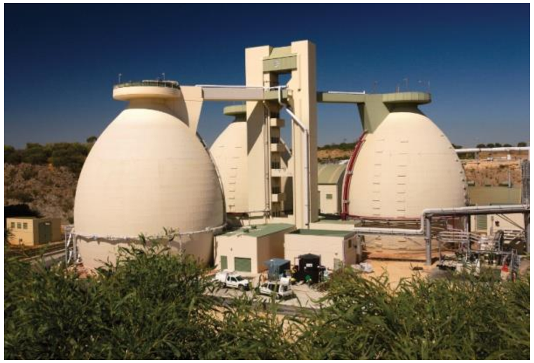
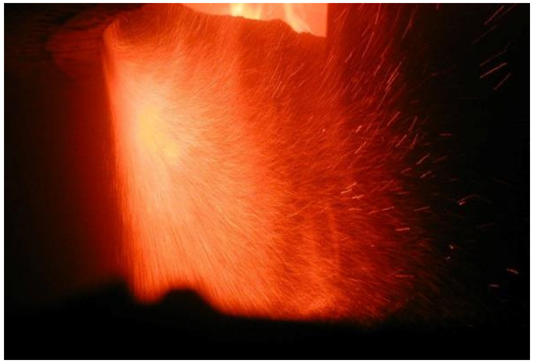




# Energy Recovery Potential from Wastewater Utilities through Innovation

## Conversion Technologies III: Energy from Our Waste—Will we Be Rich in Fuel or Knee Deep in Trash by 2025?

July 30, 2014

Leaders Innovation Forum for Technology

WERF
Water Environment Research Foundation
*Collaboration. Innovation. Results.*

WERF
Water Environment Research Foundation

# Who WERF is

**Deliver Balanced Research**

- Manage peer-reviewed research lifecycle to deliver timely, actionable results.

**Disseminate Results**

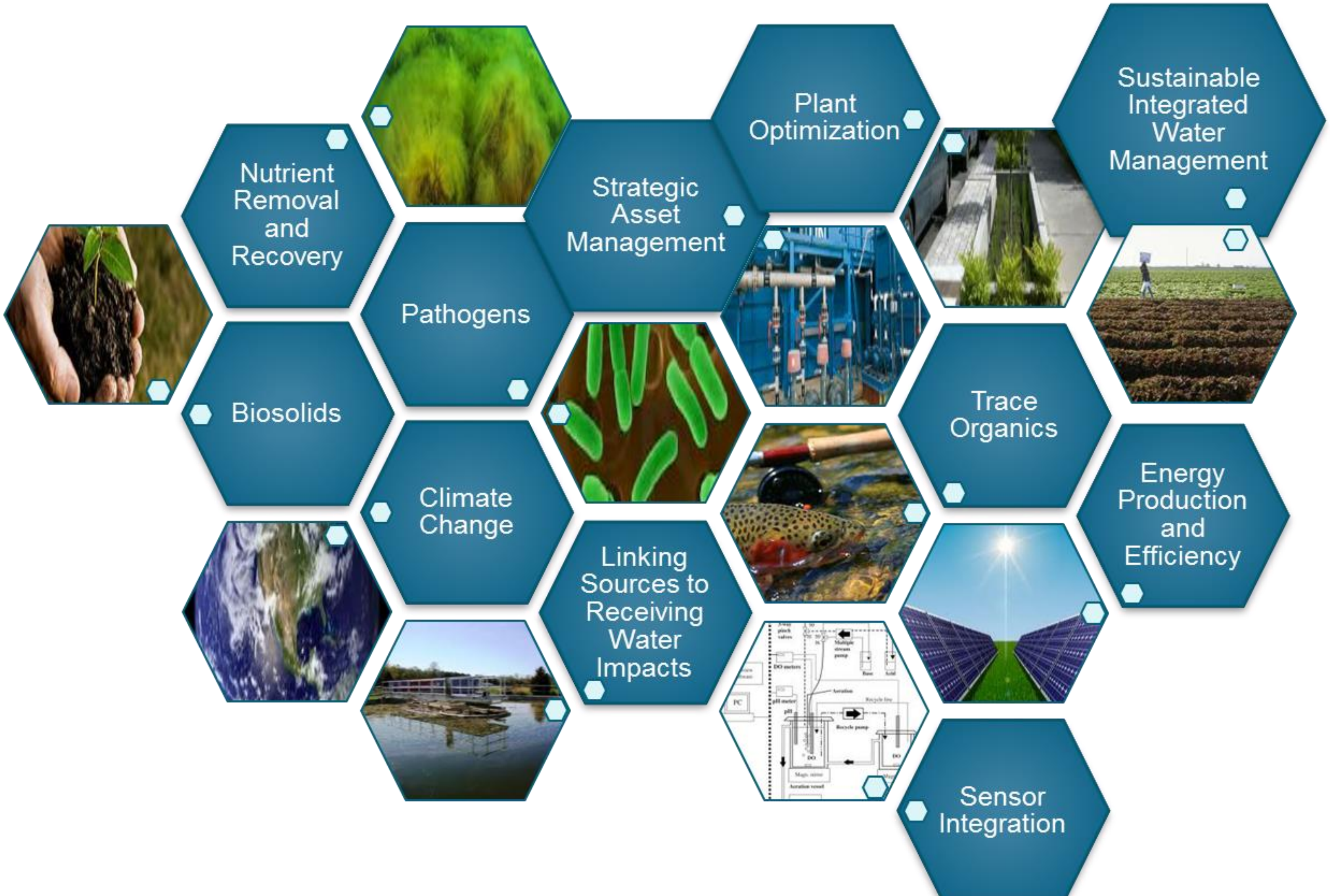
- 35-40 reports published annually that are housed in a online, searchable database.

**Create Collaborations**

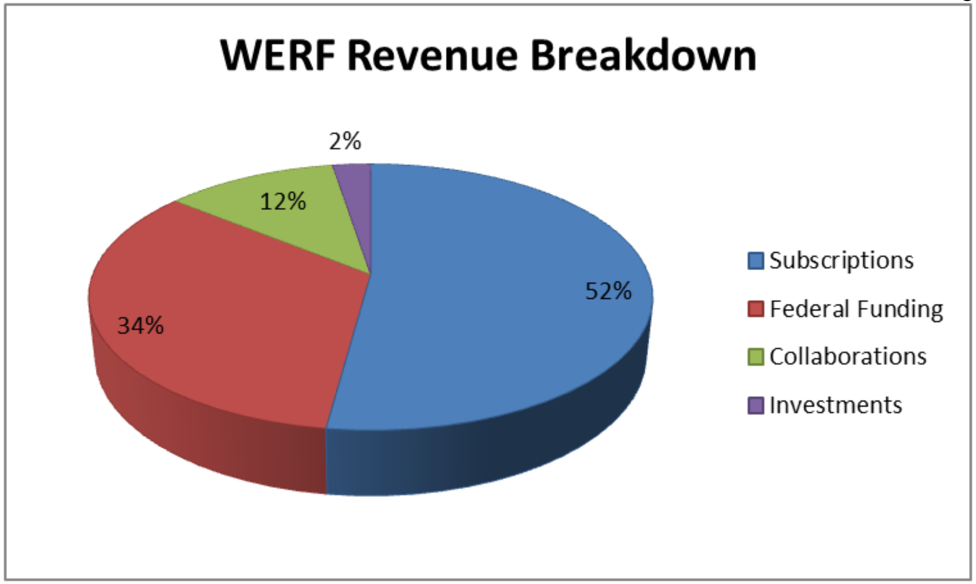
- Serve as a research hub for the water quality community; utilities, policy makers, consultants, universities and industry.

25 YEARS WERF
WATER ENVIRONMENT RESEARCH FOUNDATION

# WERF Research



# Research Funding Sources




- WERF's 300+ Subscribers:
  - Public Utilities
  - Industry
  - Engineering & Consulting Firms
  - Equipment Manufacturers
  - State Regulators
- Partnerships and collaborations
- Federal Funding

*For every dollar invested, WERF creates **four dollars** by leveraging matching and in-kind support.*

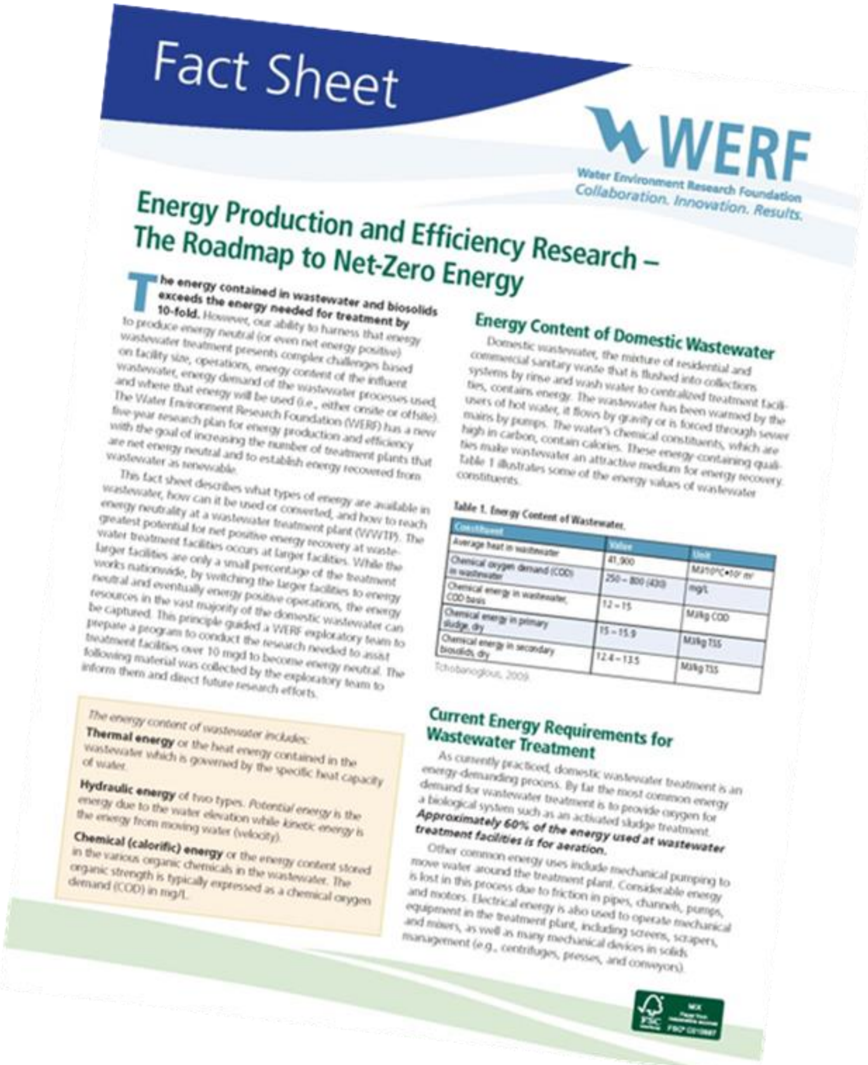
# Bottom Line: Major Paradigm Shift

PAST: collect wastewater, move it quickly downstream, treat it to acceptable standards, and dispose of waste without harming the environment.

FUTURE: manage resources to generate value for the utility and its customers, improve environmental quality at least cost to the community, and contribute to the local economy

**ENERGY RECOVERY!!!**

# Water Resource Recovery Facility



Fact Sheet

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## Energy Production and Efficiency Research – The Roadmap to Net-Zero Energy

**The energy contained in wastewater and biosolids exceeds the energy needed for treatment by 10-fold.** However, our ability to harness that energy to produce energy neutral (or even net energy positive) wastewater treatment presents complex challenges based on facility size, operations, energy content of the influent wastewater, energy demand of the wastewater processes used, and where that energy will be used (i.e., either onsite or offsite). The Water Environment Research Foundation (WERF) has a new five-year research plan for energy production and efficiency with the goal of increasing the number of treatment plants that are net energy neutral and to establish energy recovered from wastewater as renewable.

This fact sheet describes what types of energy are available in wastewater, how can it be used or converted, and how to reach energy neutrality at a wastewater treatment plant (WWTP). The greatest potential for net positive energy recovery at wastewater treatment facilities occurs at larger facilities. While the larger facilities are only a small percentage of the treatment works nationwide, by switching the larger facilities to energy neutral and eventually energy positive operations, the energy resources in the vast majority of the domestic wastewater can be captured. This principle guided a WERF exploratory team to prepare a program to conduct the research needed to assist treatment facilities over 10 mgd to become energy neutral. The following material was collected by the exploratory team to inform them and direct future research efforts.

*The energy content of wastewater includes:*

**Thermal energy** or the heat energy contained in the wastewater which is governed by the specific heat capacity of water.

**Hydraulic energy** of two types. *Potential energy* is the energy due to the water elevation while *kinetic energy* is the energy from moving water (velocity).

**Chemical (calorific) energy** or the energy content stored in the various organic chemicals in the wastewater. The organic strength is typically expressed as a chemical oxygen demand (COD) in mg/L.

### Energy Content of Domestic Wastewater

Domestic wastewater, the mixture of residential and commercial sanitary waste that is flushed into collections systems by rinse and wash water to centralized treatment facilities, contains energy. The wastewater has been warmed by the users of hot water, it flows by gravity or is forced through sewer mains by pumps. The water's chemical constituents, which are high in carbon, contain calories. These energy-containing qualities make wastewater an attractive medium for energy recovery. Table 1 illustrates some of the energy values of wastewater constituents.

Table 1. Energy Content of Wastewater.

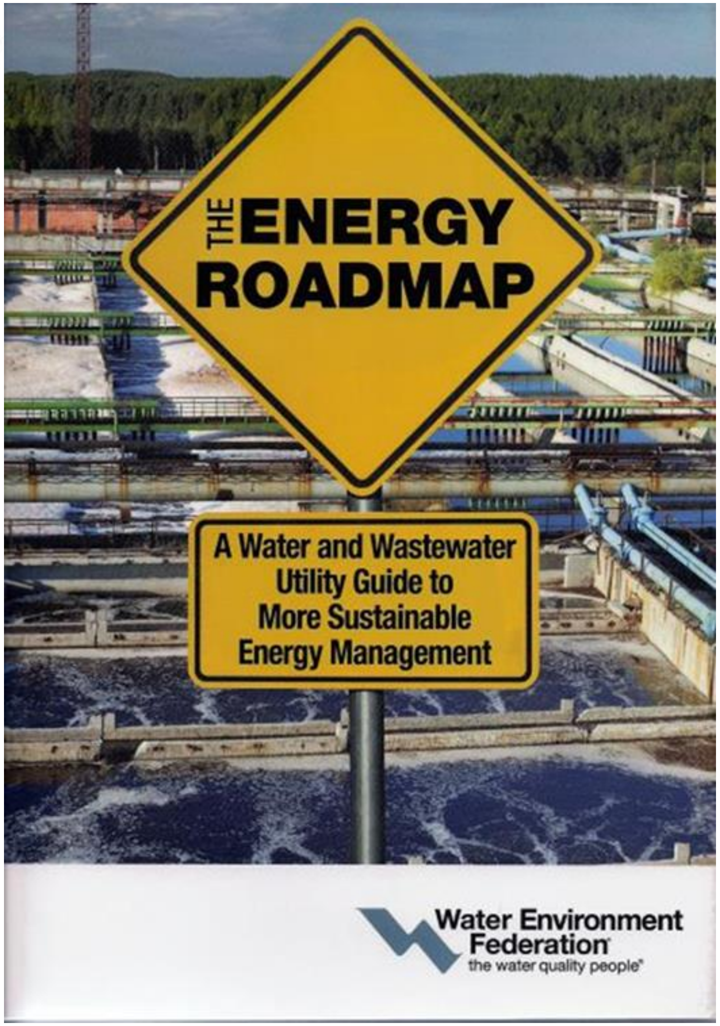
| Constituent | Value | Unit |
|---|---|---|
| Average heat in wastewater | 41,900 | [illegible] |
| Chemical oxygen demand (COD) in wastewater | 250 – 800 (430) | mg/L |
| Chemical energy in wastewater, COD basis | 12 – 15 | MJ/kg COD |
| Chemical energy in primary sludge, dry | 15 – 15.9 | MJ/kg TSS |
| Chemical energy in secondary biosolids, dry | 12.4 – 13.5 | MJ/kg TSS |

Tchobanoglous, 2009

### Current Energy Requirements for Wastewater Treatment

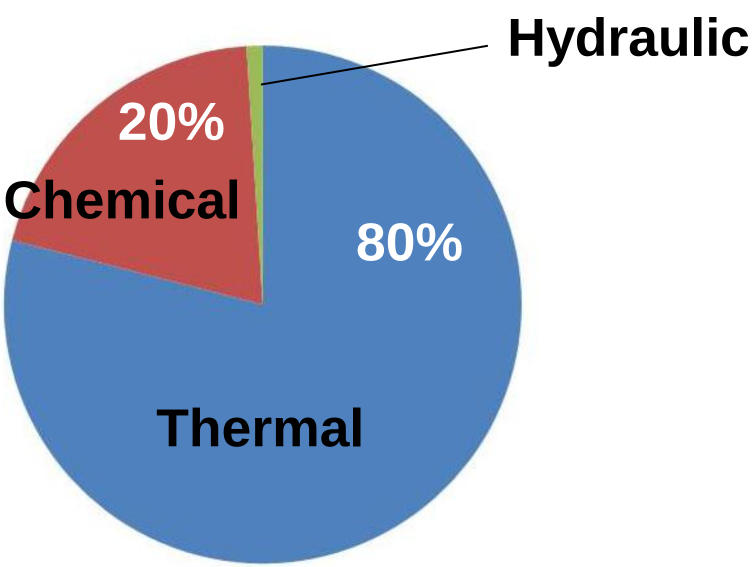
As currently practiced, domestic wastewater treatment is an energy-demanding process. By far the most common energy demand for wastewater treatment is to provide oxygen for a biological system such as an activated sludge treatment. ***Approximately 60% of the energy used at wastewater treatment facilities is for aeration.***

Other common energy uses include mechanical pumping to move water around the treatment plant. Considerable energy is lost in this process due to friction in pipes, channels, pumps, and motors. Electrical energy is also used to operate mechanical equipment in the treatment plant, including screens, scrapers, and mixers, as well as many mechanical devices in solids management (e.g., centrifuges, presses, and conveyors).



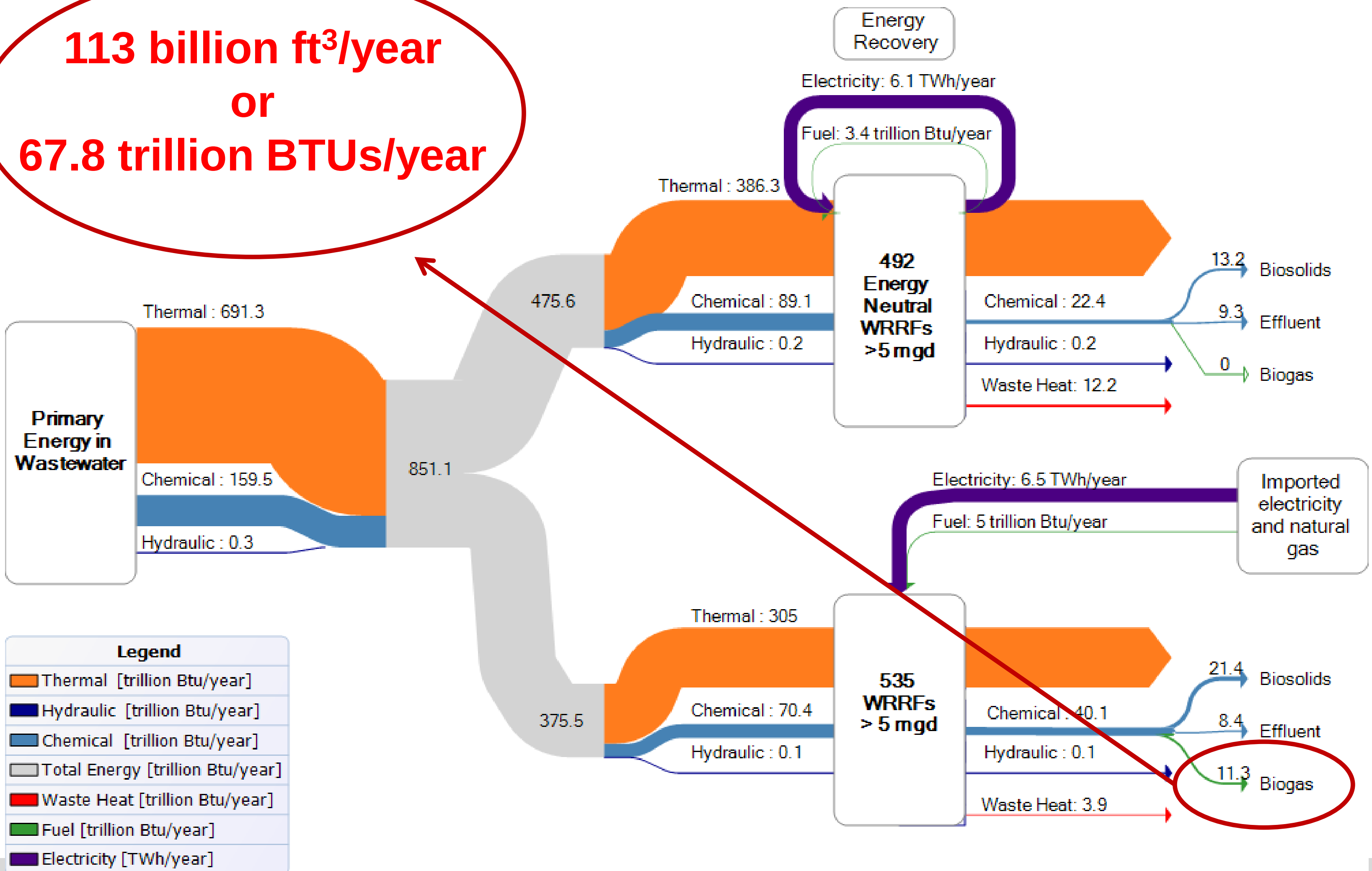
# What is the potential to recover energy from the wastewater sector?

- There is more energy in wastewater than is needed for treatment – **about 5X more**
- Total primary energy potential is 851 trillion BTU/year.



# Energy Balance and Recovery from Domestic Wastewater Sources

**113 billion $ft^3$/year**
**or**
**67.8 trillion BTUs/year**



# Next Steps and Energy Recovery Research Needs

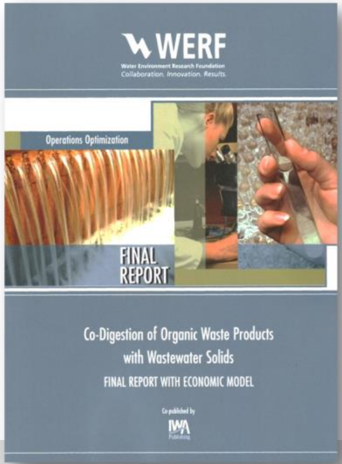
- ***Maximize carbon management*** for energy recovery or reuse.
- ***Further enhance*** Anaerobic Digestion to produce more biogas for energy recovery
- Investigate the potential for ***heat recovery*** from wastewater and heat reuse opportunities.
- Develop and demonstrate efficient, ***cool temperature conversion generators*** (Organic Rankine or Stirling) from recovered heat to power.
- Further ***short-cut nitrogen treatment*** process development and implementation as low energy alternative treatment process.

# Co-Digestion of Organic Wastes w/WW Solids

## Research Objectives

- Organic waste characterization
- Organic waste compatibility
- Operating parameters for reliable digestion operation
- Organic loading rates
- Codigestion economics

**Bench: Waste Characterization and Biogas Production**




**Pilot: Organic Loading Rate**

# Change the Economics of Siloxane Removal

- Better adsorption media performance

- Proper operation conditions (moisture removal)

- Cost-effective removal options.


WERF

# LIFT Focus Areas

1. Shortcut Nitrogen Removal
2. P-Recovery
3. Digestion Enhancements
4. Biosolids to Energy
5. Energy from Wastewater
6. Collection Systems — New
7. Green Infrastructure — New

# WERF Peer Review:
# Bay Area Biosolids to Energy (BAB2E) Coalition Demos:

- **Concord Blue**
- **Chemergy**
- **BioForce Tech** (site visit only)

LIFT
Leaders Innovation Forum for Technology

# LIFT Website: werf.org/lift

# THANK YOU

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