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Life Cycle Assessment of Printed Paper Products and Sustainability Calculator

EcoPaperLoop Project Results

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LCA of printed products.

EcoPaperLoop approach to LCA of paper products:

- **Focus on the end of life phase of LCA, environmental sustainability of the recycling / deinking process.**
- **LCA OF NEWSPAPERS**
  Screening LCA between average products of different categories.
  Assessment of different recycling options, different recycling loops.
- **STUDY OF THE MOST IMPORTANT PROCESS PARAMETERS, AFFECTING THE ENVIRONMENTAL SUSTAINABILITY OF RECYCLING.**
- **SUSTAINABILITY CALCULATOR. Software tool for the calculation of environmental impacts and sustainability of recycling.**

LCA of newspapers – screening

CASE STUDY: Standard Offset and flexographic printing of newspapers.

- **THE SCOPE OF THE STUDY is to assess the life cycle of newspapers printed with standard offset and flexographic technology, taking into account the most important phases from the production of the paper to the end of life options.**

- **Offset newspapers are considered recyclable within the graphic paper loop, by flotation deinking process.**
- **Flexo newspapers are considered undeinkable under standard flotation deinking and could not be recycled in the graphic paper loop.**
  Possible recycling in other paper loop, for instance packaging paper loop.

LCA Inventory – Impact Assessment

Inventory:

Database Ecoinvent V3 (update September 2014).

✓Average Category Data

✓Literature Data

Functional Unit is 1kg printed product.

Software for LCA
SimaPro, Version 8.0.3 (update September 2014).

Impact Assessment Method:
ReCiPe Endpoint V1.10

LCA Impact Assessment

Most Relevant Impact Categories – midpoint:

✓**Agricultural and urban land occupation** (in particular for paper production process)

✓**Climate change** (in particular for production and recycling, where a lot of energy is required) – Expressed as global warming potential.

✓**Fossil fuel and minerals depletion** (in particular for the production of chemicals).

Damage Categories – endpoint:

Human Health, Ecosystems, Resources.

LCA Product system and process

Assumptions for the study – product and process:

- **The same paper grade used for offset and flexo printed products. Newsprint made of DIP containing pulp. About 77% DIP (DeInked Pulp) and 23% virgin cellulose fibres. Source: Ecoinvent.**
- **Energy consumption and general impact of web offset printing and flexographic printing are considered the same. Differences are not significant with respect to overall life cycle.**
- **Flexo ink is supposed to have the same pigments as the offset ink, without the light weight oils fraction and solvents, which represent 47,5% of the offset ink. Source: Ecoinvent.**
- **Ink consumption is 2,5% of the paper weight for the offset printing and double for the flexographic printing. Source: Best Available Techniques in the printing industry, Ökopol, Germany.**

LCA End of Life

Assumptions for the study – end of life, general:

End of life: 90% of used newspapers (all types) are collected and recycled in the paper loop, municipal collection plus shops return.

The remaining amount is disposed 6% landfill and 4% incineration with energy recovery, as for mixed Municipal Solid Waste (MSW). Source: Cepi/Eurostat.

LCA End of Life

Assumptions for the study – end of life, specific:

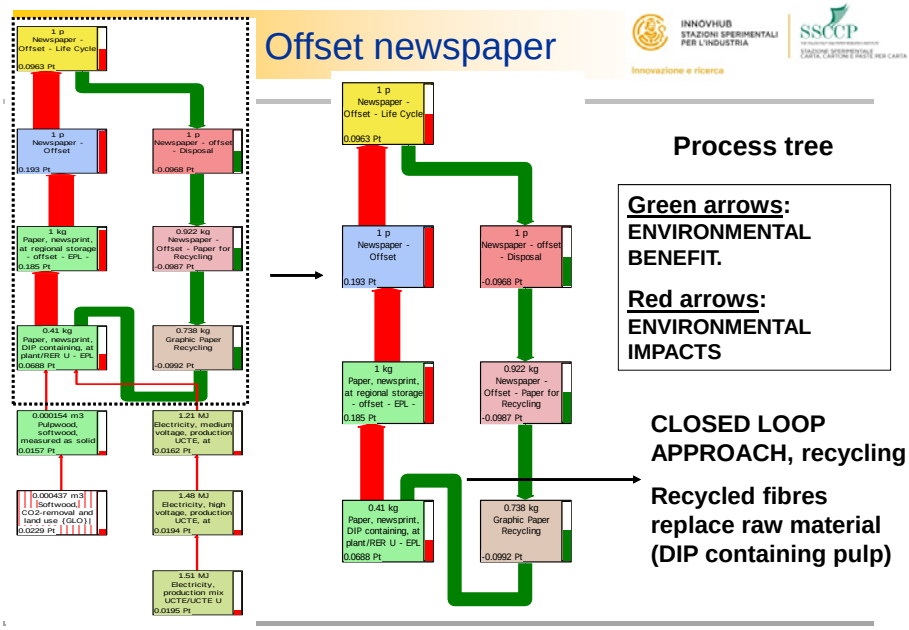
OFFSET:

- **Recycling within the same loop, graphic paper production loop.**
- **Deinking process with standard flotation technology. (2 loop flotation plant with process yield of 80%).**
- **Deinking sludge of 20% is disposed as landfill and incineration.**

FLEXO:

- **Newspapers are not deinkable by using a standard flotation technology, because the water based ink is dissolved in the pulp suspension.**
- **Products can be recycled in other loops, like packaging paper loop. This means recycling for the production of a different product, with lower quality fibers (downgrading). The benefit of recycling in this case is out of the system boundaries of the study.**

Offset newspaper



Process tree

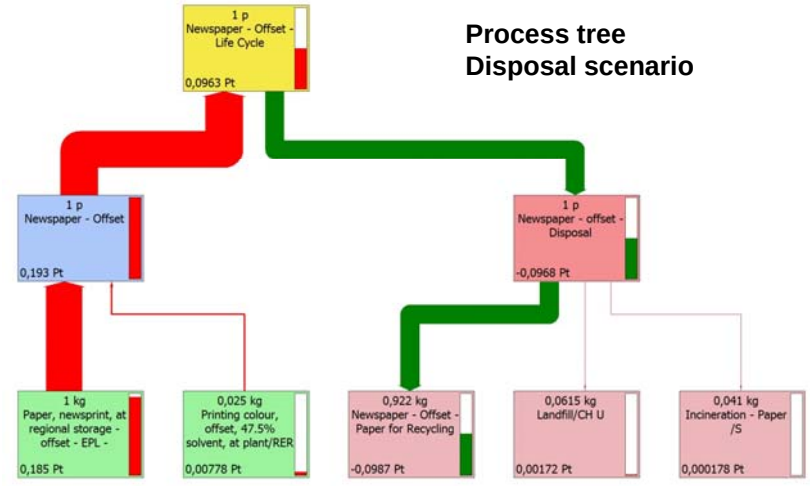
Green arrows: ENVIRONMENTAL BENEFIT.

Red arrows: ENVIRONMENTAL IMPACTS

CLOSED LOOP APPROACH, recycling

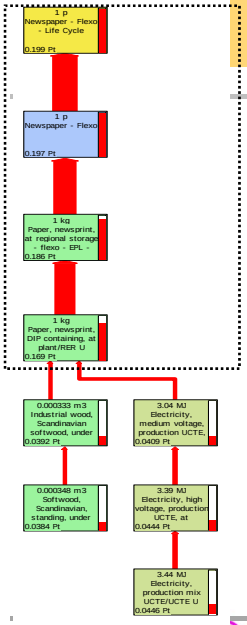
Recycled fibres replace raw material (DIP containing pulp)

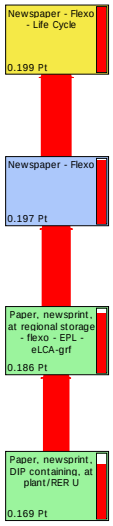
Offset newspaper



Process tree
Disposal scenario

Flexo newspaper





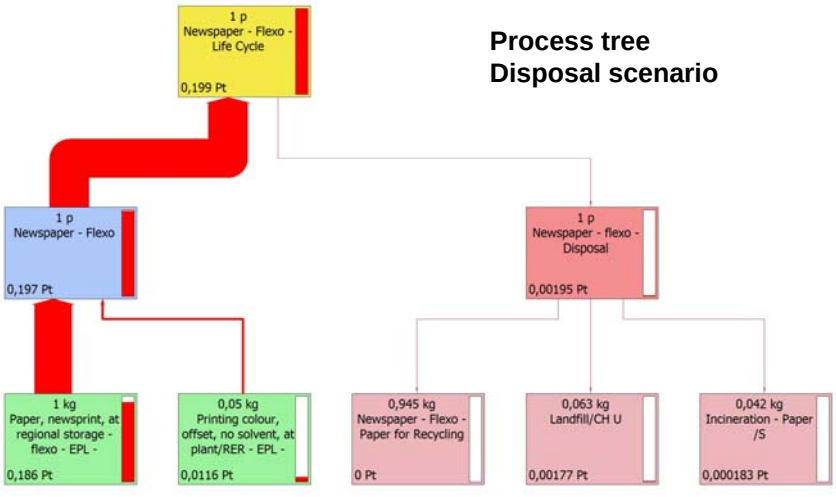
Process tree

Recycling in a different paper loop (packaging).

Raw material (DIP containing pulp) can not be replaced by recycled fibres.

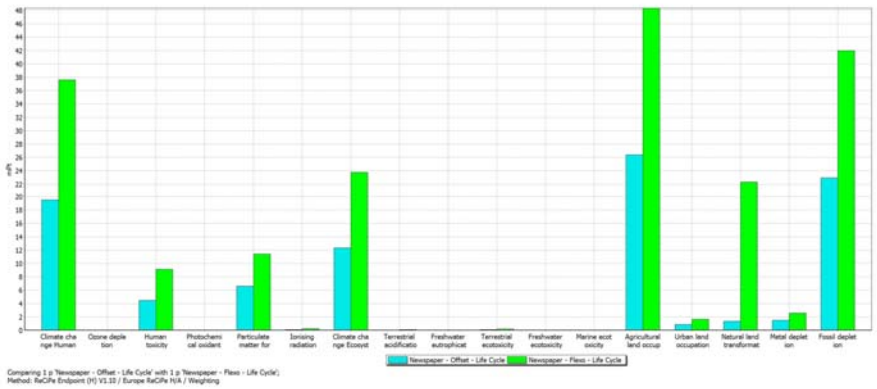
It can not be accounted any benefit nor impact for the recycling (out of system boundaries).

Flexo newspaper



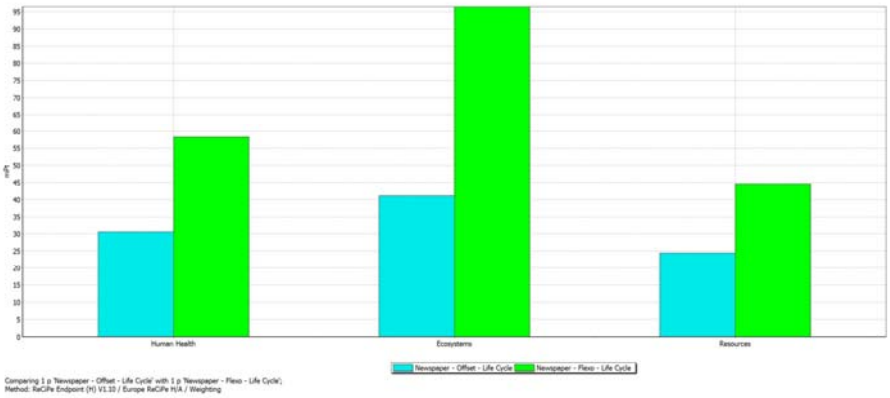
Process tree
Disposal scenario

Newspapers – Full Life Cycle



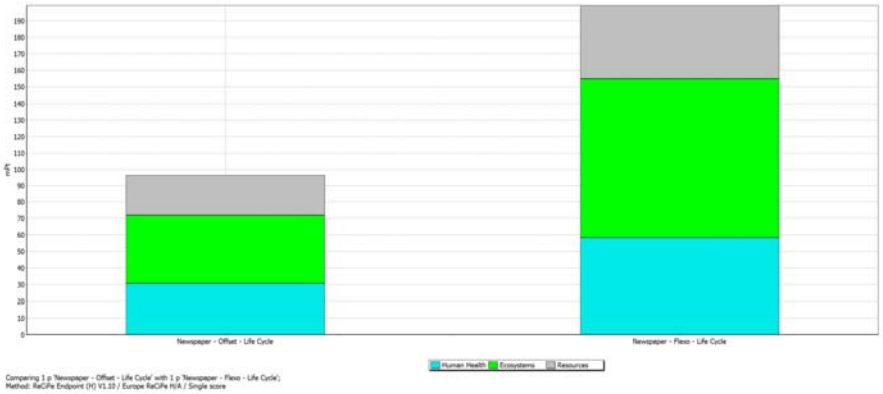
Mid point results – Impact Categories

Newspapers – Full Life Cycle



End Point Results – Damage Categories

Newspapers – Full Life Cycle



Single Score Results

Newspapers – Results

✓**<u>The process with the highest impact</u> is the pulp production for paper manufacturing, because of the recycling process for DIP production and the chemi-mechanical process for cellulose production.**

✓**<u>The printing process</u> accounts about 5% of the overall impact in the case of offset newspaper and about 4,2% for flexo newspaper (lack of light fuel oils and solvents in the ink composition). However the difference is very small with respect of full life cycle of newspapers.**

✓**<u>The most important environmental advantage</u> is the possibility of recycling the material within the same production loop, reducing the amount of raw material required.**

✓**<u>Recycling has a positive effect in all the impact categories</u> and mainly in the categories where the impact of pulp production is more evident (agricultural land transformation, natural land trasnformation, climate change, fossil resources).**

End of Life assessment

Research study focused on the End of Life phase of printed products, to be implemented in the LCA:

- **Which are the most important environmental emissions in recycling?**
- **What are the most important deinking parameters affecting environmental emissions of recycling?**
- **How are they connected?**
- **How to evaluate the environmental performances of the recycling process depending of deinking parameters?**

End of Life assessment

Three Product Categories considered in details:
<u>Newspapers</u> – <u>Uncoated Magazines</u> – <u>Coated Magazines</u>

Example: Newspapers Product Category

Table 1. Offset newspapers. Luminosity versus electricity and chemicals.
N1 and N2: linear functions for the correlation of Y, from low limit to average, and chemicals consumption.
N3: linear function for the correlation of Y, from average to high limit, and electricity consumption.

OFFSET NEWSPAPERS (including Flyers)	Luminosity (Y)				
	Y < 33,5	Low limit: Y = 33,5	Average: Y = 53,0	High limit: Y = 72,5	Y > 72,5
energy consumption, electricity, kWh/kg pulp	Poor deinkable, the most sustainable option is to improve the design of the product	constant = 0,300	0,300 (N3)	0,270 (N3)	constant = 0,270
deinking chemicals consumption, g/kg pulp		13 g/kg NaOH (N1) 40 g/kg silicate (N2)	5 g/kg NaOH (N1) 10 g/kg silicate (N2)	constant= 5 g/kg NaOH 10 g/kg Silicate	constant= 5 g/kg NaOH 10 g/kg Silicate

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End of Life assessment

Example: Newspapers Product Category

Table 2. Offset newspapers. Dirt Specks versus electricity and chemicals.
N4: linear function for the correlation of the Dirt Specks content, from Average to High Limit, and electricity consumption

OFFSET NEWSPAPERS (including Flyers)	Dirt Speckes (A_{50}), mm²/m²			
	Low limit: A_{50} = 0	Average: A_{50} = 630	High limit: A_{50} = 3000	A_{50} > 3000
energy consumption, electricity, kWh/kg pulp	constant = 0,300	0,300 (N4)	0,340 (N4)	Poor deinkable, the most sustainable option is to improve the design of the product
deinking chemicals consumption, g/kg pulp	-	-	-	

➢ Agerage and Limit values of Luminosity and Dirt Specks refers to laboratory tests results, considering hundreds of tests performed on market products.
Acknowledge: Ingede Deinkability Database.

➢Data about chemicals and electricity consumption consider a typical 2 loop flotation deinking technology for the production of newsprint paper. Data from literature and Industry.

Sustainability Calculator

WEB based SOFTWARE TOOL:

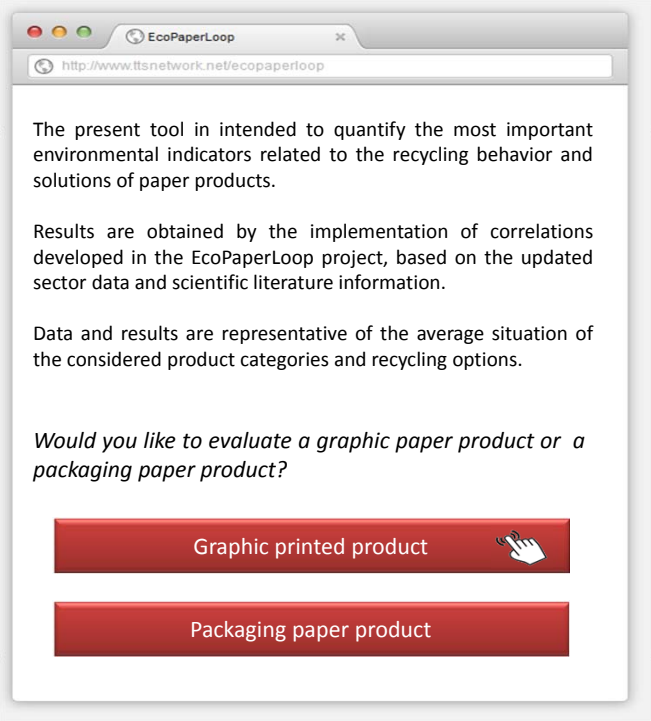
- ✓ **Simplified calculation of environmental sustainability of printed products**
- ✓ **LCA approach, focused on the end of life recycling phase**

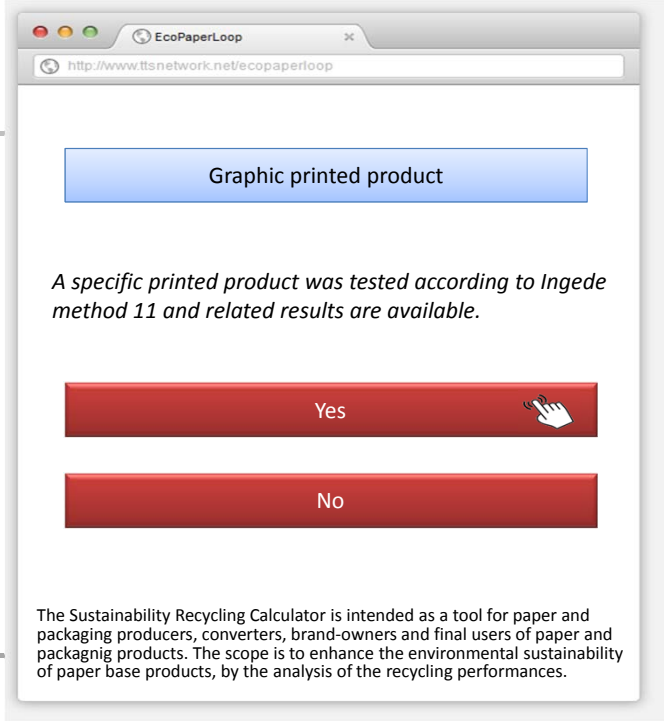
INPUTS

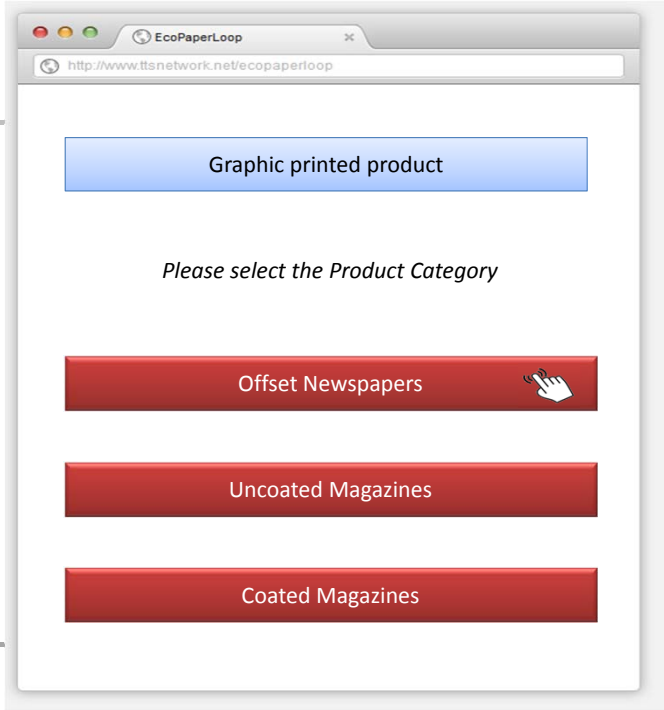
- ✓ **Deinkability parameters (Luminosity Y and Dirt Specks) of a specific product (according to INGEDE Method 11 if available)**
- ✓ **Average deinkability parameters for the product category (if specific results according to INGEDE Method 11 are not available)**

OUTPUTS

- ✓ **Chemicals and electricity consumption, average values**
- ✓ **CO_2 emission**


EcoPaperLoop
http://www.ttsnetwork.net/ecopaperloop
The present tool in intended to quantify the most important environmental indicators related to the recycling behavior and solutions of paper products.
Results are obtained by the implementation of correlations developed in the EcoPaperLoop project, based on the updated sector data and scientific literature information.
Data and results are representative of the average situation of the considered product categories and recycling options.
Would you like to evaluate a graphic paper product or a packaging paper product?
Graphic printed product
Packaging paper product


EcoPaperLoop
http://www.ttsnetwork.net/ecopaperloop
Graphic printed product
A specific printed product was tested according to Ingede method 11 and related results are available.
Yes
No
The Sustainability Recycling Calculator is intended as a tool for paper and packaging producers, converters, brand-owners and final users of paper and packagnig products. The scope is to enhance the environmental sustainability of paper base products, by the analysis of the recycling performances.


EcoPaperLoop
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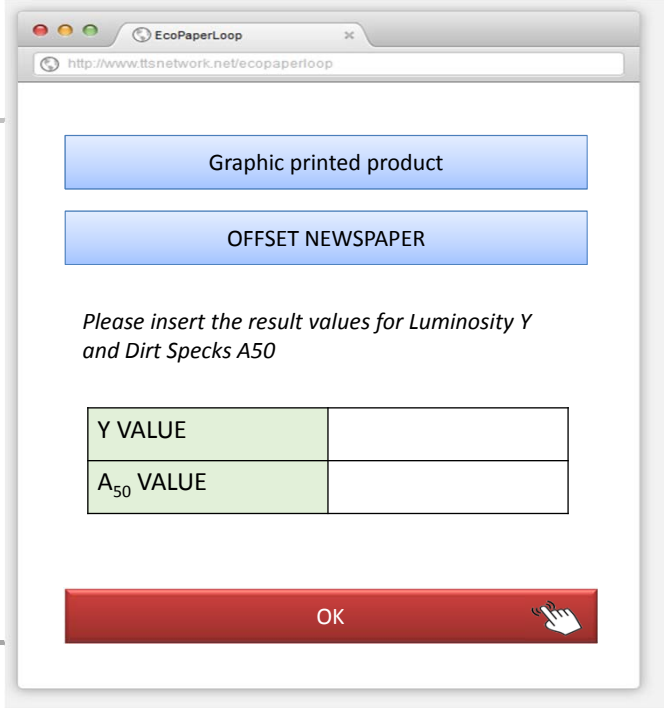
Graphic printed product
Please select the Product Category
Offset Newspapers
Uncoated Magazines
Coated Magazines


EcoPaperLoop
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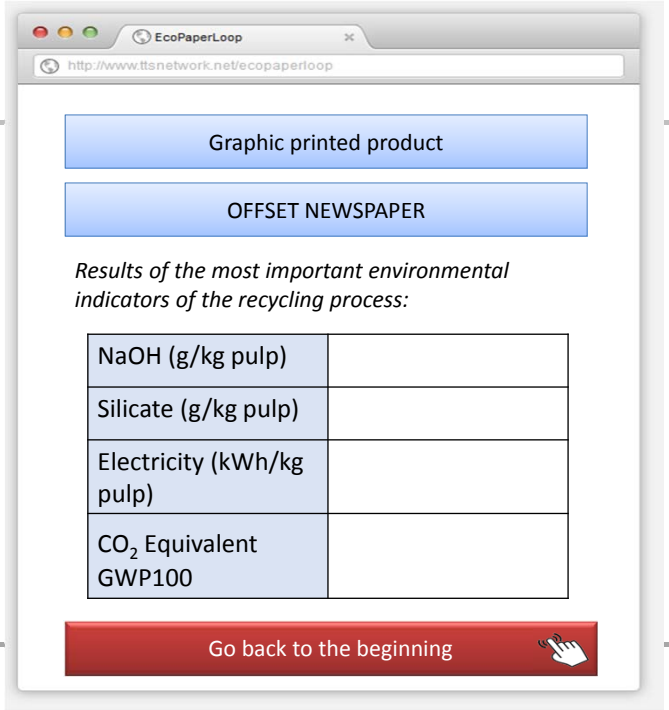
Graphic printed product
OFFSET NEWSPAPER
Please insert the result values for Luminosity Y and Dirt Specks A50
Y VALUE
A_{50} VALUE
OK


EcoPaperLoop
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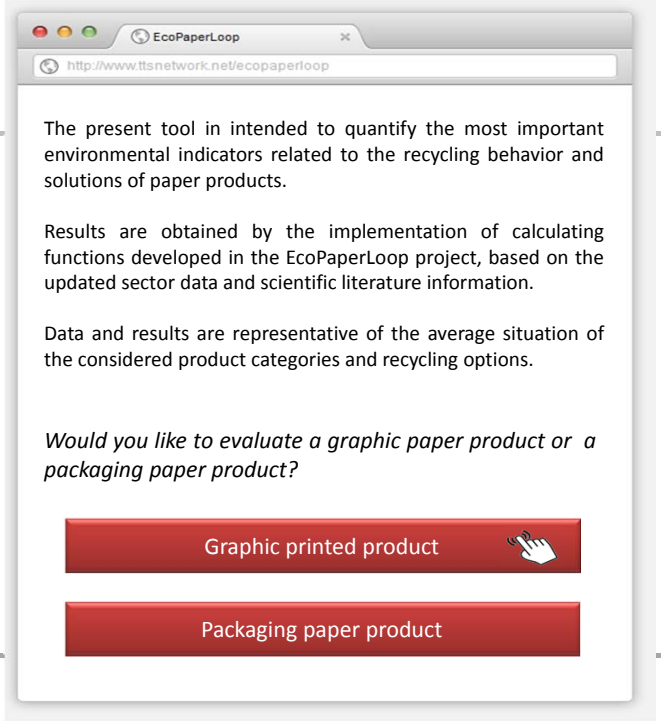
Graphic printed product
OFFSET NEWSPAPER
Results of the most important environmental indicators of the recycling process:
NaOH (g/kg pulp)
Silicate (g/kg pulp)
Electricity (kWh/kg pulp)
CO_2 Equivalent GWP100
Go back to the beginning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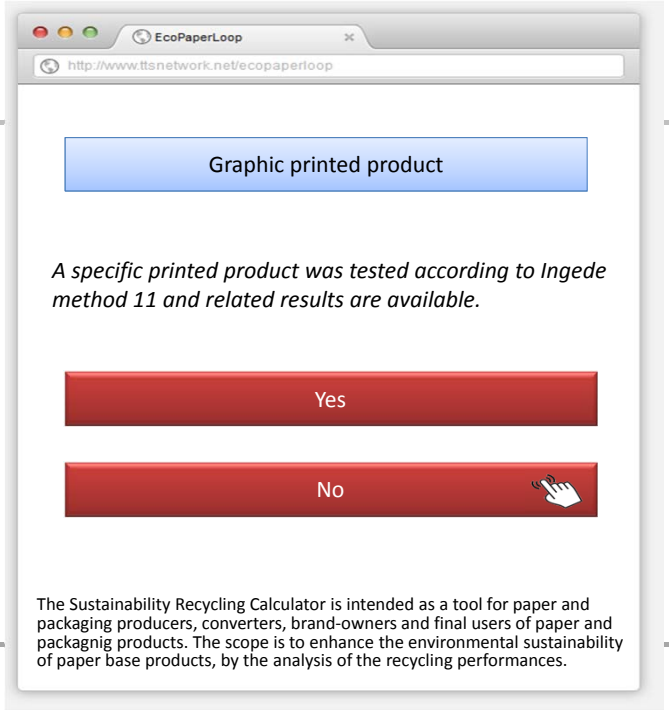
Packaging paper product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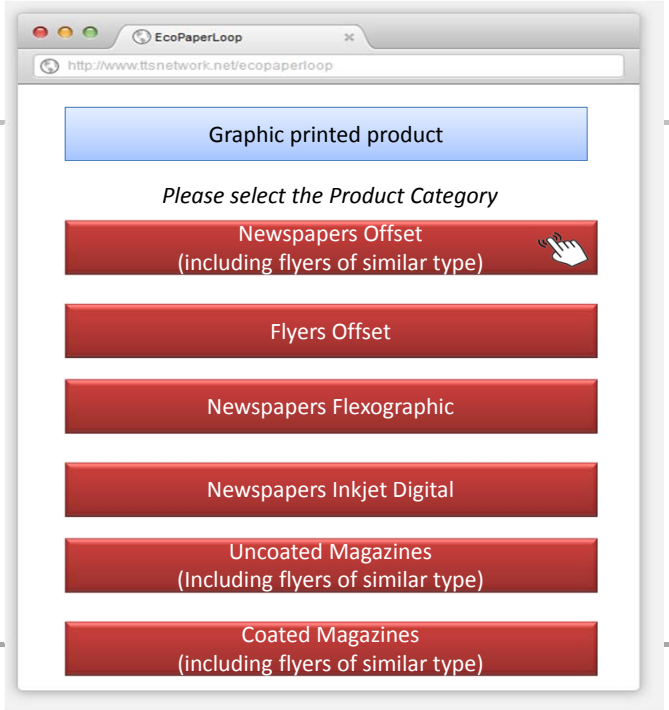
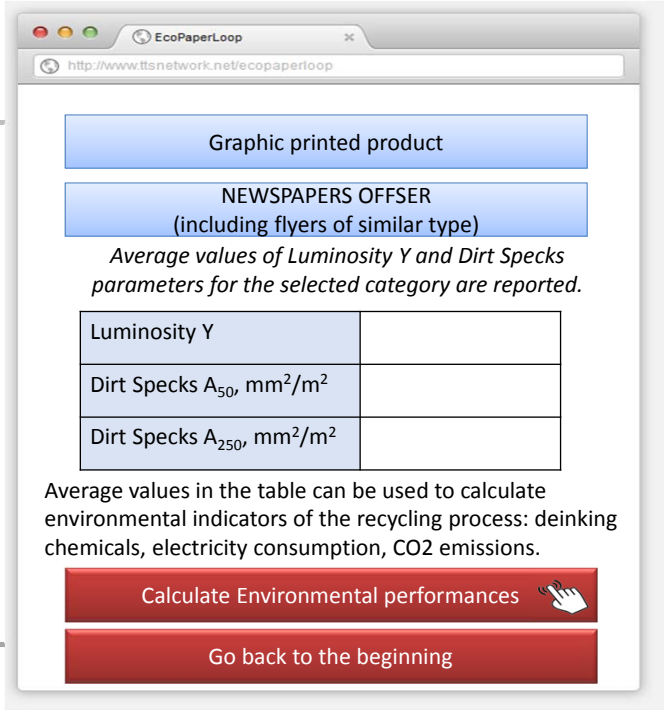
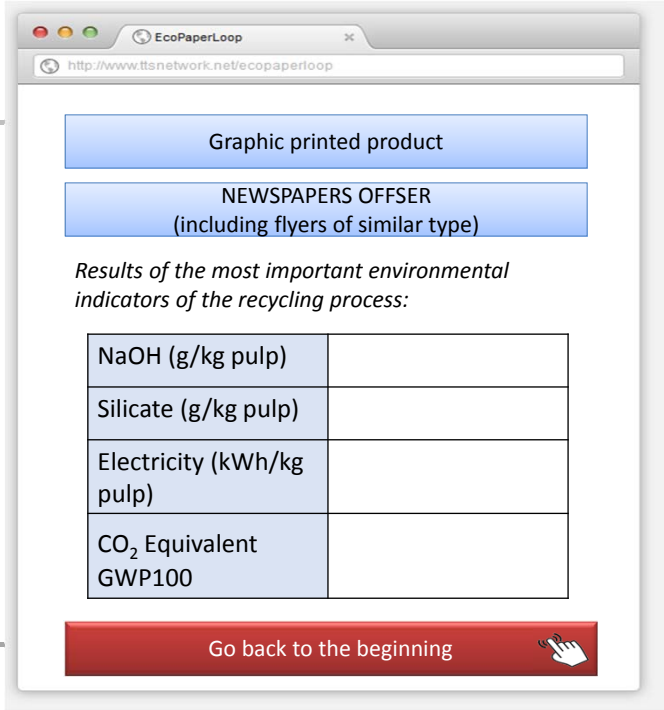

EcoPaperLoop
http://www.ttsnetwork.net/ecopaperloop
Graphic printed product
Please select the Product Category
Newspapers Offset
(including flyers of similar type)
Flyers Offset
Newspapers Flexographic
Newspapers Inkjet Digital
Uncoated Magazines
(Including flyers of similar type)
Coated Magazines
(including flyers of similar type)


EcoPaperLoop
http://www.ttsnetwork.net/ecopaperloop
Graphic printed product
NEWSPAPERS OFFSER
(including flyers of similar type)
Average values of Luminosity Y and Dirt Specks parameters for the selected category are reported.
Luminosity Y
Dirt Specks A_{50}, mm^2/m^2
Dirt Specks A_{250}, mm^2/m^2
Average values in the table can be used to calculate environmental indicators of the recycling process: deinking chemicals, electricity consumption, CO2 emissions.
Calculate Environmental performances
Go back to the beginning


EcoPaperLoop
http://www.ttsnetwork.net/ecopaperloop
Graphic printed product
NEWSPAPERS OFFSER
(including flyers of similar type)
Results of the most important environmental indicators of the recycling process:
NaOH (g/kg pulp)
Silicate (g/kg pulp)
Electricity (kWh/kg pulp)
CO_2 Equivalent GWP100
Go back to the beginning

Thank you

Acknowledgment: **EcoPaperLoop, Eco design for the enhancement of central europe Paper based products recycling Loop.**

www.ecopaperloop.eu

For further information please contact:

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