Wastewater = "Re-N-E-W-able" Resource

Energy Recovery in Wastewater and Biosolids

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Water and Watts: Potential to Save Energy and Water in the Municipal, Industrial, and Commercial Sectors

Atlantic Council, Washington DC

Tuesday, June 19, 2012
8:30 am to 6:00pm

Humanity's Top Ten Problems for Next 50 Years - *wastewater management can help provide solutions*

1. Energy
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism & War
7. Disease
8. Education
9. Democracy
10. Population

2003 6.3 Billion People
2050 9-10 Billion People

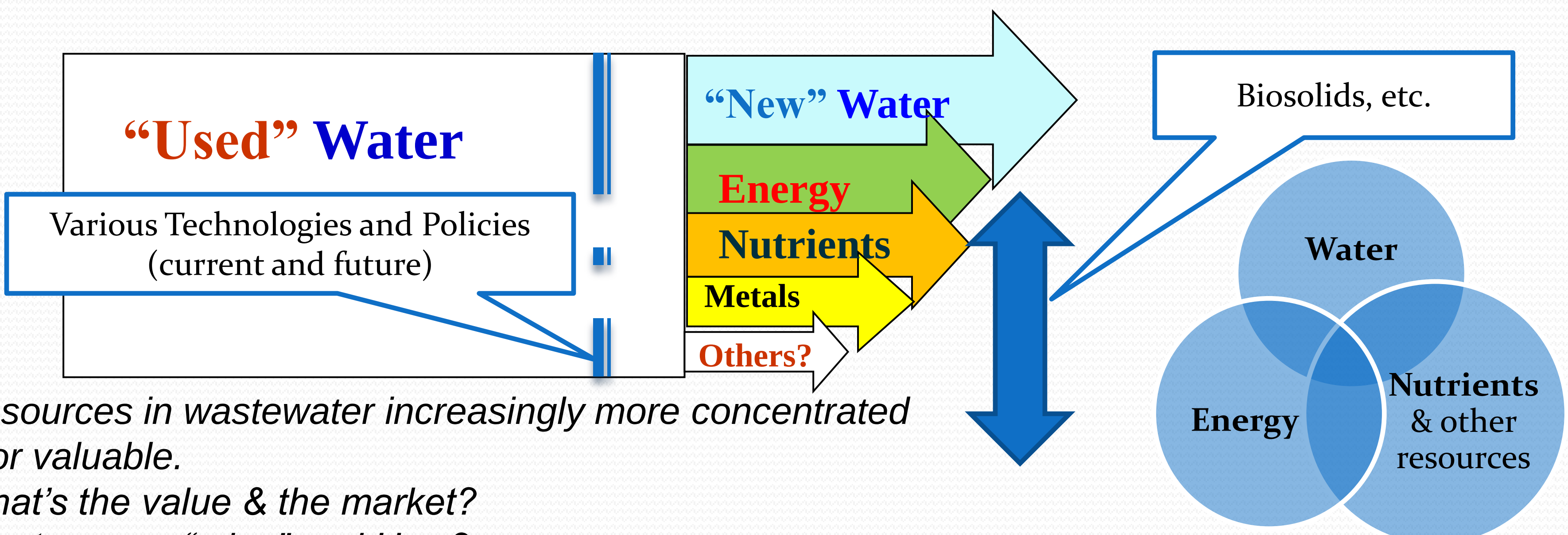
(Source: Richard Smalley, Nobel Laureate)
Slide kindly provided by Dr. Paul Bishop, NSF and Dr. Kartik Chandran, Columbia Univ., NY

Proper management and treatment of "Wastewater" can help address the Top 4 problems, and #7 (Sanitation – most significant medical advance to protect public health and prolong life)

Wastewater is a Re-N-E-W-able Resource

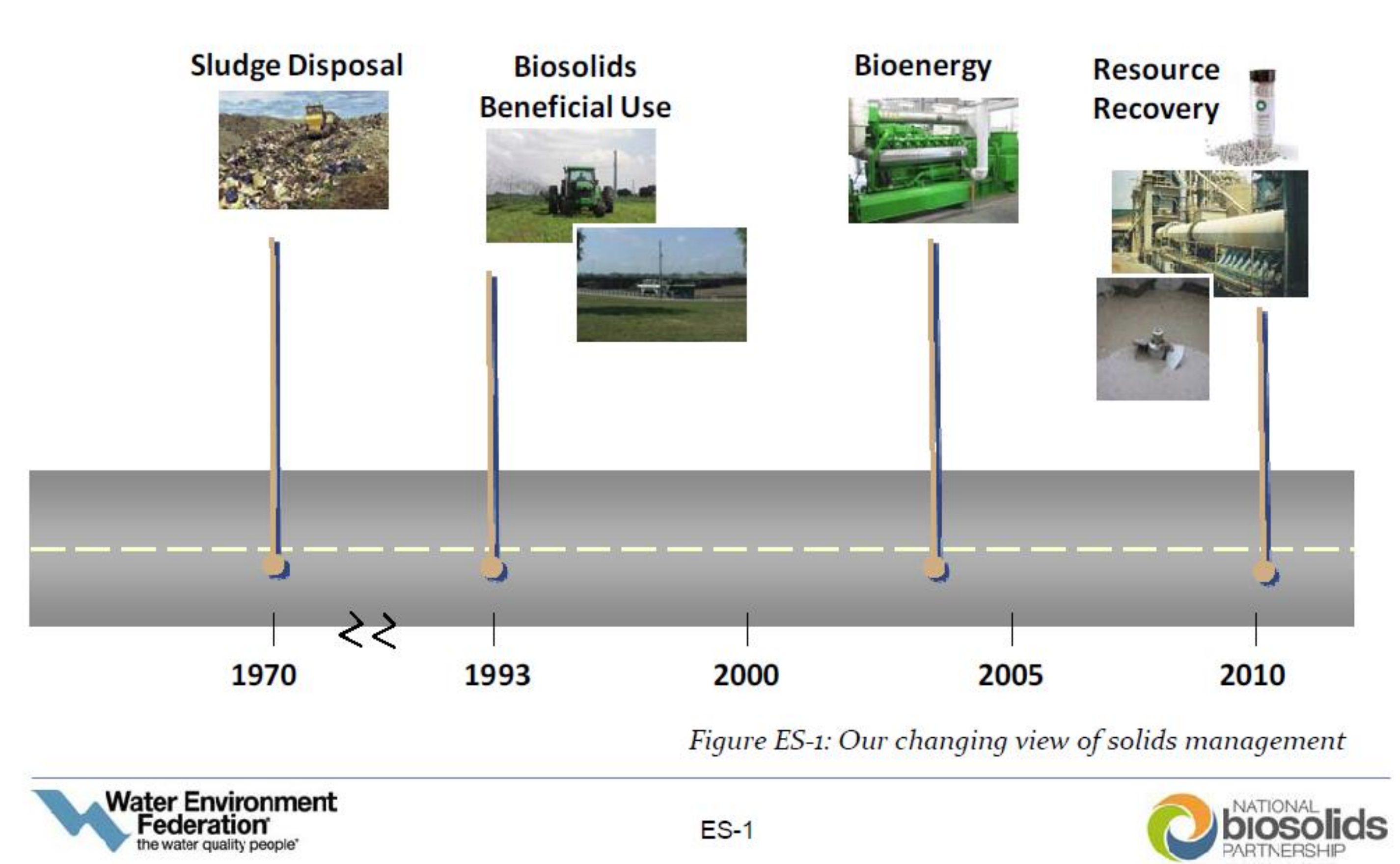
<u>Three new WERF inter-related challenges and goals</u>

- **<u>N</u>utrient Recovery** – Transition from treatment based industry to a **resource recovery** industry that is both economically and environmentally sustainable.
- **<u>E</u>nergy Production and Efficiency** – Energy self sufficiency for wastewater treatment plants.
- **<u>W</u>ater** – Establish sustainable systems that integrate management of wastewater, stormwater, drinking water and source water.



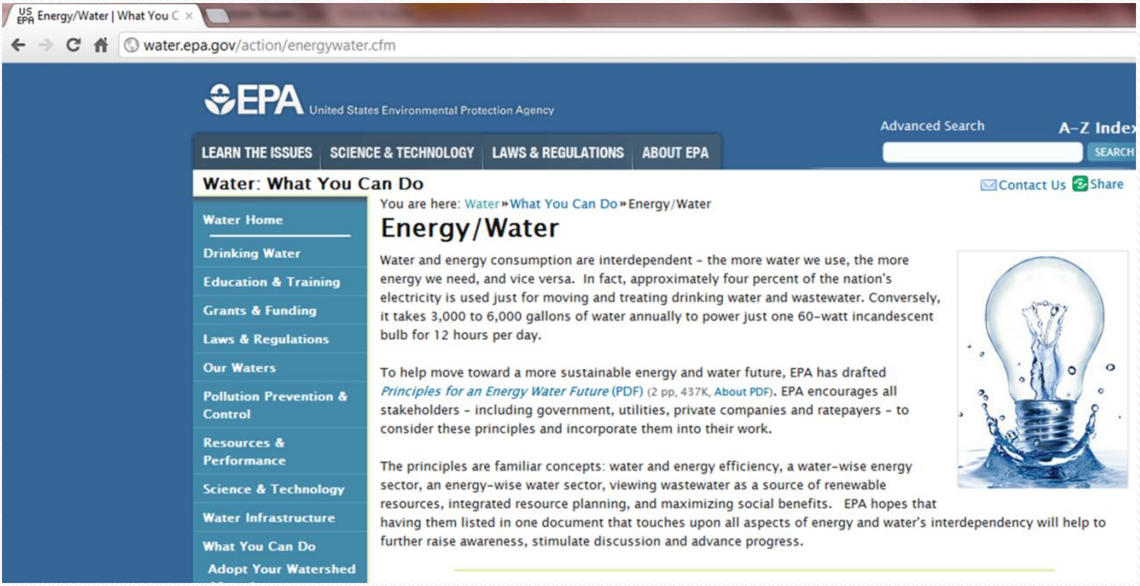
Resources in wastewater increasingly more concentrated &/or valuable.
What's the value & the market?
What can we "mine" and How?

Changing View of Biosolids Management in USA



"Charting the Future of Biosolids", by CDM for WEF & NBP, May 2011, USA

Wastewater Widely Recognized as Resource



Wastewater treatment facilities, which treat human and animal waste, should be viewed as renewable resource recovery facilities that produce clean water, recover energy and generate nutrients.

- USEPA (April 2012)

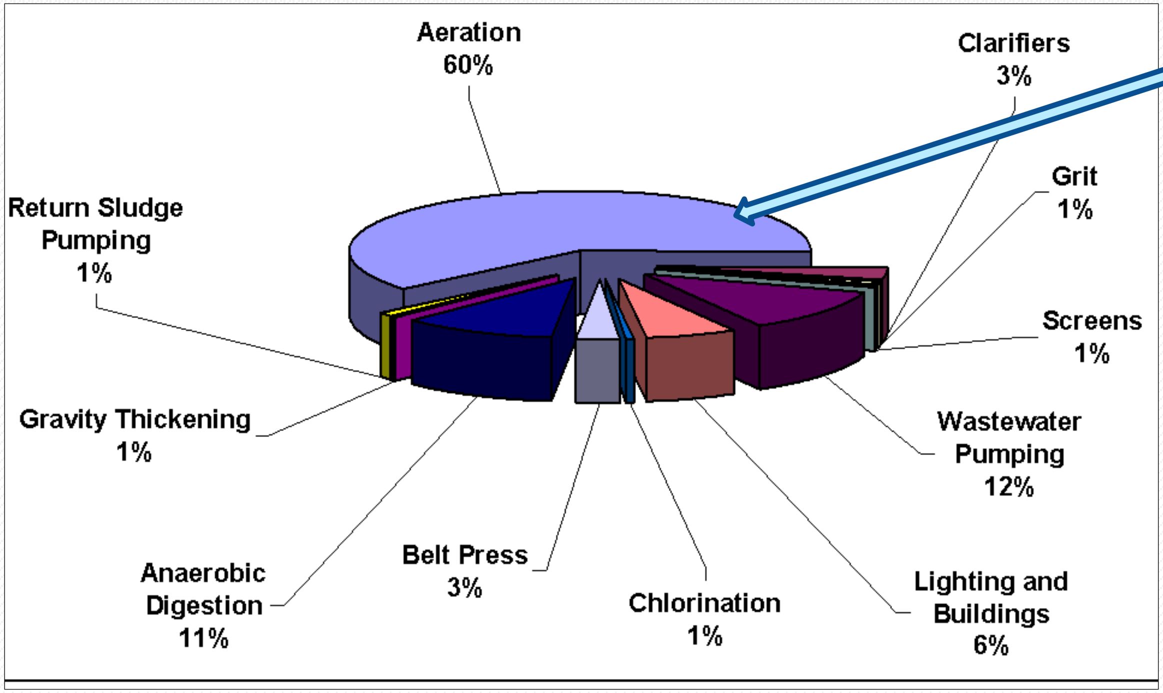
Water Environment Federation Position Statement (2011)

WEF believes that wastewater treatment plants are **NOT** waste disposal facilities, but rather ***water resource recovery*** facilities that produce clean water, ***recover nutrients***, and have the potential to ***reduce the nation's dependence on fossil fuels*** through the production and use of ***renewable energy***.

WEF launched *Energy Neutral Roadmap* initiative in March 2012

Water & Energy

- Energy in wastewater is up to **10** times the energy needed for treatment….*yet*…..
- 3 – 4% of electricity consumed in the U.S. annually is for water and wastewater conveyance and treatment (56 billion kW or $4 billion)
- Water/wastewater utilities typically the largest consumers of energy in municipalities, often 30 – 40% percent of total energy consumed



- Where does the electrical energy used by WWTPs typically go?
- Energy costs are second only to Labor in Utilities' operating budgets.
- Energy costs projected to increase, but it is also one of the most controllable.

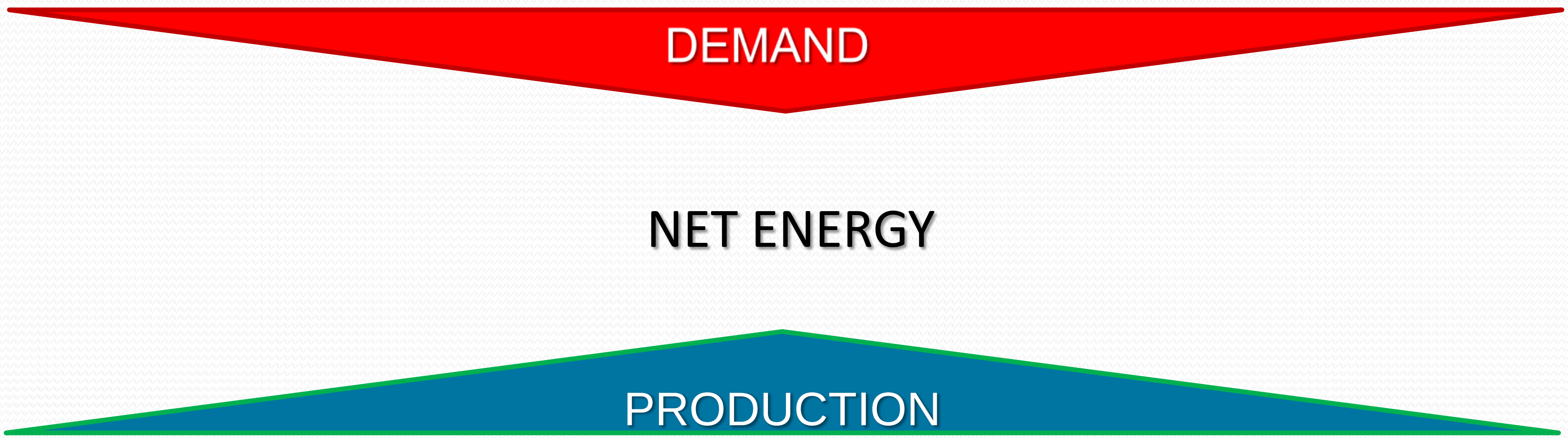
Energy Content in Wastewater

Constituent	Unit	Value
Wastewater, heat basis	$MJ/10^{\circ}C \cdot 10^3\ m^3$	41,900
Wastewater, COD basis	MJ/kg COD	12 - 15
Primary sludge, dry	MJ/kg TSS	15 - 15.9
Secondary biosolids, dry	MJ/kg TSS	12.4 - 13.5

from Tchobanoglous

Wastewater Contains 3 to 12 MJ/m^3 in COD Energy

To Achieve Energy Neutral Treatment we need to look at *Energy Demand* and *Energy Production*



Net Plant Energy = Energy Demand – Energy Production

Model WWTPs for Energy Sustainability

Produce more energy than needed for treatment


Case Study

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Collaboration. Innovation. Results.

Sustainable Treatment: Best Practices from the Strass im Zillertal Wastewater Treatment Plant

Energy Independence Through Energy Optimization

This case study highlights one of the best performing wastewater treatment plants in Europe – a facility that produces more energy than it requires for operations. Wastewater treatment facility managers in Europe are highly motivated to develop new energy initiatives due to the high rates they pay for electricity (relative to those in the U.S.). As a result, there is a wealth of information available and in practice at European wastewater plants that North American facilities can benefit from.

Overview

Located near Strass im Zillertal, the Strass wastewater treatment plant (WWTP) serves 31 communities in the Achental and Zillertal valleys east of Innsbruck, Austria. It provides wastewater treatment for a population that ranges from approximately 60,000 in the summer to 250,000 during the winter tourist season, and has treatment requirements that include organic and nitrogen removal. An energy-independent facility, the plant produces more electrical energy than it requires for its operation.

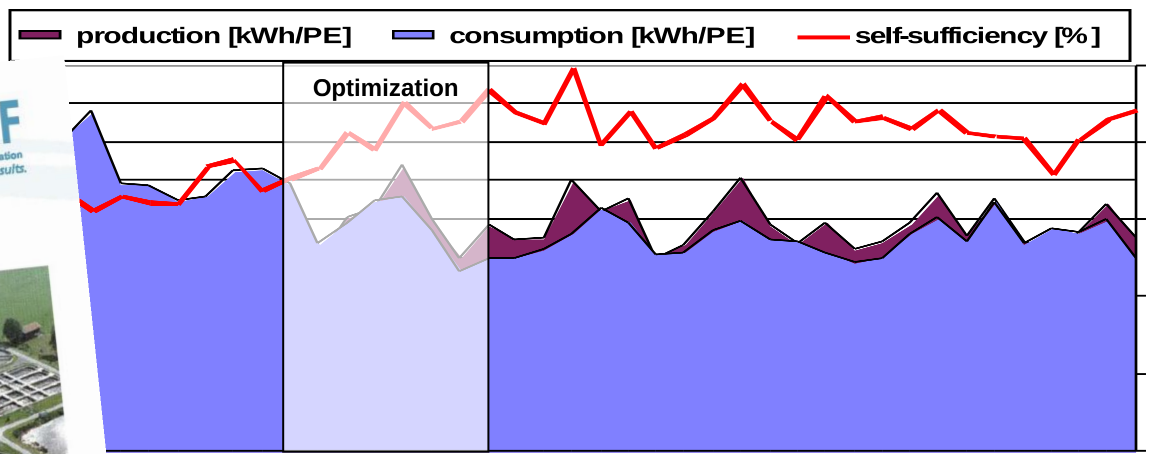
The peak winter flow and load is equivalent to a plant treatment capacity of 10 mgd. Using a two-sludge system (high rate BOD removal followed by nitrification/denitrification), it provides for both nitrogen and phosphorus removal, biologically and chemically, respectively. The plant was commissioned in 1999 and successive optimization efforts over the past decade have resulted in significant cost and resource reduction. Highlights of these efforts include:

Did You Know?

- Water and wastewater sector operations require almost 3% of the electric energy produced in the U.S. annually.
- Some of the world's best performing wastewater treatment plants can produce 100% of the energy they need to operate.
- Wastewater contains 10 times the energy needed to treat it.

Figure 1. Aerial View of Strass Wastewater Treatment Plant. Reprinted with permission from Abwasserverband Achental-Inntal-Zillertal.

- 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 NH_4-n removed in 2003 to 2.9 euro/kg NH_4-n removed in 2007/2008, primarily through active management of dissolved oxygen (DO) setpoints and conversion of the aeration system from conventional fine bubble to ultra-high efficiency strip aeration.
- Reduction in energy consumption for sidestream treatment from 350 kwh/d to 196 kwh/d by implementing a novel sidestream nitrogen removal system (DEMON®).
- Enhanced utilization of the digester gas by converting to a state-of-the-art cogeneration unit, boosting electrical efficiency from 33% to 40% and overall usage efficiency from 2.05 to 2.30 kwh/m³ of digester gas.



Examples (100%+):

East Bay Municipal Utility Dist. (Oakland, CA)

Strass im Zillertal WWTP (Innsbruck, Austria)

Examples (70%+):

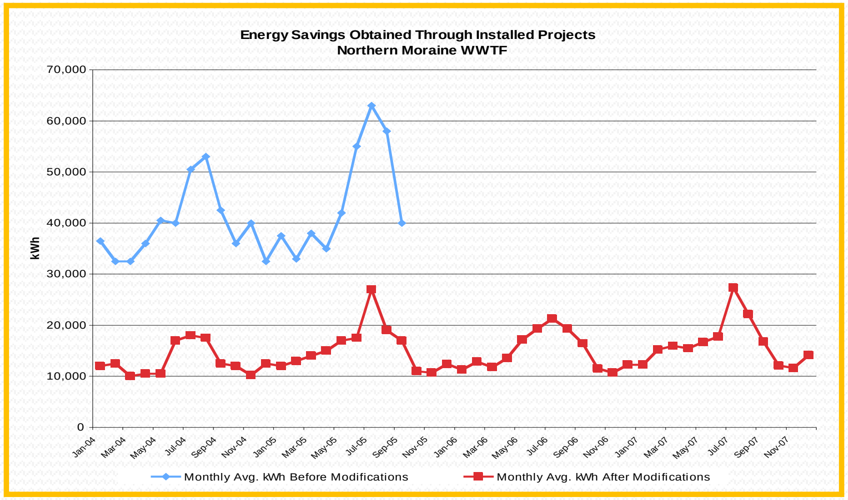
Sheboygan WWTP (Sheboygan, WI)

GJJWWTP (Johnstown, NY)

Best Performing WWT Plants...

How did they get here?

Maximize energy recovery
AND
Maximize energy efficiency



Energy Efficiency

- Reduce the energy needed for treatment
  - More efficient equipment with better control

Best Practice Benchmarks and Top Performance Quartiles for Wisconsin Wastewater Facilities

Facility Type	Flow Range (MGD)	Average Energy Use (kWh/MG)	Top Performance Quartile (kWh/MG)	Best Practice Benchmark (kWh/MG)	Average Potential Savings [10]
Activated Sludge	0 - 1	5,440	< 3,280	3,060	44%
	1 - 5	2,503	< 1,510	1,650	34%
	> 5	2,288	< 1,350	1,760	23%
Aerated Lagoon	< 1	7,288	< 4,000 [11]	3,540	51%
Oxidation Ditch	< 1.2	6,895	< 4,000 [12]	4,320	37%

Biogas – Source of Heat and Power

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

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Energy Recovery

- Generating onsite power from renewable energy (such as biogas) lowers carbon footprint at WWTPs by 20-40%.

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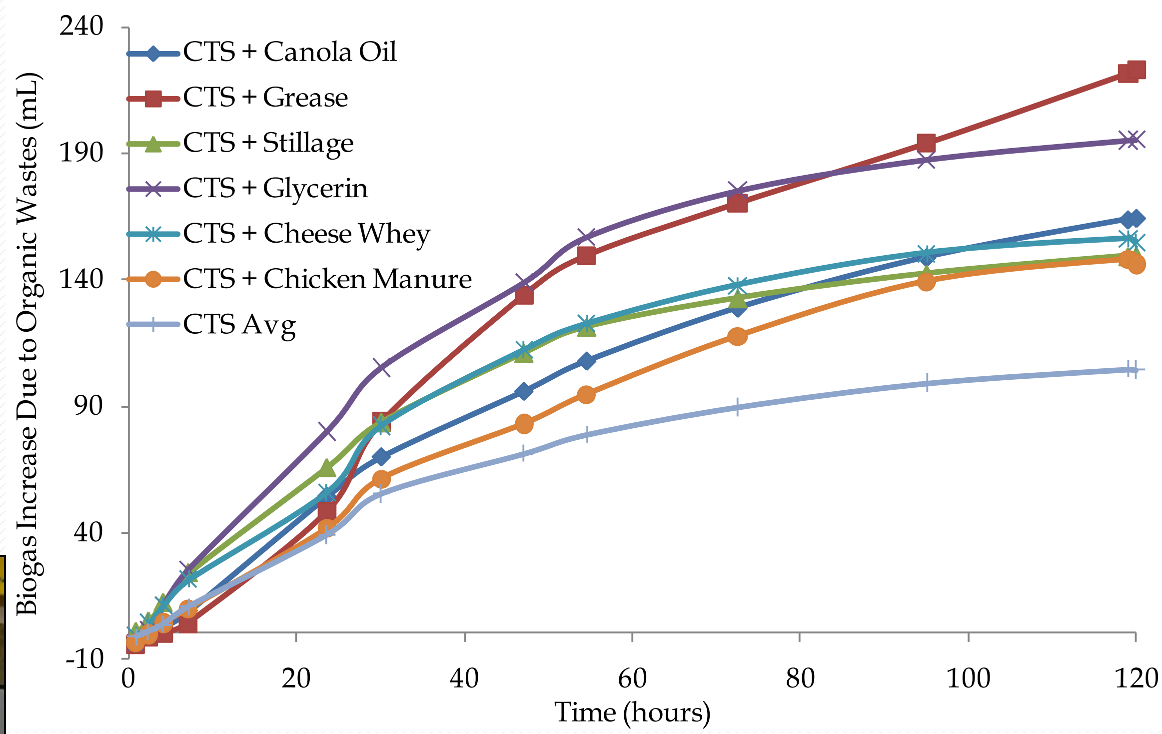
Co-digest Organic Waste with Wastewater Solids

- Increases biogas produced



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Dried Biosolids are already being used as Renewable Fuel in Maryland

Lehigh Cement in Union Bridge, MD

- •Each ton of dried biosolids replaces ½ ton of coal used in the manufacturing process
- •No negative effects on stack-gas emissions
- •Greenhouse gas reduction

← This slide courtesy Mid-Atlantic Biosolids Association's Sustainable Biosolids Technologies workshop, and Rob Kershner, 2011

Biosolids successfully used as fertilizer; for agriculture; help reclaim eroded / marginal lands

WERF Challenges on Energy

- *Optimization of Wastewater and Solids Operations (OWSO)*
  - Demonstrate >20% improvement in energy, cost, &/or environmental impact
  - >20 research projects
    - Tools (LCAMER, CHEApet, GELCAT)
    - Energy Management Decision Support Tools
    - Barriers to Biogas Utilization
    - Compendium of Best Practices and Case Studies

- *Energy Management Challenge*
  - Provide research to develop new approaches that will allow wastewater treatment plants to be <u>energy neutral</u>, and thus able to operate solely on the energy embedded in the water and wastes they treat.

(from WERF Energy Management Challenge Exploratory Team Report, Jan, 2011)

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Opportunity to Collaborate with WERF

- New research project to investigate heat and energy recovery from incinerators as a source of renewable energy
  - Calculate maximum potential per unit of processed residuals and nationwide at utilities already using SSI (sewage sludge incinerators)
  - Document effectiveness of recovering energy or heat by up-to-date and newer thermal oxidation units with combined heat and power (CHP) recovery
  - Compare TBL – triple bottom line (environmental and social costs) value of energy (per BTU) recovered from biosolids by thermal oxidation in contrast to the same energy obtained from coal

- Inform Department of Energy, regulators and law makers of the renewable energy potential in biosolids and residuals

- Contact Laureen Fillmore and Allison Deines to learn more

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Thank You

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