CIRCULAR FoodPack

# D7.1 DEFINED SCENARIOS AND DATA INVENTORIES FOR PRELIMINARY SUSTAINABILITY ASSESSMENT WORK PACKAGE 7

Associated Task(s):
T7.1 Scenario definition and process flow schemes
T7.2 Mass and energy balances

**Lead Partner**: UGent
**Partners involved**: all
**Dissemination Level**: Public
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## Disclaimer



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## PUBLISHABLE EXECUTIVE SUMMARY

In CIRCULAR FoodPack project, the newly developed value chains as part of WP2 and WP3 are assessed by means of a holistic life cycle sustainability assessment (LCSA), taking into account environmental impacts through Life Cycle Assessment (LCA), economic impacts through Life Cycle Costing (LCC) and social impacts through Social LCA (S-LCA).

Within the life cycle thinking approach, four phases are relevant to obtain the assessments:

a) the goal and scope definition phase,
b) the inventory analysis phase,
c) the impact assessment phase and
d) the interpretation phase (ISO 14044, 2006).

From June 2021 to November 2022, the emphasis was placed on the first two phases. This comprises the definition of the different scenarios which are based on the three use cases that are home packaging (H), personal care packaging (PC) and food packaging (F) including the following six demonstrators/applications: Wet wipes (H1), Detergent tabs (H2), Cosmetics in sachets (PC1), Chocolate powder (F1), Coffee (F2) and Creamer (F3). Regarding the applications, three main loops (loop 1-3) are considered differing for instance in the input of either mixed food-flexibles and non-food flexibles or solely food-flexibles. Another important step was the creation of process flow schemes in close cooperation with the project partners for the following processes:

(1) Collection, SoA sorting and Tracer-based sorting,
(2) Pretreatment including Oversorting, Shredding, Washing, Grinding and Float-sink separation,
(3) Purification with option A-CreaSolv®® and option B-Deinking and Delamination,
(4) Posttreatment consisting of Recompounding and Deodorization,
(5) Laminate production and also considering Ink production, Primer production and Tracer production and
(6) Food packaging production.

Based on this work, data collection for LCA and LCC inventories is completed by the respective partners to obtain the data for the preliminary sustainability assessment. The collection of S-LCA data is not considered in this deliverable as the impact indicators relevant for the system will be selected in a next step.

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## LIST OF FIGURES



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## ABBREVIATIONS

| Abbreviation | |
|---|---|
| B2B | Business to business |
| CAPEX | Capital expenditure |
| EoL | End of life |
| F | Food |
| FP | Food packaging |
| FU | Functional Unit |
| HP | Home packaging |
| IVV | Frauenhofer Institute IVV |
| KREYEN | Kreyenborg |
| LCA | Life cycle assessment |
| LCC | Life cycle costing |
| LCI | Life cycle inventory |
| LCSA | Life Cycle Sustainability Assessment |
| NF | Non-Food |
| OPEX | Operating expenditure |
| PCP | Personal care packaging |
| PCR | Post-consumer recyclates |
| POLY | Polysecure |
| S-LCA | Social Life Cycle Assessment |
| SoA | State of the art |
| Tbd | To be discussed |
| TBS | Tracer Based Sorting |
| UM | Maastricht University |

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# 1. INTRODUCTION

This Deliverable describes the first part of the Work Package 7 (WP7) work: Comprehensive Sustainability Assessment and Decision-support Tool. More specifically, this report comprises the scenario definition and process flow schemes (Task 7.1) and the Mass and energy balances (Task 7.2).

The objective of WP7 is to assess comprehensively the sustainability of the newly developed value chains (with new technology and packaging design), systematically taking into account the entire life cycle, performed in a holistic way by considering environmental, economic and social impacts. Life cycle assessment (LCA), life cycle costing (LCC) and social life cycle assessment (S-LCA) as part of Life Cycle Sustainability assessment (LCSA), shown in Figure 1, serve as the methodological basis for mapping the respective impacts (Kloepffer, 2008).


*Figure 1 Life Cycle Sustainability assessment (LCSA) definition adapted by (Kloepffer, 2008)*

There are four phases in a LCA study: a) the goal and scope definition phase, b) the inventory analysis phase, c) the impact assessment phase, and d) the interpretation phase (ISO 14044, 2006). These phases also serve as the basis for the LCC modelling structure (Ciroth et al., 2011). The present Deliverable addresses the definition of scenarios in close collaboration with the technology and packaging developers, starting from three defined use cases (loop 1-3), which will be compared to the state of the art (SoA) baseline treatment scenarios. Additionally, the preliminary data collection of LCA and LCC data inventory (for hotspot analysis as a function of intermediate feedback) is also part of the scope, and will be refined in the further course of the project.[1] Therefore, the data collection templates (as shown in chapter 3 and Annex) were provided to the partners.

# 2. SCENARIO DEFINITION AND PROCESS FLOW SCHEMES

The geographical scope of the study is Europe, as the composition of flexible packaging waste was investigated in three sorting facilities in France, Belgium and Germany, which are considered representative for the sorting methods used in many EU countries. The temporal scope of the assessment covers the duration of the project (2021-2024). As functional unit (FU) the comparison of different scenarios through the basket of products approach was chosen. Basket

[1] The collection of S-LCA data is not considered in this deliverable as the impact indicators relevant for the system and the partners will be selected in a workshop during the next General Assembly in Nov. 2022.

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of product is defined as a selection of product groups (European Commission, 2012). In this study (1) non-food packaging, (2) food packaging and (3) energy and heat recovery from incineration, are considered as basket of products.

## 2.3 Scenario definition

### 2.3.1 Innovative Cases

Innovative scenarios are based on three categories of packaging applications, i.e. home packaging (HP), personal care packaging (PCP) and food packaging (FP) including the following six demonstrators/applications:

1. Wet wipes (HP1)
2. Detergent tabs (HP2)
3. Cosmetics in sachets (PCP1)
4. Chocolate powder (FP1)
5. Coffee (FP2)
6. Creamer (FP3).

Regarding the applications, three main cascade cases here named as loops (Table 1) are considered differing for instance in the input of either mixed end-of-life (EoL)-food (F) flexibles and EoL-non-food (NF) flexibles or solely EoL-F flexibles. EoL-F flexibles are used, for example, for food sub-categories such as dairy products, coffee, tea, cocoa, bakery products, frozen food or fresh products. EoL-NF flexibles are used, for example, for non-food sub-categories such as collection bags, small bags, secondary packaging films or carrier bags. These examples do not include all the identified subcategories that were part of WP2's work. The full list of food and non-food sub-categories can be found in Deliverable 2.1. The result of each loop is a laminate consisting of a combination of virgin polyethylene (PE) and post-consumer-recyclate (PCR) PE. In the case of food applications (FP1-3), functional barriers are added. In loop 3, which comprises two product cycles as sub scenarios, tracers are added to the laminate.

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*Table 1 Definition of innovative cases to provide food and non-food packaging*

| Cases | Input | Output | Applications |
|---|---|---|---|
| Loop 1 | Mixed = EoL F and NF flexibles | **Laminate 1:** mono-material with<br>• PE virgin<br>• PE PCR from F and NF origin | HP1: wet wipes<br>HP2: detergent tabs<br>PCP1: cosmetics in sachets |
| Loop 2 | F flexibles | **Laminate 2:** mono-material with<br>• PE virgin<br>• PE PCR from F origin<br>• Functional barriers | FP1: chocolate powder |
| Loop 3 cycle 1 | Mixed = F and NF flexibles with tracers in F flexibles | **Laminate 3:** mono-material with<br>• PE virgin<br>• PE PCR from F origin<br>• Functional barriers and tracers | FP2: coffee<br>FP3: creamer<br>PCP1: cosmetics in sachets |
| Loop 3 cycle 2 | Mixed = F and NF flexibles with tracers in F flexibles | **Laminate 4:** mono-material with<br>• PE virgin<br>• PE PCR from F origin<br>• Functional barriers and tracers | FP2: coffee<br>FP3: creamer<br>PCP1: cosmetics in sachets |

### 2.3.2 Baseline Scenario

For the baseline scenario the following end-of-life options and shares for plastic packaging are taken into consideration (Eunomia & Plastic Recyclers Europe, 2020; Plastic Europe, 2020):

- 17% recycling
- 56.5% incineration with energy recovery
- 26.5% landfilling.

The figures for recycling are based on Eunomia & Plastic Recyclers Europe (2020) and refer specifically to PE films from household packaging. As the Eunomia report does not include corresponding figures for incineration with energy recovery and landfilling, the figures for these two waste management pathways are based on Plastic Europe (2020) figures for plastic packaging including household, commercial and industrial packaging. Here, the used ratio (1:2.1) between landfill and incineration is calculated based on the shares for each pathway, which are 39.50% for incineration with energy recovery and 18.50% for landfill (Plastic Europe, 2020). The ratio (1:2.1) is then applied to the delta (83%) of recycling and the remaining pathways.

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## 2.4 Process flow schemes

Table 2 shows the partners and one advisory board member involved in relation to the developed processes within this project.

*Table 2 Involved partners per process step*

| Partners | Process |
|---|---|
| SUEZ | Collection, SoA sorting and Pretreatment |
| POLY | Tracer-based sorting and tracer production |
| UGENT | Purification (Delamination and Deinking) |
| IVV | Purification (CreaSolv®) |
| UM, SUEZ | Recompounding |
| KREYEN | Deodorization |
| AMCOR | Laminate production(including film production and printing) |
| SIEGWERK | Ink and primer production |
| NESTLE | B2B collection + F packaging production |
| UBESOL[2] | NF packaging production |

In order to draw the process flow schemes bilateral meetings were held focusing on the inputs and outputs of each individual process step. System boundaries and process flow schemes were drawn for the following processes:

- Collection
- SoA sorting
- Tracer-based sorting
- Pretreatment
    - Oversorting
    - Shredding
    - Washing
    - Grinding
    - Float-sink separation
- Purification option A-CreaSolv®
- Purification option B-Deinking and Delamination
- Posttreatment Recompounding
- Posttreatment Deodorization
- Laminate production (including film production and printing)

[2] UBESOL is part of the advisory board. A first kick- off meeting was organised at the end of November. The creation of process flow schemes and data collection will follow in the next few weeks.

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- Ink production
- Primer production
- Tracer production
- F packaging production.

Three different purification pathways are taken into consideration for the preliminary assessment of loop 1-3: (1) Delamination + Deinking, (2) CreaSolv®, (3) Delamination + Deinking + CreaSolv®

CreaSolv® may not be applied in Loop 2 and Loop 3 if the pretreated PE-flakes show a sufficiently high purity and hence do not require additional purification after delamination and deinking. When CreaSolv® is applied as a purification step, the last step within the process is a regranulation/recompounding step, so an additional recompounding step is not required.

Taking into account the number of loops, purification pathways and applications, thirty different scenarios as shown in Table 3 can be distinguished:

*Table 3 Scenarios per loop, purification pathway and application*

| Cases | Purification pathway | Applications | Number of scenarios |
|---|---|---|---|
| Loop 1 | • Purification pathway (1)<br>• Purification pathway (2)<br>• Purification pathway (3) | HP1: wet wipes<br>HP2: detergent tabs<br>PCP1: cosmetics in sachets | 9 |
| Loop 2 | • Purification pathway (1)<br>• Purification pathway (2)<br>• Purification pathway (3) | FP1: chocolate powder | 3 |
| Loop 3 cycle 1 | • Purification pathway (1)<br>• Purification pathway (2)<br>• Purification pathway (3) | FP2: coffee<br>FP3: creamer<br>PCP1: cosmetics in sachets | 9 |
| Loop 3 cycle 2 | • Purification pathway (1)<br>• Purification pathway (2)<br>• Purification pathway (3) | FP2: coffee<br>FP3: creamer<br>PCP1: cosmetics in sachets | 9 |

## Explanation of terminology:

Since recompounding has been mentioned above, the difference between pelletizing, regranulation and recompounding is explained below.

- Pelletizing: polymer string is molded and cut into pellets (short parts of the string)
- Regranulation: Extrusion (i.e. melting) and pelletizing of post-consumer plastics
- Recompounding: regranulation incl. adding additives

The process flow schemes per loop (Figure 2-Figure 4) and the baseline scenario (Figure 5) are described below, followed by the detailed process flow schemes of each process step i.e. Collection, Sorting and Pretreatment (Figure 6-Figure 8), Purification (Figure 9-Figure 11),

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Posttreatment (Figure 12 and Figure 13), Laminate production (Figure 14-Figure 16), Tracer-, Ink- and Primer production (Figure 17-Figure 19) and F packaging production (Figure 20).

The difference between the loops can be seen in the inputs of the process flow charts. In loop 2, the input comes from commercial consumers (Figure 2), while the input of loop 1 (Figure 1) and 3 comes from households. In loop 3, in addition to state of the art (SoA) sorting, tracer-based sorting (TBS) technology has been introduced to ensure that developed packaging with tracers (shown here in Figure 3 as PE-rich flexible food with tracers) is sorted out of the waste stream. In addition, there is a difference in the output of the loops, as loop 1 produces laminate for non-food applications, while loop 2 and loop 3 produce laminates for food applications. Empty boxes and three dots between the arrows [...] serve as a preliminary illustration and represent that either several process steps, e.g. Oversorting, Shredding, Washing, Grinding, Float-sink separation, have to be considered in the case of Pretreatment or that the final order of the cascade, e.g. whether deodorization takes place before or after Recompounding, has to be finally determined. The flow of unpacked NF or F products (in grey) is listed for illustrative purposes only and is not included in the assessments. A representation of the process flow schemes for loop 1-3 in an enlarged view in landscape format can be found in the Annex.

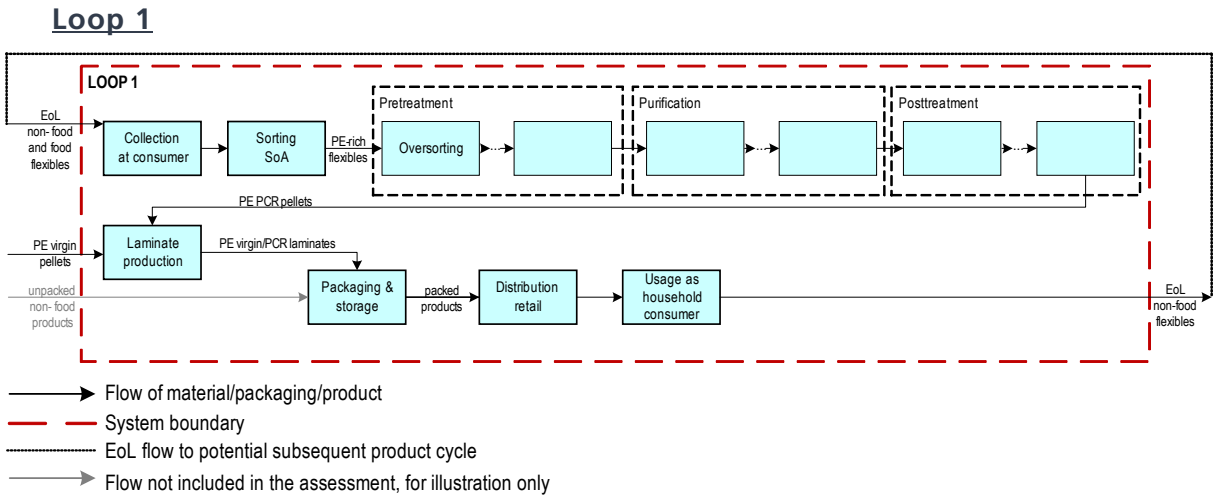


*Figure 2 Loop 1 process flow scheme for NF packaging*

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## Loop 2

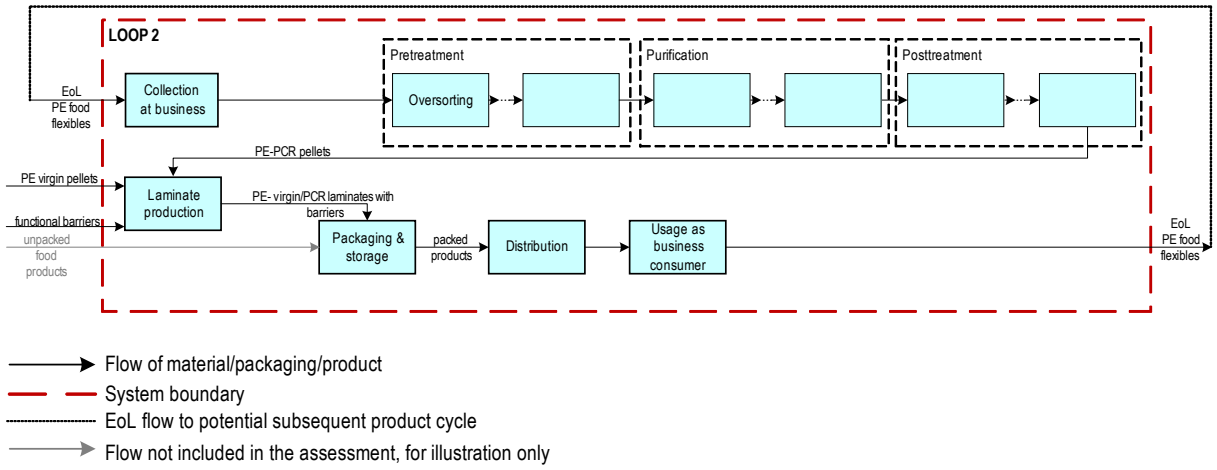


*Figure 3 Loop 2 process flow scheme for F packaging*

## Loop 3

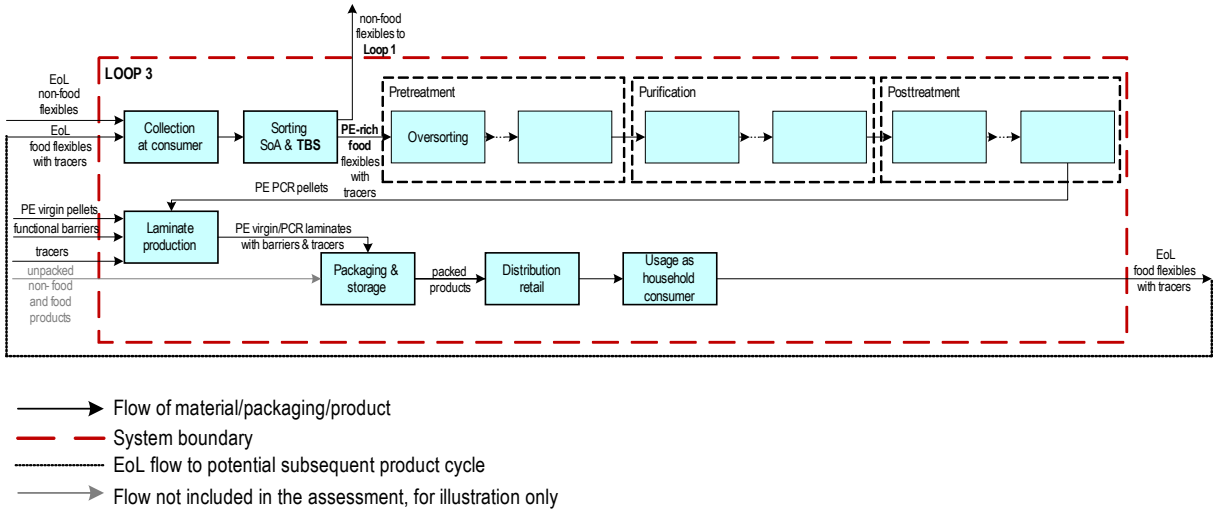


*Figure 4 Loop 3 process flow scheme for NF and F packaging*

### Baseline scenario

The process flow scheme for the baseline scenario is presented in Figure 5. The current waste treatment (*) combines incineration with energy recovery, landfilling and open-loop recycling (Plastic Europe, 2020). In open-loop recycling, the properties of the recycled material deviate from those of the virgin material (Huysman et al., 2017). As the waste input, i.e. non-food and food flexible (loop 1), solely food flexibles (loop 2) or non-food and food flexible with tracers (loop 3), differs depending on the respective loop, the baseline scenarios are adapted to the loops accordingly.

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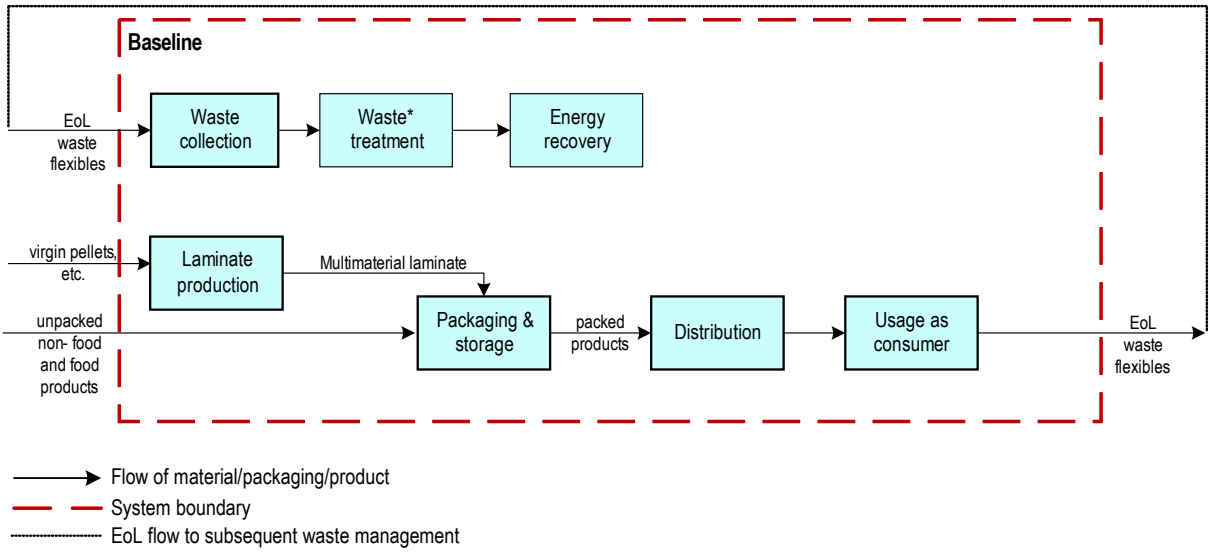


*Figure 5 Baseline scenario process flow scheme*

In the following the process steps are presented in terms of chronological sequence and loop.

### 2.4.1 Collection and Sorting and Pretreatment

The process flow scheme for Collection and SoA sorting and Pretreatment within loop 1 is shown in Figure 6 based on information provided by SUEZ. The residues from SoA sorting, Oversorting, Waste water treatment and Float-sink separation are sent to incineration with energy recovery. Data marked in green is preliminary and a final decision must be made accordingly i.e. if the following purification process takes place on the recycling site or whether a transport (T) is required.

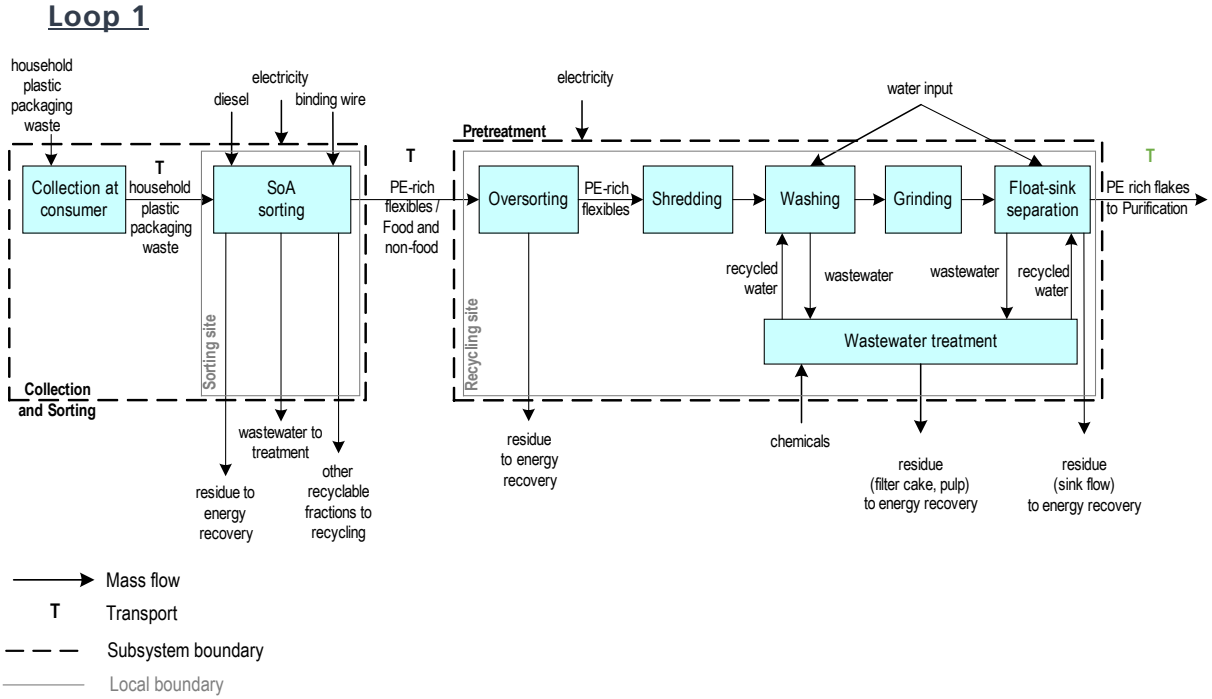


*Figure 6 Loop 1 Collection and SoA sorting and Pretreatment process flow scheme*

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The process flow scheme for Collection and SoA sorting and Pretreatment within loop 2 is shown in Figure 7. The SoA sorting step is omitted because the input material is collected from companies (B2B), resulting in a homogeneous stream that does not require SoA sorting apart from Oversorting.

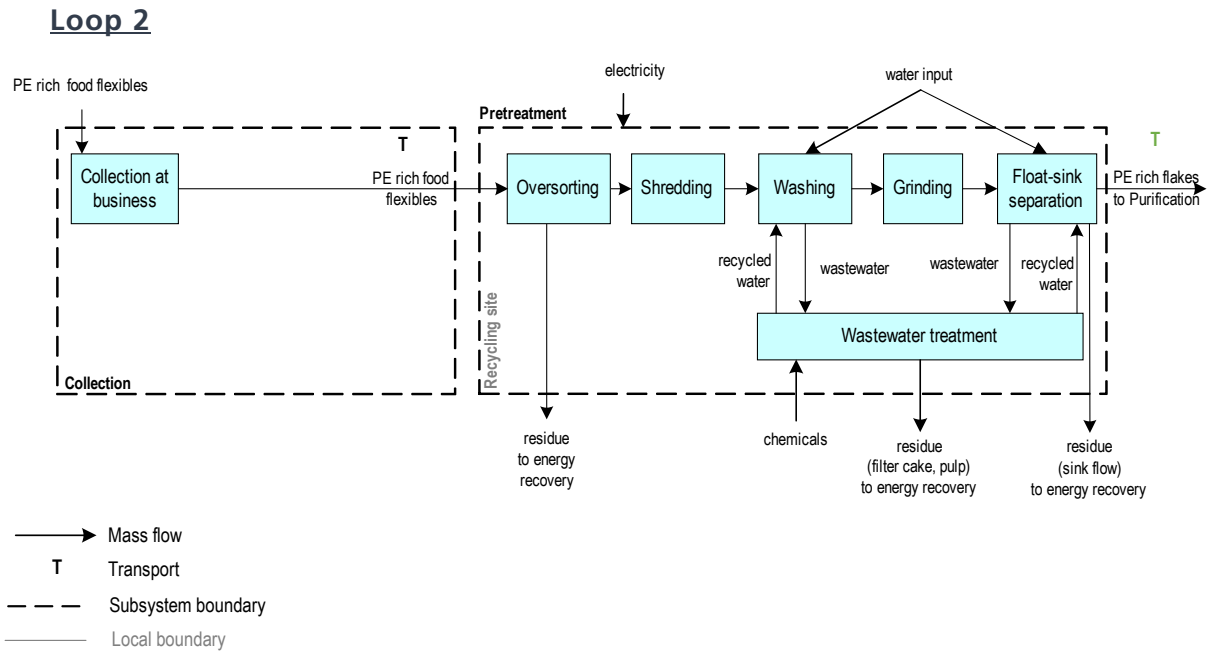


*Figure 7 Loop 2 Collection and SoA sorting and Pretreatment process flow scheme*

The process flow scheme for Collection and SoA sorting and Pretreatment within loop 3 is shown in Figure 8. An additional TBS sorting step is applied here.

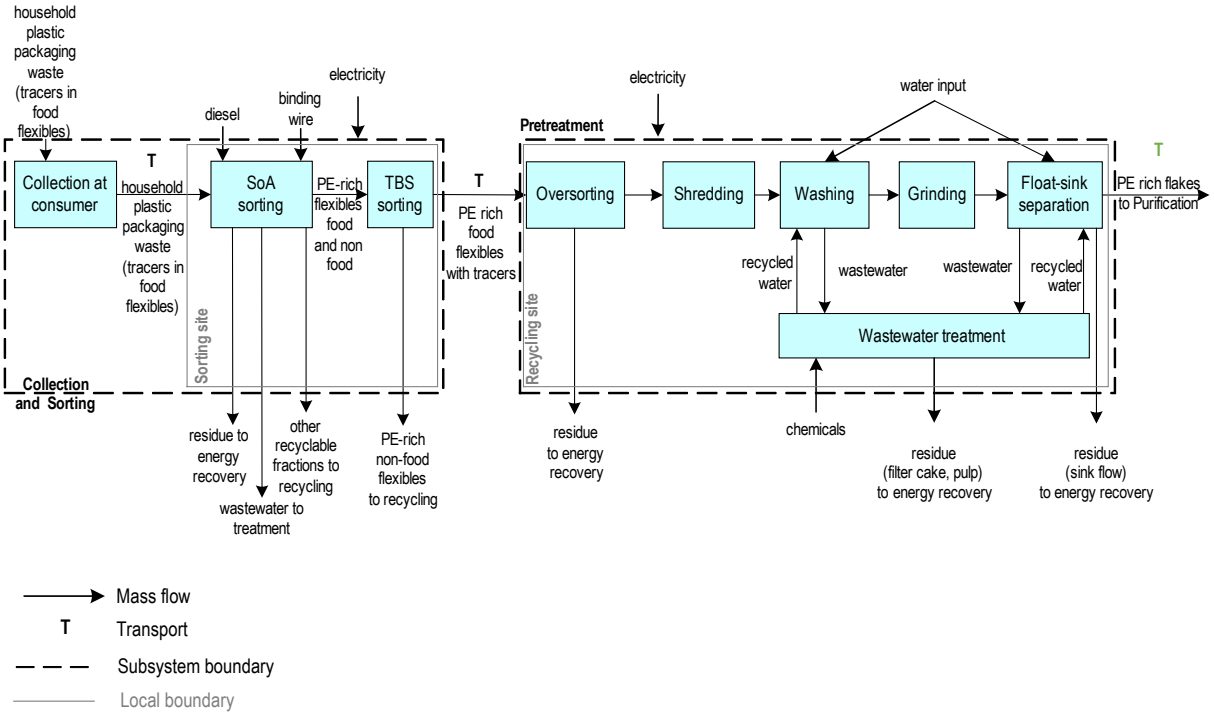


*Figure 8 Loop 3 Collection and SoA sorting and Pretreatment process flow scheme*

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### 2.4.2 Purification option A CreaSolv®

The process flow scheme for Purification option A CreaSolv® within loop 1-3 is presented in Figure 9 based on information provided by IVV. Data marked in green i.e. if additives are added in the regranulation step are preliminary and a final decision must be made accordingly.

**Loop 1-3**

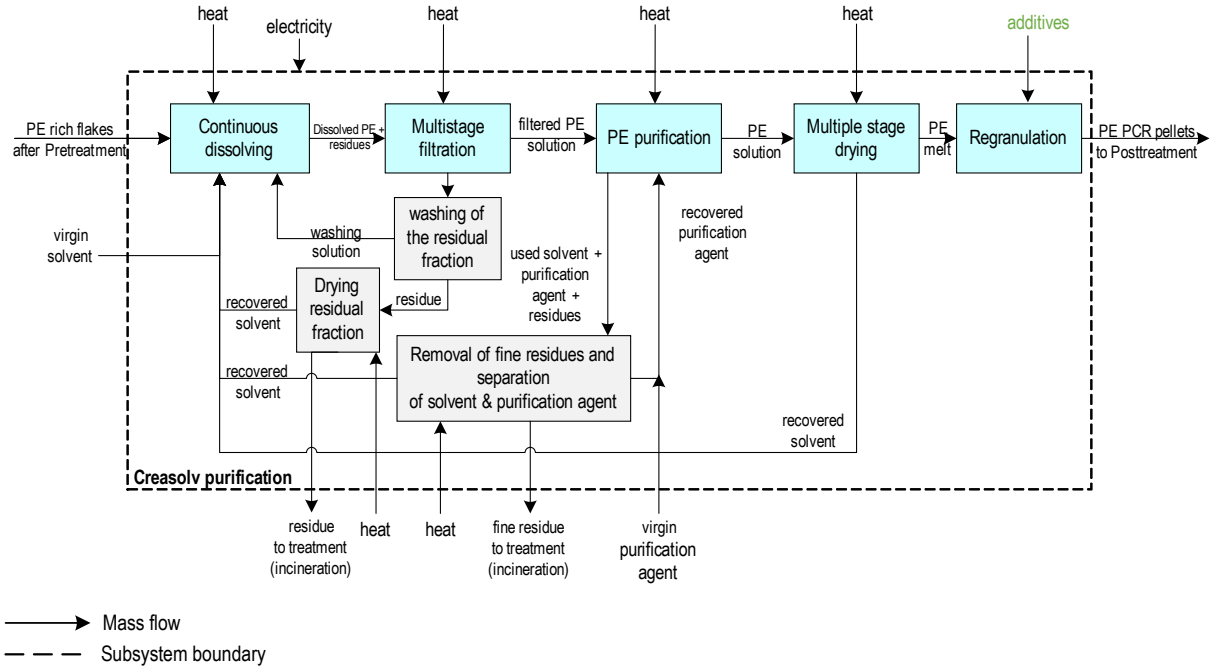


*Figure 9 Loop 1-3 Purification option A CreaSolv® process flow scheme*

### 2.4.3 Purification option B Delamination and Deinking

The process flow scheme for Purification option B Delamination and Deinking within loop 1 and 2 is shown in Figure 10 based on information provided by UGENT. Data marked in green i.e. if residues are sent to energy recovery are preliminary and a final decision must be made accordingly.

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## Loop 1 and 2

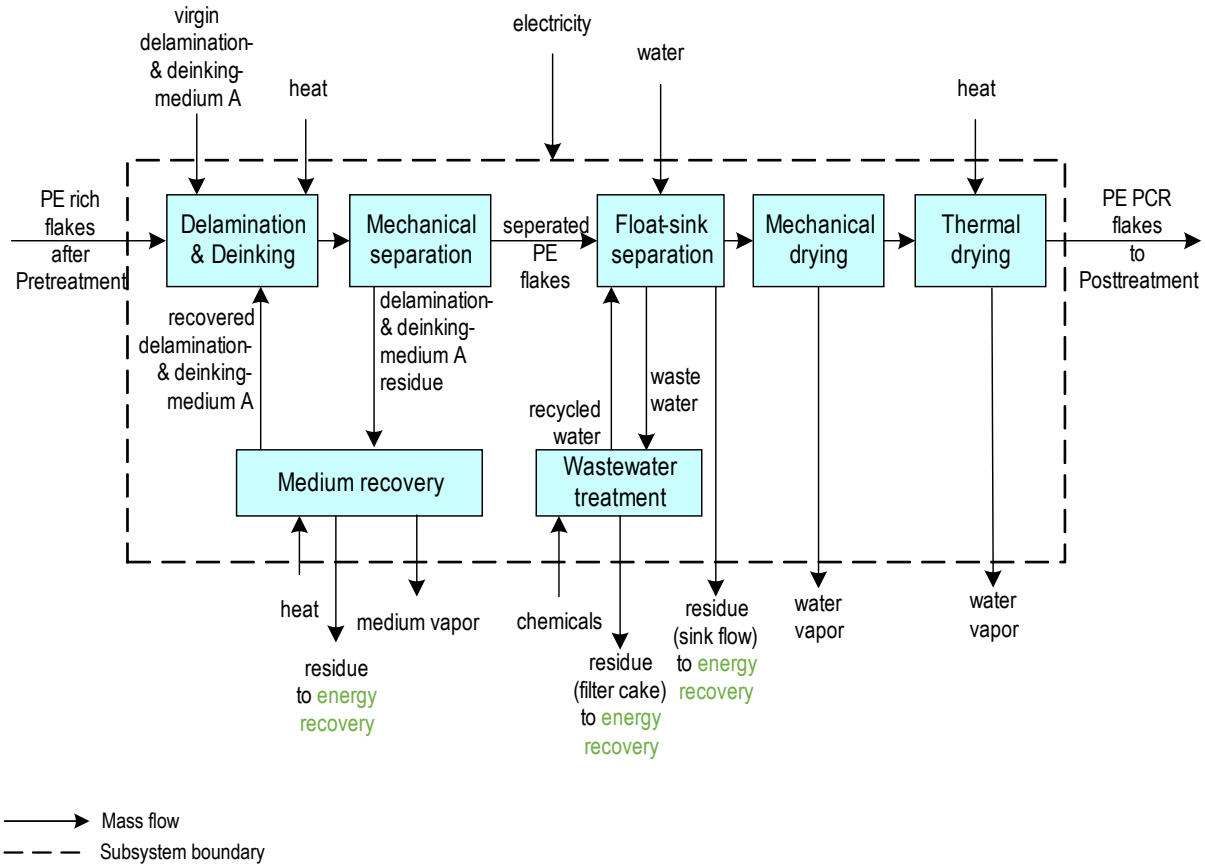


*Figure 10 Loop 1-2 Purification option B Delamination and Deinking process flow scheme*

The process flow scheme for Purification option B Delamination and Deinking within loop 3 is shown in Figure 11. The delamination and deinking medium B is different from the medium A used in loop 1-2, and medium recovery is not feasible here. Data marked in green i.e. if recycle water can be applied in various steps are preliminary and a final decision must be made accordingly.

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**Loop 3**

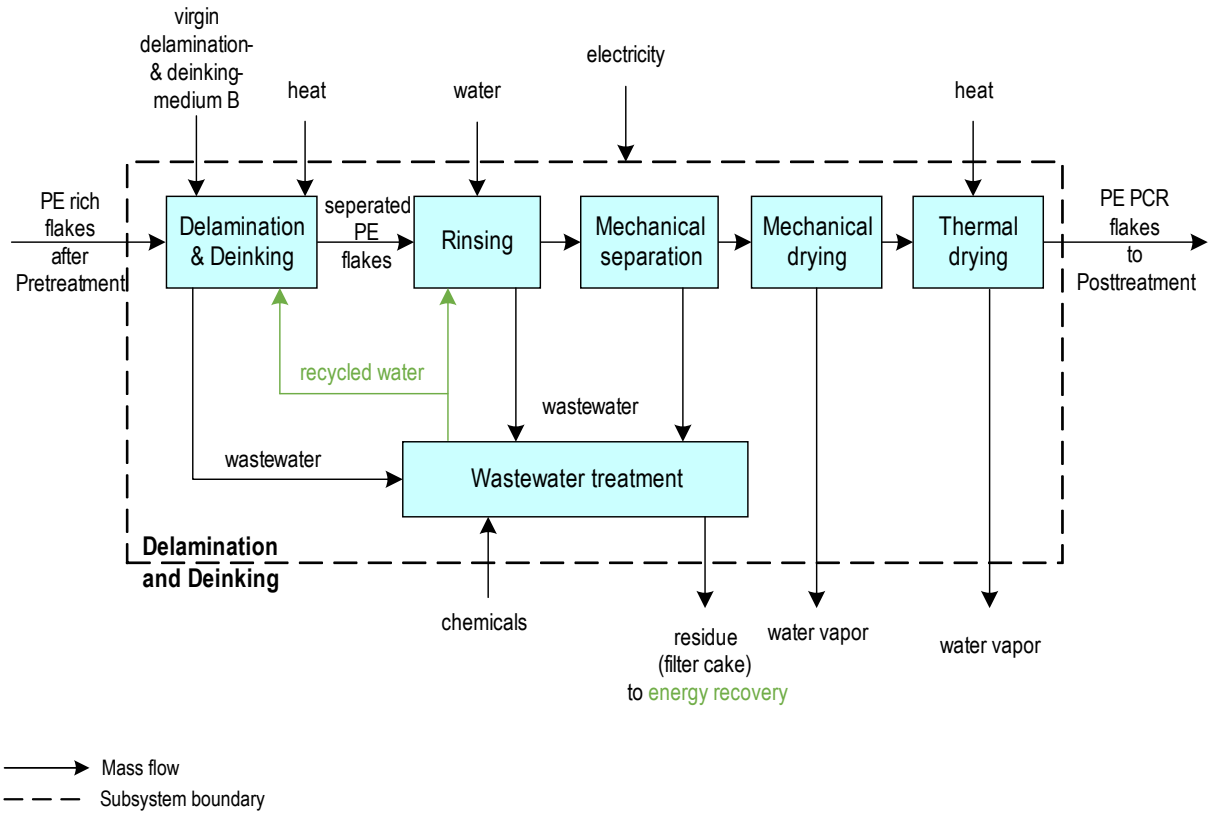


*Figure 11 Loop 3 Purification option B Delamination and Deinking process flow scheme*

### 2.4.4 Posttreatment Recompounding

The process flow scheme for Recompounding within loop 1-3 is shown in Figure 12 based on information provided by UM. Data marked in green i.e. if residues are sent to energy recovery and if additives are added are preliminary and a final decision must be made accordingly. Depending on the outcome of the different purification pathways the input (PE PCR flakes) comes either from the Purification option B or from Deodorization, respectively the PE PCR pellets go either to Deodorization or Laminate production.

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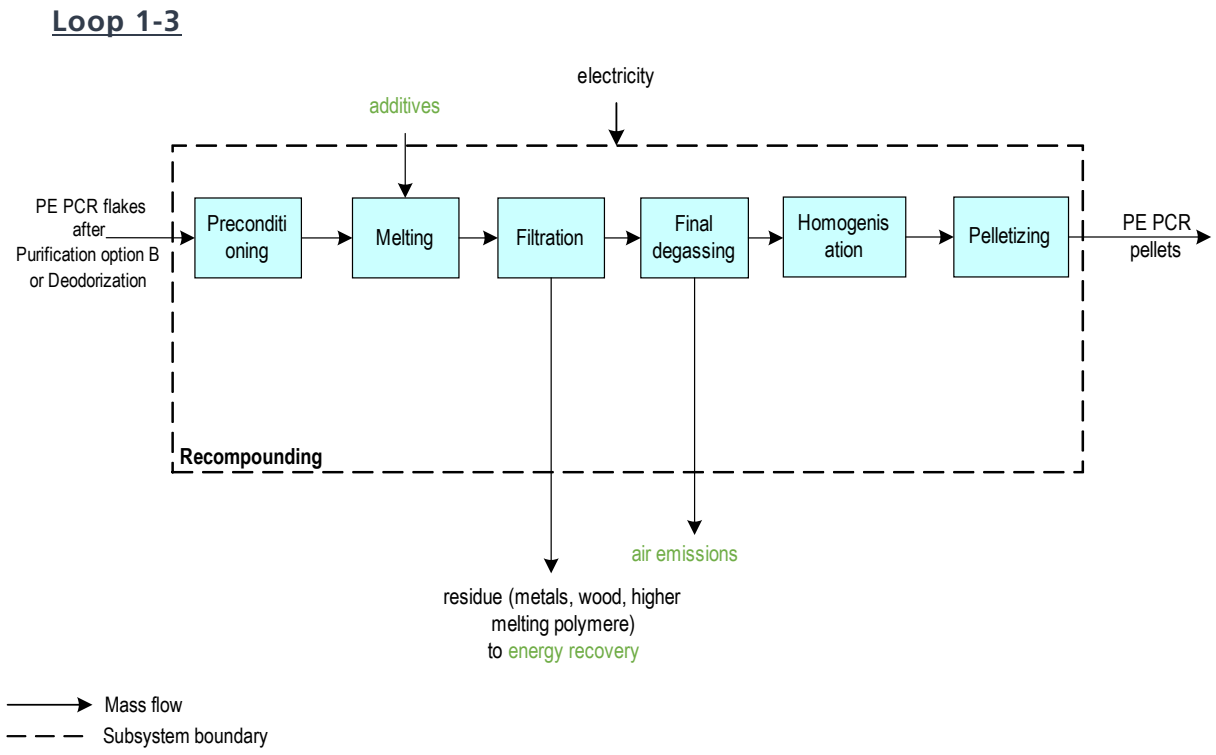


*Figure 12 Loop 1-3 Recompounding process flow scheme*

### 2.4.5 Posttreatment Deodorization

The process flow scheme for Deodorization within loop 1-3 is presented in Figure 13 based on information provided by KREYEN and consists of infrared and thermal treatment.

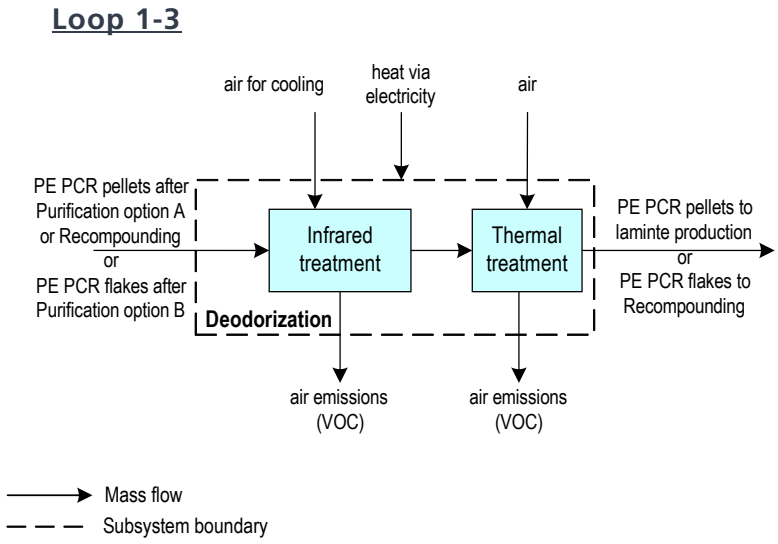


*Figure 13 Loop 1-3 Deodorization process flow scheme*

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### 2.4.6 Laminate production

The process flow scheme for Laminate production within loop 1 is presented in Figure 14-Figure 16 based on information provided by AMCOR and is shown for each application i.e. wet wipes, detergent taps and cosmetics in sachets. Laminate production involves, in a first step, the production of films, which are then processed into a printed laminate.

**Loop 1- Wet Wipes (HP1)**

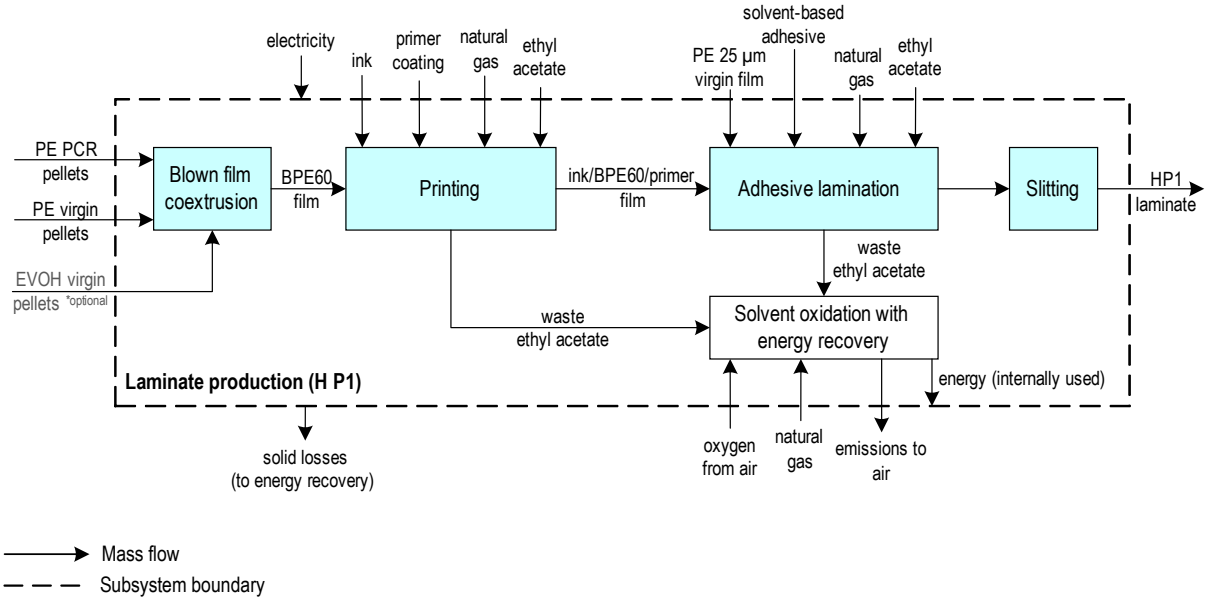


*Figure 14 Loop 1 Wet Wipes Laminate production process flow scheme*

**Loop 1- Detergent Tabs (HP2)**

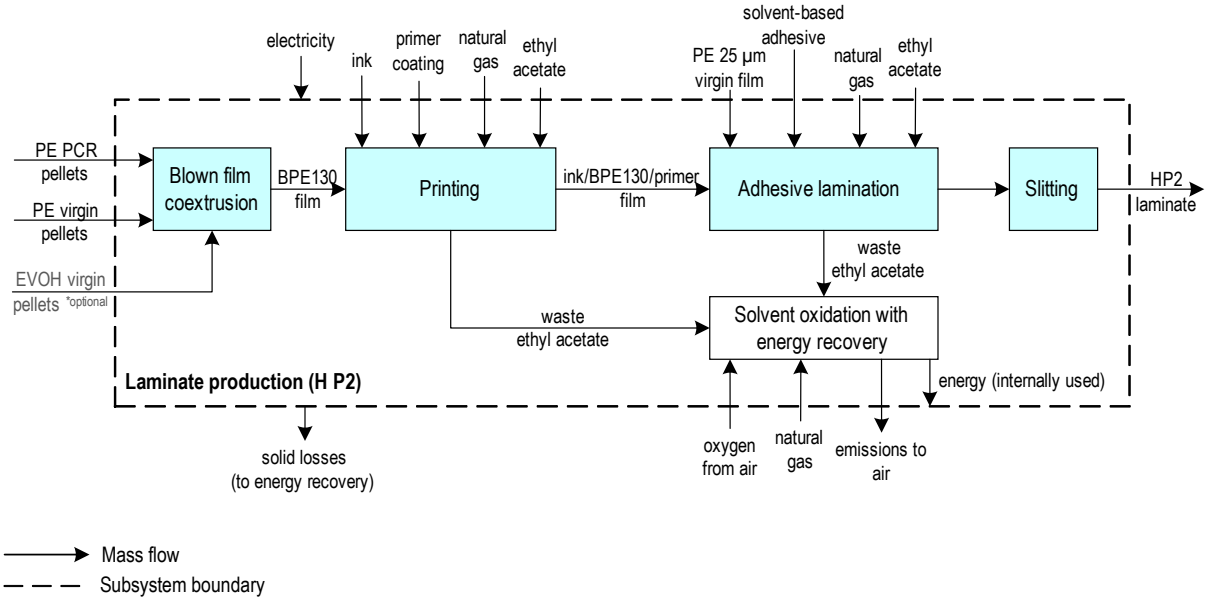


*Figure 15 Loop 1 Detergent Tabs Laminate production process flow scheme*

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## Loop 1- Cosmetics (PCP1)

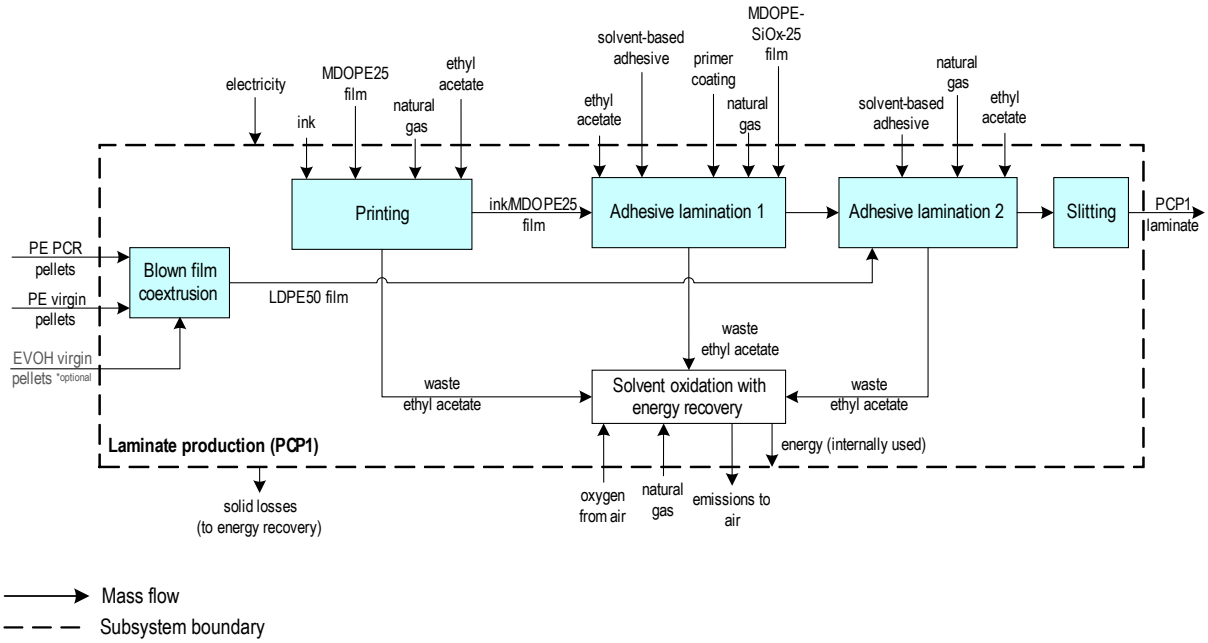


*Figure 16 Loop 1 Cosmetics Laminate production process flow scheme*

The laminates for food packaging for Loop 2 and 3 are likewise manufactured by AMCOR. The exact structure, including functional barriers, primers and inks, is still under development.

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### 2.4.7 Tracer production

The process flow scheme for Tracer production within loop 3 is presented in Figure 17 based on information provided by POLY. Tracers will be implemented in the laminate production of loop 3.

**Loop 3**

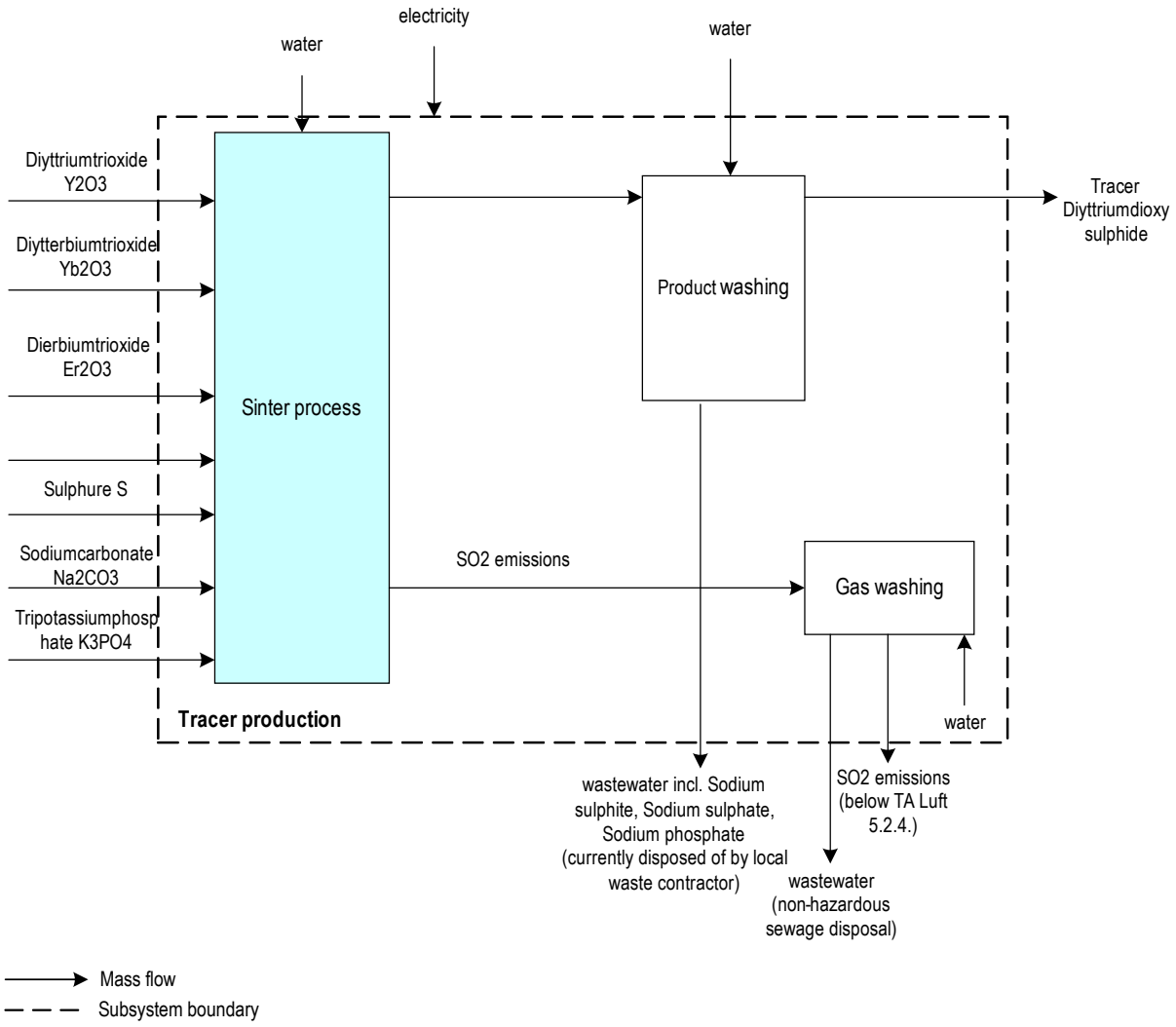


*Figure 17 Loop 3 Tracer production process flow scheme*

### 2.4.8 Ink and Primer production

The process flow scheme for Ink production within loop 1-3 is presented in Figure 18 based on information provided by Siegwerk. The process flow scheme for Primer production within loop 2 and 3 is shown in Figure 19. The primers will be implemented in the laminate production of loop 2 and 3 to facilitate the purification step.

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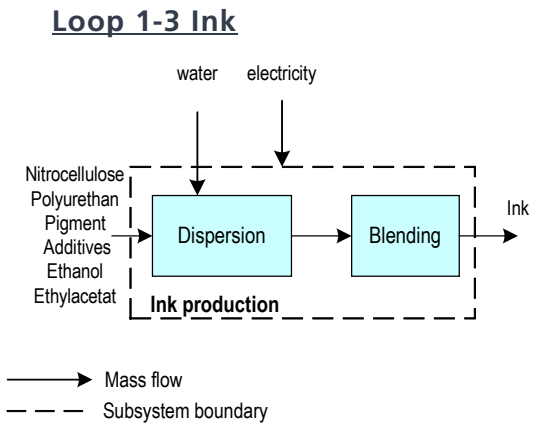


*Figure 18 Loop 1-3 Ink production process flow scheme*

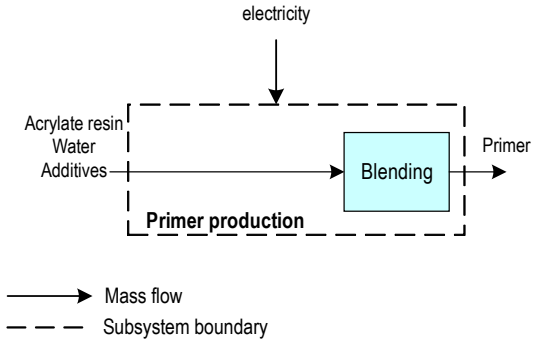


*Figure 19 Loop 3 Primer production process flow scheme*

### 2.4.9 Food packaging production

The process flow scheme for the Food packaging production within loop 2 and 3 is presented in Figure 20 based on information provided by Nestle.

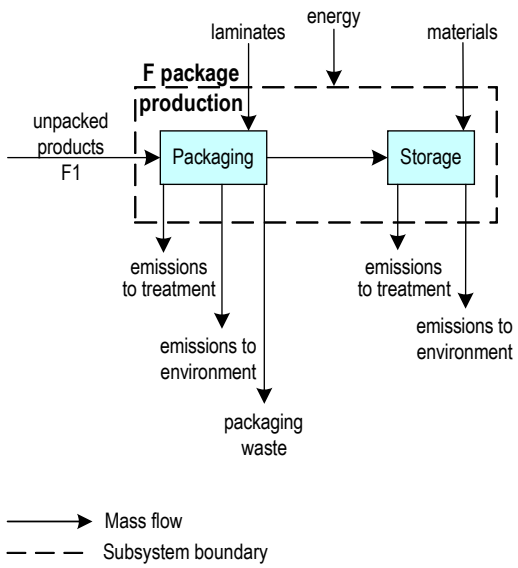


*Figure 20 Loop 2-3 Food packaging production process flow scheme*

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# 3. MASS AND ENERGY BALANCES

"The life cycle inventory analysis phase (LCI phase) is the second phase of LCA. It is an inventory of input/output data with regard to the system being studied. It involves the collection of the data necessary to meet the goals of the defined study" (ISO 14044, 2006). In order to obtain mass and energy balances for the LCA and to collect cost data for the LCC evaluation, templates for data collection were distributed and filled in by the partners.

## 3.1 Life Cycle Assessment (LCA) Data collection

Table 4 shows an example of a data collection template. The data is collected per process step in order to be able to identify any hotspots within the process flow through the analyses. Data is collected per reference flow, e.g. per year, per tonne of waste processed or per $m^2$ of laminate produced. The reference flow is the measure of the output of processes in a given product system that is required to fulfil the function expressed by the functional unit (ISO 14044, 2006). The respective unit, e.g. kWh for electricity or kg for input materials, is inserted and the origin of the respective input as well as the destination of the output are given for specification. Any additional information useful for the analysis is provided in the remark section and the source of the information is indicated accordingly.

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*Table 4 Example of Data collection template for Life Cycle Assessment (LCA)*

| **Process 1** | | | | | | |
|---|---|---|---|---|---|---|
| **Inputs** | **Data per year** | **Data per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| Input 1<br>Input 2<br>…<br>example:<br>*Electricity* | *10 000* | | *MWh* | *Grid Belgium* | | *Excel "….xls" or e-mail company x on 02/02* |
| **Outputs** | **Data per year** | **Data per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| Output 1<br>… | | | | | | |
| **Process 2** | | | | | | |
| **Inputs** | **Data per year** | **Data per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| Input 1<br>Input 2<br>… | | | | | | |
| **Outputs** | **Data per year** | **Data per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| Output 2<br>… | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Distance** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| Input 1 | | Lorry | km | EURO 6 | please specify truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| **T2** | **Distance** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| Input 2 | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |

## 3.2 Life Cycle Costing (LCC) Data collection

Life cycle costing (LCC) is based on an economic evaluation that takes into account different phases of the life cycle. It is a method that generally includes the costs of a product that are borne directly by a specific actor (Hunkeler et al., 2008). Costs are divided into capital expenditure (CAPEX), operating expenditure (OPEX) and revenues and clustered by cost type

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(Taelman et al., 2020), e.g. investment costs for equipment, costs for personnel, material, utilities, transport, emissions, waste or other operational costs for example taxes and insurance (Table 5).

*Table 5 Data collection template for Life Cycle Costing (LCC)*

| **CAPEX, OPEX, Revenues** | | | | | |
|---|---|---|---|---|---|
| **Type of cost** | **Cost points** | **Quantity** | **Unit** | **Remarks** | **Source** |
| *Capital costs* | | | | | |
| **Investment** | Land | | €/$m^2$ | | |
| | Buildings/ property | | €/$m^2$ | e.g. industrial plant | |
| | Equipment/ software | | €/pc. or year | e.g. machinery | **e.g. Corporate Carbon Footprint (CCF)** |
| | Vehicles | | €/pc. or year | | **e.g. CCF** |
| *Operational costs* | | | | | |
| **Personnel** | Salery and wages | | €/hour | Please report an average if necessary | |
| **Services** | Fee | | €/hour | | |
| **Material costs** | Raw materials | | €/kg or $m^3$ | e.g. sand, iron, chemicals | |
| | Industrial intermediate goods | | €/kg or m3 | e.g. steel, plastic, glass, etc. | |
| **Utility costs** | Fuel | | €/kg; l | | |
| | Freshwater | | €/$m^3$;l | | |
| | Electricity | | €/kWh | | |
| | Heat | | €/MJ | | |
| **Transport** | Travel and vehicle expenses | | €/km | e.g. transport of people and goods | |
| **Emission discharge & waste related costs** | Wastewater | | €/$m^3$ | e.g. cost of waste management i.e. wastewater fee | |
| | Emissions | | € per kg of release | e.g. $CO_2$ emission tax | |
| **Other operational costs** | License, legal, ... | | €/year | | |
| **Other operational costs** | Maintenance and repairs | | €/year | | |
| **Other operational costs** | Taxes | | €/year | | |

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| | | | |
|---|---|---|---|
| **Other operational costs** | Insurance | €/year | |
| *Revenues/ Positive Cash flows* | | | e.g. Revenues, by sold products, residual value of waste, by-product waste… |
| Selling of products | Product | €/product | Market prices for secondary products |
| | Co-product | €/product | Market prices for secondary products |
| | Fees | €/year | e.g. inhabitants that pay a fee to collect their waste |
| | Subsidies | €/year | e.g. for setting up a waste recycling management system |

## 4. CONCLUSION

In order to achieve a holistic life cycle analysis of the technologies and concepts developed within the framework of the CIRCULAR FoodPack project, the definition of scenario and process flow schemes as well as first mass and energy balances were set up. The geographical scope of the study is Europe and the temporal scope of the assessment covers the duration of the project (2021-2024). As functional unit (FU) the comparison of different scenarios through the basket of products approach was chosen: In this study (1) non-food packaging, (2) food packaging and (3) energy and heat recovery from incineration, are considered as basket of products.

Scenarios and respective preliminary process flow schemes (according to the loops 1-3 of the project proposal, baseline) were defined as well as individual process steps have been developed in bilateral meetings with the involved parties. This comprises the definition of the different scenarios, which are based on three use cases such as home packaging (HP), personal care packaging (PCP) and food packaging (FP) including the following six demonstrators/applications: Wet wipes (HP1), Detergent tabs (HP2) , Cosmetics in sachets (PCP1), Chocolate powder (FP1), Coffee (FP2), Creamer (FP3). Regarding the applications, three main cascade cases (loop 1-3) are considered differing for instance in the input of either mixed F-flexibles and NF-flexibles or solely F-flexibles. Three different purification pathways are taken into consideration for the preliminary assessment of loop 1-3:

(1) Delamination + Deinking, (2) CreaSolv®, (3) Delamination + Deinking + CreaSolv®. This results in the number of thirty different scenarios as shown in Table 3 Scenarios per loop, purification pathway and application.

Furthermore, the set-up of a framework for the data collection according to the scenarios was done in close cooperation with the project partners. (1) Collection, SoA sorting and Tracer-based sorting, (2) Pretreatment including Oversorting, Shredding, Washing, Grinding, Float-sink separation, (3) Purification for option A-CreaSolv® and option B-Deinking and Delamination, (4) Posttreatment consisting of Recompounding and Deodorization, (5) Laminate production including film production and printing, (6) Ink production and Primer production, (7) Tracer production and (8) F packaging production. The data collection templates for LCA and LCC data were created and distributed by UGENT. These tables are to be completed by the respective partners to obtain the data for the final assessment.

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As a next step, the environmental impact assessment (LCA) will be conducted by carefully selecting impact categories for a holistic assessment in order to analyse the hotspots of the systems under study. For the economic assessment of the system, certain data gaps need to be filled. To conduct the social assessment, relevant impact indicators are selected through participatory methods, including a workshop with partners during the second General Assembly, which took place in November 2022.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

# 6. ANNEX

## Loop 1

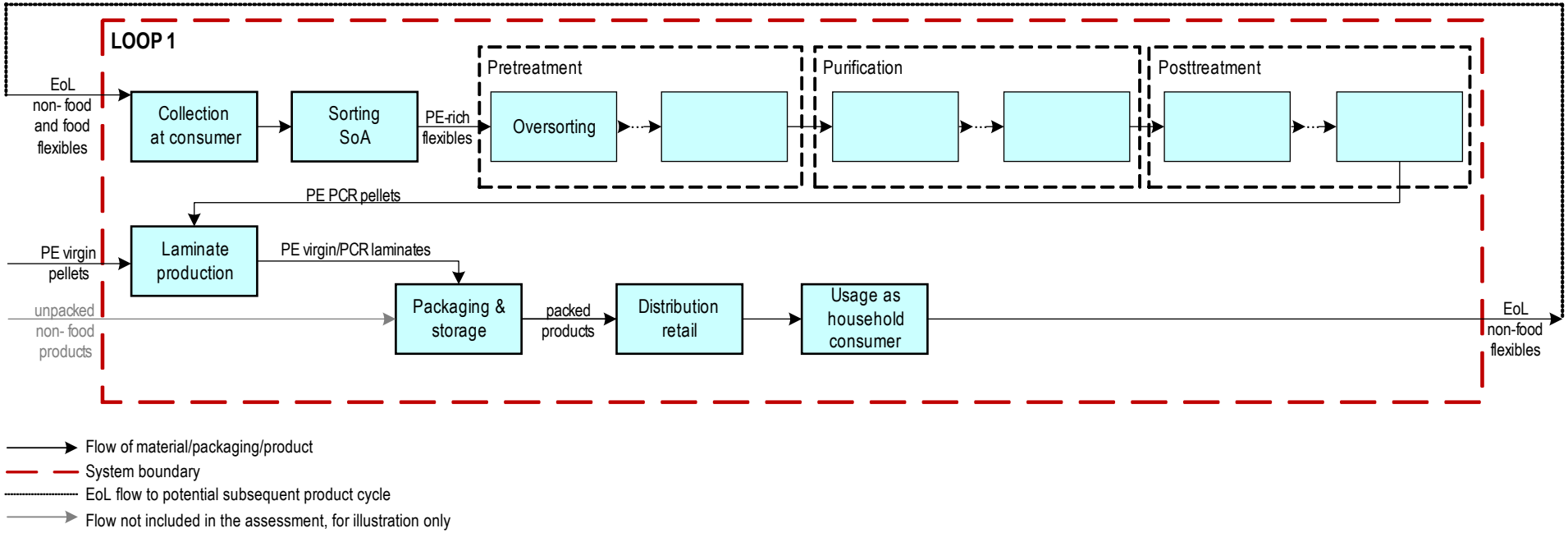


*Figure 21 Loop 1 process flow scheme for NF packaging (landscape format)*

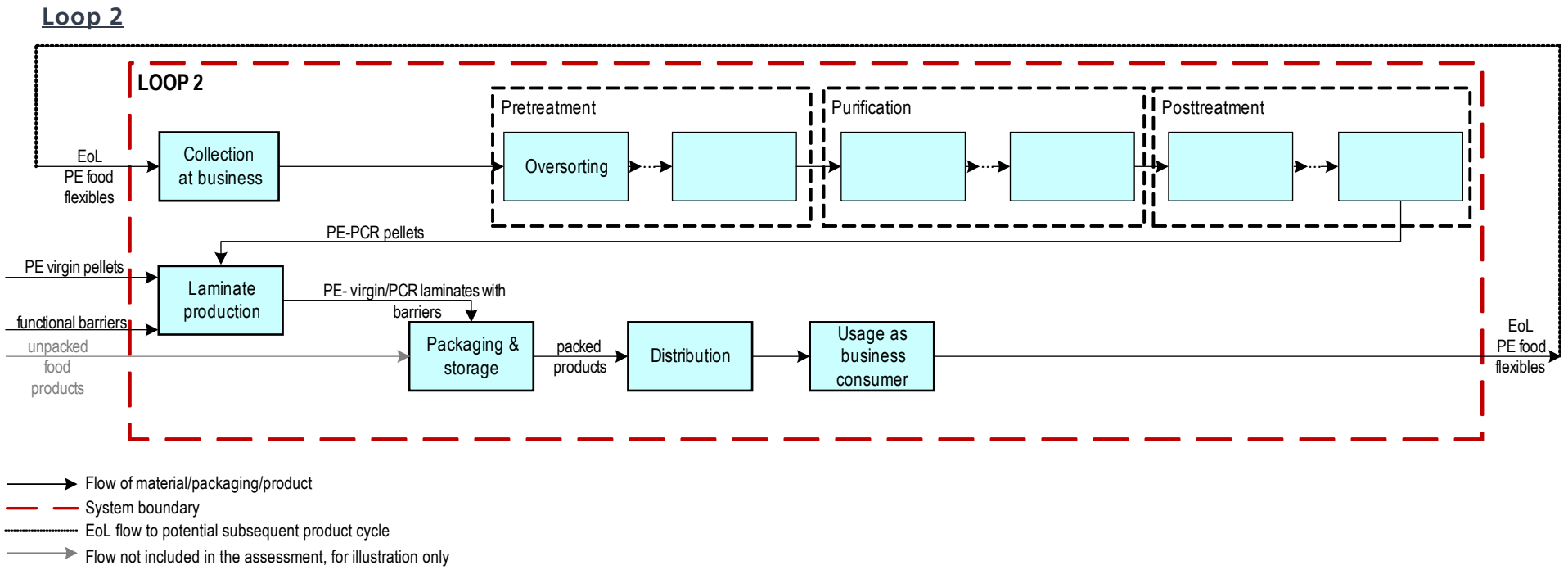


*Figure 22 Loop 2 process flow scheme for F packaging (landscape format)*

This project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No. 101003806.

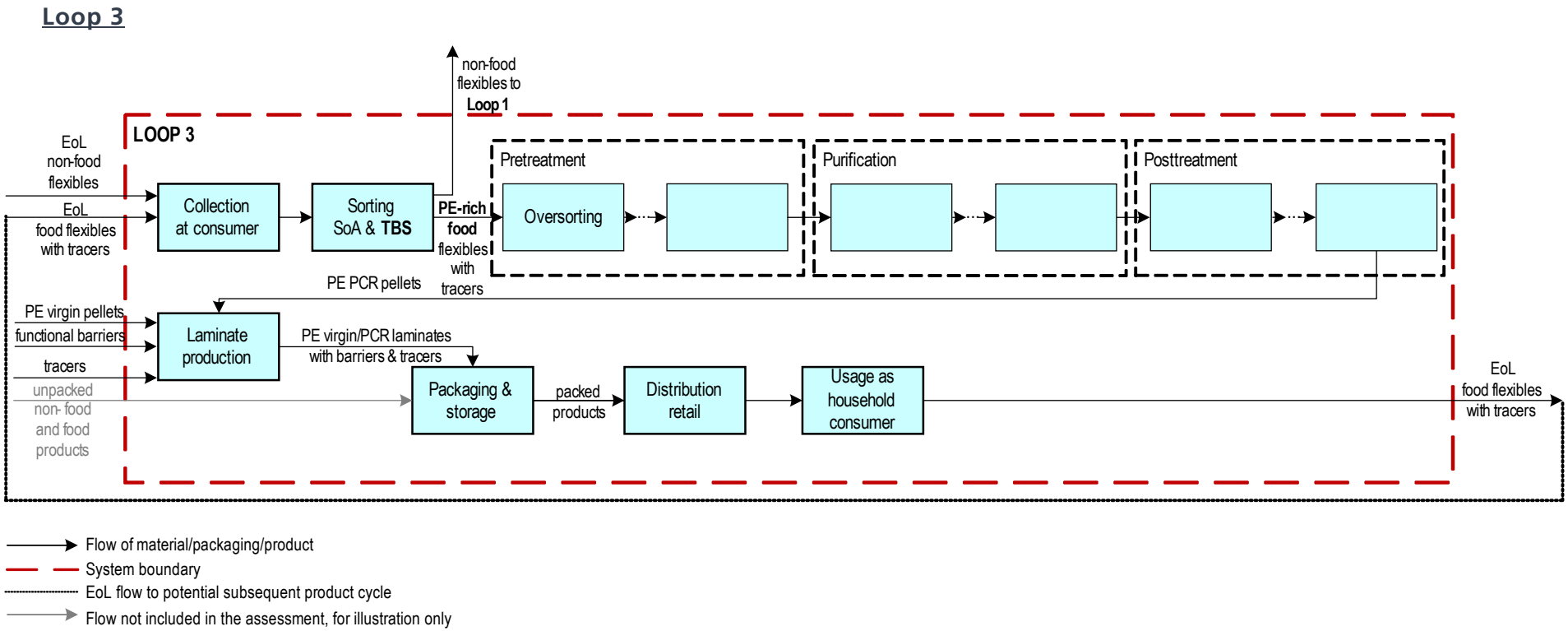


*Figure 23 Loop 3 process flow scheme for F and NF packaging (landscape format)*

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## Collection and SoA sorting and Pretreatment-SUEZ

## Loop 1

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Collection at consumer** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Household plastic packaging waste | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Household plastic packaging waste | | | | | |
| **Process 2** | | | | | | |
| **SoA Sorting** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Household plastic packaging waste | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Diesel | | | | | |
| | Binding wire | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flexibles/ Food and non-food | | | | | |
| | Residue | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Wastewater | | | | | |
| | Recycalbes | | | | please specifiy composition of recycalbes e.g. 10% PP, 20% PET | |
| **Process 3** | | | | | | |
| **Oversorting** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flexibles/ Food and non-food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flexibles | | | | | |
| | Residue | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| **Process 4** | | | | | | |
| **Shredding** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flexibles | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| **Process 5** | | | | | | |
| **Washing** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Wastewater | | | | | |
| **Process 6** | | | | | | |
| **Grinding** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| **Process 7** | | | | | | |
| **Float-sink separation** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Residue | | | | please specifiy composition of residue | |
| | Wastewater | | | | | |
| **Process 8** | | | | | | |
| **Waste water treatment** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Wastewater | | | | | |
| | Chemicals | | | | please specifiy type of chemical e.g. Chlorine, add product data sheet if applicable | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Residue | | | | please specifiy composition of residue e.g. 10% filter cake, 20% pulp | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | Household plastic packaging waste | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE-rich flakes/ Food and non-food | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |

*Figure 24 Loop 1 Collection and SoA sorting and Pretreatment data collection sheet*

## Loop 2

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Collection at consumer** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE food flexibles | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE food flexibles | | | | | |
| **Process 2** | | | | | | |
| **Oversorting** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE food flexibles | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flexibles | | | | | |
| | Residue | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| **Process 3** | | | | | | |
| **Shredding** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flexibles | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| **Process 4** | | | | | | |
| **Washing** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Wastewater | | | | | |
| **Process 5** | | | | | | |
| **Grinding** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| **Process 6** | | | | | | |
| **Float-sink separation** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Residue | | | | please specifiy composition of residue | |
| | Wastewater | | | | | |
| **Process 7** | | | | | | |
| **Waste water treatment** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Wastewater | | | | | |
| | Chemicals | | | | please specifiy type of chemical e.g. Chlorine, add product data sheet if applicable | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Residue | | | | please specifiy composition of residue e.g. 10% filter cake, 20% pulp | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE-rich flexibles | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE-rich flakes | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |

*Figure 25 Loop 2 Collection and SoA sorting and Pretreatment data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Loop 3 including Tracer-based sorting

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Collection at consumer** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Household plastic packaging waste | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Household plastic packaging waste | | | | | |
| **Process 2** | | | | | | |
| **SoA Sorting** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Household plastic packaging waste | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Diesel | | | | | |
| | Binding wire | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flexibles/ Food and non-food | | | | | |
| | Residue | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Wastewater | | | | | |
| | Recycalbes | | | | please specifiy composition of recycalbes e.g. 10% PP, 20% PET | |
| **Process 3** | | | | | | |
| **TBS Sorting** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flexibles/ Food and non-food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flexibles incl. Tracers/ f. Food | | | | | |
| | PE-rich non-f. Food flexibles | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| **Process 4** | | | | | | |
| **Oversorting** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flexibles incl. Tracers/ f. Food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flexibles incl. Tracers/ f. Food | | | | | |
| | Residue | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| **Process 5** | | | | | | |
| **Shredding** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flexibles incl. Tracers/ f. Food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| **Process 6** | | | | | | |
| **Washing** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| | Wastewater | | | | | |
| **Process 7** | | | | | | |
| **Grinding** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| **Process 8** | | | | | | |
| **Float-sink separation** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | | | | | |
| | Residue | | | | please specifiy composition of residue | |
| | Wastewater | | | | | |
| **Process 9** | | | | | | |
| **Waste water treatment** | **Inputs** | **Quantity per hour** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Wastewater | | | | | |
| | Chemicals | | | | please specifiy type of chemical e.g. Chlorine, add product data sheet if applicable | |
| | **Outputs** | **Quantity per hour** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Residue | | | | please specifiy composition of residue e.g. 10% filter cake, 20% pulp | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | Household plastic packaging waste | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE-rich flakes incl. Tracers/ f. Food | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |

*Figure 26 Loop 3 Collection and SoA sorting and Pretreatment data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Purification option A CreaSolv®-IVV

### Loop 1-3

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Continuous dissolving** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE-rich flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Recovered solvent | | | | please specifiy type of solvent, add product data sheet if applicable | |
| | Virgin solvent | | | | please specifiy type of solvent, add product data sheet if applicable | |
| | Washing solution | | | | please specifiy type of washing solution, add product data sheet if applicable | |
| | | | | | | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Dissolved PE (incl. Residues) | | | | | |
| **Process 2** | | | | | | |
| **Multistage filtration** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Dissolved PE (incl. Residues) | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Filtered PE solution | | | | | |
| **Process 3.1** | | | | | | |
| **Washing of the residual fraction** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Residues | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Filtered PE solution | | | | | |
| | Washing solution | | | | | |
| **Process 3.1.1** | | | | | | |
| **Drying residual fraction** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Residues | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Filtered PE solution | | | | | |
| | Recovered solvent | | | | | |
| **Process 3.2** | | | | | | |
| **PE purification** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Filtered PE solution | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Recovered purification agent | | | | please specifiy type of purification agent, add product data sheet if applicable | |
| | Virgin purification agent | | | | please specifiy type of purification agent, add product data sheet if applicable | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE solution | | | | | |
| **Process 3.2.1** | | | | | | |
| **Removal of fine residues** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| **and separation of solvent & purification agent** | Used solvent/purification agent/residues mixture | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Recovered solvent | | | | | |
| | Residues fine | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| **Process 4** | | | | | | |
| **Multiple stage drying** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE solution | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE melt | | | | | |
| | Recovered solvent | | | | | |
| **Process 5** | | | | | | |
| **Regranulation/-compounding** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE melt | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Additives | | | | | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |

*Figure 27 Loop 1-3 Purification option A CreaSolv®® data collection sheet (data in green tbd)*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Purification option B Delamination and Deinking-UGENT

### Loop 1 and 2

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Delamination & Deinking** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | pretreated PE flakes | | | | | |
| | virgin Delamination-Deinking medium A | | | | | |
| | recovered Delamination-Deinking medium A | | | | | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| **Process 2** | | | | | | |
| **Mechanical separation** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Delamination-Deinking medium A Residue | | | | to recovery | |
| **Process 2.1** | | | | | | |
| **Medium recovery** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Delamination-Deinking medium A Residue | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | recovered Delamination-Deinking medium A | | | | | |
| | Residue | | | | to energy recovery | |
| **Process 3** | | | | | | |
| **Washing** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | virgin Water | | | | | |
| | recycled Water | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| **Process 4** | | | | | | |
| **Mechanical drying** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Wastewater | | | | to wastewater treatment | |
| **Process 5** | | | | | | |
| **Thermal treatment** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Electricity | | kWh | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Water vapor | | | | | |
| **Process 6** | | | | | | |
| **Waste water treatment** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Wastewater | | | | | |
| | Chemicals | | | | please specifiy type of chemical e.g. Chlorine, add product data sheet | |
| | | | | | | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Residue (sinkflow, filter cake) | | | | to energy recovery; please specifiy composition of residue | |
| | recyled Water | | | | | |
| **Transport (T)** | | | | | | |
| **T1 (upstream)** | **Inputs** | **Distance** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | pretreated PE flakes | | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |
| **T2 (downstream)** | **Inputs** | **Distance** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | delaminated/deinked PE flakes | | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 28 Loop 1-2 Purification option B Delamination and Deinking data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Loop 3

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Delamination & Deinking** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | pretreated PE flakes | | | | | |
| | virgin Delamination-Deinking medium B | | | | | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| **Process 2** | | | | | | |
| **Mechanical separation** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Residue | | | | to energy recovery | |
| **Process 3** | | | | | | |
| **Neutralisation** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Solution | | | | | |
| | recycled Water | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| **Process 4** | | | | | | |
| **Mechanical drying** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Salt | | | | | |
| | Wastewater | | | | to wastewater treatment | |
| **Process 5** | | | | | | |
| **Thermal treatment** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Heat | | | | please specify source of heat e.g. natural gas | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | seperated/deinked PE flakes | | | | | |
| | Water vapor | | | | | |
| **Process 6** | | | | | | |
| **Waste water treatment** | **Inputs** | **Quantity per ton** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Wastewater | | | | | |
| | Chemicals | | | | please specifiy type of chemical e.g. Chlorine, add product data sheet | |
| | **Outputs** | **Quantity per ton** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Residue (sinkflow, filter cake) | | | | to energy recovery; please specifiy composition of residue | |
| | recyled Water | | | | | |
| **Transport (T)** | | | | | | |
| **T1 (upstream)** | **Inputs** | **Distance** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | pretreated PE flakes | | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |
| **T2 (downstream)** | **Inputs** | **Distance** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | delaminated/deinked PE flakes | | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 29 Loop 3 Purification option B Delamination and Deinking data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Recompounding-UM, SUEZ

### Loop 1-3

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Preconditioning** | **Inputs** | **Quantity per x kg output** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Pretreated PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per x kg output** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| **Process 2** | | | | | | |
| **Melting** | **Inputs** | **Quantity per x kg output** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per x kg output** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| **Process 3** | | | | | | |
| **Filtration** | **Inputs** | **Quantity per x kg output** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per x kg output** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Residue | | | | please specifiy composition of residue e.g. 10% metals, 20% wood, 50% higher melting polymere (i.e. PP, PE,...) | |
| **Process 4** | | | | | | |
| **Final degassing** | **Inputs** | **Quantity per x kg output** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per x kg output** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Air emission | | | | please specifiy | |
| **Process 5** | | | | | | |
| **Homogenisation** | **Inputs** | **Quantity per x kg output** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per x kg output** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| **Process 6** | | | | | | |
| **Pelletizing** | **Inputs** | **Quantity per x kg output** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE flakes | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | **Outputs** | **Quantity per x kg output** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE flakes | Lorry | km | EURO 5 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE PCR pellets | Lorry | km | EURO 5 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |

*Figure 30 Loop 1-3 Recompounding data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Deodorization-KREYEN

## Loop 1-3

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Infrared treatment** | **Inputs** | **Quantity per year** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| | Air for cooling | | | | | |
| | Heat via electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per year** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| | Air emissions (VOC) | | | | please specifiy | |
| | | | | | | |
| **Process 2** | | | | | | |
| **Thermal treatment** | **Inputs** | **Quantity per year** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| | Air | | | | | |
| | Heat via electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per year** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PE PCR pellets deodorized | | | | | |
| | Air emissions (VOC) | | | | please specifiy | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1 (upstream)** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE PCR pellets | Lorry | km | EURO 5 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |
| **T2 (downstream)** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE PCR pellets deodorized | Lorry | km | EURO 5 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 31 Loop 1-3 Deodorization data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Laminate production-AMCOR

## Loop 1- Wet Wipes (HP1)

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Blown film coextrusion** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| | PE virgin pellets | | | | | |
| | EVOH virgin pellets *optional | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | BPE60 film | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 2** | | | | | | |
| **Printing** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | BPE60 film | | | | | |
| | Ink | | | | please specifiy | |
| | Primer coating | | | | please specifiy | |
| | Natural gas | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Ethyl acetate | | | | | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Ink/BPE60/primer film | | | | | |
| | Waste Ethyl acetate | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 3** | | | | | | |
| **Adhesive lamination** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Ink/BPE60/primer film | | | | | |
| | Solvent-based adhesive | | | | please specifiy, add product data sheet if possible | |
| | PE 25 µm virgin film | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Natural gas | | | | | |
| | Electricity | | | | | |
| | Ethyl acetate | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Laminate | | | | | |
| | Waste Ethyl acetate | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Solid losses | | | | | |
| | | | | | | |
| **Process 2./3.1** | | | | | | |
| **Solvent oxidation with energy recovery** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Waste Ethyl acetate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Natural gas | | | | | |
| | Oxygen from air | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Energy (internally used) | | | | | |
| | Emissions to air | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 4** | | | | | | |
| **Slitting** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Laminate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | H1 laminate | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE PCR pellets | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | PE virgin pellets | | | | | |
| | EVOH virgin pellets *optional | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | H1 laminate | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 32 Loop 1 Wet Wipes Laminate production data collection sheet (data in green tbd)*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Loop 1- Detergent Tabs (HP2)

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Blown film coextrusion** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| | PE virgin pellets | | | | | |
| | EVOH virgin pellets *optional | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | BPE130 film | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 2** | | | | | | |
| **Printing** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | BPE130 film | | | | | |
| | Ink | | | | please specifiy | |
| | Primer coating | | | | please specifiy | |
| | Natural gas | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Ethyl acetate | | | | | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Ink/BPE130/primer film | | | | | |
| | Waste Ethyl acetate | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 3** | | | | | | |
| **Adhesive lamination** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Ink/BPE60/primer film | | | | | |
| | Solvent-based adhesive | | | | please specifiy, add product data sheet if possible | |
| | PE 25 µm virgin film | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Natural gas | | | | | |
| | Electricity | | | | | |
| | Ethyl acetate | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Laminate | | | | | |
| | Waste Ethyl acetate | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Solid losses | | | | | |
| | | | | | | |
| **Process 2./3.1** | | | | | | |
| **Solvent oxidation with energy recovery** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Waste Ethyl acetate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Natural gas | | | | | |
| | Oxygen from air | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Energy (internally used) | | | | | |
| | Emissions to air | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 4** | | | | | | |
| **Slitting** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Laminate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | H2 laminate | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE PCR pellets | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | PE virgin pellets | | | | | |
| | EVOH virgin pellets *optional | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | H2 laminate | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 33 Loop 1 Detergent Tabs Laminate production data collection sheet (data in green tbd)*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Loop 1- Cosmetics (PCP1)

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Blown film coextrusion** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | PE PCR pellets | | | | | |
| | PE virgin pellets | | | | | |
| | | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | LDPE50 film | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 2** | | | | | | |
| **Printing** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | MDOPE25 film | | | | | |
| | Ink | | | | please specifiy | |
| | Natural gas | | | | please specifiy | |
| | Electricity | | | | | |
| | Ethyl acetate | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | ink/MDOPE40 | | | | | |
| | Waste Ethyl acetate | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 3** | | | | | | |
| **Adhesive lamination 1** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | ink/MDOPE40 | | | | | |
| | MDOPE25 film | | | | | |
| | Solvent-based adhesive | | | | please specifiy, add product data sheet if possible | |
| | Natural gas | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Ethyl acetate | | | | | |
| | Primer coating | | | | | |
| | SiOx | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | ink/MDOPE40 SiOx/primer laminate | | | | | |
| | Waste Ethyl acetate | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Solid losses | | | | | |
| | | | | | | |
| **Process 4** | | | | | | |
| **Adhesive lamination 2** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | ink/MDOPE40 SiOx/primer laminate | | | | | |
| | LDPE50 film | | | | please specifiy, add product data sheet if possible | |
| | Solvent-based adhesive | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Natural gas | | | | | |
| | Electricity | | | | | |
| | Ethyl acetate | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Laminate | | | | | |
| | Waste Ethyl acetate | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | Solid losses | | | | | |
| | | | | | | |
| **Process 2.-4.1** | | | | | | |
| **Solvent oxidation with energy recovery** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Waste Ethyl acetate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Natural gas | | | | | |
| | Oxygen from air | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Energy (internally used) | | | | | |
| | Emissions to air | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 4** | | | | | | |
| **Slitting** | **Inputs** | **Quantity per m2 of packaging product** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Laminate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per m2 of packaging product** | **Unit** | **Destination** | **Remarks** | **Source** |
| | PC1 laminate | | | | | |
| | Solid losses | | | | | |
| | | | | | | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PE PCR pellets | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | PE virgin pellets | | | | | |
| | | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | PC1 laminate | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 34 Loop 1 Cosmetics Laminate production data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Tracer production-POLY

## Loop 3

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Sinter process** | **Inputs** | **Quantity per** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Diyttriumtrioxide Y2O3 | | | | | |
| | Diytterbiumtrioxide Yb2O3 | | | | | |
| | Dierbiumtrioxide Er2O3 | | | | | |
| | Diholmiumtrioxide Ho2O3 | | | | | |
| | Sulphure S | | | | | |
| | Sodiumcarbonate Na2CO3 | | | | | |
| | Tripotassiumphosphate K3PO4 | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Diyttriumdioxysulphide | | | | | |
| | Sodium sulphite | | | | | |
| | Sodium sulphate | | | | | |
| | Sodium phosphate | | | | | |
| | SO2 emissions | | | | | |
| | | | | | | |
| **Process 2** | | | | | | |
| **Product washing** | **Inputs** | **Quantity per** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Diyttriumdioxysulphide | | | | | |
| | Sodium sulphite | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Sodium sulphate | | | | | |
| | Sodium phosphate | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Diyttriumdioxysulphide | | | | | |
| | Wastewater | | | | please specifiy composition of residue e.g. 10% PP, 20% PET | |
| | | | | | | |
| | | | | | | |
| **Process 3** | | | | | | |
| **Gas washing** | **Inputs** | **Quantity per** | **Unit** | **Origin** | **Remarks** | **Source** |
| | SO2 emissions | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Wastewater | | | | | |
| | SO2 emissions (below TA Luft 5.2.4.) | | | | | |
| | | | | | | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | Diyttriumtrioxide Y2O3 | Lorry | km | EURO 5 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | Diytterbiumtrioxide Yb2O3 | | | | | |
| | Dierbiumtrioxide Er2O3 | | | | | |
| | Diholmiumtrioxide Ho2O3 | | | | | |
| | Sulphure S | | | | | |
| | Sodiumcarbonate Na2CO3 | | | | | |
| | Tripotassiumphosphate K3PO4 | | | | | |
| | | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | Diyttriumdioxysulphide | Lorry | km | EURO 5 | | |
| | | | | | | |

*Figure 35 Loop 3 Tracer production data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Ink and Primer production-Siegwerk

### Loop 1-3 Ink

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Dispersion** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Nitrocellulose | | | | | |
| | Polyurethan | | | | | |
| | Pigment C or M or Y or K | | | | | |
| | Additives | | | | | |
| | Ethanol | | | | | |
| | Ethylacetat | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | Water | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Process 2** | | | | | | |
| **Blending** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Dispersion | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Ink | | | | | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |
| | | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 36 Loop 1-3 Ink production data collection sheet*

### Loop 3 Primer

| Process 1 | | | | | | |
|---|---|---|---|---|---|---|
| **Blending** | **Inputs** | **Quantity per kg** | **Unit** | **Origin** | **Remarks** | **Source** |
| | Acrylate resin | | | | | |
| | *Water* | | | | | |
| | Electricity | | | | please specifiy e.g. medium voltage, provider, energy mix | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | **Outputs** | **Quantity per kg** | **Unit** | **Destination** | **Remarks** | **Source** |
| | Primer | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **Transport (T)** | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |
| | | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | |

*Figure 37 Loop 3 Primer production data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.

## Food packaging production-Nestle

## Loop 2 and 3

| Process 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Inputs | Quantity per year | Quantity per ton | Unit | Origin | Remarks | Source |
| | | | | | | | |
| | | | | | | please specifiy e.g. medium voltage, provider, energy mix, provider, energy mix | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | Outputs | Quantity per year | Quantity per ton | Unit | Destination | Remarks | Source |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **Transport (T)** | | | | | | | |
| **T1** | **Inputs** | **Transport mode** | **Distance** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | | |
| **T2** | **Inputs** | **Transport mode** | **Distance** | **Unit** | **Truck technology** | **Remarks** | **Source** |
| | | Lorry | | km | EURO 6 | please specifiy truck payload e.g. 3,5t-7,5t; 7,5t-16t, 16t-32t, >32t | |
| | | | | | | | |

*Figure 38 Loop 2-3 Food packaging production data collection sheet*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101003806.