State of the Science
Energy Conservation and Recovery from Wastewater

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Water Environment Research Foundation

What we know

- Energy in wastewater is 10 times the energy needed for treatment
- Renewable energy from wastewater can meet a significant part of the national demand for electricity
  - Enough to power NY City, Houston, Dallas and Chicago

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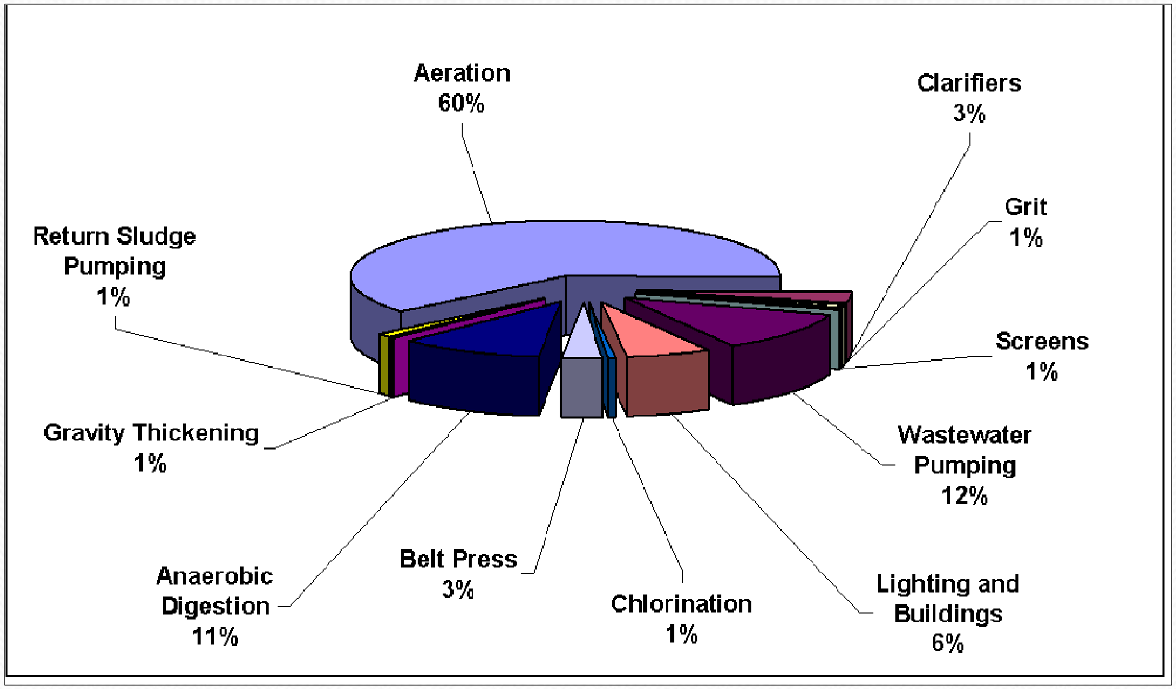
President's Goal

- 10% of US electricity needs to be met by renewable sources by 2012
- 25% by 2025

Electricity for Water and Wastewater

- *3% of electricity consumed in the US annually is used for water and wastewater conveyance and treatment*
- *This is an estimated 21 billion kW hr/year*



Where Energy is Used for WW Treatment

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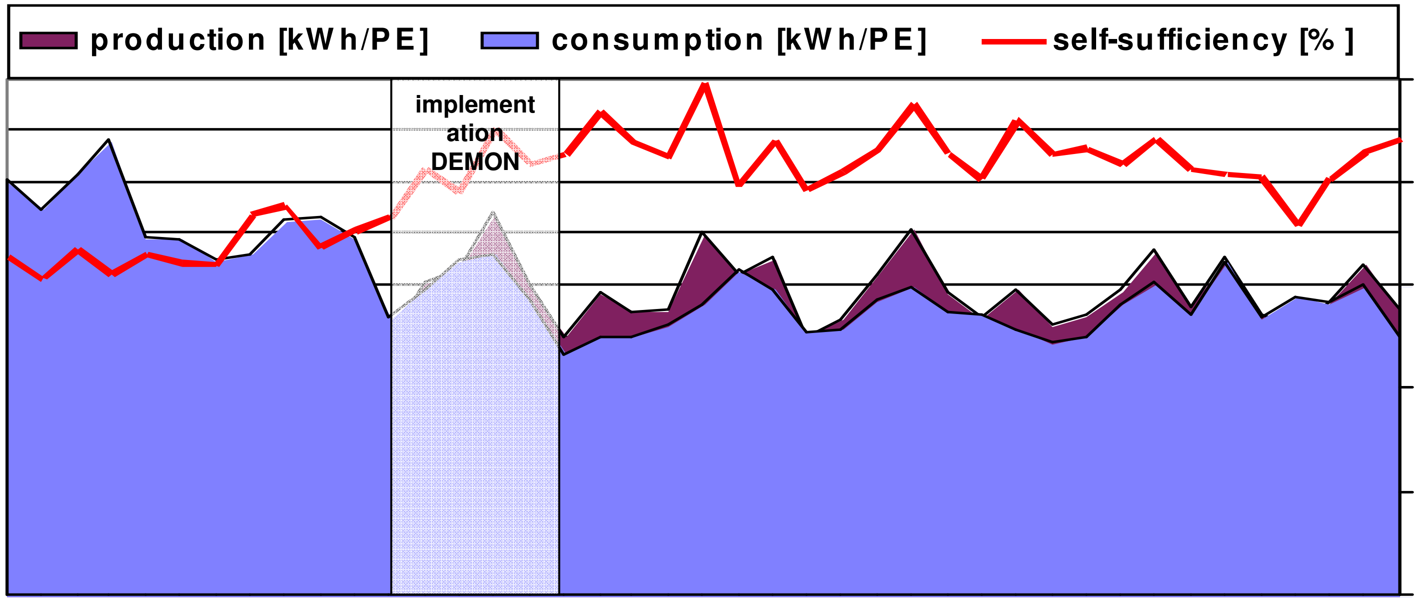
Best Performing WWT Plants..

Produce more energy than needed for treatment



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WERF Sustainable Treatment Case Study:

- Evaluation of the Strass im Zillertal WWTP
  - One of the best performing plants in Europe
  - Managers motivated to develop new energy initiatives

Strass Plant, Austria

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Best Performing WWT Plants..

- How was this achieved?
  - Highly educated workforce
  - High level of automation
  - Use of advanced process analysis tools
  - Tolerance of process risk
  - Quantifying gains

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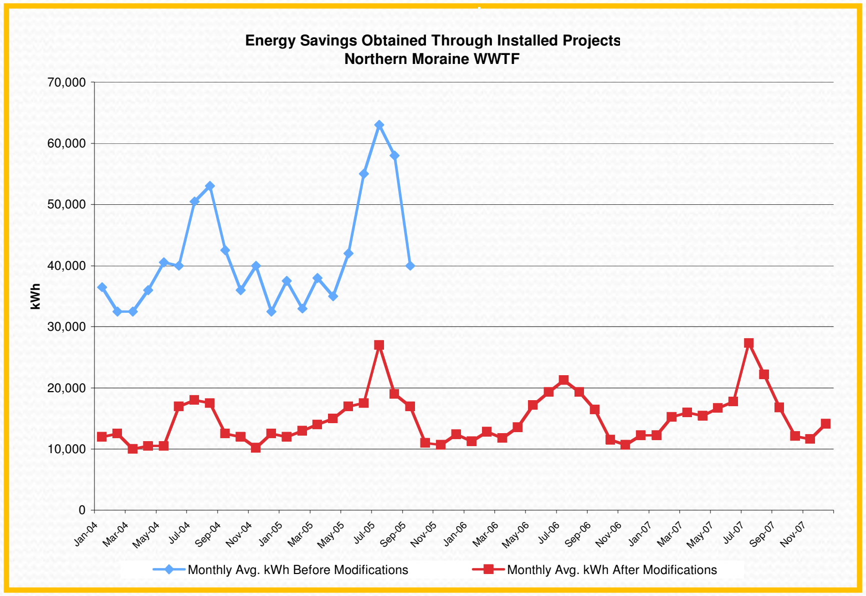
Best Performing WWT Plants..

- What was done?
  - Maximize energy recovery

AND

  - Maximize energy efficiency and conservation

GEJenbacher Gas Engine



Energy Recovery

- Offset from generating onsite power from renewable energy (such as biogas) lowers carbon footprint at WWT plants by 20-40%.

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Biosolids - Energy Recovery

- Biosolids nationwide:
  - 64 pound of solids per person per year
  - 7.2 million metric tons of dry solids

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Current Biosolids Disposal Practices

- Land disposal presently is the end use for 49% of the biosolids
- 28% goes to municipal landfills

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Biogas - Source of Heat and Power

- Approximately 1 ft^3 of biogas per person per day can be produced in a biosolids digester
- The energy content of biogas is 600 Btu/ ft^3

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Maximize Biogas Production

- Develop and use new or improved technologies to produce more biogas

Columbus Biosolids Flow-Through Thermophilic Treatment

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Improve Biogas to Energy Efficiency

- Older technologies – boilers to convert biogas to heat energy
- New technologies- micro turbines Stirling engines fuel cells

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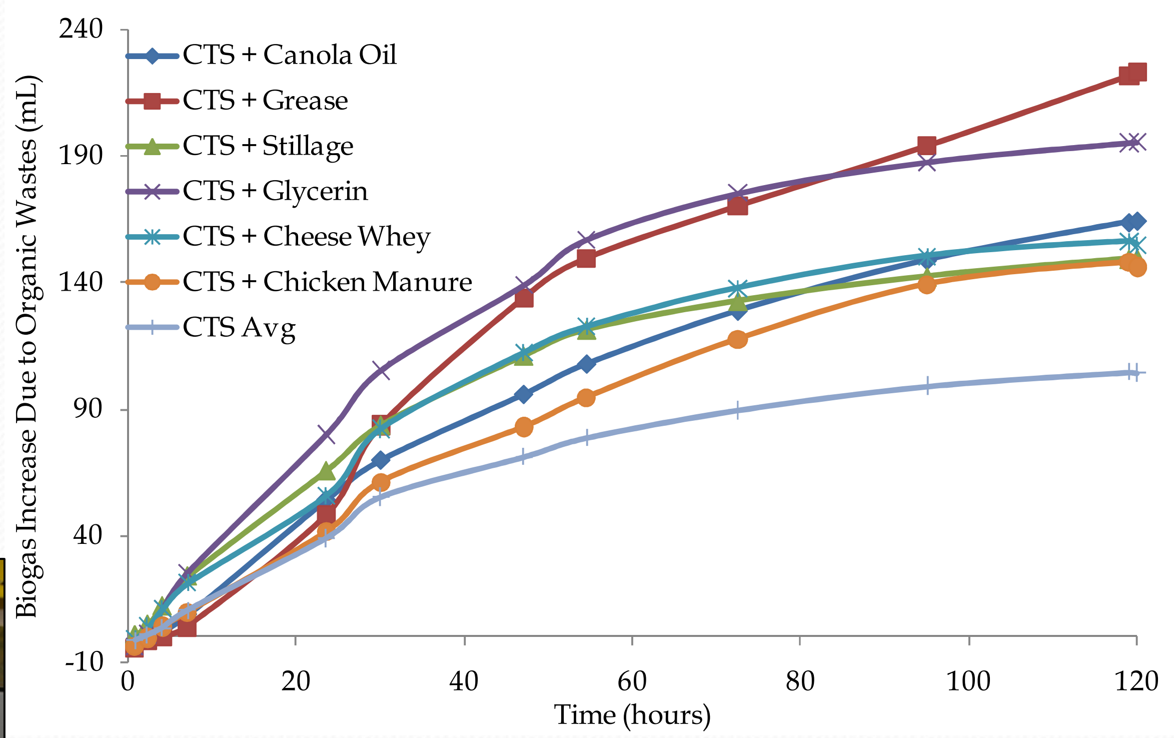
Co-digest Organic Waste with Wastewater Solids

- Increases biogas produced



Improve Biogas Pretreatment

- To optimize cost effectiveness
- To increase the use of biogas
- To use biogas better

Siloxanes from personal products in wastewater foul co-generation equipment

Develop Markets for Biogas for Other Uses

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Recover Power from Biosolids

- Develop new technologies
  - Thermal solidification
  - Wet air oxidation
  - Gasification
  - Pyrolysis

Nexterra Gasifier

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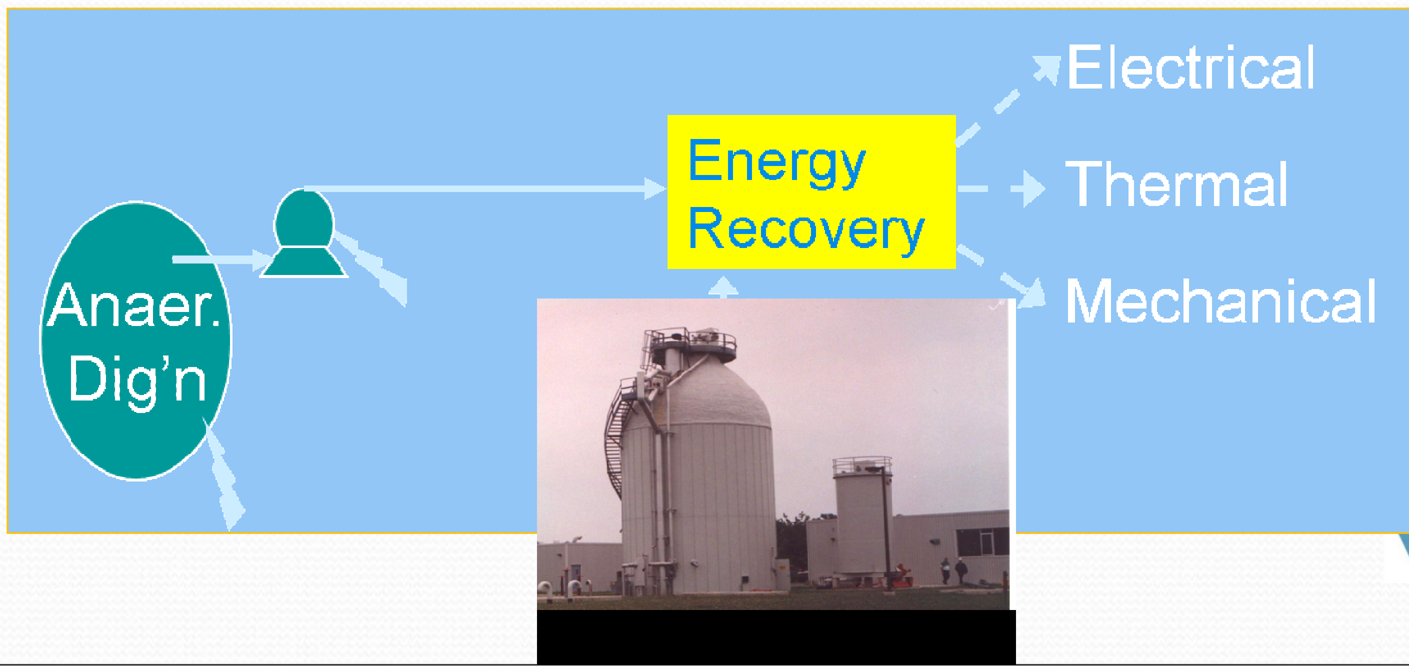
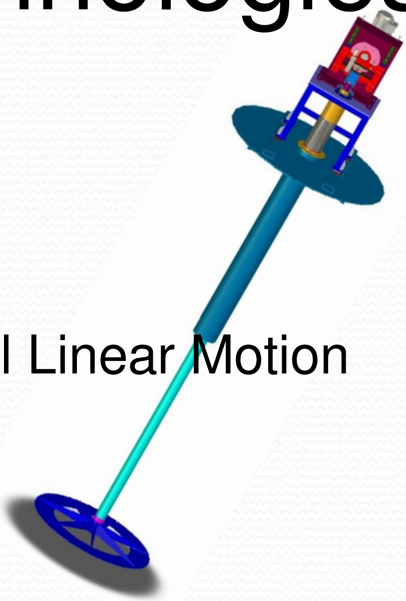
Use Better Life-Cycle Tools

- Life-Cycle Assessment Manager Energy Recovery (LCAMER) Tool from WERF
- Compare life-cycle benefits and costs of energy recovery
- Predict economical solids to energy recovery alternatives



Energy Efficiency and Conservation

Apply new technologies



Vertical Linear Motion Mixer

UASB Reactors – Rio Frio WWTP

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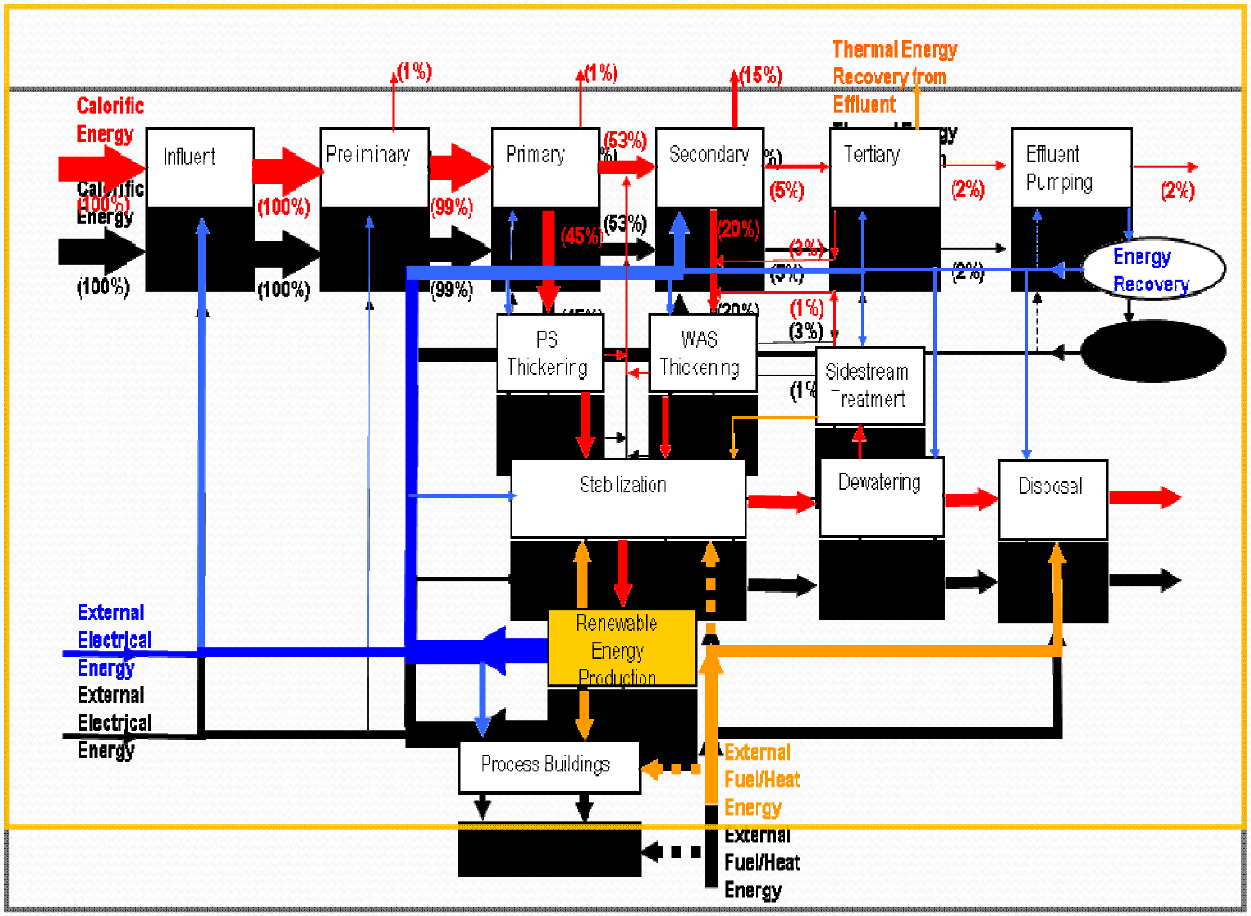
Tools to Balance Heat, Energy, & Carbon



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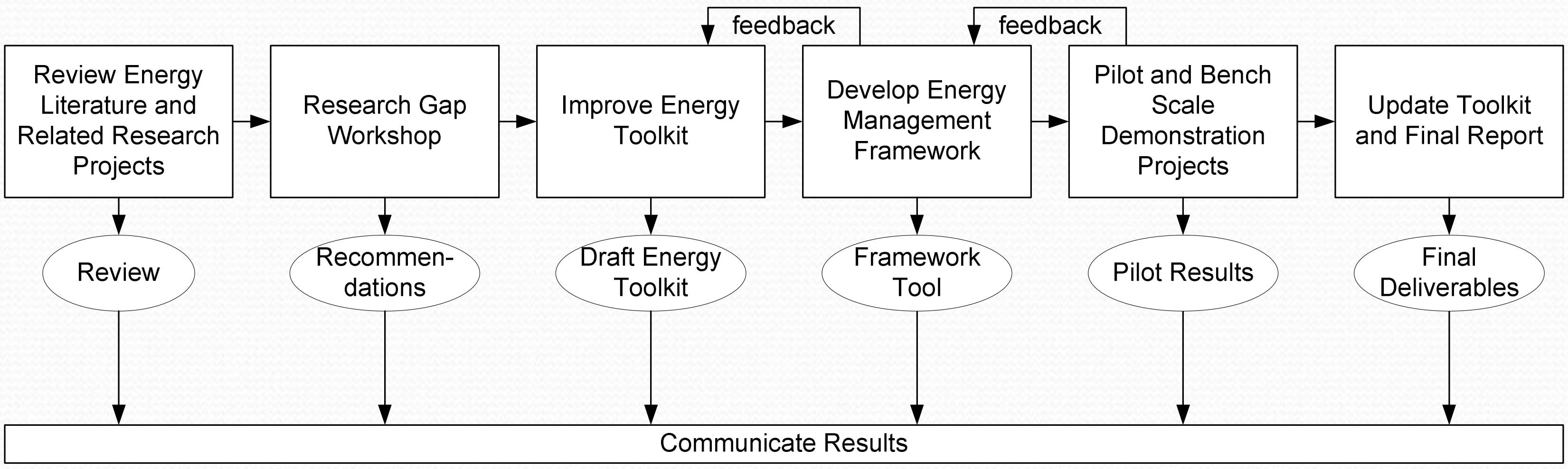
Technology Roadmap for Wastewater Treatment in a C-constrained World



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Technology Roadmap – the Future

Treatment Processes	Other Emerging Objectives	Additional Heat/Energy Recovery
Enhanced primary	Recover N, P and S	Capture heat energy
Targeted aeration	Autotrophic removal N	Use wind energy
Fixed film	Phototrophic removal N (use of algae)	Use solar energy
Super bugs	Collect sewer off-gas (methane)	New carbon sources (food waste)
Media filtration and membranes	Improved operating controls	Hydraulic energy recovery and storage
More anaerobic and side-stream treatment	Greater use decentralized or satellite	Use SMART grid technology

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To capture energy from wastewater, the Roadmap requires:

Investments of some $100 million must be made in research over the next 10 years that will:

- Increase utilization of biogas to produce energy
- Develop emerging biosolids to energy technologies
- Explore concepts that extract energy from wastewater

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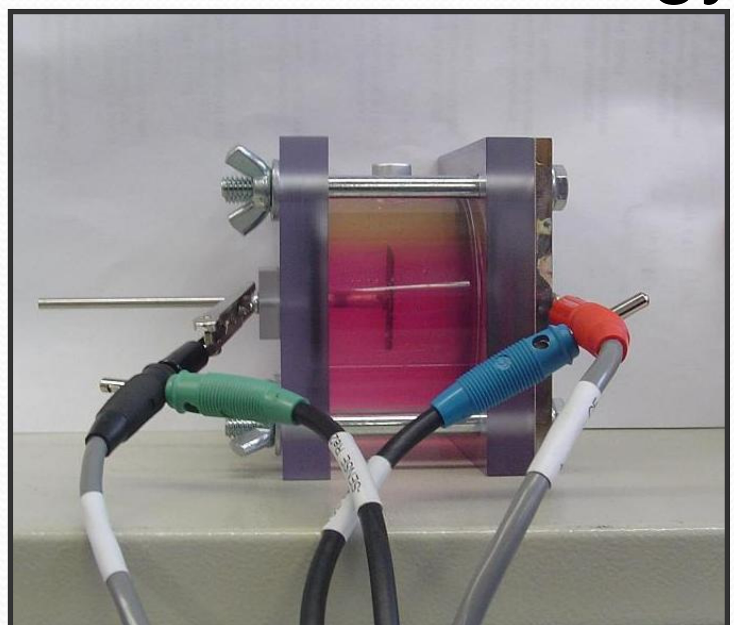
Extracting the Energy from Raw Wastewater

- Wastewater contains embedded energy
- Microbial Fuel Cells produce current
- Concept proven at lab scale or pilot scale



2009 WERF BioEnergy Research Starts

Focus on:

- Maximizing energy recovery from biogas
- Improve biogas pretreatment
  - Siloxanes
  - Sulfur
- Improvements to tools
  LCAMER
- Reduce barriers to energy recovery

30 kW microturbines at the Temecula Valley (CA) Regional Water Reclamation Facility

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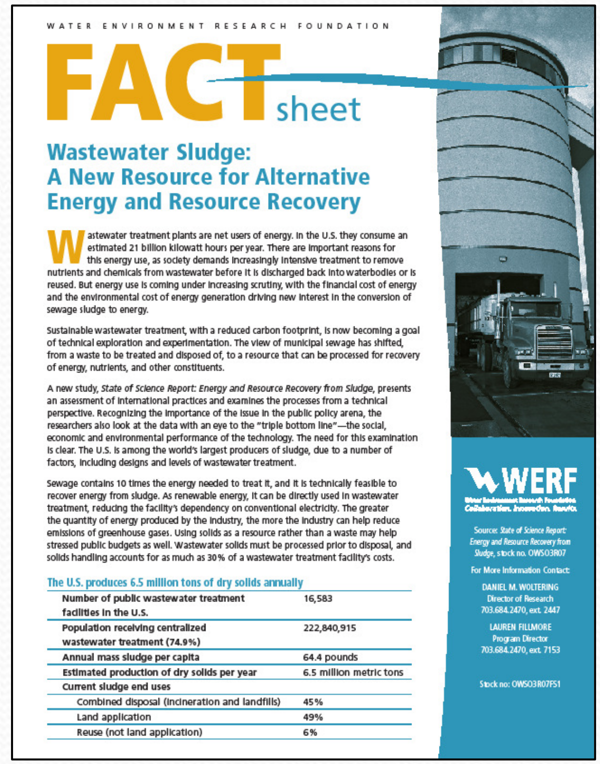
Change our Sector's Way of Doing Business

- Use life-cycle costs and triple bottom line
- Remove legacy programs that impede shift to energy production
- Improve technology transfer – enable research to cross over into applied knowledge
- Incentive-based change and investment



WATER ENVIRONMENT RESEARCH FOUNDATION

FACT sheet

Wastewater Sludge: A New Resource for Alternative Energy and Resource Recovery

Wastewater treatment plants are net users of energy. In the U.S. they consume an estimated 21 billion kilowatt hours per year. There are important reasons for this energy use, as society demands increasingly intensive treatment to remove nutrients and chemicals from wastewater before it is discharged back into waterbodies or is reused. But energy use is coming under increasing scrutiny, with the financial cost of energy and the environmental cost of energy generation driving new interest in the conversion of sewage sludge to energy.

Sustainable wastewater treatment, with a reduced carbon footprint, is now becoming a goal of technical exploration and experimentation. The view of municipal sewage has shifted, from a waste to be treated and disposed of, to a resource that can be processed for recovery of energy, nutrients, and other constituents.

A new study, *State of Science Report: Energy and Resource Recovery from Sludge*, presents an assessment of international practices and examines the processes from a technical perspective. Recognizing the importance of the issue in the public policy arena, the researchers also look at the data with an eye to the "triple bottom line"—the social, economic and environmental performance of the technology. The need for this examination is clear. The U.S. is among the world's largest producers of sludge, due to a number of factors, including designs and levels of wastewater treatment.

Sewage contains 10 times the energy needed to treat it, and it is technically feasible to recover energy from sludge. As renewable energy, it can be directly used in wastewater treatment, reducing the facility's dependency on conventional electricity. The greater the quantity of energy produced by the industry, the more the industry can help reduce emissions of greenhouse gases. Using solids as a resource rather than a waste may help stressed public budgets as well. Wastewater solids must be processed prior to disposal, and solids handling accounts for as much as 30% of a wastewater treatment facility's costs.

The U.S. produces 6.5 million tons of dry solids annually

Number of public wastewater treatment facilities in the U.S.	16,583
Population receiving centralized wastewater treatment (74.9%)	222,840,915
Annual mass sludge per capita	64.4 pounds
Estimated production of dry solids per year	6.5 million metric tons
Current sludge end uses	
Combined disposal (incineration and landfills)	45%
Land application	49%
Reuse (not land application)	6%

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Source: *State of Science Report: Energy and Resource Recovery from Sludge*, stock no. OWSO3R07

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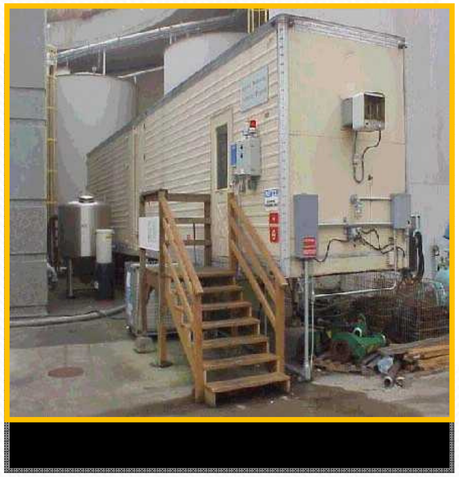
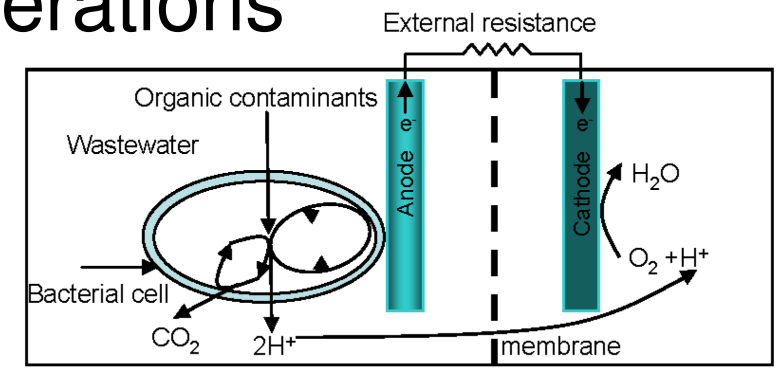
The Value of Demonstrations

- Proof of concept / demonstrations of treatment technologies under actual use conditions:
  - Emerging technologies and scale-up
  - More efficient operations
  - Effective tools





Schematic depicting the oxidation of contaminants in wastewater and the electrical output in an MFC

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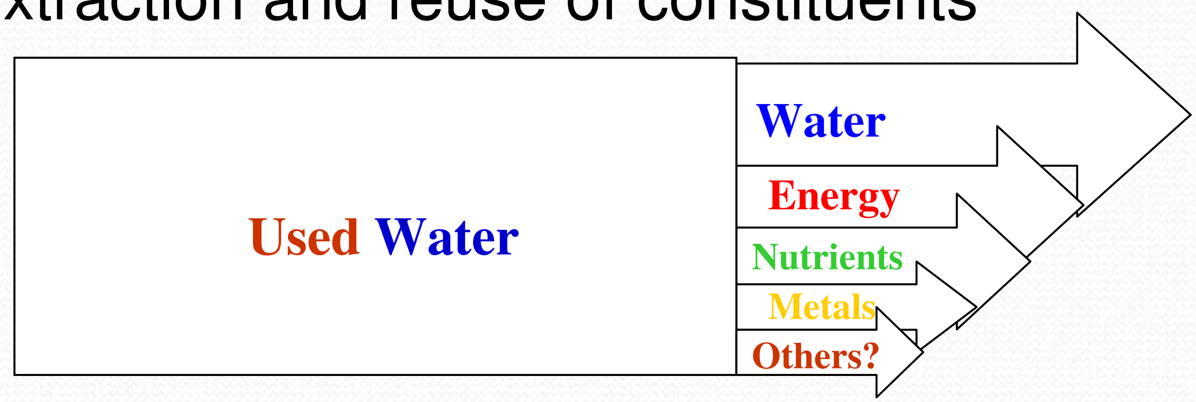
Properly Value Water and Wastewater

- **Resource recovery opportunities**
  - Biogas production w/ co-generation of heat and energy
  - Imbedded energy in sludge for fuels
  - Imbedded energy in wastewater
  - Extraction and reuse of constituents



What's the value- what can we mine?

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THANK YOU