

Low-Carbon Wastewater Treatment Pathways

May 15th, 2024



SEDAC

SMART ENERGY DESIGN ASSISTANCE CENTER

Who We Are

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

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.



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.



About the IEPA PWI Energy Efficiency Program

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
 - Program participants are eligible for grant funding opportunities within 5yrs of assessment completion.
- **Operator continuing education events**



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.



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Apply for an Energy Assessment!

Step 1: Initial Application – Pre-Qualification

- Apply at www.smartenergy.illinois.edu/water
 - Be located in Illinois and be publicly-owned
 - Allow SEDAC/ISTC to visit your site
 - Be willing to share facility information
 - Share final assessment report with Illinois EPA Office of Energy

Step 2: Data Collection – We're here to help!

- Facility information –Process flow diagram, types of processes, etc....
- 2 years of utility bills and MORs

Step 3: Site Visit Scheduled

Step 4: Report Delivery & Technical Support



Field Day - Low-Carbon Treatment & Energy Efficiency



Workshop Speakers:

- Shawn Maurer, Technical Director, SEDAC
- Village of Pingree Grove
- Dr. Daniel Johnson, Chief Technology Officer, Algaewheel
- Cassie Carroll, Program Director, SEDAC



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.



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



The background of the slide is a photograph of a wastewater treatment plant. It shows several large circular aeration tanks with water being aerated. In the foreground, there is a concrete walkway with metal railings overlooking the tanks. The background is filled with green trees under a clear blue sky. A semi-transparent teal overlay covers the entire image, and a white rectangular box is centered over it, containing the title and author information.

Overview of Low-Carbon Wastewater Treatment Pathways

Shawn Maurer - SEDAC

Renewable Energy – Biogas Use

Combined Heat & Power or Renewable Natural Gas

- Methane key off-gas from biological digestion
- 28x's more GHG impact than CO₂

Clean to pipeline quality and inject

- 95-98% methane + other requirements

OR

Combust on-site in CHP system

- Reciprocating Engine, Micro-Turbine,
Fuel Cell, or Combustion Turbines



Biogas Pipeline Injection

Need Cleaning Skid

- ≤ 2 gr./CCF Sulfur
- ≤ 4 lb/MMCF water vapor
- $\leq 2\%$ CO₂ by volume
- $\leq 0.4\%$ O₂ by volume
- Free of liquid/solids that could damage equipment



Image Source:

https://www.newsdata.com/california_energy_markets/regional_roundup/wastewater-treatment-upgrade-produces-rng-for-southwest-gas-system/article_d5984f02-7fc8-11ec-afe6-cbd274982306.html



Nicor has Pilot Program – only one in IL at this time.



Biogas Cleaning Process

Cleaning Steps:

1. Liquid separation in knock-out pot, filter, and blower.
2. Additional moisture removal with after-cooler, filtration media to remove siloxanes and sulfur.
3. Advanced removal of CO₂, O₂, N₂, VOCs and siloxanes and compression.

Biogas selective solvents treatment process

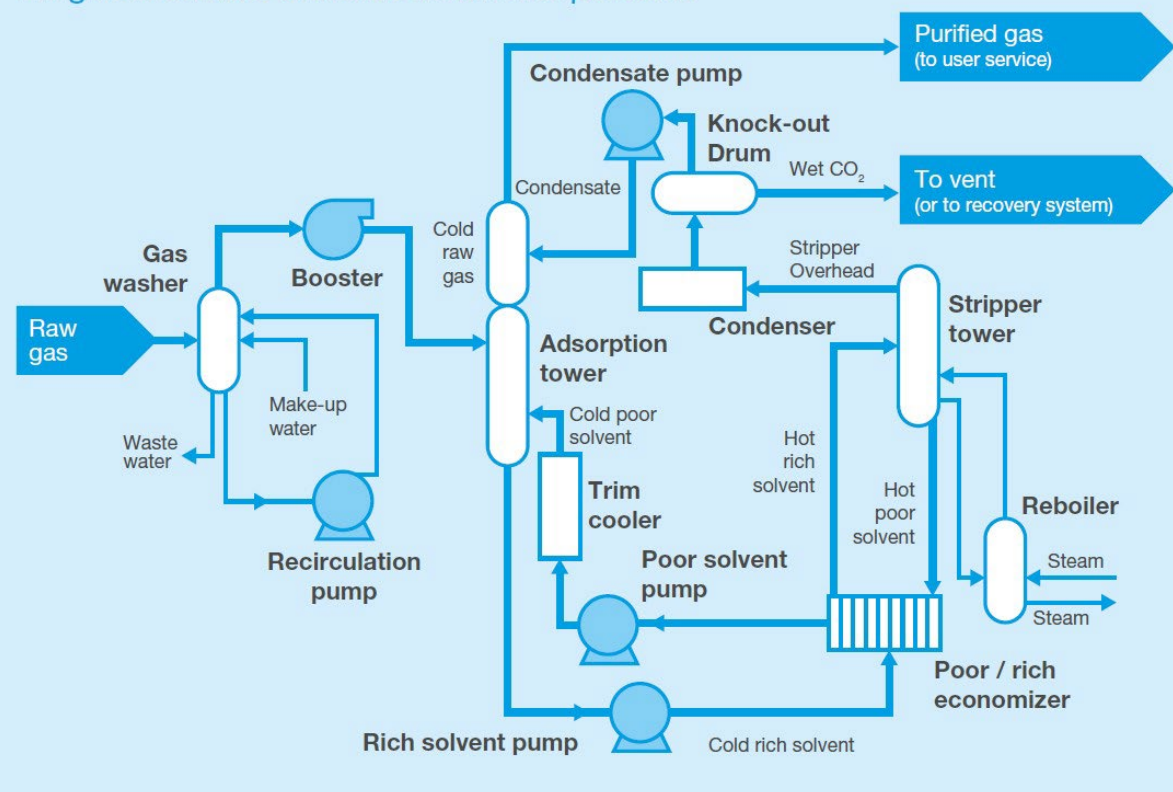
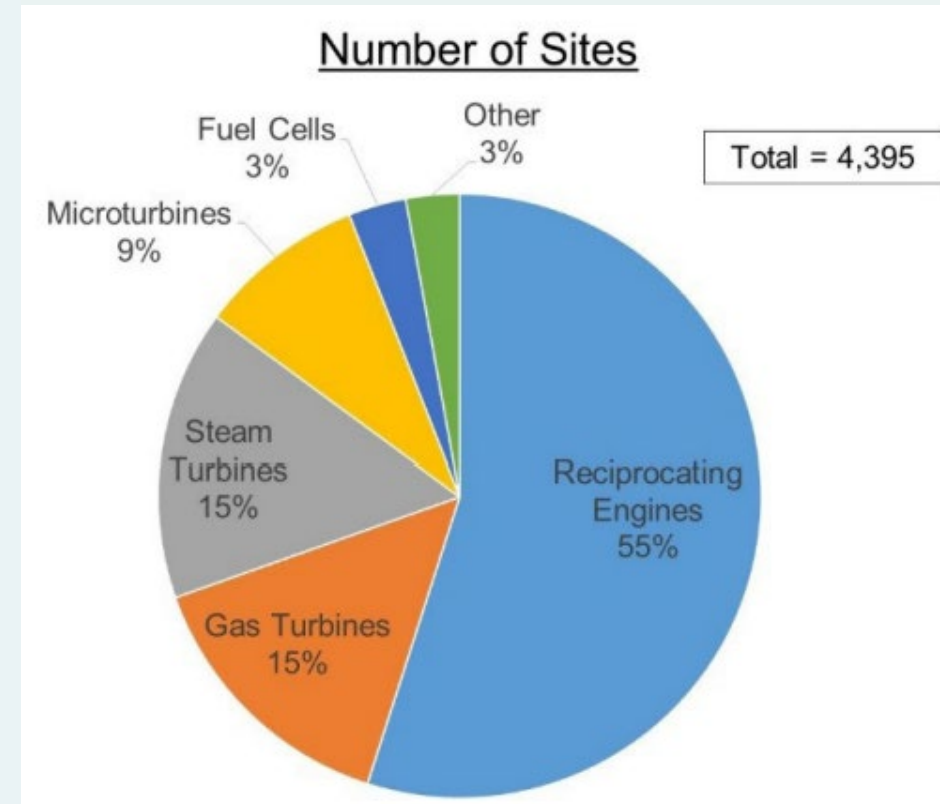


Image source: <https://www.clarke-energy.com/biogas-upgrading/>



Biogas Combined Heat and Power

- Reciprocating engine: Familiar to mechanics, but very maintenance intensive, lower initial cost, highest total efficiency
- Gas turbines: Moderate up-front costs, lower maintenance costs, but similar labor intensity to engines, moderate efficiency, low emissions, no cooling needed.
- Microturbines: Similar to gas turbines, but lower maintenance costs (smaller components), lowest total efficiency
- Fuel Cell: Highest capital costs and maintenance costs, low maintenance labor, highly efficient, lowest pressure requirement, very quiet operation



Examples of CHP Types



Reciprocating Engine at KWRD

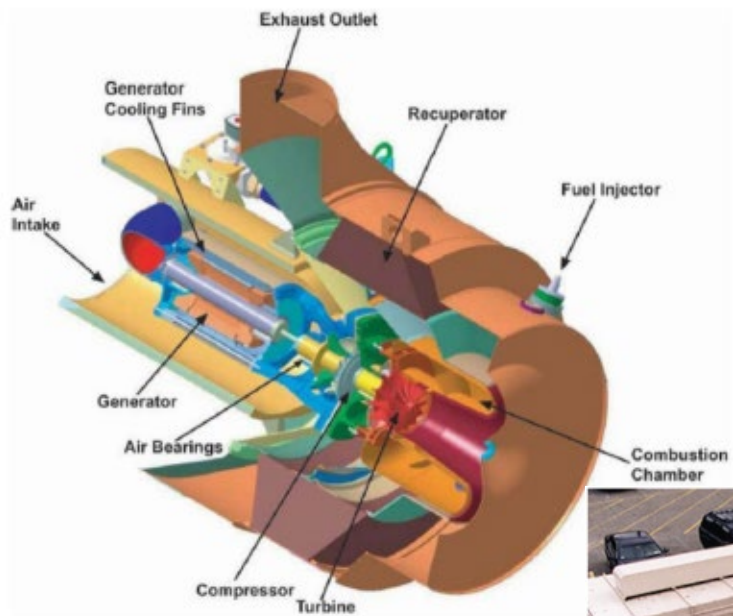


Figure 2. Microturbine illustration.
Graphic credit Capstone Turbine Corporation.

DOE Microturbine Diagram

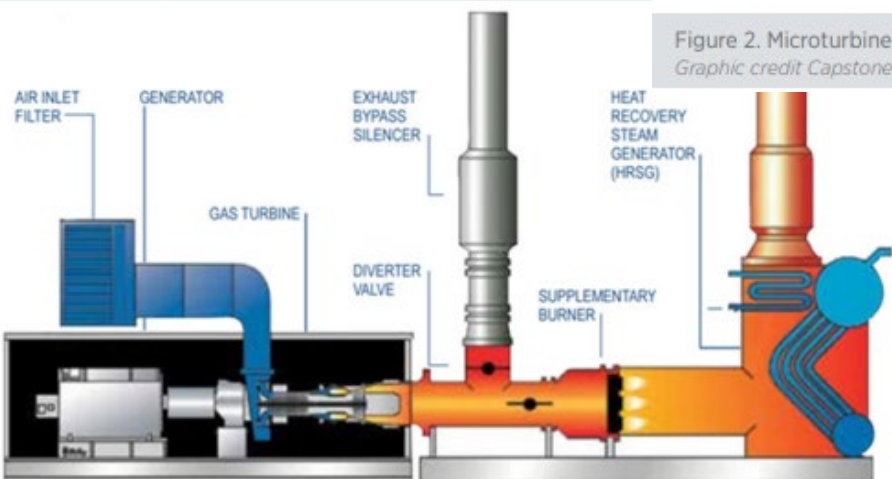


Figure 1. Gas turbine configuration with heat recovery.
Graphic credit Energy Solutions Center.

DOE Gas Turbine Diagram



CHP fuel cell installation at Verizon data center.
Photo courtesy of Verizon Communications.

DOE Fuel Cell Example



Add Renewable Power!

A straightforward solution to decarbonizing.

Note: Illinois mandatory net metering will sunset 1/1/25, replaced by supply value-based pricing.

- Some reduction in renewable conversion benefits, though still lowers electric costs.
 - Ground, rooftop, or floating PV options exist
 - Ground easiest to access for maintenance
 - Rooftop using existing constructed space if land is limited
 - Floating PV good option for lagoons and retention basins



Nutrient Recovery with Biomass

- The AlgaeWheel technology is one of a few biological nutrient recovery processes
- Initial configurations were large shallow ponds to allow maximum algal growth
- New technologies try to shrink that footprint while maintaining growth rates.



Image source: www.algaewheel.com



Image source: www.algae.com/sustainability



Plant-Based Biomass Nutrient Removal

- Floating vegetative mats can pull nutrients from water.
- Excellent for lagoon polishing cells
- Can also be floated in waterway at plant effluent to stream.



Image source:

<https://www.floatingislandinternational.com/wastewater.html>



Constructed Wetland Nutrient Removal

- Constructed wetland provide polishing step to remove additional nutrients.
- Plants host microbial colonies the nitrify and denitrify.
- Colonies also convert phosphorus into forms absorbable by the plants.
- Provide additional TSS filtration.
- Effectiveness tapers off in winter as plants die/hibernate.



Image source:

https://mcleanwater.org/?page_id=1003-BNWRD

Constructed wetland



How Vegetative Mats Clean Water

- Very similar to constructed wetlands (floating treatment wetlands).
- Plants directly uptake nutrients
- Roots provide home for biofilms and aquatic life
- Can remove N, P, heavy metals, and sediments

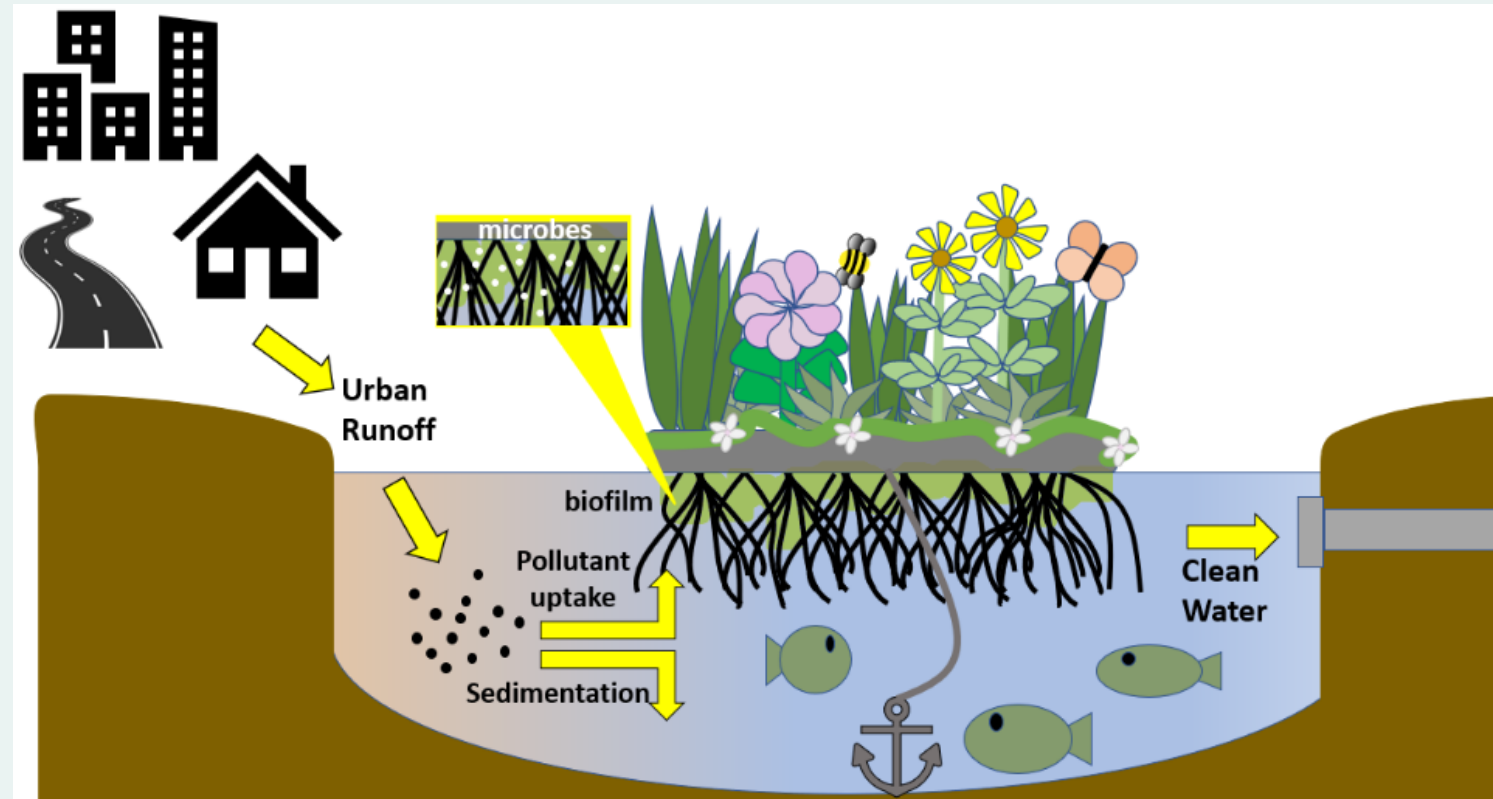


Figure 4. Diagram of a floating treatment wetland and the three primary mechanisms of reducing pollutants from urban stormwater runoff. Image credit: Clare Escamilla, Clemson University.

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!



Wastewater Reuse Case Study



- Irrigation system winterized each year, application only when ground is thawed and can accept irrigation flow.
- Non-Potable Irrigation used at 135 acres of parks, open spaces, berms, and Carillon golf course and rec. center.
- 12 miles of service mains supply system.



Map of Irrigation Areas



- 17 controller stations
- 480 zones
- 8,074 spray heads
- Annual soil analysis required
- Irrigation needs buffer between application and residents
- Land application considered treatment step
- Less stringent NPDES permit and lower fees!

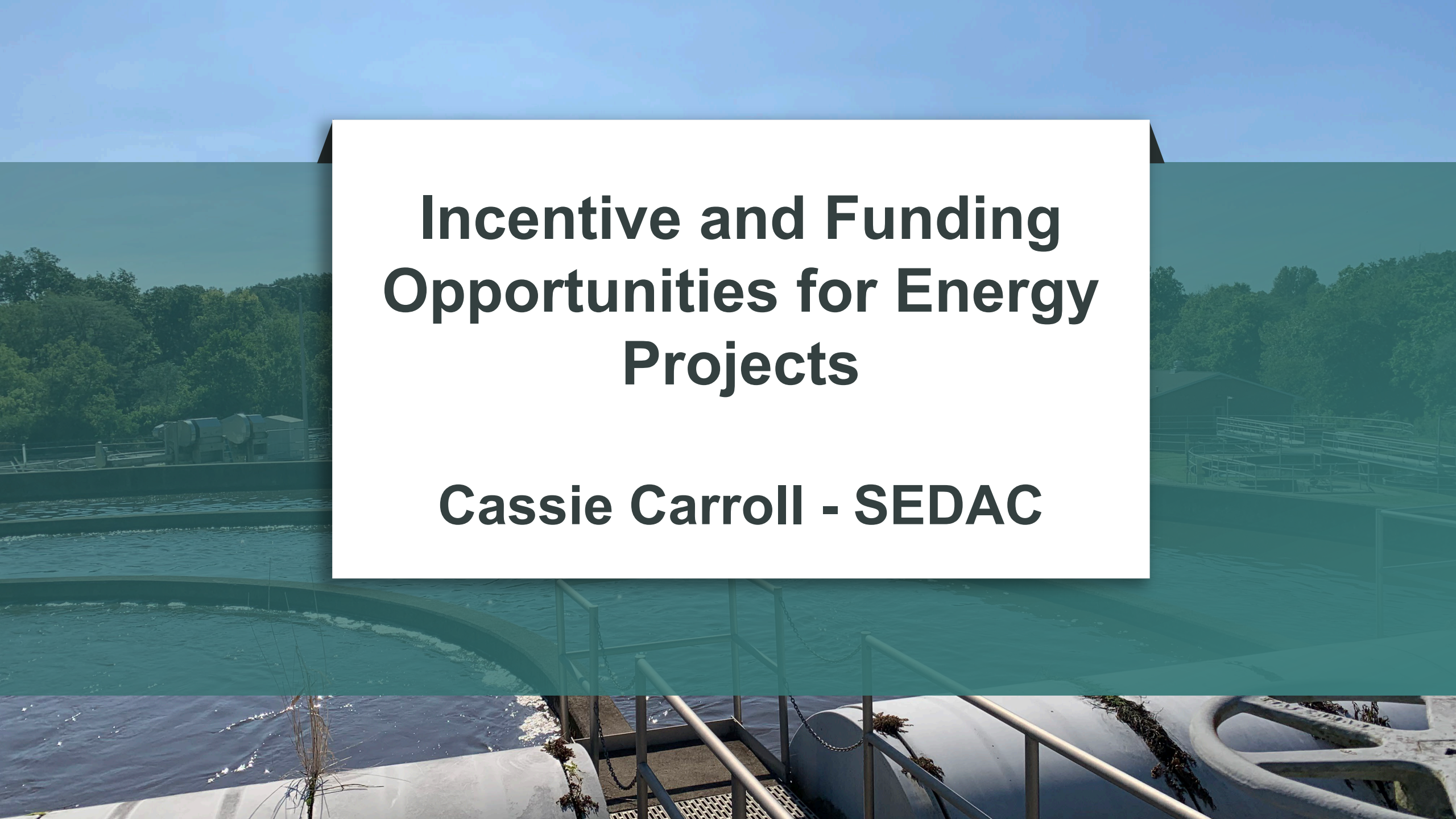


Questions?

spmaurer@illinois.edu
217-300-1771

smartenergy.illinois.edu/water





Incentive and Funding Opportunities for Energy Projects

Cassie Carroll - SEDAC

IEPA Energy Efficiency and Conservation Block Grant



Competitive Grant Program – 3rd Round

- Funding to develop local strategic energy and/or climate action plans based on Blueprints developed by US DOE.
- Eligibility: Municipalities and counties that did not receive a formula grant or Voucher funding
 - Application closes: June 17, 2024
 - Award range: \$25,000 - \$150,000
 - Cost match NOT required!

*** A separate funding opportunity will be announced in the near future to specifically fund projects, which include energy efficiency upgrades as identified within Energy Plans!



<https://epa.illinois.gov/topics/energy/energy-efficiency/energy-efficiency-conservation-block-grant.html>



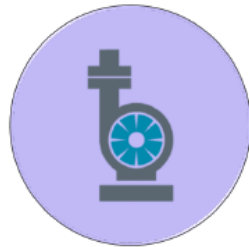
ComEd Energy Efficiency Program

Energy Efficiency Opportunities



Aeration Upgrades

- Fine bubble diffusers
- Variable blower air flow rate
- Automatic aeration control
- Blower technology options



Wastewater Pumping

- Variable frequency drive applications
- Correctly sized motors
- Avoid pump discharge throttling



Mixers and Agitators

- Vertical linear motion mixing
- On/off mode
- Multiple impellers



Upgrades for Nitrogen Removal

- Nitrite shunt
- Anammox and Deammonification



Lighting and HVAC

- LED, Lighting Controls
- High Efficiency HVAC units

ComEd Energy Efficiency Program

- **Aeration Upgrades**
 - Fine bubble diffusers
 - Variable blower air flow rate
 - Automatic dissolved oxygen control
 - Blower technology options
- **Custom Upgrades (not for aeration)**
 - Variable frequency drive applications
 - High efficient bio solids mixers
 - Ultraviolet (UV) lamp controls and upgrades
 - Combined Heat and Power (CHP)
- **Standard measures such as:**
 - Lighting, HVAC, Laboratory Equipment
 - Comed.com/WaysToSave/ForYourBusiness/Pages/FactSheets/StandardIncentives.aspx
- **Distributed Generation Rebate: \$250/kW**

Wastewater Treatment & Water Supply Plant Study

- \$0.18/kWh saved after recommendations implemented
- Aeration improvements w/ blowers/DO controls: \$0.21/kWh
- Up to 100% of eligible costs covered
- Must spend at least \$15k on measures that pay back within 1.5 years or less

Illinois EPA & USDA Grants and Loans

Illinois EPA Revolving Loan Program

- Rates: July 1, 2023 – June 30, 2024
 - Base Rate: 1.81%
 - Small Community Rate: 1.36%
 - Hardship Rate: 1%
- Green Project Reserve (10% of loan fund)
- Funding nominations are usually in March annually for upcoming fiscal year

For more information, contact Gary Bingenheimer

Gary.Bingenheimer@illinois.gov
217-782-2027



Illinois EPA & USDA Grants and Loans

USDA Rural Development – Water & Environment Grant Fund

What is an eligible area?

- Rural areas and towns with populations of 10,000 or fewer.

What is the loan term and rate?

The loan term is up to a 40-year payback period, based on the useful life of the facilities financed with a fixed interest rate. The interest rate is based on the need for the project and the median household income of the area to be served. Contact us for details and current interest rates applicable for your project.

How may the funds be used?

Funds may be used to finance the acquisition, construction, or improvement of:

- Drinking water sourcing, treatment, storage, and distribution
- Sewer collection, transmission, treatment, and disposal
- Solid waste collection, disposal, and closure
- Storm water collection, transmission, and disposal

In some cases, funding may also be available for related activities such as:

- Legal and engineering fees
- Land acquisition, water and land rights, permits, and equipment
- Start-up operations and maintenance

- Interest incurred during construction
- Purchase of facilities to improve service or prevent loss of service
- Other costs determined to be necessary for completion of the project
- See 7 CFR Part 1780.7 and 1780.9 for a complete list

<https://www.rd.usda.gov/programs-services/water-environmental-programs>



Illinois EPA & USDA Grants and Loans

USDA Rural Development – Water & Environment Loan Fund

What are the revolving loan fund terms?

- The maximum loan for each borrower is \$200,000, with a term of 10 years
- The interest rate is determined by the nonprofit that manages the revolving loan fund, and must be approved by USDA's Rural Utilities Service

What is an eligible area?

- Rural areas and towns with populations of 10,000 or fewer.

Are matching funds required?

Yes. The applicant must contribute at least 20 percent. Note: Matching funds can come from the applicant or a third party, but cannot be in-kind contributions.

<https://www.rd.usda.gov/programs-services/water-environmental-programs>



Other Opportunities

- **Illinois EPA Lead Service Line Inventory Grant Opportunity**
 - \$20,000 - \$50,000 per applicant
 - Open until \$6.57M is expended!
- **Check our website!**

Government Grants, Loans, and Assistance	Utility Incentives
US DOE Sustainable Wastewater Infrastructure of the Future (SWIFT) +	Illinois Municipal Electric Agency Rebate Program +
USDA Rural Development Water and Environmental Programs (WEP) Loans and Grants +	ComEd Energy Efficiency Program (for ComEd customers) +
Illinois EPA Wastewater Treatment Plant Energy Efficiency Grant +	Ameren Illinois Rebate Program (for Ameren customers) +
Illinois EPA Revolving Loan Fund +	Nicor Gas Energy Efficiency Incentive Programs +
Illinois Finance Authority (Loan) +	North Shore Gas Energy Efficiency Incentive Programs +
Private Grants or Assistance	
Rural Community Assistance Program (RCAP) +	
DOE Midwest CHP TAP +	
Net Zero Energy Wastewater Grant +	



Questions?

ccarrol2@illinois.edu
217-300-6477

smartenergy.illinois.edu/water

