AquaSPICE: Capitalising the experience of other projects to achieve a successful (water) symbiosis

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23 March 2022
AquaSPICE Innovation Pillars

CIRCULAR INNOVATION
• Water re-use options at different levels
• Design, monitoring and evaluation of demonstration schemes using systemic methodologies and tools, based on holistic modelling concepts

PROCESS INNOVATION
• Installation,
• Operation, and
• Assessment of advanced technologies and practices with energy and substances recovery

DIGITAL INNOVATION
• Water-specific Cyber-Physical-System (WaterCPS) synthesises digital twins of industrial and value chain entities to provide advanced water-saving awareness and optimised water efficiency at different industrial levels
• Real-time monitoring and distributed data management system connects the physical and digital worlds through smart sensor networks, IIoT and cloud/edge technologies
Capitalising the experience of relevant EU funded projects

<table>
<thead>
<tr>
<th>Name</th>
<th>Year</th>
<th>Waste</th>
<th>Type</th>
<th>Region</th>
<th>Led by</th>
</tr>
</thead>
<tbody>
<tr>
<td>enCO(_2)re</td>
<td>2015-2016</td>
<td>Carbon Dioxide</td>
<td>Gas</td>
<td>Northern Europe</td>
<td>Industry</td>
</tr>
<tr>
<td>Bri4Food</td>
<td>2016</td>
<td>Brines</td>
<td>Liquid</td>
<td>Mediterranean</td>
<td>Industry</td>
</tr>
<tr>
<td>SWAN</td>
<td>2019-2020</td>
<td>Solid Waste</td>
<td>Solid</td>
<td>Balkan Region</td>
<td>Public Authority</td>
</tr>
<tr>
<td>AquaSPICE</td>
<td>2020-2024</td>
<td>Industrial Water</td>
<td>Liquid</td>
<td>EU</td>
<td>RO</td>
</tr>
</tbody>
</table>

- Different Characteristics, Different Barriers and Different Problems
- Main factors examined
  - Technical Considerations
  - Industrial and Public Awareness
  - Common Sense
## Technical Considerations

<table>
<thead>
<tr>
<th>Waste Source</th>
<th>Solid Waste</th>
<th>Gas Waste</th>
<th>Liquid Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual or mechanical sorting and separation</td>
<td>Capture and Purification</td>
<td>Purification/Treatment</td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td>Most probably required</td>
<td>Only if liquified (as intermediate step)</td>
<td>Rarely Considered</td>
</tr>
<tr>
<td>Matching Sources with Receivers</td>
<td>Challenging since the streams are not uniform/homogenous</td>
<td>Based on purity of main component / presence of hazardous compounds</td>
<td>Based on stream composition / presence of hazardous compounds</td>
</tr>
<tr>
<td>Transportation</td>
<td>Trucks only</td>
<td>Trucks, pipes, ships</td>
<td>Mostly using pipes</td>
</tr>
<tr>
<td>Environmental Impact</td>
<td>Carbon Footprint</td>
<td>Carbon Footprint</td>
<td>Carbon &amp; Water Footprint</td>
</tr>
<tr>
<td>Safe Reuse</td>
<td>Hazardous waste excluded from the matching process</td>
<td>Need for end-of-waste criteria</td>
<td>EU/National Directives for reuse based on sector</td>
</tr>
<tr>
<td>Aspects for IS success</td>
<td>Industrial Awareness</td>
<td>Distance, Product Acceptability</td>
<td>??</td>
</tr>
</tbody>
</table>

Aspects for IS success: **Industrial Awareness**, **Distance, Product Acceptability**
315 industrial plants in the Balkan Region
- Q1 Are you familiar with the concept of industrial symbiosis?
- Q2 Would the plant be interested in participating in symbiotic value chains?
- Q3 Are there any existing symbiotic links in the company?

*Industrial awareness* exists but the *instruments* are missing. *AquaSPICE* will (hopefully) contribute closing the gap by facilitating stakeholder engagement at Case Study level.
In order of the new business models to be economic viable, there needs to be a market for the new products.

Would you buy a fizzy drink with captured CO$_2$ from a nearby chimney?

Would you buy an exfoliant from used coffee grains?

<table>
<thead>
<tr>
<th>Would you buy:</th>
<th>1: Strongly Disagree</th>
<th>5: Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol for your car</td>
<td>4.31 (SD 0.91)</td>
<td></td>
</tr>
<tr>
<td>Mattress for your bed</td>
<td>4.06 (SD 0.96)</td>
<td></td>
</tr>
<tr>
<td>Concrete for your house</td>
<td>4.20 (SD 0.91)</td>
<td></td>
</tr>
<tr>
<td>1 kg tomatoes</td>
<td>3.79 (SD 1.11)</td>
<td></td>
</tr>
<tr>
<td>1 bottle of fizzy drink</td>
<td>3.88 (SD 1.06)</td>
<td></td>
</tr>
<tr>
<td>Dietary supplements</td>
<td>3.75 (SD 1.07)</td>
<td></td>
</tr>
</tbody>
</table>

Public knowledge affects acceptability and thus success of symbiotic schemes. Public showed willingness to support such schemes. AquaSPICE will (hopefully) contribute to increase awareness via its Communication, Dissemination, Training and Social Awareness strategy.
Common Sense

- Usually, the waste stream in a symbiotic scheme is incorporated in the final product.
- What might go wrong if the waste stream is not incorporated but used as a supplementary resource in a different production line?
- A desalination unit provides drinking water to the local community, and has the right to discharge water to the water body quid pro quo...
- What if they want to redirect the wastewater stream to another local industry?

Should we / can we address everything?
Promoting Industrial Symbiosis in AquaSPICE

- Design and develop an online platform that will facilitate the formulation of novel symbiotic business models focusing on water/wastewater reuse.
- Propose alternative solutions and assess their technical feasibility using a semantic approach based on the qualitative and quantitative characteristics of the water/wastewater streams.
- Assess the economic viability of all the technically feasible symbiotic schemes.
Applying Industrial Symbiosis in AquaSPICE

1 – In-Process closed loops
2 – In-Factory closed loops
3 – Industrial Symbiosis
4 – Industrial Urban Symbiosis

Water treatment and re-use with peroxide production units at SOLVAY
Location: Tuscany and Marche (IT)
Symbiotic potential between Solvay, ARETUSA and local municipality

Waste to fuel transformation in a Biorefinery at JEMS
Location: Ljubljana (SL)
Symbiotic potential between biorefinery, agricultural stakeholders, local municipality and industrial plants
Thank You!

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