Resource Recovery Options for WWTPs

October 19th, 2023

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SMART ENERGY DESIGN ASSISTANCE CENTER

Who We Are

We are an applied research program at University of Illinois.

We assist buildings and communities in achieving energy efficiency, saving money, and becoming more sustainable.

Our goal: Reduce the energy footprint of Illinois and beyond.

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ISTC Mission

To encourage and assist citizens, businesses and government to prevent pollution, to conserve natural resources, and to reduce waste to protect human health and the environment in Illinois and beyond.

How the Program Works

The Illinois EPA Public Water Infrastructure Energy Assessment Program helps municipalities reduce the cost of water and wastewater treatment.

- NO-COST energy assessments and technical assistance
- Comprehensive report listing:
  - Cost of upgrades
  - Estimated payback period
  - Any applicable incentives or funding opportunities
- Operator continuing education events
- Program participants are eligible for grant funding opportunities within 5yrs of assessment completion.

Funding provided in whole or in part by the Illinois EPA Office of Energy. This program is in partnership with the U.S. Dept. of Energy Sustainable Wastewater Infrastructure of the Future (SWIFT) Accelerator for energy efficiency in wastewater treatment.

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U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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Resource Recovery for WWTPs

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Learning Objectives

1. Identify what “resource recovery” means to modern treatment plants
2. Describe the recoverable resources in wastewater streams
3. Determine how to convert waste streams into income streams
4. Summarize the available recovery technologies on the market today

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What is “resource recovery”?

Early plants just treated wastewater to minimize nutrient & pathogen pollution in waterways

Byproducts were treated as waste streams and discarded

Modern plants are looking to re-use these waste streams, rebranding as resource recovery facilities!

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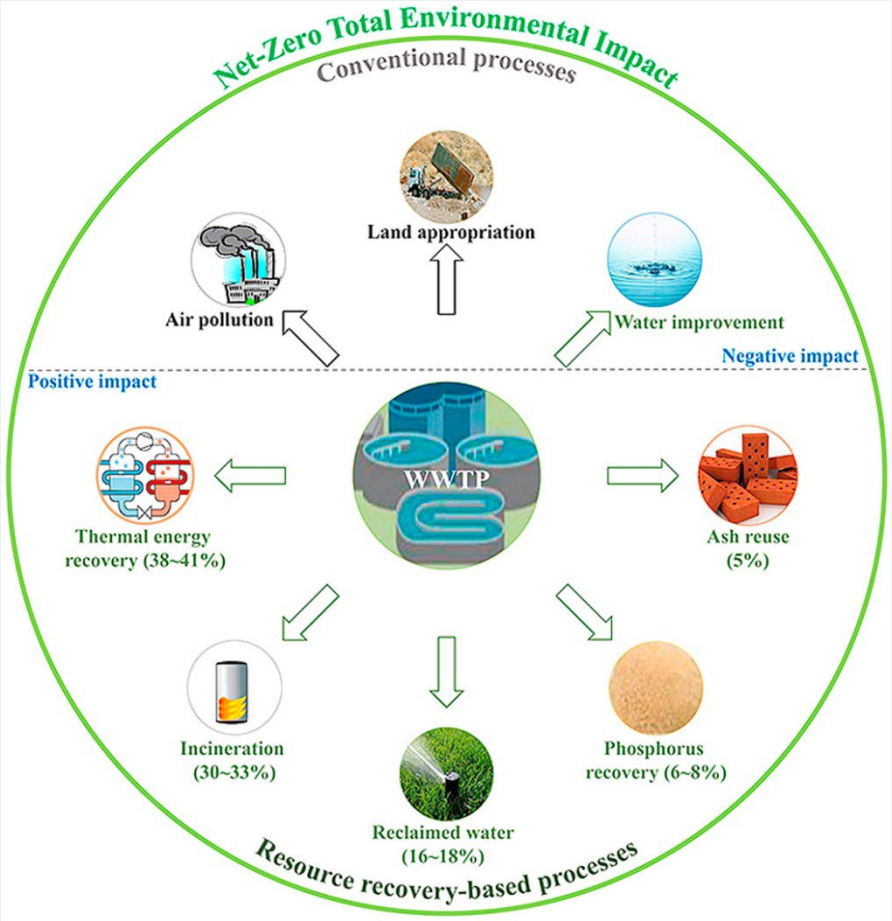
What resources can be recovered?

Resource streams can include:

- Bio-gas from anaerobic digestion
- Heat contained in wastewater
- Nutrients (Nitrogen and Phosphorus)
- Biosolids for land application
- Conversion of wastes into alternative resources:
  - Struvite into phosphorus fertilizer
  - Bio-solids into syngas or bio-oil
  - Algae into animal feed or fertilizer



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Energy recovery to reduce operating costs!

CHP is most common means of energy recovery

- Electric generation offset consumption
- Recovered heat from generator feeds back into digester heating

Water-source heat pumps draw from or reject heat to effluent stream

- Influent ~50-60F, depending on time of year
- Heat exchanger in effluent typical configuration
- Can recover heat from sewer mains

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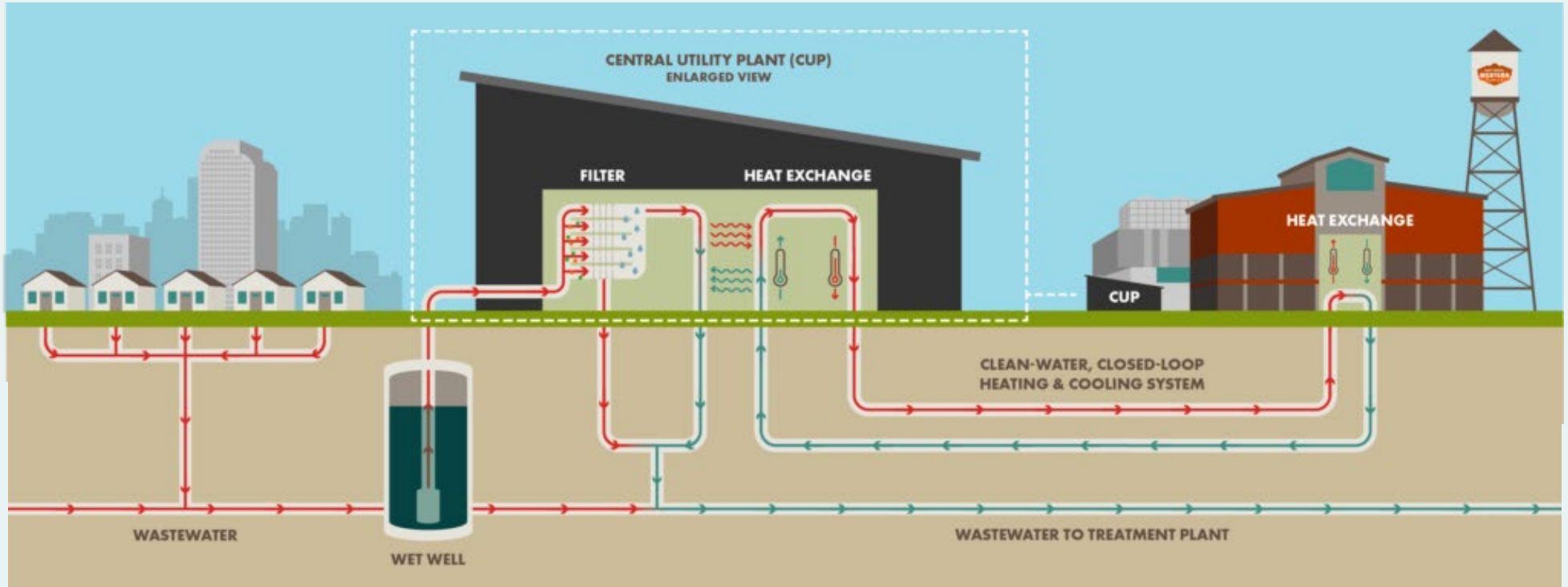
Sewer Main Heat Recovery

National Western Center in Denver, CO uses “sewerthermal” to heat 7 buildings with 3.8 MW of heating/cooling energy.

Similar district systems can heat and cool hospitals, universities, and other campus-style building complexes.



Renewable Natural Gas

Scrub digester gas to pipeline quality (96-98% CH_4)

- Nicor has an RNG Interconnection Pilot Program!
- https://www.nicorgas.com/rng

RNG production also from sludge pyrolysis.

Sometimes, selling the RNG can be more cost-effective than CHP.

1. High biogas production rates to justify cleaning equipment
2. Direct industrial uses that tolerate lower-quality natural gas

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Water Recovery

Don’t just discharge to a waterway!

- Use for non-potable needs
  - Irrigation
  - Wetlands renewal
  - Industrial needs
- Clean to potable standards
  - Local brewery use
  - Send to potable water plant

Recovered Water can be sold at lower price than potable, benefitting clients and WWTPs!

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Alternative CHPs w/ Sludge Recovery

AD Sludge can be digested to Class A bio-solids

- Land application is possible, but can be hindered by contaminants
- Further processing by pyrolysis produces:
  - Bio-oil for refining to bio-diesel
  - Bio-char for carbon sequestration
  - Some combustible gases, usually fed back into system
  - Eliminates PFAS, micro-plastics, & pharmaceuticals
  - Oxidized (stable) heavy metals remain in ash.
- Gasification of sludge produces:
  - Syngas (CO, H_2, and CH_4) only product.
  - Ash is waste product
  - Similar benefits to pyrolysis

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Nutrient Recovery

- Previously mentioned gasification and pyrolysis processes recover carbon, phosphorus, and potassium for fertilizer.
  - Nitrogen can be recovered from reject water w/ additional processing.
- Algal treatment can also capture carbon, phosphorus and nitrogen
  - Dry and pelletize for animal feed or fertilizer

Image source: www.algaewheel.com

Image source: www.algae.com/sustainability

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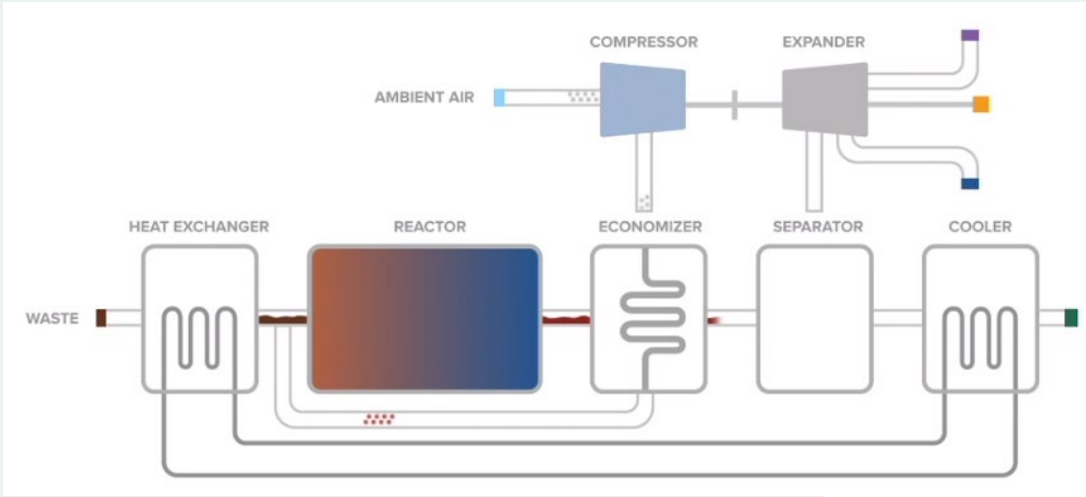
Tech to Address Contaminants

PFAS, Heavy Metals, Pharmaceuticals, etc.

Supercritical Water Oxidation option

- Heavy metals separated out in solids
- PFAS and Pharmaceuticals converted to mineral salts, water, and harmless gases
- Reaction is exothermic, can be self-sustaining after start-up
- Reducing high pressure can drive turbine



374WATER°

OUTPUTS

- Vented Gas $CO_2 + N_2$
- Clean Energy
- Distilled Water
- Water + Minerals

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