Environmental impact of source separation systems for blackwater, greywater and food waste in the H+ urban renewal project, Sweden

Hamse Kjerstadius, A. Bernstad Saraiva, J. Spångberg, Å. Davidsson
Background:

- The city of Helsingborg (Sweden) will start building source separation systems for 1,200 people in 2017.
- Main reason is increased biogas production but nutrient recovery was also important (Swedish EPA suggests national targets for nutrient recovery from wastewater).

So...

- How much nutrients can you recover AND what is the environmental impact of this for Swedish conditions? (clean electricity and heat production)
**Method:**

- Life cycle assessment with system boundary to include entire management chain.
DESCRIPTION OF SYSTEMS

- Conventional system
- Source separation system
**Conventional system**

- **Background**
  - BW+GW

- **Method**
  - BW+GW
  - FW
  - Soil improver
  - Ocean recipient
  - Soil storage and agriculture
  - Biogas upgrading & use

- **Conventional system diagram**
  - BW+GW to FW
  - FW to Food waste plant
  - FW to Biogas upgrading & use
  - 75% to Soil improver
  - 25% to Ocean recipient
  - 100% to Soil storage and agriculture

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**Source separation system**

- **Background**
- **Method**

- **Soil improver**
- **Ocean recipient**
- **Soil storage and agriculture**
- **Biogas upgrading & use**

- **FW**
- **GW**

- **75%**
- **25% sludge**
- **100% struvite and amm. sulphate**

**Nutrient recovery**

**Source separation system**

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Method:
• Life cycle assessment with system boundary to include entire management chain.

Background:
Replaced mineral fertilizer
Replaced vehicle fuel (diesel)
**Indata:**

- Process data from litterature (EcoInvent database v.3), real plants or suppliers.
- Mass balances for organic material, phosphours and nitrogen.

**Impact categories**

<table>
<thead>
<tr>
<th>Climate change</th>
<th>Return of nitrogen to farmland</th>
<th>Return of phosphorus to farmland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg CO₂ eq</td>
<td>kg N</td>
<td>kg P</td>
</tr>
</tbody>
</table>

**Functional Unit =** Management of 1 capita load of FW, BW and GW year
RESULTS
Potential for nutrient recovery to farmland

**Nitrogen**

<table>
<thead>
<tr>
<th>Source separation system</th>
<th>Conventional system</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 kg N cap(^{-1}) year(^{-1})</td>
<td>0.0 kg N cap(^{-1}) year(^{-1})</td>
</tr>
</tbody>
</table>

**Phosphorus**

<table>
<thead>
<tr>
<th>Source separation system</th>
<th>Conventional system</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6 kg P cap(^{-1}) year(^{-1})</td>
<td>0.1 kg P cap(^{-1}) year(^{-1})</td>
</tr>
</tbody>
</table>

- Source separation system increases nutrient return due to usage of struvite and ammonium stripper.
Source separation systems decreases climate impact due to:

- Increased biogas production (replace diesel as vehicle fuel)
- Less $N_2O$-emissions from activated sludge (strong greenhouse gas)
- Replaced nitrogen mineral fertilizer (nitrogen fixation is energy demanding)
- Less emissions from sludge storage (methane and $N_2O$)
CONCLUSIONS
Conclusions:

• Source separation systems have a high potential for recovery of nutrients.

• Source separation systems decreases climate impact (with 21-56 kg CO₂ capita⁻¹ year⁻¹). Benefit is increased with "dirtier" european electricity mix.
If you want to reduce climate impact:

• Maximize biogas production and replacement of mineral fertilizer.

• Decrease emissions of nitrous oxide (N$_2$O) from your activated sludge plants.

• Decrease emissions of methane and nitrous oxide from sludge storage (dewater and cover the sludge storage).
Thank you for your attention

hamse.kjerstadius@chemeng.lth.se

HAMSE KJERSTADIUS
WATER AND ENVIRONMENTAL ENGINEERING, DEP. CHEMICAL ENGINEERING