

## **The Energy Revolution**

### *How Baltimore is using innovative clean power at City facilities*

#### **Theodore Atwood**

Chief, Sustainable Energy  
Department of Public Works  
City of Baltimore, Maryland

A revolution is taking place in the energy industry that is creating opportunities that were not economically possible five to ten years ago. These opportunities allow for increased reliability of operations, cleaner air, and reduced carbon emissions.

Take a moment to consider the many changes in energy production. At the turn of the century almost 60% of the electricity in the United States was produced from coal. Today that number has dropped to 45% and in the spring of 2015 more electricity was produced from natural gas than coal. Twice the number of Americans work in the solar industry than in the coal industry and over 30% of the new generating capacity built in the U.S. in the past year was solar.

These changes bring new and less expensive small-scale generating technologies, as well as lower cost natural gas, which are opening new opportunities for municipalities to generate energy and save money. Recognizing the growing energy demand combined with the need for increased reliability of energy supply systems, the City took steps to implement a three-part energy program – buy smart, use less, and generate our own energy.

The Department of Public Works found an ideal opportunity to try these new technologies at the water and wastewater facilities for the City of Baltimore and surrounding metropolitan area. Operation of these facilities represents more than half of the City government annual energy use. A combination of an increasing demand and more stringent environmental requirements will more than double the energy demand of these facilities over the next five years.

In 2010, the first generation application was conducted at the Back River Wastewater Treatment Plant with the establishment of a two megawatt (MW) combined heat and power (CHP) facility. The Back River Wastewater Treatment Plant is located on 466 acres, serves 1.3 million residents and has the capacity to treat 180 million gallons of wastewater a day. Highlights of this project include:

- Two stage anaerobic digesters produce a gas with 60% methane content. This gas is burned in internal combustion engines with low NO<sub>x</sub> burners.
- The CHP facility operates with a efficiency in excess of 65%, far better than the average large-scale power plant operating around 40% efficiency.
- With a grant from the U.S Department of Energy, the City formed a partnership with Hy-TEK to conduct a demonstration of an algae system to remove NO<sub>x</sub> and carbon dioxide. A slipstream of 10% of the flue gas from the CHP plant is bubbled through tanks of algae, which removes 99% of the NO<sub>x</sub> and over 80% of the carbon dioxide.

- An added benefit of the algae technology used to clean the flue gas is the production of algae, which has a potential market to sell the algae at \$18-\$40/ pound, depending on the algae and the market.
- In addition to algae, oxygen can also be produced for market or utilized in the aerobic digesters in another wastewater treatment facility operated by the City.
- With the use of internal combustion engines in the CHP, a large portion of the heat comes from the jacket cooling which produces hot water. Staff is now testing a pipe in a pipe heat exchanger to preheat the sludge, which will reduce the steam needs in the digestion reactor.

The City then explored the use of solar energy in the operations. In March 2012, the City began operation of a 1 MW solar field began operation. The combined production of the solar and biomass CHP facilities represents approximately 18% of the Back River electricity demand.

Public Works is now looking to expand the Back River CHP plant from two to four MWs, which are sized based upon the heat demand. The current plant provides the heat for the buildings with the expansion expected to provide the heat for the anaerobic digesters.

Debt financing was used for both renewable projects and the savings from the projects repay the debt. Originally the economic analysis supporting the CHP investment was based upon seven-cent delivered cost for power. When the facility began operation in 2010 the cost of delivered power was 11 cents. Today the cost of delivered power is 9.25 cents. The composition of the electricity cost has changed; the electricity commodity has dropped from 6-7 cents to 3.5-4.5 cents. However, the cost of delivery and the capacity charges have increased 50%. In addition to lower cost electricity from the renewable facilities, the cost of the 70 million KWhr of electricity purchased for operating Back River is also less. This is due to a lower capacity charge as a result of generating electricity behind the meter during the five peak hours in the year.

The success of these clean energy projects at the Back River Wastewater Treatment Plant provided the technical, economic and legal experience for the City of Baltimore to expand the use of clean energy technology. The City is involved in new ventures:

- In December 2015, the City government started to receive production from a 10 MW solar farm. This is being done through a virtual net aggregate metering structure with the Baltimore Gas and Electric Co. The credit for the solar production will be applied to the meters for libraries, recreation centers and fire stations.
- The City is actively developing 30-40 MW of solar fields predominately located on closed landfills.
- In addition, the City is evaluating 15-20 MW of CHP for wastewater and water plants and a micro-grid for a complex of office buildings in downtown Baltimore.

Low-cost natural gas combined with lower cost, more efficient, smaller scale generation technology are enabling municipalities to reduce the costs of energy in addition to implementing energy efficiency programs.

*For more information, contact Theodore Atwood, Chief, Office of Sustainable Energy, City of Baltimore Department of Public Works, at (410) 396-1221 or [Theodore.atwood@baltimorecity.gov](mailto:Theodore.atwood@baltimorecity.gov).*