Sustainable Treatment

What the Bay Area can learn from the Strass in Zillertal Wastewater Treatment Plant

Introduction – WERF Optimization Challenge and EPA Energy Efficiency Efforts

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BACWA
BAY AREA
CLEAN WATER
AGENCIES

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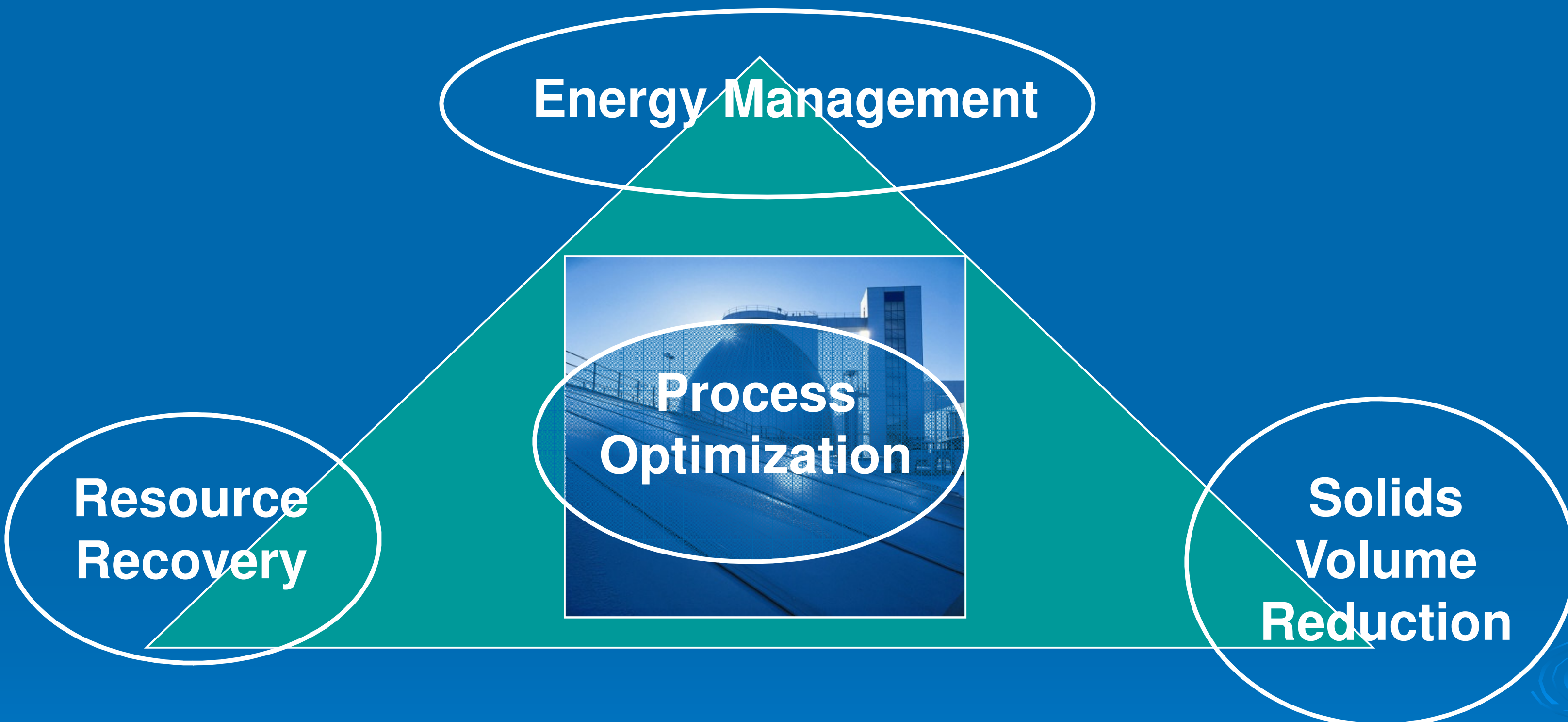
WERF and EPA Research

- Overview of the WERF Optimization Program
- A look at individual task reports
- CHEApet – Pro2D/BioWin with Carbon, Heat, Energy and GHG Analyses
- EPA Energy Conservation Measures Report

Optimization Challenge



Approved total over $3,000,000 to date in new research funds

The "Optimization" Goal

To develop and demonstrate economical and environmentally responsible processes that improve wastewater and solids treatment operations efficiencies and costs by at least 20%

20% less energy

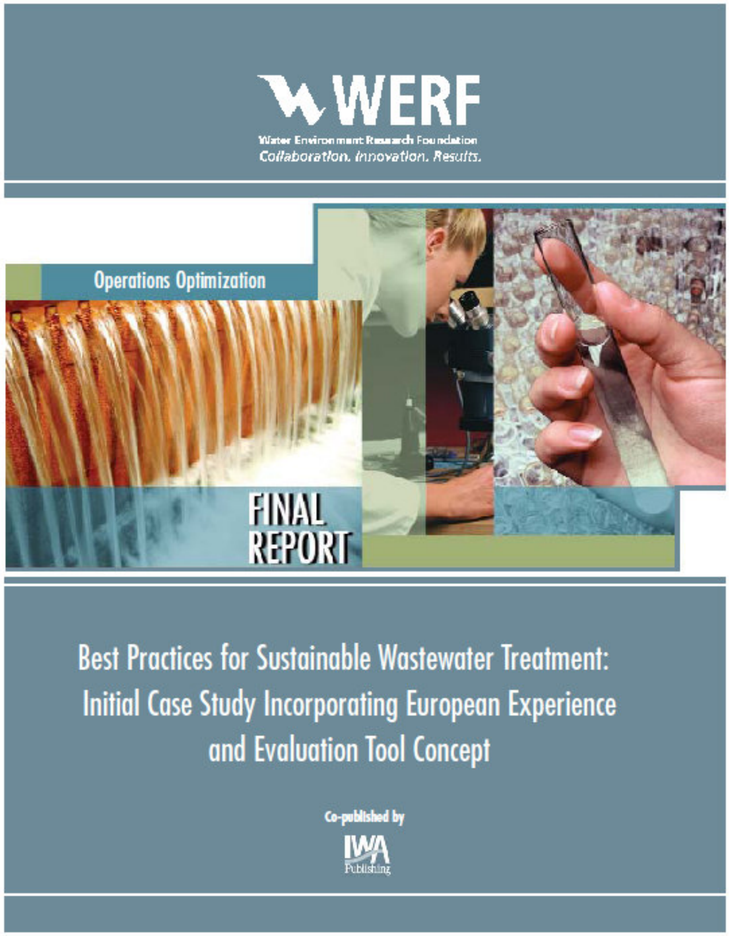
20% more resource recovery

20% less solids produced

Summary (A Sneak Preview!)

- WERF Task 2 summarizes energy-neutral Strass Plant
- WERF Task 3 creates the CHEApet model
- WERF Task 4 creates the Plant of the Future technology roadmap
- WERF Task 7 is a compendium of energy management best practices
- WERF Task 8 is demonstration testing of LCAMER
- WERF Task 9 is demonstration testing of CHEApet

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.

European Best Practices Report

- Dutch and Scandinavian benchmarking
  - Enhances performance and transparency
  - Allows comparisons with other utilities
- Swiss and German energy manuals
  - Metrics per unit process, as well as per plant
- Selected metrics are important
  - kWh per capita, or per ML, or per kg of COD removed
  - Electrical cost per capita, or per ML, or per kg of COD removed

The Strass WWTP Produces More Electricity Than It Consumes

Energy Efficiency: A Compendium of Best Practices and Case Studies in USA

- Collaboration with the Global Water Research Coalition
- Best practice summaries from four continental groups:
  - Europe
  - Americas
  - South Africa
  - Pacific Rim

Global Water Research Coalition

Summarizes Best Practices in Established Energy Optimization/Recovery

- UKWIR/ WERF/ STOWA/ Hydromantis, 2008
- USEPA, 2008
- PG&E, SBW Consulting, 2008
- NY State Energy R&D Authority, 2008
- California Public Utilities Commission/SBW, 2007
- Focus on Energy, 2006
- WERF/Hydromantis, 2006
- USEPA/Global Environment & Tech. Foundation, 2006
- Quantum Consulting/SWC Consulting, 2005
- California Energy Commission/Nexant, 2003
- PG&E, M/J Industrial Solutions, 2003
- Focus on Energy, 2002
- Water Environment Federation, 1997

Summarizes Best Practices in Established Energy Optimization/Recovery (cont.)

- Energy Management Techniques
- Treatment Process Selection, Operation, and Power Requirements
- Electrical Systems
- Electromechanical Control Systems
- SCADA Systems
- Equipment Design and Operation
- Energy Recovery Systems
- Commercial Resale and Distribution
- Energy Economics
- Regulations

Also Documents Case Studies of Novel Energy Efficiency Approaches

General WWT

- Wind, solar and hydro power at WWTPs
- UASB for WWTPs

Anaerobic Sludge Digestion

- Columbus Biosolids Flow Through Thermophillic Treatment (CBT3)
- Electrical pulse sludge reduction technology
- Co-digestion of manure and food waste
- Linear motion mixer

Biogas Co-generation

- Siloxane removal from biogas
- Co-generation – fuel cells and micro turbines
- External combustion engines

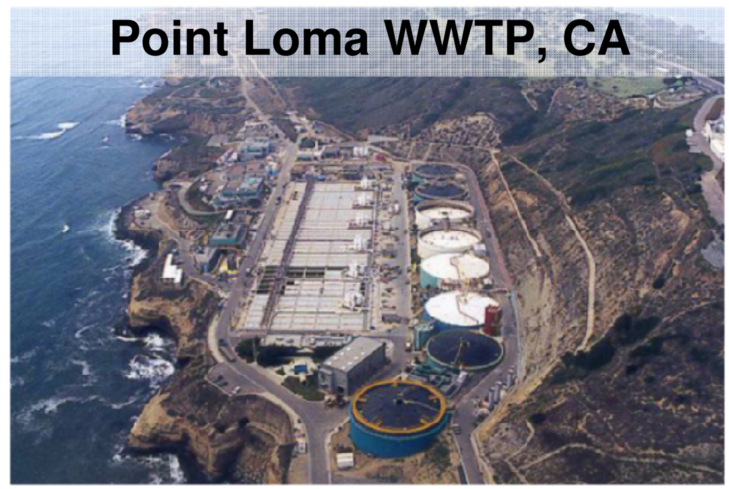
Renewable Energy Sources at WWTPs


ACUA WWTP, NJ

- Wind satisfies 67% power demand; solar 3%.
- 33% lower power unit cost


Carbon Canyon WWTP, CA

- 0,7 MW DC solar power meets ~17% of demand
- PPP implementation


Point Loma WWTP, CA

- Hydro power turbine in effluent generates 1.35 MW (~10,000 homes)
- 2-3 yr payback

Anaerobic Treatment of Municipal Wastewater

- UASB Reactors: 60-70% BOD removal
- Simple polishing (e.g. lagoons) to achieve secondary levels
- Negligible power consumption; potential of biogas co-generation
- Capital and O&M costs comparable to primary treatment

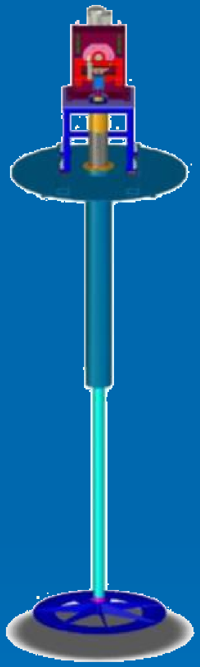
Rio Frio WWTP, Colombia

Anaerobic Digestion Optimization

- Columbus Biosolids Flow-through Thermophilic Treatment (CBT3)
- 80% combined electrical/thermal efficiency
- < 10 year pay back

- OpenCEL pulsed electric field produced 32% more biogas treating 53% of WAS
- Improved sludge dewatering

Anaerobic Digestion Optimization (cont'd)



- Co-digestion of manure and food waste increased biogas/power generation over manure alone
- Lower carbon footprint
- < 8 year pay back

- Linear motion mixer required ~ 90% less energy than draft tube mixers
- < 3 year pay back

Digester Biogas Co-generation

South WWTP, King Co., WA

Lancaster WRP, CA

- Fuel Cell capital and O&M cost estimates at $9,000/kW and $0.035/kWh
- Tested unit produced ~1 MW at full capacity

- Microturbines capital and O&M cost estimates at $4,000/kW and $0.020/kWh
- Target of > 90% of plant energy demand not met via CHP

Digester Biogas Co-generation (cont'd)

Stirling External Combustion Engines

- Simple biogas pretreatment
  - Moisture removal
  - Compression (2 psi)
- 27% power efficiency
- 75% total efficiency with CHP
- 43 kW/unit
- Installation cost $3,000 -3,500/kW
  - Simple payback of 4-4.5 years

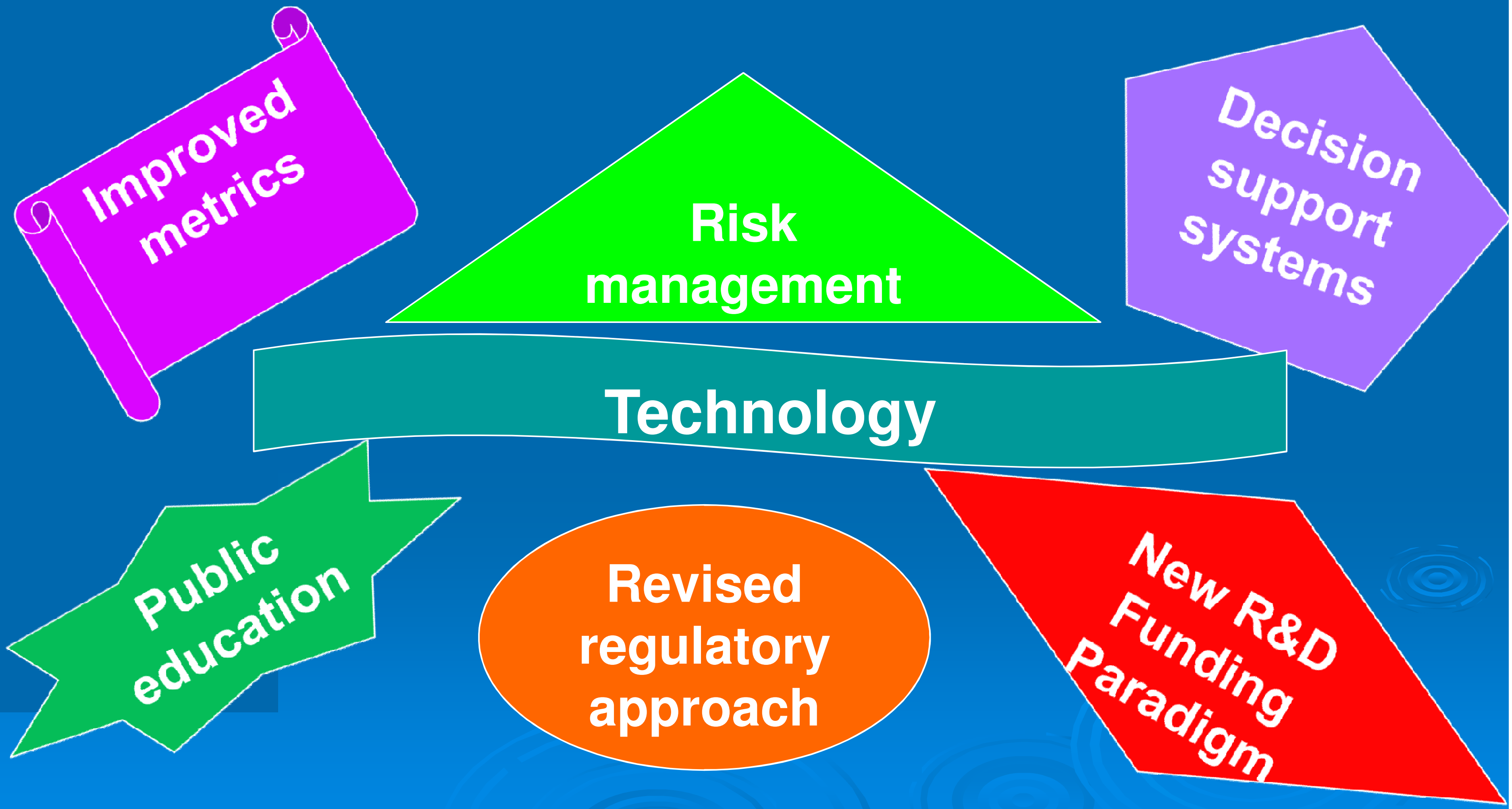
Technology Roadmap and Treatment Plants of the Future

- Look forward 40 years – water quality, energy, values
- 30 attendees at 2009 Workshop
- USA, Canada, Europe, Singapore

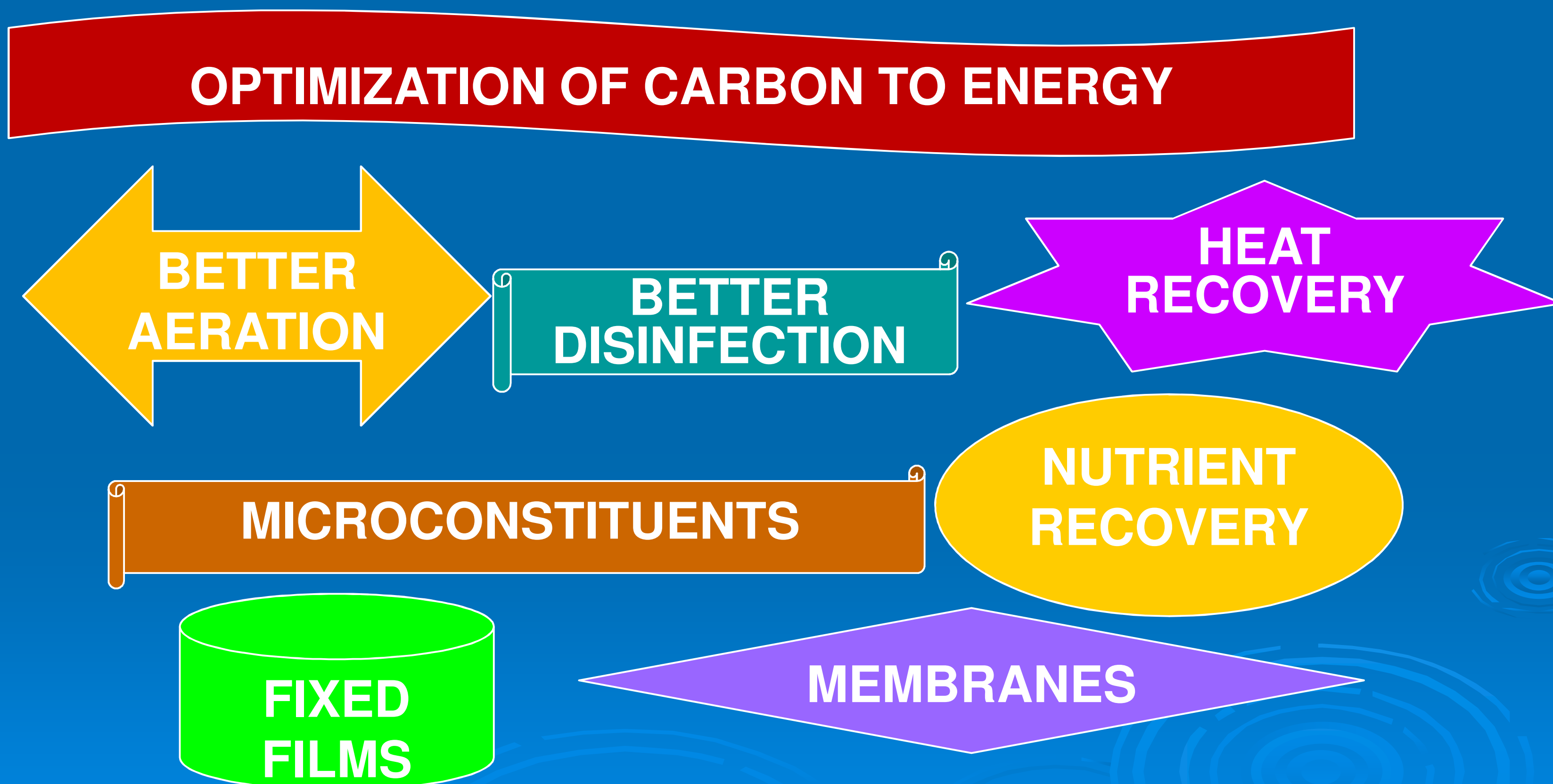
Workshop Format

- “Visioning” the Plant of the future
  - What effluent/reuse quality will be needed in 2040?
  - What will be the common treatment technologies in 2040?
  - What research and breakthroughs are needed to create or improve technologies to make WWTPs energy-sustainable?
- Can we achieve carbon and energy-neutral treatment?

How can we achieve water, carbon and energy-neutral treatment?

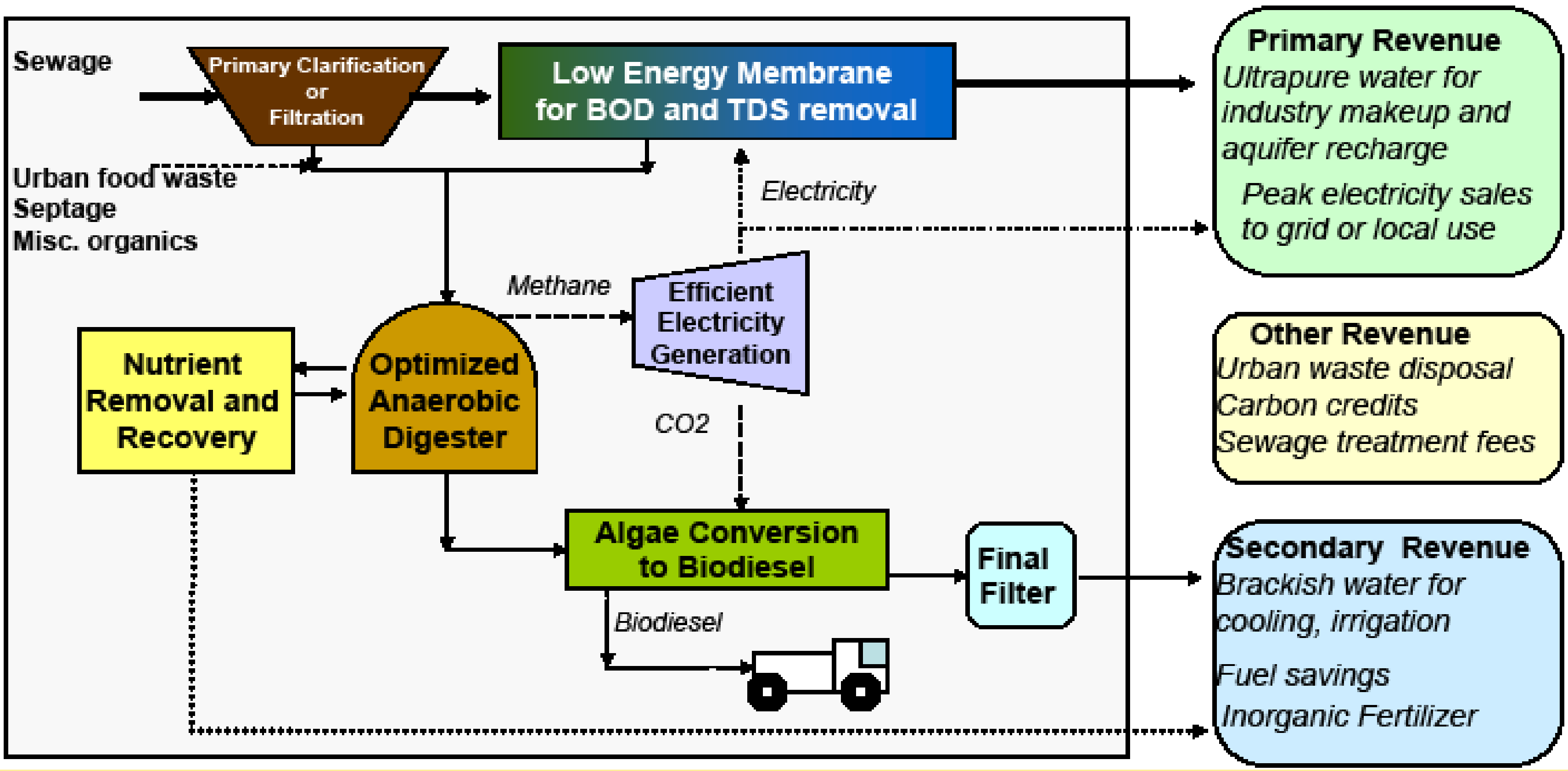


Research Needs – Summary of Highest Priorities



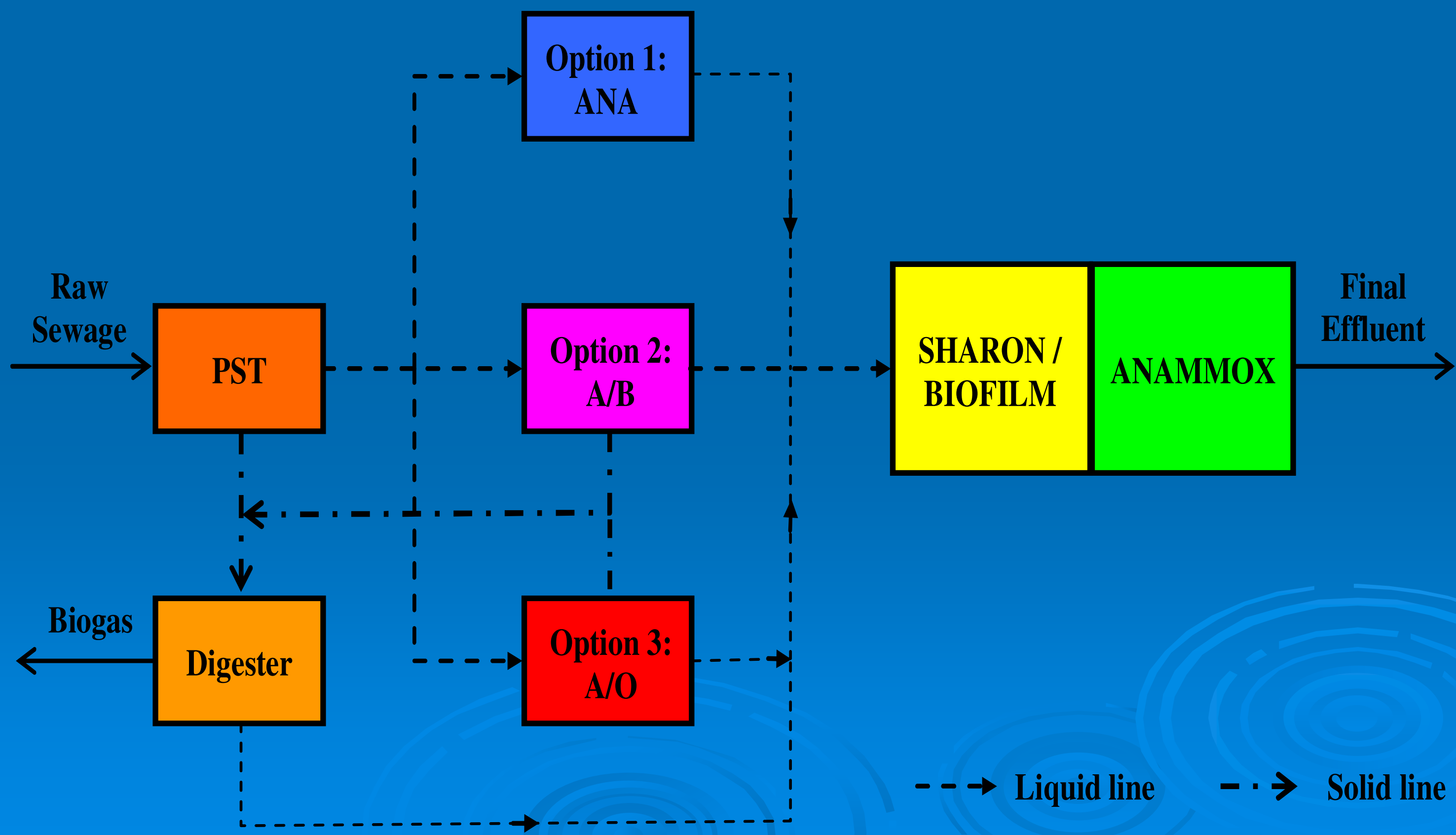
One Vision of the Future

The Urban Water Resource Recovery Center

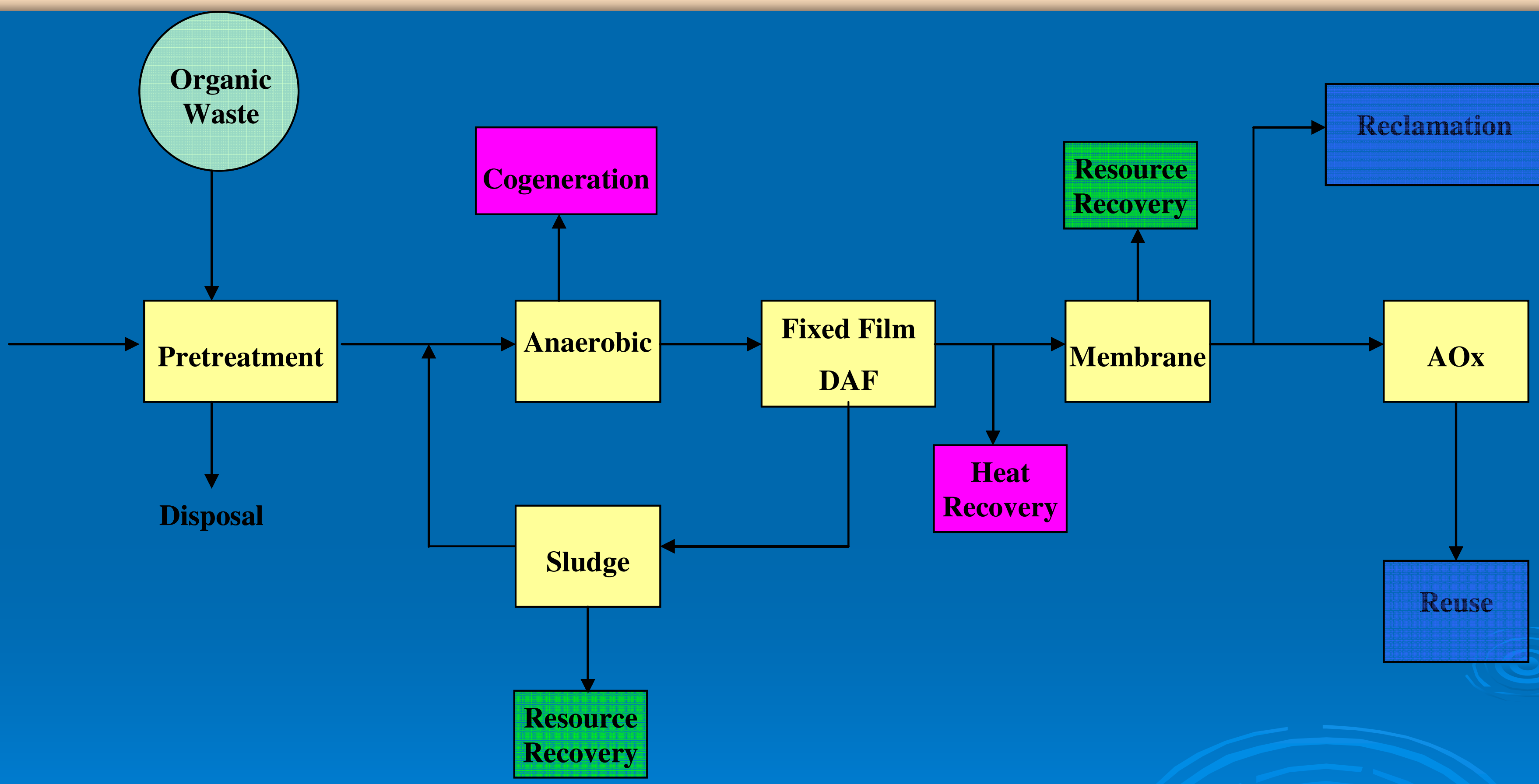


A Second Vision of the Future

Adopts the Anammox process into the main wastewater treatment train



A Third Vision of the Future



LCAMER Demonstration Studies

- Tool being upgraded by Hydromantis
- Demonstration testing by CH2M Hill at subscriber utilities
  - Collaborations with Gwinnett County and Pinellas County

LCAMER

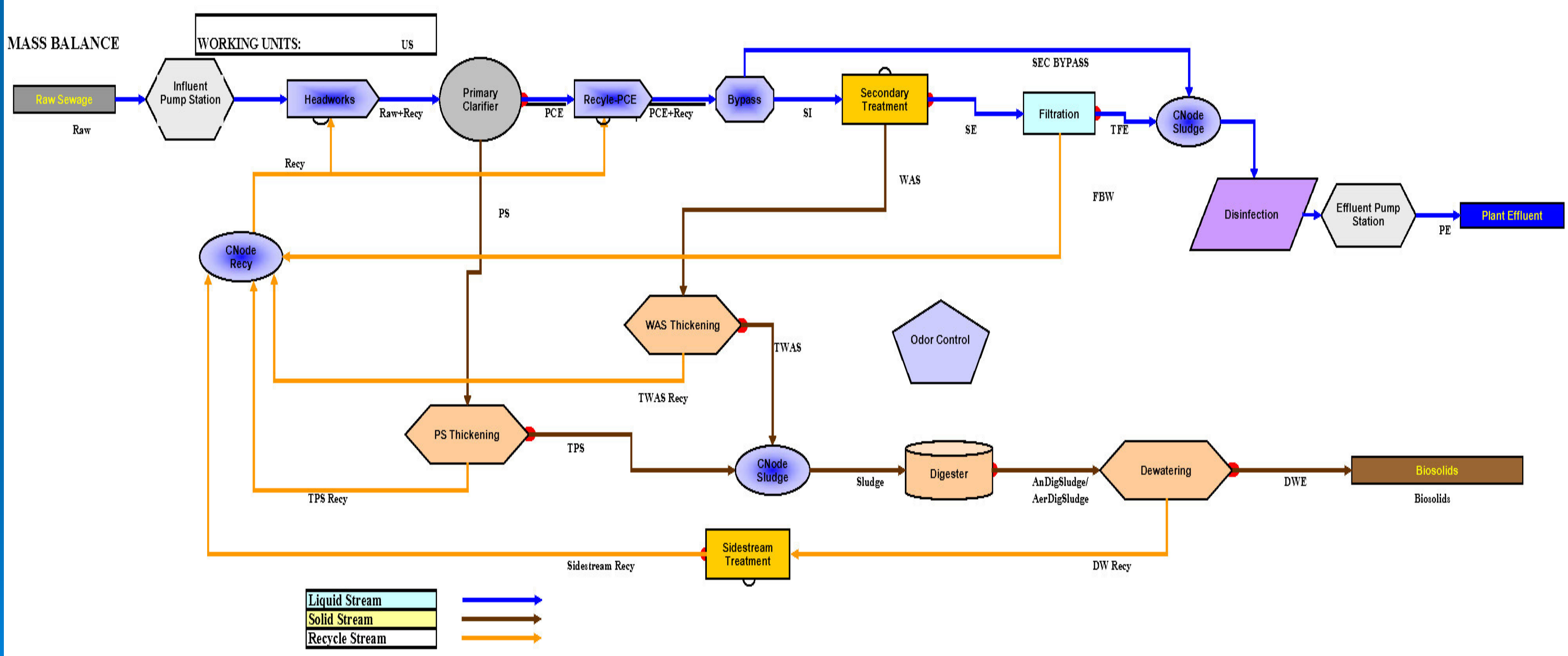
LIFE CYCLE ASSESSMENT MANAGER FOR ENERGY RECOVERY

Carbon Heat Energy Assessment and Plant Evaluation Tool (CHEApet)

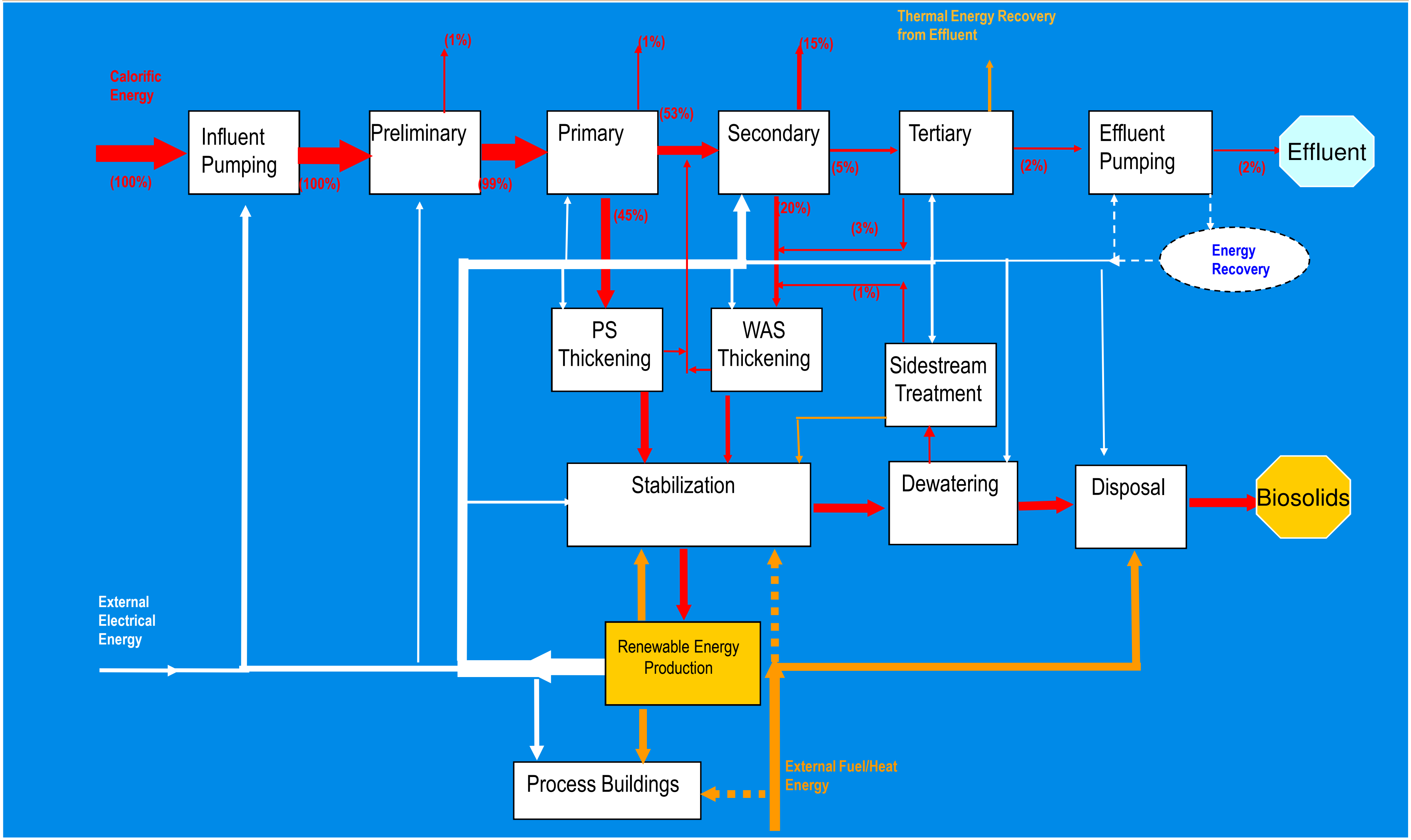
- Plant-wide modeling and mass balance calculation tool
- COD, BOD, Solids
- Carbon (Calorific), Heat, Electricity
- GHG Emissions, Carbon Footprint
- Web-based availability

CHEApet
Carbon Heat Energy Assessment Plant Evaluation Tool

CHEApet Flow Diagram



Mass and Energy Balances



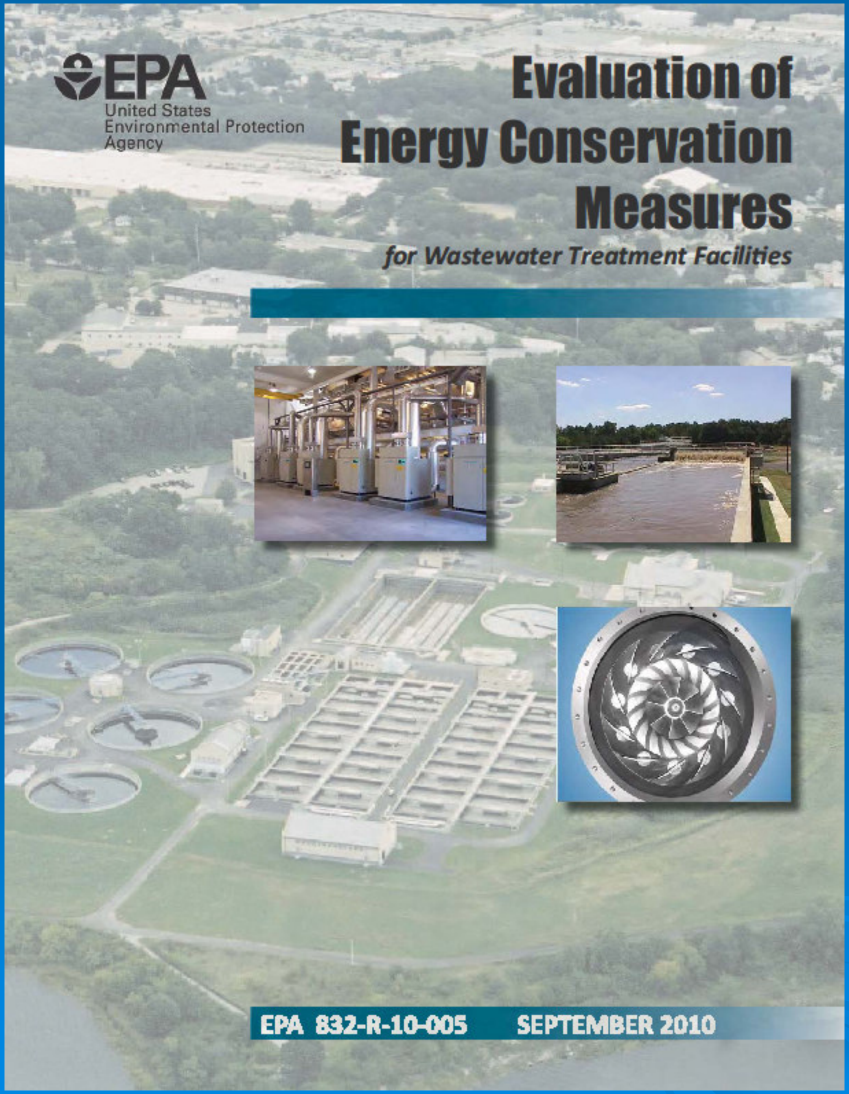
Demonstration Studies

- Demonstrating CHEApet at subscriber utilities
  - Collaboration with Oregon ACWA: two utilities
  - Collaboration with Miami-Dade

CHEApet

Carbon Heat Energy Assessment Plant Evaluation Tool

EPA – ECM Report



- One of several EPA contributions
- Focus on equipment replacement, operations modifications and controls
- CHP (cogeneration) presented separately
- Innovative (1 to 5 yrs), and emerging (developmental), technologies

Organizational Alignment

- Chapter 2 presents recommended approach
- Financing resources
- Available tools
- Related studies

Recommended 9-Step Approach to Energy Management

1. **Create an Energy Sustainability Team**. Identify an energy program management team with responsibility for implementing the improvement program from start to finish. Create a core team with representatives from all aspects of operations, maintenance and management. Consider appointing an Energy Manager whose only responsibility is energy conservation (and possibly recovery) for your facility.

2. **Gather Data**. Gather data on energy use (e.g., from gas, fuel oil and electricity bills). Make this data available to the team.

3. **Benchmark Performance**. Create a baseline of energy performance against which you can measure improvements over time. You can do this using ENERGY STAR's Portfolio Manager for wastewater treatment plants, available online at http://www.energystar.gov/index.cfm?c=water.wastewater_drinking_water. Portfolio Manager has the benefit of converting all types of energy use (e.g., natural gas, fuel oil, and electricity) to a common unit so that they can be added together, and provides an estimate of greenhouse gas emissions. You may also be able to compare your utility's performance to similar utilities if you meet certain criteria.

4. **Conduct an Energy Audit**. Determine the energy use of various processes and identify opportunities for energy use reduction.

5. **Develop Goals**. Identify quantifiable energy improvement goals that complement your utility's mission, goals, and strategic direction.

6. **Devise a Plan**. Identify ***Energy Conservation Measures (ECMs)*** and develop a plan for implementing them. Start with "low hanging fruit" and focus on energy intensive operations such as aeration and pumping. Consider renewable energy options and opportunities for energy generation using alternative methods. Determine costs and payback periods for various options.

7. **Implement Improvements.** Assign responsibilities and establish deadlines. Consider alternative financing approaches. Fully engage and train your operations staff.

8. **Monitor and Measure Results.** Track performance, review progress towards energy goals, and develop a plan for maintaining energy efficient equipment. Re-evaluate your goals in light of new information and priorities, and make changes to your program as necessary.

9. **Communicate Success.** Communicate the successes of your energy management program to employees, utility management, and your community.

Define the Metrics

Table 8-1. Summary of Facility Case Studies

Case Study No.	Facility	Avg Daily Flow (MGD)	ECM(s)	Project Cost	Energy Savings	Payback Period (Yrs)[1]
1 Green	Bay Metropolitan Sewerage District De Pere, WI	8.0	Aeration system upgrade: • Replaced 5 positive displacement blowers with 6 HST® ABS magnetic bearing turbo blowers	$850,000 ($2004)	$63,759/yr 2,143,975 kWh/yr (50% reduction)	13.3
2 Sheb	oygan Regional WWTP Sheboygan, MI	11.8	Aeration system upgrade: • Replaced 4 positive displacement blowers with 2 Turblex® blowers with upgraded DO control and SCADA • Installed air control valves on headers, upgraded PCL	$790,000 ($2005) ($773,000 with $17,000 utility incentive) for blowers, $128,000 ($2009) for air control valves	$35,644/yr associated with blower replacement (358,000 kWh/yr – 13% reduction) $38,245/yr associated with air control valves (459,000 kWh/yr – 17% reduction)	14
3 Big	Gulch Wastewater Treatment Plant, Mukilteo, WA	1.5	• Replaced mechanical aeration with Sanitare fine bubble diffusers and air bearing KTurbo blowers. • Upgraded to automated DO control • Installed automated ORP-based control for nitrification (dNOx Anoxic Control System)	For Oxidation Ditch A: $487,066 ($2007) - ($447,875 with $39,191 incentive). For Oxidation Ditch B: $1,045,023 ($2007) - ($998,429 with $46,594 incentive).	$10,721 per year (based on Y2010 savings following Ditch A and Ditch B commissioning)	135

Energy Conservation Measures

- Detailed discussions and information about ECMs available for individual plant processes
  - Pumping
  - Aeration controls
  - Blowers and diffusers
  - Advanced technologies (UV, membranes, anoxic zone mixing)
  - Solids processing
    - Digestion
    - Incineration
    - Thermal drying

Case Studies

- 9 detailed case studies selected from 30 candidate sites
- Detailed analysis of each ECM, facility cost, payback, energy savings
  - Aeration: blowers, diffusers, controls
  - SRT and DO control
  - Solids incineration upgrades
  - Pumping, aeration and thickening controls

Questions?