THE CAPITAL REGION OF DENMARK, REGION OF SOUTHERN DENMARK, CENTRAL DENMARK REGION, THE NORTH DENMARK REGION AND REGION ZEALAND

LCA SCREENING OF PACKAGING FOR HEALTHCARE PRODUCTS

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1 Context

The environmental factors presented in this report are to be utilized by the "Nordic Criteria for more sustainable Packaging for Healthcare products", produced by the Capital Region of Denmark, Region of Southern Denmark, Central Denmark Region, the north Denmark Region and Region Zealand.

PROJECT NO. DOCUMENT NO.

A218542

VERSION	DATE OF ISSUE	DESCRIPTION	PREPARED	CHECKED	APPROVED
5.0	16th November 2021		LGJA	TLHA, IRTO, MSOT	LGJA, MSOT

2 Purpose

The purpose of this report is to validate the grouping of packaging materials, which was suggested by the "Regions of Denmark", as well as the environmental factors to be used in tenders for hospital packaging in the joint Nordic tender requirements. See Table 8 for the original suggestions.

The purpose of the LCA screening is to have the overall environmental factors for use directly in tenders within the scope without having a technical consultant in the tendering process. The factors are hence overall and there will be cases where the environmental burden of the packaging will not align with the environmental factors set by this LCA screening.

Climate impact was used as the primary basis for the environmental factor for each grouping of packaging materials, but it will be adjusted in relation to selected other environmental impact categories relevant for the political focus of the client such as, for example, circular economy (sustainable resource management). The environmental factors in the tender material will thus be unitless.

3 Method

The methodology follows these two steps:

1 Validation of the proposed grouping of materials

2 Validate the environmental factors

4 Validation of grouping

The six material groupings proposed by the "Regions of Denmark", are presented in the Table 1 below and validated in this section. Many materials within one group should be validated to get a broader overview from an environmental perspective.

Table 1 Proposed material groupings

Plastic materials incl. laminates	Virgin
	Bio-based
	Recycled
Cardboard/Paper/Wood/Cellulose incl. single-use pallets and paper materials e.g. in form of manuals	Virgin
	Recycled or sustainably sourced
Metal incl. metal foils	Virgin
	Recycled

The assessment of the groups and sub-groups was made by examining CO_2-eq emissions from material production and different packaging products that are within each grouping. It was then assessed whether the range of CO_2-eq emissions within one grouping was acceptable. If the range was too large it may be recommended to split the groupings.

A more detailed definition of each grouping was furthermore determined, in order to perform the assessment. Some materials or products are not included, because they are either rare in the packaging of healthcare products or they are exempted in the suggested tender criteria.

4.1 Plastics

Virgin plastic

Virgin plastic is produced from fossil fuels. In this project, styrene polymers (PS, EPS and XPS) are excluded following the tender criteria. The most common material is assessed to be LDPE.

Bio-based plastic

Bio-based plastic is defined in this project as bio-based, but not oxo- or biodegradable polymers, as these are excluded in the criteria. The focus is on bio-based materials from primary and secondary sources, i.e. representative for the market today. Tertiary sources (from waste products, e.g. used cooking oil) are therefore excluded. The most common material is assessed to be LDPE.

Recycled plastic

Recycled plastics is defined as products/packaging that had more than 30% recycled content, as data on products from 100% recycled content is difficult to obtain. The final score should represent 100% recycled plastic, as a share between recycled and virgin is to be given. The most common material is assessed to be LDPE. Furthermore, the result represents mechanical recycling only. Chemical recycling is an upcoming recycling form, of which it has not been possible to find data.

Table 2 *Cradle to gate results for plastic packaging, where the minimum, average, median and maximum are represented of a number of values from a number of studies/databases [kg CO_2-eq per kg material]*

	Minimum	Average	Median	Maximum	# values	# studies/ data bases	References
Virgin	1.8	2.7	2.4	6.4	11	4	(COWI A/S and Utrecht University, 2018), (Sirap Gema SpA, 2020), (EcoInvent, nd-a), (Ecoinvent, nd-b), (Ecoinvent, nd-g), (Ecoinvent, nd-h), (Ecoinvent, nd-i), (Ecoinvent, nd-k), (GaBi, 2020), (Plastics Europe, 2021)
Biobased	-0.8	1.3	3.2	3.3	16	2	
Recycled	1.8	3.1	3.5	3.7	7	2	

The outliers are as follows:

- Virgin

- Maximum: Polyamide pellets, which is used to a lesser degree, however not a small degree, in packaging for healthcare products.

- Biobased
  - Minimum: The negative value is LDPE produced from European sugar beet. It furthermore includes biogenic CO_2 emissions/storage.
  - Maximum: PET bottle production in Europe with Brazilian sugarcane.
- Recycled
  - Minimum: The other values than this are higher, because they are a mix of recycled and virgin plastics. When the mix of materials are taken out the CO_2 emissions ranges from 1.8 to 2.0.

It was not possible to obtain the data for some specific plastic polymers, such as Tyvek plastics (produced from PE and EVA).

Based on the above it is recommended that biobased and recycled plastic are separated into two groupings due to the substantial differences between the recycled and biobased plastics' global warming potential. Furthermore, when resources are addressed later in this report, there is likewise a distinguishment between these. It should however also be noted that within biobased plastics variation is great.

4.2 Fibres

Fibres	Fibres include packaging produced from cardboard, paper, wood (e.g. single-use pallets), cellulose-based items (e.g. from bagasse) and other paper products e.g. in form of manuals. The most common material is assessed to be cardboard for both virgin and recycled/sustainably sourced fibres.
Virgin fibres	Virgin fibres are produced from 100% new fibres.
Recycled or sustainably sourced fibre	For fibres we identified products/packaging with more than 30% recycled/sustainably sourced content, as data on products from 100% content is difficult to obtain. The final score should represent 100% recycled/sustainably sources fibres, as a share between recycled/sustainably sourced and virgin is to be given.

Table 3 *Cradle to gate results for fibre packaging, where the minimum, average, median and maximum are represented of a number of values from a number of studies/databases [kg CO_2-eq per kg material]*

	Minimum	Average	Median	Maximum	# values	# studies/ data bases	References
Virgin	0.2	1	0.9	2.5	12	6	(Sabox Srl, 2019), (BillerudKorsnäs AB, 2018a), (BillerudKorsnäs AB, 2018b), (Miljøstyrelsen, 2020), (Ecoinvent, nd-c), (Ecoinvent, nd-d), (Ecoinvent, nd-f), (Ecoinvent, nd-j), (Ecoinvent, nd-l), (GaBi, 2020), (European Court of Auditors, 2017)
Recycled or sustainably sourced	0.2	0.9	1.2	1.9	8	6	

The outliers are the virgin maximum, which is liquid packaging board, that is not common in packaging material for healthcare equipment. Furthermore, the minimum for recycled and sustainably sourced fibres is from cellulose fibres.

Based on the above it is recommended that the groupings are kept. It could be argued that recycled and sustainably sourced fibres should be split, but the marked for the sustainably sourced fibres (cellulose based fibres) constitutes a small part of the sustainably sourced marked.

4.3 Metals

Virgin metals

Virgin metals are fully produced from primarily, raw material sources. The most common material is assessed to be aluminium.

Recycled metals

For recycled metals the study includes products/packaging that had more than 30% recycled content, as data on products from 100% recycled content is difficult to obtain. The final score will represent 100% recycled metals, as a share between recycled and virgin is to be given. The most common material is assessed to be aluminium.

Table 4 Cradle to gate results for metal packaging, where the minimum, average, median and maximum are represented of a number of values from a number of studies/databases [kg CO_2-eq per kg material]

	Minimum	Average	Median	Maximum	# values	# studies	References
Virgin	8.8	13.3	13.7	20.8	5	4	(Technocap Group, 2021), (Ecoinvent, nd-e), (GaBi, 2020), (European Aluminium Association, 2013)
Recycled	1.6	7.1	12.6	15.7	4	2	

The variety of metals is much wider than plastics and fibres, as there are many different types, which require different amounts of energy. It is however assumed that metals in packaging for healthcare products mainly consist of aluminium foils. It was difficult to obtain data on recycled aluminium and it is suspected that some of the data for virgin aluminium are in fact with a share of recycled aluminium as the market share for recycled content in aluminium is high. Other metals are hence not included in the table above.

Based on the above it is recommended that the groupings of virgin and recycled metal are kept, however vital that it is stated the environmental factor will only cover aluminium.

5 Validation of environmental factors

The actual LCA screening is now done on the basis of the above. For each grouping the most common materials are evaluated (LDPE, cardboard and aluminium respectively), however other types of materials within the groupings will be investigated.

The environmental factors are primarily based on the environmental impact category climate change (CO_2e emissions), but environmental impact categories within resource consumption are also assessed, i.e. abiotic depletion of fossil fuels, elements, metals and minerals as well as land use.

The environmental factors are determined on the basis of data sets from GaBi, Ecoinvent[1] and on the basis of calculations in reports, EPDs and LCAs from recognized sources.

The impact assessment methods chosen, when possible, are the following.

- Global warming potential; IPCC2013, 100a, no long-term effects (kg CO_2-eq).

[1] For Ecoinvent version 3.6 or 3.7 is utilised.

- Resources fossils; EF2.0 midpoint[2], no long-term effects (MJ)
- Resources minerals and metals; EF2.0 midpoint, no long-term effects (kg Sb-eq)
- Resources land use; EF2.0 midpoint, no long-term effects (points)

5.1 Methodological approach, prerequisites and delimitation of LCA screening

Method: LCA (consequential where possible), elaborated below.

Functional unit: Production of 1 kg of packaging

System delimitation: Cradle to gate (packaging manufacturer), as other requirements and criteria address recycling options. End of life is not included.

Geographical delimitation: material and packaging production in Europe. Mining/extraction might occur elsewhere.

Time delimitation: 2020. However, it should be noted that some data may be of older date.

Data is obtained from recognized LCA databases and few published studied. The screening is based mostly on consequential LCA data, in some cases it was not possible to choose or see what method has been used. It has however not been possible to go into a detailed study of all the background data and assumptions, both because data is not always available, and the time constrain of this LCA screening. All studies and databases rely on different sets of background data which creates uncertainties when comparing values from different databases or studies. The consequential approach is aimed to represent the health care sector and the materials represented in health care packaging to date. Recycled aluminium is for example not widely used in the health care sector due to criteria on purity. Therefore, an increase in recycled aluminium will have a positive environmental effect on the health care packaging market, by pushing the market towards the use of recycled aluminium.

For recycled materials there are different methodologies and assumptions of what is considered the marginal material. Considerations such as whether markets for recycled cardboard is at full capacity, so the marginal cardboard is virgin cardboard, have not been considered and it is not clear how this has been considered in the individual studies used. It is evaluated that this would likely mainly be of concern for cardboard, as most of the other materials used for packaging for healthcare products are specialised and would go into a specialised recycling marked, that is not saturated.

[2] Developer Environmental Footprint (EF) - (europa.eu)

5.2 Calculation

The data utilised for calculation of the environmental factors are selected from the data found above. Outliers and data for less utilised materials and product types are not included in the calculation.

The following steps are taken in the calculation

1 Selection of data sources

2 Average emissions for the four selected impact categories calculated.

3 Normalisation factors per person used, see Table 5

4 Weighing for the political focus have been give the following, see

5 Table 6

6 Finally, the values have been scaled with a factor 10^{-3} to form a unit less environmental factor.

7 A final score has been calculated by multiplying the environmental factor with 2 and rounding up to a whole number.

Table 5 Normalisation factors for the impact categories

Impact category	Model	Unit	Global NFs (2010) for EF	Global NFs (2010) for EF per person
Climate change	IPCC, 2013	kg CO2 eq	5.35E+13	7.76E+03
Land use	Bos et al., 2016 (based on)	pt	9.20E+15	1.33E+06
Resource use (fossils)	ADP fossils (van Oers et al., 2002)	MJ	4.50E+14	6.53E+04
Resource use (mineral and metals)	ADP ultimate reserve (van Oers et al., 2002)	kg Sb eq	3.99E+08	5.79E-02

World population used to calculate the NF per person: 6,895,889,018 people; Source: United Nations, Department of Economic and Social Affairs, Population Division (2011). World Population Prospects: The 2010 Revision, DVD Edition – Extended Dataset (United Nations publication, Sales No. E.11.XIII.7)

Table 6 Weighting percentages for the impact categories

Impact category	Weight
Climate change	99.8%
Land use	0.001%
Resource use (fossils)	0.1%
Resource use (minerals and metals)	0.1%

6 Results

The results are shown below. Consider that this is overall averaged results of multiple studies. The environmental factor has been multiplied with two in order to get a whole number that still shows a difference between the materials. The ratio between the materials remains the same and does therefore not skew the result of the environmental factors.

Table 7 Results

Material	Produced from	Definition	Environmental factor [unit less]	Score [unit less][3]	Sources
Plastics The most common material is assessed to be LDPE.	Virgin	Virgin plastic is produced from fossil fuels. Styrene polymers (PS, EPS and XPS) are excluded following the tender criteria.	2.6	5	(EcoInvent, nd-a), (Ecoinvent, nd-b), (GaBi, 2020), (COWI A/S and Utrecht University, 2018), (Ecoinvent, nd-k), (Plastics Europe, 2021)
	Bio-based	Bio-based plastic is defined as bio-based, but not oxo- or biodegradable polymers. The focus is on bio-based materials from primary and secondary sources, i.e. representative for the market today. Tertiary sources (from waste products, e.g. used cooking oil) are therefore excluded.	1.6[4]	3	(COWI A/S and Utrecht University, 2018), (Ecoinvent, nd-i), (GaBi, 2020),
	Recycled	Mechanically recycled plastics is defined as products/packaging with 100% recycled plastic.	1.9	4	(Ecoinvent, nd-g), (Ecoinvent, nd-h)
Fibres The most common material is assessed to be cardboard.	Virgin	Virgin fibres are produced from 100% new fibres.	1.6	3	(GaBi, 2020), (Miljøstyrelsen, 2020), (Ecoinvent, nd-l), (Ecoinvent, nd-k)
	Recycled or sustainable sourced	100% recycled/sustainably sources fibres. Cellulose fibres are to a lesser extent included.	1.1	2	(Sabox Srl, 2019), (Ecoinvent, nd-f), (Ecoinvent, nd-j), (Ecoinvent, nd-c), (GaBi, 2020), (European Court of Auditors, 2017)
Metals The most common material is assessed to be aluminium.	Virgin	Virgin metals are fully produced from primary raw material sources.	11.2	22	(Ecoinvent, nd-e), (Technocap Group, 2021), (GaBi, 2020), (European Aluminium Association, 2013)
	Recycled	100% recycled content.	3.4[5]	7	(Technocap Group, 2021), (European Aluminium Association, 2013)

[4] Including direct land use changes (LUC). Indirect land use changes are not included (iLUC).

[5] Including credit for use of recycled material, considering that the health care market for recycled aluminum is not saturated.

6.1 Comparison with original values

There are some differences between the original values and the ones presented in

Table 7 above. This is primarily because the end of life stage is not included in the LCA screening. The scoring still rates the materials in the same order, however the difference between them is not as great.

Table 8 Original suggested values and groupings

Material		**Weight** (filled by tenderer) Specify in kg **(A)**	**Factor** (given by contracting authority – cannot be changed) **(B)**	**Score**
Plastic material including plastic laminates and plastic non-reusable plastic pallets	Virgin fossil-based plastic	*Tenderer, specify weight here*	10	*A x B*
	Biobased or	*Tenderer, specify weight here*	5	*A x B*
	Recycled plastic	*Tenderer, specify weight here*	5	*A x B*
Cellulose based material e.g. cardboard and paper including non-reusable wooden pallets and other either adhered or attached paper e.g. manuals/leaflets	*Based on virgin fiber*	*Tenderer, specify weight here*	1	*A x B*
	Recycled or FSC el. PFEC certified	*Tenderer, specify weight here*	0.8	*A x B*
Metal Including metal foil	*Virgin*	*Tenderer, specify weight here*	60	*A x B*
	Recycled	*Tenderer, specify weight here*	45	*A x B*
Overall score				*SUM of the above*

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