Water recycling in the circular economy

Policy signals and incentives to encourage deployment of water and energy recovery technologies in industrial applications
Today’s question

What policy settings and initiatives should be used to promote industrial water recycling in the context of the circular economy?

If a key objective of the circular economy is to decouple economic growth from the availability of finite resources (Laurent et al., 2019), then the considerations are not technical or unit cost ($/m³) but rather:

- Development (regional development)
- Employment (Direct and Indirect)
- Availability of alternative water resources
- Climate change (effects & mitigation)
- Flexibility (avoid policy conflicts)

1 Source: 7215.0 - Livestock Products, Australia, March 2015, Australian Bureau of Statistics
## Policy context for the circular economy

<table>
<thead>
<tr>
<th>Industry</th>
<th>Brewing</th>
<th>Pulp &amp; Paper</th>
<th>Poultry</th>
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</thead>
<tbody>
<tr>
<td><strong>Market size</strong></td>
<td>$16.5Bn</td>
<td>$3.7Bn</td>
<td>$2.9Bn</td>
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<tr>
<td>(1.0% GDP)</td>
<td>(0.25% GDP)</td>
<td>(0.19% GDP)</td>
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<tr>
<td><strong>Employment</strong></td>
<td>3 700</td>
<td>12,450</td>
<td>9,000</td>
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<tr>
<td><strong>Production</strong></td>
<td>141,200</td>
<td>60,800</td>
<td>58,000</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Water Use</strong></td>
<td>5.6 GLA</td>
<td>100 GLA</td>
<td>27.7 GLA</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4.0 L/L (Avg)</td>
<td>6 - 40 m³/tn</td>
<td>22.2 L/Bird</td>
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<tr>
<td><strong>Specific Demand</strong></td>
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</table>
Technical approach: External (End of Pipe)

1. Poultry Abattoir
   - Scald Tank
   - Ceramic Microfiltration Membrane
   - Heat Exchanger
   - Hot Waste

2. Spin Chiller
   - Heat Exchanger
   - Ceramic Microfiltration Membrane

3. On-site Wastewater Treatment Plant
   - Cold Water
   - Biological Sludge
   - Dissolved Air Flotation Filtration

4. Water Purification Plant
   - Primary Clarifier
   - Upflow Anaerobic Sludge Blanket
   - Reverse Osmosis Membrane Filters
   - Dissolved Air Flotation Filtration
   - Moving Bed Biofilm Reactor
   - Potable Water
   - Process Water
   - Recycled Water Storage Tank
   - Brewery

5. Wastewater Treatment Plant
   - SEWER
   - LANDFILL
   - backwash Water and RO Concentrate
   - BIOGAS
   - Dissolved Air Flotation Filtration
   - Sludge
   - Waste Discharge B
   - Waste Discharge A
   - Recycled Water
Internal: Point of use treatment and reuse

- **Scalder**
  - Potable Water (High Temp)
- **Other Unit Ops.**
  - Membrane Filtrate (High Temp)
  - Wastewater
- **Spin Chiller**
  - Potable Water (Low Temp)
  - Membrane Filtrate (Low Temp)

**Key**
- Birds
- Potable Water
- Membrane Filtrate
- Wastewater
- Concentrate
Evaluation techniques: Sankey, MCA & LCA

- Power input in abattoir with centralised treatment a factor of 2.15 higher than system with internal scald tank recovery

50% reduction in GHG based on CO₂ equivalent
What policy conflicts are preventing water recycling initiatives or making existing water recycling schemes less efficient?

- Federated governance structure;
  - State based legislation (Food Safety) requiring different levels of treatment complicate standardisation of production
- National governance policy
  - Use of recycled water prohibited in red meat industry due to export focused market (high priority for issues such as BSE “mad cow disease”)
- Mandated targets on other recycled material inputs
  - Minimum content of recycled fibre (RCF) in packaging, newsprint & paper
    - Increase in salt and silica content decreases efficiency of membrane processes (Reverse osmosis).
    - Increasing RCF from 0 to 40% results in 60% increase in kgCO$_2$/m$^3$ of water recovered.
Conclusions

• Increased control over water and wastewater costs and eliminate dependencies on external water supplies.

• The unit cost ($/m³) of industrial water recycling can exceed the cost of water supply by a factor of 1.5 to 2, however, Multi Criteria (MCA) and Life Cycle Assessment (LCA) techniques which account for project externalities.

• Optimising inputs in circular economy in paper production is important. Eg recycled paper content in the feed stock results in higher cost of water recycling

• Lack of national guidelines for water quality and compliance, industrial water recycling is regulated at a state level. In addition, barriers to water recycling exist in food processing for export markets, particularly red meat exports