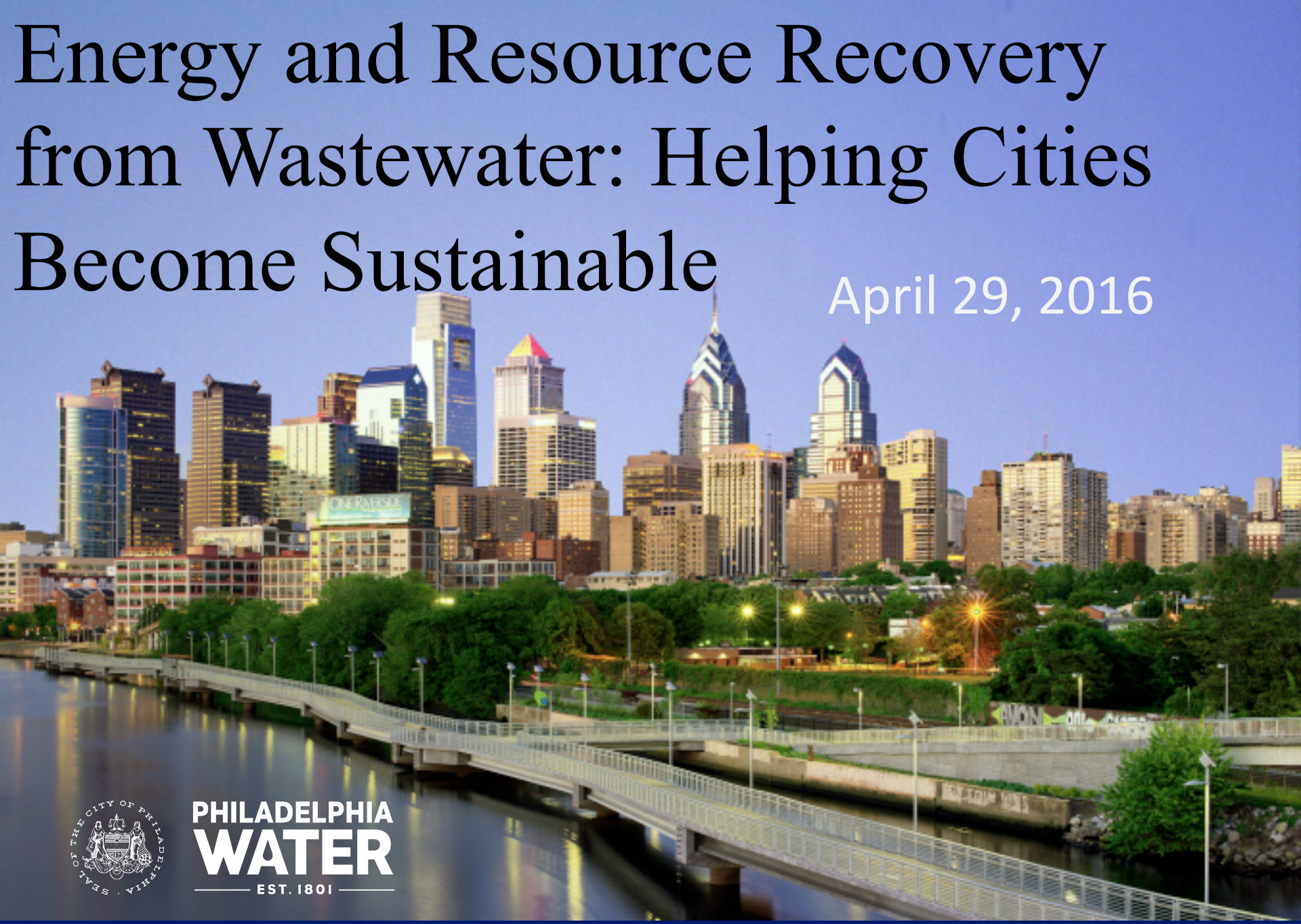
Energy and Resource Recovery from Wastewater: Helping Cities Become Sustainable

April 29, 2016



PHILADELPHIA WATER
EST. 1801

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1. National Energy Use in Water & Wastewater
2. Philadelphia's Strategy & Success
3. Future Concepts

National Energy Use in Water & Wastewater

Energy Use Expended on Water

Water and Wastewater Treatment Comprises 2% of the U.S. Energy Consumption

Regulations will require additional processes and technologies that will increase consumption and carbon footprint

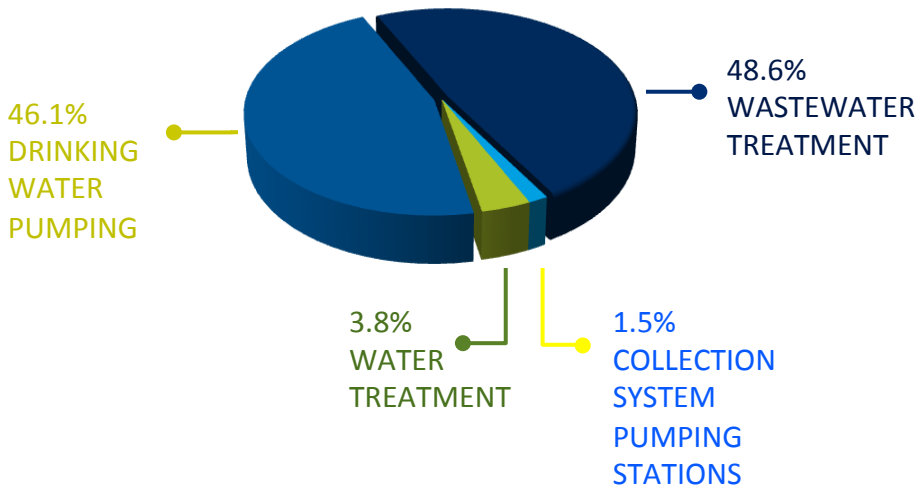
How can utilities reduce energy and carbon footprint while meeting future regulations?

Philadelphia’s Strategy & Success

Electrical Energy Consumption

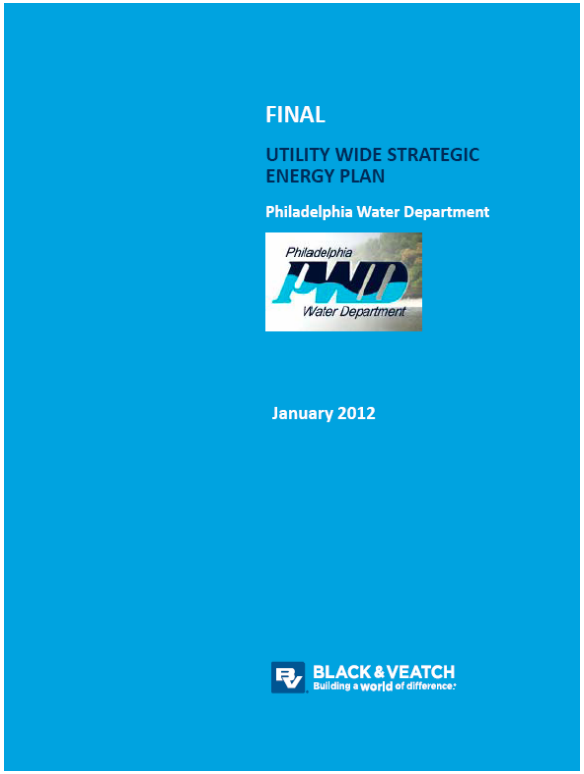
- PWD uses 274 million kWh of electricity annually.
- Electricity accounted for 78% of energy costs ($19m) and 67% of PWD's energy use in FY 2013.
- Half of PWD's electricity is used in water operations, the other half in wastewater.

- In water operations, most electricity is used for pumping.
- In wastewater operations, electrical usage is more evenly split between treatment and pumping.



Utility-Wide Strategic Energy Plan

- Based on the existing Departmental culture that encourages energy efficiency and conservation.
- Formalizes processes for information transfer and decision making.
- Codifies value of energy efficiency and generation into strategic capital processes.



Portfolio Management

BUY it

USE it

MAKE it

Solar Panel Installation

Southeast WPCP

$1.6 million project cost

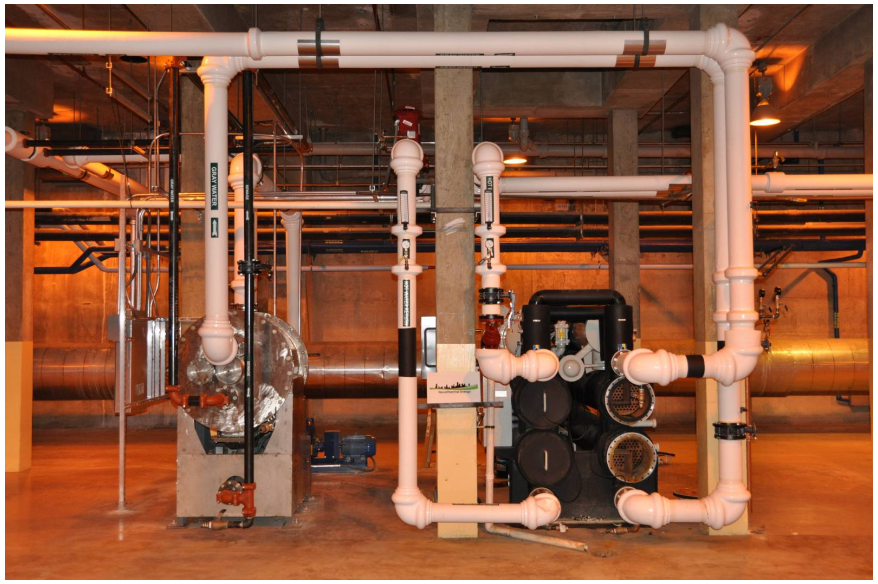
- $0.75 million from the PWD
- $0.85 million provided through an Energy Efficiency and Conservation Block Grant from the Department of Energy

Saves the PWD $30,000 - $60,000 annually (varies with cost of electricity)

Simple pay back of 11-12 years with 25-year life cycle

Sewage Geothermal Installation

Southeast WPCP



- Project cost of $240,000
  - $150,000 from Greenworks Pilot Energy Technology Grant
  - $90,000 from NovaThermal Energy
- Put into operation in February 2012
- Provides heat to compressor building and gallery space at Southeast WPCP

Aircraft Deicing Fluid Co-digestion

Southwest WPCP

- Mutually beneficial business decision
- Aircraft deicing fluid (ADF) collected from the Philadelphia International Airport
- Generates useful methane gas using anaerobic digestion
- No negative impact on wastewater treatment process

Biogas Cogeneration Facility

Northeast WPCP

- Facility will meet 85% of current Northeast WPCP electrical requirements.
- Facility will provide 15% of PWD's total electrical use.
- Captured biogas will meet all of process heating needs at plant.

Biogas Cogeneration Facility

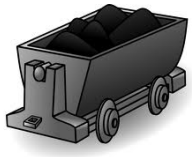
Environmental Metrics

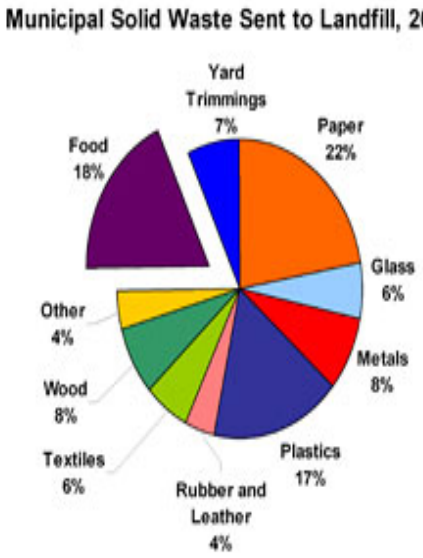
Facility will produce 4 x 1.44 MW = 5.67 MW electricity

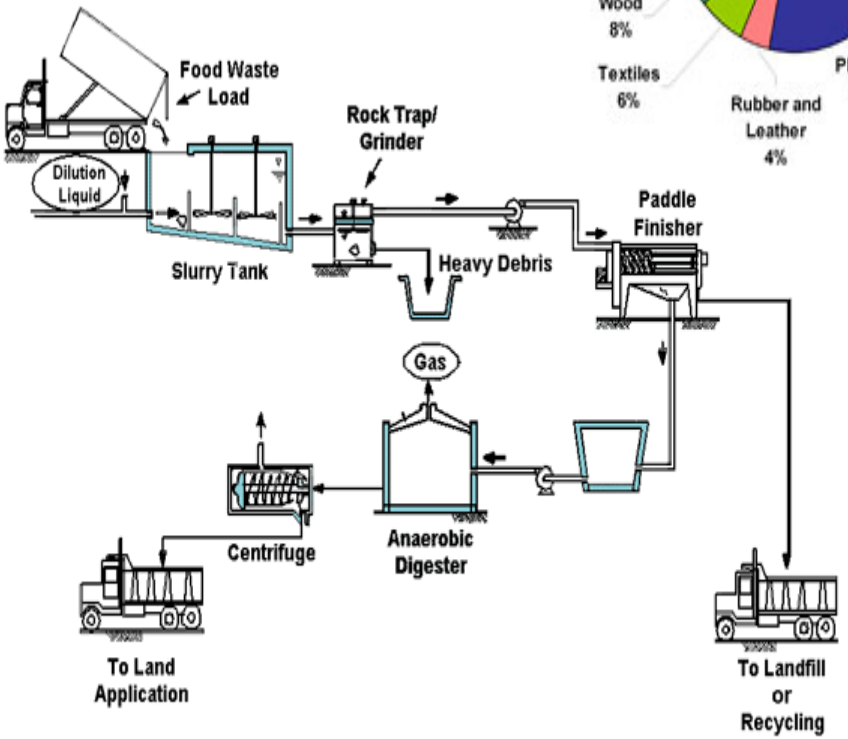
Off-set: 30,500 metric tons of CO_2e / year

This is equivalent to

- 6,427 passenger vehicles
- 25,024 acres of U.S. forests
- 164 railcars of coal
- 3,435,242 gallons of gas







Food Waste To Biogas

If 50% of the food waste generated each year in the U.S. was anaerobically digested, enough electricity would be generated to power over 2.5 million homes for a year

Food waste = 18% of the waste stream.

Over 30 million tons of food waste sent to the landfills each year.

Of the less than 3% of waste currently being diverted from landfills, most of it is being composted to produce fertilizer.

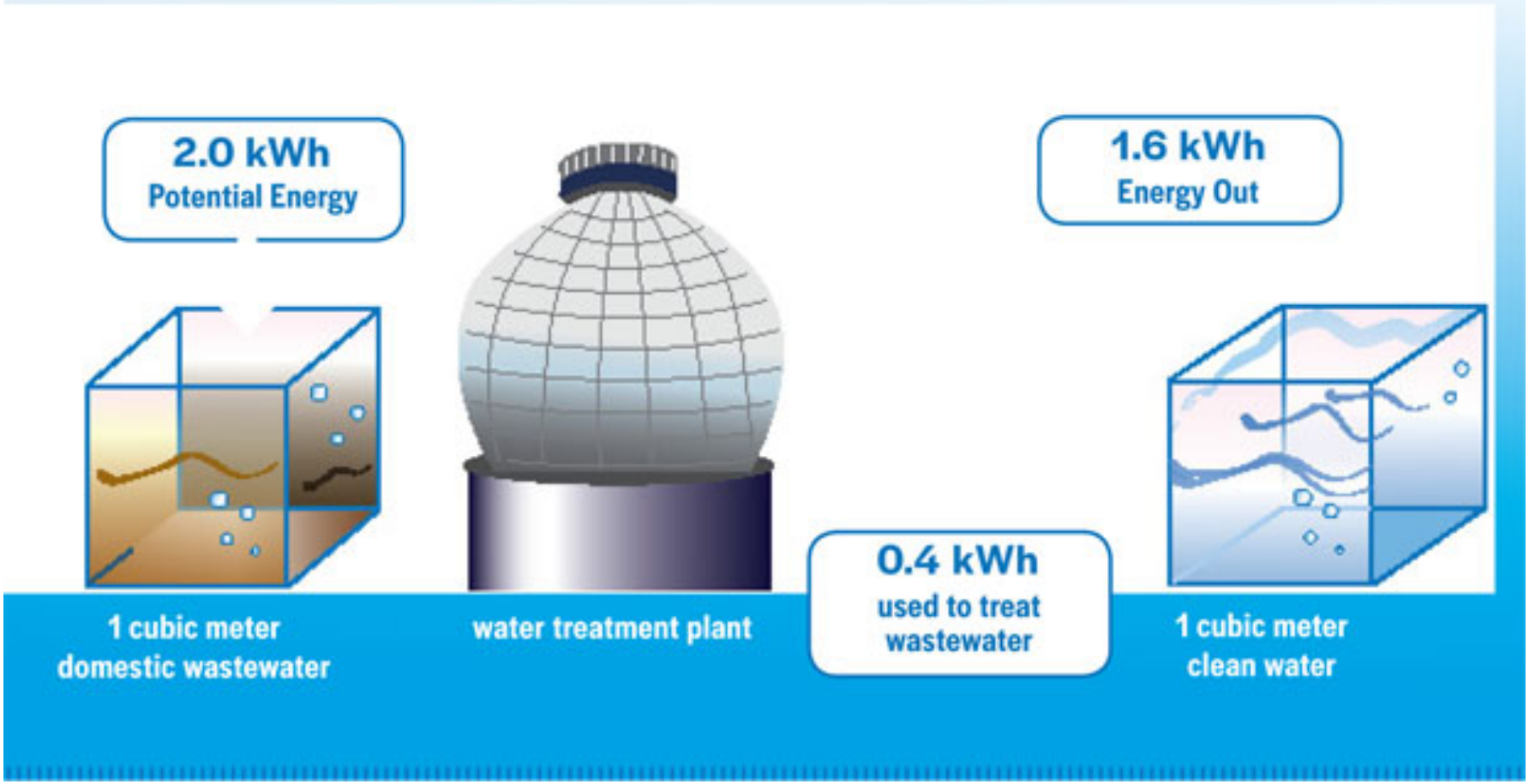
http://www.epa.gov/region9/waste/features/foodtoenergy/

What Is The Future?

Wastewater Plants will become Resource Recovery and Energy Efficiency Facilities (R2E2)

Carbon regulation and higher energy costs will support the leveraging of multiple waste streams to "close the loop"

Many potentially energy and carbon intense facilities tend to be located near one another due to zoning issues



FROM THE NOVEMBER 2012 ISSUE of DISCOVER MAGAZINE
The Future of Energy: Earth, Wind,
Water
By Eric A. Powell
Friday, October 19, 2012

The Future – Resource Recovery

One gallon of typical domestic wastewater contains enough organic compounds and nitrogen to power a 100-watt lightbulb for five minutes.

The exciting implication is that next-generation wastewater treatment plants could use new technologies, including microbe-powered fuel cells, to capture enough methane, hydrogen, and other fuels from wastewater to generate all the energy they need, and then some.

"We can reclaim high-quality water from wastewater at almost no energy cost," Luthy says. "It could go from being a liability to an asset."

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Concepts for Projects of the Future

Out-of-Box thinking

Exciting new horizons

Resource Recovery Facilities

Eco Complex

What Is The Future?

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Examples

Scum to Biofuel

Volatile Fatty Acids to Bioplastics

Ammonia and Phosphorous Recovery

Example: Wastewater & Algae

Algae Oil

- Vegetable Oil
- Biodiesel
- Refined Fuel (Gas, Diesel, Jet, Heating oil)
- Specialty Chemicals
- Nutraceuticals
- Pharmaceuticals

Algae Mass

- Biogas (Methane, Synthesis Gas)
- Liquid Fuels (Jet Fuel, Diesel)
- Alcohols (Ethanol, Methanol)
- Food
- Feed
- Fertilizer

http://www.nytimes.com/2013/04/25/business/energy-environment/german-building-uses-algae-for-heating-and-cooling.html?pagewanted=all&_r=0

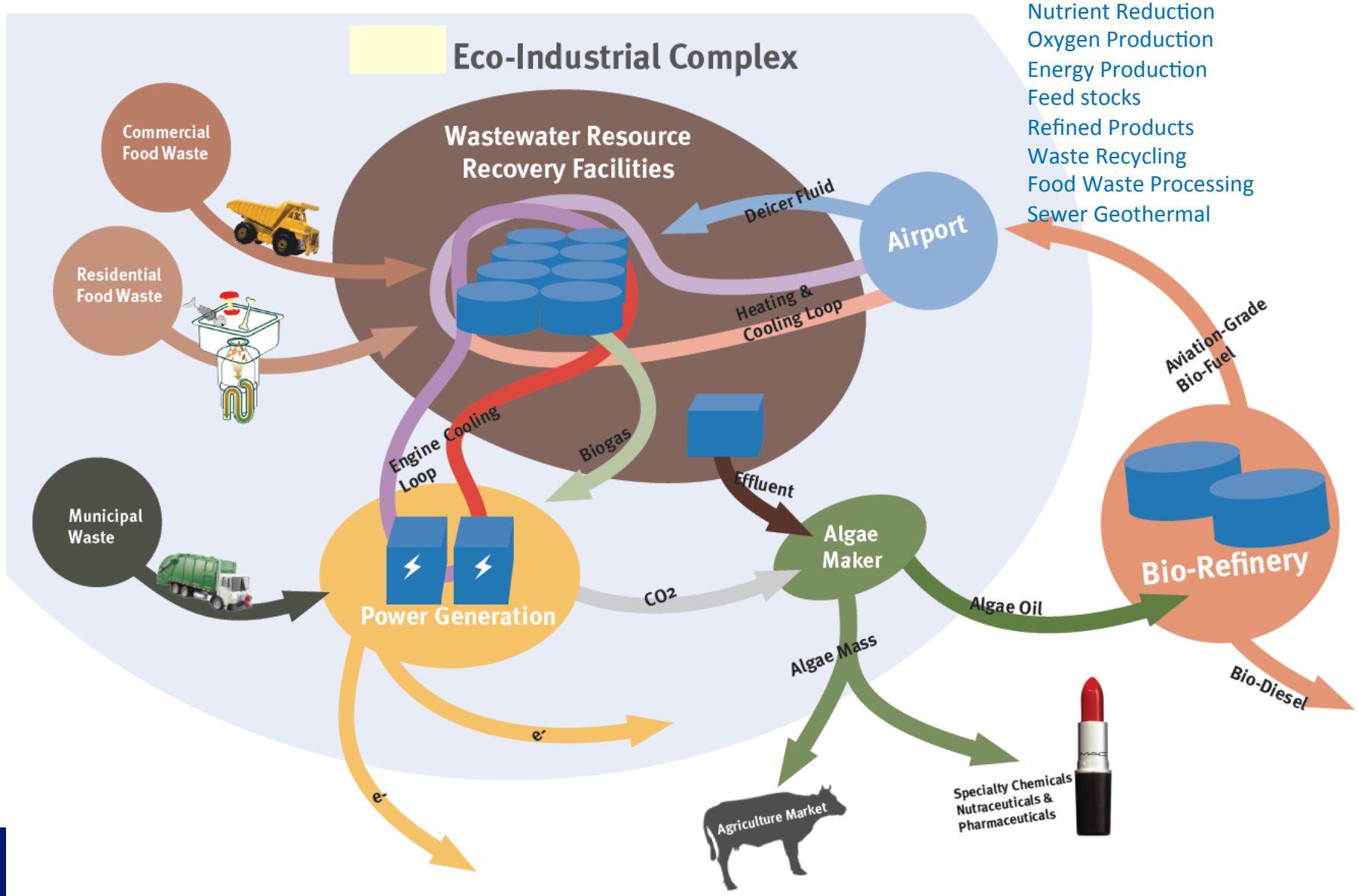
Heating & Cooling an Airport

The future expansion of the airport and existing terminals could be heated and cooled via a sewer geothermal loop to the wastewater plant

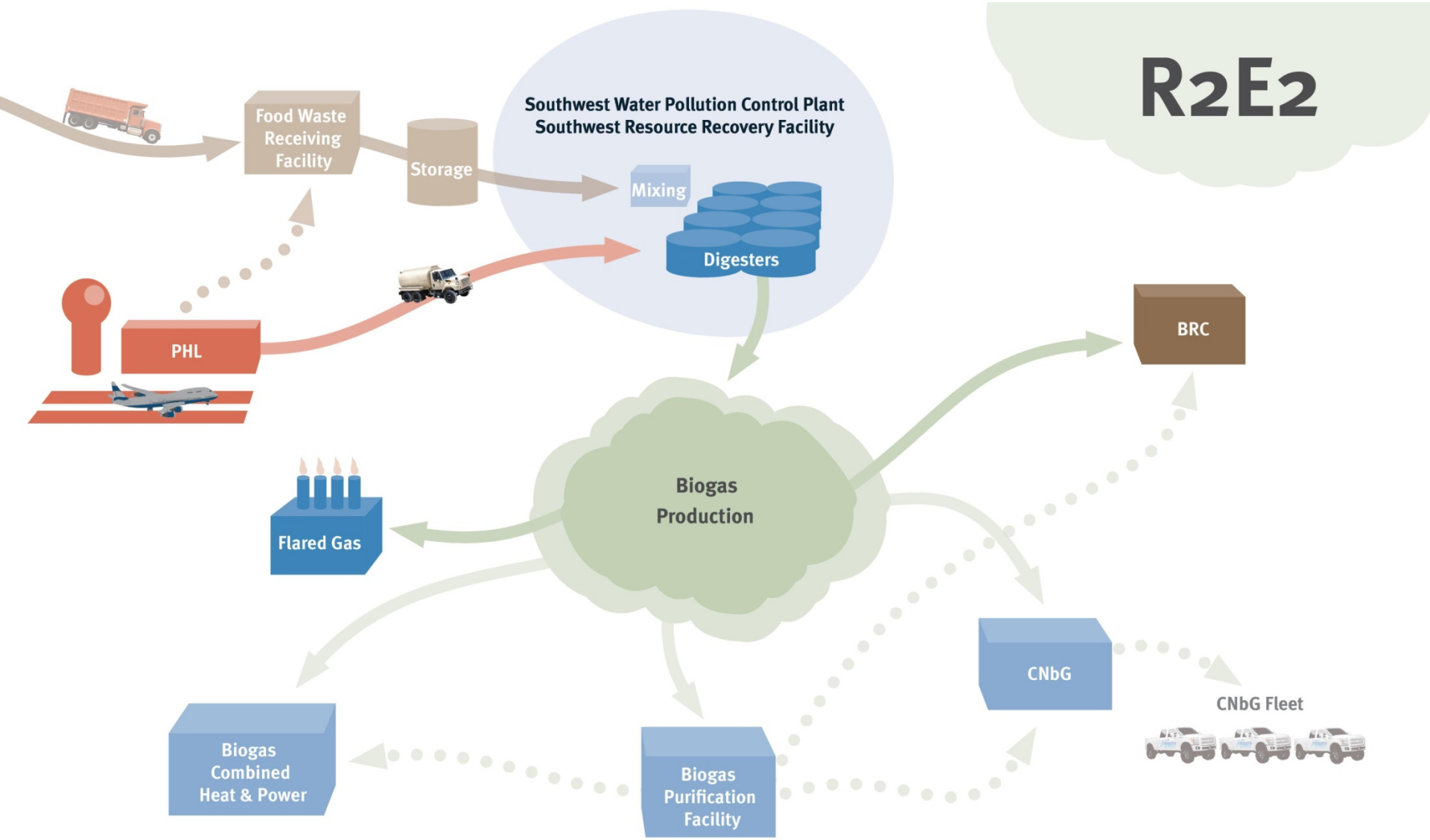
It would theoretically only increase the effluent temperature of the wastewater plant 1 degree

Future Concepts

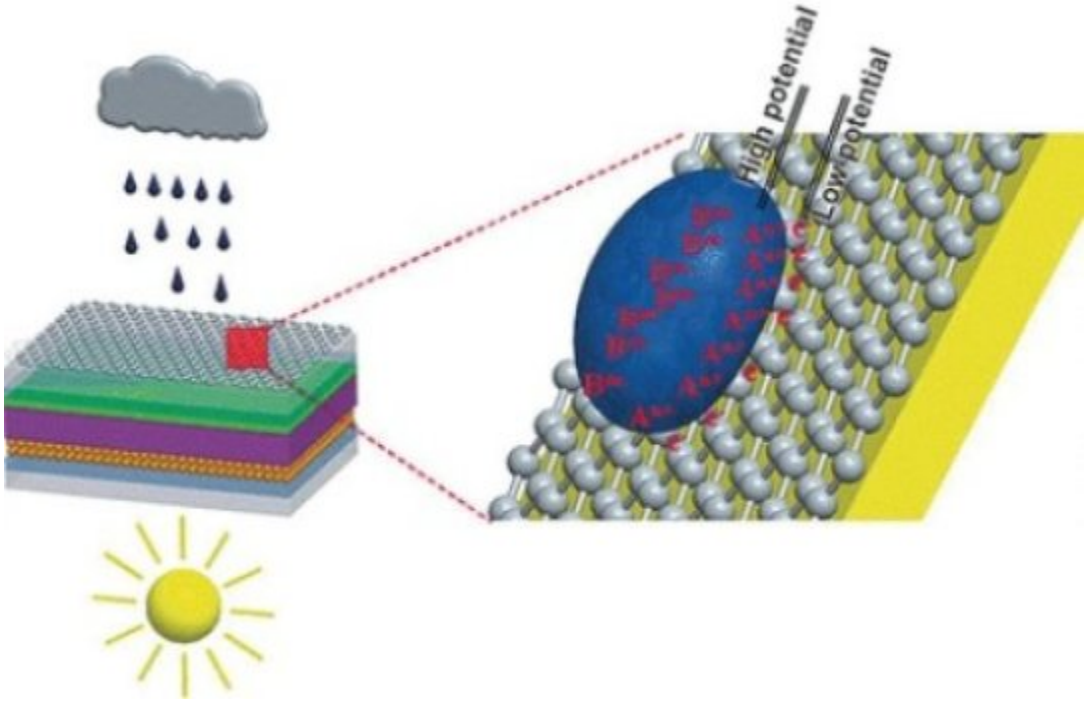
Carbon Sequestration
Nutrient Reduction
Oxygen Production
Energy Production
Feed stocks
Refined Products
Waste Recycling
Food Waste Processing
Sewer Geothermal



Conceptual Biogas Use Scenarios



Graphene layer could allow solar cells to generate power when it rains



Innovations and new technologies can take old technologies and change them

Credit: Copyright Angewandte Chemie International Edition; courtesy of ResearchSEA
http://www.researchsea.com/html/article.php/aid/9573/cid/1/research/science/researchsea/power_from_sun_and_rain.html

Conclusions

Water and Wastewater Facilities Are Becoming Energy Generators Instead of Energy Users

Future Technologies, Carbon Regulations, and Energy Market Costs will Drive Significant Growth In This Area

Facility Co-Location (Generator – User) Will Be A Key Factor in Industrial Ecosystems for Waste Stream Leveraging

Acknowledgements

Energy Team – Paul Kohl, Emily Hill, Roy Romano,

PWD Energy Leadership Team Members

Mayors Office of Sustainability

Questions?

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