Life Cycle Assessment of KTH Sustainability Day

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Abstract

This report presents a Life Cycle Assessment of the KTH- Sustainability Day held on October of 2013. The event is organized by the KTH Sustainability Division which is the intended audience of this study. The goal of the project is to identify the main environmental impacts caused by the event in order to suggest improvements for the upcoming events. To achieve this goal, a Stand Alone LCA is performed using the SimaPro software and based on information provided by the Administrators of the Sustainability Division. The functional unit used for the analysis is “A Sustainability Day Event”. The modeling of the system is developed in four different life cycles: food, drinks, materials and travel. Each of the life cycles includes different assemblies, processes and waste scenarios. Due to the lack of information regarding the quantities of the different elements needed for the event, it was necessary to make several assumptions based on literature, internet sources and common sense. After running the model in SimaPro, there were identified the main environmental impact categories which are climate change, freshwater eco-toxicity, terrestrial eco-toxicity, marine eco-toxicity, natural land transformation, particulate matter formation, terrestrial acidification , fossil depletion and freshwater eutrophication. Moreover, the identified hotspots of the event were generated by the food (specifically nuts and dairy products) and drinks (wine, beers and soft drinks). Besides, travel was also a representative environmental burden contributor but it is considered an aspect that the KTH Sustainability Division cannot improve for the next event.

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1. Goal and scope

KTH- Sustainability Council was formed in 2011 with the purpose of working on environmental issues and sustainable development. This division focuses on the areas of research, education and collaboration within KTH and it is responsible for organizing seminars and different events at campus. Once per year, the division organizes the KTH Sustainability Day in which invited speakers, personnel from KTH, professors and students take part in the different activities of the event. The KTH Sustainability Division wants to become more aware of the potential environmental burdens generated by events at KTH with the aim of making improvements in the upcoming events (KTH-Sustainability-Day, 2013).

The purpose of this project is to perform a LCA concerning the KTH-Sustainability Day conducted on the past October 17th, in order to identify the hotspots where environmental improvements can be implemented. The project will be based on information provided by the Sustainability Division's Administrators who are the intended audience of this study.

The project's research questions are: What potential environmental impacts can be generated by the KTH Sustainability Day event? And how these environmental impacts can be minimized? For answering these questions, a Stand Alone LCA will be modelled by using the SimaPro software. The Stand Alone LCA is chosen based on the purpose of the LCA, a weak-point analysis for identification of potential areas for improvement will be carried out to present recommendations for the next year event of the KTH Sustainability Division.

1.2 Functional unit

The functional unit of this study is "A KTH Sustainability Day Event". The general characteristics of the functional unit are; duration of one day, 270 people attending, 4 external invited speakers, food and drinks served for the guests and materials used for programs, posters, name tags, street talkers and roll ups. The detail information about food, drinks and material used can be found in chapter 2.

1.3 System boundaries

The environmental impacts of the sustainability event's life cycle are generated by all the ingoing and outgoing material, energy and other flows that will in have an impact. The system boundaries of a LCA study aims to identify what factors are left out and which ones are considered for the analysis. The boundaries of the LCA system can be described in terms of boundaries related to natural and technical systems as well as to time and space. This section describes the system boundaries connected to our modeled Sustainability Day Event. An initial flowchart of the model can be seen in Figure 1 below.

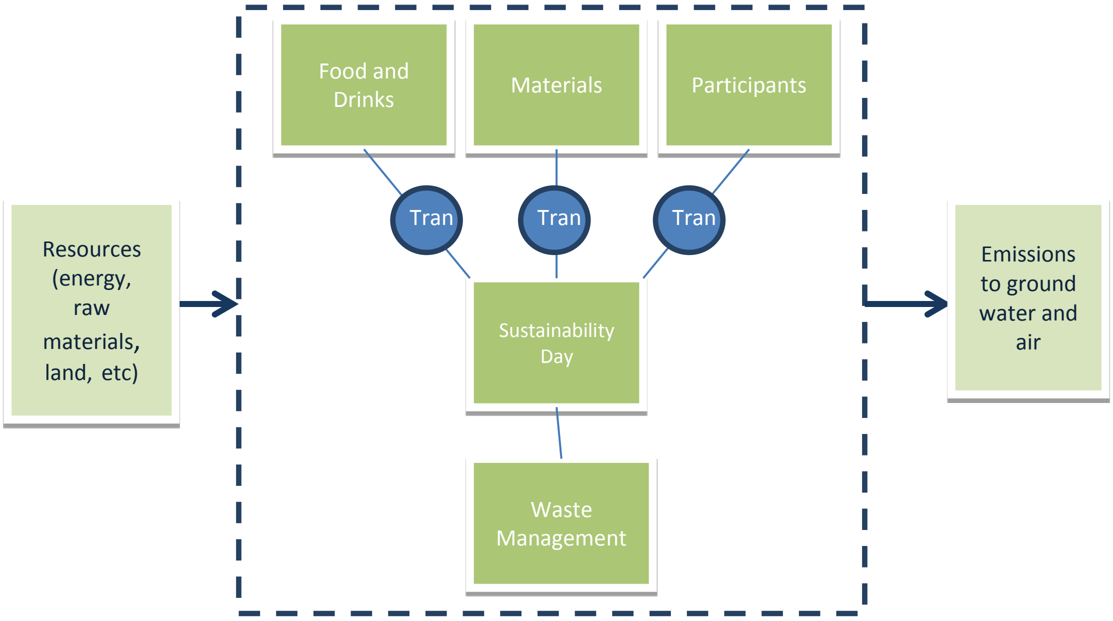

Figure 1: Initial flowchart

The study will focus on the usage of materials and foods needed for the event, the transportation of the participants coming to the event as well as the recycling and disposal of ingoing flows. The processes and products involved in the foreground and background system of the model can be seen in Table 1

Foreground systems	Background systems
Food and drinks consumption	Raw material acquisition
Material consumption	Machinery production/usage
Transportation of participants	Production of alternative fuel
Recycling of materials	Transportation of goods
Incineration of waste	

Table 1: Foreground and background systems

1.3.1 Time boundaries

This study is conducted as the project task of the course Life Cycle Assessment in the late 2013. The study aims to describe and replicate the KTH- Sustainability Day event of 2013, and therefore the event's data from that year will only be considered. The study is an Accounting LCA and one of the attributes of an accounting LCA is to assess current potential environmental impacts, thus this study is going to be limited to represent the current year with a range of about +- 5 years and will discard eventual changes in ingoing/outgoing parameters or factors such as energy or market prices.

1.3.2 Boundaries in relation to natural systems

The first line is drawn at the raw material acquisition of the system, which is chosen not to be included, based on time limits and the complexity of the system. The group project have applied data regarding the energy used for production of some products (cooking of the food, etc.), However, other parts of the system such as production of some products (production of the street talkers, etc.), usage and different disposal scenarios will not be dealt with. For the different disposal scenarios, the study will assess the human final disposal such as incineration and recycling and also consider the emissions and outputs in the natural system.

1.3.3 Geographical boundaries

Many of the ingoing materials are in fact extracted globally and transported to different locations. For that reason, the geographical boundaries for the extraction and transportation phases are rather wide. The usage and disposal phases, i.e. the event itself and the disposal and recycling of the waste, will be bound to represent the area of Sweden and more precisely KTH and the area of Stockholm. This implies that events within Sweden will use average data representing the area of Sweden. Even though, the Sustainability Day Administrators tend to use ecologically and locally produced products, some of the products for the material production probably are originally from faraway from Sweden.

1.3.4 Allocation

Since the waste stream goes to incineration, an allocation problem is presented. To solve the issue, it has to be modelled how the same amount of energy can be produced with the use of competing processes. In this case, the competing process would be to get energy (heat and electricity) from a mixture of fossil fuels, biomass and renewable materials. This information can be gained to retrieve data on the energy mix for the specific incineration plant and model the allocation according to these data in SimaPro. The avoided burdens would then result in negative environmental impacts which are avoided by getting energy from our event day instead.

Other allocation problems occur when reusing the street walkers and plastic name tag holders since some of them is lost and some needs to be replaced. This sort of allocation problem will be solved by approximating how many times each one is used and split the environmental impacts accordingly to represent the usage of one event.

1.4 Assumptions and Limitations

In this section our different assumptions and limitations are listed. More detailed assumptions concerning the data used within the model will be discussed in section 2.3.

- All transportation within the system boundaries will occur within Sweden.
- Food and drinks will have each their waste scenario while the materials concerned with the materials and serving of the foods will share the same waste scenario.
- The energy used in relation to using the building in which the event takes place will not be considered. This includes for example heating, electricity for lights and usual maintenance of the building. This could be modelled and investigated in a larger study or in a future project.
- The land used for the event (building) will not be considered or modeled.
- The menu provided by the KTH Nymble Catering is the same menu that was used for the Sustainability day.

- The energy mix used within the system boundaries are considered to be represented by a typical Swedish energy mix. The values used in the report are average values from Svensk Fjärrvärme Fortum.

1.5 Impact categories and impact assessment method

ReCipe (H) is the method used to obtain the impact assessment by using mid-point methodology (Recipe, 2013). It is a method valid only in the European region. It includes the follow impacts categories:

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

All the impact categories will be included for analysis in this study, KTH Sustainability and KTH does not have any specific goals on minimizing specific impacts (Limén, 2013). However the impact categories will be focused in Chapter 3.2.2 according to the initial level of impact from the normalization results.

1.2 Normalization and weighting

As explained above, the Europe Recipe H method has been used to assess the environmental impacts. This methodology uses the inventory results to translate the environmental impact into a fraction of the yearly average emission of a European citizen (Recipe, 2013).

2. Life Cycle Inventory analysis

2.2 Process Flowchart

A simplified flowchart is presented to show how the data was included in SimaPro. The yellow boxes represent the life cycles (Materials, Food, Drinks and Travel) and blue boxes the represents the assemblies. Each of them contains several data that can be found in Chapter 2.3. The red boxes correspond to the different waste scenarios of each life cycle. It can be observed that the life cycle 'Travel' is the only one without a waste scenario.

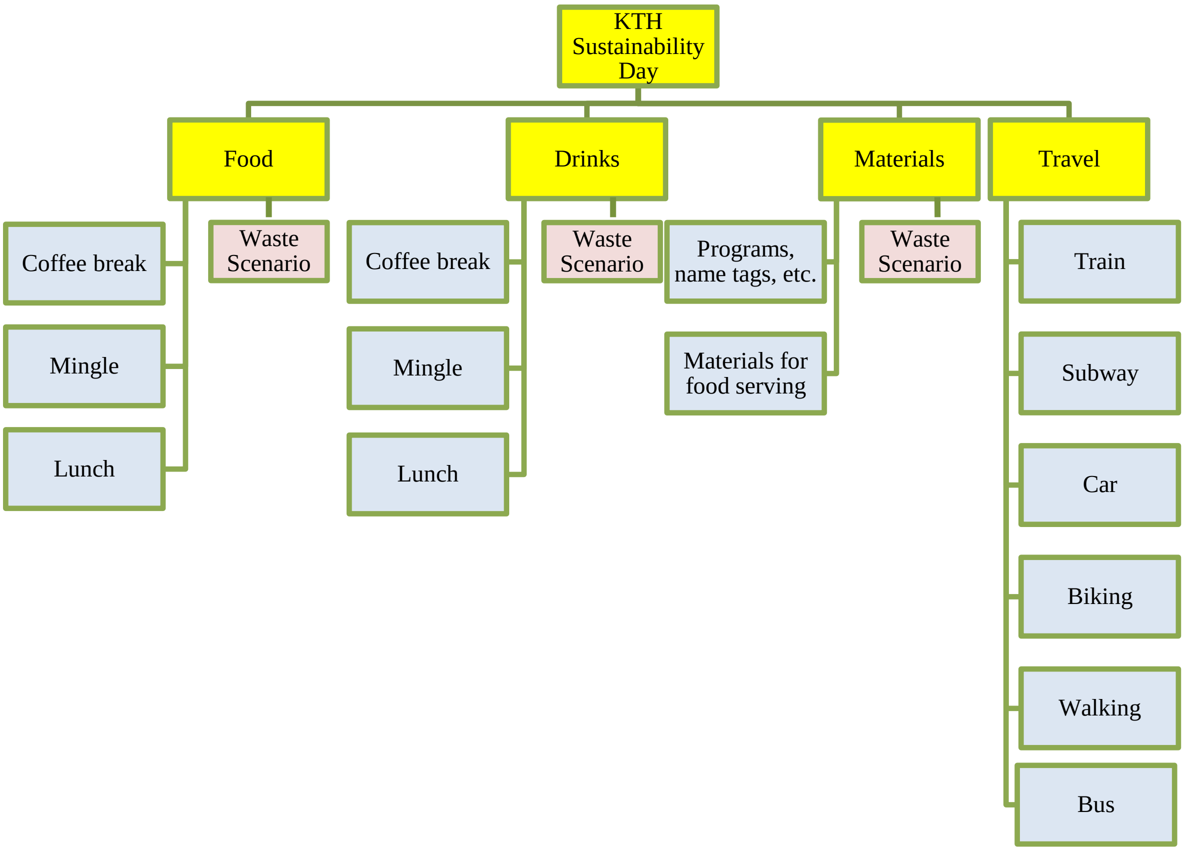

Figure 2: Simplified model flowchart

2.3 Data

The input and output data used in the study is taken from the database of SimaPro. Different databases within SimaPro are used to cover all of the materials and processes. The generic data of the project is based on information given by the KTH Sustainability Division and the contact person Helene Limen.

Most of the data is given in mass and energy units, with exception of some products which are only available in monetary terms. These data are provided by the USA Input Output Database 98. This database is based on a top down technique where a matrix of the sectorial monetary transactions is used to describe the relationships between industries at an economical national level. Some of the project results will therefore have an economic allocation that can strengthen or weaken the outcomes(Suh, 2010). For example, a high economic value does not always represent a high environmental impact, but having an economic allocation results in a detailed value chain including marketing, insurance and other services related to the product.

Moreover, the waste handling of a product from the USA Input Output Database can be complex because the SimaPro software does not take into account the amounts from monetary values.

2.3.1 Materials

The material includes all materials used in the event with the exception of the material used for food and drinks

Given Data: amount of posters, amount of name tags, amount of programs + the actual program, amount of roll-ups, and amount of street talkers. When the physical product is available the product is measured and weighed.

Assumed Data: The dimensions and materials of the materials are all assumed, when not available. Furthermore the amount of paper and plastic mugs where estimated to be 200 for each. When not being able to find the physical product, examples from online sources is used to determine the material and dimension. This applies for the Street talkers (Easyonline, 2013) and the roll-ups (Pullupstand.com, 2013)

It was informed that 10 posters were used for the event and some were reused from previous events. It is assumed that 3 out of 10 are reused.

Allocations: Several allocations arose with the items. It is assumed that the material in the street talkers will be used several times. Paper will be used one time, the plastic will be used 50 times and the street talker itself will be used 150 times. Besides, roll ups will be used 150 times. Name tags are reused; it is not estimated how many times they can last, but how many times they will be used before being disposed. It was determined that 10 percent of the name tags are lost after each event.

Table 2 shows all input to the SimaPro model. For more details see Appendix 1

Table 2 Input Material

Product	Material	Amount		database
Posters				
Printed paper	kraft paper, bleahed, at plant/RERU	388	g	Ecoinvent system processes
Roll ups				
Borrowed	Galvanized steel sheet, at plant/RNA	6	kg	USLCI
Name tags				
Printed paper	kraft paper, bleahed, at plant/RERU	72,8	g	Ecoinvent system processes
Plastic holders	Ethyl vinyl acetate, foil, at plant/RER U	1300	g	Ecoinvent unit processes
Metal pin	Steel, billets, at plants/US	585	g	USLCI
Street talkers				
Constructions	Galvanized steel sheet, at plant/RNA	33	kg	USLCI
Printed papers	kraft paper, bleahed, at plant/RERU	240	g	Ecoinvent system processes
Plastic covers	Ethylene vinyle acetate copolymer, at plant/RER S	2400	g	Ecoinvent system processes
Programs				
Printed	kraft paper, bleahed, at plant/RERU	4050	g	Ecoinvent system processes
Sevice				
Plastic spoons	PET (bottle grade) E	400	g	Industry data 2.0
Plastic mugs	PET (bottle grade) E	2000	g	Industry data 2.0

Table 3: Input Material

2.3.2 Food

Food included all organic materials except beverages and the preparation of the food served during mingle, coffee break and lunch.

Given Data: The 6 specific menus and servings for the coffee break were given, however no ingredient list or quantities.

Assumed data

Material: The ingredient list for the menus with amounts and type of food is assumed, based on small portions for 200 people. The amount of each portion is based on the catering firms own menus where it can be seen how many small portions per person are needed during a specific time, day and numbers of hours. The event was an afternoon event of two hours. This means 6 portions per person are needed and 6 different menus are served, meaning 200 of each. It was not always possible to find the specific material in SimaPro's database, so a similar material was used as input. The materials that have been replaced with other materials are: salmon, Jerusalem artichokes, cress, horseradish, cream cheese, yoghurt and several specific fruits and vegetables.

The material for the different menus served during the mingled have been summed up, therefore it is not possible to track where each of the material was used, however the different menus and the estimation of material and weight can be found in Appendix 1.

Lunch is held for the 10 speakers and it is assumed that they have a meal of 200g of meat, and 150g of potatoes, 75g of fruits/vegetables and 50g of cream.

Small service is done during the coffee break, the amount of apples and yoghurt is based on the group's estimations.

Process:

In some of the menus, there is the process of cooking, baking bread which could be found in SimaPro database, boiling water is also given in SimaPro. The washing of plates is included in the food dataset. It is estimated that around 200 plates, glasses are used for the event, the energy and water consumption for washing is based on data from a website (commercial dishwaher specialists, 2013)

The total data input for food in mingle, lunch and coffee break can be found in Table 4, Table 5, Table 6, Table 7, Table 8 and Table 9. For a more detailed description of the food input please see Appendix 1

Table 4 Input food: mingle Menu 1: Small rye bread with bean cream and cabbages, 200 portions

Product	Material	Amount		Database	Source
Dark bread	Bread, rye, conventional, fresh	6,6	kg	LCA food DK	Nymble
Dairy (creme)	Cream 38%	2	kg	LCA food DK	
Cabbages (groddar)	Fava beans IP, at farms/CH S	0,4	kg	Ecoinvent system processes	
Rootfruit (beans)	_21 Fruits and vegetable, processed, EU27	2	kg	EU & Dk input output Database	

Table 5 Input food: Mingle - Menu 2: Cold artichoke soup with croutons, 200 portions

Product	Material	Amount		Database	Source
Rootfruit (artichoke)	Carrot, conventional, washed and packed, from cool house	2	kg	LCA food DK	Nymble
Water	Tap water, at user/RER S	3	kg	Ecoinvent system processes	
Dairy (creme)	Cream 38%	3	kg	LCA food DK	
Bread (croutons)	Bread, wheat, fresh, in supermarket	1	kg	LCA food DK	

Table 6 Input food: Mingle - Menu 3: Salad with walnuts and cress, 200 portions

Product	Material	Amount		Database	Source
Vegetables (sallad)	_21 Fruits and vegetable, processed, EU27	3	kg	EU & Dk input output Database	Nymble
Wallnuts	Salted and roasted nuts and seeds	1	kg	USA input output database 98	
Vegetables (Cress)	_21 Fruits and vegetable, processed, EU27	0,4	kg	EU & Dk input output Database	

Table 7 Input food: Mingle - Menu 4: Blini with smoked salmon and horseradish, 200 portions

Product	Material	Amount		Database	Source
Light bread	Bread, wheat, fresh, in supermarket	2	kg	LCA food DK	Nymble
Fish (Smoked Salmon)	Mackerel fillet, fresh, whole sale (no quotas)	3	kg	LCA food DK	
Rootfruit (Horseradish)	Carrot, conventional, washed and packed, from cool house	0,2	kg	LCA food DK	
Dairy (creme)	Cream 38%	2	kg	LCA food DK	

Table 8 Input food: Mingle - Menu 5: Toast skagen, 200 portions

Product	Material	Amount		Database	Source
Light bread (Toast)	Bread, wheat, fresh, in supermarket	3	kg	LCA food DK	Nymble
Dairy (creme)	Cream 38%	3	kg	LCA food DK	
Fish (shrimps)	Shrimps, fresh, in supermarket (no quotas)	1	kg	LCA food DK	

Table 9 Input food: Mingle - Menu 6: Västerbotten mess with cloudberry on pumpernickel bread, 200 portions

Product	Material	Amount		Database	Source
Dark bread (pumpernickel)	Bread, rye, conventional, fresh	4	kg	LCA food DK	Nymble
Berries (cloudberry)	_21 Fruits and vegetable, processed, EU27	2	kg	EU & Dk input output Database	
Creme, cheese (the mess)	Cheese, in supermarket	3	kg	LCA food DK	

Table 10 Input food: lunch

Material	Amount (g)	Database	Source
Cream 38%	500	LCA food DK	none
chicken, fresh, in supermarket	2000	LCA food DK	
Potatoes IP, at farm/CH S	1500	Ecoinvent system processes	
_21 Fruits and vegetable, processed, EU27	750	EU & DK input output Database	

Table 11 Input food: coffee break

Product	Material	Amount		Database	Source
Ecological Yoghurt	_20 diary products, EU27	30	kg	EU & Dk input output Database	KTH Sust. Day
Homemade granola	Oat, organic, form farm	6000	g	LCA food DK	-
Fresh berries	_21 Fruits and vegetable, processed, EU27	2000	g	EU & Dk input output Database	-
Apples	_21 Fruits and vegetable, processed, EU27	15	kg	EU & Dk input output Database	-

Table 12 Cooking processes

Process	Total Amount	Database	Source
Baking of big bread	33p	LCA food DK	
Boiling of vegetebales	8kg	LCA food DK	
Electricity, production mix SE/SE S	3kWh	Ecoinvent system processes	

2.3.3 Drinks

Drinks are all beverages served during the event, plus the cans and bottles containing the beverages. This is due to the average data from the SimaPro databases for wine and soft drinks already include containers.

Data given: Coffee, tea, wine, beer and non-alcoholic were served.

Data Assumed: Information on amount of wine used, was estimated based on information of how much was used at a previous event at Nymble. The group has estimated that the participants drink 1-2 cups tea or coffee during the event, more tea than coffee (150 cups of coffee, 200 cups of tea), 2 out of 5 of the participants drink a beer and 2 out of 5 drinks a non-alcoholic drink.

The washing of glasses is included in the food dataset. It is estimated that around 200 glasses are used for the event, the energy and water consumption for washing is based on data from a website (commercial dishwaher specialists, 2013)

Moreover not only fluid materials are included in the model. The only generic data available for different beverages are data describing the impact in monetary terms and the bottles and cans are included, the price of wine (Systembolaget, 2013), beer (Systembolaget, 2013), soft drinks (My supermarket, 2013) coffee (My supermarket, 2013) and tea (My supermarket, 2013) are found on sources online. However these numbers are not counted as material but monetary values. Therefore, bottles and cans have been (glass and aluminum) added with the zero-burden approach. This means materials that do not generate environmental impact were added to the model, allowing the bottles and cans be included in the waste scenario.

The total data input for drinks can be seen in **Error! Reference source not found.** and the pecific amount for each part of the event can be found in Appendix 1.

Table 13 List of materials used for the drinks

Product	Material	Amount		Database
Mingle				
Wine	Wines, Brandy, and brandy spirits	96	$	USA input output database 98
Empty Wine	Glass zero burden KTHS day	5	kg	
Beer	Bottled and canned soft drinks	80	$	USA input output database 98
Empty Beer	Glass zero burden KTHS day	16,8	kg	
Soft Drinks	Bottled and canned soft drinks	40		USA input output database 98
Empty Soft Drinks	Metal cans zero burden sustainability day	16,8	kg	
Break				
Coffee	Roasted coffee	20,5	USD	USA input output database
Tea	Coffee-roasting & tee-packing NL	100	$	Dutch input output database 95
Water	Tap water, at user /CH S	55	l	Ecoinvent system processes
Lunch				
Drinking water	Tap water, at user /CH S	2	kg	Ecoinvent system processes
Soft drinks	Bottled and canned soft drinks	7,5	$	USA input output database 98
Processes				
Washing glasses	Eletricity, production mix SE/SE S	3	KWh	Ecoinvent system processes
boiling water for coffee and tea	Boiling of water in el. kettle	55	l	LCA food DK
Metal cans zero burden sustainability day		16,8	kg	

2.3.4 Travel

All travel of the participants going to the event and home.

Given data: The transportation's mean for the four external speakers; 2 persons commuting from Stockholm, 1 person travelling by train from Simrishamn and 1 person biking to KTH.

Only specific data is given of one person, the length of the journey is here determined by data from Google maps (total 952km) (GoogleMaps, 2013). Besides, the distance of people traveling to KTH and the means of transportation used have not been possible to obtain. However an estimated is made by assuming everybody has 10 km to KTH in average, 2%[1] of the people ride their bike, 7 %[2] take the car and the rest public transportation, with a transportation mix favoring the longest distance in commuter train, medium distance in metro-train, and small distance in bus.

The input for the travel can be seen in Table 14.

Table 14: input travel

Process	Amount	Database	Source
walking	80km	LCA food DK	none
Transport, regular bus/CH S	600km	Ecoinvent system processes	
Transport, passenger car, diesel, EURO3/CH S	400km	Ecoinvent system processes	
Transport, metropolitan train, SBB mix/CH S	3000km	Ecoinvent system processes	
Biking	100km	LCA food DK	
Transport, average train/AT S	952km	Ecoinvent system processes	Google maps

2.3.5 Waste Scenarios

Waste is created in all life cycles expect for the travel life cycle.

Drinks

It is assumed that 10 % of the beverages are wasted. This means glasses and bottles that are not emptied. These beverages will be thrown out in drains, which will go to a waste water treatment facility.

Food

Literature shows that 10 % food from a big kitchen is wasted in the serving (Jensen, 2011). This number is used as a reference for this project. This amount of wasted food will go to the regular mixed trash can and will go to a municipal waste incineration plant. In the process of

[1] This will in reality be closer to 4 % of the people, because it assumed that people with short distance (less than 5 km) to KTH ride their bike.

[2] This will in reality be closer to 4 % of the people, because it assumed that people with long distance (more than 40 km) to KTH drive their car.

incineration heat and electricity will be produced 1.940.000 MWh from an input of 700.000 tons of MSW. The energy mix is based on Fortum information as described in the assumptions chapter. The values used in this report are presented in the in Table 15.

Table 15 Swedish average electricity and heat mix

Type of energy	Percentage
Heat, at cogen, biogas agricultural mix, allocation exergy/CH S	38,71
Heat (oil)	6,32
Heat (coal)	6,32
Heat (gas)	6,32
Electricity, production mix SE/ SE S	42,33

Materials

All material in the material life cycle all material is recycled expect for material being in contact with food, which is being incinerated.

See Table 16 for input in waste scenarios.

Table 16 Input waste scenarios

Waste treatment	Part waste	Database
Drinks		
Waste water - untreated, slightly organic contaminated EU27 S	10%	ELCD
Food		
Recycling glass/RER S	100%	Ecoinvent system processes
recycling non-ferro/RER S	100%	Ecoinvent system processes
Waste incineration of municipal solid waste (MSW), EU.27 - Sustainability day	10%	Sustainability Day
Materials		
Recycling paper/RER S	100%	Ecoinvent system processes
Recycling steel and iron/RER S	100%	Ecoinvent system processes

3. Life Cycle Interpretation

3.2 Results

3.2.1 Environmental Impact Categories

Taking into consideration the research question of this study case, first it was decided to investigate all the possible different impact categories on SimaPro. Table 17 presents the name of these environmental impact categories.

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

Table 17: Environmental impact categories

3.2.2 Characterization

The first step of assessing the environmental impacts from KTH Sustainability Day is to extract the characterization results. These results can be seen in Figure 3. Each of the four life cycles modeled in SimaPro, except for the life cycle of "Materials", show that there are impact categories where they are contributing with the major impact. It can be seen that the life cycle of 'Food' has the largest impact on terrestrial eco-toxicity, climate change and terrestrial acidification, representing more than the 50% of the impact in each of these categories. The life cycle of 'Drinks' has the major impact in the categories of ozone depletion, particulate matter formation, fresh water eutrophication and fresh water eco-toxicity with also values above the 50%. And the life cycle of 'Transport' generates impacts mainly on human toxicity, ionizing radiation, marine eco-toxicity, natural land transformation, water depletion and metal depletion. However since the categories have a large impact on different impact categories, it is very difficult conclude which life cycle the focus need to be on. Therefore, it is necessary to follow up on the characterization with results from normalization to get a clearer overview of which impact categories are most exposed.

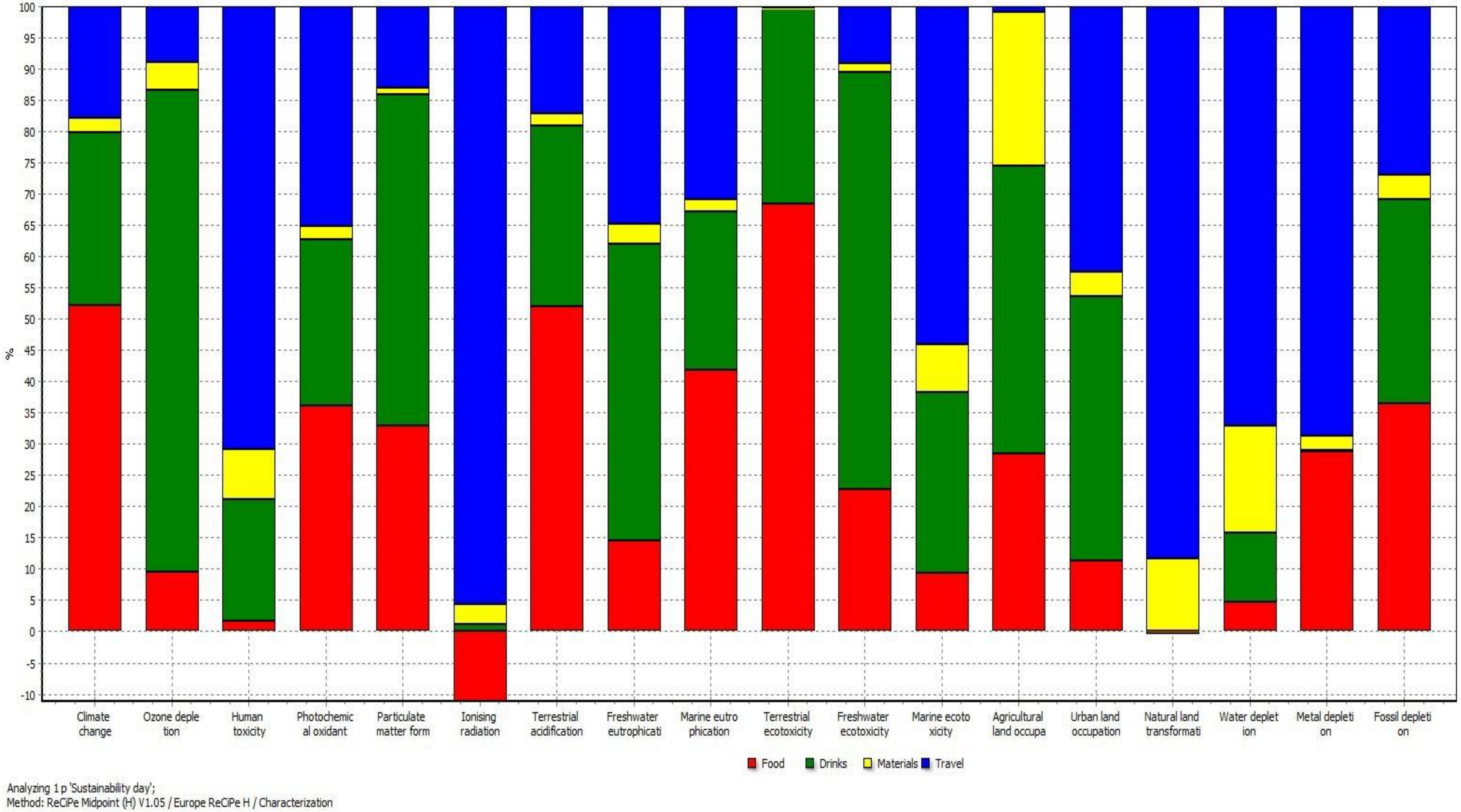

Figure 3 Characterization results from SimaPro

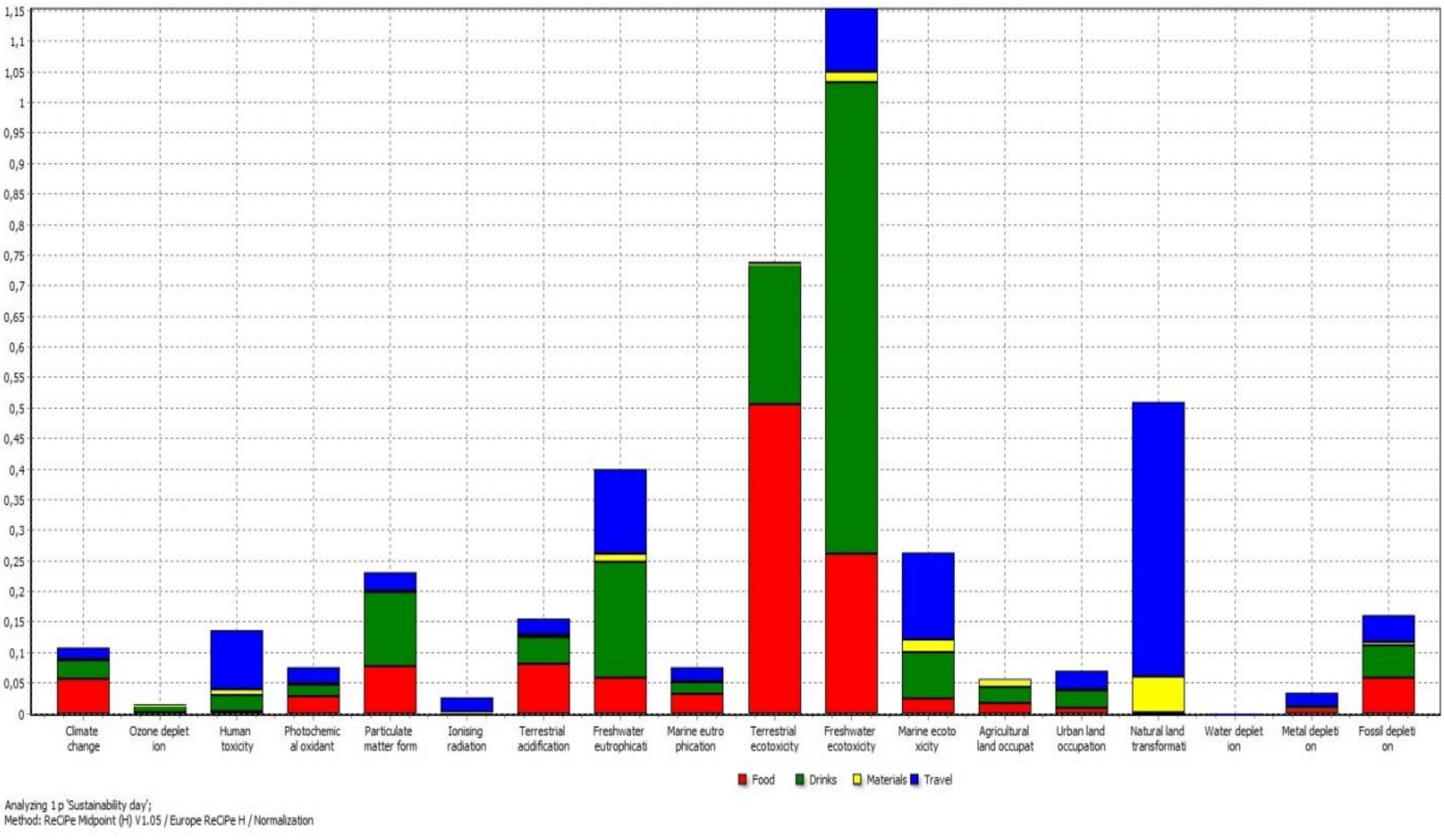

Figure 4: Normalization of impact categories

The normalization results of modeling the KTH- Sustainability Day can be seen in Figure 4.

3.2.3 Significant impact categories

To identify important impacts categories is was determine to focus on those impacts with normalization value above 0,1. This measure was taken after discussing among the group members who believe that these impacts are significantly small, considering that the data collected seems to have no direct relation with these impacts. The normalization results can be seen in Figure 4 and Table 18 shows the list of significant impacts and the impacts not considered which cells are in red.

Table 18: Significant impact categories

Terrestrial ecotoxicity	Climate change	Water depletion
Freshwater ecotoxicity	Ozone depletion	Metal depletion
Marine ecotoxicity	Human Toxicity	Fossil depletion
Agricultural land occupation	Photochemical oxidant	Freshwater eutrophication
Urban land occupation	Particulate matter formation	Marine eutrophication
Natural land transformation	Terrestrial acidification	Ionising Radiation

The significant categories were studied in detail to identify the specific problem areas. The description is presented in the following section of the report.

3.2.4 Significant Life Cycle Stages and Processes

In most of the impact categories selected, the life cycles of food and drinks seem to be the higher environmental burden contributors. If returning to the characterization results in Figure 4, some life cycles are now less important. The major categories such as Freshwater ecotoxicity and terrestrial ecotoxicity have the largest impact from Drinks and Food respectively and Drinks especially seem to take the lead. To go even further to identify the problem areas or weak points the network of the model is run with each of the chosen impact categories and the major sources of impact is identified. As an example, Figure 5 gives a visualization of the magnitude of the environmental burden concerning the climate change.

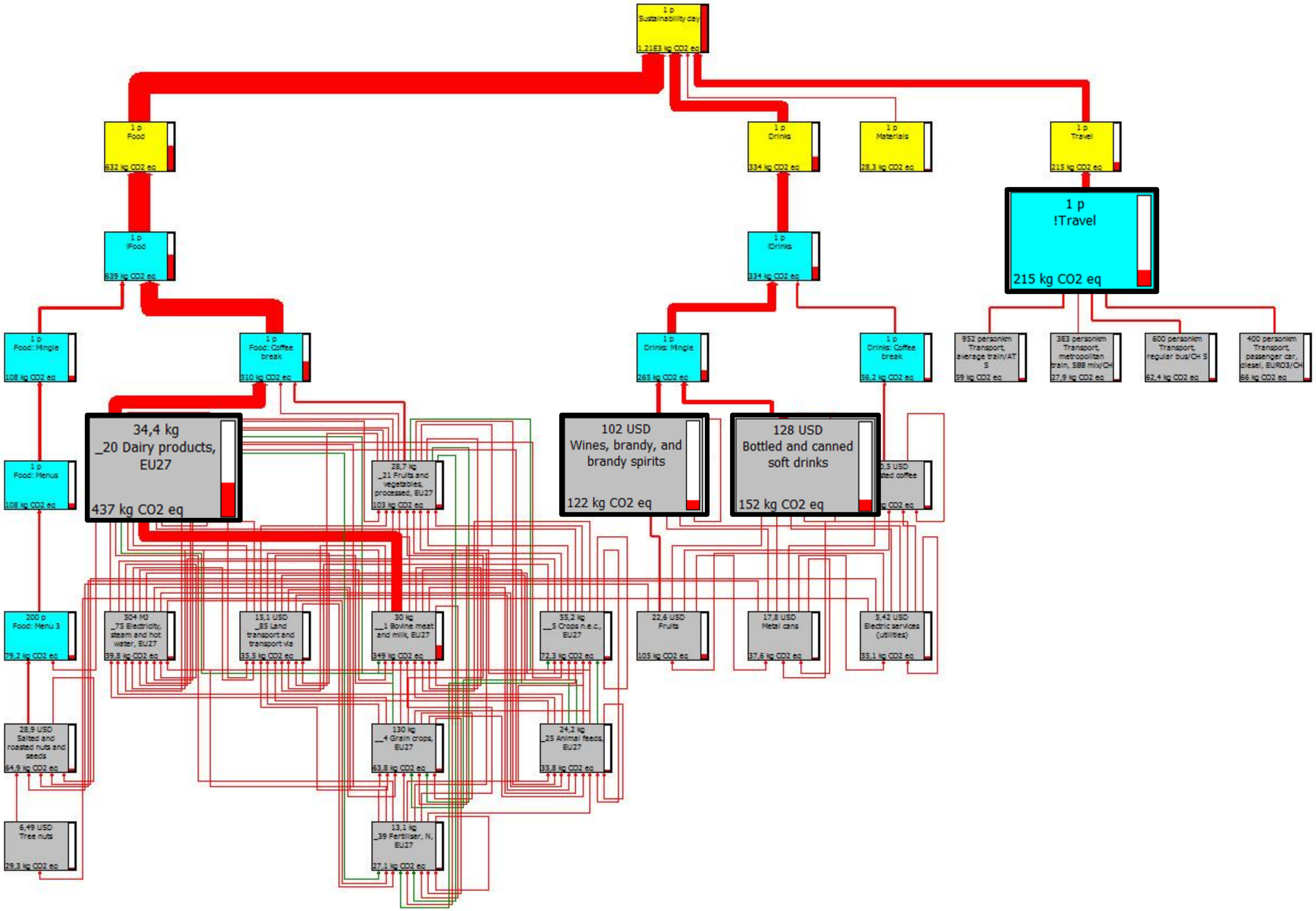

Figure 5 Climate change environmental burdens in SimaPro model

The most representative burden to climate change comes from the dairy products in the food's life cycle. The second largest contribution is generated by the drinks served during mingle which include the wine, beer and soft drinks. It can also be observed that the material's life cycle does not add a significant load to the environmental impact. These results for all the impact categories are analyzed. A summary of the major environmental impact generators can be found in Table 19 in which a life cycle and product are linked to a specific impact category.

Impact Category	Major Impact Generators		
	Priority	Life Cycle	Product
Climate change	1	Food	_20Dairy products, EU27
	2	Drinks	Wines, brandy and brandy spirits
			Bottle and canned soft drinks
Human toxicity	1	Travel	Transport average train/AT S
			Transport metropolitan train, SBB mix/CH S
			Transport passenger car, diesel, EURO3/CH S
	2	Drinks	Bottle and canned soft drinks
Particulate matter formation	1	Drinks	Wines, brandy and brandy spirits
			Bottle and canned soft drinks
			Roasted coffee
	2	Food	Salted and roasted nuts seeds
Terrestrial acidification	1	Food	_20Dairy products, EU27
	2	Drinks	Bottle and canned soft drinks
			Wines, brandy and brandy spirits
	3	Travel	Transport regular bus/CH S
Freshwater eutrophication	1	Drinks	Wines, brandy and brandy spirits
			Bottle and canned soft drinks
			Roasted coffee
	2	Travel	Transport average train/AT S
	3	Food	Salted and roasted nuts seeds
Marine eutrophication	1	Food	_20Dairy products, EU27
			Bread, rye, conventional, fresh
	2	Travel	Transport regular bus/CH S
			Transport average train/AT S
	3	Drinks	Bottle and canned soft drinks
			Wines, brandy and brandy spirits
Terrestrial eco-toxicity	1	Food	Salted and roasted nuts seeds
	2	Drinks	Wines, brandy and brandy spirits
			Bottle and canned soft drinks
Freshwater eco-toxicity	1	Drinks	Wines, brandy and brandy spirits
			Bottle and canned soft drinks
			Roasted coffee
	2	Food	Salted and roasted nuts seeds
Marine eco-toxicity	1	Travel	Transport average train/AT S
			Transport metropolitan train, SBB mix/CH S
	2	Drinks	Wines, brandy and brandy spirits
			Bottle and canned soft drinks
Natural land transformation	1	Travel	All means of transportation
Fossil depletion	1	Food	_20Dairy products, EU27
	2	Drinks	Bottle and canned soft drinks
			Wines, brandy and brandy spirits
	3	Travel	Transport average train/AT S
			Transport regular bus/CH S
			Transport passenger car, diesel, EURO3/CH S

Table 19: Major Environmental Impact Generators

The results in Figure 7, Figure 8 and Figure 9, shows on an even lower level the detail of the cause of impacts. However, looking at these results it is difficult to identify which product the impact is related to, because several products can "share" the element, but the Figures are good in order to see the magnitude of the element compared to the other.

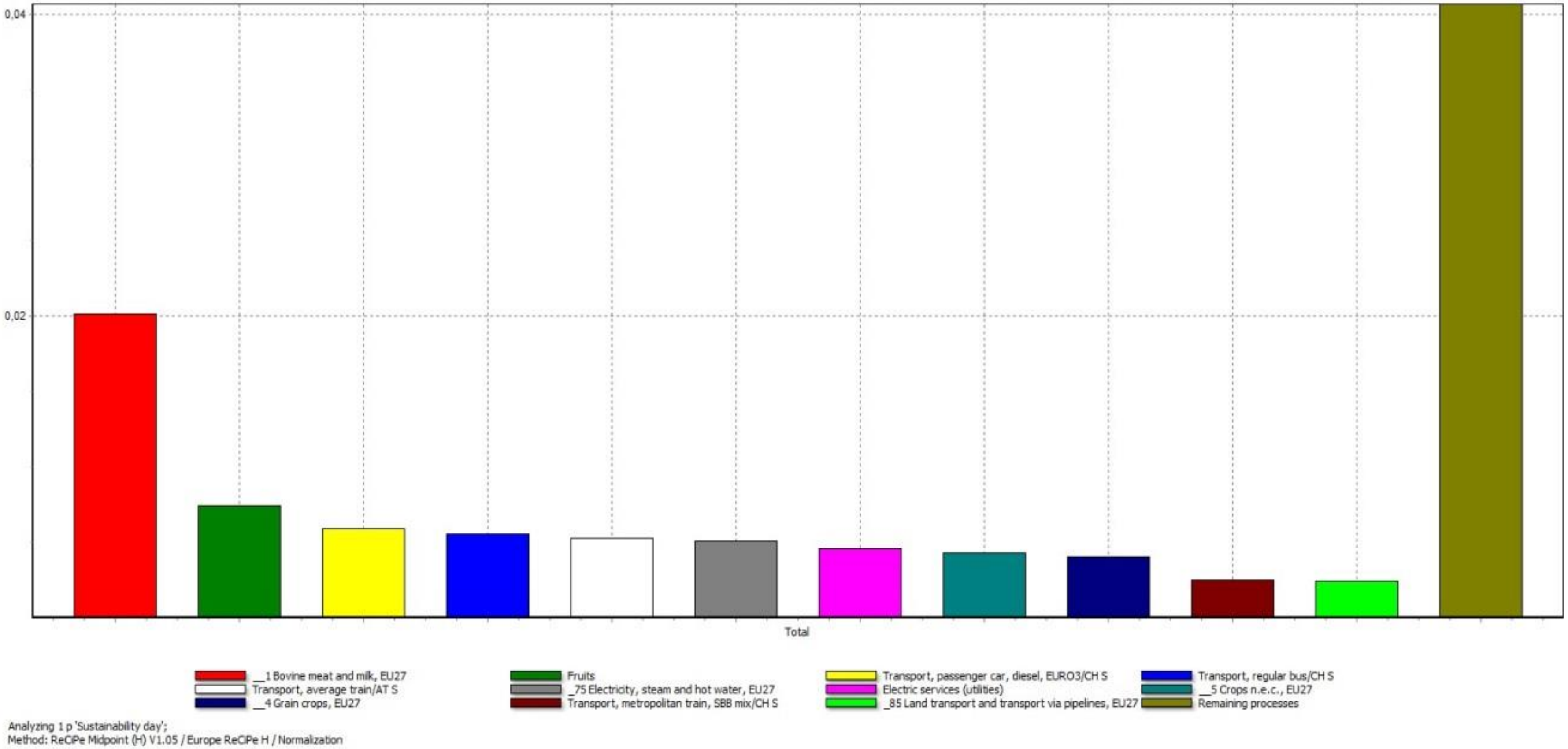

Figure 6 Detail of climate change impact

It can be observed in Figure 6 that the main contributor source for impact on climate change comes from the bovine meat and milk. Even though no meat was added directly to the model, this information is included in the EU & DK Input Output Database as known input from technosphere when choosing dairy products. The model from this database includes 142 products in 4 different categories. This means that one product category can cover different products.

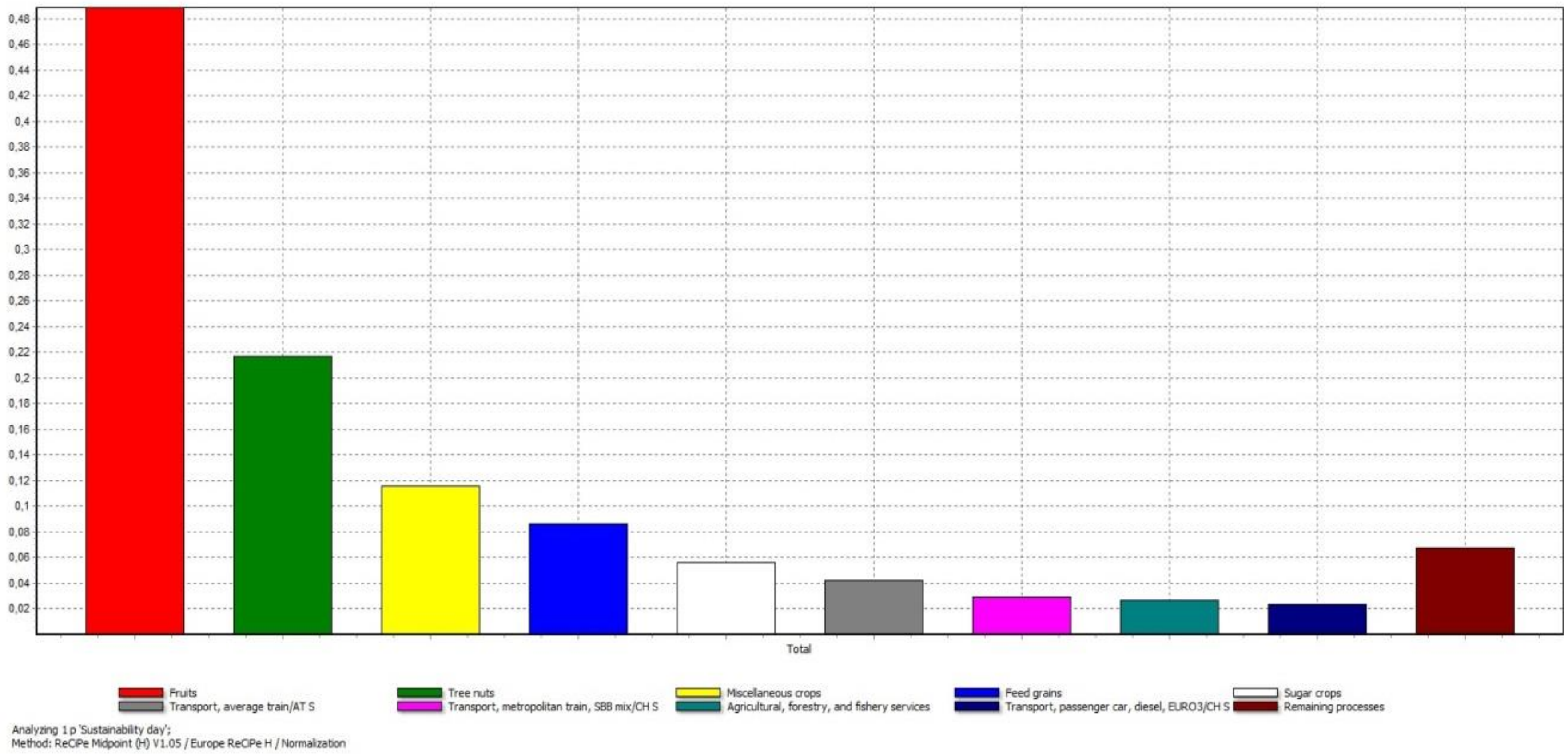

Figure 7 Detail of freshwater eco-toxicity impact

Other example for identifying the main products that generated impacts can be seen in Figure 9. The results show that the fruits used for the production of drinks and the tree nuts are the main contributors for the freshwater eco- toxicity impact category.

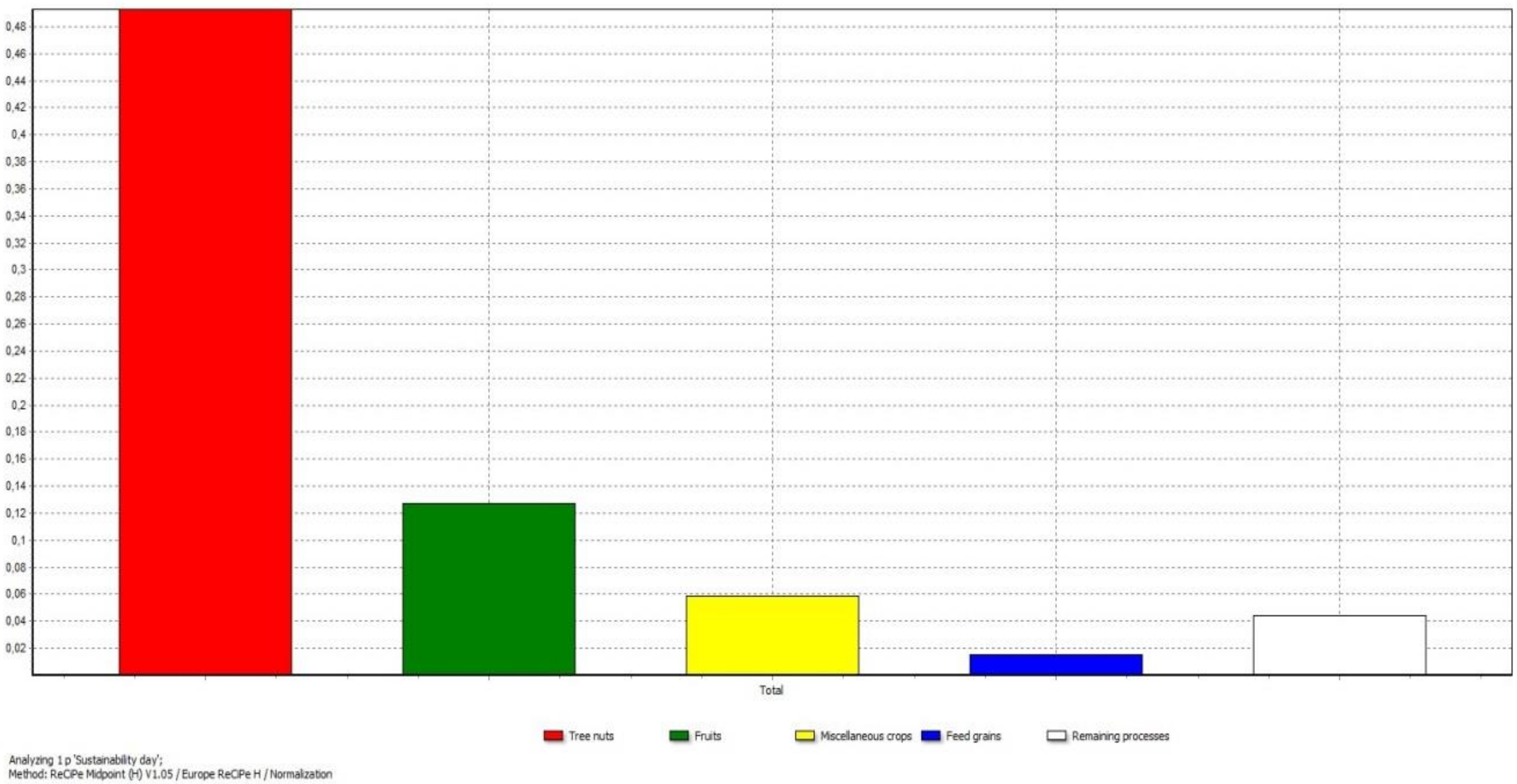

Figure 8 Detail of terrestrial eco-toxicity impact

Another case where the tree nuts and the fruits contribute significantly to an environmental category is presented in Figure 9, where the red color of the graph represents the impact from tree nuts and the green color the fruits. This graph corresponds to the terrestrial eco-toxicity impact category.

Results from the rest of the chosen impact categories can be found in Appendix 2, and the major impact does vary from impact category to impact category, but fruits and nuts are repeated. An explanation of why these impacts are caused could be the use of USA Input/Output database for wine, beer, soft drinks and nuts. These values are given in USD units and not in mass. It was seen from a LCA example that the data used was only in USD units (Product Ecology Consultants, 2006). In our case, both costs and mass units for different data are used which could affect partially SimaPro's analysis. Furthermore, the impacts of waste handling for USD data are very difficult to determine (Product Ecology Consultants , 2006). In this report, the amount of drink containers such as glass bottles and cans were estimated and included directly in the waste scenario of the life cycle of drinks. It is also noticeable that the dairy products also have a high environmental impact, first of all this could be explained by the level dairy used in the different menu are high, but dairy could also be one problem area for the menus, therefore a product that should be avoided.

There are aspects from the KTH Sustainability Day event that cannot be improved. For example, the transportation of the participants is inevitable. People have to use a mean of transportation to go to the event and then go back to their original location. The KTH Sustainability Division could encourage people to travel by bike or walking whenever is possible, but this aspect is totally dependent on the participant responsibility and willingness.

4. Sensitivity Analysis

Preliminary the results show that drinks and food are the two most important sources of environmental impacts. Some of the materials used in the inventory were accounted in an economic terms. The amount of coffee, beverage (wine, beer, soft drinks), or nuts are for instance counted in dollar. There is then an uncertainty when relating the US price of these materials to their price on the European market. As explained above it appears that these materials represent a large share of the drinks and foods environmental impacts. To have better understanding of these issues the model was run while excluding some of these materials. The results of the normalization showed in Figure 10, Figure 11 and Figure 12.

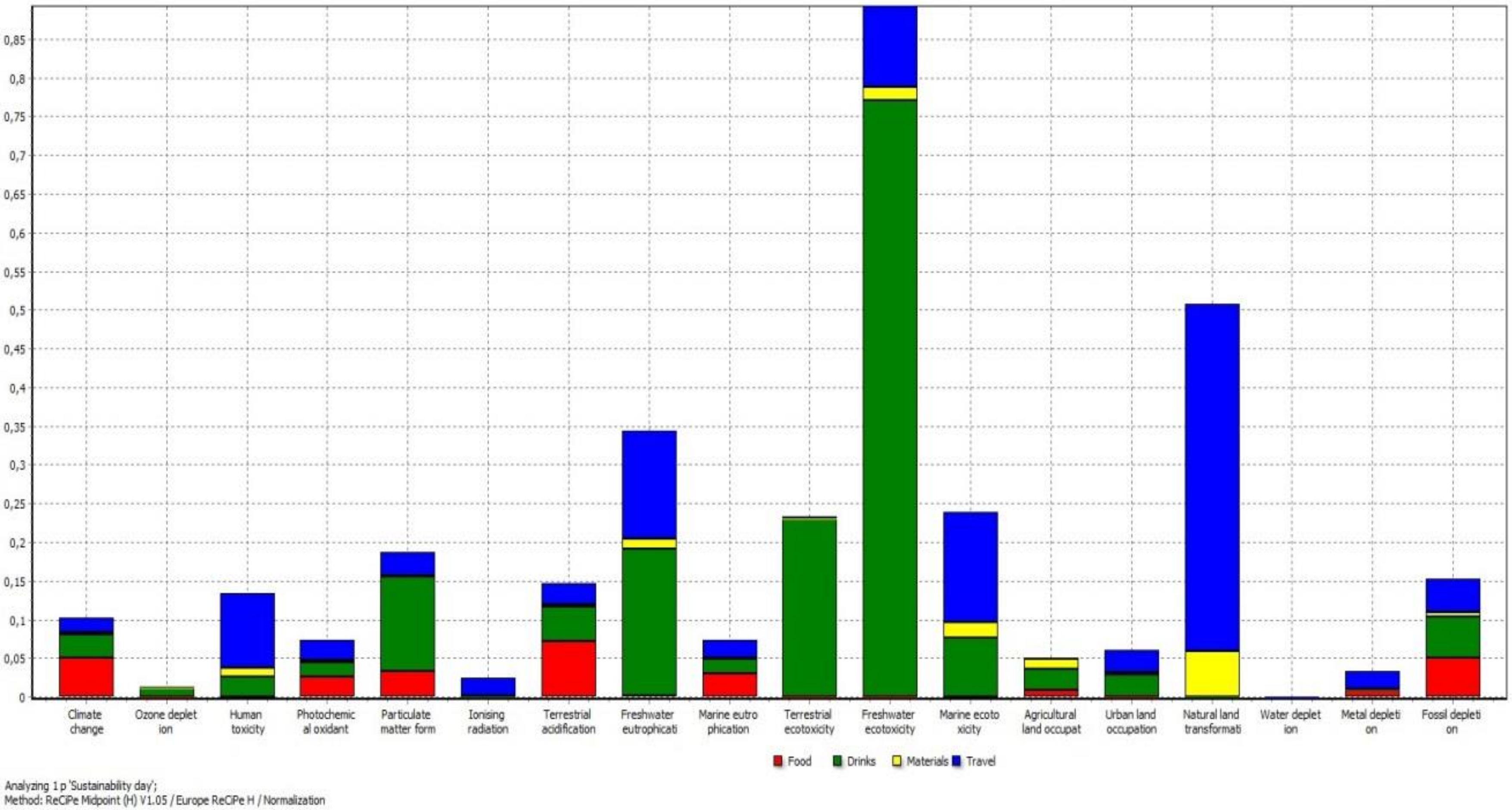

Figure 9 Normalization after excluding the walnuts from the model

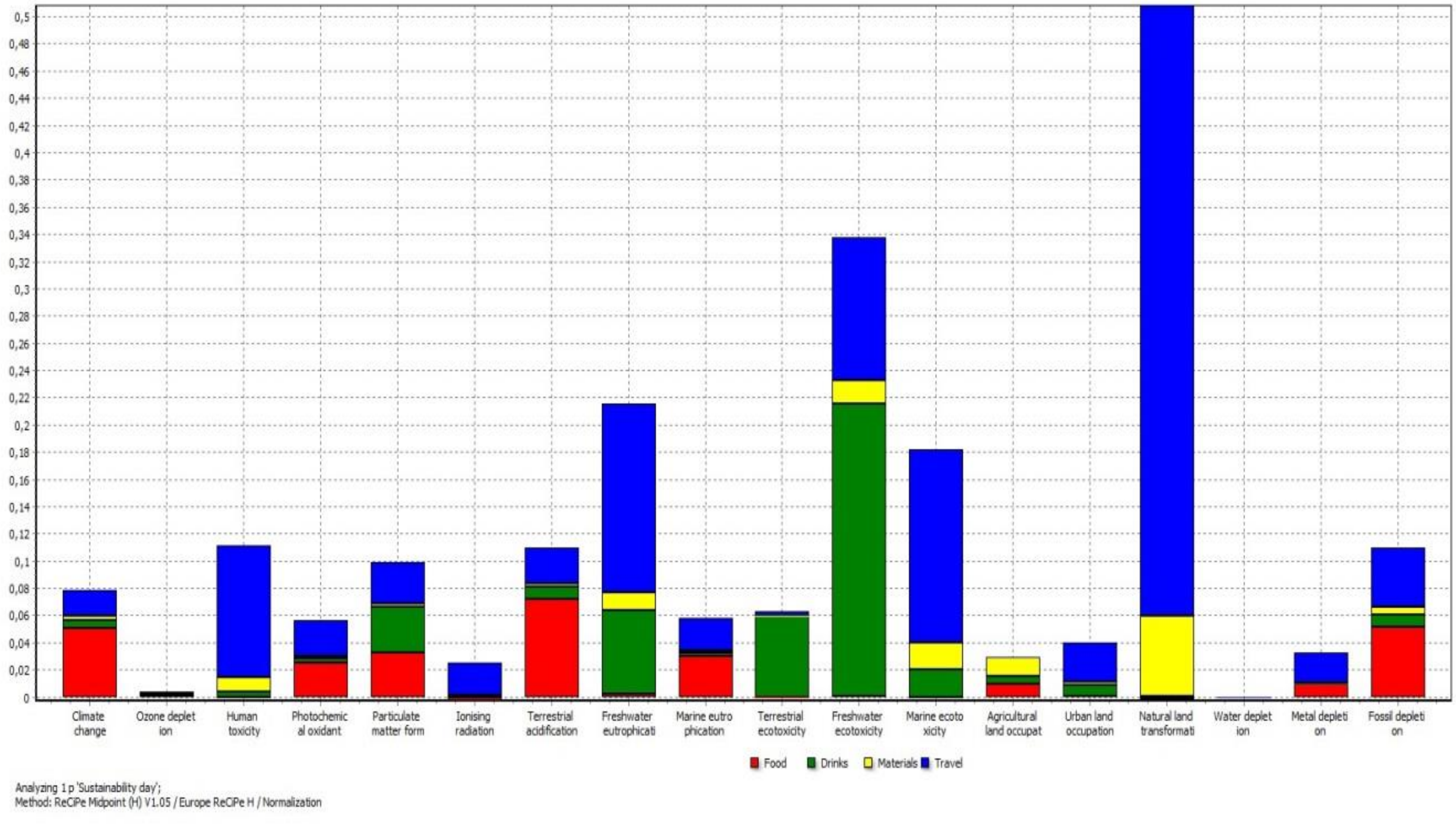

Figure 10 Normalization after excluding the walnuts and the beverage (wine, beer and soft drink) from the model

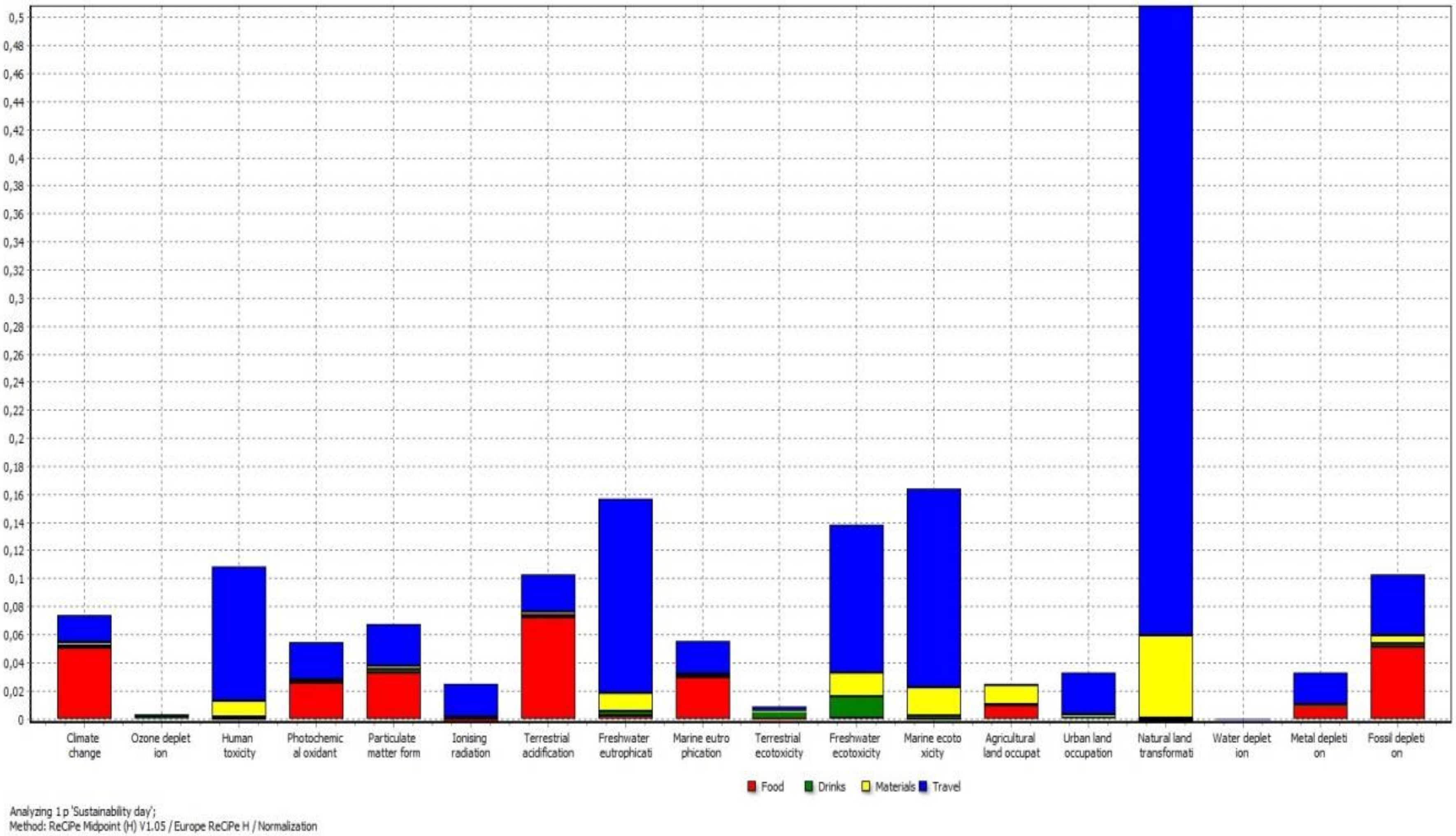

Figure 11 Normalization after excluding the walnuts and the beverage (wine, beer and soft drink) and the coffee of the model

The difference between the Figure 4 and the Figure 11 show us that the nuts are the most important contributor the environmental impact concerning the food (particularly for freshwater and terrestrial eco-toxicity). This finding could be a bit surprising as only a 1kg of walnuts have been accounted in the inventory. The impact could come from the type of farming used to produce nuts or because the impact is based on industry average of country of production, which might have high level of processing. The impacts of the drinks are mainly coming from the wine (2/3) and from the coffee (1/3). This result is much less surprising than for the nuts as wine and coffee need an intensive agricultural activity to be grown. Furthermore the distance between the production and consumption place are quite large. The database used for the wine is also from the US database, so it is expected to be American wine but in Sweden the wine will probably come from the southern Europe.

In Figure 12, the normalization without the three critical materials is shown. At that point the travel represents most of the environmental impact, and the food is also still present with impacts coming from the dairy products. However you see if these three major sources of impact are removed, the picture is turned up-side-down; even the material life cycle has a noticeable impact some categories. What is also worth noticing now is now only 6 impact categories has impact over 0,1 where it was 11 before.

5. Conclusion

There were identified eleven significant environmental impact categories: climate change, freshwater eco-toxicity, terrestrial eco-toxicity, marine eco-toxicity, natural land transformation, particulate matter formation, terrestrial acidification, fossil depletion and freshwater eutrophication. These impacts are mainly generated by the dairy products, nuts, wine, beer and soft drinks served during the KTH Sustainability Day event. The results obtained could have been affected by the database selected and the assumptions made for the analysis. As shown in the sensitivity analysis, the results of the model and the magnitude of the environmental impact are mostly affected by the walnuts, the transport, the drinks and the coffee. It should be kept in mind that this LCA was done in order to improve the ecological footprint of the event. As the organizer do not have a control on the transportation used by the participants a very few can be done on this part. Furthermore the wine and the coffee can be considered necessary for mingle. However the organizing committee could choose a different menu for mingle by using products with a lower environmental impact, so avoiding nuts and dairy and serving mainly tapped water. A very simple way to do that would be to use only ecological food. This could also be applied to the drink and coffee that could easily be found in an eco-labeled form. However, then it should be considered that other impact categories might be influence to a higher degree, e.g. does ecological farming require more arable land to produce the same amount as with conventional farming. (Cederberg, 1999) This document could be a reference for future LCA for the next year event

5.1 Recommendations for future studies

For future studies, it could be interesting to include the infrastructure's characteristics where the event is going to be held. The KTH Sustainability event is usually conducted at Nymble in KTH main campus. This building has determined characteristics for lighting and insulation that could not be easy to modify. It could be good to investigate the environmental burdens generated by the heat and electricity used during the event and if this could be improved by having the event in a more energy efficient building.

The event could reduce its environmental impact significantly by removing just four different elements in the event; this includes wine, beer, nuts and dairy.

If the administrators of the sustainability day would choose to consider only on some specific impact category, a more detailed investigation on that field would have been possible within the time limit of this course.

Moreover, it is fundamental to have a detailed data list of the sources during the event and waste handling to for making a good LCA analysis of future events. The next table presents an option to organize and collect the necessary information for the KTH- Sustainability Division.

KTH Sustainability Day			Date:	
	Amount	Unit	Waste Treatment	Specifications
Materials				
Posters				
Name tags				
…				
Materials for food and drinks				
Paper mugs				
Plastic spoons				
…				
Food				
Coffee break				
Apples				
Yoghurt				
…				
Mingle				
Menu 1				
Bread				
Shrimps				
…				
Menu 2				
….				
Lunch				
Potatoes				
Chicken				
…				
Drinks				
Breakfast				
Water				
Milk				
Mingle				
…				
Lunch				
…				

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15 december 2013

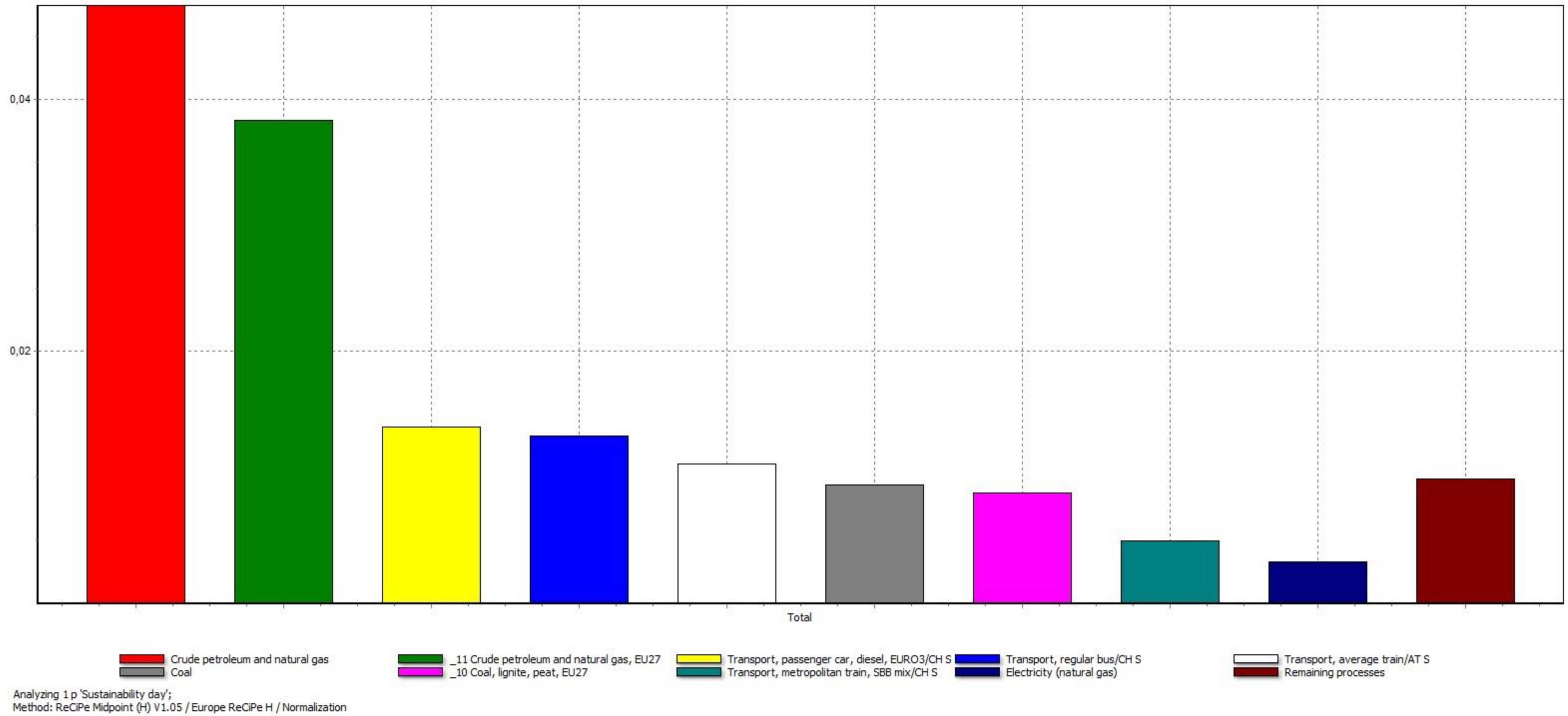
7 Appendix

Appendix 1

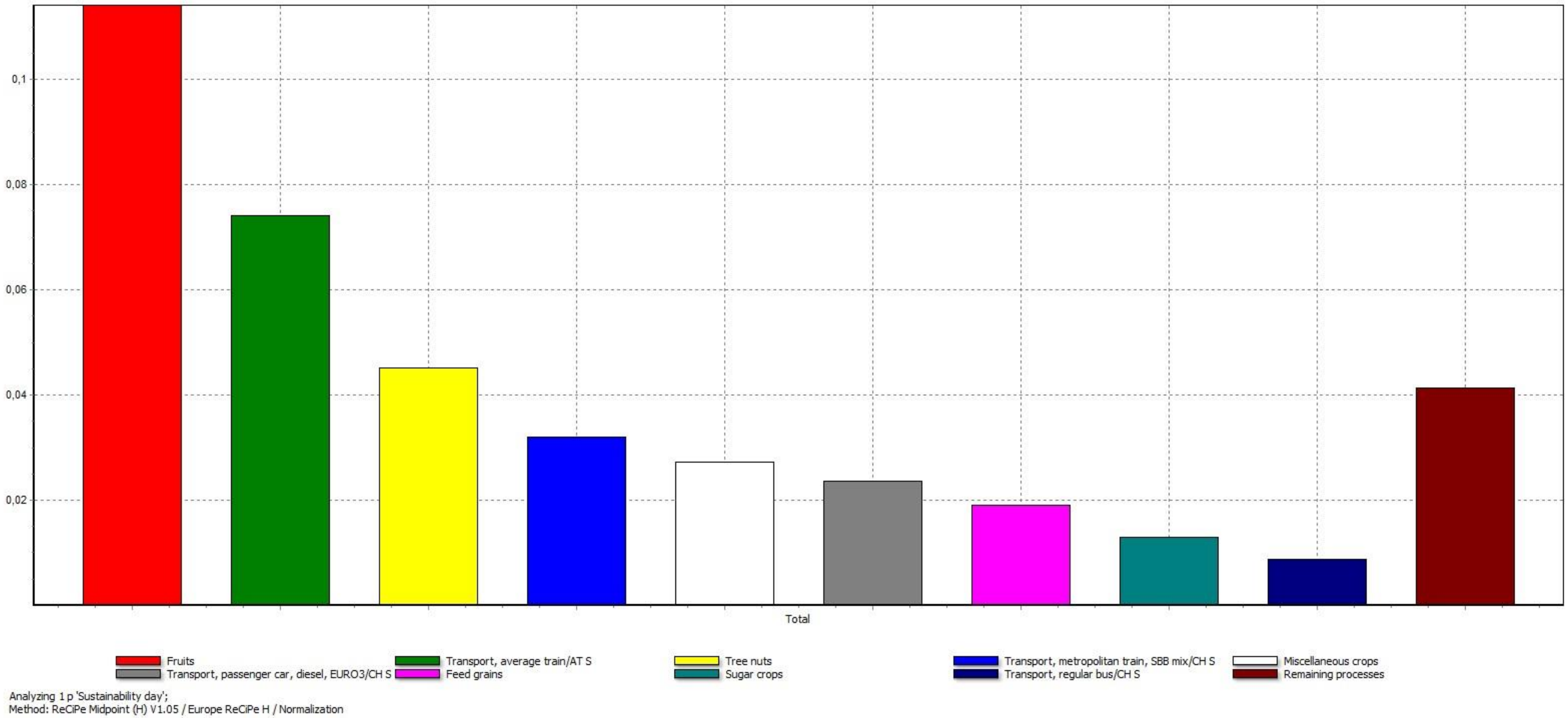
Item	Amount	Dimension/distance	Material	Weight	Total	data base
Material						
Posters						
- Printed paper	7	5551 [cm^2]	kraft paper, bleahed, at plant/RERU	100 g/m2	388,57 g	Ecoinvent system processes
- Reused	3		kraft paper, bleahed, at plant/RERU			Ecoinvent system processes
Roll ups						
- Borrowed	2		Galvanized steel sheet, at plant/RNA	3 kg	6 kg	USLCI
- paper			Viscose fibres, at platns/GLO s			Ecoinvent system processes
Name tags						
- Printed paper	260	28 [cm^2]	kraft paper, bleahed, at plant/RERU	100 g/m2	72,8 g	Ecoinvent system processes
- Plastic holders	260		Ethylvinylacateate, foil, at plant/RER U	5 g	1300 g	Ecoinvent unit processes
- Metal pin	260		Steel, billets, at plants/US	2,25 g	585 g	USLCI
Street talkers						
- Constructions	3	0,0014 m3	Galvanized steel sheet, at plant/RNA	11 kg	33 kg	USLCI
- Printed papers	6	0,4 m2	kraft paper, bleahed, at plant/RERU	100 g/m2	240 g	Ecoinvent system processes
- Plastic covers	6	0,0002 m3	Ethylene vinyle acetate copolymer, at plant/RER S	1000000 g/m3	2400 g	Ecoinvent system processes
Programs						
- Printed	270		kraft paper, bleahed, at plant/RERU	15 g	4050	Ecoinvent system processes
Food & Drinks						
Lunch						
- Cream			Cream 38%		500 g	LCA food DK
- chicken			chicken, fresh, in supermarket		2000 g	LCA food DK
- Potatoes			Potatoes IP, at farm/CH S		1500 g	Ecoinvent system processes
- Fruits	10		_21 Fruits and vegetebal, processed, EU27		750 g	EU & Dk input output Database
- Drinking water			Tap water, at user /CH S		2 kg	Ecoinvent system processes
- Soft drinks			Bottled and canned soft drinks		7,5 $	USA input output database 98
Break						
- Coffee	150	10 g	Roasted coffee	0,014	20,5026455 USD	USA input output database
- Tea	200	0,5 $	Coffe-roasting & tee-packing NL		100 $	Dutch input output database 95
- Water		55 l	Tap water, at user /CH S		55 l	Ecoinvent system processes
- Paper mugs	200	13 g			2600 g	
- Ecological Yoghurt	200	0,15 l	_20 diary products, EU27		30 kg	EU & Dk input output Database
- Home made granula	200	30 g	Oat, organic, form famr		6000 g	LCA food DK
- Fresh berries	200	10 g	_21 Fruits and vegetebal, processed, EU27		2000 g	EU & Dk input output Database
- Apples	-	-	_21 Fruits and vegetebal, processed, EU27		15 kg	EU & Dk input output Database
- Plastic spoons	200	2 g	PET (bottle grade) E		400 g	Industry data 2.0
- Plastic mugs	200	10 g	PET (bottle grade) E		2000 g	Industry data 2.0
Mingle						
- Wine	12	8 $/bottle	Wines, Brandy, and brandy spirits		96 $	USA input output database 98
- Empty Wine	12		Glass zero bruden KTHS day	420 g	5,04 kg	
- Beer	80	1 $/bottle	Bottled and canned soft drinks		80 $	USA input output database 98
- Empty Beer	80		Glass zero bruden KTHS day	210 g	16,8 kg	
- Soft Drinks	80	0,5 $/bottle	Bottled and canned soft drinks		40	USA input output database 98
- Empty Soft Drinks	80		Metal cans zero burden sustainability day	210 g	16,8 kg	
- Menu 1: Small rye bread with beancream and cabages			200 portions			
Dark bread		33,15 g	Bread, rye, conventional, fresh		6,63 kg	LCA food DK
Dairy (creme)		10 g	Cream 38%		2 kg	LCA food DK
Cabbages (groddar)		2 g	Fava beans IP, at farms/CH S		0,4 kg	Ecoinvent system processes
Rootfruit (beans)		10 g	_21 Fruits and vegetebal, processed, EU27		2 kg	EU & Dk input output Database
- Menu 2: Cold artichokesoup with croutons		0,3 l	200 portions			
Rootfruit (artichoke)		10 g	Carrot, conventional, washed and packed, from cool house		2 kg	LCA food DK
Water		15 g	Tap water, at user/RER S		3 kg	Ecoinvent system processes
Dairy (creme)		15 g	Cream 38%		3 kg	LCA food DK
Bread (croutons)		5 g	Bread, wheat, fresh, in supermarket		1 kg	LCA food DK
- Menu 3: Salad with wallnuts and cress			200 portions			
Vegetables (sallad)		15 g	_21 Fruits and vegetebal, processed, EU27		3 kg	EU & Dk input output Database
Wallnuts		5 g	Salted and roasted nuts and seeds		1 kg	USA input output database 98
Vegetables (Cress)		2 g	_21 Fruits and vegetebal, processed, EU27		0,4 kg	EU & Dk input output Database
- Menu 4: Blini with smoked salmon and horseradish			200 portions			
Light bread		10 g	Bread, wheat, fresh, in supermarket		2 kg	LCA food DK
Fish (Smoked Salmon)		15 g	Mackerel fillet, fresh, whole sale (no quotas)		3 kg	LCA food DK
Rootfruit (Horseradish)		1 g	Carrot, conventional, washed and packed, from cool house		0,2 kg	LCA food DK
Dairy (creme)		10 g	Cream 38%		2 kg	LCA food DK
- Menu 5: Toast skagen			200 portions			
Light bread (Toast)		15 g	Bread, wheat, fresh, in supermarket		3 kg	LCA food DK
Dairy (creme)		15 g	Cream 38%		3 kg	LCA food DK
Fish (shrimps)		5 g	Shrimps, fresh, in supermarket (no quotas)		1 kg	LCA food DK
- Menu 6: Västerbotten mess with cloudberry on pumpernickel bread			200 portions			
Dark bread (pumpernickel)		20 g	Bread, rye, conventional, fresh		4 kg	LCA food DK
Berries (cloudberry)		10 g	_21 Fruits and vegetebal, processed, EU27		2 kg	EU & Dk input output Database
Creme, cheese (the mess)		15 g	Cheese, in supermarket		3 kg	LCA food DK
Travel	262	average km				
- Commuting to KTH (walking)		40	walking		80 km	LCA food DK
- Commuting to KTH (bus)		300	Transport, regular bus/CH S		600 km	Ecoinvent system processes
- Commuting to KTH (car)		200	Transport, passenger car, diesel, EURO3/CH S		400 km	Ecoinvent system processes
- Commuting to KTH (subway)		1500	Transport, metropolitan train, SBB mix/CH S		3000 km	Ecoinvent system processes
- Biking to KTH		50	Biking		100 km	LCA food DK
- Long distance train		476	Transport, average train/AT S		952 km	Ecoinvent system processes
Waste disposal						
waste water			Waste water - untreated, slightly organic contaminated EU27 S			ELCD
recycled glass			Recycling glass/RER S			Ecoinvent system processes
recycled aluminum			recycling non-ferro/RER S			Ecoinvent system processes
Incinerated wastes			Waste incineration of municipal solid waste (MSW), EU.27 - Sustainability day			Sustainability Daz
Recycled paper			Recycling paper/RER S			Ecoinvent system processes
Recycled steel			Recycling steel and iron/RER S			Ecoinvent system processes
Processes						
Drinks						
Washing glasses	200		Eletricitz, production mix SE/SE S		3 KWh	Ecoinvent system processes
boiling water for coffe and tea			Boiling of water in el. kettle		55 l	LCA food DK
Food						
Baking bread			Baking of big bread		33 p	LCA food DK
Boling soup			Boiling of vegetebales		8 kg	LCA food DK
Washing plates	200		Electricity, production mix SE/SE S		3 KWh	Ecoinvent system processes
Material						
Printing programs, posters and name tags			use, printer, laset jet, b/w, per kg printed paper(CH S		5,2 kg	Ecoinvent system processes

Appendix 2

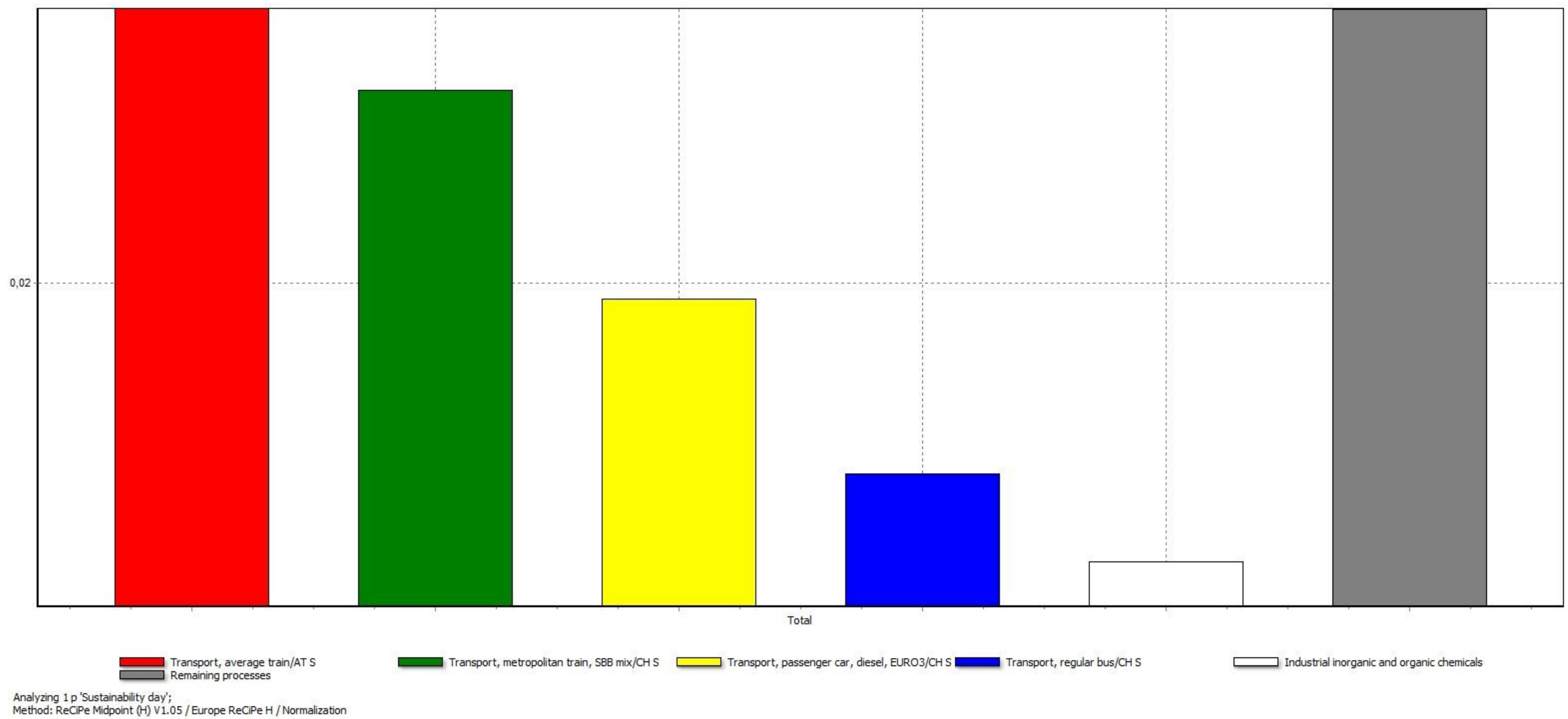
Fossil Depletion



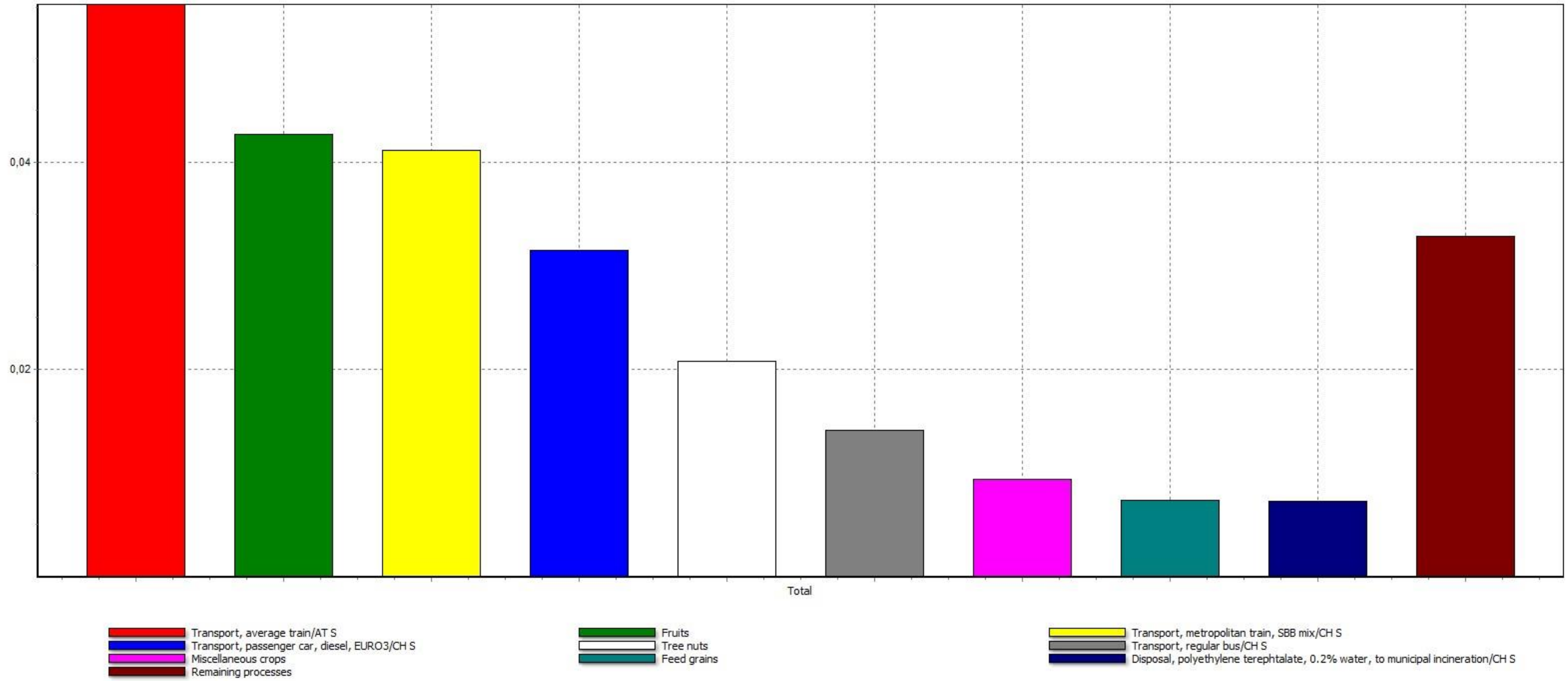
Freshwater eutrophication



Human toxicology

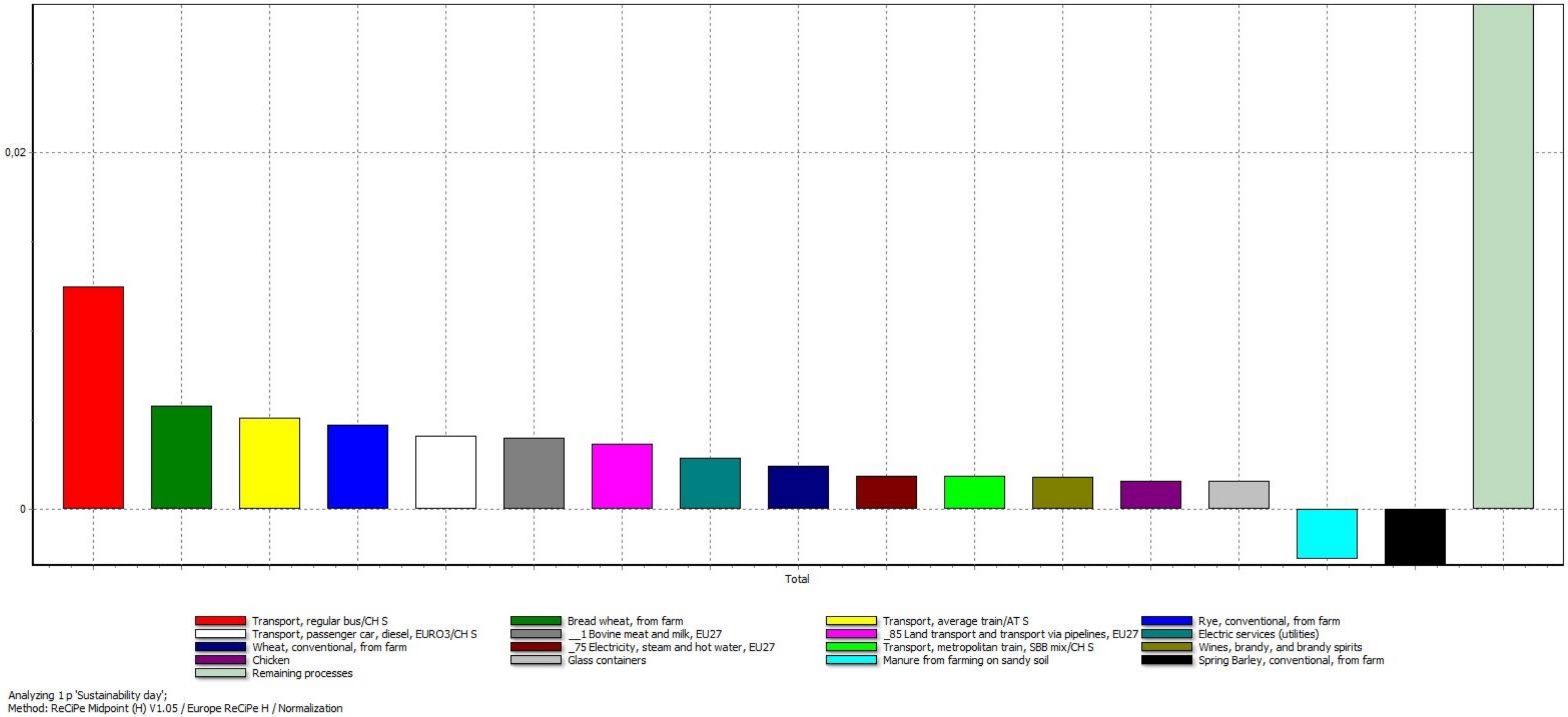


Marine Eco-Toxicity

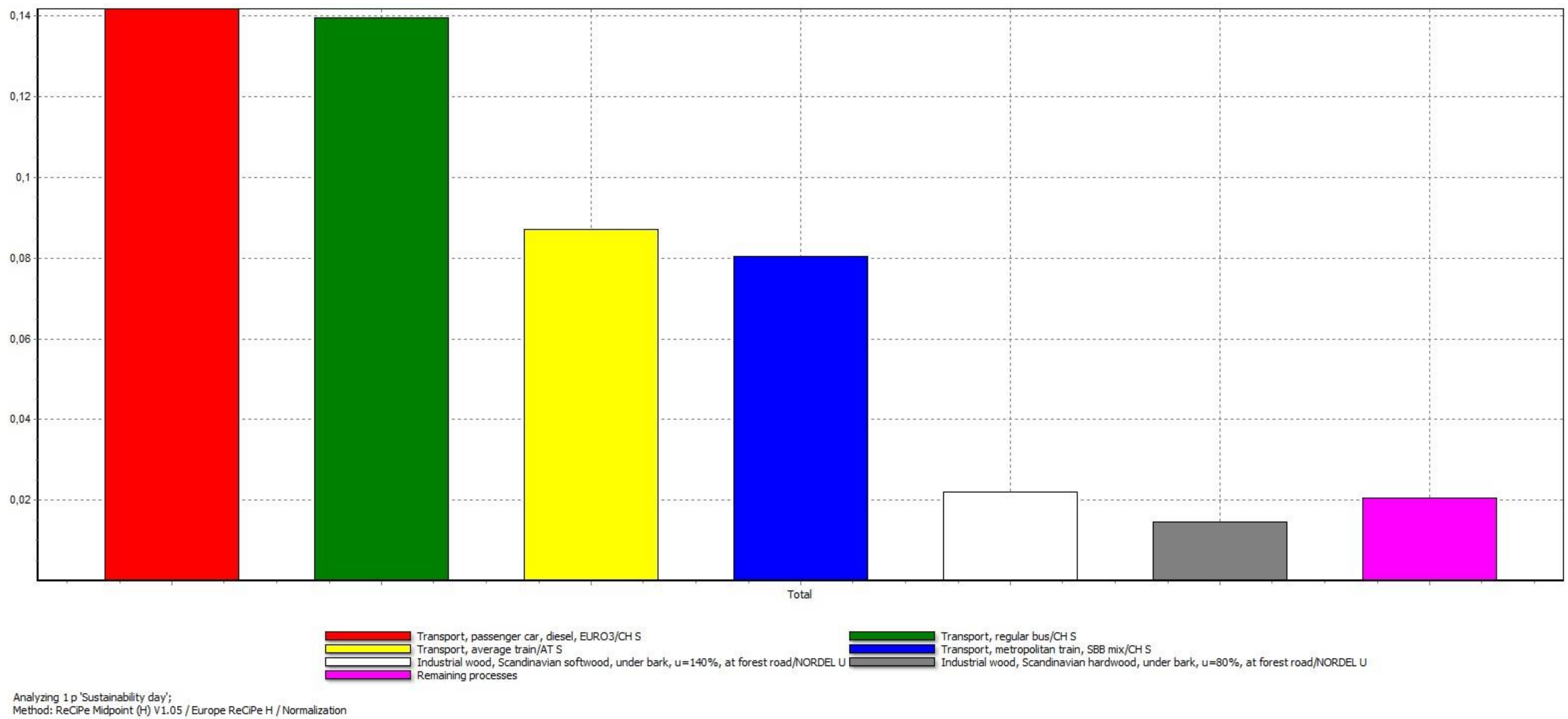


Analyzing 1 p 'Sustainability day';
Method: ReCiPe Midpoint (H) V1.05 / Europe ReCiPe H / Normalization

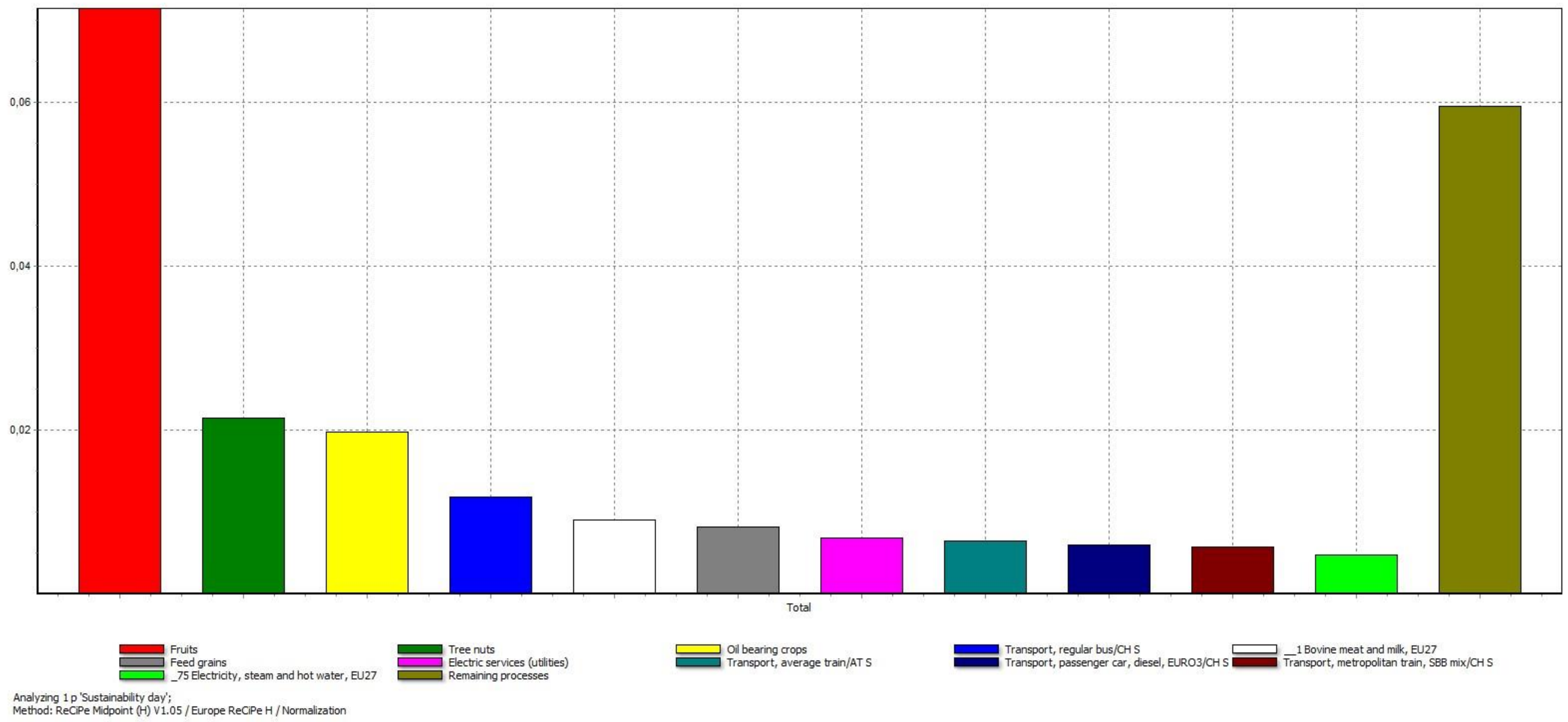
Marine Eutrophication



Natural Land Transformation



Particulate Matter Formation



Terrestrial Acidification