Life cycle assessment of brown-seaweed-based plastic

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Publication date:
2022

Document Version
Publisher's PDF, also known as Version of record

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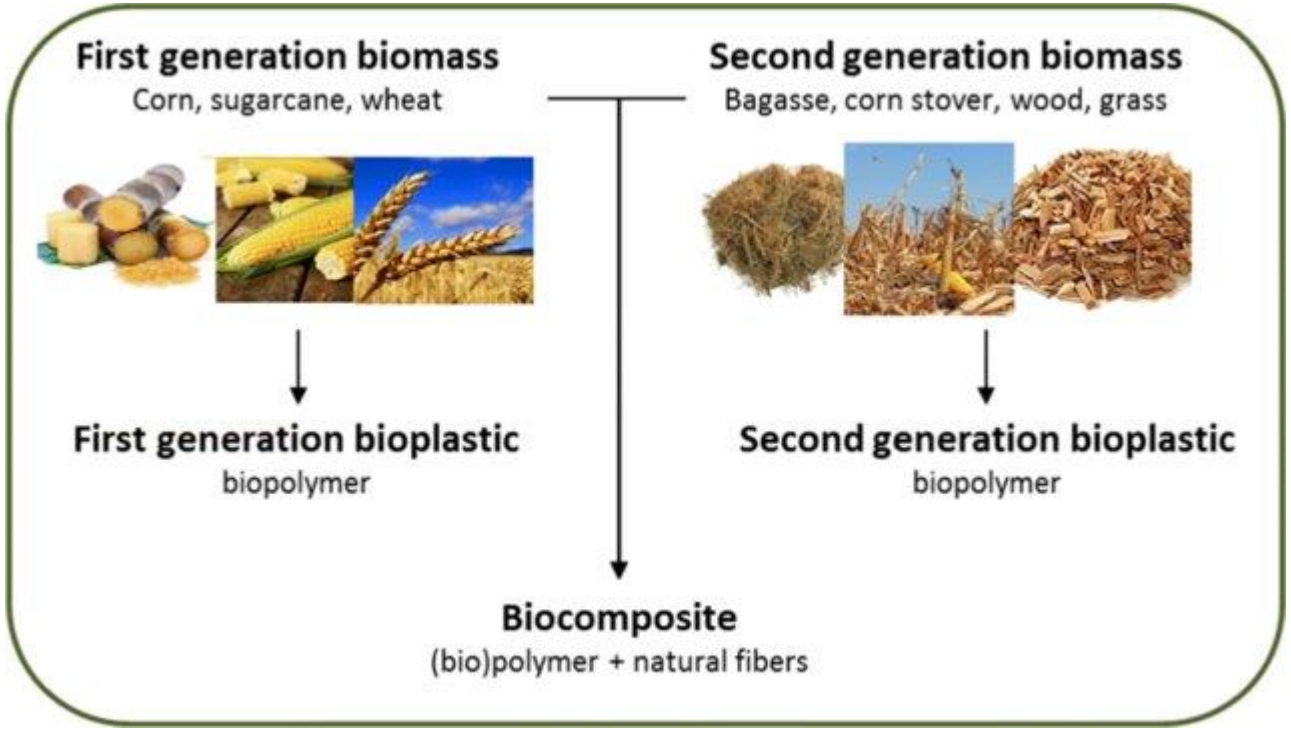
Outline

- Seaweed cultivation and seaweed-based plastics
- Consequential LCA and pilot scale data
- Scenarios for resource recovery and end-of-life
- Carbon balances and carbon footprints
- Wrap up, uncertainties and future work

Bioplastics from primary and secondary sources

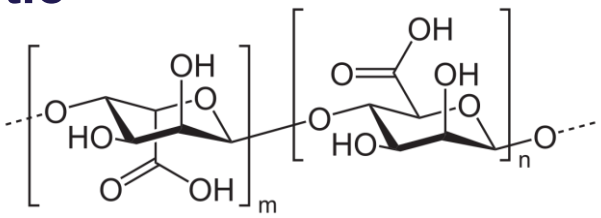


Seaweed-based plastic

Seaweed cultivation, provides ecosystem services:

- Reduces eutrophication via nutrient uptake
- Carbon uptake and oxygenation of coastal waters

Seaweed-based plastic

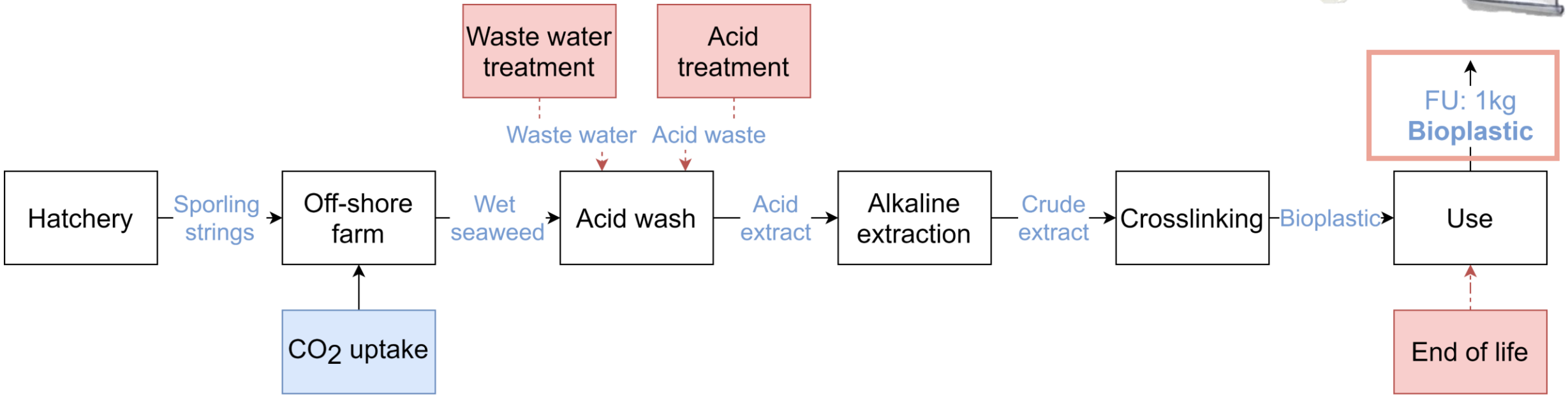


- No land-use
- Alginate-based
- Emerging technology, pilot scale only
- Yet unclear life-cycle trade-offs and impact

LCA methods used in this study

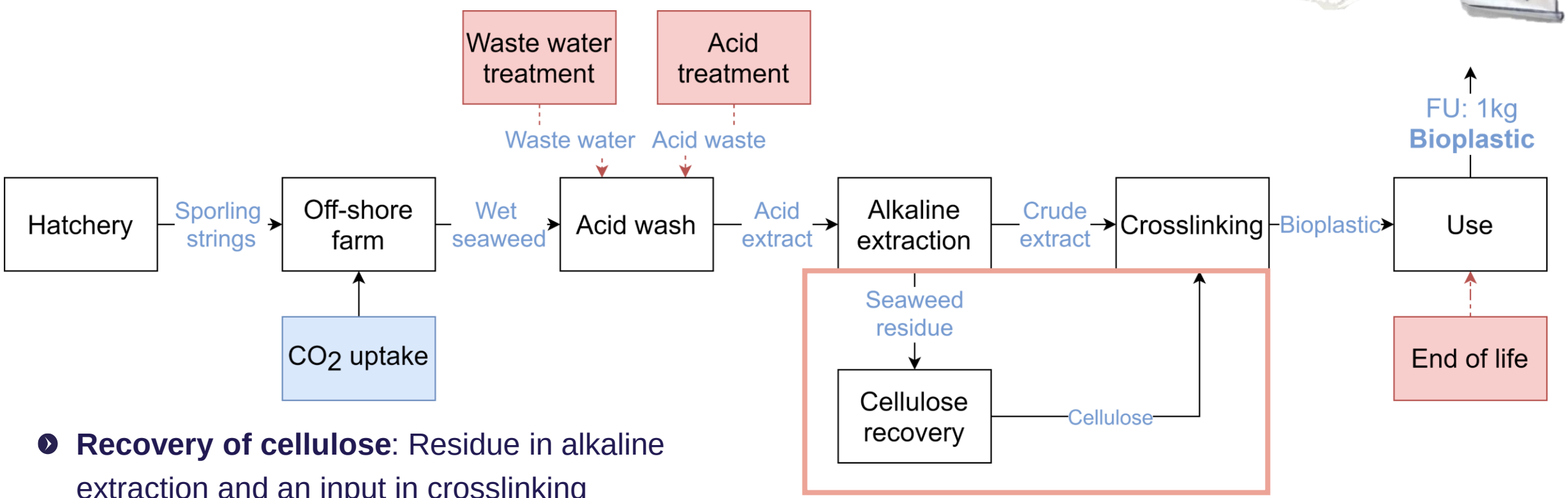
- Consequential LCA
  - Consequences for increasing demand of bioplastic
- Scope: from seaweed cultivation to plastic production and end-of-life
  - Carbon balance and footprint
  - Modelling different co-products scenarios (substitution method)
  - EoL scenarios for the plastic management
- Support in early R&D stage within **PlastiSea** project

Scenario 1: base pilot scale system



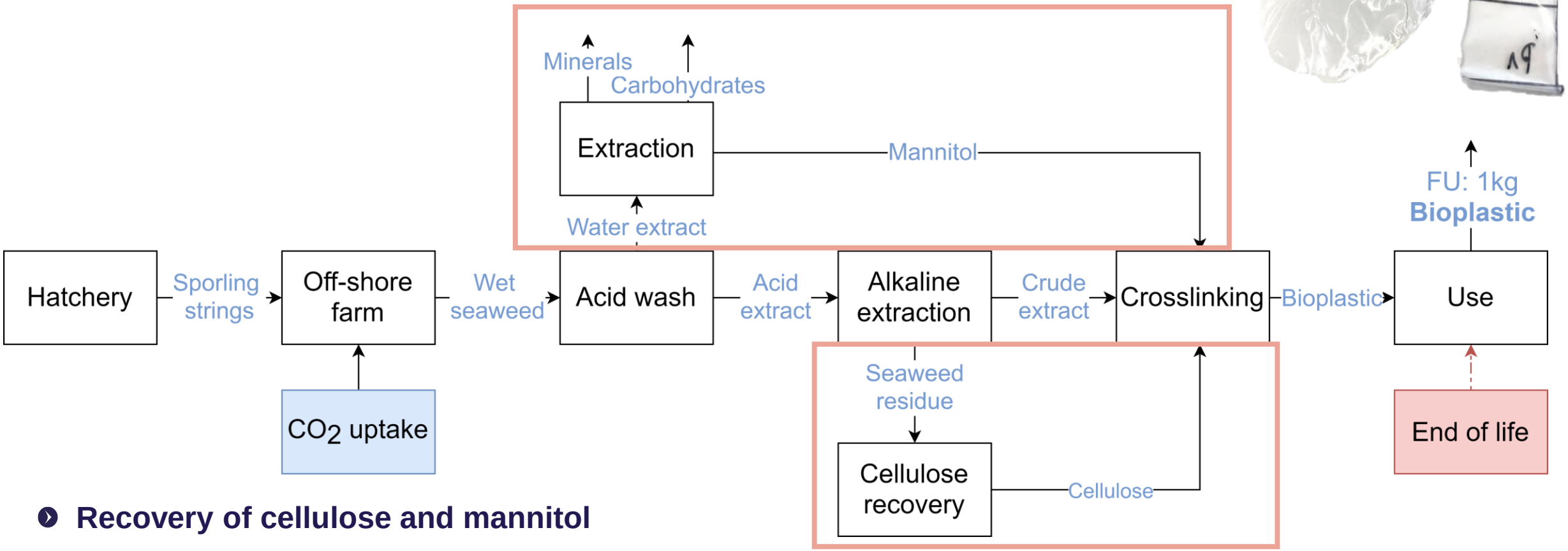
- CO_2 uptake
- Waste water and acid treatment
- End of life: Incineration and biodegradation
- No co-products

Scenario 2: cellulose recovery



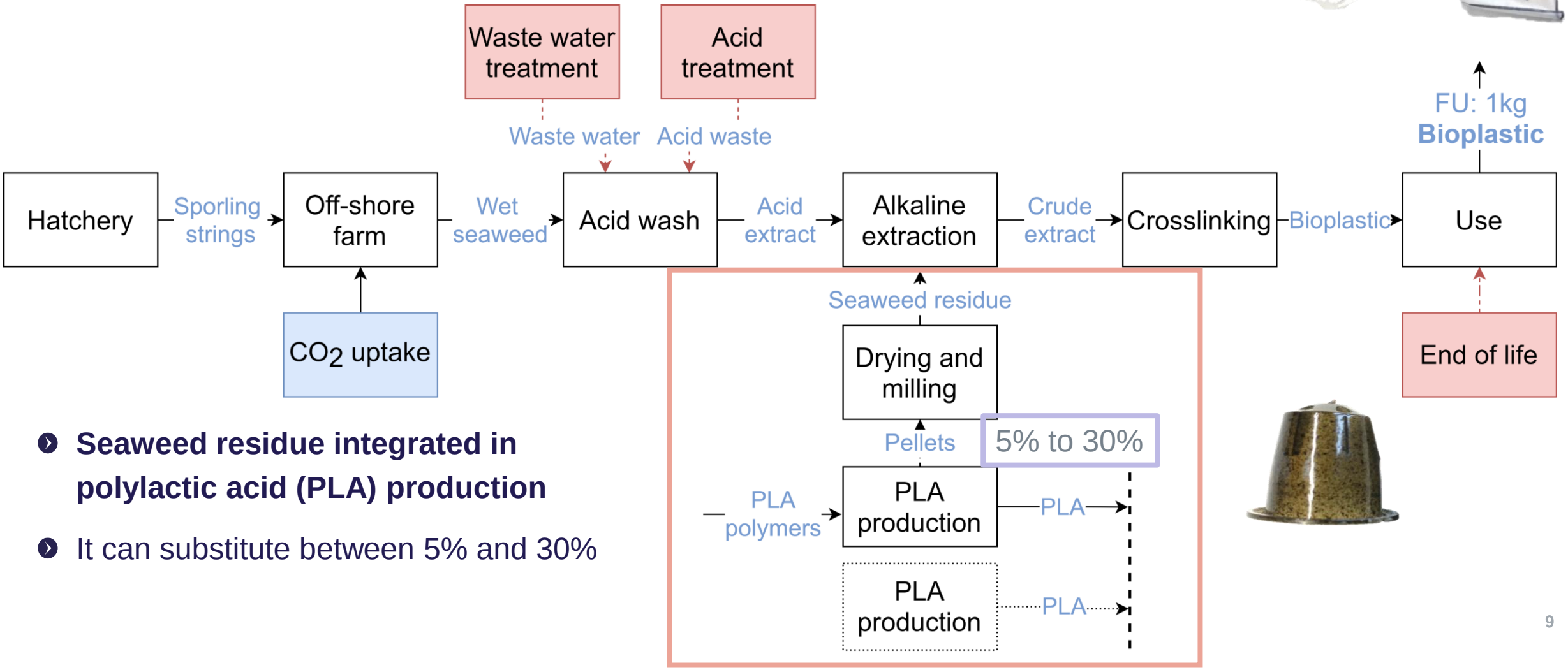
- **Recovery of cellulose**: Residue in alkaline extraction and an input in crosslinking
- End of life: Incineration and biodegradation

Scenario 3: mannitol recovery



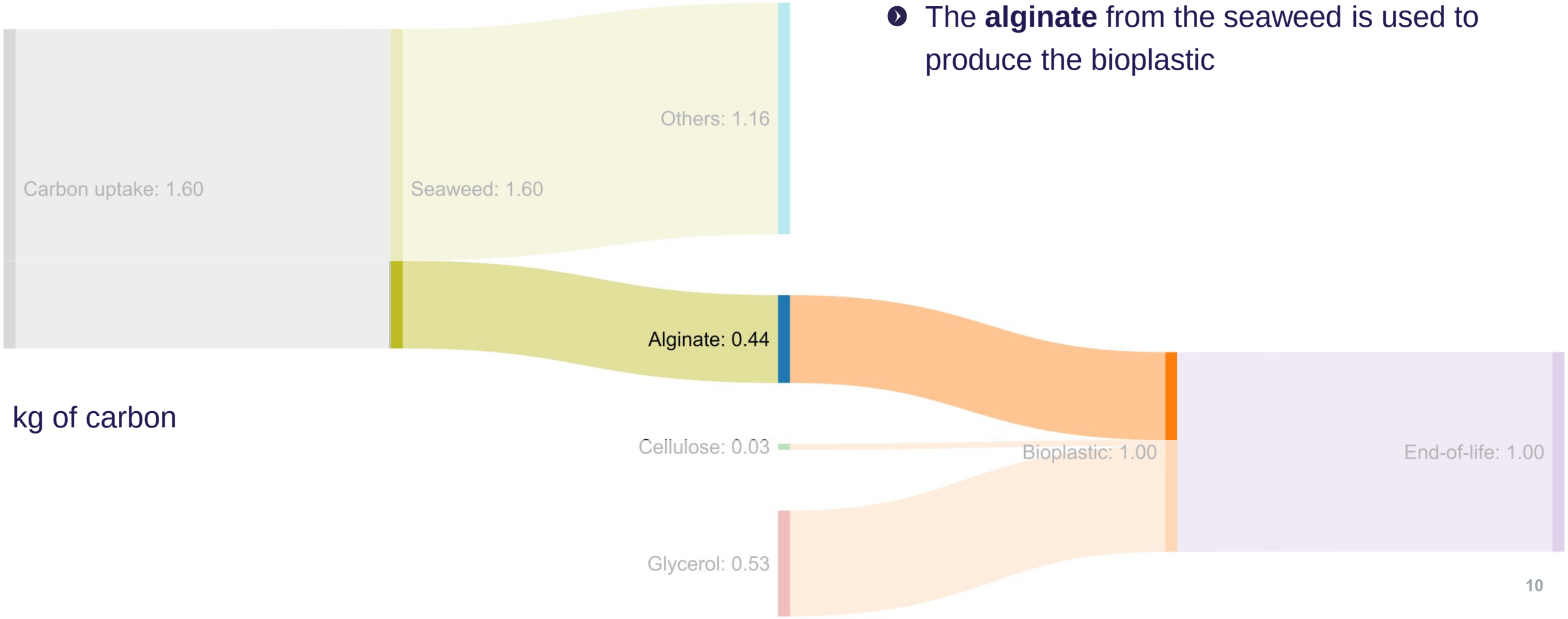
- **Recovery of cellulose and mannitol**
- Mannitol could be used to replace glycerol (a hotspot) in the crosslinking.
- End of life: Incineration and biodegradation

Scenarios 4, 5: PLA substitution (5%, 30%)



- **Seaweed residue integrated in polylactic acid (PLA) production**
- It can substitute between 5% and 30%

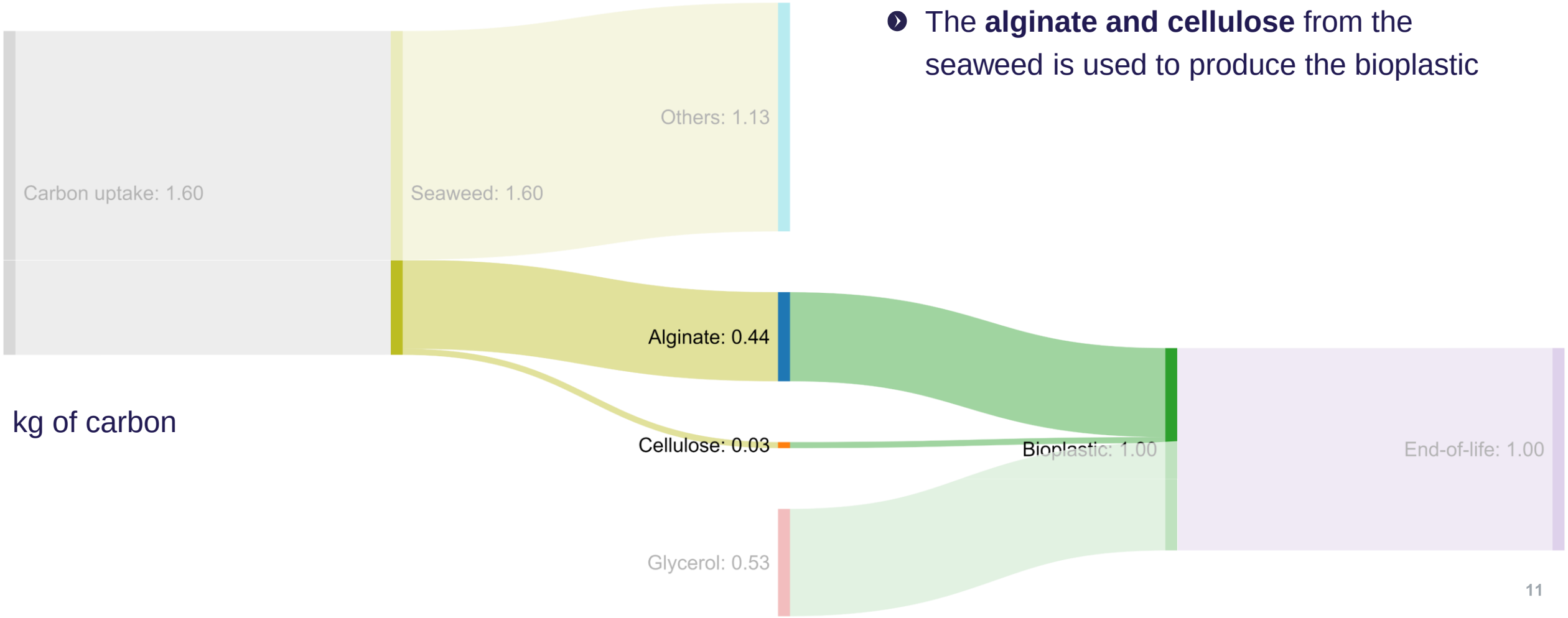
Scenario 1: carbon balance - base scenario



- The **alginate** from the seaweed is used to produce the bioplastic

kg of carbon

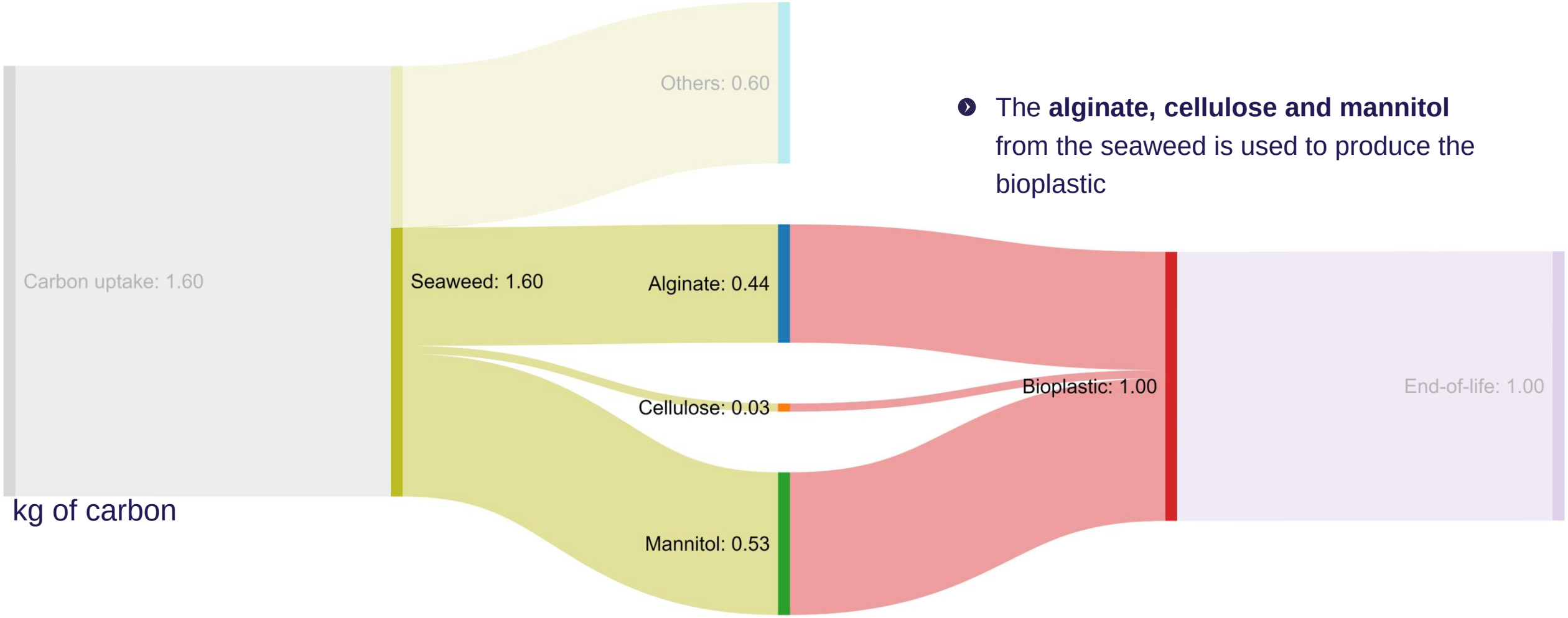
Scenario 2: carbon balance - cellulose recovery



kg of carbon

- The **alginate and cellulose** from the seaweed is used to produce the bioplastic

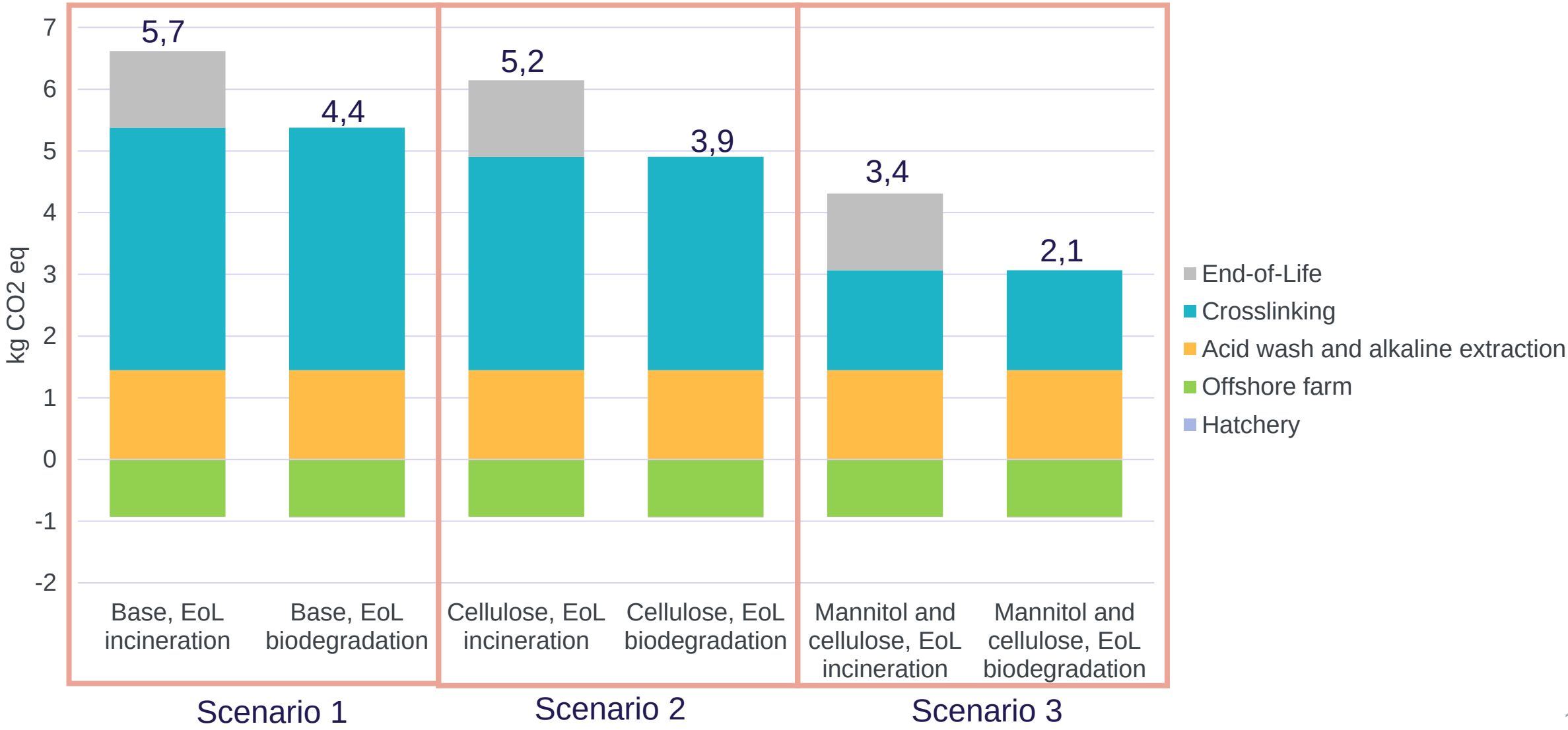
Scenario 3: carbon balance - mannitol recovery



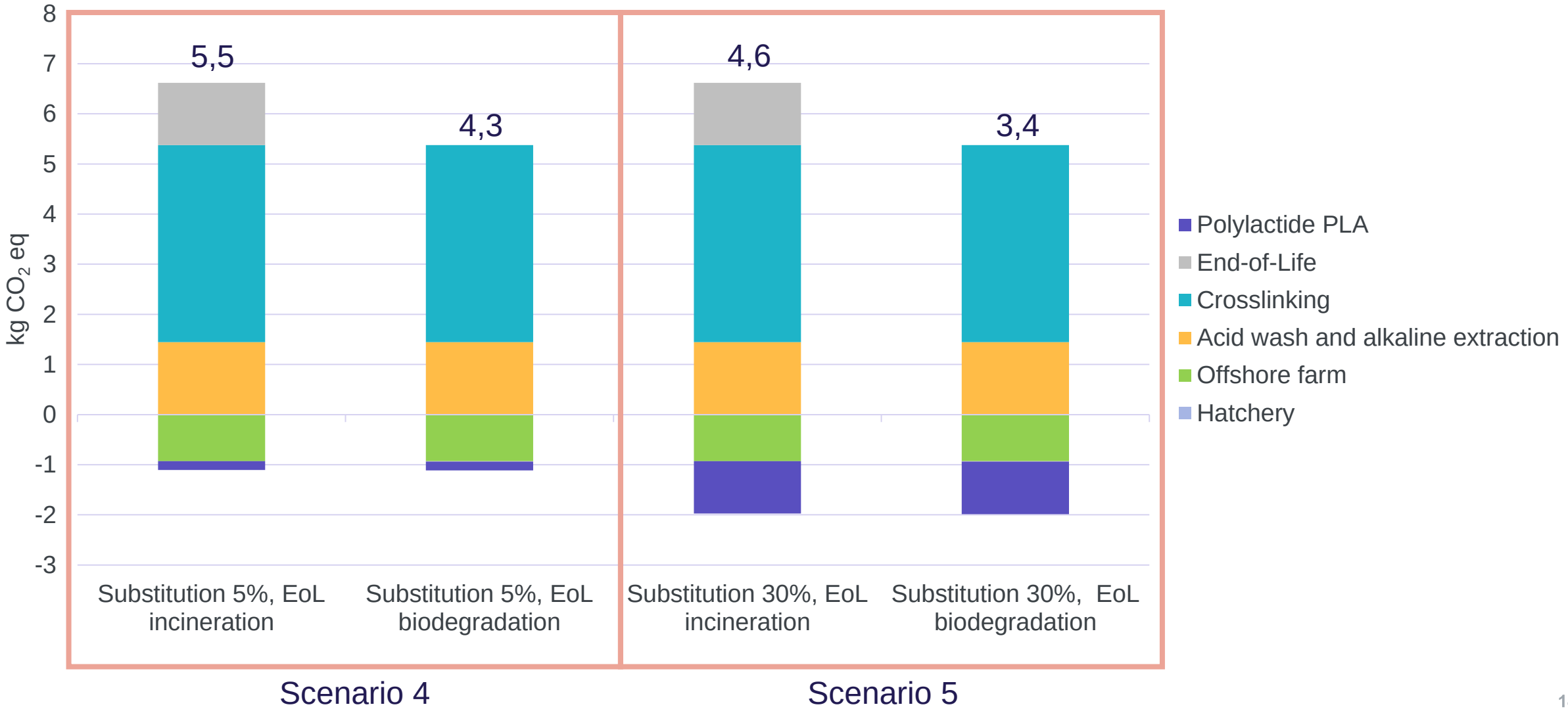
kg of carbon

- The **alginate, cellulose and mannitol** from the seaweed is used to produce the bioplastic

Results: carbon footprint, co-products scenarios



Results: carbon footprint, substitution



Wrap up

- Full carbon balance for different scenarios shows great potential of resource recovery
- Base scenario carbon footprint of **5,7** kg CO_2 eq.
- Recirculate by-products: cellulose and mannitol recovery reduce footprint by approx. **40%**
- End of life scenario reduce footprint by approx. **23%** via biodegradation compared to incineration

Uncertainties and future work

- Pilot scale data, unrealistic picture: working on upscaling scenarios using different techniques
- Recirculate by-products: only theoretical, trade offs to be investigated in lab and then model
- Unclear which end-of-life pathways will be used, likely a mix and location-specific
- Future work on upscaled industrial scale impacts

Thank you for your attention!

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Department of Planning

My university profile

Project funding:

ERA-NET Cofund BlueBio, grant no. 9082-00011

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