Edmonton Waste Management Centre of Excellence

Energy Efficient Wastewater Treatment and Solid Waste Management

The Strass im Zillertal Wastewater Treatment Plant

A Case Study – Net Energy Positive WWTP near Innsbruck, Austria

George Crawford – CH2M HILL

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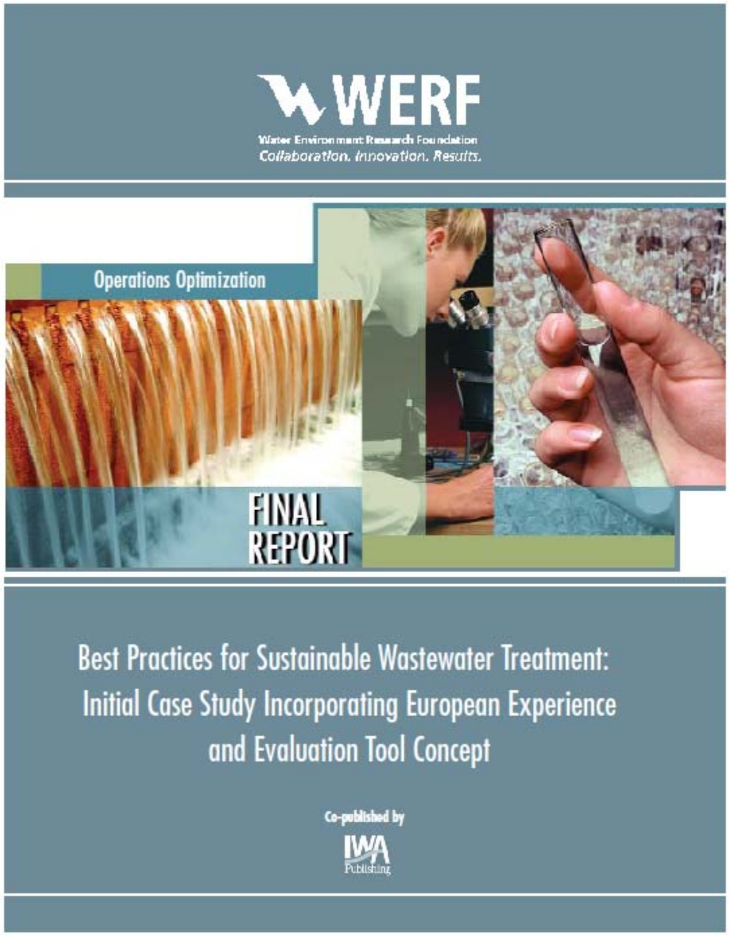
WERF European Best Practices Report



- Evaluation of European Best Practices
- Strass WWTP Case Study
- Foundation for Comprehensive Plant Evaluation Tool

WERF
Water Environment Research Foundation
Collaboration. Innovation. Results.

Overview

- Strass WWTP operated by Abwasserverband Achental-Inntall-Zillertal,Strass, Austria
- An Energy-Positive Facility

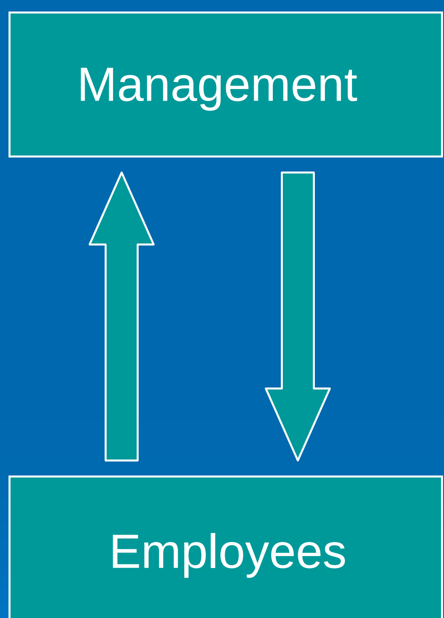
- Strass's Sustainability Journey
  - Organizational:
    - Defining Sustainability Goals
    - Using Benchmarking Metrics to Target and Communicate Priorities
  - Incorporating Technological Innovation

Organizational Factors

Strass: Organizational Characteristics

- A Clearly Articulated and Communicated Vision of What Sustainability Means to Their Organization
- A Highly Educated, Well Paid Workforce
  - Active in the Public Forum
- Strong Partnering with Local Industry
  - R&D, Resource Recovery
- Continuous Internal Benchmarking
  - Quantifying Gains and Missteps - Metrics
  - Early Adopters of Energy Management Practices
- Tolerance for Managed Risk

Articulating the Vision



- <u>The Challenge</u>:
  - Defining Technically Accurate Metrics that Reflect the Priorities of the Organization
    - “Sustainable”?
    - Energy-neutral?
    - Electricity-neutral?
    - Minimal carbon footprint?
    - Cost-neutral?
    - Odour, noise?

Process Specific Metrics

Process Specificity Can Make the Difference!

Primary Treatment
- ~~kW-hr Consumed/MGD Treated~~
- kg Chemical Consumed/kg BOD Removed
- kg PS Produced/ kg TSS Applied

Secondary Treatment
- ~~kg BOD Removed/MGD Treated~~
- ~~kW-hr Consumed/MGD Treated~~
- kW-hr Consumed/lb BOD Removed

Using Mass-Based Process Metrics Will Provide a More Meaningful Measure of Efficiency and Prevent the Proverbial Wild Goose Chase

Lessons Learned

Organizational	
Lesson Learned	**Strass Key Feature**
Define, and align, your organizational behavior	Mgt and ops desired a sustainable organization and jointly defined their objective to be cost and energy neutral
Consider the customer's perspective	Rates are considered to be a temporary subsidy – plant should be cost-neutral!
Educate and train operating staff Streamline accountability structure	Employee empowerment
Use the right metrics	Management set objectives based upon kWh per kg COD removed, or per capita
Try to do the right thing, even if beyond current regulations	Employed Swiss and German approaches, not just Austrian practices

Incorporating Technological Innovation

Strass Data and Results

- Strass WWTP operated by Abwasserverband Achental-Inntall-Zillertal, Strass, Austria.
- 10 mgd in the Winter
  - 250K p.e.
- 5-6 mgd in the Summer

The Strass WWTP Produces More Electricity Than It Consumes

- Energy conservation philosophy, including:

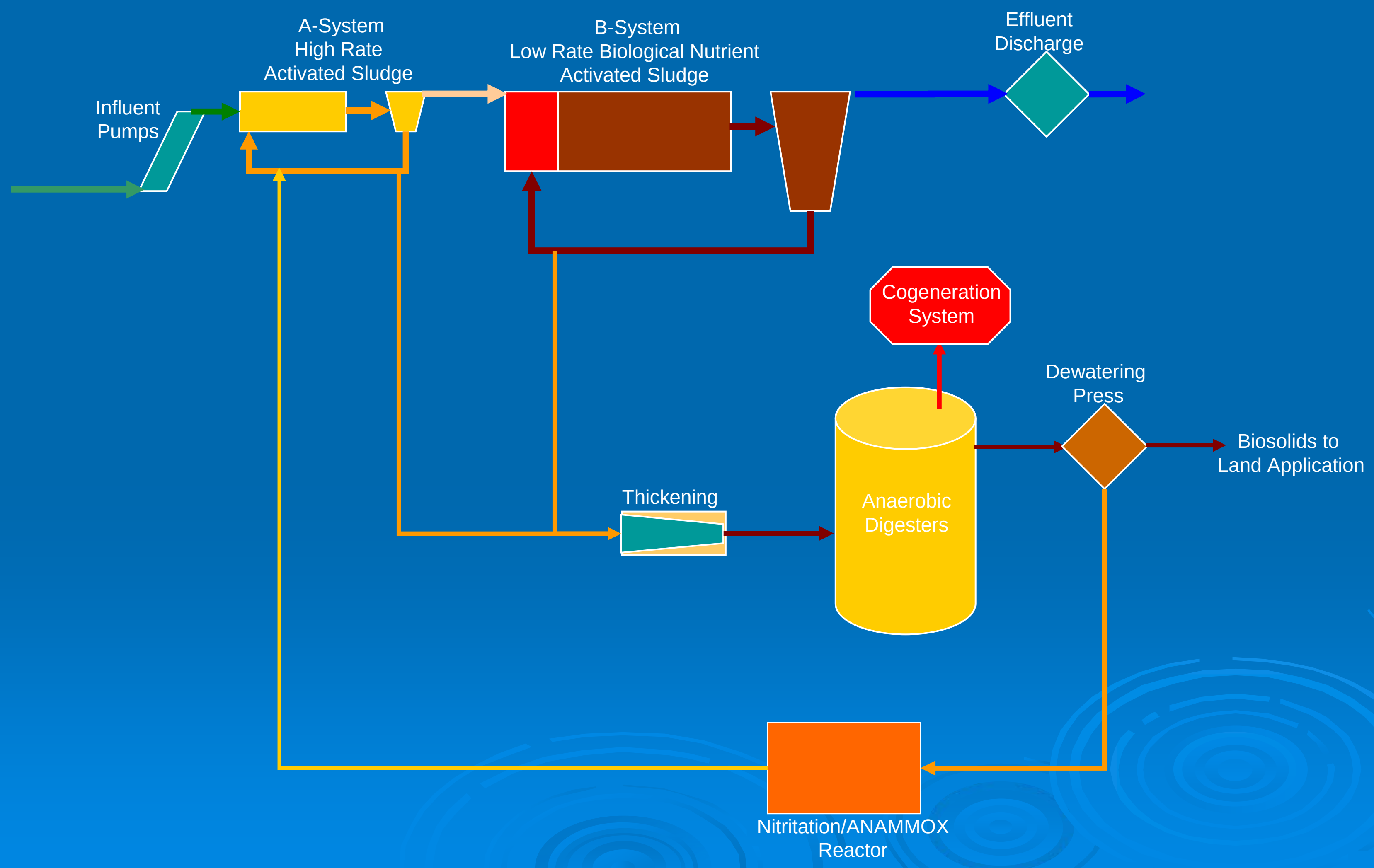
  - Continuous improvement
  - Control setpoints at minimums
  - Major equipment selected based upon power
  - Total plant perspective

Discharge Permit Makes a Difference!

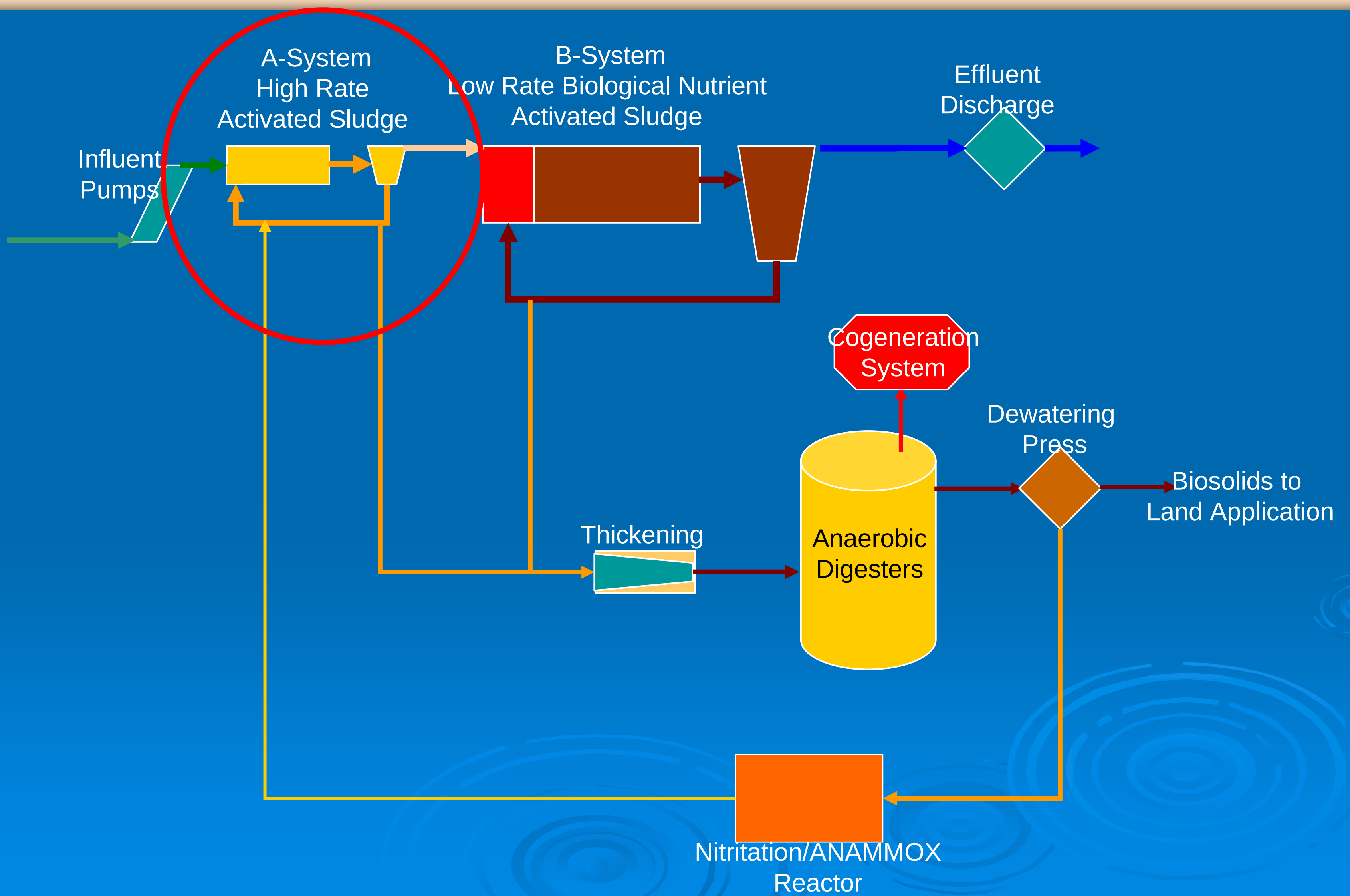
- Discharge Permits Based on the European Directive vs. Typical North American Permits

	ED	NPDES	Comments
BOD5 (mg/L)	20	5-30	
TSS (mg/L)	20	5-30	
Ammonia (mgN/L)	5	1-12+	T>8C
Nitrogen (% rem.)	85	-	T>12C
Phosphorus (mgP/L)	1	0.1 - 2+	

Strass Process Configuration



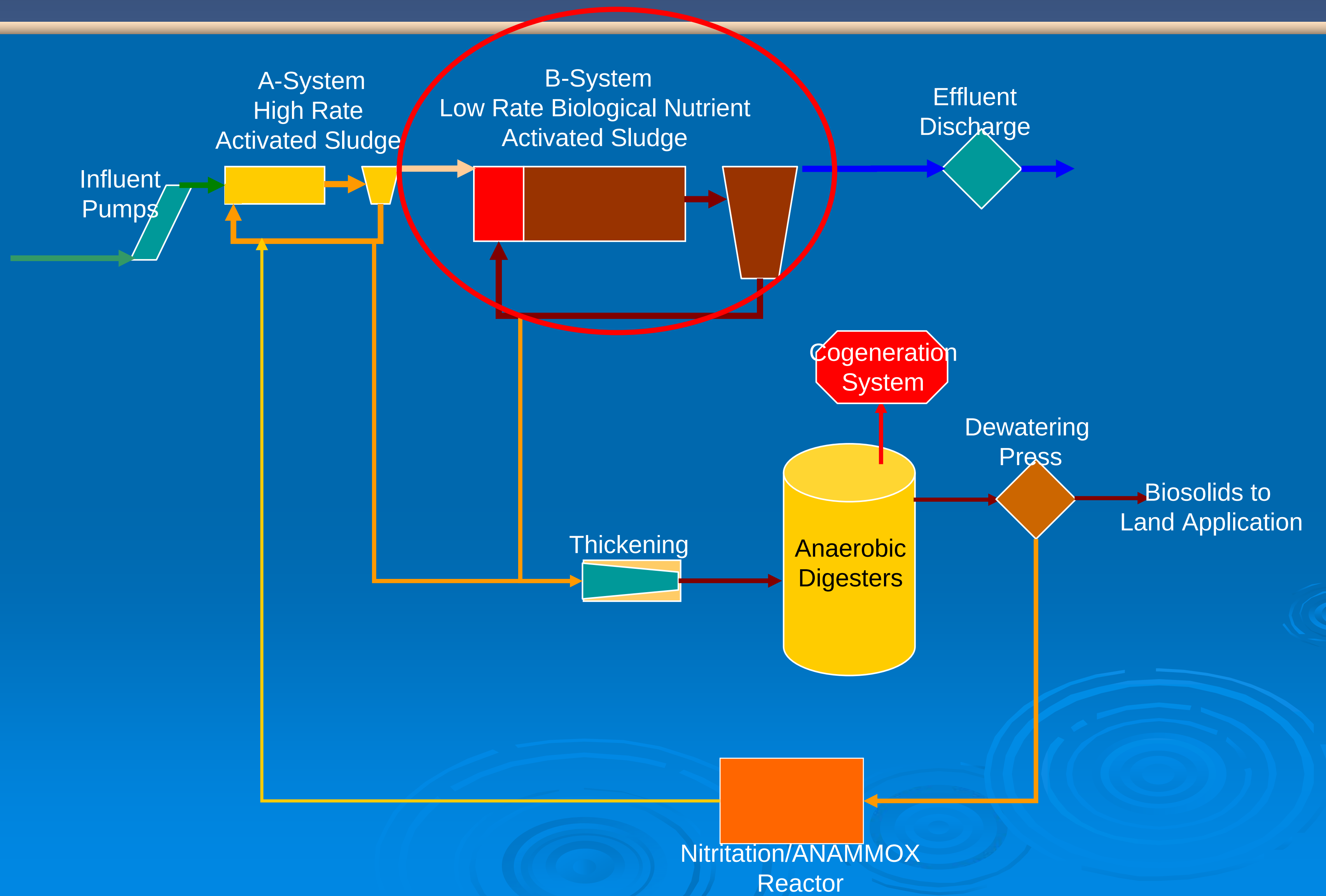
Strass Data and Results



A-System: Maximize Organics to Digestion

- The A Process:
  - High Rate Activated Sludge
    - 0.5 Hr HRT; 12-18 Hr SRT
    - Particulate, Colloidal & SOLUBLE Organics Removal Without Chemical Addition
  - Rapid Transfer from Aerobic Conditions to Anaerobic Conditions for Thickening Preserves Organics

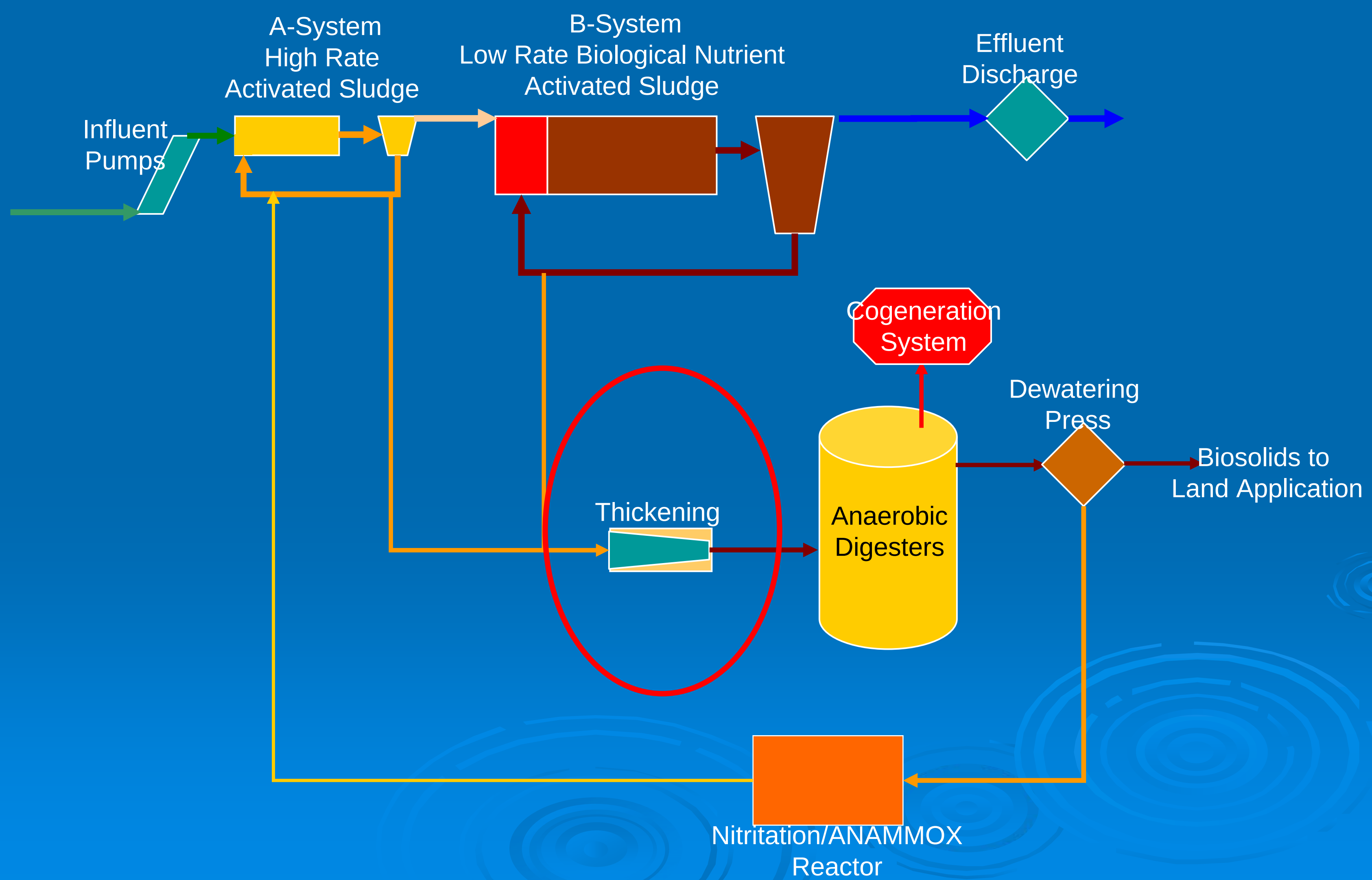
Strass Data and Results



B-System: Sustainable Nitrogen Removal

- High Efficiency Strip Panel Aeration…..
- Ability to Remove Nitrogen Cost Effectively
- Effective Aeration Control throughout the Mass Loading Diurnal

Strass Data and Results



Thickening is Key for Several Reasons

Thickening reduces volume….

Process	Best at %TS
Storage	< 6
Pumping	< 8
Digestion	4-6
Dewatering	> 4

- Reduces capital and O&M costs of processing facilities
- Increases performance of downstream processes

Power Cost Plays an Important Role in Determining Best Thickening Option

Gravity Thickeners

Centrifuges

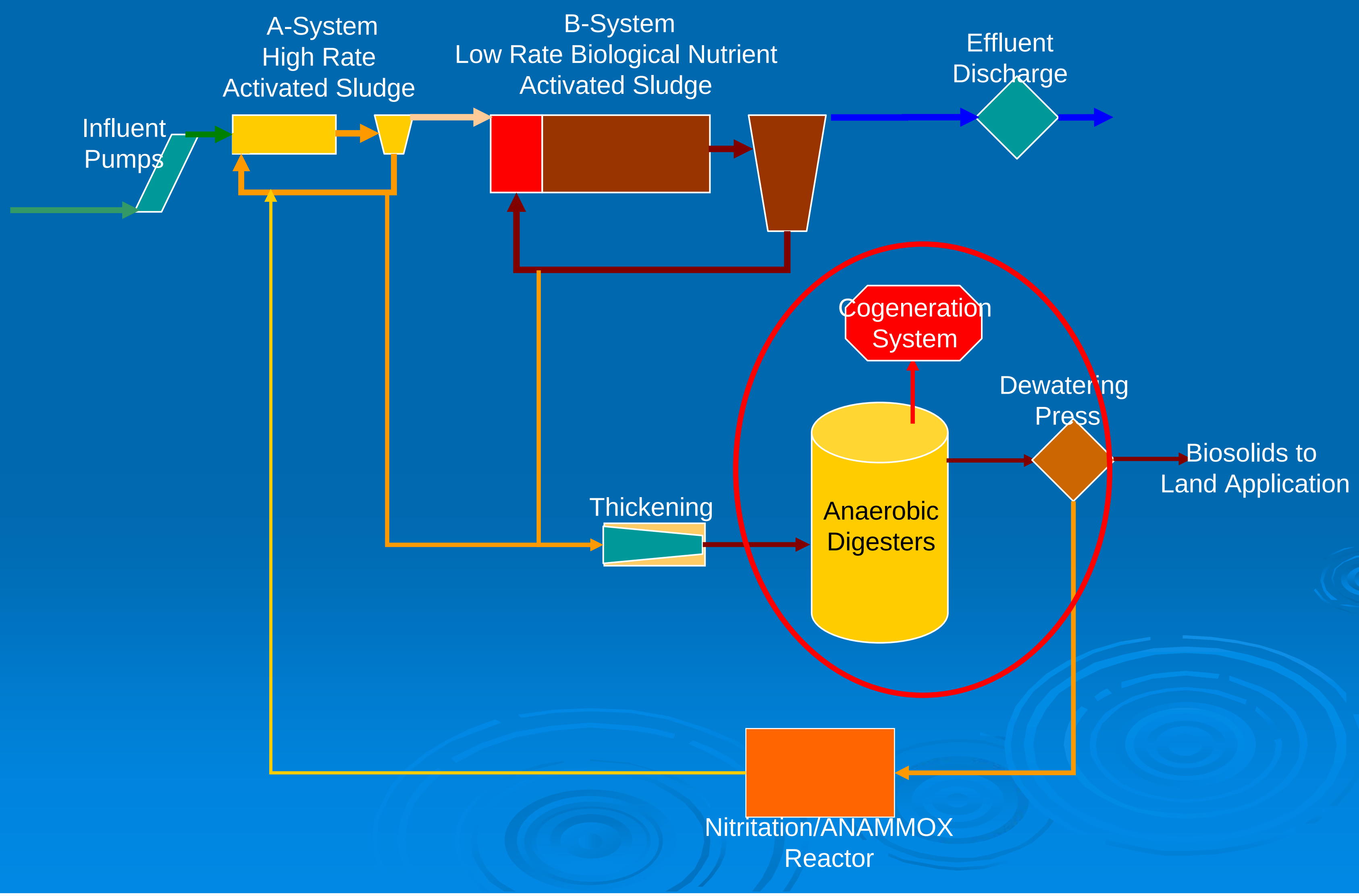
Gravity Belt Thickeners

Rotary Drum

DAF

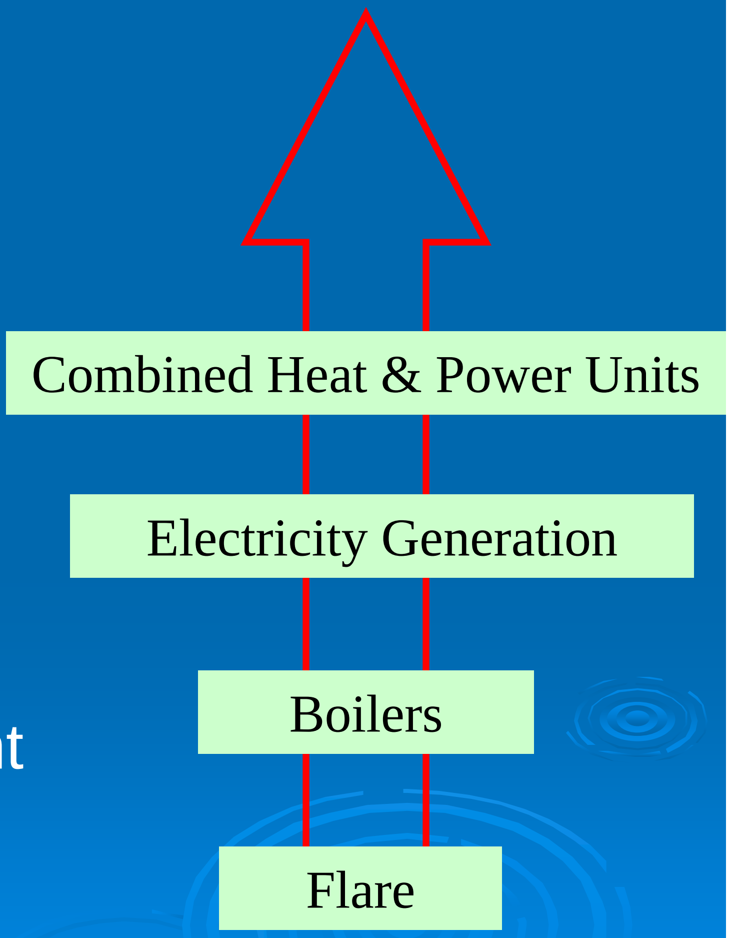
etc

Strass Data and Results



Energy Production - Biogas Utilization

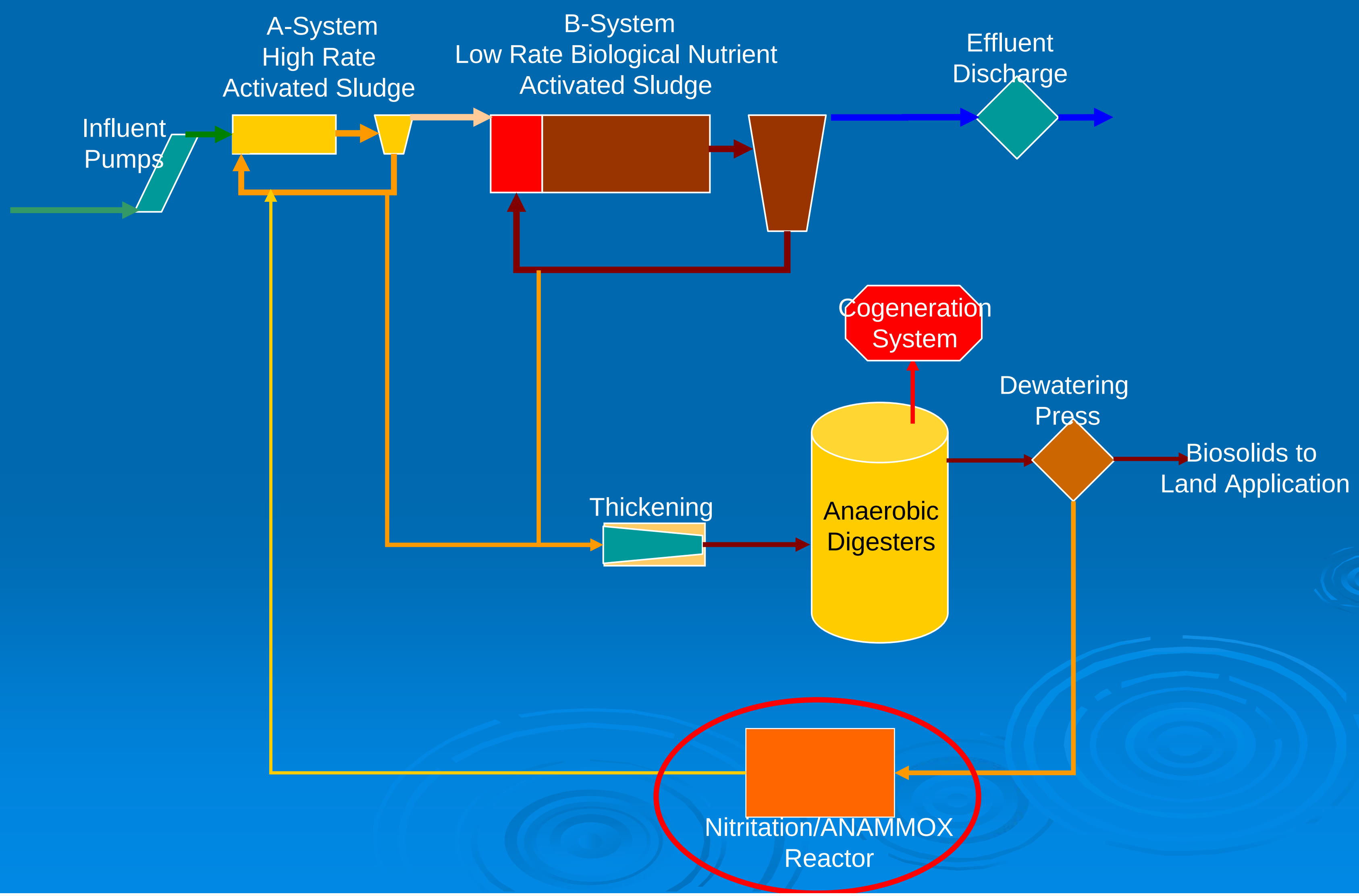
- Best Use Of Biogas
  - Term Can Mean Different Things for Different Plants
- Typical Paradigm for Energy Efficiency:
  - 20-30% Reduction in Energy Consumption
  - CHP: Can Meet **50-100+**% of Plant Energy Demand



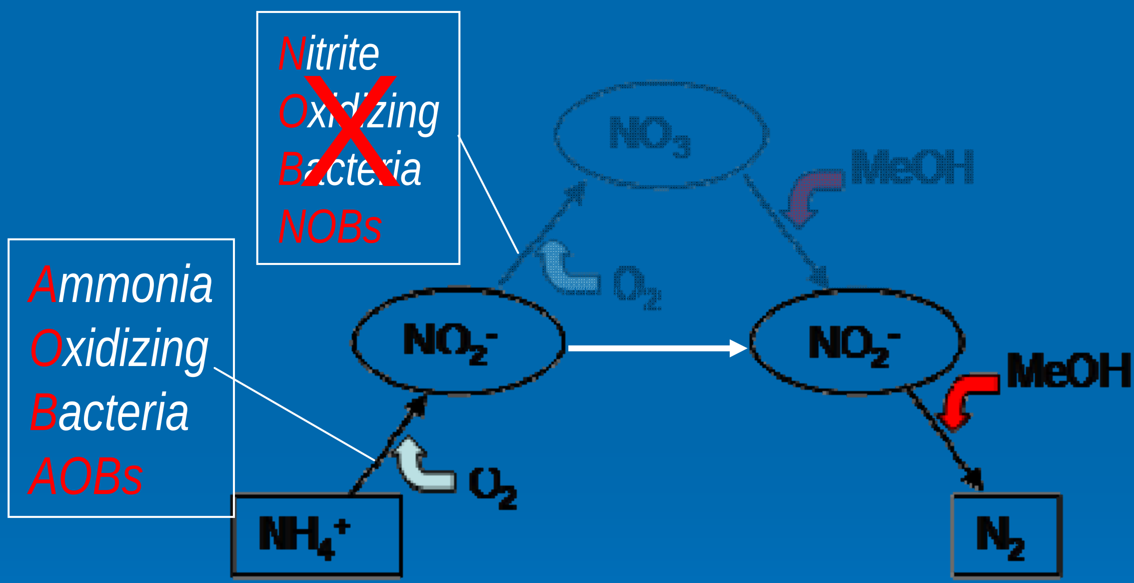
An Incremental Approach to Electrical Self Sufficiency

- 2001: Deployment of the new GE-Jenbacher Co-Gen Plant (JMS 208 GS)
  - 340 kW Electrical
  - 744 kW Total
- Increases Electrical Efficiency to 38% from 33.2% - almost a 20% Increase
- Overall Digester Gas Utilization Efficiency Increases to 2.3 kW-Hr/m^3 digester gas from 2.0 kW-Hr/m^3

Strass Data and Results



Incorporating Nitritation/anammox



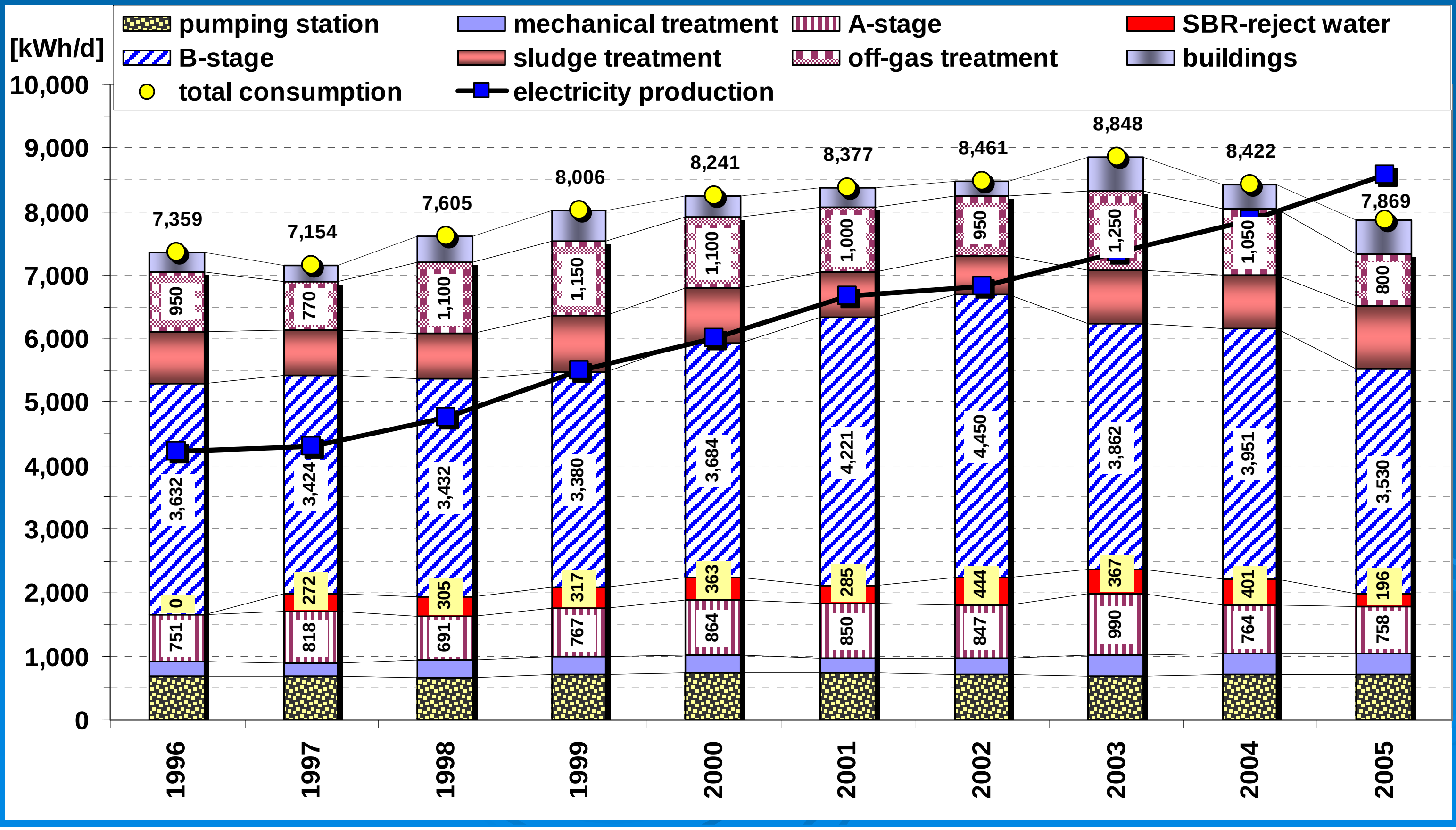
Reduced Costs and Environmental Impacts for Eliminating a Byproduct - Ammonia

vs.

The Risks of Being An Early Adopter

The Results so Far: Electrical Self Sufficiency in 2005

- Key Contributors:
  - anammox sidestream nitrogen removal process (2005)
  - high efficiency strip-aeration system (2001-2004)



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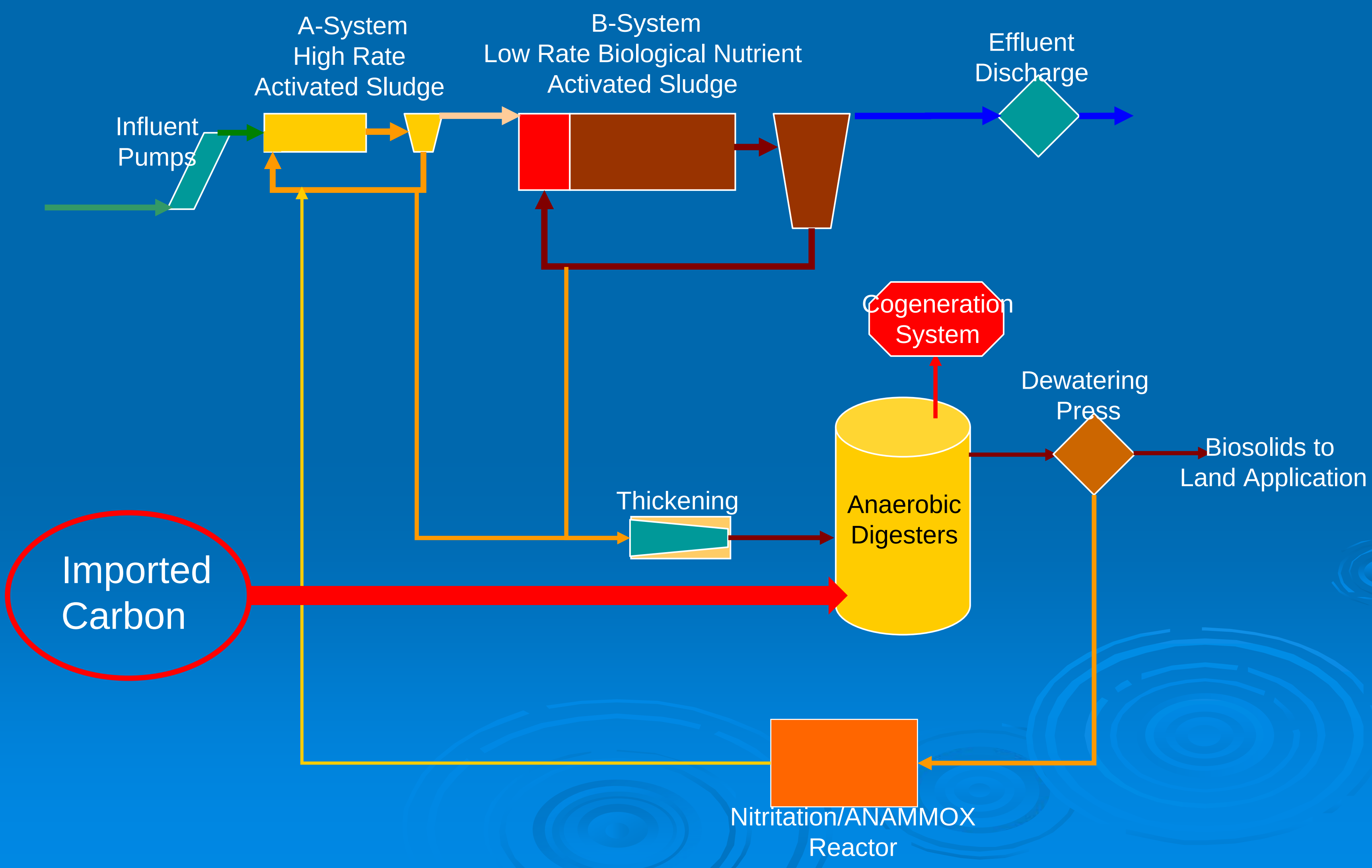
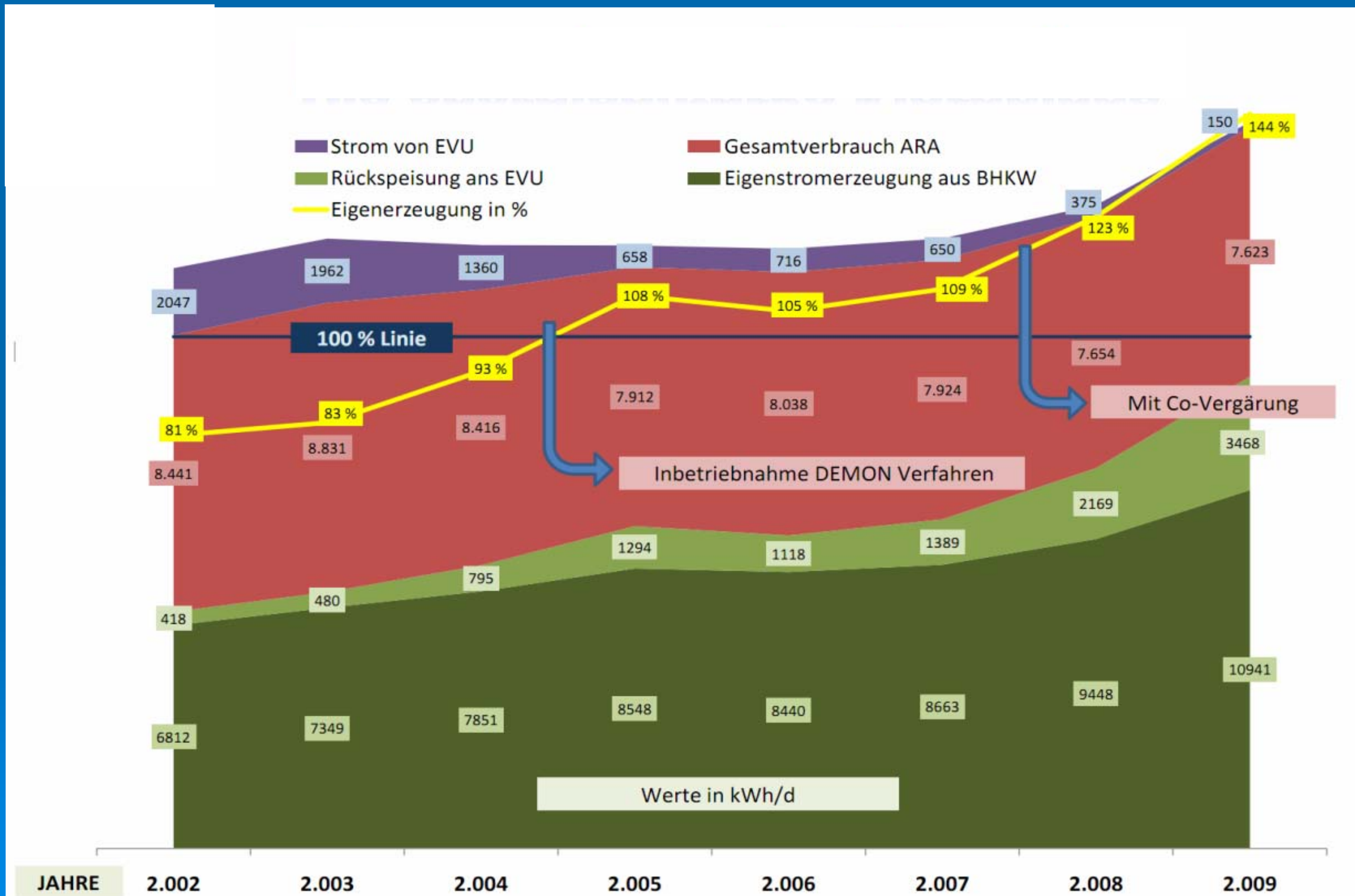


Co-Digestion Provides the Next Step Up

- Recognition of Wider Range of BioFuel Sources
  - Trap Grease
  - Glycerol from Biodiesel Production
  - Industrial Biological Processing Waste (Antibiotic Production)
  - And More Recently ….Food Waste
- The Costs to Local Industry are Offset by Minimizing their Costs for Disposal

Electrical Production at 120% of Demand in 2008



Lessons Learned

Technical	
Lesson Learned	**Strass Key Feature**
Plan long term; implement short term (aka ensure each step takes you toward a long term goal)	Two stage CAS minimizes energy requirements while maximizing digester gas production
Conserve COD for diversion to digestion and biogas	Short SRT first stage CAS, particulate, colloidal and soluble organics capture with little endogenous decay
Minimize aeration costs for BOD and ammonia oxidation	1. High efficiency strip aeration 2. DO setpoint control
Use tools that allow comparison of alternatives	Whole plant energy balances used for decision analysis
Select equipment and controls with the overall objective in mind	1. Screw press instead of centrifuge for dewatering 2. CHP generator replaced with higher efficiency units
1. Maximize COD to digestion and biogas – codigestion. 2. Partner with industry!	1. Grease waste augmentation. 2. Also glycerol from biodiesel and select pharmaceuticals. 3. Minimal/No Cost to High value waste contributors
Treat wastes at their highest concentration to unlock additional cost savings	Anammox on hot high-N sidestream

Specific Accomplishments at Strass

- Reduction of chemical costs for sludge thickening by 50%
- Reduction in sludge dewatering costs by 33%
- Reduction in energy consumption on mass treated basis from approximately 6.5 euro/kg NH4-N removed in 2003 to 2.9 euro/kgNH4-N removed in 2007/2008
  - active management of dissolved oxygen (DO) setpoints
  - conversion to ultra-high efficiency strip aeration
- Sidestream treatment
  - 350 kWh/d to 196 kwh/d by implementing Nitritation/anammox (DEMON®)
- Digester gas utilization
  - cogeneration unit, boosting electrical efficiency from 33% to 40% and overall usage efficiency from 2.05 to 2.30 kwh/m3 of digester gas

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Questions?

george.crawford@ch2m.com

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