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# NEWEA 2015 Annual Conference

# The DEMON® process: Resource savings through sidestream centrate treatment

*Presented By*

*Andrea Nifong*

Clean Water and Energy from Wastewater

# Agenda

**Section I: INTRODUCTION**

**Section II: DEMON TECHNOLOGY**

**Section III: DOCUMENTED RESULTS**

# Award Winning World-Class Manufacturing

**Quality * Safety * Cost * Schedule * Innovation**

Headquarters: Oklahoma City, OK USA

- Global Leader in MBBR/DAF Technology
- BNR Specialists
- Advanced R&D Capabilities
- Experienced Process Engineering
- World-wide Delivery Team

WWW is one of the Fastest Growing US Companies

**2013**

Inc.5000

- #25 — Top 100 Environmental Services Companies
- #21 — Top 100 Oklahoma Companies

**2012**

Inc.5000

- #52 — Top 100 Manufacturing Companies
- #13 — Top 100 Oklahoma Companies

Inc.HirePower

- #4 — Top 10 Oklahoma Companies


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**Section I: INTRODUCTION**

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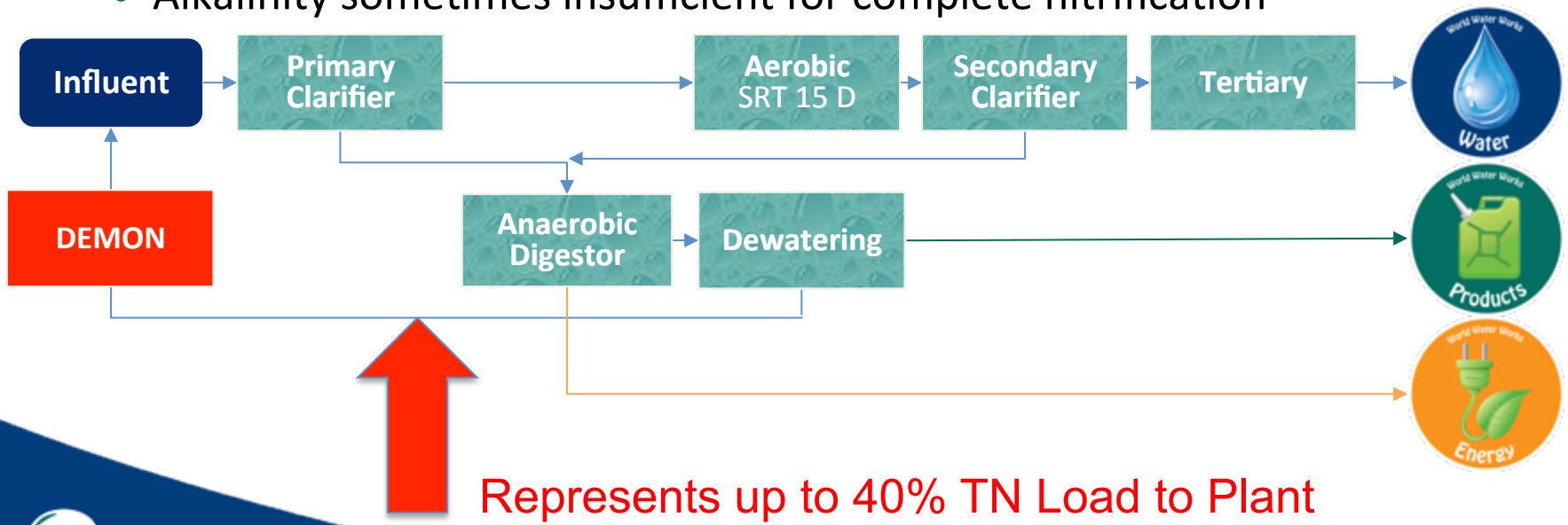
# Why DEMON?

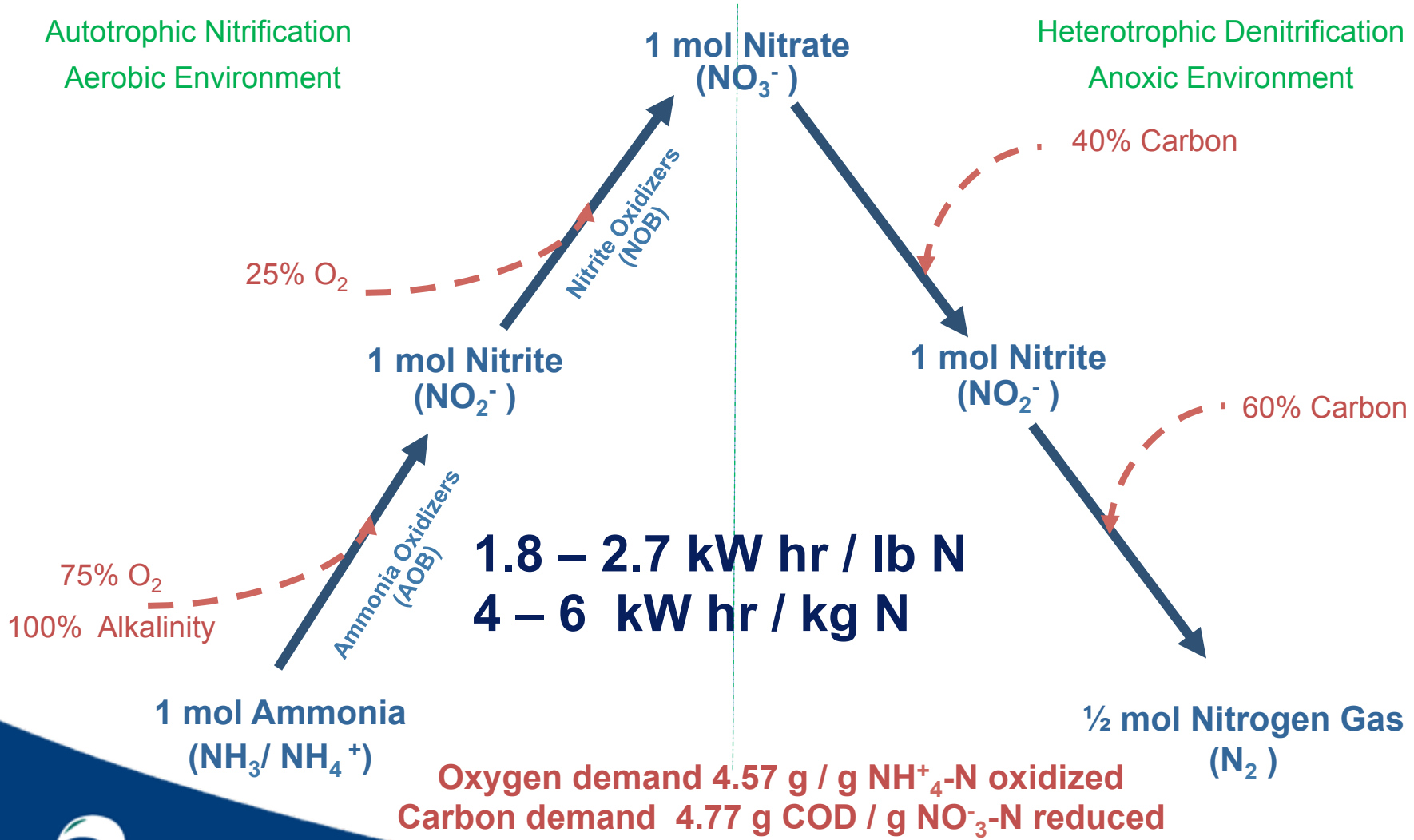
Anaerobic sludge digestion is very beneficial;

**However, recycling of high ammonia stream has many "bad" effects**:

- Reduction in C/N ratio which minimizes denitrification potential – thus requiring external carbon for meeting effluent Nitrogen limits
- Shock loads to system due to infrequent dewatering
- Alkalinity sometimes insufficient for complete nitrification



# Fundamentals of Nitrification – Denitrification

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# Fundamentals of Nitritation – Denitritation

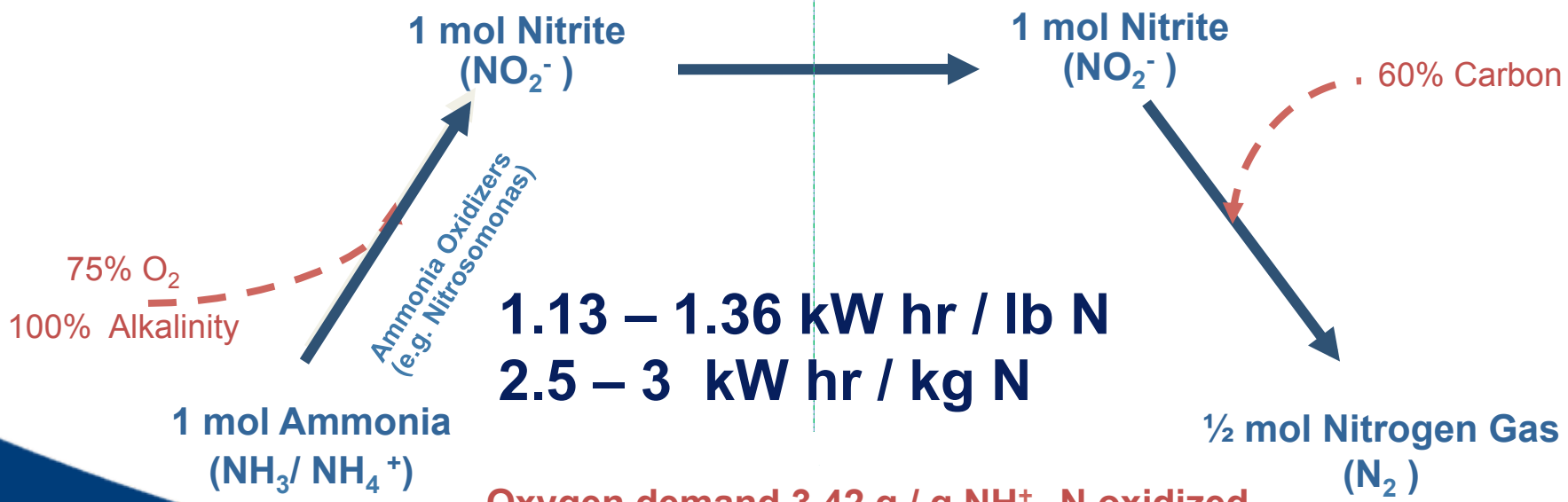
Autotrophic Nitritation

Aerobic Environment

Heterotrophic Denitritation

Anoxic Environment

- **25% reduction in Oxygen**
- **40 % reduction in Carbon demand**
- **40% reduction in Biomass production**




**Oxygen demand 3.42 g / g $NH^+_4$-N oxidized**

**Carbon demand 2.86 g COD / g $NO^-_3$-N reduced**

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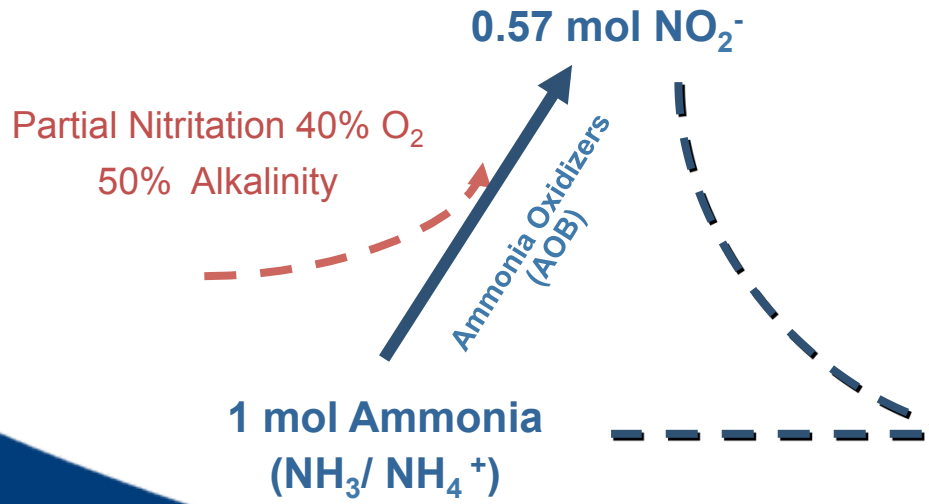
# Fundamentals of Deammonification

Aerobic Ammonium Oxidation
AerAOB

Anaerobic Ammonium Oxidation
Anammox or AnAOB

- **> 60% reduction in Oxygen**
- **Eliminate demand for supplemental carbon**
- **50% of the alkalinity demand**

**0.45 – 0.79 kW hr / lb N**
**1 – 1.75 kW hr / kg N**




$NH_4^+ + 1.32\ NO_2^- + 0.066\ HCO_3^- + 0.13\ H^+$
$\rightarrow 0.26\ NO_3^- + 1.02 N_2 + 0.066\ CH_2O_{0.5}N_{0.15} + 2.03\ H_2O$

**Oxygen demand 1.9 g / g $NH^+_4$-N oxidized**

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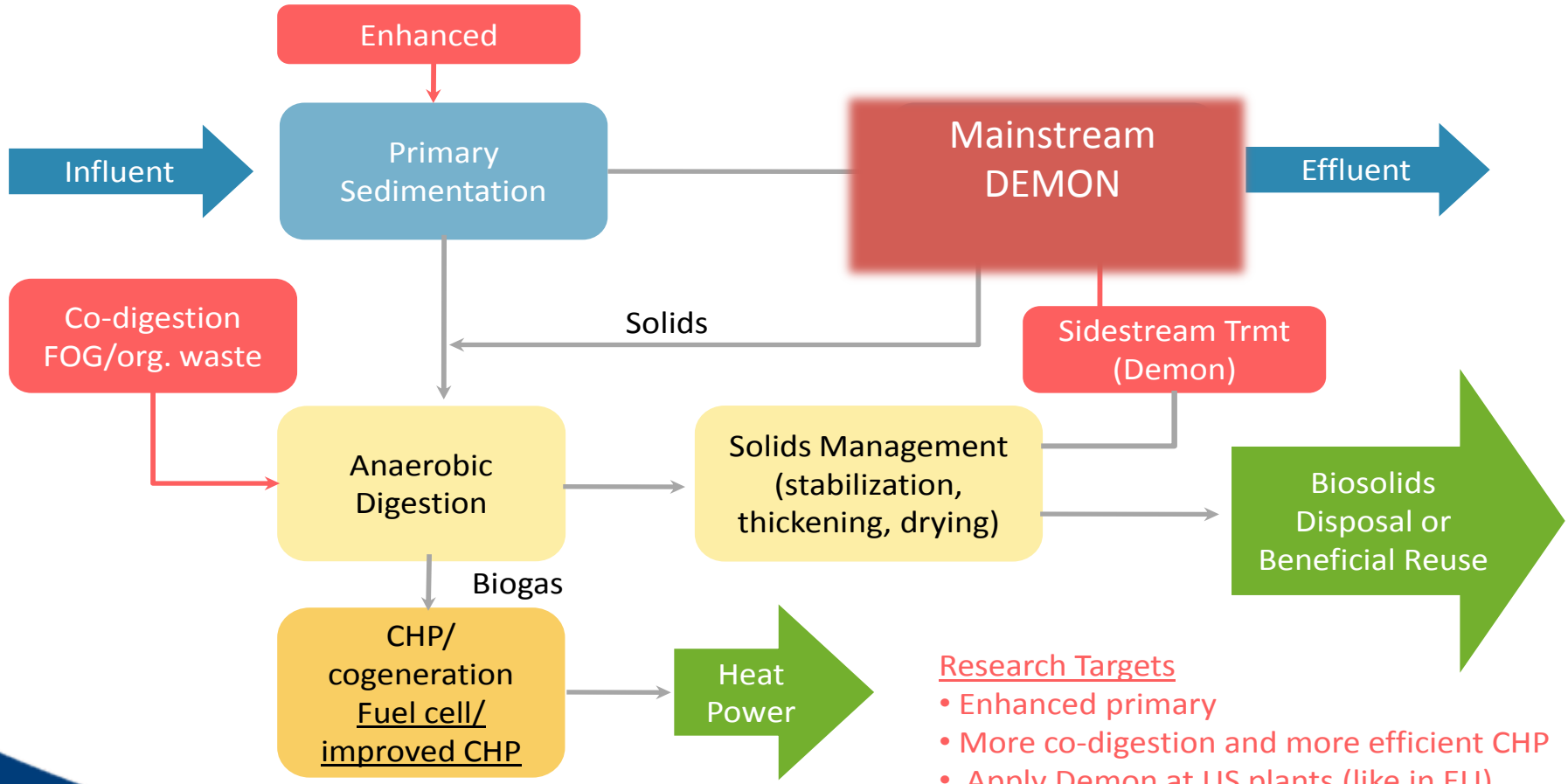
# Innovation in Plant Design to Achieve Energy Neutrality




Research Targets

- Enhanced primary
- More co-digestion and more efficient CHP
- Apply Demon at US plants (like in EU)

Lauren Filmore.2012. *Roadmap to Energy Neutral Wastewater Treatmen*t. VWEA Annual Education Seminar. Richmond, VA

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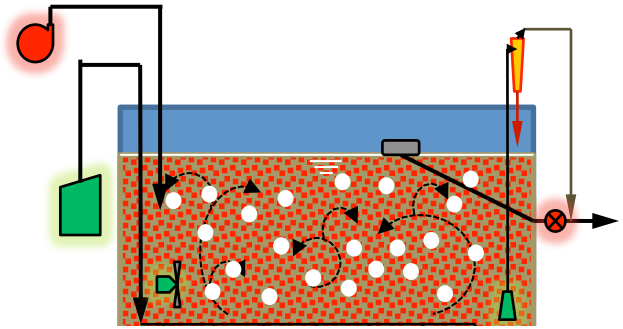
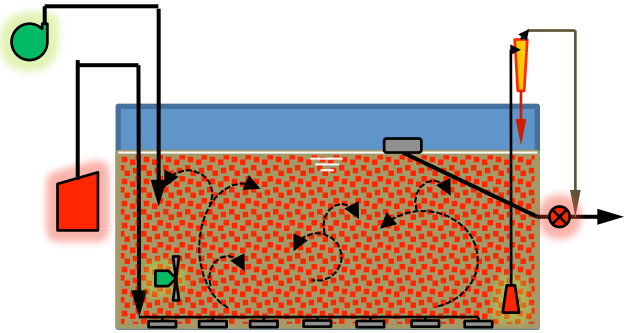
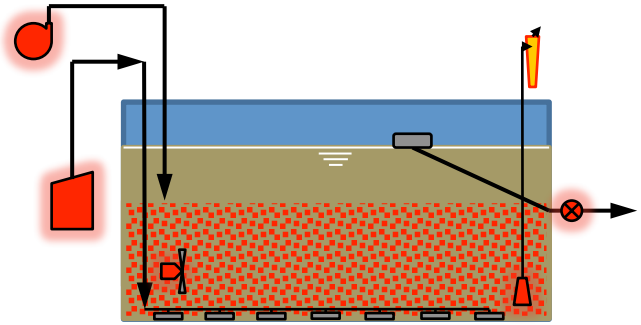
# Demon® Operational Philosophy as an SBR



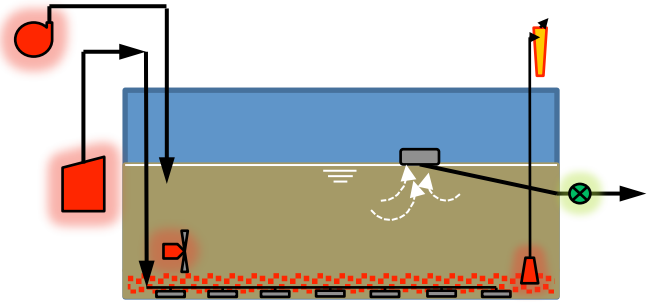
Aeration phase



Fill / React phase

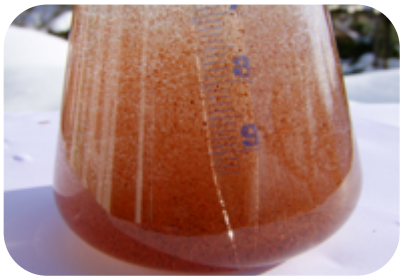


Settling phase

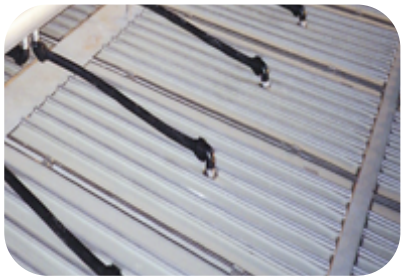


Discharge phase

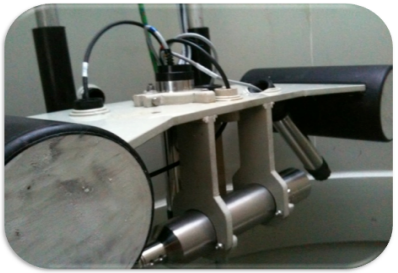
# Major Components



Seed Sludge



Aeration System



Instruments & Controls

Tank

Blowers

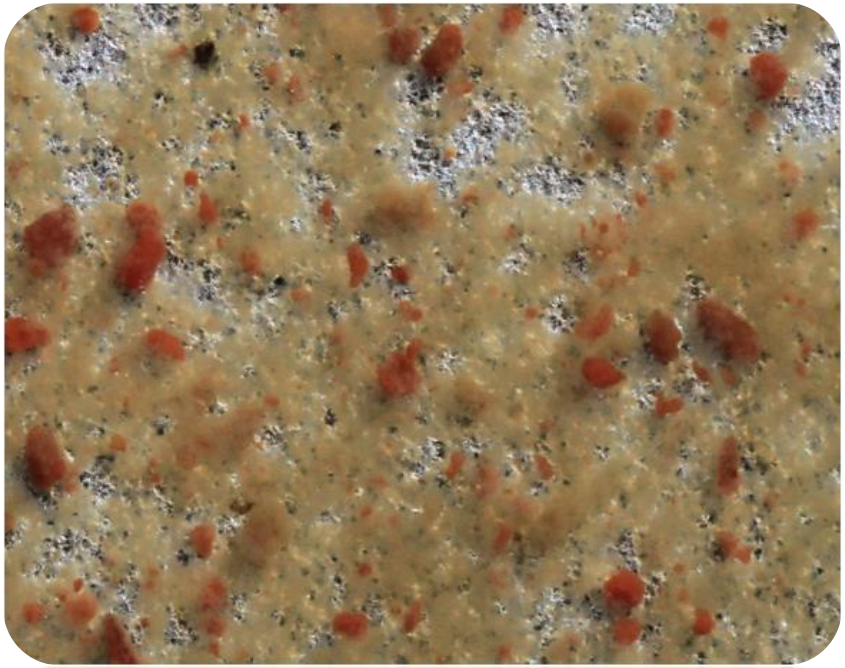
Decanter

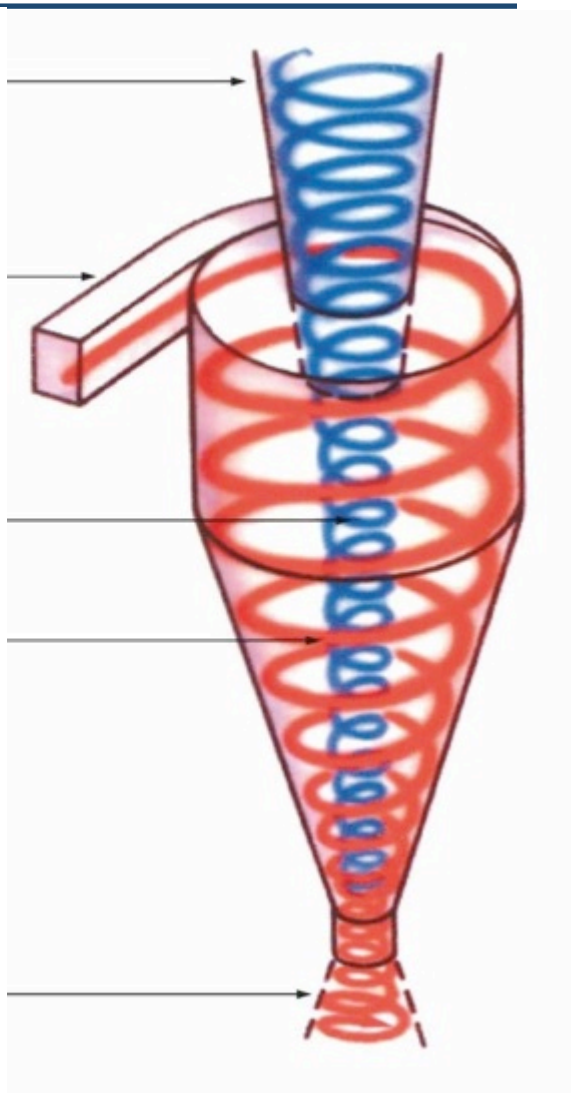
Mixer

Cyclone

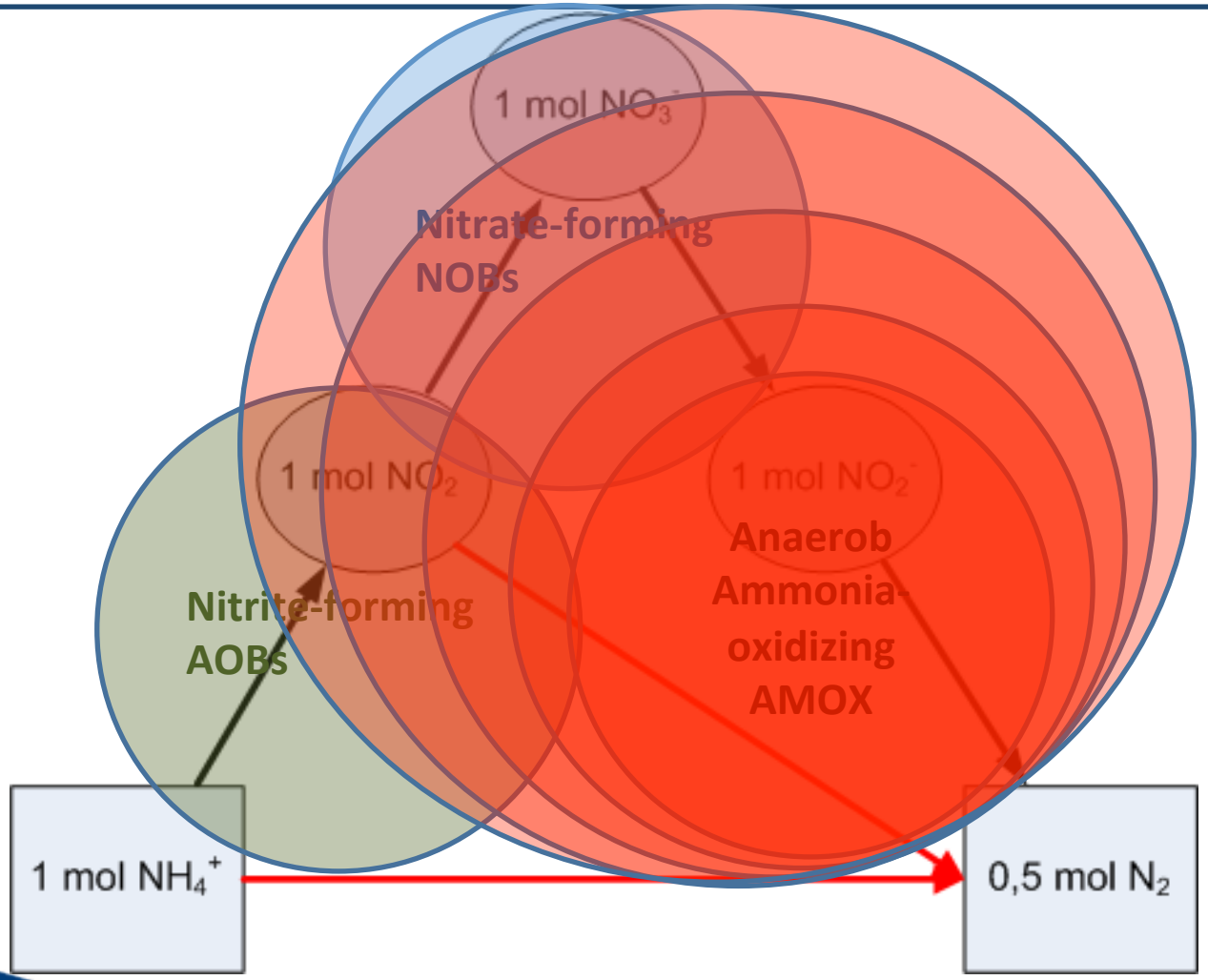
# DEMON® - Biomass Separation System

## Enrichment of Anammox Bacteria with DEMON-cyclone





# Maintaining a Single Sludge System



# Expected Effluent Quality

**Standard Effluent Quality**

90% removal of ammonia-nitrogen

10% production of nitrate-nitrogen

80% removal of total nitrogen (could increase in with influent carbon)

**Increased Effluent Quality (2 reference plants)**

>98% Ammonia-nitrogen

>94% Total nitrogen (with added carbon source)

< 10 mg/L Ammonia-nitrogen

< 10 mg/L Nitrate-nitrogen

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**Section I: INTRODUCTION**

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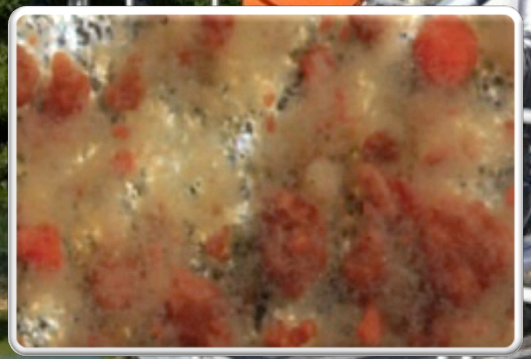
# Demon® Projects in Design in North America

| | | |
|---|---|---|
| ❖York River, VA | Operational | 480 lb/day |
| ❖Biogas facility | Operational | 1,550 lb/day |
| ❖Alexandria, VA | Operational Summer 2015 | 3,968 lb/day |
| ❖DC Water, DC | In Construction | 26,000 lb/day |
| ❖City of Greeley, CO | Operational Summer 2015 | 781 lb/day |
| ❖City of Guelph, Ontario | Operational Summer 2015 | 921 lb/day |
| ❖Pierce County, WA | In Construction | 3,260 lb/day |
| ❖Philadelphia, PA | 100% review by client | 9,514 lb/day |

# Case Study - DEMON®

## HRSD – Seaford, VA

**2013 Environmental Sustainability Award** – American Association of Environmental Engineers and Scientists (AAEES)

**Site:**

- Hampton Roads Sanitation District (HRSD) – York River Plant
- Municipal Treatment Facility

**Goal of New System:**

- Reduce N returned to Main Stream
- Reduce Energy Costs

**New System vs. Traditional Method:**

- Reduced Energy by 65%
- Eliminated Carbon Need
- ~50% Reduction in Alkalinity
- ~90% Reduction in Sludge

**Result:**

- Environmental Sustainability Award
- Achieved Operating Objectives January 2013 (startup Oct. 2012)
- Saving $200,000+/year

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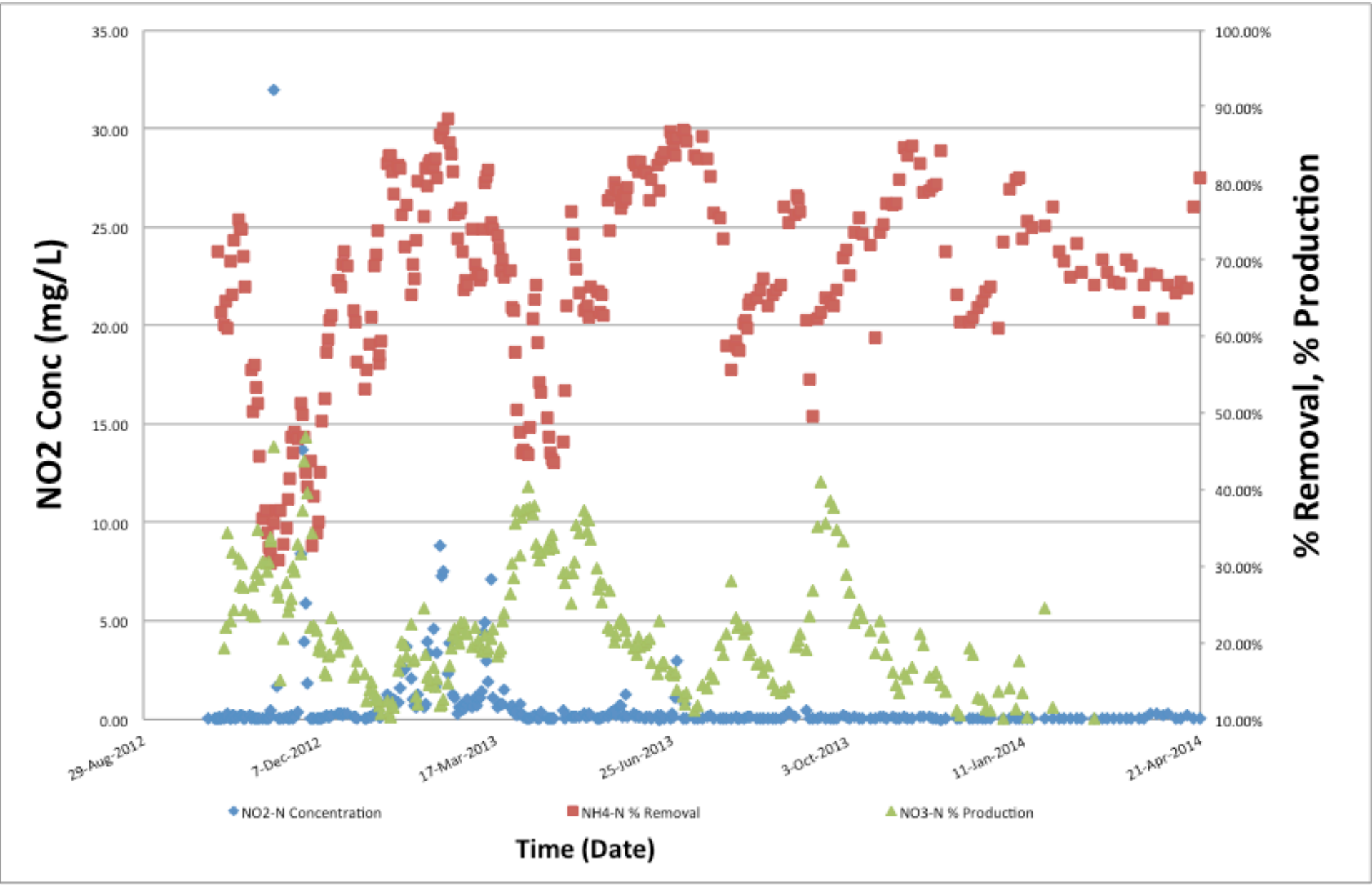
Water Energy Sustainable

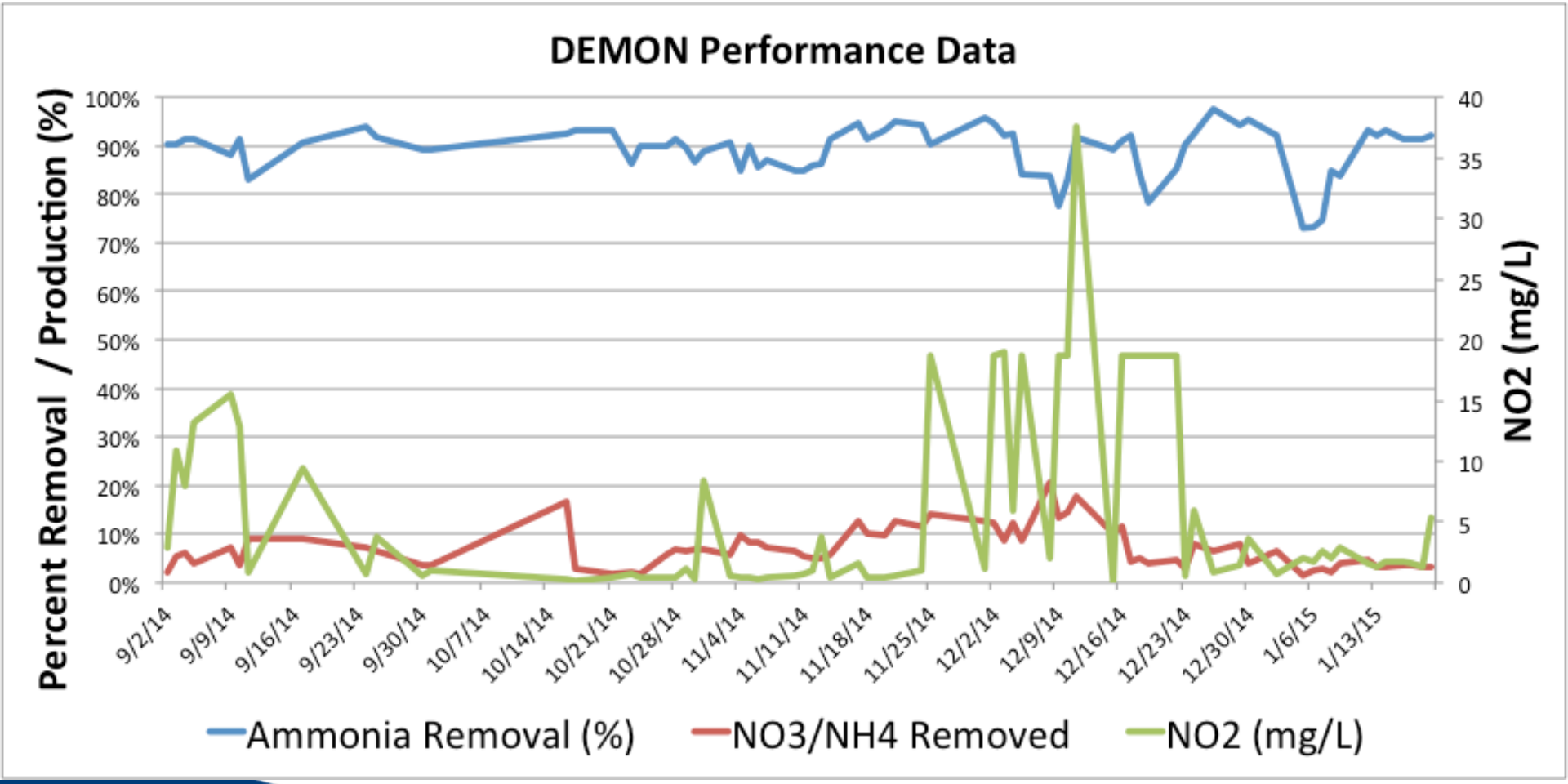
# York River Performance Data



# Biogas Facility

- Organics management and renewable energy facility
- Converts organic waste into renewable biogas
- BioFuel Sources:
  - Food
  - Biosolids
  - FOG

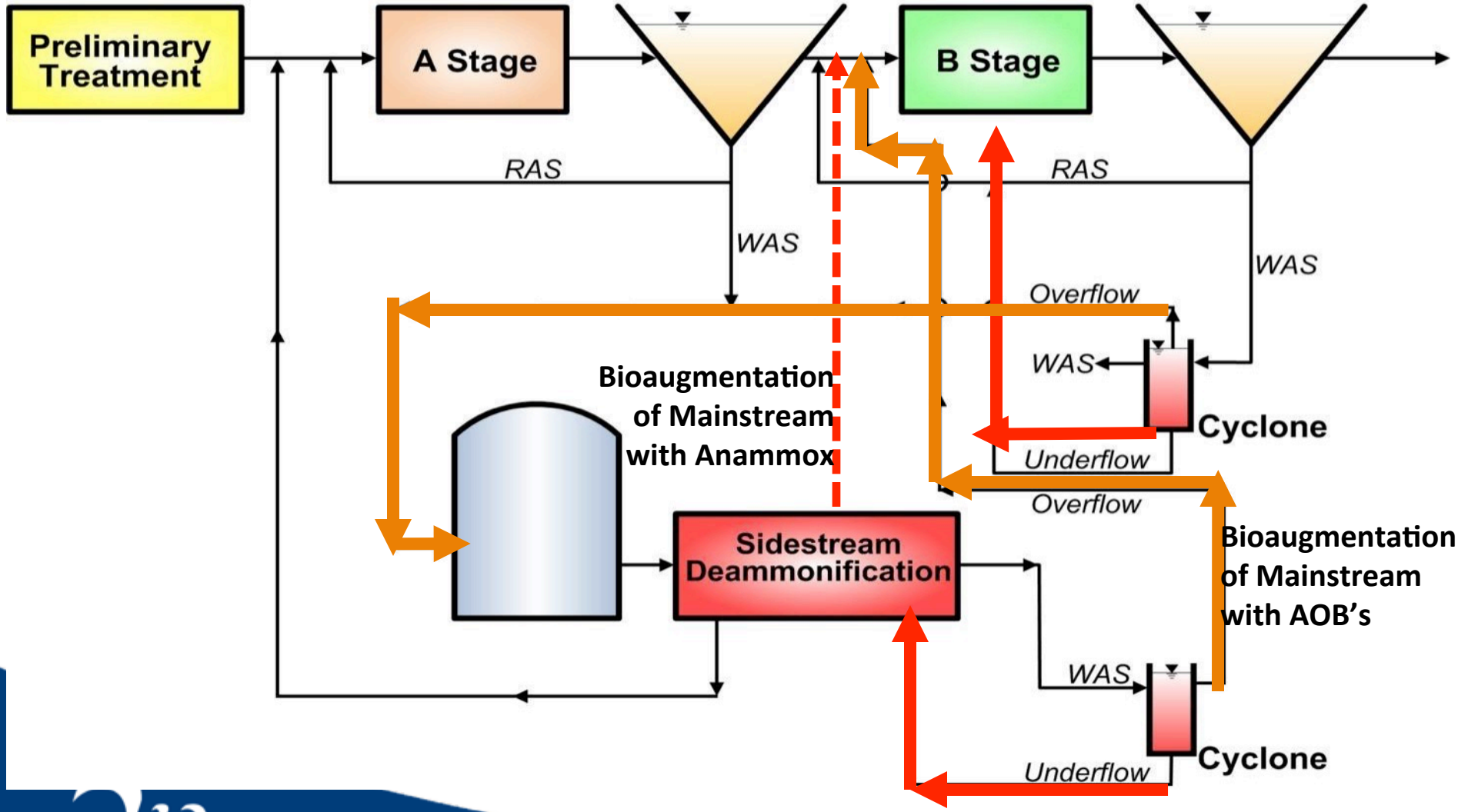
# Biogas Facility – DEMON Performance Data



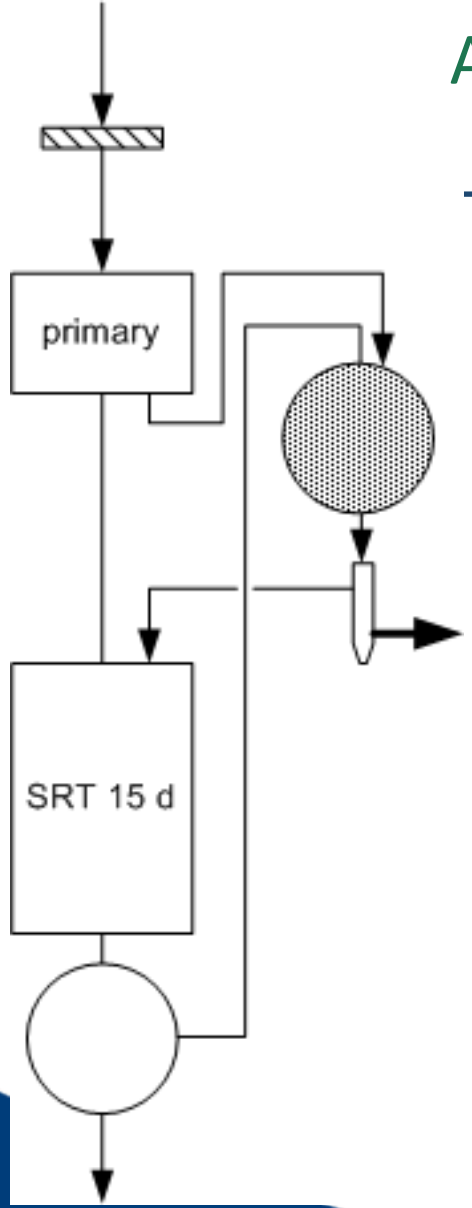
# Strass im Zillertal WWTP near Innsbruck, Austria

- Net energy positive plant
- Mainstream treatment by an A/B process
- Sidestream by DEMON deammonification process
- Co-digestion Facility since 2001
- 10 MGD Winter, 5 MGD Summer
- Equipment selection based on power consumption
- BioFuel Sources:
  - Trap Grease
  - Glycerol from Biodeisel
  - Industrial Biological Processing Waste
    - Food Waste

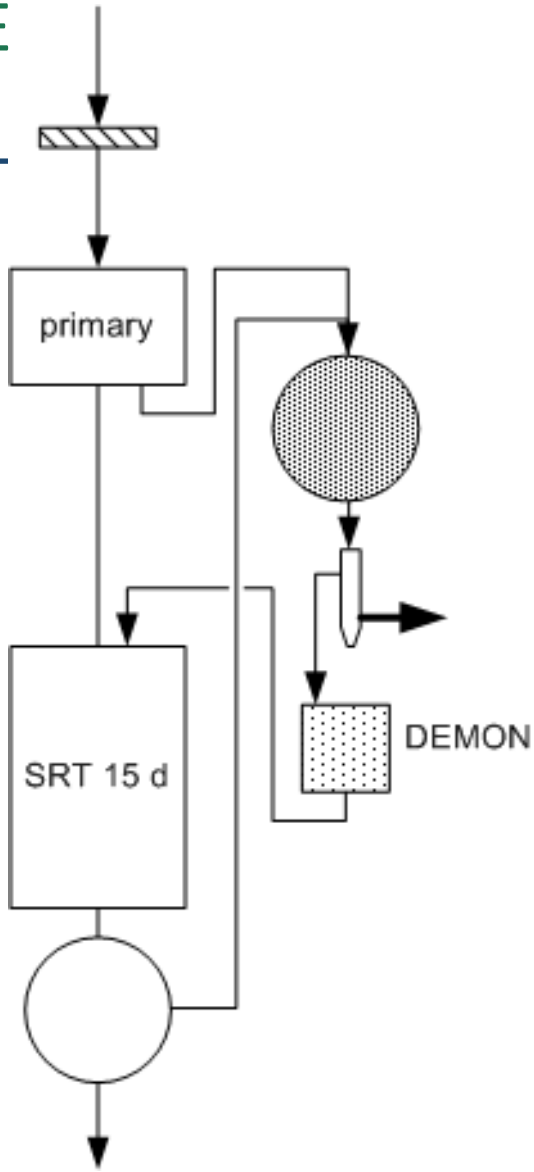
# Hydro-Cyclones Select Granules to De-Couple SRT of MLSS



# A LOOK TOWARD THE FUTURE
## Energy self-sufficient WWTP




| Conventional N-removal | DEMON® in side stream DEMON® |
|---|---|
| Aeration +39,3 Wh /pe d | Aeration +37,2 Wh /pe d |
| Total +56,5 Wh /pe d | Total +54,1 Wh /pe d |
| Gas el. -42,0 Wh /pe d | Gas el. -42,0 Wh /pe d |
| Balance +14,5 Wh /pe d | Balance +12,2 Wh /pe d **15 % reduction** |



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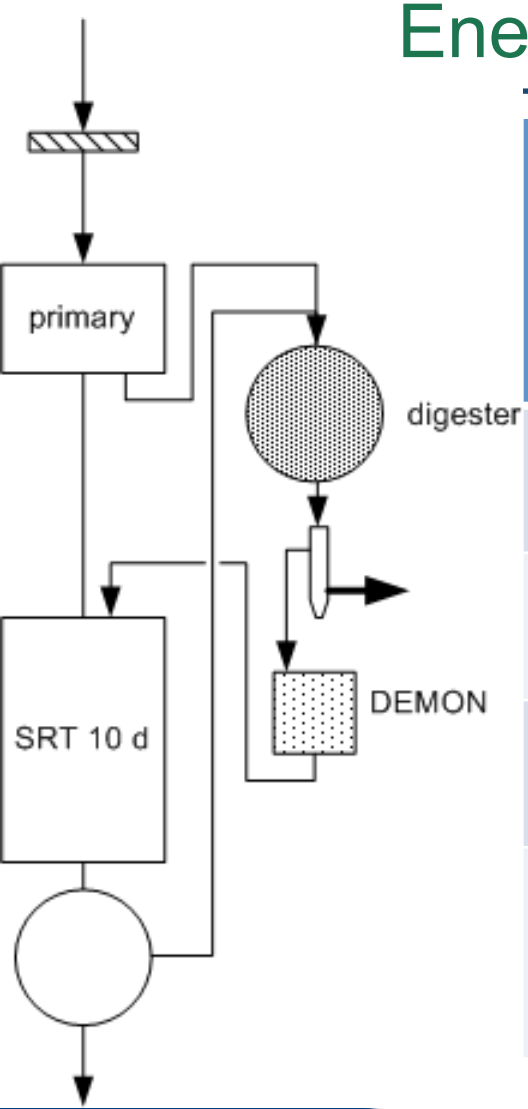
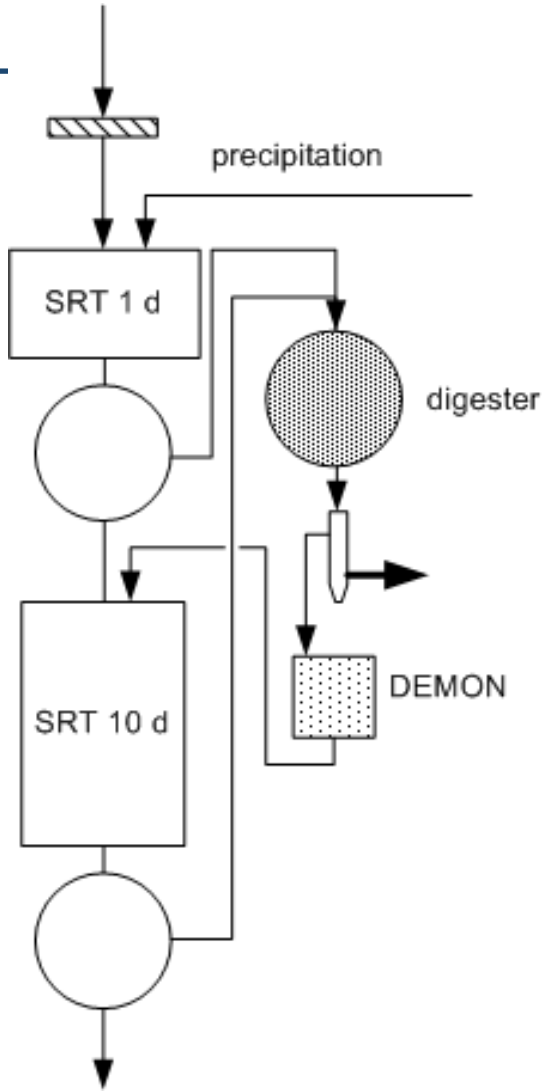
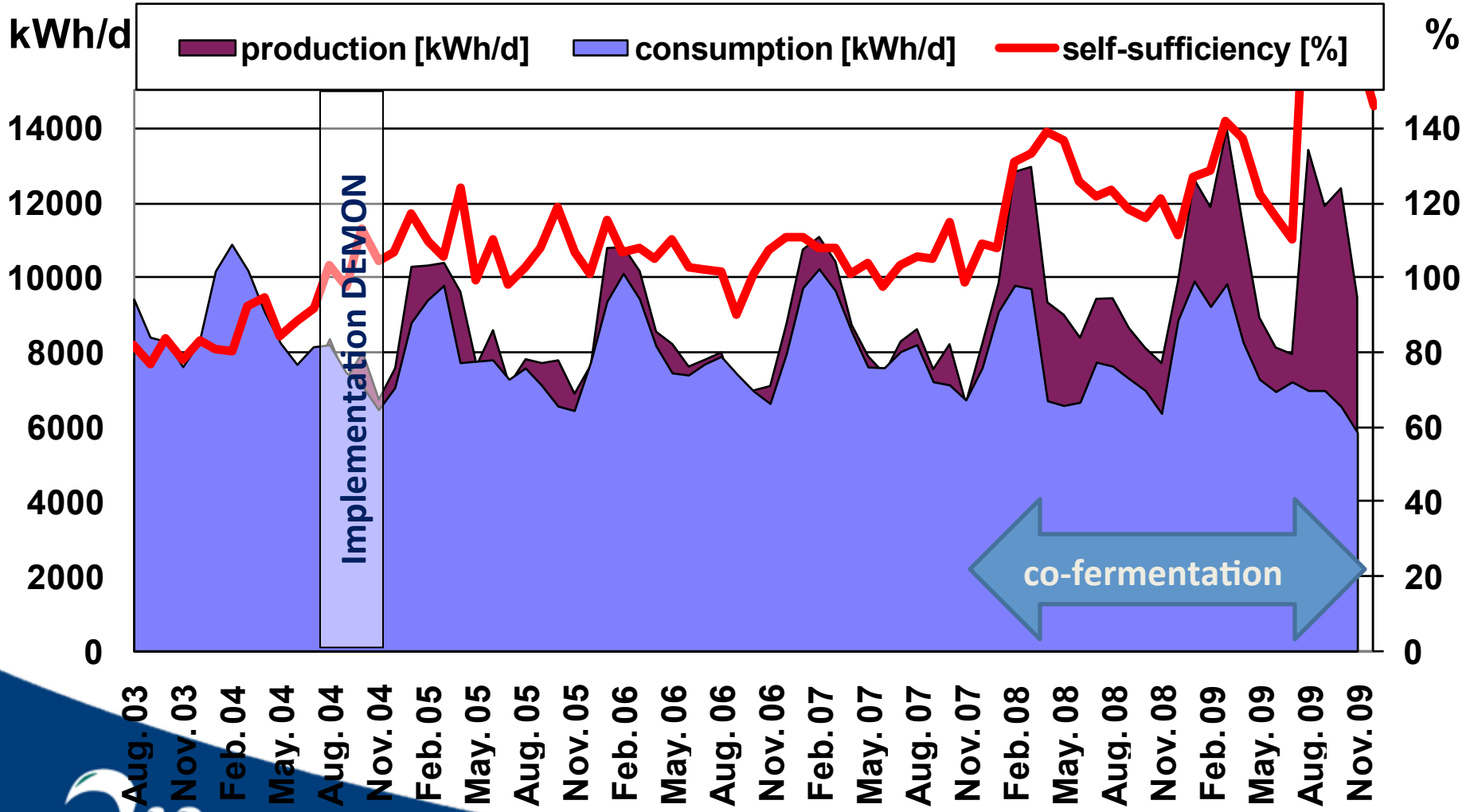



| DEMON® in side- and main stream<br>**DEMON®+** | A & B Step DEMON® & Demon®+<br>**EssDe®** |
|---|---|
| Aeration<br>+31,5 Wh/pe d | Aeration<br>+16,4 Wh /pe d |
| Total<br>+48,4 Wh /pe d | Total<br>+33,3 Wh /pe d |
| Gas el.<br>-42,0 Wh /pe d | Gas el.<br>-64,7 Wh /pe d |
| Balance<br>+6,4 Wh /pe d<br>**56 % reduction** | Balance<br>-31,4Wh /pe d |



# Strass WWTP Degree of Self-Sufficiency >160% in 2010

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# Summary of Benefits of DEMON® Treatment System

- Significant saving of consumables;
  ≥ $0.63 / lb N savings
- 60 % energy saving
- No external carbon required
- CO2 fixation (Δ > 5t CO2/tN)
- Minimized surplus sludge production
- Simple and flexible technology
- SBR or continous flow
- Major step to energy self-sufficient WWTP
- Numerous Awards for Energy Savings & Sustainability
- > 10 years full scale experience

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# Thank you

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1-405-ANAMMOX (262-6669)
1-405-943-9006 Fax

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