Natural mink fur and faux fur products, an environmental comparison

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Contents

Summary

In 2010, CE Delft published an LCA study on the environmental impact of mink fur. In the study, based on publically available sources, the environmental impact of 1 kg of mink fur was assessed. The result was compared with 1kg of other types of cloth: cotton, polyester (PET), wool and polyacryl. The study (CE Delft, 2010) did not compare actual products: it was a 'cradle to gate' study. The present study takes off where the 2010 study finished: the study is extended to a 'cradle to grave' study in which the impact of natural mink fur products are compared to the impact of faux fur products, including the use phase and waste treatment after final disposal. The selected products for this study are:

- a natural mink fur coat, compared to a faux fur coat;
- a natural mink fur trim, compared to a faux fur trim.

Some aspects include uncertainty and sometimes it is necessary to make assumptions. In this study we attempted to reduce the risk that a change in assumptions will change the conclusions. When given the choice, we selected the option that will minimize the difference in results. In practice, this means that for natural fur we selected the option that is likely to be the lower boundary and for faux fur we selected the option that is likely to be the upper boundary.

Two influential aspects in a comparative LCA of a natural fur coat and a faux fur coat are the lifespan of the coats and the necessary maintenance.
No publically available research results were found for the average lifespan of either a natural fur coat or a faux fur coat. In an LCA study, commissioned by the fur industry (DSS, 2011), it is assumed that a natural fur coat has a lifespan that is five times longer than a faux fur coat. However, other scenarios are also a possibility. For instance, it is conceivable that the lifespan is determined by the change in fashion; in this case the lifespan of a natural fur coat and a faux fur coat could be equal. To what extent maintenance is required depends on regional circumstances, like temperature and atmospheric humidity. To what extent maintenance really is applied depends on personal choices.
Results are shown for these two mentioned scenario's, with a variation in maintenance. In the body of the report, results are also shown for a variable lifespan and with a variation in maintenance scenario.

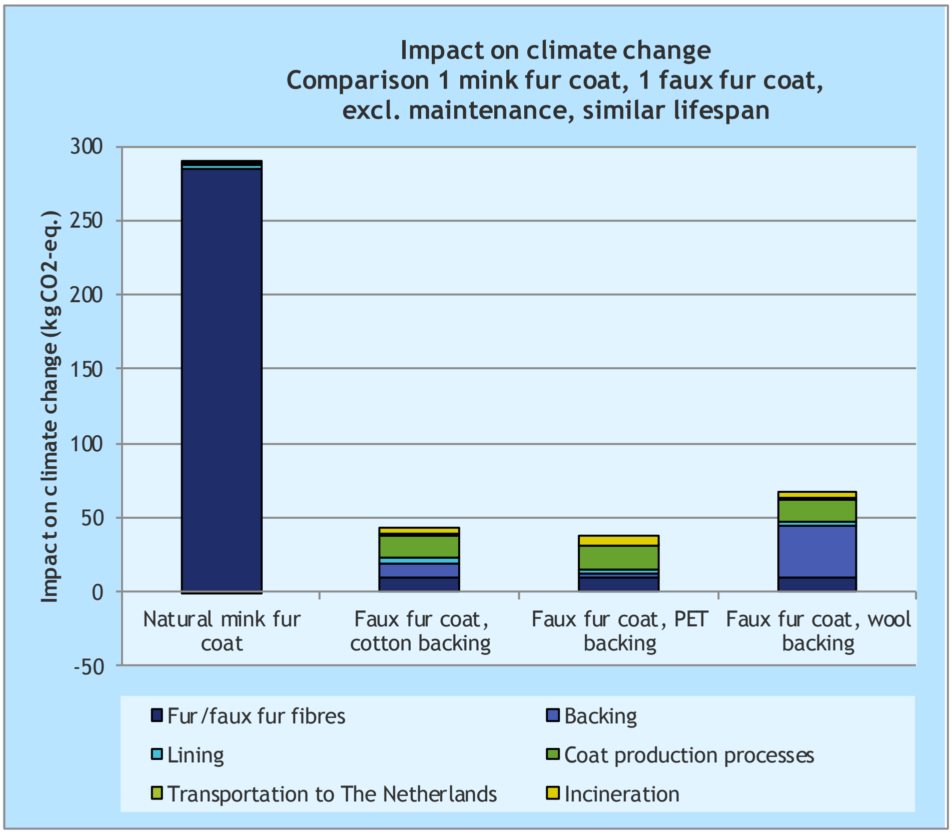
Two environmental assessment methods are applied: the ReCiPe midpoint method and the ReCiPe single score. The midpoint assessment method calculates a large number of individual environmental impacts; the single score assessment weighs these impacts into one single environmental indicator.

Results
The assessment clearly shows that the environmental impact of natural mink fur coats and trims is higher than the impact of faux fur coats and trims. In the figure below this is illustrated: it compares 1 natural mink fur coat with 1 faux fur coat, excluding possible maintenance.

The type of backing of the faux fur is of influence to the results, but the difference between the faux fur types is smaller than the difference between natural mink fur and faux fur.

The difference in impact in the climate change result between the natural mink fur coat and the highest scoring faux fur coat is a factor of 4. The natural fur coat will only have a better result for impact on climate change than a faux fur coat when it has at least a 4 times longer lifespan.

Impact on climate change: comparison one fur coat, one faux fur coat; excluding maintenance, similar lifespan

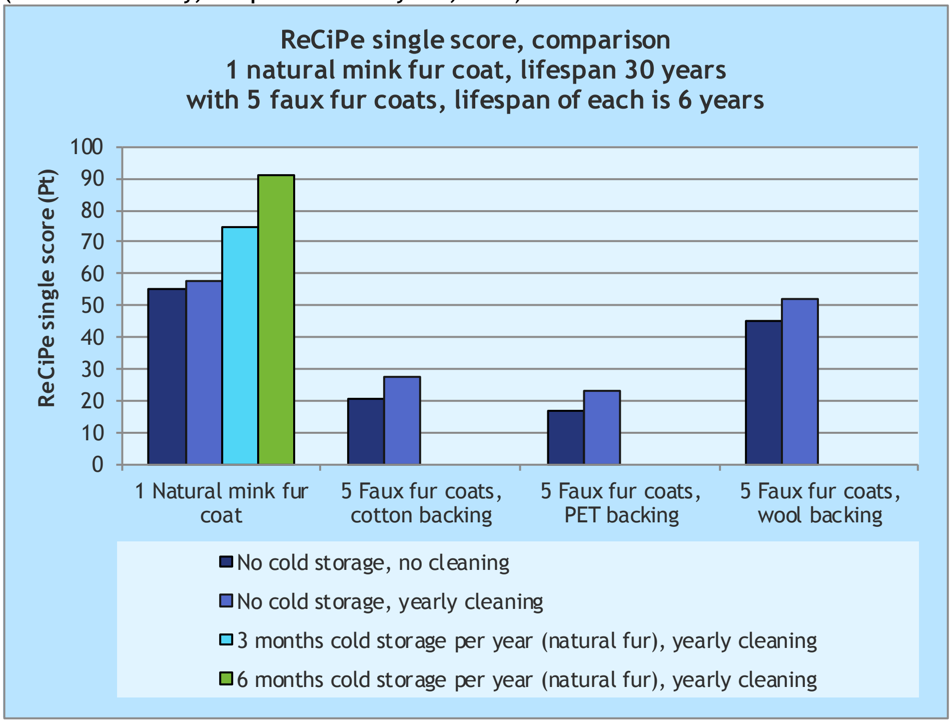


For all environmental effects the difference in score is at least a factor 3; for a large number of environmental effects the factor is higher than 10.
The ReCiPe single score result shows a difference factor of 6 (woollen backing) to 17 (PET backing).

For the natural mink fur trim and faux fur trims, similar ratios between the environmental results apply. Even when a natural fur trim is reused once or twice, on a new product (coat, vest), and the faux fur trim is not, the impact of a natural mink fur trim is higher.

The figure below shows the comparison between the results for the ReCiPe single score for one natural mink fur coat and five faux fur coats. Such a lifespan is according to the assumption by the natural fur industry (DSS, 2011). Results are calculated for various scenarios for cold storage and cleaning. The ReCiPe single score results show that the use of five faux fur coats has less impact than the use of one natural mink fur coat, although the score of five fake fur coats with woollen backing approaches the score of one natural mink fur coat if cold storage during warm months is not taken into account.
When cold storage is required, the score for the natural fur coat increases.

ReCiPe single score, comparison of 1 natural mink fur coat with 5 faux fur coats
(CE Delft inventory, lifespan scenario by DSS, 2011)



Conclusions

In case of equal lifespan, a natural mink fur product will always have a higher environmental impact than faux fur, even when the lowest possible environmental impact is used for the feed of the minks. Only when the difference in lifespan of a natural mink fur product and the faux fur product is a factor 4 or more, the natural mink fur product will have a better score on some of the environmental effects, provided that no cold storage is applied.

When active cooling is required to obtain a long lifespan, the difference in impact between the natural mink fur coat and a faux fur coat increases.

Samenvatting

In 2010 bracht CE Delft een rapport uit over de milieukundige impact van nertsenbont. In die studie is op basis van openbare literatuur de milieu-impact bepaald van 1 kilogram nertsenbont, die vervolgens werd vergeleken met 1 kilogram aan andere stof: katoen, polyester, wol en polyacryl. In de studie werd echter geen vergelijking gemaakt tussen daadwerkelijke producten gemaakt van echt bont en nepbont. Het was daarmee een ‘cradle-to-gate’-studie. Voorliggende studie gaat verder waar de studie uit 2010 gestopt is: de studie is uitgebreid tot een volledige ‘cradle-to-grave’-studie door verschillende producten te vergelijken, inclusief gebruiksfase en eind-verwerking na afdanking. De producten waarvan de echte bont- en nepbontvariant worden vergeleken, zijn een jas en een kraagje.

Voor de inventarisatie van gegevens, die ten grondslag ligt aan de vergelijkende analyse, is gebruik gemaakt van openbaar beschikbare bronnen. Enkele aspecten brengen onzekerheid met zich mee en soms is het doen van aannames onvermijdelijk. Bij het doen van aannames is getracht het risico dat verandering van aanname de conclusie verandert, zo klein mogelijk te houden. Omdat het beeld is dat echt bont veel milieubelastender is dan nepbont, betekent dit dat we bij het doen van aannames de meest behoudende gegevens voor bont en de meest verstrekkende gegevens voor nepbont hebben geselecteerd.

Twee zeer belangrijke factoren in de vergelijkende LCA van een echte bontjas en een nepbontjas zijn de levensduur en het benodigde onderhoud. Benodigd onderhoud hangt echter af van regionale omstandigheden (temperatuur, luchtvochtigheid) en persoonlijke keuzes. Er zijn geen openbare bronnen beschikbaar voor gemiddelde levensduur voor zowel bontjassen als nepbontjassen. In een onderzoek, uitgevoerd in opdracht van de bontindustrie (DSS, 2011), is de aanname gemaakt dat de echte bontjas vijf keer zo lang meegaat als de nepbontjas. Er zijn echter ook andere scenario’s denkbaar. Het is bijvoorbeeld ook denkbaar dat de veranderende mode de gebruiksduur bepaalt; in dat geval is de gebruiksduur van een echte bontjas en nepbontjas gelijk.
De resultaten worden getoond voor deze uitersten in levensduur (een vergelijking van één echte bontjas met één nepbontjas, en een vergelijking van één echte bontjas met vijf nepbontjassen) en voor een aantal scenario’s voor onderhoud. In het hoofdrapport wordt ook de resultaten getoond voor variabele levensduur en met variatie in onderhoudscenario.

De milieu-impactmethodes ReCiPe midpoint en ReCiPe single score zijn gebruikt voor de analyse. Met de midpoint-analyse worden een groot aantal milieueffecten berekend; met de single score-analyse worden deze milieu-effecten gewogen tot 1 milieuschade-indicator.

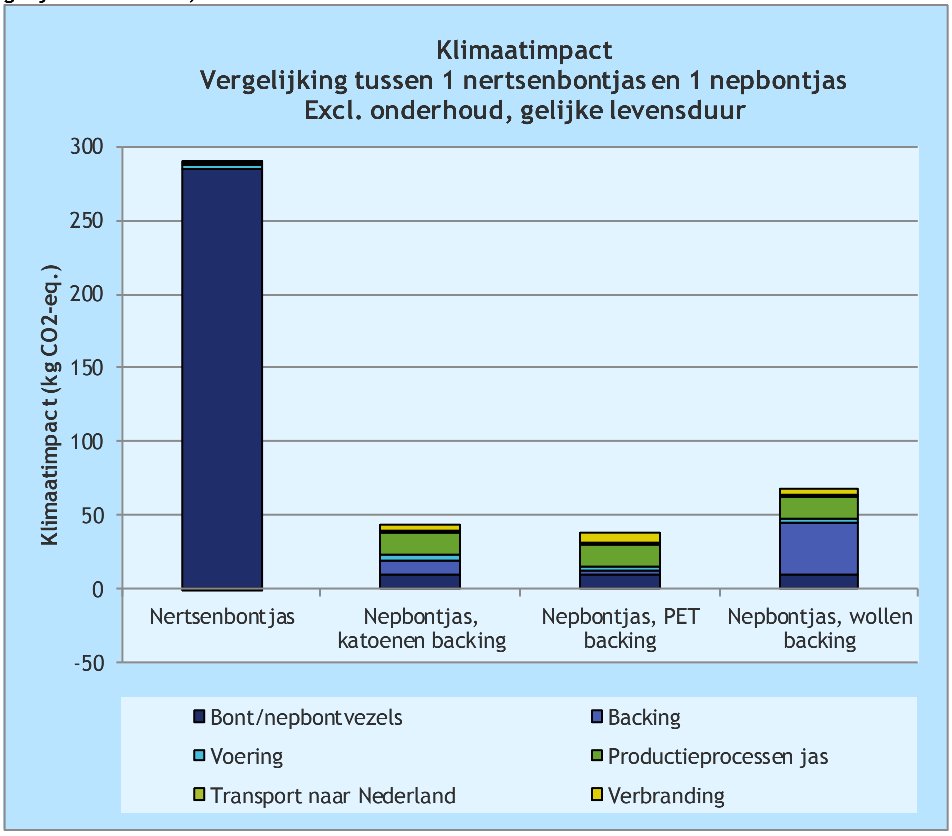
Resultaten

Onze analyse toont duidelijk aan dat de milieu-impact van jassen en kraagjes uit echt bont een stuk hoger is de milieu-impact van jassen en kraagjes uit nepbont. Voor de klimaatimpact van jassen is dit weergegeven in het volgende figuur: hier wordt 1 bontjas met 1 nepbontjas vergeleken en wordt eventueel onderhoud niet meegenomen.

Er is een klein verschil tussen varianten van nepbont, dat veroorzaakt wordt door het type backing. Het onderlinge verschil is kleiner dan tussen echt bont en nepbont.

Voor de klimaatimpact geldt dat de echte bontjas alleen een lagere klimaatimpact heeft als de echte bontjas ten minste vier keer langer meegaat dan de nepbontjas.

Milieu-impact klimaatverandering, voor een jas van echt bont of nepbont (drie types), voor gelijke levensduur, zonder onderhoud

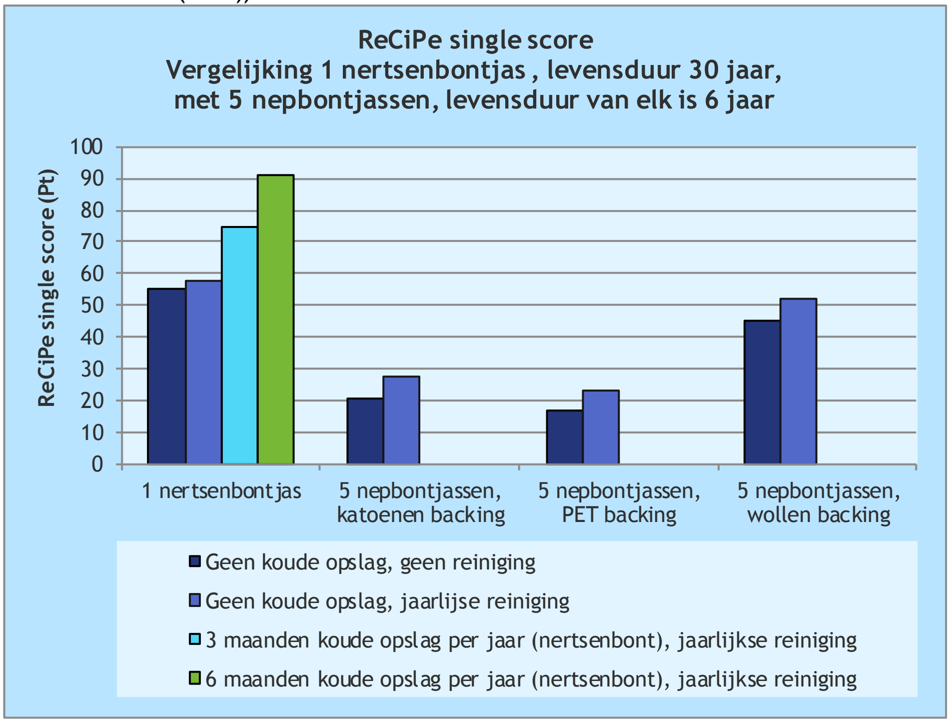


Voor alle milieueffecten geldt dat het verschil in score tussen de echte bontjas en nepbontjas groter is dan een factor 3; voor een groot aantal milieueffecten geldt een factor hoger dan 10. Voor de ReCiPe single score geldt dat het verschil in score een factor 6 (wollen backing) tot 17 (PET backing) is.

Voor kraagjes geldt eenzelfde impactverhouding tussen echt bont en nepbont als voor de 1-op1 vergelijking van jassen. Ook als een bontkraag zou worden hergebruikt op een nieuw product (jas, vest) en de nepbontkraag niet, is de impact van de echte bontkraag hoger.

In het volgende figuur is weergegeven hoe de milieu-impact (ReCiPe single score) van één bontjas zich verhoudt tot de milieu-impact van vijf nepbontjassen. De onderliggende aanname, door de bontindustrie, is dat een bontjas vijf keer zo lang meegaat dan een nepbontjas (DSS, 2011). Er zijn een aantal scenario's voor gekoelde opslag en reiniging berekend. Zoals is te zien scoort gebruik van vijf nepbontjassen lager dan gebruik van één echte bontjas. De score van 5 nepbontjassen met wollen backing benadert de score van 1 bontjas, indien wassen en koel opslaan in de zomermaanden buiten beschouwing worden gelaten. Met jaarlijkse koeling van de bontjas stijgt de score van de bontjas.

ReCiPe single score, 1 echte bontjas en 5 nepbontjassen, inclusief de invloed van onderhoud gedurende de levensduur van de producten (inventarisatiegegevens CE Delft, levensduur-scenario van DSS (2011))



Inventarisatiegegevens CE Delft, levensduur-scenario van DSS (2011)).

Conclusies

Wanneer de levensduur van een echt bontproduct en een nepbontproduct gelijk is, zal het nepbontproduct altijd de laagste milieuscore hebben, zelfs wanneer voor echt bont wordt gerekend met de laagste milieu-impact voor het voer voor de nerts. Pas wanneer de levensduur van een echt bontproduct een factor 4 of meer hoger ligt dan het vergelijkbare nepbontproduct is het mogelijk dat het bontproduct een betere score behaalt op sommige milieueffecten, mits geen koeling gedurende de zomerperiode plaatsvindt.

Als het nodig is om een hoge levensduur te bereiken door actief te koelen tijdens warme maanden, wordt het verschil in impact tussen een echte bontjas en nepbontjas vergroot.

1 Introduction and inventory

1.1 This study

In 2010, CE Delft published an LCA study on the environmental impact of mink fur. In the study, based on publically available sources, the environmental impact of 1 kg of mink fur was assessed. The result was compared with 1 kg of other types of cloth: cotton, polyester (PET), wool and polyacryl. The study (CE Delft, 2011a) did not compare actual products: it was a 'cradle-to-gate' study. The present study takes off where the 2010 study finished: the study is expended to a 'cradle-to-grave' study in which the impact of natural fur products are compared to the impact of faux fur products, including the use phase and waste treatment after final disposal. The selected products for this study are:

- a natural fur coat, compared to a faux fur coat;
- a natural fur trim, compared to a faux fur trim.

For natural fur, the inventory data and results apply to mink fur. In Europe, other animals are kept for their fur as well, such as foxes and chinchillas. The life cycle of coats made from these animals is similar in nature: they are kept for their fur only and transportation routes of the fur, production and maintenance of the product are similar. CE Delft cannot state, however, that the results in this report are representative for natural fur types other than mink, since aspects that influence the results might differ, such as size of the animals (amount of fur needed per m^2), life span of the animals (which influences the total amount of feed needed), feed composition and manure composition.

In 2011, DSS Management Consultants performed an LCA study of natural fur coats and faux fur coats, commissioned by the International Fur Trade Federation (IFTF), of which a public summary was published. CE Delft has requested the full report from IFTF, in order to be able to match assumptions and learn which sources were used. This request remained unanswered by IFTF. The public summary does not list the inventory data that are at the basis of the study. Therefore, it is unknown to what extent sources and assumptions match and what exactly cause the differences between the results.

1.2 Goal and scope

The goal of this study is to compare the potential environmental impact of natural mink fur products with faux fur products. Two types of products are selected for this comparison: fur coats and fur trims. When it says in the report 'fur product', we refer to both natural mink fur and faux fur products; if only one of the fur types is referred to, this is explicitly stated ('natural fur', 'natural mink fur' or 'faux fur')

1.2.1 Functional units

The functional unit is the subject of the assessment: that what is to be assessed. In this study we have performed four assessments, with slightly different functional units:

1. A fur coat with similar lifespan, no maintenance.
2. A fur coat with variable lifespan, various maintenance scenarios.
3. A natural mink fur coat with a lifespan of 30 years compared to five faux fur coats with a lifespan of six years each (DSS scenario), various maintenance scenarios.
4. A fur trim.

In this study, CE Delft chooses not to make a statement on the most feasible lifespan and maintenance scenario. Instead, we give insight in how the choice of maintenance, lifespan and relative lifespan determines the LCA results. For natural fur coats, many scenarios for lifespan and maintenance are possible. No public data are available for the average use and lifespan of natural fur coats and faux fur coats.
Individual coats are different in nature and the location of use (country, region) and how the user of the coat treats and maintains the coat all have influence on the lifespan.

With the results of the four assessments, the reader can determine for which conditions one coat type has a better environmental result than the other coat type.

1.2.2 System boundaries

The environmental assessment is a life cycle assessment and covers all life cycle phases of the coats and trims, from production of the natural fur and synthetic fibres to final disposal at the end-of-life of the product.
The Netherlands is selected as reference country, as representative for Western Europe.

Table 1 System boundaries for the natural mink fur coat

Life cycle aspect	Explanation
Feed production for minks	These life cycle aspects are inventoried in CE Delft, 2011a. For detailed description of these steps and allocation rules see the report 'The environmental impact of mink fur production' (CE Delft, 2011a)
Animal raising (in the Netherlands)	
Pelt preparation	
Disposal of carcass	
Transportation to Norway for auctioning	
Transportation to Greece	
Fur treatment	
Manufacturing of viscose lining	
Coat construction	
Transport to the Netherlands	
Use of the natural fur coat: maintenance (optional)	Various maintenance scenarios: cleaning and cold storage
Waste treatment after final discarding of the coat: incineration	Including energy and heat generation

The system boundaries for the natural mink fur trim are the same, with exception of the viscose lining and maintenance[1].

[1] No lining and maintenance included; see the data inventory for explanation.

Table 2 System boundaries for the faux fur coat

Life cycle aspect	Explanation
Production of acrylic fibres	All the production steps, including the manufacturing of the faux fur coat, are assumed to take place in China
Production of fibres for backing	Three backing types are assessed: cotton, polyester (PET) and wool
Production of backing out of various fibre materials	
Production processes for making faux fur out of the acrylic fibres and backing	Various production processes are included
Manufacturing of viscose lining	
Coat construction	
Transport from China to the Netherlands	
Use of the coat: maintenance (optional)	Optional: washing of the coat
Waste treatment after final discarding of the coat: incineration	Including energy and heat generation

Not included are the auctioning of the fur coat and additional materials on the coat such as zippers and buttons.

1.2.3 Environmental impact assessment

This study includes two environmental impact assessments:

1. ReCiPe midpoint assessment, which calculates many environmental effects. In this study we focus on the impact on climate change: the results for this effect are shown in graphs; the results for other environmental effects are shown in tables.
2. ReCiPe single score assessment, which expresses the environmental effects in terms of damage and weighs the damage categories into one environmental score. The single score results are shown in graphs.

In Annex A, the ReCiPe method, the various environmental effects and the relation between the Midpoint level and single score are explained.

1.2.4 Modelling, software and databases

For modelling the life cycle of fur products, CE Delft makes use of the dedicated software programme SimaPro. This software program enables modelling and, after completion of the model, assessment of the life cycle. Modelling is enabled through the availability of databases with environmental information about materials, production processes, waste treatment processes, etc. For general background processes like materials and electricity consumption, we use the Ecoinvent database. In addition to the more general Ecoinvent database, we make use of specific LCI data from other sources, for instance for textile production processes (elaborated on in Section 1.3.2).

1.3 Data inventory

This paragraph presents the background data for the environmental assessment. With these data, the life cycle of natural fur and faux fur is modelled and, subsequently, environmentally assessed.

Some aspects include uncertainty and sometimes it is necessary to make assumptions. It is attempted in this study to reduce the risk that change in assumption will change the conclusions. When given the choice, we selected the option that will minimize the difference in results. In practice, this means that for natural fur we selected the option that is likely to be the lower boundary and for faux fur we selected the option that is likely to be the upper boundary.

1.3.1 Production of natural mink fur

The production of natural mink fur - production in the Netherlands as representative of fur keeping in Europe - was assessed in a previous report by CE Delft. For the background data of mink keeping and management, animal processing and pelt processing we refer to (CE Delft, 2011a). This report calculates the environmental impact of 1 kg of natural fur, ready to be used in clothing or other fashion objects.

One sensitivity assessment is added: the influence of a change in mink feed composition is investigated. The environmental impact of fish offal is lower than the impact of chicken offal. As a sensitivity assessment, the scenario which leads to the least impact is calculated, in which minks are supposed to eat only fish offal.

Table 3 Mink feed: base scenario and alternative (least impact) scenario

	Fish offal	Chicken offal	Meal (wheat)
Base scenario (according to LEI, 2007)	28%	64%	8%
Sensitivity assessment: least impact scenario	92%	0%	8%

1.3.2 Production of faux fur

On madehow.com the production of faux fur is described step by step.
Faux fur is made out of acrylic fibres that are fixated on fabric (the backing). The acrylic fibre is made out of acrylic polymer (a plastic), which is spun, coloured, washed and dried. The backing can be made out of various materials, such as cotton, wool or polyester (PET). After spinning or extruding to obtain fibres, the backing is made by weaving or knitting the fibres. Weaving was selected because it is most energy intensive and therefore reduces the risk of underestimating the impact of faux fur. The backing and acrylic fibres are attached to each other by creating loops of fibres through the backing, followed by a number of finishing processes like shearing (opening the loops by cutting), heat setting, electrifying (brushing the fibres to separate the individual fibres), coating, and colouring to resemble a specific animal and improve the feel and look of the fabric.

Table 4 shows the modelled processes and sources for environmental data for faux fur.

Table 4 **Data sources for environmental assessment of materials and production processes**

Process	Source for environmental data
Cotton fibre production	Ecoinvent database: 'yarn, cotton, at plant/GLO'
Acrylic fibre production	ELCD Database 'Polyacrylonitryl fibres (PAN)'
Wool	Ecoinvent database: 'Wool, sheep, at farm/US'
PET	Ecoinvent database: Polyethylene terephthalate, granulate, amorphous, at plant/RER S
Extrusion of PET	Ecoinvent database: Extrusion, pipes/RER
Weaving of backing	Modint Ecotool(*)
Tufting	Modint Ecotool
Brushing and shearing	Modint Ecotool
Colouring	Modint Ecotool
Heat setting process	Modint Ecotool

(*) The Modint Ecotool is a life cycle assessment calculation tool for the textile manufacturing industry, developed by CE Delft in 2010 (Modint Ecotool, 2010). It contains data for specific manufacturing processed, including energy consumption and use of chemicals.

1.3.3 Construction of coats and trims

For good comparison, the mink fur coat and the faux fur coat are of the same size and pattern (same area of fabric). The same goes for the trim. Both coats are assumed to have a viscose lining on the inside; the trim does not have a lining, since it is attached to a jacked. The coats and trims are modelled with the following data:

Table 5 **Inventoried data for the modelling of the construction of coats and trims**

Aspect	Amount	Source and explanation
Area of natural fur needed for one coat	3 m^2	Based on an online available sewing pattern for coats (Images.patternreview.com) Amount of fabric, for size 26 to 40: 1.4 0 m x 2.20 = 3,1 m^2, rounded 3 m^2
Area of faux fur needed for one coat		
Area of viscose needed for one coat		
Area of natural fur needed for one trim	0.035 m^2	Assumed area of 70 x 5 cm Size based on measurement of a natural fur trim
Area of faux fur needed for one trim		
Density faux fur	750 g/m^2	Measurements (*)
Composition faux fur	28% backing 72% fibre	Van Dijk, 2002
Density natural mink fur	670 g/m^2	Measurements (CE Delft, 2011a)
Density viscose	200 g/m^2	Viscosefabric.net

(*) Van Dijk uses a density of 693 g/m^2. However, two patches of faux fur were measured for this study (weight and area) and the highest measured density proved to be 740 g/m^2. This was rounded 750 g/m^2.

1.3.4 Transportation

For this study, we assumed that the faux fur fabric and the coat are made in China. After manufacturing, the faux fur coat or trim is transported to Europe - the Netherlands as representing country. Transportation is either done by plane or freight ship; both options are calculated, but by freight ship is assumed to be the base scenario.
The natural mink fur products are assumed to be made in Greece (CE Delft, 2011a). After manufacturing, the coat and trim are transported to the Netherlands by truck or plane; both options are calculated, but by truck is assumed to be the base scenario.

The following data are used to model the transportation:

Table 6 Inventoried data for the modelling of transportation routes

Transportation step	Distance	Environmental data
Natural mink fur, Greece to NL, by truck (base scenario)	2,500 km	STREAM (CE Delft, 2011b): 'Truck >20 tonne, Average, average bulk and general cargo'
Natural mink fur, Greece to NL, by plane	2,225 km	Ecoinvent database: 'Operation, aircraft, freight, Europe'
Faux fur, Shanghai to Rotterdam, by freight ship (base scenario)	19,000 km	STREAM (CE Delft, 2011b): 'General Cargo, 0-5 dwkt, average bulk and general cargo'
Faux fur, Shanghai to Schiphol, by plane	9,000 km	Ecoinvent database: 'Transport, aircraft, freight, intercontinental'

Distances are determined either by using Google Maps (truck), Worldatlas.com (plane) or Searates.com (boat) and are rounded. The transported weight of the coats and trims is calculated according the densities and areas as mentioned in Table 5. Any closures like zippers or buttons are not taken into account (assumed to be equal for both coat types).

1.3.5 Use phase: maintenance

For both natural fur coats and faux fur coats, maintenance is recommended. Good maintenance is likely to extend the lifespan of the coat. After purchase, however, it is up to the user to maintain the product. As explained in Section 1.2.1, CE Delft chooses not to make a statement on the most feasible lifespan and maintenance scenario. Rather we give insight in the importance of the selection of lifespan and maintenance on the results of the LCA, by working with scenarios.

Natural fur coats

Various informative websites on the maintenance of natural fur, such as Furcare.org, recommend storing the coat in a cold storage facility, with humidity control, when the user is done wearing the coat for the season. The optimal keeping temperature of natural fur coats is 1 to 7˚C, with a humidity of around 50%. This slows the biodegradation process and the evaporation of natural oils from the leather. The longer the coat is kept in these conditions, the longer it will last (Furcare.org). The necessity and duration of cold storage depends on the location of use: temperature and humidity differ between countries/regions. In warm countries, the need for active cooling is larger than in relatively cold countries.

In addition to cold storage, it is recommended to let the natural fur coat be cleaned professionally annually, to remove dust and pollutants that affect the natural oils and leather. This is not done by conventional washing or dry cleaning, but by tumble treatment with sawdust and electrifying (or glazing) (amongst others). Franksfurs.com offers a step-by-step description of the cleaning process.

Figure 1 Fur cleaning machines: drum and glazing machine

Source: Tsop.org

Inventory for the environmental assessment of natural fur coat cold storage

The energy consumption for cooling of coats per year is determined by a number of factors:

1. The energy consumption at a storage facility for cooling 1 m^3 per year.
2. The duration of cooling of the coat.
3. The volume that the coat represents. This does not only include the volume of the coat itself, but also a part of the empty space in a cold storage, such as aisles and space above, under and surrounding the coat. The degree of capacity utilization is also of importance: is the storage cooled in winter, even when maybe few coats are kept in storage? Should we account for this?

For all three aspects, data or assumptions are needed.

1. Recent research on cold storage facilities in Europe (ICE-E, 2012) showed a large variation in energy consumption per m^3 of storage capacity. The data demonstrated that 47% of the chilled storage facilities have an energy consumption of less than 50 kWh/m^3/year. For this study, we selected 40 kWh/m^3/year, to be sure not to overestimate the energy consumption for fur storage. The energy consumption is modelled with the average Western European electricity mix of the Ecoinvent database: 'Electricity, low voltage, production UCTE, at grid'.
2. Two maintenance scenarios are constructed: three months and six months of storage per year.
3. The volume that the coat represents is the most uncertain aspect. The volume of the coat itself is about ¼ m^3 (1 x 1 x 0.25 m). But the total volume of the storage facility, accounting for empty space and for capacity utilization of the facility, per coat is uncertain. In this study we assume that one coat represents 1 m^3 when it is in storage, including aisles and surrounding space. But we do not account for cooling of the storage at times when not utilized at high capacity (for instance in winter).

Uncertainty
The first and third aspects bring uncertainty to the results. Our choices are motivated here, but are based on assumptions. Energy efficiency of the cold storage might be less or better than the assumed 40 kWh/m^3/year. The coat may represent less or more m^3, depending on how the cold storage is managed.
We expect that our assumptions are likely to represent a more conservative scenario, because 1 m^3 per coat is not much, especially when the storage room is not efficiently used.
As we will see in Section 2.1.2, cold storage can double or even triple the impact of a coat when stored a couple of months every year, for many years.

In this study we indicate that cold storage is likely to have a large impact on the life cycle of natural fur coats. For environmental impact assessments for individual natural fur coats, CE Delft recommends to inventory the need for cold storage for the particular coat in detail.

Figure 2 Examples of cold storage facilities of fur coats

Source: Livingstonfurs.com Source: Webfurs.com

Inventory for the environmental assessment of natural fur coat cleaning
For cleaning by tumbler with sawdust and for glazing treatment, assumptions need to be made, since no public information on electricity and sawdust consumption was found.
Electricity consumption for cleaning one natural fur coat is assumed to be 1 kWh, based on cleaning once per year, 1 hour use of the appliances, with an estimated average electricity consumption of 1 kW per hour for all machines combined.
Sawdust consumption is assumed to be 1 kg per cleaning cycle (so for one coat, cleaning once a year).

Faux fur coats

Faux fur coats have no need for cold storage, but it is recommended to clean the coat once a year. According to Laundry.about.com, faux fur is best cleaned by hand, especially when it is long-haired, but can be cleaned in a washing machine without much agitation and at low temperatures.
For faux fur, the most energy intensive scenario was selected: cleaning by washing machine, short cycle, with a little bit of detergent.
The site Carbonfootprint.com provides energy consumption data for washing machines: an A-label machine has an average consumption of 0.63 kWh, at 40˚C using a 2 kg load. It was assumed that one cycle is about one hour (soaking, rinsing and mild spinning). Water consumption is estimated at 20 l per cycle. Detergent consumption is according to the EC Ecolabel criteria: 17 g/kg.
Cleaning is modelled with the following Ecoinvent processes:
- 'tap water, at user';
- 'soap, at plant';
- 'electricity, low voltage, production UCTE, at grid'.

Trims

For trims (either faux fur of real fur), no maintenance is taken into account. It is assumed that the garments the trims are connected to are either not washed, or washed after taking the trim of.

1.3.6 Disposal

Coats may be used for many years and may be handed down. In this study, we work with a variable lifespan. Eventually, all garments are disposed of for good and will either end up in a landfill or be incinerated in a municipal solid waste incineration facility (MSWI). In this study the second option is selected. Incineration causes emissions, but generates electricity and heat as well. The generated electricity and heat is calculated with the efficiency of generation and the lower heating value of the incinerated materials.
The generated electricity and heat avoid the need of conventional electricity and heat generation.

For the modelling of the end-of-life of the garments, the following data are used:

Table 7 Data for modelling the end-of-life phase of natural mink fur and faux fur

Aspect	Data
Emissions of incineration of acrylic fibres	'Disposal, polypropylene, 15.9% water, to municipal incineration' (as approximation)
Emissions of incineration of natural mink fur, cotton and wool backing	'Disposal, textiles, soiled, 25% water, to municipal incineration' (as approximation)
Emissions of incineration of PET backing	'Disposal, polyethylene terephthalate, 0.2% water, to municipal incineration'
Average electrical efficiency of Dutch MSWI	13.7%
Average thermal efficiency of Dutch MSWI	15.9%
Lower heating value acrylic fibre	29.5 MJ/kg
Lower heating value cotton	17.4 MJ/kg
Lower heating value polyester	22.95 MJ/kg
Lower heating value wool	23.2 MJ/kg
Avoided electricity production	'Electricity, low voltage, production UCTE'
Avoided heat production	'Heat, natural gas, at industrial furnace low-NO_x >100 kW'

2 Results

Based on the inventoried data, as elaborate on in Section 1.3, the environmental assessment of natural mink fur and faux fur coats and trims was performed. As explained in Section 1.2, we have chosen not to work with a fixed lifespan of the products, since there are no hard data available about the lifespan of coats and trims made of natural mink fur or faux fur.
Also, the lifespan of a natural fur product depends on maintenance and the location of use (local environmental characteristics as temperature and humidity).

The environmental assessment is focussed on the environmental effects, calculated with the ReCiPe midpoint method, as well as the weighted environmental score, the ReCiPe single score. Since emphasis is currently put on the impact of climate change in many environmental assessments, this environmental effect is selected for presentation of the results in graphs.
The results of the other environmental effects are shown in tables. The results of the ReCiPe single score are shown in graphs and details are shown in tables.

2.1 Results: coats

For coats, three assessments are made, according to the functional units, as defined in Section 1.2.1:

1. A fur coat with similar lifespan, no maintenance.
2. A fur coat with variable lifespan, various maintenance scenarios.
3. A natural mink fur coat with a lifespan of 30 years compared to five faux fur coats with a lifespan of 6 years each (DSS scenario), various maintenance scenarios.

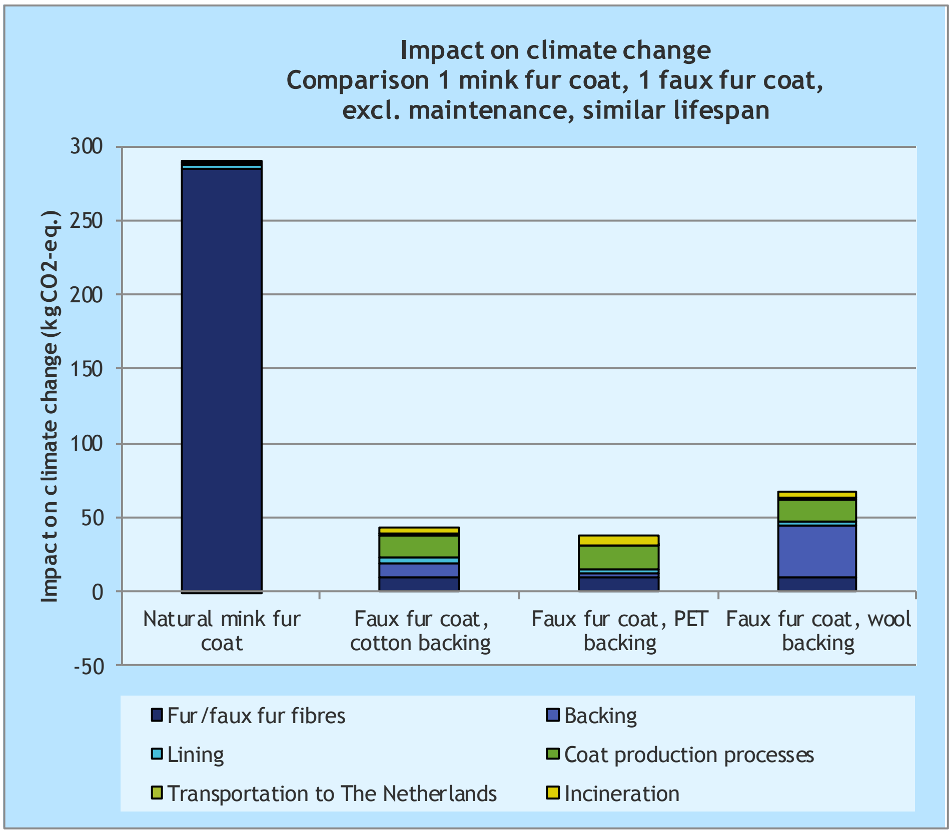
2.1.1 Impacts for similar lifespan and without maintenance

This section compares the result of one natural mink fur coat with one faux fur coat. It is a one-on-one comparison: the lifespan of the two coats is assumed to be similar (and remains undetermined). Since the lifespan is undetermined, optional maintenance is not taken into account.

This one-on-one comparison gives the reader insight into the impact of each coat and of the coats relative to each other.

Figure 3 shows the results for impact on climate change, one of the environmental effects. The contribution of the distinct life cycle steps is shown for one natural mink fur coat and three types of faux fur coats.

Figure 3 **Impact on climate change: comparison one fur coat, one faux fur coat; excl. maintenance, similar lifespan**



This result shows that the production of natural mink fur leads to the highest climate impact. As is indicated in the previous study by CE Delft on mink fur production (CE Delft, 2011a), the mink feed and mink keeping are the two main contributing factors to this impact on climate change. The production processes of the coat, the lining, the transportation and the incineration at the end of life all have relatively very small contributions to the total CO_2 score. Incineration leads to a very small benefit (due to generation of electricity and heat).

The CO_2 scores for one faux fur coat are a factor 4 to 7.5 lower than the scores for one natural mink fur coat. The production of the acrylic fibres has a small contribution. The backing material makes the difference: a wool backing has the highest contribution of all three backings and of all life cycle phases of the faux fur. Faux fur is created by a number of subsequent production processes, as mentioned in Section 1.3.2. These production steps combined lead to a significant contribution to the total CO_2 score of faux fur, of between 22% and 40% of the total CO_2 score. The incineration of the synthetic materials leads to a CO_2 emission, instead of a CO_2 benefit[2].

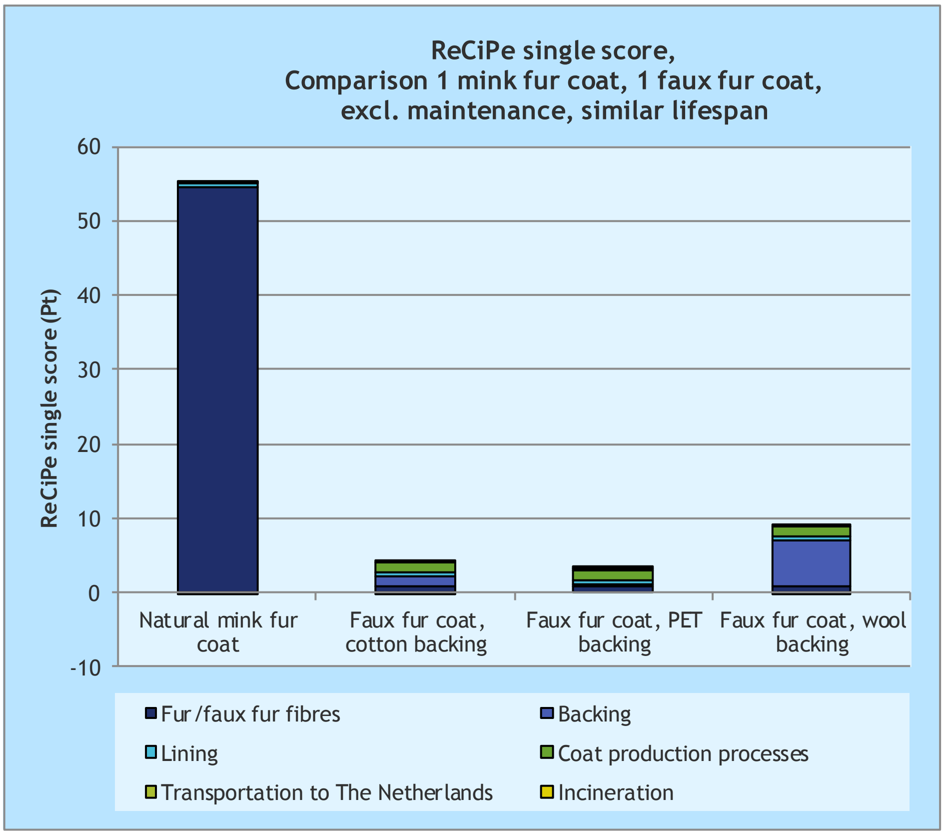
2 Incineration of plastics leads to a high amount of electricity and heat generation (also compared with other materials) but at the same time incineration of plastics causes a lot of CO_2 emissions. The net result is an CO_2 emission, rather than a benefit.

Table 8 shows the results for all environmental effects that were calculated with the ReCiPe midpoint method. Impact on climate change is one of them. The two rightmost columns show the factor of difference between the fur coat and the faux fur coats. It shows a minimum and maximum difference, based on the differences in backing material of the faux fur coat.
A factor of 4 means that the fur coat has a four times higher score than the faux fur coat. A factor of 4 also means that the coats have an equal environmental score when the natural mink fur coat has a four times longer lifespan than the faux fur coat, but only provided that both coats undergo no maintenance. In Section 2.1.2 we will see that maintenance can have a large impact. Especially when natural mink fur has to have a long lifespan, maintenance is likely to be a necessity.

In Table 8 it can be seen that for all environmental impacts, in this one-on-one comparison, the natural mink fur coat has a higher impact than faux fur.
It depends on the type of backing of the faux fur coat what the factor of difference is. The factor of difference widely fluctuates: some factors 3 and 4 occur; about a dozen of factors 5 to 10; and many 10 or higher. For all environmental effects except four, the wool backing leads to the highest score for faux fur.

A factor of difference of 7 means that the environmental score of the natural mink fur coat is 7 times higher than the score for the faux fur coat. At a difference factor of 7, for the natural coat to environmentally outperform the faux fur coat, the relative lifespan of the fur coat has to be at least 7 times longer than the lifespan of the faux fur coat.

Figure 4 ReCiPe single score: comparison one fur coat, one faux fur coat; excl. maintenance, similar lifespan



Secondly, the coats are assessed with the ReCiPe single score, the weighted environmental score according to actual damage, again in one-on-one comparison and excluding maintenance. It can be seen in Figure 4 that if all environmental impacts are weighted, the natural mink fur coat has a higher relative score to the faux fur coats than for impact on climate change (at least a factor of 6, instead of 4).

Table 8 Environmental results for one coat, similar lifespan and excluding maintenance. All environmental effects (midpoints)

Environmental effect category (midpoint)	Unit	Natural mink fur coat	Faux fur coat, cotton backing	Faux fur coat, PET backing	Faux fur coat, wool backing	Difference factor (minimum)	Difference factor (maximum)
Climate change	kg CO_2 eq.	289	43	38	68	4	7
Ozone depletion	kg CFC-11 eq.	1.8E-05	1.2E-06	1.0E-06	1.4E-06	13	17
Terrestrial acidification	kg SO_2 eq.	14	0.3	0.2	1.1	13	72
Freshwater eutrophication	kg P eq.	0.1	0.004	0.001	0.011	4	44
Marine eutrophication	kg N eq.	1.4	0.02	0.01	0.2	7	186
Human toxicity	kg 1,4-DB eq.	35	5.9	4.3	5.5	6	8
Photochemical oxidant formation	kg NMVOC	0.8	0.15	0.12	0.16	5	7
Particulate matter formation	kg PM_{10} eq.	2.1	0.08	0.06	0.18	12	34
Terrestrial ecotoxicity	kg 1,4-DB eq.	4.0	0.05	0.00	0.03	83	1537
Freshwater ecotoxicity	kg 1,4-DB eq.	2.1	0.3	0.2	0.8	3	10
Marine ecotoxicity	kg 1,4-DB eq.	0.7	0.2	0.2	0.2	3	4
Ionising radiation	kg U_{235} eq.	20	0.6	-0.1	0.3	35	316
Agricultural land occupation	m^2a	586	16	9.1	105	6	64
Urban land occupation	m^2a	22	0.4	0.3	0.9	23	76
Natural land transformation	m^2	0.03	0.004	0.003	0.004	8	11
Metal depletion	kg Fe eq.	7	0.6	0.4	0.8	10	17
Fossil depletion	kg oil eq.	35	9.3	8.4	8.7	4	4

In Annex A, the contribution of the environmental effects to the weighted single score is shown. In general, the factors of difference for the contributing environmental effects are about the same or a little higher compared to the factors of difference of the midpoint assessment.

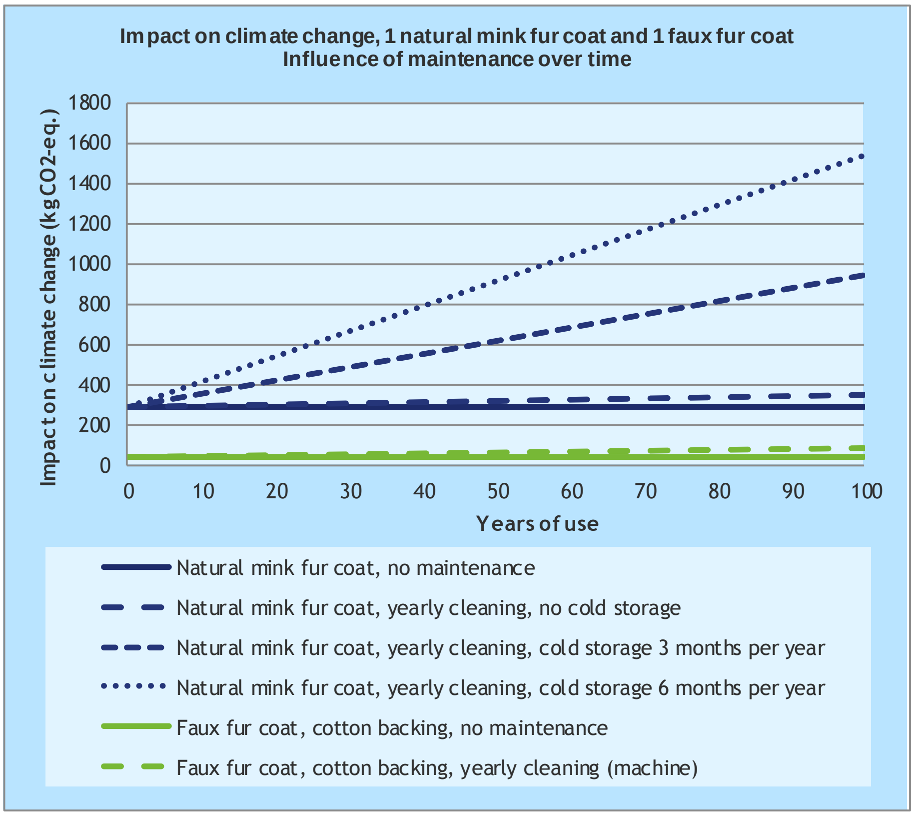
2.1.2 Impacts including lifespan and maintenance

In this section, the impact on climate change and the ReCiPe single score are assessed, including maintenance over a variable amount of years. With the graphs in this section, the reader can compare practically any scenario for a natural mink fur coat and a faux fur coat. This assessment is not performed for the other environmental impacts at midpoint level.

At year 0, Figure 5 shows the initial impact of one coat, after production. In the subsequent years, the user may maintain the coat. Three maintenance scenarios are shown for natural mink fur, one for faux fur (according to the inventory, Section 1.3.5). Yearly cleaning only slightly increases the impact on climate change of the coats over the years. Yearly cold storage of natural fur, for three or six months per year, significantly increases the impact of the natural fur coat.

As indicated at the inventory data for cold storage (Section 1.3.5), the cold storage data contain uncertainty and results may vary. The assumptions, which lie at the basis of these results for cold storage, are conservative, so the scores might even be higher. Individual cases might have lower scores. These results however indicate that cold storage is likely to have a large influence on the life cycle impact of natural fur coats. It is recommended that the cold storage aspect of natural fur coats is investigated more in detail.

Figure 5 **Impact on climate change, 1 natural mink fur coat and 1 faux fur coat, including influence of maintenance over time**



The average lifespan of natural fur coats and of faux fur coats is unknown, as is the relative lifespan of faux fur coats to natural fur coats. It might be that a fur coat last longer than a faux fur coat, but would that be some years, twice as long, three times as long, or more? CE Delft does not know this and refrains from making a statement.

Instead, we show Figure 5. With this figure, the reader can compare many scenarios. He/she can determine in what cases the natural fur coat has a higher or lower impact on climate change compared to faux fur coat(s). This is done by selecting a lifespan of a (your) coat, determine whether maintenance is necessary and what type of maintenance.

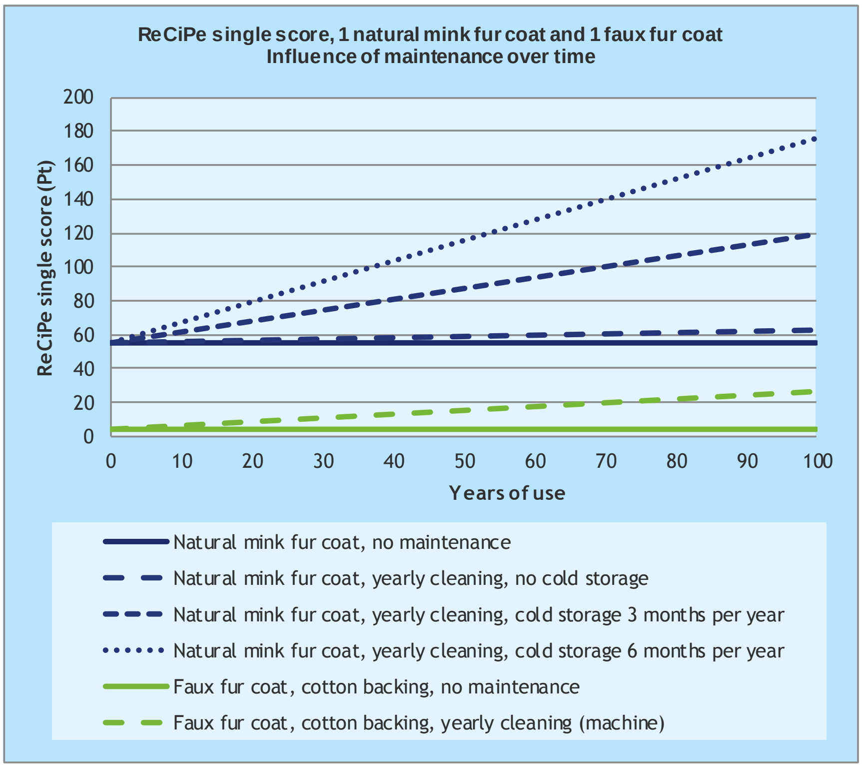
If, for instance, you select a natural fur coat to last 40 years with three months cold storage per year, the impact on climate change is about 500 kg CO_2 eq. This equals about ten faux fur coats (cotton backing) without maintenance.

The figure also raises the question: what is realistic?

Box 1 Question: What is realistic?
Good maintenance is beneficial to the lifespan of the natural fur coat. But is it indeed necessary to actively cool the coat by bringing it to the cold storage, as is recommended on various websites? Or can a natural fur coat easily last 50 years - for instance - without active cooling? Where is the coat used: in warm countries like Spain or Italy, or in colder regions?

Figure 6 shows the results for the ReCiPe single score, the weighted environmental score. It can be seen that the difference between the two coats at year 0 is larger than for the impact on climate change, but that the impact of cleaning faux fur coats is of greater consequence.

Figure 6 ReCiPe single score, one natural mink fur coat and one faux fur coat, including influence of maintenance over time



2.1.3 Impacts for a specific lifespan scenario

In a recent study by DSS Management Consultants, the environmental impact of natural fur coats and faux fur coats is compared (DSS, 2011). This study works with a specific lifespan scenario for both coat types:

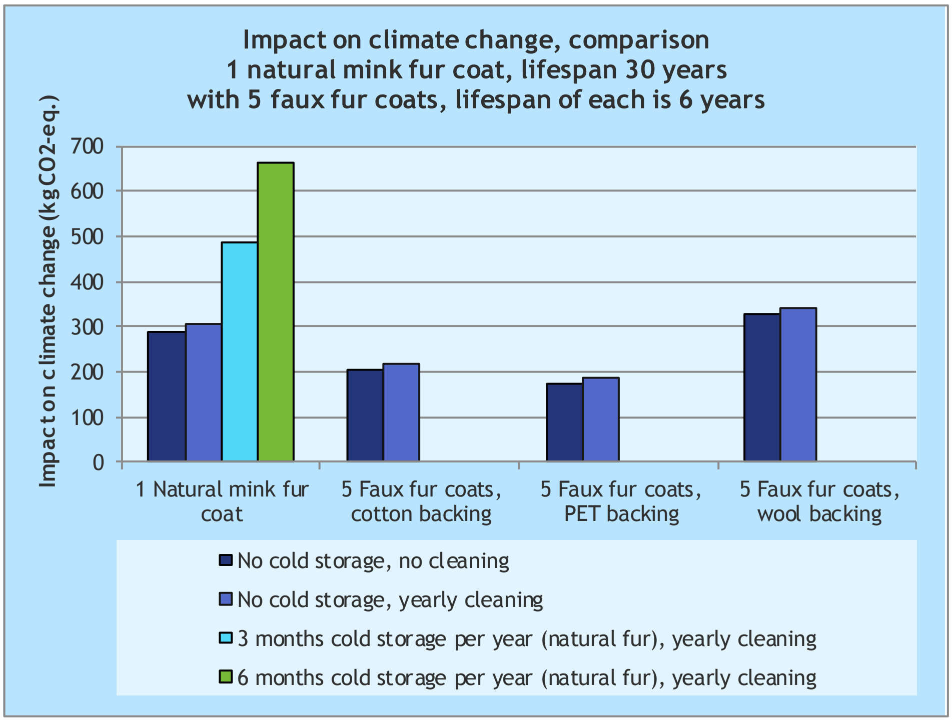
– a natural fur coat lasts 30 years;
– a faux fur coat lasts 6 years.

Therefore, five faux fur coats represent one natural mink fur coat. This choice for lifespan in (DSS, 2011) seems to be an assumption; the choice is not founded in the public summary. We reproduced this analysis, using the DDS assumption of a five times longer lifespan for a fur coat, but our own data, to be able to compare the results.

Figure 7 shows our results for the impact on climate change for such an assumption, for various maintenance scenarios. According to this assessment of the impact on climate change, the natural fur coat has a higher impact on climate change than five faux fur coats with cotton or PET backing including yearly cleaning. Five wool backed faux fur coats have a higher impact on climate change than one natural fur coat with yearly cleaning.

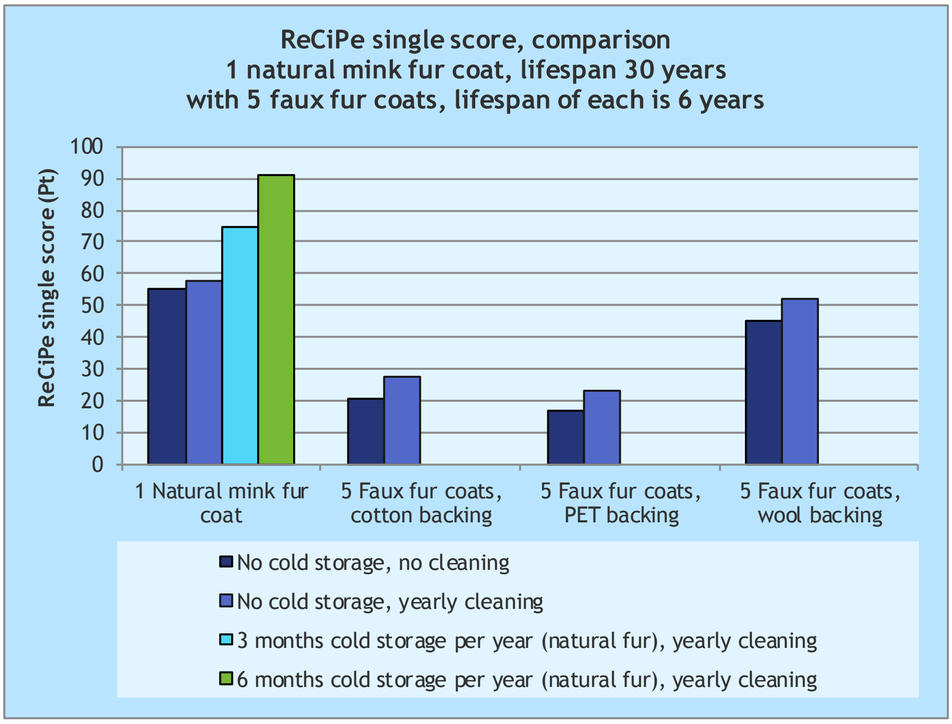
If active cooling is necessary to make sure the coat will last 30 years, the natural fur coat has a higher impact on climate change than five coats of any of the three coat types.

Figure 7 Impact on climate change, CE Delft inventory, lifespan scenario by DSS, 2011



For the ReCiPe single score, the results are somewhat different. It can be seen in Figure 8 that the natural mink fur coat as a higher ReCiPe single score than all three faux fur scenarios. 5 faux fur coats with woollen backing have about the same score as a natural mink fur coat without active cooling.

Figure 8 ReCiPe single score, CE Delft inventory, lifespan scenario by DSS, 2011



This result differs from the results represented by DSS (2011). The DSS results show that the natural mink fur coat has a lower weighted environmental score than five faux fur coats. The public summary (DSS, 2011) does not list the inventory data that are at the basis of the study. Therefore, it is hard to determine what exactly causes the difference.
From the DSS summary, it becomes clear that cleaning once per six years and yearly cold storage of natural fur is taken into account, but the underlying data or assumptions are not reported in the summary. The faux fur coat is constructed with acrylic fibre and cotton backing. Transport routes remain unknown.

We think a few main reasons could be responsible for the difference in results:
- Different environmental assessment method (Impact 2002+), although a sensitivity assessment with ReCiPe is performed. ReCiPe results are not shown in the public summary, however.
- Different feed composition.
- Different data and/or assumptions for cold storage and cleaning

2.2 Results trims and sensitivity assessment transport

Fur trims and faux fur trims have an equal lifespan, since they are an accessory to the coat it is on. Figure 9 and Figure 10 show the results for impact on climate change and for ReCiPe single score.

The relative results are similar to the results in Section 2.1.1, since no maintenance is taken into account and the products have a similar lifespan. Therefore, the difference factors for the various environmental effects, as shown in Table 8, apply to the trims as well.

It is clear that natural mink fur used as an accessory has a higher impact on all environmental effects and on the weighted environmental score (ReCiPe single score) compared to a faux fur alternative, even when the natural mink fur accessory is reused a couple of times.

Figure 9 Impact on climate change, natural mink fur trims and faux fur trims

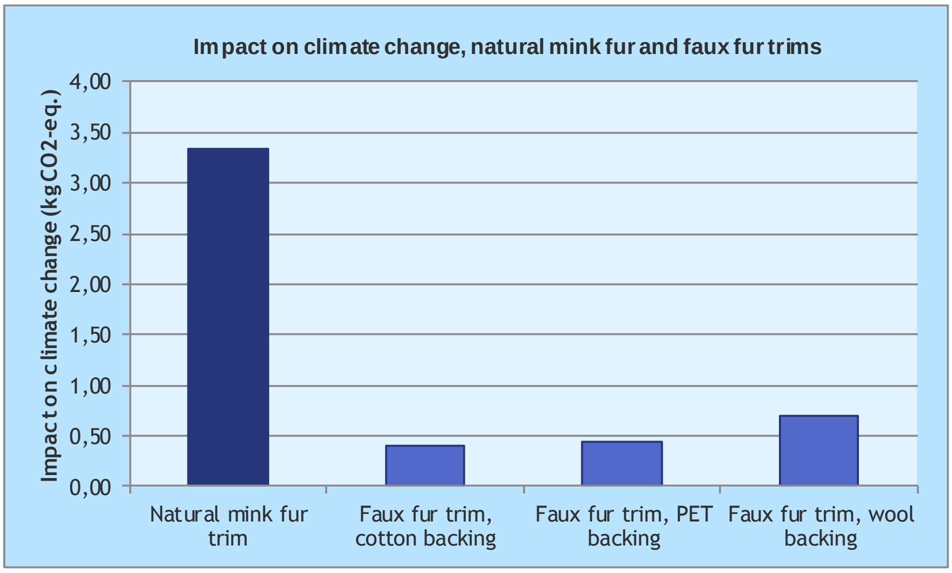
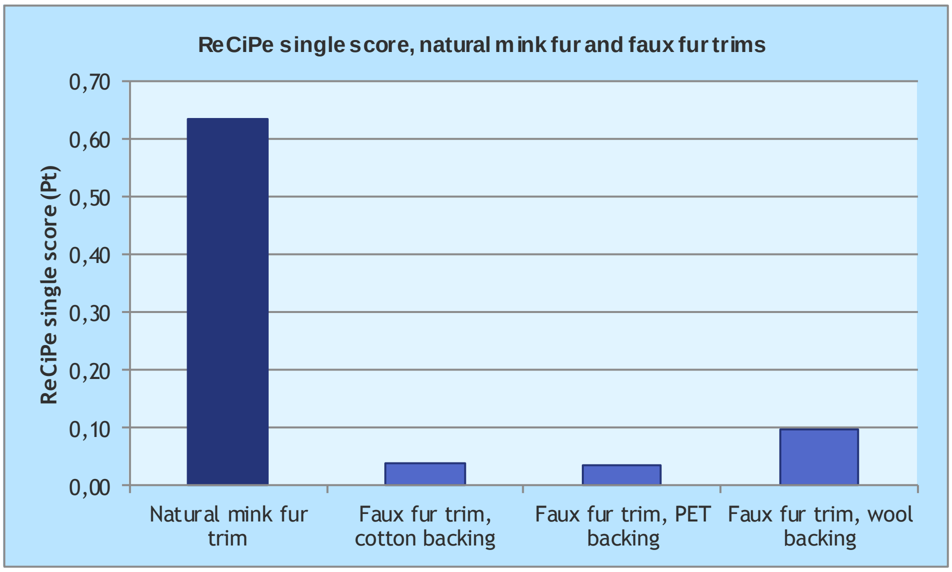


Figure 10 ReCiPe single score, natural mink fur trims and faux fur trims



2.3 Sensitivity Analysis mink feed

2.3.1 Mink feed

In the study by DSS (2011) it is rightly stated that the mink feed composition has a large influence on the results of the assessment. In our study, the feed composition is determined according to (LEI, 2007): 64% chicken offal, 28% fish offal and 8% meal (wheat). Chicken offal has a higher environmental impact than fish offal per kg. Therefore, when the share of fish offal is increased, the environmental impact of natural mink fur will decrease. In addition to this sensitivity assessment, the effect of change in transportation modality is calculated. This only has a small effect.

The effect of change in feed composition is visualized, in extreme, in Figure 11, Figure 12 and Figure 13: the results are shown both for the base scenario and for the (unrealistic) scenario in which the minks only receive fish offal instead of chicken offal (92% fish offal, 8% meal). It can be seen that this lowers the impact of a natural mink fur product by about one third.

This means that the difference factors as shown in Table 8 and Table 9, also are lowered by one third. In that case, the lifespan of a natural mink fur coat compared to a faux fur coat should still be four times longer than a faux fur coat (excluding maintenance) in order to have the same environmental performance (ReCiPe single score). If maintenance is included, the relative lifespan of natural fur compared to faux fur coat needs to be even higher.

Figure 11 **Coats, impact on climate change, sensitivity assessment, excl. maintenance, similar lifespan**

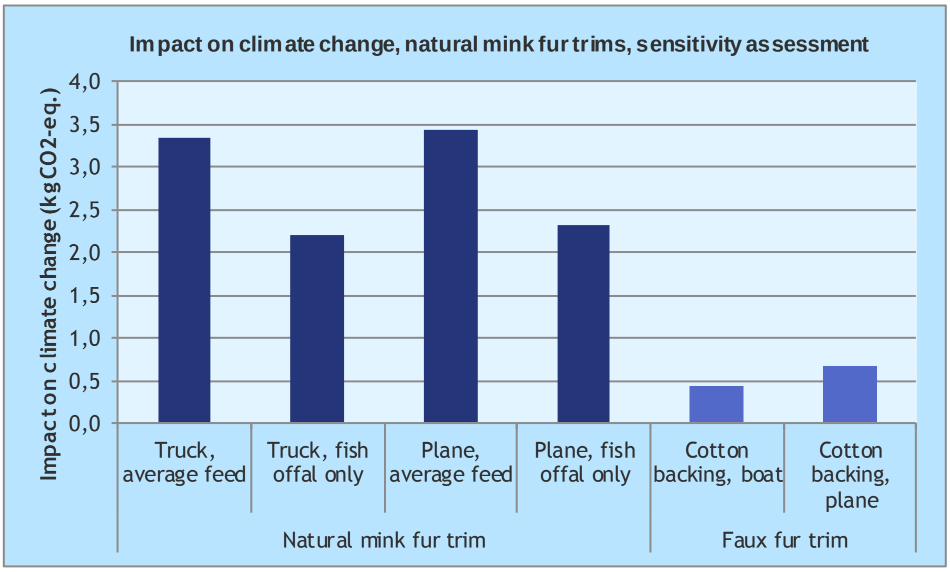
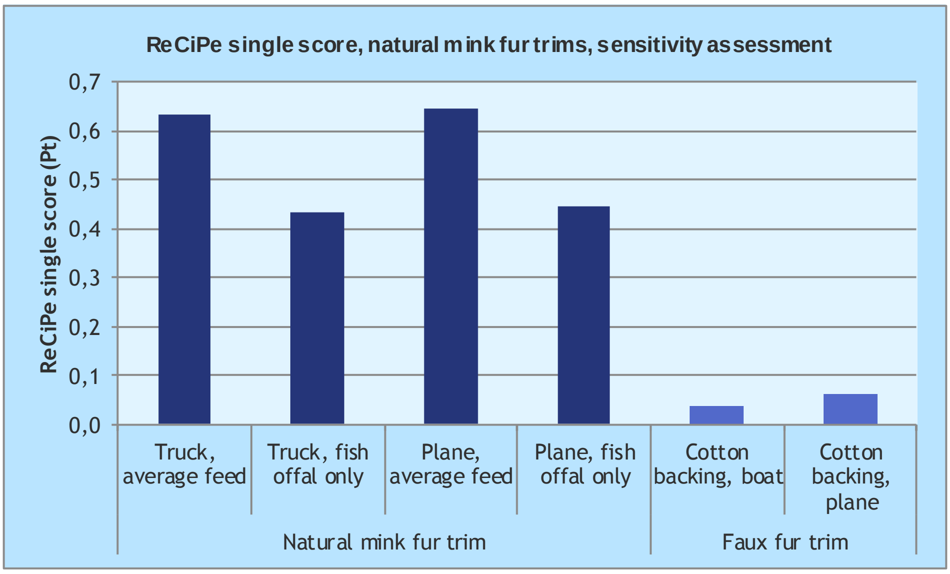
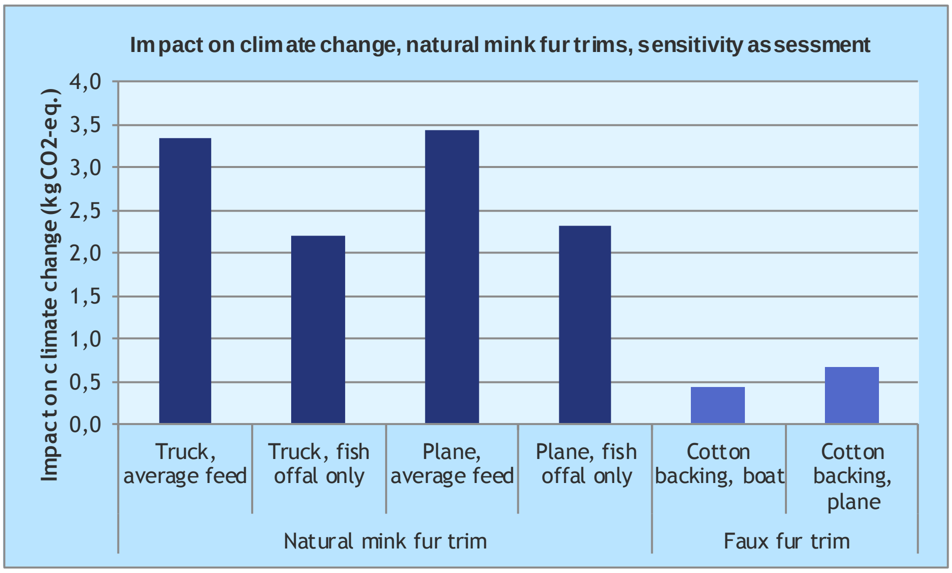


Figure 12 Coats, ReCiPe single score, sensitivity assessment, excl. maintenance, similar lifespan



For trims, the figures follow the same contours, but the values on the y-axis differ.

Figure 13 Trims, impact on climate change, sensitivity assessment, excl. maintenance, similar lifespan



2.4 Conclusions

Our assessment has clearly shown the significant difference between natural mink fur coats and faux fur coats. The natural mink fur coat only outperforms the faux fur coat if the lifespan of the coat is at least a factor 4 (climate change) or 6 (ReCiPe single score) longer than the lifespan of the faux fur coat. The impact of a natural mink fur coat in all cases is at least 3 times higher than the impact of a faux fur coat. For a large number of environmental effects the factor of difference is 10 or higher.

The same result applies to natural mink fur trims and faux fur trims. When the lifespan of the products is the same, the natural mink fur product has the highest environmental score on all accounts, even when the least impact scenario for mink feed is applied.

Our assessment has also shown that the impact between different types of faux fur varies, although not by as much as the difference between fur and faux fur.

The lifespan of a fur coat and of a faux fur coat is open to debate. Therefore, and to illustrate the importance of lifespan, we have presented a range of scenarios. The results have shown that maintenance can contribute substantially to the results. The lifespan links to the question of cooling: during warm summer seasons it is recommended to store the natural fur coat at a low temperature, which is beneficial to the lifespan of the coat.
Active cooling can cause the environmental impact of the natural fur coat to double over the years.

Because DDS (2011) does not list inventory data it is difficult to compare the results from that study and ours in great detail. Throughout our assessment we have made an effort to make realistic and conservative assumptions. A change in assumptions is likely to increase the difference between natural fur and faux fur, and make faux fur look even more favourable, environmentally.
On some topics questions as to these assumptions may remain. For example: for environmental impact assessments for individual natural fur coats, CE Delft recommends to inventory the need for cold storage for the particular coat in detail.

References

CE Delft, 2011a
Marijn Bijleveld, Marisa Korteland, Maartje Sevenster
The environmental impact of mink fur production
Delft : CE Delft, 2011

CE Delft, 2011b
Eelco den Boer, Matthijs Otten, Huib van Essen
STREAM International Freight 2011 - Comparison of various transport modes on a EU scale with the STREAM database
Delft : CE Delft, July 2011

CE Delft, 2011c
Maartje Sevenster, Marijn Bijleveld, Margaret van Valkengoed,
Gerdien van de Vreede
De textielketen in beeld : Methodiek en data voor ketentool
Delft : CE Delft, 2011
See also : Modint Ecotool, 2011

DSS, 2011
A Comparative Life Cycle Analysis: Natural fur and Faux Fur
Public Summary
Pickering, Canada : DSS Management Consultants Inc., 2011

Ecoinvent, 2007
Ecoinvent Database, Version 2.2
Dübendorf : Swiss Centre for Life Cycle Inventories, 2007

ICE-E, 2012
J. Evans
Improving Cold storage Equipment in Europe
ICE-E; Intelligent Energy Europe
Bristol : London South Bank University, 2012

LEI, 2007
W.H.M. Baltussen, J.H. Wisman, I. Vermeij (ASG)
Economische verkenning van sanering van de nertsenhouderij in Nederland
Den Haag : LEI, september 2007

Modint Ecotool, 2011
Ontwikkeling ketentool voor Modint
See: CE Delft, 2011c

Websites

All accessed May 2013

Carbonfootprint.com
Electricity consumption of the use of a washing machine
http://www.carbonfootprint.com/energyconsumption.html

EC Ecolabel criteria
http://ec.europa.eu/environment/ecolabel/ecolabelled_products/categories/pdf/laundry/final_draft.pdf

Franksfurs.com
Step by step explanation of professional natural fur cleaning
http://www.franksfurs.com/furcleaning.html

Furcare.org
Explanation of the necessity and characteristics of cold storage
http://www.furcare.org/fur-storage/

Furcare.org
Explanation of the necessity of cleaning of natural fur coats
http://www.furcare.org/fur-cleaning-explained/

Images.patternreview.com
Sewing pattern and information on amount of fabric for a coat
http://images.patternreview.com/sewing/patterns/burda/8292/8292.pdf

Livingstonfurs.com
Image and information about cold storage of fur
http://www.livingstonfurs.com/storage.html

Viscosefabric.net
Density of viscose fabric; accessed May 2013
http://www.viscosefabric.net/en/index.asp?k1=2&k2=&q=detay&h=23

Webfurs.com
Image and information about cold storage of fur
http://www.webfurs.com/1services.shtml

Annex A The ReCiPe method

In this study CE Delft uses the ReCiPe impact assessment method, the successor to the frequently used Eco-Indicator 99 and CML2 methods.

After completing the data inventory, the environmental result is calculated by the ReCiPe assessment method. The primary result of this assessment is a long list of emissions, raw material requirements and other relevant aspects (see the left-hand column of Table 9). The ReCiPe method converts the long list of inventory results to understandable indicators. The method offers three levels of impact assessment:

- midpoint level (18 environmental impacts);
- endpoint level (3 indicators);
- one single indicator.

In this study, both the impacts at midpoint level and the single score are reported.

Table 9 **Schematic overview of ReCiPe midpoint and endpoint impact categories**

LCI results	Midpoint	Normalization	Endpoint	Single indicator
Long list of emissions and substances: Raw materials Land use CO_2 VOS P SO_2 NO_x CFC Cd DDT, etc.	Ozone depletion	DALY	Damage to human health (DALY)	Single indicator, obtained by weighting the three endpoints
	Human toxicity	DALY		
	Ionising radiation	DALY		
	Photochemical oxidant formation	DALY		
	Particulate matter formation	DALY		
	Climate change	Human Health: DALY		
		Ecosystems: species*yr	Damage to ecosystems (species*yr)	
	Terrestrial acidification	species*yr		
	Terrestrial ecotoxicity	species*yr		
	Urban land occupation	species*yr		
	Agricultural land occupation	species*yr		
	Marine ecotoxicity	species*yr		
	Freshwater eutrophication	species*yr		
	Freshwater ecotoxicity	species*yr		
	Minerals depletion	$	Resource depletion ($)	
	Fossil depletion	$		
	Marine eutrophication	-	-	-
	Water depletion	-	-	-

Table 10 shows the midpoints and the units in which they are expressed.

Table 10 **Midpoint indicators and their units**

Environmental impact (midpoint)	Unit
Climate change	kg CO_2 eq. to air
Ozone depletion	kg CFC-11 eq. to air
Terrestrial acidification	kg SO_2 eq. to air
Freshwater eutrophication	kg P eq. to freshwater
Marine eutrophication	kg N eq. to freshwater
Human toxicity	kg 14 DCB eq. to urban air
Photochemical oxidant formation	kg NMVOC eq. to air
Particulate matter formation	kg PM_{10} eq. to air
Terrestrial ecotoxicity	kg 14 DCB eq. to soil
Freshwater ecotoxicity	kg 14 DCB eq. to freshwater
Marine ecotoxicity	kg 14 DCB eq. to marine water
Ionising radiation	kg U_{235} eq. to air
Agricultural land occupation	m^2 * yr
Urban land occupation	m^2 * yr
Water depletion	m^2
Minerals depletion	kg Fe eq.
Fossil depletion	kg oil eq.

Description of environmental impacts (midpoint indicators)

Climate change
The impact category 'climate change' refers to the reinforced greenhouse effect: a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, among which carbon dioxide (CO_2), methane (CH4) and N_2O. As a result, the temperature is higher than it would be if direct heating by solar radiation were the only warming mechanism. The effect is calculated according to IPCC standards with a 100 year time horizon.

Ozone layer depletion
Most atmospheric ozone is found at an altitude of around 15-30 kilometres and this part of the atmosphere is therefore known as the ozone layer. This layer absorbs much of the damaging ultraviolet radiation emitted by the sun.
The ozone layer is depleted by a variety of gases, including chlorofluorocarbons (CFCs), resulting in a decline of layer thickness.
The reduction is greatest in spring, but at most locations levels are almost back to normal by autumn.

Acidification, terrestrial
Acidification of soils (and water) is a consequence of air pollutant emissions by factories, agricultural activities, power stations and vehicles. These acidifying emissions include sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3) and volatile organic compounds (VOC), which are transported via the atmosphere or the water cycle and end up in soils. This is referred to as acid deposition. By way of foliage and root systems these substances penetrate trees and other plants, making them more susceptible to disease.
Acid deposition also causes damage to lakes and rivers, ultimately harming the wildlife that lives or drinks there, because of elevated acid and aluminium concentrations.

Eutrophication, freshwater
Eutrophication is the term used for elevated nutrient concentrations in water in particular. In biology it is used to refer to the phenomenon of certain species exhibiting strong growth and/or reproduction following addition of a nutrient surplus, generally leading to a sharp decline in species richness, i.e. loss of biodiversity. Eutrophication may occur, for example, in freshwater bodies subject to fertiliser run-off, particularly nitrogen and phosphate deriving from manure, slurry and artificial fertilisers from farming activities. The result is pronounced 'algal bloom', recognisable as dark-coloured water masses with an unpleasant smell. Eutrophication can lead to hypoxia, a deficiency of oxygen in the water.

Human toxicity
The impact category 'human toxicity' covers emissions to air, water and soils that result (ultimately) in damage to human health. In calculating toxicity, the environmental persistence (fate) of the substance and its accumulation in the human food chain (exposure) are taken into account as well as its toxicity (impacts).

Ecotoxicity, terrestrial, freshwater and marine
The impact category 'ecotoxicity' covers emissions to air, water and soils that result (ultimately) in damage to the ecosystems in soils, freshwater and marine waters.

Photochemical oxidant formation
Photochemical oxidant formation, or smog (a combination of the words 'smoke' and 'fog'), is a form of air pollution involving mist polluted by smoke and exhaust fumes, which may in certain periods suddenly increase in severity, with potential consequences for human health. The substances of greatest influence on smog formation are ozone and airborne particulates and, to a lesser extent, nitrogen dioxide and sulphur dioxide.

Particulate matter formation
Particulate matter (PM) refers to airborne particulates with a diameter of less than 10 micrometres. It consists of particles of varying size, origin and chemical composition. When inhaled, PM causes health damage. In people with respiratory disorders and cardiac problems, chronic exposure to airborne particulates aggravates the symptoms, while in children it hampers development of the lung function. The standards for particulate levels are currently exceeded at numerous locations in Europe, particularly along busy roads.

Ionising radiation
Ionising radiation results from the decay of radioactive atoms like those of uranium-235, krypton-85 and iodine-129. There are two types of ionising radiation: particle-type radiation (alpha radiation, beta radiation, neutrons, protons) and high-energy electromagnetic radiation (X-rays, gamma radiation). Ionising radiation can damage DNA and cause a variety of cancers.

Land use, agricultural and urban

The impact category 'land use' refers to the damage to ecosystems associated with the effects of human land occupation over a certain period of time.

Depletion, minerals and fossil

Consumption of mineral resources and fossil fuels has been weighted using a factor that increases in magnitude as the resource in question becomes scarcer and its concentration declines.

Annex B Additional results

Table 11 **Environmental results for 1 coat, excluding maintenance, similar lifespan. Contribution to the ReCiPe single score**

Contribution to single score	Unit	Natural mink fur coat	Faux fur coat, cotton backing	Faux fur coat, PET backing	Faux fur coat, wool backing	Difference factor (min)	Difference factor (max)
Total	**Pt**	**55**	**4.1**	**3.3**	**9.0**	**6**	**17**
Climate change Human Health	Pt	8.0	1.2	1.1	1.9	4	8
Climate change Ecosystems	Pt	5.1	0.8	0.7	1.2	4	8
Ozone depletion	Pt	9.9E-04	5.5E-05	4.6E-05	6.5E-05	15	22
Terrestrial acidification	Pt	0.2	3.6E-03	2.5E-03	1.4E-02	13	72
Freshwater eutrophication	Pt	5.0E-03	3.9E-04	1.1E-04	1.1E-03	4	44
Human toxicity	Pt	0.5	0.08	0.06	0.08	6	8
Photochemical oxidant formation	Pt	6.2E-04	1.2E-04	9.5E-05	1.3E-04	5	7
Particulate matter formation	Pt	11.0	0.4	0.3	1.0	12	34
Terrestrial ecotoxicity	Pt	1.3	0.02	0.00	0.01	82	1539
Freshwater ecotoxicity	Pt	4.0E-03	5.5E-04	3.8E-04	1.5E-03	3	10
Marine ecotoxicity	Pt	2.8E-04	7.9E-05	7.8E-05	9.1E-05	3	4
Ionising radiation	Pt	6.4E-03	1.9E-04	-2.0E-05	1.0E-04	35	-316
Agricultural land occupation	Pt	24	0.5	0.2	3.8	6	98
Urban land occupation	Pt	1.0	0.02	0.01	0.04	23	76
Natural land transformation	Pt	0.1	0.03	0.03	0.03	4	5
Metal depletion	Pt	0.3	0.03	0.02	0.04	10	17
Fossil depletion	Pt	3.8	1.0	0.9	0.9	4	4