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## **Life cycle assessment of brown-seaweed-based plastic**

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# Life cycle assessment of brown-seaweed-based plastic

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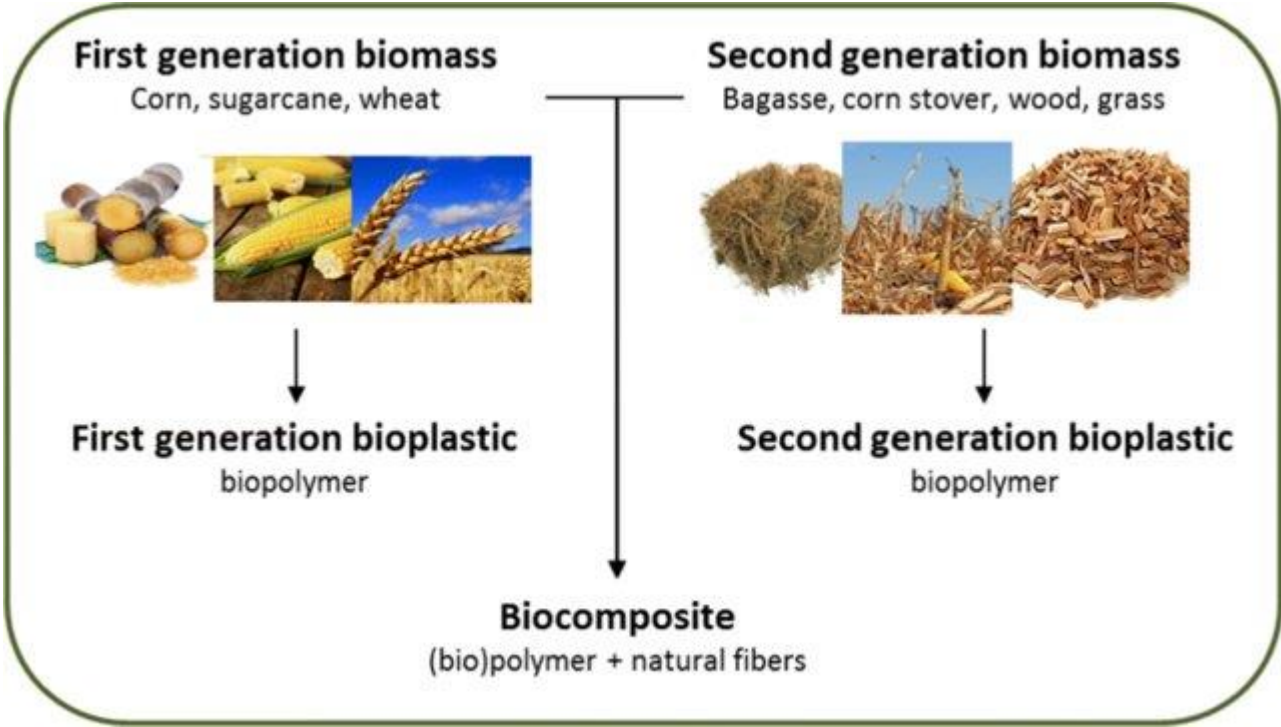




# Outline

- ▶ 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



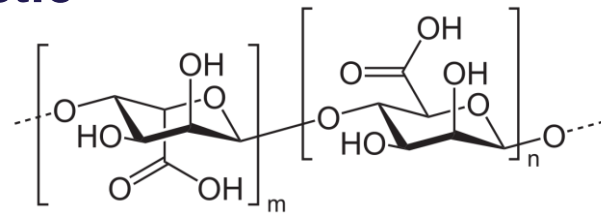
# Seaweed-based plastic

**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

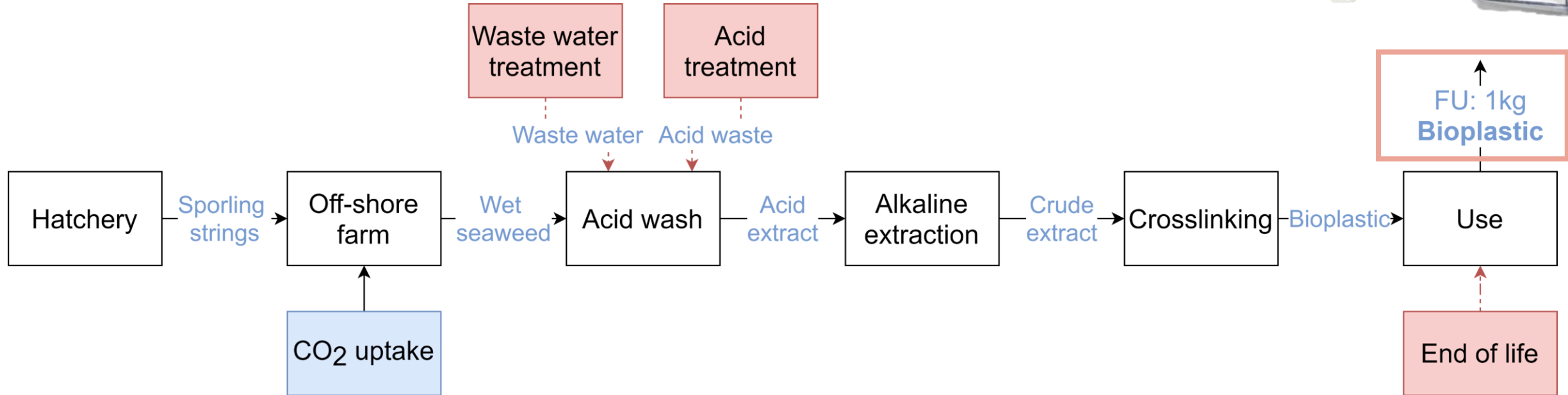


# LCA methods used in this study

- 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

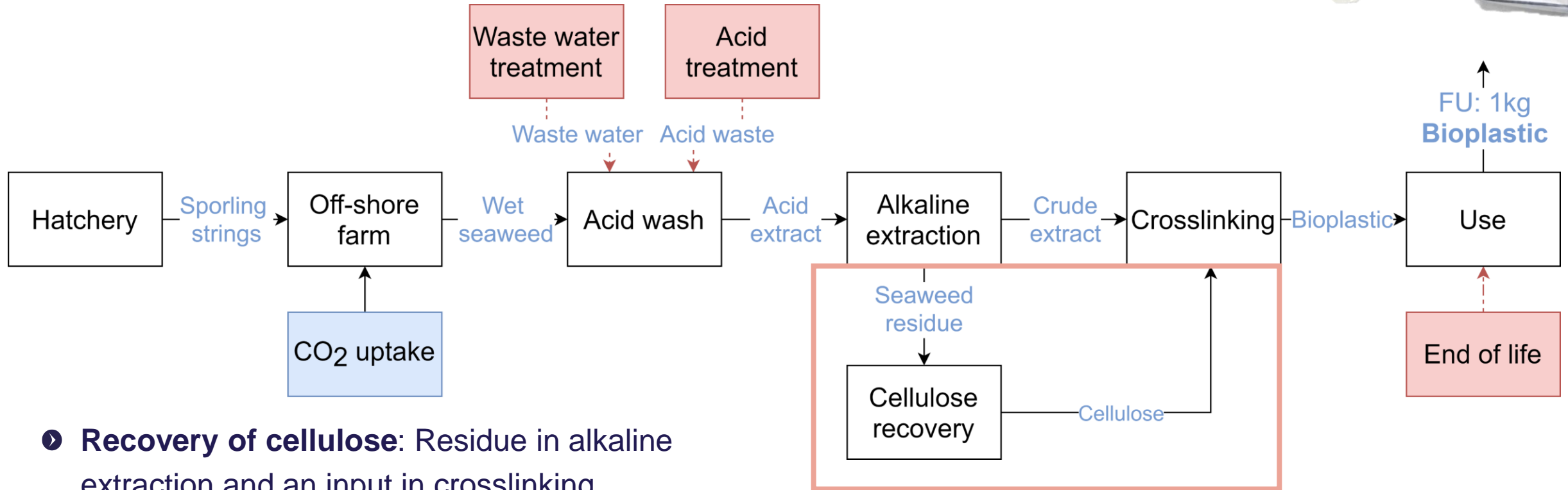


# Scenario 1: base pilot scale system



- CO<sub>2</sub> uptake
- Waste water and acid treatment
- End of life: Incineration and biodegradation
- No co-products

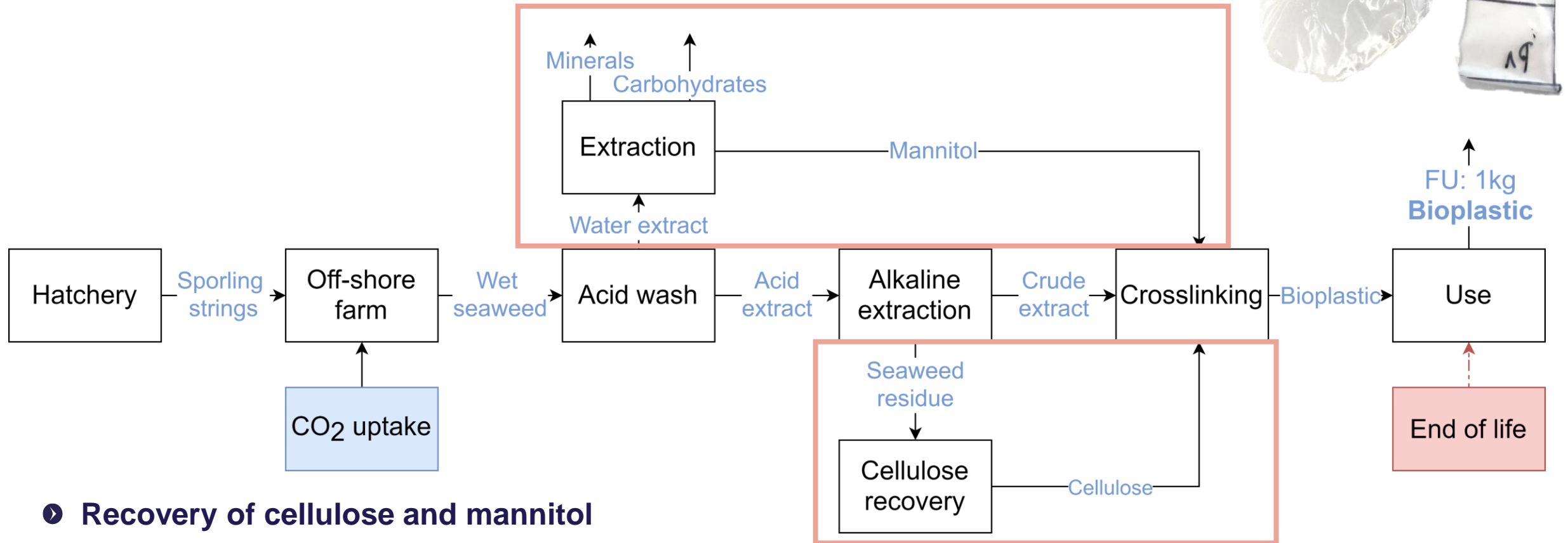
# Scenario 2: cellulose recovery



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



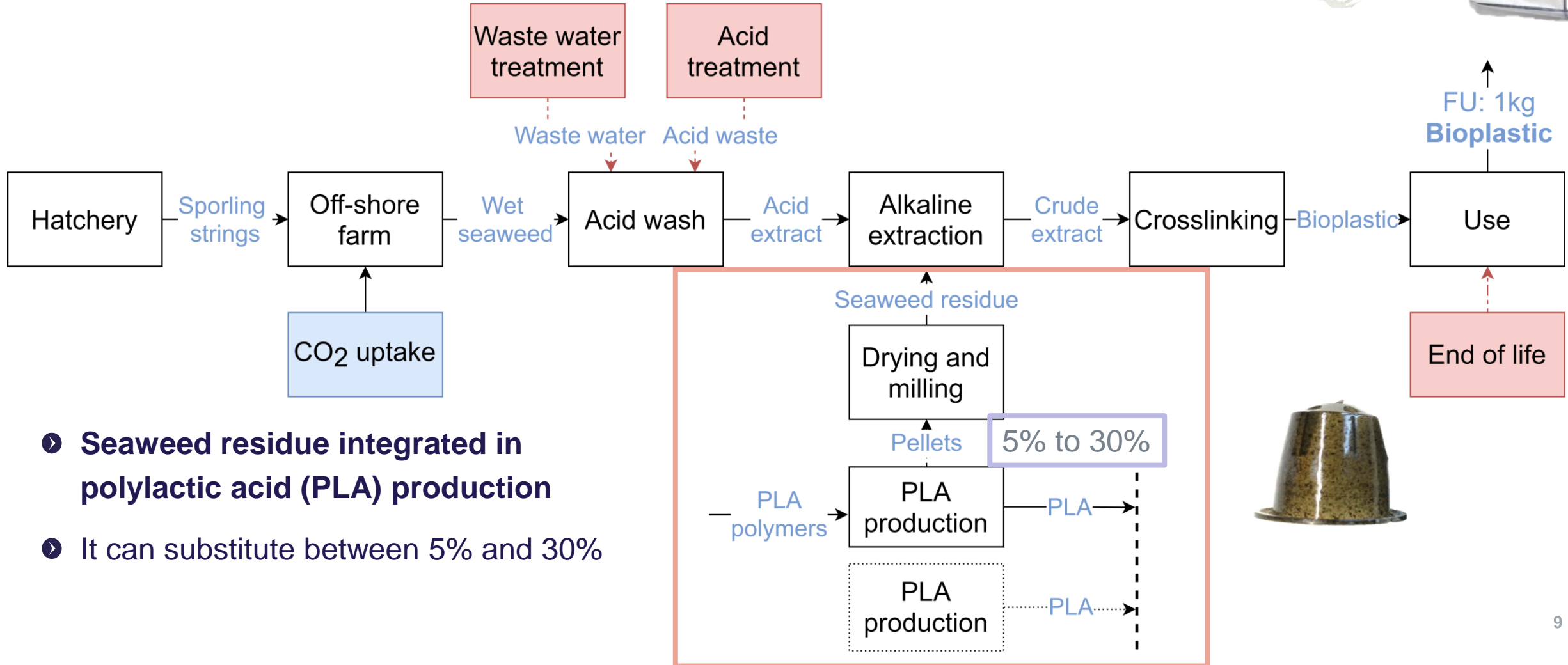
# Scenario 3: mannitol recovery



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

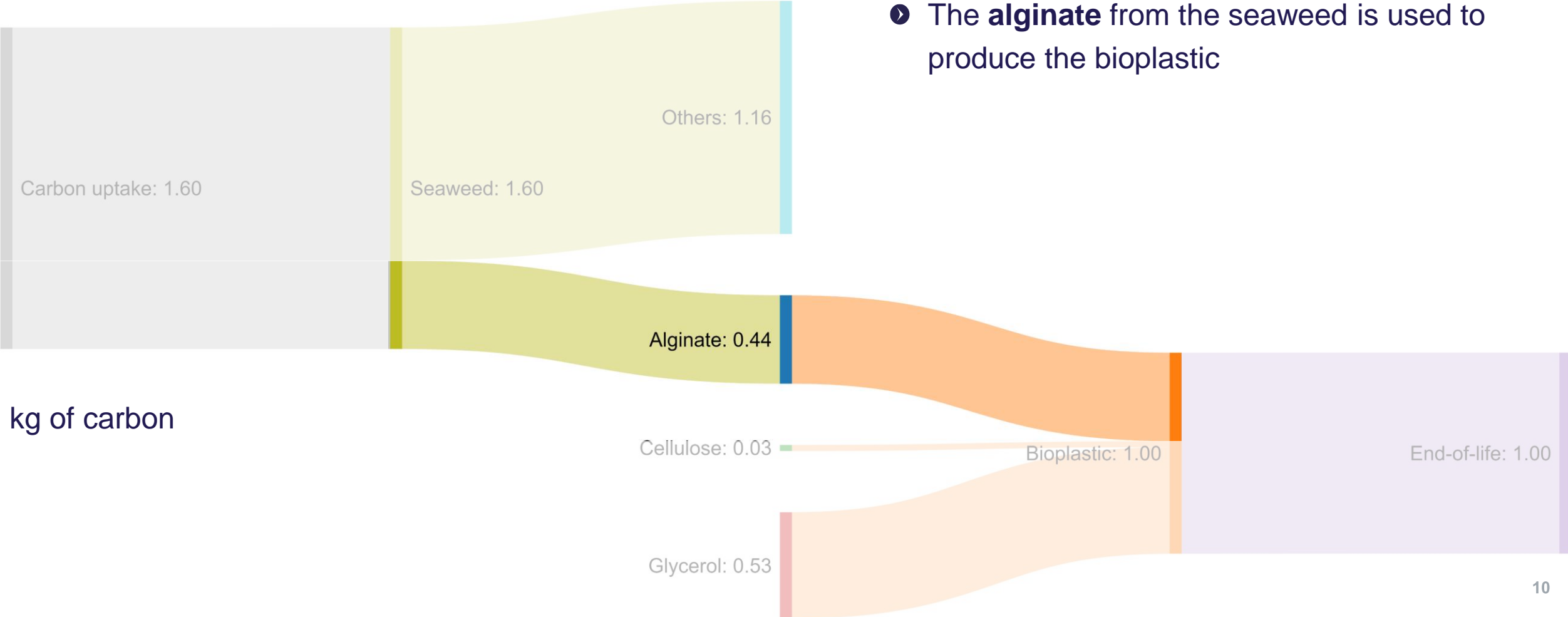


# Scenarios 4, 5: PLA substitution (5%, 30%)



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

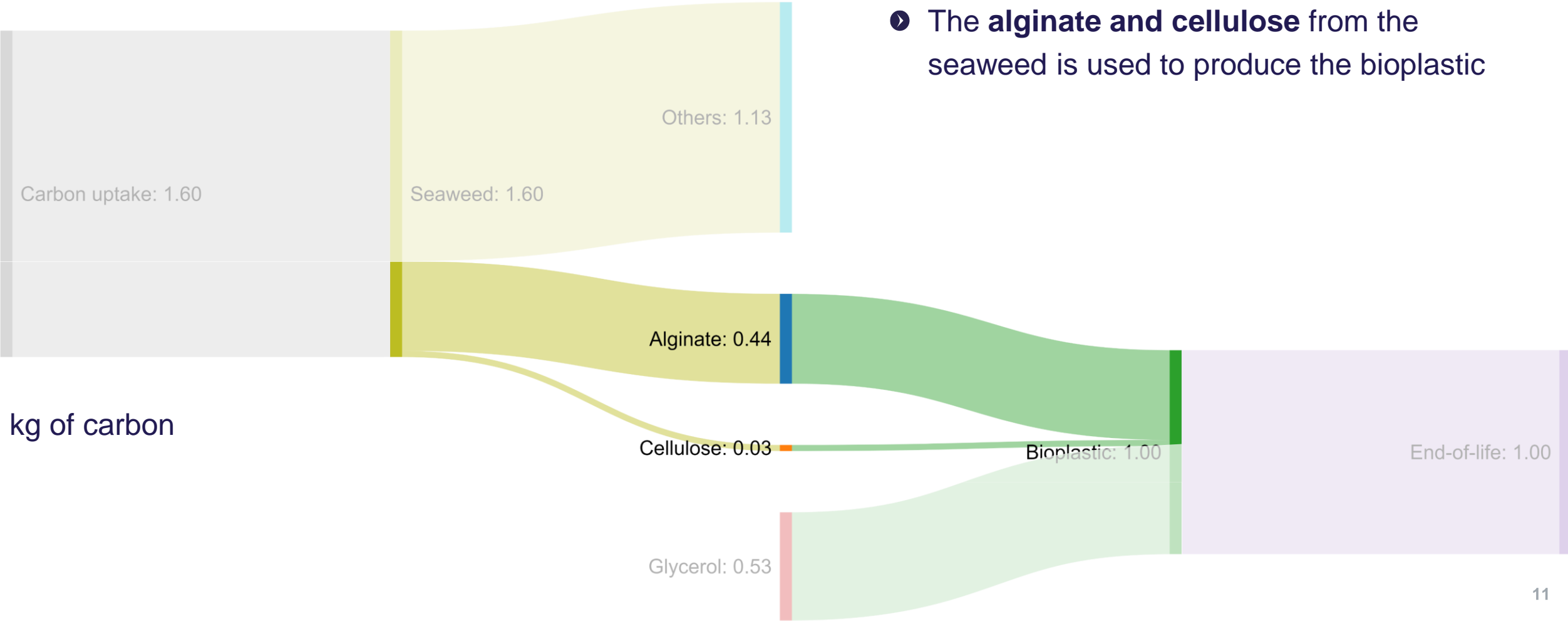
# Scenario 1: carbon balance - base scenario



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

kg of carbon

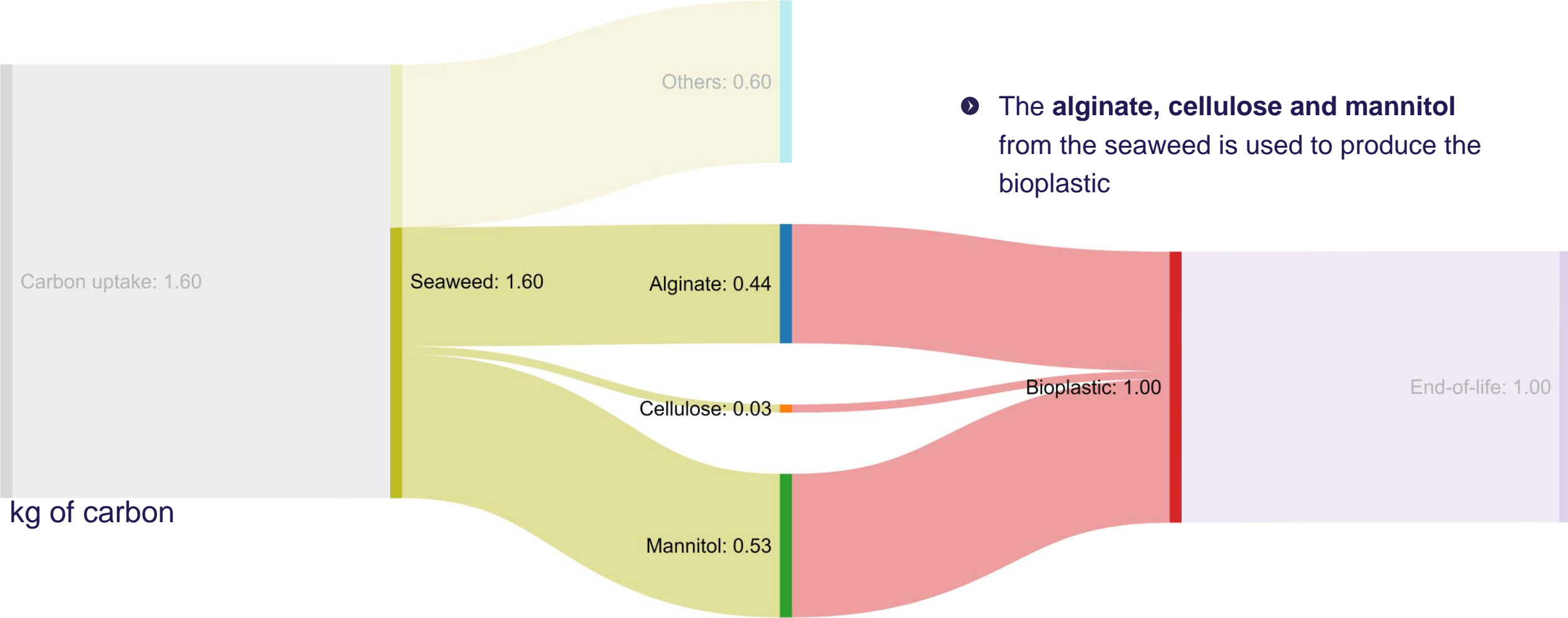
# Scenario 2: carbon balance - cellulose recovery



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

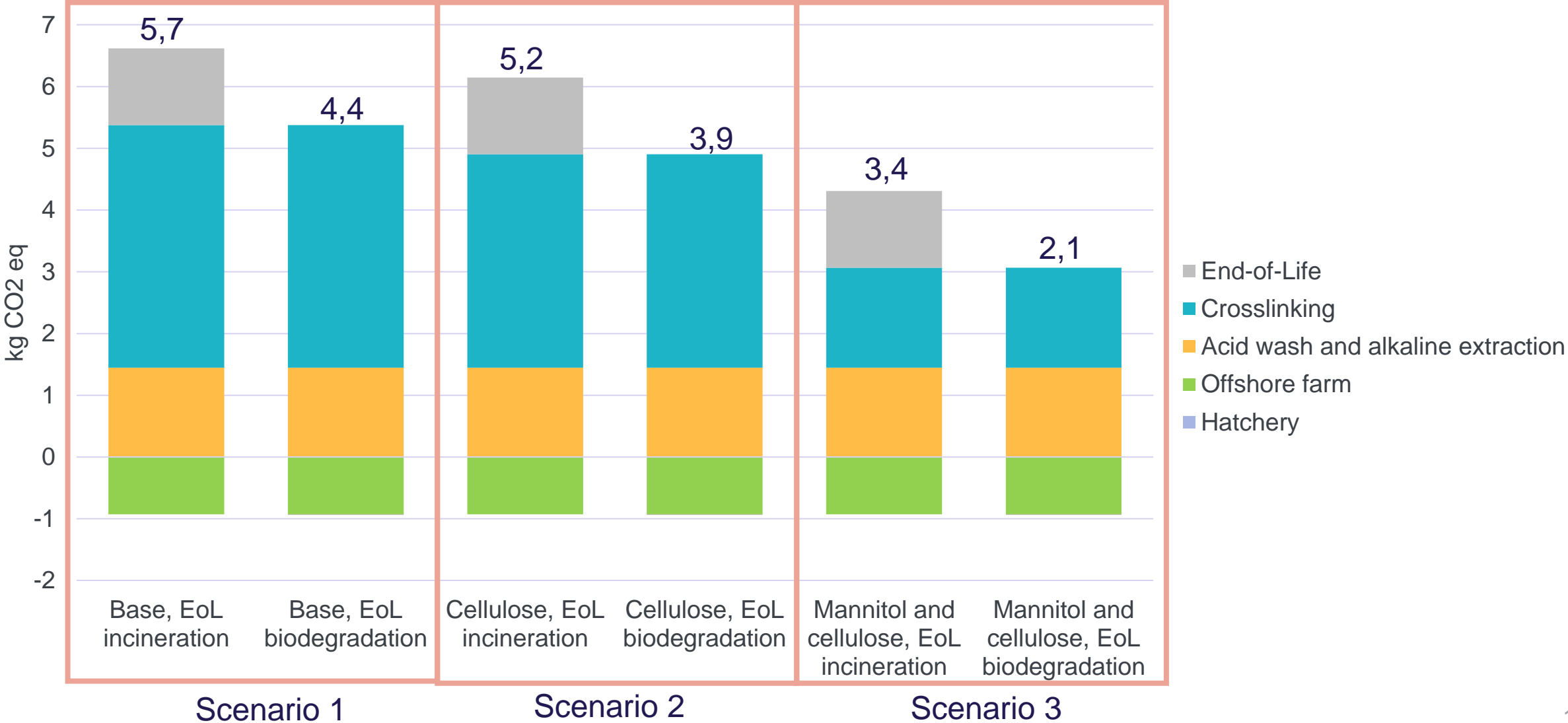
kg of carbon

# Scenario 3: carbon balance - mannitol recovery

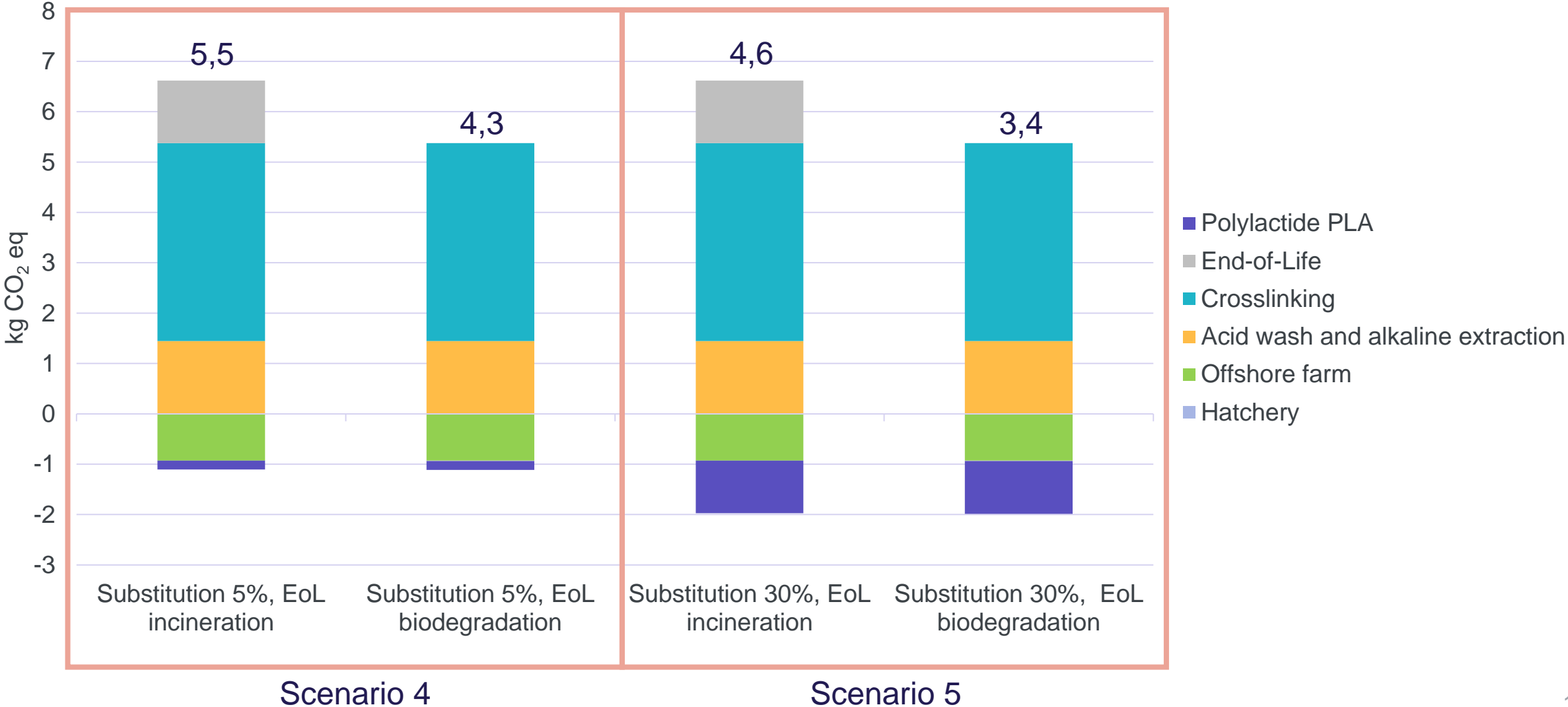


► The **alginate, cellulose and mannitol** from the seaweed is used to produce the bioplastic

# 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<sub>2</sub> 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



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Thank you for your attention!



My university profile

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