Case Study: Ann Arbor Water Treatment Services, Michigan

Vanessa Leiby, The Cadmus Group, Inc.

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Background on the Water System and History of the "Issue"

The Ann Arbor Water Treatment Services (AAWTS) obtains surface water from the Huron River and treats it at two water filtration treatment facilities. AAWTS operates four dams on the Huron River—two without hydroelectric power generating facilities (Argo and Geddes Dams) and two with hydroelectric power generating facilities (Superior and Barton Dams). The first water filtration treatment facility was constructed between 1938 and 1949 and has a 22 million gallons per day (MGD) capacity. The second water filtration treatment facility was constructed between 1966 and 1975 and has a capacity of 28 MGD. Both facilities are considered conventional filtration treatment with rapid mixing, flocculation, sedimentation, and filtration in addition to disinfection treatment. Each plant has two stages, primary and secondary. The water is softened in the primary stage and the water is recarbonated (pH adjustment) in the secondary stage.

The AAWTS also operates and manages the city's water distribution system, which is comprised of five pressure districts within the city. The city has a main reservoir supplying the core of the city's finished water storage. Three reservoirs, four pump stations, and two elevated tanks are located in the outer pressure districts. The water distribution system is comprised of over 439 miles of water pipe. The city operates 60 facilities from the source water collection and treatment locations to all sites within the water distribution system. In 2005, the city spent $4.5 million on energy—about 1.6% of a $288 million annual budget.

Energy use and the cost of purchasing energy has long been a concern of the City of Ann Arbor, but to install cost-saving measures and construct energy-efficient facilities, initial capital investment funds are needed. Utility and public works budgets typically do not have a large cash reserve from which to draw from to fund these kinds of projects.

In 1981, Ann Arbor first began to promote energy conservation in all city buildings. By 1988, the city's municipal bonding authority provided a $1.4 million energy bond to implement efficiency measures at 30 different city facilities. The payments for this 10-year bond have been generated through energy cost savings. In 1998, the final payment on the energy bond was made after energy bond payments of over $200,000/year had been included in the annual city budget for each of the previous 10 years. Instead of discontinuing the budget item, it was reduced by 50% to $100,000 for the next five years and used to establish a municipal energy fund. The energy fund is self-financed by taking funds saved through energy efficiency measures and reinvesting the funds into new energy saving projects. The city requires facilities using the energy fund to pay back 80% of the

funded project's estimated energy savings for five years commencing with the first year the facility/energy saving measure is in operation. The energy fund is administered by the city's energy office under the supervision of a three-person board.

Energy Management Change(s) Implemented and Results

The City of Ann Arbor takes pride in being on the leading edge of energy efficiency in terms of creative projects and project funding. All city branches have embraced the concept of energy efficiency, including the AAWTS. City managers, treatment plant supervisors, plant operators, and distribution system operators all contribute to a collective resource pool of ideas that lead to innovative projects and improvements. Several of these innovative ideas are captured in the four projects described below.

Ozonation Optimization. AAWTS operates an ozone disinfection system as a primary disinfection treatment process. The high energy costs of producing ozone led AAWTS to investigate whether manipulating the water conditions would result in water that is easier to treat with ozone and thereby uses less energy for the ozonation process. Prior to any full-scale construction, AAWTS conducted a pilot study to see if changing the water chemistry could result in lowering the energy demand for operating the ozone system. The pilot study results showed that depressing the pH of the water with carbon dioxide before ozone application and then raising the pH with caustic soda after ozone treatment improved the efficiency of the ozonation process and reduced its energy needs.

Operating the ozonation disinfection system under the depressed water pH conditions has reduced the ozone generation energy costs. It is difficult for AAWTS to quantify the savings since the ozone process has only been operated with the depressed pH process since the pilot study was done prior to the completion of the ozone plant. The energy savings costs from less ozone generation must be balanced against the added costs of the chemicals used to depress and then raise again the pH, as well as the chemical pumping costs.

Demand Management System (DMS). AAWTS has set up an operations system that allows operators to view real-time power usage (kWh) at any treatment or pumping facility. The system is treated like a working operations guide for the operator who must stay inside of pre-determined energy setpoints unique to each treatment facility and pumping station. At any given time, operators are able to schedule and time the sequencing of certain process operations to best accommodate the lowest energy rates that the utility can purchase.

DMS allowed AAWTS to switch to off-peak hour pumping for the distribution booster pump stations and the backwash water pumps at the water filtration treatment plants. The off-peak hour pumping at the booster pump stations allows AAWTS to buy power at a lower rate by avoiding on-peak surcharges. However, the DMS is not able to reduce AAWTS's overall energy consumption from its power company. The advantage of the DMS is to shift energy purchases to alternate off-demand times and thereby save the amount of ratepayer money spent on energy. AAWTS estimates that it is able to shift enough on-peak energy demands to off-peak times to realize a 15 to 20% savings on its monthly energy bill.

Use of Variable Frequency Drives. Over the last few years, AAWTS has replaced motors and pumps at the water treatment plant for several processes (backwash water, plant pumping, etc). AAWTS has plans to also upgrade pumps and pump stations in the distribution system with high efficiency pumps and motors. In general, replacing single speed motors is an efficient way to reduce electrical demands (and thereby reducing electrical costs). Single speed motors are generally set to operate in the higher ranges. But

as the demand for the pumping capacity decreases, the single speed motor does not perform as efficiently as it would in the high range. Variable speed or variable frequency motors allow the motor to run efficiently at a lower speed.

In most cases, variable frequency drive (VFD) motors replaced older motors. In other cases, multiple smaller-capacity pumps and motors were used where once one large pump and motor was used. The capital investment for VFDs and multiple pumps and motors can be larger than single speed motors, but AAWTS estimates the payback time on the investment to be about 5 years, which is significantly less than the useful life of the pump and motor.

Computerized Air Handling System. Heating and cooling large air spaces can be a very expensive, inefficient operation. AAWTS recognized that this large ongoing expense could be lowered if the system was centrally controlled. AAWTS' heating systems are powered by natural gas which has a volatile price history. AAWTS installed a computer system to control the operation of the heating, ventilation, and air conditioning system. The utility selected a Windows-based software package at a capital cost of $18,000 based on an upgrade to a previous DOS-based system already in place.

Conclusion

Like many utilities today, AAWTS is in the early stages of realizing how to conserve energy and lower energy costs. As the utility continues to implement energy savings strategies, it will continue to develop metrics to document the savings achieved. Currently, AAWTS is focusing attention on attainable goals to lessen the cost for purchasing power.

Utility Profile

Utility name: Ann Arbor Water Treatment Services, a municipally owned utility
Service area: approximately 125,000
Size of utility in mgd: average = 14 mgd
Source of water: Both surface and groundwater sources. Approximately 85% of the water comes from the Huron River. The remaining 15% comes from multiple wells located south of Ann Arbor.