Drivers, Successes, Challenges and Opportunities for Onsite Industrial Water Reuse: a Path Forward for Collaboration and Growth (WateReuse-13-04)

Joan Oppenheimer, Mohammad Badruzzaman, Carla Cherchi, Jason Weakley, Jonathon Pohl
The WateReuse Research Foundation is a nonprofit charitable organization that conducts research to improve the treatment, distribution, and acceptance of water reuse.

More Information
www.watereuse.org/foundation

Research Reports
www.watereuse.org/foundation/publications
A Few Notes Before We Get Started…

- Today’s webcast will be 60 minutes.
- There is one Professional Development Hour available.
- A PDF of today’s presentation can be downloaded when you complete the survey at the conclusion of this webcast.
- If you have questions for the presenters, please send a message by typing it into the chat box located on the panel on the left side of your screen.
- If you would like to enlarge your view of the slides, please click the Full Screen button in the upper right corner of the window. To use the chat box, you must exit full screen.
Today’s Presenters

Joan Oppenheimer, BCES
*MWH Global*

Jon Pohl, P.E., LEED AP
*MWH Global*

Erin Augustine
*Kellogg Company*
WateReuse Research Foundation (WRRF)
Industrial Reuse Projects

**External Reuse**
Supply by the external reuse water producers, mainly utilities

- **WRRF-08-12**
  Requirements and Opportunities for Water Reuse in Energy and Biofuels

- **WRRF-09-04**
  The Value of Water Supply Reliability in the CII Sector

- **WRRF-12-03**
  Analysis of Technical and Organizational Issues in the Development and Implementation of Industrial Reuse Projects

**Internal Reuse**
Water is being used, treated, and reused onsite

- **WRRF-13-04**
  Drivers, Successes, Challenges and Opportunities for Onsite Industrial Water Reuse: a Path Forward for Collaboration and Growth

- **WRRF-14-04**
  Framework of Onsite Industrial Reuse

- **WRRF-14-05**
  White Paper on Hydraulic Fracturing
Acknowledgements

• Project Officer - Justin Mattingly

• Technical Advisory Committee
  – Jimmy Yu (PepsiCo)
  – Anthony Lau (IDI)
  – Greta Zornes (ConocoPhillips)
  – Richard Cisterna (Natural Systems Utilities)

• Active Industry Participants
Retention of water within a given facility that has served a useful purpose & then using the same water again for a beneficial purpose within the same facility.
Types of Onsite Water Reclamation

- Operation 1
- Operation 2
- Operation 3

Regeneration - Recycling
Regeneration - Reuse

Feed Water → Operation 1 → Regeneration

Reuse

Waste Water
Conservation vs Reclamation

• Cooling Towers recirculate water to cool equipment
  – Evaporation (temp differential)
  – Drift (drift rate)
  – Blowdown or Bleed-off (COC)

Where Cycles of Concentration (COC) = \( \frac{TDS_{\text{Blowdown}}}{TDS_{\text{Makeup}}} \)

Make-up = Evaporation + Blowdown + Drift

So while improving COC is a conservation measure, reuse makeup water can enhance COC
Project Objectives

- Identify Drivers – economic, regulatory, social
- Understand on-site industrial reuse/recycling factors
- Explore roadblocks/impediments to onsite reuse
- Summarize gaps – knowledge, tools, technologies
- Assess future expansion opportunities
Project Approach

Task 1: Desktop Study
- Lit Review
- Vendor Outreach
- Trade Associations
- Public/Private Partnerships
- Regulations

Task 2: Survey
- Water Needs
- Scarcity Issues
- Tools
- Current Reuse
- Drivers/Needs
- 10 of 21 Companies
- 17 Facilities

Task 3: Workshop
- 2 Workshops
- 8 of 21 Companies
- Research Roadmap
- Knowledge Gaps
Industrial Reuse Differs from Municipal Reuse

• Larger diversity of industrial facility processes
• Proprietary nature of industrial corporations
• More diverse and exotic variety of constituents
• Greater need for rapid return on investment
• Historically fewer subsidized economic incentives
• Less technology performance data from installations
## North American Industry Classification System (NAICS)

<table>
<thead>
<tr>
<th>Code</th>
<th>Definition</th>
<th>Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Mining, Quarrying, O&amp;G</td>
<td>325</td>
<td>Chemical Manufacturing</td>
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<tr>
<td>22</td>
<td>Utilities (Power)</td>
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<td>Plastics &amp; Rubber Manufacture</td>
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<tr>
<td>311</td>
<td>Food Manufacture</td>
<td>327</td>
<td>Nonmetallic Mineral Manufacture</td>
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<td>Beverage/Tobacco Manufacture</td>
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<td>Primary Metal Manufacture</td>
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<td>Textile Mills</td>
<td>332</td>
<td>Fabricated Metal Manufacture</td>
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<td>Textile Product Mills</td>
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<td>Machinery Manufacture</td>
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<td>315</td>
<td>Apparel Manufacture</td>
<td>334</td>
<td>Computer/ Electronic Manufacture</td>
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<tr>
<td>316</td>
<td>Leather Manufacture</td>
<td>335</td>
<td>Electrical Equipment Manufacture</td>
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<td>321</td>
<td>Wood Product Manufacture</td>
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<td>Transportation Manufacture</td>
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<td>Paper Manufacture</td>
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<td>Furniture Manufacture</td>
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<td>323</td>
<td>Printing &amp; Support Activities</td>
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<td>Miscellaneous Manufacture</td>
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<td>324</td>
<td>Petroleum/Coal Manufacture</td>
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</table>
Eight General Water Use Categories

- Cooling & boilers
- Cogeneration/energy recovery
- Process
- In-plant conveyance
- Cleaning
- Environmental controls
- Sanitation
- Irrigation of landscape
Factors Creating Drivers / Challenges

KPI Water Metrics Used
Site Constraints
Expansion Needs
Licenses to Operate
Branding/Stewardship

Volume Ratios
Technology Parity
Technology Risk
Regulatory Parity
Production Risks
Water audit Accuracy
True Cost of Water
Stakeholder Relations
Permitting Clarity
Infrastructure Limitations
Financial Incentives

Water Scarcity
Supply Costs

Discharge Permit
Discharge Costs
Factors Creating Drivers / Challenges

KPI Water Metrics Used
- Site Constraints
- Expansion Needs
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Volume Ratios
- Technology Parity
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- Infrastructure Limitations
- Financial Incentives

Water Scarcity
- Supply Costs

Discharge Permit
- Discharge Costs
Physical Water Risk – Regional Stress

- Inadequate Local Supplies
  - Increasing population / community development needs
  - Climate change altering regional distribution
  - Pollution

Source: www.unep.org/dewa/vitalwater/jpg/0407-runoff-scenario-EN.jpg
Water Stress for Mining Regions

Source: Moody’s Investor Service, 2013
Regulatory Water Risks

- **Government Use Restrictions**
  - Pricing of supply & discharges
  - Licenses to operate (permitting)
  - Water rights
  - Quality standards

*Example of electricity TOU tariff*

*Example of block water tariff*
## Cost of Water by OECD Nation

<table>
<thead>
<tr>
<th>OECD Nation</th>
<th>Household ($US/1000 gal)</th>
<th>Industrial &amp; Commercial ($US/1000 gal)</th>
<th>Irrigation &amp; Agriculture ($US/1000 gal)</th>
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<td>France</td>
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<td>0.30</td>
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<td>4.3</td>
<td>4.3</td>
<td>0.19</td>
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<td>USA</td>
<td>4.7</td>
<td>1.9</td>
<td>0.19</td>
</tr>
<tr>
<td>Hungary</td>
<td>1.7</td>
<td>5.8</td>
<td>0.011</td>
</tr>
<tr>
<td>UK</td>
<td>8.6</td>
<td>6.4</td>
<td>0.076</td>
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<tr>
<td>Australia</td>
<td>6.2</td>
<td>6.2</td>
<td>0.076</td>
</tr>
<tr>
<td>Canada</td>
<td>2.6</td>
<td>6.0</td>
<td>0.038</td>
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**Project Survey Mean Cost was $2.88 (n=14)**
Factors Creating Drivers / Challenges

Water Scarcity
Supply Costs

Volume Ratios
Technology parity
Technology risk
Regulatory parity
Production Risks
Water audit accuracy
True Cost of Water
Stakeholder Relations
Permitting Clarity
Infrastructure Limitations
Financial Incentives

KPI Water Metrics Used
Site Constraints
Expansion Needs
Licenses to Operate (Social)
Branding/Stewardship

Discharge Permit
Discharge Costs
Water Risks - Reputational

- Prevent tarnishing of brand or image
  - Negative ecological impacts
  - Negative public health impacts
  - Appropriating more than “fair share”
  - Exporting water away from local users
Factors Creating Drivers / Challenges

Water Scarcity
Supply Costs

Volume ratios
Technology parity
Technology risk
Regulatory parity
Production risks
Water audit accuracy
True cost of water
Stakeholder relations
Permitting clarity
Infrastructure limitations
Financial incentives

KPI Water Metrics Used
Site Constraints
Expansion Needs
Licenses to Operate
Branding/Stewardship

Discharge Permit
Discharge Costs
Water Use in United States (Year 2005)

Water Use in Norway by Industry (Year 2003)

### Generic Use by Industry Data for Norway

<table>
<thead>
<tr>
<th>NACE Code</th>
<th>Total Use (Mgal)</th>
<th>Sanitary (%)</th>
<th>Processing (%)</th>
<th>Cooling Water (%)</th>
<th>Water in Products (%)</th>
<th>Leaks &amp; Evaporation (%)</th>
<th>Other Use (%)</th>
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</thead>
<tbody>
<tr>
<td>11</td>
<td>86,097</td>
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<td>&lt;1</td>
<td>22</td>
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<td>&lt;1</td>
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<td>13</td>
<td>10,534</td>
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<td>99</td>
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<td>-</td>
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<td>15</td>
<td>19,382</td>
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<td>40</td>
<td>49</td>
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<td>21</td>
<td>45,937</td>
<td>0.40</td>
<td>40</td>
<td>57</td>
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<td>24</td>
<td>166,641</td>
<td>&lt;1</td>
<td>8.6</td>
<td>90</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

- 11 = upstream oil and gas
- 13 = mining of metal ores
- 15 = food and beverage manufacturing
- 21 = pulp, paper and paperboard manufacturing
- 24 = chemicals and chemical product manufacturing
<table>
<thead>
<tr>
<th>Industry</th>
<th>Vol/unit produced (from literature)</th>
<th>Mgal/Yr (Facility) (from survey)</th>
<th>Bgal/Yr (Corporate) (from survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>5 – 54 gal/lb Cu (^1)</td>
<td>212 - 4980</td>
<td>8 - 82</td>
</tr>
<tr>
<td>Power</td>
<td>0.1 – 1.1 gal/kWh (^2)</td>
<td>118</td>
<td>-</td>
</tr>
<tr>
<td>Food &amp; Beverage</td>
<td>0.07 – 2 gal/lb (^4)</td>
<td>85 - 318</td>
<td>3.5 - 66</td>
</tr>
<tr>
<td>Chem Manufacturing</td>
<td>15 – 100 L/kg (^9)</td>
<td>-</td>
<td>732</td>
</tr>
<tr>
<td>Metal Manufacturing</td>
<td></td>
<td>12 - 70</td>
<td>-</td>
</tr>
</tbody>
</table>

1 (Singh, 2010), 2 (Feely III, 2008 for thermoelectric power plants), 3 (Torcellini et al., 2003 for hydroelectric power plants), 4 (State of California, 2013), 5 (IBWA, 2013 for bottled water), 6 (IBWA, 2013 for carbonated soft drinks), 7 (BIER, 2011 for water consumption for aluminum can body and lid), 8 (BIER, 2011 for glass container and steel cap), 9 (Rupp, 2011 for textile dyeing)
# Food and Beverage Wastewater Production

<table>
<thead>
<tr>
<th>Food Processing</th>
<th>Wastewater Effluent Production (m³/ton)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy (Milk)</td>
<td>0.2 - 10</td>
<td>Vourch et al., 2005</td>
</tr>
<tr>
<td>Seafood</td>
<td>11</td>
<td>Afonso and Borquez, 2002</td>
</tr>
<tr>
<td>Meat (HSCW)</td>
<td>3 - 10</td>
<td>Sampson et al., 2005</td>
</tr>
<tr>
<td>Fruits &amp; Vegetables</td>
<td>1.2 - 5</td>
<td>Muro et al., 2012</td>
</tr>
<tr>
<td>Sugar</td>
<td>1.5</td>
<td>Chavez-Rodriquez et al., 2013</td>
</tr>
<tr>
<td>Fats (Olives)</td>
<td>0.25 – 1.24</td>
<td>Valta et al., 2013</td>
</tr>
<tr>
<td><strong>Beverage Processing</strong></td>
<td><strong>Wastewater Effluent</strong></td>
<td><strong>References</strong></td>
</tr>
<tr>
<td>Beer</td>
<td>3 - 10</td>
<td>Simate et al., 2011</td>
</tr>
<tr>
<td>Wine (grapes)</td>
<td>3 - 5</td>
<td>Mosse et al., 2013</td>
</tr>
<tr>
<td>Alcohol Distilleries (alcohol)</td>
<td>10 - 20</td>
<td>Simate et al., 2011</td>
</tr>
</tbody>
</table>

Approximate range of 0.53 – 15 m³/ton water use from previous slide.
<table>
<thead>
<tr>
<th>Generic Category</th>
<th>Percentage of Water Consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling tower</td>
<td>60 - 85</td>
</tr>
<tr>
<td>Boiler</td>
<td>65 - 95</td>
</tr>
<tr>
<td>Process</td>
<td>5 - 90</td>
</tr>
<tr>
<td>Process cleaning</td>
<td>10 - 50</td>
</tr>
<tr>
<td>Sanitation</td>
<td>2 - 7</td>
</tr>
<tr>
<td>Irrigation</td>
<td>&gt;95</td>
</tr>
</tbody>
</table>

Evaluation of Water Use and Reuse/Recycling Opportunities
Steps Towards Water Reuse & Recycling

Water Audit
- site familiarization
- water processes
- water data
- measure flows
- sampling/testing
- sources & sinks
- water pinch
- analysis
- process evaluation

Process Integration
- water flow diagram
- water saving opportunities
- improved process efficiency
- improved water-use efficiency

Water Reuse or Recycling
- treatment options
- bench/pilot testing
- process reuse
- other activities

Adapted from Agana, B.A. et al. / Journal of Environmental Management 114 (2013) 446
Take a Water Walk…

- Identify all water-consuming equipment, high-use areas, meter locations and where sub-meters are needed
- Observe shift clean-ups & process changeovers
- Note the water quality used in each process step
- Note all water losses, evaporative losses, excessive water pressure & leaks
- Quantify water flow rates & usage
- Determine water quality needs for each process & quality of wastewater discharged
The Water Balance – How To Determine Water Usage

Water Used, gallons/year
- Utility bills
- Flow Meters
- Engineering Calcs.
- Measurements

Water Evaporated, gallons/year
- Engineering Calcs.
- Equipment Specifications
- Mass Balance

Wastewater discharged, gallons/year
- Flow Meters
- Engineering Calcs.
- Measurements
- Permit Information

Wastewater dispose off-site, gallons/year
- Shipping records
- Site records
- Mass Balance
Develop a Water Flow Balance

- Pretreatment: 950 gals.
- Cooling Towers: 700 gals.
- Boilers: 100 gals.
- Processing: 100 gals.
- Landscaping: 50 gals.
- Wastewater: 600 gals.
- Water in Products: 100 gals.
- Losses: 50 gals.
What is “True Cost”?

The less visible costs of receiving, distributing & treating water include:

<table>
<thead>
<tr>
<th>Cost Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licensing</td>
</tr>
<tr>
<td>Maintenance</td>
</tr>
<tr>
<td>Chemical addition</td>
</tr>
<tr>
<td>Analytical costs</td>
</tr>
<tr>
<td>Pumping (power &amp; maintenance)</td>
</tr>
<tr>
<td>Pre-Treatment</td>
</tr>
<tr>
<td>Effluent treatment costs</td>
</tr>
<tr>
<td>Sludge treatment &amp; disposal</td>
</tr>
<tr>
<td>Softening chemicals</td>
</tr>
<tr>
<td>Backwash water/RO reject water effluent treatment costs</td>
</tr>
<tr>
<td>Water treatment costs</td>
</tr>
<tr>
<td>Cooling tower legionella control</td>
</tr>
<tr>
<td>Borehole abstraction costs</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Labor</td>
</tr>
</tbody>
</table>
Example of True Cost of Water

Cost per 1,000 Gallons

- City Water
  - Cost: $7.00
  - Percentage: 8%

- Wastewater
  - Cost: $1.20
  - Percentage: 2%

- Reverse Osmosis Water
  - Cost: $20.00
  - Percentage: 23%

- De-Ionized Water
  - Cost: $50.00
  - Percentage: 58%

- Cooling Tower Electricity
  - Cost: $4.50
  - Percentage: 5%

- Cooling Tower Maintenance
  - Cost: $3.10
  - Percentage: 4%
### Potential Reuse/Recycle Streams

<table>
<thead>
<tr>
<th><strong>Streams Description</strong></th>
</tr>
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<tbody>
<tr>
<td><strong>Membrane Filtration Concentrate</strong></td>
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<tr>
<td><strong>Cooling Tower</strong></td>
</tr>
<tr>
<td><strong>Pump Seal Water</strong></td>
</tr>
<tr>
<td><strong>Continuous Monitoring Flows</strong></td>
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<tr>
<td><strong>Chemical Feed Systems</strong></td>
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<tr>
<td><strong>Product Final Rinse</strong></td>
</tr>
<tr>
<td><strong>Flue Gas Scrubbing</strong></td>
</tr>
<tr>
<td><strong>Miscellaneous Facility Cleaning</strong></td>
</tr>
<tr>
<td><strong>Vehicle Wash Water</strong></td>
</tr>
<tr>
<td>Technology</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Membrane Bioreactor</td>
</tr>
<tr>
<td>Ultrafiltration</td>
</tr>
<tr>
<td>Reverse Osmosis</td>
</tr>
<tr>
<td>Ozonation</td>
</tr>
<tr>
<td>Ultraviolet Light</td>
</tr>
</tbody>
</table>
### Reuse Assessment Options

<table>
<thead>
<tr>
<th>Direct Reuse Sources</th>
<th>Membrane Filtration Permeate</th>
<th>Cooling Water</th>
<th>Filler Cool Down Water</th>
<th>Cooling Tunnels</th>
<th>Granular Media Backwash</th>
<th>Continuous Monitoring Flows</th>
<th>WTP Sludge Thickener Supernatent</th>
<th>WTP Sludge Dewatering Filtrate</th>
<th>WWTP Effluent</th>
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### Potential Direct Reuse Application

<table>
<thead>
<tr>
<th>Direct Reuse Sources</th>
<th>Cooling Water for Bottle/Container Filling</th>
<th>Chemical Feed Systems</th>
<th>Flue Gas Scrubbing</th>
<th>Sanitary (Toilet Flushing)</th>
<th>Evaporative Cooling Tower Feed</th>
<th>Boiler Pre-Treatment</th>
<th>Production Pump Seal Water</th>
<th>Miscellaneous Facility Cleaning</th>
<th>Non-Contact Cooling Water</th>
<th>WWTP Utility Water</th>
<th>Vehicle Wash Water</th>
<th>Landscape Irrigation</th>
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<tr>
<td>Cooling Water</td>
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<td>Filler Cool Down Water</td>
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<td>Cooling Tunnels</td>
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### Notes:
- **Group 1**: Applicable for Direct Reuse at full volume assuming minimum water quality parameters of source stream are met
- **Group 2**: Disinfection may be necessary to blend at full volume
- **Group 3**: pH adjustment may be necessary to blend at full volume
- **Group 4**: Sedimentation/Disinfection may be necessary to blend at full volume
- **Group 5**: Full treatment including filtration may be necessary to blend at full volume
Reclaimed Juice Processing WW

Algoma Orchards treats wastewater to potable water standards for reuse in process equipment sanitation.
Reuse/Recycling Implementation Issues

• Material and water balance
  – Insufficient flow meters and water quality sensors
  – Limited knowledge on flow and quality variability

• Treatment options
  – Identifying suitable technologies for specific wastewater
  – Identifying use for various water quality sources and demands
  – Site constraints (available space, infrastructure upgrades, etc.)

• Economics
  – Identifying options that provide a suitable ROI
  – Identifying other factors that offset ROI
Survey and Workshop Findings
Water Use on % Basis (from survey)

- Irrigation
- Sanitation (Staff)
- Sanitation (Facility)
- Environmental Controls
- Process/Product Cleaning
- In-plant Conveyance
- Product Processing
- Cogen & Energy Recovery
- Cooling & Boilers

% of Annual Total Water Use

- Maximum
- Mean
# Ease of Implementation (Workshop Responses)

<table>
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<tr>
<th>Reuse Category</th>
<th>Mining</th>
<th>Mining</th>
<th>Food &amp; Bev</th>
<th>Food &amp; Bev</th>
<th>Power</th>
<th>Manufacturing</th>
<th>Mode (N=6)</th>
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</table>

1 = easy; 8 = hard
# Reuse/Recycling Benefits & Cost Savings – Food Industry

<table>
<thead>
<tr>
<th>Sub-sector</th>
<th>Reuse/Recycle</th>
<th>Benefits</th>
<th>Cost Savings</th>
</tr>
</thead>
</table>
| Dairy                       | • Pasteurization cleaning water used for first rinse of tanks  
                           |   • Tank rinse water used for cleaning                                          | 30% reduced water consumption | $73K/yr                    |
| Dairy / Fruit Juice         | • Milk processing steam reuse  
                           |   • Once through cooling water recaptured for washing                          | 19,000 L daily reduction of water consumption | $6.3K rebate  
                           |                                                                               |                               | $9K/yr                      |
| Brewery                     | • Reclaimed bottle/can pasteurizer water (excess holding capacity)             | Reduced discharge & water consumption         | $60K/yr  (10 month payback) |
| Brewery                     | • Pasteurization overflow & bottle washer final rinse to keg and floor washing | Reduced water consumption                     | $37.5k/yr  (2 yr payback)  |
Workshop Identified Solutions to Challenges

- Promote circular economy training for management
- Establish accreditation program (similar to LEED)
- Create active database of case study projects
- Provide tools for calculating true cost of water
- Develop fouling resistant membranes
- Assess recalcitrant compound biological catalysts
- Develop chemical fate and transport tools
- Enhance process modeling
- Improve facility metering and sensing
Major Research Topic Needs

- **Financial**
  - Develop ROI calculator based on true cost of water

- **Technology**
  - Develop salt handling, recalcitrant organics
  - Compile latest developments, applicability, benefits
  - Develop cost-effective ZLD applications

- **Communication**
  - Create knowledge sharing platforms for industrial groups with similar needs
  - Continually compile case studies in publicly accessible format
Guidance Development for:

- New facility design criteria promoting marginal water use
- Existing facility auditing protocols promoting reuse/recycle
- Treatment and residuals criteria
- Model treatment schemes for different industrial sectors
- Validation protocols for process train solutions
- Reuse/recycling criteria for generic water use categories
- Reuse/recycling integration within existing footprint tools
Tools to Increase Water Reuse

- Water audit benchmarking tools
- Process recycling optimization tools
- Monetization of non-economic factors
- Technology transfer (modular approach)
- Identifying “difficult” chemicals across industries
Manufacturing Footprint

33,000 Kellogg employees worldwide

Approximate employee numbers by region:
- North America: 18,000
- Latin America: 4,000
- Europe: 9,000
- Asia Pacific: 2,000
Why Sustainability Matters

• Sustainability fits with our core values

• These types of commitments are very important for our consumers, improving the trust in our foods:
  • It strengthens the equity (integrity, trust, progress) in our brands
  • It drives relevance for our strategic categories
  • It builds corporate reputation
  • And it supports delivery of business results
GLOBAL SUSTAINABILITY COMMITMENTS

Supporting the livelihoods of individuals, families and communities that rely on us and on whom we depend.

Conserving natural resources where our ingredients are sourced and our foods are made.

Driving consumer demand by building trust and love for our foods.
Building on Our Success

• By 2020, Kellogg is committing to:

  – Expand our use of low-carbon energy in our plants by 50%
  – Reduce energy and GHG emissions by 15%*
  – Support watershed quality and reduce water use by additional 15%*
  – Increase to 30% number of plants sending zero waste to landfill

• (*Per metric tonne of food produced)
 Opportunities

– Reusing water within the same equipment/system
– Reusing water in nearby non-contact equipment

 Challenges

– Food safety is our #1 priority
– Cost of water is low
Water Reuse Success

Partnering with water treatment chemical companies and neighbors, we have successfully reused water in

– Dust Collection Equipment
– Boilers
– Cooling Towers
– Landscape Irrigation
Questions?

Submit Your Questions Through the Chat Box

Joan Oppenheimer, BCES  
*MWH Global*

Jon Pohl, P.E., LEED AP  
*MWH Global*

Erin Augustine  
*Kellogg Company*