Summary of the context and overall objectives of the project

Absorbent Hygiene Products (AHPs) have become essential everyday products to society and their use has increased substantially. As with every consumer product, also AHP's end up in solid waste after their use. Today, they represent approx. 3-4% of the total municipal solid waste and are considered a non-recyclable fraction, which is usually incinerated or landfilled. Over the past 20 years there has been great progress by AHPs manufacturers to reduce the environmental impact of AHPs, for example, the average weight of baby diapers was reduced by around 50%. However, to meet society's needs for sustainable consumption there is further innovation required: FaterSMART has developed and patented an innovative recycling solution for post-consumer AHP waste creating secondary raw materials for higher value applications. This is already demonstrated through an industrial scale unit based in Lovadina di Spresiano (Treviso – Italy).

EMBRACED is aimed at closing the loop for AHP waste, reducing CO_2 emission and increasing sustainability in Europe. The objective of the project is the establishment of a first-of-its-kind demonstration plant of an integrated biorefinery in The Netherlands, with a throughput of 10,000 t/year, based on the valorisation of the cellulosic fraction of AHP waste towards the production of bio-based building blocks, polymers and fertilizers. EMBRACED will operate valorising all the fractions from the process, to obtain marketable end-products fully competitive in terms of cost, quality and sustainability. Importantly, the project will follow a circular economy approach, closing the cycle of raw materials and minimizing the use of primary resources, through the establishment of virtuous models of cooperation among all the involved stakeholders.

The EMBRACED biorefinery model can be divided in six main phases along the value chain:

1. AHP waste separate collection by waste operators from households and Institutions and transport to the pre-treatment plant
2. Pre-treatment plant, which allows the recycling of AHP waste for the recovery of cellulose, plastic and Super Absorbent Polymer (SAP)
3. Value chain A: cellulose from the AHP pre-treatment is hydrolysed towards obtaining second-generation sugars. Sugars then feed a fermenter for producing bio-based building blocks that is used for producing bio-based polyesters targeted at film applications
4. Value chain B: cellulose containing SAP and part of the plastic fraction undergo a gasification process targeted at producing syngas. The cleaned gaseous stream is then fed to a bioreactor for producing bio-based PHB via fermentation with selected microorganisms
5. Application into final products: all the materials and by-products from the upstream (SAP and plastic) and downstream (PHB, bio-based polyesters and cells) are further processed towards the validation into end products with increased sustainability, competitive cost and relevant market impacts

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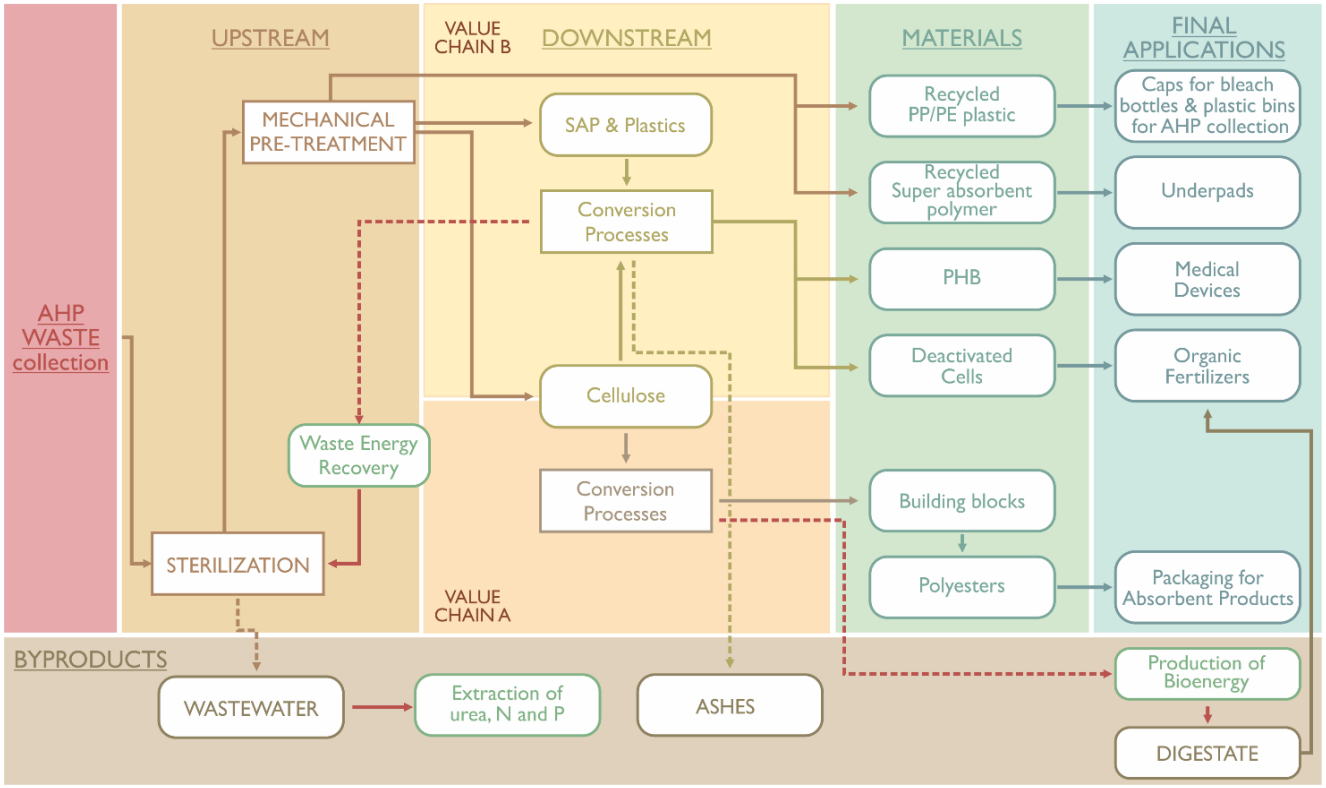
6. Recovery of by-products: extraction of nutrients from wastewaters, recovery of waste energy from gasification process, recovery of cells from fermentation broths and further valorisation into bioenergy and fertilizers production.



EMBRACED biorefinery model

Work performed during the first 18 months (June 2017-November 2018)

Overall, EMBRACED is fully on track. During the first period of EMBRACED project, the design and test of an innovative AHP waste collection system from households, with prototype smart bins located in front of day cares and stores, have been started in Amsterdam after market research and discussion with various local players. The logistics for achieving 10,000 t/year of feedstock collection from households and institutions and an adequate storage system in Amsterdam have been also defined.

The installation of the upgraded upstream AHP waste treatment plant at Contarina, including equipment for third product fraction separation, has been completed. The process for plastic and cellulose separation has been fine-tuned, while the SAP-cellulose separation process has been implemented.

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AHP waste pre-treatment plant

The pre-permitting for the installation of the biorefinery in Amsterdam has been approved by the Dutch Authority and the permitting preparation and the End-of-Waste procedures are underway.

The selection of the gasification for the production of syngas suitable for feeding the downstream gas bioprocessing has almost been completed. Also, the selection of the strains for the PHB production and the development of process are in a well advanced phase. Design of the bioprocess pilot has moved from basic engineering to value engineering.

Activities on AHP waste cellulose conversion into fermentable sugars and biotechnological conversion into biobased building blocks progressed significantly by identifying at pilot scale an optimal process enabling the obtaining of high quality sugars, which have been successfully validated into the biotech conversion into biobased building blocks suitable for further polymerization.

Development of the technical specification of biomaterials to test in the final applications has been achieved. The thermodynamic model and thermo-economic assessment for the AHP pre-treatment plant, to be applied for the identification of energy efficiency measures, have been finished.

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Identification of every potential nutrient to be extracted from the AHP pre-treatment process and preliminary tests with artificial wastewater and membranes in order to recover Mg and NH4 have been completed. Waste collection bins, P&G detergent cups and underpads from recovered SAP, plastics and cellulose are even almost finished as well.

By-products from the bioconversion of syngas (value chain B) are being defined. By-products from sugars and biobased building block production from value chain A have been successfully valorised for bioenergy production.

EMBRACED final products

The consultation phase within the institutions on the regulations about the End of Waste criteria is running at European and National level, taking advantage also of the cooperation with the stakeholders' group that has been successfully set up, involving already 20 stakeholders from 11 different European Countries.

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Preliminary assessment on the implementation of the European ETV scheme to the AHP waste pre-treatment technology has been done and has been positively assessed by an accredited Verification Body.

Analysis of the social context in the Netherlands has been finalised and an Action Plan for social acceptance of the biorefinery model has been defined and is about to be implemented.

Progress beyond the state of the art and expected results until the end of the project

Currently, AHPs find their way to landfills or incineration, leading to important environmental concerns and causing loss of valuable material resources and high economic and societal costs. Composting of AHP waste is also applied in some territories, but presents many technical and environmental hurdles: it does not allow the recovery of the valuable raw materials; it worsen the industrial composting process because of the non-biodegradable plastic and SAP content; it allows only the production of a low grade quality compost that potentially contains zinc, pathogens and drugs residues.

Recycling of AHP waste is the most environmentally friendly option, as it offers the potential to avoid the main issues associated with landfilling, incineration and composting. The EMBRACED biorefinery allows the full recovery of AHP waste into high value bio-based and biodegradable products diverting 10,000 t/year of AHP waste from landfilling and incineration, thus generating clear advantage for the environment, municipalities and citizens, the industry and creating new employment.

Address (URL) of the project's public website

https://www.embraced.eu/

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