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Development of EU Ecolabel Criteria for Sanitary Products

Preliminary Report - Draft

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PE INTERNATIONAL
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DEKRA

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List of Acronyms

ADL	acquisition and distribution layer
AHP	absorbent hygiene products
AP	acidification potential
ASTM	American Society for Testing and Measurement
BBP	benzyl butyl phthalate
CAS	Chemical Abstracts Service
CLP	Classification, labelling and packaging
CMR	carcinogenic, mutagenic and reprotoxic
COD	chemical oxygen demand
CTMP	Chemi-Thermo-Mechanical pulp
DBP	dibutyl phthalate
DEHP	bis(2-ethylhexyl)phthalate
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DnOP	di-n-octyl phthalate
ECF	Elemental Chlorine Free
ECNZ	Environmental Choice New Zealand
ECHA	European Chemicals Agency
EEC	European Economic Community
EINECS	European Inventory of Existing Commercial Chemical Substances
EMAS	Eco-Management and Audit Scheme
EP	eutrophication potential
EPD	Environmental Product Declaration
EU	European Union
FSC	Forest Stewardship Council
GECA	Good Environmental Choice Australia

GmbH	Gesellschaft mit beschränkter Haftung (company with limited liability)
GPP	Green Public Procurement
GPSD	General Product Safety Directive
GWP	global warming potential
IFOAM	International Federation of Organic Agriculture Movements
IPTS	Institute for Prospective Technological Studies
ISO	International Organization for Standardization
JRC	Joint Research Centre
LCA	life cycle assessment
MBT	mechanical-biological treatment
OCIA	Organic Crop Improvement Association
PBT	persistent, bioaccumulative and toxic
PCR	product category rules
PE	polyethylene
PEFC	Programme for the Endorsement of Forest Certification
POCP	photochemical ozone creation potential
PP	polypropylene
PPWD	Packaging and Packaging Waste Directive
PVC	polyvinyl chloride
RAPEX	Rapid Exchange of Information System
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical substances
REPA	recycling system for packaging (Sweden)
SAP	superabsorbent polymers
SEMCo	Swedish Environmental Management Council
SVHC	substances of very high concern

TARIC	Tarif intégré des Communautés européennes (Integrated tarif of the European Union
TCF	Total Chlorine Free
TOC	total organic carbon
vPvB	very persistent and very bioaccumulative
WSP	Worldwide Strategic Partners

1. BACKGROUND AND INTRODUCTION

The Institute for Prospective Technological Studies (IPTS) delivers scientific and interdisciplinary analyses with the overall goal of supporting the EU policy-making process. In particular, the services of the Sustainable Consumption and Production Unit within the IPTS include providing socio-economic analyses with regards to key aspects of sustainable consumption and performing techno-economic and environmental impact assessment of technologies, products and processes.

The aim of this project is to develop EU Ecolabel criteria for sanitary products. The implementation of this scheme will assist in the reduction of negative impacts of consumption and production on the environment, on human health and natural resources. The project is led by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) with the technical support of DEKRA Industrial GmbH together with PE INTERNATIONAL. The built team will carry out the necessary groundwork so that a solid basis for the development of sustainability criteria can be made available for policy-making.

As part of the project, an initial scoping document delivered the rationale for the products to be included in this project. This report was shared with a group of stakeholders involved in the project (23 February 2012). To date, the suggested scope of products has been confirmed and considered relevant for the development of EU Ecolabel criteria.

Based on the results of the scoping document, this preliminary report provides a brief description of selected products, main features and uses (Section 2). Section 3 of this report reviews existing legislation, standards and environmental schemes relevant to the products within the scope of this project. This review is important because it outlines rules, requirements and criteria currently in existence for the relevant products and as such provides useful insights for development of EU Ecolabel criteria.

Section 4 of this report analyses the market for the products within the scope of this project. Information on sales, consumption, import/export figures as well as market growth rates or market shares help to understand the economic relevance of the selected sanitary products and to address the work towards the development of effective EU Ecolabel criteria.

Section 5 of this report provides the technical analysis which discusses the technological aspects of sanitary products regarding the material compositions and production processes of children's diapers, incontinence products, feminine care pads, tampons and breast pads. An overview of previously conducted and published life cycle assessments (LCA) studies is given and new LCA models are developed and interpreted for each of the single products within the scope.

2. DEFINITION OF PRODUCT SCOPE

2.1 Overview of definitions of sanitary products

A large number of definitions and categorisations exist for sanitary products. This Section aims to provide a brief overview of different definitions and understandings.

According to the Cambridge Dictionary a product can be described as 'sanitary' if it *"…protects health by the removal of dirt and waste, especially human waste"* or *"…describes the things which are used by women during their period*."[1]

Different eco-labelling and green procurement schemes group different products into the category 'sanitary products' or sub-categories such as 'sanitary paper products' or 'absorbent hygiene products'.

The **Blue Angel** includes eight different products in 'sanitary paper products', i.e.cleaning rags, handkerchiefs, kitchen roll, napkins, paper handkerchiefs, paper towels, sanitary paper and toilet paper.[2]

The **Nordic Swan** explicitly only includes disposable products in their labelled product group 'sanitary products', which came into existence due to the amalgamation of two individual eco-labelled groups, namely 'disposable diapers' and 'female sanitary products'. The products include breast pads, children's diapers, incontinence care products (panty liners, formed diapers and diapers with tape strips), sanitary towels (pads and panty liners), tampons, cotton buds, cotton wool, toothpicks, underlays, draw sheets, bed linen, wash cloths and surgical gowns. The Nordic Swan label excludes wet wipes, paper handkerchiefs, wash cloths made of paper or textile materials, and mesh pants for use together with certain sanitary products from the label under this product group. Any products containing medications/medicine, disinfectant substances and the like are also ineligible.[3]

The U.S. eco-labelling scheme **Green Seal** includes quite a different list of product under the term 'sanitary paper products', i.e. paper towels, general purpose wipes, paper napkins, bathroom tissue, facial tissue, toilet seat covers, place mats, tray liners, table coverings and others. Non-woven sanitary products, general purpose disposable and flushable wipes containing cleaning agents or fragrances, disposable diapers or sanitary napkins and tampons are explicitly excluded.[4]

The Australian eco-label **Good Environmental Choice Australia (GECA)** applies its standards to sanitary paper products including toilet paper, facial tissues, paper towels, hand towels and table napkins.[5] The closely related **Environmental Choice New Zealand (ECNZ)** Standard includes the following products under the relevant sanitary paper product scheme: toilet paper, facial tissue, paper towels and table napkins.[6]

The Japanese eco-labelling scheme **Ecomark** deals with sanitary paper products as well, but only includes tissue paper, toilet paper and coarse tissue paper. Paper towels and other types of sanitary paper are instead excluded.[7]

The **Swedish Environmental Management Council (SEMCo)** has developed procurement criteria for a group of products they call 'Incontinence and Urology Products'. They include diapers for children as well as products referred to in the Standard ISO 9999, namely urination devices, catheters, urine drip collector, urine collectors, urine receptacles, suspension and attachment devices for urine collection bags, absorbent aids for incontinence, attachment device for absorbent aids for incontinence.[8]

Guidelines for the procurement of 'green' sanitary products have also been developed by the Finnish organisation **Efeko Ltd.** They include disposable nappies, panty liners, tampons, pads and incontinence care products.[9]

The organisation supervising the certification of **Environmental Product Declarations (EPDs), Environdec,** approved the development of Product Category Rules (PCRs) for two distinct product groups which could both be included within the definition of 'sanitary products'. One PCR exists for **absorbent hygiene products (AHP)**, a subset of products from UN CPC/division 32/subclass 32193, which consist of a) feminine sanitary protection products, i.e. sanitary towels, sanitary napkins, panty liners, panty shields and tampons; b) baby diapers, i.e. baby diapers, pant diapers, training pants and swimming pants and c) incontinence products, i.e. all-in-one products containing both the absorbent core and the outer shell with fastening, insert pads and pants/briefs, liner pads, male pouches, bed protection and underpads.[10] Products such as toilet paper, handkerchiefs, towels, serviettes and articles of apparel, paper pulp, paper and cellulose wadding or webs of cellulose fibres are excluded within the AHP PCRs but covered in the second set of PCRs for **tissue products.** The following characteristics apply for this group of products:[11]

- products must consist of at least 90% fibres, virgin or recycled;
- sheets, rolls, tissue paper fit for use for personal hygiene, wiping, cleaning, absorption; and
- laminated tissue products and wet wipes are excluded.

The industry association of non-woven materials, EDANA, was closely involved in the development of the EPD PCRs for AHPs and tissue paper. However, in 2008 EDANA developed a proposal of GPP criteria for sanitary products in which they only include disposable AHPs for incontinence care as characterised in the ISO 15621 Standard.[12]

Criteria for the procurement of incontinence products have been also developed by the **Agency for Public Management and eGovernment (Difi)** on behalf of the Norwegian Department of Environment.[13] From the analysis of the final report ENV.G.2/SER/2009/0059r "Assessment and Comparison of National Green and Sustainable Public Procurement Criteria and Underlying Schemes", it is moreover apparent that national GPP schemes related to sanitary paper products are implemented in most of the countries included in the study (Austria, Belgium, Denmark, Finland, France, Germany, Netherland, Norway, Sweden, UK). On the contrary, only the Scandinavian countries seem to have implemented – up to 2010 - procurement schemes dealing with incontinence products.

From the above it can be concluded that the definitions for sanitary products and whether certain products are included or not vary widely. As a result and for the purpose of defining a product scope suitable for the development of EU Ecolabel

criteria, it is recommended that selection criteria are developed, by which the process of choosing products to be included in the product scope is made transparent and defensible. The next Section intends to provide such a selection criteria framework.

2.2 Criteria for the definition of the product scope

This Section should be read in conjunction with the product criteria matrix illustrated in Annex I. In the matrix, an extensive list of products is given which was compiled by scanning the various documents referred to in Section 2.1. The matrix also shows the various selection criteria which were developed with the aim of categorising the various products and ultimately of defining the product scope for this project. The selection criteria are presented and discussed in the following. After each criterion, a recommendation is given as to whether certain products shall be excluded or included in the product scope for this project.

Criterion 1: Coverage under existing EU Ecolabelling Scheme

Products which are already covered within the existing EU Ecolabelling scheme are considered out of scope for this product group (criterion 1). An EU Ecolabel already exists for tissue paper (Commission Decision 2009/568/EC).[14] Article 1 of the Directive states that *"the product group 'tissue paper' shall comprise sheets or rolls of tissue paper fit for use for personal hygiene, absorption of liquids and/or cleaning of soiled surfaces. The tissue product consists of creped or embossed paper in one or several plies. The fibre content of the product shall be at least 90 %."* Article 1 further indicates that a) wet wipes and sanitary products, b) tissue products laminated with other materials than tissue paper and c) products as referred to in the Cosmetics Directive (76/768/EEC) are excluded.

Another EU Ecolabel exists for textile products.[15] Accordingly, some further products can be excluded, since "*textile products for interior use consisting of at least 90% by weight of textile fibres"* are included in this label.

> ***Recommendation regarding criterion 1:*** *Products such as facial tissues, cleansing tissues, kitchen rolls, paper towels, tissues, napkins, rags, tissue papers, handkerchiefs toilet paper and tissue sheets/rolls as well as bed linen, cleaning rags, mesh pants, draw sheets and wash cloths are NOT part of the product scope for sanitary products due to being covered under existing EU Ecolabel schemes.*

In accordance with the recommendation regarding criterion 1, the respective products are highlighted in red in the product criteria matrix. It is important to note that the abovementioned restriction only applies to products covered by the EU Ecolabel (EU Flower) and is not to be confused with products included in other existing ecolabelling schemes (e.g. Blue Angel, Nordic Swan, etc.). Nevertheless, the product criteria matrix

also shows as additional information which particular sanitary products are included in other labelling schemes.

Criterion 2: Products to be included due to categorisation of products in other ecolabelling schemes

Selection criterion 2 aims at reflecting the decisions of other eco-labelling schemes with regards to including or excluding certain products from a defined product scope.

As mentioned in Section 2.1, EPD PCRs were developed for two main groups of sanitary products, i.e. AHPs and tissue products. The two main distinctive features for products in these two groups are the content of paper pulp and the ability of products to absorb liquid human waste streams. For the tissue products, it was defined that the paper pulp content must be at least 90%. Preliminary research for AHPs shows that the paper pulp content is typically around 60% (incontinence products) and can be less than only 40% in children's diapers.[16] For AHPs, other materials such as superabsorbents and different kinds of polymers make up the remaining share of raw materials. The paper pulp content was also used by the EU Ecolabel as the distinctive feature for tissue paper.[13]

From the definitions of sanitary products as presented in Section 2.1 one notices that other eco-labelling schemes either focus on diapers/incontinence products (i.e. products with high absorptive capacity) or on products with high paper pulp content which are often called 'sanitary paper products'. For example, the Nordic Swan and Efeko include products such as diapers, incontinence care products and others, whereas most other labels, i.e. Blue Angel, GECA, ECNZ, Ecomark and Green Seal include only products with a high paper pulp content.

Recommendation regarding criterion 2: *It is in line with other ecolabelling schemes to distinguish between products that feature high absorptive capacities and products which have a high paper pulp content. Since the latter group of products is excluded due to criteria 1, the product scope for this project should focus on the former group.*

Both in the EPD PCRs and in the EDANA sustainability report, the group of products that possess high absorptive capacities are called AHP and include three main product sub-groups, i.e. feminine sanitary protection products, baby diapers and incontinence products. [10],[17]

Although not explicitly included in the EPD PCR or EDANA scope for AHP, it seems recommendable to include also breast pads into the product scope of this project. This is supported by the following reasons: a) The Nordic Swan includes breast pads into their sanitary products category; b) breast pads are a product with an estimated high sales volume and c) breast pads possess very similar characteristics to AHPs (see also criterion 3).

According to the above, the AHP are highlighted green in the product criteria matrix.

Criterion 3: EU Ecolabel requirements and typical characteristics of products suggested for the product group sanitary products

In Article 3.1 of the EC Regulation 66/2010 it is stated that a *"'product group' means a set of products that*

a) serve similar purposes and

b) are similar in terms of use, or have similar functional properties, and

c) are similar in terms of consumer perception"[18]

According to this requirement, it is important to only include products which have similar attributes in the abovementioned aspects. Only if similar characteristics of products in the same product group can be ensured, is it possible to develop a set of criteria which strike a balance between comprehensively reflecting the environmental performance of the products along their life cycle and being simple and easy to understand for all stakeholder groups involved, as also stated in paragraph 5 of the EC Regulation 66/2010: *"Those criteria should be simple to understand and to use…"*[18]

According to this principle and in order to develop a comprehensive and easy to understand set of criteria, the products to be included in the product scope should have similar characteristics. Analysing the products identified through criterion 2, the following typical characteristics can be described:

a) all products fulfil a similar purpose, which could be described as the collection of human body waste streams by acting as a physical absorbent during prolonged and direct contact with the human body;

b) all products present a relatively similar material composition;

c) all products are designed to be disposed immediately after use; and

d) all products possess similar waste management scenarios.

Recommendation regarding criterion 3: *Products within the product scope should have similar characteristics in terms of their purpose, use, functional properties and consumer perception. The products to be included in the product scope should possess the abovementioned characteristics.*

Applying this criterion, the products listed in the Table *1* should be **excluded** from the product scope (highlighted in red in the product criteria matrix).

Table 1. Products excluded according to criterion 3

Excluded product	***Reasons considered in support of the exclusion*** a) products do not fulfil similar purpose; b) products do not present similar material composition; c) products are not designed to be disposed after use; d) products possess different waste management scenarios
- breast wipes	a)
- cotton buds/pads	a), b), d)
- cotton wool	a)
- facial tissue	a)
- hand towels, paper towels, tissues, napkins, rags, kitchen roll	a)
- placemats, table coverings, table napkins, tray liners	a)
- plastic accessories and devices	a), b), c), d)
- all kinds of sanitary/toilet paper	a), b)
- surgical gowns	a), d)
- toilet seat cover	a)
- tooth picks	a), b)
- underlays	a), c)
- urination/urology devices (other than diapers)	b), d)
- wet wipes	a), b), d)
- other wipes	a)

According to criterion 3, the following products named in the product criteria matrix should be thus **included** (highlighted in green):

- all kinds of diapers
- all kinds of sanitary pads and panty liners
- all kinds of tampons
- breast pads

It should be noted that the key distinctive features of products identified through criterion 3 is their absorptive capacity through **direct** and prolonged contact with the human body. Accordingly, bedding underlay is excluded since the absorption of bodily waste streams takes place away from the human body.

As noted under criterion 2, it is recommended to include breast pads into the project scope due to their very similar characteristics in comparison to other products identified through criterion 3.

Criterion 4: Market volume of relevant groups of sanitary products

The EU Ecolabel Regulation (EC 66/2010) states that the scheme intends to achieve a significant reduction of environmental impacts through the use of the EU Ecolabel.[*] Consequently, it is highly likely that the overall environmental benefits of ecolabelling a particular product increase with the scale of production and consumption of a given product. Annual sales data for the EU27 for relevant groups of sanitary products are presented in Table 2. The data are split into two main groups (the respective general PRODCOM category is NACE 17.22, called 'manufacture of all household and sanitary goods and of toilet requisites'):[18]

a) products with the CPA code 17.22.11, i.e. toilet paper, handkerchiefs, cleansing or facial tissues and towels, tablecloths and serviettes, of paper pulp, paper, cellulose, wadding or webs of cellulose fibres and

b) products with the CPA code 17.22.12, i.e. sanitary towels and tampons, napkins and napkin liners for babies and similar sanitary articles and articles of apparel and clothing accessories, of paper pulp, paper, cellulose wadding or webs of cellulose fibres.

Since the first group of products was excluded from the scope according to criterion 1, the analysis of the sales data for the second group (see Table 2) shows that the products with the highest sales volumes are children's diapers (65%) followed by sanitary pads and tampons (13%). Wadding and articles made of wadding forms all together 9% of the total volume. According to TARIC codes *"wadding and articles of wadding* [are] *impregnated or coated with pharmaceutical substances or put up in forms or packings for retail sale for medical, surgical, dental or veterinary purposes."*[19] Due to these purposes, these articles are excluded from the product scope (see criterion 5 for details). For completion purposes, 13% of the sales come from other products that are not further specified.

Table 2. PRODCOM sales data for sanitary products within EU27 [20]

PRODCOM Code	***Description***	***Annual sales volume 2010 in M€***	***% of overall sales volume***	***% of remaining sales after application of criterion 1***
17.22.11.20	Toilet paper	5,439	31%	excluded
17.22.11.40	Handkerchiefs and cleansing or facial tissues of paper pulp, paper, cellulose wadding or webs of cellulose fibres	986	6%	excluded
17.22.11.60	Hand towels of paper pulp, paper, cellulose wadding or webs of cellulose fibres	2,628	15%	excluded
17.22.11.80	Tablecloths and serviettes of paper pulp, paper, cellulose wadding or webs of cellulose fibres	1,329	8%	excluded
17.22.12.10	Sanitary towels and tampons, napkins and napkin liners for babies and similar sanitary articles, of wadding	121	1%	2%
17.22.12.20	Sanitary towels, tampons and similar articles of paper pulp, paper, cellulose wadding or webs of cellulose fibres	869	5%	13%
17.22.12.30	Napkins and napkin liners for babies and similar articles of paper pulp, paper, cellulose wadding or webs of excluding toilet paper, sanitary towels, tampons and similar articles	4,522	26%	65%
17.22.12.40	Wadding; other articles of wadding	584	3%	7%
17.22.12.50	Articles of apparel and clothing accessories of paper pulp; paper; cellulose wadding or webs of cellulose fibres (excluding handkerchiefs, headgear)	32	0%	0%
17.22.12.90	Household, sanitary or hospital articles of paper, etc, n.e.c.	884	5%	13%
TOTAL		**17,394**	**100%**	**100%**

This preliminary and quantitative screening was aimed at highlighting clusters of products characterized by a large-market-share. A limited portion of the basket of products was considered. However, it is likely that other products complying with the previous criteria do not have high sale volumes and that the EU ecolabelling of these products would thus produce only marginal benefits (e.g. bedding underlays).

Recommendation regarding criterion 4: *According to EU27 sales data, there is strong support towards focussing on baby diapers and sanitary napkins as well as similar products belonging to the relevant PRODCOM categories for inclusion into the product scope for this project. In contrast, other products can be considered a minority product and should be excluded from the product scope.*

The products included through criterion 4 are highlighted in green in the product criteria matrix, while products although complying with the previous criteria but supposedly only covering a marginal share of the market are highlighted in red. It should be noted that due to the high level of aggregation in the PRODCOM Statistics, only the products that can be clearly identified through the PRODCOM Code are highlighted. More detailed market information is provided in Section 4.

Criterion 5: Products to be excluded from EU ecolabelling scheme due to legislation

Article 2.2 of the EU Ecolabel Directive stipulates that the EU Ecolabels shall not be applied to "…medicinal products for human use, as defined in Directive 2001/83/EC…or for veterinary use, as defined in Directive 2001/82/EC, nor to any type of medical device".[21] In accordance with WHO, incontinence could be considered a disease, and not a natural condition, after an age of 5 years.[22] The Commission is currently clarifying if this leads to a mandatory exclusion of incontinence products from the EU Ecolabelling scheme.

Recommendation regarding criterion 5: *Due to regulatory restrictions, incontinence products should be excluded from the product scope for the EU Ecolabel.*

It would be interesting to hear from stakeholders their opinion about this potential restriction.

2.3 Conclusions

In conclusion, **the following products are proposed** within the product group scope of the EU Ecolabel:

- **all kinds of children's diapers**
- **all kinds of sanitary pads/napkins and panty liners**
- **all kinds of tampons**
- **breast pads**

This product scope is highlighted in green in the product criteria matrix (row 3) and further explained in the following. Incontinence diapers, because of the legal uncertainty if they can be part of the Ecolabelling scheme, are highlighted in yellow in the product criteria matrix.

According to the exclusion criterion 1, only those products which are not yet covered by any existing EU Ecolabel schemes can be included in the product scope. Certain products that resemble key characteristics of products with a high paper pulp content as well as products considered 'textiles' are thus excluded.

Due to the main distinction between sanitary products with a high paper pulp content (sanitary paper products) and sanitary products with absorptive capacities (AHP), it is recommended to follow the product scope defined for the AHP group. Following the

recommendation of the Nordic Swan Ecolabel and due to the fact that the product characteristics of breast pads are very similar to those of the AHP, breast pads should also be included.

Owing to the requirement that products within the product scope should possess similar characteristics and based on the analysis of the common main features of the products identified through criteria 2, further reasons for the inclusion and exclusion of certain products were collected (criterion 3). In this context it should be noted that it is recommended to exclude reusable diapers from the product scope for the following main reasons: a) 95% of families in the EU use disposable diapers[18], b) disposable diapers are rated *"…the second greatest improvement in contemporary life (the first being the automatic washing machine)"* by survey respondents with children[23], c) the raw materials used as well as the waste management scenarios are very different and d) the types of environmental impacts are different compared to disposable diapers. Other ecolabelling schemes, e.g. Nordic Swan have also excluded reusable diapers.

EU27 sales data for sanitary products complying with the previous criteria revealed that high sales volumes are in particular associated with children's diapers and sanitary napkins. Hence, it can be concluded that all together these products could be responsible for a large amount of environmental impact and should therefore be included in the product scope for this project. The product criteria matrix also indicates which products presumably are of negligible relevance and hence should be excluded from the product scope.

Finally, it should be noted that the majority of the products (especially when considering product volumes) are aimed at the end consumer. Hence, provided that a suitable set of sustainability criteria can be determined, labelling the defined products with an EU flower can be expected to be a powerful tool for reducing the environmental impact caused by these products while effectively promoting the EU Ecolabel at the consumer level.

2.4 Selected product scope – main product characteristics

In accordance with the product scope as defined in the previous Section (2.3), the individual products are briefly described detailing their main characteristics. Further information about the products within the scope of this project such as the material composition or the production technology needed to manufacture the sanitary products will be provided in Section 5.1.

Disposable children's diapers

For the first two to three years of their lives, children usually wear diapers. Over 95% of these children in Europe use disposable diapers. Disposable children's diapers are used for absorbing and retaining infants' urine and faeces while keeping the skin dry

and healthy. There is a wide range of sizes available to fit different age groups of children. In 1987 the average children's diaper weighed 67 grams. This weight was reduced to 59 grams in 1990, and further reduced to 51 grams in 1993. By 1997 the average children's diaper weight was 47 grams.[63] In the last 15 years the mass of the average diaper was further reduced to 36 – 42 grams (see Section 5.1 for details). Disposable diapers have become fundamental in families across Europe as they offer numerous benefits, such as health protection (reduced incidence of skin rash, skin irritation and infections), comfort (superior comfort for the baby due to softness, lightness and the breathable nature of the materials used), convenience (easy use) and hygiene (reduction of the risks of transmitting infectious diseases and prevention of faeces and urine leakage). Table 3 illustrates the main features of different types of children's diapers.

Table 3. Description of main types of children's diapers

Product group	***Individual product***	***Definition***
Children's diapers	New born nappies/diapers	Disposable children's nappies/diapers; Newborn - 2-5kg (4-11lbs)
	Standard nappies/diapers	Disposable children's nappies/diapers; Standard - 6-10kg (13-24lbs)
	Junior nappies/diapers	Disposable children's nappies/diapers; Junior - 11kg+ (24lbs+)
	Disposable pants	Includes products designed for toilet training of babies or small children. Disposable Pants are usually thinner than diapers, but resemble diapers in their absorbency and are similar to normal underwear in design and the way they are worn.

Feminine care pads

Feminine care pads (also called external feminine care products) are designed to meet the hygiene needs of women during the menstrual cycle. They are also used after childbirth or surgical interventions for the purpose of absorbing liquids. Although not specifically intended for this purpose, they are also sometimes used for light urinary incontinence.

Modern feminine care products offer a range of benefits to women, such as increased freedom to maintain leisure and sporting activities during the menstrual cycle. These products are designed to be comfortable, easy to use and provide highly efficient and discreet hygienic protection. Products can be easily and discreetly carried around and hygienically disposed by wrapping the product with its individual packaging.

Table 4 illustrates the main features of different types of feminine care pads.

Table 4. Description of main types of feminine care pads

Product group	***Individual product***	***Definition***
Feminine Care - Pads	Panty liners	External sanitary protection designed for light flow, may be used in conjunction with a tampon, often promoted as offering protection and "freshness" throughout the whole month, having minimal absorbency.
	Standard Towels With Wings	Included are standard full-size towels usually designed for medium to heavy flow (excluded are any slim line towels); standard towels with adjustable extension tabs.
	Standard Towels Without Wings	Included are standard full-size towels usually designed for medium to heavy flow (excluded are any slim line towels); standard towels without extension tabs.
	Ultra-Thin Towels With Wings	Included are thin-layered sanitary protection towels, designed to absorb different flows and promoted as more convenient and discreet; ultra-thin towels with adjustable extension tabs.
	Ultra-Thin Towels Without Wings	Included are thin-layered sanitary protection towels, designed to absorb different flows and promoted as more convenient and discreet; ultra-thin towels without extension tabs.

Feminine care tampons

Tampons offer very discreet and effective protection by absorbing the menstrual fluid while inside the body. Tampons are used by women throughout their reproductive age (between 12 and 50, on average) and come in different absorbent capacities and with or without an applicator. The benefits that tampons offer include discretion, comfort and convenience.

Incontinence products

Single-use incontinence products are used for absorbing and locking away urine and faeces to prevent leakage and to keep the users' skin dry and healthy. The current product range is extensive and is designed to meet the needs of people of different ages and both genders. Panty liners, pads and light pants are appropriate in case of light to medium incontinence. Pants, two piece products (pad and pants), all in one, and belted diapers are used for medium and heavy incontinence.

Incontinence products provide benefits for its users and society in general. They allow users to maintain their sense of dignity and lead a full and satisfying life. These products are healthy for the skin and help to prevent rashes, irritations and infections. They enable hygiene, cleanliness, odour reduction and independence. Society benefits include assistance in infection control and minimisation of the spread of infection between patients in care settings. Additionally, care assistant time and costs are

reduced valuably. Table 5 illustrates the main features of different types of incontinence products.

Table 5. Description of main types of incontinence products

Product group	***Individual product***	***Definition***
Incontinence products	Away-from-home incontinence	Includes a variety of protective products for different levels of bladder or bowl adult incontinence. The term 'away-from-home' refers to incontinence products used in hospitals and other health or nursing care establishments and are distinguished from incontinence products purchased from retailers. Products with different levels of absorbency are covered.
	Light incontinence	The sector covers products designed for mild incontinence protection and light flow. Included are products, normally characterised by limited absorbency levels, such as normal pads, liners, shields, male pouches and guards.
	Moderate/heavy incontinence	The sector covers products designed for moderate and severe levels of incontinence. Products such as ultra-absorbent pads and shields, pants (protective underwear), briefs, undergarments, adult diapers are included. The sector also includes pant/pad systems.

Breast pads

Breast or nursing pads are soft, absorbent pads that women use to soak up leaking milk. They prevent stains or damp patches on the clothing that are not just uncomfortable, but also increase the risk of infection. The functionality and simple use of breast pads make them essential for many women during their breast-feeding period.

3. EXISTING LEGISLATION AND STANDARDS

3.1 Review of relevant regulations and legislation

In this Section, regulations and relevant legislation related to the products within the scope are reviewed. The main goal is to identify specific clauses or guidelines of relevance for the development of EU Ecolabel criteria.

Feedback from stakeholders on the presented section regarding regulations and standards for sanitary products will be much appreciated. In particular, it would be important to know whether the information reported is extensive, clear and correct in all its parts or whether additional pieces of information or clarifications are needed. This will be greatly beneficial for the development of EU Ecolabel criteria.

General Product Safety Directive (GPSD) 2001/95/EC

The goal of the GPSD is to ensure a high level of consumer protection. It institutes a broad-based safety requirement for consumer products. Products placed on the market must be safe and must not present any risks, or only the minimum risks, related to their use. The GPSD applies in the absence of more specific Community legislation on safety of the products. To ensure the compliance of products with the general safety requirement, the Directive sets obligations for producers, distributors, Member States and the Commission. The GPSD also sets up the EU rapid alert system for dangerous consumer products – rapid exchange of information system (RAPEX).

According to the Directive, the conformity of a product to the general safety requirement is assessed by taking into account both EU and national legislation as well as voluntary national standards, Commission recommendations, product safety codes of good practice, state-of-the-art technology and reasonable consumer expectations concerning safety.[24] Thus, the GPSD serves as a starting point by giving a broad definition of the relevant regulations and other sources that apply to consumer products, in this case sanitary products within the scope as defined in Section 2.

Given the rather general requirements expressed through this Directive, the prescriptions contained in this Directive should not have a significant influence on the development of EU Ecolabel criteria for sanitary products. The sources that are more narrowly focused on the products within the scope shall rather supply more specific and relevant information.

Waste Framework Directive 2008/98/EC

Directive 2008/98/EC (Waste Framework Directive) institutes the legal framework for the treatment of waste in the Community. Its goal is the protection of the environment and human health by minimising the harmful effects of waste generation and management. In order to achieve this goal, the Directive establishes crucial waste management requirements, major principles such as an obligation to handle waste in a way that does not have a negative impact on the environment or human health, an encouragement to apply the waste hierarchy and the polluter-pays principle.[25]

The Waste Framework Directive establishes the waste hierarchy whose goal is to guide waste management measures in the following manner:

"a) prevention;

b) preparing for re-use;

c) recycling;

d) other recovery, e.g. energy recovery; and

e) disposal."

Generally, the products within the scope of this project fall under the categories 'energy recovery' or 'disposal' while the packaging may also fall under the 'recycling' category[26] (see Section 2.3 and Section 5.3 for more information). These options belong to the three bottom levels of the waste hierarchy outlined in the Directive 2008/98/EC. In addition to the waste hierarchy, the Directive mentions the importance of the economic, technical and social principles along with environmental aspects. Accordingly, the consumer benefit of using disposable sanitary products should be compared with the environmental burdens due to their disposal and with the environmental implications associated with reusable products that offer alternative options.

The Directive describes safe disposal operations to protect human health and the environment. The disposal operations shall be carried out:

"a) without risk to water, air, soil, plants or animals;

b) without causing a nuisance through noise or odours; and

c) without adversely affecting the countryside or places of special interest."

This specification of safe disposal operations applies to the sanitary products that fall under the project scope.

Additionally, various disposal and recovery operations are listed in Annex I and II of the Directive which need to be considered (see Section 5.3 for further details). Taking into account various EU-national regulations on waste management, **the most environmentally friendly scenarios of disposal or recovery of sanitary products could be promoted.**

Annex III of the Directive relates to properties that allow products being classified as hazardous. In accordance with this listing, the waste from products under the project scope is categorised as non-hazardous.[27]

Due to the broad nature of the given legislation that encompasses a large variety of waste, there are no specific criteria that directly apply to sanitary products under the scope of this project. Nevertheless, it supplies valuable input that serves as a framework in shaping the EU Ecolabel criteria with regard to waste management.

European Packaging and Packaging Waste Directive 94/62/EC

The European Packaging and Packaging Waste Directive 94/62/EC has been in force since 1994 and regulates, besides the heavy metal content through the Essential Requirements, also the responsibility for recovery of any packaging that is put on the market. In most countries within the EU this has led to the introduction of the producer responsibility concept, i.e. it is the producer, filler or importer of any packed product that is financially responsible for the environmentally sound and correct collection and treatment of the packaging material(s). As a result, there are national 'producer responsibility organisations', e.g. Green Dot, in most EU countries which organise the actual collection of packaging waste and which are financed by the producers, fillers and/or importers.

As with the previously mentioned Waste Framework Directive, it is unlikely that some of the waste management criteria outlined in the European Packaging and Packaging Waste Directive which will lead to conflicts or overlaps with the EU Ecolabel criteria for sanitary products.

Product Liability Directive 85/374/EEC

Directive 85/374/EEC addresses the liability of European producers in the case of defective products that could cause damage to consumers. It covers issues such as proof of damage, producer exemptions from liability, damage covered and liability expiration.[28]

The Product Liability Directive deals with universal commercial regulations on the EU level that apply to all products with very few exceptions. The rules also apply to the sanitary products under the project scope, without, however, addressing issues which could be considered particularly relevant for the development of EU Ecolabel criteria.

Directive on the Protection of Animals Used for Scientific Purposes 2010/63/EU

The goal of the Directive 2010/63/EU which revises Directive 86/609/EEC underlines the importance of the protection and welfare of animals used for scientific purposes. It stresses the principle of replacement, reduction and refinement, specifies the purposes of procedures and methods of killing of animals. It sets minimum standards for housing, care and personnel competence and regulates the use of animals through a systematic project evaluation. By introducing measures such as non-technical project summaries and retrospective assessments, the transparency with regards to the use of animals for scientific purposes is improved.[29]

To the knowledge of the authors, animal experiments are not an issue for the products within the scope of this report. Consequently, the given legislation is of little relevance for developing EU Ecolabel criteria. Nevertheless, **a written statement from the manufacturer stating the non-involvement in animal testing could theoretically be introduced as a requirement.**

Medical Devices Directive 93/42/EEC

The goal of the Medical Devices Directive is the harmonization of the conditions regulating the movement, the market placement and the bringing into service of medical devices throughout the internal market. It applies to medical devices and their accessories.

The Directive defines medical devices as *"any instrument, apparatus, appliance, software, material or other article, whether used alone or in combination, including the software intended by its manufacturer to be used specifically for diagnostic and/or therapeutic purposes and necessary for its proper application, intended by the manufacturer to be used for human beings for the purpose of:*

- *diagnosis, prevention, monitoring, treatment of alleviation of disease;*
- *diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap;*
- *investigation, replacement or modification of the anatomy or of a physiological process;*
- *control of conception;*

and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means."[30]

An accessory is defined as *"an article which whilst not being a device is intended specifically by its manufacturer to be used together with a device to enable it to be used in accordance with the use of the device intended by the manufacturer of the device."*

The essential requirements of the Directive stress the safety of patients and the performances intended by the manufacturer. The devices must be designed in a manner to withstand the storage and transport conditions. Further, the Directive covers, amongst others, free movement of goods, persons, services and capital, reference to standards, information on incidents, conformity assessment procedures, European databank for storing regulatory data and CE marking.

As mentioned above (see Section 2.2, Criterion 5), **products that fall under the Medical Devices Directive should not be included within the EU Ecolabel product scope. The Commission is currently looking into the question if this leads to the exclusion of incontinence products.**

Biocidal Products Regulation 98/8/EC

The Biocidal Products Directive (Directive 98/8/EC) regulates the placing of biocidal products on the market and aims at the establishment at community level of a positive list of active substances which may be used in biocidal products. Biocidal Products are defined in the current European legislation as *"active substances and preparations containing one or more active substances, put up in the form in which they are supplied to the user, intended to destroy, deter, render harmless, prevent the action of, or otherwise exert a controlling effect on any harmful organism by chemical or biological means."*[31] A list of active substances agreed at community level for inclusion in low-risk biocidal products is listed in Annex IA of the Regulation.

Active substances cannot be added to the list if they can be classified as: carcinogenic, mutagenic, toxic for reproduction, sensitising, or bioaccumulative and not readily degrade according to the Directive 67/548/EEC **on** the classification, packaging and labelling of dangerous substances. Each Member State must authorise products containing the biocide before they can be placed on the market in that Member State. Once authorised by a Member State, the product can be placed on the market in any other Member State.

The Directive also planned a 10-year programme of work for the systematic examination of all active substances already on the market. All provisions necessary for the establishment and implementation of the programme were provided in 2003 through the Regulation (EC) 2032/2003. The mandate for the regulation of biocidal products will be regularly transferred to the REACH system.

The scope of the Directive covers 23 product groups, including "human hygiene biocidal products". According to a decision ruled in 2003, diapers are considered a biocidal product *"if the active substance is placed on the market as an inseparable ingredient of a product*" and *"if it is intended that the biocidal active substance is released from the treated article to control harmful organisms outside the treated article"*, e.g. humans[32]

The products within the scope may, for example, contain nano-particles of silver in order to prevent micro-organisms from growing on their surface. **It needs to be checked in the technical analysis and with the help of the stakeholders involved in this project whether the use of such substances is common practice and what kind of implications can be derived for the purpose of EU Ecolabel criteria development.**

ISO 15621 Urine absorbing aids – General guidelines on evaluation

The international standard, ISO 15621 Urine absorbing aids gives general guidelines on the methodology of evaluating disposable urine-absorbing aids. As such, the Standard provides performance factors of AHPs covering the following areas: economy, product safety, environment, nature of incontinence, discretion and a number of performance factors as staying in place, ease of putting on/taking off, skin health, comfort and freedom of leakage.[33]For the development of EU Ecolabel criteria, it is important to define a specific product performance in parallel to environmental criteria. For example, an AHP with superior product performance characteristics (e.g. high absorptive capacity) but with potentially higher environmental burdens may still be preferable compared with a product performing worse but with slightly lower environmental impact, based on the fact that the user may need more units of the latter product to fulfil the same function. Consequently, it is important also to define a minimum performance for each product within the scope. The performance criteria and test methods described in ISO 15621 may provide some guidance in this respect. However, some of the stakeholders involved in this project point out that ISO 15621 is only a rough guideline and lacks in specifics. Tests developed by industry (e.g. various absorbency measurements) may also support the development of product performance measures.[34],[35]

REACH and CLP

Article 6.6 of the Regulation (EC) No 66/2010 on the EU Ecolabel outlines the restricted use of substances or preparations/mixtures which can be classified as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction according to the CLP (Classification, Labelling and Packaging of substances and mixtures) Regulation EC No 1272/2008 or to Article 57 of the REACH (Registration, Evaluation, Authorisation and Restriction of Chemical substances) Regulation EC No 1907/2006

The Regulation EC No 1272/2008 entered into force in January 2009, replacing two previous pieces of legislation, the Dangerous Substances Directive (Directive 67/548/EEC) and the Dangerous Preparations Directive (Directive 1999/45/EC), and implementing the UN Globally Harmonised System (GHS) of Classification and Labelling of Chemicals at EU level. In particular, this implies that risk phrases, safety phrases and symbols are replaced with the mostly equivalent UN GHS hazard statements, precautionary statements and pictograms. The new system is to be implemented by 1 December 2010 for substances and by 1 January 2015 for mixtures. However, substances and mixtures will still have to be classified and labelled according to the predecessor Directive 67/548/EEC and Directive 1999/45/EC for preparations until 1 June 2015.

The REACH Regulation (Regulation EC No 1907/2006) is a piece of legislation which regulates the production and use of substances in the EU with the aim of improving the protection of human health and the environment from the risks that can be posed by chemicals along the whole value chain. [36] To comply with the regulation, manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database managed by the European Chemicals Agency (ECHA).

The legislation, which entered into force in June 2007, distinguishes between “phase-in” substances (i.e. those substances listed in the EINECS - European Inventory of Existing Commercial Chemical Substance - or those that have been manufactured in the Community, but not placed on the Community market, in the last 15 years, or the so-called “no longer polymers” of Directive 67/548) and “non-phase-in” substances. Deadlines for the registration of phase-in substances are set as follows:

- 30 November 2010 for substances manufactured or imported at 1000 tonnes or more per year, for carcinogenic, mutagenic or toxic to reproduction substances above 1 tonne per year, and for substances dangerous to aquatic organisms or the environment above 100 tonnes per year.
- 31 May 2013 for substances manufactured or imported at 100-1000 tonnes per year.
- 31 May 2018 for substances manufactured or imported at 1-100 tonnes per year.

Non-phase-in substances have to be registered before being placed on the market. All substances notified under Directive 67/548/EEC are considered as registered under REACH.

Substances with properties of very high concern (SVHC) are subject to authorization. In this case, applicants have to demonstrate that risks associated with uses of these

substances are adequately controlled or that the socio-economic benefits of their use outweigh the risks associated. Applicants must also analyse whether there are safer suitable alternative substances or technologies. If there are, they must prepare substitution plans, if not, they should provide information on research and development activities. A Member State, or ECHA at the request of the European Commission, can propose a substance to be identified as a SVHC. If identified, the substance is added to the Candidate List, which includes candidate substances for possible inclusion in the Authorisation List (REACH Article 57). SVHCs are identified among:

- Substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction category 1A or 1B in accordance with Commission Regulation (EC) No 1272/2008 (CMR substances);
- Substances which are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB) according to REACH (Annex XIII)
- Substances for which there is scientific evidence of probable serious effects that cause an equivalent level of concern as with CMR or PBT/vPvB substances (e.g. endocrine disruptors)

If the chemical risks cannot be adequately controlled, authorities can restrict the use of substances. Restrictions may limit or ban the manufacture, market and use of a substance.

With respect to substances contained in articles, producers and importers must submit a registration for any substance which fulfils both (a) the overall quantity of the substance in the articles is above 1 tonne per year and (b) the substance is intended to be released under normal or reasonably foreseeable conditions of use (REACH, Article 7). In case the overall quantity of the substance in the articles is above 1 tonne per year and the substance is present in the articles above a concentration of 0.1% weight by weight (w/w), it must also be notified if the substance may be classified as SVHC. The notification does not apply where exposure to humans and environment can be excluded during normal conditions of use including disposal.

Article 33 (duty to communicate information on substances), Article 37 (passing on of information of substances up the supply chain and identifying, applying and recommending risk reduction measures) and Annex XVII (restrictions on the manufacture, placing on the market and use of certain dangerous substances, preparations and articles)[37] are of special importance for the manufacturers and importers of the sanitary products.

At this point it must be noted that these are legal requirements, whereas the goal of the EU Ecolabel is to go beyond the law and offer additional value to the consumers. A potential area for the development of the criteria with regards to REACH could be the **replacement of substances of very high concern (no matter whether included or not within the SVHC list) potentially included in sanitary products with safer alternatives.**

Other relevant regulations

For some products within the scope of this project there are other documents which may provide relevant information for the development of EU Ecolabel criteria. For example, European manufacturers of tampons follow the **EU Tampon Code of**

Practice or a national equivalent, which originated from a voluntary industry (EDANA) initiative to harmonise relevant consumer information in all EU countries, irrespective of the tampon brand used. [38] A key element of the code of practice is a droplet system that categorises the absorbency of tampons into six classes.[39] This product performance criteria may be an important element for EU Ecolabel criteria development as pointed out in the previous Section.

Another relevant standard is the test method for predicting the leakage performance of disposable body-worn pads for heavy urinary incontinence, i.e. ISO 11948-1 (the Rothwell method); however, this standard is outdated according to experts' view and currently under revision. Hence, stakeholders involved in this project considered the following Worldwide Strategic Partners' (WSP) methods more important:

1) WSP 354.1 (11): Method for testing the performance of adult incontinence devices; ADULT MANNEQUIN TEST: Absorption before leakage; and
2) WSP 350.1 (05): Standard test method for menstrual tampons absorbency – syngina method.

Where sanitary products within the scope of this project contain lotions or fragrances, they must also comply with the **European Cosmetics Directive**. At this stage, however, no further details on this Directive will be provided since **it is likely that EU Ecolabel criteria will ban the use of these substances in labelled sanitary products**. Both the Nordic Swan criteria and the SEMCo criteria (see Section 3.3) ban the use of lotions and fragrances. The EDANA GPP criteria also suggest the abandonment of these substances.

3.3 Criteria and testing procedures for existing Environmental Labels of Sanitary Products

The following Section provides an insight of environmental labels and schemes that exist for the products within the scope and analyses further the respective criteria and the testing procedures currently in place. Given the similarity between the purpose of the different schemes and the criteria development procedures, the information provided in this Section can be considered of great importance for the development of EU Ecolabel criteria.

The Blue Angel

The Blue Angel exists for "Sanitary paper products made of recycled paper": cleaning rags, handkerchiefs, kitchenroll, napkin, paper handkerchief, paper towels, sanitary paper and toilet paper.[40] The listed products are out of the scope for this project, hence, no further analysis of the criteria was carried out.

Nordic Swan

"Sanitary products" under the Nordic Swan eco-label include disposable products such as breast pads, children's diapers, incontinence care products (panty liners, shaped diapers and diapers with tape strips), sanitary towels (towels and panty liners), tampons, cotton buds, cotton wool, toothpicks, bedding underlays, draw sheets, wash cloths and surgical gowns. As such, the criteria developed for the Nordic Swan are relevant and could provide useful insights for the development of EU Ecolabel criteria. Table 6 below outlines the criteria and the testing procedures.[41]

Table 6. Nordic Swan ecolabel criteria, requirements and verification procedures for sanitary products[41]

Criteria	***Requirements***	***Verification procedure***
R1 Description of the product and the packaging	The applicant must provide a description of the product and the primary packaging. Information must be provided on the raw materials, components, chemicals and if applicable other additives present in the product, providing e.g. CAS number, product safety datasheets or the equivalent. Subcontractors must be specified by business name, production site, contact person, the raw materials/chemicals they supply and the production processes they perform (e.g. printing). A technical description must be provided of the production of the sanitary products.	Information as described above.
R2 Percentage composition	The percentage composition of materials, chemicals and if applicable other additives in the product must be stated in terms of weight percentage of the total product excluding packaging. Similarly the composition of the primary packaging and if applicable attached information material must be stated. Sewing thread present in quantities of less than 1% by weight is exempted from the requirements in the document and from the calculation of the composition of the product. Other materials, components or additives for which no requirements are imposed in the document may make up a maximum of 5% by weight of the product. (Packaging/material around individual products in a pack must be included in the composition.)	Information as described above.
R3 Chemical products, classification	Chemical products used in the production of sanitary products must not be subject to a classification requirement as specified in Table 2 (p. 8 of the Nordic Ecolabelling document).	Product safety data sheets for chemical products in accordance with the applicable regulation 1907/2006/EEC.

Criteria	***Requirements***	***Verification procedure***
R4 Fluff-/ cellulose pulp, optical brightener	Optical brightener must not be added to the pulp.	Declaration from the pulp/cellulose manufacturer that the requirement has been fulfilled.
R5 Fluff-/cellulose pulp, general requirements as to production	The fluff pulp must fulfil the requirements in the ”Criteria Document for ”Swan-labelling of Paper Products – Basic Module, Chapter 2 for pulp suppliers” and ”Swan-labelling of Paper Products – Chemical Module”. Version 1 or later applies in the case of both documents. (see Annex II for the overview of the criteria)	The fluff supplier must document that the requirements have been fulfilled.
R6 Fluff-/cellulose pulp – Fibre raw material	The use of recycled fibre in sanitary products is not permitted. Off-cuts from production are not classified as recycled fibre and may therefore be used. On a year-on-year basis a minimum of: 1) 20% of fibre raw materials in the pulp must derive from certified forestry operations, or 2) 75% of fibre raw materials in the pulp must be woodshavings or sawdust or 3) a combination of 1 and 2. If the fibre raw material in the pulp consists of less than 75% by-products such as woodshavings or sawdust, the proportion of fibre raw material based on certified wood from sustainable forestry operations must be calculated using the following formula: Requirement applicable to the proportion of fibre raw material from certified forestry operation present in the pulp (Y): $Y (\%) \geq 20 – 0.267x$ where x = the proportion of wood shavings or sawdust.	The pulp manufacturer must document that the requirement is fulfilled and information on the proportion of fibre raw materials from certified forestry operations and the proportion of woodshavings or sawdust in the pulp must be reported annually for as long as the license remains in force. The report for the proceeding year must be submitted to Nordic Ecolabelling by 1 April together with calculations documenting fulfilment of forestry requirement.
R7 Fluff-/cellulose pulp, energy requirements for production	Energy points from the production of pulp must fulfil the following requirements: $P_{energy\ total} = (P_{el} + P_{fuel})/2 < 1.25$ and $P_{el} < 1.75$ The energy points P_{el} and P_{fuel} for pulp are calculated as energy consumed divided by the reference value for energy for the process used, see R38 of the Basic Module.	The pulp manufacturer must document that the requirements have been fulfilled and show the calculations of energy points on the basis of the methods described in the Basic Module.

Criteria	*Requirements*	*Verification procedure*
R8 Fluff-/cellulose pulp, requirements as to emissions during production	Emissions of organic halogen compounds (AOX) to water must not exceed 0.15 kg/tonne of pulp. The total of the emission points for chemical oxygen demand (COD) and phosphorous to water and sulphur (S) and nitrogen oxides (NOx) to air must not exceed 4: $P_{emission\ total} = P_{COD} + P_P + P_S + P_{NOx} \leq 4$ The individual emission points for P_{COD}, P_P, P_S, P_{NOx} must not exceed 1.5. Emission points are calculated by dividing the measured emissions by a reference value: $PCOD = COD_{total}l/COD_{reftotal}$	The pulp manufacturer must document fulfilment of the requirements.
R9-R12 refer to paper criteria. Products in which paper makes up less than 2% of the product, does not have to comply with R9-R12.		
R13 Cotton, bleaching with the aid of chlorine gas	Cotton must not be bleached with the aid of chlorine gas (Cl_2).	Declaration from the cotton producer that the requirement has been fulfilled.
R14 Cotton, raw fibre	The cotton must be organically cultivated or cultivated in a transitionary phase to organic production. The cotton must be produced and controlled in accordance with EU Directive 2092/91 or produced and controlled by equivalent means under an equivalent control system, such as KRAV, SKAL, IMO, OCIA, etc. The string on tampons is exempted from this requirement.	Certificate or transition certificate from a competent body for the certification of organic cultivation. If in the case of cultivation in a transitionary process no certificate is available, the ecolabelling organization must be supplied with information on the supplier and method of cultivation and sufficient documentation showing that the cultivation is in the process of transition to organic production. The cotton plantation may be inspected by the ecolabelling organisation.
R15 Viscose, bleaching with chlorine gas	Cellulose pulp or cellulose fibre must not be bleached with chlorine gas.	Declaration from the manufacturer of cellulose pulp and regenerated cellulose that the requirement has been fulfilled.

Criteria	Requirements	Verification procedure
R16 Viscose, chemical oxygen demand (COD) emissions	COD emissions from viscose production (the production of cellulose pulp and regenerated cellulose) must not exceed a combined total of 55 kg per tonne of regenerated cellulose. The quantity of COD may also be stated as the equivalent quantity of TOC.	Analyses reports on measurement of COD or TOC emissions from the production of cellulose pulp and regenerated cellulose. The methods of analysis must be described and the laboratories responsible must be stated.
R17 Viscose, sulphur emissions	Sulphur emissions from the dissolving of pulp and fibre production must not exceed more than 20 kg S/tonne of viscose.	Calculation of sulphur emissions from the stated processes.
R18 Viscose, zinc emissions	Zinc emissions must not exceed 0.20 kg Zn/tonne of regenerated cellulose.	Analysis report for measurement of zinc emissions from the production of regenerated cellulose. The methods of analyses must be described and the laboratories responsible for analysing the emissions must be stated.
R19 Non-woven, general requirements	The manufacturer of the non-woven used must specify the materials (raw materials and additives) used in production and state the names of raw material suppliers.	Declaration from the non-woven manufacturer
R20 Non-woven, chemicals	All additives used in non-woven must fulfil R3 ”Chemical products, classification”.	Documentation in accordance with R3
R21 Wood materials – only applies to cotton buds and toothpicks		
R22 Polymers, halogen-based	Sanitary products and their packaging must not contain halogen-based polymers, e.g. polyvinyl chloride (PVC).	Declaration from the polymer manufacturer or documentation from the manufacturer of sanitary products that the requirement is fulfilled.
R23 Polymers, constituent substances	The polymers in sanitary products and their packaging must not contain halogenated organic compounds or phthalates, except pollutants. Nor may the polymer contain organotin compounds or antimony.	Declaration from the polymer manufacturer that the requirement is fulfilled.

Criteria	Requirements	Verification procedure
R24 Polymers, residual monomers in superabsorbents	Superabsorbents may contain a maximum of 400 ppm residual monomers (the total of unreacted acrylic acid and cross linkers) that are subject to a classification requirement and have been allotted the R phrases in the Classification of monomers Table.	The manufacturer must document the composition of the superabsorbent by means of a product safety data sheet which specifies the full name and CAS number and the residual monomers contained in the product classified in accordance with the above requirements and the quantities thereof. The methods used for analyses must be described and the names of the laboratories used for analyses must be stated.
R25 Polymers, extracts in superabsorbents	Superabsorbent polymers (SAP) may as a maximum contain 5% by weight of water-soluble extracts.	The manufacturer must specify the quantity of water-soluble extracts in the superabsorbents. The methods of analyses used must be described and the analysis laboratories must be stated.
R26 Composition of the materials in the sanitary product	Sanitary products, including packaging/ material around the individual product in a pack must fulfil requirement A, B or C: A. A minimum of 7% by weight of the polymers must be based on renewable raw materials. B. The global warming potential (GWP) of the primary materials in the sanitary product must be less than or equal to 2.10 kg CO2 eq/kg of sanitary product. C. At least 50% by weight of the materials in the sanitary product must consist of renewable raw materials.	Based on the percentage composition of a product (as specified in R2), the manufacturer of the sanitary product must document compliance with the requirement by means of a calculation. A: A list of the renewable polymers used must be provided. The polymer manufacturer must state the proportion of renewable raw materials contained in the polymers used in the product. B: The calculation of GWP/product for the polymers used in the product must be documented. C: The calculation of renewable raw materials in the product must be documented.

Criteria	Requirements	Verification procedure
R27 Cotton buds and toothpicks – not relevant for products within the scope of this project		
R28 Silicone treatment, solvents	Where components in sanitary products are treated with silicone, the manufacturer must ensure that employees are protected from the solvents.	Information on the method used in silicone treatment and documentation showing that the employees are protected if solvents are used.
R29 Silicone treatment, siloxane	Neither octamethyl cyclotetrasiloxane D4 (CAS 556-67-2) nor decamethyl cyclopentasiloxane, D5, (CAS 541-02-6) may be present in chemical products used in the silicone treatment of components in sanitary products.	Declaration that the requirement has been fulfilled.
R30 Adhesive	Adhesives must not contain phthalates, colophony resin. For formaldehyde, the maximum limit for the content of formaldehyde generated under the production of the adhesive is, however, 250 ppm (0.0250%) measured in newly produced polymer dispersion. The content of free formaldehyde in hardened adhesive (glue) must not exceed 10 ppm (0.001%). Hotmelt adhesives are exempted from this requirement.	Declaration from the adhesives supplier that the adhesive used does not contain phthalates or colophony resin. Results of analysis of the formaldehyde content of the adhesive.
R31 Fragrance and flavour	Perfume or other fragrance substances (e.g. essential oils and plant extracts) and flavour must not be present in the product.	Completed and signed declaration from the manufacturer.
R32 Lotion and skin care preparations	The product must not contain lotion, skin care and/or moisturising preparations.	Completed and signed declaration from the manufacturer.
R33 Odour control substances	Odour control substances are permitted only in incontinence care products.	In the case of products that are not incontinence care products, the manufacturer must declare that the requirement is fulfilled.
R34 Medicaments	Products containing chemical substances designed to prevent, alleviate or cure illness, sickness symptoms and pain or to alter bodily functions cannot be ecolabelled.	The manufacturer must declare that the requirement is fulfilled. Appendix 4 may be used.
R35 Nanomaterials	Nanomaterials/particles must not be actively added to sanitary products unless adequate documentation exists that they will not cause health or environmental problems and that they are essential to the performance of the sanitary product. TiO2 used for dying of polymers and viscose is exempted from this requirement.	Declaration from the manufacturer that the requirement is fulfilled.
R36 Flame retardants	Flame retardants must not be added to sanitary products.	Declaration from the manufacturer that the requirement is fulfilled.

Criteria	***Requirements***	***Verification procedure***
Criteria	***Requirements***	***Verification procedure***
R37 Dying	Sanitary products must not be dyed. This requirement also applies to the single raw materials used in these products with exception of tampon strings. Exceptions may be granted in the case of certain specialist products for use in hospitals and nursing homes, subject to agreement with Nordic Ecolabelling.	Declaration from the manufacturer of the sanitary product that neither the product nor the raw materials have been dyed. In the case of exemptions for specialist products the manufacturer/ supplier of the dyestuff must document that the requirement is fulfilled by means of health, safety and environment datasheets and a report on the contents of the product using Appendix 6 or the equivalent.
R38 Inks for printing,	The inks must fulfil requirement R3 in this criteria document and R9 to R14 of the Chemical Module (”Nordic Ecolabelling of Paper Products – Chemical Module, Version 1 or later”). The requirement does not apply to printing on the packaging.	The ink/dyestuff manufacturer/supplier must declare that the requirement is fulfilled by submitting health, safety and environment datasheets and a report on the content of the product with the aid of Appendix 6 or the equivalent.
R39 Packaging	The manufacturer must report the type and quantity of packaging used.	Description and specification of the quantity and type of packaging material.
R40 Labelling of plastic packaging	Plastic packaging must be labelled in accordance with ISO 11469:2000 Plastic – Generic identification and labelling of plastic products, DIN 6120 or the equivalent. The requirement does not apply to packaging of single products in a package.	Samples of labelling of plastic packaging.
R41 Production waste	A waste plan for sorting at source must be attached to the application. The quantity of waste generated during the manufacture and packaging of ecolabelled sanitary products must not exceed 5% (w/w) of the end products, unless the manufacturer is able to certify that the waste is reused or that materials are recovered from the waste. All waste generated during manufacturing of the product must be included in the statement of the quantity of waste. In the case of tampon	The waste plan of the plant with a specification of quantities and end processing (e.g. incineration or recycling).

Criteria	Requirements	Verification procedure
	production, waste quantities must not exceed 10% (w/w). Incineration with energy exploitation is accepted as reuse.	
R42 Tampons	Tampons may as a maximum contain 1,000 aerobic micro organisms per gram of product.	Description of the test used for fibre deposits from the tampon and a report on the test results.
R43 Information on packaging	The absorption ability must be specified on the packaging in the case of product types where this is relevant. E.g. for diapers, sanitary products (sanitary towels and panty liners), tampons and incontinence care products this information can be provided by means of clear details of the size (e.g. the weight of the child in kilos or pictograms/values indicating the absorption capacity of the product). In the case of relevant products, consumers must be urged not to discard them in the toilet. This information can be stated by use of a pictogram. Relevant products include diapers, sanitary towels, panty liners, tampons, etc.	Sample of the packaging information
R44 Performance	The efficiency/quality of the product must be satisfactory and must match that of equivalent products on the market. In the case of diapers, sanitary products (sanitary towels and panty-liners), incontinence care products and breast pad, the performance test must as a minimum include absorption capacity and rewet under pressure (dryness on the outside). In the case of tampons the performance test must as a minimum encompass absorption capacity.	Documentation (test report or user report) of the performance of the product, including where applicable tests of absorption capacity and wet back. The chosen test must be described and data attached.

Additionally, the Nordic Swan Ecolabel provides nine quality and regulatory requirements (e.g. swan license persons, documentation, etc.) that are not directly related to the product itself.[41]

Green Seal

The Green Seal Standard includes sanitary products, in particular paper towels, general-purpose wipes, paper napkins, bathroom tissue, facial tissue, toilet seat covers, placemats, tray liners, table coverings, and other sanitary paper products. Non-woven sanitary products, general-purpose disposable and flushable wipes containing cleaning agents or fragrances, disposable diapers, sanitary napkins and tampons are excluded.[42] The products included under the Green Seal are out of the scope for this project, hence, no further analysis of the criteria was carried out.

Good Environmental Choice Australia

The GECA Ecolabel program applies to a range of sanitary paper products such as toilet paper, facial tissues and napkins.[43] The products included under the GECA Label are out of the scope for this project, hence, no further analysis of the criteria was carried out.

Environmental Choice New Zealand

In the ECNZ Ecolabel the following sanitary products are included: toilet paper, facial tissue, paper towels and table napkins.[44] The products included under the ECNZ are out of the scope for this project, hence, no further analysis of the criteria was carried out.

Eco Mark

Products applicable to the Eco Mark Label are tissue paper, toilet paper, and coarse tissue paper (excluding paper towels and other types of sanitary paper).[45] The products included under the Eco Mark are out of scope for this project, hence, no further analysis of the criteria was carried out.

Swedish Environmental Management Council

The Swedish Environmental Management Council procurement criteria for incontinence and urology products apply to children's diapers as well as urination devices, catheters, urine drip collector, urine collector, urine receptacle, suspension and attachment devices for urine collection bags, absorbent aids for incontinence and attachment devices for absorbent aids for incontinence (products referred to in the standard ISO 9999).46 Thus, there are some relevant overlaps between the given label and the developing EU Ecolabel for sanitary products, hence relevant criteria are presented in Table 7.

Table 7. SEMCo ecolabel criteria, requirements and verification procedures for products relevant for the discussed product scope

Criteria	***Requirements***	***Verification procedure***
Mandatory Supplier Requirements		
A.1. Producer's responsibility for packaging	The tender must state that the tenderer fulfils requirements for producer responsibility for packaging in accordance with regulation (SFS 2006:1273 with most recent amendment). Producer responsibility can be fulfilled for the offered products by the tenderer or tenderer's upstream supplier being in the Swedish REPA register or the equivalent or by having its own established system.	Contract of adhesion with the REPA registry and/or Swedish Glass Recycling or description of an in-house system for producer responsibility.
Mandatory Requirements for incontinence and urology products		
B.1. Plastic/Polymers in the product	Lead, cadmium, mercury, hexavalent chrome and attendant impurities, as well as organostannic compounds must not exceed 0.1% in contents expressed as mass of the plastic material (and metal wherever it may arise) in the product.	Product information sheet/product sheet and/or self-declaration of manufacturers/suppliers or equivalent.
B.2. Perfume	Must not be added to the product.	
B.3. Visual whitening agents	Must not be added to the pulp and other paper parts included in the product.	
B.4. Colophony (Rosin)	Colophony (CAS no. 8050-09-7, 8052-10-6 or 73138-82-6) must not be added to the product.	
B.5. Bleaching fluff pulp	The fluff pulp in the product must be produced from unbleached pulp or pulp bleached without chlorine gas, i.e. according to the Elemental Chlorine Free (ECF - bleached with chlorine dioxide) or Total Chlorine Free (TCF - bleached without chlorine-containing chemicals) methods. The AOX emission to the recipient must not exceed 0.25 kg/tonne of dry pulp.	Environmental labelling licence from Svanen (The Swan) or the EU Flower or equivalent, certification from manufacturer.
B.6. Packaging in plastic	Packaging material must not consist of PVC.	Product information sheet or self-declaration of manufacturer/supplier or equivalent.

Criteria	Requirements	Verification procedure
B.7. Cellulose packaging	Paper/carton in the packaging must be produced from return pulp, unbleached pulp or pulp without chlorine gas, i.e. according to the ECF or TCF methods. The AOX emission to the recipient must not exceed 0.25 kg/tonne of dry pulp.	
Award Criteria for Urology Products		
C.1. Phase-out substances in the product	Does the plastic in the product contain less than or equal to 0.1 % bis(2-ethylhexyl)phthalate (DEHP) (cas no. 117-81-7), dibutyl phthalate (DBP) (cas no. 84-74-2) and benzyl butyl phthalate (BBP) (cas no. 85-68-7) by mass of the plasticised material in the product?	Safety data sheet for the additive and/or product information sheet with content declaration and/or self-declaration of manufacturer/supplier or equivalent.
C.2. DNOP (Phthalate) in the product	Does the plastic in the product contain less than or equal to 0.1 % Di-n-octyl Phthalate (DnOP) (Cas no. 117-84-0) by mass of the plasticised material in the product?	
C.3. Carcinogenic, mutagenic and reprotoxic (CMR) substances in the product	Does the plastic in the product contain less than or equal to 0.1 % additive by mass of the plasticised material in the product which is toxic, highly toxic and/or a so-called CMR substance (carcinogenic, harmful to genetic make-up or reproduction), i.e. is the additive: classified as highly toxic, toxic, carcinogenic, mutagenic or teratogenic with the indication of danger "toxic" (risk phrases R 23, R 24, R 25, R 26, R 27, R28, R39, R 40,R45, R46, R48, R 49, R 60, R61, R 62, R 63, R 68) based in the criteria in the Swedish Chemicals Inspectorate regulations on classification and labelling (KIFS 2005:7 with amendments) or the EC dangerous substances directive (67/548/EC with amendments)?	
C.4. Material in the product	Is the product free from chlorinated plastics?	Product information sheet or self-declaration of manufacturer/supplier or equivalent.

EDANA GPP Criteria

The industry association of the non-wovens, EDANA, developed a GPP guideline for AHPs in public and in business-to-business (B2B) procurement. The following criteria were developed:[47]

Table 8. EDANA GPP criteria for AHPs

Criteria	***Requirements***
A. Mandatory Supplier Requirements	
A.1. Producer's responsibility for packaging	The tender must state that the tenderer fulfils requirements for producer responsibility for packaging in accordance with relevant national legislation based on the Packaging and Packaging Waste Directive (PPWD).
B. Mandatory Requirements for Sanitary Products	
B.1. Heavy metals/tinorganics in the plastic/polymers of the product	Lead, cadmium, mercury, hexavalent chrome and attendant impurities, as well as organostannic compounds must not arise in contents exceeding 0.1 per cent expressed in the mass of the plastic material (and metal wherever it may arise) in the product.
B.2. Visual whitening agents	Visual whitening agents must not be added to the pulp and other paper parts included in the product.
B.3. Colophony (rosin)	Colophony (CAS no. 8050-09-7, 8052-10-6 or 73138-82-6) must not be added to the product.
B.4. Bleaching fluff pulp	The fluff pulp in the product must be produced from unbleached pulp or pulp bleached without chlorine gas, i.e. in accordance with the ECF or TCF method. The AOX emission to the recipient must not exceed 0.25 kg/tonne of dry pulp.
B.5. Packaging in plastic	Packaging material must not consist of PVC, unless either required and justified by requirements of the medical device directive/comparable requirements or justified by superior environmental life-cycle performance.
B.6. Cellulose packaging	Paper/carton in the packaging must be produced from return pulp, unbleached pulp or pulp without chlorine gas, i.e. in accordance with the ECF or TCF methods. The AOX emission to the recipient must not exceed 0.25 kg/tonne of dry pulp.
B.7. Classified substances	Substances/preparations that are classified according to directive 67/548/EEC including latest amendments as: - carcinogenic (R45, R40), - mutagenic (R46, R68), - may impair fertility and may cause harm to unborn child (R60, R61, R62, R63) - may cause sensitisation (R43), must not be intentionally added to the product during the final production of AHPs. This requirement shall not apply if this is required and justified by requirements of the medical device directive/comparable requirements.

Criteria	*Requirements*
C. Supplier Evaluation Criteria	
C.1. Producer's environmental certification/registration	1) Does the production unit(s) have an implemented environmental management system according to Eco-Management and Audit Scheme (EMAS) or ISO 14001:2004? 2) Is the unit(s) registered according to EMAS or certified according ISO 14001:2004? Continue only if the answer to question 1 and 2 is NO: 3) Does the supplier have an environmental policy? 4) Does the supplier have set environmental goals and an activity plan?
D. Comprehensive Supplier Requirements	
D.1. Wood sourcing policy	The supplier shall have a wood sourcing policy, requiring that no wood from controversial sources is used in the production of fluff pulp for AHP.
E. Comprehensive Evaluation Criteria for Sanitary Products	
E.1. Perfume	Based on local market requirements perfume-free products may be preferable. In case a product contains perfume, the manufacturer must declare its presence.
E.2. Life cycle calculation	Award is given for demonstrating advantage in the listed environmental impacts of the cradle-to-gate analysis. Advantage in this context means lower environmental impact. These criteria should apply only as long as there are significant differences between products.
E.3. Global warming potential calculation	The GWP is calculated from Edana/Ifeu's (http://www.ifeu.de/) database, and the following numbers shall be used in a cradle-to-gate calculation. Material weights to be filled in by the supplier .

Product and specific material	Weight of material/ product [g]	Edana GWP factor [g CO2eq/g material]	Total GWP of product (cradle-to-gate) [g CO2eq/ product]
NW (PP)		x	
Polyethylene (PE)-film		x	
Pulp/paper		x	
Superabsorber		x	
Acquisition layer		x	
Consumer package		x	
Outer package		x	
Total		-	

<table>
<tr><th>Criteria</th><th>Requirements</th></tr>
<tr><td>E.4. Acidification potential calculation</td><td>The acidification potential (AP) is calculated from Edana/Ifeu's database, and the following numbers shall be used in a cradle-to-gate calculation.
Material weights to be filled in by the supplier.
<table>
<tr><th>Product and specific material</th><th>Weight of material/product [g]</th><th>Edana AP-factor [g SO2-eq/g material]</th><th>Total AP of product (cradle-to-gate) [g SO2-eq/product]</th></tr>
<tr><td>NW</td><td></td><td>y</td><td></td></tr>
<tr><td>PE-film</td><td></td><td>y</td><td></td></tr>
<tr><td>Pulp</td><td></td><td>y</td><td></td></tr>
<tr><td>Superabsorber</td><td></td><td>y</td><td></td></tr>
<tr><td>Acquisition layer</td><td></td><td>y</td><td></td></tr>
<tr><td>Consumer package</td><td></td><td>y</td><td></td></tr>
<tr><td>Outer package</td><td></td><td>y</td><td></td></tr>
<tr><td>Total</td><td></td><td>-</td><td></td></tr>
</table></td></tr>
<tr><td>E.5. Eutrophication potential calculation</td><td>The eutrophication potential (EP) is calculated from Edana/Ifeu's database, and the following numbers shall be used in a cradle-to-gate calculation.
Material weights to be filled in by the supplier.
<table>
<tr><th>Product and specific material</th><th>Weight of material/product [g]</th><th>Edana EP-factor [g PO4 3-eq/g material]</th><th>Total EP of product (cradle-to-gate) [g PO4 3-eq/product]</th></tr>
<tr><td>NW</td><td></td><td>z</td><td></td></tr>
<tr><td>PE-film</td><td></td><td>z</td><td></td></tr>
<tr><td>Pulp</td><td></td><td>z</td><td></td></tr>
<tr><td>Superabsorber</td><td></td><td>z</td><td></td></tr>
<tr><td>Acquisition layer</td><td></td><td>z</td><td></td></tr>
<tr><td>Consumer package</td><td></td><td>z</td><td></td></tr>
<tr><td>Outer package</td><td></td><td>z</td><td></td></tr>
<tr><td>Total</td><td></td><td>-</td><td></td></tr>
</table></td></tr>
</table>

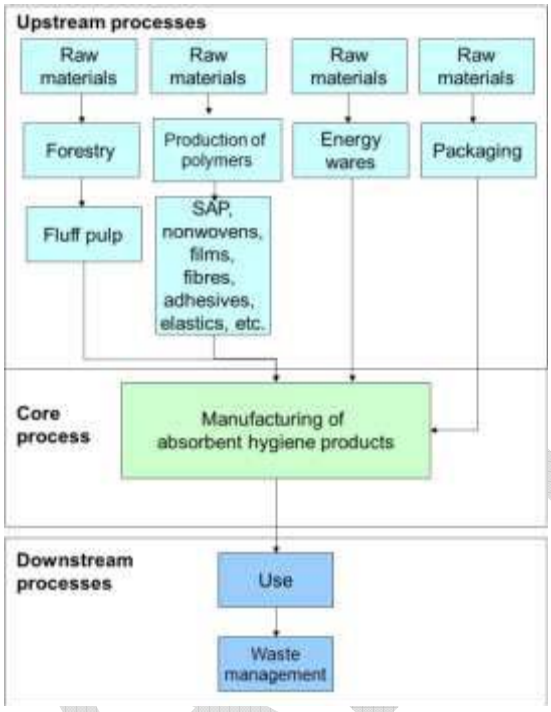
Verification procedure
Verifications are required to be submitted with the tender, but may also be requested in a follow-up. Verification/certification can be issued at various levels and must be traceable to the products being procured. The safest and most reliable are third-party verifications, and it is possible to request such verifications from tenderers/suppliers. Otherwise, a self-declaration or a company certification, for example, may be sufficient. Verification can be a third-party verification, for example, environmental labelling in conformance with ISO 14024, certification in conformance with the ISO 14001 environmental management system or EPD in conformance with ISO 14025. Other examples of verifications are second-party verifications or self-declarations from a quality or monitoring system, supply contract, etc., declarations in conformity with ISO 14021 or equivalent forms of verification.

Product Category Rule (PCR) for Absorbent Hygiene Products (AHP)

Environdec is the organization that supervises the certification of Environmental Product Declarations (EPDs). An EPD is a certified environmental declaration developed in accordance with the standard ISO 14025. Product category rules (PCR) for the assessment of the environmental performance of absorbent hygiene products (AHP) include: female sanitary protection, children's diapers and adult incontinence products.[48]

Table 9. PCR criteria for AHPs

Criteria	***Requirements***
2.2 Specification of the product	Description of the product, i.e. type, size and weight of the product. Weight and absorption capacity may be reported in addition.
3 Functional unit	The functional unit is one day of absorbent product use. The functional unit shall include the specification of a reference flow in terms of the number of product units used per day and the citation of an appropriate reference study. In addition, an alternative functional unit may be used. Reference studies used in determining the rate of product use shall be based on a broad and representative consumer use study for the product in question and shall be available to the EPD audience. If different reference studies are available, these studies shall be declared in the EPD and reported in the LCA study for the product in question. In the case of missing information regarding the number of products used per day, the reference flow and functional unit shall be one product unit. The functional unit shall be declared in the EPD. The environmental impact shall be given per functional unit.
4 Content of materials and chemical substances	The EPD shall include a content declaration of the product covering relevant materials and substances. The gross weight of material shall be declared in the EPD at a minimum of 99% of one product unit.
5 Units and quantities	SI units shall be used. For electricity and fuels, the preferred units are: - kWh (MWh) for electricity - MJ (GJ) for fuels

Criteria	Requirements
6 General system boundaries	Picture 6. Illustration of the upstream, core and downstream modules and processes[49] 
Chapters 6 through 9 describe the requirements regarding the processes outlined in Picture 6.	
10 Environmental performance-related information	
10.1 Use of resources	The consumption of resources per functional unit shall be reported in the EPD under the following categories: Non-renewable resources - Material resources - Energy resources (used for energy conversion purposes) Renewable resources - Material resources - Energy resources (used for energy conversion purposes) - Water use
10.2 Potential environmental impact	The environmental impact per functional unit for the following environmental impact categories shall be reported in the EPD - Emissions and removals of greenhouse gases (expressed in GWP, in 100 years perspective) - Emissions of acidification gases (expressed as SO2 equivalents) - Emissions of gases that contribute to the creation of ground level ozone (expressed as the sum of ozone-creating potential, ethene-equivalents) - Emissions of substances to water contributing to oxygen depletion (expressed as $PO4^{3}$-equivalents).

Criteria	Requirements
10.3 Other indicators	Additional indicators are voluntary. The following indicators connected to waste may be reported in addition to the potential environmental impact under 10.2: - Waste generation: the amount of waste, separated into hazardous and non-hazardous - Odour: - Odour concentration, measured according to EN 13725:2003. - Hedonic tone (odour assessment), measured according to VDI 3882-2:1994.
10.4 Additional environmental information	Additional environmental information is voluntary.
11 Content of the EPD	
11.1 Programme related information	The programme related part of the EPD shall include: - Name of the programme and programme operator - The reference PCR number - Date of publication and validity - Geographical scope of application of the EPD if deviating from an international coverage - Information about the year of reference period of the underlying date to the EPD - Reference to the homepage – www.environdec.com – for more information
11.2 Product related information	- Specification of the manufacturing company; - Specification of the product; - Functional unit; - Content of materials and chemical substances; - Comparisons of EPDs within this product category; - Validity of the EPD.
11.3 Environmental performance-related information	- Environmental performance declaration – minimum set of parameters from the LCA study, reported per functional unit: - Use of resources; - Potential environmental impact; - Other indicators; - Additional environmental information.

An EPD exists for Natracare regular natural ultra pads with wings. The results of the study can be obtained in the Technical Analysis (see Section 5.4).

3.3 Other environmental schemes and claims

This section provides a brief overview of other environmental schemes and claims that exist for products within the scope. Besides environmental labels according to the standard ISO 14024 (Environmental labels and declarations - Type I environmental labelling - Principles and procedures, e.g. EU flower, Nordic Swan, etc.) and environmental product declarations according to the standard ISO 14025 (Environmental labels and declarations - Type III environmental declarations - Principles and procedures, e.g. EPDs) manufacturers often develop environmental claims which also communicate environmental benefits of their products. Generally speaking, these environmental claims come without independent third-party verification which is the main difference in comparison to environmental labels and product

declarations. However, there are certain rules which are outlined in the standard ISO 14021 (Environmental labels and declarations - Self-declared environmental claims - Type II environmental labelling), and which need to be followed in order to avoid risks of green-washing. Normally, environmental claims only focus on one particular environmental issue and provide manufacturers with greater flexibility in communication to the final consumer.

For the purpose of this project it is worth to investigate the main trends of environmental claims for the products within the scope because they may indicate key environmental areas of relevance for the development of EU Ecolabel criteria.

Trend 1: Raw materials derived from renewable sources

For all products within scope there is a clear trend towards using renewable resources for at least parts of the product. The list of claims includes:

- “20% of the superabsorbence comes from renewable sources” (nappies)
- “Use of 60% natural materials instead of plastic” (nappies)
- “Leakage barrier made of natural material. No plastic.” (nappies)
- “Distribution layer made of natural material. No plastic” (nappies)
- “Core based on corn starch” (nappies)
- “Bottom layer made of corn film” (panty liner)
- “Do not contain synthetic materials, plastic, chemical additives such as binders or surfactants, fragrances, polyacrylate superabsorbents or dyes” (panty liners, tampons)
- “Pads and the packaging are 100% plastic-free” (panty liners)
- “Free from petroleum-derived superabsorbants and plastics” (incontinence product)

As can be seen from the claims presented, often the resources used are referred to as “natural” whereby the term is used to distinguish from petroleum-based plastics.

Trend 2: Certified organic or sustainably produced raw materials

Another trend identified for products within scope relates to the certified nature of production processes of key raw materials, namely cotton and pulp. For cotton the organic farming principles are emphasised whereas with the material pulp the sustainable forest management practices are often mentioned via environmental claims. See some examples below:

- “Pulp is from sustainably harvested Scandinavian forests” (nappies)
- “Materials sourced via the controlled Scandinavian Forestry” (nappies)
- “Made from 100% organic cotton” (tampons)

Trend 3: Products being compostable or biodegradable

In order to understand the claims referring to compostable or biodegradable, it has to be understood what these terms mean and how they can be distinguished. According to the US Federal Trade Commission (FTC) Green Guide, a product or package qualifies as biodegradable if it *"completely breaks down and returns to nature, decomposing into elements found in nature within a reasonably short period of time after customary disposal."*[50] At this stage, however, *"a reasonably short period of time"* has not been quantified.

In contrast, when compostable products break down, they turn into humus, which provides valuable nutrients to the soil. According to the FTC, for products to qualify as certified compostable *"all the materials in the product or package will break down into, or otherwise become part of, usable compost (e.g., soil-conditioning material, mulch) in a safe and timely manner in an appropriate composting program or facility, or in a home compost pile or device. Compostable products typically break down over one to four months in a composter, depending on the product size and material used.*[50]

As it can be derived from the definitions given, the term 'biodegradable' is much broader. In addition, it obviously very much depends on the actual disposal scenario of the products as to whether the claimed potential benefits actually materialises (see Section 5.3 for details). A brief review of literature offers a very diverse picture of the standards and guidelines relating to definitions of the two terms (e.g. ASTM6400-04 - Standard Specification for Compostable Plastics; EN13432 - Requirements for packaging recoverable through composting and biodegradation - Testing scheme and evaluation criteria for the final acceptance of packaging; DIN V-54900 -Testing of Compostability of Plastics; ISO 17088 - Specifications for compostable plastics; ASTM D6954-04 - Standard Guide for Exposing and Testing Plastics that Degrade in the Environment by a Combination of Oxidation and Biodegradation; ASTM D6868: - Standard Specification for Labeling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities). Nevertheless, the environmental claims often do not provide further details on the specific standards used. It is thus recommended to evaluate these Standards only if they become relevant for the development of EU Ecolabel criteria.

The following claims related to Trend 3 have been identified for the products within the scope:

- "Compostable" (nappies)
- "Disposable - 80% of the nappy is produced of raw paper" (nappies)
- "The diaper consists of a 100% biodegradable back sheet" (nappies, incontinence product)
- "Pads and packaging 100% biodegradable and compostable" (panty liners)
- "100% biodegradable compostable packaging" (tampons)
- "Biodegradable and compostable" (breast pads).

Trend 4: Chlorine-free bleaching

The last trend identified concern chlorine-free manufacturing processes related to individual raw materials used for products within the scope or even for the complete product. This claim is in line with environmental criteria found in different schemes (see Section 3.2). A few examples are given below:

- "The pulp is bleached without any use of chlorine" (nappies)
- "100% chlorine-free" (nappies, breast pads, incontinence product)
- "Totally Chlorine Free pulp" and "Chlorine free outer cover" (nappies)
- "Core of unbleached wood pulp" (nappies)

It will need to be confirmed whether the trends identified on the basis of self-declared environmental claims can be confirmed through the technical analysis and can consequently be used to inform the development of EU Ecolabel criteria.

3.4 Conclusion

The review of legislation and regulations, of the existing environmental labels and schemes as well as of trends communicated via other environmental claims - as presented in Sections 3.1 to 3.3 - provides useful insights and points of reference towards the development of EU Ecolabel criteria. In particular, it is considered that:

- A **preliminary list of reference criteria** could be generated based on the Nordic Swan's ecolabel criteria for sanitary products; the GPP criteria that SEMCO and EDANA developed for adsorbent hygiene products and the Envirodec's product category rules for adsorbent hygiene products;
- **Issues which are common with other product groups** (e.g. certification of wood and pulp production) could be also addressed also based on the existing criteria that EU Ecolabel and Blue Angel set for other product groups (e.g. paper based products);
- **Criteria on hazardous substances and related testing procedures** could be directly affected by some of the existing pieces of European legislation (e.g. Directive on the Protection of Animals Used for Scientific Purposes 2010/63/EU; Biocidal Products Regulation 98/8/EC; REACH and CLP regulations);
- **Fit-for-use and quality criteria** are considered topical and could interest: absorptive capacity and leakage protection; retention capacities; skin dryness; dampness sensation; skin protection; discretion; fit/sizing and wearing comfort. The list of standards which could be used to address these issues includes: ISO 15621 (Urine absorbing aids – General guidelines on evaluation); ISO 11948-1 ("the Rothwell method" for predicting the leakage performance of disposable body-worn pads for heavy urinary incontinence); WSP 354.1 (11: Method for testing the performance of adult incontinence devices; ADULT MANNEQUIN TEST: Absorption before leakage); WSP 350.1 (05: Standard test method for menstrual tampons absorbency – syngina method); EU Tampon Code of Practice (classes of absorbency for tampons).

Stakeholders are invited to review and complement the pieces of information provided within this section. Depending on feedback provided by the stakeholders and in relation with the information given in the following two Sections (Section 4: Market analysis and Section 5: Technical analysis), certain aspects of Section 3 will be investigated further so that it can be ensured that appropriate EU Ecolabel criteria are developed.

4. MARKET ANALYSIS

4.1 Market data

In the following section of the report, key market data is presented and analysed. Understanding the market of the products within the scope of this project can help to gain valuable insights for the development of EU Ecolabel criteria. For example, the contribution made by each specific product to the overall sales volumes or tonnages produced in the EU27 can provide a first indication on the relative environmental importance of a given product. This information may influence the focus of this project during the criteria development phase.

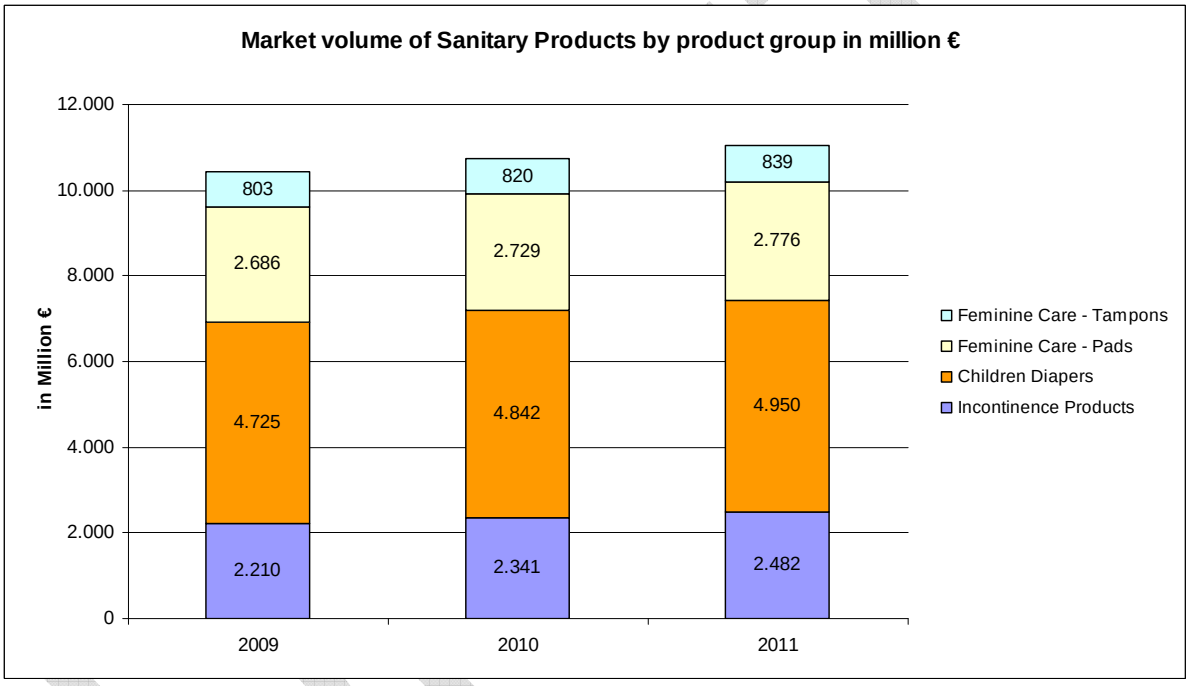
One of the main sections of this report is the technical analysis (Section 5), which provides information about the environmental performance of the products within the scope of this project. This is fundamental information for developing science-based EU Ecolabel criteria. In order not to overwhelm the reader, only key market data which seem most relevant for the purpose of this project are presented. **As for the other pieces of information presented in this report, the project team appreciates further additions or clarifications from the group of stakeholders.**

All market data presented in this report – if not referenced otherwise – are sourced from Euromonitor data which was provided to EDANA. Unfortunately, at this stage neither Euromonitor nor EDANA are in a position to provide specific market data on breast pads. It was stated in the preliminary background report that the market of "breastfeeding and baby food crockery" in Japan is small and large about one tenth of the Japanese diaper market.[9] Hence, the share of breast pads in the overall market of products within the scope of this project is probably marginal. **However, it would be greatly appreciated if stakeholders with access to market data on breast pads could provide relevant information or if it were possible to be addressed to companies producing breast pads.**

Sales volume of sanitary products in Euros

As illustrated in Picture 1, the EU27 market of sanitary products within the scope of this project (excluding breast pads) was valued at just over 11 billion Euros in 2011. The largest share of this market belongs to children's diapers (45%), followed by feminine care pads (25%) and incontinence products (22%). Tampons' share of the total market is about 8%. Assuming that the Japanese sanitary product market is similar to the European market and that the share of breast pads is 10% of the diaper market at the most (as indicated above), the share of breast pads would be around 500 million Euros or about 4% of the total.

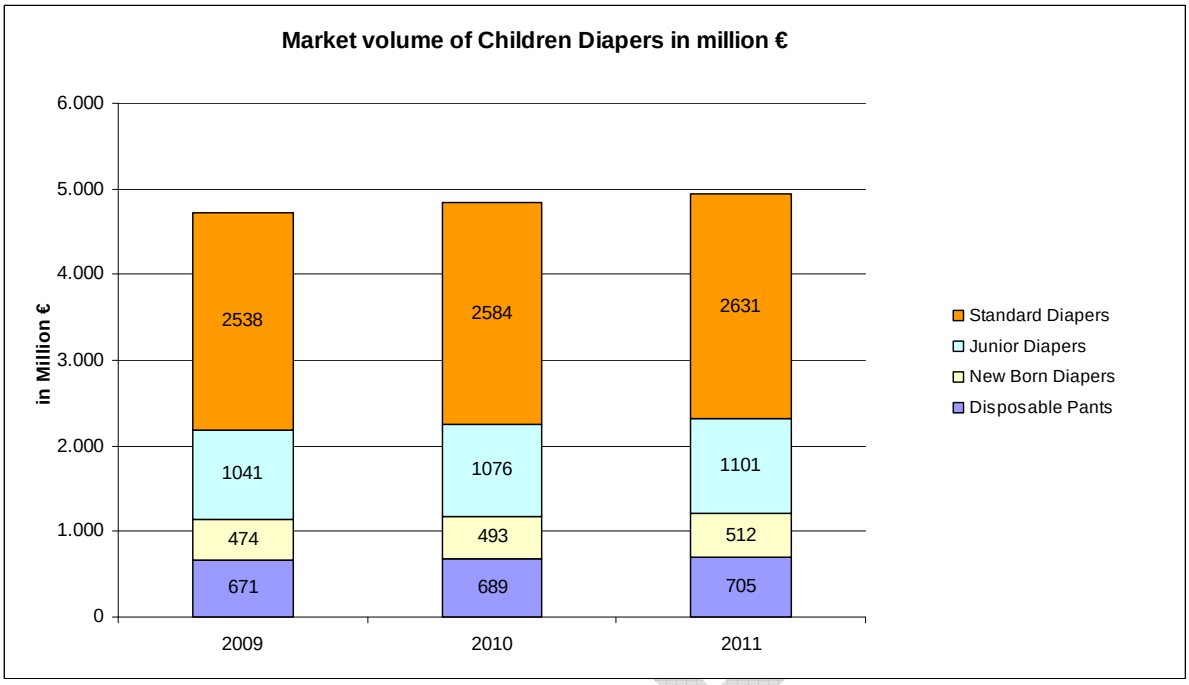
Picture 1. Market volume of sanitary products by product group in million Euros



From Picture 1 a slight overall and product group-specific market growth between 2009 and 2011 can be observed (see below for further details).

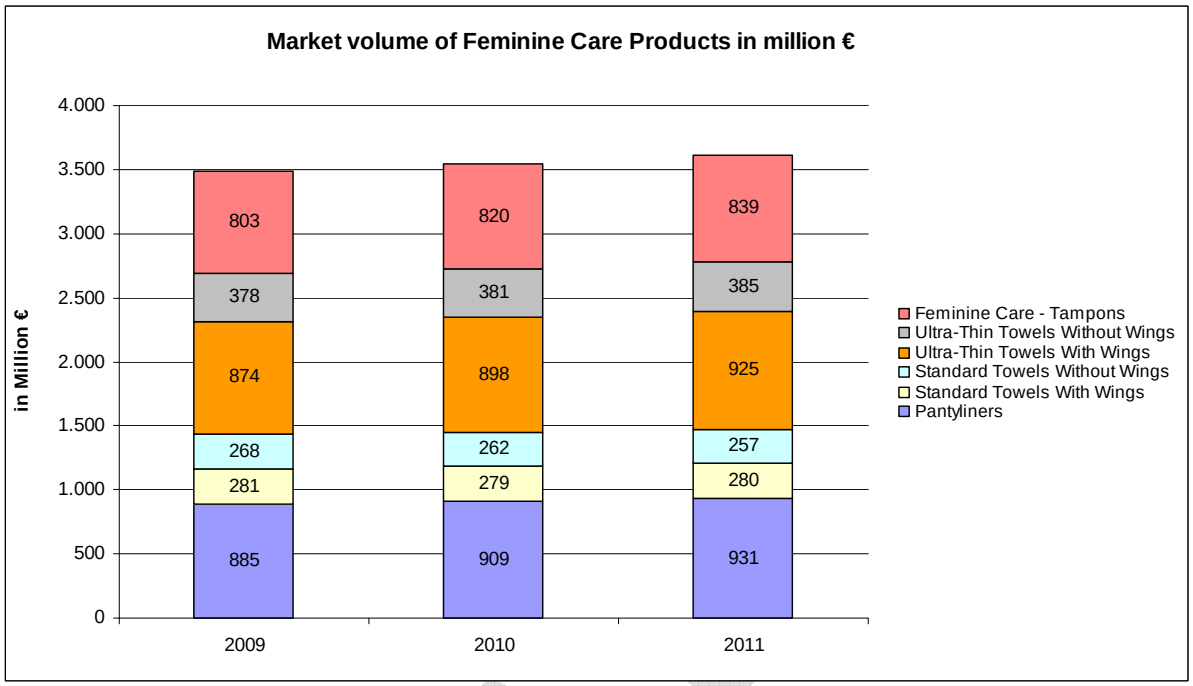
Picture *2* to Picture *4* illustrate the market shares in million Euros of the individual products within each product group.

Picture 2. Market volume of children's diapers in million Euros



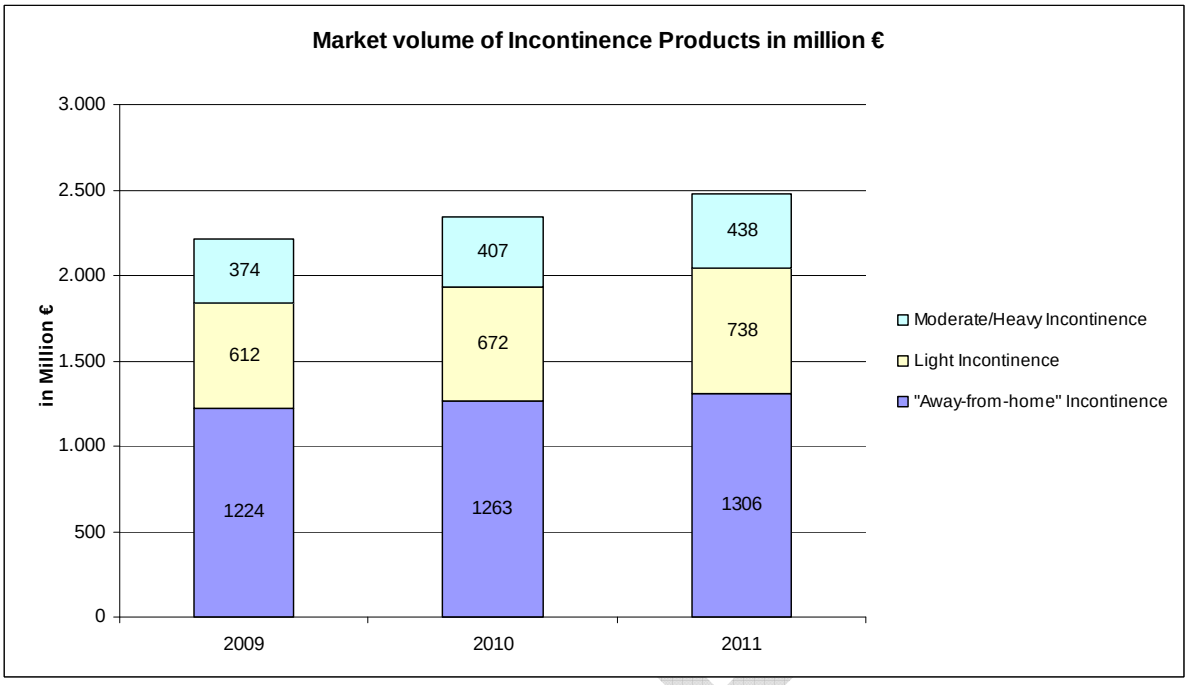
Taking into account the recommended children's weights for each diaper type, it is plausible that standard diapers make up the largest portion (53%) of the market, since they are used for a longer period of time compared to the newborn diapers and probably changed more frequently compared to the junior diapers. According to a weight-for-age distribution of children in the EU 27 and considering the given weight classes of diapers, the newborn diapers are only used for the first three months, whereas the standard diapers are used for about one year.[51] Assuming that children wear diapers for about 2.5 years on average, the junior diaper share should be higher, however, it may be the case that diapers do not have to be changed as often at that age anymore. Furthermore it can be stated that the sales figures for each type of diaper have increased slightly between 2009 and 2011.

Picture 3. Market volume of feminine care products in million Euros



With regards to feminine care products, ultra-thin pads with wings and panty liners seem to be most popular with consumers in the EU27 (51% in 2011); tampons have a share of 23%. The remaining share is split between standard pads and ultra-thin pads without wings (25% in 2011). There is a slight tendency towards thinner pads: whereas standard pads have slightly lost market share in terms of sales volume, ultra-thin pads have grown almost 5% over the last two years. Picture 10 provides further details.

Picture 4. Market volume of incontinence products in million Euros



More than 50% of incontinence products are sold in hospitals or other public care facilities as can be seen in Picture *4*. Due to the separate 'away-from-home' category, it is difficult to determine the absolute split between moderate or heavy incontinence products with an increased absorptive capacity and the lighter version.

It would be feasible to analyse country-specific differences in the use of individual sanitary products. If it is required for the definition of EU Ecolabel criteria or if it is desired by stakeholders involved in this project, this information could be added to the report.

Error! Not a valid bookmark self-reference. presents some country-specific differences in the use of sanitary products. A threshold of 3% was chosen to highlight countries with higher sanitary product sales volumes. A threshold of 3% was also chosen in order to highlight the greatest differences of sanitary product sales share in relation to population share for individual countries.

Table 10. Sales volume percentage of sanitary products by EU countries and population share in 2011

	Incontinence Product	***Children's Diapers***	***Feminine Care - Pads***	***Feminine Care - Tampons***	***Total***	***Population share 2011***
Austria	1%	2%	1%	3%	2%	2%
Belgium	2%	3%	3%	2%	3%	2%
Bulgaria	0%	0%	1%	1%	0%	1%
Cyprus	0%	0%	0%	0%	0%	0%
Czech Republic	1%	2%	2%	1%	2%	2%
Denmark	1%	2%	2%	1%	2%	1%
Estonia	0%	0%	0%	0%	0%	0%
Finland	1%	1%	2%	1%	1%	1%
France	18%	16%	12%	16%	15%	13%
Germany	19%	14%	17%	22%	17%	16%
Greece	2%	2%	4%	1%	3%	2%
Hungary	0%	1%	1%	2%	1%	2%
Ireland	0%	1%	1%	1%	1%	1%
Italy	13%	12%	12%	5%	12%	12%
Latvia	0%	0%	0%	0%	0%	0%
Lithuania	0%	0%	0%	0%	0%	1%
Luxembourg	0%	0%	0%	0%	0%	0%
Malta	0%	0%	0%	0%	0%	0%
Netherlands	4%	5%	4%	3%	4%	3%
Poland	6%	5%	7%	5%	6%	8%
Portugal	5%	2%	2%	1%	3%	2%
Romania	0%	2%	1%	1%	2%	4%
Slovakia	0%	1%	1%	1%	1%	1%
Slovenia	0%	0%	0%	0%	0%	0%
Spain	12%	9%	13%	10%	11%	9%
Sweden	0%	3%	2%	2%	2%	2%
United Kingdom	13%	15%	9%	19%	14%	12%
Total	100%	100%	100%	100%	100%	100%

Legend:
overall country share for sanitary products >3%
+/- 3% difference sanitary product sales share in relation to population share

From Table 10 it can be derived that the sales volumes of the products within the scope of this project are very closely related to the number of people living in each country. Regardless of which country is observed, the difference between the share of population in the EU27 and the overall share of sanitary product sales is never greater than 2%. There are some examples of countries, however, for which slight discrepancies in this population-sales-relation can be observed. For example, Poland has a EU27 population share of 8% but only 6% of the overall sanitary product sales volume is generated in this country. In contrast, France has a population share of 13% but 15% of the products analysed in this project are sold in this country. Without having access to more detailed market information, it could be hypothesised that the registered discrepancies are linked to:

- The price of sanitary products in these countries;
- The amount of disposable income;
- The use of alternative products for the intended purposes (e.g. re-usable diapers).

On a product group-specific level, greater individual differences can be observed. For example, in Italy the use of tampons is comparatively low, whereas it is considerably higher in countries such as Germany, the UK and France. Further noticeable differences are highlighted in yellow.

Another result from the country-specific analysis of the market sales volume is that the eleven most populated EU27 countries (highlighted in blue) consume 88% of the sanitary product sales.

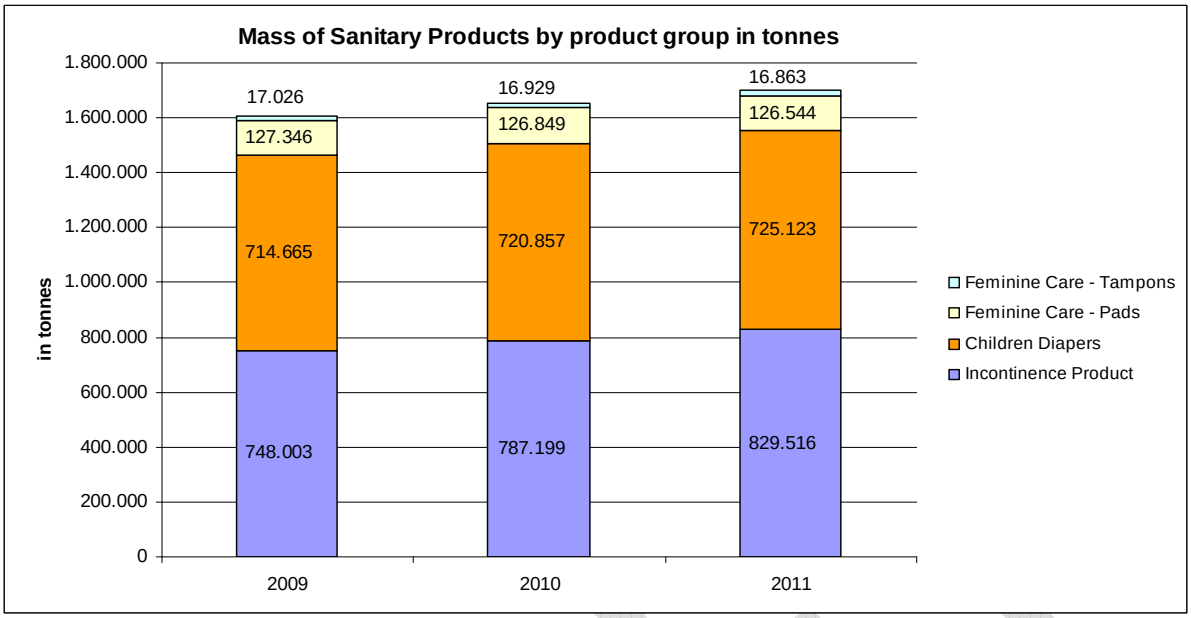
Production volume of sanitary product in mass

Since the overall environmental impact related to the products within the scope of this project is greatly influenced by the weight of the manufactured products, it is important to consider the mass of sanitary products being produced. Production volumes were based on Euromonitor unit sales figures and average unit masses supplied by EDANA, as indicated in Table 11.

Table 11. Average mass of sanitary products or product groups

Product/product group	***Average mass in grams***
Incontinence products	116
Children's diapers	36
Panty liners	1.5
Feminine care pads (standard)	10
Feminine care pads (ultra-thin)	6
Tampons	2.5

Picture 5. Production volume of sanitary products by product group in tonnes

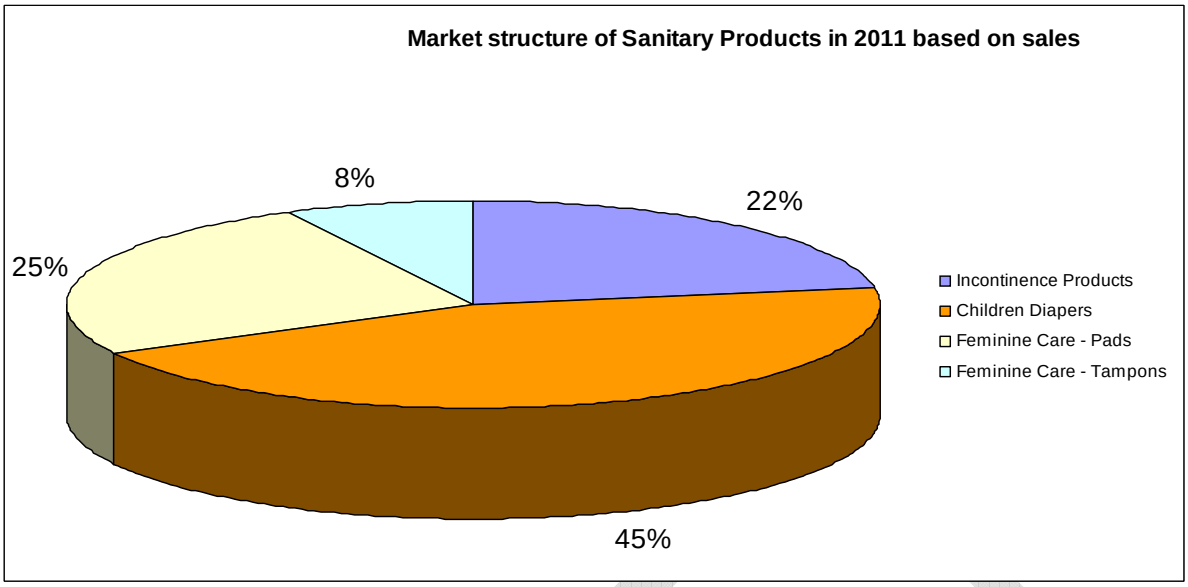


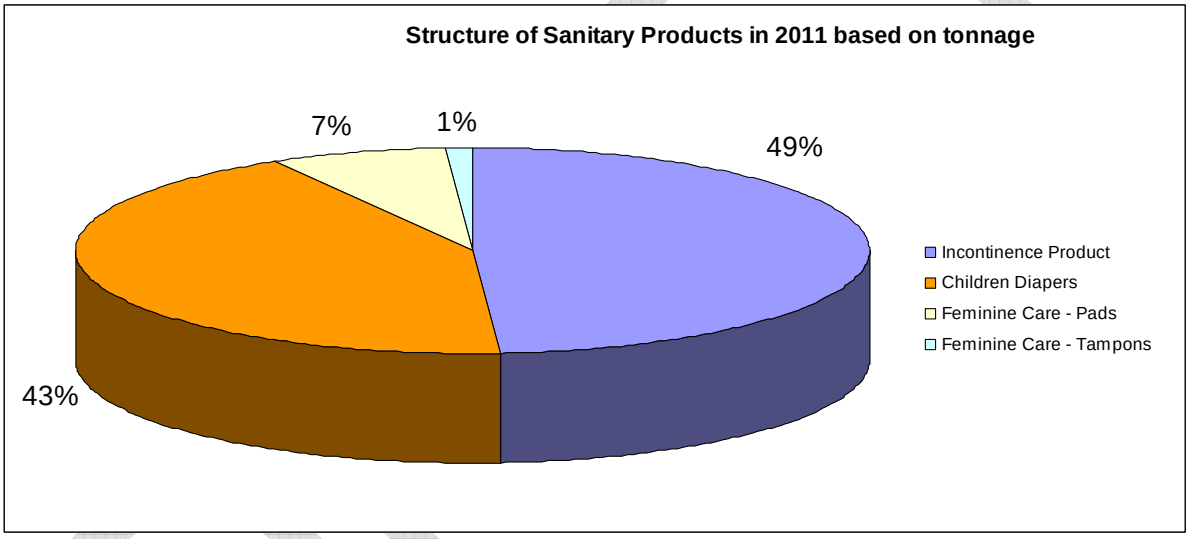
The total annual mass of sanitary products produced in the EU27 was almost 1.7 million tonnes in 2011. As can be seen from Picture 5, on a mass basis incontinence products make up the largest share, closely followed by children's diapers. Together these two products make 92% of the overall mass of sanitary products produced in the EU27. The share of feminine care products is much lower in comparison (8%). It is further interesting to note that in comparison to the sales figures, a slight decline in production can be observed for both types of feminine care products over the last three years. A reason for this can be that feminine care products have become lighter and that this effect overcompensates for the increased sales figures (irrespective of other potential factors that may also play a part). Average mass figures were used for the analysis showed above. Since it is not known how individual sanitary product masses vary, a more detailed analysis has been omitted. It is reasonable to assume that the inter-country specific differences are similar to the values presented in Table 10.

It would be feasible to analyse country-specific differences in the volumes of sanitary products manufactured although it has to be considered that specific masses for products sold in these countries are not available. If it is required for the definition of EU Ecolabel criteria or if it is desired by stakeholders involved in this project, this information could be added to the report.

Picture 6 illustrates the difference between sales and production figures for the products within the scope of this project.

Picture 6. Comparison of sanitary product structure based on sales and on production figures for 2011





Import and export figures for sanitary product

For the purpose of this project it is also important to know the proportion of sanitary products manufactured and consumed within the EU27 and the proportion of sanitary products which are exported and imported through the EU27. Table 12 and Table 13 provide the information necessary to shed some light on import and export figures for the different sanitary product groups and to calculate the total consumption of sanitary products. It is important to note that the data is available only at an aggregated level for each product group. A distinction between sales figures on value or mass was made. For the calculation of the production of sanitary products in tonnes, the average product masses indicated in Table 11 were used and multiplied with the unit amounts provided. The total sales figures are provided with respect to the EU27. According to EDANA, value and mass of the product are not always logically connected since the products are sold as units. Hence, the values presented in Table 12 in terms of Euros can be

considered a more precise estimation. The discrepancies between mass and value can be seen when comparing the two tables below. On a qualitative level it can also be stated that exported sanitary products are generally lighter and more expensive and that imported products tend to be heavier and cheaper.[52]

Table 12. Import, export and total consumption figures for EU27 based on Euros for 2011

	Total sales in million €	***Imports in million €***	***Exports in million €***	***Total consumption in million €***	***Import in % of total sales***	***Export in % of total sales***
Incontinence Products	2,482	47	279	**2,249**	2%	11%
Children's Diapers	4,950	123	652	**4,421**	2%	13%
Feminine Care - Pads	2,776	53	315	**2,514**	2%	11%
Feminine Care - Tampons	839	22	33	**829**	3%	4%

Table 13. Import, export and total consumption figures for EU27 based on mass for 2011

	Total production in tonnes	***Imports in tonnes***	***Exports in tonnes***	***Total consumption in tonnes***	***Import in % of total production***	***Export in % of total production***
Incontinence Products	829,516	14,405	111,445	**732,476**	2%	13%
Children's Diapers	725,123	41,298	198,493	**567,928**	6%	27%
Feminine Care - Pads	126,544	13,652	43,050	**97,146**	11%	34%
Feminine Care - Tampons	16,863	3,652	3,917	**16,598**	22%	23%

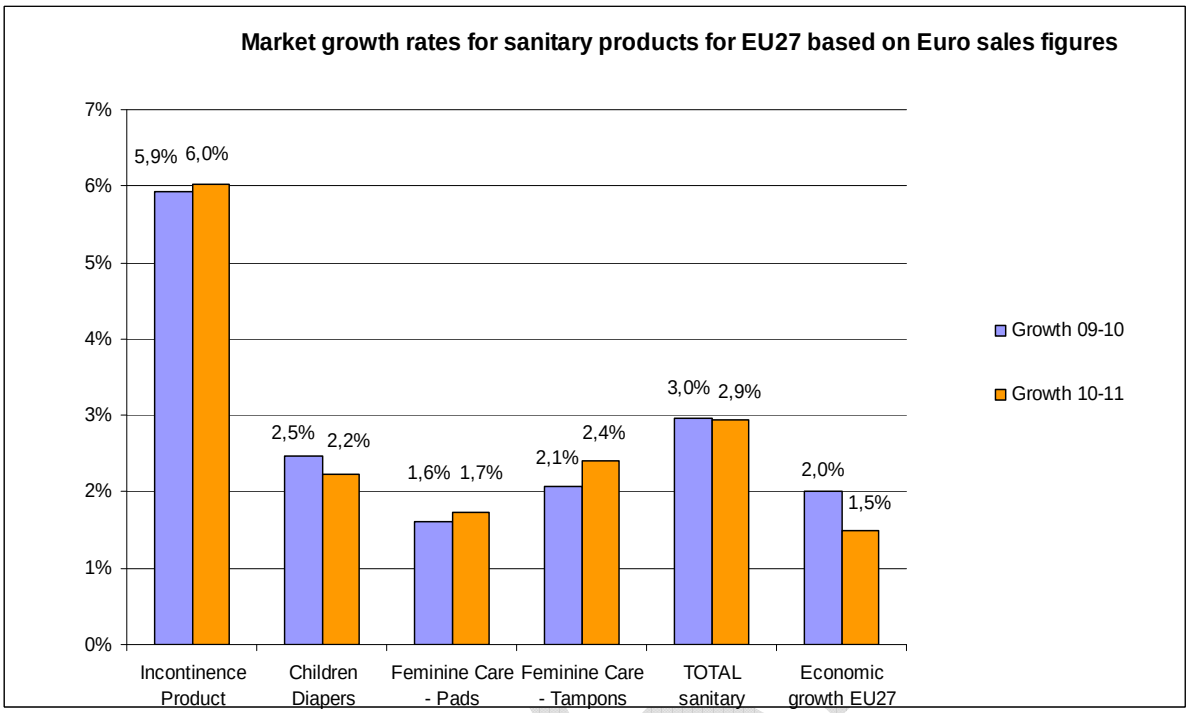
One important observation from the analysis is that most sanitary products manufactured in the EU27 are also destined to be consumed in the EU27. Secondly, the value and the amount of sanitary products exported are significantly higher than what is imported. Furthermore, since sanitary products are quite bulky, the distance between production sites and market tends to be small. According to information from EDANA, most of the imported sanitary products come from Northern Africa or the Middle East. The Middle East may most likely also be the recipient of exported sanitary products.[52] Although only 2011 data was presented in this report, the data for the two previous years reveals a very similar picture.

Market growth rates for sanitary products

As briefly mentioned above, based on sales within the EU27, the market of products within the scope of this project has grown slightly between 2009 and 2011. A more detailed analysis of the development of the overall market and in the different sanitary

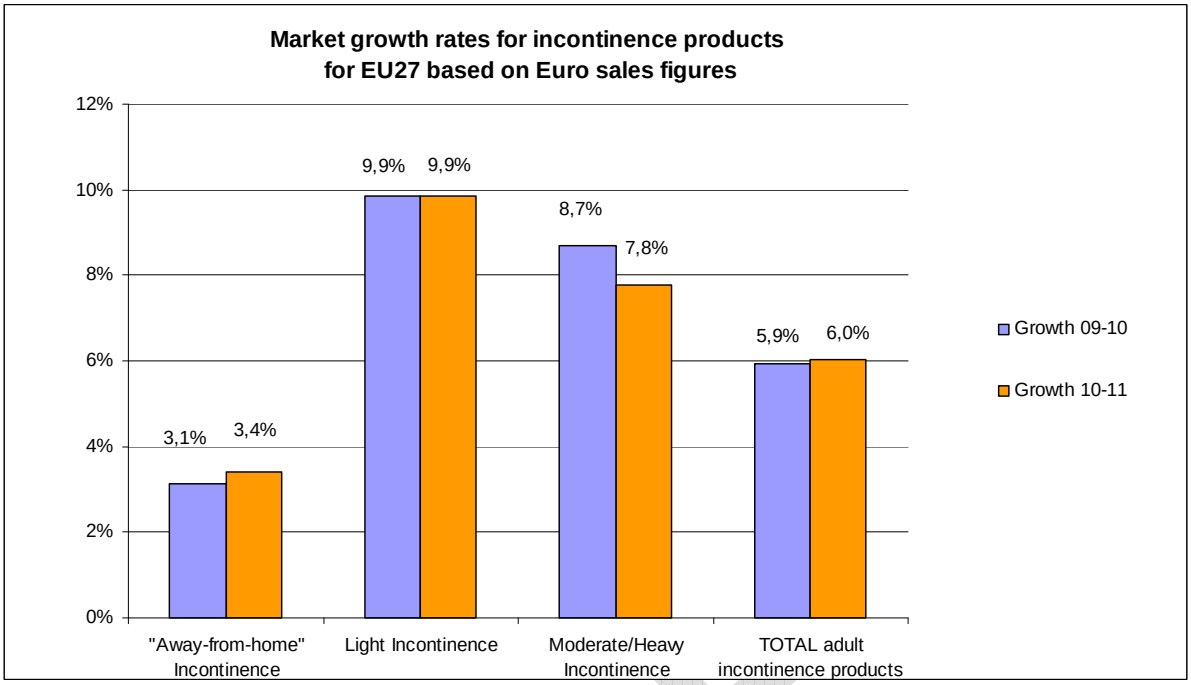
product groups over the last three years provides some interesting insights, as can be seen in Picture 7 to Picture 10.

Picture 7. Market growth rates for sanitary products for EU27 based on Euro sales figures



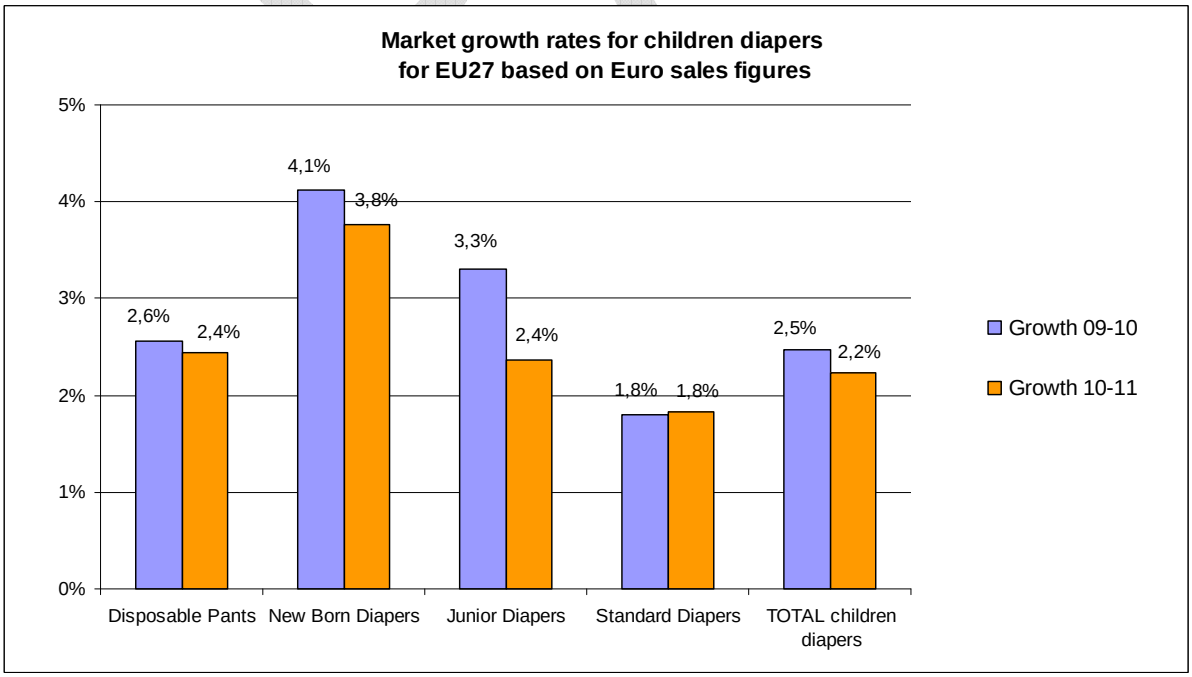
The market for incontinence products has grown more than twice as fast as the market for all the other sanitary product groups. This fact must be due to the demographic changes we can observe within the EU27. It is further interesting to note that the total sanitary product market shows stronger growth than GDP over the same time period.[53] Mainly incontinence products, but also children's diapers and tampons show growth rates above the EU27 GDP average, whilst feminine care pads show the lowest growth rates.

Picture 8. Market growth rates for incontinence products for EU27 based on Euro sales figures



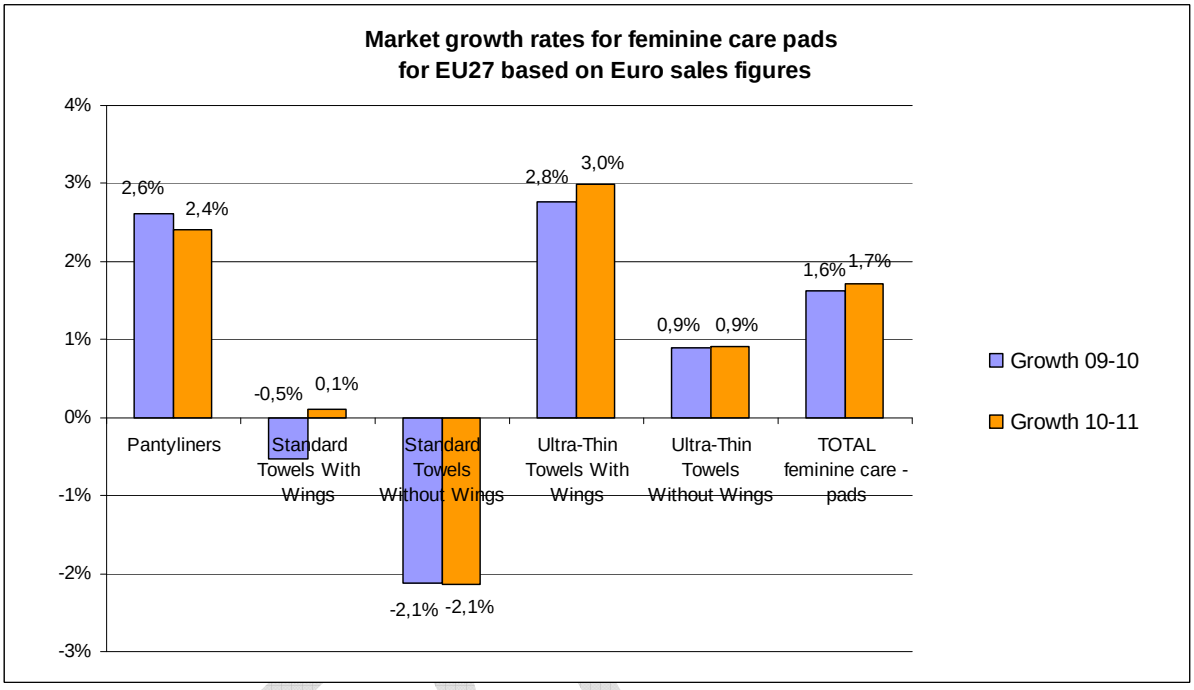
As can be seen in Picture 8, incontinence products purchased at the retailers are the main responsible for the high market growth of these products. This observation is particularly interesting for the purpose of this project and can be considered a justification for the proposal to include these products within the scope of this project.

Picture 9. Market growth rates for children's diapers for EU27 based on Euro sales figures



The market for children's diapers has grown by more than 2% over the last two years. Newborn diapers show the highest growth rates, standard diapers the lowest. Stakeholders involved in this project describe a trend towards increased product segmentation created by the development of niche markets, for example the ultra-slim or superabsorbent diaper or the boy, girl and unisex diapers.

Picture 10. Market growth rates for feminine care pads for EU27 based on Euro sales figures



Within the sanitary product group 'feminine care pads' a trend can be observed towards the use of light-weight ultra-thin pads and panty liners. For standard pads, negative market growth rates can be instead detected.

Table 14 illustrates the market growth rates between 2009 and 2011 on a EU27 country basis whereby market growth rates higher than 10% are highlighted green, negative growth rates greater than 10% are highlighted red. For most countries a sales increase for sanitary products can be observed; a few exceptions are Greece, Ireland, Latvia and Romania. The trend towards an increased use of incontinence products is apparent in most European countries.

It should be noted that the interpretation of this further disaggregated data should be handled with care because it cannot be guaranteed that each country reported the correct figures for the given years. Analysing the same data but on an individual product level sometimes shows even more unrealistic results. Hence, it is suggested to refrain from focusing on overly detailed product- and country-specific analyses because they may lead to misleading conclusions.

Table 14. Market growth rates of sanitary product groups by EU countries

	Incontinence Product		***Children's Diapers***		***Feminine Care - Pads***		***Feminine Care - Tampons***		***Total***	
	Growth 09-10	***Growth 10-11***	***Growth 09-10***	***Growth 10-11***	***Growth 09-10***	***Growth 10-11***	***Growth 09-10***	***Growth 10-11***	***Growth 09-10***	***Growth 10-11***
Austria	5%	6%	1%	1%	0%	0%	2%	2%	2%	2%
Belgium	5%	4%	-1%	1%	0%	0%	-2%	-2%	0%	1%
Bulgaria	0%	0%	1%	4%	-1%	1%	2%	2%	0%	2%
Cyprus	0%	14%	8%	4%	2%	2%	0%	8%	5%	4%
Czech Republic	12%	11%	8%	10%	4%	8%	-1%	6%	6%	9%
Denmark	4%	6%	1%	3%	2%	4%	2%	4%	2%	4%
Estonia	0%	0%	0%	4%	-2%	7%	-14%	17%	-1%	5%
Finland	2%	4%	4%	4%	2%	3%	2%	3%	3%	3%
France	6%	7%	3%	3%	1%	0%	2%	2%	3%	3%
Germany	5%	5%	1%	1%	2%	2%	0%	0%	2%	2%
Greece	1%	-3%	-10%	-12%	-1%	-1%	-2%	0%	-5%	-6%
Hungary	5%	2%	3%	1%	6%	6%	7%	6%	5%	3%
Ireland	-6%	-4%	-5%	-3%	-6%	-3%	-7%	-4%	-6%	-3%
Italy	4%	4%	-1%	-1%	-1%	-1%	-5%	-2%	0%	0%
Latvia	-13%	-14%	-15%	-7%	-9%	-3%	0%	-7%	-12%	-6%
Lithuania	0%	0%	-8%	1%	2%	4%	0%	0%	-4%	2%
Luxembourg	13%	4%	4%	2%	5%	0%	0%	0%	6%	2%
Malta	40%	0%	15%	0%	25%	20%	0%	33%	20%	7%
Netherlands	6%	6%	2%	2%	2%	2%	1%	1%	2%	3%
Poland	16%	11%	13%	9%	11%	7%	16%	7%	13%	9%
Portugal	5%	5%	0%	0%	-3%	-2%	3%	2%	2%	2%
Romania	-4%	0%	4%	2%	-12%	-5%	-7%	-4%	-1%	0%
Slovakia	3%	8%	2%	2%	1%	2%	5%	2%	2%	2%
Slovenia	4%	4%	1%	4%	-1%	3%	0%	0%	1%	3%
Spain	3%	3%	0%	0%	-1%	0%	0%	0%	0%	1%
Sweden	28%	20%	14%	8%	14%	8%	14%	7%	14%	8%
United Kingdom	10%	13%	9%	7%	6%	7%	6%	7%	8%	8%
Total	5,9%	6,0%	2,5%	2,2%	1,6%	1,7%	2,1%	2,4%	3,0%	2,9%

Legend:
market growth rate >10%
market growth rate <-10%

Market shares for sanitary products

With regards to market shares, the available data must also be considered with caution and allows only for a snapshot of the sanitary product market. Market shares were only available for 22 of the EU27 countries for the years 2009 and 2010 (data was not

available for Cyprus, Finland, Luxemburg, Malta and the UK). Further, only aggregated data for three main product groups were available: incontinence products, children's diapers and feminine care products. In addition, within the group of incontinence products, only the retail volume and not the "away-from-home" share is captured. Table 15 presents the companies responsible for the highest proportion of sales within the given countries.

Table 15. Companies with highest market shares in 2010

Companies	***% market share (2010)***	***Comments***
Procter & Gamble	27%	all product groups, many countries
SCA	11%	all product groups, many countries
Fater SpA	8%	all product groups, only Italy
Arbora & Ausonia SL	8%	all product groups only Portugal and Spain
Kimberly Clark	7%	all product groups, many countries
Johnson	6%	all product groups, many countries
Aldi	2%	all product groups, only Belgium, Hungary, Denmark, Germany, Ireland, Netherlands
Torunskie Zaklady Materialow Opatrunkowych SA (TZMO)	2%	all product groups, only Poland, Bulgaria, Lithuania
Companies with a market share <10%	24%	
TOTAL	95%	

Table 15 also indicates that companies with product group- and country-specific market shares of less than 10% make up 24% of the market for the given countries. For companies with product group- and country-specific market shares of less than 5%, the respective value is 11%. From this analysis it can be concluded that although there are some large players, there is also quite a long list of smaller companies which overall produce a "fair share" of sanitary products.

Further information, insights or possible corrections from stakeholders on market shares within the EU27 will be appreciated.

4.2 Conclusions from the market data analysis

The market analysis presented in this Section allows for some key conclusions about the products within the scope of this project. The main messages are summarised in this Section. Furthermore, additional information in terms of market segmentation, market developments or other aspects which could be beneficial for the development of EU Ecolabel criteria is even provided.

The market analysis presents two significantly different pictures depending on whether sales figures are reported in value (Euros) or tonnages of the products (see

Picture 6). On a weight basis, children's diapers and incontinence products make more than 90% of the sanitary product market. However, on the basis of sales shares in Euros, feminine care products contribute more than 30% to the overall market.

In terms of the **functional segmentation** of the market, the following observations can be pointed out:

- Although the standard children's diaper still makes up more than 50% of the overall diaper market, a trend towards greater differentiation of diapers can be observed, e.g. ultra-slim, superabsorbent, boys, girls, unisex, etc.;
- A similar trend towards product differentiation can be observed for incontinence products. Products include pads in different sizes and shapes and for men or women and all-in-one incontinence briefs or pants;
- With regards to feminine care products the share of pads or panty liners is greater than the share of tampons;
- Within the feminine care pads product group, generally thinner pads as well as pads with wings or panty liners are preferred over standard pads;
- No data was available in order to determine shares of applicator and non-applicator tampons.

Regarding the **geographical segmentation** of sanitary products within the EU27, the following key statements can be made:

- Sanitary products are generally articles of daily use. There is a good correlation between the population share of each country of the EU27 and the share of sanitary products sold in each country;
- Some regional differences on a product group-specific level can be identified, see Table 10;
- Italian women seems to prefer feminine care pads whereas the German, English or French women purchase relatively more tampons;
- The use of incontinence products is greater in countries such as France, Germany, Spain or Portugal;
- The use of children's diapers is highest in France and lowest in Poland.

With regards to the **import and export** of sanitary products within the scope of this project, the following conclusions can be drawn despite some market data uncertainties (see Table 12 and Table 13 for details):

- The great majority (about 90%) of sanitary products produced in the EU27 are also consumed in the EU27;
- The share of sanitary products being exported is higher than the share of sanitary products being imported;
- The Middle East seems to be the main recipient for the exported sanitary products; the imported products tend to come from countries in Northern Africa or the Middle East;
- In general, exported products tend to be lighter and more expensive, whereas imported products tend to be cheaper and heavier.

In terms of **market growth rates**, a slight increase in the overall sanitary product market can be observed between 2009 and 2011 (about 3% per year). On an individual sanitary product basis, the following key trends were identified:

- The market for incontinence products has grown twice as much as all other product groups; in particular, the share of light incontinence products has grown almost 10% per year between 2009 and 2011;
- Of all products within the scope of this project, only the standard pads show a downward trend;
- Predictions on growth rates for sanitary products for the next two to three years are currently in progress and have been not included in this report.

An analysis of **market shares** for sanitary products within the EU27 identified the following (see Table 15):

- Procter & Gamble have the largest market share (27%), which is more than three times higher than the next competitor;
- After Procter & Gamble, the next five largest companies together make up more than 40% of the market;
- There are also a lot of small and medium sized companies with lower market shares present in the sanitary product market;
- In some countries (e.g. Slovenia or Romania) there are individual companies with significant market shares, but these countries have a low sales volume compared to the EU27.

Stakeholders involved in this project named the following **key factors influencing the market** of sanitary products in the EU27:

- The evolution of the birth rate: after a steady decline in the number of live births in the EU27 between the 1960s (~7.5 million) and 2002 (~5 million), recent years show a slight upward trend (~5.4 million in 2008, 2009 and 2010). Ireland and France have the highest fertility rates in the EU27 (2.1 and 2 children per woman), whereas Latvia, Portugal and Hungary have the lowest (~1.3 children per woman)[54];
- The number of menstruating women: no data was available for further explanations
- The evolution of life expectancy, which has consequences for the market development of incontinence products: life expectancy at birth increased by about 10 years in the last 50 years. More recently (between 2002 and 2008) there was an increase in life expectancy of 1.5 years for women (average life expectancy in 2008: 82.4) and 1.9 years for men (average life expectancy in 2008: 76.4). There are significant differences in life expectancy at birth between the EU Member States, e.g. a woman born in 2009 is expected to live between 77.4 years (Bulgaria) and 85.0 years (France); a man born in 2009 can be expected to live between 67.5 years (Lithuania) and 79.4 years (Sweden)
- Consumer preferences in terms of pants vs. diapers or pads vs. tampons: Regarding pants or diapers, no further data was available. With regards to pads or tampons, see some comments above. With regards to the preference for

disposable over reusable children's diapers, it is estimated that today about 95% of parents in advanced economies use the disposable option.[55]

- Consumer needs in particular in terms of factors such as hygiene, absorbency, skin care and comfort: **further stakeholder input would be required to provide a more detailed analysis.**
- Stakeholders further mentioned factors influencing the market such as price pressure in public procurement, consolidation in the retail sector, different financing/reimbursement models, the growth of private labels for sanitary products as well as affordability of sanitary products. **Further stakeholder information on this aspect would be required in order to understand how these factors may need to be considered for the development of EU Ecolabel criteria.**

EDANA mentioned that data forecasting the market of sanitary products for the next few years will become available in the next few weeks. Once available, this information will be incorporated in this Section of the report.[52]

Stakeholders are kindly invited to revise the information contained in this section and to provide further details on the market of sanitary products.

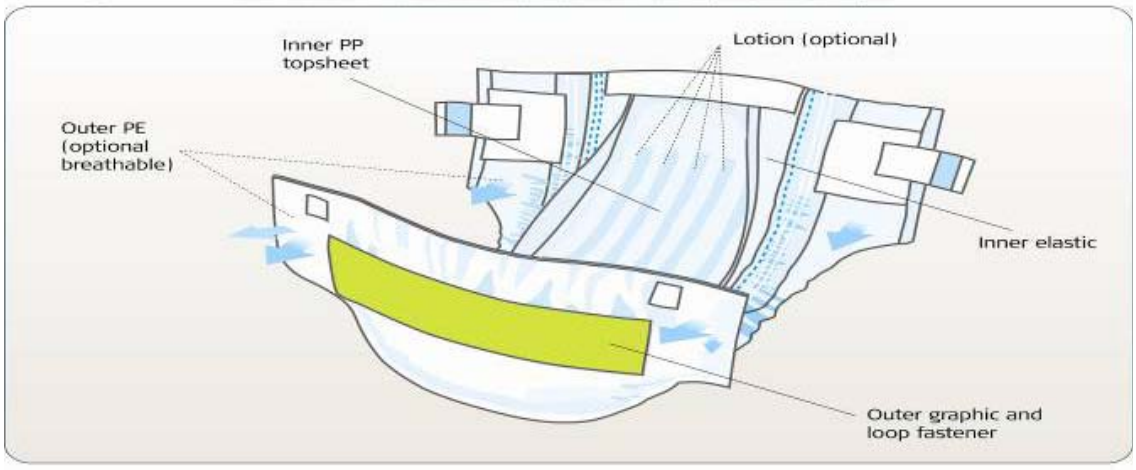
5. TECHNICAL ANALYSIS

5.1 Technological aspects and material compositions

Disposable Children's Diapers

A typical disposable children's diaper consists of four main components, i.e. a top-sheet, an acquisition and distribution layer (ADL), the absorbent core and a back-sheet (see Picture 11).

Picture 11. Schematic overview of a modern disposable diaper[56]



The disposable diaper top-sheet (also called the facing) is the layer closest to the skin through which urine easily passes to be collected in the subsequent layers, minimising contact time with the skin causing irritation and infection.[65] Both the top-sheet and the back-sheet at the bottom compose the main structure of the diaper and keep it sturdy whether it is wet or dry. Polypropylene (PP) nonwovens, the material used for the top-sheet, have a soft and smooth surface, which makes the user feel more comfortable, since the top-sheet comes into direct contact with the skin. PP nonwovens are also highly permeable to fluids, an additional and important feature.

The acquisition and distribution layers (ADL) are the next layers of contact after the urine passes through the highly permeable top-sheet.[65] The ADL stores the liquid temporarily before it is distributed through capillaries to the absorbent core, where it is stored in the fluff pulp and superabsorbent polymers.

The absorbent core structure is the main part of the disposable diaper and acts as liquid storage component.[65] The two main functions of the absorbent core are quick

absorption of liquids and liquid distribution through the core structure. The disposable diaper core consists of fluff pulp and superabsorbent polymers (SAP). The fluff pulp is the liquid collection component, which makes up about 50% of the core. The SAP, which makes up 25-30% of the entire core, becomes a gel when it comes in contact with the liquid. The liquid is stored within the gel structure and is no longer released, even under pressure, due for instance to sitting or lying down on the saturated diaper. SAP has a water absorption capacity of 500 times its weight, but the absorbency drops significantly with saline solutions.. Salts and minerals in the urine reduce the absorbing capacity to 20-40 ml per gram of the polymer.[57]

An optional layer is a tissue wrap made of cellulose, which can be found around the core of the diaper or storage layer, and which is an additional aid to support the structure of the disposable diaper even when it is saturated with urine.[65]

The back-sheet (also called the outer cover) is made up of low density polyethylene (PE) film or of a composite of film and nonwovens, and keeps the urine from escaping the diaper and reaching clothing by acting as a barrier. This component must be sturdy enough to contain the entire diaper, even when it is wet, as well as thin enough to not produce a noticeable sound during movement. Micro-pores are created in the PE substrate during film extrusion, making the PE film breathable, which allows air to reach the skin, keeping it dry and preventing irritations and infections. The nonwoven fibres can also undergo hydrophobic treatment.

Diapers are available in varying sizes and on average weight between 36 to 42 grams[58]. The material composition of an average children's diaper is reported in Table 16. Slight differences can be observed comparing children's diapers with incontinence products, as illustrated later.

Table 16: Average compositions of children's diapers in 2004[65], 2006[65] and 2011[59]

Material	***2004***	***2006***	***2011***
Fluff pulp	43%	35%	36.6%
Superabsorber (SAP)	27%	33%	30.7%
Polyethylene, low density (LDPE)	7%	6%	6.2%
Polypropylene (PP)	15%	17%	16.0%
Adhesive	3%	4%	2.8%
Elastics	1%	1%	0.4%
Other materials	4%	4%	7.3%
Tape			1.3%
Elastic back ear			3.2%
Frontal tape			1.4%
Various synthetic polymers			1.4%

In 2004 the average children's diaper was made up of 43% fluff pulp, 27% superabsorbent polymers (SAP), 7% polyethylene, 15% polypropylene, 3% adhesive, 1% elastics and 4% other materials.[65] In 2006 the average children's diaper changed

focusing on a reduction of raw materials (see section 2.4 on disposable diapers). A higher content of SAP leads to a decreased use of fluff pulp. Changes are rather small for all the other materials. In 2011, the average children's diaper composition changed only slightly compared to the standard diaper in 2006.[65] The reduced use of fluff pulp and at the same time higher input of SAP was maintained.

Additional materials in disposable diapers include fastening systems and elastics for legs and inner cuffs, as well as within and next to the absorbent core, to allow the diaper to stretch.

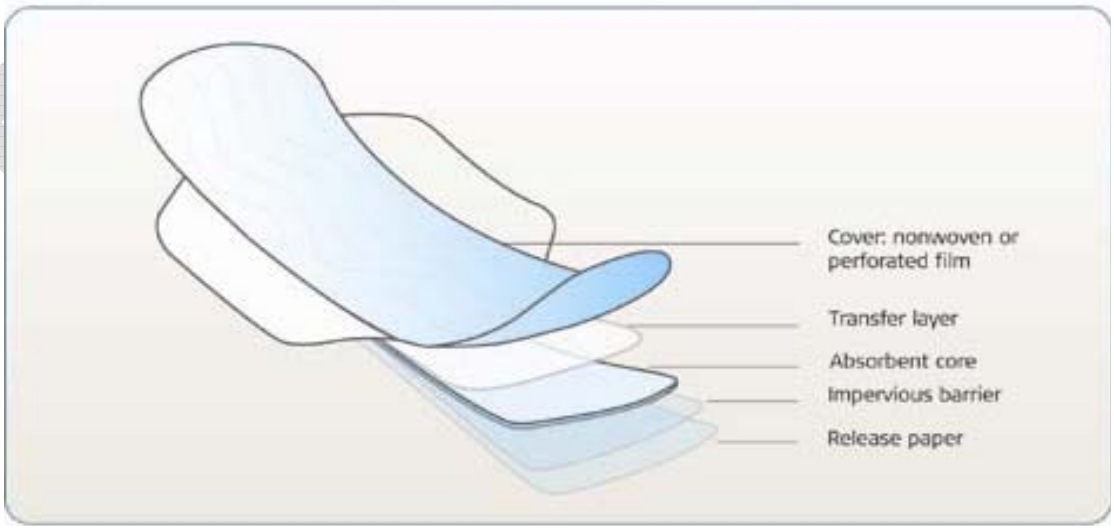
If available, stakeholders are kindly invited to provide further details on the composition of children's diapers (e.g. potential use of alternative materials, composition and average weight trends for the coming years).

Feminine care pads

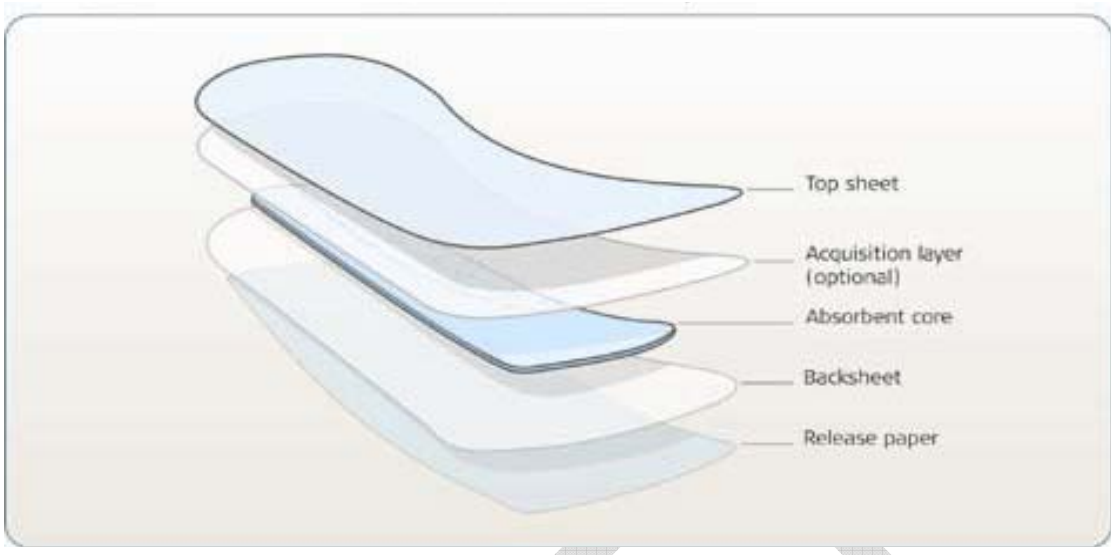
Feminine care pads vary in size depending on the amount of liquid, the size and the physical activity of the user. The weight of feminine care pads is between 1.5 grams (panty liners) and 10 grams (standard towels).

The average feminine care pad is composed of the four main components present in diapers. Moreover, they also include a silicon-coated paper or a polyethylene sheet in order to protect the glue under the bottom layer. See Picture 12 and Picture 13 for details.

Picture 12. Schematic view of an ultrathin feminine care pad; Average ultrathin feminine care pad composition 2006[60]



Picture 13. Schematic view of a panty liner[60]



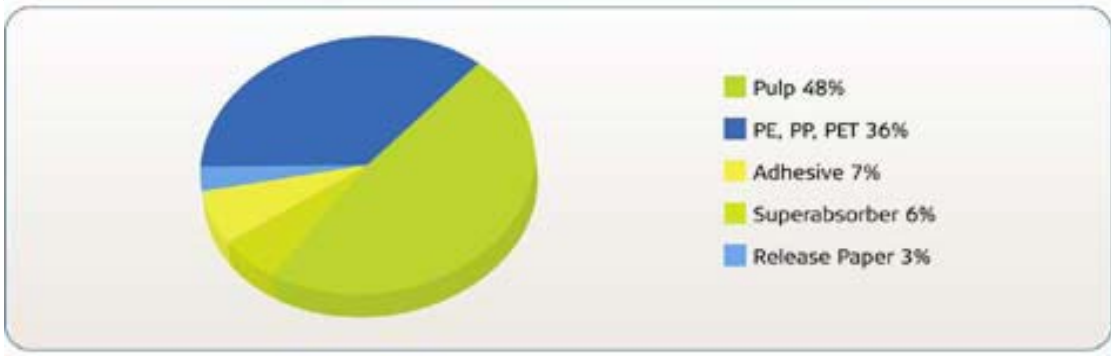
The absorbent layer in feminine hygiene products marketed as “ultrathin” is an engineered airlaid substrate, which usually consists of a multiple layered structure with fluff pulp, SAP and other capillary fibres.[77]

Compressed cellulose is another advanced material used for the adsorbent layer of a feminine care pad because it effectively spreads liquid over the entire area of the material for adsorption.[77]

Pads can also present wings. The purpose of the wings is to wrap around the sides of the woman's underwear to add additional leak protection and help secure the pad in place. They also help to reduce the thickness of the pads.[61]

The principal materials contained in pads and panty liners are wood pulp, nonwoven fabrics made of polymers (polyethylene, polypropylene), superabsorbent polymer, and adhesives made of natural and synthetic resins, see Picture 14 for details.

Picture 14. Average ultrathin feminine care pad composition, 2006[60]



If available, stakeholders are kindly invited to provide further details on the composition of feminine care pads (e.g. potential use of alternative materials, more specific and recent data, composition and average weight trends for coming years)

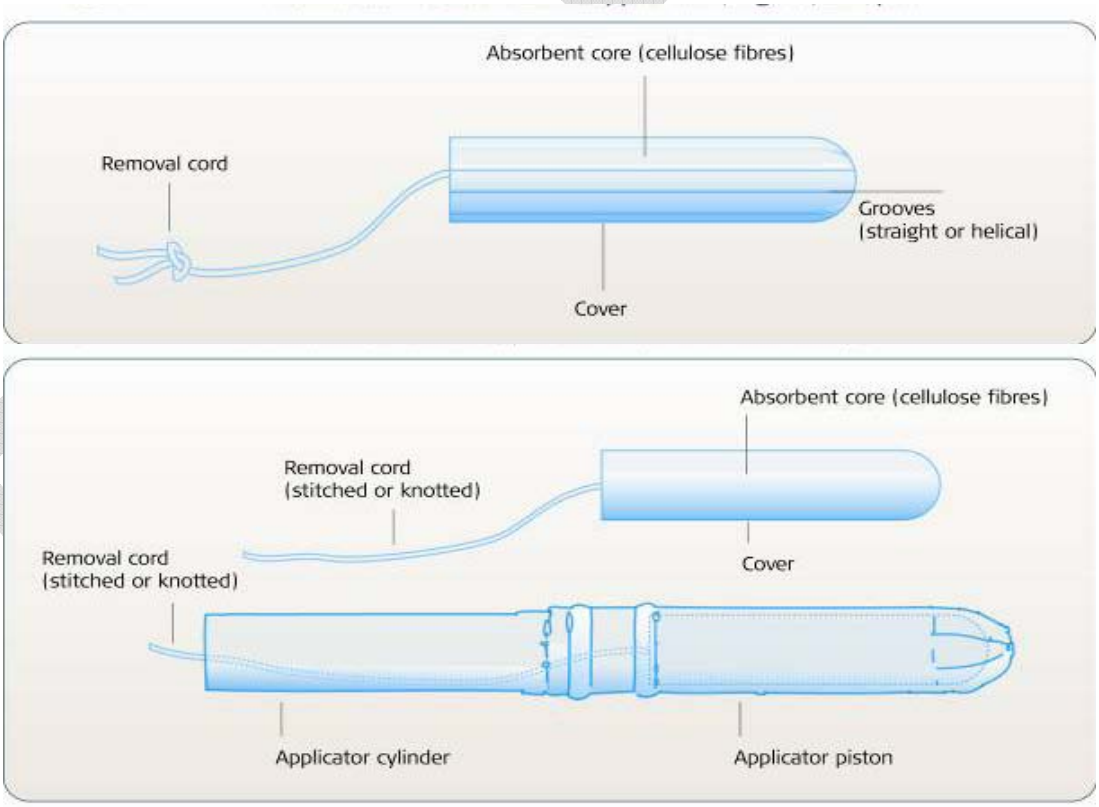
Tampons

Modern tampons are mainly composed of a natural cellulosic absorbent material, e.g. rayon or cotton or a mixture of both (over 90% of the tampon).[65] In most of the products, the absorbent core of the tampon is covered by a thin, smooth layer of nonwoven perforated film which helps to reduce the loss of fibres and makes the tampon easy to insert and remove. The withdrawal cord which is necessary to remove the tampon is usually made of cotton or other fibres and can be coloured. Applicators can be made of either coated paper or plastic or a combination of both.

Both tampon types are usually covered with a nonwoven of perforated film and are individually wrapped in a thin film or paper wrapper to provide cleanliness and hygiene until usage.[62]

The average weight of a tampon is 2.5 grams.

Picture 15. The schematic view of an applicator and non-applicator tampon



If available, stakeholders are kindly invited to provide further details on the composition of tampons (e.g. potential use of alternative materials, more specific and recent data on composition and average weight of the product, trends for coming years).

Incontinence Products

When looking at the structure of incontinence products, it is important to differentiate among light, medium and heavy incontinence products.

The structure of light incontinence products is similar to feminine hygiene products (e.g. feminine care pads and panty liners), but they are especially designed for incontinence due to sophisticated leakage protection for urine. These products are sandwich-structured with an absorbent core comprising a blend of fiberised fluff pulp and superabsorbent polymer (SAP). The top sheet is a layer of polyethylene (PE) or polypropylene (PP) nonwovens or a mix of both. The back sheet is usually formed of a PE film or alternatively of a nonwoven/film composite which may be breathable. The product is fastened to the underwear by an adhesive strip on the back sheet, protected by release paper prior to use.

The structure of medium to heavy incontinence products is similar to a children's diaper. The top-sheet layer closest to the skin consists of nonwoven fabric through which urine passes to the subsequent layers. The acquisition and distribution layer distributes urine and other liquids to the absorbent core, which consists of cellulose fluff pulp and superabsorbent polymers. For heavy flow products two distinct cores may be used. The final back-sheet layer consists of polyethylene or composite film that blocks liquids from escaping to clothing. Additional materials featured in incontinence products for user comfort include belts, elastics for the waist, barriers protecting against leakage and hook and loop or tape fasteners. A very commonly used form of heavy incontinence products are the so called “two-piece systems”, comprising the pad and the pant into which the pad is inserted.[63]

A sample schematic view of an average all-in-one incontinence product is provided in Picture 16.[64]

The material composition of an average incontinence product has changed only slightly between 2004 and 2006 as illustrated in Table 17. From the data analysed it can be observed a slight shift from using less SAP towards using more fluff pulp. Although performance requirements for incontinence products are high because they have to absorb large amounts of liquids (i.e. urine) and solid material (i.e. faeces), the percentage content of SAP is usually lower than in nappies. This is generally due to the cost pressure that national health systems intend to apply on patients, which even depend on the existing incentive schemes for the supply of incontinence products.

Stakeholders are kindly invited to provide further details on the composition of incontinence products (e.g. more specific and recent data for light, medium and heavy products, composition trends for the coming years, and average weight of the products)

Picture 16. Schematic view of a belted incontinence product

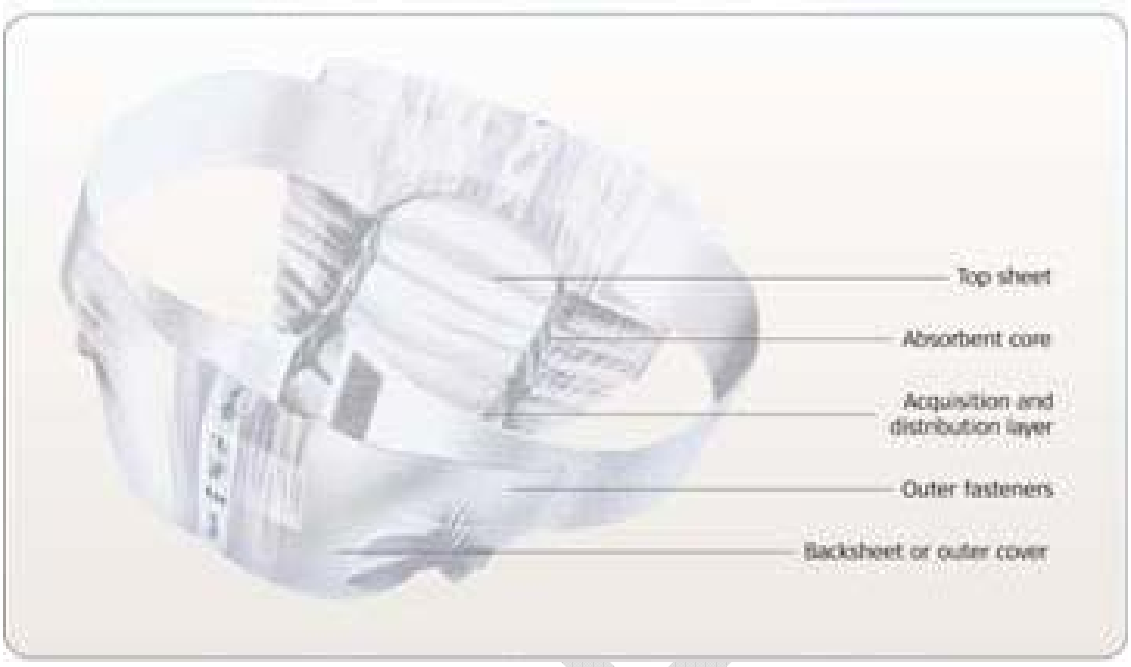


Table 17. Average material compositions of incontinence products in 2004[65] and 2006[65]

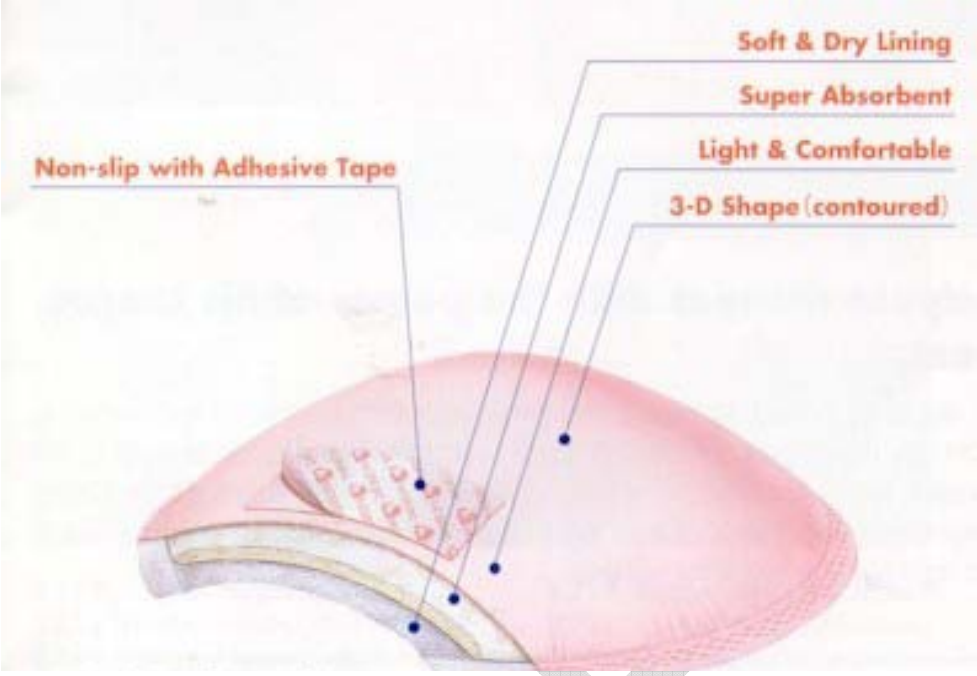
Material	2004	2006
Fluff pulp	59%	62%
Superabsorber (SAP)	14%	12%
Polyethylene (LDPE)	10%	10%
Polypropylene (PP)	9%	10%
Adhesive	4%	3%
Elastics	1%	0.4%
Other materials	3%	3%

Breast pads

The composition and functionality of breast pads is similar to that of incontinence care products. Most commercial types have self adhesive tape backing that enables their easy placement. They are shaped to fit the breast form without any visible lumps under the clothing.[66] Picture 17 illustrates a common disposable breast pad.

Stakeholders are kindly invited to provide further details on the composition and weight of breast pads (e.g. material used, amounts, trends for the coming years). Indication of companies producing breast pads and potentially interested in the EU Ecolabel would be even welcome.

Picture 17. Schematic view of a disposable breast pad



5.2 Description of production processes of sanitary products

Manufacture of children's diapers and incontinence products

The production of children's diapers and incontinence products is characterised by three major processes:

1) Fluff pulp is fiberised, superabsorbent polymer is added and absorbent pads are formed;
2) The pads are then laminated with films, nonwoven substrates and elastic.

Finally, the pads are shaped, cut, folded and packaged for distribution.[63] The process and technology behind the development and manufacture of disposable diapers and incontinence products is continuously evolving in order to find more efficient processes and designs which utilise materials that are thinner and lighter.

Substrates are laminated using hot melt adhesives, therefore precluding solvent-based adhesives, which can have negative health and environmental effects. The melting temperature range for the adhesives is between 130°C and 160°C, and adhesives with a lower melting point are currently in development because melting temperatures are directly correlated to energy consumption.

The final diaper or pad must be cut into an anatomic shape, resulting in off-cut waste, which can be recycled, disposed of or reused. The amount of off-cut waste strongly depends on the product design. Looking at materials as foils or PP fleece, for example, the more efficiently surfaces of material can be used, the less waste is being produced. Waste generation during production is often minimised for cost reasons and therefore it can be estimated to be marginal (3-5%).

Raw materials used to manufacture disposable diapers and incontinence products are made mainly of cellulose from wood and polymers from crude oil or other renewable feedstock. Energy and water are also consumed during the production stage.[63]

Packaging

Children's diapers and incontinence products can usually be purchased as multiple products in a PE-bag. The products leave the production site packed in cardboard boxes on pallets. Attempts to reduce packaging in the last years have been made. For example, single products can be compressed in order to pack more units of product within PE-bags with consequent benefits for truck loading and transport efficiency[63]. As a quantitative example, packaging of incontinence products has decreased from 13.3 kg per 1000 pieces in 1995 to 10.3 kg per 1000 pieces in 2005, for an overall reduction of 22%. The reduction of packaging leads to an improvement of storage and transport efficiencies and to a decrease of the environmental burdens associated with the production and disposal of the packaging itself.

Stakeholders are kindly invited to revise the information provided and to indicate the industrial initiatives related to the design, manufacture and packaging of the products which can lead to an effective and environmentally sustainable innovation of product/technology (e.g. avoidance of solvent-based adhesives and use of adhesives with low melting point, reduction and disposal of waste fraction, avoidance of hazardous or needless chemical substances, selection of the most appropriate raw materials and packaging solutions).

Manufacture of feminine care pads

The manufacturing of feminine care pads is usually similar to the production of children's diapers and incontinence products.[65] The main difference is the presence of an additional layer of silicon-coated paper which covers the glue at the bottom layer

with which the product is fixed to the clothing. This silicone-coated paper, sometimes substituted by silicone-coated polyethylene, is attached to the product at the last step of the production process.

Packaging

Feminine care pads can be packed in cardboard boxes either with or without single plastic wrapping or in PE-bags. The plastic wrapping of those products wrapped individually can then also be used to hygienically wrap the used product for disposal. For transportation from the manufacturing site to the location of retail, the boxes for retail are placed in large boxes on palettes, wrapped with stretch film (PE).

Stakeholders are kindly invited to revise the information provided and to indicate the industrial initiatives related to the design, manufacture and packaging of the products which can lead to an effective and environmentally sustainable innovation of product/technology (e.g. avoidance of hazardous or needless chemical substances, selection of the most appropriate raw materials and packaging solutions).

Manufacture of tampons

The main materials used for the production of tampons are cellulose, viscose (rayon) or cotton. Two types of tampons are currently manufactured:

Coiled tampons – A removal cord is looped around a rectangular fibre pad. A cylindrical shape comes from compressing an asymmetrically folded and rolled fibre pad. The compression creates helical grooves and the tampon expands radially.

Tampons with applicator – They also begin with a fibre pad of rectangular shape. The pad is compressed into a cylindrical shape into which a removal cord has been sewn lengthwise. The cord for withdrawal may also be connected post-compression through a pierce and loop attachment at the bottom of the tampon.[63] The applicator can be made of plastic materials or siliconised paper.

Packaging

Tampons are individually wrapped in PE foil. Multiple products are packed in a cardboard box. As for the other sanitary products, the single cardboard boxes for retails are packed in large boxes after production and wrapped in PE stretch film after being stacked on pallets.

Stakeholders are kindly invited to revise the information provided and to indicate the industrial initiatives related to the design, manufacture and packaging of the products which can lead to an effective and environmentally sustainable innovation of product/technology (e.g. avoidance of hazardous or needless chemical substances, selection of the most appropriate raw materials and packaging solutions).

Manufacture of breast pads

Production of breast pads is similar to the manufacture of other multi-layered sanitary products, such as diapers. Breast pads are usually produced from a fully automated manufacturing line. After fiberisation of fluff pulp, SAP is added to form the absorbent core of the product. The absorbent cores are then laminated with the respective nonwoven materials, foils or tissues. The products are finally shaped and packaged.

Packaging

Breast pads are either packaged as single products or as a bulk in cardboard boxes. Boxes of products are again packed in larger cardboard boxes, put on palettes and wrapped with stretch film (PE) before being transported from the manufacturer to the retailer.

The pieces of information provided within this paragraph are generic due to a lack of more specific information. Stakeholders are kindly invited to revise, and possibly complement, the information provided and to indicate the industrial initiatives related to the design, manufacture and packaging of the products which can lead to an effective and environmentally sustainable innovation of product/technology (e.g. avoidance of hazardous or needless chemical

substances, selection of the most appropriate raw materials and packaging solutions). Indication of companies producing breast pads and potentially interested in the EU Ecolabel would be even welcome.

Description of raw materials used in the production of sanitary products

Fluff pulp

Cellulose is the raw material used for the production of fluff pulp. Cellulose usually comes from natural fibres, usually wood. Wood is made of cellulose (40-55%), hemi-cellulose (8-30%), lignin (20-30%) and other compounds which includes waxes, resins, lipids and proteins (i.e. the “extractives”, 1.5-5%).[63] Cellulose, a natural polymer, must be extracted from wood or other natural fibres. This is usually done through the chemical pulping process. The most widespread methods in Europe seem the sulphate or Kraft process and the sulphite process.

Chemical pulp requires the wood chips as input. Lignin is removed in a digester through application of heat and chemicals. Tree bark and recovered lignin can be fed into wood mills or used as an energy source. The remaining "fluff pulp" is bleached and diluted, and packaged and transported via truck, ship or rail to the customer.

CTMP (Chemi-Thermo-Mechanical pulp) can also be used instead of fluff pulp. In this case, wood chips are pre-treated with chemicals before lignin is mechanically removed. The conditions of the chemical pre-treatment are much less vigorous (lower temperature, shorter time, less extreme pH) than in the previous process. The entire process is almost completely energy-independent because the by-products of the pulping process are used to produce energy, which is consumed within the production facility and/or sold as a surplus.

For the manufacturing of sanitary products, only the use of primary fluff pulp is allowed. No recycled material is used for safety issues since the sources of recycled material might be not completely traceable and the presence of potentially harmfully substances might thus be not ruled out.

Pulps can be produced from different processes (e.g. Mechanical pulp; Thermomechanical pulp; Chemi-thermo-mechanical pulp; Chemical pulp; Recycled pulp; Organosolvl pulping) which can use several materials of natural origin (e.g. wood chips, field crop fibre, agricultural residues).

With respect to the pulp used for the manufacture of sanitary products, it would be much appreciated to receive feedback from stakeholders on the following questions:

1. In which sense do the properties of the pulp differ from those used in other applications (e.g. paper or viscose production)? Is the bleaching process in particular necessary?

2a. Which are the most relevant technologies currently applied in Europe and worldwide? Which trends and innovations can be expected?

2b. Is information available on the market diffusion of these technologies?

2c. Which parameters should be ruled within the EU Ecolabel and how (e.g. energy and chemical consumption, AOX emission)?

3a. Which are the most relevant materials used in Europe and worldwide? Which trends and innovations can be expected?

3b. Is information available on the market diffusion of these materials?

3c. Which parameters should be ruled within the EU Ecolabel and how (e.g. sustainable sourcing of wood and other natural fibres)?

Superabsorbent polymers

Superabsorbent polymers (SAP) are polymers that can absorb and retain extremely large amounts of a liquid. These are commonly made of sodium polyacrylates in cross-linked, grain form and can be found in personal care products such as children's diapers, incontinence products and feminine hygiene products.[63] A significant technical improvement was registered in the 1980s when it became possible to incorporate SAP into the absorbent pulp core of diaper and incontinence products.[63] Other uses for SAP currently on the market are food packaging, cable wrapping, sealing components and agricultural products.

Combined with fluff pulp in the product core, SAP has the ability to absorb the fluids excreted by the human body and to store them away from the skin, thus reducing the risk of infections and irritations. The ratio of fluff pulp to SAP in the absorbent core is variable and it depends on the product. Children's diapers usually contain more SAP than incontinence products on a percentage basis. Microbiological evaluation of

breathable children's diapers has shown that SAPs can hinder the growth of Candida albicans, which causes infections and dermatitis. SAP can absorb liquids 500 times its weight (from 30–60 times its own volume), but the absorbency drops significantly with saline solutions.[57] The gel which is formed when the polymers come into contact with the fluid from the human body successfully stores the fluid even under pressure generated by the user.[65]

With respect to the SAPs used for the manufacture of sanitary products, it would be much appreciated to receive feedback from stakeholders on the following questions:

1a. Which are the SAPs currently applied in Europe and worldwide? Which trends can be expected?

1b. Is information available on the market diffusion of SAPs?

1c. Which parameters should be ruled within the EU Ecolabel and how (e.g. sustainable production, energy demand, material properties)?

Polymers and plastic materials

Polymers present in sanitary products usually include SAP (see above), Polyethylene (PE), Polypropylene (PP) and sometimes polyethylene terephtalate (PET). Polyurethane (PU) can be also present in the elastics. These materials are crude-oil derived and non-compostable. If products are incinerated with energy recovery at the end-of-life, they contribute significantly to the calorific values of the waste fraction since heat values of plastic materials and crude oil are close (i.e. about 40 MJ/kg)[67]. However, their biological persistence does not allow the composting of sanitary products.

In order to make sanitary products more easily compostable, plastics produced from renewable sources (for example Polylactic acid) can be used. Previously, such polymers have been used for the production of plastic films in packaging applications and for the disposal of organic waste disposal. The currently used plastic materials are polyolefin based resins, which are three times less expensive than resins derived from polymers of renewable sources. This limits the current utilisation of compostable films in personal care products.[63]

For SAP, sourcing from renewable materials is also already possible. The company ADM (Archer Daniels Midland Company) in Illinois, USA, for example, produces a starch-based SAP called BioSAP™ [68]. They claim that their product is biodegradable, hypoallergenic, non-toxic and safe.

Another important point of discussion besides higher costs of bio-based materials is the fact that the complete environmental lifecycle performance of materials should be taken into account and compared to conventional, petroleum-based plastics. There are clear environmental advantages of polymers made from renewable materials such as saving resources and biological degradation at the end-of-life, but in order to gain a holistic understanding of the environmental performance of materials, life cycle thinking has to be applied. If a bio-based polymer comes along with a much higher energy use during production it has to be thoroughly evaluated which might be the most environmentally beneficial solution.

With respect to the plastic materials used for the manufacture of sanitary products, it would be much appreciated to receive feedback from stakeholders on the following questions:

1a. Which are the plastics currently applied in Europe and worldwide? For which products and components? Which trends can be expected?

1b. Is information available on the market diffusion of plastic materials?

1c. Which parameters should be ruled within the EU Ecolabel and how (e.g. sustainable production, energy demand, material properties, use of renewable/recycled materials)?

Viscose and cotton

Rayon (also called viscose) is the main component of tampons. It is comfortable and versatile and derived from natural cellulose contained in wood pulp.[65] Purified cellulose must be chemically converted to produce rayon. The solution is then mixed into a solution of caustic soda and gaseous carbon disulphide (CS_2) to swell and to produce a block copolymer of cellulose and cellulose xanthate.[69] The high viscosity of this copolymer suspension is the reason for the name “viscose”. After coagulation in an acid bath the solution passes through a spinneret which results in soft filaments to be converted and regenerated into a cellulose yarn. During the dissolving and coagulation process, several parameters can affect the physical properties of the viscose, such as

colour and fibre length or thickness. The resulting fibres are bleached through the Elemental Chlorine Free (ECF) method, which removes lignin using chlorine dioxide, or through the Totally Chlorine Free (TCF) method, where peroxy acetic acid is converted to biologically degradable acetic acid.

Rayon can be considered a regenerated cellulose fibre, due to the reconversion of cellulose from the solution. Zinc emissions to water and hydrogen sulphide emissions to air are two of the major emissions from rayon production. Possible methods of emission reduction include zinc recovering through ion-exchange, crystallisation and use of higher purity cellulose. Absorption and chemical scrubbing are also used in order to reduce emissions to the air.

Cotton is a soft fibre produced from plants which are native of the world's tropical and subtropical regions.[65] Seeds, wax and protein must be removed from cotton fibre, which is almost pure cellulose. Less than 10% of the weight of cotton is lost in production. Tampons' absorbent core consists of short cotton comber or cotton linters. The fibres of cotton in the absorbent core are also bleached via ECF or TCF methods.

With respect to the fibres used for the manufacture of sanitary products, it would be much appreciated to receive feedback from stakeholders on the following questions:

1a. Which are the fibres currently applied in Europe and worldwide? For which products and components? Which trends can be expected?

1b. Is information available on the market diffusion of fibres?

1c. Which parameters should be ruled within the EU Ecolabel and how (e.g. sustainable production, energy demand and emissions to water and air, material properties, use of renewable/recycled materials)?

Technological alternatives and related trends

Stakeholders are kindly invited to revise, and possibly complement, the information provided in this section and to indicate:

1. Technological alternatives of relevance already in the market;

2. Industrial initiatives of interest which could lead to an effective and environmentally sustainable innovation of products and technologies;

3. Expected trends for the future years.

5.3 The end-of-life of sanitary products

Possible disposal methods for children's diapers and other incontinence products include disposal in landfill, incineration, composting and mechanical-biological treatment (MBT).[63] Diapers can be compressed and contained in a landfill, as well as incinerated. Composting is possible if a system is in place to separate the cellulose-made sections, which are biodegradable, from the synthetic parts.

Children's diapers comprise about 2% of Europe's municipal solid waste (MSW), which is between 8 and 15% of the entire continent's waste, by current estimates.[63]

Landfill is often the easiest and cheapest method of waste disposal. Since diapers and incontinence products can be compressed, they have the same properties of other MSW, without creating excessive risks for environment and safety.[63]

It is possible to incinerate diapers and incontinence products, with or without energy recovery.[65] The emissions resulting from the incineration of diapers and incontinence products are not more toxic or harmful than other MSW. Rather, diapers are made with high quality materials and can enhance the overall ash quality by reducing the load of heavy metals, which ordinarily occurs within average MSW. When incinerated, diapers produce ash that is less than 10 % by weight. In contrast, MSW produces ash that can even be 25 % or more by weight. Hygiene products reduce the weight to volume ratio by 90 % through incineration.[63]

Biological treatment is another possible method of disposal of the organic waste and of the plastic parts which cannot be recycled.[65] The two types of biological treatment are: aerobic digestion for the production of compost and anaerobic digestion for the production of bio-gas. Both processes stabilise the residual waste and decrease its volume before the final landfilling as well as allowing for the production of valuable products.[65]

Mechanical biological treatment (MBT) is a pre-treatment method of disposal in which the waste is first sorted mechanically, and then treated biologically.[65] After sorting, the organic material is composted or digested anaerobically. The non-organic part is landfilled or incinerated. For disposable diapers, the pulp and human waste, which are biodegradable, can be separated from the inert plastic parts, which can be landfilled or incinerated.

Although recycling could theoretically appear the best option from an environmental perspective, it should be considered that this process needs energy and material resources and creates waste streams.[65] Recycle of disposable diapers and incontinence products is very difficult and unlikely at the state-of-art. The main concern of recycling is its economic feasibility.

Knowaste is a company in the UK which is specialised in the development of technologies for recycling “absorbent hygiene products (AHP)”. This is made through an extensive research effort aimed at separating the materials contained in the AHP and at recycling the plastic and paper components. The company opened a treatment facility in 2011 to recycle 36,000 tonnes of material. It is claimed that up to 70% of CO_2-equivalent emissions were saved through Knowaste’s methods, compared to regular landfill and incineration methods. More information can be found on their website: www.knowaste.com.

As another example for innovative approaches, EarthBaby is a US-based service dedicated to composting children's diapers. Instead of taking up space in landfills, over 10,000 pounds of waste from children's diapers in the San Francisco Bay Area goes to compost and is converted to soil fertilizer. More information can be found on their website: http://www.earth-baby.com/home.php.

Although end-of-life is a crucial point in the environmental performance of single-use sanitary products, no environmentally friendly and technically feasible solution seems to be effectively promotable, apart from diverting waste from landfill.

However, one of the product parameters which strongly influences the amount of waste produced is the performance of the products. If the performance of sanitary products is optimised, less sanitary products will need to be used and the amount of waste produced can be reduced. As an example, incontinence products exist in a wide variety of shapes and sizes. If a product does not fit correctly, it potentially has to be changed more often. If the right product is chosen, the amount of diaper changes can be minimised. This is not only more sustainable in terms of environmental aspects, but also regarding ethical or social aspects, as for incontinence patients, the physically and also psychologically uncomfortable process of diaper changes can be minimised.

Stakeholders are kindly invited to revise, and possibly complement, the information described in this section and to provide:

1. Further information on the options currently available for the final disposal of sanitary products (in particular with respect to the recycling and use of recycled materials);

2. Expected trends for the future years and options which are considered worthy of promotion within the EU Ecolabel;

3. Further examples of initiatives which could lead to an effective and more environmentally friendly disposal of sanitary products.

5.4 Life cycle assessment of sanitary products

Introduction

Life cycle assessment (LCA) is a tool conventionally used to estimate the environmental impacts of a product. The methodology is defined in the standard ISO EN 14044.[70]

Sanitary products within the scope of the EU Ecolabel have been subject of LCA studies for many years. The product that was the first, and until today is also still the most often, analysed product in LCA studies were children's diapers. After the introduction of disposable diapers, consumers of children's diapers started to wonder about the most environmentally friendly choice between the available diaper systems (single-use vs. reusable). On the one side, the benefits of disposable products regarding handling and use clearly outmatch reusable products, but at the same time they consume more material resources and produce more waste. A clear and quantitative comparison regarding environmental impacts of both the systems was thus desired.

Overview of published LCA studies

Already in the late eighties and the nineties of the 20th century, first LCA studies on diapers were published, either comparative (e.g. comparing disposable and reusable systems) or just assessing the environmental impacts of one specific product

group.[71],[72],[73],[74] It became clear quite quickly that it is not trivial to assign higher or lower environmental impacts to a diaper system, but that rather a trade-off occurs.

Lentz et al. (1989) compared cotton and disposable diapers in an early LCA.[71] They concluded that none of the solutions is environmentally clearly superior to another regarding all environmental impacts analysed. The two product systems cause indeed different environmental impacts. Due to high amounts of laundry, more water is used in the reusable product system compared to the disposable system, where more waste is produced. Similar results were obtained in the study of Fava and Curran (1990).[72] Here, disposable and reusable diaper systems were compared concluding that both diaper systems come along with environmental impacts. While the use of water is significantly higher in the reusable diaper system, more waste is being produced and more raw materials are needed for production in the disposable system.

After 2000, with increasing awareness of environmental implications coming along with the consumption of consumer goods and of resource depletion, more and more studies were carried out and also a wider range of product groups was considered. In 2005 and, as last revised version, in 2008, the UK Environment Agency published a study in which they compared three diaper systems: disposable, home-laundered cloth diapers and commercially laundered cloth diapers delivered to the homes of consumers.[75],[76] The environmental impacts for all three diaper types analysed were associated to an average wearing time of diapers of two and a half years for one child. As impact assessment methodology, CML 2001 was used. They highlight that the production of disposable diapers has a greater environmental impact than their waste management that was modeled as landfilling. For the reusable systems, they showed that results strongly depend on the method of laundering. Their baseline scenario was based on average values regarding washing temperatures, loads and drier use and the Global Warming Potential (GWP) resulted about 4% higher than in the disposable system. Washing diapers at fuller loads while at the same eliminating dryer use, switching to line-drying and reusing the nappy system at a second child decreases the environmental impacts to 45% of the impacts associated to the disposable system. If consumer behavior changes in a way that washing temperatures are increased to 90°C and laundry is always tumble dried, the GWP is around 80% higher compared to disposable systems. Therefore, also in this study, no clear environmental preferences can be seen for any of the product systems.

In 2006, the Royal Institute of Technology Stockholm conducted a comparative LCA of the feminine care products feminine care pads vs. tampons.[77] A lack of quantitative

data related to the tampon production was found in this LCA. Only raw materials consumption, waste generation during production and waste treatment after use were considered in the study. Therefore, only impacts from pads and tampons assemblies were considered (i.e. from extraction, processing and supply of raw materials). Eco-indicator 99 was the impact assessment method selected for the study. Impact categories related to human health, ecosystem quality and resources were this assessed. The following environmental impacts resulted more relevant: climate change, ozone layer depletion, ecotoxicity, acidification, eutrophication, land use and use of fossil fuels and minerals. Main findings were that the most relevant environmental impacts in the pads are caused by the production of the LDPE foil. A comparison between the raw materials used for tampons and pad productions indicated that tampons are environmentally favorable within most of the impact categories. This is due to the different product compositions: tampons present a higher content of renewable raw materials (e.g. cotton) while petrochemical based materials (e.g. polyethylene) are used within pads. However, acidification and eutrophication potential due to over-fertilising is associated with cotton cultivation. As a consequence, the impacts due to respiratory inorganics and land use result higher for tampons than pads.

In order to address regional aspects of laundering diapers in dry regions, reusable and disposable diapers were compared in Australia by the University of Brisbane (2009).[78] In the study, similar to the study from the UK Environment Agency, disposable diapers were compared to home-washed and commercially washed reusable diapers over a use stage of 2.5 years for one child. As impact indicators, the authors quantified water resource depletion, energy consumption, solid waste and land area for resource production. As main results, they found that for disposable nappies, over 90% of water and energy consumption and land use can be attributed to the production stage. Reusable home-washed nappies are environmentally dominated by their resource production as well as washing, while transportation from users to the washing facility also becomes an important factor for commercially laundered diapers. The authors of the study emphasised that results of the comparison greatly vary with the use patterns of the different products (wearing time, nappy mass, lifespan, washing machine).

The international association of nonwovens, EDANA, accompanied the industry sector in the process of dealing with sustainability for a long time. The long list of publications only from the first decade of the millennium shows the high interest and engagement of the association in education and information of consumers regarding single-use sanitary products. In their sustainability reports that are published on a regular basis,

Edana gives information on various aspects of sustainability in forms of information on product components, state-of-the-art of production processes and waste management, options for environmental improvement but also social issues.[63] On behalf of EDANA, the independent German research institute IFEU (Institut für Energie und Umweltforschung, - *Institute for Energy and Environmental Research*) carried out an LCA study on incontinence products in 1994.[79] In this study, average incontinence products from 1995 and 2002 were compared. The introduction of superabsorbent polymer (SAP) within this time-span showed to lead to a significant decrease of raw materials and natural resources. For instance, CO_2 emissions and consumption of fossil energy, have decreased by about 13%.

Similar results were reported in other LCA studies of children's diapers.[63] The use of SAP in the production of children's diapers decreased the average children's diaper weights by about 40% within 17 years. Regarding emissions to air, fossil-based CO_2 decreased by approximately 14% while renewable-based CO_2 emissions decreased by more than 60%. Nevertheless, about one quarter of the environmental parameters analysed showed an increase (e.g. unspecified metals), mainly due to the production of SAP and polypropylene (PP) nonwoven materials. Emissions into water also show favorable effects mainly caused by changes in the bleaching process and reduction in the use of pulp content. About 40% of the parameters measured for emissions into water, for example sulphates (+ 23%), increased as a consequence of the higher use of SAP. However, the Life Cycle Impact Assessment Analysis (LCIA) showed a significant decrease, 15-20%, for all the impact categories analysed (global warming potential, acidification, nutrification potential and photochemical ozone creation potential).

The most recent diaper LCA study was published in 2012 in the International Journal of Life Cycle Assessment by Weisbrod&Hoof.[80] In this cradle-to-grave study, one model of Pampers® diapers produced by Procter and Gamble (P&G) was analyzed in a time series analysis comparing the product design from 2007 to a newer design version from 2010. The functional unit in this study was the number of diapers used in a child´s diapering lifetime. Environmental indicators chosen were nonrenewable energy, global warming potential, respiratory effects from inorganics, total solid waste and cumulative energy demand. As general results they found that the main contribution (63-92%) to the environmental indicators can be assigned to sourcing and production of diaper materials, similarly to other studies. Amongst raw materials, results were particularly influenced by polypropylene and a fossil fuel-derived absorbent gelling material (AGM). The end-of-life of products contributed to the overall results only to a small extent (1-

12%). Furthermore, packaging and transportation showed only small contributions to the overall results. Comparing the two product design options from 2007 and 2010, the newer version showed slight reductions in most of the environmental categories due to a reduction of product weight and, thus, of raw material consumption.

The comparison of the studies, which use different impact assessment methods, shows that, in general, the results obtained with IMPACT 2002+ are comparable with those obtained with other LCIA methods such as Eco-Indicator 99, CML 2000 and TRACI.

Colon et al. should be mentioned among the authors who did not perform a complete LCA but who rather focused on a single aspect, such as the end-of-life of the product. In their paper, they address the compostability of disposable diapers.[81] Thereby, they discuss different treatment options such as 1) mechanical-biological treatment, 2) mechanical separation and recycling, 3) anaerobic digestion with subsequent energy recovery and 4) composting. The authors also point out that harmful effects on human health could be due to SAP, as discussed in other studies mentioned in the paper. However, new SAP raw materials seem to be available today which do not show negative effects on human health. The authors also carried out studies on composting selected material from disposable diapers with organic waste fractions (3% shredded diaper material in 97% organic waste). Parameters analysed were moisture content, organic matter content, pH, electrical conductivity, C/N ratio (ratio of carbon to nitrogen), bulk density, porosity, temperature, amount of pathogens (Salmonella and E. coli the selected indicator organisms), heavy metal content, phytotoxicity and respiration index. Results indicate that all the parameters are quite similar whether or not diapers were fed to the composting plant. The authors relate this to the high content of pure organic material in their experimental set-up (97% of organic material and 3% of materials from diapers). However, this also shows that small amounts of diapers composted together with organic materials should not decrease the quality of the compost with regard to the content of main nutrients and pathogens.

Another document worthy of mentioning is a recently published EPD on a sanitary product which fulfils the PCR for absorbent hygiene products developed by the International EPD System of the Swedish Environmental Management Council.[82] The EPD is valid for a sanitary pad called “Ultra Pad with wings” by Natracare. The product is made out of totally chlorine-free, plastic-free (only compostable materials) substances with fluff pulp from sustainably certified forests. The functional unit is one single product. The environmental impacts declared include: use of material and resources; global warming potential (IPCC 2001), acidification potential (CML 1999),

photochemical oxidants potential (CML 1999) and eutrophication potential (CML 1999). The results show that the largest shares of environmental impacts are caused by the raw materials forming the pad.

Summary

Most of the studies available in literature refer to diaper systems. The LCA studies reviewed show that the main contribution to the environmental impacts is given by the **production and consumption of raw materials**. **Transportation, packaging and end-of-life seem to play a less significant role** in defining the environmental performance of a product. Nevertheless, the impacts due to these elements and to the product manufacture stage should be assessed further and in a coherent way.

In most of the cases **no clear answer can be given regarding the environmental favourability of reusable or disposable diapers**. On the one hand, the impacts due to the life cycle of reusable diapers are mainly associated with the energy and water consumed to clean the product after use. On the other hand, impacts due to disposable diapers are related to raw materials and to the production of solid waste.

While diapers have been subject of LCA studies for many years now, feminine care products were only occasionally the subject of LCA studies. Only one study was found that calculated LCAs for feminine care pads and tampons based on more or less solid data. However, an Environmental Product Declaration for a sanitary pad exists. **LCA studies on breast pads are not available at the moment**. Further investigation is thus necessary in order to depict a more complete picture of the environmental impacts associated with the sanitary products included within the scope of the EU Ecolabel.

LCA case studies, materials and methods

Definition of base case scenarios

Five sanitary products, representative for average products available on the market, have been analysed in the present section: a children's diaper, an incontinence product, a feminine care pad, a tampon and a breast pad.

Functional unit

Different types of functional units have been chosen in the literature for the analysis of sanitary products. Often, a time factor was included in the definition of the functional unit (e.g. the number of diapers worn by a child in a period of 2.5 years). In some other cases, the product performance was assessed considering, for instance, the number of diapers changed.

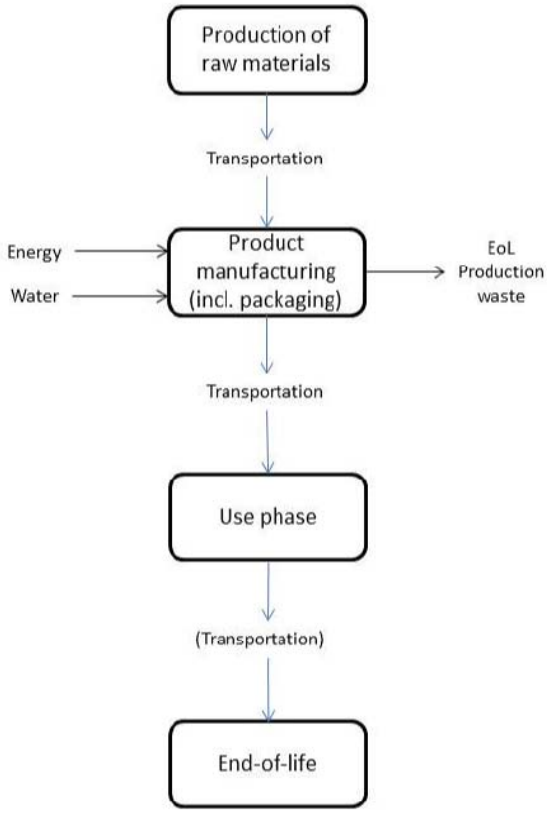
A single unit of product has been selected here as functional unit since the main goal of this LCA study is to identify critical issues associated with the overall life cycle of a product rather than to compare the performance given by alternative product options.

System boundaries

The system boundaries include all life cycle stages and the other parameters which are taken into account in a LCA study. The aim is to include within the model all the processes and all the material and energy flows which are significant, without neglecting any potential factor of relevance.

The goal of the LCA study carried out within the scope of this report is to assess the "cradle-to-grave" environmental performance of typical, “average” sanitary products. Data used for the calculations were supposed to be representative for the European market. Picture 18 schematically shows the system boundaries considered in the studies. The models include all the upstream processes which lead to the production and supply of the materials used in the manufacture of sanitary products. Consumption of electrical and thermal energy as well as of water was even considered at the manufacture stage. Wastes and emissions during production are even included. After the use phase, which includes transportation from the manufacturer to the consumer, products are discarded and the waste is disposed accordingly.

Picture 18: System boundaries considered for the sanitary products included within the scope of the study



Data sources

Different sources were used in order to find material and energy data for the products within the scope of the project. The abundance and the quality of the information available in the literature vary greatly. For children's diapers, for example, a relatively large number of publications are available. In contrast, the situation is different for feminine care products, such as feminine care pads and tampons, as well as for breast pads.

Data on the weight of sanitary products used to build the LCA models differ slightly from market analysis data (see Table 11). Data for the market analysis was obtained via email from EDANA and this should be slightly more update than the data used for the LCA models, which stems from various EDANA Sustainability Reports. This slight inconsistence will be fixed when revising and validating the LCA models before the completion of the technical analysis.

LCI background data was taken from the GaBi databases 2011[83]. The models were generated and analysed using the LCA software GaBi 5.

General comments on LCA data applicable to all products

Production Wastes:

In order to take into account that a certain amount of production wastes usually occur in manufacturing sites, an average production waste rate of 4% was estimated in all cases. The production wastes were treated as municipal solid waste. Disposal and waste treatment was modelled as for the end-of-life of products: 22.5% incineration with energy recovery, 14.1% incineration without energy recovery, 63.4% landfill (see below for further explanations). For packaging materials, production wastes were not taken into account because they are produced in negligible amounts.

Transportation:

For raw materials procurement, it was generally estimated an average transportation distance of 100 km by truck (Euro 3, 27.4 t payload capacity). For transportation of the final products from the factory gate to the customer, it was assumed a transportation distances of 1000 km by truck (Euro 3, 27.4 t payload capacity). These estimations are derived from the LCA study carried out by the UK environmental agency in 2005 (and updated in 2008), in which disposable and reusable nappies in the UK were compared. In this study, a transportation distance of 1000 km by ship was even considered for all raw materials. In the current report, transportation by ship was taken into account only for fluff pulp, which is potentially produced overseas. For all the other materials, it is expected that transportation can generally take place via trucks due to wider availability of the resource However, according to the UK and to other studies, transportation is expected to have only a small effect on the overall LCA results.

End-of-life of used products

As described above, the following disposal scenario was considered for all the products: 22.5% incineration with energy recovery; 14.1% incineration without energy recovery and 63.4% landfill. Basic data for these calculations are derived from CEWEP, the Confederation of European Waste-to-Energy Plants (http://www.cewep.eu/index.html). EU27 average data were used. For municipal waste

treatment, it is reported that 38% of the waste is landfilled, 22% incinerated and 40% recycled and composted. Since recycling and composting do not seem a common disposal practice for the sanitary products, shares were re-calculated without taking into account for recycled and composted fraction. Within the incinerated waste, it was estimated that about 1/3 of the European waste-to-energy plants in Europe have no technical possibility to recover energy, while about 2/3 are state-of-the-art waste-to-energy co-generation plants (generating steam and electricity).

Stakeholders are kindly invited to revise and complete the information reported above. Indications are also welcome which can be used to gather information on:

- **Statistical variation of the input parameters for the model;**
- **More critical parameters worthy of consideration in a sensitivity analysis;**
- **Alternative options of significance for the analysis and future trends.**

Impact assessment method

For the impact assessment the following impact categories have been preliminarily selected:

- CML2001 - Nov. 2010, Eutrophication Potential (EP) [kg Phosphat-Eqv.]
- CML2001 - Nov. 2010, Photochemical Ozone Creation Potential. (POCP) [kg Ethen-Eqv.]
- CML2001 - Nov. 2010, Global Warming Potential (GWP 100 years) [kg CO2-Eqv.]
- CML2001 - Nov. 2010, Acidification Potential (AP) [kg SO2-Eqv.]

Additionally:

- Primary Energy Demand from non-renewable and renewable resources (lower heating value) [MJ]

CML (status 2001) is a stable well established impact assessment methodology which is widely used in science and in industry. This is for instance used by PE as standard reference in many LCA projects which have been reviewed by independent experts.

The impact categories preliminarily selected for this project are those that are considered more relevant for the products under consideration. Additionally, primary energy demand is also taken into account, although this could not be properly considered an environmental impact category. However, information on the overall

primary energy consumption is an important parameter of evaluation in account for the depletion of energy resources.

Attention is in particular paid to GWP and to primary energy demand due to the public discussion and the common concern on these environmental issues.

Children's Diapers

Materials used for the production of one average children's diaper

As described already in the literature section, several LCA studies on children's diapers are available. Product composition data of children's diapers were taken from the EDANA Sustainability report 2011, where a universal description of the product is provided which can be considered the state-of-the-art for the European market.[17] Table 18 reports the average composition for a children's diaper in 2011 (total weight of 41.1 g).

Table 18: Composition of an average children's diaper (reference year 2011)[17]

Raw Material	***Weight [g]***	***Production waste [g]***	***Dataset from GaBi databases 2011***[83]
Fluff pulp	15.0	0.60	Cellulose
Superabsorber (SAP)	12.6	0.50	SAP
Polyethylene, low density (LDPE)	2.5	0.10	LD-PE film
Polypropylene (PP)	6.6	0.26	PP Fleece
Adhesive	1.2	0.05	Adhesives
Elastics	0.2	0.01	PU Elastics
Other materials - Tape - Elastic back ear - Frontal tape - Various synthetic polymers	3.0 (0.5) (1.3) (0.6) (0.6)	0.12 (0.02) (0.05) (0.02) (0.02)	
Total	41.1	1.58	

Production of children's diapers

The manufacturing of disposable diapers usually is a continuous automated process. Average data on energy and water use, on the consumption of auxiliary materials (e.g. lubricants) and packaging and on the emission of dust in the process were derived from manufacturers. Water was assumed to fully evaporate and leave the system as water vapour.

Table 19 shows the LCA data considered in the model of the production process. Wastes from the production of packaging materials were not taken into account due to very small and therefore negligible amounts per final product sold.

Table 19:Data considered for modelling the production of an average children's diaper (packaging, energy & water use, auxiliary materials consumption and emissions)

Packaging	***Data***	***Dataset from GaBi databases 2011***[83]
Polyethylene bag [g]	0.51	LD-PE film
Cardboard box [g]	4.00	Corrugated cardboard
Polypropylene tape [g]	0.03	PP tape
Wooden pallet [g]	0.23	Wooden pallet (40%moisture content)
Polyethylene stretch wrap [g]	0.51	LD-PE film
Energy data	***Data***	***Dataset from GaBi databases 2011***[83]
Electrical energy [MJ]	0.21	EU-27 grid mix
Thermal energy [MJ]	0.02	EU-27 thermal energy from natural gas
Auxiliary materials	***Data***	***Dataset from GaBi databases 2011***[83]
Lubricants [g]	$3.8 \cdot 10^{-3}$	Lubricants
Solvents/Ink [g]	$5.8 \cdot 10^{-3}$	Solvent mix
Other data	***Data***	***Dataset from GaBi databases 2011***[83]
Water use [L]	0.002	Deionised water
Dust emissions [g]	$3.5 \cdot 10^{-4}$	Dust (> PM 10)

Stakeholders are kindly invited to revise and complete the information included in tables 18-19. Indications are also welcome which can be used to gather information on:

- **Statistical variation of the input parameters for the model;**
- **More critical parameters worthy of consideration in a sensitivity analysis;**
- **Alternative options of significance for the base case scenario and future trends.**

Incontinence products

Materials used for the production of one average incontinence product

The definition of the composition of incontinence products was even based on the EDANA's sustainability reports, given that these products are technically comparable to children's diapers. Information on the average product composition is given in the EDANA Sustainability Report on Absorbent Hygiene Products from 2007-2008 (see

Table 20, reference year 2006). In contrast to children's diapers, a much wider range of sizes and absorption capacities has to be covered for incontinence product. For this report, an average product weight of 100.4 g was chosen.

Table 20: Composition of an average incontinence product (reference year 2006). Data taken from EDANA Sustainability Report on Absorbent Hygiene Products from 2007-2008)

Raw Material	***Weight [g]***	***Production waste [g]***	***Dataset from GaBi databases (2011)***[83]
Fluff pulp	62.0	2.48	Cellulose
Superabsorber (SAP)	12.0	0.48	SAP
Polyethylene, low density (LDPE)	10.0	0.40	LD-PE film
Polypropylene (PP)	10.0	0.40	PP Fleece
Adhesive	3.0	0.12	Adhesives
Elastics	0.4	0.02	PU Elastics
Other materials	3.0	0.12	
Total	100.4	4.02	

Production of incontinence products

Similar to children's diapers, the production of incontinence products is fully automated, optimised and continuous. Also in this case, data on energy and water consumption, on

packaging and auxiliaries use and on process emissions were modelled according to information provided by the manufacturers. Data used in the LCA modelling are summarised in Table 21.

Table 21: Data considered for modelling the production of an average incontinence product (packaging, energy & water use, auxiliary materials consumption and emissions)

Packaging	***Data***	***Dataset from GaBi databases (2011)***[83]
Polyethylene bag [g]	1.24	LD-PE film
Cardboard box [g]	9.72	Corrugated cardboard
Polypropylene tape [g]	0.06	PP tape
Wooden pallet [g]	0.56	Wooden pallet (40% water content)
Polyethylene stretch wrap [g]	0.13	LD-PE film
Energy data	***Data***	***Dataset from GaBi databases (2011)***[83]
Electrical energy [MJ]	0.52	EU-27 grid mix
Thermal energy [MJ]	0.05	EU-27 thermal energy from natural gas
Auxiliary materials	***Data***	***Dataset from GaBi databases (2011)***[83]
Lubricants [g]	9.2·10-3	Lubricants
Solvents/Ink [g]	1.4·10-2	Solvent mix
Other data	***Data***	***Dataset from GaBi databases (2011)***[83]
Water use [L]	0.006	Deionised water
Dust emissions [g]	8.5·10-4	Dust (> PM 10)

Stakeholders are kindly invited to revise and complete the information included in tables 20-21. Indications are also welcome which can be used to gather information on:

- **Statistical variation of the input parameters for the model;**
- **More critical parameters worthy of consideration in a sensitivity analysis;**
- **Alternative options of significance for the base case scenario and future trends.**

Feminine care pads

Materials used for the production of one average feminine care pad

As for children's diapers and incontinence products, data for the modelling of an average feminine care pad were taken from the EDANA Sustainability Report on Absorbent Hygiene Products from 2007-2008.[63] Also in this case, product sizes and designs can vary slightly depending on the required product performance. Table 22 reports the composition of an average product weighting 8.6 g.

Table 22: Composition of an average feminine care pad (reference year 2006)

Raw Material	***Weight [g]***	***Production waste [g]***	***Dataset from GaBi databases (2011)***[83]
Fluff pulp	5.68	0.23	Cellulose
Superabsorber (SAP)	0.26	0.01	SAP
Polyethylene, low density (LDPE)	0.63	0.03	LD-PE film
Polypropylene (PP)	0.63	0.03	PP Fleece
Polyethyleneterephtalate(PET)	0.63	0.03	PET film
Adhesive	0.41	0.02	Adhesives
Release paper	0.31	0.01	Siliconated Kraftliner
Total	8.55	0.36	

Production of a typical feminine care pad

Feminine care products and diapers have similar design and composition and are also produced with similar equipment. Modelling data for the manufacture stage (energy and water consumption, packaging and auxiliaries use and process emissions) were derived from manufacturers and are shown in Table 23. Similar to children's diapers and incontinence products, the production of feminine care pads is a fully automated, optimised continuous process.

Table 23: Data considered for modelling the production of an average feminine care pad (packaging, energy & water use, auxiliary materials consumption and emissions)

Packaging	***Data***	***Dataset from GaBi databases (2011)***[83]
Polyethylene bag [g]	0.11	LD-PE film
Cardboard box [g]	0.83	Corrugated cardboard
Polypropylene tape [g]	0.01	PP tape
Wooden pallet [g]	0.05	Wooden pallet (40% water content)
Polyethylene stretch wrap [g]	0.01	LD-PE film
Energy data	***Data***	***Dataset from GaBi databases (2011)***[83]
Electrical energy [MJ]	0.04	EU-27 grid mix
Thermal energy [MJ]	4.49·10-3	EU-27 thermal energy from natural gas
Auxiliary materials	***Data***	***Dataset from GaBi databases (2011)***[83]
Lubricants [g]	7.9·10-4	Lubricants
Solvents/Ink [g]	1.2·10-3	Solvent mix
Other data	***Data***	***Dataset from GaBi databases (2011)***[83]
Water use [L]	5.0·10-4	Deionised water
Dust emissions [g]	7.2·10-5	Dust (> PM 10)

Stakeholders are kindly invited to revise and complete the information included in tables 22-23. Indications are also welcome which can be used to gather information on:

- **Statistical variation of the input parameters for the model;**
- **More critical parameters worthy of consideration in a sensitivity analysis;**
- **Alternative options of significance for the base case scenario and future trends.**

Tampons

Materials used for the production of a typical tampon

Tampons have not been the subject of extensive LCA-studies so far. Although their purpose is similar to that of diapers or feminine care pads (i.e. absorption of liquids), their composition and manufacturing processes are different.

Tampons can consist of different materials. Often, tampons consist of only one raw material to over 90% of one material. For the tampon LCA in this study, a cellulose tampon with applicator was modelled.

Often, the tampon core is covered in a synthetic nonwoven fleece made, for example, of polypropylene. The string can be made of either cotton or a synthetic material. A cotton string was integrated in the model. However, due to the small mass of the string, the influence of this component on the overall results of the model is considered low.

The packaging of the tampons also differs from that of other sanitary products: the tampon is usually primarily wrapped in an LDPE foil and then packed into paper boxes.

Additionally, some tampons also have an applicator. This applicator often consists of either synthetic materials (e.g. polypropylene) or siliconised paper. To take into account for the environmental impacts of the applicator, a polypropylene applicator was considered within the model.

The composition of a standard tampon is summarised in

Table *24*. A tampon of 3.0 g and an applicator of 2.0 g were considered.[77]

Table 24: Composition of an average tampon with applicator (reference year 2006)

Raw Material	***Weight [g]***	***Production waste [g]***	***Dataset from GaBi databases (2011)***[83]
Primary material (cellulose)	2.69	0.1	Cellulose
Polypropylene PP fleece	0.19	7.3·10-3	PP Fleece
Cotton yarn	0.11	4.4·10-3	Cotton fibre
Polypropylene applicator[1]	2.00	0.08	PP casting part
Total	2.99 + 2.00	0.12 + 0.08	

[1]weight for applicator estimated

Production of a typical tampon

Primary data for tampon production were not available. For the estimation of energy and water consumption it was assumed that tampon production is less intensive than the production of multi-layered diapers or pads. Therefore, it was made the approximation that tampon production requires 70% of the energy needed for the production of other sanitary products. Values estimated for the production of an average tampon can be found in Table 25.

Table 25: Data considered for modelling the production of an average tampon with applicator (packaging, energy & water use, auxiliary materials consumption and emissions)

Packaging	***Data***	***Dataset from GaBi databases (2011)***[83]
Polyethylene wrap [g]	0.14	LD-PE film
Cardboard box [g]	0.93	Corrugated cardboard
Wooden pallet [g]	0.016	Wooden pallet (40%moisture content)
Polyethylene stretch wrap [g]	0.004	LD-PE film
Energy data	***Data***	***Dataset from GaBi databases (2011)***[83]
Electrical energy [MJ]	1.05·10-2	EU-27 grid mix
Thermal energy [MJ]	1.06·10-3	EU-27 thermal energy from natural gas
Auxiliary materials	***Data***	***Dataset from GaBi databases (2011)***[83]
Lubricants [g]	1.86·10-4	Lubricants
Solvents/Ink [g]	2.87·10-4	Solvent mix
Other data	***Data***	***Dataset from GaBi databases (2011)***[83]
Water use [L]	1.7·10-4	Deionised water
Dust emissions [g]	2.44·10-5	Dust (> PM 10)

Stakeholders are kindly invited to revise and complete the information included in tables 24-25. Indications are also welcome which can be used to gather information on:

- **Statistical variation of the input parameters for the model;**
- **More critical parameters worthy of consideration in a sensitivity analysis;**

- **Alternative options of significance for the base case scenario and future trends.**

Breast Pads

Materials used for the production of breast pads

Breast (or nursery) pads are made of materials which are similar to those of the other absorbent sanitary products. The product design is also comparable to that of diaper products or feminine care pads, i.e. a multilayer product consisting of different inner and outer layers. Fluff pulp was assumed as main absorbent material. SAP was also assumed to support the absorbing performance of the product core since the thickness of breast pads is limited due to comfort and optical reasons, The outer layers of the product can be made out of polypropylene PP fleece (skin contact side) and paper (side facing clothing). Table 26 summarises the composition of an average breast pad which is assumed to weigh 4g.

Table 26: Composition of an average breast pad

Raw Material	***Weight [g]***	***Production waste [g]***	***Dataset from GaBi databases (2011)***[83]
Fluff pulp	3.12	0.13	Cellulose
Superabsorber (SAP)	0.76	0.03	SAP
Polypropylene PP fleece	0.04	1.6·10-3	PP fleece
Paper	0.08	3.2·10-3	Siliconated kraftliner
Total	4.00	0.16	

Breast pad production

Due to the comparable multi-layered product composition, products are manufactured with similar, fully automated equipment as the other sanitary products (e.g. diapers and feminine care pads). Due to a lack of primary data on breast production, data regarding energy and water use as well as consumption of other auxiliaries and dust emissions was estimated in accordance with diaper production (see Table 27).

Table 27: Data considered for modelling the production of an average breast pad (packaging, energy & water use, auxiliary materials consumption and emissions)

Packaging	***Data***	***Dataset from GaBi databases (2011)***[83]
Polyethylene bag [g]	0.050	LD-PE film
Cardboard box [g]	0.389	Corrugated cardboard
Polypropylene tape [g]	0.002	PP tape
Wooden pallet [g]	0.022	Wooden pallet (40%moisture content)
Polyethylene stretch wrap [g]	0.005	LD-PE film
Energy data	***Data***	***Dataset from GaBi databases (2011)***[83]
Electrical energy [MJ]	2.09·10-2	EU-27 grid mix
Thermal energy [MJ]	2.10·10-3	EU-27 thermal energy from natural gas
Auxiliary materials	***Data***	***Dataset from GaBi databases (2011)***[83]
Lubricants [g]	3.7·10-4	Lubricants
Solvents/Ink [g]	5.7·10-4	Solvent mix
Other data	***Data***	***Dataset from GaBi databases (2011)***[83]
Water use [L]	2.35·10-4	Deionised water
Dust emissions [g]	3.39·10-5	Dust (> PM 10)

Stakeholders are kindly invited to revise and complete the information included in Tables 26-27. Indications are also welcome which can be used to gather information on:

- **Statistical variation of the input parameters for the model;**
- **More critical parameters worthy of consideration in a sensitivity analysis;**
- **Alternative options of significance for the base case scenario and future trends.**

Preliminary LCA results

Children's diapers

Overall LCA results for children's diapers are reported in Table 28 and in Table 29.

Table 28: Results of impact categories and primary energy for one children's diaper (absolute values)

Impact category	*Raw Materials*	*Transportation*	*Production*	*Packaging*	*Use phase*	*End-of-life*	*Total*
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	9.4E-05	3.6E-07	3. 1E-06	3. 3E-06	3.7E-06	3.4E-05	1.4E-04
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	6.5E-05	-6.1E-07	5.9E-06	2.8E-06	-6.3E-06	5.0E-06	7.2E-05
Global Warming Potential (GWP) [kg CO_2-Eq.]	9.5E-02	2.3E-04	9.7E-03	-7.1E-04	2.3E-03	3.1E-02	1.4E-01
Acidification Potential (AP) [kg SO_2-Eq.]	5.3E-04	1.5E-06	3.5E-05	1.7E-05	1.5E-05	1.0E-05	6.1E-04
Primary Energy Demqand [MJ]	4.6E+00	3.3E-03	1.7E-01	1.4E-01	3.4E-02	8.5E-03	4.9E+00

Table 29: Results of impact categories and primary energy for one children's diaper (relative values)

Impact category	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	68%	0%	2%	2%	3%	25%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	91%	-1%	8%	4%	-9%	7%
Global Warming Potential (GWP) [kg CO_2-Eq.]	69%	0%	7%	-1%	2%	23%
Acidification Potential (AP) [kg SO_2-Eq.]	87%	0%	6%	3%	3%	2%
Primary Energy Demand [MJ]	93%	0%	3%	3%	1%	0%

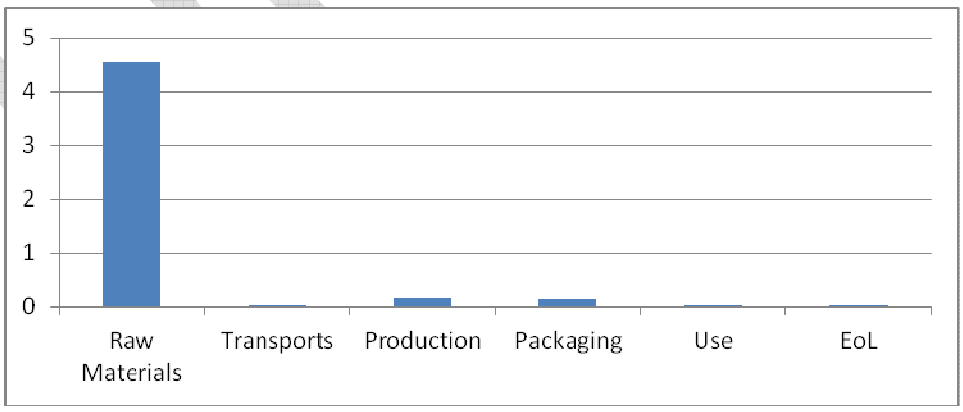
Picture 19 shows the contributions of the single life cycle stages to the global warming potential of a children's diapers. The two main contributions to global warming are given by raw materials and end of life (almost 0.1 and 0.03 kg of $CO_{2,\ eq}$ per single diaper, respectively). The impact from transportation is almost negligible within this category, while negligible benefits could be associated with packaging (-0.0007 kg of CO_2 equivalent), under the assumptions considered in the model. The global warming potential associated with the manufacture stage is about 0.01 kg of CO_2 equivalent (7% of the whole life cycle) and mainly due to electrical and thermal energy (88.2% of the GWP for the production phase) and disposal of production waste (almost the complement to 100%), as reported in Table 30. The impact of the auxiliary inputs, including lubricants, to the manufacture stage production is almost negligible (less than 1% of the production phase).

Picture 19: Global warming potential of a children's diapers, contribution of the single life cycle stages

Picture 20 shows the contributions of the single life cycle stages to the primary energy demand. The highest amount of primary energy is demanded for the production and supply of raw materials (4.6 MJ per single diaper; 93% of the whole life cycle), which again results the main contribute also with respect to this impact category. The manufacture of the single children's diaper requires less than 0.2 MJ of energy, while the total life cycle requires almost 5 MJ.

The primary energy demand associated with the manufacture stage is about 0.17 MJ (3% of the whole life cycle) and mainly due to electrical and thermal energy (99.3% of the manufacture stage), as reported in Table 30. The impact of the other processes is almost negligible (less than 1%).

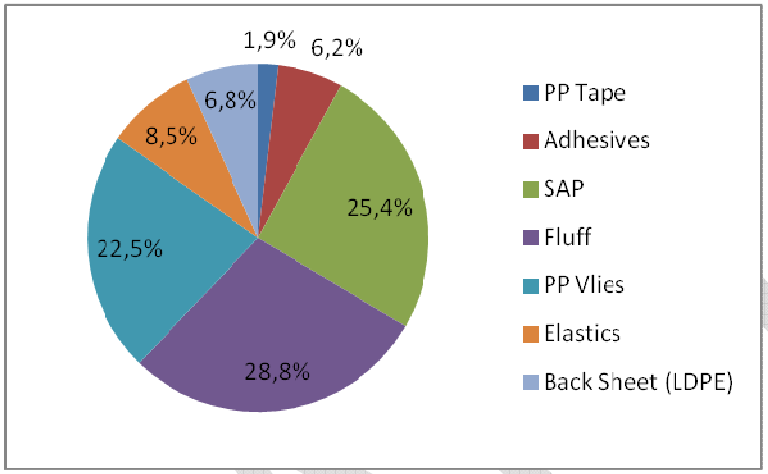
Picture 20: Primary energy demand of the single life cycle stages of a children's diaper



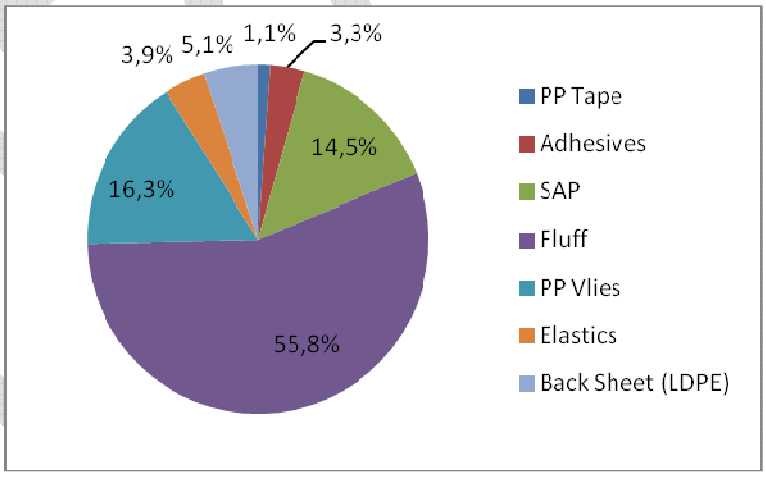
A children's diaper is composed of polypropylene tape, adhesives, superabsorbent polymer, cellulose, PP fleece, elastics and polyethylene foil. Production and supply of

cellulose, superabsorbent polymer and PP fleece are the main contributors to global warming potential at 28.8%, 25.4% and 22.5%, respectively (Picture 21). Cellulose accounts for 55.8% of the primary energy demand. PP fleece and the superabsorbent polymer also contribute significantly to the primary energy demand (Picture 22).

Picture 21: Relative contributions of single raw materials to total global warming potential of all raw materials



Picture 22: Relative contributions of single raw materials to total primary energy demand of all raw materials



As apparent from Table 28, raw materials are the main contributors even for the other impact categories considered in the assessment: 68% of the eutrophication potential, 91% of the photochemical ozone creation potential and 87% of the acidification potential associated with the life cycle of a children's diaper. Within raw materials, the highest impacts are due to cellulose: 82% of the eutrophication potential given by raw

materials, 53% of the photochemical ozone creation potential given by raw materials and 70% of the acidification potential given by raw materials.

Table 30: Relative contributions of individual processes to selected impact categories

	Energy	Water	Auxiliaries	EoL production waste
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	60.9%	0.2%	0.1%	38.8%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	37.0%	0.0%	0.2%	62.7%
Global Warming Potential (GWP) [kg CO_2-Eq.]	88.2%	0.1%	0.2%	11.4%
Acidification Potential (AP) [kg SO_2-Eq.]	98.7%	0.1%	0.2%	1.0%
Primary Energy Demand [MJ]	99.3%	0.1%	0.4%	0.2%

Key inventory results for the cradle-to-grave life cycle assessment of a children's diaper can be found in Table 31 for the complete life cycle and in Table 33 for the raw materials only.

Table 31 Key data for the life cycle inventory of the children's diaper

[kg / functional unit]	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	1.28E-01	1.01E-01	2.18E-04	8.52E-03	5.64E-03	2.26E-03	1.03E-02
CO_2 ren.	3.11E-01	2.92E-01	2.06E-05	1.86E-03	6.71E-03	2.13E-04	9.74E-03
Methane	1.94E-02	7.19E-03	5.90E-06	8.14E-04	2.82E-04	6.12E-05	1.10E-02
N_2O	1.40E-02	1.38E-02	1.95E-06	5.89E-05	5.87E-05	2.02E-05	2.28E-05
NO_2	9.01E-07	7.95E-09	7.84E-08	1.26E-09	4.79E-13	8.13E-07	-7.16E-11
SO_2	2.76E-04	2.33E-04	1.56E-07	2.82E-05	1.13E-05	1.62E-06	1.44E-06
Coal	3.48E-01	2.83E-01	1.45E-05	4.97E-02	1.07E-02	1.50E-04	4.25E-03
Crude oil	1.39E+00	1.29E+00	2.88E-03	8.61E-03	3.41E-02	2.98E-02	2.31E-02
Natural gas	1.18E+00	1.10E+00	2.33E-04	4.26E-02	4.79E-02	2.42E-03	-1.39E-02

Table 32 Key data for the life cycle inventory of the children's diaper (relative values)

	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	100%	8%	4%	11%	75%	0%	2%
CO_2 ren.	100%	-18%	12%	-1%	106%	0%	0%
Methane	100%	63%	2%	6%	29%	0%	0%
N_2O	100%	0%	0%	0%	99%	0%	0%
NO_2	100%	0%	0%	0%	1%	8%	91%
SO_2	100%	0%	3%	13%	83%	0%	0%
Coal	100%	1%	3%	20%	76%	0%	0%
Crude oil	100%	2%	3%	1%	92%	0%	2%
Natural gas	100%	-2%	8%	11%	83%	0%	0%

Table 33: Key inventory data for the raw materials used in the children's diaper.

	Total	PP tape	Adhesive	SAP	Fluff pulp	PP/PE fleece	Elastics	PE foil
CO_2 fossil	100%	2%	5%	22%	39%	19%	7%	6%
CO_2 ren.	100%	0%	0%	0%	99%	1%	0%	0%
Methane	100%	2%	6%	23%	26%	28%	8%	7%
N_2O	100%	0%	0%	1%	95%	1%	3%	0%
NO_2	100%	3%	5%	10%	35%	15%	32%	0%
SO_2	100%	1%	2%	21%	54%	12%	3%	7%
Coal	100%	1%	1%	24%	45%	18%	6%	4%
Crude oil	100%	2%	4%	11%	42%	27%	4%	10%
Natural gas	100%	2%	8%	37%	11%	27%	8%	6%

Incontinence products

The overall LCA results for incontinence products are reported in Table 38 and in Table 35.

Table 34: Results of impact categories and primary energy for one incontinence product (absolute values)

	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life	Total
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	3.4E-04	8.4E-07	7.5E-06	7.8E-06	9.4E-06	8.7E-05	4.5E-04
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	2.0E-04	-1.4E-06	1.4E-05	6.9E-06	-1.6E-05	1.3E-05	2.1E-04
Global Warming Potential (GWP) [kg CO_2-Eq.]	2.1E-01	5.3E-04	2.3E-02	-1.8E-03	6.0E-03	7.9E-02	3.2E-01
Acidification Potential (AP) [kg SO_2-Eq.]	1.8E-03	3.5E-06	8.3E-05	3.8E-05	3.9E-05	2.5E-05	2.0E-03
Primary Energy Demand [MJ]	1.4E+01	7.7E-03	4.0E-01	3.3E-01	8.6E-02	2.2E-02	1.4E+01

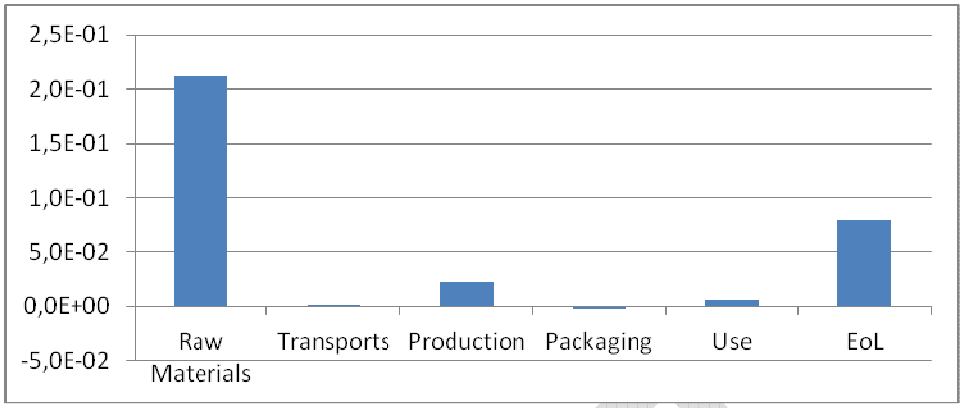
Table 35: Results of impact categories and primary energy for one incontinence product (relative values)

	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	75%	0%	2%	2%	2%	19%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	92%	-1%	7%	3%	-8%	6%
Global Warming Potential (GWP) [kg CO_2-Eq.]	67%	0%	7%	-1%	2%	25%
Acidification Potential (AP) [kg SO_2-Eq.]	90%	0%	4%	2%	2%	1%
Primary Energy Demand [MJ]	94%	0%	3%	2%	1%	0%

Picture 23 shows the contribution of the single life cycle stages to the global warming potential of an incontinence product.

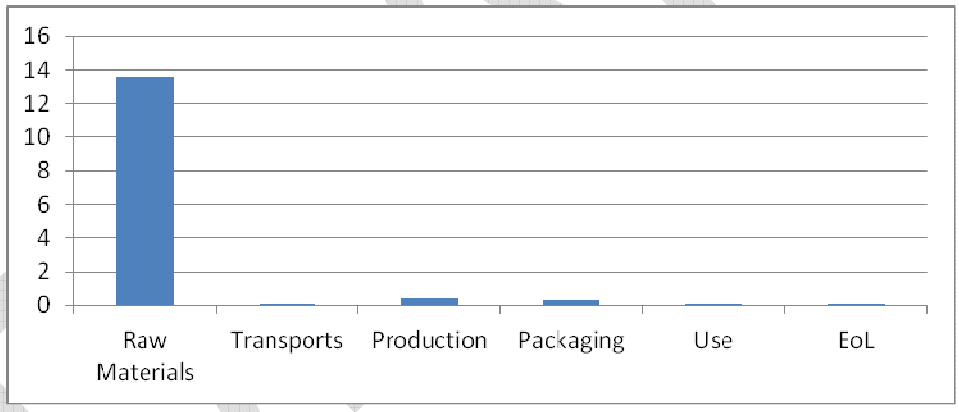
The average incontinence product has a global warming potential of 0.3 kg of CO_2 equivalent per single product (Picture 24). The two main contributions to global warming potential are given by raw materials and by the end of life stage (almost 0.2 and 0.08 kg of $CO_{2,\,eq}$ per single incontinence product, respectively).

Picture 23: Global warming potential of the single life cycle stages of an incontinence product



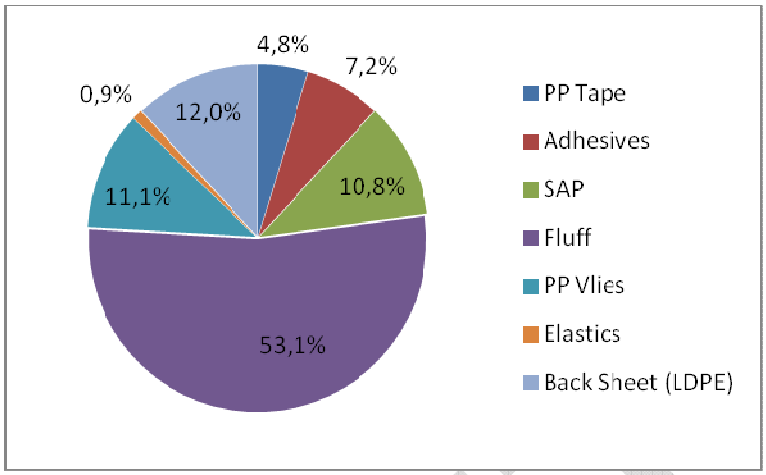
Picture 24 shows the contributions of the single life cycle stages to the primary energy demand. The primary energy demand results in 14.4 MJ for the whole life cycle of an incontinence product (Table 34 and Picture 24). The main contribution comes from raw materials (94% of the whole life cycle).

Picture 24: Primary energy demand of the single life cycle stages of an incontinence product

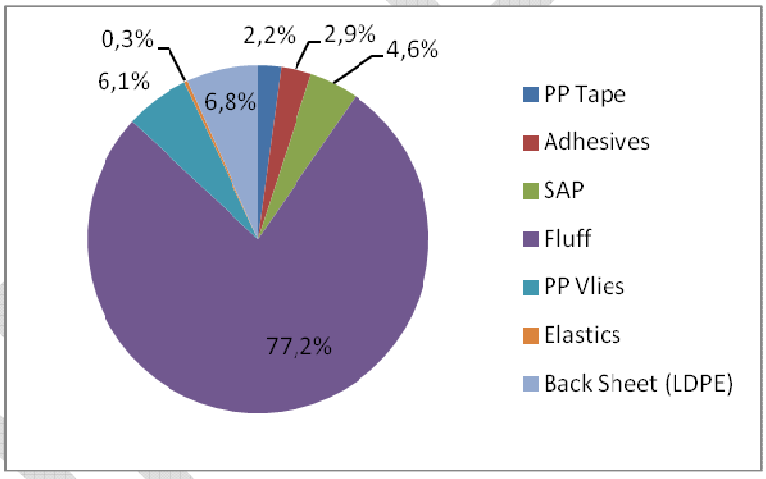


Among the raw materials used in incontinence products (which include polypropylene tape, adhesives, superabsorbent polymers, cellulose fluff pulp, PP fleece, elastics and polyethylene backsheet), the cellulose fluff pulp has the greatest impact on global warming potential (53.1% of the impact given by raw materials). The cellulose fluff pulp also has the highest primary energy demand with 10.5 MJ (77.2%), out of 13.6 MJ for all of the raw materials.

Picture 25: Relative contributions of single raw materials to total global warming potential of all raw materials



Picture 26: Relative contributions of single raw materials to total primary energy demand of all raw materials



Cellulose also contributes the highest impact for eutrophication potential (93.4% of the impact given by raw materials), photochemical ozone creation potential (70.0% of the impact given by raw materials) and acidification potential (86.3% of the impact given by raw materials) in the raw materials stage.

Table 36: Relative contributions of individual processes to selected impact categories

	Energy	Water	Auxiliaries	EoL production waste
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	59.8%	0.2%	0.1%	39.9%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	36.0%	0.0%	0.2%	63.8%
Global Warming Potential (GWP) [kg CO_2-Eq.]	87.8%	0.1%	0.2%	11.9%
Acidification Potential (AP) [kg SO_2-Eq.]	98.7%	0.1%	0.1%	1.1%
Primary Energy Demand [MJ]	99.4%	0.1%	0.3%	0.2%

In the production phase, the energy inputs have the highest impact on global warming potential with a value of 0.02 kg of CO_2 equivalent, which is 87.8% of the total global warming potential coming from the production of the incontinence product. The highest primary energy demand for the production phase also comes from energy use, which is 99.4% of the total 0.401 MJ of energy in the production phase (Table 36).

The end-of-life of the production phase of the incontinence product has a higher impact on the photochemcial ozone creation potential (63.8% of the production phase), while contribution given by energy is only 36.0. 59.8% of the eutrophication potential and 98.7% of the acidification potential are given by the energy demanded in the production phase.

Selected key inventory results for the cradle-to-grave life cycle assessment of an incontinence product are described in detail in Table 37 and in Table 39 for the single (relative) contribution of the raw materials only.

Table 37: Life cycle inventory data for total incontinence product lifecycle

[kg / functional unit]	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	3.21E-01	2.54E-01	5.15E-04	2.00E-02	1.37E-02	5.77E-03	2.64E-02
CO_2 ren.	1.24E+00	1.20E+00	4.86E-05	4.37E-03	1.66E-02	5.45E-04	2.49E-02
Methane	4.67E-02	1.57E-02	1.39E-05	1.95E-03	7.00E-04	1.56E-04	2.82E-02
N_2O	5.52E-02	5.48E-02	4.62E-06	1.38E-04	1.43E-04	5.18E-05	5.82E-05
NO_2	2.28E-06	1.65E-08	1.85E-07	2.94E-09	1.84E-10	2.08E-06	-1.83E-10
SO_2	7.85E-04	6.87E-04	3.69E-07	6.58E-05	2.35E-05	4.14E-06	3.67E-06
Coal	8.82E-01	7.25E-01	3.42E-05	1.16E-01	2.90E-02	3.83E-04	1.09E-02
Crude oil	3.77E+00	3.54E+00	6.80E-03	2.00E-02	6.85E-02	7.62E-02	5.90E-02
Natural gas	2.08E+00	1.88E+00	5.52E-04	1.00E-01	1.24E-01	6.19E-03	-3.55E-02

Table 38: Life cycle inventory data for total incontinence product lifecycle (relative values)

	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	100%	79%	0%	6%	4%	2%	8%
CO_2 ren.	100%	96%	0%	0%	1%	0%	2%
Methane	100%	34%	0%	4%	1%	0%	60%
N_2O	100%	99%	0%	0%	0%	0%	0%
NO_2	100%	1%	8%	0%	0%	91%	0%
SO_2	100%	88%	0%	8%	3%	1%	0%
Coal	100%	82%	0%	13%	3%	0%	1%
Crude oil	100%	94%	0%	1%	2%	2%	2%
Natural gas	100%	91%	0%	5%	6%	0%	-2%

Table 39: Relative life cycle inventory data for incontinence diaper raw materials

	Total	PP tape	Adhesive	SAP	Fluff pulp	PP/PE fleece	Elastics	PE foil
CO_2 fossil	100%	4%	6%	8%	64%	8%	1%	9%
CO_2 ren.	100%	0%	0%	0%	100%	0%	0%	0%
Methane	100%	5%	7%	10%	49%	14%	1%	13%
N_2O	100%	0%	0%	0%	99%	0%	0%	0%
NO_2	100%	7%	7%	5%	70%	8%	4%	0%
SO_2	100%	2%	2%	7%	75%	4%	0%	10%
Coal	100%	2%	1%	9%	72%	8%	1%	7%
Crude oil	100%	4%	4%	4%	63%	11%	0%	14%
Natural gas	100%	7%	12%	20%	27%	18%	1%	14%

Feminine care Pads

Overall LCA results for feminine care pads are reported in Table 40 and in Table 41.

Table 40: Results of impact categories and primary energy for one feminine care pad (absolute values)

	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life	Total
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	3.1E-05	7.2E-08	6.5E-07	7.0E-07	7.7E-07	7.1E-06	4,05E-05
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	1.9E-05	-1.2E-07	1.2E-06	6.0E-07	-1.3E-06	1.0E-06	2,03E-05
Global Warming Potential (GWP) [kg CO_2-Eq.]	1.9E-02	4.6E-05	2.0E-03	-1.1E-04	4.9E-04	6.5E-03	2,75E-02
Acidification Potential (AP) [kg SO_2-Eq.]	1.6E-04	3.0E-07	7.3E-06	3.7E-06	3.2E-06	2.1E-06	1,75E-04
Primary Energy Demand [MJ]	1.2E+00	6.6E-04	3.5E-02	3.0E-02	7.1E-03	1.8E-03	1,29E+00

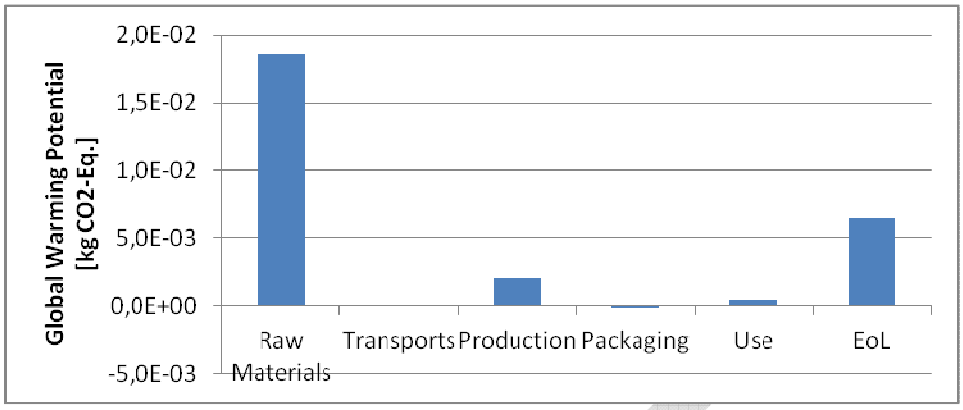
Table 41: Results of impact categories and primary energy for one feminine care pad (relative values)

	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	77%	0%	2%	2%	2%	18%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	93%	-1%	6%	3%	-6%	5%
Global Warming Potential (GWP) [kg CO_2-Eq.]	68%	0%	7%	0%	2%	24%
Acidification Potential (AP) [kg SO_2-Eq.]	90%	0%	4%	2%	2%	1%
Primary Energy Demand [MJ]	94%	0%	3%	2%	1%	0%

Picture 27 shows the contribution of the single life cycle stages to the global warming potential of a feminine care pad.

The average feminine care pad has a global warming potential of 0.03 kg of CO_2 equivalent. The two main contributions to global warming are given by raw materials and end of life stage (almost 0.2 and 0.07 kg of $CO_{2,\ eq}$ per single feminine care pad product, respectively).

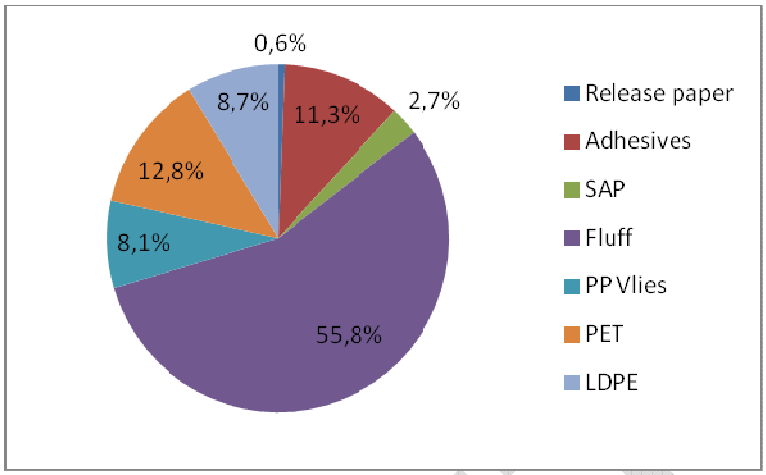
Picture 27: Global warming potential of the single life cycle stages of a feminine care pad



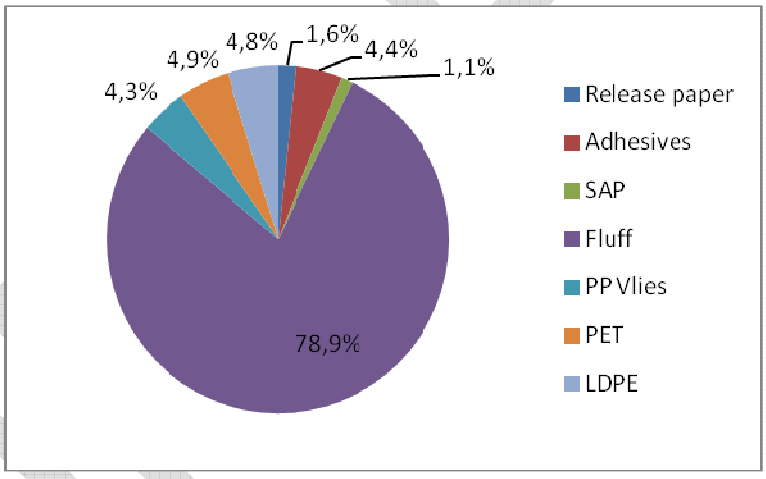
Picture 28: Primary energy demand of the single life cycle stages of a feminine care pad

Among the raw materials used in feminine care pads (which include silicon release paper, adhesives, superabsorbent polymers, cellulose fluff pulp and a mixture of polypropylene PP fleece, polyethylene terephthalate foil and polyethylene foil), cellulose is the main contributor to global warming potential (55.8% of the impact given by raw materials). The cellulose fluff pulp also has the highest primary energy demand, 0.96 MJ (or 78.9% of the impact given by raw materials) out of 1.22 MJ for all raw materials.

Picture 29: Relative contributions of single raw materials to total global warming potential of all raw materials



Picture 30: Relative contributions of single raw materials to total global warming potential of all raw materials



Cellulose is the raw material that even contributes most to eutrophication potential (93.9% of the impact given to raw materials), photochemical ozone creation potential (69.4% of the impact given to raw materials) and acidification potential (88.1% of the impact given to raw materials).

Table 42: Relative contributions of individual processes to selected impact categories

	Energy	Water	Auxiliaries	EoL production waste
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	60.7%	0.2%	0.1%	39.0%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	36.9%	0.0%	0.2%	62.9%
Global Warming Potential (GWP) [kg CO_2-Eq.]	88.1%	0.1%	0.2%	11.5%
Acidification Potential (AP) [kg SO_2-Eq.]	98.7%	0.1%	0.2%	1.0%
Primary Energy Demand [MJ]	99.3%	0.1%	0.4%	0.2%

In the production phase, the energy inputs have the highest impact on global warming potential with a value of 0.0018 kg of CO_2 equivalent, which is 88.1% of the total global warming potential coming from the production of the feminine care pad (Table 42). The highest primary energy demand also comes from energy, which is 99.3% of the total 0.04 MJ due to the production phase. The end-of-life of the production phase has a higher impact on the photochemical ozone creation potential (62.9%).

Key inventory analysis data for feminine care pads can be found in

Table 43 and split up in relative contribution for the raw materials only in Table 45.

Table 43: Life cycle inventory data for total feminine care pad life cycle

[kg / functional unit]	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	2.92E-02	2.35E-02	4.39E-05	1.76E-03	1.21E-03	4.71E-04	2.16E-03
CO_2 ren.	1.14E-01	1.11E-01	4.14E-06	3.85E-04	1.40E-03	4.45E-05	2.03E-03
Methane	3.91E-03	1.36E-03	1.19E-06	1.69E-04	6.20E-05	1.28E-05	2.30E-03
N_2O	5.05E-03	5.02E-03	3.94E-07	1.22E-05	1.24E-05	4.23E-06	4.75E-06
NO_2	1.91E-07	5.37E-09	1.58E-08	2.61E-10	3.81E-12	1.70E-07	-1.49E-11
SO_2	6.91E-05	6.02E-05	3.15E-08	5.83E-06	2.42E-06	3.38E-07	3.00E-07
Coal	7.69E-02	6.34E-02	2.91E-06	1.03E-02	2.30E-03	3.13E-05	8.88E-04
Crude oil	3.33E-01	3.12E-01	5.80E-04	1.78E-03	7.66E-03	6.22E-03	4.81E-03
Natural gas	1.70E-01	1.53E-01	4.70E-05	8.81E-03	1.05E-02	5.05E-04	-2.90E-03

Table 44: Life cycle inventory data for total feminine care pad life cycle (relative values)

	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	100%	81%	0%	6%	4%	2%	7%
CO_2 ren.	100%	97%	0%	0%	1%	0%	2%
Methane	100%	35%	0%	4%	2%	0%	59%
N_2O	100%	99%	0%	0%	0%	0%	0%
NO_2	100%	3%	8%	0%	0%	89%	0%
SO_2	100%	87%	0%	8%	3%	0%	0%
Coal	100%	82%	0%	13%	3%	0%	1%
Crude oil	100%	94%	0%	1%	2%	2%	1%
Natural gas	100%	90%	0%	5%	6%	0%	-2%

Table 45: Relative life cycle inventory data for feminine care pad raw materials

	Total	Silicon paper	Adhesive	SAP	Fluff pulp	PP/PE Fleece	PET	PE foil
CO_2 fossil	100%	5%	8%	2%	64%	6%	9%	6%
CO_2 ren.	100%	1%	0%	0%	99%	0%	0%	0%
Methane	100%	2%	12%	3%	52%	10%	12%	10%
N_2O	100%	0%	0%	0%	99%	0%	0%	0%
NO_2	100%	0%	3%	0%	20%	2%	76%	0%
SO_2	100%	2%	3%	2%	79%	3%	4%	7%
Coal	100%	4%	2%	2%	76%	6%	6%	5%
Crude oil	100%	0%	6%	1%	66%	8%	9%	10%
Natural gas	100%	2%	21%	5%	30%	14%	17%	11%

Tampons

The overall LCA results for tampons are reported in Table 46 and in Table 47.

Table 46. Results of impact categories and primary energy for one tampon (absolute values)

	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life	Total
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	1.5E-05	4.1E-08	5.0E-07	7.9E-07	4.8E-07	4.4E-06	2,11E-05
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	7.9E-06	-7.0E-08	4.1E-07	7.0E-07	-8.1E-07	6.5E-07	8,81E-06
Global Warming Potential (GWP) [kg CO_2-Eq.]	1.1E-02	2.6E-05	1.7E-03	-6.4E-05	3.0E-04	4.0E-03	1,68E-02
Acidification Potential (AP) [kg SO_2-Eq.]	8.2E-05	1.7E-07	6.2E-06	4.2E-06	2.0E-06	1.3E-06	9,55E-05
Primary Energy Demand [MJ]	6.5E-01	3.7E-04	3.0E-02	3.4E-02	4.4E-03	1.1E-03	7,16E-01

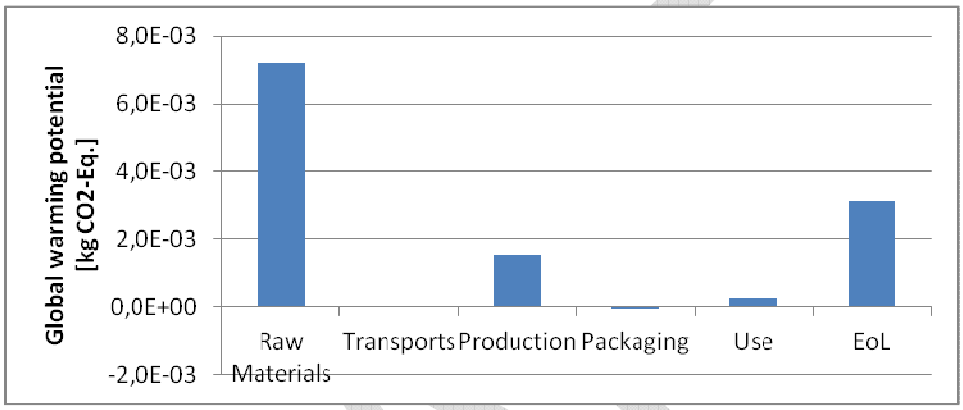
Table 47 : Results of impact categories and primary energy for one tampon (relative values)

	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	71%	0%	2%	4%	2%	21%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	90%	-1%	5%	8%	-9%	7%
Global Warming Potential (GWP) [kg CO_2-Eq.]	65%	0%	10%	0%	2%	24%
Acidification Potential (AP) [kg SO_2-Eq.]	85%	0%	6%	4%	2%	1%
Primary Energy Demand [MJ]	90%	0%	4%	5%	1%	0%

Picture 31 shows the contribution of the single life cycle stages to the global warming potential of tampon.

The average tampon has a global warming potential just below 0.02 kg of CO2 equivalent. The two main contributions to global warming are given by raw materials and end of life (almost 0.1 and 0.04 kg of $CO_{2,\ eq}$ per single feminine care pad product, respectively).

Picture 31. Global warming potential of the single life cycle stages of a tampon

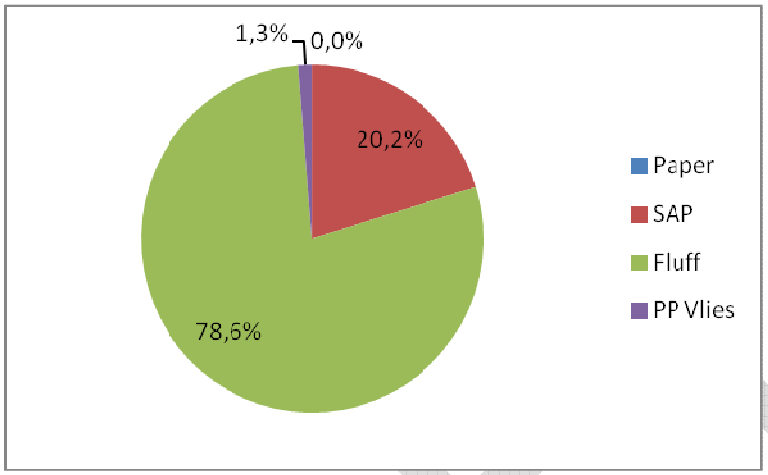


Picture 32: Primary energy demand of the single life cycle stages of a tampon

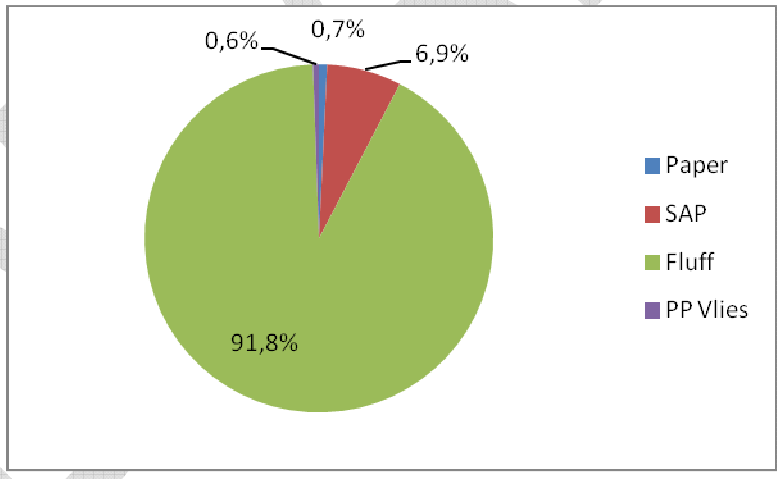
Among the raw materials use in the cotton tampon (which include a polypropylene applicator, cellulose fluff pulp, PP fleece and cotton string), the applicator has the greatest impact on global warming potential (52.3% of the impact given by the raw materials). The fluff pulp, made of cellulose, is the second largest contributor to the global warming potential among the raw materials (43.5% of the impact given by the raw materials). The cellulose fluff pulp does, however, have the highest primary energy

demand: 0.44 MJ out of 0.65 MJ (68%) of the energy demanded for all the raw materials.

Picture 33: Relative contributions of single raw materials to total global warming potential of all raw materials



Picture 34: Relative contributions of single raw materials to total primary energy demand of all raw materials



The cellulose fluff pulp, used as a basis or foundation of the tampon, also accounts for most of the eutrophication potential (89.4% of the impact given by raw materials), photochemical ozone creation potential (75% of the impact given by raw materials) and acidification potential (78.0% of the impact given by raw materials).

Table 48: Relative contributions of individual processes to selected impact categories

	Energy	Water	Auxiliaries	EoL production waste
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	66.6%	0.1%	0.0%	33.3%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	93.8%	0.0%	0.0%	6.1%
Global Warming Potential (GWP) [kg CO_2-Eq.]	90.7%	0.1%	0.0%	9.2%
Acidification Potential (AP) [kg SO_2-Eq.]	99.2%	0.0%	0.0%	0.8%
Primary Energy Demand [MJ]	99.8%	0.0%	0.0%	0.1%

In the production phase, energy consumption produces the highest impact on global warming potential with a value of 0.0015 kg of CO_2 equivalent, or 90.7% of the overall emission of CO_2 equivalent coming from the production of the cellulose tampon. 99.8% of the primary energy demand associated with the manufacture stage is also due to consumption of energy.

Energy accounts for 66.6% of the eutrophication potential in the production phase, while the end-of-life stage accounts for the other 33.3%. Photochemical ozone creation potential and acidification potential due to the production phase are similarly dominated by energy (93.8% and 99.2%, respectively.

Key inventory data for the LCA of a tampon can be found in Table 50 and as relative contributions of raw materials in.Table 51

Table 49: Life cycle inventory data for total tampon lifecycle

[kg / functional unit]	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	1.70E-02	1.25E-02	2.50E-05	1.47E-03	1.36E-03	2.93E-04	1.34E-03
CO_2 ren.	-5.07E-03	-4.86E-03	4.04E-08	4.39E-05	-1.51E-03	4.73E-07	1.25E-03
Methane	1.00E-04	3.49E-05	2.71E-08	5.09E-06	2.80E-06	3.17E-07	5.71E-05
N_2O	7.97E-06	7.87E-06	7.52E-10	3.44E-08	4.68E-08	8.80E-09	9.90E-09
NO_2	1.76E-07	1.42E-09	1.37E-08	3.36E-10	1.99E-13	1.60E-07	-1.41E-11
SO_2	3.39E-05	2.74E-05	1.44E-08	3.95E-06	2.23E-06	1.68E-07	1.49E-07
Coal	3.11E-03	2.42E-03	8.90E-08	4.83E-04	1.74E-04	1.04E-06	2.81E-05
Crude oil	4.59E-03	4.17E-03	7.80E-06	3.32E-05	2.12E-04	9.14E-05	7.08E-05
Natural gas	2.65E-03	2.25E-03	6.08E-07	1.68E-04	2.62E-04	7.12E-06	-4.09E-05

Table 50: Life cycle inventory data for total tampon life cycle (relative values)

	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	100%	74%	0%	9%	8%	2%	8%
CO_2 ren.	100%	96%	0%	-1%	30%	0%	-25%
Methane	100%	35%	0%	5%	3%	0%	57%
N_2O	100%	99%	0%	0%	1%	0%	0%
NO_2	100%	1%	8%	0%	0%	91%	0%
SO_2	100%	81%	0%	12%	7%	0%	0%
Coal	100%	78%	0%	16%	6%	0%	1%
Crude oil	100%	91%	0%	1%	5%	2%	2%
Natural gas	100%	85%	0%	6%	10%	0%	-2%

Table 51: Relative life cycle inventory data for tampon raw materials

	Total	Applicator	Fluff/Basis	Top Layer	Removal string
CO_2 fossil	100%	41%	55%	3%	1%
CO_2 ren.	100%	0%	96%	0%	4%
Methane	100%	56%	37%	5%	3%
N_2O	100%	1%	96%	0%	2%
NO_2	100%	46%	52%	3%	0%
SO_2	100%	34%	63%	2%	2%
Coal	100%	42%	54%	3%	1%
Crude oil	100%	43%	53%	4%	0%
Natural gas	100%	72%	21%	6%	0%

Breast pads

The overall LCA results for breast pads are reported in Table 52 and in Table 53.

Table 52: Results of impact categories and primary energy for one breast pad (absolute values)

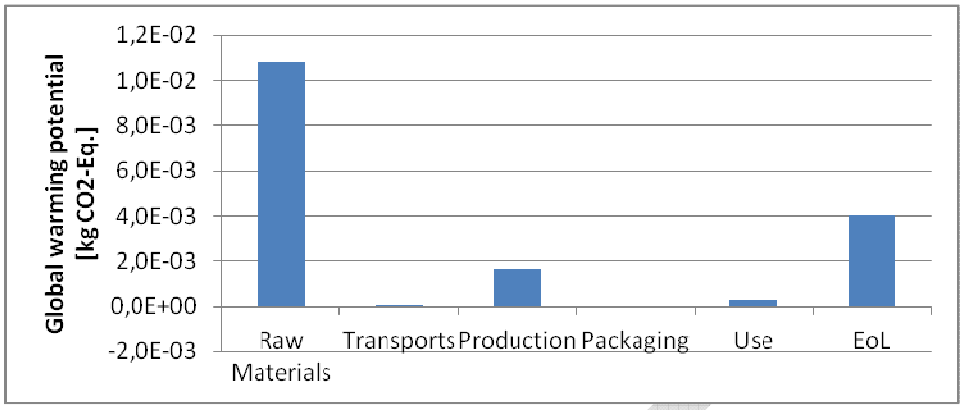
	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life	Total
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	1.7E-05	3.3E-08	4.4E-07	3.3E-07	3.7E-07	3.4E-06	2,13E-05
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	7.9E-06	-5.7E-08	7.1E-07	2.8E-07	-6.4E-07	5.1E-07	8,70E-06
Global Warming Potential (GWP) [kg CO_2-Eq.]	7.2E-03	2.1E-05	1.5E-03	-5.3E-05	2.4E-04	3.1E-03	1,21E-02
Acidification Potential (AP) [kg SO_2-Eq.]	8.2E-05	1.4E-07	5.9E-06	1.7E-06	1.5E-06	1.0E-06	9,25E-05
Primary Energy Demand [MJ]	5.7E-01	3.1E-04	2.8E-02	1.4E-02	3.4E-03	8.6E-04	6,22E-01

Table 53: Results of impact categories and primary energy for one breast pad (relative values)

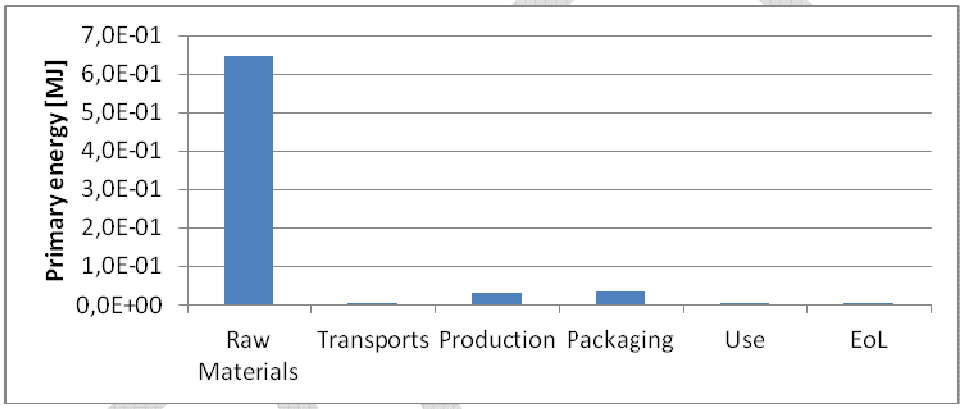
	Raw Materials	Transportation	Production	Packaging	Use phase	End-of-life
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	78%	0%	2%	2%	2%	16%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	91%	-1%	8%	3%	-7%	6%
Global Warming Potential (GWP) [kg CO_2-Eq.]	60%	0%	13%	0%	2%	26%
Acidification Potential (AP) [kg SO_2-Eq.]	89%	0%	6%	2%	2%	1%
Primary Energy Demand [MJ]	92%	0%	5%	2%	1%	0%

Breast pads are fundamentally similar to children's diapers and incontinence products in terms of basic materials, production and disposal, but are smaller because covering a smaller part of the human body. Breast pads, like children's disposable diapers and incontinence products are multilayer products consisting of different inner and outer layers. A single breast pad has a global warming potential of 0.012 kg of CO_2 equivalent, and requires about 0.6 MJ of primary energy (Table 52). These values are much lower than those associated with children's diapers, as an example. This is understandable due to their smaller size and to their simpler structure and material composition. Graphical illustrations of the results for global warming potential and primary energy demand can be seen in Picture 35 and Picture 36.

Picture 35: Global warming potential of the single life cycle stages of a breast pad

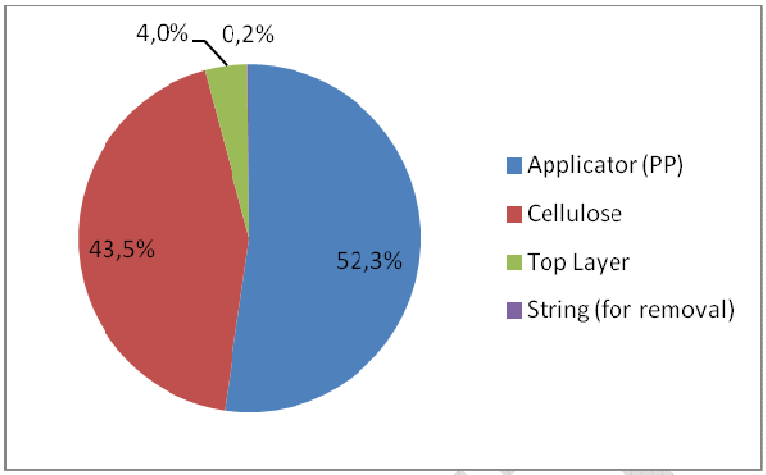


Picture 36: Primary energy demand of the single life cycle stages of a breast pad

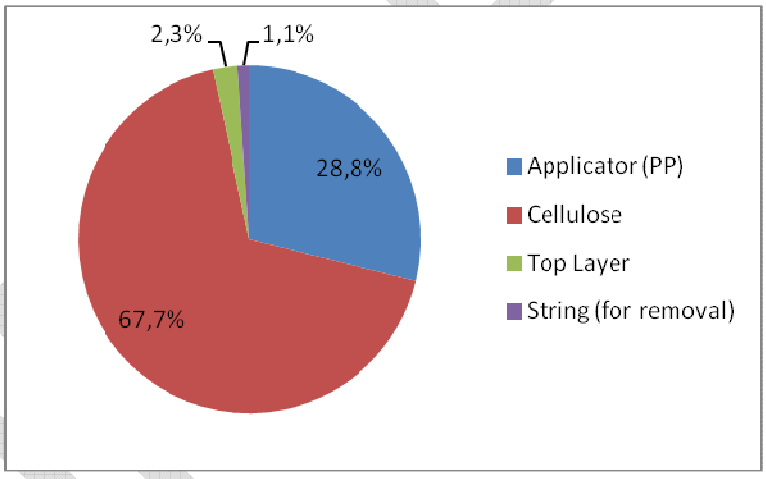


Among the raw materials used in breast pads (which includes paper, superabsorbent polymers, cellulose and fleece), cellulose is the highest contributor to both global warming potential (78.6% of the impact given by raw materials, Picture 37) and primary energy demand (91.8% of the impact given by raw materials, Picture 38). Cellulose fluff pulp is the most important contributor also with respect to eutrophication potential (96.2% of the impact given to raw materials), photochemical ozone depletion potential (90.8% of the impact given to raw materials) and acidification potential (93.4% of the impact given to raw materials).

Picture 37: Relative contributions of single raw materials to total global warming potential of all raw materials



Picture 38: Relative contributions of single raw materials to total global warming potential of all raw materials



The total global warming potential of the raw materials phase is 0.007 kg of CO2 equivalent (78% of the whole life cycle). Primary energy demand of the pre-products is less than 0.6 MJ (92% of the whole life cycle).

Table 54. Relative contributions of individual processes to selected impact categories

	Energy	Water	Auxiliaries	EoL production waste
Eutrophication Potential (EP) [kg PO_4^{3-}-Eq.]	66.6%	0.1%	0.0%	33.3%
Photochemical Ozone Creation Potential (POCP) [kg Ethene-Eq.]	93.8%	0.0%	0.0%	6.1%
Global Warming Potential (GWP) [kg CO_2-Eq.]	90.7%	0.1%	0.0%	9.2%
Acidification Potential (AP) [kg SO_2-Eq.]	99.2%	0.0%	0.0%	0.8%
Primary Energy Demand [MJ]	99.8%	0.0%	0.0%	0.1%

Electrical and thermal energy accounts for the highest contribution to the global warming potential and to the primary energy demand of the production phase (92.7% and 99.6%, respectively). The primary energy demand of the production phase is about 0.03 MJ, while the global warming potential is 0.0015 kg of CO_2 equivalent (13% of the whole life cycle). Absolute values are again significantly lower in comparison to those for children's diapers.

Disposal of production wastes is responsible for a significant share of the impacts in eutrophication potential (27.1% of the production phase) and photochemical ozone depletion potential (48.7% of the production stage).

Selected key life cycle inventory data of the LCA of breast pads can be found in Table 55 for the complete life cycle and in Table 57 as relative contributions of the raw materials only.

Table 55: Life cycle inventory data for total breast pad lifecycle

[kg / functional unit]	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	1.31E-02	9.90E-03	2.05E-05	1.39E-03	5.63E-04	2.28E-04	1.05E-03
CO_2 ren.	-5.55E-03	-5.90E-03	3.30E-08	3.02E-05	-6.53E-04	3.69E-07	9.77E-04
Methane	7.04E-05	2.01E-05	2.22E-08	4.33E-06	1.14E-06	2.47E-07	4.45E-05
N_2O	9.22E-06	9.15E-06	6.15E-10	3.27E-08	1.95E-08	6.86E-09	7.71E-09
NO_2	1.37E-07	9.66E-10	1.12E-08	3.19E-10	7.79E-14	1.25E-07	-1.10E-11
SO_2	2.84E-05	2.35E-05	1.18E-08	3.76E-06	9.15E-07	1.31E-07	1.16E-07
Coal	2.35E-03	1.80E-03	7.28E-08	4.59E-04	7.23E-05	8.12E-07	2.19E-05
Crude oil	3.17E-03	2.92E-03	6.38E-06	3.19E-05	8.43E-05	7.12E-05	5.52E-05
Natural gas	1.42E-03	1.18E-03	4.97E-07	1.61E-04	1.08E-04	5.55E-06	-3.19E-05

Table 56: Life cycle inventory data for total breast pad lifecycle (relative values)

	Total	Raw Materials	Transportation	Production	Packaging	Use	End-of-life
CO_2 fossil	100%	75%	0%	11%	4%	2%	8%
CO_2 ren.	100%	106%	0%	-1%	12%	0%	-18%
Methane	100%	29%	0%	6%	2%	0%	63%
N_2O	100%	99%	0%	0%	0%	0%	0%
NO_2	100%	1%	8%	0%	0%	91%	0%
SO_2	100%	83%	0%	13%	3%	0%	0%
Coal	100%	76%	0%	20%	3%	0%	1%
Crude oil	100%	92%	0%	1%	3%	2%	2%
Natural gas	100%	83%	0%	11%	8%	0%	-2%

Table 57: Relative life cycle inventory data for breast pad raw materials

	Total	Release paper	SAP	Fluff pulp	PP/PE Fleece
CO_2 fossil	100%	3%	14%	83%	1%
CO_2 renewable	100%	4%	0%	96%	0%
Methane	100%	1%	20%	77%	2%
N_2O	100%	0%	0%	100%	0%
NO_2	100%	0%	8%	91%	1%
SO_2	100%	1%	10%	88%	0%
Coal	100%	1%	10%	88%	1%
Crude oil	100%	0%	8%	91%	1%
Natural gas	100%	1%	47%	49%	2%

Summary

The following indicators have been considered in this preliminary analysis of sanitary products:

- Eutophication Potential (EP)
- Photochemical Ozone Creation Potential (POCP)
- Global Warming Potential (GWP)
- Acidification Potential (AP)
- Primary Energy Demand.

Raw materials result the main contributors to the life cycle impacts for all the sanitary products considered in the analysis. Their contribution varies between 60% and 94% of the overall impacts given by the whole life cycle.

The **End-of-Life** stage appears even important with respect to these impact categories. The following scenario was considered for the End-of-Life::

- 22.5% incineration with energy recovery;
- 14.1% incineration without energy recovery;
- 63.4% landfill.

Components and raw materials of potential environmental concern are reported below:

Component	Children's diaper	Incontinence product	Feminine care pad	Tampon with applicator	Breast pad
Fluff pulp	x	x	x	x	x
SAP	x	x			x
PP Fleece	x	x	x		
PET film			x		
PE film	x	x	x		
Applicator				x	

The contribution to the LCA results given by packaging and transports seems to be relatively small, compared to the previously highlighted elements of the life cycle of sanitary products.

A sensitivity analysis will be developed in the next weeks in order to evaluate, possibly, the influence on the results given by the main parameters of the LCA model, such as: weights of main raw materials, use of alternative materials end-of-life disposal scenarios, transport distance variation, impact assessment methods. **Stakeholders are kindly invited to review the information provided and to indicate the parameters which they consider more interesting to assess in the sensitivity analysis. Information which could be used in support of the completion of this step of the analysis will be also very much appreciated.**

Hazardous substances and other product related issues

Identification of substances and material of potential concern

Sanitary products can consist of a variety of different materials, depending on the complexity of the product. The multi-layered sanitary products, for example, are made of a larger number of materials and components than a tampon. Among the materials used, it has to be ensured that no safety issues occur and that human health is not threatened at any time. The harmlessness of the raw materials is particularly important for sanitary products since, for example

- Products have direct contact with skin or mucous, i.e. with parts of the body which might be potentially irritated or injured by rashes or inflammations;
- Products might be used by consumers with potentially weakened immune systems (children and elderly persons);
- Products come into contact with liquids which could potentially lead to leaching of substances from the product.

The EU Ecolabel regulation No 66/2010 declares in Art. 6.6 that

"The EU Ecolabel may not be awarded to goods containing substances or preparations/mixtures meeting the criteria for classification as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction (CMR), in accordance with Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures nor to goods containing substances referred to in Article 57 of Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006

concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)".

However, the regulation also allows exceptions, where unavoidable (Art. 6.7 of the regulation):

"For specific categories of goods containing substances referred to in paragraph 6, and only in the event that it is not technically feasible to substitute them as such, or via the use of alternative materials or designs, or in the case of products which have a significantly higher overall environment performance compared with other goods of the same category, the Commission may adopt measures to grant derogations from paragraph 6. No derogation shall be given concerning substances that meet the criteria of Article 57 of Regulation (EC) No 1907/2006 and that are identified according to the procedure described in Article 59(1) of that Regulation, present in mixtures, in an article or in any homogeneous part of a complex article in concentrations higher than 0,1 % (weight by weight). Those measures, designed to amend non-essential elements of this Regulation, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 16(2)."

Taking into account articles 6.6. and 6.7. of the EU Ecolabel regulation No 66/2010, products should not contain any substances or preparations which can be classified as hazardous according to the EC Regulation 1272/2008 (the CLP Regulation on classification, labelling and packaging of substances and mixtures) nor substances that fulfil the criteria described in Article 57 of the EC Regulation 1907/2006 (the REACH Regulation).

Hazard statements of the EC Regulation 1272/2008 expressing health hazards as well as environmental hazards are listed in Table 58 and Table 59.

Table 58. Internationally accepted hazard statements and corresponding H-phrases according to EC Regulation 1272/2008 of relevance within the EU Ecolabel scheme.

Hazard statement (internationally valid)	***H-phrase***
H 300: Health hazards	
Fatal if swallowed	H300
Toxic if swallowed	H301
May be fatal if swallowed and enters airways	H304
Fatal in contact with skin	H310
Toxic in contact with skin	H311
Fatal if inhaled	H330
Toxic if inhaled	H331
May cause genetic defects	H340
Suspected of causing genetic defects	H341
May cause cancer	H350
May cause cancer by inhalation	H350i
Suspected of causing cancer	H351
May damage fertility	H360F
May damage the unborn child	H360D
May damage fertility. May damage the unborn child	H360FD
May damage fertility. Suspected of damaging the unborn child	H360Fd
May damage the unborn child. Suspected of damaging fertility	H360Df
Suspected of damaging fertility	H361f
Suspected of damaging the unborn child	H361d
Suspected of damaging fertility. Suspected of damaging the unborn child	H361fd
May cause harm to breast-fed children	H362
Causes damage to organs	H370
May cause damage to organs	H371
Causes damage to organs through prolonged or repeated exposure	H372
May cause damage to organs through prolonged or repeated exposure	H373
H 400: Environmental Hazards	
Very toxic to aquatic life	H400
Very toxic to aquatic life with long-lasting effects	H410
Toxic to aquatic life with long-lasting effects	H411
Harmful to aquatic life with long-lasting effects	H412
May cause long-lasting harmful effects to aquatic life	H413
May cause allergy or asthma symptoms or breathing difficulties if inhaled	H334
May cause allergic skin reaction	H317

Table 59: Hazard statements and corresponding H-phrases according to EC Regulation 1272/2008 valid in Europe.

Hazard statement (valid in EU)	H-phrase
Explosive when dry.	EUH001
Explosive with or without contact with air.	EUH006
Reacts violently with water.	EUH014
In use may form flammable/explosive vapour-air mixture.	EUH018
May form explosive peroxides.	EUH019
Risk of explosion if heated under confinement.	EUH044
Contact with water liberates toxic gas.	EUH029
Contact with acids liberates toxic gas.	EUH031
Contact with acids liberates very toxic gas.	EUH032
Repeated exposure may cause skin dryness or cracking.	EUH066
Toxic by eye contact.	EUH070
Corrosive to the respiratory tract.	EUH071
Hazardous to the ozone layer.	EUH059
Contains lead. Should not be used on surfaces liable to be chewed or sucked	EUH201
Warning! Contains lead.	EUH201A
Cyanoacrylate. Danger. Bonds skin and eyes in seconds. Keep out of the	EUH202
Contains chromium (VI). May produce an allergic reaction.	EUH203
Contains isocyanates. May produce an allergic reaction.	EUH204
Contains epoxy constituents. May produce an allergic reaction.	EUH205
Warning! Do not use together with other products. May release dangerous	EUH206
Warning! Contains cadmium. Dangerous fumes are formed during use. See	EUH207
Contains <name of sensitising substance>. May produce an allergic reaction	EUH208
Can become highly flammable in use.	EUH209
Can become flammable in use.	EUH209A
Safety data sheet available on request.	EUH210
To avoid risks to human health and the environment, comply with the	EUH401
Explosive when dry.	EUH001
Explosive with or without contact with air.	EUH006
Reacts violently with water.	EUH014

According to the EU Ecolabel Regulation, derogations are in general possible only if it is technically feasible and if an alternative material does not decrease the environmental performance significantly. No derogation is instead possible for substances meeting the criteria of Article 57 of EC Regulation No 1907/2006 in concentrations exceeding 0.1% by weight.

In case any of those substances of concern are contained in the product, it is suggested that manufacturers applying for the EU Ecolabel specify substances contained in their products and relative concentrations in Safety Data Sheets in order to verify conformance with the regarding regulations.

In the Nordic Swan Ecolabelling Scheme, this procedure is also required for chemical products used in the production of sanitary products (Criteria R3). If mixtures are used, they must be provided also a declaration of compliance and a Safety Data Sheets compiled according to Annex II of the EC Regulation No 1907/2006 and reporting the list of ingredients used. The same prescription has to be applied to articles and products, i.e. a declaration of compliance together with related documentation (e.g. declarations of compliance signed by the material suppliers as well as relevant Safety Data Sheets for substances or mixtures).

Table 60 shows an overview of potential areas of risks for sanitary products. The table can be used as a preliminary outlook on this issue since further information from manufacturers is expected.

Table 60: Potential areas of risks in sanitary products

Material	Purpose of materials	Skin contact?	Potential substances of concern
Cellulose (Fluff pulp) / Viscose (Rayon)	Absorption of liquids (diapers, breast pads, feminine care pads and tampons)	Yes (Tampons)	Debonding agents, softeners, bleaching process (chlorine), chlorine, dioxine, pesticides
Cotton	Absorption of liquids (tampons)	Yes	Bleaching process, chlorine, dioxine, pesticides
Superabsorbent polymer	Absorption and retention of liquids	No	Residual monomers of acrylic acid; other water-soluble extracts
Plastic materials	Product shell	Yes	Additives (e.g. flame retardants); halogen-based polymers; phtalates
Elastics	Retaining product shape and fitting	Potentially yes	Solvents (e.g. Dimethylacetamide)
Siliconised paper	Protection of adhesive product area	No	Siloxanes fulfilling criteria for classifications according to the EC Regulation 1272/2008 (e.g. octamethyl cyclotetrasiloxane or decamethyl cyclopentasiloxane)
Glues and adhesives	Fixation of product layers or different product parts or fixation of product on clothing	Potentially yes	Solvents, chemicals such as phthalates, colophony resin, formaldehyde
Inks and dyes	Product design and labelling	Not during normal use	Solvents, heavy metals or toxic coloring agents such as Azo colors
Lotions/fragrances	Consumer satisfaction, skin care, odour control	Potentially yes	Various chemicals

As mentioned above, it has to be proven that no material alternatives are possible at the current state if derogations are desired. Substances of very high concern which are included in the list foreseen in Article 59(10) of REACH cannot be derogated if they are present in the product in concentrations higher than 0.1% by weight. This is the minimal prescription to be respected. Stricter prescriptions can be even thought for particular groups of substances by decreasing thresholds and/or referring to single materials of

the product. The list of substances identified so far as SVHC (Substances of Very High Concern) can be found in http://echa.europa.eu/web/guest/candidate-list-table.

The list of materials and substances of concern used in sanitary products is currently under discussion. Stakeholders are invited to review the pieces of information contained in Table 50 and to provide further details on:

1. **Substances which can be found in sanitary products or used during the manufacture stage**
2. **Quantities and materials where these can be found**
3. **Substance normally present in sanitary products or used during the manufacture stage but whose use could be avoided concretely**
4. **Substances that can be classified as hazardous based on the definition given within the EU Ecolabel regulation (Art. 6.6 and 6.7) and for which inherently safer option exists**
5. **Substances that can be classified as hazardous based on the definition given within the EU Ecolabel regulation (Art. 6.6 and 6.7) and for which stakeholders would like to ask for a derogation request (to be evaluated by the European Commission).**
6. **Tests, standards and procedures which are considered appropriate in order to analyse and report the chemical composition of the product**

6. EU ECOLABEL CRITERIA DEVELOPMENT

6.1 Foregoing considerations and criteria requirements

The development of an EU Ecolabel should not only provide consumers with science-based guidance regarding the purchase of green products, but also motivate manufacturers to optimise product design and manufacture in order to reduce their environmental impacts.

In order to award sanitary products with an EU Ecolabel, a set of criteria has to be defined. Companies wishing to apply for the EU Ecolabel will have to provide evidence that they fulfil the criteria for a particular product and will then be awarded the right to display the EU Flower.

Criteria are defined within alternative ecolabelling schemes (see Section 3.3 for specific details on sanitary products) based on a set of common principles. Differences between labels can involve, for instance,

- Single- vs. multi-criteria assessment;
- Qualitative vs. quantitative criteria;
- Single phase focus vs. product's life cycle perspective;
- Setting cut-off threshold vs. a scoring based approach.

The EU Flower, being a type 1 ecolabel, combines a multi-criteria assessment with the adoption of a life cycle perspective, has a mixture of qualitative and quantitative criteria and usually sets cut-off thresholds within the criteria.

Two main trends are apparent when investigating the development of type 1 ecolabel criteria in recent years:

1) The adoption of a full life cycle perspective and the consequent development of criteria which sufficiently capture cradle-to-grave impacts of the product;
2) The incorporation not only of environmental criteria but also of other dimensions of sustainability (e.g. social or human health indicators).

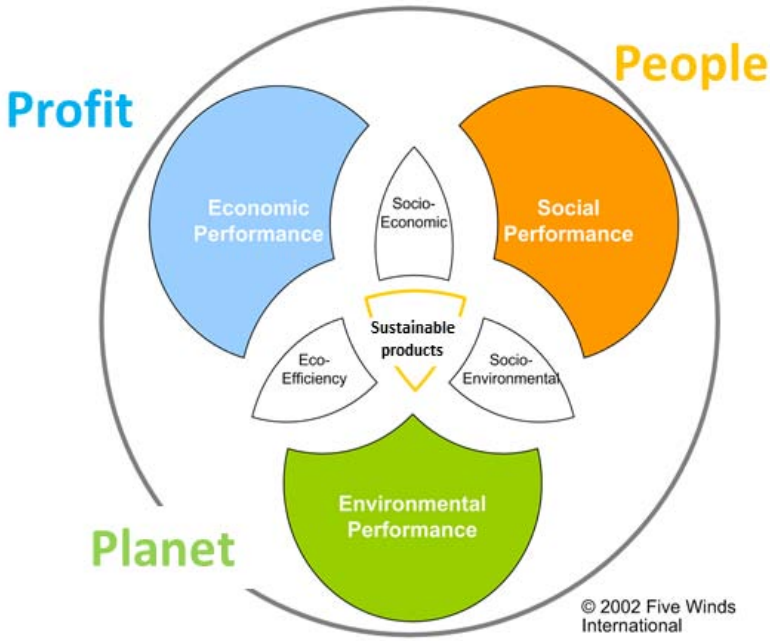
Regarding the first trend, feedback from stakeholders obtained via questionnaires sent out by the project team indicated that **a true LCA approach is favoured.** This means that criteria reflecting the environmental impacts associated with the full life cycle of a sanitary product, and which are commonly presented through sound methodologies (e.g. a LCA study carried out according to ISO 14044) and widely accepted indicators, would be suitable for the EU Ecolabel. In contrast, some stakeholders consider that the

long and detailed list of criteria adopted by the Nordic Swan do not incorporate a life cycle perspective sufficiently and could furthermore hinder product innovation. For example, stakeholders mentioned that the restriction in the use of a particular substance (e.g. nanomaterials), presented as a pass/fail criterion, may lead to a shift of the environmental burdens along the life cycle of a sanitary product. Similarly, restriction of a particular substance or material may promote the use of substitutes which may eventually result in worse overall environmental impacts. Consequently, the use of criteria which capture environmental burdens based on a more holistic approach, would allow the avoidance of undesirable trade-offs and would contribute to an overall improvement of the environmental performance of the products. Furthermore, criteria would set goals in terms of desired environmental performance without limiting manufacturers from deciding on how to achieve these goals. In addition, if a criteria development process based on life cycle impact categories were to be adopted, the number of criteria could be relatively lower, which could potentially ease the burdens placed on organisations wishing to apply for the EU Ecolabel.

On the other hand, if criteria for the EU Ecolabel were to consist of environmental impact categories (e.g. GWP), manufacturers of sanitary products would be required to carry out the underlying calculations based on the LCA methodology. In this case, it is extremely important that underlying standard rules can be applied fairly by all producers. Further, it has to be possible to achieve environmental performance improvements with the criteria. These would require access to specific pieces of information related to the life cycle inventory data (e.g. for products obtained from a given supplier).

The second trend identified relates to the overall goal of enhancing the development both of environmentally friendly, and also of more sustainable products. **The area of sustainability not only covers environmental aspects, but also social and economic fields** (see Picture 39).

Picture 39. The pillars of sustainability



Sometimes, dimensions such as **human health or intergenerational and global equity** (e.g. no free trade barriers) are considered when defining sustainable development. If there were to be a very narrow focus only on one of the three main sustainability pillars, the outcome might neither be sustainable nor feasible. For example, if only environmental criteria were considered within the EU Ecolabel for sanitary products, excellent environmental performance might come at the expense of product performance and pricing and thus be unacceptable for customers. Consequently, as many aspects of sustainability as possible should be taken into account as part of the development of EU Ecolabel criteria.

Further specific suggestions from stakeholders regarding **suitable environmental improvement options** for sanitary products should also be considered. The following inputs were obtained via the questionnaires:

- Lower raw material use (in particular high performance absorption cores);
- Use of "greener" raw materials (e.g. from renewable sources, biodegradable/compostable);
- Use of pulp from sustainably managed forests (e.g. certified by SFI, PEFC or FSC);
- Improved logistics (e.g. high compression packaging);
- Environmentally friendlier packaging material;
- Reduced energy use, emissions and waste production during production;
- Improved waste treatment.

The preliminary results of the LCA study being carried out in this project also point out the need to focus on raw materials, both in terms of overall reduction and selection of the most appropriate options, and on the best alternatives of waste treatment to be promoted. For this reason, stakeholders are invited to share their experience on these critical topics. Other issues seem of secondary importance but further analysis and discussion is expected.

Within the EU Ecolabel criteria development process, the integration of **product performance criteria** is another key area of discussion. Besides the main sanitary product performance criteria of absorptive capacity and leakage protection, stakeholders involved in this project named retention capacities, skin dryness, dampness sensation, skin protection, discretion, fit/sizing and wearing comfort.

In developing EU Ecolabel criteria for sanitary products, **the first step** of the approach was the review of the criteria existing in other ecolabelling schemes for products within the scope of this project (see Section 3) and the parallel development of a draft technical analysis (see Section 5). A pool of criteria worthy of consideration is generated from this process. **In a second stage**, identified criteria are screened in order to assess whether or not they are suitable also for the EU Ecolabel of sanitary products. This assessment of the criteria is based upon several factors, which are listed below:

- Environmental relevance based on insights gained during the technical analysis, i.e. the environmental impact assessment of the products within the scope of this project. (For example, if the LCA carried out for tampons had shown high impacts associated with the use of chlorine gas for cotton bleaching, it is likely that a criterion restricting the use of chlorine gas would have been suggested.)
- Potential impacts on human health;
- Requirements outlined in the current regulation for EU Ecolabels (EC 66/2010);
- The effectiveness and feasibility of a certain criterion, also in terms of measuring, declaration and verification.
- The direct influence and motivation of manufacturers to improve the sustainability performance of their products.

Further recommendations and comments from stakeholders will be welcome and discussed within the process of EU Ecolabel criteria development for the sanitary products group.

6.2 Towards a set of criteria for the EU Ecolabel for sanitary products

In accordance with the criteria development process described in the previous Section Table 61 shows the results of this assessment. High suitability of a particular criterion is highlighted in green, optional criteria are highlighted in yellow and criteria which are considered unsuitable are highlighted in red. The second last column provides the key reason why a certain colour code was assigned to individual criteria. Further explanation is provided in the last column.

In a next step, additional criteria not yet included in existing ecolabelling schemes were added. Again, the reason as to why they were considered suitable for inclusion in the list of criteria is given.

Table 61. List of criteria for the EU Ecolabel for sanitary products

Criteria category	Criteria	Reference	Suitability of criteria for EU Ecolabel	Key reason for recommendation	Comments
Product description					
	Description of product and packaging	Nordic Swan		optional criteria	Should be included in an application, but maybe not as criteria
	Material composition incl. packaging	Nordic Swan		optional criteria	Should be included in an application, but maybe not as criteria
	Producer responsibility statement for packaging	SEMCo, EDANA GPP		optional criteria	Should be included in an application, but maybe not as criteria
Product performance					
	Absorption capacity	Nordic Swan		necessary criteria	In order to describe a minimum product performance; must be stated on packaging for some products (Ref. Nordic Swan)
	Leakage protection	NEW		optional criteria	May further specify a specific standard regarding the product performance
	Possibly additional product-specific performance measures, e.g. rewet under pressure, skin dryness, etc.	Nordic Swan, others		optional criteria	May further specify a specific standard regarding the product performance
Materials used for products and packaging					
	Chemical products classification	Nordic Swan		necessary criteria	Required according to 66/2010 Article 6.6
	Fluff-/cellulose pulp (e.g. production requirements, reduced energy use, reduced emissions (AOX, COD, P to water; S, NOx to air)	Nordic Swan		environmental relevance (based on LCA results)	Fluff-/cellulose pulp production causes high env. impacts across all impact categories; some individual emissions hard to monitor; reduced AOX emissions (EDANA GPP)
	Fluff-/cellulose pulp (no use of recycled fibre)	Nordic Swan		optional criteria	Use of recycled materials difficult due to safety requirements; Stakeholder feedback required
	No visual whitening agent added to pulp	Nordic Swan, SEMCo, EDANA GPP		no statement possible	Stakeholder feedback required
	No chlorine gas in pulp bleaching	SEMCo, EDANA GPP		human health relevance	Assumed to potentially cause toxic shock syndrome (TSS) and dioxin emissions
	No chlorine gas in cotton bleaching	Nordic Swan		human health relevance	Assumed to potentially cause toxic shock syndrome (TSS) and dioxin emissions
	Cotton (organic raw fibre production)	Nordic Swan		environmental relevance (based on LCA results)	Cotton production causes high env. impacts across all impact categories

Criteria category	Criteria	Reference	Suitability of criteria for EU Ecolabel	Key reason for recommendation	Comments
Materials used for products and packaging					
	No chlorine gas in viscose bleaching	Nordic Swan		human health relevance	Assumed to potentially cause toxic shock syndrome (TSS) and dioxin emissions
	Viscose production	NEW		environmental relevance (based on LCA results)	Viscose production causes high env. impacts across all impact categories
	Viscose (reduced COD emissions, reduced sulphur and zinc emissions)	Nordic Swan		feasibility (i.e. measurability)	Partly captured in env. impact categories; some emissions hard to monitor
	Non-wovens (general requirements, additives must fulfil chemical products classification)	Nordic Swan		necessary criteria	Required according to 66/2010 Article 6.6
	No halogen-based polymers, e.g. PVC	Nordic Swan, SEMCo		outdated	To be checked whether substances such as PVC are still in use today
	Reduced constituent substances in polymers, e.g. phthalates	Nordic Swan, SEMCo		necessary criteria	Required according to 66/2010 Article 6.6
	SAP production	NEW		environmental relevance (based on LCA results)	SAP production causes high env. impacts across all impact categories
	Polymers (reduced residual monomers and reduced water-soluble extracts in SAP)	Nordic Swan		necessary criteria	Required according to 66/2010 Article 6.6
	Reduced lead, cadmium, mercury, hexavalent chrome and attendant impurities in plastic material; also no organostannic compounds (EDANA GPP)	SEMCo, EDANA GPP		necessary criteria	Required according to 66/2010 Article 6.6
	No carcinogenic, mutagenic and reprotoxic additives in plastics	SEMCo, EDANA GPP		necessary criteria	Required according to 66/2010 Article 6.6
	No substances that may cause sensitisation (R43)	EDANA GPP		necessary criteria	Required according to 66/2010 Article 6.6
	Adhesives must not contain phthalates, colophony resin or formaldehyde	Nordic Swan		necessary criteria	Required according to 66/2010 Article 6.6
	No fragrances; if present, it needs to be declared (EDANA GPP)	Nordic Swan, SEMCo		optional criteria	Not environmentally relevant, may be used unless they contain SVHCs
	No lotions	Nordic Swan		optional criteria	Not environmentally relevant, may be used unless they contain SVHCs

Criteria category	Criteria	Reference	Suitability of criteria for EU Ecolabel	Key reason for recommendation	Comments
Materials used for products and packaging					
	No odour control; only allowed in incontinence care products; if present, it needs to be declared	Nordic Swan		optional criteria	Not environmentally relevant, may be used unless they contain SVHCs
	No medicaments	Nordic Swan		necessary criteria	Products containing medicaments cannot be ecolabelled
	No nanomaterials	Nordic Swan		no statement possible	Stakeholder feedback required
	No flame retardants	Nordic Swan		optional criteria	Not environmentally relevant; are not necessary in sanitary products and should therefore not be present
	No colophony (Rosin)	SEMCo, EDANA GPP		necessary criteria	Required according to 66/2010 Article 6.6
	Dyes and inks	Nordic Swan		optional criteria	Not environmentally relevant, may be used unless they contain SVHCs
	Paper/carton in the packaging must be produced from return pulp, unbleached pulp or pulp without chlorine gas	SEMCo, EDANA GPP		direct influence and motivation to improve product	Not environmentally relevant
	FSC or PEFC certification for all products based on wood	Nordic Swan, also Blue Angel, EU Flower tissue paper		direct influence and motivation to improve product	
Composition of materials					
	Share of renewable sources for polymers and total of sanitary product	Nordic Swan		no statement possible	Critical point: depends on materials chosen. Materials based on renewable raw materials are not necessarily more environmentally friendly than petroleum-based plastics. Detailed analyses have to be carried out in order to prove this. However, raw materials from renewable sources could have positive effects on end-of-life impacts, e.g. composting
	Share of renewable raw material	Nordic Swan		no statement possible	See comment above

Criteria category	Criteria	Reference	Suitability of criteria for EU Ecolabel	Key reason for recommendation	Comments
Lifecycle impacts of sanitary product					
	Reduced GWP per kg of sanitary product	Nordic Swan, EDANA GPP, PCR for AHP		environmental relevance (based on LCA results)	Key environmental indicator
	Reduced Acidification Potential per kg of sanitary product	EDANA GPP, PCR for AHP		environmental relevance (based on LCA results)	Key environmental indicator
	Reduced Eutrophication Potential per kg of sanitary product	EDANA GPP, PCR for AHP		environmental relevance (based on LCA results)	Key environmental indicator
	Non-renewable material resource consumption	PCR for AHP		no statement possible	See comment regarding renewable raw materials
	Non-renewable energy consumption	PCR for AHP		environmental relevance (based on LCA results)	Key environmental indicator; should at least be declared for production process
	Renewable material resource consumption	PCR for AHP		no statement possible	See comment regarding renewable raw materials
	Renewable energy consumption	PCR for AHP		environmental relevance (based on LCA results)	Key environmental indicator; should at least be declared for production process
	POCP	PCR for AHP		optional criteria	Important environmental indicator; may be declared for production process
Production process					
	Employees must be protected from solvents (i.e. silicone production)	Nordic Swan		feasibility (i.e. measurability)	
	No siloxane in silicon treatment process	Nordic Swan		necessary criteria	Required according to 66/2010 Article 6.6
	Odour concentration	PCR for AHP		optional criteria	
	Hedonic tone (odour assessment)	PCR for AHP		optional criteria	

Criteria category	Criteria	Reference	Suitability of criteria for EU Ecolabel	Key reason for recommendation	Comments
Waste					
	Reduced production waste (share compared to final product)	Nordic Swan		direct influence and motivation to improve product	From an LCA point of view, assuming that production wastes are in a low %-area, this is not so relevant
	Amount of hazardous waste	PCR for AHP		feasibility (i.e. measurability)	For production sites, might make sense, not for supply chain (hard to measure)
	Amount of non-hazardous waste	PCR for AHP		feasibility (i.e. measurability)	For production sites, might make sense, not for supply chain (hard to measure)
Other					
	Producer certified according to Eco-Management and Audit Scheme (EMAS) or ISO 14001	EDANA GPP		direct influence and motivation to improve product	
	Producer certified according to ISO 50001: Energy Management System	NEW		direct influence and motivation to improve product	
	Producer certified according to BS OHSAS 18001: Occupational Health and Safety Management System	NEW		direct influence and motivation to improve product	
	Pro-active consumer education	NEW		optional criteria	
	Producer owns environmental policy and goals	EDANA GPP		direct influence and motivation to improve product	
	Statement of non-involvement in animal testing	NEW		optional criteria	
	Use of biocidal substances	NEW		optional criteria	
	Compostability, biodegradability	NEW		feasibility (i.e. measurability)	Contradicting definitions; no widespread disposal system available

It should be noted that at this stage of the project, only criteria areas are described; neither a distinction of criteria by individual products or product groups is carried out nor are criteria thresholds defined or testing procedures determined.

Following the LCA-based approach, the project team preliminarily recommends the selection of criteria in line with these key environmental impact categories: Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), renewable and non-renewable energy consumption as well as Photochemical Ozone Creation Potential (POCP). The combination of these environmental indicators could provide a good basis for the assessment of the environmental impacts of the product and should limit potential burden-shifting along the life cycle, which occur when the reduction of one environmental effect (e.g. greenhouse gas emissions) cause an increase in a different environmental burden (e.g. eutrophication). The advantages and disadvantages of setting criteria in these areas are discussed in the previous Section and need to be evaluated.

The LCA results proved that major contribution to the environmental impacts is due to the production and supply of the main **raw materials** contained in sanitary products (e.g. fluff-/cellulose pulp or SAP). Hence, it may be an option **to define life cycle impact indicator thresholds** either for individual raw materials (e.g. fluff-/cellulose pulp or SAP) or per kg basis of sanitary products. Another approach worthy of consideration would be not to define any thresholds at all, but merely **to declare the life cycle impact performance**. Experience across a wide range of industries has shown that engaging in LCA activities can lead to environmental performance improvements of products, which is also one of the first goals of the EU Ecolabel.

In order to **improve the effects on human health** associated with the production of sanitary products, it is particularly recommended that the use of chlorine gas in bleaching processes should be avoided.

A list of **criteria from other ecolabelling schemes** was generated and discussed to screen the requirements which can be of relevance for the EU Ecolabel. For sure, a requirement on **hazardous substances and substances of very high concern (SVHC)** will be set in response to the prescription of the EU Ecolabel regulation (Art. 6.6 and 6.7). For some ingredients of sanitary products (e.g. lotions or fragrances), it is needed to check if **substances which are hazardous or included within the SVHC list are present and actually required.**

Further criteria were identified which would contribute to engage manufacturers and suppliers in a **continuous improvement process** with regards to the sustainability of sanitary products.

Requirements of interest for the EU Ecolabel are also **fit-for-use and quality criteria** or **'pro-active consumer education'**. The environmental performance of sanitary products, indeed, could be improved if, for example, consumers chose the right product for a particular purpose or pay attention to the most appropriate (i.e. environmentally friendly) disposal option.

In order to develop effective and accepted criteria, a **balance has to be struck** between rules and practices in place within the EU Ecolabel, scientific evidence and level of flexibility accepted. Once a common understanding has been established among the stakeholders involved in this project, the suitability of individual criteria is to be discussed. It should be noted that the criteria definition process will be informed by

further analysis of the products within the scope of this project (e.g. identification of improvement options; screening of the best performing products available in the market).

Stakeholder feedback on the issues outlined above will be essential for the development of EU Ecolabel criteria.

Annex I

#	CRITERIA	Bed linen	Bedding underlay	Breast pads (disposable)	Breast wipes	Cleaning rags	Cotton buds	Cotton pads	Cotton wool	Draw sheets	Diapers / nappies (children)	Diapers (incontinence)	Diapers formed (incontinence)	Diapers contoured (incontinence)	Diapers w tape strips (incontinence)	Facial tissue / cleansing tissue	Hand towels	Kitchen roll	Mesh / net pants	Paper towels / tissues / napkins / rags	Placemats	Plastics accessories & devices	Sanitary paper
		PRODUCTS										Group: incontinence products											
1	**Covered under existing eco labels**																						
	EU Flower	✓				✓				✓						✓		✓	✓	✓			
	Blue Angel (Germany)					✓												✓		✓			✓
	Nordic Swan (Scandinavia)	✓		✓			✓		✓	×	✓	✓	✓		✓				×				✓
	Green Seal (USA)						×				×	×	×	×	×		✓	✓		✓	✓		✓
	Good Env Choice (Australia)															✓	✓			✓			
	Ecomark (Japan)																		×				
	Env Choice (New Zealand)															✓				✓			
2	**Products to be inlcuded due to categorisation of products in other ecolabelling schemes**																						
3	**EU Ecolabel requirements and typical characteristics of products suggested for the product group sanitary products** a) products fulfil a very similar function: the direct absorption (and removal) of human body waste streams b) products are made of similar raw materials c) disposable product d) products possess similar waste management options																						
4	**Priority products identified through PRODCOM sales data and minority products**																						
5	**Products to be excluded from EU ecolabelling scheme due to legislation**																						

Legend	
	= product included in study (both GPP and Eco Label)
	= product excluded in Eco Label but included in GPP)
	= out of scope (both GPP and Eco Label)
✓	= product included in Eco Label scheme
×	= product explicitely excluded in Eco Label scheme

#	CRITERIA	PRODUCTS																							REFERENCE
		Sanitary towel / napkin	**Sanitary pads**	Panty liners	**Panty liners (incontinence)**	**Sanitary napkin (incontinence)**	**Male pouch (incontinence)**	Surgical gowns	Table coverings	Table napkin	Tampons	**Tampons (incontinence)**	Tissue paper / handkerchief	Toilet paper (bathroom) tissue (sheets/rolls)	Toilet seat covers	Toothpicks	Tray liners	Underlays	Urination devices	Urology products (others than diapers)	**Wash cloths**	**Wet wipes**	Wipes (general purpose)	
		Group: feminine care pads			Group: feminine care pads (incontinence)																			
1	**Covered under existing eco labels**																								
	EU Flower												✓	✓							✓	×			
	Blue Angel (Germany)	✓											✓	✓											
	Nordic Swan (Scandinavia)	✓	✓	✓	✓			✓			✓		×			✓		×			✓	×			
	Green Seal (USA)	×	×	×	×	×	×		✓	✓	×	×	✓												
	Good Env Choice (Australia)									✓				✓											
	Ecomark (Japan)	×											✓	✓											
	Env Choice (New Zealand)									✓				✓											
2	**Products to be inlcuded due to categorisation of products in other ecolabelling schemes**																								EPD PCR, Oct 2011, valid globally until Oct 2014; EDANA Definition
3	**EU Ecolabel requirements and typical characteristics of products suggested for the product group sanitary products** a) products fulfil a very similar function: the direct absorption (and removal) of human body waste streams b) products are made of similar raw materials c) disposable product d) products possess similar waste management options																								2010/66/EC, Article 3.1 and informed decision through logical conclusion and based on a range of specific documents
4	**Priority products identified through PRODCOM sales data and minority products**																								PRODCOM data
5	**Products to be excluded from EU ecolabelling scheme due to legislation**																								"EU eco labels shall apply neither to medicinal products for human use, as defined in Directive 2001/83/EC [...], nor on any type of medical devices" (2010/66/EC, Article 2.2)

Legend	
	= product included in study (both GPP and Eco Label)
	= product excluded in Eco Label but included in GPP)
	= out of scope (both GPP and Eco Label)
✓	= product included in Eco Label scheme
×	= product explicitely excluded in Eco Label scheme

Annex II

Swan labelling of paper Products – basic module (Version 1.0)[84]

Criteria for Swan labelling of paper products encompass a wide range of requirements, most of which relate to pulp and paper production. The Basic Module contains requirements regarding forest management, emissions, energy and waste in pulp and paper manufacturing.

Criteria applicable to paper manufacturers

R1	Principles of documentation
R2	Other environmental reporting systems
R3	Types of paper
R4	Trade mark and trade name
R5	Technical description
R6	Production technology
R7	Requirements of the authorities
R8	Environmental and quality assurance
R9	Quality manual
R10	Origin of the fibre raw material
R11	Chemicals
R12	Total energy score
R13	Calculation of the reference value
R14	Used energy
R15	Energy scores for paper production
R16	Energy scores for a mixture of different pulp types
R17	Total energy score for paper and pulp production
R18	Generation of electricity based on fossil fuel and nuclear power
R19	Chemical oxygen demand (COD), phosphorus (P), sulphur (S) and nitrogen oxides (NOx)
R20	Allocation
R21	AOX
R22	Chelating agents
R23	Chlorate
R24	CO2 from the combustion of fossil fuels within the plant
R25	Waste

R26 Annual reporting

Criteria applicable to pulp producers

R27 Principles of documentation

R28 Other environmental reporting systems

R29 Type of pulp

R30 Production method

R31 Requirements of the authorities

R32 Environmental and quality assurance

R33 Quality manual

R34 Origin of the fibre raw material

R35 Fibre raw material from certified forestry

R36 Exception to the requirement concerning fibre raw materials from certified forestry operation

R37 Chemicals

R38 Calculation of energy scores for pulp production

R39 Calculation of the reference value

R40 Reporting the quantity of energy used

R41 Generation of electricity based on fossil fuel and nuclear power

R42 Emissions of chemical oxygen demand (COD), phosphorus (P), sulphur (S) and nitrogen oxides (NOx)

R43 Allocation

R44 Chlorine gas bleaching

R45 Emission of AOX

R46 Emissions of chelating agents

R47 Emissions of chlorate

R48 CO2 from the combustion of fossil fuels within the factory

R49 Waste

Nordic ecolabelling of paper products – chemical module (Version 1.0)[85]

The Chemical Module covers requirements of chemicals used in the production of pulp and paper.

Requirements as to chemicals

R1 Production chemicals

R2 Alkylphenol ethoxilates

R3 De-inking surfactants

R4	Biocides
R5	Residual monomers
R6	Foam inhibitors / defoamers
R7	Wet strength agents
R8	Bleaching chemicals
R9	Dye for printing and colouring
R10	Classification of environmental hazard for dyes
R11	Heavy metals in dyes and pigment
R12	Impurities in dyes
R13	Phthalates in dyes
R14	Amines that are discharged from the dyes
R15	Adhesives

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