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# Smart Metering for Water Utilities

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## Introduction

Should water utilities replace current consumption meters with “Smart Metering” systems that provide more information to customers and utilities?

As drought and population growth sharpen the focus on water issues, utilities, environmental groups, and government bodies are increasingly looking to Smart Metering to:

- Help customers better understand their water use and curb waste.
- Identify leaks.
- Underpin new rate and regulatory programs that respond flexibly to community water needs.

This paper helps water utilities, regulators, and policymakers understand the ways Smart Metering can contribute significantly to water sustainability. It also illustrates many of the ways technology, middleware, and software help maximize the value of Smart Metering data to all stakeholders.

## Smart Metering Defined

In today's global water industry, Smart Metering generally indicates the presence of one or more of the following

- Interval meters on customer premises that measure consumption during specific time periods and communicate it to the utility, often on a daily basis. While in the electric industry, measurement intervals can be as short as every 10 or 15 minutes, water intervals of 30 to 60 minutes or longer generally provide adequate information.
- A communications channel that permits the utility, at a minimum, to obtain meter reads on demand, to ascertain whether water has recently been flowing through the meter and onto the premises, and to issue commands to the meter to perform specific tasks such as disconnecting or restricting water flow.

Smart Metering may also include:

- At the customer site: an easy to read display. It helps customers check for leaks, reduce consumption, and monitor compliance with local restrictions.<sup>1</sup>
- At the utility: additional data collection and processing software, such as a meter data management application. This isolates the existing billing system from the increasing meter data volumes that smart metering introduces.

IT Infrastructure to Look For:

- A meter data management application that can validate, format, and store a high volume of meter reads and provide billing determinants to a customer information system.
- A gateway through which various applications can send orders to a meter. For instance, a customer service representative needs a path through which to order and receive a customer's final meter reading during the few short moments that the customer is on the telephone.

## Smart Metering vs. AMR

Smart Metering provides more detailed information than does the older, related Automatic Meter Reading (AMR) system. In AMR, meters communicate their monthly or daily consumption totals to a central collector using one of a number of different communications techniques, such as radio signals, power-line communications, or satellite reads. In other words, they are designed to replace house-to-house meter readers with centralized collection.

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<sup>1</sup> Utilities can also provide information to customers via web portals and detailed printouts.

Smart Metering, in contrast, uses more robust communications channels controlled from a central point and readily available on demand. It accommodates interval data collection—not merely simple totals—and facilitates delivery of a wide variety of services, such as remote disconnects and checks to ensure that service is currently available.

That said, water utilities are increasingly looking to AMR to provide a first step towards Smart Metering. By reading AMR meters once or twice daily, they can use the reads as 12 or 24 hour “intervals.” These measurements can be effective in some conservation programs, such as leak detection and providing information to customers.

## Why Use Smart Metering?

### Information to the Customer

#### **In-Home Displays**

Display devices that show water use in real time help customers detect leaks. While diligent customers may, a few times a year, turn off all water and check an outside meter to ensure there is no flow, most meters are deliberately located in out-of-the-way areas that make it hard to detect new, small leaks. A conveniently located on-premises monitor can help a customer notice a leak because, for instance, the reading is higher in the morning than it was at night even though in theory no water was used in the day.

Displays located prominently serve as a constant reminder about the need for water conservation. They can help parents build games for children around the readings aimed at teaching water-conservation habits. They also enable jurisdictions to win customer compliance with water-use advisories or restrictions, such as a weekly maximum use per occupant.

Preliminary investigation indicates that customers with displays are more likely to use less water. Displays tailored to the specific needs of the user, such as those comparing current water use with neighborhood averages or with consumption in previous months, may help consumers further focus on conservation.

#### IT Infrastructure to Look For:

- A meter data management and/or customer information system that can process data rapidly so as to provide timely data to customers.
- A customer information or portal system that can format data into charts and tables that customers can readily understand.

#### **Computer Portals**

Installing monitors at each customer site may come with price tag water utilities find difficult to afford. As a result, many elect less expensive ways to provide consumption details, such as computer websites with individualized portals or even printouts enclosed with bills. Surveys

appear to indicate that customers prefer the on-site display, which provides rapid and easily accessible data. Web portals, however, have an added advantage: they readily link concerned customers to information on how to lower consumption and/or bills.

### Effectiveness

Because Smart Metering is a relatively new phenomenon, information about the long-term effects of providing detailed consumption to water customers is not yet available. Preliminary information is available, however, for electricity.

- Two electricity consumer surveys, for instance, indicate a strong consumer preference to receive more detailed consumption information from their electric utility.<sup>2</sup>
- The results of “The Effectiveness of Feedback On Energy Consumption,” a study performed by the Environmental Change Group at the University of Oxford, indicates that electricity consumers receiving direct feedback from smart meters reduced consumption by 5 percent to 15 percent, while those receiving indirect feedback reduced consumption up to 10 percent.
- A real-time feedback pilot at Hydro One in Ontario Canada achieved an average aggregate electricity reduction of 6.5 percent<sup>3</sup>.

### Information to the Utility

Utilities can use time-of-use or interval data to:

- Detect customer-premises leaks.

Leak detection for households is relatively simple. Leaks or faulty plumbing are the most likely culprits if hourly usage never drops to zero. Utilities can use more sophisticated algorithms, generally available from software vendors, to identify possible leaks at commercial and industrial properties with round-the-clock water use.

Preliminary experience indicates that substantial numbers of customers will sign up for voluntary leak notification if utilities offer it and will provide telephone numbers or email addresses where utilities can send automatic alerts. In communities with serious or growing water issues, mandatory notification may become the norm. In many cases, it appears,

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<sup>2</sup> Gartner’s Utility Consumer Survey: Energy Efficiency, Do They Care and Why, May 6, 2009; and Oracle’s Turning Information Into Power Study, March 2009.

<sup>3</sup> Hydro One. 2006. “The Impact of Real-Time Feedback on Residential Electricity Consumption: The Hydro One Pilot.” <http://tinyurl.com/5q4w3u> (or [www.reduceenergy.com/PDF/Summary%20Results%20Hydro%20One%20Pilot%20-%20Real-Time%20Feedback.pdf](http://www.reduceenergy.com/PDF/Summary%20Results%20Hydro%20One%20Pilot%20-%20Real-Time%20Feedback.pdf)).

customers may already know about, for instance, a dripping faucet, but notification from the utility pointing out the cost and long-term community implications can encourage repair. Utility notifications are even more welcome and effective when customers are unaware of leaks in walls and foundations that, left unrepaired, have the potential to damage structures significantly.

As water issues escalate, some jurisdictions are considering fines or penalties for customers who fail to fix leaks.

In regions with competitive or partially competitive utility markets, utilities can use this leak detection ability to offer leak insurance to property owners.<sup>4</sup>

- Detect small leaks in mains.

A utility that compares a day's consumption for a group of customers (such as residences on a block) with readings from a water main serving that block may be able to identify small leaks (or possibly theft) before they become too large to be overlooked.

- Identify the location and extent of a water main break.

Smart meters can activate the communication link to the utility and send “last gasp” messages when they detect a significant drop in pressure.

- Monitor compliance with local water restrictions.

Water utilities and sister municipal agencies in drought-plagued areas may be under heavy pressure to identify possible violations of local restrictions on, for instance, outdoor watering or non-essential water use during daylight hours. Analyses of smart metering data can help them fulfill such public mandates.

The utility's ability to detect leaks is, in some regions, becoming a major financial factor for utilities. Regulators concerned about reducing water waste may establish performance-based incentives for utilities to reduce water loss. The faster utilities can detect, size, and prioritize repairs for leaks, the greater their ability will be to earn these incentives.

#### IT Infrastructure to Look For:

- Integration that links leak detection with a mobile workforce management system so as to automatically dispatch field crews to the sites of suspected major leaks.

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<sup>4</sup> Note that most regulated and municipally owned water utilities are not permitted to develop offerings that would compete with similar commercial products and services. In instances where these are allowed, both regulated and unregulated operations are typically closely scrutinized by regulators to guard against cross subsidization and unfair competitive business practices.

- A customer information system that can compare current meter readings with past and anticipated readings so as to readily identify consumption patterns that may result from leaks.
- A customer information system that, once provided with local use regulations, can be programmed to detect and report likely violations.
- Automatic customer contact systems (email, SMS, telephone) that alert customers to problems.

## Better Services Without Incremental Costs

The costs to implement Smart Metering systems are significant. Once implemented, however, utilities can use them to:

- Obtain off-cycle, “final” meter reads for customers moving or leaving the area. It is common to couple these real-time final meter reads with on-line or credit-card bill payment that enable utilities to collect immediately on bills that might otherwise take weeks or months to reach a relocated customer.
- Remotely disconnect or restrict the flow of meters in regions where this is permitted.<sup>5</sup> Remote-disconnect meters reduce the costs to send field crews to the premises of customers who have either requested a disconnect or who are being disconnected (or ratcheted back) for bill nonpayment.<sup>6</sup>
- Check meter status (“ping the meter”) prior to sending a repair crew in response to a customer call. These checks can sometimes prevent needless field crew dispatch to customer sites where problems are not the utility’s responsibility.
- Remotely detect theft.
- Ensure that almost all bills are based on actual meter reads rather than on estimates; this reduces calls to the contact center and improves customer satisfaction.
- Help control electricity costs for utilities that pump water to a high point during off-peak hours, then use gravity feeds when electricity prices are higher. Utilities that want to avoid turning on the pumps during high-price periods can develop water rates that track electricity rates and thus excess on-peak water consumption. These rates may become increasingly popular as electric utilities institute exceptionally high “critical peak” prices.

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<sup>5</sup> Disconnection is not universally practiced. In the UK, for instance, the Water Act 1991 and NRSWA Section 79/80 prohibit disconnection or flow restriction for bill non-payment.

<sup>6</sup> Note that, unlike smart meters for electricity, smart water meters must be equipped with a separate device in order to control water flow. This increases the total cost of a water smart meter.



- Offer prepayment options to customers without the expense of special prepayment meters.<sup>7</sup>
- Provide feedback to utility staff on the effectiveness of various conservation programs and enable them to make rapid changes.

IT Infrastructure to Look For:

- Customer information systems that accept a variety of different bill-paying methods, process final bills (including prorationing) rapidly, and provide robust support for customer service representatives.
- Customer information systems that can support prepayment arrangements without the need for prepayment meters.
- Customer information or customer relationship management systems that analyze conservation program effectiveness and report results in ways helpful to customers, utilities, and communities.
- Meter data management systems or gateways that link to mobile workforce management systems in order to dispatch crews automatically to the sites of non-working meters.
- Integration between mobile workforce management and asset management applications to ensure the prompt ordering of replacements for non-working meters and automatic applications for refunds for failed equipment still under warranty.
- Project management software that helps minimize the costs to install Smart Meters.

## Issues in Smart Metering

### Locating System Intelligence

There is a continuing debate in the utility industry as to whether smart metering data and data processing should be distributed or centralized.

One side of this debate advocated sending data from smart meters to a central repository where it would be checked for accuracy and stored. The data can then be made available to various processes such as billing, outage reporting, forecasting, asset management, water conservations, and analytics. It can also be exported to web portals or in-home devices to better assist customers in assessing and planning consumption.

Others suggest distributed processing to facilitate immediate feedback to customers who can use the data to make decisions about water use. Various display devices and home area networks incorporate some data processing to provide not only real-time consumption totals but also alerts, usage comparisons, historical perspectives, and cost estimates.

It now seems clear the data from smart meters will be used in both a distributed and centralized manner. Centralized data brings the advantages of cleaned data to supply many business and

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<sup>7</sup> For an explanation of how such programs work, see the Oracle Utilities white paper *Serve Prepaid Customers Without Prepayment Meters*.

operational applications in a utility as well as serve as a base of data for analysis. Distributed data provides the consumer with timely feedback and can also be used to control home appliances.

## Hidden Costs of Smart Metering

Many smart metering costs are obvious. It is relatively easy to estimate the costs for smart meters, two-way communications infrastructure to facilitate communications to the smart meter, a meter data management application to do the initial processing of the meter data and store it in a central repository, and the integration necessary for utility applications to utilize the data.

Less immediately apparent are costs to:

- Add technology and infrastructure to implement and support smart meters and the huge volumes of data they generate.
- Modify or replace the customer information system (CIS).
- Expand asset tracking to include such things as smart meter communication capability, software, and firmware version.
- Expand or obtain software to view and analyze the usage data by various utility business and operating functions.
- Obtain or expand middleware and messaging software to reliably handle communications between applications, alerts from field devices, and various data communications methods.
- Upgrade or acquire additional hardware to store and process interval usage data.
- Educate customers about the meter replacement project, including its anticipated costs and benefits.
- Research and design new rate tariffs.
- Retrain existing staff to install and maintain the smart meters and new infrastructure.

### IT Infrastructure to Look For:

- Database, middleware, and business applications that can scale to accommodate exceptionally high data volumes without loss of processing throughput.
- Middleware to monitor and govern security and regulatory compliance.
- Asset management applications that can expand to cover the new equipment and maintenance schedules required for Smart Metering.
- Mobile workforce management applications that schedule meter installation (including coordination with the customer), minimize installation time and costs, and provide field technicians with robust checklists, monitoring, and other support to help them install and maintain the new equipment properly.
- Customer information and/or customer relationship management applications that provide easy ways to communicate with customers and to offer new programs.
- Customer information systems that easily and rapidly implement new rates.
- Customer information systems that support contact center representatives with computerized forms and menus, on-screen help, and business process assistants that help in efforts to explain Smart Metering to customers.

## Managing Meter Data

Smart Metering inevitably increases the amount of meter data utilities must handle. In the residential arena, for instance, hour-long intervals may replace four or 12 annual reads per customer with 8,760. That's a 730-fold increase that many water billing systems will not be able to handle at all.

To solve the problem of too much data, water utilities moving toward Smart Metering increasingly implement a meter data management (MDM) application specifically designed to gather large volumes of data from multiple meter types, store it, and process it according to specific utility needs.

Water utilities can implement Smart Metering without meter data management by channeling data directly to the billing / customer information system (CIS). This frequently proves less than ideal, however. Only a few of the best CIS applications on today's market can handle huge data volumes. And even those that can operate under utility-specific rules that generally place a high priority on getting accurate bills into customer hands so that revenue flow continues uninterrupted. While other departments clearly need the data that the CIS has gathered, they must frequently wait for it until the billing cycle is complete.

Meter data management in contrast, can assign equal priority to all data recipients. It can also perform preliminary processing for each recipient so that individual departments do not deal either with raw data or with data processed according to the needs of billing.

Meter data management's independent service function may be further refined through the addition of a meter data warehouse. In situations where both exist, the meter data management typically manages real-time, transactional processing while the warehouse handles data extraction, reporting, and analytical processing.

Separating the meter data management from the billing solution has clear advantages. It maintains bill production efficiency while providing even-handed data access to all departments. It can reduce the cost of building and maintaining application interfaces. It permits a utility to add security to meter communications and data without complicating customer access to bill payment and analysis websites. And meter data management lets utilities change the source of the meter data with no negative effect on other IT systems and architecture.

### IT Infrastructure to Look For:

- A flexible, high-volume meter data management application that can validate, edit, estimate; and store a high volume of meter reads while providing information to applications across the utility in the formats and timeframes needed.

## The Organizational Implications of Meter Data Management

Meter data management is, for most utilities, a new type of application. It shatters the typical utility IT model in which each department "owns" its own set of applications.

Meter data management treats every department as its "owner." It thus forces departments to work together. If meter data management is to serve all equally efficiently, then the various

stakeholders must share information. They must agree to application configurations that serve all needs optimally.

This process of information sharing is proving eye opening to departmental heads. Suddenly, sharp minds have the knowledge and tools to propose better, more efficient program administration.

In other words, meter data management is becoming an avenue for rethinking utility business processes independent of existing departmental boundaries. It is the first major utility silo-breaking application.

IT Infrastructure to Look For:

- Applications that arrive pre-integrated and/or use standards to facilitate integrated business processes and reduce the long-term maintenance costs of application integration.
- Applications flexible enough to rapidly accommodate new ideas and programs that will inevitably be developed by utility staff.

### **Expanding the Concept**

Meter data management, by providing both unique and common resources to multiple applications, has the potential to advance the quest for multi-departmental business process orchestration. If it succeeds in this role—as it very likely will—other functions may quickly follow suit. Scheduling, for instance, might be pulled out of asset management, field management, and appointment setting and consolidated into a single instance that serves multiple departments.

Meter data management owned cooperatively among departments rather than individually, could thus be the “missing link” that facilitates the smooth flow of business processes across the organization that thus increases the efficiency with which utilities serve all stakeholders.

IT Infrastructure to Look For:

- Integrated applications that can share infrastructure resources.

## **Weighing Smart Metering’s Costs And Benefits**

While discussion of smart metering abounds, many utilities hesitate when they see the large financial commitments involved and the uncertainties of customer response. Will they be able to recover the costs? Will they find themselves on the bleeding rather than leading edge of technology?

Fortunately, there are ways to mitigate the risks involved.

## Including All Potential Benefits

Smart Metering may be hard to cost-justify if it rests solely on lower water use. It is easier to cost-justify when it includes, for instance, the value of:

- Ensuring that all meters are recording water flow following repair of a break in a main.
- Remote programming that enables customers to use new products or services to advance community and environmental.
- Fewer meter readers, which means lower total costs for salary, benefits, and workers' compensation.
- Remote rather than expensive and occasionally risky on-site disconnects or flow restrictions. Consider in this context the current cost of technician time, fuel to transport the crew to the site, vehicular wear and tear, and insurance.
- Less wasted time in attempts to pinpoint the size and source of leaks and breaks.
- Lower risk to public safety from flooded intersections or lack of service to hydrants.
- Better meter reading accuracy, resulting in fewer calls to the contact center.
- Faster theft or other loss detection.
- Lower electricity costs (for those utilities using electric pumps).
- Reduced use of chemicals currently used to treat water that is then wasted through leakage from water mains or via customer-premises leaks from pipes or fixtures.
- Longer lifespans for water treatment equipment.

IT Infrastructure to Look For:

- Gateways that can check on meter operational status and report problems.
- Asset management systems that can analyze meter performance and check warranty status automatically.
- (For water utilities that use electric pumping) Meter data management and/or customer information systems that facilitate time-of-use or demand response programs.

## Valuing Conservation

For most water utilities, the most important Smart Metering benefit is the role it can play in conservation.

As governments and citizens become increasingly conscious of the potential for water shortages, emphasis on conservation increases. While few jurisdictions have monetized the value of, for instance, maintaining aquifer levels, the potentially devastating effect of aquifer depletion is clear. So is over-use of reservoir supply—a situation confronting many regions where droughts are becoming more severe while populations continue to increase.

That does not mean, of course, that water utilities can gain approval for Smart Metering merely by invoking conservation. It does mean, however, that regulators are more likely to value conservation as a non-monetized benefit of Smart Metering.

## Conclusion

There is every reason to believe that Smart Metering will replace most of today's electromechanical metering approaches within the foreseeable future. At today's prices, many utilities are constructing conservative business cases that foresee a relatively short payback periods for Smart Metering investments. Rapidly falling prices and the multiple advantages to both customers and utilities should make the systems even more compelling.

As a result, prudent water utilities worldwide are increasingly factoring Smart Metering into long-term IT and customer-program strategies.



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