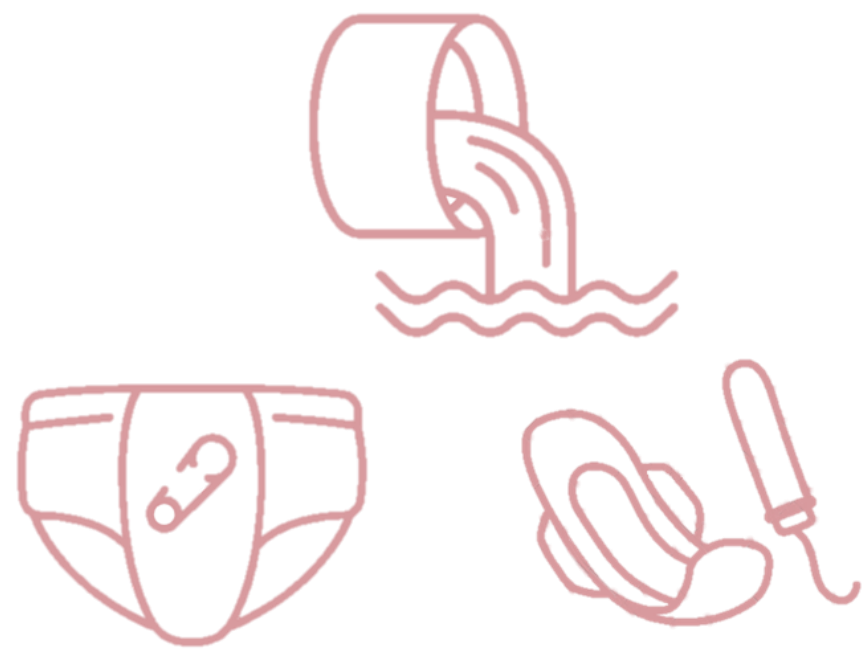


## Upcycling Cellulosic Waste Streams into Construction Materials – Life cycle assessment under ICARUS project

M. Azevedo <sup>1</sup>, J. Ortigueira <sup>1</sup>, S. Luciani <sup>2</sup>, María M. Micó <sup>3</sup>, D. Hiniesto <sup>3</sup>, R. Castellanos <sup>4</sup>, F. Verdugo <sup>5</sup>, D. Hidalgo <sup>5</sup>, M. Victoria Martinez-Lorenzo <sup>5</sup>, H. Monteiro <sup>1</sup>

<sup>1</sup> Low Carbon & Resources Efficiency, R&Di, Instituto de Soldadura e Qualidade, Portugal  
<sup>2</sup> i-Foria, Italy  
<sup>3</sup> Acciona, Spain  
<sup>4</sup> Fundación Agustín de Betancourt, Spain  
<sup>5</sup> CARTIF Technology Centre, Circular Economy Area, Boecillo (Valladolid), 47151, Spain  
 Presenting author email: [himonteiro@isq.pt](mailto:himonteiro@isq.pt)



### Introduction

The circular economy promotes resource efficiency and waste reduction by supporting the reuse and recycling of materials, reducing dependence on virgin raw materials. In this context, secondary raw materials play a key role in improving sustainability and lowering environmental impacts. The construction industry, responsible for high raw material and energy consumption, faces significant environmental challenges. Therefore, the valorisation of waste streams as secondary raw materials has emerged as an important strategy to support circular economy practices in the sector. Within this context, the ICARUS project aims to demonstrate how high-impact industrial waste can be transformed into valuable construction materials by validating innovative upcycling solutions through three real-scale demonstration cases across Europe, contributing to a more circular and digital industry. This study focuses specifically on the environmental assessment of the Demo Case 2 - Upcycling of industrial and urban cellulosic waste.

### Materials and Methods

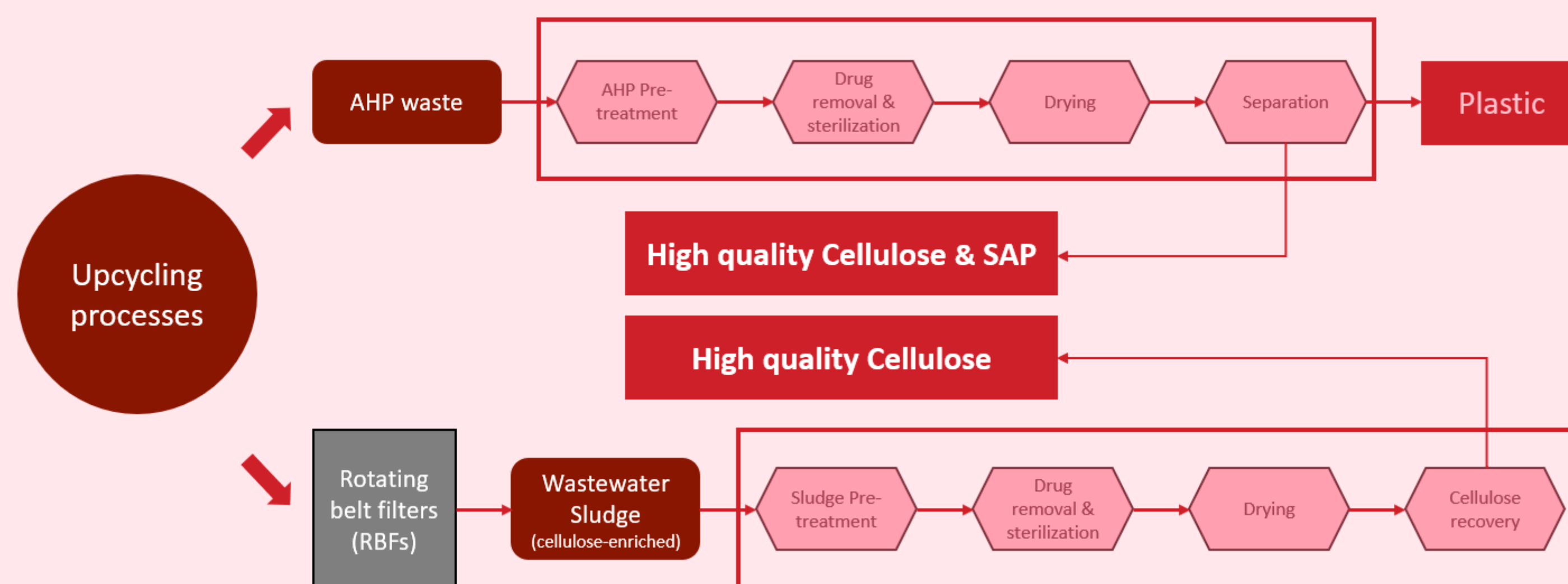
**Goal and scope** To quantify the environmental impacts, a Life Cycle Assessment (LCA) will be conducted according to ISO 14040 and ISO 14044 standards. The assessment will follow a cradle-to-gate with options approach, including manufacturing, end-of-life, and recovery or recycling stages. Two functional units are defined to represent the different stages of the value chain:

1. for the recovery and upcycling processes
2. for the final construction application

This approach enables the independent assessment and comparison of both the production of secondary raw materials (SRMs) and their end-use performance against baseline scenarios.

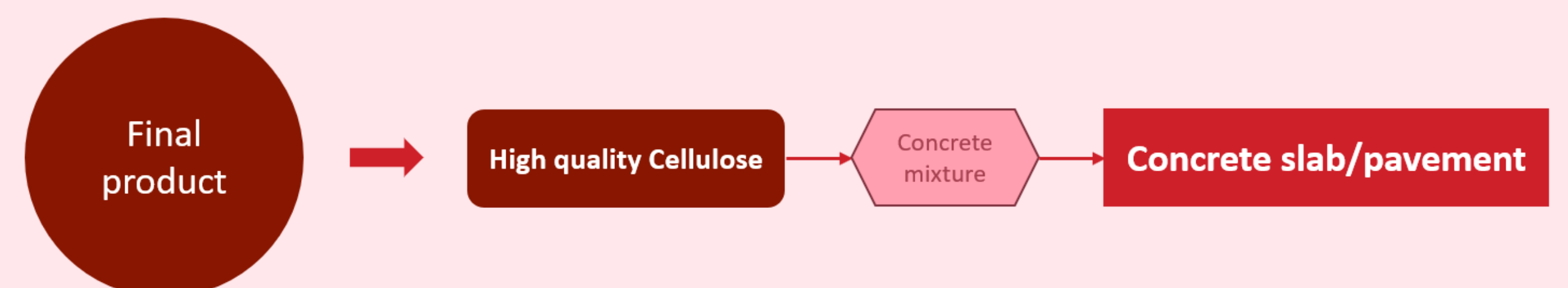
#### 1) Upcycling process

**Functional unit** 1 kg of high-quality recovered cellulose



#### 2) Final product

**Functional unit** 1 m<sup>3</sup> of concrete slab or pavement incorporating the upcycled materials



### Impact Assessment

This assessment will compare SRM production and end-use performance with conventional baseline scenarios:

1. biodegradation for WWTP sludge and landfilling or incineration for AHP waste
2. reference concrete mixes without fibres and with conventional polypropylene (PP) microfibres

The results quantify the environmental benefits of material substitution and circularity and identify key environmental hotspots across the system.

#### 1) Upcycling process



#### 2) Final product



### Conclusion

The integration of secondary raw materials in the construction sector represents a promising pathway towards a more sustainable and circular economy. This approach enables the assessment of environmental benefits associated with material substitution and circularity, while identifying key process hotspots that can support future optimisation and scale-up strategies. By reducing waste generation, lowering the consumption of virgin resources, and decreasing environmental impacts, circular practices can contribute to a more resource-efficient and resilient construction industry.