Willingness to pay for environmental performance; the case of decentralised waste treatment systems

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Who am I?

- Ghent University
  - Faculty of Bioscience Engineering
    - Department of Green Chemistry and Technology

- Topic: “sustainable design of process chains from waste”

- Assistant professor since 2016
  - 1 postdoc
  - 1 technician
  - Promotor/copromotor of 10 PhD students
Strategy/equipment

Designing separation trains towards desired purity for a specific application:
- Characterisation of product by chemical analysis (IR, GC-MS, HPLC, ICP, …)
- Basic modeling (ASPEN)
- Pilot experiments
- Basic economic/environmental assessment

Available unit operations:
- Distillation (continuous, batch, vacuum, reactive)
- Membrane treatment (micro/nanofiltration)
- Adsorption units (ion exchange, active coal, …)
- Absorption units
- S/L extraction (used for biomass, but also deinking, …)
- L/L extraction
- Hydrocyclones
- Crystallisation
- Froth flotation
- Windshifting
- Friction washing
  working volume between 1 to 10 L
Two main research topics: plastic waste

(Froth) Flotation
Cyclones
Solvent treatment
windshifting
Solvent recycling
Deodorization/deinking

Other sample projects:
• PROFIT: Bringing the municipal waste refinery to a next level: Plastic Recuperation and valOrisation FIT for use
• PSYCHE: Conversion of plastic waste to base chemicals via gasification
Two main research topics

Fruit and vegetable waste

- Homogenisation
- Precipitation
- Selective adsorption
- S/L, L/L Extraction
- Distillation
- Affinity & stability testing

Natural dyes/fatty acids
Chemical building blocks

Dyes/derivates

- Quinonoids
- Anthocyanins
- Carotenoid


Derivatization
Mordants/Surfactants
pH
Temperature

Washing fastness
Photodegradation

Fibers

- Wool/hair
- Cotton/cellulose
- Lignin
- Polyester
- Nylon

Other sample projects:
- Optimisation of the distillation process of fatty acids from fats
- ALPO: Specialty polymers from algae
Now on topic: the starting questions

- Do people “care” about their wastewater treatment?
  - Do they have any preference?
  - How do they value the performance of the treatment system?
Materials & Methods: the case study

Centralised WWTS

Decentralised WWTS

No resource recovery: Constructed wetland

With direct resource recovery: ZAWENT
Materials & Methods: Data collection

- Centralised: WWTP Eindhoven
- Decentralised: constructed wetland
Materials & Methods: Data collection

- Centralised: WWTP Eindhoven
- Decentralised: ZAWENT (Zero AfvalWater met Energie- en NutriëntTerugwinning)
Materials and methods

- Life Cycle Assessment for environmental performance (Recipe Endpoint H)
- Life Cycle Costing for economic performance
- Stated Preference analysis for social aspects and WTP (Qualtrics software)
  - Choice experiments between the options based on
    - Environmental score
    - Cost
    - Participation
  - General opinion based on Likert scale
    - Awareness
    - Aesthetics
    - ...
    - ...
Results: LCA

Environmental impact

- Centralised WWTS
- Constructed wetland WWTS
- ZAWENT WWTS

Environmental impact (% relative to created impact of centralised WWTS)

- Human health created impact
- Ecosystems created impact
- Resources created impact
- Human health avoided impact
- Ecosystems avoided impact
- Resources avoided impact
Results LCC

- Generally bad data quality
  - For example no ‘overhead’ included in decentralised, whereas it is estimated as almost half of the cost of centralised WWTS
  - ZAWENT not operational yet. Also cost of building excluded
  - Wetlands: way of construction, scale, soil type, …
  - …

<table>
<thead>
<tr>
<th></th>
<th>Centralised WWTS</th>
<th>Constructed wetland</th>
<th>ZAWENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPEX (€/p/y)</td>
<td>-</td>
<td>10-150</td>
<td>33.13</td>
</tr>
<tr>
<td>OPEX (€/p/y)</td>
<td>-</td>
<td>2-30</td>
<td>37.00</td>
</tr>
<tr>
<td>Total costs (€/p/y)</td>
<td>122.89</td>
<td>12-180</td>
<td>70.13</td>
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</tbody>
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Note: €/p/y = euro per person per year.
Preferences towards type of WWTS

- Centralised WWTS > Decentralised WWTS *
- ZAWENT WWTS > Constructed wetland WWTS > Centralised WWTS *
- Constructed wetland WWTS > ZAWENT > Centralised WWTS *
- ZAWENT WWTS > Centralised WWTS > Constructed wetland WWTS
Results: stated preference

This means respondents are willing to pay extra especially if they can gain profit one day.

How much?
WTP analysis

Extra WTP in function of percentage of environmental impact decrease

\[ y = 1.4249 \ln(x) + 19.679 \]
Conclusions

- Decentralised systems seem to perform better related to environmental impact
- Decentralised systems seem to perform better related to economic cost, but with high uncertainty
- People value environmental impact
- Not endlessly + their understanding of environmental impact is not sufficient (they don’t care/know/value if it is 10 or 100% reduction)
- Potential thesis student bias in the result
- A combination of sustainability assessment methods is fun
Welcome to contact
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