Utility of the Future
One City’s Journey

Nathan Cassity,
Utility of the Future

“Clean water utilities are undergoing a remarkable transformation. They are evolving from wastewater treatment plants to resource recovery facilities...Delivering maximum environmental benefits at the least cost to society”

The Water Resources Utility of the Future: A Blueprint for Action
Utility of the Future

- Reclaiming and reusing water
- Extracting nutrients and other constituents
- Capturing waste heat and latent energy in biosolids and liquid streams

Electricity Efficiencies  | Biogas to Renewable Electricity  | Solar Energy  | Nutrient Recovery  | Nutrient Reuse  | Water Reuse  | Heat Efficiencies and Recovery
Utility of the Future: Converting Waste Streams to Value Streams
Wastewater Today: Meeting the Environmental Challenges of 21st Century

- Water quality protection and water reuse
- Reducing fossil fuel consumption and using renewable energy
- Reducing consumption and capturing energy
- Recovering nutrients and carbon to sustainably feed a growing population
Relevant at Every Community: Enhancing Cost Effectiveness and Maximizing Return on Previous Infrastructure Investments
Wastewater Today: Saving Energy, Producing Energy, and Recovering Nutrients

+ Enhancing Cost Effectiveness and Maximizing Return on Previous Infrastructure Investments
Example Electricity Consumption Distribution at an Advanced Nitrifying A/S Facility

Typical “Bang for the Buck” Order
1. Aeration
2. Pumping
3. Solids Processing

Source: WEF, MOP 32
Example Biogas Potential at Facility without Hauled-In High-Strength Waste

Biogas Can Contribute 20%+ Without HSW

Source: WEF, MOP 32
High-Strength Waste Program to Increase Biogas Production Can Make Net Zero

- Chemical Addition
- Lighting
- Preliminary Treatment
- Settling
- Aeration
- Filtration
- UV Disinfection
- Solids Processing
- Pumping

Biogas

Biogas Can Contribute 100%+ with HSW

Source: WEF, MOP 32

HSW and Associated Biogas Offers Greatest Potential to Dramatically Move the Energy Needle
Aggressive HSW and Biogas Projects

- Milwaukee, WI
- Topeka, KS
- Sioux City, IA
- Fort Wayne, IN
- Sheboygan, WI
- St. Cloud, MN
- WLSSD, MN
- Stevens Point, WI

High-Strength Waste Program to Increase Biogas Production Can Make Net Zero

Biogas Can Contribute 100%+ with HSW

Source: WEF, MOP 32
ST. CLOUD RESOURCE RECOVERY FACILITY

17.9 MGD Design Flow – Full Biological Nutrient Removal Facility

Regional Facility – Wastewater Treatment and Conveyance Services for St. Cloud, St. Joseph, Sartell, Sauk Rapids, Waite Park and St. Augusta
St Cloud’s Journey Started with a Plan

- Energy Efficiency and Resource Recovery (R2E2) Planning Report

- Electricity Efficiencies
- Biogas to Renewable Electricity
- Solar Energy
- Nutrient Recovery
- Nutrient Reuse
- Water Reuse
- Heat Efficiencies and Recovery
Roadmap to Electricity Independence: Net Zero

6.6M kWh Purchased 2013

- Efficiencies
- Renewable Biogas
- Solar

0.3M
1.3M
5M
Project 1 – Energy Efficiency and Biogas (E2B)

- Facility-Wide Electrical Efficiencies
  - Buildings
  - Lighting
  - Mechanical Systems
  - Aeration
    - Enhanced aeration and process control
- Solar Garden
342,000 KILOWATT-HOURS ANNUALLY

20KW rooftop
220KW front lawn
Project 1 – Energy Efficiency and Biogas (E2B)

• Biogas Conditioning, Utilization (Electricity and Heat)
• High-Strength Waste (HSW) Receiving and Co-Digestion
HIGH STRENGTH WASTE PILOT
Project 1 – Energy Efficiency and Biogas (E2B)

BIOGAS UTILIZATION PROJECT

ST.CLOUD → SUSTAINABILITY

Renewable Today | GREATER Tomorrow

Project Summary
The Biogas Utilization Project consists of the installation of biogas conditioning equipment and a 635kW engine generator to convert biogas to electricity. Heat rejected by the engine generator is recovered and used to heat buildings and the digestion process.

Biogas to Electricity
Organic waste carry energy to the digestion process. The digestion process extracts this energy in the form of biogas. The biogas fuels boilers to heat buildings and an engine-driven generator to produce electricity. The Biogas Utilization Project converts organic wastes to renewable, sustainable energy.

Utility of the Future
- Water Re-Use
- Energy Production
- Heat Recovery
- Beneficial Re-Use

By The Numbers
- 6.6M PURCHASED
- 5M REPRODUCE BIOM
- 1.3M FUEL SAVER REDUCED
- 0.3M ADDITIONAL SOIL

Greater Sustainability
- 5 MILLION KILOWATT HOURS GENERATED IN ONE YEAR
- 3,749,644 POUNDS OF COAL
- 8,421,560 MILES DRIVEN BY A PASSENGER VEHICLE

Project Timeline
- 2015: Planning
- 2016: Design, Construction Begins, Gas Conditioning Installed
- 2017: Generator Installed, Electrical Production Begins

Project Partners
- City of St. Cloud
- Apex
- DONOHUE
- Staab Construction Corporation
Project 2 – Nutrient Recovery and Reuse (NR2)

- **Biofuel Storage**
  - 55,000 cubic feet

- **Biosolids Reuse**
  - Dewatering
  - Class A Processing - Lystek

- **Nutrient Recovery**
  - Struvite Harvesting
NR2 PROJECT COMPONENTS

Biofuel Storage
- 55,000 cubic feet

Biosolids Reuse
- Dewatering
- Class A Processing - Lystek

Nutrient Recovery
- Struvite Harvesting
BIOFUEL STORAGE

55,000 ft³ dual membrane gas storage
NR2 Project Components

Biofuel Storage
- 55,000 cubic feet

Biosolids Reuse
- Dewatering
- Class A Processing - Lystek

Nutrient Recovery
- Struvite Harvesting
Project 2 – Nutrient Recovery and Efficiency (NR2)

- Biosolids Product Enhancement
  - Lystek
    - Class A process
    - 14% Flowable Liquid
14% LIQUID BIOSOLIDS VS. CAKE BIOSOLIDS

• CAPITAL SAVINGS vs. NEW BUILDING and EQUIPMENT for CAKE STORAGE
• POLYMER SAVINGS
• REUSE OF EXISTING EQUIPMENT & STORAGE
• < NUTRIENT RUNOFF & NITROGEN VOLATILIZATION
• < ODORS
LYSTEK PROCESS OVERVIEW
**LYSTEK PROCESS OVERVIEW**

**HEAT**
STEAM

**pH**
BASE

**MIXING**
HIGH SHEAR

**14% LIQUID PRODUCT**

Dewatered Biosolids

Heat

Caustic (KOH or NaOH)

- Temp = 70 °C
- pH > 9.5
- HRT = 30 mins
- Mixing Speed > 3000 fpm

Class A/EQ
(Pending Region 5 & MN Approval)
14% Flowable Solids
LYSTEK INSTALLATION – ELORA CANADA – UPPER LEVEL

Centrifuge  Reactor  Boiler
LYSTEK INSTALLATION – ELORA CANADA – LOWER LEVEL

Cake Feed Hopper

Reactor

KOH System
Project 2 – Nutrient Recovery and Efficiency (NR2)

- Maximizing Return on Previous Investment
  - Repurposing Liquid Biosolids Storage

- Lystek Biosolids Storage
  - 198 days of storage at future average flow

- Digested Sludge Storage
  - 39 days of storage at future average flow

- Sidestream EQ/Treatment
  - 21 days of storage at future max month flow
Biofuel Storage
- 55,000 cubic feet

Biosolids Reuse
- Dewatering
- Class A Processing - Lystek

Nutrient Recovery
- Struvite Harvesting
Struvite Recovery

- Protect anaerobic digestion system
  - Maintenance benefit
- Remove P from biosolids
  - Enhance land application logistics and reduce costs
- Enhance dewatering performance
  - Reduce costs
- Recovery P for reuse
  - Revenue
Pilot Studies: Dewaterability

- 3-5% Higher Cake Solids
- 33% Less Polymer

No Struvite Recovery (AirPrex)
Pilot Studies – Dewaterability
AirPrex®

CalPrex™

Potential Phosphorus Harvesting Processes

NuReSys®

Struvia™

PHOSPAQ™

Crystalactor®

 ACTIVE STRUVITE PROCESSES
- Chemicals Addition – MgCl2
- Struvite recovery
- Reduced phosphorus return load

DIGESTER
digested sludge
dewatering
reagent liquors
struvite recovery

DIGESTER
treated sludge
reagent liquid
struvite reactor

DIGESTER
treated sludge
reagent liquid
struvite reactor
Potential Phosphorus Harvesting Processes
Selected Phosphorus Harvesting Process
NUTRIENT RECOVERY PROCESS

WAS P-Release ➔ Gravity Belt Thickener ➔ Digesters ➔ Centrifuge

WAS ➔ Primary Sludge ➔ Filtrate ➔ Centrate

Struvite Harvesting ➔ Equalization Tank
NR2 – UTILIZING EXISTING INFRASTRUCTURE

• Processes placed in existing Biosolids Building
NR2 – EQUIPMENT LAYOUT

Lystek

Polymer Storage
NR2 PROJECT TIMELINE

**R2E2 Master Plan**
Development of a Resource Recovery & Energy Efficiency Master Plan

**NR2 Funding & Regulatory**
- PFA IUP
- PSIG
- Facilities Plan
- NPDES Permit

**Pilots**
- Bioset
- Screw Press (2)
- Ostara

**Construction Schedule**
- July 2017 – Started Construction
- April 2019 – Final Completion

**Finalize Design & Bidding**
- April – Advertise
- May – Open Bids
- June – Award Bid
Project 2 – Nutrient Recovery and Reuse (NR2)
NR2 PROJECT TEAM & PARTNERS

ST CLOUD TEAM
• EMMA LARSON
• JACOB ETHEN
• BRIAN SCHOENECKER
• CHRIS PLAUTZ

• MARK WEYER
• DAVE WIRE
• WAYNE ETHEN
• PATRICK SHEA
• TRACY HODEL
Thank You

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