Implementing Automatic Meter Reading for Water: A Reflective Approach to Weighing Options

Roy McKenzie and Brian Houston

The water industry is both a business and a public service, relying on revenues to provide both. Because all things within the water utility typically are paid for with revenue income from water meters, revenue recovery, protection, and maintenance are integral to its successful operation. Though revenues are not generated from the service side of the industry, customer service is critical to the success of the utility's business.

Modern Automatic Meter Reading (AMR) technology and Advanced Metering Infrastructure (AMI) enable water utilities to achieve the following objectives more effectively:

- Maximize the use of available resources.
- Lower costs.
- Increase efficiencies.
- Improve customer service.
- Improve conservation.

Given the rapid technological developments in automatic metering reading technology over the last decade, selecting from the technologies available today and preserving the ability to build on today's investment tomorrow are daunting tasks.

In 2002, the Tampa Water Department staff conducted cost-benefit studies and small test pilot programs on AMR systems available at that time. The results indicated that cost savings and improved operational efficiency were achievable, but because the investigations focused mainly on direct cost savings that could be created from eliminating meter reading personnel, the payback period was unacceptable.

Recognizing that many other benefits and implications are available today than in 2002, last year Tampa engaged the management consulting and engineering firm SAIC Energy, Environment & Infrastructure LLC to provide a thorough, unbiased assessment of the costs and benefits associated with transitioning from a manual water meter reading system to the advanced meter system known as AMI. The goal was to help control costs by improving the efficiency of meter reading and related customer service operations while enhancing the level of the services provided to customers.

A cost-benefit analysis was prepared in collaboration with city staff through group workshops and individual interviews. Through SAIC's expertise in meter reading systems and the city staff's understanding of city-specific procedures, policies, customer concerns, and organizational priorities, a customized, comprehensive business case was developed that addresses the implications to the city of transitioning to an automated system.

Properly constructed, a utility's business case is an extensive, customized evaluation of all types of costs and benefits. AMI has the potential to offer far-reaching benefits across many areas of a utility organization—some which are financially quantifiable and others which may carry a very subjective value. Whether or not these benefits are attainable greatly depends on a utility's ability to implement and manage the organizational change that successful AMI transitions can create.

Very recently, a number of high-profile complaints have been made against the city because of high water bills that may have been the result of customer-side leaks. This situation has prompted the city staff and leadership to give special attention to AMI.

Roy McKenzie, MSCE, is an engineer and project manager for the Tampa Water Department. Brian Houston, P.E., LEED AP, is a senior project manager for water, environment, and transportation with SAIC Energy, Environment & Infrastructure LLC.

A well-run AMI system would have enabled Tampa to notify these customers of leaks within days after they began, rather than waiting until the leaks were discovered weeks or months later as a result of a very high bill.

In AMR and AMI systems, water meters are read by electronic devices installed on each meter (meter interface units, or MIUs) that collect readings from the meter and transmit them via radio signals to data collection units (DCUs). In AMR systems, DCUs are mobile, requiring meter readers to walk or drive routes with a DCU in order to collect readings. With AMI systems,

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DCUs are permanently located strategically across the service area and relay the collected data to a single central location, where it is organized in a meter data management system (MDMS) database.

A key distinction between AMI and other meter reading techniques is how often meter data can be collected. AMI-enabled meters can be read as often as desired, typically every hour, or instantaneously upon demand. Such detail offers tremendous potential for analysis-based decision making, and timely information about individual customer usage can be used to transform customer service drastically.

For a utility looking to collect once-monthly meter readings for billing purposes only, converting from manually read meters to AMI is rarely cost effective. To make AMI a sensible investment, a utility must extend its benefits across many areas of the organization, including billing and customer service, operations and maintenance, engineering and planning, and conservation and public relations. Also, the impacts on human resources, information technology, and finance that inevitably will occur during implementation must be planned and managed carefully to minimize costs and transition complications.

SAIC evaluated a full-scale deployment of AMI (i.e., for all metered accounts), considering a range of equipment costs and a range of potential benefit levels for Tampa. Many of the potential benefits can be quantified financially, based on reduced workloads and associated cost reductions. Some are well documented in other business cases and may create eventual financial savings for the city, but are difficult to quantify in Tampa's current situation. Still others can be characterized as "soft" benefits that can only be weighed subjectively against the net costs of AMI in order to support the city's decision regarding implementation of AMI.

Recent customer leak issues and related high bill complaints have caused Tampa to move from the prior practice of bi-monthly meter reading to monthly reading. The estimated additional cost of this decision is $826,000 annually. Since monthly reads have become the policy, AMI is compared financially against the city's costs of operation, including this recent addition.

The financial evaluation of AMI identifies capital costs as well as achievable annual operational savings. Capital costs are amortized over 15 years to correspond with the expected life of the electronic field components, which comprise the majority of the system infrastructure. The amortized capital cost and operational savings then can be represented as a net savings or net cost per meter per month.

If the operational savings outweigh the capital costs, AMI represents an investment that provides a financial return, even if only in the readily identifiable financial benefits. If the capital costs outweigh the operational savings, the city must weigh other potential benefits—soft benefits, as well as benefits that may be realized when the city's circumstances change—against the net cost of AMI to decide if implementation is warranted. Utilities often decide that the customer service benefits tip the scale toward AMI.

Table 1 identifies the costs, savings, and net per meter per month amount for full-scale implementation of AMI in Tampa, based on a conservative set of assumptions. As shown, transitioning to an AMI system from the recently adopted practice of monthly manual meter reading would result in a net cost per meter per month (over and above the $0.47 recently incurred as a result of the transition to monthly meter reading) of between $0.38 and $0.74.

Subject to market fluctuations, the commodity nature of AMI components implies that capital costs are relatively certain. While the precise cost depends on factors such as contract risk assignment, feature selection, and delivery and financing method, the val-

Table 1: Summary of Costs and Financial Benefits
(Full Deployment for All Metered Accounts)

	Recent Conversion to Monthly Reading	Conversion to AMI from Manual Monthly	
		Conservative	Less Conservative
Capital Cost	n/a	$32.3 million	$30.1 million
Capital Cost on a per-meter per-month basis	n/a	Additional $1.72	Additional $1.60
Expected Annual Operating Cost	Additional $826,000	Savings of $1.7 million	Savings of $2.1 million
Operating Cost on a per-meter per-month basis	Additional $0.47	Savings of $0.98	Savings of $1.22
Net Present Value Cost of AMI (cost less benefits)		$16.7 million	$8.7 million
Net Per-Meter Per-Month Cost	Additional $0.47	Additional $0.74	Additional $0.38

ues shown in Table 1 should fairly approximate the contracted cost Tampa would incur for the initial implementation. The operational savings associated with AMI, however, depend greatly on the city's internal ability to implement the identified organizational changes. The city staff's contributions to the business case in this regard were crucial in developing these estimates.

The transition to AMI must be planned and managed carefully to ensure that costs are contained and savings are realized. Planning will entail fully defining the desired outcome and identifying the needed departmental involvement and organizational impacts of the transition. A well-managed AMI implementation will include a unique procurement, changes in staff roles and responsibilities in many areas of the organization, and extensive internal communication and public relations.

Objectives

Primary objectives for considering a new metering system include improving the effectiveness of the city's meter reading and customer service operations and enhancing the city's service to its customers. AMI can help accomplish these objectives by:

- Reducing labor and vehicle costs, along with human error associated with routine manual meter reading.
- Downloading all the meter readings in every billing cycle quickly so bills can be generated rapidly, enabling the city to notify customers proactively about abnormally high consumption (such as that caused by leaks), before several weeks of consumption have accumulated into a large bill.
- Eliminating the difficulties and risks associated with reading difficult-to-access meters.
- Reducing theft of service by enabling the city to observe evidence of possible theft (tamper flags, sudden decrease in consumption between regular billing dates, etc.).
- Continuously monitoring accounts that have been shut off to ensure they stay off.
- Creating greater customer awareness of water consumption habits, leading to conservation improvements.

When implementing an AMI system, Tampa would replace older meters through the meter replacement program. This practice provides added benefits of increasing revenues, reducing the city's non-revenue water and also reducing the extent to which customers with new, accurate meters subsidize customers with older meters that do not register all the water going through them.

Any new meter reading system that the city acquires should: 1) provide benefits (financial and/or qualitative) equal to or exceeding the costs of the system, 2) remain reliable over its entire service life (15 years or more for the electronics), and 3) avoid technological obsolescence during its service life.

Alternative Strategies

The city of Tampa supplies water to more than 146,000 customer meters. All of its customers are metered, and meters are installed outdoors in meter boxes and vaults. The city has approximately 1,000 meters that are very difficult to access because they are located in locked back yards. These customers have been directed to read their own meters.

Several options are available to improve meter reading and customer service. Understanding the limitations and benefits of each option helps to focus the discussion of the city's alternative strategies.

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Continue Current Operations

During the course of this business case evaluation, Tampa transitioned from bi-monthly meter reading to monthly meter reading, using an outside contractor to collect the additional readings. The contracted cost per additional read is $0.56, and staff estimates that managing the additional data will require a total of six additional staff members in the call center, field service, and billing area. The net result is an additional cost over prior bi-monthly meter reading operations of $826,000 per year. When averaged across the city's entire meter population, including those read by the city's own staff, this additional cost translates to $0.47 per meter for each monthly reading and billing.

The "no-change" option is that the city continues to physically read meters every month in accordance with this recent decision. No additional investment in staff or technology would be required, so monthly manual meter reading is used as the baseline for evaluating an investment in alternatives.

Mobile AMR

Tampa could invest in mobile AMR, which would mean that over 99 percent of the meters would be read by meter readers driving throughout the service area with portable radio-based meter-reading devices.

Meter data collected by this method could include not only readings, but also data flags indicating leaks or tampering that is detected between readings; however, the flags are not known to the utility until the reader drives by (i.e., monthly). Also, gathering more detailed information about consumption (such as very frequent readings to describe consumption patterns for meter sizing, to detect specific wasteful use patterns, or to describe leaks) would require a separate trip to each subject meter.

In recent years, many larger water utilities—including Washington, D.C.; New York City; Toronto; Cleveland; and San Francisco—have rejected mobile AMR, having determined that the cost differential between mobile AMR and AMI systems is relatively small compared to the additional benefits AMI offers when deployed across the entire service territory. Mobile AMR is perceived to be an inferior choice for utilities anticipating that future opportunities and requirements will be placed on their customer service operations.

Fixed Network AMI

The city could elect to install AMI equipment and the fixed network communications system that allows meters to be read without routinely deploying meter readers. Fixed networks are somewhat more expensive than mobile systems, but in exchange for higher cost they offer greater operational savings and a richer customer service experience.

These networks can enable the utility to gather a great deal of water-use information quickly, such as detailed descriptions of changes in a customer's consumption patterns that could indicate leaks, and to share that information proactively with the customer, thereby reducing customer inquiries. They also can provide the communications network for other water operations data functions, such as water main leak detection, backflow monitoring, or pressure monitoring.

The economic models presented in this article are based on cost estimates associated with a fixed network solution because it is the only alternative that can provide the operational and customer service benefits sought by the city.

Comparison of Existing & Alternate Scenarios

This article presents the business case comparing manual meter reading processes with the costs and benefits of a prototypical fixed-base network system, or AMI. The business case was developed from two perspectives: 1) using a more conservative set of assumptions to illustrate the effect of current uncertainties on the costs of implementation and operational savings and, 2) using less conservative assumptions. The result is ranges of potential costs and savings, with greater costs and lower savings being associated with the more conservative perspective.

The business case includes the principal components of a quantitative economic analysis of costs associated with AMI deployment and the resultant benefits that readily lend themselves to quantitative measurements, along with consideration of additional benefits realized from AMI utilization that are not as readily quantified with a dollar value.

The second component can be divided into two groups: 1) "soft" benefits, which typically result in subjectively valued customer service improvements and 2) engineering and operations improvements that eventually may become financially quantifiable, but for which current city circumstances do not provide support to quantify. The following sections present a summary of the quantitative economic analysis and a review of the other potential benefits AMI provides the city.

Quantitative Economic Model

The quantitative comparisons are based on installing the proposed AMI systems over a three-year term and phasing in the benefits of the systems over the installation period. The three-year timeframe is deemed the optimal installation period for the following reasons:

An aggressive installation schedule (shorter than three years) requires comprehensive management, including a reliable mechanism for expediting the resolution of contract management issues, adequate staffing for field installation support and oversight, and intense change management within the utility and with the public. For a utility the size of Tampa, and with the changes anticipated by transitioning to AMI, a timeframe much shorter than three years would be overly aggressive.

On the other hand, completing the transition more quickly would enable the utility to enjoy the benefits of the new technology more quickly. Although not recommended for planning purposes, the potential savings associated with a faster implementation could be investigated during the procurement process, should installation contractors express interest.

There are disadvantages to making the installation process longer than three years. First, installation contractors prefer to move faster, making the most of the contract management staff they need on-site, lowering project overhead costs and thereby creating economies of scale and generally lower per-unit installation costs. Second, installation contractors proposing on a longer-term implementation would likely submit higher unit prices to reflect the impact of inflation on their prices for material and labor.

Third, the project management in the city itself may not benefit from a longer timeframe. Longer timeframes increase the likelihood of turnover of critical staff work-

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ing directly on the project, and of loss of critical support for the program at other levels of the organization. Finally, taking longer would delay realizing the savings in operating expenses and the increases in revenues.

Meters

More than 97 percent of the city's more than 146,000 meters are one inch or smaller, and 99 percent of the meters are manufactured by Neptune Technology Group. The economic service life of a meter is a function of its accuracy decline (which is related to water quality, total usage and usage pattern), the cost of water (which influences the value of under-registration), and the cost of the meter and the labor to replace it. Typical economic lives for small meters among U.S. water utilities range from 12 to 25 years.

Tampa's research into the accuracy of its own meters reveals an unusually high rate of wear and degradation among the small meters. In 2002, the city initiated a test program to assess the accuracy of representative samples of its 5/8-inch and one-inch meters at American Water Works Association standard low, medium, and high flow rates (0.25 gpm, 2 gpm, and 15 gpm, respectively). From the weighted average rate of registration for meters in each age group, the city determined that meters over eight years old can be replaced cost effectively.

Based on these findings, the model presumes that three-eighths of Tampa's meters would age beyond the eight-year mark during the AMI implementation project, so these would be replaced as part of the AMI system installation. The balance of the small meters must be retrofitted with new registers as part of an AMI installation because the current registers are designed to be read visually and don't include the electronic interface required for AMI.

While fewer than 3 percent of Tampa's water meters are over one inch in size, they generate 60 percent to 70 percent of water revenues. The city has established regular, frequent schedules to test large meters for accuracy, so for this AMI project evaluation it is assumed that no meters larger than one inch would be replaced, and accordingly the financial model assumes no additional revenue generation resulting from replacing the older large meters.

The increased revenues associated with replacing the oldest and least accurate meters during an AMI installation would be $152,000 annually.

Each meter would require a meter interface unit (MIU). Since Tampa's meter pit lids are nearly exclusively cast iron (which is sub-optimal for radio signal transmission and also costly to modify), all lids would also be replaced with plastic or fibrous concrete lids. In the conservative model, the cost of replacing a meter register and installing an MIU is $42 for a 5/8-inch meter, by far the predominant size in Tampa's meter population. While this figure is reasonable based on national experience, local circumstances and the city's recent experience indicate that this estimate may be high.

The less conservative version of the model assumes a price of a meter register and MIU installation is $25. This figure reflects recent contracting experience in which Tampa paid $17 to $18 per meter in replacement costs, which elsewhere may cost double that amount. During AMI installation, the city could avoid some of the current costs of its meter change-out program.

Tampa would need to purchase meter-reading equipment, which would include data collection units (DCUs) installed throughout the service territory. Some companies design systems to use fewer DCUs by making more powerful MIUs that are capable of transmitting data over greater distances and by making more sensitive DCUs that can collect MIU data from a greater distance. Other companies have developed what they believe is a more cost-effective solution by providing less sensitive and less powerful DCUs. While more of the less sensitive devices are needed to cover the service territory, the unit price of the DCUs and their installation requirements are less expensive, yielding a lower cost system as a whole.

The best specific solution for Tampa would be determined after actual proposals and prices were submitted by bidding contractors. The economic analysis presumes one (of the less costly variety) DCU for each square mile of the service territory.

The meter reading system would also include a computer and software for running the network; portable computers to maintain and program meter interface units; and a meter data management system to store, control, and use the very large amount of data an AMI system generates.

Staffing

AMI deployment requires a project management team for the duration of the installation period. The team would include six to seven people, including three to four field inspectors checking installations and resolving problems. These staff members would control the quality of the data generated by the AMI installer and resolve problems at customers' premises. Associated costs include office and field staff, as well as vehicles. The project could be managed by a specialized third-party contractor or by in-house staff.

Many utilities are constrained from hiring additional staff, they may be constrained competitively when attempting to hire specialized new personnel, or their existing staff is already fully committed to current assignments. Using a third party to perform contract management would still require some in-house staff to handle customer issues associated with the project, such as consumption true-ups.

The Tampa call center has undergone significant changes within the last year. A total of 20 call center staff from different centers were consolidated into one center, with the ultimate goal of cross training staff to handle a wider variety of calls. Eight staff members are associated with water customer service inquiries, and two more are being added to support the recent conversion to monthly meter reading. The call center receives 1,400 customer service calls per day.

SAIC led a workshop with Tampa staff members to review the flows of work handled by the call center and to explore how that work would change if AMI were installed system-wide and integrated into the city's business processes. The staff reached the following conclusions for the four categories of calls typically received:

- Payment-related calls, currently using 25 percent of the call center staff resources, would be reduced by 5 percent.
- High-bill complaints, currently using 25 percent of the call center staff time, would be reduced by 45 percent.
- Calls related to changes in occupancy would be unchanged, although the calls for turn-offs and turn-ons would require fewer field trips because the city would monitor the accounts electronically instead of turning them off.
- General topic calls would be modestly reduced.

In summary, participants at the workshop concluded that the call center workload would be reduced by 15 percent compared to the workload experienced under the prior bi-monthly meter reading operations. This lower workload would result in a staff reduction to seven people (conservatively). The less conservative model reflects a reduction of staff to five people.

The customer service representatives would be able to access detailed consumption data that would enable them to explain a customer's water use patterns precisely during an initial telephone call, possibly resolving the inquiry without needing to perform (and wait for) field investigations. Also, AMI systems would alert the city to suspected customer leaks, enabling the city to notify customers of a potential problem before it becomes a high bill and generates a customer service complaint.

The workshop also produced the following conclusions about the field staff workload:

- Currently 1 percent of cycle bills, or approximately 50 cases per day, are referred to the field staff for investigation. These cases generally involve verifying a meter reading or gathering a reading if none was gathered for billing. In the discussion about the implications of AMI, workshop participants felt that 95 percent of these orders would be eliminated, saving the equivalent of one full-time position.
- Field staff workers are assigned approximately 250-300 orders per day to visit properties to turn off water service, turn it back on, or read the meter. These work orders are created in response to changes of ownership or occupancy, although some of the orders to turn water service on are in response to a payment made on an account that had been turned off for non-payment. Workshop participants felt that these orders would be reduced by 50 percent if Tampa used AMI systems to monitor accounts for unautho-

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rized water use. Each field worker completes up to 50 orders per day, so the savings would be the equivalent of three positions.

- Field staff workers in the collections unit shut off services to delinquent accounts. Workshop participants concluded that AMI-based monthly bills and faster leak detection would reduce some payment problems because surprising large bills would be less frequent; they estimated that the workload would be reduced by one person.

These field work reductions result in a total staff workload equivalent of five full-time positions. The less conservative model estimates these reductions at a total of seven full-time positions. The total savings in staffing was projected to be between 25 and 32 full-time positions.

Additional Benefits of AMI

In addition to the quantifiable reductions in workloads that would be created, the fixed network and the detailed consumption data would benefit the city in areas that are not included in the economic and financial evaluation described previously. These factors, though not possible to quantify precisely, are significant both in fashioning the relationship with Tampa's customers and in improving the management of the city's water distribution system, which eventually may yield additional quantifiable financial benefits.

Managers of water utilities that have implemented AMI systems are quick to point out that their systems have improved customer service and customer satisfaction. Despite the difficulty of measurement, competitive companies recognize the value of customer service, and in competitive industries, good customer service encourages loyalty and increases revenue. For water utilities, whose customers are "captive," it is harder to correlate customer service with revenues or costs.

Water utility customers, however, clearly appreciate good service. AMI enables the city to improve customer service levels and levels of satisfaction substantially by providing:

- Frequent (monthly) bills based on error-free actual meter readings.
- Near-real time notification of leaks and tampering.
- Online access to detailed descriptions of water use to help identify wasteful water consumption and help educate customers about their consumption.
- Customer choices about billing frequency, and even the time of the month that bills are created.
- New services such as submetering (for stores or buildings in a complex, or for deduct meters), which the city might provide reliably and at low marginal costs with AMI in place.

Customers' attitudes come into play through the political or regulatory process when the utility has to raise rates, undertake needed infrastructure improvements, annex new service areas, or inconvenience customers for street openings for repairs. Utilities with poor customer service have experienced difficulty in obtaining needed approvals, while utilities with high levels of customer service are seen as valuable assets to the community. While difficult to quantify in monetary terms, good customer service does lower the cost per customer of providing service and improves employee morale and turnover.

AMI data could be used to enable or significantly enhance conservation efforts targeted at high demand periods, and the city could lower the maximum day water demand as a result. This is not considered a quantifiable benefit because it reduces revenue from a consumption-based rate structure, but conservation earns significant goodwill with many populations. Conservation benefits of AMI could include:

- Monitoring and enforcing alternate-day sprinkling bans and time-of-day outdoor use limitations.
- Establishing peak demand pricing and using AMI to measure the water used during the various rate timeframes.
- Analyzing customer consumption data in order to educate customers about optimal irrigation practices.
- Enabling customer-specific water budgeting.

Several potential benefits which may be quantifiable financially in the future are related to non-revenue water (NRW): the difference between the amount of water introduced into the distribution system and the total amount of water billed as consumption. It reflects leaks, theft, flushing and other hydrant use, and meter inaccuracies. Tampa's current NRW is approximately 10 percent of production, which is not outside the normal range for utilities of its size, but that percentage corresponds to more than $15,000 per day of lost water on a revenue basis. AMI potentially could reduce that loss.

AMI data could enhance meter right-sizing programs and meter wear detection. These improvements will maximize registration and revenue, as well as optimize the investment in water meters to ensure that the meters are not too large (thereby under-registering flow) or too small (thereby wearing out prematurely from overuse).

A fixed network system could offer support for acoustic leak detection devices that can provide the utility with the earliest possible notification of a perceptible change in system acoustics, indicating a possible leak near installed monitors. Finding leaks when they are small or non-surfacing could provide huge savings where service lines or mains are prone to joint and small corrosion leaks. Systems where the surface and subsurface conditions keep leaks hidden (such as sandy soil) could benefit substantially. If a leak is identified promptly, it typically costs less to repair, having done less damage during a short-duration flow.

Proactive leak repair could also be performed during regular working hours, reducing costs. Installing AMI equipment on fire meters or bypass meters on detector checks could allow close monitoring of fire lines to detect leaks or theft.

AMI enables mass balancing with district metering. The American Water Works Association's *Manual on Water Audits and Loss Control (M36)* promotes district metering as a best-practice method to reduce leakage. By observing flow during the off-peak period and contrasting that with expected minimal consumption by customers, the net background flow could be calculated.

With AMI, the customer demand for any geographic area could be measured for specific periods of time and analyzed relative to district meters. If the net flow, assumed to be leakage and other forms of non-revenue water (e.g., theft) were high, field staff could focus on that area to reduce non-revenue water. Like acoustic leak detection, district metering coupled with detailed customer meter data could be helpful in finding non-surfacing leaks by concentrating investigations where there is meter data evidence for them.

AMI provides a number of benefits through its ability to support monitoring of daily peak and off-peak consumption. Some utilities are considering imposing peak demand charges on some customers to encourage them to reduce water demands and related pumping costs during periods of high demand or high energy cost. Administering such rates and providing monitoring and feedback to customers in real time requires AMI.

AMI data could be used to improve demand forecasting because it allows access to detailed consumption data, enhancing the ability to analyze demand from various classes of customers. Detailed consumption data aids in determining not only how to meet future peak demand, but potentially how to reshape it through conservation efforts like time-of-use billing. By doing so, the city could more accurately size and schedule replacement or expansion of mains, tanks, pumps, and additional water production facilities—and perhaps wastewater collection and treatment facilities, as well.

AMI data could be used as an energy management tool. Energy for pumping is the largest significant component of the cost of water service, so better managing energy use may provide significant savings. Many electric utilities impose peak kilowatt demand charges as well as peak and off-peak kilowatt-hour charges on their large customers, which include water utilities. When subject to such electric utility rate schedules water utilities are motivated to reduce peak energy requirements, especially if they coincide with the electric utility's peak rate periods.

Water storage management and pump scheduling commonly are used to reduce peak energy use. To maximize capacity and minimize pumping costs, distribution system storage is replenished during off-peak hours that coincide with lower electricity costs; however, during periods of high demand or if distribution system storage is constrained, the higher energy costs still could be incurred. The challenge is to avoid compromising the ability to deal with fire-fighting, unusual customer demands, and main breaks or other interruptions of service. Better information about the patterns of water use could allow the city to optimize the use of storage reserves and pumping without compromising operational reliability.

AMI could provide potentially significant information about reverse flow at meters that could alert the city to water distribution system issues, meter errors or inappropriate customer activity. Reverse flow detected by a meter or an AMI system may be caused by four possible conditions, all of which should be of interest to the city: back-siphoning caused by pressure changes in the distribution system; backflow caused by an intentional or unintentional increase in pressure on the customer side; meter tampering or improper installation (where the meter is reversed in its setting); or failure of the meter or the MIU to transmit correct readings, usually caused by programming errors in these devices.

If Tampa could lower the maximum daily water demand (and/or the peak-to-average ratio), it might be able to design new capital facilities slightly smaller, or postpone certain capital projects and extend the life of existing infrastructure. Every year the city could postpone the construction, annual financing costs would be saved.

Conclusion

The presently quantifiable financial benefits of an AMI implementation in the city of Tampa do not, in and of themselves, outweigh the capital costs when amortized over the useful life of the needed AMI infrastructure. The anticipated net cost of AMI, ranges between $0.38 and $0.74 per meter per monthly bill. The city must determine if this cost is worth the additional benefits that are not yet readily quantifiable.

These additional benefits are significant, and other water utilities have judged them to offset sufficiently the net cost of AMI implementation. They include: improved customer service, including additional service offerings; substantial reduction of high bills and a resultant overall increase in customer satisfaction; opportunities to implement a number of innovative conservation tools, which would increase goodwill among regulators and certain customer populations; collection of detailed data that would enable more targeted reduction of non-revenue water, an issue that costs the city more than $15,000 per day; the ability to detect flow reversal in the distribution system quickly, supporting distribution system analysis and public safety; and the ability to analyze and influence peak demands to more appropriately size and schedule capital projects.

Should Tampa choose to proceed with AMI, a number of the above benefits could provide significant financial benefits in the future, which may even result in a positive return on the capital investment.