



Panel Discussion: Achieving Energy-Positive Water Resource Recovery Facilities

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The way forward – not linear

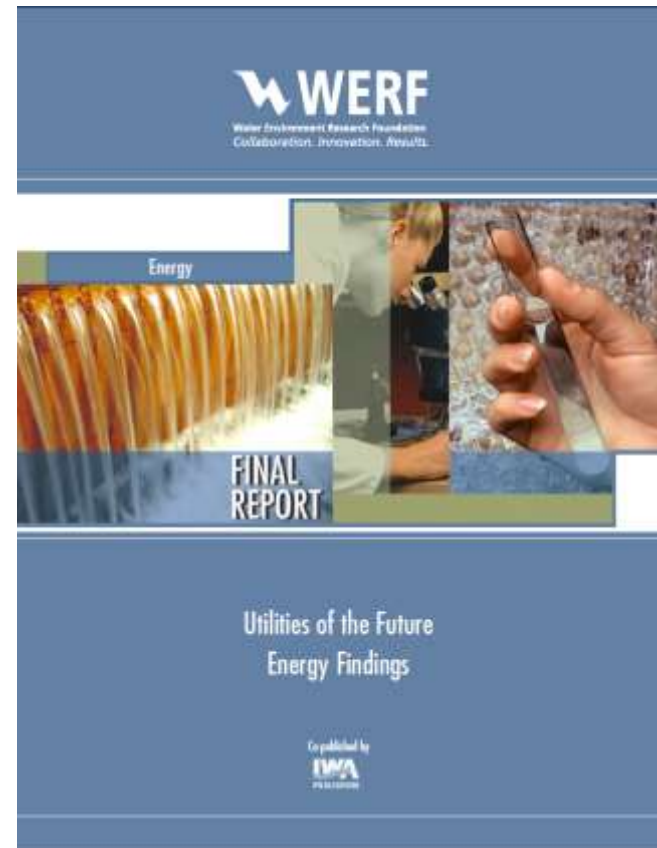


Labyrinth - Chartres Cathedral, France

Utility of the Future

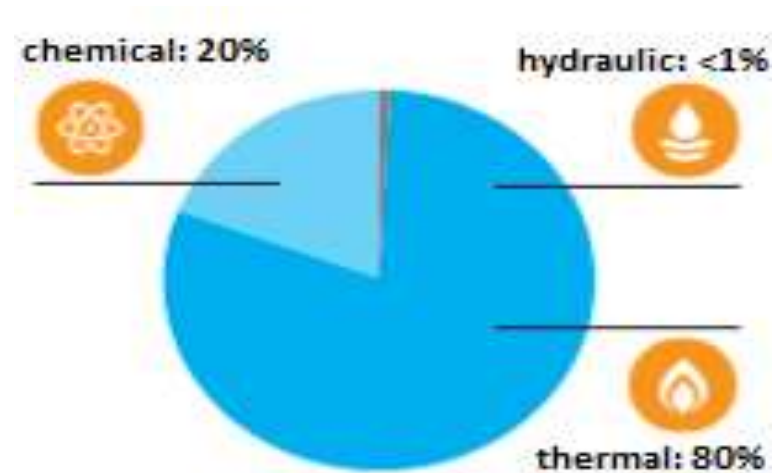
“Wastewater facilities have the potential to produce the energy needed to not only treat our water, but to help heat and power the cities that depend on them.”

- WERF/WEF/NACWA 2014



Energy Embedded in Wastewater

- 851 trillion BTU per year
- 80% of that energy is thermal

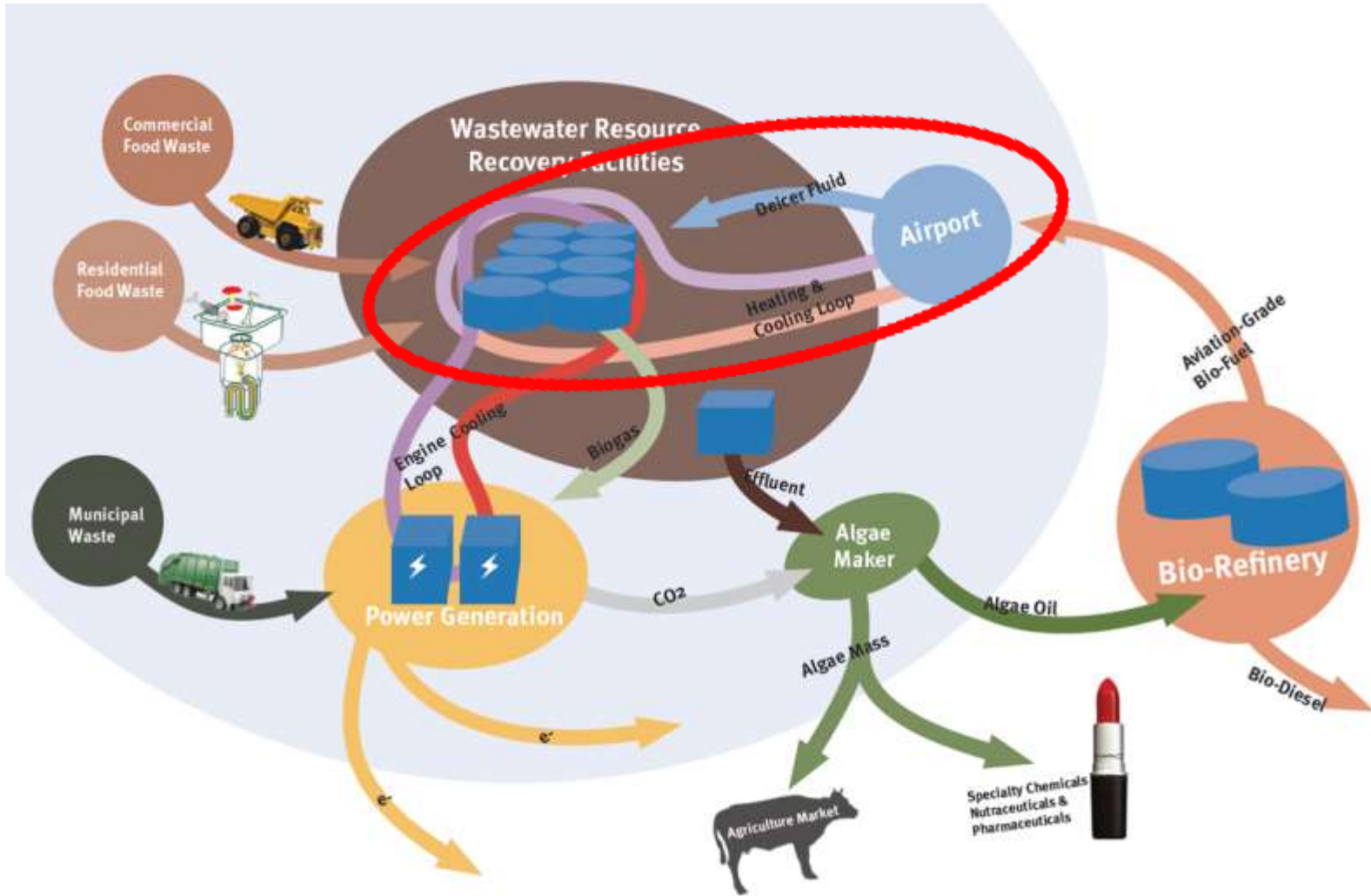


Maximizing Resources in Wastewater

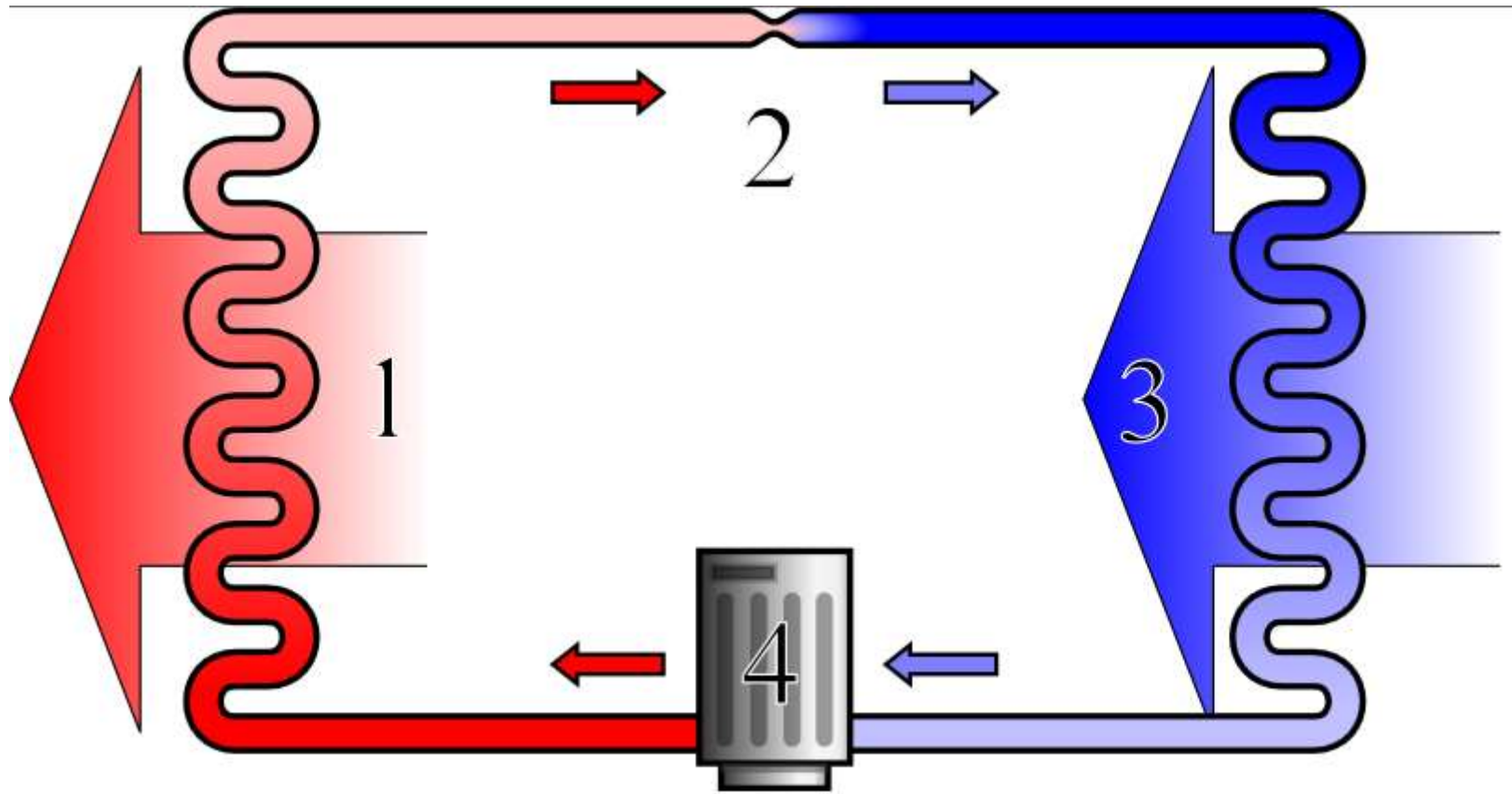
- Efficient energy use within plants
- Accessing available energy
 - High heat
 - Low heat -> sewage geothermal
- Increasing the available energy -> co-digestion
- Effectively recovering resource (LCA)
 - P, N and water itself

ENVISIONING THE POSSIBILITIES

Eco-Industrial Complex



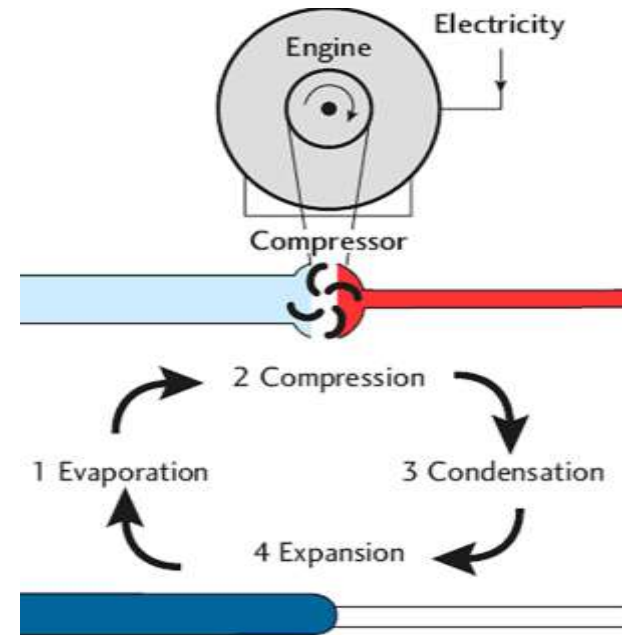
Heat Pump Process



adapted from Wikipedia

Sewage Geothermal Basics

- Conversion of low-grade heat into useful thermal energy
- Sewage into evap. at 50° F
- COP of 3.5 (700 kW comp)
- 4° drop in sewage temp
- Hot water:
 - Inlet – 130° F
 - Outlet – 150 to 175° F



Heat Pump



Large Scale Use of Sewage Geothermal in Asia

Yue Du Hotel
Beijing - 2004



Tianjin Chateau
Tianjin - 2008



Government Building
Shan Xi - 2007



Wangjiang Hotel
Harbin City - 2003



Beijing Southern Railway Station



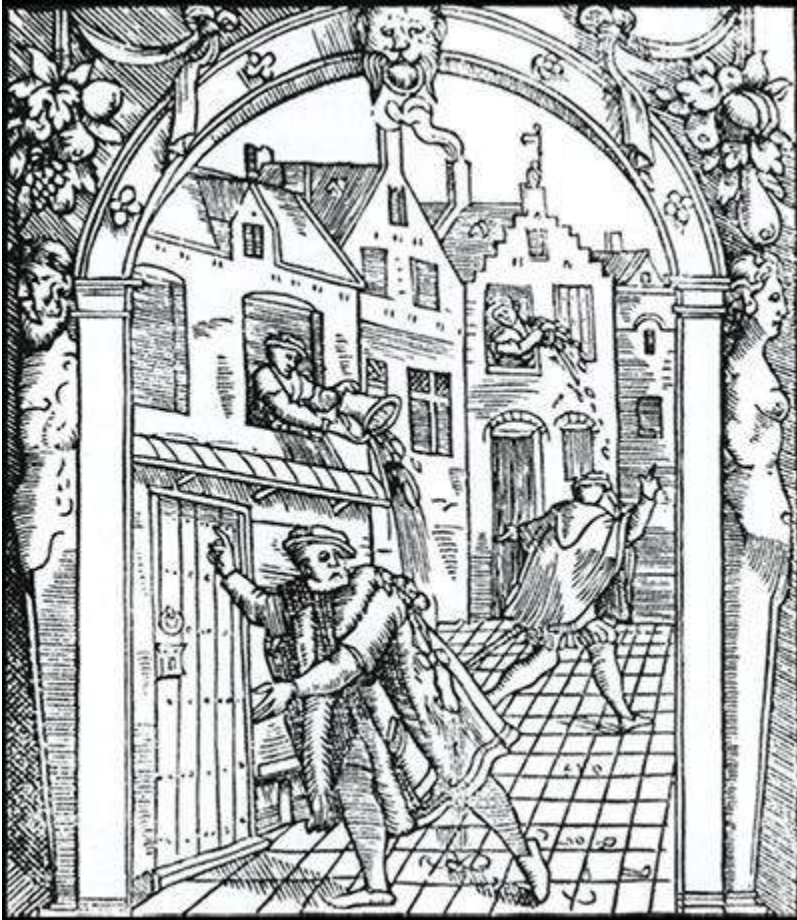
ASSESSING GAPS AND HURDLES

Coefficient of Performance

$$\text{COP} = \frac{Q}{W}$$

- Q = Heat supplied to or removed from reservoir
 - W = Work consumed by the heat pump
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- **Low Temperature lifts, High COP**
 - **Integration of radiant heat into Architectural norms**
 - **Heating and Cooling**

Public Perception - Gardyloo



“De damno per ejecta” (1554): Yale Law Library

- Proactively assemble diverse team of community professionals
- Anticipate and address perception-based reactions
- Focus on education

WHERE COULD ADDITIONAL RESEARCH HAVE THE GREATEST IMPACT?

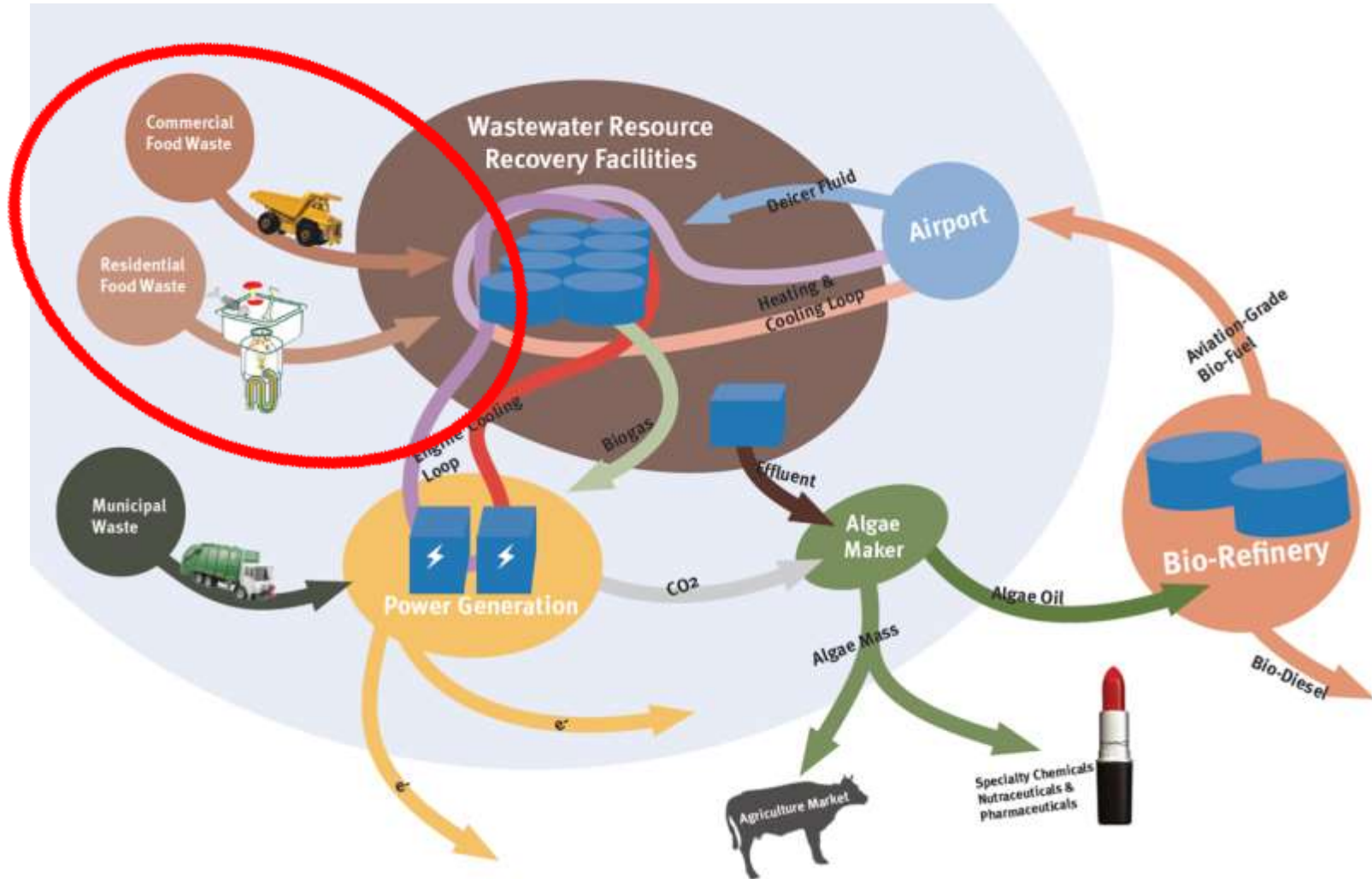
Technological Challenges

- Effective filtration – clogging, flow
- Max heat exchanger efficiency - fouling
- Refrigerants
 - Environmental impacts air and water
- Plumbing Codes
 - Within building
 - Within street
- Low temperature ORC – is this possible

Policy Challenges

- Flow volume and consistency – optimization
- Logistical, legal, and regulatory issues
 - Up stream, down stream
 - Ownership – best public use
- Utility identity – wastewater or energy

Eco-Industrial Complex



Food Waste Co-Digestion



Source: theecoambassador.com

ENVISIONING THE POSSIBILITIES

A New Vision of Food Waste

- Valuable organic substrate
- Medium allowing nutrients to be recycled
 - Return pathway allows re-distribution of depleted nutrients – Food is Highly Dispersed.
- Alternative “green” fuel
- Capitalization and promotion of AD assets

ASSESSING GAPS AND HURDLES

Undervalued Resources

- Nutrients
 - Recycle vs. destroy
 - Value other than market value? -> Life Cycle Analysis
- Soil
 - Reversal of depletion
- Water
 - Energy foot print getting larger and larger
 - Water itself has value

WHERE COULD ADDITIONAL RESEARCH HAVE THE GREATEST IMPACT?

Challenges of Food Waste

- Nutrient recovery