AECOM

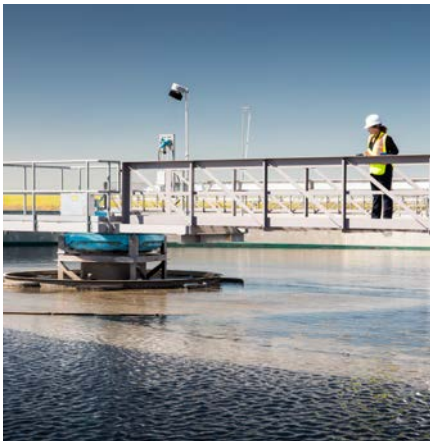
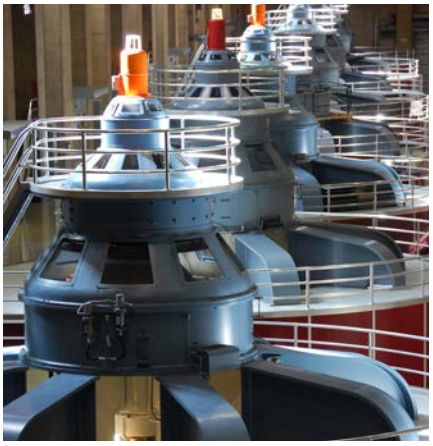
# Water/Energy Nexus

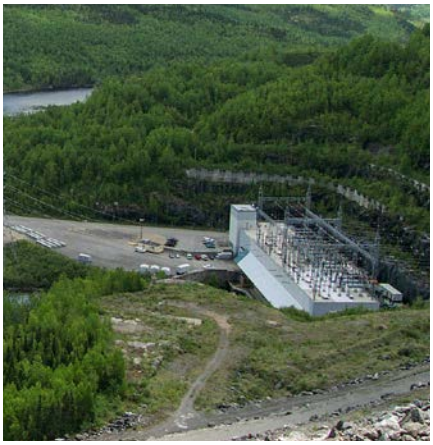
Sustainable Project Delivery

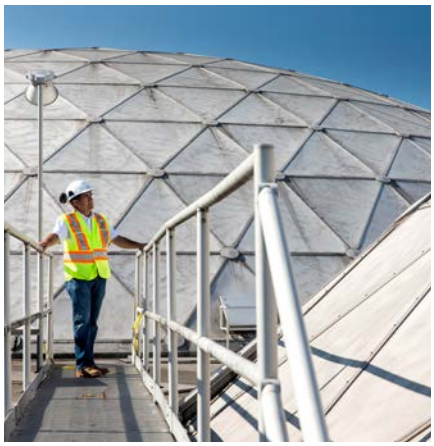

Delivering a better world









## AECOM's combination of global experience and integrated technical capabilities deliver strategic solutions through the water/energy nexus that improve and modernize infrastructure, enhance sustainability and resiliency and benefit the community.

Water and, more specifically, wastewater utilities are among the largest energy users in the nation. In addition to the high cost of energy expended by these utilities, they contribute significantly to greenhouse gas (GHG) emissions. The industry is focusing on environmental responsibility, affordability, resource recovery and attaining energy neutrality. As a result, there are significant opportunities for utilities to reduce energy demand through technologies and logistics, produce energy through use of waste products, and incorporate innovative design as well as dynamic operations and maintenance (O&M) practices.

We are leaders among engineering and architectural firms that deliver water/energy programs and projects to public and private utilities. We have the vision, knowledge base and skills to assist utilities in meeting existing and future state of good repair needs; regulatory requirements; operation and maintenance sustainability; and environmental, economic and social responsibilities. We are also an industry leader in researching and demonstrating innovative technology that has proved beneficial to the water/energy partnership.

Every water resource recovery facility could be energy neutral. Digester gas —which is 60 percent methane—holds potential to be used in a number of ways for energy production. The gas can be cleaned and used for transmission into the gas grid, compressed natural gas (CNG) vehicle fueling or for electric and heat production. Other energy recovery opportunities include: harnessing energy from water/wastewater transmission and system hydraulic gradients; use of large surface areas for solar or wind farms; heat recovery from water/wastewater and mechanical equipment. Digester gas availability also presents the opportunity for partnerships with waste management companies to collect organic food waste, oils and grease for increased biogas production from their digestion/co-digestion with sludge for additional generation of electric, heat or biomethane.

AECOM is well situated to develop strategic plans for private and public utilities to assist them in obtaining/approaching energy neutrality as well as reducing costs and achieving long-term sustainability. Our expertise and success in these businesses provides utilities with a "one stop shop" for contracting.

Collaboration between water and energy business lines enable utilities to improve design, management practices (including demand management) and optimization—measures that significantly advance energy efficiency.

Our areas of expertise include:

- Wastewater plant energy optimization
- Biosolids
- Hydroelectric and geothermal
- Solar, wind and combined heat and power (CHP)
- Transmission and distribution
- Water and wastewater resource recovery
- Energy management

# Wastewater Plant Energy Optimization

**Newtown Creek Water Resource Recovery Facility**
New York, New York, USA

**Greenhouse Gas (GHG) Emissions and Energy Audits, New York City Department of Environmental Protection (DEP)**
New York, New York, USA
*AECOM has performed extensive energy evaluation work ranging from energy audit for 8 of its 14 wastewater treatment plants (WWTPs) as well as evaluating the GHG emissions for each of its WWTPs. The GHG audits were based on Local Government Operations Protocol (LGOP) guidelines. The ECMs were developed based on plant operations and best technologies and techniques to reduce energy demand and produce renewable energy. These have become the foundation of efforts to achieve the DEP's energy and GHG emission goals.*

## Wastewater Plant Energy Audits

Water and wastewater treatment plant energy optimization starts with a facility energy audit and culminates in the design and construction of economically feasible energy conservation measures (ECM) identified in the audits. Several wastewater ECMs are defined in the areas of energy conservation and reduction in wastewater treatment plants section that follows. AECOM provides several different energy audit levels that, in general, follow ASHRAE-defined levels. These levels are augmented to account for their initial use in buildings and wastewater plants, which have unique biologic/chemical and physical processes.

Level 1 audits, or screening audits, are those in which energy usage is benchmarked against other similar facilities to identify an initial potential level of energy savings. The first level audit also involves minimal interviews with operators, energy data and major process operational data review, as well as a walk through of the facility with a focus on major energy consuming processes. Audit results produce a list of potential areas that could result in energy savings and an order of magnitude level of reductions in this area as well as a simple cost and payback to perform the work.

**Stickney Water Reclamation Plant Energy Management Program**
Cicero, Illinois, USA
*AECOM performed an Energy/GHG audit of this facility and developed a conceptual roadmap of energy conservation measures that would drive the facility towards energy neutrality.*

An investment grade, or level 2 audit, expands on the level 1. The level 2 audit examines the energy and operational data and its ECMs include potential operational changes (ammonia-based aeration control), technology changes (i.e. ANAMMOX, Granular Sludge), as well as institutional controls (heating and cooling policies and incorporating energy analysis in design). Level 2 audits include an economic analysis which can range from a simple payback analysis with a basic conceptual level design to a life cycle cost analysis with a 10 percent design.

AECOM also conducts level 3 audits which expand those of the level 2 to include capital planning and state of good repair analysis while also identifying additional benefits, synergistic construction, needed repairs and upgrades and other economic, environmental and public benefits.

AECOM's comprehensive energy audits provide the foundation for economically feasible and sustainable energy optimization, GHG reduction and recovery of resources from wastewater byproducts.

**Blue Plains Wastewater Treatment Plant**
Washington, D.C., USA
*AECOM performed the alternatives analysis and 10 percent design for the "Deammonification Processes" that uses the ANAMMOX bacteria to greatly reduce energy and chemical costs when removing nitrogen from a filtrate stream of dewatered digested sludge.*

## Areas of Energy Conservation

Energy conservation measures are a product of energy audits. We are well-versed in identifying these measures for the wastewater processes and the biosolids processes. These measures for the wastewater stream include operational modifications requiring little to no capital costs such as:

- Reducing recycle flows to the head of the plant
- Transferring grease/scum to the digester as opposed to landfill
- Minimize pumping energy by minimizing TDH by allowing wet wells to operate at a maximum height as often as feasible
- Implementing occupied and unoccupied ventilation, as state and local laws allow
- Masking and subdividing areas to focus odor control on unit processes instead of rooms or buildings

ECMs also include equipment replacement with higher efficiency models. These typically include:

- Employing more efficient pumps such as return pump, influent pumps, etc.
- More efficient blowers, such as turbo blowers
- LED lighting


AECOM is also versed in ECMs that use innovative and advanced technologies. These include:

- Granular sludge that reduces pumping needs and footprint
- ANAMMOX for nitrogen removal for dewatered sludge filtrate/centrate
- Chemically enhanced primary treatment (CEPT) to maximize sending energy rich primary sludge to anaerobic digestion to enhance biogas production while minimizing carbon loading to secondary treatment lowering air demand

These are only a few of the ECMs that AECOM can identify, analysis, plan, design and construct for process and buildings. Additional biosolid ECMs are discussed in the following section.

**Washington Suburban Sanitation Commission West Branch Wastewater Treatment Plant**
Upper Marlboro, Maryland, USA
*We designed the improvements for the Washington Suburban Sanitation Commission West Branch Wastewater Treatment Plant, which included four magnetic bearing turbo blowers for aeration. This resulted in energy efficiency gains at the facility.*

# Biosolids and Water/Wastewater Resource Recovery

From left:
**Oxford Advanced Digestion Plant**
Cassington, Oxfordshire, UK

**Blue Plains Wastewater Treatment Plant**
Washington, D.C., USA
*As program managers, we assisted in the selection of the biosolids handling processes including the thermal hydrolysis process (THP).*

## In-Plant Biosolids Handling

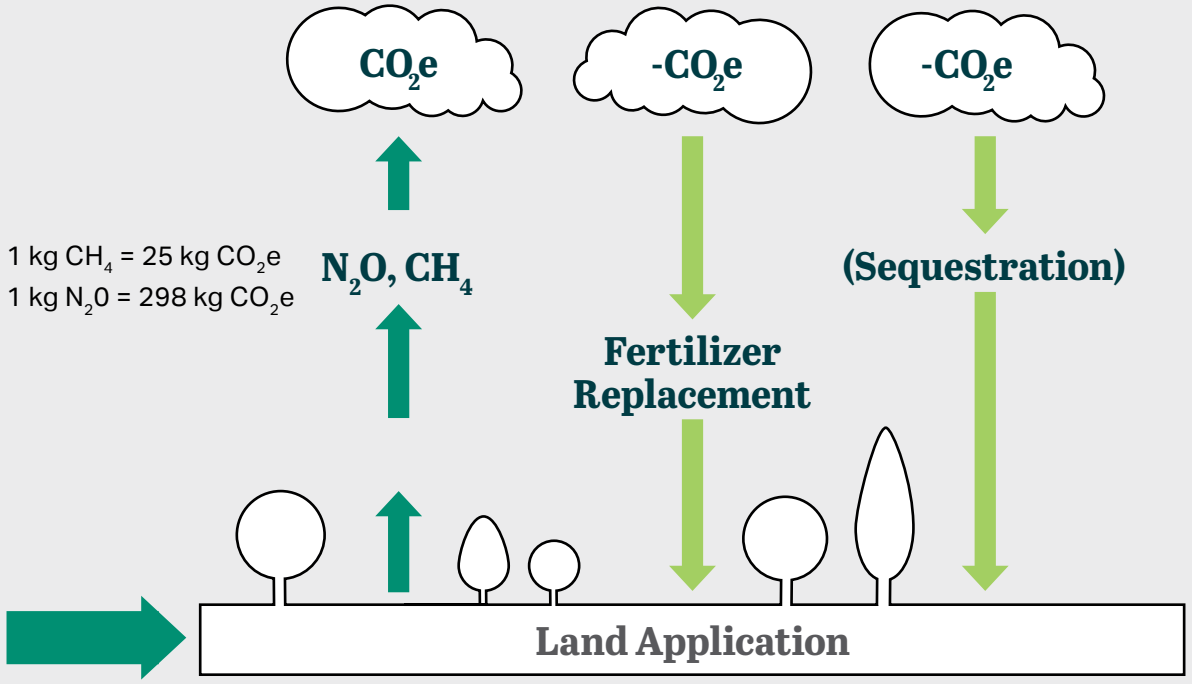
Once considered a waste product, biosolids are in actuality, an energy resource. Demand for the beneficial use of biosolids is growing quickly and the technologies to make this usage a reality—maximizing energy from biosolids, reducing landfill and increasing post-treatment use—are fast-developing. Our experts have a clear understanding of the desire and technologies for beneficial biosolids use and processing. Once these are identified during the energy audit, we work with facility planners to develop various ECM possibilities which can be categorized as either in-plant or out-of-plant ECMs.

In-plant biosolid ECMs start with handling, but also include use of biogas production and combined food waste and biosolids digestion. Some major ECMs include:

- Separate thickening for secondary/tertiary sludges and primary sludges reduces the sludge volume to anaerobic digesters, increasing digestion hydraulic retention times (and subsequently biogas) and reducing heating mass
- Thermal hydrolysis to get Class A biosolids, reduce needed hydraulic detention times and possibly increase biogas production
- Identify optimum anaerobic digestion configuration (acid phase/methane phase, thermophilic and mesophilic/thermophilic)
- Investigate codigest biosolids with food waste—this process includes a digestion analysis (maximum amount of food waste that can be processed and increased biogas production), a market analysis for available food waste and required collection and processing measures
- Post-digestion processing including dewatering (possible thermal hydrolyisis), incineration, gasification and liquifaction
- Combined heat and power generation from produced biogas or applying additional biogas cleaning processes and placing the gas on the grid

**Carbon Footprint of Land Application**

*AECOM assists clients through technical support of their Biosolids Management Programs. Land application of biosolids has a net benefit though fertilizer and growth along with sequestration of inorganic carbon into the soils.*




## Out-of-Plant Biosolids Handling

Out-of-plant biosolids handling technologies is a growing field. The main use consists of composting biosolids or employing other processes to convert biosolids into fertilizers. These fertilizers can be applied in municipality park flower beds, sold on the open market, or used for crops. Developing "fuel crops" such as willow farms are another potential use. Here, spent surface mined land or brownfields can be used to grow these energy crops and the biosolids become the major part of the soil. These crops will sequester carbon dioxide and the grown crops can then be incinerated to produce electric and heat.

Since every facility is different with respect to existing processes, location, capacities and state and local laws, viable biosolids handling technologies will vary from facility to facility. We are aware that thermal hydrolysis may be applicable to one facility where thermophilic codigestion is suitable for another. We are also keenly aware that off-site regional biosolids handling facilities may be an additional option for a municipality operating multiple wastewater treatment plants or from an agreement between several independent facilities or municipalities. AECOM also uses our Technical Practice Network (experts in different fields of technologies) to identify and evaluate innovative and emerging technologies that have the potential to evolve into viable, cost effective and environmentally responsible sustainable biosolids that become energy solutions.

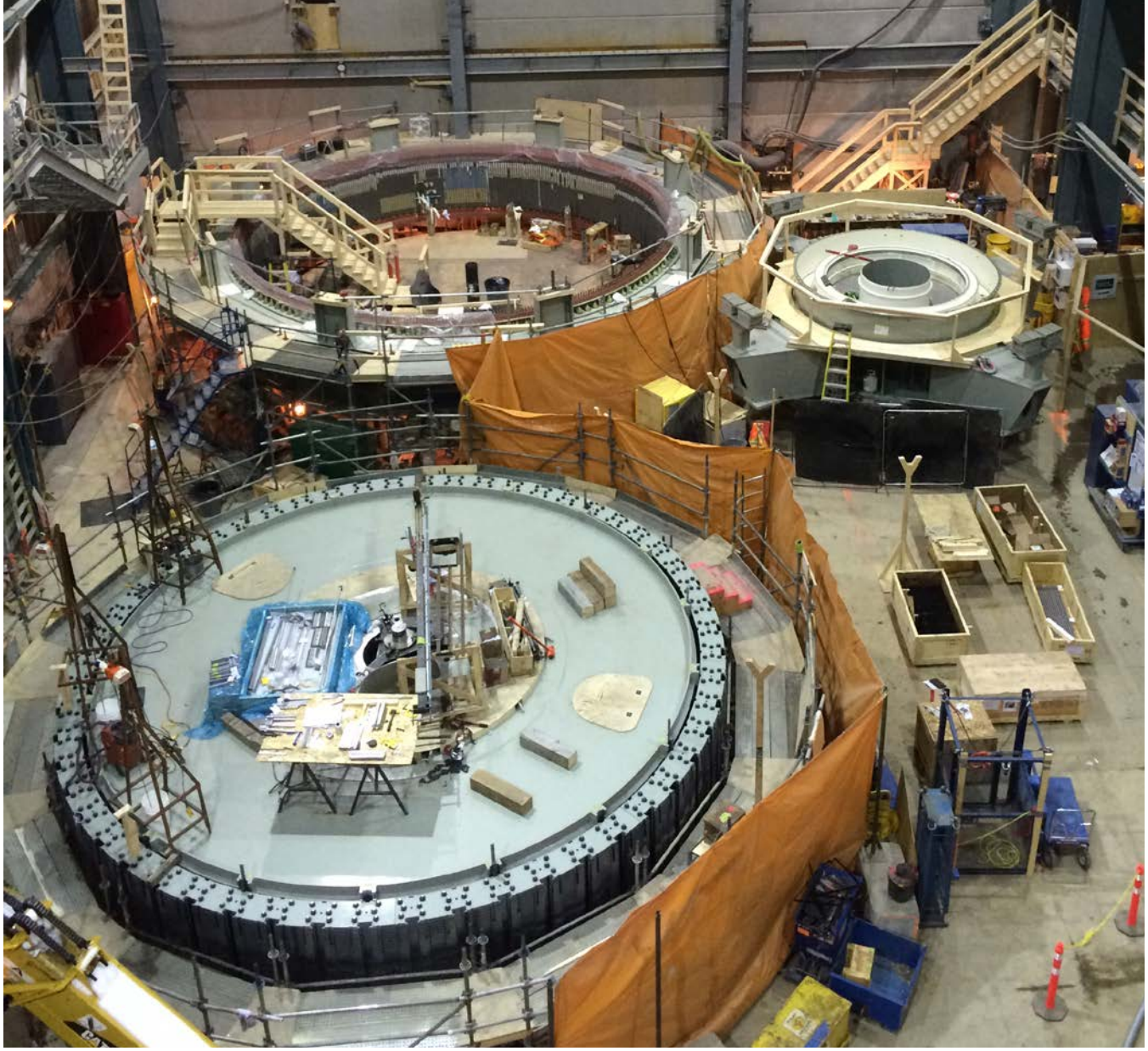
# Hydroelectric and Geothermal

**Outardes Hydropower Plant Rehabilitation and Modernization**
Baie-Comeau, Quebec, Canada

**National Western Center Integrated Campus Energy Systems**
Denver, Colorado, USA

The potential energy inherent in water and wastewater systems can be leveraged to supply power, heat and cooling to reduce system energy footprints and reduce GHG emissions. We are leaders in project delivery that maximizes the potential for harnessing these energy sources. Our clients benefit through cost efficiency and environmental responsibility.

We have the experience and expertise to deliver greenfield or rehabilitation hydropower projects to our clients. We have designed and constructed dams and conveyance hydropower projects ranging from low-head distribution systems to gravity fed piping systems to dams with capacities of up to 12,600 mega-watts (MW) and 2,100 feet of head. Our team has also evaluated and engineered incorporating turbine power systems using head differential from hydraulic drops in wastewater collection systems and plants. Safety in design construction and operations are consistent themes across these programs and projects. Our comprehensive engineering services include design, construction, feasibility and performance evaluation studies, monitoring, inspection, maintenance and risk assessment.



Water and wastewater systems can be used to provide geothermal energy for our clients. Heat can be recovered from sewage in the interceptors or the interceptors can be used as a thermal sink to provide a means of rejecting heat from cooling systems. Water supply systems can also be engineered to use water from storage and transmission or cooling of equipment through heat transfer systems. This process can also be used for in-plant wastewater. Our water and energy business lines collaborate to provide full energy efficient water transmission and geothermal studies, design and construction services to our clients.

AECOM realized more than 140,000 MW of hydropower generation globally. With more than 100 years of experience in designing and developing hydropower projects, we provide fully integrated project planning, feasibility, design, project management and O&M services to hydropower clients.

**La Romaine-2 Hydroelectric Plant**
Quebec, Canada
*AECOM provided engineering, environmental and social expertise to develop Quebec's hydropower potential. This renewable energy project increases generating capacity, while meeting current energy needs without jeopardizing the energy supply of the future.*

# Solar, Wind and Combined Heat and Power

*AECOM can assist utilities in reducing their electrical energy demand by designing wind farms on protected watershed areas.*

Watershed areas, water supply systems, treatment facilities and wastewater facilities have large properties and footprints. These facilities can provide space for solar and wind farms. Areas and potential uses include:

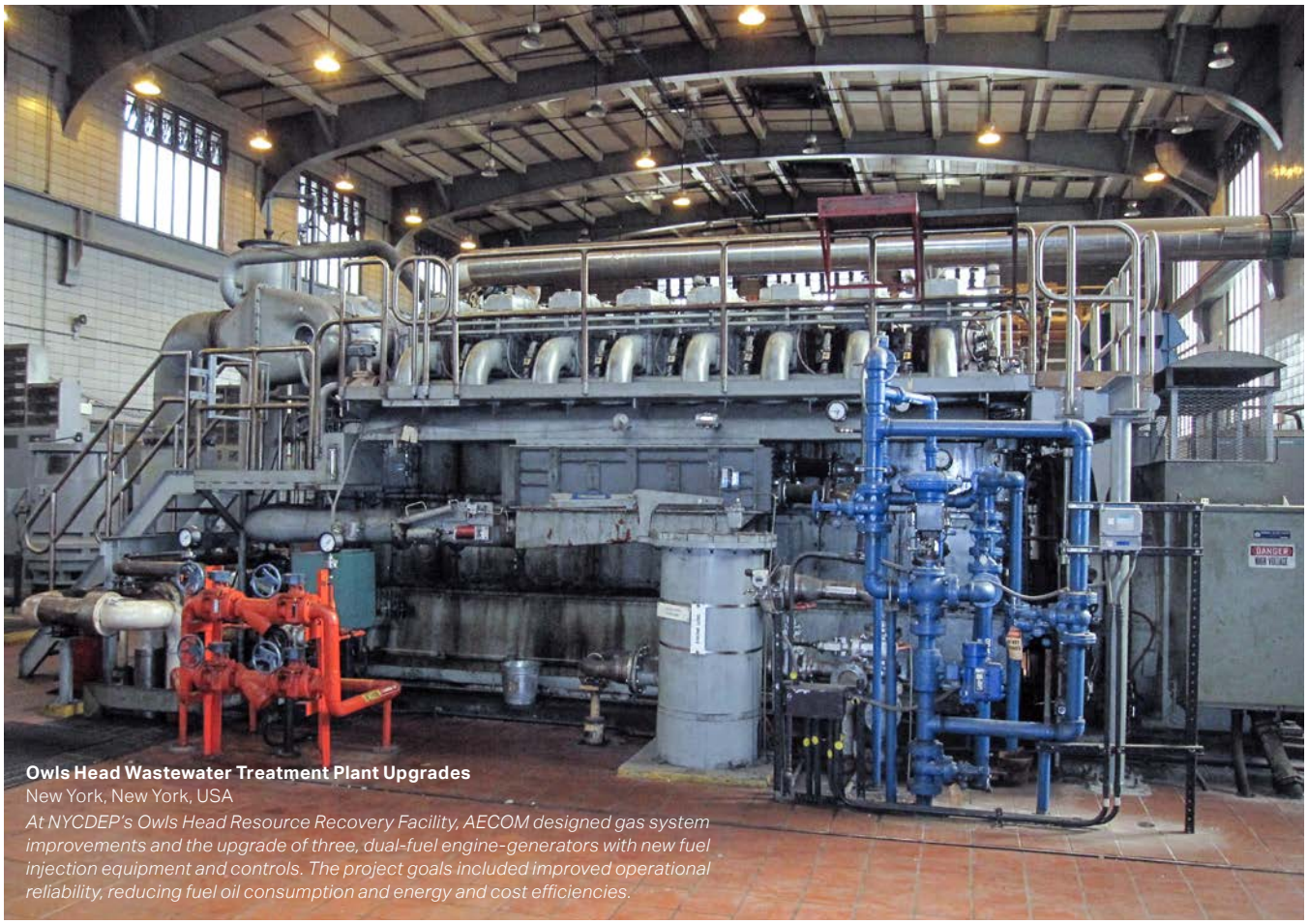
- Open watershed fields, which can be used to construct solar and wind farms
- Covered reservoirs, which can house solar panels
- Water and wastewater treatment facility roofs, which can provide space for solar panels
- Open and covered tankage, over which solar panels may be installed while allowing for operation and maintenance of the tanks

## Solar

Our teams have been involved in some of North America's largest projects. We are currently working with many of the world's foremost solar energy developers, manufacturers and leading solar-adopting utilities and government entities on solar power generation facilities. With over 300 offices spread across North America, we provide local and cost-effective resources wherever the effort is needed. We combine local resources and a strong internal network connecting specialists from around the world to effectively and efficiently solve our clients' challenges.

We help developers, electric utilities and end users evaluate solar energy options, navigate regulatory environments and implement solar strategies from buildings and facilities to large-scale utility-size solar fields built to deliver energy to thousands of homes and businesses.

AECOM has helped deliver more than 15 GW of solar power globally.



**Owls Head Wastewater Treatment Plant Upgrades**
New York, New York, USA
*At NYCDEP's Owls Head Resource Recovery Facility, AECOM designed gas system improvements and the upgrade of three, dual-fuel engine-generators with new fuel injection equipment and controls. The project goals included improved operational reliability, reducing fuel oil consumption and energy and cost efficiencies.*

## Wind

Our experts offer multidisciplinary environmental and engineering services for the development, design, construction and O&M support of wind energy projects. We have helped our clients meet their energy goals using wind energy programs and projects that incorporate generation and transmission. Worldwide, our experts have provided planning, development, permitting, engineering and construction of more than 30 GW of wind power.

## Combined Heat and Power

We have provided services for over 150 power generation projects, including water/wastewater utilities. Evaluating and engineering combined heat and power using biogas from digestion is a sustainable use for turning a waste byproduct into renewable energy that is cost efficient and reduces greenhouse gas emissions.

Our scope of services include geotechnical and foundation design, selection of required generation equipment and ancillary systems transmission and distribution.

Our professionals can also assist with installation of all systems and components. Our engineering solutions include a heat recovery system, providing the prime source of electrical and thermal energy to the client, while maintaining a synchronized connection to the utility grid so that the utility can pick up any excess electrical load.

# Transmission, Distribution and Energy Management

**Digester Gas Utilization**
Janesville, Wisconsin, USA
*AECOM designed a BioCNG system to convert anaerobic digester gas into compressed bio natural gas.*

AECOM supports utilities by providing engineering services for cogeneration, including power distribution within the facility campus and/or transmitting power into the electrical power company grid. We have also provided engineering services for cleaning and transmission of produced biogas into the utility gas grids.

Water and wastewater utilities have requirements for transporting residuals. Our professionals can assist these utilities in the development of biosolids and residuals master planning. We can also assist utilities in the evaluation and engineering of biogas transmission for use as a vehicle fuel.

AECOM can provide additional energy transmission and distribution and energy management including:

- Demand management and demand response
- Energy master planning
- Resiliency planning
- Innovative project financial solutions
- Investment-grade audits
- Lighting design and implementation
- Industrial controls systems
- Microgrids/smart grids
- Distributed generation
- Energy efficiency
- System resilience


*AECOM has designed switchgears, as demonstrated in this photo, with real time metering to assist clients with demand management.*

- Systems integration and communication
- Battery energy storage system
- Battery backup
- Interconnection studies
- Power factor
- Infrastructure reliability upgrades

We are excited about helping our clients find synergistic solutions to water and energy management. By aligning proven and innovative designs in water and energy engineering, triple bottom line benefits are shared by our clients and their stakeholders.

**Digester Gas Utilization**
Janesville, Wisconsin, USA

**About AECOM**

AECOM is the world's trusted infrastructure consulting firm, delivering professional services throughout the project lifecycle – from planning, design and engineering to program and construction management. On projects spanning transportation, buildings, water, new energy and the environment, our public- and private-sector clients trust us to solve their most complex challenges. Our teams are driven by a common purpose to deliver a better world through our unrivaled technical expertise and innovation, a culture of equity, diversity and inclusion, and a commitment to environmental, social and governance priorities. AECOM is a *Fortune 500* firm and its Professional Services business had revenue of $13.3 billion in fiscal year 2021. See how we are delivering sustainable legacies for generations to come at aecom.com and @AECOM.

**Key Contacts**

Beverly Stinson, P.E., PhD
Senior Vice President
Global Business Line Leader
T +1 917.355.3169
beverley.stinson@aecom.com

John G. Petito, P.E., BCEE
Associate Vice President
T +1 646.670.2195
john.petito@aecom.com

Robert J. Pape, P.E.
Senior Technical Specialist
T +1 732.564.3940
robert.pape@aecom.com

Leonard Dorr
Senior Vice President, Energy
T +1 909.579.3964
leonard.dorr@aecom.com

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