Technology Innovations for Sustainable and Energy-Efficient Wastewater Treatment

Tanja Rauch-Williams, PE, PhD
Outline

- Resource recovery at WRRFs – State of the Nation
- Innovative sustainable energy technologies:
  - New uses for biogas
  - Thermal energy recovery
  - Suboxic nutrient removal
- What made industry leaders successful?
U.S. Resource Recovery in WRRFs – status and benchmarking

Water
Biosolids
Phosphorus
Nitrogen
Energy
Carbon

Resource Recovery

WRRFs

Disposal

https://www.wef.org/resources/topics/browse-topics-o-z/resource-recovery-roadmaps/renew-water-project/
Resources recovered by WRRFs in U.S. today

- **Water (H₂O)**: 7%, 2.2 billion gallons/year
- **Biosolids (Bio)**: 51%, 3.4 million dry metric tons/year
- **Energy (E)**: <1%, 350 megawatts/year
- **Phosphorus (P)**: 21%, 68,220 dry metric tons/year
- **Nitrogen (N)**: 11%, 172,400 dry metric tons/year
Specific electricity consumption at WRRFs in U.S.
Innovative sustainable energy technologies

New uses for biogas
Are we using biosolids energy most efficiently?

Department of Energy, 2018
Biogas use is changing to more lucrative alternatives

**Vehicle fueling**  
City of Longmont, CO (13 mgd)  
Progressive design/build  
$1M DOLA grant

**Pipeline Injection**  
South Platte Renew: (30 mgd)  
Payback less than 5 years  
Revenues $25-$30M over 20 yrs from biogas and RIN credits
Does gas heating of digesters make sense?

- Chemical: 20%
- Hydraulic: <1%
- Thermal: 80%
Innovative sustainable energy technologies

Thermal energy recovery
First Cities with bans:
- Berkeley
- San Jose
- Mountain View
- Santa Rosa
- Brisbane
- San Francisco

Discussions and plans in many other communities around the country

Alternatives to natural gas for heating and cooling – electrification:
- Solar
- Wind, etc.
- Low grade heat recovery from heated (waste)water
Examples: heat recovery from WW

Sewer pipes carrying dirty water will be a key part of National Western Center’s clean energy future

Denver campus to be home to North America’s largest sewer heat recovery energy system, officials announce

Denver National Western Center
City-wide planning of heat recovery from sewer lines

- Planning
- Collection system analysis

Business solutions/
Financial planning

- PPP
- Contracts
- Utility fee structure
- Guarantees
- ROIs
- …
Typical wastewater treatment plant energy-using processes

Two typical facility examples:

Aeration
Pumping
UV Disinfection
Other

Aeration
Pumping
Anaerobic Digestion
Lighting and Buildings
Belt Press
Clarifiers
Grit
Chlorination

Department of Energy, 2018
Innovative sustainable energy technologies

Suboxic nutrient removal
We know suboxic nutrient removal works in oxidation ditches

- Boxelder Sanitation District, CO
- 11°C winter average
- DO 0.6-1 mg/L seasonally

Credits: Craig Hibbard, Boxelder SD
And even lower DO concentrations!

- Glenwood Springs, CO
- 10°C winter average
- DO 0.15-0.5 mg/L
/// The energy potential of suboxic nutrient removal

Suboxic N removal

Versus

Traditional Biological Nutrient Removal

Aeration Basins

Organic Carbon Demand

Organic Carbon Oxidized with Energy Input

>10-20% Carbon Diverted for Energy Recovery for the same or better effluent N and P quality

Energy Recovery

850-1,500 kWh/MG

< 650 kWh/MG

Aeration Energy
Proof of concept for flow through aeration basins
Next step: Suboxic nutrient removal – Technology commercialization and full-scale demonstration

Ponoma WRP, LACSD

Hampton Roads Sanitation District – BNR Pilot
City of Chico 2018 results with DO/NMaster and SRTMaster

- Electrical savings:
  - $200,000/yr (47.1%)
- GHG reduction:
  - 900 metric tons/year CO₂
  - $121,000 rebate from the electrical utility
- Effluent nitrate reduced 30%-40%
- Effluent TSS reduced from 7mg/-15mg/l to below 5 mg/l
- Payback period of <2 years
- Unintentional P removal!

![Energy Consumption Chart]

**Energy Consumption (kWh/lb of O₂ Demand)**

<table>
<thead>
<tr>
<th>Control</th>
<th>Energy Consumption (kWh/lb O₂ Demand)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing DO</td>
<td>0.57</td>
</tr>
<tr>
<td>MPC – DO</td>
<td>0.43</td>
</tr>
<tr>
<td>MPC – NH₃</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Sustainable and energy efficient treatment

What has made industry leaders successful
Getting WW treatment ready for the future is a balancing act
Facilities in U.S. on track to energy neutrality
Example: City of Gresham, OR

Solar
Cogen 2
Cogen 1
Consumption

Your energy use
Meter #: NM31032275NM
Schedule: 85
Meter Multiplier: 4800
Service Period: 04/01/15
Meter Reading: 893
03/02/15
30 days of service: 0 kWh

Graph showing energy consumption from 2005 to 2015.
Thank you for your interest and attention after another long virtual day

Tanja Rauch-Williams
trauch-williams@carollo.com