EPFL

Plast it Back

A Proof of Concept for a Sustainable Logistic Chain for Laboratory Plastics

(en attente)

Image des objets finis

Collège des Humanités, Cours Gestion des Organisations

Plast it back

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We aim to establish a sustainable logistic process, by creating a network of partners as well as raise awareness within EPFL community on single-use plastics and their recycling processes

The project **Plast It Back**, in close collaboration with **SV Sustainability**, was founded in the context of the class of Humanities and Social Sciences at EPFL. Our team is composed of 10 EPFL students from various backgrounds and sections.

With this project we were able to establish a proof-of-concept, by showing the evolution of the process from single-use plastics found in SV's faculty laboratories into reusable objects while assessing the environmental impact recycling processes. The plastics used for the process are of the following types: polypropylen (PP) and polystyren (PS), as those are the main types that are incinerated and not recycled.

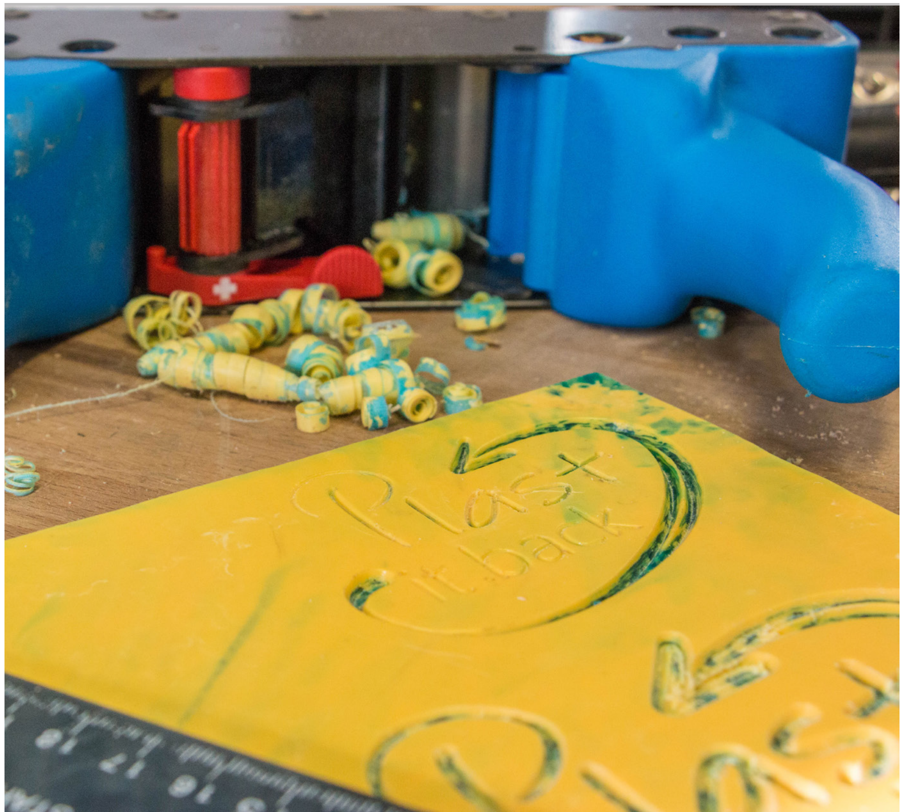
Our Partners

A preliminary test phase

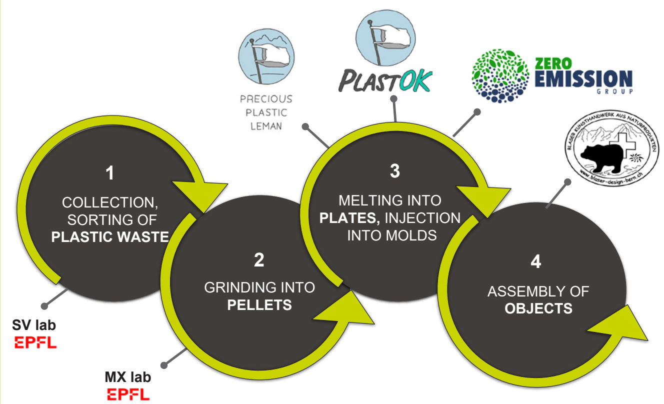
Before the establishment of the final recycling chain, our team made some **prototypes** of the plates and objects in the IMX[1] laboratory and the SKIL[2] practical workshop at EPFL. For this, we received technical advice from **Joanne Vaucher**, engineer at the LPAC[3] laboratory. The SKIL also provided us with practical expertise for plastic recycling tests.

The “Precious Plastic” concept

Initiated in 2013, the concept was to develop machine plans and know-how while making them available on the internet in free access. The aim was to permit anyone around the world to build their own plastic recycling workshop and participate in a global **community effort**. Today, Precious Plastic is a combination of people, machines, platforms and knowledge to create an **alternative global recycling system**.



- **Precious Plastic Léman** : They manufacture durable products with recycled plastic from the Leman Lake. In our project, they realized the plates to create the clocks.
- **PlastOk** : Another «Precious Plastic» group working in Geneva. In our project, they performed the injection of the pellets into the molds to create the pots.
- **Zero Emission Group** : An EPFL student-led initiative, aimed at finding solutions against climate change. In our project, they supported us financially to buy the mold for the pots.
- **Blaser Design Bern** : Handicraft company producing design pieces made from swiss natural products. In our project, they made the engravings on the plates to realize the clocks.



[1] IMX: Institute of Materials
[2] SKIL: Student Kreativity and Innovation Laboratory
[3] LPAC: Laboratory for Processing of Advanced Composites

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A Waste of Plastic

300 millions tons of plastic waste are produced each year. This is nearly equivalent to the weight of the world population.

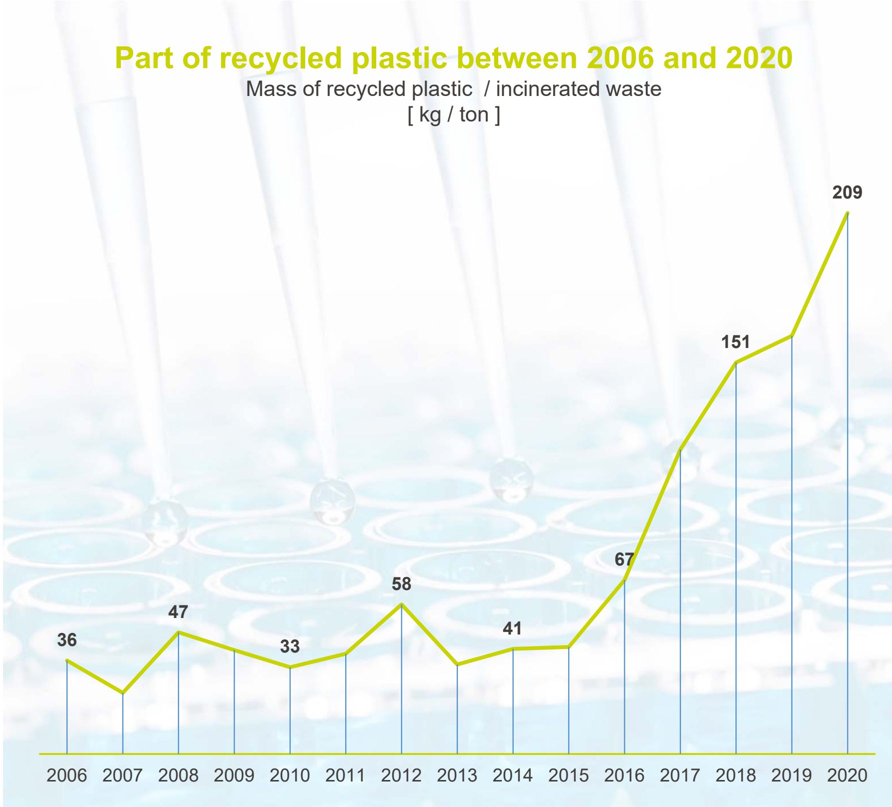
This plastic waste production is the source of crucial environmental problems:

- air pollution caused by NOx, PMs and SOx emissions during incineration of waste
- uncontrolled landfills in developing countries, where plastic constitutes the major part of the waste, leading to plastics entering the oceans and soils. Microplastics, which is partially formed by decomposed macro plastics, have even been found in snowfall !
- To a lesser extent (5% of CO_2 emission in Switzerland), the negative impact on climate change due to greenhouse gases emissions (carbon dioxide, methane) during incineration.

Plastic Waste at EPFL

125 kg of plastic waste per capita is produced each year. Of the total annual consumption of plastic waste, 10% of plastics are recycled and 25% of polyethylene (PE) films from industry are recycled.
The principal obstacle to plastic recycling is the complex composition of plastics often constituted of many types of polymers. Therefore, the success of a recycling process depends on several factors : plastic type, efficiency of collection, homogeneity and purity of the collected material Improvements in eco-conception has to be done at the source to increase this recycling part.
In 2015, a person consumes about 10 kg of waste per year only at the EPFL campus. For the moment : only PET, plastic films and crushable plastic are recycled.
The remaining part of plastic waste is only incinerated in thermal recovery plants.

The top figure shows the amount of plastic recycled for 1 ton of waste incinerated along the years. The recycled part has been multiplied by a factor 4 in 5 years ! This shows the way forward and has prompted us to explore the possibilities to increase the share of recycled plastics.



On the other hand, many members of this group have observed the large amount of plastic waste used in EPFL laboratories. Noting that much of this waste was not yet recycled, we thought that there is still room for improvement and that is why we wanted to explore what alternatives were possible.

Sources:

[1] « Usines d'incinération: Doris Leuthard signe un accord de réduction du CO2 avec la branche ». https://www.bafu.admin.ch/bafu/fr/home/themes/climat/communiques.msg-id-54175.html
(consulté le mai 10, 2021).

[2] « Le pari suisse dans la guerre contre le plastique », Le Temps, juin 17, 2020. Consulté le: mai 02, 2021. [En ligne]. Disponible sur: https://www.letemps.ch/economie/pari-suisse-guerre-contre-plastique

[3] O. fédéral de l'environnement OFEV, « Matières plastiques ». https://www.bafu.admin.ch/bafu/fr/home/themen/thema-abfall/abfallwegweiser--stichworte-a--z/kunststoffe.html
(consulté le mai 02, 2021).

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Plastic Recycling Circular Chain

From experimental testing at EPFL to outsourcing to viable partners, we have revalorized [qty] kg of plastic waste into useful objects.

Research at EPFL Life Science laboratories produces a huge amount of plastic waste. This pilot project aims to show the possibilities of recovering non-contaminated waste and to valorize these resources while keeping in mind the environmental impact of the recycling process.

Recycling chains already exist. However, they are not used yet on a large scale and almost no recycling process is yet implemented in industry for non-expanded Polystyrene. Therefore, one main goal is to sensibilize the different laboratories about the issue and enhance the discussion by proposing different solutions.

At first, different recycling processes were tested using the resources available on campus. In a second phase, production on a bigger scale has been externalized and clocks, plant and pen pots were produce.

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1st Step - harvesting, plastic waste

In order to set up harvesting, garbage cans (exclusively dedicated to PP and PS plastic) waste were installed in each laboratory with precise instructions.

The harvesting of PP and PS plastics was carried out in 3 laboratories of the SV section as well as from waste bins outside SV.

- UPRAD | Radtke Lab
- VDG | Prof. van der Goot Group - Laboratory of Cell and Membrane Biology
- UPOATES | Prof. Oates Group - Segmentation Timing and Dynamics Laboratory

When the waste is collected, traces of glue or felt are cleaned and then the waste is sorted:

- by type (pp, ps)
- by colour
- by brand (for similar additives to have the same properties)
- by hardness (to have the same chemical structure of the plastic)

2nd Step - grinding, pellets

Once the PS and PP have been harvested, the plastic is transformed into pellets by type and colour with a mill. First, the milding was performed in the laboratory IMX at EPFL for test phases and afterwards it will be performed at our partner Plast Ok.

During test phases at EPFL, between 2.4kg and 7.8kg of waste can be shredded in 2h30. This variation in quantity depends on the homogeneity of the shredded plastic (type, colour, etc.). Furthermore there are losses of plastics in the machine (residues along the walls, in the rotor and trapped by the grid) which are not subsequently recovered. However at a larger scale, it will be possible to implement the recycling of residues.

Grinding (or milling) is the breaking up of solids, reducing the size or increasing the specific surface area of solid particles. This phenomenon results from the action of a field of constraints generated by contact forces (compression, shear, torsion, bending, attrition, more rarely traction)

The fragmentation of a particle can be described according to a sequence of 4 successive stages:

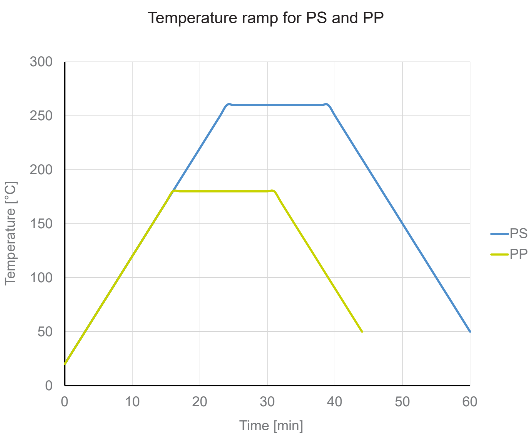
- «loading» or «stress» (transmission of energy) of the particle
- deformation of the particle
- formation of a non-uniform force field
- fragmentation or not of the particle

3rd Step - melting, plates

Once the granules are produced, they are transformed into a plate by melting them under pressure. First, tests were carried out at the EPFL. Subsequently, the transformation of the plates will be carried out with the company Plastok and Precious Plastic Léman respectively located in Geneva and Lausanne.

Explanation of the process

- The pellets are placed in a mould.
- Then the mould is placed in an oven and the oven is heated with temperature ramps of 10°C/min to 260°C for PS and 180°C for PP. After 15 minutes at the final temperature, the oven is cooled with a temperature ramp of -10°C/min to 50°C
- The mould is removed from the oven



The plates and the processes performed at EPFL were characterized as follows:

- Area: 28 cm x 28 cm
- Max depth: 7.4 mm
- Amount of plastic: 250-500 g
- Production time: 50 min - 1h20

4th Step - cutting & injecting, objects

Flower pots and pencil pots

The flowerpots and pencil pots are made from PP and PS pellets in a mould with our partner "Plast Ok". The pots are produced by injection moulding.
The process consists of filling a mould with one or more cavities with molten plastic. The mould is filled mainly under pressure using an injection moulding machine. Once the material has polymerised in the mould, the mould is opened and the part can be removed.

The different characteristics of the pots are:

- Amount of pellets: 110 g
- Pot height: 7 cm
- Bottom diameter of the pot: 5 cm
- Top diameter of the pot: 7 cm
- Thickness: 3 mm

Clocks

The clocks are made from the plates produced by our partner «Precious Plastic Léman». Afterwards the engravings are made on the plates to realize the clocks at our partner Blaser Design Bern. The dimensions of the clocks are 270 cm x 270 cm.

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Life Cycle Assesment

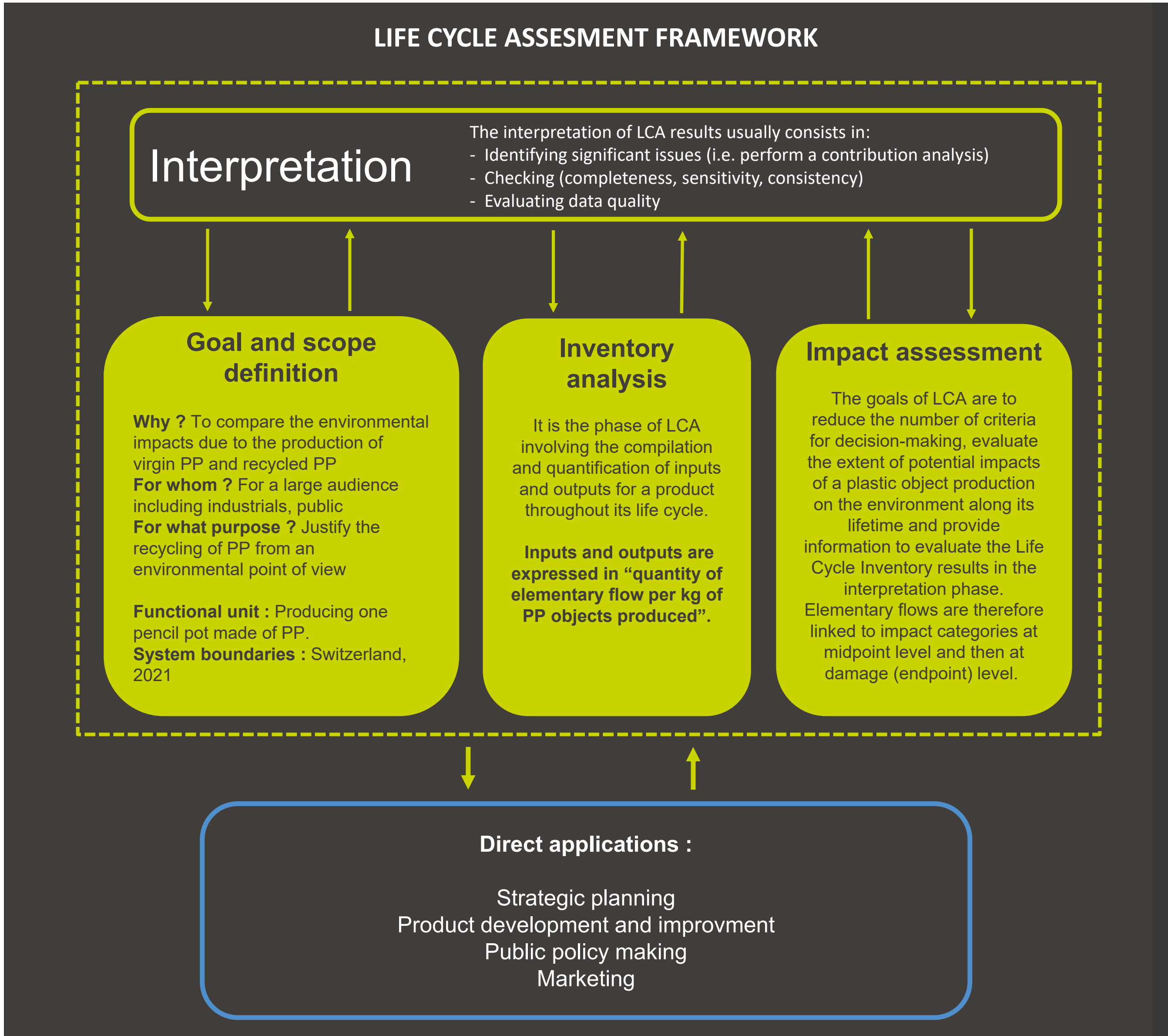
The aim of this life cycle assessment is to compare the environmental impacts from the production of virgin PP vs recycled PP

A Life Cycle Assignment (LCA) is needed to analyse clearly what are the impacts of each production method, and therefore assess the relevance of the project in these terms.

Virgin PP is produced with raw materials only. It has no recycled content. Therefore, its life cycle contains the step of resource extraction.

Concerning recycled PP, data provided by the project will be used. The recycled content method is used, with 100% of recycled material.

The Life Cycle Assessment framework is generally represented as shown on the central figure.

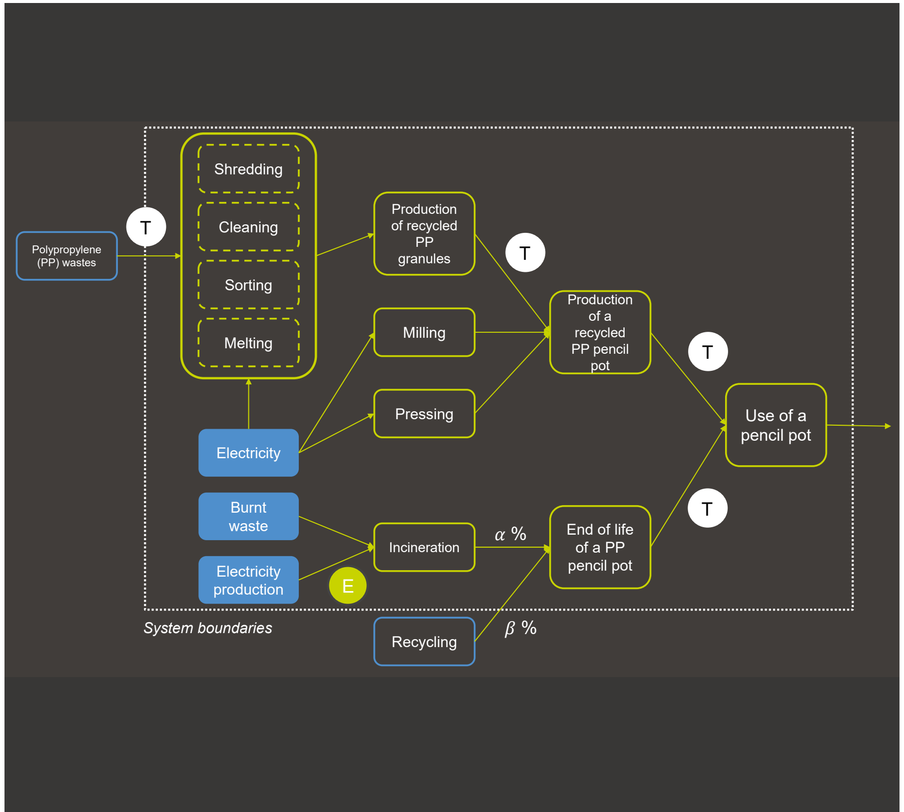


Our Life Cycle Assesment

The **functional unit** used in this project is *"Using a pencil pot made out of PP in Switzerland in 2021"*.

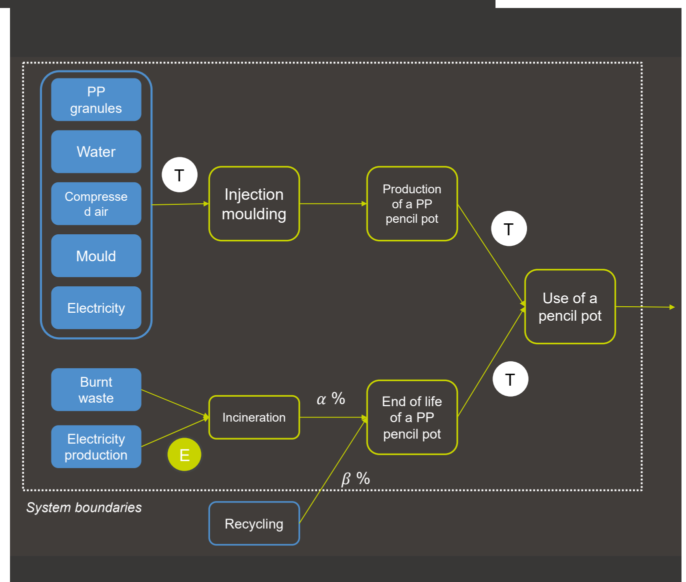
A **process tree** (or **flow diagram**) is a simplified representation of a product system. It has to be simple enough to be legible and complete enough to understand what is included in the study. The process tree is not useful for calculations, but to visualize the system and to communicate the results.

The process trees of the virgin and recycled PP are the following.



Legend

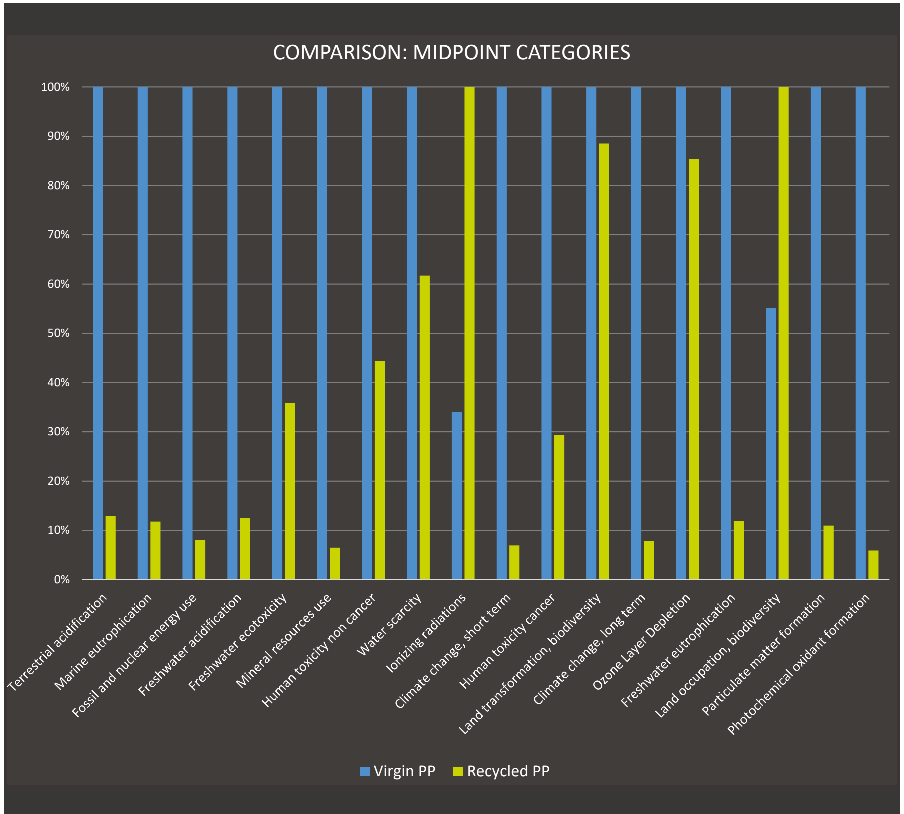
- Aggregated Processes
- Other Systems
- T Transport
- E Energy Recovery



Overview of our Results

For the sake of simplicity, **we will only consider the environmental impacts due to the production of PP granules** in both cases (recycled vs virgin). The following results are not corresponding to the whole life cycle, as we would like to use only reliable data.

As an example, a very simple way to model the production of PP granules is to consider the flow “Polypropylene, granulate” available in Ecoinvent 3.6 to represent virgin PP (i.e. all the steps necessary to produce PP granules from raw materials, but without any transport). Additionally, the recycling of PP waste into PP granules (which is equivalent to the production of PP granules from raw materials from an LCA point of view, the new functional unit in this specific case being “Producing 1 kg of PP granules in Switzerland in 2021”) is modelled by the total electricity consumption needed to perform the recycling of PP waste in order to get 1 kg of recycled PP granules (this data has been collected by our team). Therefore, recycled PP granules are modelled by the flow “1.28 kWh electricity, low voltage CH” available on Ecoinvent 3.6.



The results of this very simple comparison are shown on the top figure.

We can observe that the recycled PP has less environmental impact on almost all impact categories, but not all of them ! This example is pretty unbalanced, but this gives a good overview of the difficulty that decision-makers may face with more balanced results.

In our case, we can suggest that recycling waste into granules is generally better from the environmental point of view. It is also important to notice that the reduced workflow that we consider (only production of PP granules) only partly represents the overall results considering the entire workflow (from raw material extraction to pencil plot end of life). However, these results still constitute a good overview for environmental footprint comparison.

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The work presented in this booklet has been exhibited at the SV Hall EPFL from September 11th to October 11th 2021 together with the exhibition *Voir et Savoir*.

The content was produced during the academic year 2020-2021, despite strong COVID-19 restrictions, during the Social and Human Sciences class "*Gestion des Organisations I et II"*.

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