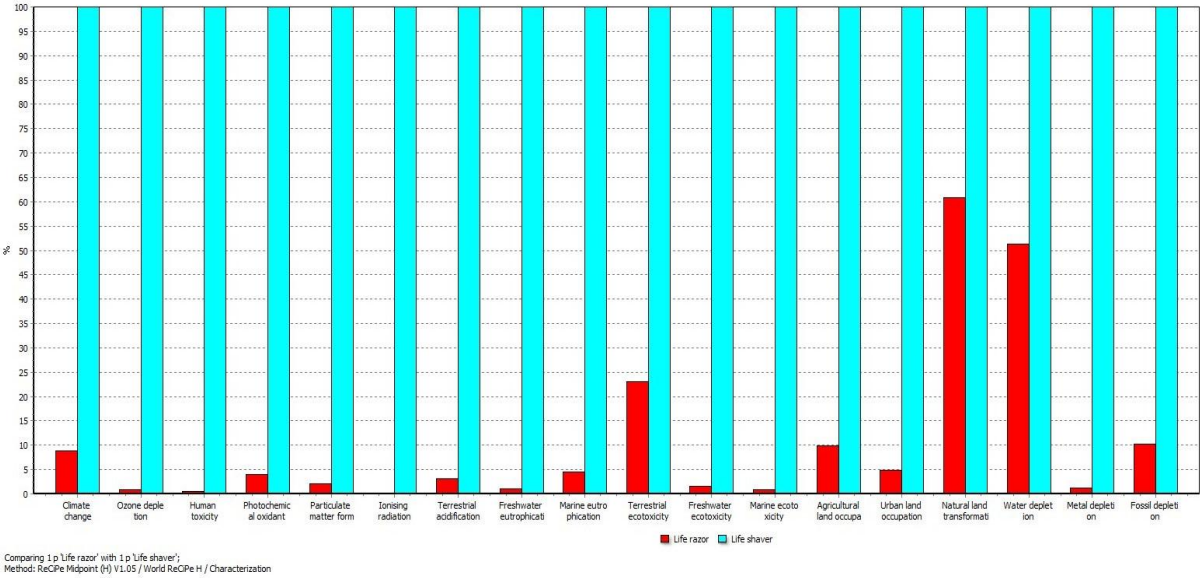



*Figure 10: Characterization of impact categories- razor blade and shaver head. The blue bars represent the electric shaver and the red bars represent the razor blade.*

As can be seen from figure 10, the electric shaver has a larger environmental impact than that of the razor blade in all categories

Figure 11 show the normalization result. It is normalized in order to identify the categories with the most significant impact in the system. It is clearly seen that the electric shaver have a larger impact, in which human toxicity and marine ecotoxicity are the largest impact in this categories. For both categories the impacts might be due to the usage of electricity and the production of the power cord. The ionising radiation shows high impact and that also depends on the usage of electricity. For big picture please refer Appendix 2

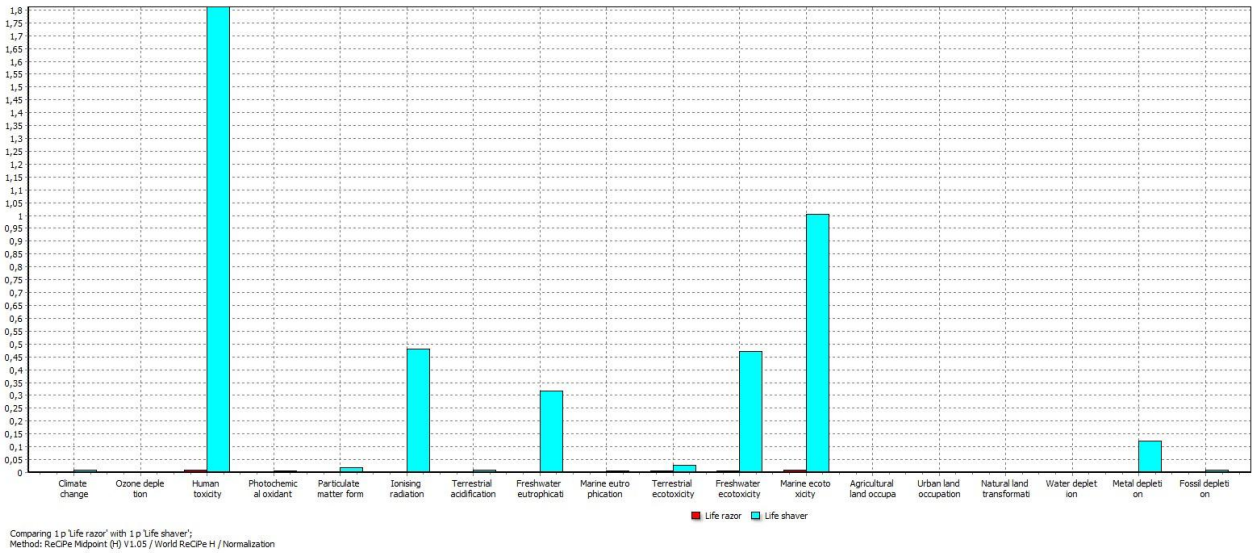



*Figure 11: Normalization of impact comparison between the electric shaver and the razor blade.*

### *Identify hot spot in electric shaver*

As explained and shown above the electric shaver is the highest environmental impact, moreover to see which processes affecting the most a network with all life cycle processes are made. The network with the most significant life cycle processes in the electric shaver's life is presented in the figure 6 above. Looking at the network it is clear that the largest environmental impact is the usage phase. The reason for the large impact is due to the high electricity consumption. Also the raw material used such as the circuit board and the power cord have a big influence on the environment.

Figure 12 describes normalization impact categories and the phases in the life cycle that affecting the most is depicted. Both raw materials for the electric shaver (red bar) and the usage phase (green bar) contribute the human toxicity and marine ecotoxicity, moreover, the use phase have a large impact on ionasing radiation.

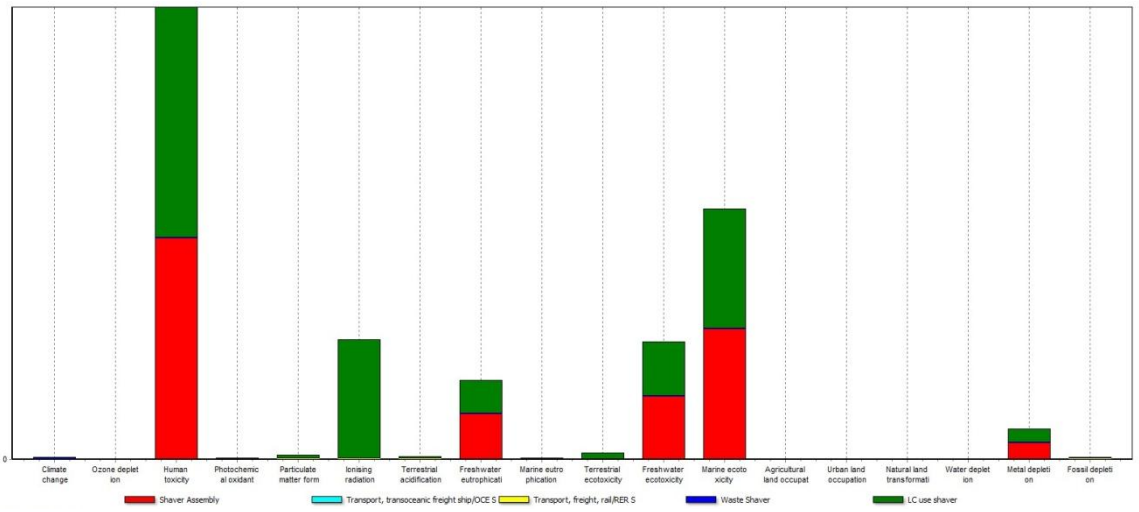



*Figure 12: Normalization of the highest impact categories and the worst impact in life cycle of electric shaver*

***Flow chart model razor blades***

The network for the razor blade life cycle is presented figure 5 above to see which processes are affecting the environment the most when shaving with razor blade. There are two significant processes having the largest environmental impact. One is during use phase of the razor the usage of soap and tap water contributes the most. The other largest impact is the materials for the razor and in that category the plastic package and the holder for the razor contributes also the most.

In figure 13 the impact categories and which phases in the life cycle affecting them the most is shown when a razor blade is used. The largest impacts are the usage phase (pink color) and the razor blade parts (red color) (this might due to the material used for the production) and they are affecting human toxicity, freshwater eutrophication, terrestrial ecotoxicity, freshwater ecotoxicity and marine ecotoxicity.

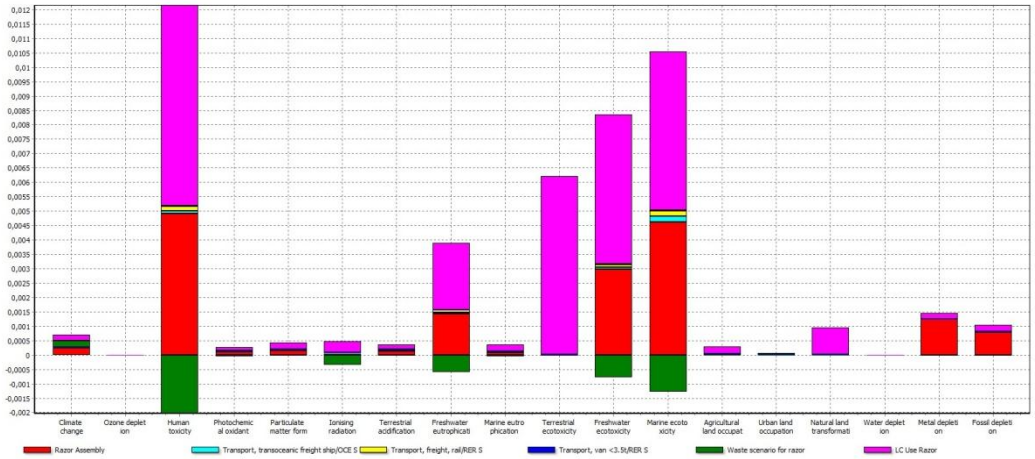



*Figure 13: Normalization of the highest impact categories and the worst impact in life cycle of razor blade*

***Sensitivity analysis***

As we mentioned in the previous section under assumption, as per 'Electricity and Energy company Eon'', leaving the water running during shaving enhances the energy usage. To see the effect of the change in water consumption of razor blade in comparison to electric shaver, the level of water in the system , Simapro, is changed(increased by 250%) and the result on normalization, figure 14, shows that even if an increasing resources is used , it is a worst to shave using electric shaver. Though it stands alone, the impacts are higher for the razor blade when more water is consumed but not even close impact to the impact from the electric shaver.

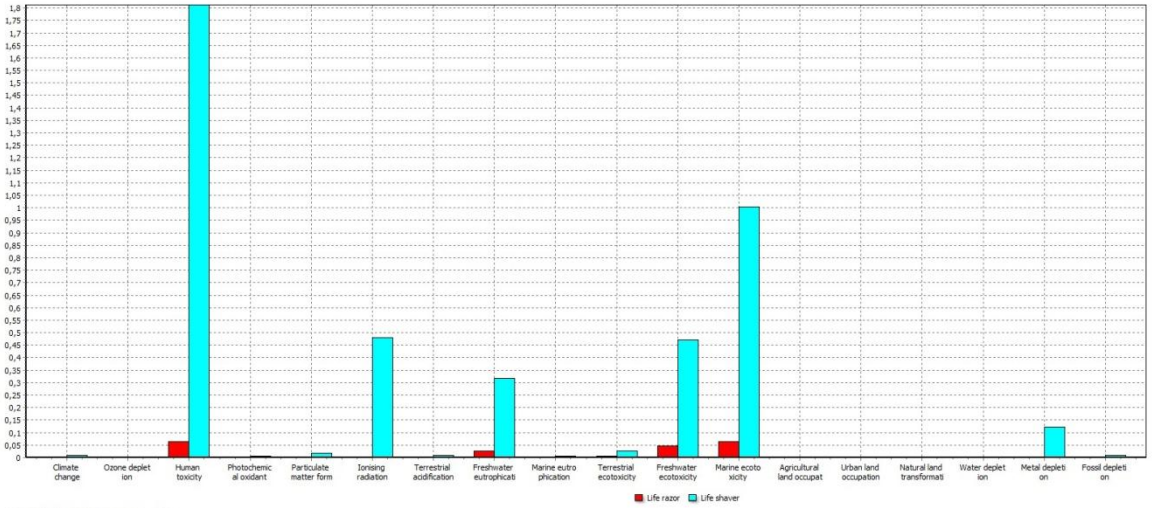



*Figure 14: Comparison between the electric shaver and the razor blade with 250% increase in water usage.*

The network figure presented in figure 15 has all the same inputs as in figure 5 except the water consumption is increased by 250% (when the person leaves the water running during shaving using razor blade). It is shown that the major impact now is the usage phase.

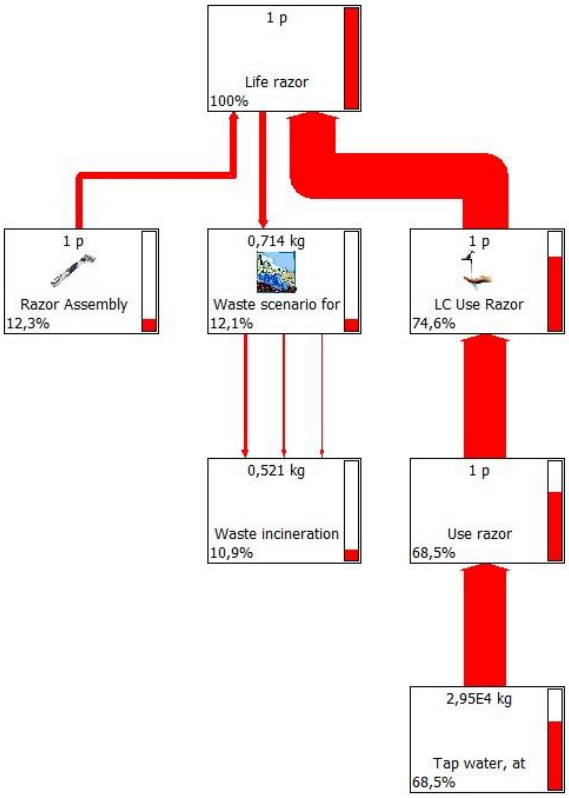



*Figure 15: Flow chart network in Sima Pro for the life of the razor blades when shaving with running water.*

## 3.2. Conclusions and recommendations

***Conclusions***

The major question to answer in this chapter is the research question: *Which one are the potential environmental impacts of razor blade and/ or electric shaver and which one is best to use if you want to make a good environmental choice?*

As explained thoroughly in the result section on the flow chart and the impact in different categories, this research shows that it is worst using electric shaver for shaving a person's hairs from areas of the body. The human toxicity and marine ecotoxicity are the largest impact categories resulted during the use phase and due to the material used for the assembly of the product. The usage phases also give rise to the impact ionising radiation. This larger environmental impact during use phase is due to the consumption of electricity during shaving.

For the razor blade increase in the consumption of water doesn't contribute a huge difference in the environment in comparison to electric shaver though it has a small effect that can't be negligible. However, most of the impacts in the razor blade are caused by the plastic packages and the plastic holders for the rechargeable heads in that process.

To answer the major question about which of the two alternatives is the worst to use when being concerned about the environment the results are clear: **The best choice is to shave using razor blade!**

The long distance transportation from China to Holland and from Holland to Sweden had such a low environmental impact contribution in the life cycle of the product; this is the very surprising thing in this research work.

We did some assumptions that could have affected the result. If we modeled the shaving gel there could have been a larger impact in categories considering toxics in the life cycle of razor blade.

***Recommendations***

- It is obvious to recommend; it is the most environmentally sound option to use razor blade instead of an electrical shaver.
- While using the razor blade take attention, on the usage of water. It is recommended that don't use water than need and turn off the tap. This can also be applied when brushing teeth.
- Since a large impact in the razor blades life is due to the plastic packages and the holders for the re changeable razor blade head. Therefore, it is recommended for the companies to produce the package that can hold more than four pieces of re- changeable head per pack (since, currently the maximum number of re-changeable razor head is four ) in order to save the plastic materials and to contribute to the environment.

## 4. Reference


Anon., 2012. *Distance calculator.* [Online]
Available at: http://www.distance-calculator.co.uk/
[Accessed 22 11 2012].

City, S., 2012. *Stockholm city.* [Online]
Available at: http://www.stockholm.se/ByggBo/Avfall-och-atervinning/Sortera-dina-sopor/Sopsortering-A-O/

Eon, 2012. *Eon.* [Online]
Available at: http://www.eon.se/upload/eon-se-2-0/flash/privatkund/energiradgivning/vardagsmyter.html

Finnveden, G., 2012. *Lecture 6.* Stockholm: s.n.

Gilette, 2012. *Gilette series shave gel.* [Online]
Available at: http://www.pg.com/productsafety/msds/beauty_care/Gillette_Consumer_Products/Gillette_Series_Shave_Gel_Extra_Comfort_%2898651970%29.pdf

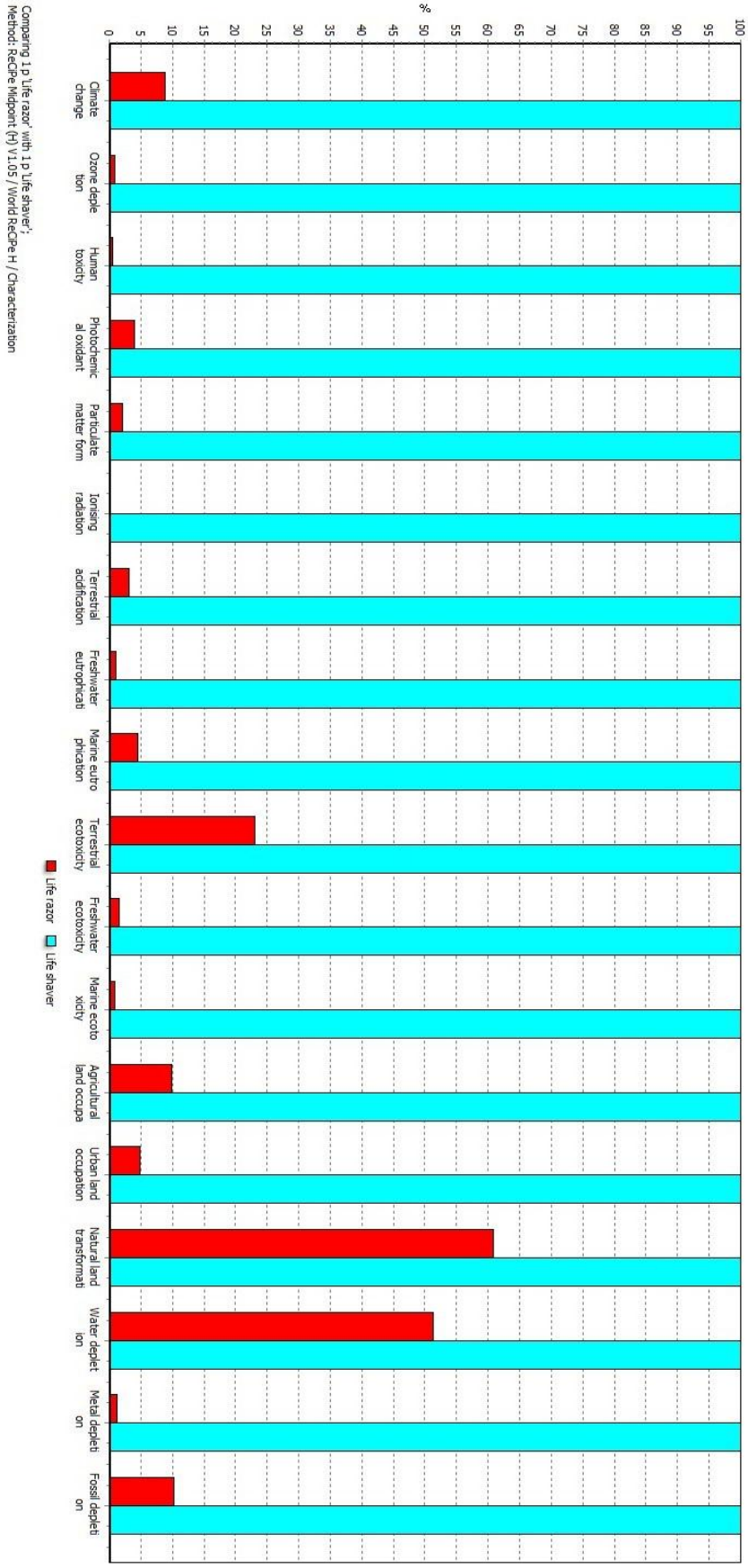
Howstuffwork, 2012. *howstuffwork.* [Online]
Available at: http://health.howstuffworks.com/skin-care/beauty/hair-removal/how-often-switch-razor-blade.htm

LKF, 2012. *LKF.* [Online]
Available at: http://www.lkf.se/Miljo-pa-LKF/Energispar/Vatten---elspartips/

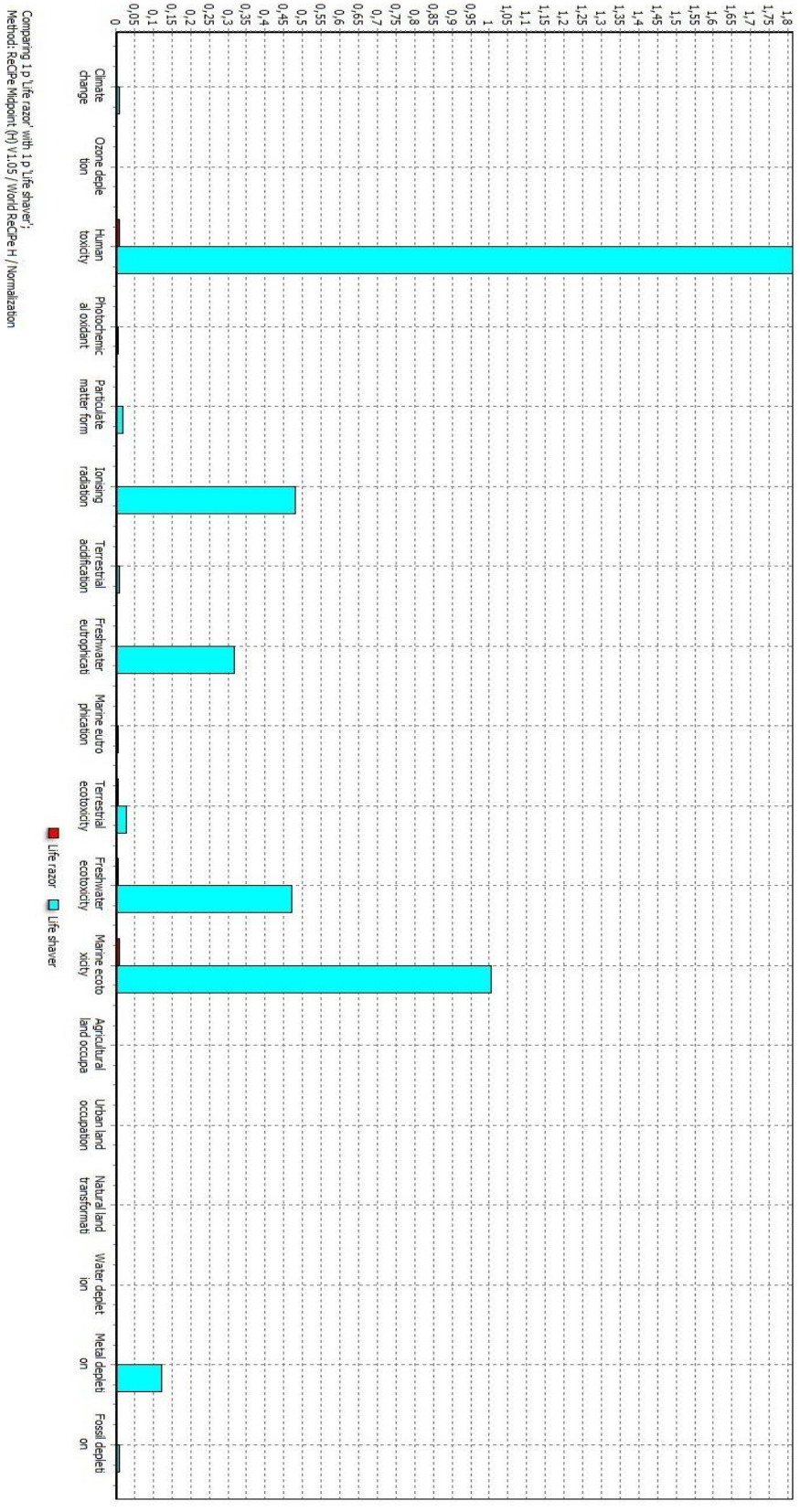
ReCiPe, 2012. *ReCiPe.* [Online]
Available at: http://www.lcia-recipe.net/
[Accessed 04 12 2012].

website, A. h. d., 2012. *At home dad.* [Online]
Available at: http://www.athomedad.org/node/437

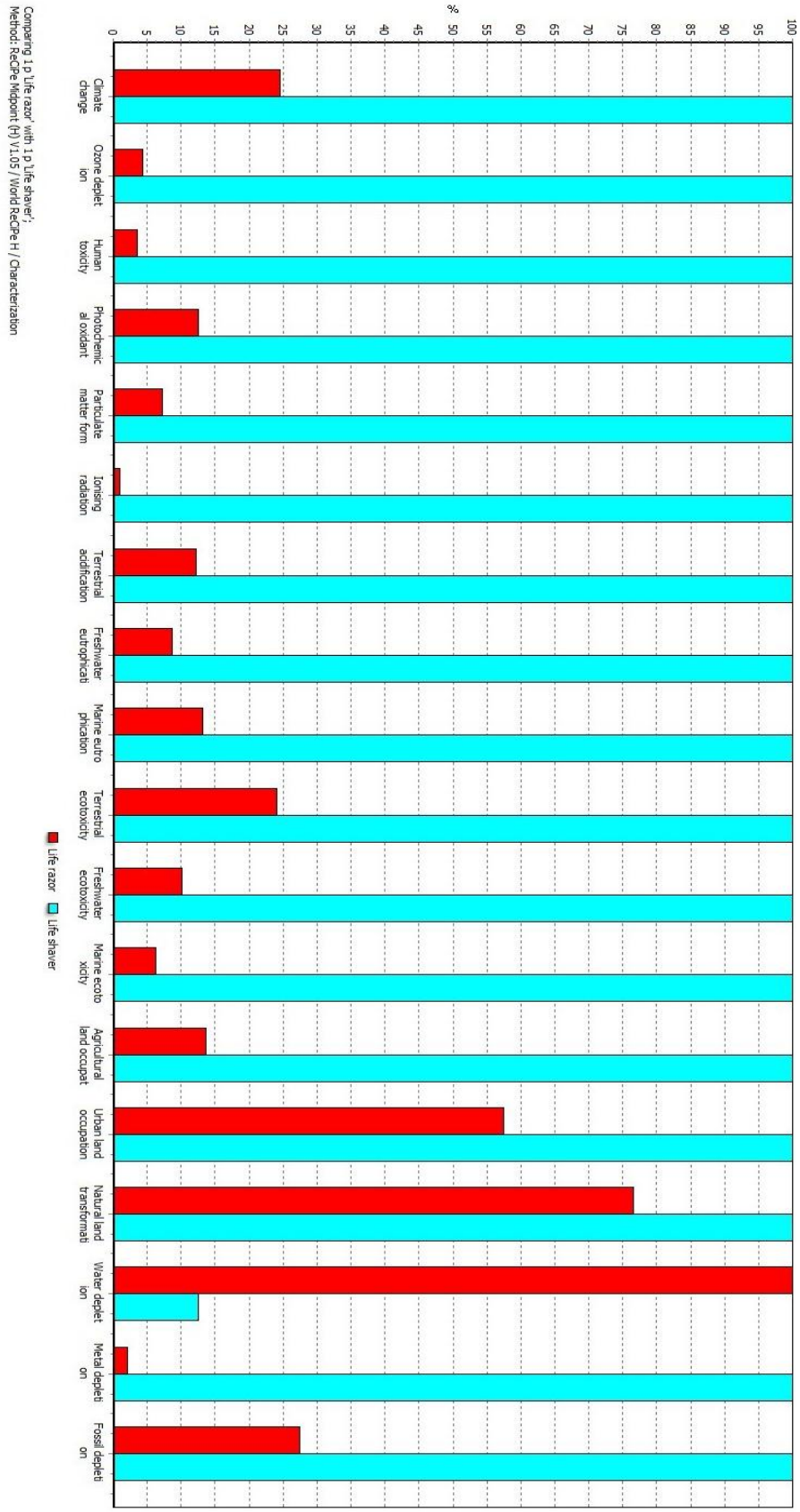
**Appendix 1 -** ***Characterization of impact categories- razor blade and shaver head***



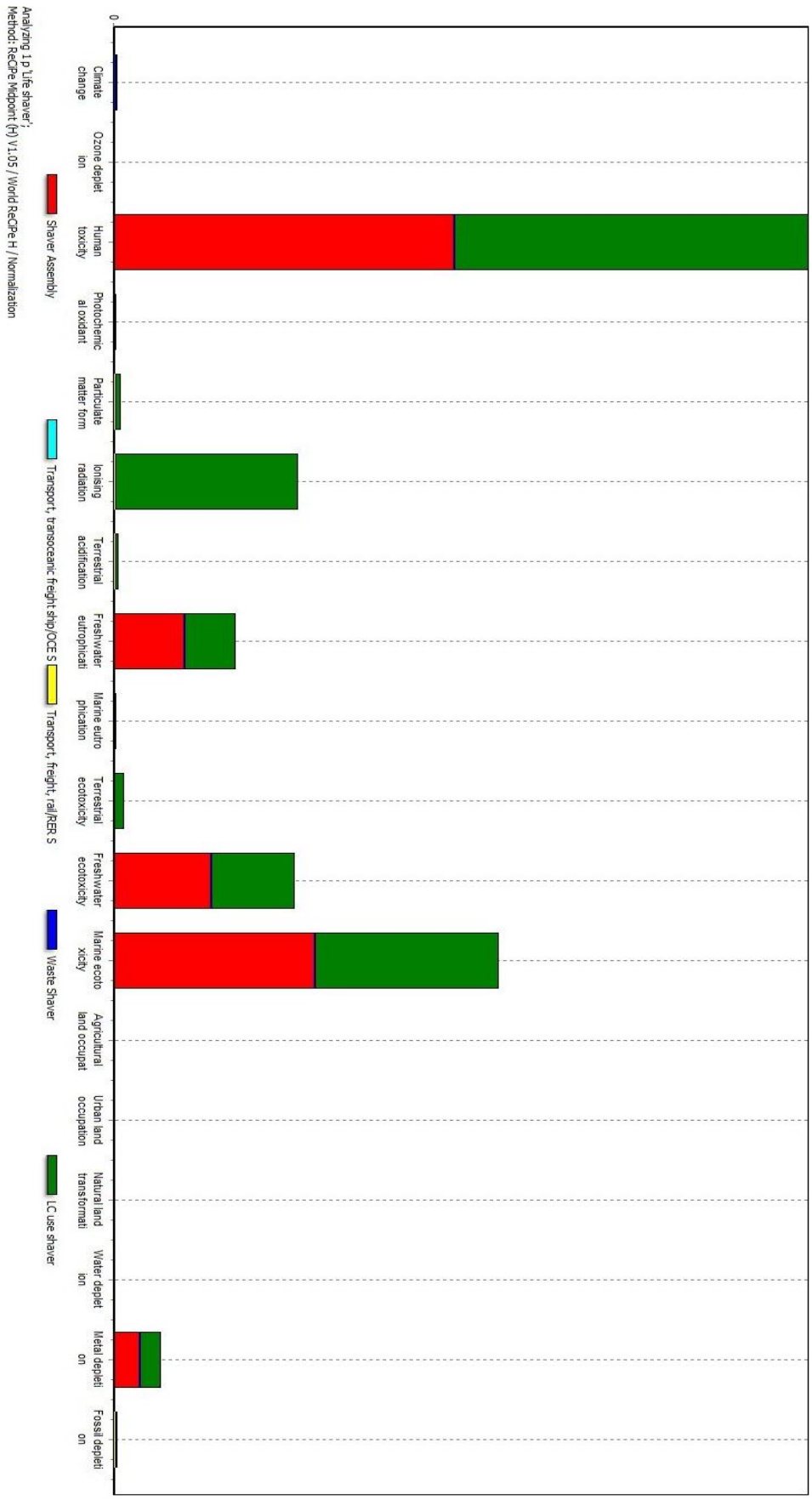
**Appendix 2 -** ***Normalization of impact comparison between the electric shaver and the razor blade.***



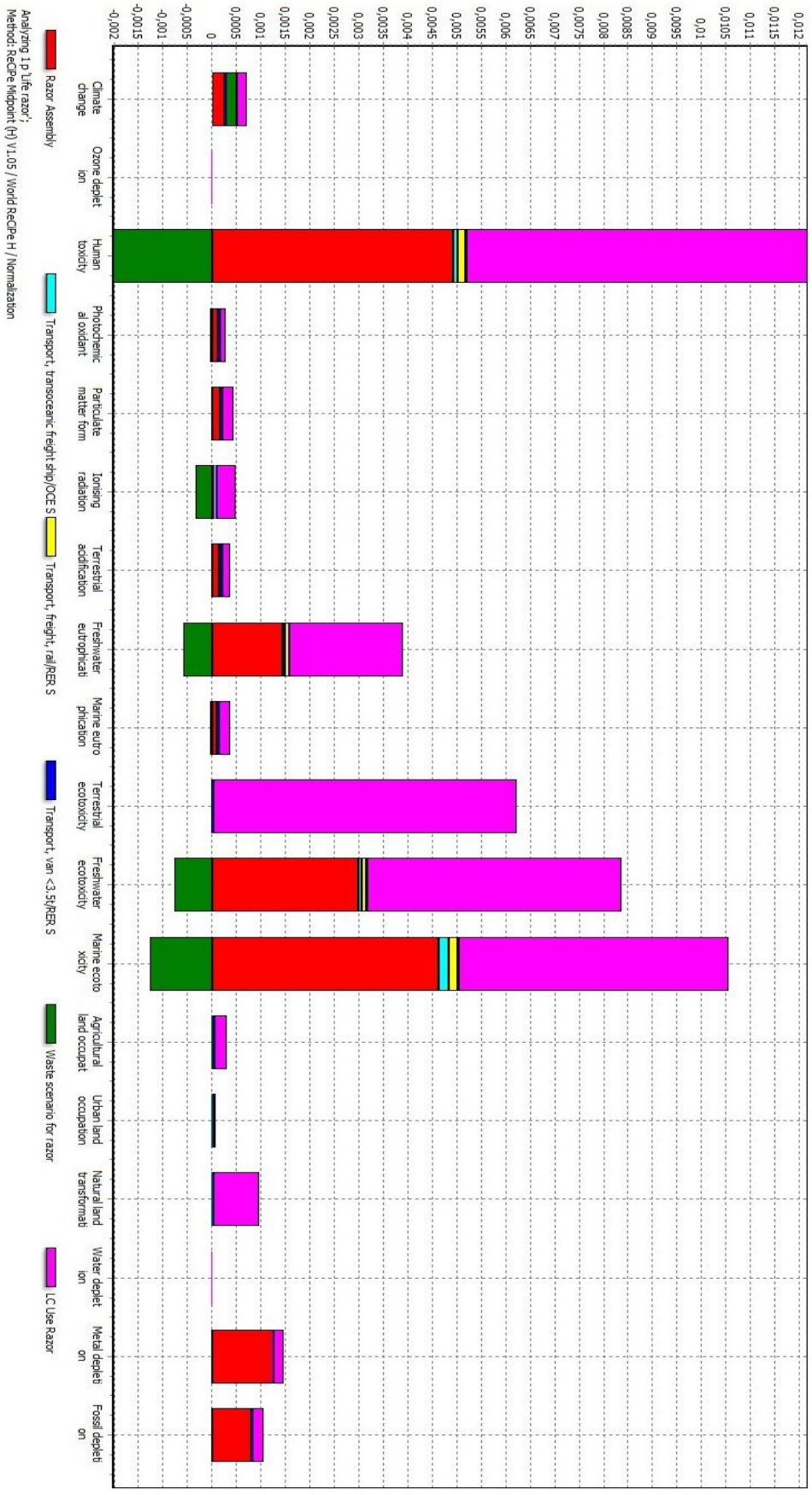
***Appendix 3 - Comparison between the electric shaver and the razor blade when shaving with running water.***



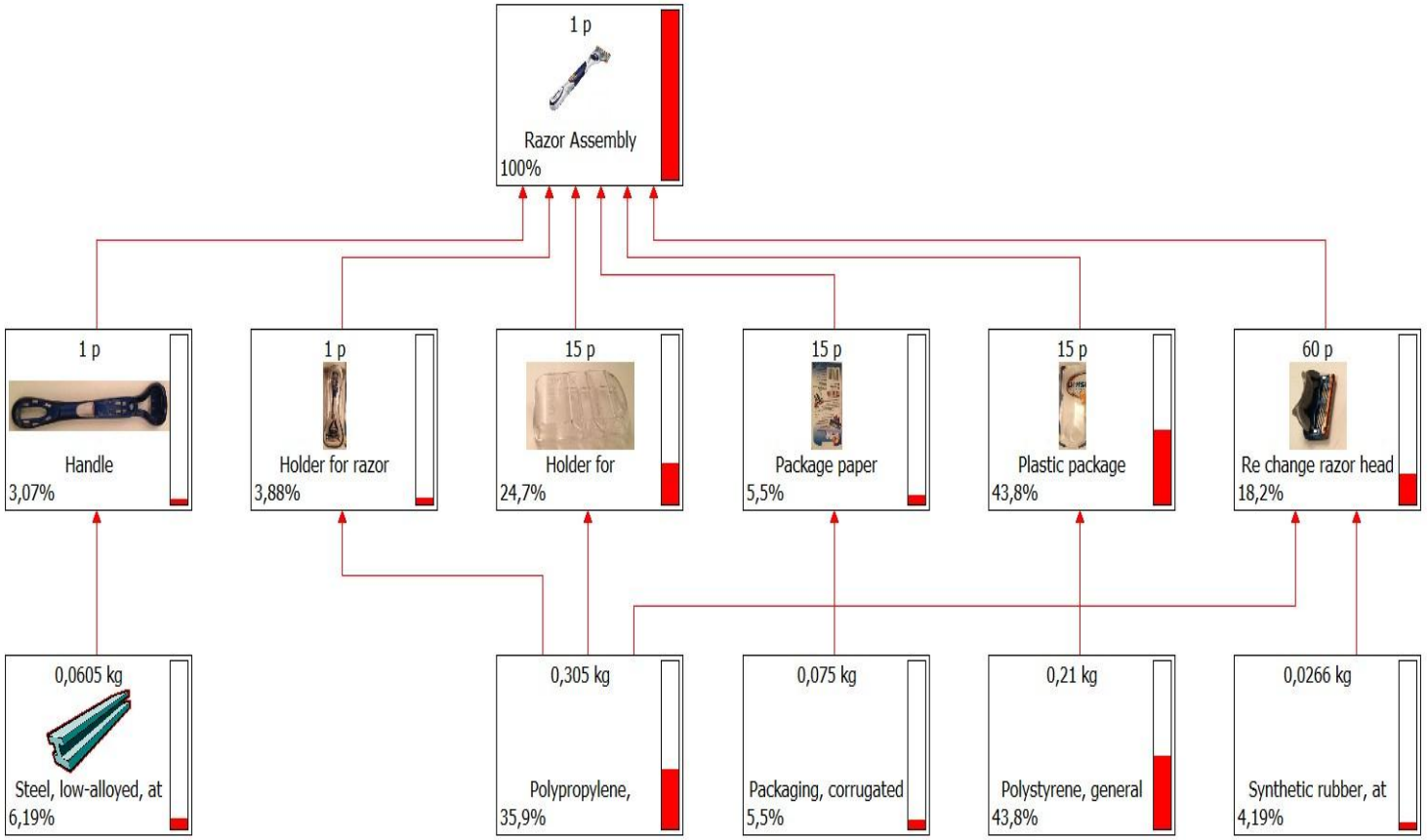
## *Appendix 4 - Impact assessment shaver- Normalized result.*



## *Appendix 5 - Impact assessment razor*



***Appendix 6 – Razor blade assembly part***


1 p
Razor Assembly
100%
1 p
Handle
3,07%
1 p
Holder for razor
3,88%
15 p
Holder for
24,7%
15 p
Package paper
5,5%
15 p
Plastic package
43,8%
60 p
Re change razor head
18,2%
0,0605 kg
Steel, low-alloyed, at
6,19%
0,305 kg
Polypropylene,
35,9%
0,075 kg
Packaging, corrugated
5,5%
0,21 kg
Polystyrene, general
43,8%
0,0266 kg
Synthetic rubber, at
4,19%